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TITLE: Arizona, Southwestern US, Groundwater-Level Network

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Overview of Work

The Arizona Department of Water Resources (ADWR) performed work as an existing data provider with the USGS National Ground-Water Monitoring Network (NGWMN) per Cooperative Agreement Number: #G18AC00086, for the grant period 9/30/2018 – 9/29/2020. Objectives awarded include: Objective 1) to perform work necessary to add a significant number of new sites to the Network that were not previously selected; five sites previously added to the Network under grant completed September 2018. Objective 2) to perform work necessary to maintain current data services to the NGWMN Portal.

As an existing data provider, the following work was conducted:

Objective 1: Expansion of sites by existing data providers.

- Select and classify sites for the NGWMN;
- Provide required data elements for selected sites;
- Populate the NGWMN Well Registry with site and network information;
- Provide water level, lithology, and well construction data between agency databases and the NGWMN using previously established Web Services;
- Document field and data management practices;
- Prepare a brief report documenting outcomes.

ADWR added 40 well sites under this grant to the USGS Network-Portal providing well registry, well construction, lithology, and water level data (see Figure 1.). The selection and classification of 40 real-time continuous and discrete monitoring well-sites per NGWMN (aka Network) guidelines and follow the Agreement statement of work.

Six (6) of the forty sites are within the Colorado Plateau Principal Aquifer (PA), 26 within the Basin and Range PA classification and eight (8) within the "Other Aquifer" classification on the national aquifer map. Fifteen sites provide daily water levels and 25 sites provide annual, monthly or quarterly measurements.

Objective Two (2): Support persistent data service from existing data providers.

- Maintain web services that provide data to the Portal;
- Keep list of sites in the NGWMN Well Registry current;
- Perform routine updates to site information at Network sites;
- Update web services to meet the current requirements.

This includes maintaining existing web services and applying routine updates to existing network sites, removing well sites that are no longer viable and uploading replacement and new well site location per the Agreement statement of work. This technical report summarizes work performed and results obtained during the grant period.

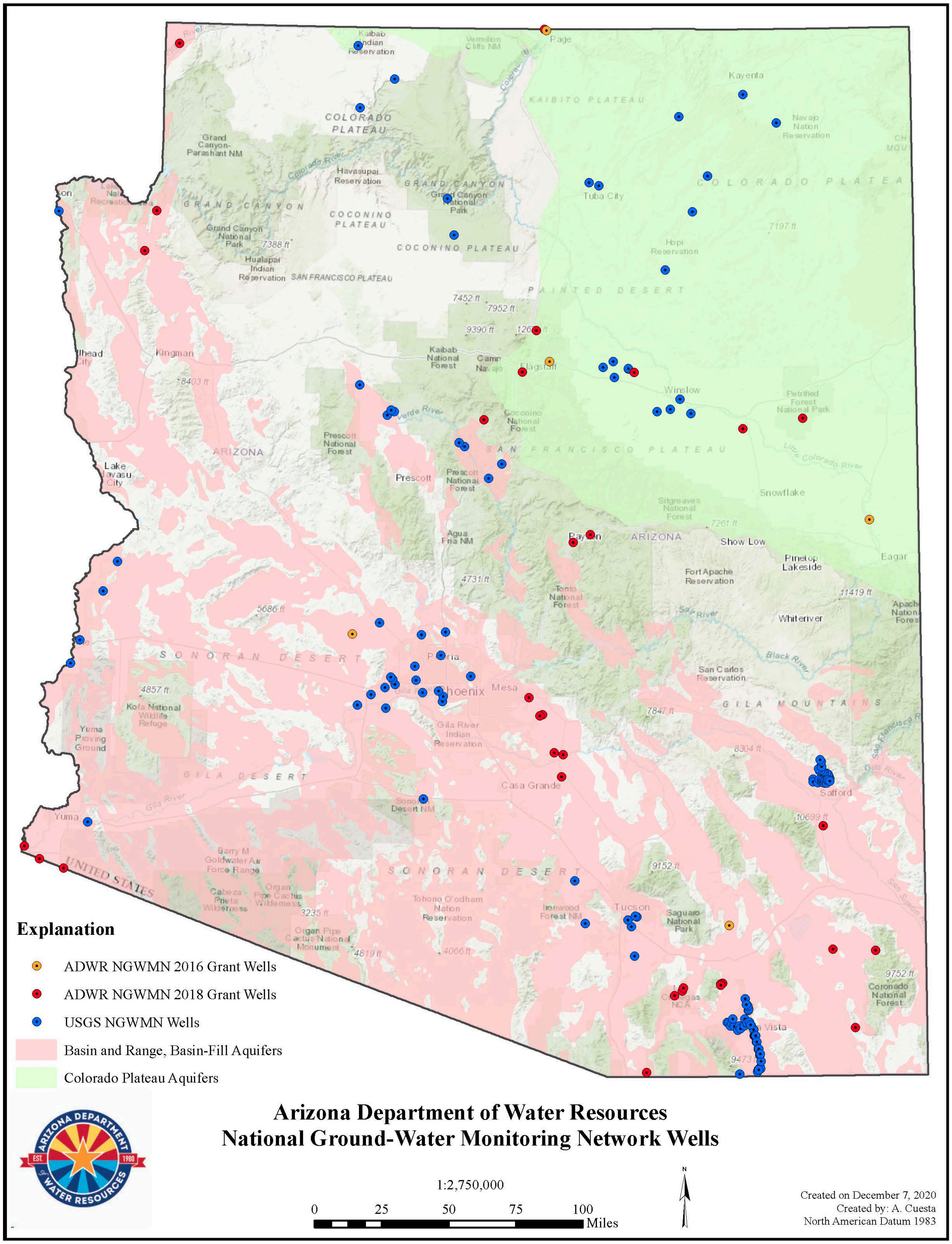


Figure 1. ADWR National Ground Water Monitoring Network (NGWMN) wells.

Existing Water-Level Network

With the establishment of the ADWR in 1980, ADWR assumed lead responsibility from the U.S. Geological Survey (USGS) for the collection of groundwater levels in wells statewide. ADWR's groundwater monitoring program serves to monitor the state's groundwater resources as directed by the Groundwater Management Act of 1980 (the Act). The Act ultimately formed five Active Management Areas (AMAs) and three Irrigation Non-Expansion Areas (INAs) in addition to designating 53 groundwater basins within the state.

ADWR staff adopted and follows all USGS data collection protocols for well and spring site inventories, water-levels, water quality, and well discharge measurements. This provides ADWR data instant compatibility with all USGS historical data. A copy of the USGS Ground Water Site Inventory (GWSI) database was received in the 1980s which ADWR staff has continually maintained and updated by ongoing field investigations and through the statewide network of water level sites (ADWR GWSI): https://gisweb.azwater.gov/waterresourcedata/GWSI.aspx.

ADWR has two primary Oracle databases: 1) as discussed above, ADWR GWSI consists of over 40,000 wells – including cadastral and GPS locations, current and historical water-level measurements and associated information relating to those wells, and 2) the ADWR well registry database, known as WELLS55, required by statute to contain owner-supplied and driller information of wells of record:
https://gisweb.azwater.gov/waterresourcedata/WellRegistry.aspx.

ADWR currently monitors statewide groundwater levels at more than 1,450 wells on an annual basis. Most of these well sites were originally chosen by the USGS and have measurements dating back into the 1940s to 1960s. ADWR also monitors water levels in about 100 wells on a semi-annual basis, more than 100 wells quarterly, 18 wells monthly and approximately 130 wells on a continuous basis with about 80 on real-time telemetry.

ADWR also collects water levels within critical groundwater basins annually during what is known as "basin sweeps". A basin sweep is an extensive data collection effort within a specific groundwater basin to measure water levels both spatially and vertically within basin aquifers to provide a comprehensive picture of the groundwater system. An AMA or INA basin sweep occurs once every five years, with other basin sweeps completed as needed. Using these data, ADWR produces various reports like Groundwater Level Change - Open File Reports (OFR) and various Hydrologic Monitoring Reports (HMR). These and other reports can be viewed here: https://new.azwater.gov/hydrology/e-library.

Principal or major aquifers (as defined by the U.S. Geological Survey, 1995) monitored by ADWR include:

- Basin and Range aquifers (Basin-fill aquifers and Basin carbonite-rock aquifers); and
- Colorado Plateau aquifers (Mesa Verde aquifer, Dakota-Glen Canyon aquifer system, and Coconino-De Chelly aquifer).

With the completion of this Agreement, ADWR has 45 sites provided to the National Ground-Water Monitoring Network (Network). ADWR's initial project to become a new provider in 2016 added 5 sites. ADWR's second project with the NGWMN was in 2018 where 40 new sites were added to the Network and necessary work to maintain current data services to the NGWMN Portal performed.

Description of Site Selection Criteria and Process

Candidate monitoring well sites within principal or major aquifers were considered for potential inclusion in the Network based on the site selection criteria generally described within the Framework document and "tip sheets", (SOGW, 2013): https://acwi.gov/sogw/ngwmn_framework_report_july2013.pdf.

Wells within ADWR's network were evaluated per principal aquifer: Basin and Range basin-fill, Basin and Range carbonate-rock, or Colorado Plateau PA or Other Aquifer classification.

- A review of the frequency of water-level data collection and the period of record.
- A review of all available data for each site was made. Preference was given to sites that have available the minimum data elements found in the Framework document.
- Principal or National aquifer codes for these wells were assigned (see Appendix I).

ADWR water level monitoring sites have historically been selected to provide spatial distribution or coverage within a groundwater basin and to assess vertical gradients where possible. ADWR measures water levels in a wide variety of well types including irrigation, stock, domestic, municipalities, monitor, and unused. Generally, wells that had been selected for "index" well designation (wells that are measured at least annually, with many being measured more frequently) are based on guidelines developed by the USGS Office of Ground Water for the Collection of Basic Records (CBR) Program.

Minimum criteria for monitoring well selection can include:

- Open to a single, known aquifer category (i.e. Principal, Secondary, Local and/or Hydrogeologic Unit).
- Known well construction, including total depth.
- Minimally affected by pumping or nearby pumping and likely to remain so.
- Unaffected by irrigation, canals, and other potential sources of artificial recharge.
- High probability of long-term monitoring for the foreseeable future.
- Well has never gone dry and low probability of going dry due to well construction and aquifer parameters (exceptions may apply to wells used for specific monitoring purposes such as compliance or short-term objectives).
- Up to-date and accurate well site inventory.
- Prior record of water levels exists from sources ADWR, USGS, or BOR and, or has been used in previous hydrologic studies or other published works.
- Lithologic and/or geophysical logs available.

Please note the selection criteria may vary for ADWR GWSI Index wells depending on area specific monitoring objectives. For example, a well may be selected to monitor confined conditions versus unconfined for specific regional data needs. Others may include, but are not limited to, drought specific wells, recharge monitoring wells, flood/event monitoring wells, and other special project wells. See Appendix 1 for wells added to the Network and aquifer assignments.

Site Classification of Subnetworks and Monitoring Categories

Monitoring categories and subnetworks for sites with sufficient period of record were reviewed per Framework document Monitoring Categories "tip sheets", (SOGW, 2013). All forty ADWR Network wells (wells within the USGS Network that ADWR is providing data) are measured frequently, each least annually, therefore falling into the "trend" monitoring category (see Appendix 1., Appendix 2.). Fifteen well sites are measured daily by continuous automated water level devices (pressure transducers), thirteen are measured on a monthly basis by a calibrated water level sounder and twelve are measured on a quarterly basis by a calibrated water level sounder. Six had been measured on an annual basis that now are rescheduled to quarterly measurements also made by a calibrated water level sounder.

Review of hydrographs and well logs (geologic, geophysical, and, or driller) provided the data necessary to determine both monitoring and subnetwork categories and aquifer type determinations. Documented changes are observed within two of the Colorado Plateaus aquifers wells. Suspected changes are observed in the both Colorado Plateaus aquifers and Basin and Range - Basin Fill aquifer wells.

Field Techniques for Water-Level Measurements

ADWR's data collection procedures are consistent with the standards outlined in Appendix 5 of the Framework Document (SOGW, 2013), Field Practices for Ground-Water Data Collection. ADWR's original groundwater level monitoring program was patterned after the USGS management practices, collection protocols, standards, and techniques, specifically Garber and Koopman (1968) and Mann (1980). A copy of Mann's "Operational guidelines for measuring ground-water levels - Arizona District" is provided in Appendix III.

Today, ADWR continues to model field techniques for water level measurements and water level monitoring practices after the USGS (Taylor and Alley, 2001 and Cunningham and Schalk, 2011). ADWR groundwater level data collection protocols and methods, and field techniques for water level measurements, are documented in the ADWR Field Service Section Training Manual which is undergoing final update and revision. Appendix IV contains a final draft version of the Training Manual.

Presently, ADWR uses commercial electric tapes, graduated steel tapes, electric sounders, and a variety of pressure transducers, bubblers, and float recorders with shaft encoders for groundwater-level measuring instruments. All water-level measuring devices are calibrated annually if not more often by a dedicated steel calibration tape that is always kept in the office as a reference; the frequency of their calibration varies depending upon the instrument. See Appendix IV for additional water-level measurement techniques.

Description of Data Quality and Quality Assurance Processes

All field collected data are entered into ADWR's GWSI database through an application that has data quality checks built into the data entry forms. ADWR has updated both versions of ADWR GWSI Database Handbook (ADWR, 2007) and ADWR GWSI User's Guide (ADWR, 2008) which are provided in Appendix V (ADWR, 2020).

Data are quality controlled by standardized field methods and procedures designed to identify anomalous measurements or data. Once all data are entered into ADWR GWSI, information is further reviewed by established protocol for consistency with previous water level trends. Water level change error reports are sent to the Section Manager, Supervisor and GWSI database administrator for review and verification for previous water levels greater than set parameters. Other SOPs such as well site inventory validations and unable to measure procedures are documented with the Field Service Section Training Manual (see Appendix IV).

Web Services - Minimum Data Elements

All well construction, water level, and lithology data contained within ADWR's GWSI database are provided to the Network using web services described below. ADWR has an enterprise in-house application that allows the collection and maintenance of the monitoring data. The infrastructure uses Oracle 12c database on the back-end and both Window-based and web-based client systems. The windows-based application is software written in Delphi and ADWR web applications are ASP.NET C# developments. In addition, ADWR has a GIS back-end database on ESRI´s Spatial Database Engine (SDE) and front-end application developed with MVC. ADWR currently has a web infrastructure in place that allows data sharing using web services. The security for this infrastructure is provided by the State of Arizona firewall as well as ADWR´s firewall. All ADWR data are provided to the NGWMN by this mechanism (see Figure 2.).

ADWR's GWSI Oracle database holds the construction and water level data needed for the services. ADWR's LOGS Oracle database contains the lithology data, aquifer and other water-bearing or hydrogeologic unit information from well logs needed for the services. ADWR already provides data to other entities using web services though Simple Object Access Protocol (SOAP); the web service is called ADWRDataWebService. SOAP, an XML-based messaging protocol defines a set of rules for structuring messages that can be used for simple one-way messaging but are particularly useful for performing RPC-style (Remote Procedure Call) request-response dialogues. ADWR adopted all original data collection procedures from the USGS including the same protocol for establishing a new site from Minimum Data Elements for Site Schedules. Minimum data elements for ADWR Network selected wells were provided to the data portal through the online Well Registry or linked using web services using the tip sheet on populating the Well Registry.

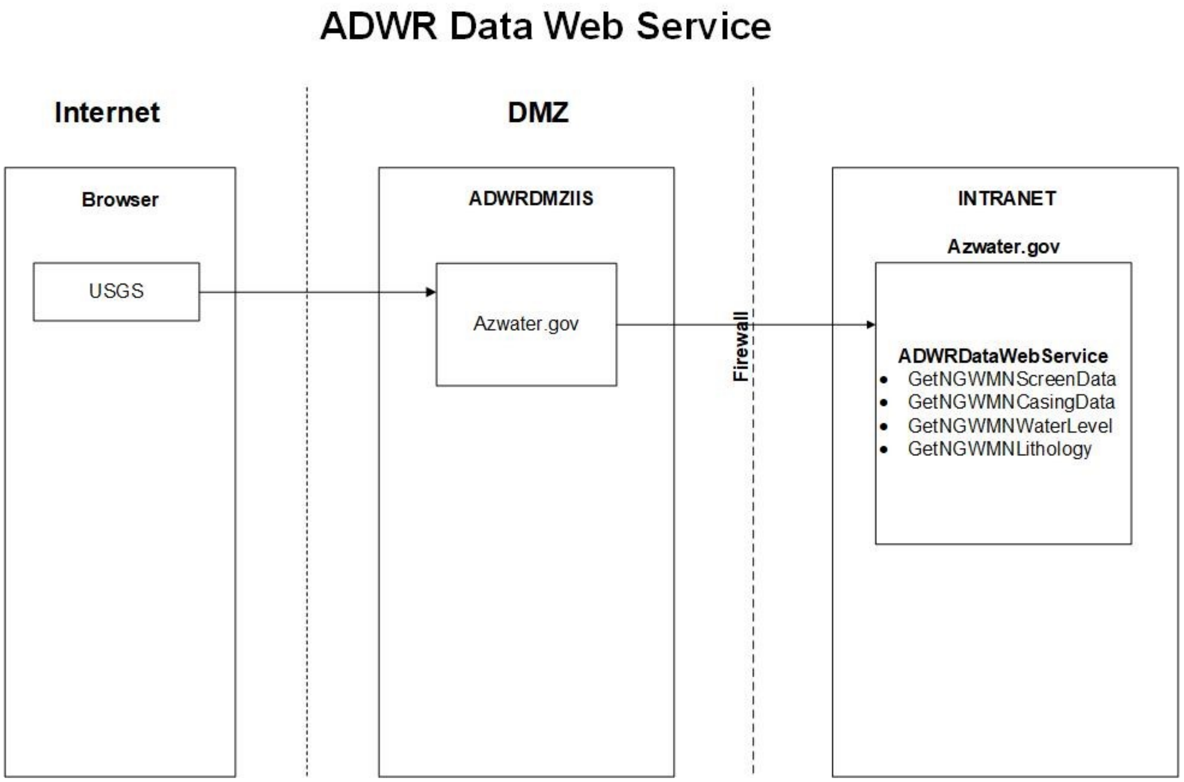


Figure 2. ADWR web service data flow.

The service has 4 methods that provide data for a specific site, they are:

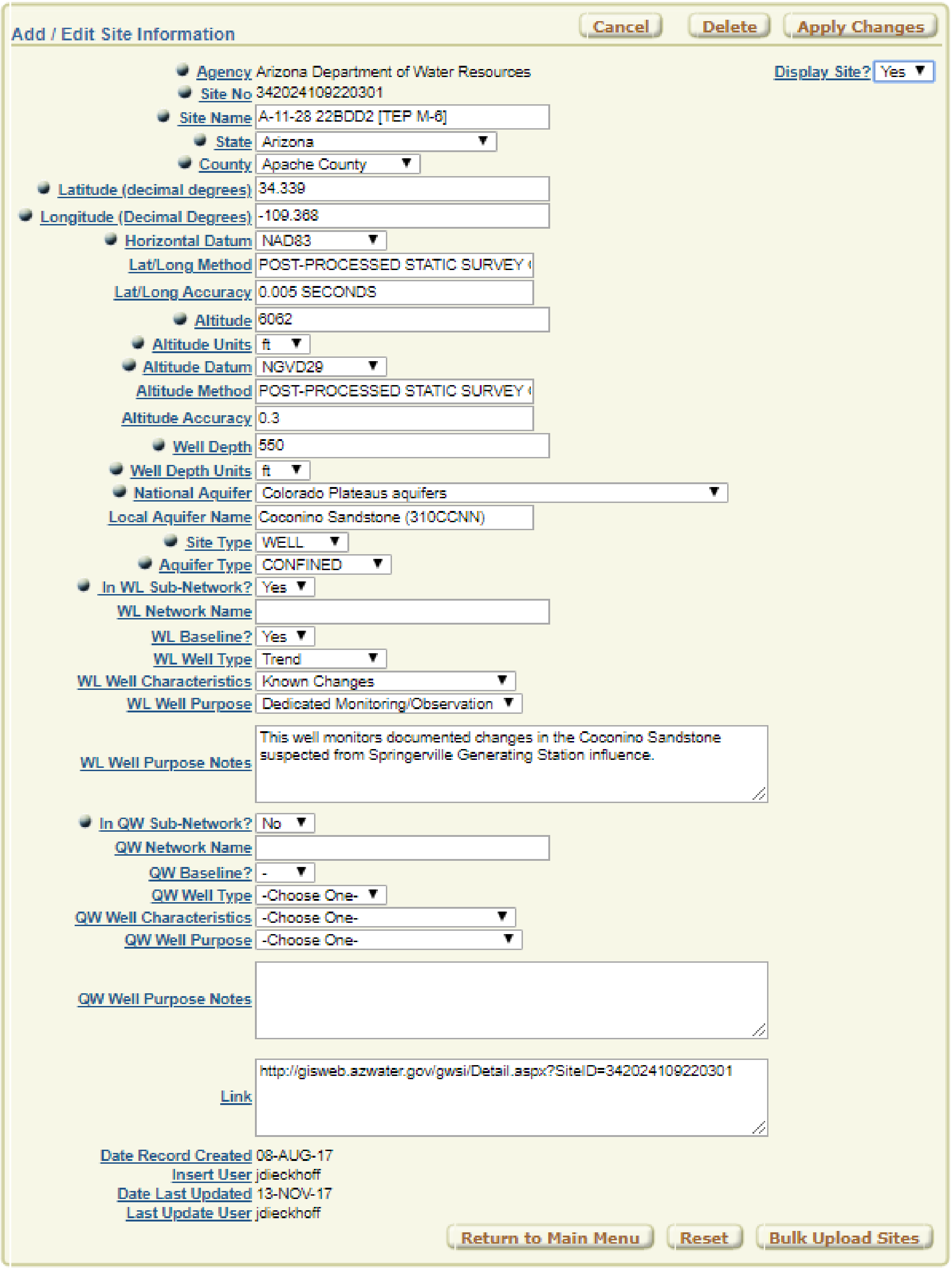
Screening Data GetNGWMNScreenData(string site)
Water Level GetNGWMNWaterLevelsData(string site)
CasingGetNGWMNCasingData(string site)
LithologyGetNGWMNLithologyData(string site)

Each method runs a live query against ADWR's Oracle databases and returns the data. The NGWMN adds our data in the following map: https://cida.usgs.gov/ngwmn/index.jsp.

Intranet Server Specifications include the following:

- Server: Windows Server 2008 Enterprise
  - Code Location:E:\developers\ADWR Data\ADWRDataWebService
  - IIS:Version:6
    - Site:AzWater
    - Application:ADWRDataWebService
  - Data software:Oracle client
- Software: Visual Studio 2017, coded in C# and utilizing the SOAP protocol.
- Database: Oracle 12: ADWR Database Structure

A screen shot of the Add/Edit Site Information screen of the Well Registry for well completed within the Coconino Sandstone Local aquifer of the Colorado Plateaus National aquifer, A-11-28 22BDD2 [TEP M-6], shows the Minimum Data Elements "entered directly into a table in the Portal database which contains Site information called the 'Well Registry'", (see Figure 3).



Add / Edit Site Information

Display Site?	Yes
Agency	Arizona Department of Water Resources
Site No	342024109220301
Site Name	A-11-28 22BDD2 [TEP M-6]
State	Arizona
County	Apache County
Latitude (decimal degrees)	34.339
Longitude (Decimal Degrees)	-109.368
Horizontal Datum	NAD83
Lat/Long Method	POST-PROCESSED STATIC SURVEY (
Lat/Long Accuracy	0.005 SECONDS
Altitude	6062
Altitude Units	ft
Altitude Datum	NGVD29
Altitude Method	POST-PROCESSED STATIC SURVEY (
Altitude Accuracy	0.3
Well Depth	550
Well Depth Units	ft
National Aquifer	Colorado Plateaus aquifers
Local Aquifer Name	Coconino Sandstone (310CCNN)
Site Type	WELL
Aquifer Type	CONFINED
In WL Sub-Network?	Yes
WL Network Name	
WL Baseline?	Yes
WL Well Type	Trend
WL Well Characteristics	Known Changes
WL Well Purpose	Dedicated Monitoring/Observation
WL Well Purpose Notes	This well monitors documented changes in the Coconino Sandstone suspected from Springerville Generating Station influence.
In QW Sub-Network?	No
QW Network Name	
QW Baseline?	-
QW Well Type	-Choose One-
QW Well Characteristics	-Choose One-
QW Well Purpose	-Choose One-
QW Well Purpose Notes	
Link	http://gisweb.azwater.gov/gwsi/Detail.aspx?SiteID=342024109220301
Date Record Created	08-AUG-17
Insert User	jdieckhoff
Date Last Updated	13-NOV-17
Last Update User	jdieckhoff

Figure 3. Minimum Data Elements entered directly into a table in the Portal database which contains site information called the Well Registry.

For the same well, A-11-28 22BDD2 [TEP M-6], the Minimum Data Elements were entered by the following web services script.

Water Levels WebServices Query

```
select 'ADWR' “AgencyCd", s.site_well_site_id "SiteNo", trunc(l.wlwa_measurement_date)
"MeasurementDate", m.code_description "MeasurementMethod", d.code_description "Source", null
"OriginalParameter", 'Down' "Original Direction", 'ft' "Original Unit",
to_char(l.wlwa_depth_to_water,'9,999.99') "Original Value", r.code_description "Remarks",
to_char(l.wlwa_depth_to_water,'9,999.99') "DTW Below Land Surface", m.accuracy
"WaterLevelAccuracy", 'ft' "Accuracy Unit"
from sites s, ww_levels l, mm_codes m, data_sources d, mr_codes r
where s.site_well_site_id = l.wlwa_site_well_site_id
  and l.wlwa_source_code = d.code_entry
  and l.wlwa_method_code = m.code_entry
  and l.wlwa_remark_code = r.code_entry(+)
  and l.wlwa_depth_to_water is not null
  and s.site_well_site_id =  <site>
 union
select 'ADWR' "AgencyCd", s.site_well_site_id "SiteNo", trunc(t.measurement_date)
"MeasurementDate", m.code_description "MeasurementMethod", d.code_description "Source", null
"OriginalParameter", 'Down' "Original Direction", 'ft' "Original Unit",
to_char(avg(t.depth_to_water),'9,999.99') "Original Value", r.code_description "Remarks",
to_char(avg(t.depth_to_water),'9,999.99') "DTW Below Land Surface", m.accuracy
"WaterLevelAccuracy", 'ft' "Accuracy Unit"
from sites s, transducer_levels t, mm_codes m, data_sources d, mr_codes r
where s.site_well_site_id = t.well_site_id
  and t.source_code = d.code_entry
  and t.method_code = m.code_entry
  and t.remark_code = r.code_entry(+)
  and s.site_well_site_id = <site>
  and t.depth_to_water is not null
group by s.site_well_site_id, trunc(t.measurement_date), m.code_description, d.code_description,
r.code_description, m.accuracy
```

Casing WebService Query

```
select 'ADWR' "AgencyCd", s.site_well_site_id "SiteNo", c.case_top "CasingDepthFrom",
nvl2(c.case_top, 'Feet', null) "CasingFromUnit", c.case_bottom "CasingDepthTo",
nvl2(c.case_bottom, 'Feet', null) "CasingDepthToUnit", cf.code_description "CasingMaterial",
c.case_diameter "CasingDiameter", 'Inches' "CasingDiameterUnit"
from sites s, well_completions w, casing_completions c, casing_finishes cf
where s.site_well_site_id = w.wlco_site_well_site_id
  and w.wlco_site_well_site_id = c.case_wlcomp_site_well_site_id(+)
  and w.wlco_id = c.case_wlcomp_id(+)
  and c.case_finish_code = cf.code_entry(+)
```

```
  and s.site_well_site_id = <site>
 order by s.site_well_site_id
```

Screen WebService Query

```
select 'ADWR' "AgencyCd", s.site_well_site_id "SiteNo", p.perf_top "ScreenDepthFrom",
      nvl2(p.perf_top,'Feet',null) "ScreenDepthFromUnit", p.perf_bottom "ScreenDepthTo",
      nvl2(p.perf_bottom,'Feet',null) "ScreenDepthToUnit", p.perf_width "HoleSize",
      nvl2(p.perf_width,'Inches',null) "HoleSizeUnit", pt.code_description "ScreenMaterial",
      p.perf_diameter "ScreenDiameter", nvl2(p.perf_diameter,'Inches',null) "ScreenDiameterUnit"
from sites s, well_completions w, perforation_completions p, perforation_types pt, screen_materials sm
where s.site_well_site_id = w.wlco_site_well_site_id
  and w.wlco_site_well_site_id = p.perf_wlcomp_site_well_site_id(+)
  and w.wlco_id = p.perf_wlcomp_id(+)
  and p.perf_type_code = pt.code_entry(+)
  and p.perf_material_code = sm.code_entry(+)
  and s.site_well_site_id = <site>
 order by s.site_well_site_id
```

Lithology WebService Query

```
select 'ADWR' "AgencyCd", s.site_well_site_id "SiteNo", dl.code "LithologyId", dl.description
"LithologyDescription", 'UNKNOWN' "ObservationMethod", l.top_dbls "LithologyDepthFrom", l.bot_dbls
"LithologyDepthTo", 'ft' "DepthUnit"
from sites s, LOGS.LOG_EVENTS le, LOGS.layers l, logs.cd_drillers_log dl
where s.site_well_reg_id = le.well_id
  and le.id = l.log_event_id
  and l.drl_code = dl.code
  and s.site_well_site_id = <site>
```

Notes on Sites Missing Required Data Elements

ADWR received an award starting on December 30, 2020 through December 29, 2022 to fill metadata gaps at NGWMN sites. Specifically, the following data will be collected to meet the minimum data requirements as outlined in NGWMN tip sheets; 1) total depth measurements, 2) survey grade GPS, and 3) research missing well logs.

Well depth will be determined by a depth measurement using an ADWR well sounder. Currently, geologic inference has been made as to principal and local aquifer from surrounding well logs for wells missing well logs and well depth. Table 1 shows sites missing required data elements.

Table 1. ADWR Sites Missing Required Data Elements.

Site #	Local ID	Site Name	Missing Data Element
322449114323901	C-12-22 06DAA2	21 1/2S-4E	Total depth measurement, Survey-grade GPS
345312111532001	A-17-04 01ACA	A-17-04 01ACA	Survey-grade GPS, Research well log
324113109415401	D-08-26 33CDC1	ARTESIA SCHOOL	Total depth measurement, Research well log
331735111293601	D-01-08 36CCC	B2A	Survey-grade GPS
314621110385801	D-19-17 19BAC	EMPIRE E1	Survey-grade GPS
320029109221601	D-16-29 26CCC2	FARAWAY RANCH WELL CHIRICAHUA NM	Total depth measurement, Research well log
345023110111401	A-17-20 26DBC	HOLBROOK	Total depth measurement
315005110212501	D-18-19 25DCB1	KARTCHNER WELL	Total depth measurement, Research well log
312124110493301	D-24-15 08ADC UNSURV	Kino Springs TW	Survey-grade GPS
322737114415301	C-11-24 23BCB	LCRP #10	Survey-grade GPS
323133114475501	C-10-25 26CDB	LCRP 17REP	Total depth measurement, Survey-grade GPS
370006111300401	A-42-08 35ABB	OW-10	Total depth measurement, Survey-grade GPS, Research well log
341605111111301	A-11-11 26ADD PZ1	R-5	Survey-grade GPS
341605111111302	A-11-11 26ADD PZ2	R-5B	Survey-grade GPS
350845110540101	A-20-14 07CAD UNSURV	RED GAP RANCH	Total depth measurement, Research well log
320105109382001	D-16-27 30BAC	ROLL RANCH	Total depth measurement
331703111303401	D-02-08 02CBB PZ1	SG-10 PZ1	Survey-grade GPS
331703111303402	D-02-08 02CBB PZ2	SG-10 PZ2	Survey-grade GPS
331703111303403	D-02-08 02CBB PZ3	SG-10 PZ3	Survey-grade GPS
332308111345001	A-01-07 36DAA2 PZ1	SG-2 PZ1	Survey-grade GPS
332308111345002	A-01-07 36DAA2 PZ2	SG-2 PZ2	Survey-grade GPS

Table 1. ADWR Sites Missing Required Data Elements.

Site #	Local ID	Site Name	Missing Data Element
332308111345003	A-01-07 36DAA2 PZ3	SG-2 PZ3	Survey-grade GPS
330515111245601	D-04-09 15BCA2 PZ1	SG-5 PZ1	Survey-grade GPS
335733111220201	D-05-10 31BBA PZ1	SG-9 PZ1	Survey-grade GPS
335733111220202	D-05-10 31BBA PZ2	SG-9 PZ2	Survey-grade GPS
335733111220203	D-05-10 31BBA PZ3	SG-9 PZ3	Survey-grade GPS
330435111212601	D-04-10 18DCD PZ1	SG 23 PZ1	Survey-grade GPS
330435111212602	D-04-10 18DCD PZ2	SG 23 PZ2	Survey-grade GPS
352214111324601	A-23-08 21ABA	SUNSET CRATER	Total depth measurement, Survey-grade GPS
314849110353901	D-19-17 03ADB	TEST WELL GAC 1	Survey-grade GPS
314756110360601	D-19-17 10BCD	Well EP-1	Survey-grade GPS

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APPENDIX I

Wells Selected and Principal Aquifer Codes Assigned from ADWR’s Existing Water Level Index Network for NGWMN

National Ground-Water Monitoring Network - ADWR Water Level Sites (December 2020)					
Site Name	National Aquifer Name	Local Aquifer Name	Monitoring Frequency	Period of Record (Non-Daily)	WL Count (Non-Daily)
A-01-07 36DAA2 PZ1 [SG-2 PZ1]	Basin and Range - Basin Fill (N100BSNRGB)	Basin Fill, Lower (121BSFLL)	Monthly	04/11/1978 - 10/27/2020	116
A-01-07 36DAA2 PZ2 [SG-2 PZ2]	Basin and Range - Basin Fill (N100BSNRGB)	Basin Fill, Lower (121BSFLL)	Monthly	04/11/1978 - 10/27/2020	114
A-01-07 36DAA2 PZ3 [SG-2 PZ3]	Basin and Range - Basin Fill (N100BSNRGB)	Basin Fill, Lower (121BSFLL)	Monthly	06/09/1993 - 10/27/2020	42
A-10-10 11ACB [PE-11]	Other aquifers (N9999OTHER)	Precambrian Granite (400GRNT)	Transducer	11/25/1986 - 10/29/2020	114
A-11-11 26ADD PZ1 [R-5]	Other aquifers (N9999OTHER)	Precambrian Granite (400GRNT)	Quarterly	04/19/2001 - 11/16/2020	11
A-11-11 26ADD PZ2 [R-5B]	Other aquifers (N9999OTHER)	Precambrian Granite (400GRNT)	Quarterly	04/09/2008 - 11/16/2020	10
A-17-04 01ABD	Other aquifers (N9999OTHER)	Tapeats Sandstone (374TPTS)	Annually	4/7/1994 - 10/20/2020	30
A-17-20 26DBC [HOLBROOK]	Colorado Plateaus (N300C0PLTS)	Coconino Sandstone (310CCNN)	Transducer	12/02/1969 - 10/28/2020	93
A-17-24 09ABD [PETRIFIED FOREST]	Colorado Plateaus (N300C0PLTS)	Coconino Sandstone (310CCNN)	Transducer	02/02/1984 - 10/28/2020	63
A-20-07 03ACA [SKUNK CANYON]	Colorado Plateaus (N300C0PLTS)	Supai Formation (310SUP)	Transducer	10/31/1996 - 10/27/2020	72
A-20-14 07CAD UNSURV [RED GAP RANCH]	Colorado Plateaus (N300C0PLTS)	Coconino Sandstone (310CCNN)	Transducer	12/05/1978 - 10/27/2020	25
A-23-08 21ABA [SUNSET CRATER]	Colorado Plateaus (N300C0PLTS)	Supai Formation (310SUP)	Quarterly	03/30/1965 - 10/20/2020	83
A-42-08 35ABB [OW-10]	Colorado Plateaus (N300C0PLTS)	Glen Canyon Group (227GLNC)	Quarterly	06/25/1964 - 11/12/2020	369
B-28-17 31CCC2 [PIERCE FERRY]	Basin and Range - Basin Fill (N100BSNRGB)	Lower Basin Fill and Miocene Sedimentary Rocks, Undifferentiated (121LBFM)	Transducer	12/05/2007 - 10/21/2020	42
B-30-17 14DCC [MEADVIEW]	Basin and Range - Basin Fill (N100BSNRGB)	Alluvium, Older (112ALVM)	Transducer	01/13/1982 - 10/21/2020	121
B-40-15 06CDD [MESQUITE]	Basin and Range - Basin Fill (N100BSNRGB)	Muddy Creek Formation (121MDCK)	Transducer	11/01/1994 - 10/22/2020	74

National Ground-Water Monitoring Network - ADWR Water Level Sites (December 2020)					
Site Name	National Aquifer Name	Local Aquifer Name	Monitoring Frequency	Period of Record (Non-Daily)	WL Count (Non-Daily)
C-10-25 26CDB [LCRP 17REP]	Basin and Range - Basin Fill (N100BSNRGB)	Holocene Alluvium (111ALVM)	Annually	12/30/1977 - 09/30/2020	39
C-11-24 23BCB [LCRP #10]	Basin and Range - Basin Fill (N100BSNRGB)		Annually	02/01/1963 - 09/30/2020	162
C-12-22 06DAA2 [21 1/2S-4E]	Basin and Range - Basin Fill (N100BSNRGB)	Holocene Alluvium (111ALVM)	Annually	11/04/2009 - 09/30/2020	14
D-01-08 36CCC [B2A]	Basin and Range - Basin Fill (N100BSNRGB)	Basin Fill - Lower (121BSFLL)	Monthly	01/10/2018 - 10/27/2020	18
D-02-08 02CBB PZ1 [SG-10 PZ1]	Basin and Range - Basin Fill (N100BSNRGB)	Basin Fill - Lower (121BSFLL)	Monthly	02/17/1979 - 10/27/2020	96
D-02-08 02CBB PZ2 [SG-10 PZ2]	Basin and Range - Basin Fill (N100BSNRGB)	Basin Fill, Upper and Lower, Undifferentiated (112BSFL)	Monthly	02/20/1985 - 10/27/2020	51
D-02-08 02CBB PZ3 [SG-10 PZ3]	Basin and Range - Basin Fill (N100BSNRGB)	Basin Fill, Upper and Lower, Undifferentiated (112BSFL)	Monthly	03/26/1979 - 10/27/2020	74
D-04-09 15BCA2 PZ1 [SG-5 PZ1]	Basin and Range - Basin Fill (N100BSNRGB)	Basin Fill - Lower (121BSFLL)	Monthly	04/21/1978 - 10/29/2020	78
D-04-10 18DCD PZ1 [SG 23 PZ1]	Basin and Range - Basin Fill (N100BSNRGB)	Basin Fill, Lower (121BSFLL)	Monthly	07/12/1979 - 10/29/2020	79
D-04-10 18DCD PZ2 [SG 23 PZ2]	Basin and Range - Basin Fill (N100BSNRGB)	Bedrock (BEDROCK)	Monthly	01/12/1979 - 10/29/2020	79
D-05-10 31BBA PZ1 [SG-9 PZ1]	Basin and Range - Basin Fill (N100BSNRGB)	Basin Fill, Upper and Lower, Undifferentiated (112BSFL)	Monthly	02/21/1979 - 10/28/2020	31
D-05-10 31BBA PZ2 [SG-9 PZ2]	Basin and Range - Basin Fill (N100BSNRGB)	Basin Fill, Upper and Lower, Undifferentiated (112BSFL)	Monthly	02/21/1979 - 10/28/2020	31

National Ground-Water Monitoring Network - ADWR Water Level Sites (December 2020)					
Site Name	National Aquifer Name	Local Aquifer Name	Monitoring Frequency	Period of Record (Non-Daily)	WL Count (Non-Daily)
D-05-10 31BBA PZ3 [SG-9 PZ3]	Basin and Range - Basin Fill (N100BSNRGB)	Basin Fill, Upper and Lower, Undifferentiated (112BSFL)	Monthly	02/21/1979 - 10/28/2020	31
D-08-26 33CDC1 [ARTESIA SCHOOL]	Basin and Range - Basin Fill (N100BSNRGB)	BASIN FILL, LOWER (121BSFLL)	Transducer	03/13/1950 - 10/20/2020	187
D-16-27 30BAC [ROLL RANCH]	Basin and Range - Basin Fill (N100BSNRGB)	Bedrock (BEDROCK)	Transducer	06/28/1965 - 10/20/2020	34
D-16-29 26CCC2 [FARAWAY RANCH WELL CHIRICAHUA NM]	Other aquifers (N9999OTHER)		Transducer	10/16/1979 - 10/20/2020	109
D-18-19 25DCB1 [KARTCHNER WELL]	Other aquifers (N9999OTHER)	Alluvium (112ALVM)	Transducer	03/26/2008 - 10/21/2020	36
D-18-19 36ADC [KARTCHNER CAVERNS #3]	Other aquifers (N9999OTHER)	Escabrosa Limestone (339ECBR)	Transducer	10/25/2007 - 10/21/2020	44
D-18-20 30CAB [KARTCHNER CAVERNS #4]	Other aquifers (N9999OTHER)	Alluvium (112ALVM)	Transducer	03/22/2007 - 10/21/2020	43
D-19-17 03ADB [TEST WELL GAC 1]	Basin and Range - Basin Fill (N100BSNRGB)		Annually	04/08/1970 - 11/18/2020	14
D-19-17 10BCD [WELL EP-1]	Basin and Range - Basin Fill (N100BSNRGB)	Bisbee Group (218BISB)	Quarterly	03/24/1982 - 11/18/2020	12
D-19-17 19BAC [EMPIRE E1]	Basin and Range - Basin Fill (N100BSNRGB)	Bisbee Group (218BISB)	Annually	07/19/1974 - 11/18/2020	11
D-21-28 21BCB [LESLIE CANYON]	Other aquifers (N9999OTHER)	Valley Fill (110VLFL)	Transducer	04/08/2009 - 10/21/2020	35
D-24-15 08ADC UNSURV [KINO SPRINGS TW]	Basin and Range - Basin Fill (N100BSNRGB)	Nogales Formation (No Associated Code)	Quarterly	12/09/1987 - 11/19/2020	70

APPENDIX II

Monitoring Categories and Subnetworks - ADWR Wells Selected for NGWMN

National Ground-Water Monitoring Network - ADWR Water Level Sites (December 2020)			
Site Name	Water Level Network		Aquifer Type
	Subnetwork Category	Monitoring Category	
A-01-07 36DAA2 PZ1 [SG-2 PZ1]	Documented Changes	Trend	Unconfined
A-01-07 36DAA2 PZ2 [SG-2 PZ2]	Documented Changes	Trend	Unconfined
A-01-07 36DAA2 PZ3 [SG-2 PZ3]	Documented Changes	Trend	Unconfined
A-10-10 11ACB [PE-11]	Background	Trend	Unconfined
A-11-11 26ADD PZ1 [R-5]	Suspected Changes	Trend	Unconfined
A-11-11 26ADD PZ2 [R-5B]	Suspected Changes	Trend	Unconfined
A-17-04 01ABD	Documented Changes	Trend	Unconfined
A-17-20 26DBC [HOLBROOK]	Documented Changes	Trend	Unconfined
A-17-24 09ABD [PETRIFIED FOREST]	Suspected Changes	Trend	Confined
A-20-07 03ACA [SKUNK CANYON]	Suspected Changes	Trend	Unconfined
A-20-14 07CAD UNSURV [RED GAP RANCH]	Suspected Changes	Trend	Unconfined
A-23-08 21ABA [SUNSET CRATER]	Suspected Changes	Trend	Unconfined
A-42-08 35ABB [OW-10]	Documented Changes	Trend	Unconfined
B-28-17 31CCC2 [PIERCE FERRY]	Suspected Changes	Trend	Unconfined
B-30-17 14DCC [MEADVIEW]	Documented Changes	Trend	Confined
B-40-15 06CDD [MESQUITE]	Suspected Changes	Trend	Unconfined
C-10-25 26CDB [LCRP 17REP]	Documented Changes	Trend	Unconfined
C-11-24 23BCB [LCRP #10]	Documented Changes	Trend	Unconfined
C-12-22 06DAA2 [21 1/2S-4E]	Documented Changes	Trend	Unconfined
D-01-08 36CCC [B2A]	Documented Changes	Trend	Confined
D-02-08 02CBB PZ1 [SG-10 PZ1]	Documented Changes	Trend	Unconfined
D-02-08 02CBB PZ2 [SG-10 PZ2]	Documented Changes	Trend	Unconfined

National Ground-Water Monitoring Network - ADWR Water Level Sites (December 2020)			
Site Name	Water Level Network		Aquifer Type
	Subnetwork Category	Monitoring Category	
D-02-08 02CBB PZ3 [SG-10 PZ3]	Documented Changes	Trend	Unconfined
D-04-09 15BCA2 PZ1 [SG-5 PZ1]	Documented Changes	Trend	Unconfined
D-04-10 18DCD PZ1 [SG 23 PZ1]	Documented Changes	Trend	Confined
D-04-10 18DCD PZ2 [SG 23 PZ2]	Documented Changes	Trend	Confined
D-05-10 31BBA PZ1 [SG-9 PZ1]	Documented Changes	Trend	Unconfined
D-05-10 31BBA PZ2 [SG-9 PZ2]	Documented Changes	Trend	Unconfined
D-05-10 31BBA PZ3 [SG-9 PZ3]	Documented Changes	Trend	Unconfined
D-08-26 33CDC1 [ARTESIA SCHOOL]	Documented Changes	Trend	Unconfined
D-16-27 30BAC [ROLL RANCH]	Documented Changes	Trend	Unconfined
D-16-29 26CCC2 [FARAWAY RANCH WELL CHIRICAHUA NM]	Background	Trend	Unconfined
D-18-19 25DCB1 [KARTCHNER WELL]	Documented Changes	Trend	Unconfined
D-18-19 36ADC [KARTCHNER CAVERNS #3]	Suspected Changes	Trend	Unconfined
D-18-20 30CAB [KARTCHNER CAVERNS #4]	Documented Changes	Trend	Unconfined
D-19-17 03ADB [TEST WELL GAC 1]	Background	Trend	Confined
D-19-17 10BCD [WELL EP-1]	Background	Trend	Confined
D-19-17 19BAC [EMPIRE E1]	Background	Trend	Confined
D-21-28 21BCB [LESLIE CANYON]	Background	Trend	Unconfined
D-24-15 08ADC UNSURV [KINO SPRINGS TW]	Documented Changes	Trend	Unconfined

APPENDIX III

Operational Guidelines for Measuring Ground-Water Levels
(Mann, 1980)

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

OPERATIONAL GUIDELINES FOR MEASURING GROUND-WATER LEVELS—ARIZONA DISTRICT

By

Larry J. Mann

For Administrative Use Only

Tucson, Arizona
May 1982

CONTENTS

Illustrations

METHODS OF WATER-LEVEL MEASUREMENT

The electric sounder and graduated steel tape are the two main ground-water level measuring devices used in the Arizona District. These devices primarily are used to measure the depth to water in a well on a periodic basis, i.e., monthly or annually. Water-level fluctuations resulting from barometric pressure changes, seasonal changes in recharge rates, the effect of pumping wells, etc., are more easily measured using water-level recorders or pressure transducers. A discussion of measuring devices is provided in TWRI Book 8, Chapter A1—"Methods of Measuring Water Levels in Deep Wells,"—and National Handbook of Recommended Methods for Water-Data Acquisition, Chapter 2. Moreover, the sections that follow assume that the user is familiar with the types of equipment being discussed; if not, he or she should consult the subdistrict's lead ground-water technician or hydrologist or immediate supervisor.

Both methods of measuring ground-water levels—an electric sounder and graduated steel tape—have certain advantages and disadvantages depending mainly on site conditions. For the most part, however, the electric sounder is a more reliable and simpler method of measuring the depth to water than a steel tape. The reasons are as follows:

1. In wells with cascading water, it is imperative that an electric sounder with a shielded probe be used to measure the depth to water. Cascading water greatly affects the accuracy and reliability of steel-tape measurements; most measurements are worthless.

2. In wells for which the depth to water and well depth are unknown, use of an electric sounder eliminates the time consuming and frustrating method described in "Precaution 3" of the section entitled "Graduated Steel Tape."

3. Steel-tape measurements require two or more times in and out of the well to check the measurement. In places where the depth to water is several hundred feet, a lot of time and effort is spent to obtain an accurate measurement.

4. In wells equipped with electric-powered submersible pumps, a tape may cut through the insulation on the electric power wires. This is a safety hazard and could lead to electrocution or to pump failure.

5. Steel tapes are inordinately expensive when compared to sounding wire and much more difficult to repair in the field when they are broken.

In general, steel tapes should only be used for measuring the depth to water in wells where: use of an electric sounder is not feasible owing to access, i.e., hole into well bore is too small for a sounder and cannot be enlarged with a drill; to set the datum on a recorder; cascading water does not exist; to record the oil level (see "Precaution 6" in section entitled "Electric Sounder"); the water level is shallow and visible; or there is a small diameter access line—such as a one-half inch airline—that extends from land surface to below the water level.

Electric Sounder

Electric sounders are perhaps the most versatile of water-level measurement devices. They are small and portable, simple to operate and repair in the field, and easily used by one person. Most electric sounders in the Arizona District consist of an aluminum reel that will hold 1,000-2,000 ft of 22-gauge insulated sounding wire, a battery-powered water-level indicating meter, a water-level probe, and a ground wire. In its simplest description, the water-level probe is attached to and lowered down a well by the sounding wire. The sounding wire is connected through the reel and a brush system to the water-level indicating meter, which is, in turn, grounded to the well casing or pump column. When the probe enters the water an electrical circuit is completed, and the meter will give a steady reading.

The depth to water in a well is equal to the combined length of the sounding wire and probe at the point at which the needle on the meter is deflected. The sounding wire usually is calibrated using a steel tape and marked at 100- and 50-foot intervals; markings at 25-foot intervals are optional. When the water level is between two marks, a steel tape is used to measure from the nearest point of the line that the level was measured. The sounding wire can be marked using different methods:

1. Three-quarter inch plastic tape wrapped tightly around the wire;
2. Water-resistant markers similar to felt-tip pens; and
3. Paint or fingernail polish.

Although the type and the interval of markings are largely dependent on personal preference of the field person, the following policies and guidelines are hereby proposed in order to establish consistency from office to office and within a specific office.

1. A bound equipment book will be prepared and kept current for each sounder. The contents of the book will include the following:
   (a) The type and color of marks used on the sounding wire.
   (b) The interval(s) at which the sounding wire is marked.
   (c) A record showing the date, person(s), and method used to calibrate, check the calibration, or recalibrate the marks. In general, the calibration of the sounding wire and probe should be spot checked: prior to a field trip in which the sounder will be extensively used; at least once daily; after replacing a probe;

immediately after being "hung-up"—to document whether the sounding wire was stretched; and anytime the field person questions its accuracy, e.g., if the depth-to-water measurement is inconsistent with the trend defined by previous measurements.

(d) The date, person(s), and changes that were made to the length of the sounding wire or probe.

2. It is suggested that the sounding wire be marked at least at 50-foot intervals; marks at 25-foot intervals are optional.

3. The 100-foot marks on the sounding wire should be obviously recognizable and distinguishable from 0.0 ft to 300 ft. It is suggested that the following scheme be used for 100-300 ft and then reused or recycled for 400 to 600 ft, 700 to 900 ft, and so on. (See example on next page.) Two marks should be used to designate 50-foot intervals; if 25-foot intervals are opted for, they should be designated by a single mark. There is also a question of using other marking systems. For example, some personnel prefer to mark the sounding wire in the same manner as a cableway is marked, e.g., each 100-foot mark is unique. On 500- to 2,000-foot long sounding wires, this system is impractical. The main problem being that the entire wire has to be remarked if part of the wire is lost and replacement wire is not available. Secondly, several more marks have to be replaced when the wire is recalibrated. Once again, whatever marking system is used should be clearly defined in the equipment book that accompanies the instrument.

4. Each office in the District has its own type of water-level probes, which were designed to best fit their needs. Each probe should be constructed so that the contact is shielded and will not come in contact with the casing or pump column. The shield can also serve to eliminate the effects of cascading water.

5. The point of reference for the actual footage designated by a specific mark will be the center of the mark; the yellow marks help protect the specific marks on a sounder, so we use the C/L (center line) as the absolute point. An alternative is to use the extreme end of the first mark nearest to the probe. The method used should be thoroughly described in the equipment book. An advantage to using the extreme end of the marks as a reference point, is that if there is stretch in the sounding line all that needs to be done to recalibrate is to replace the end mark; most often the stretch will be a few tenths of a foot.

Distance		Marking	*Color of marking
0.0 ✓	✓	-	R
25 (optional)		-	Y
50 ✓	✓	- -	Y/Y
75		-	Y
100	✓ 100	- - -	Y/R/Y
150 ✓	50	- -	Y/Y
200 ✓	200	- - - -	Y/R/R/Y
250	250	- -	Y/Y
300 ✓	300	- - - - -	Y/R/R/R/Y
350 ✓	350	- -	Y/Y
400 ✓	400	- - -	Y/R/Y
450 ✓	450	- -	Y/Y
500 ✓	500	- - - -	Y/R/R/Y
550 ✓		- -	Y/Y
600 ✓		- - - - -	Y/R/R/R/Y

*Color of marking: R, red; Y, yellow

Reference point for measurements: C/L (center line): $\overset{\text{C/L}}{\downarrow}$ - - - $\overset{\text{C/L}}{\downarrow}$ - - - -

or

Extreme end: Reel → - - - $\downarrow$ → Probe.

6. The 0.0-foot mark should be clearly marked and distinguishable from other marks on the sounding line. Because the 0.0 mark usually is above the probe, the distance from the mark to the end of the probe should be measured and noted in the equipment book. This distance—usually referred to as the tare—is commonly between 2 and 5 ft and must be added to the length of the sounder line when computing the depth to water.

Some field persons prefer to set a reference mark at a predetermined footage, say 5 ft, and adjust the length of the probe so that the contact on the probe is at 0.0 ft. This is permissible as long as the practice is fully documented in the equipment book.

Precautions.-- 1. If the field person is unfamiliar with a particular electric sounder, verify markings on sounding wire, and the length of the water-level probe, and record the information in the equipment book.

2. If length of wire has changed because of stretching and use, replace it with new wire rather than remark it; two sets of marks are confusing to the user and, if the amount of stretch is a significant factor, the wire probably is weakened and subject to breaking.

3. Always carry a spare battery and several spare probes.

4. Always attach probe so that the point at which it is attached is "the weakest link in the chain." It is better to lose a probe than to lose several hundred feet of wire down a well.

5. When using an electric sounder, keep the reel sitting on a clean dry area such as a 2-foot long, 2-inch by 12-inch lumber, and do not let the reel touch any metal around the well. Many reels short out when set on damp ground or touch the casing.

6. Oil-lubricated turbine pumps typically have an oil film on top of the water. Care should be taken that the oil does not foul the water-level probe as it passes through the oil before entering the water. If several feet of oil is on the surface, it is better to use a steel tape and record the oil level rather than record the water level at the base of the "oil plug." For example, assuming that there is 10 ft of oil, the surface of the oil will be within 1.4 ft of the "true water level;" the oil-water contact on the other hand will be 8.6 ft deeper than the "true water level." To adjust the depth-to-water measurement for the effect of the oil column, the height of the oil column must be determined. The top of the column can usually be measured with a steel tape and the oil-water contact with an electric sounder; an alternate method of measuring the oil-water contact is to use a steel tape and a water-sensing paste that undergoes a permanent color change when wetted. The height of the oil column is multiplied by 0.86 to obtain the height of a water column of

equivalent weight; although this coefficient ranges from 0.85 to 0.88, depending on the type of oil, 0.86 represents an average value for oils typically used to lubricate turbine pumps. The height of the water column is then subtracted from the depth to the oil-water contact.

For example:

Depth to top of oil = 132.6 ft
Depth to oil-water contact = 147.3 ft
Height of oil column - 147.3 minus 132.6 = 14.7 ft
Height of oil column times 0.86 = 12.6 ft
Depth to oil-water contact minus 12.6 ft = 134.7 ft
Depth to water adjusted for the effect of the oil column = 134.7 ft

An example of how data should be entered in the field notes is shown on figure 1.

7. Except for sites where a film of oil or other debris on the water precludes it, the probe should be submersed and the water-level reading taken as the probe is removed from the water. This insures that the sounding wire is as straight as possible and sags are minimal. Sag can sometimes account for a 1- to 2-foot error in water level especially in crooked wells or in wells with debris in the water.

8. An ideal way to check the calibration of a sounding line is to first measure the depth to water in a well with the sounder, then make a verification measurement with a steel tape; this assumes that there is no cascading water. If the sounding wire is properly calibrated, the difference between the two measurements should be less than 0.1 ft per 100 ft of depth to water. Calibration checks of this nature should be documented in the equipment book.

9. When lowering or removing the sounding wire and probe down the well, it should be done very slowly so that "tight" spots can be detected. When lowering, the "tight" spots should be noted so that care can be taken when removing the line. A second advantage to slowly lowering or removing the sounding wire and probe, is that it gives the field person the opportunity to inspect the markings and determine whether they have slipped or need repair or replacement; for example, plastic tape has a tendency to slip on the sounding wire especially if the marks contact oil which is often present on the water surface in wells equipped with oil-lubricated turbine pumps.

10. The sounding wire can gently be popped in the well as a check to see if it is hanging freely.

11. Always measure the distance from the tip of the probe to the 0.0-foot marker before sounding for a water level. The probe may be lost while retrieving the sounding wire from the well; the measurement is then useless.

FORM NO. 9—1904—E
Revised September 1980

U.S. DEPT. OF INTERIOR
GEOLOGICAL SURVEY
WATER RESOURCES DIVISION

WATER-LEVEL DATA

WELL NO. A-10-20 30ABC(2)
MP HEIGHT 2.0 ft above LS
SHV area

Site Ident. No 341234111123401 | R-234 • | T- A •

	DATE	WATER LEVEL (BELOW LSD)	STATUS	METHOD	HOLD	CUT	DEPTH BELOW MP	REMARKS	DATE PUNCHED	DATE ENTERED
Example 1: Steel tape	235 #	237	238 -	239 -	100.0	-12.5	87.5	No oil; L. Mann		
	235 # 9/10/1982	237 85.5	238	239 S	95.0	-7.5	87.5			
	235 #	237	238	239 -						
	235 #	237 -	238	239 -						
Example 2: Combination	235 #	237	238 -	239 - V	113.7	+1.4	115.1	Trace of oil; unadjusted		
	235 # 9/20/1982	237 113.0	238 R	239 - S	118.0	-3.0	115.0	for oil - L. Mann		
	235 #	237	238 -	239 -						
	235 #	237	238 -	239 -						
Example 3: Sounder	235 # 9/30/1982	237 113.1	238 S	239 - V	113.7	+1.4	115.1	No oil detected; double		
	235 #	237 -	238 -	239 -				checked measurement - L. Mann		
	235 #	237	238 -	239 -						
Example 4: Oil correction	235 #	237 -	238 -	239 - S	150.0	-17.4	132.6	Top of oil		
	235 #	237	238 -	239 - V	141.3	+6.0	147.3	Oil-water contact		
	235 #	237 -	238 -	239 -	147.3-	132.6 =	14.7 ;	14.7 × 0.86 = 12.6		
	235 # 1/31/198	237 132.7	238 R	239 - S	147.3 -	12.6 =	134.7	b/w MP - L. Mann		
	235 #	237 -	238 -	239 -						
	235 #	237 -	238 -	239 -						
	235	237 -	238 -	239 -						
	235	237 -	238 -	239 -						
	235 #	237 -	238 -	239 -						
	235 #	237 -	238 -	239 -						
	235 #	237 -	238 +	239 -						
	235 #	237 -	238 -	239 -						
	235 #	237 -	238 -	239 -						
	235 #	237	238 -	239 -						

-7-

MEASURING POINT
R-320 • | T- [✓ A] D M •
add, delete, modify

M.P. Begin Date 321 # 9/10/1982 •
M.P. End Date 322 - •
M.P. Height 323 - 2.0 •
M.P. Remark 324 TOP OF CASING 2.0 FT ABV LAND SURFACE •

Method of Measurement 239 - A airline, B analog, C calibrated airline, E estimated, G pressure gage, H calibrated pressure gage, L geophysical logs, M manometer, N nonrecording gage, R reported, S steel tape, T electric tape, V calibrated electric tape, Z other

Site Status 238 - D dry, E recently flowing, F flowing, G nearby flowing, H nearby recently flowing, I injector, J injector site monitor, N discontinued, Ø obstruction, P pumping, R recently pumped, S nearby pumping, T nearby recently pumping, V foreign matter on water, W well destroyed, X affected by surface water, Z other

12. The sounding wire should be reeled into and out of the well and not be allowed to accumulate on the ground; the reasons are nearly the same as those discussed for the use of a steel tape (see "Precaution 2" in section entitled "Graduated Steel Tape").

Graduated Steel Tape

The graduated steel surveyor's tape has long been used to measure the depth to water in wells. Steel tapes are available in lengths up to 500 ft, although some as much as 2,000 foot long have been specially made. In the day-to-day use of a steel tape, lengths over 800 to 1,000 ft are cumbersome and awkward to use even with special reels and other associated equipment.

The depth to water in a well is measured by inserting the tape in an opening in the top of the casing, base of turbine pump, or plate covering the casing that gives direct access to the inside of the casing. The tape is lowered through the opening to a predetermined footage so that the lower few feet of tape are submerged in water. The lower part—20 to 50 ft—of tape is usually coated with a substance such as carpenters chalk or water-sensing paste that exhibits a marked color change when wetted. The depth to water is calculated by subtracting the length of wet tape from the predetermined footage.

Precautions.-- 1. A small weight of 2 to 4 oz should be attached to the end of the tape prior to inserting the tape in the well. The weight serves three purposes: (a) First, it makes the tape hang straight by removing minor bends and kinks; (b) in the event that the water surface is covered by floating debris, such as oil, sludge, and fine trash, a weighted tape will more easily penetrate the debris than will a nonweighted tape; and (c) the added weight will aid the field person in "feeling" his or her way down the well.

The weight can be attached in one of two ways. It can be attached to the ring on the end of the tape that is standard on most tapes, or the ring can be removed and a hole drilled or punched in the end of the tape. The weight is attached to the tape by a fine wire or nylon string, which will easily break if the weight is bound up by an obstruction. The weight can be considered expendable, but the tape should not be.

2. The tape is always spooled directly from the reel into the well—a few feet at a time—back onto the reel and never allowed to accumulate on the ground. This precaution serves three functions: (a) By inserting the tape a few feet at a time, the field person can monitor the weight of the suspended tape and, thereby, detect whether the tape is hanging freely or the hole is obstructed; (b) the possibility of kinking the tape is minimal; and (c) if the tape accumulates on the ground, it can be a tripping hazard, come in contact with an electrical circuit, or interfere with the operation of equipment at the well site.

3. Depth-to-water measurements in wells that previously have not been measured and for which the depth of the well is not known should be done with great care and caution. The tape should be inserted a few feet at a time and to regular intervals such as 50 or 100 ft. For example, lower the tape 50 to 100 ft and remove it to check if water was encountered. On a second trial, lower the tape an additional 50 to 100 ft and remove it again. Repeat this additive process until water is detected on the tape. The length of tape lowered in the well is left up to the discretion and "common sense" of the field person, but under no conditions should it be lowered at intervals exceeding 100 ft. This practice will minimize the likelihood of getting the tape "balled-up" or "bound-up" in the well. Once the depth to water is measured using this process, a second measurement will be made and recorded using the knowledge gained from the first measurement.

4. In wells in which the depth to water is more than about 200 ft, carpenter's chalk tends to dry out as the tape is removed from the well; the result is an erroneous measurement or none at all. The chalked interval of the tape should be closely scrutinized for the possibility of the chalk drying out. If the chalk dries too quickly, alternate methods can be used to measure the depth to water, e.g., replace the chalk with the water-sensing paste or use of an electric sounder.

5. If the chalk appears to be spotty and it is difficult to detect the wet interval, an alternate method should be used to measure the depth to water. The most common conditions that lead to "spotty" tapes are cascading water and condensation on the inside of the casing.

6. All steel tapes should periodically be inspected for kinks, worn spots, and other conditions that would affect the reliability and accuracy of measurements or the likelihood of the tape breaking while suspended in a well. If practical the tape should be repaired, otherwise it should be replaced.

7. Each field person should securely attach the steel tape to the reel so that the tape cannot accidently separate from the reel and be lost down a well.

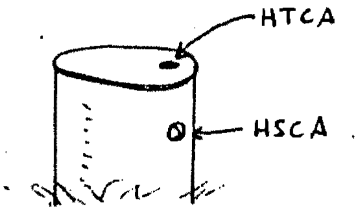
Recording of Water-Level Data

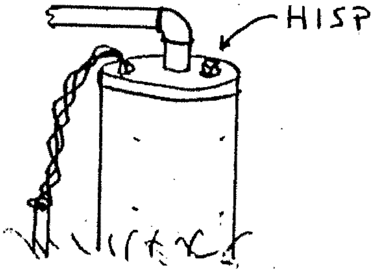
The accuracy to which the depth to water can be measured is largely dependent on field conditions. In general, the depth to water can be measured to ±0.1 ft per 100 ft with either the steel tape or electric-sounder method. The measurements should be recorded on the field sheet to the nearest 0.1 ft; this implies that the measurement is accurate to the nearest 1 ft. On the other hand if the measurement is recorded to the 0.01 ft, this implies that the measurement is accurate to the nearest 0.1 ft. Because of many unknown field conditions, such as alignment and crookedness of the well and the expansion and contraction of steel tapes and sounding wire, accuracies of less than 0.1 ft are usually not obtainable and, therefore, should not be implied by recording the depth to water to the nearest 0.01 ft.

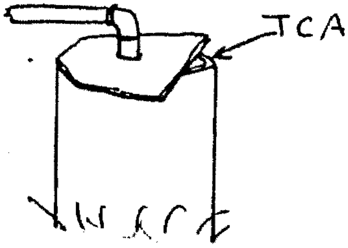
When entering the depth to water on the field sheet, it should be obvious which method was used to make the measurement. Several codes have been devised to indicate the "method of measurement." (See figure 1.) If a steel tape was used, an "S" should be coded. If an electric sounder was used, a "V"—code for a calibrated electric tape—should be coded. The code for an electric tape—"T" implies the tape is uncalibrated—should be used only if an unmarked sounder was used to measure the water level and the length of sounder wire was measured using a steel tape once the wire was removed from the well.

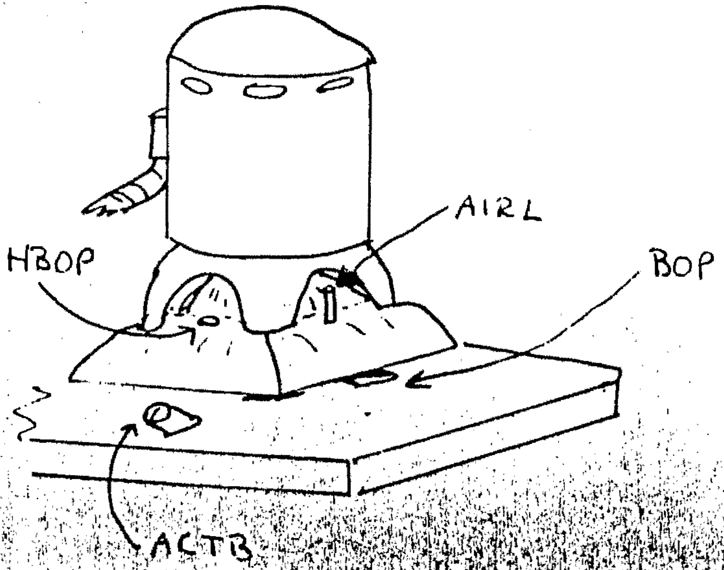
In most instances, the depth to water is measured to the nearest 0.1 ft and verified by a second measurement. The field notes should clearly indicate that the measurement was verified and the method used to obtain both measurements. However, only the measurement that is deemed as being most accurate by the field person will be entered into the water-level file. Examples of the field notes are shown on figure 1.

HTCA, W	Hole in top of casing, west side
HSCA, N	Hole in side of casing, north side
TCA, SE	Top of casing, southeast side
HBOP, S	Hole in pump base, south side
BOP, N	Access under base of pump, north side
ACTB, S	Measuring (access) tube, south side
AIRL, S	Airline, south side
HISP, NE	Hole in submersible cap plate, northeast side









APPENDIX IV

ADWR Field Service Section Training Manual

(November 2018)

ARIZONA DEPARTMENT OF WATER RESOURCES

Field Services Training Manual

Prepared by
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PROTECTING
ARIZONA'S WATER SUPPLIES
for ITS NEXT CENTURY

Hydrology Division
Field Services Section
2018

Revised November 2018

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ACKNOWLEDGEMENTS

For many years, the Field Services Section staff relied on an instructional manual prepared by Ron Stulik. At the time (1983), Ron was a Water Resource Specialist at Field Services. Ron had spent many years at the USGS doing data collection. Ron helped pattern Field Services Section after the data collection units of the USGS. All of us who knew Ron, worked with him, and were trained by him can be thankful for his influence. Ron taught us to do a hard job, and to do it in a concise, professional manner. Much of the fine reputation our Unit now enjoys is in no small way due to the efforts of Ron Stulik.

Ron's manual was largely based on USGS memos written in 1982 by Larry Mann (USGS). For years we simply referred to the manual as the "Field Services Bible". New technology has made much of the "old" manual obsolete, but the message of the original – such as attention to detail, pride in what we do, and dedication to a worthy endeavor – will never change.

This new training manual draws generously from the efforts of Ron Stulik and Larry Mann, and the protocols they developed. New innovations have made our work easier in the post-2000 era. However, it is my hope that the commitment to excellence that we inherited will be conveyed in this new manual.

Chapter I

INTRODUCTION

The Arizona Department of Water Resources (ADWR) has been in existence since 1980. Before we became an agency, we were known as the Arizona Water Commission (a much smaller group), which was a part of the Arizona State Land Department. The Field Services Section, formerly known as Basic Data, has been the data collection arm of ADWR since the beginning. The unit was patterned after similar data collection units in the United States Geological Survey (USGS). We adopted all data collection protocols from the USGS, including field inventories, water-level measurements, discharge measurements, automated groundwater monitoring measurement and land subsidence surveying. This enabled the data that we collected to have instant compatibility with all USGS historical data.

Personnel from the Field Services Section (FSS), which include hydrologists and water resource specialists, perform many tasks. In the field, we measure water levels in wells, measure discharge from pumping wells, measure stream flows, maintain a collection of transducers, inventory wells for our (GWSI) database and collect elevation and gravity data to monitor land subsidence throughout Arizona. Also, hydrologists of the FSS produce the Hydrologic Map Series (HMS) reports, Hydrologic Monitoring Reports (HMR) and the Water Level Change Map Series (WLCMS) reports, which show groundwater conditions statewide.

FSS maintains a statewide network of about 1800 index wells which are used to monitor water levels. Manual water-level measurements are taken at all of these wells on an annual, semiannual or quarterly basis. Approximately 125 wells are continuously monitored with digital pressure transducers, shaft encoders, and bubblers. Many of the automated sites are equipped with GOES radios, which transmit water-level data to ADWR via satellite.

The Field Services Section also maintains the Groundwater Site Inventory (GWSI) database. GWSI is a field verified database consisting of thousands of wells – including cadastral and GPS locations, current and historical water-level measurements and numerous associated data relating to those wells (see Arizona Department of Water Resources, 2007).

This manual is intended to introduce the new employee to the “how and why” of what we do, but it is also intended to serve as a reference manual for both new and experienced employees. The procedures outlined in these pages are the “tried and true” methods which have been perfected over the years. To become a skilled field hydrologist or field technician takes time, you must gain experience in the field, and for this there is no substitute. However, before you can work in the field, it is imperative that you have the proper knowledge and introduction into how and why we collect data. This manual is intended to provide FSS employees with the necessary techniques and understanding to facilitate the accurate collection of data. It is hoped that it will become a valuable reference for both new and experienced FSS personnel.

The following performance skills checklist (Table 1) is a tool for the employee and their supervisor to plan their training needs. Not all employees will receive all the training. This checklist is primarily intended to assure the employee has the necessary training to successfully complete their immediate assignments, but it also intended to be used to plan career development. All employees in FSS that do field work are required to be trained in each of the listed field skills. Computer skills and specialized skills will be taught to the employee as needed.

Table 1: Field Services Section Skills Checklist

Field Skills	**Computer Skills**	**Specialized Skills**
☐ GPS	☐ Understanding GWIS	☐ Sounder Probe Construction
☐ Well Location	☐ ArcGIS	☐ Sounder/Tape Calibration
☐ Well Inventory	☐ Access & Excel	☐ Discharge Measurements
☐ Water-Level Measurements	☐ GPS & All Topos	☐ Water Level Measurements
☐ Safety	☐ ArcMap in the Field	☐ Automated Sites Download
☐ First Aid		☐ Automated Site Installation
☐ Dealing with the Public		☐ GPS Survey Measurements
☐ 4 x 4 Vehicle Training		☐ Gravimeter Measurements
		☐ Streamflow Measurements

____
Employee Signature/Date

____
Supervisor Signature/Date

Chapter II

DATA

The primary responsibility of FSS is the collection of groundwater related data. The data that we collect is critical to the planning and protection of Arizona's groundwater resources. But, what exactly is groundwater data? The evaluation of the groundwater resources of an area should include such things as an assessment of the amount of water available, the depth to the water, the conditions under which it occurs, the quality of the water, the past and present uses of the water, and the effects of past and present water use. Much of this can be determined by collecting well data, water levels and water samples from existing wells within the area. An individual well owner may know the depth to water, production figures, water quality, and pumping effects of his own well, but only an area-wide compilation of these data from numerous wells can determine the groundwater conditions of an entire basin. The collection and compilation of this data is our responsibility.

What Kind of Data Do We Collect?

We collect several different types of data including water levels, well discharge measurements, streamflow measurements, various types of location and physical (inventory) well information, and USGS grade GPS/elevation measurements in select areas. Each of these data types will be discussed in detail in subsequent chapters of this manual.

Why Do We Collect Data?

To assure Arizona's continued growth and prosperity, our State lawmakers enacted the 1980 Groundwater Management Act. At the very heart of this Act is the management and conservation of Arizona's groundwater resources. To effectively execute this mandate would require vast amounts of information on the physical condition and make-up of Arizona's groundwater; past, present and future. Before 1980, the USGS was Arizona's groundwater data collection authority. After the 1980 Groundwater Management Act, the responsibility of groundwater data collection was inherited by the newly formed ADWR (specifically the FSS).

How is the Data Used?

We use the data to publish our Hydrologic Map Series (HMS) reports, Hydrologic Monitoring Reports, and Water-Level Change Map Series (WLCMS) reports. HMS reports contain maps and associated text describing the hydrogeology of a given groundwater basin. The maps show depth to water, contours of water table elevation, water level changes, flow direction of the groundwater, approximate boundaries of the main and sometimes lesser water bearing units (aquifers) in the basin, and water quality information. These published reports are a compilation and interpretation of the hydrologic data we have collected. HMR and WLCMS reports can be published for each basin, by AMA or on a statewide basis. The maps from both series are made for the public. See appendices C and D for guidelines for preparing these reports.

Other uses of the data we collect include but are not restricted to the preparation of groundwater models, numerous types of map construction, development of annual water budgets, determination of assured water supply, growth and development planning for both urban and rural communities and resource management (especially critical during drought conditions).

Who Uses the Data?

Aside from the ADWR, our data is used by a wide spectrum of professionals and non-professionals. Our data is used by other government agencies (on the federal, state and local levels), numerous municipalities and power providers, construction companies, consultants, attorneys, universities and students, developers and realtors, farmers, ranchers and land owners, drillers, and the general public.

Sales of real estate can frequently be dependent on the verification of the adequacy of the water supply. This information is not only valuable to sellers, but to buyers as well. Industries contemplating location within the state are generally concerned about the availability and suitability of the groundwater. Industries requiring large amounts of water are advised against locating in areas where water use is already in excess of recharge thereby protecting interests of both the industry and the existing water users. Well owners whose historically adequate water supply suddenly becomes inadequate may suspect that new use or overuse by nearby users is causing the problem and may seek relief through the legal system. In such a case, retained attorneys and consultants could make use of our publications and historical data. Banks often require certificates of adequacy before granting loans on land. Drillers are frequent users of our depth to water maps, especially in areas where they have not previously drilled.

Construction interests commonly need to know depth to water information (especially where deep basements or underground parking is planned). The list goes on and on. Environmental impact studies, the pollution of an aquifer and the resultant potential heath concerns require vast amounts of current and historical groundwater data. It is extremely important to know the depth of pollutants and which direction the contaminant (plume) is moving, when an aquifer is found to be contaminated and before the clean-up can begin. Water is important everywhere, but in an arid state like Arizona, it is vital that we be good managers and custodians of our groundwater. The problem is exacerbated by the almost uncontrolled growth and subsequent development the state is currently experiencing. Arizona now finds itself in the throes of an extended drought, and the data we collect is invaluable in assessing the drought’s impact.

Where Do We Collect the Data?

We collect data throughout the State of Arizona, with the exception of most Indian reservations, (where we work only with the approval of the individual Tribal Councils). It is our responsibility to provide current groundwater data for most parts of the state. We are just as responsible to the citizens of Willcox, Snowflake, Sonoita and San Simon as we are to those who live in Phoenix and Tucson. We are kept busy, but with the knowledge that we are being responsive to needs of all the people of Arizona and hopeful that our data will play an important part in securing Arizona's future.

The Importance of Quality Control

Without quality control, there can be questions regarding the integrity of the data. Incorrect data can result in misleading conclusions, inaccurate maps, models, management and ultimately in a loss of confidence in the unit. The job we do is important, and the data we collect is vital if the Department is to manage Arizona's groundwater resources properly. It is therefore imperative that we do the utmost to insure accuracy. First, the data must always be collected according to protocol with properly calibrated equipment. This however, is only half the job. The data, once collected, must be entered into the database (see Arizona Department of Water Resources, 2008). Great care must be taken when entering data, as this process can introduce many errors. Data entry accuracy in any business has always been a function of the diligence of those entering the data. It is extremely easy to misplace a decimal, or invert two numbers. It can easily happen, even to the most experienced of personnel. To combat this type of error, we have always used "field data sheets" which are filled out immediately after the data is collected. It is imperative for FSS personnel to double-check every measurement, correctly document their findings and relate it to previous measurement in order to find drastic changes, or possibly incorrect measurements. This type of double check should eliminate most field generated errors. When entering data into GWSI, if a water level differs from the previous water level by more that 10 feet, the computer automatically generates a warning. These types of checks are extremely important if we are to uphold the integrity of our database. It is not realistic to think that our database is perfect. Sometimes errors are made, however, it remains our goal to be diligent with our data collection, data entry and quality control as we strive to keep our database as accurate as possible.

Chapter III

NAVIGATION

Navigation is defined as the ability to control one's course. Perhaps the most important aspect of field work, regardless of the discipline, is knowing where you are. If you don't know where you are; any subsequent data that you collect is useless. Not to mention the fact that in Arizona's harsh summer climate, the result of becoming lost or disoriented can be fatal. For these reasons, it is extremely important that field personnel know "where they are". To this end, it is necessary that all field personnel are well acquainted with and become fluent with all of the navigational tools at our disposal.

It seems improbable that a trained Earth scientist could somehow be confused about where they are. However, as unlikely as it sounds, it can happen; and we have had to discard a considerable amount of data, simply because the "location of collection" could not be verified.

Maps

For decades, field hydrologists have used maps to guide them to well sites. Maps have traditionally been the only navigational medium available for field work. There are several types of maps at our disposal. We use road maps to guide us, in our travels, throughout the state. The road maps are scaled at 1:1,000,000 (1" = 16 miles). By using road maps, we can traverse the state and usually reach the general area we are looking for (i.e., assignment area). We also use another set of road/topographic maps. This set of maps is called the *Arizona Atlas & Gazetteer*. These maps are scaled at 1:250,000 (1" = 4 miles), and they offer a more detailed view, than the previously mentioned road maps.

When looking for a particular area, a map with greater detail must be used; these maps are known as Quadrangles or "topographic maps". These maps are prepared by the U.S. Geological Survey. A Quadrangle map covers four sided areas bounded by parallels of latitude and meridians of longitude. Quadrangle size is given in minutes or degrees. Work assignments (or working areas), are usually assigned by Quadrangles. That is, an individual is responsible for all the wells found within the area covered by a given Quadrangle. The first Quadrangles used by our office were the 15' maps, (15 minutes of latitude and 15 minutes of longitude). These maps are scaled at 1:62,000 (1" ≈ 1 mile). Most of the older 15' maps have now been replaced by 7½' maps, (7½ minutes of latitude and 7½ minutes of longitude). These maps are much more detailed than the 15' maps and are almost exclusively used for our field assignments. They are scaled at 1:24,000 (1" = 2,000 ft.).

Global Positioning System (GPS) Units

The advent of the GPS unit has greatly improved our ability to locate or orient ourselves in the field. Briefly, the GPS unit communicates with any one of numerous GPS satellites (in geosynchronous orbit), to tell the operator the current latitude and longitude of his/her position. By mounting the GPS unit in your field vehicle, your corrected latitude and longitude will continuously be displayed as you drive. Considering the fact that we work with maps delineated in degrees of latitude and longitude, the value of such an instrument is obvious. At any given time, you can pinpoint your location on the particular map you are working. This is extremely important as we commonly operate in areas where there are no discernable roads. We occasionally must go cross-country, or travel up washes, as it is the only way to get to an old abandoned well site. It is easy to become disoriented in these types of situations. However, with a functioning GPS unit, becoming lost is no longer an issue.

Horizontal Datums

Please take the time needed to determine how to set the horizontal datum. FSS will be collecting all latitude and longitude (in degrees-minutes-seconds format) in NAD27.

Laptops and PenTabs

Portable computers have made the life of the field hydrologist easier yet. The benefit of having your computer-housed database in the field with you is clear, but modern technology has again made field navigation easier. Some trucks are all outfitted with custom mounts to accommodate a laptop. These mounts allow us to see the screen of the computer as we travel (very similar to the arrangement in police cars). Our computers are downloaded with a software called *All Topo Maps: Arizona*. This software makes available (in electronic form), all the 7½ minute topographic Quadrangles in Arizona. The map upon which an individual is working can then be displayed on the computer screen. By attaching the GPS unit to the computer, the field person can follow his/her movements within their assigned area. An ArcMap project on your laptop will also have similar capabilities. This innovation should prevent field personnel from ever being lost or disoriented.

This arrangement also allows you to establish retraceable waypoints, or to program the latitude and longitude of a particular well(s). The GPS will then lead you to the desired well, as you follow your movements on the screen of the computer.

The new technology has certainly simplified field navigation, however it is not without its potential pitfalls. The most common of which is a difficulty seeing the screen of the computer in the bright Arizona sun. Another source of potential trouble arises when an individual spends a little too much time staring at the computer screen, and not enough time watching where they are going. You would be amazed how quickly you can drive into serious trouble (even at <5mph). The backcountry is loaded with ditches, washes, holes, cactuses, trees, posts, barbed wire fences, and occasionally mud. All these things have the potential to "ruin your day". The worst-case scenario would be gazing at your computer screen while driving on a road or highway and drifting across the center line. **Always exercise care and caution when navigating with the computer and watch where you are going!**

While off-road navigation with the GPS and computer have certainly simplified the lives of FSS staff, to become completely reliant upon these innovations, is to invite trouble. Both the GPS and laptops are sensitive electronic instruments and they can fail in the heat of an Arizona summer, or due to the "beating" they take in the backcountry. Should such a failure occur, the ability to read and be proficient with Quadrangle maps can at the very least allow you to continue your work assignment. The ability to read and fully understand a topographic Quadrangle map could save your life.

For this reason, it is mandatory that all field personnel be trained to read and interpret topographic maps and learn to navigate using them. This was the method used by field hydrologists for decades, and it is still a virtually foolproof way to navigate in the field. If for any reason your computer fails (and it eventually will), you must rely on your maps to navigate, and complete your assignment. Ultimately, your field maps may be the only navigational tool left to you, so make sure you have learned how to use them.

Summary

If you are well versed in the use of all methods of field navigation, you should never become disoriented in the field. Should your computer "go down", you can use the GPS to determine the latitude and longitude of your position. By plotting that point on the 7½ minute map, you can locate your position on the map. You may not know exactly where you are, but you won't be lost. If you can read and interpret the topographic Quadrangle maps, you can still navigate, even if your GPS should fail.

Our computer, GPS, and topographic Quadrangle maps are the tools of navigation. They all have their positives and negatives, but without them, we are truly lost.

Chapter IV

WELL LOCATION

Before a well can be properly inventoried (see Chapter IV), it must first be located and identified. Each well in the Groundwater Site Inventory (GWSI) has two unique identifiers; a site identification number (site ID) and a cadastral location (local ID). This chapter will deal with the protocols involved in locating and naming a well.

Site Identification Number

A site identification number or site ID is a unique 15-digit number assigned to one, and only one well. It is based on the latitude and longitude of the well in question. Once a site identification number has been assigned to a well, it is **never** changed for any reason.

In the interest of historical continuity, a bit of digression is necessary. The latitude and longitude of any well was originally determined by locating the well on a topographic Quadrangle (either 7½ minute or 15 minute), preferably a 7½ minute map, because of the greater detail. Some wells are already located and printed on the maps, with an associated well elevation. In this case, location of the well is already done, however, latitude and longitude still must be determined. Very few wells are pre-located on the maps, so it became the job of the field hydrologist to actually locate the well and mark its position on the map. This is not a difficult task, but it requires patience and a great deal of attention to detail. Once the well is located (and when back in the office), the latitude and longitude of the well can be determined. This determination is made using a transparent interpolation grid. By overlaying the map with the grid, and properly aligning it, the latitude and longitude of a particular well can be determined. There are two separate grids; one for 7½ minute maps, and one for 15 minute maps.

Well location became much easier and accurate with the development of orthophoto quads. The orthophoto quads are essentially aerial photos of the exact area covered by a given 7½ minute topographic Quadrangle and they are in nearly all cases, much more current. They are overlain with an imprinted latitude and longitude grid. The orthophoto quads became an immediate and invaluable tool for well location and subsequent latitude/longitude determination. Using orthophotos in the field made well location much easier. You could often see individual wells on the photo, and when you couldn't clearly see them, the well could usually be located by spotting trees, bushes, or other noticeable nearby features. The orthophotos greatly increased the certainty of accurate well location. Once located, a straight pin was used to make a pinhole in the photo at the determined location of the well. Once located on the photo, there was a permanent record of the well's location regardless of what future changes might be made in the area. Using the same transparent interpolation grids, the latitude and longitude of the individual wells (pinholes) could be determined. Once locations are determined, the appropriate notations are made on the back of the photo, at the proper pinhole.

So far, we have talked about latitude and longitude determination. As previously stated, the site identification number is based on the latitude and longitude of the well. The latitude (ex. 32º 45’ 15”) and the longitude (ex. 109º 15’ 31”) are combined to form the first part of the site ID. For example, the above hypothetical locations become 3245151091531. The suffix (01) is added to indicate that there is only one well at this location. So the official site ID of this hypothetical well becomes 324515109153101. There are rare occasions when more than one well or perhaps a piezometer nest is located at a particular latitude and longitude. In the case of two wells, (01) is attached to the oldest well, and (02) to the younger of the two. Generally, piezometer nests house 3 wells and the suffixes (01, 02, & 03) are attached, based on criteria such as depth, drilling order, etc.

When this unique site identification number is established for a site (well), it is never changed and all pertinent data in the database (GWSI), will be referenced to that number. It should be noted that the site ID, once determined, becomes an identifier, and should **not** be used as a locator. The thinking behind this is, that for any number of reasons, errors can be made when establishing the site ID. Numbers in the latitude or longitude can be transposed, or incorrectly recorded. The latitude or longitude may have been incorrectly determined in the first place, however those incorrect numbers become the basis for the site ID of the well. Making a simple transcribing error such as 108º instead of the actual 109º, would place the well miles from its actual location if you were using the site ID as a locator. You can easily see how using the site identification number as the location of the well could lead to problems. In many cases, the site ID is spot on to the actual latitude/longitudinal location, but it cannot be assumed, and is therefore not to be used as a locator.

Many years have passed since the previously mentioned methods were used to determine latitude and longitude of a well site. Portable (hand held) GPS units have replaced the old methods and are now exclusively used to determine the location of wells. The GPS is placed on the well and after stabilizing the location is saved. However, even though the GPS unit will, when properly used, give you an extremely accurate latitude and longitude, transcribing errors can still occur. For this reason, we still **never** use the site identification number as a locator.

Cadastral Location

When the physical location of a given well is determined, based on its latitude and longitude, a cadastral location [ex. (A-03-04) 25abc2] can be assigned. The well numbers and letters (cadastral location) used by the FSS , as well as the USGS, are in accordance with the U.S. Bureau of Land Management’s system of land subdivision (Cadastral system). The land survey in Arizona is based on the Gila and Salt River meridian and baseline, which divide the State into four quadrants. These quadrants are designated counterclockwise by the capital letters; A, B, C and D. All land north and east of the point of origin is in A quadrant. The land north and west is in B quadrant. The land south and west is in C quadrant and that south and east is in D quadrant. The first two digits of a well location indicates the Township, the second two digits, the Range, and the fifth and sixth refer to the Section in which the well is located. The lowercase letters a, b, c, and d after the section number indicates the well location within the section. The first letter denotes a 160-acre tract, the second the 40-acre tract, and the third the 10-acre tract. These letters are also assigned in a counterclockwise direction, beginning in the northeast quarter. In the example, well (A-03-04) 25abc2 is read as being located in the SW¼, of the NW¼, of the NE¼ of Section 25, Township 03 north, Range 04 east. If there is more than one well in a given 10-acre location, then numbers (ex. 1,2,3) are added as a suffix, in chronological order if known, with the oldest well being designated (1), and so on in order of age. If the chronologic order can't be determined, then the order will be arbitrary. A suffix number will not be used at all if only one well exists in the 10-acre tract, (for more information on the Cadastral system see Arizona Department of Water Resources, 2007).

Once the well is accurately located (using GPS generated data) on the proper 7½ minute topographic Quadrangle, the cadastral location can be determined by overlaying a transparent locator. This is a multiple scale locator which can be used to name all wells located within the Gila and Salt River meridian and baseline system.

Unlike the site identification number, the cadastral number is a locator, and can be changed if found to be incorrectly designated. With the benefit of GPS units and proper quality control, there should be very few newly generated erroneous well locations.

Whether you are attempting to assign a cadastral location to a well, or determine a site identification number, multiple wells in a given 10-acre location can be a source of confusion. As previously stated, suffixes are added to additional wells. In instances of more than one well within a 10-acre tract, it is unlikely that both the latitude and the longitude for each would be the same, especially now that we are using GPS units which report to the nearest tenth of a second. Therefore, the latitude and/or longitude for each well within a 10-acre tract should reflect a difference, either north-south or east-west, relative to one another. Although it might not seem important at the time of location, a photograph should be taken and a sketch should be drawn (on the back of the inventory sheet, see Chapter IV), showing the location of each well in relation to the other. In following years, attempts to duplicate water level measurements or water quality samples could be confused by the absence (destruction) of one or more of the wells at a single location. Perhaps the only way of identifying a remaining well or wells would be a photograph and/or a sketch of the original wells and some permanent landmarks.

Chapter V

WELL INVENTORY

The early part of any basin investigation involves a very important phase called the well inventory. Well inventory consists of the collection of information pertaining to individual wells. The inventory is conducted by the field personnel of the FSS. The first step in the well inventory is the determination of the location of the well (covered in detail in Chapter III).

When conducting an inventory, a **well inventory form** is filled out (Figure 1). This form, when properly filled out, will contain all pertinent “field” information regarding that individual well. This data will eventually be entered into the GWSI database, and the inventory form will be placed in the permanent well file along with all other pertinent data regarding that particular well.

An obvious question might be, “How do we find all these wells?” Many wells are pre-marked on the topographic Quadrangle maps. When working in a given area, visual observation will yield many other wells not shown on the topographic maps. You can sometimes find potential well locations by carefully inspecting the orthophoto maps. You should always visit old homesteads. From a lofty vantage point use binoculars to scan the area, looking for dirt mounds, old broken-down windmills, casing laying on the ground, old cable and isolated power poles. Ask ranchers, farmers, foremen, drillers and land tenants if they know of any old abandoned wells in the area, or any newly drilled wells. Search the GWSI for old wells entered by the USGS; wells that have not been visited by ADWR staff.

Basin and Date

When a new well is found, the first thing the field person does is record the date and the appropriate ADWR groundwater basin and sub-basin. The date that the inventory is conducted is extremely important. The inventory form will become an official State document, and without a date it is of diminished value. So always fill out the current date first.

Site ID

This is the only data line that should **never** be filled out in the field. As previously stated in Chapter III, this unique 15-digit number is to be determined in the office. The site ID data line is only used for new wells (those not in GWSI).

Well Location

Again, this information and the way it is derived was covered in detail in Chapter III. This information can be filled in, if known, at the time of inventory. If there is confusion regarding multiple wells in a given 10-acre tract, the proper suffix number can more easily be determined when back in the office. In the office you would have access to driller’s logs, GWSI, and 55-file information.

55 Number

This is a number assigned to registered wells, by ADWR. Unless you receive this information from the owner at the time of inventory, you would have no definitive way of obtaining it in the field. You should never match a 55 number to a well unless you are sure that the two belong together. It is better not to match a 55 number to a well, than to attach the wrong number to a well. This can best be accomplished in the office. **Since many wells are not registered, it is important to realize that some wells will not have a 55-number.**

Latitude and Longitude

Now that we have the benefit of GPS units, this information should always be filled out in the field. The first thing you do when you arrive at a well is to turn on the GPS and set it somewhere on the well. When the unit has stabilized (it can take a minute or two for the unit to acquire a satellite signal and become stable), you save the information in the GPS unit. It will be saved as a waypoint (ex. 045). You then record the latitude/longitude values and the waypoint number on the Inventory Sheet,. This allows you to quality control your latitude/longitude values when back in the office (before you enter the data into GWSI).

Topographic Quadrangle

This information is simply the full name and scale of the topographic Quadrangle map where you are working, (ex. Green Valley 7½’).

Topographic Setting

Fill in the description of the topographic setting where the well is located, (ex. valley flat, undulating, stream channel, hillside, etc.). See ADWR, 2006 for a list of topographic settings.

Altitude

Fill in the altitude as determined from the topographic Quadrangle map. Some wells have a surveyed value on the map. This value should be used when available. Otherwise you must interpolate the altitude of the well site. Before assigning an altitude value, you should scan the area to be sure that the well isn’t located in a high or a low that isn’t obvious on the topographic map. If this happens to be the case, adjust the interpolation accordingly. After recording the altitude, also record the accuracy (± ½ the contour interval). Altitude should always be determined while in the field, never in the office.

Water Use/Site Use

Note the water use and any pertinent factors that might affect the use. If the use is irrigation, you might note approximate number of acres irrigated, type of crop being irrigated, whether a sprinkler system, center pivot, or if gravity flow is used. If the use is domestic, try to note the number of families being served, number of houses or trailers, or if the use is public supply you might ask the number of accounts being served or the annual pumpage. The essential information is the actual water use, i.e. irrigation, domestic, public supply, stock, recreational, industrial, etc.

Pump Type/ HP/ Power Type

Note the type of pump such as turbine, submersible, piston (windmill or Jenson), etc. If the pump is a turbine, you will see a data plate somewhere on the side of pump. The horsepower of the pump will be listed on this plate. If the pump is a submersible, the horsepower will be shown on the starter box. Power types include; electric, gasoline, diesel, natural gas, wind, etc. If the well is, or was used for irrigation, check for indications of previous different power sources, such as natural gas mounts near a well that is now electric. This type of information is helpful in tracing historic pumpage data or in matching current wells to old wells.

Meter Number

The meter number assigned to the meter by the utility company is what you should record, rather than the meter manufacturer's serial number. The number you want is usually on a plate inside the glass meter housing on an electric meter and on a metal tab riveted to the cubic feet meter on a natural gas meter. These meter numbers are the key to identification of power use records, both past and present, and in the case of irrigation wells are extremely important. They are also frequently the only clue to matching old records to new records. It should also be noted whether the meter belongs to SRP, TGE, APS, etc., if known. In the case of domestic or public supply wells, the meter number is not nearly as important, but it should be noted and recorded if it is readily available.

Driller

If known, the drillers name is recorded (or it may be added later using a drillers log). This information would probably come from the owner.

Construction Method

This information is generally taken from a driller's log, and unless the owner provides the information, you would most likely never have this information in the field.

Date Drilled

Again, an owner can often supply this data. Sometimes the date is scratched into the concrete pad. There are many things that can be learned by being a "good detective" in the field.

Depth of Well

This is also data that generally will come from the driller's log if available. However, many owners may have this information. This information may be scratched into the concrete pad, so always check the pad carefully.

Casing Diameter

This is absolutely necessary information. You should never leave the well site without measuring the diameter of the well casing. This information can be vital when matching new well data to historical well data.

Casing Length

This information comes from Driller's logs and it is unlikely you will ever get this information when performing a well inventory.

Casing Circumference

There are times when you can't physically get a measure of diameter (due to pump sitting on top of casing, etc.), however you may be able to measure the circumference of the casing. Record this information, because the diameter can be calculated from the circumference.

Owner

If known, the well owner's name is recorded.

Log

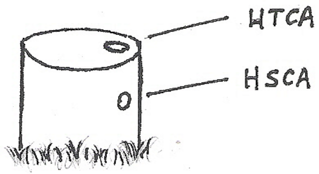
Generally, you will not have access to a log in the field, unless the owner lets you see their copy, or if they give you a copy.

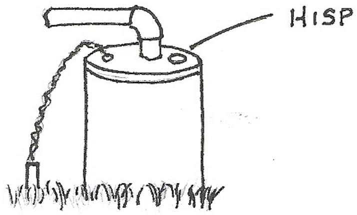
Depth to Water below Measuring Point and Remarks

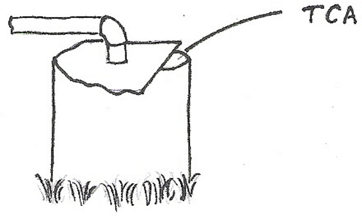
The number that you record here is the measured depth below the measuring point. **Note** this number (depth) is **not** the water level unless the measuring point height is 0.0' (see Chapter V, Water Level Measurement). Be sure to associate any measurement remakes, and include them on your form (pumping, cascading etc.)

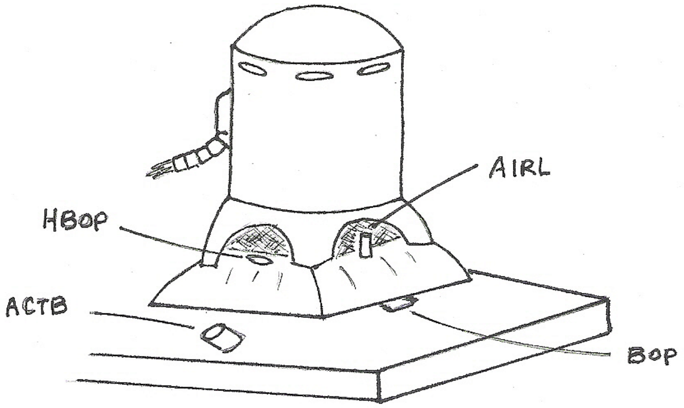
Measuring Point Description

This is the physical description of the location of the point where access for the sounder probe or steel tape was gained. Examples might be the top of casing, hole in pump base, a crack between wood timbers, slot between pump base and casing, hole in submersible pump plate, etc. Meaningful abbreviations, such as TCA for top of casing, HBOP for hole in base of pump and HISP for hole in submersible pump plate are generally used. See Figure 2 for a full list of access descriptions and abbreviations. Frequently, more than one access hole is available and sometimes when only one of several access holes allows access to the water table, it becomes necessary to identify which point should be used for the current and all future measurements. An example might be a hole in pump base, west side (HBOP,w), or slot under pump base, northeast corner (BOP,ne), etc. Some pumps have completely enclosed pump bases with the only access holes hidden inside. Some of these pumps have a plate which is held in place by four screws. By removing the screws, the plate can be removed and access may be gained, (always replace the plate when you are finished). Inspect pump installations carefully for access, especially when the measurement is badly needed.









HTCA, w	Hole in top of casing, west side
HSCA, n	Hole in side of casing, north side
TCA, se	Top of casing, southeast side
HBOP, s	Hole in pump base, south side
BOP, n	Access under base of pump, north side
ACTB, s	Access (measuring) tube, south side
HISP, ne	Hole in submersible cap plate, northeast side
AIRL, w	Airline, west side
STB	Sounding tube (PVC)

Figure 2: Measuring Point (Access Hole) Descriptions The access hole in the pump base may be filled with debris (by digging around with a long screw driver or metal rod, the access hole can often be found). Sometimes you may find a slot between the concrete pad and the pump base or a small crack between the top of the casing and the plate that covers the casing. It is incumbent upon each field person to fully inspect the pump for possible access holes. Look carefully and take your time, you will often find an access hole where you didn't originally see one. **Note!** We often measure wells that have been measured before. When this is the case, **always try to use the same access hole from which the previous measurement was made.** This information is available in GWSI (in your PenTab) or on the water level printouts we always carry in the field. If this is impossible, you must try to find another access hole, accurately describe it, and note the reason for the change. This is extremely important!

Measuring Point Height above Land Surface Datum (LSD)

This is the measured height (rounded to the nearest 0.5'), from land surface to the point of access (access hole). If you are measuring a well that has been previously measured, use the same measuring point height as previous. This information will be available in GWSI (in your PenTab), or on the water level printouts that we always carry in the field. The only exception to this rule would be an actual physical change to the pump or pump base, or the need to use an alternate access hole, due to blockage, etc.

Method of Measuring

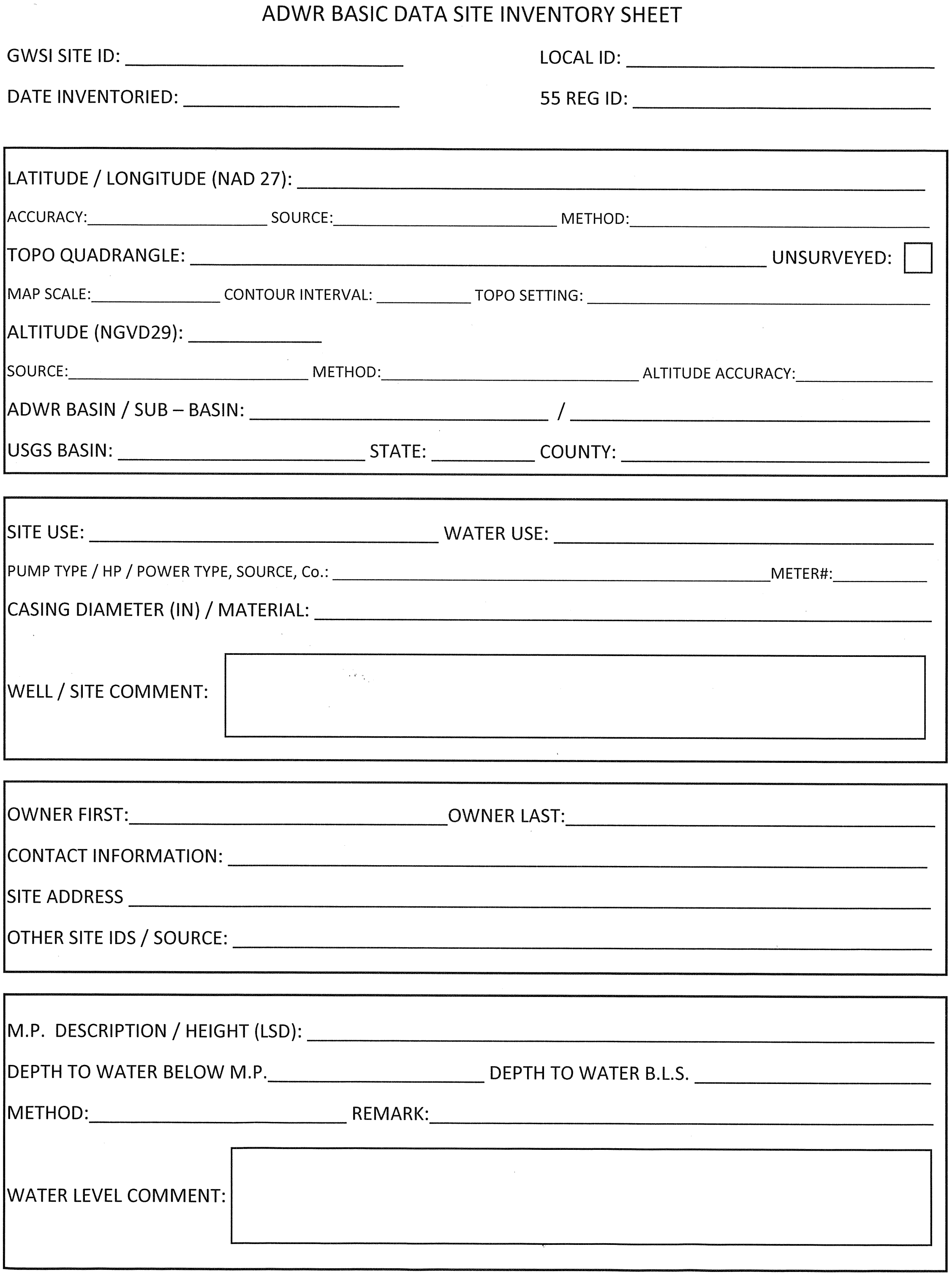
You record the type of instrument that you used to make the water level measurement. In nearly all cases, this will be either the sounder (V) or the steel tape (S). The exception would be an electric tape (T), which is used for measuring water levels in sounding tubes at transducer sites.

Sketch

If there is more than one well at the site, or if the well is hard to find, always draw a sketch on the back of the inventory sheet. Always use a north arrow, note landmarks, trees, power poles, etc., and measure distances so that subsequent inquiries may easily be solved.

Field Checked By

Always print your name at the bottom of the field inventory sheet. The well inventory form is one of the most important documents that field hydrologists and technicians use while conducting an investigation. The accurate reporting of all possible data can be of incalculable value a year, two years, or maybe even ten years down the road. Always be diligent and thorough in your investigation. If something seems important, write it down.



ADWR BASIC DATA SITE INVENTORY SHEET

GWSI SITE ID: ____________________ LOCAL ID: ____________________

DATE INVENTORIED: ____________________ 55 REG ID: ____________________

LATITUDE / LONGITUDE (NAD 27): ____________________

ACCURACY: __________ SOURCE: __________ METHOD: __________

TOPO QUADRANGLE: ____________________ UNSURVEYED: ☐

MAP SCALE: __________ CONTOUR INTERVAL: __________ TOPO SETTING: __________

ALTITUDE (NGVD29): __________

SOURCE: __________ METHOD: __________ ALTITUDE ACCURACY: __________

ADWR BASIN / SUB – BASIN: __________ / __________

USGS BASIN: __________ STATE: __________ COUNTY: __________

SITE USE: ____________________ WATER USE: ____________________

PUMP TYPE / HP / POWER TYPE, SOURCE, Co.: ____________________ METER#: __________

CASING DIAMETER (IN) / MATERIAL: ____________________

WELL / SITE COMMENT: ☐

OWNER FIRST: ____________________ OWNER LAST: ____________________

CONTACT INFORMATION: ____________________

SITE ADDRESS ____________________

OTHER SITE IDS / SOURCE: ____________________

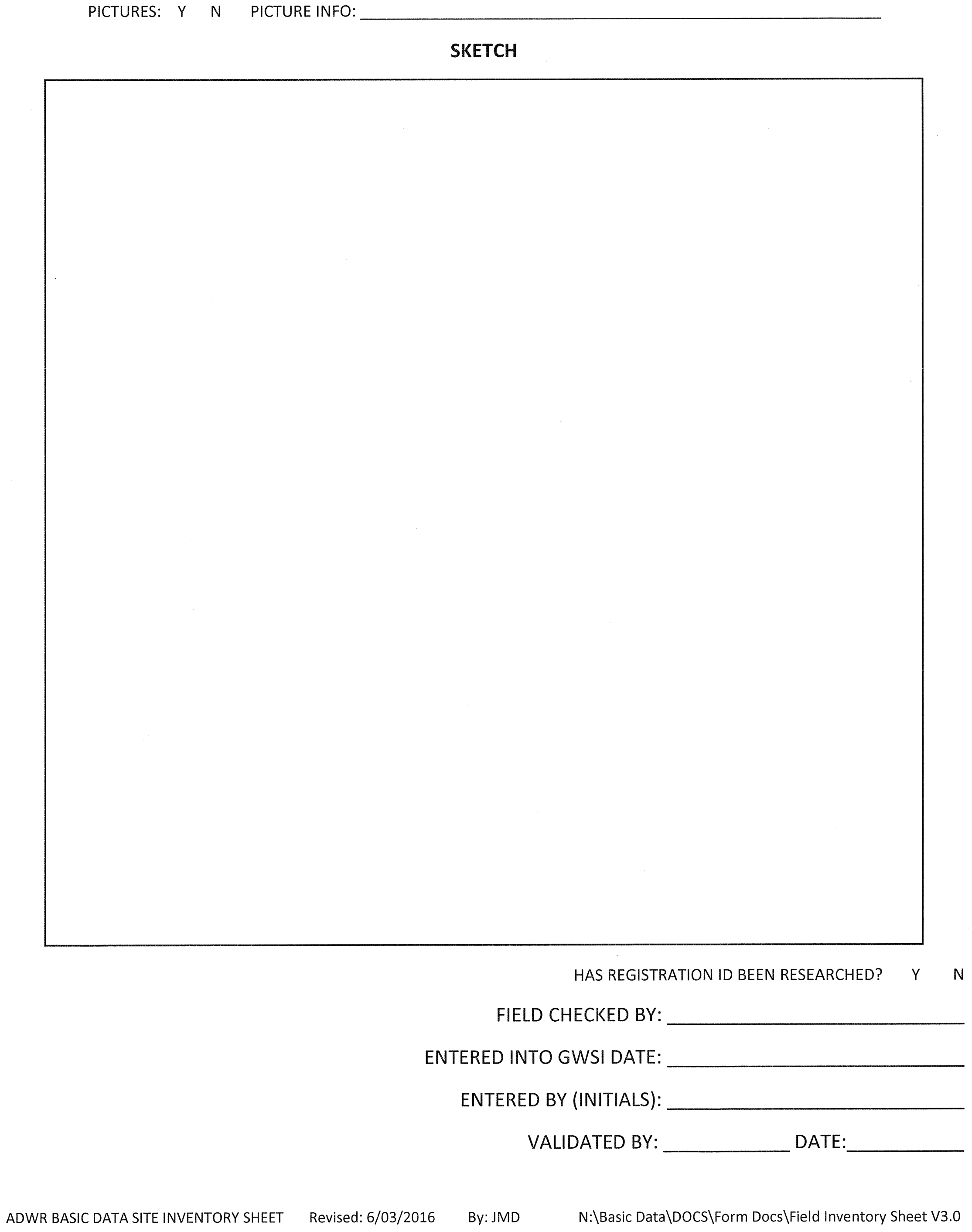
M.P. DESCRIPTION / HEIGHT (LSD): ____________________

DEPTH TO WATER BELOW M.P. __________ DEPTH TO WATER B.L.S. __________

METHOD: __________ REMARK: __________

WATER LEVEL COMMENT: ☐

Figure 1: Well Inventory Form



PICTURES: Y N PICTURE INFO: ____________________

SKETCH

HAS REGISTRATION ID BEEN RESEARCHED? Y N

FIELD CHECKED BY: ____________________

ENTERED INTO GWSI DATE: ____________________

ENTERED BY (INITIALS): ____________________

VALIDATED BY: __________ DATE: __________

ADWR BASIC DATA SITE INVENTORY SHEET Revised: 6/03/2016 By: JMD N:\Basic Data\DOCS\Form Docs\Field Inventory Sheet V3.0

Figure 1: Well Inventory Form

Chapter VI

MANUAL WATER-LEVEL MEASUREMENTS

Water levels are the measurement of the distance from the land surface down to the top of the water table. The collection of high-quality water-level data is dependent upon specific measurement techniques and the use of properly maintained and calibrated equipment. In a non-pumping well, these measurements are called static levels. In a pumping well, the resultant measurement is called a pumping level. The vast majority of the water levels we collect are static levels, but pumping levels are important, and we do, at times, measure pumping levels. In this chapter, it will be assumed that all the methodology discussed will pertain to static water levels. There are three instruments that we use to measure water levels: the electric tape, the steel tape, and the electric sounder. They all have strengths and limitations. Electric tapes and steel tapes are usually more precise than electric sounders, but electric sounders are generally more robust than steel tapes, and steel tapes are generally more robust than electric tapes.

Steel Tape

The first 20 feet of our steel tapes are graduated in hundredths of a foot. It is this part of the tape that is used to determine the water level. Before the tape is inserted into the well opening, a small weight is attached to the end of the tape and the graduated part is coated with chalk. The depth to water is obtained by lowering the tape to a predetermined footage so that the lower few feet of tape are submerged in the water. The tape is quickly removed from the well and the water level is determined by subtracting the length of wet tape from the predetermined footage (amount of tape lowered into the well).

Example	100.00’	(tape lowered into well)
	-9.15’	(length of wet tape)
	90.85’	(depth to water)

If the general depth to water is not known, trial and error will be necessary before an initial water level can be determined. Once the initial water level is established, the measurement must be re-done until repeatable. All water levels obtained with the steel tape must be repeated to insure accuracy.

Steel tapes are often used when the use of an electric tape or sounder is not feasible. Examples include wells where the access hole is too small to accommodate the probe (of the sounder). The steel tape can be slipped into small openings and cracks that the electric sounder would never fit into. The steel tape is also used to obtain an oil measurement. Another common application for the steel tape is to obtain water levels in shallow wells where the water table can be seen.

The steel tapes that we use are 500-foot tapes as well as 250-foot tapes, so an obvious limitation is that we can't measure a water level that is greater than 500 feet. Another disadvantage of the steel tape is that it cannot be used when cascading water is present in the well casing because the chalk will be removed. When the water level is deep, a lot of time and energy can be spent obtaining an accurate measurement. In wells equipped with electric-powered submersible pumps, a steel tape may cut through the insulation on the electric power wires. This is a safety hazard, which could result in a severe shock, electrocution, and/or pump failure. Using the steel tape to measure deep water levels in equipped wells is discouraged. The tape may become wedged or hung-up. Pulling on the tape can result in a break, which renders an expensive instrument worthless. Should such a break occur, the broken part of the tape may fall down the casing of the well and become entangled in the pump bowls. This can result in pump failure. To sum up, the steel tape, like all tools has its limitations, but when used properly, in the appropriate application, there should be no reluctance to use it. The steel tape is an invaluable tool, and an irreplaceable part of the field hydrologist's arsenal.

Electric Tape

Electric tapes are used on the transducer project and are used only in wells with sounding tubes and in shallow wells were the water table is visible. Four electric tapes manufactured by Waterline Envirotech LTD are available for use – two 500-foot tapes and two 1500-foot tapes. These tapes have two stainless steel electrodes that complete an electric circuit when they are in water (Figure 3). The first electrode to contact the water is the stainless-steel tip, and the second electrode to contact the water is the stainless-steel tubing. The circuit is completed when the bottom of the tubing contacts the water. When this happens, a buzzer and/or LED is activated to indicate the water level has been contacted. Moving the probe fractionally up and down, while noting the selected indicator, usually allows measurements to be precisely determined to the nearest 0.01 foot.

Function Switch

This switch has four settings: off, test, LED, and buzzer. When not in use the setting should be in the off position. The test position allows you to test the charge of the battery and the function of the electronic circuitry. When set to LED, the LED light will be activated when the circuit is complete. When set to buzzer, the buzzer will be activated when the circuit is complete.

Sensitivity Switch

The "LO" position is used for high salinity water. The "HI" position is used for very pure water.

Battery

The tapes require a 9-volt battery to operate. When not in use, turn the function switch to off to keep the battery from draining.

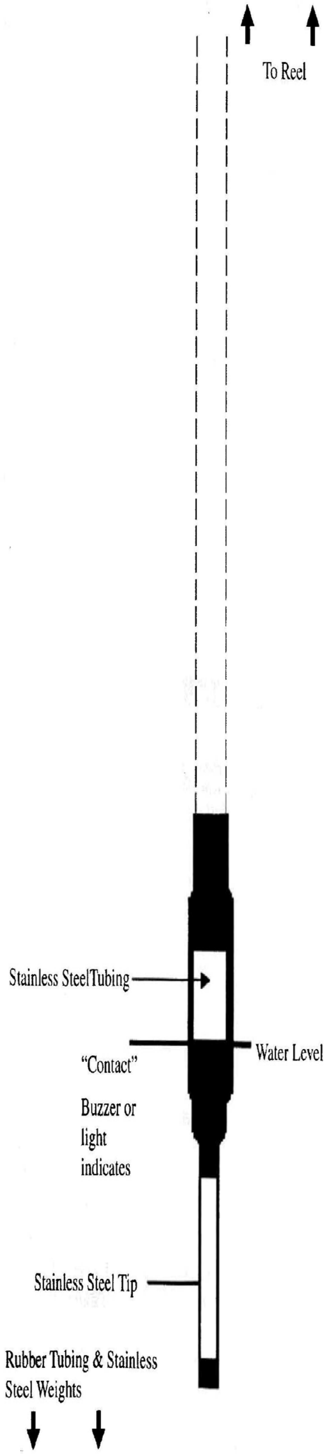


Figure 3: Electric Tape

Operation

1. Before inserting the probe into a well, the function switch should be set to test; this activates the LED and buzzer. If this does not work, then turn the sensitivity switch to HI and try again. If it still doesn't work, then replace the battery and try again.
2. Clean the electrodes. It is common to have a thin film of dirt form on the electrodes that may make it impossible for the electric circuit to be completed when the electrodes are in water.
3. Select the preferred indication. For most users and applications this will be buzzer. Occasionally, because of noise such as traffic at a busy intersection, it is hard to hear the buzzer and it may be easier to set the indicator to LED.
4. Set the sensitivity to HI.
5. Gently lower the tape into the sounding tube. Never let the electric tape free fall; when the free fall stops the weight of the tape may cause it to be permanently stretched and damaged. This is important because electric tapes do not have the tensile strength of our sounders. It is easy to permanently damage an electric tape by stretching it.
6. When the indicator is activated, then slowly reduce the sensitivity until the indicator is just deactivated, then increase the sensitivity about ¼ turn. This is generally an ideal setting to get precise measurements. If the sensitivity is too high, it is easy to get false readings when the stainless-steel tubing contacts condensation on the side of the sounding tube. If the sensitivity is too low, it is possible to have the stainless-steel tubing in the water without the indicator being activated.
7. Raise and lower the tape by small increments and observe the indicator until the measurements are precise to about 0.01 foot. If this does not seem possible then raise or lower the sensitivity by about ¼ turn and try again until the desired precision is attained.
8. Turn the function switch to off and neatly rewind the tape.

Troubleshooting

Installing a fresh battery will eliminate most problems.

1. Continuous signal
    - i. Thoroughly clean and dry the electrodes.
    - ii. Check the sensitivity setting.
    - iii. Inspect the electrodes and tape for damage which might cause a short.
2. No signal
    - i. Make sure the function switch is in the correct mode.
    - ii. Set the sensitivity to HI.
    - iii. Inspect the tape for damage.

Electric Sounder

The electric sounders used by the FSS consist of an all aluminum reel that can hold in excess of 2000 feet of 22-guage insulated (military communication wire) wire, a battery-powered meter box, a probe and a ground wire. The probe is attached to the sounding wire, which is connected through the reel and a brush system to the meter box, which is connected to ground. When the probe enters the water, an electrical circuit is completed and a deflection is indicated on the meter box. When using an electric sounder, water levels are generally measured to a precision of about 0.1 foot.

The Calibrated Wire

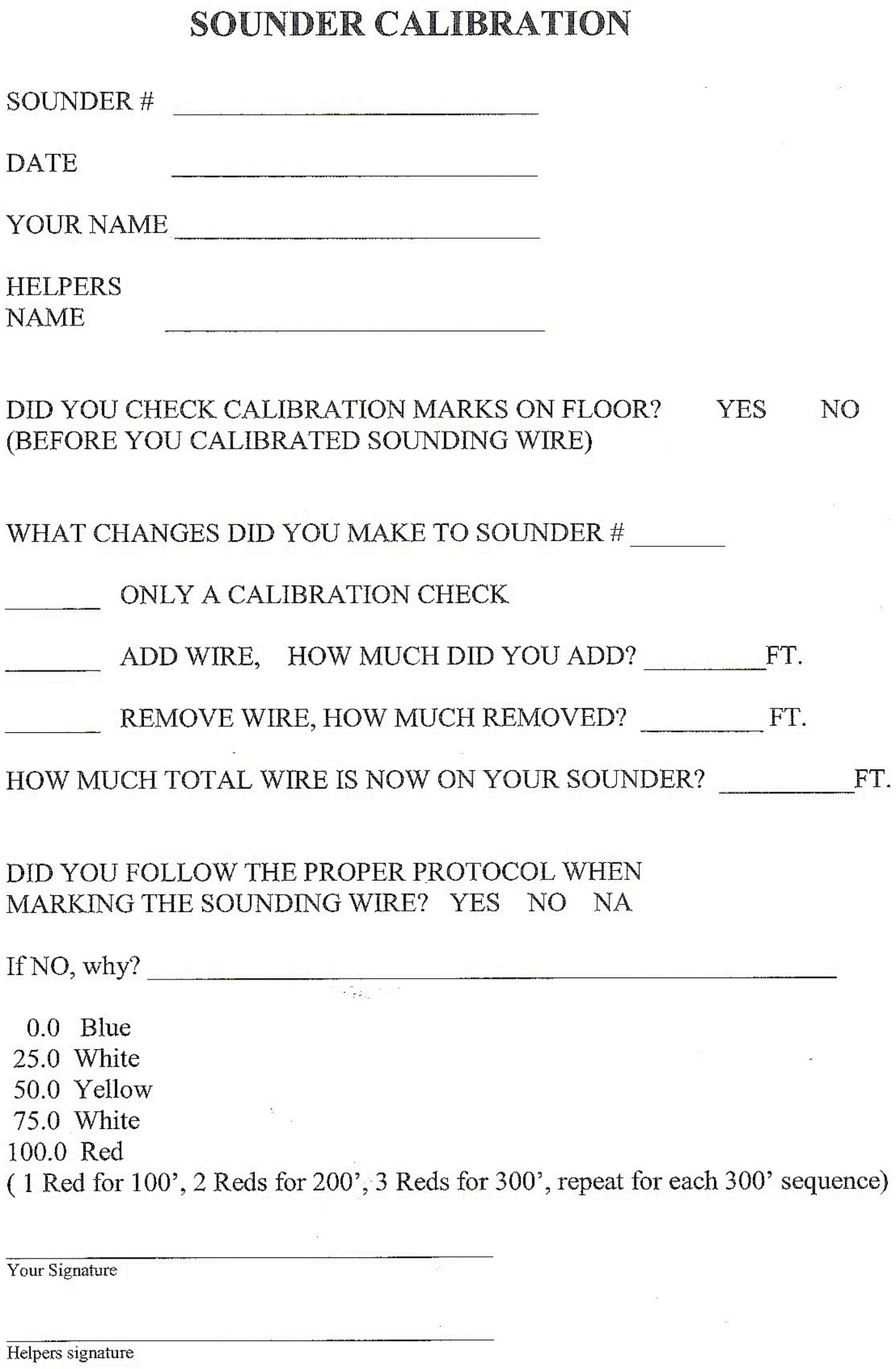
The sounder wire is calibrated using a steel tape and marked at 25-foot intervals using different colored three-quarter inch plastic tape. The 100-foot marks on the sounder wire are an obviously recognizable and distinguishable sequence from 0 to 300 ft. The same sequence is repeated for the interval from 400 to 600 ft., from 700 to 900 ft., from 1000 to 1200 ft., and so on for the entire length of sounder wire used. The following scheme must be followed.

Distance	Color
0	Blue
25	White
50	Yellow
75	White
100	Red
125	White
150	Yellow
175	White
200	Red Red
225	White
250	Yellow
275	White
300	Red Red Red

The above 300-foot sequence is repeated and marked the same way for each additional 300 feet of sounder wire used.

All sounding wire is marked at 25-foot intervals, and the reference point for measurements is **always the down hole side of the down hole mark**.

All sounders are numbered, and a companion equipment book is kept with the sounder. The equipment book is kept current for each sounder. The contents of the book include the sounder calibration form (figure 4). This form must be completed for each calibration of all sounders.



SOUNDER CALIBRATION

SOUNDER # ____________________________

DATE ____________________________

YOUR NAME ____________________________

HELPERS
NAME ____________________________

DID YOU CHECK CALIBRATION MARKS ON FLOOR? YES NO
(BEFORE YOU CALIBRATED SOUNDING WIRE)

WHAT CHANGES DID YOU MAKE TO SOUNDER # _______

_______ ONLY A CALIBRATION CHECK

_______ ADD WIRE, HOW MUCH DID YOU ADD? _________FT.

_______ REMOVE WIRE, HOW MUCH REMOVED? _________ FT.

HOW MUCH TOTAL WIRE IS NOW ON YOUR SOUNDER? __________FT.

DID YOU FOLLOW THE PROPER PROTOCOL WHEN
MARKING THE SOUNDING WIRE? YES NO NA

If NO, why? ____

0.0 Blue
25.0 White
50.0 Yellow
75.0 White
100.0 Red
(1 Red for 100’, 2 Reds for 200’, 3 Reds for 300’, repeat for each 300’ sequence)

____
Your Signature

____
Helpers signature

Figure 4: Sounder Calibration Form

The Probe

The sounder probe used by ADWR is designed to minimize measurement errors caused by cascading water. Cascading water is not always obvious by sound. A number of assumedly accurate water level measurements made with steel tapes by the USGS during the late 1950's and early 1960's were later found to be inaccurate due to cascading water. A probe was developed to solve this problem.

At FSS, we use a very similar probe to the original design developed by the USGS. We use a 16" length of 3/8" vinyl PVC tubing, a 24" length of 18 gauge insulated wire, #7 steel shot and ½" lengths of plastic tubing (plugs), to construct our probes, (Figure 5). When first packed, the vinyl tubing will be curved and need to be straightened. This can be accomplished in several steps:

- First, the probes should be massaged to tightly pack the shot into the bottom of the probe; this will leave more room at the top of the probe to add additional shot.
- Second, heating the probe with a hair dryer can take some of the curvature out of the probe.
- Third, packing the probes tightly together into bundles with rubber bands and leaving them to rest for a few days can help straighten the probes.
- Fourth, inspect the probes to make sure they are ready to use.
    1) First, make sure the probe is tightly packed with shot. A good way to make sure the probes are tightly packed is to hold them upright and tap the bottom end of the probe onto a desk top. If the probes are not tightly packed, there will be room at the top of the probe to add additional shot.
    2) Finally, make sure the wire tip is not protruding from the vinyl tubing. New employees should work closely with their supervisor to make sure that their probes are being constructed properly.

The probes are designed so that a ¾" to 1" shroud (of PVC vinyl) protects the bare wire at the tip of the probe, and thereby eliminating false readings on the meter box. This simple, but effective development has made it possible to accurately measure thousands of water levels in wells where cascading water is present. One of the advantages of this probe is that it is designed to be disposable. It is attached to the sounder wire in such a way as to be the "weakest link in the chain". If it becomes hung-up while removing the sounding wire from the well; it will pull off with a simple pull on the wire. It is far better to lose one probe than to potentially lose hundreds of feet of wire down a well. After the sounder has been strung with calibrated wire, a probe is attached and the tare (including length of probe) is accurately measured and recorded in the equipment book.

PROBE SPECIFICATIONS

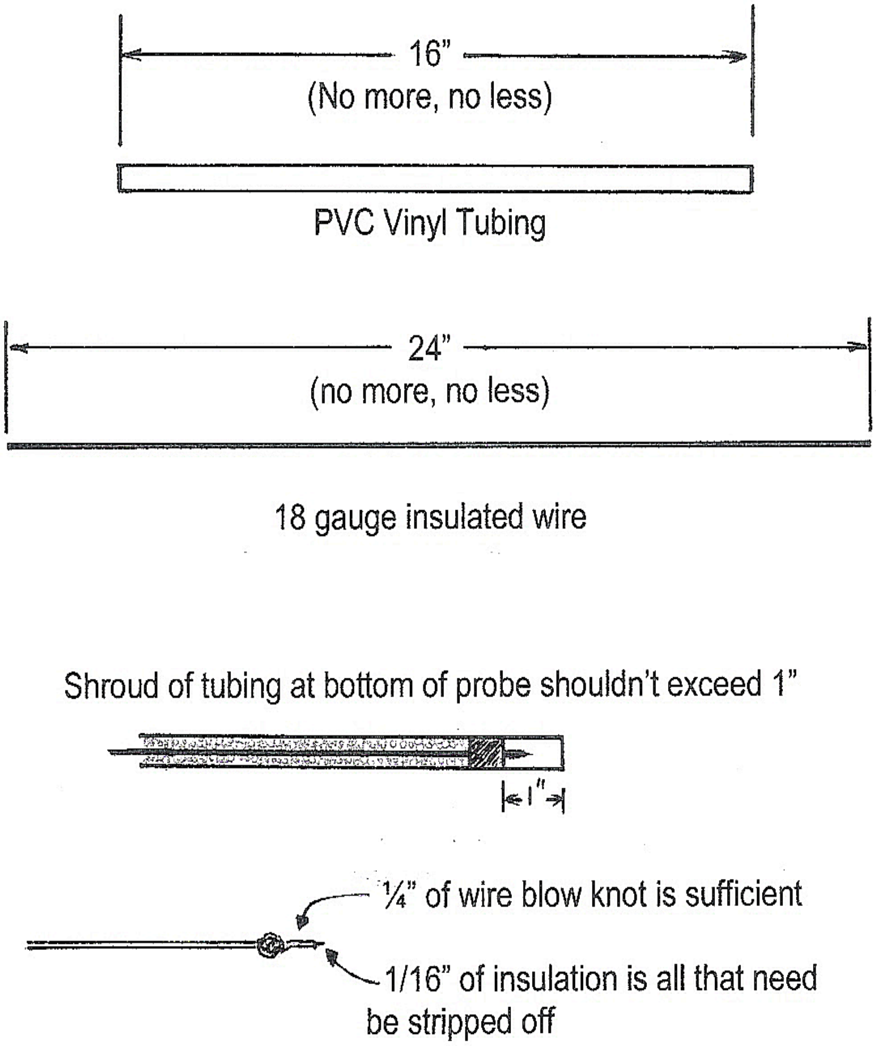


Figure 5: Probe Specifications

Operation

A measurement may be obtained once the probe has been lowered into the water. At this point, an electrical circuit will have been completed and the needle on the meter will be deflected. The sounding wire is very slowly pulled out of the water until the circuit is broken. This can be noted by watching the needle, (when it falls, the circuit is broken, meaning the probe is no longer in the water). By very slowly lowering and raising the sounding wire, the surface of the water table can be pinpointed. **Note!** The point from which you measure is **always** determined coming out of the water, **never** going into the water. By measuring from this point on the wire to the nearest 25-foot mark, an offset distance can be calculated by either adding (if the measured point is above the closest 25-foot mark), or by subtracting (if the measured point is below the closest 25-foot mark). The offset distance and tare are added to obtain the depth to water measurement. The measurement is then repeated to insure a precision of about 0.1 foot. The measuring point is generally above the land surface. If this is the case, by subtracting the height of the measuring point from the depth to water that has just been determined, you will obtain an accurate measurement of the depth to water below land surface at that particular well, (if below land surface, you add the measuring point distance).

When using an electric sounder, always keep the unit sitting on a dry area. If you are working in wet weather, carry some dry wood to sit the sounder on. Do not let the sounder touch any metal around the well. Sounders can short out when touching the well casing or being set on wet ground.

When lowering or removing the sounding wire and probe in a well, it should be done very slowly so that “tight spots” can be noticed and negotiated. When lowering, the “tight spots” are noted so that care can be taken when removing the sounding wire. A second advantage of slowing lowering the sounding wire and probe is that it gives the field person the opportunity to inspect the markings on the wire and determine whether they may have slipped and/or need repair or replacement. **Note!** Tape can slip after repeated use or become susceptible to slippage after coming in contact with oil.

A good general practice is to gently “snap” the sounding wire every 50’ when lowering it into a well. This will allow the operator to tell if the probe is hanging free, or if it is hung-up. **Note!** Always know the length of the tare, before sounding for a water level. This is important because the probe may be lost while retrieving the sounding wire. Sounding wire should be reeled into and out of the well and not allowed to accumulate on the ground. This can easily lead to tangles and kinks (which lead to weak spots), in the sounding wire.

Oil Measurements

Oil-lubricated turbine pumps typically have an oil film on top of the water column. Care should be taken that the oil does not foul the probe as it passes through the oil before entering the water. If several feet of oil floats on the surface of the water, it is better to use a steel tape and record the oil level, rather than record the water level at the base of the "oil column". For example, assuming that there is ten feet of oil, the upper surface of the oil will be within 1.4 feet of the true water level; the oil-water contact on the other hand will be 8.6 feet deeper that the true water level. However, it is possible to obtain a much more accurate water level when dealing with an oil-water interface. To adjust the depth to water measurement for the effect of the oil column, the height of the oil column must be determined. The top of the column can generally be measured with a steel tape and the oil-water contact can be measured with an electric sounder. By subtracting the depth of the oil measurement from the depth of the oil-water contact measurement, you can determine the height of the oil column. The height of the oil column is then multiplied by 0.86 (constant), to obtain the height of a water column of equivalent weight. Although this coefficient ranges from 0.85 to 0.88, depending on the type of oil, 0.86 represents an average value for oils typically used to lubricate turbine pumps. The height of the water column is then subtracted from the depth to the oil-water contact. For example:

Depth to top of oil (using steel tape) = 132.6 ft.
Depth to oil-water contact (using sounder) = 147.3 ft.
Height of oil column
147.3 ft. - 132.6 ft. = 14.7 ft.
Height of oil column X 0.86 = 12.6 ft.
Depth to oil-water contact
minus 12.6 ft. = 134.7 ft.
Depth to water adjusted for the
Effect of the oil column = **134.7 ft.**

Recording of Water-Level Data

When recording depth to water data, it is extremely important that the date and type of instrument used is recorded. The code for steel tape is "S", "T" for electric tape, and "V" for electric sounder. Other data that must be accurately recorded is the description of the measuring point and the height of the measuring point above/below the land surface. Unless there have been physical changes to the measuring point since the last measurement, you should always use that which was previously used for continuity.

Decontamination of Probes and Tapes

Water-level measuring instruments can become contaminated after use. It is good practice to clean the equipment regularly. All parts of the equipment that come into contact with the well water should be cleaned. Oil and grease can be easily cleaned using soapy water. Biological microbes can be killed using a dilute bleach solution. For wells used for drinking water, it is required that the equipment be cleaned before taking the measurement. A dilute bleach solution that is at least 1-part bleach per 10 parts tap water is acceptable to spray onto the equipment, then rinsed using a spray bottle of tap water. For wells that are located within areas of known contamination, all parts of the equipment that have come into contact with the well water must be cleaned immediately after the measurement using Alconox and then rinsed with tap water. The wash water from contaminated sites must be collected and handled in accordance with federal, state, and local laws or regulations.

Calibration

Water level measuring instruments require periodic calibration. The frequency of their calibration varies depending upon the instrument. The steel and electric tapes should be calibrated no less than once per year. The electric sounder should have a full calibration once a year, with a simple field calibration taking place daily, when the instrument is in constant use.

One **dedicated steel calibration tape is kept in the office at all times** as a reference. This tape is never used to measure water levels in wells. It is used as a “standard” for the calibration checks of all the other tapes and sounders.

At the time a sounder is strung, you are in effect performing the initial calibration. Once checked, the sounding wire is marked by variously colored 3M plastic tape. A new 25’ calibration table is now in use as opposed to traditional methods. The measured and calibrated edge of the tape is the down hole (probe) end of the sounding wire. The sequence for marking the sounder wire shall always be the same. That sequence is described earlier in this chapter.

A **master calibration book** and the reference steel tape are kept by the FSS Supervisor. Each time a sounder is strung, re-strung, has wire added, or is simply checked for calibration; the sounder number, the date, and the amount of wire added, and the names of the staff members performing the calibration is recorded in the book (Figure 4).

When working in the field, there is a simple field calibration that should be performed daily or at any time that the user has reason to believe that his or her sounder may be out-of-calibration. For example, if you think the length of wire has changed due to extended use, or because of applying extended tension to wire has become hung during retrieval. An “easy to measure” well should be selected that is representative of the general water levels in the area you are working. Attach a small lead weight to the end of the steel tape and make a water level measurement. Repeat the measurement to assure accuracy. You then measure the well with the electric sounder. If the sounding wire is properly calibrated, the difference between the two measurements should be less than 0.1 foot per 100 feet of depth to water. Record the time, date, and depth to water of the steel tape and the sounder in the **equipment book**, of the sounder you are using.

Anytime a new probe is attached, you immediately measure the new tare, the distance between the down hole edge of the blue tape, and the exposed tip of wire in the shroud of the probe. This is in effect a mini-calibration and should be recorded on a piece of paper somewhere in your vehicle or tool bag. This “tare” will be added to the total length of your measurement. Record the length of the new tare, along with the date and time. This provides you with an accurate reference, until a new probe is attached, at which time the procedure is repeated. By recording this measurement, you are assuring that you will never forget the tare.

The reference steel tape is used to check the calibration of other steel tapes and electric tapes. This calibration technique is taken directly from Oregon District (USGS) Ground-Water Technical Note N0. 3, (2003). An unobstructed area with a flat surface is needed to lay out the tapes. We currently use the same 25’ calibration table. The reference tape needs to be secure at both ends using appropriate hardware. Secure both ends of the tape and apply 20 pounds of tension. Unreel the field tape and align the zero marks of the two tapes and secure the field tape applying 20 pounds of tension. It is critical to apply the correct tension. Straighten and align tapes as needed with the tapes as close together as possible. Record observations at intervals no greater than 25% of the entire length of tape (100-foot intervals should suffice). At each observation point on the master tape, record the field tapes values. Compute the interval and the cumulative difference between the master tape and the field tape. Determine the accuracy standard for the tape. For example, steel field tape measurements should be within +/-0.01% of the master tape value, therefore there should be differences of no more than +/-0.005 feet (0.0001 ft. X 50 ft.) for each 50-foot interval, or twice the values for 100-foot intervals. Attempt to isolate the location of any discrepancies exceeding the standard to within an interval equal to 5% of the overall tape length. For example, 5% of a 200-foot length would be 10 feet; if a difference exceeding 0.005 feet was found in the 50 to 100-foot interval, check measurements should be made at 10-foot intervals from 50 to 100 feet to try and isolate the part of the tape where the 0.005 difference is located if possible. Release tension on tapes and rewind onto reels and fill out check sheets and record findings in the **master calibration book**, (Figure 6) If the tape is found to be within acceptable tolerances, the date for the next check is recorded and the tape may be released for further field use. If the instrument failed to meet the accuracy standard, a determination by FSS supervisor will determine whether the instrument should be repaired or retired.

ADWR/FIELD SERVICES SECTION
SOUNDER CALIBRATION CHECK SHEET

Inspected by:	Field Instrument/ID #	Date

Sounder Reading	Reference Reading	Cumulative Difference	Sounder Reading	Reference Reading	Cumulative Difference
0.0	0.00	0.00			
25.0			625.0		
50.0			650.0		
75.0			675.0		
100.0			700.0		
125.0			725.0		
150.0			750.0		
175.0			775.0		
200.0			800.0		
225.0			825.0		
250.0			850.0		
275.0			875.0		
300.0	0.00		900.0	0.00	
325.0			925.0		
350.0			950.0		
375.0			975.0		
400.0			1000.0		
425.0			1025.0		
450.0			1050.0		
475.0			1075.0		
500.0			1100.0		
525.0			1125.0		
550.0			1150.0		
575.0			1175.0		
600.0	0.00		1200.0	0.00	

COMMENTS, RECOMMENDATIONS & CALCULATIONS:

ADWR/FIELD SERVICES SECTION
SOUNDER CALIBRATION CHECK SHEET

Inspected by:	Field Instrument/ID #	Date

Sounder Reading	Reference Reading	Cumulative Difference	Sounder Reading	Reference Reading	Cumulative Difference
1225.0			1825.0		
1250.0			1850.0		
1275.0			1875.0		
1300.0			1900.0		
1325.0			1925.0		
1350.0			1950.0		
1375.0			1975.0		
1400.0			2000.0		
1425.0			2025.0		
1450.0			2050.0		
1475.0			2075.0		
1500.0	0.00		2100.0	0.00	
1525.0			2125.0		
1550.0			2150.0		
1575.0			2175.0		
1600.0			2200.0		
1625.0			2225.0		
1650.0			2250.0		
1675.0			2275.0		
1700.0			2300.0		
1725.0			2325.0		
1750.0			2350.0		
1775.0			2375.0		
1800.0	0.00		2400.0	0.00	

COMMENTS, RECOMMENDATIONS & CALCULATIONS:

ADWR/FIELD SERVICES SECTION
TAPE CALIBRATION SHEET

Inspected by:	Field Instrument/ID #	Date

1. Steel Tape Range	500	**Ft.**
2. Planned check Interval	100	**Ft.**
3. Accuracy Standard for Steel Tape	0.01	**%**
4. Discrepancy Tolerance	.005	**Ft.**
5. Discrepancy Check Internal	25	**Ft. ≤ 5% of Full Range**

Check Instrument Reading	Field Instrument Reading	Cumulative Difference	Interval Difference	NOTES
0.0	0.00	0.00	0.00	
50.00				
100.0				
150.0				
200.0				
250.0				
300.0				
350.0				
400.0				
450.0				
500.0				

General Condition of Instrument: ☐ Excellent ☐ Good ☐ Fair ☐ Poor

COMMENTS, RECOMMENDATIONS & CALCULATIONS:

Figure 6: Tape Calibration Sheet

Chapter VII

AUTOMATED WATER-LEVEL MEASUREMENTS

This chapter is not yet completed but will be added in the future. For DH-21 operating instructions, see ADWR, 2008a.

Chapter VIII

WELL-DISCHARGE MEASUREMENTS

Measuring the discharge of pumping wells has constituted a significant portion of historic groundwater data collection in Arizona. The USGS began measuring well discharge in the 1940's. The vast majority of those measurements were made on agricultural irrigation wells, since they accounted for more than 90% of the groundwater withdrawal in the state. The results were combined with groundwater withdrawal data supplied by irrigation districts, municipalities, industries, private water companies and military installations to determine annual withdrawal in the state. The amount and distribution of annual withdrawal is an extremely important parameter in the assessment of a state's water resources, whether it is for planning, development or modeling purposes.

The Groundwater Act of 1980 stipulated that persons who withdraw groundwater from a non-exempt well in an Active Management Area (AMA) or an Irrigation Non-expansion Area (INA) are required to use an approved water-measuring device to monitor and annually report the quantities withdrawn. The Act further stipulated that withdrawals of groundwater for domestic use from wells having a pump with a maximum capacity of not more than 35 gallon-per-minute are considered exempt from monitoring and reporting annual withdrawal. These stipulations created a need for measuring the discharge of pumping wells that are now part of the duties of the FSS. Although annual groundwater withdrawal in the AMA's and INA's can now be ascertained from the annual reports required by the Act, periodic discharge measurements to validate the accuracy of approved measuring devices are necessary. When questions arise by the individual AMA's as to the exempt or non-exempt status of wells, discharge measurements by the FSS are the deciding factor.

The Cox Flow Meter and the Control-o-tron were at one time used by the FSS to measure discharge, however the primary instrument now used to determine a well's discharge rate is the Fuji Portable Ultrasonic Flowmeter. This instrument can measure the flow rate in a non-evasive manner from outside the discharge pipe. Because the Fuji unit is small and lightweight, it can easily be adapted to most all well sites. Once the section of pipe has been selected where the measurement will be made, the discharge measurement is completed by first measuring the outside diameter of the pipe as well as the pipe wall thickness (there is an instrument that determines this measurement), and the type of pipe material that the pumping groundwater is flowing through. This information is entered directly into the Fuji Flowmeter which then calculates the cross-sectional area of the inside of the pipe and displays the distance that the transducers need to be separated when attached to the outside of the pipe. Once the transducers are attached with the correct spacing, the instantaneous discharge is displayed as gallons-per-minute as well as an integrated flow rate in total gallons. If possible, the flow discharge measurement is read over a 6 to 10-minute time period to minimize any possible varying flow rates by the pump. The Fuji Flowmeter can be used on pipes that range from ½ inch to 72 inches in diameter with an accuracy of 1 to 2%.

Chapter IX

STREAMFLOW MEASUREMENTS

In 2007 the FSS, using USGS standards, was asked to begin streamflow measurement on two separate rivers in the state. The first being the Santa Cruz River which flows north through the Satan Cruz AMA from Nogales toward Tucson. The second being the Verde River which originates near Paulden, Arizona and flows through the Verde Valley Basin south into Phoenix. Though the purpose of each project remains separate, the discharge measurements in both rivers are generally taken within the same week on a quarterly basis.

Measurement of Discharge

The discharge or rate of flow of a stream is the quantity of water flowing past a cross section of the stream in a unit of time. The unit in which discharge is usually expressed is cubic foot per second, which is contracted into second-foot. A second-foot of water is defined as the quantity flowing through a cross section 1 square foot in area at a velocity of 1 foot per second. The procedure of measuring the area of a cross section of a stream and the velocity of flow past the section is known as the velocity-area method of measuring discharge. The product obtained by multiplying the area of the cross-section by the velocity constitutes a discharge measurement for that area.

The velocity of water may be measured either directly or indirectly, depending on the method employed. A direct method consists in observing the rate of travel of a float or a chemical placed in the stream. An indirect method consists either in the measurement of the slope of the water surface from which the velocity is computed by means of a slope-velocity formula or in the use of an instrument to measure the velocity of flow within a selected section. Discharge measurements are classified according to the method used in measuring velocity. The most common method used by the USGS for measuring discharge in a stream is the mechanical current-meter method. In this method, the stream channel cross section is divided into numerous vertical subsections. In each subsection, the area is obtained by measuring the width and depth of the subsection, and the water velocity is determined using a current-meter. The discharge in each subsection is computed by multiplying the subsection area by the measured velocity. The total discharge is then computed by summing the discharge of each subsection. ADWR has adopted the same methods as the USGS to complete any streamflow project.

Meter Types

To complete these stream discharge measurements field staff are equipped with two types of devices, the Marsh McBirney and the SonTek FlowTracker. The Marsh McBirney provides the hydrologist with an instantaneous velocity at each vertical within a cross-section. The total discharge is calculated by hand after a sufficient number of verticals are taken. More commonly used by FSS Staff, and many other entities, is the SonTek FlowTracker. This device will calculate total discharge and all other cross-section information automatically at the ended of the measuring period

Completing a Wading Measurement

Before making a wading measurement, the hydrologist should examine various cross sections near the gage to find the one most suitable for this type of measurement. With the measuring section selected and the equipment assembled, the next step is to span the measuring section with a tag line at right angles to the direction of the streamflow. Any unnecessary deviation should be avoided by careful placing of the line. While placing the tag line, the hydrologist should obtain a general idea of the proper spacing of verticals by observing the total width of the section and the character of the stream bed.

After the tag line is placed, the actual discharge measurement has begun. The edge of the water in reference to a marker on the line and the bank from which the measurement is started (whether left or right bank, looking downstream) are recorded. The rod is then placed in a perpendicular position in the first selected vertical and the depth observed. If the depth in the vertical is 1.5 feet or greater, the two-point method should be used. If the depth is less than 1.5 feet the method used will depend largely upon the type of current-meter, the depth of the water, and the roughness of the stream bed. The performance of current-meters in water of shallow depths has been investigated by the USGS at the National Hydraulic Laboratory of the National Bureau of Standards. The results indicate that the 0.6-depth method should be used for depths between 0.5 foot and 1.5 feet and that the 0.5-depth method should be used for depths less than 0.5 foot.

It appears that coefficients other than unity may be necessary for current-meter measurements in very shallow depths for two reasons: First, the distribution of velocity in a vertical may be such that the actual velocity at the point of observation is not the mean for the vertical as, for instance, an observation at 0.5 of the depth; and second, the registration of the current-meter may be affected by its proximity to the water surface or the stream bed. Sometimes the errors from those two sources may be of opposite sign and therefore compensating. Under other circumstances the errors may be of the same sign, or may be predominantly of one sign, and therefore not compensating. As a result of the investigations mentioned above, coefficients have been determined for use with observations of velocities in shallow depths.

In wading measurements, the engineer should stand in a position that least affects the velocity of the water passing the current-meter. Field and laboratory studies conducted by the Hydraulic Laboratory Committee of the USGS indicate that the position of the hydrologist least affecting the accuracy of a discharge measurement by wading may be described as follows: With the meter rod at the tag-line and facing the bank with the water flowing against the side of his leg, the engineer, should stand from 1 to 3 inches downstream from the tag-line and 18 inches or more from the meter rod. If facing the left bank, they will naturally hold the meter rod with their left hand; if facing the right bank, they will hold it with their right hand. The results of the investigation show that no coefficient for position need be applied if this position is used. The hydrologist can maintain a standing position 18 inches or more from the meter rod with a reasonable degree of comfort and at that distance can also give proper attention to the current-meter.

Care should be taken to keep the rod in a vertical position and the meter parallel to the direction of flow while the velocity is being observed. If the flow is not at right angles to the tag-line, the amount by which the angle deviates from 90° or the angle coefficient for that difference should be recorded. This angle coefficient, which is the cosine of the angle of difference, may be determined using an angle chart or a protractor held in proper alinement with the tag-line while the "angle-coefficient line" that corresponds most nearly to the direction of the flow is being observed on the chart or protractor. Upon completion of the necessary observations at the first measuring point, a similar procedure is followed successively at each of the remaining verticals.

If the velocity at the edge of the water is not zero, it is customary to estimate this velocity as a percentage of the velocity measured at the first vertical or measuring point. In order that no appreciable error may be introduced into the total measurement as a result of such estimates, care should be taken to space the verticals so that the flow in the section bordering the edge of water is extremely small in comparison with the total flow. Furthermore, it should be kept in mind that the vertical-shaft cup-type meter tends either to under register or to over register when used close to a vertical wall or bank where the velocity is nonuniform, the direction of deviation depending on whether the bank or wall is to the right or left of the meter, looking downstream.

Two-Point Method

In the two-point method of measuring velocities, observations are made in each vertical at 0.2 and 0.8 of the depth below the surface. The average of these two observations is taken as the mean velocity in the vertical.

The two-point method is based on many studies of actual observations and on the theory that the vertical velocity curve corresponds to part of a parabola with axis horizontal at the point of highest velocity, for which it may be mathematically demonstrated that the average of the velocities at 0.2114 and 0.7886 of the depth is equivalent to the mean velocity. Studies of many vertical velocity curves made for different depths, velocities, and conditions of stream bed support this theory. Experience has shown that this method gives more consistent and accurate results than any of the other methods, except the vertical velocity curve method when it is used under measuring conditions of constant stage and steady flow. Because of the support given the two-point method by both theory and practice, it is generally used by the USGS in current-meter measurements of discharge.

There are, however, a few situations where correct results are not obtainable using the two-point method. One situation relates to the use of the vertical-shaft cup-type current-meter, which under registers near the surface and near the bed of the stream, so that for shallow depths a coefficient greater than unity may be required. The coefficient may vary with both depth and velocity. With the cup-type meter it is generally not advisable to use the two-point method in depths of less than about 2.0 feet unless a coefficient is applied. Occasionally, conditions may necessitate the application of a coefficient less than unity to obtain the correct discharge, as for example in deep water immediately above a dam where the measuring section is sloping upward. Before any coefficient is applied, however, its applicability should be thoroughly established by vertical velocity curves for the entire range of conditions covered by the measurement or by such other data as are available.

Sixth-Tenths-Depth Method

In the 0.6-depth method an observation of velocity is made in each of the selected verticals at 0.6 of the depth below the surface. This method is based on the theory that the vertical velocity curve corresponds to part of a parabola with the maximum abscissa within the upper third of the ordinate representing the depth. On this basis, the mean abscissa lies between 0.58 and 0.67 of the depth below the surface. If the maximum abscissa is in the upper fourth of the measured depth, the 0.6-depth ordinate is very nearly the mean. Although a large percentage of velocity curves that have been studied indicate that the mean velocity in the vertical is at approximately 0.6 of the depth below the surface, experience on certain streams, particularly those of great depths or with smooth beds, has shown that the results obtained by this method tend to be slightly greater than those obtained by the two-point method. Under those circumstances it is possible that the maximum abscissa for several of the selected verticals in the measuring section may be more than one-fourth of the depth below the surface. Laboratory investigations of performance of current-meters in water of shallow depth indicate that vertical-axis cup-type current-meters when used at 0.6 of the depth give results that are too small (requiring coefficients greater than unity) for velocities of 0.3 foot per second and less and where depths are 0.5 foot or less.

Although the 0.6-depth method generally gives fairly satisfactory results, nevertheless as the variations of individual observations may be somewhat greater than those shown by the two-point method it is used by the USGS only if the two-point method is found impracticable because of insufficient depth or for other reasons such as a rough stream bed or aquatic growth.

Chapter X

GEOPHYSICS & SURVEYING UNIT

The Geophysics/Surveying Unit's primary purpose is to gather, process and interpret land subsidence and aquifer storage in order to aid the ADWR in better management of the State's water resources. The data are gathered by using survey-grade Global Positioning System (GPS) equipment, gravity meters, and Synthetic Aperture Radar (SAR) satellites. The data consist primarily of GPS positions and elevations at discrete points, absolute and relative gravity values at discrete points for depth to bedrock and aquifer storage modeling, and broad swaths of SAR data that cover several critical areas of the State.

The primary programs supported by the Unit are the Land Subsidence Monitoring Program, the Aquifer Storage Monitoring Program, and Depth-to-Bedrock Modeling Projects. In addition, the Geophysics/Surveying Unit has performed surveys and supplied data to a wide variety of ADWR programs.

In the past, the Geophysics/Surveying Unit has worked collaboratively with numerous outside groups to perform projects that aid ADWR in a variety of efforts, including: water resource management, required survey-grade GPS measurements, gravity measurements, and/or the collection, processing, and interpretation of InSAR data. These efforts are mutually beneficial to a great many organizations, including: AZGS, Flood Control District of Maricopa County, State Land, CAP, SRP and more.

Trimble R8 GNSS Receiver Operating Instructions

To Check the Bluetooth Connection:

Press the windows button on the survey controller (the top left button on the TSC2 controller)

Click “settings”

Click the “Connection” tab at the bottom of the screen

Click “Wireless Manager”

If Bluetooth is off, just click on the Bluetooth line and the Bluetooth will turn on.

Click done after the Bluetooth shows up as “on”

Close the setting window by clicking on the “x” at the upper right corner of the screen

You should now be back in the main menu of the surveying software

Tripod and Receiver Set Up:

Verify the survey monument with the stamping to ensure you are surveying the correct survey monument.

Set up the center leg of the tripod to the 2-meter mark.

Set up and level the tripod on the survey monument (depends on survey monument). Try to have the two, hand-adjustable tripod legs on the south side of the center tripod leg.

Remove the brass receiver mount from the top of the tripod by loosening the holding screw.

Screw the brass receiver mount into the bottom of the receiver.

Plug the external power chord into the receiver by lining up the red dot and the red line on the power port.

Place the receiver on top of the tripod and tighten the holding screw for the brass receiver mount.

Re-check the level on tripod and re-level if necessary. Be sure to tighten the screw on the third tripod leg.

Changing the Receiver Between Rover and Base Mode:

Select the Instrument Tab

Select the GNSS Functions Tab

Select the Bluetooth Tab

If you want the receiver in rover mode, select the rover serial number from the drop-down menu for the GNSS rover and select none for the GNSS base.

If you want the receiver in base mode, select the base serial number from the drop-down menu for the GNSS base and select none for the GNSS rover.

After you make your selections, changing between rover and base mode, hit the accept button at the bottom right corner.

It might take a few minutes for the receiver to change modes, but you'll know when it has been completed when all the buttons (position, receiver status, etc.) are illuminated again on the GNSS functions screen

Starting GNSS Survey:

Turn on the TSC2 survey controller/handheld (Only push the green power button for a second. Holding it down more than a few seconds will reset the controller.)

Connect the external power cables for the receiver to the battery.

Wait for the receiver to connect to the handheld.

Once the receiver is connected to the handheld, select the Measure tab.

Select the Fast Static Tab. Select Start Base Receiver.

Enter in the Point name (e.g. FRESH) and click okay for the error message regarding entering GPS coordinates after the survey after you enter the point name.

Make sure the Height of the Antenna is 2.0 meters (or the height of the tripod labeled on the center adjustable pole) and that the measured to bottom of tripod is selected.

Select the Measure button at the bottom right of the screen. Click OK for the message that the Base has started.

Survey for four hours or whatever pre-determined time (use a stop watch and/or record the starting time of the survey on the GPS session sheet).

Enter the PDOP and number of satellites on the form in 30-minute increments.

To check the name of the file for the current survey, select the Instruments tab, select the Receiver Files tab, and the file with the T0A by it is the current file that is being created.

To check your current position, select the Instruments tab and select the Position Tab

Turn the controller off when you aren't using it to check the PDOP or start/end the survey.

Once the four hours is completed, select the measure tab, select the fast static tab, and select End GNSS base survey.

Select Yes to power down the GPS receiver. Turn the controller off (Only push the green power button for a second. Holding it down more than a few seconds will reset the controller.)

Put the GPS receiver and controller back in the case, break down the tripod, and move to your next point.

At the end of the day, download the receiver using the Trimble Data Transfer program and place the files in a folder on your laptop

Rename both the .T01 and the .DAT files, so the Point name and date (using YYYYMMDD) is at the beginning of each file name (e.g. X479_20180201_19940371)

Typical GNSS Survey Setup

Scintrex CG-3M Operating Instructions

Taking a Field Measurement:

Setting up Excel Gravity Data Entry Form

Open the Excel Gravity Data Entry Form and rename it to the Date (yyyymmdd) followed by the name of the gravity loop or base tie and gravimeter. For example, 20161206_Loop1_NewMeter, or 20161206_Loop1_CG5, or 20161206_PHXAA_PHXAB_BaseTie

Setting up the tripod and gravimeter

Set up the tripod so that the level bubble is oriented to the north. The two adjustable legs should be on the southern and western-most points. The tripod leg with the spacer is always on the top right (northeast). Never adjust the top right leg and make sure it is hand tightened against the spacer. After you set up the tripod, very carefully and very gently place the gravimeter on the tripod.

Changing the Gravimeter Mode (If needed)

Press the Aux button twice. Scroll to the Autograv setup screen and press enter. Scroll to the mode screen. Press enter and then scroll to the appropriate gravimeter mode (none, fld grav, or cycling) and press enter. For collecting data in the field, be sure to scroll to the fld grav and then press enter. Press Aux twice to leave this screen.

Changing the Time (If needed)

Press the Aux button twice. Scroll to the Initialize screen and press enter. Scroll to the time screen. Press enter and then follow the screen by entering HH, then MM, then SS, then YY, MM, and DD and press enter. Press the Aux button twice to leave the time screen.

Changing the Enter the lat/long

CG-3M Gravimeter Screen/Menu

Press the Aux button twice and use the arrow keys to scroll to the Autograv setup screen and press enter. Then scroll until you see Deg Long to change the Longitude. Press the enter button and then enter the decimal longitude to one decimal place (for example 112.1) and press enter. To change the latitude, scroll up to the Deg Lat and press enter. Enter the latitude to two decimal places (for example 33.45) and press enter. Press the Aux button twice to leave the time screen.

CG-3M Tripod Setup

Leveling the gravimeter

Press the Aux button twice and then press the start button. The autograv adjust screen will appear with the X and Y tilt. You always need to adjust the Y tilt first by using the upper left tripod adjustment knob. If the Y value is too negative, turn the knob to the left or counter clockwise. If the Y value is too positive, turn the knob to the right or clockwise. Adjust the Y until it is between +/-2. Next adjust the X tilt by using the bottom tripod adjustment knob. If the X value is too positive, turn the bottom knob to the left or counter clockwise. If the X value is too negative, turn the knob to the right or clockwise. Adjust the X until it is between +/-2. Doublecheck that both X and Y tilt are between +/-2 and make any necessary adjustments. Let the gravimeter sit and stabilize for one minute.

Taking a measurement

CG-3M Gravimeter Setup

After the gravimeter has stabilized for one minute, press the Aux button twice. Press the start button and confirm that the levels are still good (X and Y are within +/- 2). Press the start button again for the measurement to begin. The measurement takes around 60 seconds. While the gravimeter is making the measurement, remain as still as possible, and shield the gravimeter from the sun and/or wind with your body. The gravimeter will pick up the vibrations from any operator movements, as well as other environmental noise like traffic or wind. Also, direct sun on the tripod will affect the gravimeter's level. Record the station number, name, and any comments on the excel gravimeter form on the Microsoft Surface Pro during the measurement. As the measurement is ending, be sure to record the SD value on the form. When the measurement is complete, the final gravimeter value will appear. Enter the final gravity value on the form press the record button to record the value. In rare cases, you may not want to record the measurement. If you don't want to record the measurement, press the start button to start a new measurement without recording it. If you want to cancel taking a measurement at any time while you are at the leveling screen, press the Aux button a few times. If you want to cancel taking a measurement at any time while a measurement is recording, press the start button again and the measurement will stop. Don't record the measurement by pressing the start button again.

Be sure to take a minimum of two measurements at each location. Continue to take a measurement until the final two measurements are within 0.003 mGal of each other. When starting each field day, take a minimum of five measurements at the gravity base station and continue taking measurements until the final two measurements are within 0.003 mGal of each other.

Gravity Looping Procedure

CG-3M Gravimeter Setup

The gravimeter is a relative gravimeter and will drift during the gravity survey. To account for the drift, gravity loops must be completed. Start each day off by measuring the gravity base station first. You will take five measurements at the gravity base station and continue taking measurements until the last two measurements are within 0.003 mGal. After you measure the gravity base station, move to the first gravity station and take a minimum of two measurements and continue taking measurements until the final two measurements are within 0.003 mGal of each other. Move to the next gravity station and repeat these steps. Once all the gravity stations have the first set of measurements, return to the gravity base station (to close out the first loop) and take a minimum of three measurements and continue taking measurements until the final two measurements are within 0.003 mGal of each other.

After you measure the gravity base station for the second time, move to the first gravity station and repeat the procedure of collecting measurements at all the gravity stations. Once all the gravity stations have the second set of measurements, return to the gravity base station (to close out the second loop) and take a minimum of three measurements and continue taking measurements until the final two measurements are within 0.003 mGal of each other.

At this point review the results worksheet on the gravity spreadsheet and see if the differences between loops 1 and 2 for the gravity stations are within 0.005 mGal of each other. If not, repeat a third loop of measurements ONLY for those stations that have differences that are greater than 0.005mGal. After the third loop of measurements is completed, including the gravity base station, review the results and see if differences between loops 1 and 3, and loops 2 and 3 are within 0.005mGal for the stations measured in the third loop. If not, those gravity stations will need to be measured a fourth time if time permits. Otherwise, measure those gravity stations another day with a minimum of two gravity loops.

When completing gravity base ties, take a minimum of five measurements for all the base stations. For example, a PHXAA and PHXCC base-time would have five measurements each time at PHXAA and PHXCC for each gravity loop.

All gravity stations must be measured a minimum of two times using two gravity loops.

Returning to the Office:

Set up the gravimeter:

Set the tripod up and carefully place the gravimeter on the tripod. Plug the gravimeter into the external power supply. Remove the battery compartment cover. Level the gravimeter.

Downloading the gravimeter:

Plug the serial/parallel cable into the laptop and the gravimeter. Open the command line on the laptop and type:

```
cd /

cd idump

idump mm_dd_yy.NEW com1 2400 no 8 1 s
```

(for example: `idump 11_23_16.NEW com1 2400 no 8 1 s`)

The idump window will then appear within the command line screen. Go to the gravimeter and press the Aux button twice on the gravimeter and scroll to the Output page and press enter and then press start. The data will then start to be dumped onto the laptop and you will see it appear on the command line screen on the laptop. Let the data download. If it's just a field day of gravity data, it will only take a few minutes. If it's a few days to a week worth of drift data, it will take around an hour to download. When no more data is scrolling across the command line screen the data dump is completed. Hit the ESC key on the laptop and then type exit. The command line will disappear. Copy the file onto N:\SUBSIDEN\ASM PHOENIX AMA\PHX AMA GRAVITY\Phoenix AMA Gravity 2016

Open the idump file in excel. When the text import wizard appears, select fixed width, and scroll down to row 15 and change the start import at row value to 15 and click next. Insert break lines in between all the columns where break lines don't already exist. Copy and paste the Grav., SD., and Time values into the form. Copy the file onto N:\SUBSIDEN\ASM PHOENIX AMA\PHX AMA GRAVITY\Phoenix AMA Gravity 2016

Erasing the memory:

Confirm that the dump file is on the laptop before erasing the gravimeter memory. Press the Aux button and scroll to the Initialize screen, press enter and then scroll to the memory screen. Press enter and then press start. The memory will be erased, and you will know it's done when it says 100%. Press Aux twice to return to the main menu.

Setting up for a Drift Measurement (If needed):

Press the Aux button twice. Scroll to the Autograv setup screen and press enter. Scroll to the mode screen. Press enter and then scroll to the appropriate gravimeter mode (none, fld grav, or cycling) and press enter. For drift measurements, be sure to scroll to cycling and then press enter. Press Aux twice to leave this screen.

Be sure the memory is cleared on the gravimeter (see erasing the memory above).

Level the gravimeter and then start the measurement. There will be nothing to record during the drift measurement. The gravimeter will continuously be taking a measurement every five minutes until it is stopped or runs out of memory. The drift measurement usually last anywhere between 3 to 9 days.

Changing the Drift Value (If needed)

Press the Aux button twice. Scroll to the Autograv setup screen and press enter. Scroll to the drift screen. Press enter and scroll to the drift date. Press enter and then enter again to change the drift date. Next, change the drift value. Scroll to the drift value. Write down the drift value and then calculate the new drift value by adding the drift correction value to the drift value. (For example, Drift Value 0.251 + Drift Correction value -0.008 = 0.243 New Drift Value). Press the enter button and then enter in the new drift value (0.243 in the example) and press enter. Press Aux twice to leave this screen.

GPS STATION OBSERVATION SHEET

Project Name:____________________________________ Project Number(WO#):________

STATION INFORMATION

Station Name _________________________

4 Letter Station ID __ __ __ __

Lat: __ __ __° __ __’ __ __”N
Long: __ __ __° __ __’ __ __”W
Elevation: __ __ __ __ . __ meters/feet

WEATHER

	START	MID	END
Temp. (F/C)			
Wind (mph)			
Cloud Cover			

OBSERVATION INFORMATION

Operator: Last Name: ______________________ First Name: _______________________

File name: __ __ __ __-__ __ __-__ Session : __

Start: Date:__ __/__ __/__ __ Julian: __ __ __
Time: Local __ __:__ __am/pm 24H __ __:__ __ U.T.C: __ __:__ __

Finish: Date:__ __/__ __/__ __ Julian: __ __ __
Time: Local __ __:__ __ am/pm 24H __ __:__ __ U.T.C: __ __:__ __

EQUIPMENT CONFIGURATION

Logged Data in (Data Collector / Receiver) Equipment Name/Number: _______________
Receiver Type ____
Antenna Type ____

Antenna Measurement __.__ __ __ meters / feet true / uncorrected

Check Plumb
☐ Begin
☐ Mid
☐ End

MONUMENT DESCRIPTION

Monument type and description ____
Monument stamping or tag number: ____

STATION INFORMATION

Monument sketch	Remarks (Comment on any potential problems)

Time	PDOP	# SV

Chapter XI

DEALING WITH THE PUBLIC

Without the cooperation of the well owners of Arizona, we would effectively be out of the data business. We rely on the well owners to allow us access to their property and to their wells. This access and any subsequent information we receive is totally voluntary on the part of the owners, and yet without it, most groundwater studies would be impossible. FSS staff have worked hard to gain the respect of the land owners, well operators and the general public. This respect is not something just given, it is something earned, and we constantly strive to maintain that relationship and trust.

The keyword when working with the public is **respect**. It is incumbent upon each member of our staff to show respect to any land owner. After all, we are a guest on their property. The law provides for us to enter private property; to obtain permission, and nothing else. Unless these are your intentions, you may well be trespassing, and you may incur the wrath of an angry rancher or farmer, and be asked to exit, posthaste. Due to vandalism, disregard for No Trespassing signs and the potential for legal issues, many land owners have become very sensitive to unauthorized people “nosing” around their property.

When obtaining permission to enter anyone’s property, present yourself in the best possible way. If you have to go to a public office, don’t show up at the end of the day in your dirty clothes. It is far better to approach these types of situations first thing in the morning, when you would be much more presentable. Many people judge us by first impression, and as the old saying goes, “You only get one chance to make a first impression”. If you are requesting permission from a rancher, farmer or rural landowner; approach their homes respectfully. Nearly all rural roads are dirt, so drive slowly, raising as little dust as possible. If you must open a gate to get in; once through, get out and close the gate. Many land owners have animals freely roaming their land and just because you don’t see them at the time, doesn’t mean they aren’t there. **Always respect a closed gate** (open it to pass through and immediately close it). If the owner is not around, ask to see the foreman or someone in charge.

Some owners have no problem with our visits to their property, but some take great exception to our presence. Regardless of their disposition, they deserve to have their permission sought in a courteous way. Many owners will ask why the government wants information about their well or the groundwater beneath their property? What are we going to do with the data? Why do we need to collect the data? Are we going to use the information against them? They may see our presence as an intrusion into their privacy. However, when presented with such owners, we need to explain, as best we can, that our request to measure a well is strictly for scientific and resource assessment purposes that will benefit all well owners in the area. It may help to mention that you are a taxpayer just like them, and that you are a scientist, not a bureaucrat.

Ultimately, it is up to you to try to answer their questions succinctly, in a very polite way, and hopefully to sway their opinion. This means being informed on the water issues of the area and being well versed with exactly what it is you are doing and why you are doing it, (See Chapter I). You should explain why it is beneficial to know the groundwater conditions of the area in which they live. You may even be asked to leave the property and yelled at, but if you do a good job of explaining your (our) interest in their well, chances are you are going to be granted permission most of the time.

If you get permission from one rancher, sometimes passing that information on to his neighbor will carry some weight. If an owner requests information on their well, give them copies of the data that we collect from their wells, and encourage them to visit our online database to access historical records, or submit a public records request. If we have a publication on the area, direct them to our website for further information. If time allows, show the owner where his land is on the map and how to interpret the information. Offer to come back when it is more convenient for them, especially if there are many gates that need to be unlocked. Very seldom will the ranchers offer to give you a key, more than likely they will want to accompany you. If they do give you *carte blanche* to their property, don't ever exceed your stated business. Close all gates, especially near windmills, as cattle are often nearby. The last thing you want to have to do is tell the rancher you let some of his cattle out, (however, if this should be the case, or if you damage anything while on the property, you must report the loss immediately).

Be willing to make an appointment with the land owner. They are busy people, and we need to try to accommodate them. Other than being well informed and respectful, most of our interaction with the public is simple common sense. Treat people the way you would want to be treated. Try to put yourself in their position. To whom would you grant access to your land?

Never measure a well without permission. We won't get permission to measure every well we find; these wells may not be measured. Some owners simply can't be found, and many others are absentee owners. Occasionally, determining the actual owner is impossible. Many wells are obviously abandoned or unused, but these wells may not be measured without permission.

If you see someone (even if they are not the owner), tell them who you are and what you are doing. Offer to show them your State ID or give them a business card. When in farm country, it is extremely difficult to tell which farmer owns which well. The important thing is to try. If there is a home, a barn, or an equipment shelter where people are gathered, stop and ask questions about who owns which wells. Make the effort. Make yourself known, so people are at ease with you, and what you are doing.

Never jump a fence to measure a well, unless you know it to be permissible. **Never** make a discharge measurement without permission. **Never** start or turn-off someone's well. **Never**

enter Indian lands for the purpose of conducting any investigation without prior approval. Indian reservations are considered sovereign nations and are administered by the U.S. Bureau of Indian Affairs. We, as employees of the State of Arizona are considered to be trespassing if we conduct any type of water resource investigation without approval of the Tribal Council.

The overlying theme of all this is that the best source of hydrologic data in any area is the existing wells, and their owners. Cooperation between owners and department personnel provide an avenue to data and information that are mutually beneficial. It is of the utmost importance that we do all we can to nurture this valuable relationship.

Chapter XII

SAFETY

It is difficult to over emphasize the value of safety. When it comes to safety, doing little things can pay big dividends. We work in climate extremes and are often exposed to the denizens of the desert (i.e. bees, scorpions, black widows, rattlesnakes, etc.). You should always be aware of the potential dangers to which you are exposed. The intent of this chapter is to alert the FSS personnel to the potential dangers of field work. Doing what we can to prevent accidents is important, but accidents will occasionally occur. While great lengths can be taken to prevent an unfortunate accident or injury, it may well be how **you** react, after an accident or injury that makes the difference.

Vehicle Safety

Each of our trucks are assigned to an individual staff member. That is to say that nearly every time you go into the field, you will be in the same vehicle. All of our trucks are maintained by the Arizona Department of Transportation. We and Fleet Management are responsible for seeing to it that the trucks are serviced regularly (by ADOT). They maintain the integrity of the mechanics of the vehicle. We are responsible for making sure the truck is equipped with the proper safety equipment. You should become well acquainted with the location of the jack, and how to use it. You should carry several small (6”), pieces of 2”x4” or 4”x4” wood to set the jack on (if you have a flat tire or get stuck in the mud, these pieces of wood may come in very handy). Always maintain a complete set of tools. In the case of a break down, you may have to perform some maintenance to get your vehicle back to town, or at least out to the main road. The following is a list of some of the safety equipment your truck should always be equipped with.

1. Well stocked first-aid kit
2. Fire extinguisher
3. A nylon tow-strap
4. A shovel
5. An axe
6. Jumper cables
7. A portable air pump, and/or 2 cans of pressurized quick fix tire repair
8. At least 2 gallons of water
9. Flashlight (and extra batteries)

When you return from the field each day, you should do a quick inspection of the tires (a low tire could be the result of a slow leak). Check the ground under the engine, looking for any leaking fluids. If you should notice leaking fluids or tires, the situation needs to be addressed immediately, so you can get back out in the field the following morning. Worse yet, would be to ignore or not notice the leaks and become stranded somewhere far from help.

When operating a state vehicle always obey all traffic laws and speed limits. Remember that while 65mph may be lawful and safe on a dry highway, it can be anything but safe on a wet slippery road. Slow down when conditions dictate. Don't drive into muddy areas without first getting out of the truck and checking the conditions. One quick minute of your time may save you hours of digging or walking for help. **There is no substitute for common sense.**

Personal Safety

The degree to which an individual may go to ensure personal safety, is indeed a personal choice. However, there are some very basic and general precautions that all field personnel should take to protect themselves. The first thing any field person should understand is that the Sonoran Desert can be a very unforgiving place. There are temperature extremes, dangerous insects, reptiles, a myriad of thorned plants and cacti, the potential for flash floods, and very little help when you are in need. So, as previously stated, the way you prepare yourself for and react to adversity may well save you a lot of heartache.

We do most of our field work in the Fall/Winter/Spring months, however there are many times you will be in the field during the Summer months. There is no way a person can really be immune to the extreme heat of an Arizona summer day. Even if you've spent your entire life in Arizona, the heat can kill you just as certainly as it can a person who has only been here a week. So don't be arrogant and think you are immune to the heat. You must always respect the heat and do all you can to protect yourself from it. General precautions include, starting early in the morning, before the heat of the day. You can have most of a day's work done by 2:00 PM, if you get an early start. So simply avoiding the heat is the number one thing you can do. If the job you are doing requires that you stay out longer, be prepared. Always drink plenty of water. Have plenty of extra drinkable water (at least 2 gallons). This will not only sustain you, but if your truck overheats, you may have to add water to the radiator. Stay in your truck as much as possible (shelter from the sun as well as air conditioning). So unless the work you are doing absolutely requires you to be outside, stay in the truck. Even a parked truck with the engine off (no AC), will give you shelter from the sun, but maintain ventilation, by opening a window. Use protective clothing. Wear light colored shirts (long sleeve shirts are better than the best sun block), long pants and leather field boots (preferably some that offer ankle protection and steel toes). If you wear a short sleeve shirt, use plenty of sun block. Never wear shorts and sneakers into the field. Wear a hat at all times (the larger the brim, the more protection from the sun). Know the symptoms of heat exhaustion. If caught in the Arizona sun for too long you will most likely suffer heat cramps or heat exhaustion as a precursor to heatstroke, so those are the most important symptoms for you to recognize. Heat cramps are associated with heavy sweating and painful spasms in the legs and/or abdomen. The symptoms of heat exhaustion include an overall feeling of weakness and profuse sweating. The skin feels cool and clammy and an individual's pulse becomes unsteady. Vomiting may occur, or possible fainting. If you ever recognize these symptoms or general dizziness and headaches in a fellow worker, or yourself, there is still time but you must act quickly. It may well save a life. Get yourself or fellow worker to some shade or a cooler area (air-conditioned truck). Sit down and rest, slowly drink cool water if available. If an individual's symptoms have progressed to extremely high body temperature, with hot dry skin, rapid pulse and possible unconsciousness, or if the lesser symptoms haven't rapidly improved, seek medical attention immediately. **Waiting, or being indecisive can result in death. Don't mess with heat stroke, it's a real killer.**

As previously stated, Field Services does the largest percentage of its fieldwork in the Fall/Winter/Spring months. While the heat is generally not a factor in these months, the cold can be the source of some difficult field conditions, especially when working in the northern and southeastern parts of the state. It is not uncommon for us to work in cold rain, sleet and occasionally in snow. Warm clothes, good leather boots, gloves and a hat are necessary to protect us from the elements. It is far better to dress in layers, than to wear a large bulky coat. By layering, you have the option to dress lighter as the daytime temperatures rise. Good rain gear is also a necessity (either a rain slicker or "pancho"). The ability to stay dry, when working in cold weather, is very important. Cold weather also presents a different set of driving conditions. You must drive in accordance with the conditions. It is quite common for Field Services staff to drive on wet and muddy roads, or occasionally in snow. Fog is another common occurrence in the Winter months. The fog usually burns off, as the daytime temperature rises, but proper caution must be exercised when driving in the fog. Wet roads, rain, snow and fog all present problems, but these conditions can be overcome by **slowing down**, staying on paved roads as much as possible and driving with your lights on. Know your limitations as a driver, and never exceed your ability. Continually test your brakes in wet weather, and never exceed your vehicles ability to safely stop.

Desert dust storms present problems as well. Blowing dust can literally cut visibility to near zero. This situation is especially prevalent on Interstate 10 (between Phoenix and Tucson). This area supports a great deal of farming, and when combined with high speed driving on the Interstate, a very dangerous situation can be produced. Should you ever encounter these conditions; pull safely (as far off the road as you can get) off the road or highway, stop your vehicle and **turn your lights <u>off</u>**. Many people believe that you should keep your lights on, so other drivers can see you. However, in a no visibility situation, other drivers might see your lights and try to follow you. The results could be fatal.

Wear your leather work gloves anytime you are working, or handling tools. **Don't** ever stick your hand into something you haven't looked into first, and even after you have looked, play it safe and keep your gloves on. Dark, relatively cool places are ideal refuges for black widows and brown recluse spiders, scorpions and sometimes a rattlesnake. If you have to dig around in the base of a pump, use a long screw driver or metal rod. Don't use your hands. Anytime you are walking in the field, keep your eye on the ground in front of you. When walking through tall grass or weeds, move slowly, and if possible, use a long stick to prod the grass ahead of you. The department can provide you with snake guards that protect your lower ankles from bites. Better the stick arouses a rattlesnake, than your foot. In the mornings, rattlesnakes like to sun themselves out in the open, so be vigilant. Listen for the characteristic "rattling" warning of an angered rattlesnake, and if you should ever hear it, stop immediately. A rattlesnake strikes at motion, so your best option is to freeze until you determine where the snake is. A rattlesnake bite, while generally not fatal, can make you wish you were dead. Most rattlesnake bites occur on the hands, wrist, feet or ankle area. High top leather boots and leather gloves may well save you from the misery of a snake bite. Should you ever sustain a rattlesnake bite, do your best to stay calm and immediately drive to the nearest emergency medical facility, if your ability to drive is impaired, call 911 or an emergency contact. This holds true for black widow and brown recluse spider bites, and scorpion or bee (if allergic) stings.

Watch for wasp nests and bee hives. You must now assume that all honey bees in Arizona are of the ”Africanized” variety. They regularly make hives in well casings and their presence is not always obvious, so be vigilant. They don’t have to be provoked, if they feel you are too close, they will attack. Their attack is relentless, and your only real retreat is to your truck. Staff members have been chased for a quarter mile by attacking bees. If you are allergic to bee stings, it is imperative that you carry a bee sting kit with you in the field. Even if you are not allergic, a bee sting kit is a good idea and should be part of the first aid kit.

General Safety Tips

Perhaps the most important thing a field person can do is to keep their eyes open, be observant, pay attention to the task at hand and don’t “daydream”. Look around and expect the unexpected. Beware of open well casings. Don’t step on large pieces of plywood lying on the ground. The wood may be partially rotted and covering a 20’’ well casing. When looking under large pieces of wood, use a stick or metal rod to flip the wood over. Don’t use your hands, as rattlesnakes often take refuge under wood, old blankets, or rugs. Be careful around windmill towers. It is very easy to knock yourself senseless on the metal crossbars of a windmill tower. Don’t try to measure wells if there is lightening anywhere near. Be careful around pumping wells, especially natural gas wells. Natural gas pumps are driven by a very rapidly rotating drive shaft. Stay clear of the drive shaft, as loose clothing or hair can easily get wrapped around the shaft, resulting in severe injury, or perhaps worse. When working around noisy pumps; for the purpose of obtaining pumping levels, or discharge measurements, hearing protection is advised. Respirators are also advised for very dusty work sites, or for use in sheds. Watch for nails sticking up through old boards. It is very easy for a nail to penetrate the sole of a shoe or to scratch yourself on barbed wire, so a current tetanus shot is highly recommended.

When approaching an owner’s home, you are often first met by any number of dogs. Some dogs are very friendly, some are not. Unfortunately, you can’t always tell the friendly ones from the unfriendly ones. Generally, when the owner hears his/her dogs barking, they will investigate the cause, and call their dogs off. At this point, you can approach the owner. If the owner doesn’t appear, you may choose not to get out of the truck. Sometimes a gentle honk on the horn will bring the owner out, (excessive honking will only irritate the owner and lessen your chances of measuring his wells). As a general rule, always leave the truck door open when you approach the owner’s house. Dogs can often appear suddenly and your ability to get back into the truck quickly can spare you the pain of a dog bite.

In addition to a couple of gallons of spare water, it is always a good idea to take a small ice chest (filled with drinking water or Gatorade), into the field. Another handy item to take to the field on an everyday basis, is a small knapsack. If you should become stranded and have to walk, the knapsack will allow you to carry your drinking water, GPS unit, maps, binoculars, first aid items and cell phone, while allowing you to keep your hands free. It is much easier to walk over rugged terrain if your hands are free. If you become stranded, but know where you are, and you can reach help by walking, then this is the best plan of action. If you are hopelessly lost, it is always best to stay with your vehicle and wait for help to find you.

In addition to these precautions, field services staff are equipped with a SPOT device. Each SPOT device provides location-based messaging and emergency notification technology that allows you to communicate from remote locations, where cell phone service may not be available. Your SPOT device can send staff and supervisors a pre-determined message with your current location, notifying them you may need assistance (truck stuck or flat tire). It is also capable of notifying local emergency services of your location and that you are in need of immediate, life threatening help. The operating instructions for the SPOT GEN3 device are included in the manual.

As your day in the field comes to a close, it is important to notify your supervisor that you have safely arrive back at your hotel room or at home. If your supervisor does not hear from you by a set time, they may call, text or email you questioning your safety. **DON'T FORGET TO CHECK IN**.

Fieldwork presents many challenges, but if an individual is observant and mindful of common safety procedures and barring any unforeseen calamities, their time in the field should be just as safe and productive as a day in the office.

SAFETY CHECKLIST FOR FIELDWORK

Nearest Emergency Medical Care Facility
Area #1 Address:___________________________
Phone# :___________________________

Area#2 Address:___________________________
Phone# :___________________________

Area#3 Address:___________________________
Phone# :___________________________
Do You Have ?

____First aid kit (+bee sting)
____Fire extinguisher
____Nylon tow strap
____Shovel
____Jumper cables
____Extra water
____Quick fix tire repair
____SPOT device
____Cell phone
____Knapsack
____Binoculars
____Hearing protection
____Respirator
____GPS
____Maps
____Hardhat

Should you receive one of the following:
Injury (cuts, broken bones, etc)
Toxic contamination
Scorpion sting
Black Widow or Brown Recluse spider bite
Bee stings (if allergic)
Rattlesnake bite
Dog or other animal bite
Heat cramps/exhaustion/stroke
Other emergency

If able
Note: Time of event_________ AM, PM

Phone ahead to nearest medical facility: Tell them where you are and ask for instruction on how best to treat the injury until you can get there.

Remember: Try to stay calm; haste can cause further injury or accidents while driving for help.

NOTE! Fill out this form and keep it handy when you travel

SPOT Generation 3 Device Operating Instructions

TO TURN SPOT ON: Simply locate the Power button on the upper left corner of the device, press and hold the button; lights will illuminate.
TO TURN SPOT OFF: Press and hold the Power button until the Power light blinks rapidly.
TO CONSERVE POWER: Your SPOT unit **will automatically** turn off after one hour of inactivity unless the unit is being line powered.

PLACEMENT OF YOUR SPOT

The placement of your SPOT can make a difference. For best reception, **always keep the logo pointed towards the sky** (the satellite antenna is located under the logo).

GPS

The GPS light notifies you whether SPOT is able to see the GPS satellites and obtain a GPS location.

- Green – The GPS light blinks green if SPOT sees the GPS satellites and is looking for/has found your GPS location.
- Red – The GPS light blinks red if SPOT cannot see the GPS satellites and /or cannot find your GPS location. If the GPS light blinks red, you should move to a location with a clearer view of the sky.

USING THE CHECK IN OR CUSTOM MESSAGE FUNCTION

Press and hold the Check In or Custom Message button until the function light blinks green. The GPS light will blink green when SPOT sees the GPS satellites and will continue blinking while obtaining your GPS location.

Once your GPS location is obtained, SPOT sends your message with GPS location. The GPS light and Message Sending light will both blink green. The message is sent three times over a 20-minute period to the SPOT network - this is to ensure maximum reliability in getting your message out. Only one message will be sent to your contacts.

The Message Sending light continues to blink green until the next scheduled message or until the mode ends.

If no GPS signal is found, the GPS light will blink red. If possible, you should move to a location with a clearer view of the sky. SPOT will keep looking for your GPS location for up to 4 minutes. If no GPS location is found in 4 minutes, SPOT does not send your message. To try again, simply press and hold the function button. If the message does not send, the Message Sending light will blink red.

TO CANCEL

You can end the transmission of a Check In or Custom Message by pressing and holding the function button until the light blinks red. This action does not cancel any message already transmitted.

USING THE HELP FUNCTION

To send a Help message, open the protective flap then press and hold the Help button until the light blinks green. The GPS light will blink green when SPOT sees the GPS satellites and while obtaining your GPS location.

Once your GPS location is obtained, SPOT sends your Help message with GPS location every five minutes for one hour. The GPS light and Message Sending light will both blink green.

The Message Sending light continues to blink green until the next scheduled message or until the mode ends.

If no GPS signal is found, the GPS light will blink red. If possible, you should move to a location with a clearer view of the sky. SPOT will keep looking for your GPS location for up to 4 minutes. If no GPS location is found in 4 minutes, SPOT sends your message without GPS location; the GPS light will blink red and the Message Sending light will blink green in unison.

TO CANCEL

Press and hold the Help button until the Help light blinks red. Leave SPOT on while the Help cancel message is sent, turning off your SPOT DOES NOT cancel the Help message. When it is finished, the Message Sending light will blink green indicating it has sent the cancel message.

USING THE S.O.S. FUNCTION

To send an S.O.S. alert, open the protective flap then press and hold the S.O.S. button until the function light blinks green. The GPS light will blink green when SPOT sees the GPS satellites and while obtaining your GPS location.

Once your GPS location is obtained, SPOT sends your S.O.S. message with GPS location. The GPS light and Message Sending light will both blink green.

The Message Sending light continues to blink green until the next scheduled message to notify you that your most recent message was transmitted.

If no GPS signal is found, the GPS light will blink red. If possible, you should move to a location with a clearer view of the sky. The first message will be sent within one minute after activation with or without your GPS location. For all subsequent messages, SPOT will keep looking for your GPS location for up to 4 minutes. The S.O.S. message will send every 5 minutes (with or without GPS) until cancelled or the power source runs out.

TO CANCEL S.O.S.

Press and hold the S.O.S. button until the light blinks red. Let SPOT work until the S.O.S. button stops blinking red to finish sending the cancellation message. The Message Sending light will blink green indicating it has sent the cancel message. Turning off your SPOT while in S.O.S. mode DOES NOT send an S.O.S. cancel message.

MESSAGE INDICATORS

For all functions, SPOT lets you know what it is doing.

INDICATOR	BLINKING GREEN	BLINKING RED
GPS	Searching for GPS signal	GPS location fix failed, move to a new location
Message Sending	Message transmission schedule in progress	Last message was not sent
Check In or Custom Message	Message sequence in progress	Message sequence has been cancelled
Help	SPOT in Help/SPOT S.O.V. mode	Help/SPOT S.O.V. has been cancelled
S.O.S.	S.O.S. is engaged	S.O.S. has been cancelled
Tracking	SPOT in Track mode	Track sequence has been cancelled
Power	On	Low battery

Chapter XIII

GWSI & ACCESSING GWSI WITH ACCESS

The Groundwater Site Inventory (GWSI) database is ADWR's main repository for accurate, state-wide groundwater and well data. GWSI consists of field data collected and verified by personnel from the ADWR's Field Services Section or the USGS. The information in GWSI is constantly updated and added to by ongoing field investigations. In addition to normal field investigations, ADWR conducts a state-wide water level monitoring program that annually measures water levels in approximately 1800 wells, which are located throughout the state. Along with using the application to access information, data can also be queried by using Microsoft Access. More information on using the **GWSI** application and **Microsoft Access** can be found in the **GWSI Manual**.

Chapter XIV

MAKING MAPS WITH ARCGIS

In recent years FSS has become a more frequent user of ArcGIS. ArcGIS is a platform for organizations to create, manage, share, and analyze spatial data. It consists of server components, mobile and desktop applications, and developer tools. This platform can be deployed on-premises or in the cloud (Amazon, Azure) with ArcGIS Enterprise, or used via ArcGIS Online which is hosted and managed by ESRI. Our most commonly used applications are ArcGIS Pro and ArcMap. They are part of ArcGIS Desktop suite and allow users to publish and manage data and maps in conjunction with ArcGIS Online and ArcGIS Enterprise. These desktop tools also excel at detailed and sophisticated analysis and can be extended and scripted with various tools. For an overview of the capabilities of ArcGIS Desktop, visit the ArcGIS Desktop website.

In the FSS, ArcMap is commonly used for navigational purposes and to display database information that may be related to a well you are visiting or a well nearby. ArcMap can toggle between different layers of spatial data that contain a variety of information that may be necessary to get you where you need to go, or to answer questions that you may encounter in the field. The Department will assign you a laptop along with a GPS unit that can connect to your computer. Once ArcGIS Desktop is installed on your computer you can begin the process of adding the needed project files to your laptop. Following this process will allow you to work without an active internet or network connection. This is an extremely useful tool, specifically when conducting a 'Basin Sweep'. It allows access to imagery that might not otherwise be available without a connection. You will likely still be assigned a topo map packet, in case any technical errors should arise.

ARCMAP IN THE FIELD

Before using ArcMap in the field, be sure to check out a license using "ArcGIS Administrator" **while connected to the network in the office.**

1) Open ArcGIS Administrator
2) Click "Borrow/Return"
3) Select "Desktop Basic"
4) Select "OK"

Installing Imagery

1) On your laptop C: Drive create a folder titled < "ArcGIS Data"
2) In the "ArcGIS Data" folder, create a folder titled < "ArcMap"
3) On the N: Drive visit the following link N:\SUBSIDEN\ArcGisData\ArcMap
4) Copy the "LayerNAIP" folder and paste it in the "ArcMap" folder previously created on your C: Drive.
5) Copy the "NAIP2010" folder and paste it in the "ArcMap" folder previously created on your C: Drive.
6) THIS WILL TAKE A WHILE – PLUG YOUR COMPUTER IN

Installing Your Arc Project/Updating Your Arc Project

1) Navigate to the "Basic Data" folder on the N: Drive
2) Copy the "GIS_FieldWork" folder and paste it on your C: Drive in the "ArcGIS Data" folder
3) Open the "GIS_FieldWork" folder and open "ArcProject_Field_Work_MapPack" and begin selecting layers you want to use
4) To add imagery, navigate to the LayerNAIP folder in your ArcMap Catalog. (Imagery is broken up in to sections throughout the state, select the degree of Latitude and Longitude you are working in to display imagery.

Using Your GPS

1) Connect your GPS to your computer
2) In ArcMap navigate to the "Customize" Tab
3) Select "Toolbars" and Scroll down to "GPS"
4) Select the "GPS" dropdown in the toolbar and click "GPS Connection Setup"
5) In the "GPS Connection Setup" Window, select "Detect GPS port"
6) Your GPS should be recognized by your computer, select "OK"
7) On your GPS Toolbar click the "Open Connection" button, then click the "Pan to GPS Position"
8) Your location should now be visible on your project.

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Mann, L. J., 1982, Operational guidelines for measuring ground-water levels – Arizona District: United States Geological Survey Memorandum (unnumbered), 10 p., 1 figure.

Mann, L. J., 1982, OPERATIONAL GUIDELINES- -Selecting equipment to Measure the discharge of wells – Arizona District: United States Geological Survey (unnumbered), 12 p.

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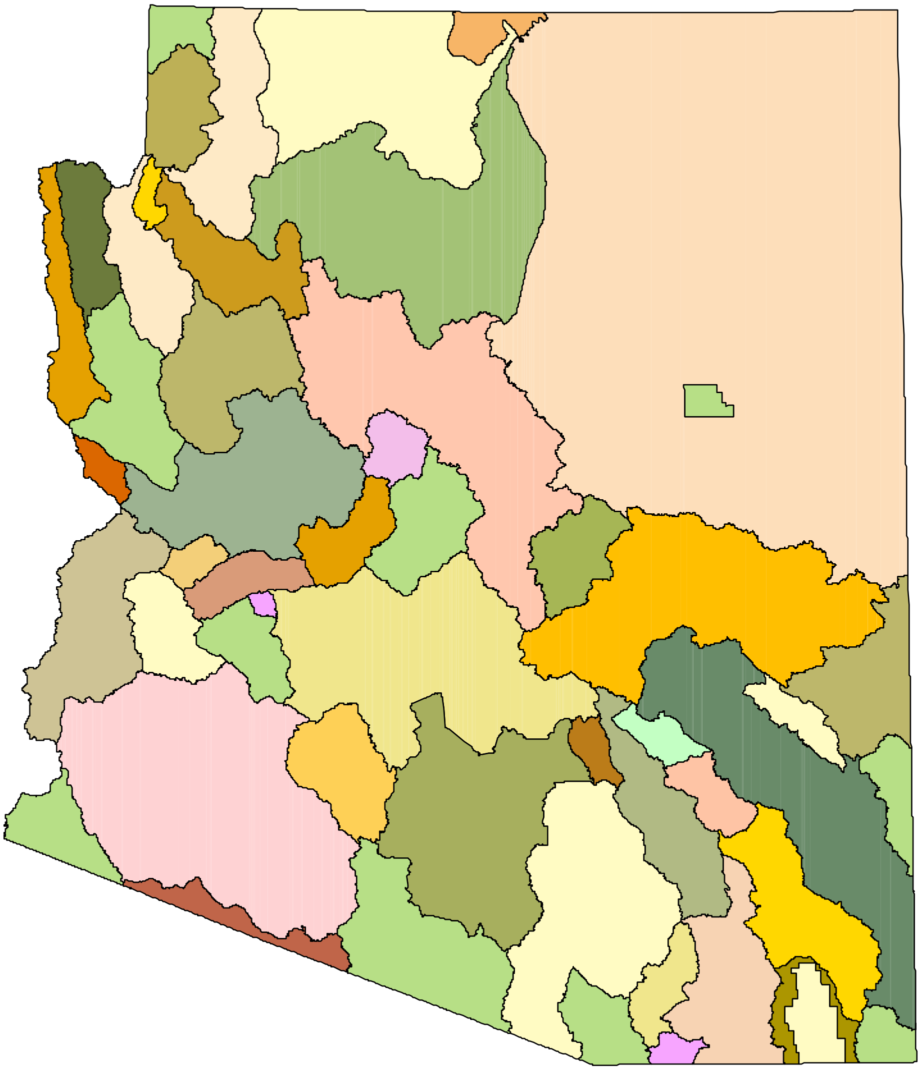
APPENDIX V

ADWR GWSI Database Handbook and User’s Guide

(Field Services Section, 2020)

ARIZONA DEPARTMENT OF WATER RESOURCES



GROUNDWATER SITE INVENTORY (GWSI) DATABASE HANDBOOK

HYDROLOGY DIVISION
2019

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Groundwater Site Inventory (GWSI) Database

Introduction

The Groundwater Site Inventory (GWSI) database is ADWR's main repository for state-wide groundwater data. The GWSI consists of field-verified data regarding wells and springs collected by personnel from Hydrology Division's Basic Data Section, the U.S. Geological Survey, and other co-operating agencies. The information in GWSI is constantly being updated by ongoing field investigations and through a state-wide network of water level and water quality monitoring sites.

This handbook has been developed for use by both the Basic Data section and other Department personnel. With the Department's move to a PC based client–server network, the data in GWSI have become more readily available to everyone within the Department. This handbook has been developed to help department personnel understand the GWSI database system, the data available in the system, and how the different data tables in the system can be used to extract meaningful information from the GWSI.

The GWSI data reside in 17 separate Oracle data tables, with each table containing a unique set of data. For example, the SITES data table contains the cadastral location (township, range, section, and quarter, quarter, quarter section), latitude/longitude, site elevation, well use, well depth, and other general information for each GWSI site. There are also a number of other tables in the GWSI folder. These tables contain letter codes associated with fields in the main GWSI data tables and other data related to the GWSI system. A full list of the main GWSI data tables along with a brief description of the data they contain is presented below.

Each data site in GWSI is assigned a unique 15-character identification number, the SITE ID, which is a common field in all the GWSI data tables. All the information available for a specific site can be obtained by using the SITE ID number. Site specific information can be accessed by using either the Oracle Application Forms or a relational database query tool such as Oracle Browser, Access, or Paradox. The SITES data table is the main data table in the GWSI system and can be linked to other GWSI tables using the SITE ID when using a relation database query tools. Data in any of the GWSI tables can be retrieved for any given geographic area using the townships and ranges, groundwater area designations, latitudes and longitudes, or UTM coordinates located in the SITES data table. In addition to the data tables there is an Oracle view, the TRS View, that can be used to aid in designing queries based on a sites township, range, and section.

Listed below are the main GWSI data tables and a general description of the information available in each table. The main body of this report presents each data table and lists each field in the table, then the acceptable codes for each field are listed and explained.

Table Name	**Table Description**
Sites	General Location Data, Well Depth, Well Altitude, and Water Use Data
Well_Completions	Well Construction and Finish Data, Driller's Name, and Completion Date
Bore_Completions	Bore Hole Data
Casing_Completions	Well Casing Data
Perforation_Completions	Well Casing Perforation Data
Flowing_Discharges	Flowing Discharge Data – for flowing wells and springs
Pumping_Discharges	Instantaneous Pumped Discharges from Wells
Well_Lifts	Well Lift (Pump) Data
Well_Logs	Well Log Data
Well_Owners	Well Ownership Data
Owner_Site_Names	Other Well Identification Data
Remarks	Pertinent Notes about Site
Site_Inventories	Personnel Who Inventoried Site
Spring_Names	Name of Spring and other Data Pertaining to the Spring (if Site is a Spring)
WW_Levels	Historic Water Level Measurements
WQ_Reports	Water Quality Data
WM_Points	Well Measurement Height and Location point
TRS	Oracle View with Local Id broken into Quadrant, Township, and Range – used for queries based on township and range.

Sites Data Table (SITES**)**

The SITES Data Table is used for recording general information about the site, including location information, general well construction, and well use information. The Sites data table is the main table in the GWSI system. All other GWSI tables are linked to it by the Site Id field.

Site Identification Number (GWSI_Sites . Site_Well_Site_Id)

This field contains the 15-digit identification number assigned to the site. The SITE ID contains no blanks or alphabetic characters. It is used as a unique identification number that allows users to link records in the SITES data table with records in other GWSI data tables. By linking across to other GWSI data tables all the data for one specific site can be retrieved. Although the Site Identification Number is derived initially from the latitude and longitude of the site, the number is a unique identifier and not a locator. It cannot be too strongly emphasized that the site identification number, once assigned, is a pure number and has no locational significance. The site identification number never changes once it is established except under unusual conditions.

The site identification number is assigned by locating the site on the best available map or orthophoto as accurately as possible. Using appropriate locational techniques, the latitude and longitude of the point on the map that represents the site is determined. The location of this point is always scaled to the nearest second of latitude and longitude, even if there is doubt as to the exact location of the site or the accuracy of the map. The first six digits of the site identification number are the value of the latitude, the seventh through thirteenth digits are the value of the longitude, and the value 01 is used for the fourteenth and fifteenth numbers. Leading zeros are used if the value of the minutes, or seconds of the latitude or longitude is less than 10, for example, 01, 02, ...09. No blanks or alphabetic letters are to be used in the Site Id. The site identification number usually ends in 01; however, in rare instances sequential numbers such as, 00, 02, 03, ..., have been assigned to these last two digits. Generally, this happens when more than one well occupies the same latitude and longitude, commonly occurring in nested piezometers.

With piezometers, the hole and casing that contains the nested piezometers (primary hole), is assigned a site identification that meets the minimum site requirements and the site identification will end in 00 but will have no water levels associated with it. Each piezometer or casing in the nest then has its own unique site identification meeting minimum site requirements and will contain detailed construction information (perforations, etc.), water levels, and a measuring point for each of the inner casings. Latitude and longitude for each piezometer and the “primary hole” is the same down to the Second. The “primary hole” and the piezometers site identifications share the same first 13 characters in the site identification and requires that each piezometer is assigned a unique identification ending in 01, 02, 03, and so on while the “primary hole” ends in “00” as stated above.

Local Identification Number (GWSI_Sites . Site_Local_Id)

This is a 20 character-long site location based on the U. S. Bureau of Land Management’s system of land subdivision. The land survey in Arizona is based on the Gila and Salt River Baseline and Meridian, which divides the state into four quadrants. These quadrants are designated **A**, **B**, **C**, and **D** in a counterclockwise direction starting in the upper right hand corner (Figure 1). All land with north *Townships* and east *Ranges* are in the **A** quadrant, north *Townships* and west *Ranges* in the **B** quadrant , south *Townships* and west *Ranges* in the **C** quadrant, and south *Townships* and east *Ranges* in the **D** quadrant. The first number in the cadastral location is the *Township*, the second is the *Range*, and the third is the *Section* in which the site is located. The letters following the section number indicate the well location within the section. The first letter indicates the 160-acre quarter section, the second letter the 40-acre quarter-quarter section, and the third letter the 10-acre quarter-quarter-quarter section. These letters are also assigned in a counterclockwise direction, beginning with the northeast quarter of the section. For example, a well with the cadastral location **D-04-05 16CAA** is located in *Township* 4 South, *Range* 5 East, *Section* 16 in the southwest quarter section, the northeast quarter-quarter section, and the northeast quarter-quarter-quarter section. Leading zeros are included in the township, range, and section numbers. If more than one well or site is located within a 10-acre tract, consecutive numbers beginning with 1 are added as suffixes with the oldest known well labeled as 1.

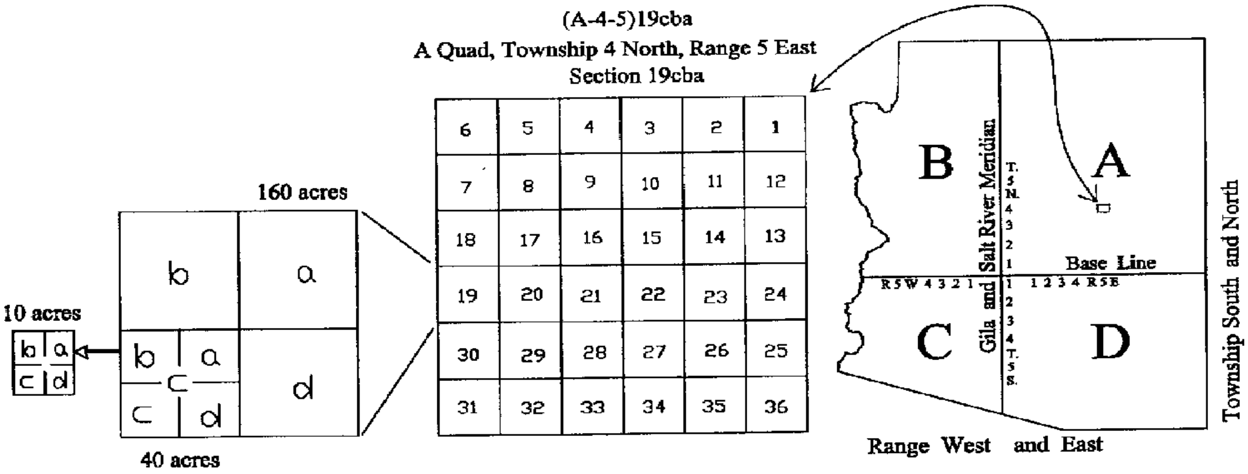
Piezometer nests have a unique convention where the “primary hole” will be assigned a Local ID without any suffix and each of the individual piezometers will be assigned a suffix consisting of a single space plus a PZ number of PZ1, PZ2, or PZ3, and so on. The PZ number needs to match the last number the piezometer was assigned in the site ID. For example, if the site ID for a piezometer ends with 01, the PZ will be PZ1 and the Local ID would be A-00-00 00AAA PZ1.

Groundwater Site Inventory (GWSI) Database

The well numbers and letters used by the Geological Survey in Arizona are in accordance with the Bureau of Land Management's system of land subdivision. The land survey in Arizona is based on the Gila and Salt River meridian and base lines, which divide the state into four quadrants. These quadrants are designated counter clockwise by the capital letters A, B, C, and D. All land north and east of the point of origin is in A quadrant, that north and west is in B quadrant, that south and west in C quadrant, and that south and east in D quadrant. The first digit of a well number indicates the township, the second the range, and the third the section in which the well is situates The lowercase letters a, b, c, and d after the section number indicate the well location within the section. The first letter denotes a particular 160-acre tract, the second the 40-acre tract, and the third the 10-acre tract. These letters are also assigned in a counter clockwise direction, beginning in the north east quarter. If the location is known within the 10-acre tract, three lowercase letters are shown in the well number. In the example shown in figure 2, well number (A-4-5) 19cba designates the well as being in the SWI/4 NW1/4 NEl/4 sec.19, T. 4 N., R. 5 E. Where there is more than one well within a 1 0-acre tract, consecutive numbers beginning with 1 are added as suffixes.

When a section is more than 1 mile in any dimension, the section numbers applies as usual. The oversized section is divided so that a full square-mile unit of the section is adjacent to a normal section within the appropriate N., S., E., or W. letters are assigned to the units, depending upon where they lie in relation to the full square-mile unit. A well would be designated as shown in figure 2 with the appropriate letter following the section number in which the well is located.

Oversized sections occur in several areas of the state. If a section is more than a mile in the north/south or east/west dimension, the excess area is considered a part of that section and has the same section number. A control corner is established for the section on the section corner that is closest to the center of the township (see Figures 2a and 2b). The oversized section is divided so that a full square-mile unit is adjacent to the control corner, the rest of the section is considered a separate unit of land. Appropriate N, S, E, W, or X letters are assigned to the separate units of land depending on where they lie in relation to the full square-mile land unit.



FICURE 2. -- WELL NUMBERING SYSTEM IN ARIZONA.

Figure 1 – Arizona Well numbering System

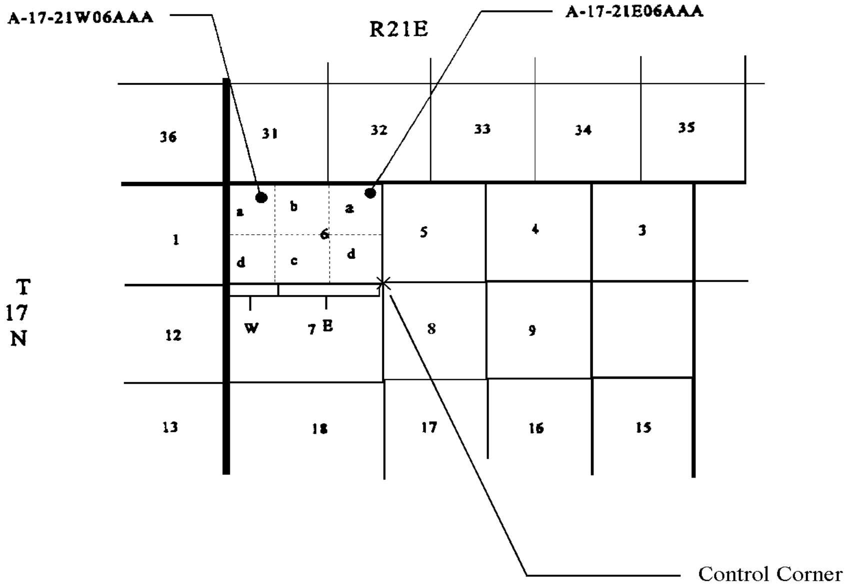


Figure 2a. Cadastral location of over-sized section in on direction.

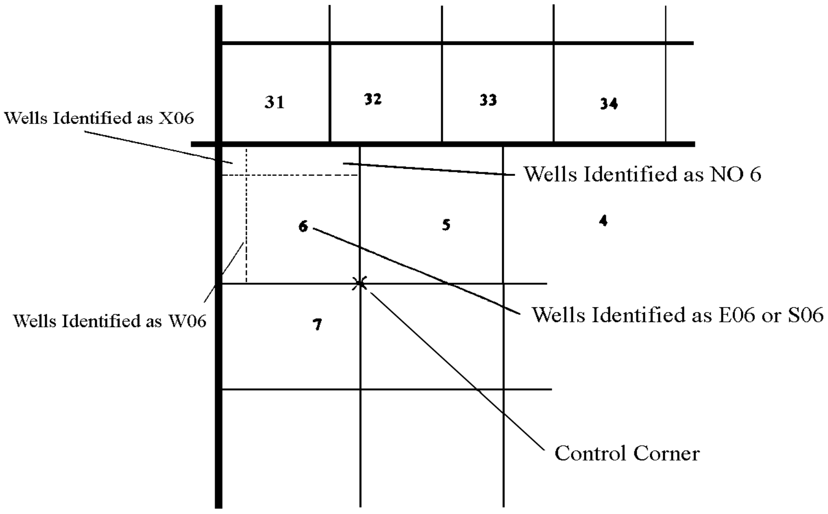


Figure 2b. Cadastra locatons for over-sized sections in two directions.

Figure 2. Cadastral locations for over-sized sections in Arizona.

For example, in Figure 2a, the section is over-sized in only one direction (East-West). Well A-17-21E06AAA is in the northeast quarter, of the northeast quarter, of the northeast quarter, of the *eastern* unit of Section 6, Township 17 North, Range 21 East. The well location is determined by placing the lower right-hand corner of the map locator on the control corner and reading the location within the full-sized section of land. The location of well A-17-21W06AAA is determined by moving the lower right-hand corner of the map locator to the lower right-hand corner of the *western* unit of Section 6 and reading the location within the over-sized unit of land (Figure 2a). Sections that are over-sized in the north-south direction use the same general procedure.

Figure 2b illustrates how wells are identified for sections that are over-sized in both east-west and north-south directions. Wells in the full section can be identified as being in either the *eastern* or *southern* unit of Section 6. A well located in the unit of land north of the full section are in the *northern* unit, and a well located in the unit of land to the west of the full unit is in the *western* unit of section six. A well in the small unit of land to the *north* and *west* of the full section uses an X as identifier, for example, X06 (Figure 2b).

Some areas of the state have half townships and half ranges. Half township and half ranges are designated by the letter **H** following the township or range. In some areas of the state survey lines have not been established. Sites in these areas have the suffix UNSURV in the last six spaces of the LOCAL ID field to indicate that the location is in an unsurveyed area. The cadastral location of a site in an unsurveyed area may not be as accurate as in a surveyed area and may only be identified to the 160 or 40 – acre location. Listed below are examples of some typical cadastral locations:

A-09-12 19ADD2	A-10H05 06ACD
D-05-04N27CDD	B-24-12 13BA UNSURV

A different numbering system is used to locate GWSI sites on the Navajo and Hopi Indian Reservations. The Navajo Indian Reservation is divided into 17 administrative districts, numbered 1 to 5 and 7 to 18, and the Hopi Indian Reservation comprises District 6. The Reservation is further divided into 15-minute quadrangles arbitrarily numbered from 1 to 151 starting in the northeast corner of the area and numbering consecutively in a row from east to west. Within the 15-minute quadrangle a site is located in miles south and west from the northeast corner of the quadrangle. The first two numbers in the well number represent the district, the next three numbers are the quadrangle, the decimal numbers are miles west by (X) miles south of the northeast corner of the quadrangle. For example, the site identified as 02 021-05.28X10.68 identifies a well that is in district 2, quadrangle 21, and is 5.28 miles west by 10.68 miles south of the northeast corner of the map.

GWSI sites located in California, New Mexico, Nevada, and Utah use different baselines and meridians. Cadastral identifications for non-Arizona GWSI sites are presented in Appendix D. The complete list of land net meridians is listed below. Some land in Arizona falls in the California Survey because changes in the Colorado River have left parts of California on the Arizona side of the river.

Land Net Meridian (GWSI_Sites . Site_Meridian) No corresponding code lookup table

This field records the land net meridian that is used to establish the Local Id or cadastral location of the site. In general, all sites located in Arizona, except those on the Navajo and Hopi Indian Reservation, use the Gila and Salt River Meridian and Baseline. There are six meridian codes in GWSI. They are:

B - San Bernardino Meridian and Baseline
D - Mount Diablo Meridian and Baseline
G - Gila and Salt River Meridian and Baseline
N - Navajo Meridian and Baseline
P - New Mexico Principal Meridian and Baseline
S - Salt Lake Meridian and Baseline

Site Type (GWSI_Sites . Site_Sittyp_Code_Entry) (Code Lookup Table: GWSI_Site_Types)

This field is used to describe what is at the location of the site. Generally, ADWR is interested only in wells and springs, however, several different types of sites have been entered in the past. The site codes and their descriptions are listed below.

C - Collector or Ranney type well.

D - Drain dug to intercept the water table or potentiometric surface to either lower the water table or serve as a water supply.

E - Excavation

G - Gravity data

M - Multiple Wells. Used for well fields consisting of a group of wells that are pumped through a single header and for which little or no data are available.

S - Spring

T - Tunnel or Shaft. Tunnel, shaft, or mine from which groundwater is obtained.

W - Well. For single wells other than wells of the collector or Ranney type.

X - GPS data

Y - Stream flow

Reliability (GWSI_Sites . Site_Rely_Code_Entry) (Code Lookup Table: GWSI_Reliabilities)

This field is used to describe the reliability of the data available for the site.

C - Field Checked. The data have been field checked by the reporting agency.

L - Location Not Accurate. Location of the latitude and/or longitude is not accurate.

M - Minimal Data. Used when modifying an existing record when the investigator is unsure if the site has been field checked.

U - Unchecked. The data have not been field checked by the reporting agency, but the reporting agency considers the data reliable.

Topo Setting (GWSI_Sites . Site_Toposet_Code_Entry) (Code Lookup Table: GWSI_Topo_Settings)

The Topographic Setting field contains codes that best describe the topographic setting of the area in which the site is located. (Figure 3).

* - Undetermined

A - Alluvial Fan. Refers to a slopping mass of material, shaped like an open fan or cone, deposited by a stream or wash at a place where it issues from a narrow mountain valley onto a plain or broad valley.

B - Playa. Refers to a dried-up, vegetation-free, flat-floored area composed of thin, evenly stratified sheets of fine clay, silt, or sand, that represents the bottom of a shallow, enclosed or undrained desert lake basin in which water accumulates and is quickly evaporated, usually leaving deposits of soluble salts.

C - Stream Channel. Refers to the bed in which a natural stream of water runs. The stream may be perennial, intermittent, or ephemeral. The term includes washes, arroyos, and coulees.

Topo Setting (continued)

D - Local Depression. Refers to an area that has no external surface drainage. Depressions can range from a few acres to several square miles and should be considered local features. Do not use for regional features such as the large closed basins found in the Basin and Range province, or on the undulating surface of glacial drift (use undulating).

E - Dunes. Refers to mounds or ridges of windblown, or eolian sand. This term should not be used for an isolated mound unless it has a rather extensive area and is of hydrologic significance to the site.

F - Flat Surface. Refers to a flat surface that may be part of a larger feature, such as an upland flat, mesa or plateau, coastal plain, lake plain, or pediment. Terraces and valley flats, which are special varieties of flat surfaces, are classified separately.

G - Floodplain. Refers to the surface or strip of relatively smooth land adjacent to a river channel, constructed by the present river in its existing flow regime and covered with water when the river overflows its banks at flood stage.

H - Hilltop. A hilltop is the upper part of a hill or ridge above a well-defined break in slope.

K - Sinkhole. A sinkhole is a special type of depression that results from the dissolving of soluble rock (salt, gypsum, limestone) and the subsequent collapse of the earth into the solution cavity.

L - Lake, Swamp, or Marsh. This code stands for any inland body of water where the ground may be saturated, or water may stand above the land surface for a period of time.

M - Mangrove Swamp. Refers to a tropical or subtropical marine swamp containing abundant mangrove trees.

P - Pediment. Refers to a plain of combined erosional material that forms at the foot of a mountain range.

S - Hillside. Refers to the sloping side of a hill, i.e., the area between a hilltop and valley flat.

T - Terrace. Refers to an alluvial or marine terrace that is generally a flat surface, usually parallel to but elevated above a stream valley or coast line. Due to the effects of erosion, the terrace surface may not be as smooth as a valley flat, and within the general terrace area there may be undulating areas.

U - Undulating. Refers to topography characteristic of areas which have many small depressions and low mounds. An undulating surface is primarily a depositional feature, not an erosional one. The term should not be used for areas that have a slightly irregular shape due to erosion.

V - Valley Flat. Refers to a low flat area between valley walls and bordering a stream channel. It includes the stream floodplain and, generally, is the flattest area in the valley. A valley flat may have a slight slope towards the main drainage, towards the valley walls, or may be cut by smaller streams. Generally, the valley flat is separated from alluvial terraces or the upland by a pronounced break in slope.

W - Upland Draw. Refers to a small natural drainage or depression, usually dry, on a hillside or upland area.

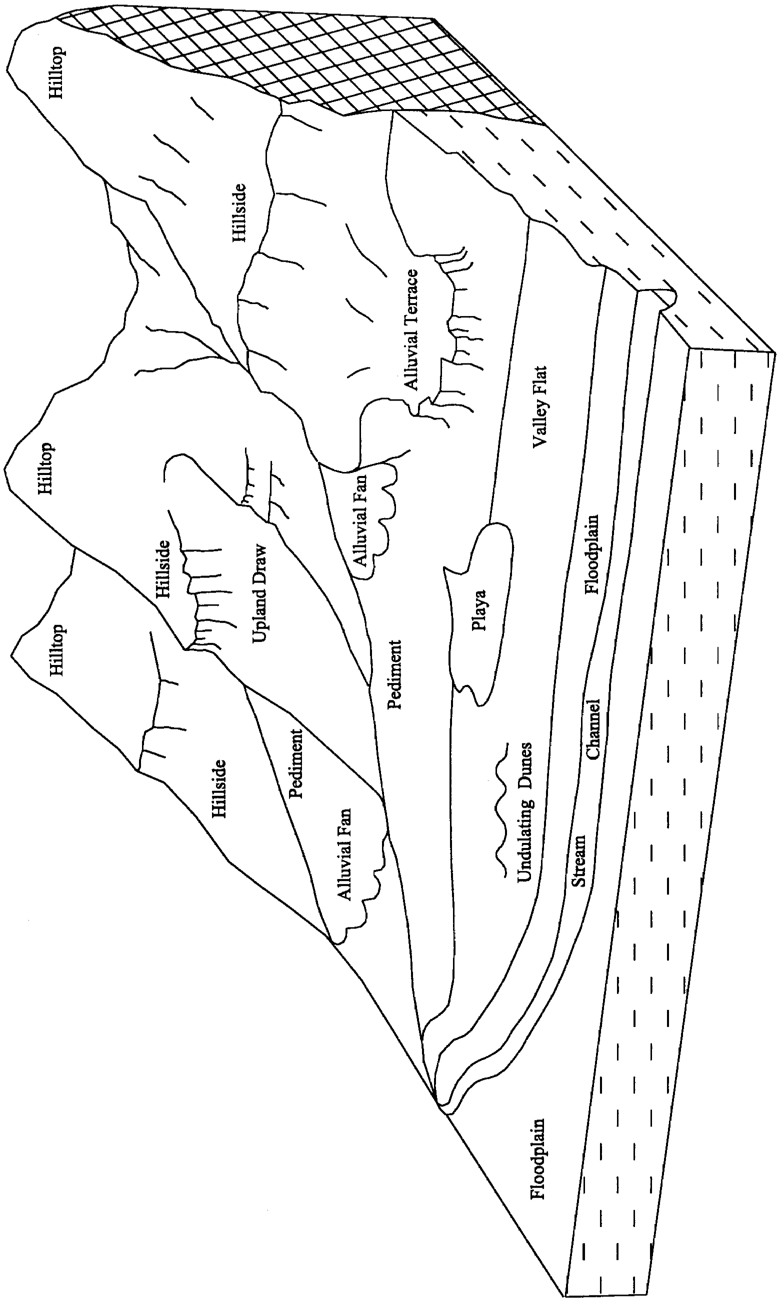


Figure 3. Diagrammatic sketch of Topographic features.

Figure 3. Diagrammatic sketch of Topographic features.

Site Data Source (GWSI_Sites . Site_Sisrc_Code) (Code Lookup Table: GWSI_Site_Sources)

This field contains the agency making the original field check and initial data entry, usually ADWR or USGS.

ADWR - Arizona Department of Water Resources
USBR - U.S. Bureau of Reclamation
USGS - U.S. Geological Survey

Topographic Quad Name (GWSI_Sites . Site_Tqnam_Quad_Name)

This field contains the name of the U.S. Geological Survey Topographic Quadrangle map on which the site is located. Use the drop-down list to select the proper map name.

Map Scale (GWSI_Sites . Site_Map_Scale)

This field records the scale of the topographic quadrangle map on which the site is located.

ALRIS Quadrangle Number (GWSI_Sites . Site_Quad_No)

This field contains the Arizona Land Resource Information System (ALRIS) number of the topographic quadrangle that the site is located on. ALRIS is supported by the Arizona State Land Department and is based on a row - column grid of all 7.5 minute quadrangle maps that cover a part of the state. The first two numbers represent the column a map is in and the second two numbers are the row the map occupies. ORACLE assigns the ALRIS quadrangle number based on the name that is entered into the Topographic Quadrangle Name field.

Latitude and Longitude (GWSI_Sites . Site_Latit_Degree, Site_Latit_Min, Site_Latit_Sec)
(GWSI_Sites . Site_Longit_Degree, Site_Longit_Min, Site_Longit_Sec)

The three latitude fields and the three longitude fields contain the best available value for the latitude and longitude of the site in degrees, minutes, and seconds. The site is located on an orthophoto and/or best available map in the field. The position of the site may be measured in the field by global positioning system (G.P.S.) equipment if available. The longitude and latitude will be determined from the orthophoto or map by the field person in the office. Each value for the degrees, minutes and seconds should be entered into the appropriate field.

Latitude/Longitude Accuracy (GWSI_Sites . Site_Llaccr_Code_Entry)
(Code Lookup Table: GWSI_Lon_Lat_Accuracies)

This field records the accuracy of the latitude/longitude location for the site. If the site cannot be spotted on an orthophoto within 2 seconds, then the field person will indicate the appropriate accuracy. In general a site can be located to within five seconds on a map, two seconds on an orthophoto with a templet, and one second if it is digitized. The appropriate codes are listed below:

1 - 0.1 seconds
2 - The measurement is accurate to + or - two seconds
5 - 0.5 seconds
B - 0.2 seconds
F - The measurement is accurate to + or - five seconds
H - 0.01 seconds
M - The measurement is accurate to + or - 1 minute
O - 0.001 seconds
Q - 0.4 seconds
R - The measurement is accurate to + or - three seconds
S - The measurement is accurate to + or - one second
T - The measurement is accurate to + or - ten seconds
U – Undetermined
V – 0.005 seconds

Method of Latitude/Longitude Measurement (GWSI_Sites . Site_Latlong_Meth_Code)
(Code Lookup Table: GWSI_Latlong_Method_Codes)

This field records the method used to determine the altitude of the site.

C - Calculated from Land Net
D - Differential Globe Positioning System (DGPS)
E - Reported
N - Interpolated from Digital Map
O - Other
P - Photo

<u>Method of Latitude/Longitude Measurement</u> (continued)

F - Calculated from Cadastral
G - Globe Positioning System (GPS)
H - Reported by Source Agency
K - Post-Processed Static Survey System
L - Long-Range Navigation System
M - Interpolated from Map
R - Real-Time Kinematic GPS Position
U - Unknown Source
V - Instrument Survey Method
X - Visually Interpolated from USGS 7.5’ Map
Y - Calculated Using GIS TRS Cover

<u>Decimal Latitude</u> (GWSI_Sites . Site_Latitude_Decimal)

This field contains the latitude in decimal format of the site which is calculated by ORACLE.

<u>Decimal Longitude</u> (GWSI_Sites . Site_Longit_Decimal)

This field contains the longitude in decimal format of the site which is calculated by ORACLE.

<u>UTM Coordinates</u> (Site_Utm_East, Site_Utm_North) No corresponding table linked to GWSI

The two UTM fields contain the Universal Transverse Mercator (UTM) location of the site. The Universal Transverse Mercator system is a special application of the Transverse Mercator map projection. The UTM system divides the globe into sixty (60) zones, each spanning six (6) degrees of longitude. Each UTM zone has a central meridian which divides the zone into two equal parts, three degrees east and three degrees west. The origin of a zone is the central meridian and the equator, all points within a zone are referenced from this point in meters. To eliminate negative values the origin is assigned a false easting value of 500,000 meters; thus Easting values of less than 500,000 meters are located in the east half of a zone and easting values of more than 500,000 meters are located in the west half of a zone. The UTM values for a GWSI site are calculated from the latitude and longitude coordinates and currently are in NAD27, Zone 12.

<u>State Well Registration Number</u> (GWSI_Sites . Site_Well_Reg_Id)

This field contains the State Well Registration (55) number of the well if the site can be positively matched to a registered well. The 55 number is matched with a GWSI well only when the field investigator is absolutely positive that the wells are the same. If there is any doubt about the match, the 55 number is not entered until those doubts are resolved.

<u>Site Altitude</u> (GWSI_Sites . Site_Well_Altitude)

This field contains the altitude of the site in feet above NGVD, precision to two decimals can be coded if available. This value is determined by the person field checking the site.

<u>Method of Altitude Measurement</u> (GWSI_Sites . Site_Altmeth_Code_Entry)
(Code Lookup Table: GWSI_Altitude_Methods)

This field records the method used to determine the altitude of the site.

A - Altimeter
D - Differential G.P.S.
E - Reported
G - Hand-held G.P.S. unit
H - Reported by source agency
I - Interferometric synthetic aperture radar (I.F.S.A.R.)
J - Light detection and ranging (L.I.D.A.R.)
K - Post-Processed static survey G.P.S.
L - Level or other surveying method
M - Interpolated from topographic map
N - Interpolated from digital elevation model (D.E.M.)
O - Other
P - Photo
R - Real-time kinematic G.P.S.
S - Transit, theodolite, or other surveying method
U - Unknown
V - Instrument surveying method
X - Interpolated from USGS 7.5’ map

Altitude Accuracy (GWSI_Sites . Site_Altit_Accuracy)

This field contains the level of accuracy, in feet, of the site altitude. Site altitudes taken from a map are generally accurate to one half the maps contour interval. Sites that are leveled in from a bench mark are considered accurate to within 1.0 foot.

ADWR Basin Codes (GWSI_Sites . Site_Ama_Code_Entry)

This field contains the appropriate letter code for the ADWR groundwater basin or Active Management Area (AMA) in which the site is located. For sites that are in either a subdivided and non-subdivided basin the appropriate basin code is entered into this field. For sites that are in Active Management Areas (AMAs) the appropriate AMA code is entered. Sites that are located in Irrigation Non-Expansion Areas (INAs) have the three letter code of the groundwater basin within which the INA occurs entered in this field, and the three letter INA code entered into the ADWR Sub-basin field. See Appendix A for the appropriate ADWR Basin, Sub-basin, AMA, and INA Codes.

ADWR Sub-Basin Codes (GWSI_Sites . Site_Adwbas_Code_Entry)

Many of the ADWR groundwater basins and AMAs are subdivided into smaller sub-basins based on hydrologic conditions. This field contains the appropriate three letter code for the ADWR designated groundwater sub-basin. For sites that are in basins or AMAs with no Sub-basins, i.e., non-subdivided basins, the three letter basin or AMA code is entered into this field. Sites that are located in Irrigation Non-Expansion Areas (INAs) have the three letter INA code entered into this field. See Appendix A which contains the ADWR Basin, Sub-basin, AMA, and INA Codes.

USGS Basin Codes (GWSI_Sites . Site_Usbasn_Code_Entry)

This field contains the appropriate three letter code for the U S Geological Survey groundwater area in which the site is located. See Appendix B which contains the USGS area codes.

State Codes (GWSI_Sites . Site_State_Code_Entry) (Code Lookup Table: GWSI_States)

This field contains the appropriate letter code for the state in which the site is located.

AZ - Arizona
CA - California
CO - Colorado
NM - New Mexico
NV - Nevada
SO - Sonora
UT - Utah

County Codes (GWSI_Sites . Site_Cnty_Code) (Code Lookup Table: GWSI_Countys)

This field contains the appropriate numeric code for the county in which the site is located.

Arizona

01 - Apache
03 - Cochise
05 - Coconino
07 - Gila
09 - Graham
11 - Greenlee
12 - La Paz
13 - Maricopa
15 - Mohave
17 - Navajo
19 - Pima
21 - Pinal
23 - Santa Cruz
25 - Yavapai
27 - Yuma

Nevada

03 - Clark

Utah

25 - Kane

California

25 - Imperial
65 - Riverside
71- San Bernardino

Colorado

83 - Montezuma

County Codes (continued)

New Mexico

03 - Carton
17 - Grant
23 - Hidalgo
31 - McKinley
45 - San Juan
61 - Valencia

Site Use (GWSI_Sites . Site_Use_1, Site_Use_2, Site_Use_3) (Code Lookup Table: GWSI_Site_Use_Codes)

The three Site Use fields contain the appropriate letter codes for the use of the site. SITE_USE1 is the principal use of the site at the time of the last field visit. If the site is used for more than one purpose then the second and third Site Use entries can be coded with the appropriate letter codes.

* - Undetermined

A - Anode. An anode is a hole used as an electrical anode. Included in this category are wells used solely for cathodic protection of pipelines or electronic relays and other installations.

C - Standby, Emergency Supply. This refers to a water supply source that is used only when the principal source of water is unavailable.

D - Drain. Refers to the drainage of surface water underground.

E - Geothermal. A geothermal well is a hole drilled for geothermal energy development. Use this category for dry geothermal wells or wells into which water is injected for heating. For a wet geothermal well, from which water is withdrawn, use W – Withdrawal of water for the site use, and E - Power Generation as the primary use of water.

G - Seismic. A seismic hole is one drilled for seismic exploration. A seismic hole converted for other uses should be coded based on its current use.

H - Heat Reservoir. Refers to a well in which a fluid is circulated in a closed system. Water is neither added nor withdrawn from the well.

M - Mine. A mine includes any tunnel, shaft, or other excavation constructed for minerals extraction.

N - Non-exempt well in AMA/INA

O - Observation - Water Level. An observation well is a well that is used for water level observations. Do not use this category for oil test holes or water-supply wells used only occasionally as observation wells. ADWR statewide water level monitoring wells are identified by convention with the code O only in the Site_Use_ 2 or Site_Use_3 fields.

P - Oil or Gas. Refers to any well or hole drilled in search of, or for production of, petroleum or gas. This category includes any oil or gas production well, dry hole, core-hole, or injection well drilled for secondary recovery of oil and/or gas. An oil-test hole converted to a water supply hole should be classified as Withdrawal.

Q - Water Quality Monitoring. An observation well is a well that is used for water-quality observations. Do not use this category for oil test-holes or water supply wells used only occasionally as observation wells. ADWR statewide water quality monitoring wells are identified by convention by the code Q only in the Site_Use_2, or Site_Use_3 fields

R - Recharge. A recharge site is a site constructed for, or converted for, use in replenishing the aquifer. Use this category for wells that are used only to place water into an aquifer.

Site Use (continued)

S - Repressurized. Refers to pumping water into an aquifer in order to increase the pressure in the aquifer for a specific purpose, for example, water flood purposes in an oil field.

T - Test. Refers to either an uncased or temporarily cased hole, that was drilled for water, or for geologic or hydrogeologic testing. The hole may be temporarily equipped with a pump in order to make a pump test, but if the well is developed after testing it is still a test hole. A core hole that is part of mining or quarrying exploration work should be in this class.

U - Unused. Refers to an abandoned site or one for which no use is contemplated. At an abandoned farmstead a domestic, or stock well equipped with a pump may be classed as unused. An irrigation well that is not equipped with a pump, nor used for other reasons, also may be classified unused.

W - Withdrawal. Refers to a site that withdraws water for one of the purposes listed under water use. It includes a dewatering well if the dewatering is accomplished by pumping groundwater.

X - Waste . Refers to a site used to convey industrial waste, domestic sewage, oil-field brine, mine drainage, radioactive waste, or other waste fluid into an underground zone. An oil-test or deep-water well converted to waste disposal should be in this category.

Z - Well Destroyed. Refers to a site that is has been destroyed and is no longer in existence.

Water Use (GWSI_Sites . Site_Water_Use_1, Site_Water_Use_2, Site_Water_Use_3)
(Code Lookup Table: GWSI_Water_Use_Codes)

The three Water Use fields are used to indicate to what purpose any water withdrawn from the site is used. Use WATER_USE_1 to indicate the principal use of the water from the site. Other uses are entered in the other two water use fields.

* - Undetermined

A - Air Conditioning. Refers to water supplied solely or principally for the heating or cooling of a building. Water used to cool industrial machinery should be coded as Industrial, not as Air Conditioning.

B - Bottling. Refers to the storage of water in bottles and use of the water for potable purposes.

C - Commercial. Refers to use by a business that does not fabricate or produce a product. Filling stations and motels are examples of commercial establishments. If some product is manufactured, assembled, remodeled, or otherwise fabricated, use of water at the plant should be considered as Industrial, even though the water is not used directly in the production and/or manufacture of the product.

D - Dewatering. Refers to water pumped for dewatering a construction or mining site, or to lower the water table for agricultural purposes. In this respect, it differs from a drainage well that is used to drain surface water underground. If the main purpose for which the water is withdrawn is to provide drainage, Dewatering should be indicated even though the water may be discharged into an irrigation ditch and subsequently used to irrigate land.

E - Power. Refers to water withdrawn for the use of generating any type of power.

F - Fire. Refers to the principal use of the water and should be indicated if the site was constructed principally for this purpose, even though the water may be used at times for other purposes.

H - Domestic. Refers to water used to supply household needs, principally for drinking, cooking, washing, and sanitary purposes, but includes watering a lawn and caring for pets. Most domestic wells will be in suburban or farm homes, but wells supplying small quantities of water for domestic purposes to one-room schools, turnpike gates, and similar installations, should also be included in the category.

Water Use (continued)

I - Irrigation. Refers to water used to irrigate cultivated crops. Most irrigation site will supply water for farm crops, but this category should include wells used to water the grounds of schools, industrial plants, cemeteries, or golf courses if more than a small amount is used and that is the sole use of the water.

J - Industrial Cooling. Refers to a well that supplies water used solely for industrial cooling.

K - Mining. Refers to a well that supplies water used solely for mining purposes.

M - Medicinal. Refers to water believed to have therapeutic value. Water may be used for bathing and/or drinking. If used of water is mainly because of its claimed therapeutic value, use this category even if the water is bottled.

N - Industrial. Refers to water used within a plant that manufactures or fabricates a product. The water may or may not be incorporated into the product being manufactured. Industrial water may be used to cool machinery, to provide sanitary facilities, to air condition the plant, or to irrigate the grounds at the plant.

O - Observation. Refers to water that is used for water quality sampling.

P - Public Supply. Refers to water that is pumped and distributed through a network that supplies several homes. Such supplies may be owned by a municipality or community, a water district, or a private water company. If the system supplies five or more homes it should be considered. "Public Supply"; for four or fewer homes classify use as . "Domestic". Wells that supply motels and hotels should be classified as "Commercial". Many public supply wells also supply water for a variety of uses, such as industrial, institutional, and commercial.

Q - Aquaculture. Refers to water used solely for aquaculture, such as fish farms.

R - Recreation. Refers to water discharged into pools, or channels, which are dammed to form pools, that are used for swimming, boating, fishing, ice rinks, or other recreational uses. Also used for wells that irrigate golf courses and parks.

S - Stock. Refers to a well pumped to supply water to livestock.

T - Institution. Refers to water used in the maintenance and operation of institutions such as large schools, universities, hospitals, rest homes, or similar institutions. Owners of the institutions may be individuals, corporations, churches, or government bodies.

U - Unused. Means that water is not being removed from the site for one of the purposes listed above. A test hole, oil or gas well, recharge, drainage, observation, or waste-disposal well will be in the category. Do not use this classification for a stock, irrigation, domestic, or other well during off season or other temporary periods of nonuse.

Z - Other.

Depth of Hole (GWSI_Sites . Site_Hole_Depth)

This field records the total depth to which the hole was drilled in feet, below the land surface datum, even though it may have been plugged back in completing the well. For collector or Ranney-type wells, the depth of the central shaft should be entered. For multiple-well fields, ponds, tunnels, springs, or drains, the field should be blank. If the hole depth is given, all other depths associated with the site will be compared with it for validity.

Depth of Well (GWSI_Sites . Site_Well_Depth)

This field contains the depth of the finished, or cased, portion of the well in feet below land surface datum. The depth of the well is usually taken from the completed well drillers report.

Source of Depth Data (GWSI_Sites . Site_Adwrs_Code) (Code Lookup Table: GWSI_ADWR_Sources)

This field contains the source of the reported depth of a well.

* - Undetermined
A - Arizona Department of Water Resources.
B - U.S. Bureau of Reclamation.
C - Consultant.
D - Driller. Depth taken from a drillers log or report.
E - New Mexico Office of State Engineer.
F - Arizona Geologic Survey.
G - Geologist.
L - Logs.
M - Memory. Depth from owner, driller, or well operator.
O - Owner. Depth reported by well owner.
R - Other Reported. Depth reported by person other than owner, driller, or another governmental agency.
S - Reporting Agency. Depth reported by a reporting agency.
U - U.S. Geological Survey. Depth reported by personnel from the U. S. Geological Survey.
Z - Other. Depth reported by other source. Explain source in Remarks section.

Geological Unit (GWSI_Sites . Site_Geo_Unit)

This field contains an 8-character code that identifies the lithologic unit in which the well is finished. See Appendix C for the appropriate Geological Unit Codes.

Site Creation Date (GWSI_Sites . Site_Create_Date)

This field is filled by ORACLE with the date when the SITES entry was created.

Site Update Date (GWSI_Sites . Site_Update_Date)

This field is filled by ORACLE with the date when information in any of the data tables related to the GWSI site is updated or modified.

Last Action Date (GWSI_Sites . Site_Last_Act_Date)

This field is filled by ORACLE with the date when any field in the SITES data table is changed or modified.

Last Action Operator (GWSI_Sites . Site_Last_Act_Oper)

This field is filled by ORACLE with the user id of the last person to change or modify any field in the SITES data table.

Valid Entry Dates (GWSI_Sites . Site_Cdate_Valid, Site_Udate_Valid)

The two Valid Entry Date fields contain flags that indicate the accuracy of the dates in the Site Create or Site Update fields. Prior to being loaded into the ORACLE data tables GWSI was located on an IBM mainframe computer. Some of the date fields in the GWSI on IBM mainframe had no month or day values. The ORACLE GWSI date fields would not accept the null date entries when the IBM data were loaded into the ORACLE forms. To get around this problem, values were added to those GWSI entries with null dates. The month field was assigned a value of one (1) if it was empty, and the day field was assigned a value of one (1) if it was empty. The letter code ‘M’ in the Date Valid field indicates the month value has been assigned and the date is only accurate to the year. The letter code ‘D’ in the Date Valid field indicates the day value has been added and the date is accurate only to the month. A blank entry indicates that the full date is accurate. Each data table in GWSI that contains date fields will contain a Date Valid field.

Arizona Watershed Codes (GWSI_Sites . Site_Wshd_Code) No corresponding table linked to GWSI

This field contains the Arizona Watershed that the site falls in. Watershed codes are listed below

Arizona Watershed Codes (continued)

01 - Virgin River
02 - Colorado River
03 - Little Colorado River
04 - Bill Williams River
05 - Verde River
06 - Agua Fria River
07 - Salt River
08 - Upper Gila River
09 - Santa Cruz River
10 - San Simon River
11 - San Pedro River
12 - Willcox Playa
13 - White Water Draw
14 - Rio Yaqui
15 - La Paz

Index Book (GWSI_Sites . Site_Idx_Book)

If the site is an active index well the number of the index book is entered in this field. It needs to be noted that this field only includes active index wells. Other wells that were index wells and then were removed from the index lines are not noted in this field. Wells that are on the index lines are a good place to start when looking for long-term water level records. However, other wells in the area of interest still need to be checked. A well that has been removed from the index line may still contain a very useful water level history.

Quasi-Index Well (GWSI.SITES)

Well Completions Data Table (WELL_COMPLETIONS)

The Well Completions Data Table is used to record detailed information about the construction of a site that is a well. The information includes the drillers' names, dates of completion, drilling methods, casing finishes, and sources of the data.

Construction Entry Number (GWSI_Well_Completions . Wlco_Id)

Construction data can be entered more than once for a given site, such as when a well is deepened or some other major work is done. Therefore, a unique identifying control number is assigned by Oracle for each construction data entry. The number need not be sequential but needs to be unique for the site. The unique construction number is also assigned to any related construction information that is entered into the Bore Completions, Casing Completions and Perforation Completions Data Tables.

Well Completion Date (GWSI_Well_Completions . Wlco_Completion_Date)

This entry is the date the drilling was completed. If the day or month are not known enter 01 for the month and 01 for the day, and code the appropriate letter is entered into the Date Valid Field.

Drill Method (GWSI_Well_Completions . Wlco_Drilmth_Code_Entry) (Code Lookup Table: GWSI_Drill_Methods)

This field describes the method by which the site was constructed. Allowable entries are:

* - Undetermined.

A - Air Rotary. This method uses a stream of air to cool the bit and bring the rock cuttings to the surface.

B - Bored or Augured. This method uses an auger to cut and remove the earth material. The auger may be powered by hand or by machinery.

C - Cable Tool. Refers to a well drilled by the percussion or churn-drill method whereby a heavy drilling tool is raised and lowered with enough force to pulverize the rock. The rock debris is commonly removed from the hole with a bailer.

D - Dug. Hand dug holes are excavated by hand tools or power-driven digging equipment. Caissons, Ranney-type collectors, and galleries belong in this classification including if they may have laterals that are driven or jetted.

Drill Method (continued)

H - Hydraulic Rotary. With this method a well is constructed by rotating a length of pipe (drill stem) equipped with a drill bit that cuts or grinds the rocks. Water or drilling mud is pumped down the drilling stem. Cuttings are carried to the surface in the annular space between the drilling stem and the wall of the hole. Note that separate categories are provided for air-rotary and reverse-rotary.

J - Jetted. Jetted wells are excavated by using high velocity streams of water that are pumped through a pipe having a restricted opening or jetting nozzle. For some types of earth material, a cutting bit is attached to the end of the jetting nozzle. The material cut or washed from the hole is carried to the surface in the annular space outside the pipe as in the hydraulic-rotary method.

P - Air Percussion. This method uses a cutting tool powered by compressed air. A rapid percussion effect, coupled with rotary action, is used to drill through the earth material. Compressed air is also used to blow cuttings from the drill hole. Air-percussion drills are generally used in conjunction with air-rotary drilling rigs.

R - Reverse Rotary. This method is similar to the hydraulic rotary method except that the water or drilling mud flows down the annular space between the drilling stem and the walls of the hole and the cuttings are pumped out through the drill stem.

T - Trenching. Refers to the construction of a sump or open pit from which groundwater may be pumped. Trenching may be done by hand, but more commonly power equipment, such as a bulldozer, power shovel, or back-hoe is used. Ponds and Drains belong in this category.

V - Driven. A well constructed by driving a length of pipe, usually of a small diameter and generally equipped with a sand point, to a desired depth. These wells may be driven by hand or with an air hammer or other power equipment. An essential feature of a driven well is that no earth material is removed as the well is constructed.

W - Drive and Wash. These wells are constructed by driving a small diameter open-ended casing a few feet into the earth and then washing the material inside the casing out with a jet of water. The process is repeated until the well is at the desired depth.

Z - Other. Any other drilling method that may be used. The method may be described in the Remark Field.

Well Finish (GWSI_Well_Completions . Wlco_Wlcase_Code_Entry) (Code Lookup Table: GWSI_Well_Finishes)

This data field is used to describe the method of finish or the nature of the openings that allow water to enter the well. The allowable codes are listed below.

* - Undetermined

C - Porous Concrete. This is a concrete casing that is pervious enough to allow groundwater to seep into the well.

F - Gravel Pack with Perforations. Refers to a well that has a gravel envelope opposite a casing section with perforations which allows water to enter the well.

G - Gravel Pack with Screen. Refers to a well that has a gravel envelope opposite a commercially available casing section with screening material which allows water to enter the well.

H - Horizontal Gallery. This type of finish is a horizontal-type well in which the screen, slotted pipe, or gravel-filled trench is horizontal. All horizontal wells should be in this class, including Ranney collectors and infiltration galleries.

O - Open Ended. Refers to a well that is cased to the bottom of the hole so that water can enter the well only through the bottom of the hole.

P - Perforated or Slotted. Refers to casing that has had holes punched or slots cut into it to allow water to enter. Do not use this classification if the well has a gravel pack; use F or G, whichever is appropriate.

Well Finish (continued)

S - Screened. Refers to commercially available well screen manufactured for the purpose of allowing water to enter the well casing. Common types of screen are wire mesh, wrapped trapezoidal wire, or shutter screen. Do not use this classification if the well also has gravel pack; use G instead.

T - Sand Point. Refers to the screen part of a drive point and usually is part of a driven well.

W - Walled or Shored. Refers to a dug well that has walls that have been shored up with open-jointed fieldstone, brick, tile, concrete blocks, wood cribbing or other material. A dug well that is mostly open hole but has even a few feet of cribbing, corrugated pipe, or other shoring to prevent caving should be in this category. Wells of this type with gravel walls belong in this category, not in the F or G.

X - Open Hole. Refers to a well that has a finished open hole in the aquifer. A well belongs in this classification even if the casing does not actually extend to the geologic unit or zone from which the water is obtained.

Z - Other. Any other drilling method that may be used. The method may be described in the Remark Field.

Source of Construction Data (GWSI_Well_Completions . Wlco_Adwrs_Code)
(Code Lookup Table: GWSI_ADWR_Sources)

This field contains the source of the construction data and has the same letter codes as those found in the Sites_Adwrs_Code field in the Sites Data Table. See page 14 for the appropriate letter codes.

Name of Driller (GWSI_Well_Completions . Wlco_Driller_Name)

This field contains the name of the driller or drilling company that constructed the well. For very long company names use meaningful abbreviations as needed to fit the name into the space provided.

Last Action Date (GWSI_Well_Completions . Wlco_Last_Act_Date)

This field is filled by ORACLE with the date when any field in the Well Completions data table is changed or modified.

Last Action Operator (GWSI_Well_Completions . Wlco_Last_Act_Oper)

This field is filled by ORACLE with the user id of the last person to modify or change any field in the Well Completions data table.

Valid Completion Date (GWSI_Well_Completions . Wlco_Valid_Date)

This field contains a flag that indicates the accuracy of the well completion date. See the previous explanation of the Valid Date field.

Bore Hole Completions Data Table (BORE_COMPLETIONS)

The Bore Hole Completions Data Table is used to record specific data describing the drill hole for a well site.

Construction Entry Number (GWSI_Bore_Completions . Bore_Wlcomp_Id)

The construction entry is the unique control number assigned by Oracle to well construction data in the Well Completions Data Table. This control number is assigned to the corresponding bore hole construction information.

Bore Hole Interval (GWSI_Bore_Completions . Bore_Hole_Interval)

This field contains a sequential number assigned by Oracle to each separate bore hole diameter record for a specific construction entry number. For example, a bore hole that is drilled at 16 inches in diameter from land surface to 500 feet below land surface and then drilled at 12 inches in diameter from 500 feet below land surface to 750 feet below land surface would have two bore hole intervals. The first interval is 0 to 500 feet, the second bore hole interval is 501 to 750

feet. The interval numbers for the bore hole completions data table is assigned sequentially and generally starts from the construction entry number. For example, for a well with a construction entry number of 451384 the first bore hole interval would be assigned 451385, a second bore hole interval would be assigned 451386.

Top of Bore Hole (GWSI_Bore_Completions . Bore_Hole_Top)

This is the depth to the point at which the top of a segment of the hole begins in feet below land surface. The first section of the hole begins at zero (0).

Bottom of Bore Hole (GWSI_Bore_Completions . Bore_Hole_Bottom)

This is the depth to the bottom of the hole segment, in feet below land surface.

Diameter of Bore Hole (GWSI_Bore_Completions . Bore_Hole_Diameter)

This is the normal diameter of the bit used to drill this section of the hole, or the diameter to which the hole was reamed, in inches. Two decimal places are provided for fractional sizes.

Last Action Date (GWSI_Bore_Completions . Bore_Last_Act_Date)

This field is filled by ORACLE with the date when any field in the Bore Completions data table is changed or modified.

Last Action Operator (GWSI_Bore_Completions . Bore_Last_Act_Oper)

This field is filled by ORACLE with the user id of the last person to modify or change any field in the Bore Completions data table.

Casing Completion Data Table (CASING_COMPLETIONS)

The Casing Completions Data Table describes information about the casing of a well.

Construction Entry Number (GWSI_Casing_Completions . Case_Wlcomp_Id)

The construction entry number is the unique control number assigned by Oracle to well construction data in the Well Completions Data Table. This control number is assigned to the corresponding well casing information.

Casing Interval (GWSI_Casing_Completions . Case_Interval)

This is a sequential number assigned to each casing diameter for a specific construction entry number. For example, a well that is cased at 16 inches in diameter from land surface to 500 feet below land surface and then cased at 12 inches in diameter from 500 feet below land surface to 750 feet below land surface would have two casing intervals. The first casing interval is 0 to 500 feet, the second casing interval is 500 to 750 feet. The casing interval numbers are assigned sequentially and generally start from the construction entry number.

Top of Casing (GWSI_Casing_Completions . Case_Top)

This is the depth to the point at which the top of a casing segment begins in feet below land surface. The first section of casing begins at zero (0).

Bottom of Casing (GWSI_Casing_Completions . Case_Bottom)

This is the depth to the bottom of the casing segment, in feet below land surface.

Diameter of Casing (GWSI_Casing_Completions . Case_Diameter)

This is the outside diameter of the casing segment in inches. Two decimal places are provided for fractional sizes.

Casing Material (GWSI_Casing_Completions . Case_Finish_Code) (Code Lookup Table: GWSI_Casing_Finishes)

This data table indicates the material from which the casing is made. The codes and their meanings are:

* - Undetermined
B - Brick
C - Concrete
D - Copper
G - Galvanized Iron
I - Wrought Iron
M - Other Metal
P - PVC or Any Plastic
R - Rock or Stone
S - Steel
T - Tile
U - Coated Steel
W - Wood
Z - Other

Last Action Date (GWSI_Casing_Completions . Case_Last_Act_Date)

This field is filled by ORACLE with the date when any field in the Casing Completions Data Table is changed or modified.

Last Action Operator (GWSI_Casing_Completions . Case_Last_Act_Oper)

This field is filled by ORACLE with the user id of the last person to change or modify the Casing Completions Data Table.

Perforation Completion Data Table (PERFORATION_COMPLETION)

The Perforation Completion Data Table is used to record information about the openings through which water enters a well.

Construction Entry Number (GWSI_Perforation_Completions . Perf_Wlcomp_Id)

The construction entry number is the unique control number assigned by Oracle to well construction data in the Well Completions Data Table. This control number is assigned to the corresponding well perforation information.

Perforation Interval (GWSI_Perforation_Completions . Perf_Interval)

This is a sequential number assigned to each perforation interval for a specific construction entry number. For example, a well that is perforated from 200 feet below land surface to 500 feet below land surface and then perforated from 600 feet below land surface to 750 feet below land surface would have two perforation intervals. The first perforated interval is 200 to 500 feet, the second perforated interval is 600 to 750 feet. The interval numbers are assigned sequentially and generally start from the construction entry number.

Top of Perforation (GWSI_Perforation_Completions . Perf_Top)

This field contains the depth to the point at which the top of a perforated segment begins in feet below land surface.

Bottom of Perforation (GWSI_Perforation_Completions . Perf_Bottom)

This field contains the depth to the bottom of the perforated segment, in feet below land surface.

Diameter of Perforation Casing (GWSI_Perforation_Completions . Perf_Diameter)

This field records the outside diameter, in inches, of the perforated casing or slotted pipe, the diameter of a screen or the diameter of the hole, if the well is finished as an open hole. Two decimal places are provided for fractional sizes.

Screening Material (GWSI_Perforation_Completions . Perf_Material_Code)
(Code Lookup Table: GWSI_Screen_Materials)

This is a code that indicates the type of material from which the screen or other open section is made. The codes and their meanings are:

Screening Material (continued)

* - Undetermined
B - Brass or Bronze
C - Concrete
G - Galvanized Iron
I - Wrought Iron
M - Other Metal
P - PVC or Any Plastic
R - Stainless Steel
S - Steel
T - Tile
Z - Other

Perforation Type (GWSI_Perforation_Completions . Perf_Type_Code) (Code Lookup Table: GWSI_Perforation_Types)

This entry indicates the type of open section that allows groundwater to enter the well. The codes and their meanings are:

* - Undetermined
F - Fracture
L - Louvered or Shuttered
M - Mesh
P - Perforated or Slotted
R - Wire Wound
S - Screen (Type Unknown)
T - Sand Point
W - Walled
X - Open Hole
Z - Other

Length of Perforations (GWSI_Perforation_Completions . Perf_Length)

This field records the long dimension of the perforations or slots, in inches, or the individual openings in the screen or slotted pipe.

Width of Perforations (GWSI_Perforation_Completions . Perf_Width)

This field records the short dimension of the perforations or slots, or the mesh size of the screen, in inches.

Last Action Date (GWSI_Perforation_Completions . Perf_Last_Act_Date)

This field is filled by ORACLE with the date when any field in the Perforation Completions Data Table is changed or modified.

Last Action Operator (GWSI_Perforation_Completions . Perf_Last_Act_Oper)

This field is filled by ORACLE with the user id of the last person to modify or change any field in the Perforation Completions Data Table.

Flowing Discharge Data Table (FLOWING_DISCHARGES)

The Flowing Discharge Data Table is used to record water discharge data or springs that flow naturally. Occasionally data for both flowing and pumped conditions will be collected for the same site. In the event data are collected at a flowing site during natural flow and also while being pumped (to increase discharge or during a time of no natural flow), the pumped data should be entered in the Well Production Data Table.

Discharge Number (GWSI_Flowing_Discharges . Flwd_Id)

Each flowing discharge entry for a site is assigned a unique identifying number by Oracle. The discharge numbers are assigned sequentially starting from the construction entry number and including any sequential numbers already assigned to records in other data tables with the same sites Id.

Measurement Date (GWSI_Flowing_Discharges . Flwd_Measure_Date)

This field records the date on which the discharge was measured. The associated data field Date Valid indicates the accuracy of the measurement date. See the previous explanation of the Valid Date field.

Discharge Rate (GWSI_Flowing_Discharges . Flwd_Discharge_Rate)

This is the discharge rate of the site in gallons per minute. If discharge is determined in other units (such as cfs or other metric units) convert to gallons per minute. Two decimal places are provided for very small discharges.
Flowing Discharge Measurement Method (GWSI_Flowing_Discharges . Flwd_Dscmth_Code_Entry)
(Code Lookup Table: GWSI_Discharge_Methods)

This is the method by which the discharge was measured. The methods and their codes are:

* - Undetermined
B - Bailer
C - Current Meter
E - Estimated
F - Flume
M - Totaling Meter
O - Orifice Plate
P - Pitometer
R - Reported
S - Ultrasonic Transit Time
T - Trajectory
V - Volumetric
W - Weir
Z - Other

1 A current meter may be either a propeller-type meter in a discharge pipe, or a induction-type in a channel (e.g. Marsh-McBirney).

Discharge Data Source (GWSI_Flowing_Discharges . Flwd_Datasrc_Code_Entry)
(Code Lookup Table: GWSI_Data_Sources)

This entry indicates who provided the discharge data. The codes are listed below:

* - Undetermined
3 - Third Party
A - Arizona Department of Water Resources
B - U.S. Bureau of Reclamation
C - Consultant
D - Driller
E - New Mexico Office of the State Engineer
F - Arizona Public Service
G - University of Arizona
J - Military
L - Arizona State Land Department
M - Bureau of Land Management
O - Owner
R - Other Reported
S - Salt River Project
T - City of Tucson
U - U.S. Geological Survey
W - Wellton Mohawk Irrigation and Power
Z - Other

Last Action Date (GWSI_Flowing_Discharges . Flwd_Last_Act_Date)

This field is filled by ORACLE with the date when any field in the Flowing Discharges data table is changed or modified.

Last Action Operator (GWSI_Flowing_Discharges . Flwd_Last_Act_Oper)

This field is filled by ORACLE with the user id of the last person to modify or change any field in the Flowing Discharges data table.

Flow Valid Date (GWSI_Flowing_Discharges . Flwd_Date_Valid)

This field contains a flag that indicates the accuracy of the flowing discharge date. See the previous explanation of the Valid Date field.

Pumping Discharge Data Table (PUMPING_DISCHARGE)

The Pumping Discharge Data Table is used to record water levels and discharge data needed to estimate well performance for pumped well sites. Occasionally data for both flowing and pumped conditions will be collected for the same site. In the event data are collected at a flowing site during natural flow and also while being pumped (to increase discharge or during a time of no natural flow), the pumped data should be entered in this Data Table.

Discharge Number (GWSI_Pumping_Discharges . Pmpd_Id)

Each discharge entry for a site is assigned a unique identifying number by Oracle. The discharge numbers are assigned sequentially starting from the construction entry number and including any sequential numbers already assigned to records in other data tables with the same sites Id.

Measurement Date (GWSI_Pumping_Discharges . Pmpd_Measure_Date)

This field records the date on which the discharge was measured. The associated data field Date Valid indicates the accuracy of the pumping discharge measurement date.

Discharge Rate (GWSI_Pumping_Discharges . Pmpd_Discharge_Rate)

This field contains the discharge rate of the site in gallons per minute. If discharge is determined in other units (such as cfs or other metric units) convert to gallons per minute. Two decimal places are provided for very small discharges.

Pumping Discharge Measurement Method (GWSI_Pumping_Discharges . Pmpd_Pmpdmth_Code_Entry)
(Code Lookup Table: GWSI_Pump_Discharge_Methods)

This field records the method by which the discharge was measured. The methods and their codes are listed below:

* - Undetermined
B - Bailer
C - Current Meter
E - Estimated
F - Flume
M - Totaling Meter
O - Orifice Plate
P - Pitometer
R - Reported
S - Ultrasonic Transit Time
T - Trajectory
U - Venturi
V - Volumetric
W - Weir
Z - Other

Discharge Data Source (GWSI_Pumping_Discharges . Pmpd_Data_Source) (Code Lookup Table: GWSI_Data_Sources)

This field indicates who provided the discharge data. The codes are the same as for Flowing Discharge Source found on page 22.

Production Water Level (GWSI_Pumping_Discharges . Pmpd_Production_Water_Level)

This field records the water level in feet below land surface, while the well was discharging. The difference between this value and the static water level is the production drawdown.

Static Water Level (GWSI_Pumping_Discharges . Pmpd_Static_Water_Level)

This field records the static, or pre-pumping, water level in feet below land surface. If the static water level is above the land surface, the head (if measurable) is preceded by a minus sign (-).

Static Water Level Method (GWSI_Pumping_Discharges . Pmpd_Statmth_Code_Entry)
(Code Lookup Table: GWSI_Static_Methods)

This field records the code that indicates the method by which the static water level was measured. If the static and production water levels were measured by different methods, record the method considered least accurate. The water level measurement codes are listed below.

* - Undetermined
A - Airline
B - Analog
C - Calibrated Airline
E - Estimated
G - Pressure Gauge
M - Manometer
N - Non-Recording Gauge
R - Reported
S - Steel Tape
T - Electric Tape
V - Electric Sounder
Z - Other

Static Water Level Source (GWSI_Pumping_Discharges . Pmpd_Static_Source)
(Code Lookup Table: GWSI_Data_Sources)

This field contains the code that indicates the source of the static water level measurement. The code letters are the same as for the source of the Flowing Discharge Data Source found on page 22.

Pumping Period (GWSI_Pumping_Discharges . Pmpd_Pumping_Period)

This field contains the length of time, in hours, that the well was pumped prior to the measurement of the production levels. Two decimal points are provided for times less than an hour.

Well Drawdown (GWSI_Pumping_Discharges . Pmpd_Well_Drawdown)

This field contains the drawdown, in feet, of the pumping well (static level - pumping level).

Specific Capacity (GWSI_Pumping_Discharges . Pmpd_Specific_Capacity)

The specific capacity is calculated by Oracle from the Pumping level and the discharge rate.

Last Action Date (GWSI_Pumping_Discharges . Pmpd_Last_Act_Date)

This field is filled by ORACLE with the date when any field in the Pumping Discharges data table is changed or modified.

Last Action Operator (GWSI_Pumping_Discharges . Pmpd_Last_Act_Oper)

This field is filled by ORACLE with the user id of the last person to modify or change any field in the Pumping Discharges data table.

Pumping Valid Date (GWSI_Pumping_Discharges . Pmpd_Date_Valid)

This field contains a flag that indicates the accuracy of the Pumping Discharge date. See the previous explanation of the Valid Date field.

Well Lifts Data Table (WELL_LIFTS)

The Well Lifts Data Table contains information about the pump that is used to bring water to the surface at the site.

Lift Number (GWSI_Well_Lifts . Wlli_Id)

Each lift entry for a site is assigned a unique identifying number by Oracle that is a sequential variation of the well construction entry number.

Lift Inventory Date (GWSI_Well_Lifts . Wlli_Entry)

This entry is the date on which the well lift was observed. The associated data field Date Valid indicates whether the date has been modified to be accepted by ORACLE.

Lift Type (GWSI_Well_Lifts . Wlli_Type_Code) (Code Lookup Table: GWSI_Lift_Types)

This field contains the code for the type of pump or lift that brings water to the surface.

* - Undetermined.

A - Air lift. An air lift is a jet of air pumped below the water table that causes a stream of mixed air and water to flow from the well.

B - Bucket. This type of lift includes a rope and bucket, chain and bucket lifts, and a small bailer lifted by a rope or chain and pulley.

C - Centrifugal. Centrifugal pumps have rotating impellers in a closed chamber that draw the water into the pump. The water is then discharged from the pump, under pressure, by centrifugal force. Centrifugal pumps have a maximum lift of about 25 feet.

Lift Type (continued)

J - Jet. Jet pumps have two pipes extending from the pump into the well. One pipe forces air down the well bore under pressure while the other pipe discharges water that has been forced to the surface by the jet.

N - None. The well has no pump.

P - Piston. Piston pumps include the familiar lift and pitcher pumps, reciprocating pumps, and deep-wells with “walking-beam jacks” pumps.

R - Rotary. Rotary pumps operate on the principle that direct pressure is created by squeezing water between specially designed runners. A high vacuum is created on the intake side so that a suction lifts the water to the surface. Rotary pumps have a maximum lift of about 25 feet.

S - Submersible. A submersible pump is a special type of turbine pump that is designed to be submerged in water. An electric motor is connected directly to impellers and then submerged in water.

T - Turbine. There are several types of turbine pumps that are designed for either deep or shallow wells. In a turbine pump a series of impellers are placed below the surface of the water and rotated by a vertical shaft connected to a power source at the land surface. The impellers pick up the water and force it to the surface through the pump column. Turbine pumps are capable of lifting large amounts of water at high pressure. Most high capacity public supply, industrial, and irrigation wells use turbine pumps.

U - Unknown. If the pump type is unknown or cannot be identified.

V - Not Assigned.

Z - Other. Any lifting device that is not listed above.

Lift Power Type (GWSI_Well_Lifts . Wlli_Power_Type) (Code Lookup Table: GWSI_Power_Types)

This field contains the code for the type of power used to power the pump.

* - Undetermined
D - Diesel
E - Electric
G - Gasoline
H - Hand
L - LP Gas
N - Natural Gas
W - Wind
Z - Other

Lift Meter Number (GWSI_Well_Lifts . Wlli_Meter_Num)

This field can contain the meter number of the gas or electric meter which records the power consumption of the pump. This information in this field can be used as a cross reference to help identify a well.

Power Company (GWSI_Well_Lifts . Wlli_Power_Company) (Code Lookup Table: GWSI_Power_Companies)

This field contains a three letter code for the name of the company that provides electrical, natural gas, or other power for the pump. For a complete list use the pull/down menu in the ORACLE forms application.

* - Undetermined
APS - Arizona Public Service
CAL - Calapco
CIT - Citizens Utility
COM - City of Mesa
DIX - Dixelette (Utah)
DVE - Duncan Valley Electric Co-Op
ED1 - Electrical District 1
ED2 - Electrical District 2
ED3 - Electrical District 3
ED4 - Electrical District 4
MWE - Morenci Water and Electric
NAE - Navapache Electric Co-Op
NAV - Navajo Tribal Utility Authority
NEV - Nevada
PHS - Public Health Service
PTU - Papago Tribal Utility
RD1 - Electrical Dist. RD1 (Roosevelt District)
REA - Rural Electrification Administration
SCP - San Carlos Project
SOU - Southern Union Gas
SRP - Salt River Project

ED5 - Electrical District 5
ED7 - Electrical District 7
SSV - Sulphur Springs Valley Elect. Co-Op
SWG - Southwest Gas

Power Company (continued)

ED8 - Electrical District 8
GAR - Garkane Power Association
GCE - Graham County Electric Co-Op
IID - Imperial Irrigation District
INT - Interstate Utility
MAG - Magma Gas Company
MEC - Mohave Electric Co-Op
TEP - Tucson Electric and Power
TGE - Tucson Gas and Electric
TPE - Tucson Electric and Power - Use TEP
TRI - Trico Electric Co-Op
USB - U.S. Bureau of Reclamation
WD1 - Electric District WD1 (Maricopa Water Distrcit)
WEM - Wellton Mohawk Irrigation and Power

Lift Horsepower (GWSI_Well_Lifts . Wlli_Horsepower)

This field contains the power rating, in horsepower, of the wells primary power source. Two decimal places are provided for small motors.

Lift Account Number (GWSI_Well_Lifts . Wlli_Account_Num)

This field contains the account number under which the power company stores power consumption rates for the site.

Lift Power Divider (GWSI_Well_Lifts . Wlli_Divider)

This field contains the pump rating as the unit of power consumed per volume of water lifted. The value should be expressed as kilowatt-hours per acre-foot of electricity or therms per acre-feet of water depending on the type of power used by the pump.

Source of Lift Measurement (GWSI_Well_Lifts . Wlli_Source_Code) (Code Lookup Table: GWSI_Data_Sources)

This field contains the name of the source of the power divider or the rating of the pump as the volume of water lifted per unit of power consumed.

* - Undetermined
3 - Third Party
A - Arizona Department of Water Resources
B - U.S. Bureau of Reclamation
C - Consultant
D - Driller
E - New Mexico Office of the State Engineer
F - Arizona Public Service
G - University of Arizona
J - Military
L - Arizona State Land Department
M - Bureau of Land Management
O - Owner
R - Other Reported
S - Salt River Project
T - City of Tucson
U - U.S. Geological Survey
W - Wellton-Mohawk Irrigation and Drainage District
Z - Other

Method of Lift Measurement (GWSI_Well_Lifts . Wlli_Method_Code)
(Code Lookup Table: GWSI_Lift_Measure_Methods)

This field contains the method of the measurement that determined the power divider, or pump rating.

* - Undetermined
A - Dedicated power meter, instantaneous discharge with approved equipment/method, with static pressure <10 psi
B - Dedicated power meter, instantaneous discharge with approved device with static pressure <10 psi
D - Non-Dedicated power meter, instantaneous discharge with approved equipment/method, with static pressure <10 psi
E - Non-Dedicated power meter, instantaneous discharge with approved device with static pressure <10 psi
P - Dedicated power meter, instantaneous discharge with approved equipment/method, with static pressure > = 10 psi
Q - Dedicated power meter, instantaneous discharge with approved device with static pressure > = 10 psi
R - Non-Dedicated power meter, instantaneous discharge with approved equipment/method, with static pressure > = 10 psi
S - Non-Dedicated power meter, instantaneous discharge with approved device, with static pressure > = 10 psi

Last Action Date (GWSI_Well_Lifts . Wlli_Last_Act_Date)

This field is filled by ORACLE with the date when any field in the Well Lifts Data table is changed or modified.

Last Action Operator (GWSI_Well_Lifts . Wlli_Last_Act_Oper)

This field is filled by ORACLE with the user id of the last person to modify or change any field in the Well Lifts Data table.

Valid Date (GWSI_Well_Lifts . Wlli_Valid_Date)

This field contains a flag that indicates the accuracy of the Well Lifts date. See the previous explanation of the Valid Date field.

Well Log Data Table (WELL_LOGS)

The Well Log Data Table contains information about the types of geophysical and/or other log data available for the site.

Log Type (GWSI_Well_Logs . Wllo_Logtyp_Code_Entry) (Code Lookup Table: GWSI_Log_Types)

This field contains letter codes for the types of logs that are available for a site.

* - Undetermined
A - Time
B - Collar
C - Caliper
D - Driller
E - Electric
F - Fluid Conductance
G - Geologist
I - Induction
J - Gamma Ray
K - Dipmeter
L - Lathering
M - Microlog
N - Neutron
O - U Later
P - Photo
Q - Radioactive
S - Sonic
T - Temperature
U - Gamma-Gamma
V - Fluid Velocity
X - Core
Z - Other

Log Start (GWSI_Well_Logs . Wllo_Log_Start)

This field contains the depth to the top of the logged interval in feet below land surface.

Log End (GWSI_Well Logs . Wllo_Log_End)

This field contains the depth to the bottom of the logged interval in feet below land surface.

Source of Log Data (GWSI_Well_Logs . Wllo_Adwrs_Code) (Code Lookup Table: GWSI_ADWR_Sources)

This fields contains information that indicates who provided the log information. The codes are the same as those found in the Sites_Adwrs_Code field in Sites Data Table found on page 14.

Last Action Date (GWSI_Well_Logs . Wllo_Last_Act_Date)

This field is filled by ORACLE with the date when any field in the Well Logs Data table is changed or modified.

Last Action Operator (GWSI_Well_Logs . Wllo_Last_Act_Oper)

This field is filled by ORACLE with the user id of the last person to modify or change any field in the Well Logs Data Table.

Well Owners Data Table (WELL_OWNERS)

The Well Owners Data Table contains the name of the site owner and the date of their known ownership of the site. It should be emphasized that the last entry in this data table may not be the current owner of the site but is the owner at the time indicated in the Owner Entry Date Field.

Owner Id (GWSI_Well_Owners . Wlow_Id)

Each ownership entry for a site is assigned a unique identifying number by Oracle that is a sequential variation of the construction entry number.

Owner Entry Date (GWSI_Well_Owners . Wlow_Entry_Date)

This entry is the date that the owner acquired ownership of the site, or the earliest date on which the owner was known to own the site. The associated Date Valid field indicates the accuracy of the Well Owner Entry date

Owners Last Name (GWSI_Well_Owners . Wlow_Last_Name)

This field is used for recording the last name of the well owner.

Owners First Name (GWSI_Well_Owners . Wlow_First_Name)

This field is used for recording the first name of the well owner.

Owners Middle Initial (GWSI_Well_Owners . Wlow_Middle_Initial)

This field contains one (1) space for recording the middle initial of the well owner.

Last Action Date (GWSI_Well_Owners . Wlow_Last_Act_Date)

This field is filled by ORACLE with the date when any field in the Well Owners Data Table is changed or modified.

Last Action Operator (GWSI_Well_Owners . Wlow_Last_Act_Oper)

This field is filled by ORACLE with the user id of the last person to modify or change any field in the Well Owners Data Table.

Valid Date (GWSI_Well_Owners . Wlow_Valid_Date)

This field contains a flag that indicates the accuracy of the Well Owners date. See the previous explanation of the Date Valid Field.

Site Names (OWNER_SITE_NAMES)

The Owner Site Id Data Table contains identifying numbers or names that have been assigned to a site, usually by the site owner. For example, a city or town may assign a number to each of its wells.

Other Site Id (GWSI_Owner_Site_Names . Owns_Other_Id)

This field contains spaces for recording the name or number used to by the owner to identify the site.

Other Site Name Assigner (GWSI_Owner_Site_Names . Owns_Assigner)

This field contains thirty (30) spaces for recording the person or organization that assigned the other Id.

Last Action Date (GWSI_Owner_Site_Names . Owns_Last_Act_Date)

This field is filled by ORACLE with the date when any field in the Owners Site Name Data Table is changed or modified.

Last Action Operator (GWSI_Owner_Site_Names . Owns_Last_Act_Oper)

This field is filled by ORACLE with the user id of the last person to modify or change any field in the Owner Site Name Data Table.

Remarks Data Table (REMARKS)

The Remarks data table contains remarks from field investigators that may help clarify data entered in other data tables regarding the site.

Remarks Id (GWSI_Remarks . Rem_Id)

Each remarks entry for a site is assigned a unique identifying number by Oracle that is a sequential variation of the construction entry number.

Remarks Date (GWSI_Remarks . Rem_Remarks_Date)

This entry is the date that the remarks for the site were recorded. The associated Date Valid field indicates the accuracy of the Remarks Date.

Remarks (GWSI_Remarks . Rem_Remarks)

This field contains 40 spaces per line to record remarks used to clarify information associated with the site. More than one line can be used to record the site remarks.

Last Action Date (GWSI_Remarks . Rem_Last_Act_Date)

This field is filled by ORACLE with the date when any field in the Remarks Data Table is changed or modified.

Last Action Operator (GWSI_Remarks . Rem_Last_Act_Oper)

This field is filled by ORACLE with the user id of the last person to change or modify any field in the Remarks Data Table.

Valid Date (GWSI_Remarks . Rem_Date_Valid)

This field contains a flag that indicates the accuracy of the Remarks Date. See the previous explanation of the Date Valid Field.

Site Inventories Data Table (SITE_INVENTORIES)

The Site Inventories Data Table contains information on the date of the site visit and the name of the person who made the site visit.

Site Inventory Id (GWSI_Site_Inventories . Siti_Id)

Each site inventory visit is assigned a unique identifying number by Oracle that is a sequential variation of the construction entry number.

Site Inventory Date (GWSI_Site_Inventories . Siti_Inventory_Date)

This field records the date that the site was visited. The associated Date Valid field indicates the accuracy of the Inventory Date.

Inventoried By (GWSI_Site_Inventories . Siti_Inventoried_By)

This field is used to record the name of the person making the site inventory or visit. (The last name is entered first followed by a comma, a space and the first and middle initials. Do not include periods or extra spaces. Examples are listed below.)

BARNES, RL
BLACK, K
MASON, DA
RASCONA, S

Last Action Date (GWSI_Site_Inventories . Siti_Last_Act_Date)

This field is filled by ORACLE with the date when any field in the Site Inventories Data Table is changed or modified.

Last Action Operator (GWSI_Site_Inventories . Siti_Last_Act_Oper)

This field is filled by ORACLE with the user id of the last person to change or modify any field in the Site Inventories Data Table.

Valid Date (GWSI_Site_Inventories . Siti_Valid_Date)

This field contains a flag that indicates the accuracy of the Inventory Date. See the previous explanation of the Date Valid Field.

Spring Names Data Table (SPRING_NAMES)

The Spring Names Data Table is used to record the name of flowing springs that have been inventoried. Additional data such as, spring type, flow variability, spring name and any site improvements may also be entered into the record.

Spring Name (GWSI_Spring_Names . Spna_Spring_Name)

This field is used to record the name, if any is given, that has been assigned to the spring.

Permanence (GWSI_Spring_Names . Spna_Spperm_Code_Entry) (Code Lookup Table: GWSI_Spring_Permanences)

This field is used to describe the dependability of the spring flow, if it is known, at the site.

* - Undetermined
E - Periodic - Ebb and Flow
G - Geyser
I - Intermittent
P - Perennial
R - Response to Precipitation
S - Seasonal
Z - Other

Type of Spring (GWSI_Spring_Names . Spna_Sptype_Code_Entry) (Code Lookup Table: GWSI_Spring_Types)

This field is used to describe the type of spring found at the site.

* - Undetermined
A - Artesian
B - Perched or Contact
C - Contact
D - Depression
E - Perched or Depression
F - Fracture
H - Perched or Tubular
J - Artesian and Depression
K - Artesian and Seepage
L - Fracture and Depression
O - Perched and Fracture
P - Perched
R - Perched Seepage
S - Seepage of Filtration
T - Tubular Cave
Z - Other

Spring Improvements (GWSI_Spring_Names . Spna_Spimprv_Code_Entry)
(Code Lookup Table: GWSI_Spring_Improvements)

This field contains the record of any improvements that have been made to the site to improve, impound or redirect the spring flow.

* - Undetermined
B - Boxed Basin
C - Concrete Gallery
G - Gallery
H - Spring House
L - Lined
N - None
P - Pond
R - Pipe
T - Trough
Z - Other

Last Action Date (GWSI_Spring_Names . Spna_Last_Act_Date)

This field is filled by ORACLE with the date when any field in the Spring Name Data Table is changed or modified.

Last Action Operator (GWSI_Spring_Names . Spna_Last_Act_Oper)

This field is filled by ORACLE with the user id of the last person to modify or change any field in the Spring Name Data Table.

Water Levels Data Table (WW_LEVELS)

The Water Levels Data Table contains information related to the depth to water at the site. Data that is contained includes, depth to water, water table elevation, measurement date, method of measurement, measurement remarks and source of the water level measurement.

Water Level Id (GWSI_WW_Levels . Wlwa_Id)

Each water level entry for a site is assigned a unique identifying number by Oracle that is a sequential variation of the construction entry number.

Date Measured (GWSI_WW_Levels . Wlwa_Measurement_Date)

This field records the date that the water level was recorded for the site. The associated Date Valid field indicates the accuracy of the Water Level Measurement Date.

Depth to Water (GWSI_WW_Levels . Wlwa_Depth_To_Water)

This field records the depth to water, in feet, below land surface. Depth to water can be carried out to two decimal places. If the water level is above land surface, enter the water level in feet above land surface preceded by a minus (-) sign. If the head at a flowing site is unknown, if the water level can not be measured, the site is dry, or the well destroyed then this field is left blank and the appropriate code must be placed in the associated Water Level Remarks Code field (Wlwa_Remarks). (By default there can be no 0.00 depth to water.)

Water Level Elevation (GWSI_WW_Levels . Wlwa_Water_Level_Elevation)

This field contains the elevation of the water table above mean sea level datum. This field is calculated by subtracting the depth to water from the well altitude as entered in the Sites Data table. Except for flowing wells water level elevations are blank for records that have no depth to water measurements.

Method of Water Level Measurement (GWSI_WW_Levels . Wlwa_Method Code)
(Code Lookup Table: GWSI_MM_Codes)

This field contains the code for the method used to measure the depth to water.

Method of Water Level Measurement (continued)

A - Airline
B - Analog or Graphic Recorder
C - Calibrated Airline
D - Differential G.P.S.
DC - Downhole Camera
E - Estimated
F - Automated Device
G - Pressure Gauge
H - Calibrated Pressure Gauge
L - Geophysical Logs
M - Manometer
N - Non-Recording Gauge
O - Observed
P - Acoustic Pulse
R - Reported
S - Steel Tape
T - Electric Tape (Uncalibrated)
U - Undetermined
V - Electric Sounder or Non-Electric Tape
VT - Electric Tape
Z - Other

Water Level Measurement Remarks (GWSI_WW_Levels . Wlwa_Remark_Code)
(Code Lookup Table: GWSI_MR_Codes)

This field contains letter codes that describe the status of the site at the time of the water level measurement. If the water level measured represents a static level, this field is blank.

A - Atmospheric Pressure.

C - Ice.

D - Dry. The site was dry and no water level was recorded.

E - Recently Flowing. The site had recently been flowing.

F - Flowing. The site was flowing, but no head could be measured (no water level is recorded).

G - Nearby Flowing. A nearby site was flowing at the time of measurement.

H - Nearby Recently Flowing. A nearby site had recently flowed.

I - Well Injecting. The well was being used to inject water into the aquifer at the time of the measurement attempt. Examples of injection wells are wells used to recharge water into an aquifer.

J - Nearby Injecting.

K - Cascading Water. Water was cascading down the well casing from some point above the water table.

L - Brackish Saline.

M - Well Plugged.

N - Measurements Discontinued at the site.

O - Obstructed. An obstruction in the well casing prevented a measurement (no water level is recorded).

P - Pumping. The site was being pumped at the time of measurement.

R - Recently Pumped. The site had been pumped recently.

S - Nearby Pumping. A site nearby was being pumped at the time of measurement.

T - Nearby Recently Pumped. A nearby site had recently been pumped.

U - Undetermined.

V - Foreign Material (Oil). A foreign material, usually oil, was encountered on the surface of the water table.

W - Well Destroyed. The well has been destroyed and no water level is recorded.

Water Level Measurement Remarks (continued)

X - Surface Water Effects. The water level may be affected by the a nearby surface water site.

Z - Other. Other conditions that may affect the measured water level. (Explain in the Remarks Data Table).

Unable to Measure (UTM) Remarks (GWSI_WW_Levels . Wlwa_UTM_Code)
(Code Lookup Table: GWSI_UTM_Codes)

This field contains letter codes that describe the reason why a site was unable to be measured. This field is only used when a water level is not obtained.

BE - Bees. There are bees near the site or in the well that pose a risk to the safety of a field personnel.

D - Dry. The site was dry, and no water level could be obtained.

K - Cascading Water. Water was cascading down the well from some point above the water table that prevents an accurate measurement.

LG - Locked Gate. A locked gate prevented access to a site.

LS - Locked Well Site. A measurement can not be obtained due to a locked building, structure, well cap, or measuring point (MP).

M - Well Plugged. Well has visible cement, debris, dirt, or other material blocking access to the water table and is not in hydraulic contact with formation. However, a well casing is still visible.

MP - No Measuring Point (MP) Access. A water level cannot be obtained because there is no equipment access at the site to gain access to the water table.

N - Measurements Discontinued. Measurements are discontinued at the site.

NA - No Site Access. Something that hingers, impedes, and prevents getting to the site and cannot be defined by any other UTM remark.

NC - No Contact. A water level was not obtained due to the necessity to contact the owner, business, or property before a water level is to be obtained.

NP - No Permission. An owner or responsible party has denied and/or refused access to the site or water table.

O - Obstruction. A blockage in the well prevents a water level from being obtained.

P - Pumping. The site is being pumped at time of measurement.

RC - Road Condition. All roads or drivable paths to a site are unsafe for equipment or personnel.

SH - Site Hazard. The environment at or around the site pose a risk to personnel and cannot be defined by any other UTM remark.

UL - Unable to Locate. The site location cannot be verified and/or there is no site at the best-known location.

V - Oil. Oil located on the surface of the water table has prevented an accurate water level from being obtained.

W - Well Destroyed. The well hole and casing has been destroyed and any future water levels would be impossible.

Water Level Source Code (GWSI_WW_Levels . Wlwa_Source_Code) (Code Lookup Table: GWSI_Data_Sources)

This field contains letter codes for the source of the water level measurement.

* - Undetermined
3 - Third Party
A - Arizona Department of Water Resources
B - U.S. Bureau of Reclamation
C - Consultant
D - Driller
E - New Mexico Office of the State Engineer
F - Arizona State Land Department
G - University of Arizona
J - Military
L - Arizona State Land Department
M - Bureau of Land Management
O - Owner
R - Other Reported
S - Salt River Project
T - City of Tucson
U - U.S. Geological Survey
W - Wellton-Mohawk Irrigation and Drainage District
Z - Other

Last Action Date (GWSI_WW_Levels . Wlwa_Last_Act_Date)

This field is filled by ORACLE with the date when any field in the Water Levels Data Table is changed or modified.

Last Action Operator (GWSI_WW_Levels . Wlwa_Last_Act_Oper)

This field is filled by ORACLE with the user id of the last person to modify or change any field in the Water Levels Data Table.
Valid Date (GWSI_WW_Levels . Wlwa_Valid_Date)

This field contains a flag that indicates the accuracy of the Water Levels Date. See the previous explanation of the Valid Date field.

Water Level Measuring Point Data Table (WM_POINTS)

The Water Level Measuring Point Data Table contains a description of the point used to measure the depth to water in a well.

Water Level Point Id (GWSI_WM_Points . Welm_Id)

Each water level measuring point entry for a site must have a unique identifying number that is used only once at a site.

Date Established (GWSI_WM_Points . Welm_Date_Measured)

This field records the date that the water level measuring point was established for the site. The associated Date Valid field indicates the accuracy of the Measuring Point Date.

Measuring Point Height (GWSI_WM_Points . Welm_Measure_Point_Height)

This entry is the height above the land surface from which the depth to water measurement was made. If the measurement point is below land surface, the measurement height is preceded by a minus sign (-).

Measuring Point Descriptions (GWSI_WM_Points . Welm_Mp_Description)

This field contains a description of the point use to measure the depth to water. Listed below and illustrated in Figure 4 are some of the common measuring point descriptions.

HTCA, W - Hole in Top of Casing, West Side
HSCA, N - Hole in Side of Casing, North Side
TCA, SE - Top of Casing, Southeast Side
HBOP, S - Hole in Pump Base, South Side
BOP, N - Access under Base of Pump, North Side
ACTB, S - Measuring (Access) Tube, South Side
AIRL, S - Airline, South Side
HISP, NE - Hole in Submersible Plate, Northeast Side

Last Action Date (GWSI_WM_Points . Welm_Last_Act_Date)

This field is filled by ORACLE with the date when any field in the Measuring Point Data Table is changed or modified.

Last Action Operator (GWSI_WM_Points . Welm_Last_Act_Oper)

This field is filled by ORACLE with the user id of the last person to modify or change any field in the Measuring Point Data Table.

Valid Date (GWSI_WM_Points . Welm_Date_Valid)

This field contains a flag that indicates the accuracy of the Measuring Point Date. See the previous explanation of the Date Valid Field.

Water Quality Reports Data Table (WQ_REPORTS)

The Water Quality Data table contains six (6) basic water quality parameters that are gathered by Department personnel during field investigations. The seven parameters are specific conductance, in microsiemens per centimeter at 25 degrees Celsius; fluoride, in milligrams per liter (mg/L); temperature, in degrees Celsius; pH; alkalinity as $CaCO_3$, in milligrams per Liter; and dissolved oxygen, in milligrams per Liter. Not all parameters may have been tested for at any given site and at any given time. Blank data in the water quality fields indicate that the parameter was not tested for at the time of sampling.

Water Quality Id (GWSI_WQ_Reports . Watq_Id)

Each water quality measurement entry for a site is assigned a unique identifying number by Oracle that is a sequential variation of the construction entry number.

Date Collected (GWSI_WQ_Reports . Watq_Date_Measured)

This field records the date that the water quality sample was analyzed at the site. The associated Date Valid field indicates the accuracy of the Date Measured.

Specific Conductance (GWSI_WQ_Reports . Watq_Specific_Conductance)

Specific conductance is a measure of the electrical conductance of a water sample, and as such, is an indicator of the amount of total dissolved solids (TDS) in a sample. The specific conductance value is reported as microsiemens per centimeter at 25 degrees Celsius.

Fluoride (GWSI_WQ_Reports . Watq_Fluoride)

Fluoride is measured to one decimal point in milligrams per liter (mg/L).

Temperature (GWSI_WQ_Reports . Watq_Temperature_Celcius)

Temperature is the water temperature in degrees Celsius (C^o) at the time of sampling. The temperature can be entered to one decimal point.

pH (GWSI_WQ_Reports . Watq_Ph)

The pH is a measure of the hydrogen activity of the sample. The pH can be entered to one decimal point.

Alkalinity (GWSI_WQ_Reports . Watq_Alkalinity)

Alkalinity is a measure of metallic ions, principally calcium and magnesium, in the water sample and is reported as milligrams per liter (mg/l) of calcium carbonate ($CaCO_3$).

Dissolved Oxygen (GWSI_WQ_Reports . Watq_Dissolved_Oxygen)

Dissolved oxygen is the measure of the amount of oxygen dissolved in water an is measured in milligrams per Liter.

Last Action Date (GWSI_WQ_Reports . Watq_Last_Act_Date)

This field is filled by ORACLE with the date when any field in the Water Quality Data Table is changed or modified.

Last Action Operator (GWSI_WQ_Reports . Watq_Last_Act_Oper)

This field is filled by ORACLE with the user id of the last person to modify or change any field in the Water Quality Data Table.

Valid Date (GWSI_WQ_Reports . Watq_Date_Valid)

This field contains a flag that indicates the accuracy of the Water Quality Date. See the previous explanation of the Date Valid Field.

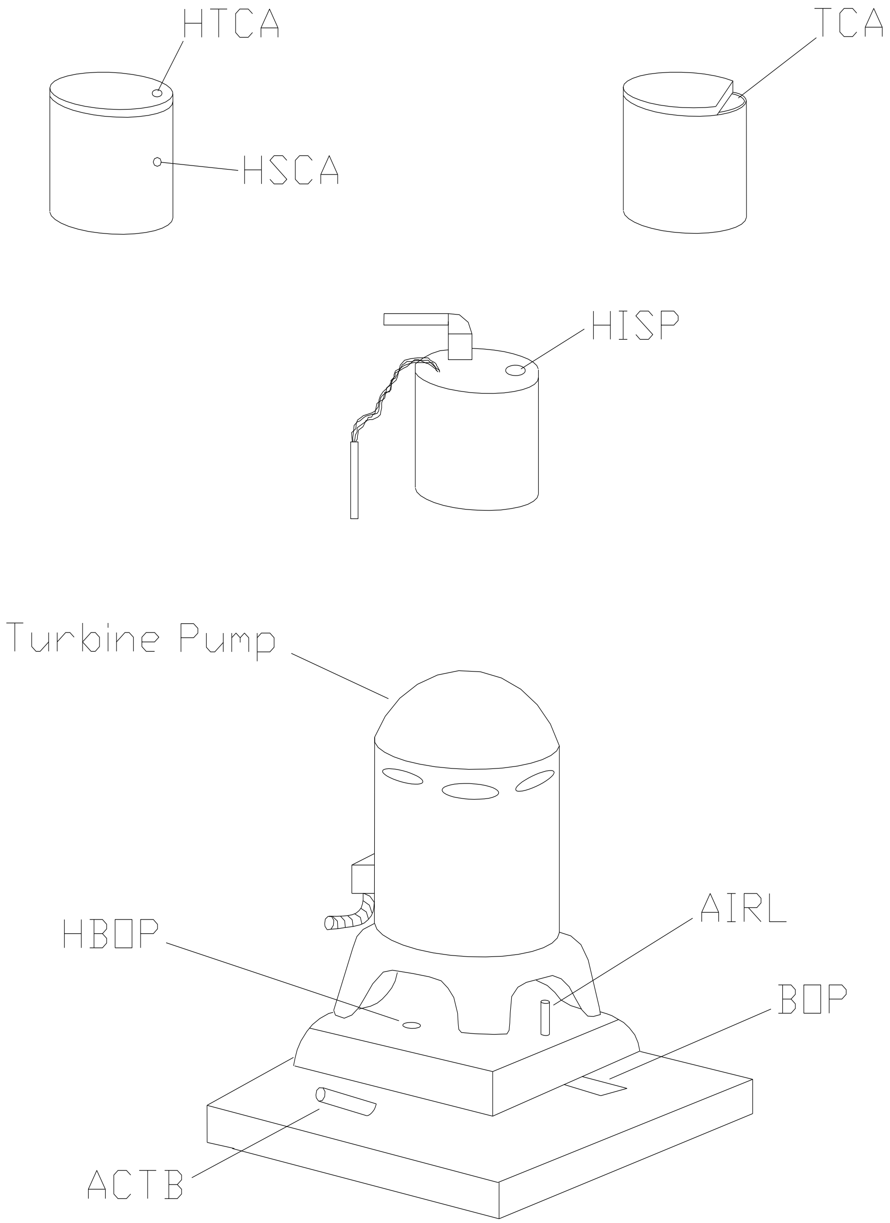
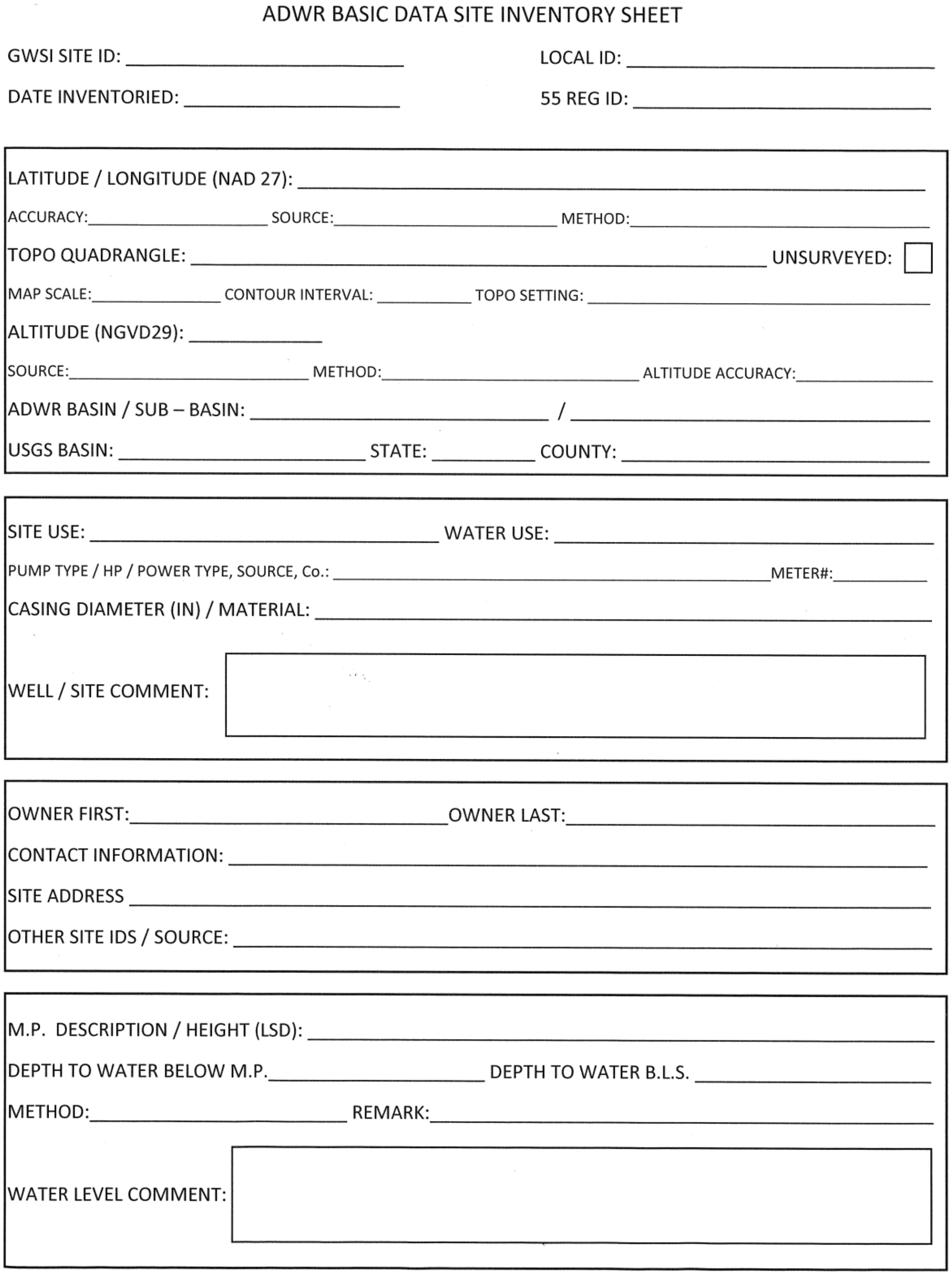


Figure 4**.** Well Casing Measurement Descriptions.

Appendix A : ADWR Basic Data Site Inventory Sheet



ADWR BASIC DATA SITE INVENTORY SHEET

GWSI SITE ID: ____________________ LOCAL ID: ____________________

DATE INVENTORIED: ____________________ 55 REG ID: ____________________

LATITUDE / LONGITUDE (NAD 27): ____________________

ACCURACY: __________ SOURCE: __________ METHOD: __________

TOPO QUADRANGLE: ____________________ UNSURVEYED: ☐

MAP SCALE: __________ CONTOUR INTERVAL: __________ TOPO SETTING: __________

ALTITUDE (NGVD29): __________

SOURCE: __________ METHOD: __________ ALTITUDE ACCURACY: __________

ADWR BASIN / SUB – BASIN: __________ / __________

USGS BASIN: __________ STATE: __________ COUNTY: __________

SITE USE: __________ WATER USE: __________

PUMP TYPE / HP / POWER TYPE, SOURCE, Co.: __________ METER#: __________

CASING DIAMETER (IN) / MATERIAL: ____________________

WELL / SITE COMMENT: ☐

OWNER FIRST: __________ OWNER LAST: __________

CONTACT INFORMATION: ____________________

SITE ADDRESS ____________________

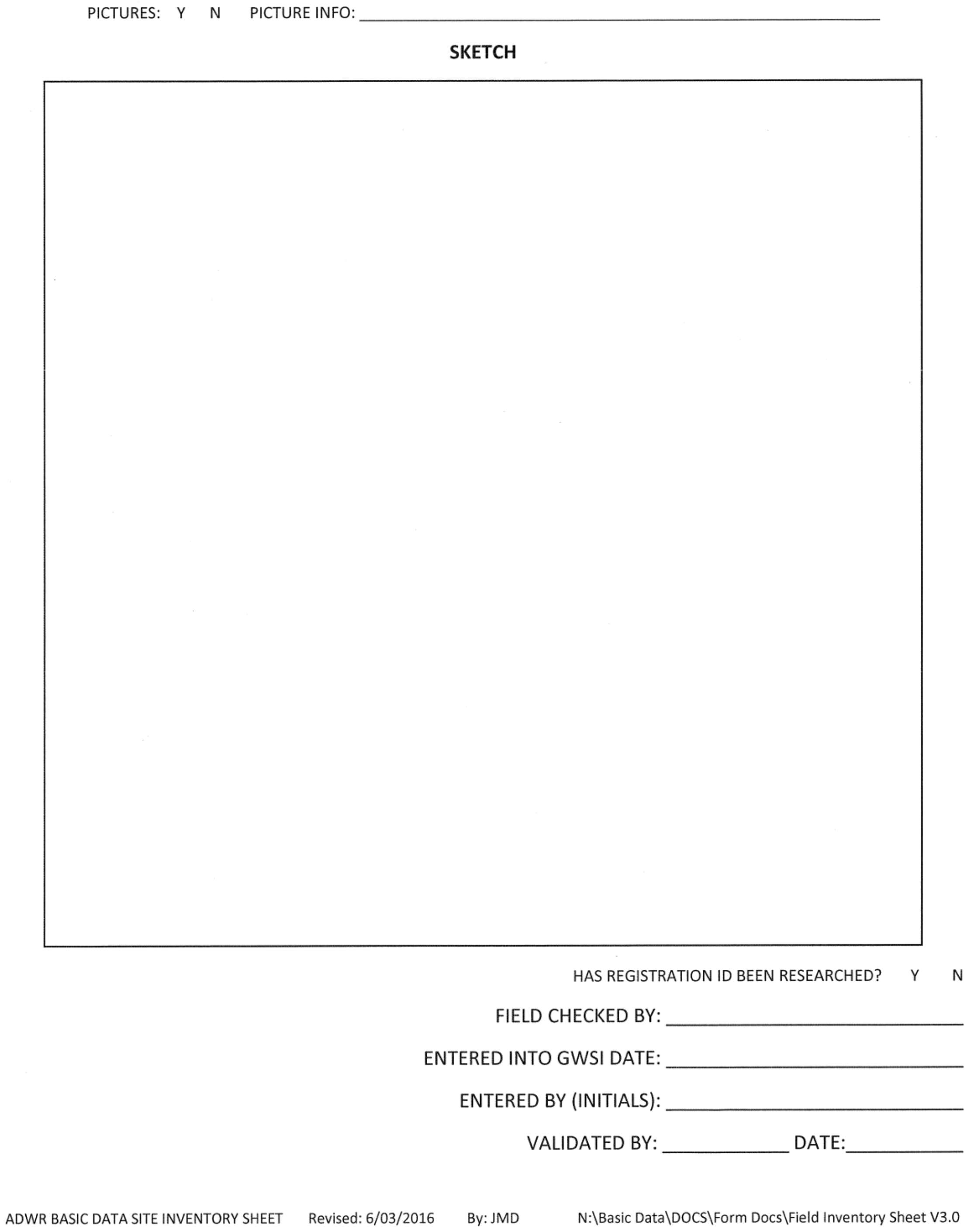
OTHER SITE IDS / SOURCE: ____________________

M.P. DESCRIPTION / HEIGHT (LSD): ____________________

DEPTH TO WATER BELOW M.P. __________ DEPTH TO WATER B.L.S. __________

METHOD: __________ REMARK: __________

WATER LEVEL COMMENT: ☐



PICTURES: Y N PICTURE INFO: ______________________________

SKETCH

HAS REGISTRATION ID BEEN RESEARCHED? Y N

FIELD CHECKED BY: ______________________________

ENTERED INTO GWSI DATE: ______________________________

ENTERED BY (INITIALS): ______________________________

VALIDATED BY: ____________ DATE: ____________

ADWR BASIC DATA SITE INVENTORY SHEET Revised: 6/03/2016 By: JMD N:\Basic Data\DOCS\Form Docs\Field Inventory Sheet V3.0

Groundwater Site Inventory (GWSI) Database

Appendix B : ADWR Groundwater Basin Codes

Listed below are the letter codes used to identify the ADWR Groundwater Basins, Sub-basins and Active Management Areas (AMAs).

ADWR Non-Subdivided Groundwater Basins

Basin Name	Basin Code
Agua Fria	AGF
Aravaipa Canyon	ARA
Bonita Creek	BON
Butler Valley	BUT
Cienega Creek	CCK
Coconino Plateau	COP
Detrital Valley	DET
Donnelly Wash	DON
Douglas	DOU
Dripping Springs Wash	DSW
Duncan Valley	DUN
New Mexico section of Duncan Valley Basin	DNM
Gila Bend	GIL
Grand Wash	GWA
Hualapai Valley	HUA
Kanab Plateau	KAN
Lake Havasu	LKH
Lake Mohave	MHV
Little Colorado River Plateau	LCR
McMullen Valley	MMU
Meadview	MEA
Morenci	MOR
Paria	PAR
Peach Springs	PSC
Ranagras Plain	RAN
Sacramento Valley	SAC
San Bernadino Valley	SBV
San Rafael	SRF
San Simon Wash	SSW
Shivwits Plateau	SHV
Tiger Wash	TIG
Tonto Creek	TON
Upper Hassayampa	UHA
Virgin River	VRG
Western Mexican Drainage	WMD
Willcox	WIL
Yuma	YUM

ADWR Subdivided Groundwater Basins

Basin	Subbasin	Basin Code
Big Sandy		**BIS**
	Fort Rock	FTR
	Wikieup	WIK
Bill Williams		**BWM**
	Alamo Reservoir	ALR
	Burro Creek	BUR
	Clara Peak	CLA
	Santa Maria	SMR
	Skull Valley	SKU
Lower Gila		**LGB**
	Childs Valley	CHV
	Dendora Valley	DEN
	Mohawk-Wellton	WEM
Lower San Pedro		**LSP**
	Camp Grant Wash	CGW
	Mammoth	MAM
Parker		**PKB**
	Colorado River Indian Reservation	CRI
	Cibola Valley	CIB
	La Posa Plains	LPC
Safford		**SAF**
	San Carlos Valley	GSK
	San Simon Valley	SSI
	Gila Valley	SAF
Salt River		**SRB**
	Black River	BRB
	White River	WRB
	Salt River Canyon	USR
	Salt River Lakes	SRL
Upper San Pedro		**USP**
	Allen Flat ALF	
	Sierra Vista	SEV
Verde River		**VRB**
	Big Chino	BIC
	Verde Canyon	LVR
	Verde Valley	VER

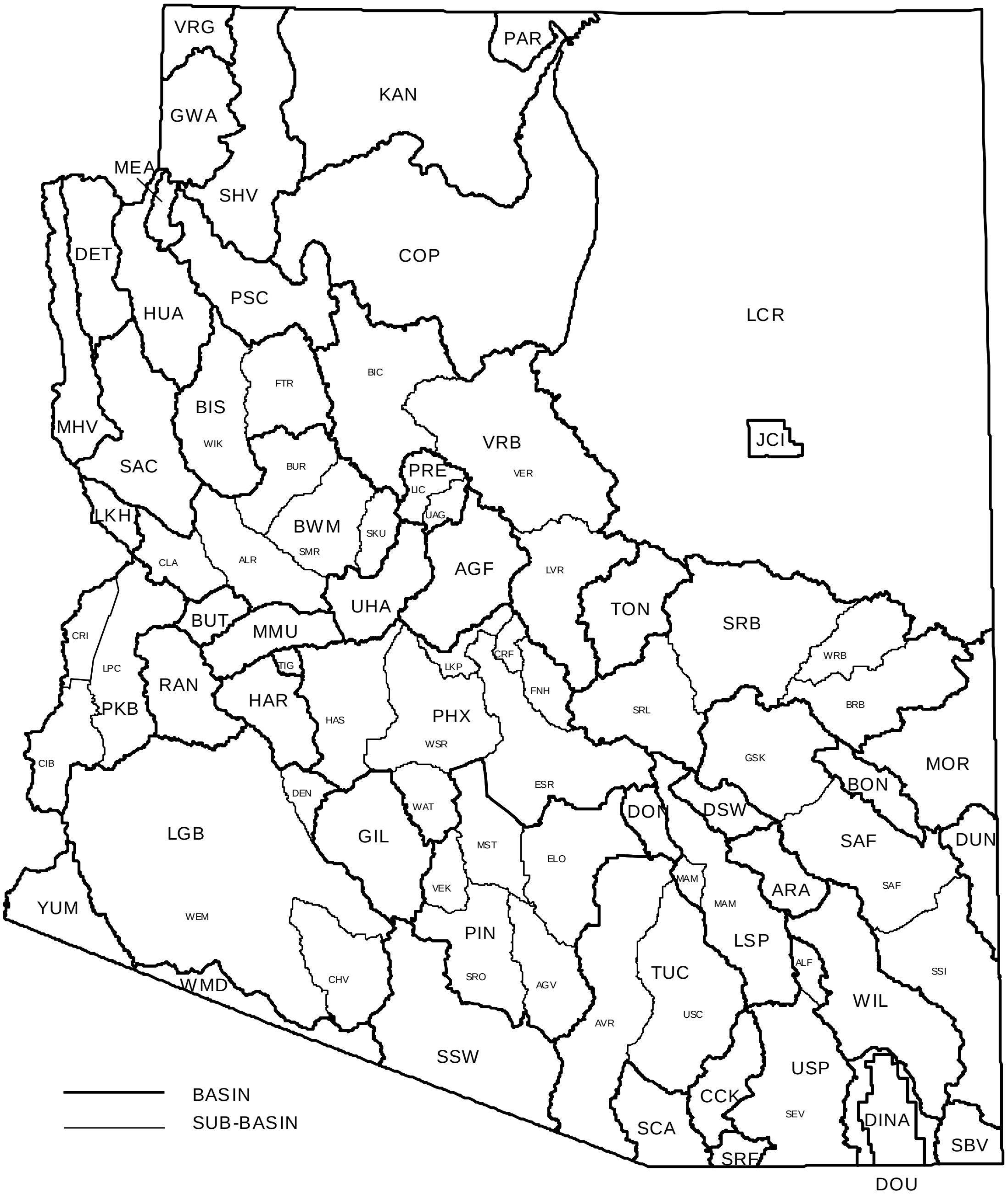


Figure 5. ADWR Groundwater Basins and Subbasins Map.

Groundwater Site Inventory (GWSI) Database

ADWR Active Management Areas (AMA)

AMA Name	Subbasin	Code
Phoenix AMA		**PHX**
	West Salt River Valley	WSR
	East Salt River Valley	ESR
	Carefree	CRF
	Lake Pleasant	LKP
	Fountain Hills	FNH
	Hassayampa	HAS
	Rainbow Valley	WAT
Pinal AMA		**PIN**
	Aguirre Valley	AGV
	Eloy	ELO
	Maricopa-Stanfield	MST
	Santa Rosa Valley	SRO
	Vekol Valley	VEK
Prescott AMA		**PRE**
	Upper Agua Fria	UAG
	Little Chino Valley	LIC
Santa Cruz AMA		**SCA**
Tucson AMA		**TUC**
	Avra Valley	AVR
	Upper Santa Cruz	USC

ADWR Irrigated Non-Expansion Areas (INA)

INA Name	Code
Douglas INA	DIN
Harquahala INA	HAR
Joseph City INA	JCI

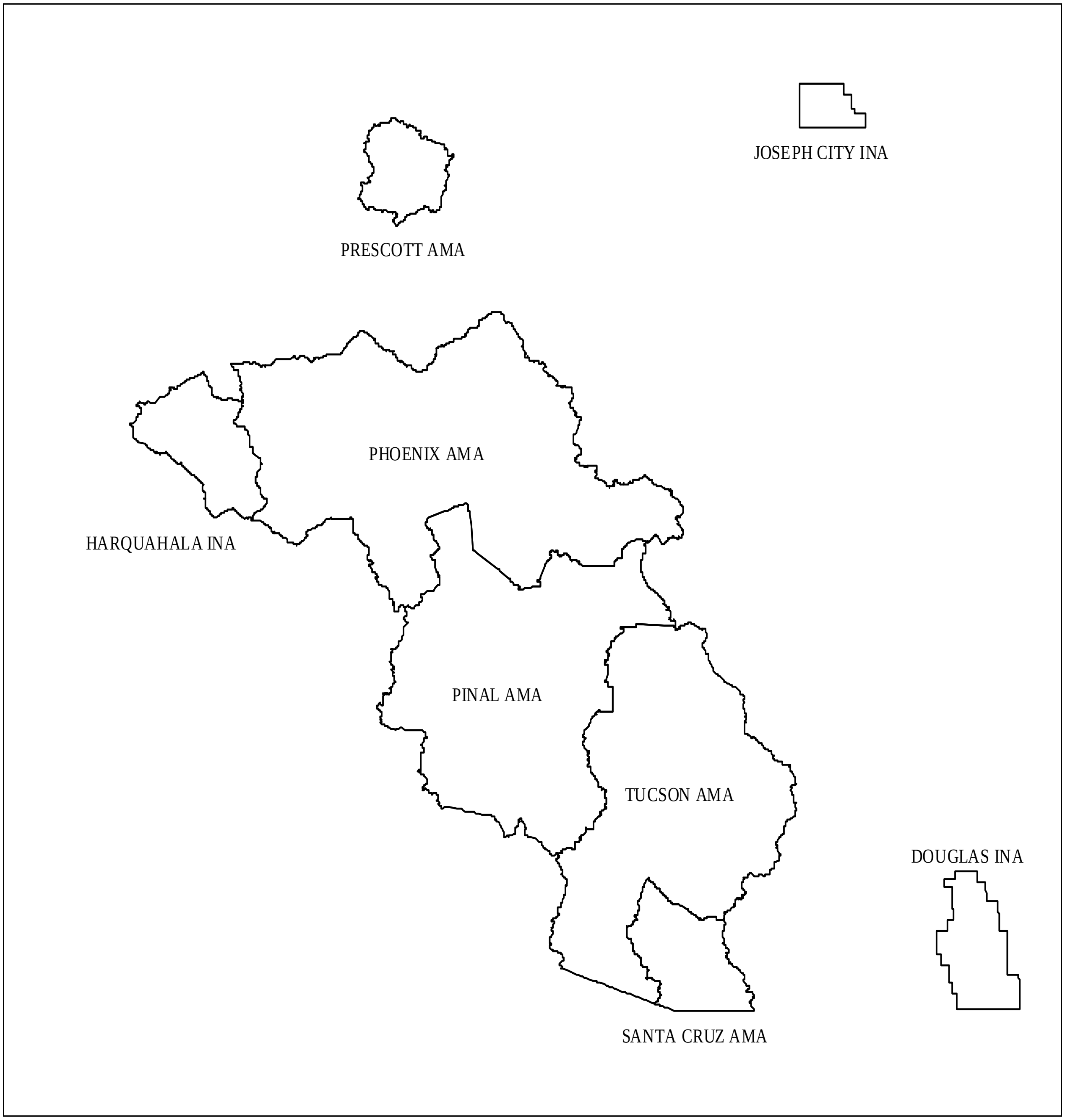


Figure 6 ADWR Active Management Areas and sub-basins Map**.**

Groundwater Site Inventory (GWSI) Database

Appendix C : U.S. Geological Survey Groundwater Area Codes

Listed below are the letter codes used to identify the U.S. Geological Groundwater Areas

Basin Name	Basin Code
Agua Fria Basin	AGF
Altar Valley	ALT
Aravaipa Valley	ARA
Avra Valley	AVR
Big Chino Valley	BIC
Big Sandy Valley	BIS
Bill Williams	BWM
Black Mesa	BLM
Black River Basin	BRB
Bodaway Mesa	BOD
Butler Valley	BUT
Canyon Diablo	CDI
Chevelon	CHV
Chinle	CHN
Coconino Plateau	COP
Colorado River, Hoover Dam to Imperial Dam	CHI
Concho	CON
Douglas Basin	DOU
Duncan Basin	DUN
Gila Bend Basin	GIL
Gila River, Painted Rock Dam to Texas Hill	GRD
Gila River, San Carlos Reservoir to Kelvin	GSK
Gila River, Texas Hill to Dome	GTD
Grand Wash	GRA
Harquahala Plains	HAR
Hassayampa Basin	HAS
Holbrook	HOL
Hopi	HOP
House Rock	HOU
Hualapai Valley	HUA
Kaibito	KAI
Kanab	KAN
Little Chino Valley	LIC
Lower Hassayampa	LHA
Lower San Pedro	LSP
Lower Santa Cruz	LSC
Lower Verde River	LVR
McMullen Valley	MMU
Monument Valley	MNV
New River-Cave Creek	N-C
Peach Springs Canyon	PSC
Puerco-Zuni	PRZ
Ranegras Plain	RAN
Sacramento Valley	SAC
Safford Basin	SAF
Saint Johns	STJ
Salt River Valley	SRV
San Bernardino Valley	SBV
San Francisco Peaks	SFP
San Francisco River Basin	SFR
San Simon Basin	SSI
San Simon Wash	SSW
Shivwits	SHV
Snowflake	SNO
Tonto Basin	TON
Tuba City	TUB
Upper Salt River Basin	USR
Upper San Pedro Basin	USP
Upper Santa Cruz Basin	USC
Upper Verde River	VER
Virgin River	VRG
Waterman Wash	WAT
Western Mexican Drainage	WMD
White Mountains	WHM
White River Basin	WRB
Willcox Basin	WIL
Williamson Valley	WMN
Yuma	YUM

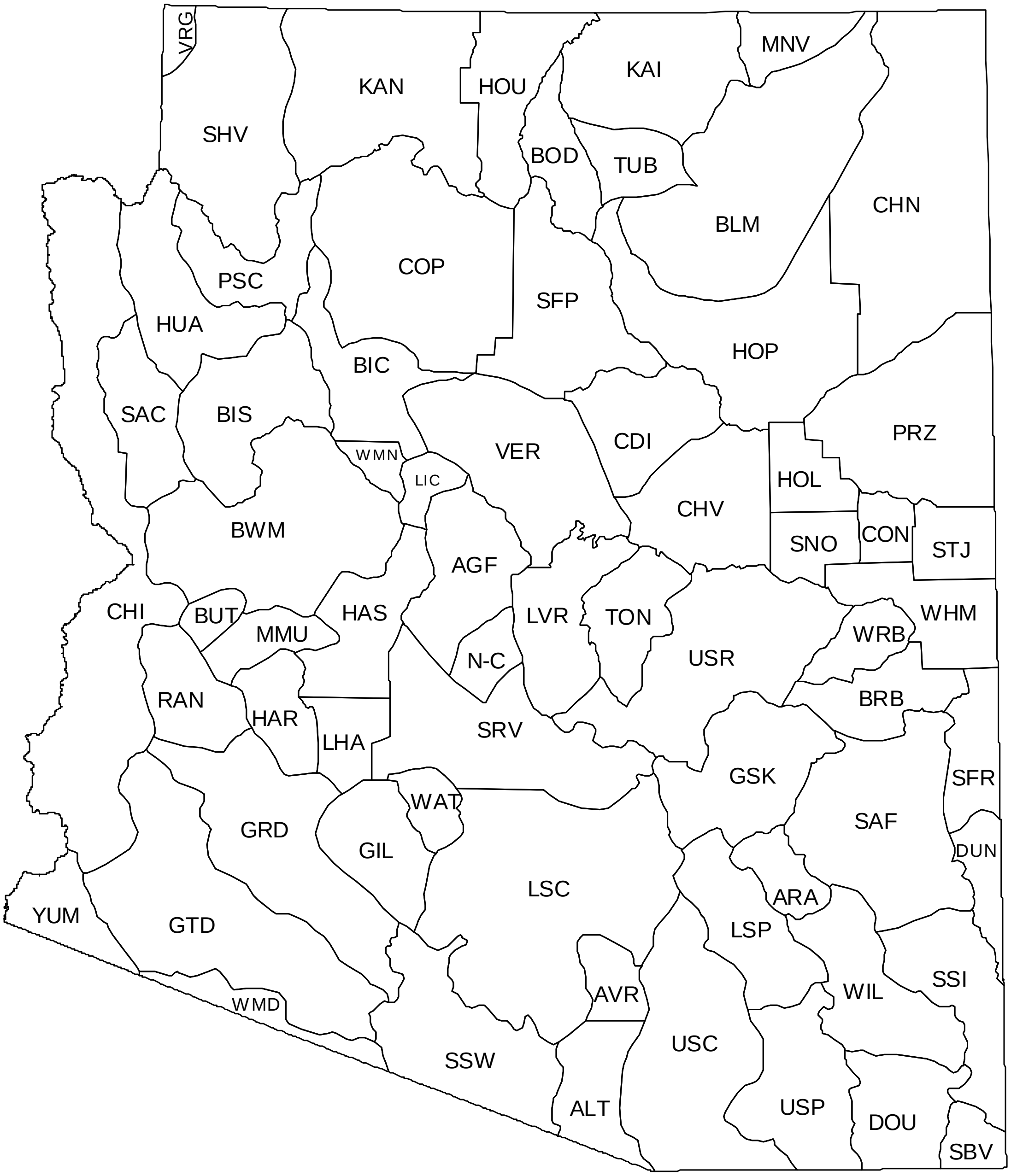


Figure 7. U. S. Geological Survey Groundwater Areas

Appendix D : Geological Unit Codes

Cenozoic

Quaternary

Holocene

Alluvium (Flood-Plain and Stream Channel)	111ALVM

Pleistocene

Basaltic Flows	112BLCF
Basin Fill - Upper, Lower, Undifferentiated	112BSFL
Basin Fill - Upper	112BSFLU
Sand and Gravel - Upper	112SDGVU
Terrace (and Surficial) Deposits	112TRRC

Tertiary

Consolidated Sedimentary Rocks, Tertiary and Mesozoic Undifferentiated	120CDSM
Datil Formation	120DATIL
Felsic Volcanic Rocks	120FCVC
Intrusive Rocks	120IRSV
Mafic Volcanic Rocks	120MFCV
Mafic and Felsic Volcanic Rocks	120MFFV
Sedimentary Rocks	120SDMR
Volcanic Rocks	120VLCC

Pliocene

Bidahochi Formation	121BDHC
Bidahochi Formation - Lower	121BDHCL
Bidahochi Formation - Middle	121BDHCM
Bidahochi Formation - Upper	121BDHCU
Basaltic Flows	121BLCF
Basin Fill - Lower	121BSFLL
Chuska Sandstone	121CHSK
Lower Basin Fill and Miocene Sedimentary Rocks - Undifferentiated	121LBFM

Miocene

Basalt-Andesite Flows	122BLAD
Sedimentary Rocks	122SDMR
Volcanic Breccias, Agglomerates, and Tuffs	122VBAT
Muddy Creek Formation	121MDCK
Verde Formation	121VERD

Tertiary

Oligocene

Felsic Flows or Welded Tuffs	123FFTW
Sedimentary Rocks	123KDMR
Mafic Flows	123MFCF
Volcanic Breccias, Agglomerrates, or Tuffs	123VBAT
Volcanic Rocks	123VLCC

Eocene

Felsic Volcanic Rocks	124FCVC
Mafic Volcanic Rocks	124MFCV
Sedimentary Rocks	124SDMR

Paleocene

Nacimiento Formation	125NCMN
Ojo Alamo Formation	125OJAM

Mesozoic

Felsic Intrusive Rocks	200FCIV
Felsic Volcanic Rocks	200FCVC
Mafic Volcanic Rocks	200MFCV
Mafic Intrusive Rocks	200MFIV
Sedimentary Rocks	200SDMR
Volcanic Rocks	200VLCC

Cretaceous

Upper Cretaceous

Allison Member of Menefee Formation of the Mesaverde Group	211ALSN
Bartlett Barren Member of Crevasse Canyon Formation of the Mesaverde Group	211BRLB
Cliff House Sandstone of the Mesaverde Group	211CLFH
Cleary Coal Member of Menefee Formation of the Mesaverde Group	211CLRY
Crevasse Canyon Formation of the Mesaverde Group	211CRVC
Dilco Coal Member of Crevasse Canyon Formation of the Mesaverde Group	211DLCO
Dalton Sandstone Member of Crevasse Canyon Formation of the Mesaverde Group	211DLTN
Dakota Sandstone	211DOKT
Fruitland Formation	211FRLD
Farmington Sandstone Member of Kirkland Shale	211FRMG
Gallup Sandstone	211GLLP

Mesozoic

Cretaceous

Upper Cretaceous (cont.)

Hosta Tounge of Point Lookout Sandstone of the Mesaverde Group	211HOST
Juana Lopez Member of Mancos Shale	211JLPZ
Kirkland Shale - Upper	211KRLDU
Lewis Shale	211LWIS
Menefee Formation	211MENF
Mulatto Tongue of Mancos Shale	211MLTT
Mancos Sahle	211MNCS
Pictured Cliffs Sandstone	211PCCF
Point Lookout Sandstone	211PNLK
Pescado Tongue of Mancos Shale	211PSCD
Santan Tongue of Mancos Shale	211SATN
Sedimentary Rocks - Undifferentiated	211SDMR
Toreva Formation	211TORV
Wepo Formation	211WEPO
Yale Point Sandstone	211YLPN

Lower Cretaceous

Burro Canyon Formation	217BRCN

Jurassic

Navajo Sandstone	220NVJO

Upper Jurassic

Bluff Sandstone	221BLFF
Brushy Basin Shale Member of Morrison Formation	221BRSB
Carmel Formation	221CRML
Cow Springs Sandstone	221CSPG
Entrada Sandstone	221ENRD
Entrada Sandstone - Lower	221ENRDL
Entrada Sandstone - Middle	221ENRDM
Entrada Sandstone - Upper	221ENRDU
Morrison Formation	221MRSN
Recapture Shale Member of the Morrison Formation	221RCPR
Salt Wash Sandstone Member of the Morrison Formation	221SLWS
Summerville Formation	221SMVL
Todilto Limestone	221TDLT
Westwater Canyon Sandstone Member of the Morrison Formation	221WSRC

Mesozoic

Triassic

Hoskinnini Member of the Moenkopi Formation	230HSKN
Moenkopi Formation	230MNKP

Triassic

Upper Triassic

Church Rock Member of Chinle Formation	231CCRK
Chinle Formation	231CHNL
Correo Sandstone Bed of Petrified Forest Member of Chinle Formation	231CORR
Dinosaur Canyon Sandstone Member of Moenave Formation	231DSRC
Kayenta Formation	231KYNT
Lukachukai Member of Wingate Sandstone	231LKCK
Monitor Butte Member of Chinle Formation	231MNRB
Moenave Formation	231MOONV
Mesa Redondo Member of Chinle Formation	231MRDD
Owl Rock Member of Chinle Formation	231ORCK
Petrified Forest Member - Lower - of Chinle Formation	231PFDFL
Petrified Forest Member - Upper - of Chinle Formation	231PFDFU
Rock Point Member of Wingate Sandstone	231RCKP
Sonsela Sandstone Bed of Petrified Forest Member of Chinle Formation	231SNSL
Springdale Sandstone Member of Moenave Formation	231SPGD
Shinarump Member of Chinle Formation	231SRMP
Wingate Sandstone	231WNGT

Middle Triassic

Holbrook Sandstone Member of Moenkopi Formation	224HLBK

Lower Triassic

Moqui Member of Moenkopi Formation	237MOQU
Wapatki Member of Moenkopi Formation	237WPTK

Paleozoic

Limestone	300LMSN
Quartzite	300QRTZ
Sandstone	300SNDS

Permian

Abo Formation	310ABO
Coconino Formation	310CCNN
Cedar Mesa Sandstine Member of Cutler Formation	310CDRM
Cutler Formation	310CTLR
De Chelly Sandstone	310DCLL
Glorieta Sandstone	310GLRT
Halgaito Tongue of Cutler Formation	310HLGT
Hermit Shale	310HRMT
Kaibab Limestone	310KIBB
Meseta Blanca Sandstone Member of Yeso Formation	310MBLC
Naco Formation	310NACO

Paleozoic

Permian (cont.)

Organ Rock Tongue of Culter Formation	310OGRK
Rico Formation	310RICO
Supai Formation	310SUPI
Supai Fprmation - Lower	310SUPIL
Supai Formation - Middle	310SUPIM
Supai Formation - Upper	310SUPIU
San Ysidro Member of Yeso Formation	310SYDR
Toroweap Formation	310TRWP
Yeso Formation	310YESO

Guadalupian

San Andres Limestone	313SADR

Pennsylvanian

Hermosa Formation	320HRMS
Molas Formation	320MOLS

Mississippian

Redwall Limestone	330RDLL

Devonian

Upper Devonian

Martin Limestone	341MRTN

Cambrian

Middle Cambrian

Bright Angle Shale	374BGAG
Muav Limestone	374MUAV
Tapeats Sandstone	374TPTS

Precambrian

Granitic Gneiss	400GRCG
Granite	400GRNT
Schist	400SCST
Sedimentary Rocks	400SDMR

Appendix E : GWSI Index Well Siting Criteria

In general, ADWR Index wells historically have been selected to provide good spatial distribution or coverage within a groundwater basin and to assess vertical gradients if possible. ADWR GWSI Index wells are selected based on guidelines developed by the USGS Office of Ground Water for the Collection of Basic Records (CBR) Program: https://groundwaterwatch.usgs.gov/net/ogwnetwork.asp?ncd=crn

Specific criteria for Index well selection can include at a minimum the following:

- Open to a single, known hydrogeologic unit
- Known well construction that allows good water-level measurements
- Located in unconfined aquifers or near-surface confined aquifers that respond to climatic fluctuations
- Minimally affected by pumpage and likely to remain so
- Essentially unaffected by irrigation, canals, and other potential sources of artificial recharge
- Long-term accessibility
- Well has never gone dry (not susceptible to going dry)

Additional desired characteristics:

- Representative of broad area (e.g., a regional aquifer)
- Complete characterization of the site is available
- A long record of water-level measurements exists
- Lithologic and geophysical logs available

Please note that selection criteria may vary for GWSI Index wells depending on area specific monitoring objectives. For example, wells may be selected that are located in confined conditions versus unconfined for specific regional data needs.

Appendix F : Mandatory Data Elements for Water-Level Measurements for Submittal to ADWR Groundwater Site Inventory (GWSI)

Data supplied by verified Groundwater Data Cooperator well sites will be input into the Department's Oracle Groundwater Site Inventory (GWSI) database. The following descriptions provide explanation of the Mandatory Data Elements (fields and formats) needed to complete a record.

Water Levels Data Table (WW_LEVELS)

The Water Levels Data Table contains information related to the depth to water at the site. Data that is contained includes, depth to water, water table elevation, measurement date, method of measurement, measurement remarks and source of the water level measurement.

Date Measured (Wlwa_Measurement_Date)
This field records the date that the water level was recorded for the site. The associated Date Valid field indicates the accuracy of the Water Level Measurement Date.

Depth to Water (Wlwa_Depth_To_Water)
This field records the depth to water, in feet, below land surface. Depth to water can be carried out to two decimal places. If the water level is above land surface, enter the water level in feet above land surface preceded by a minus (-) sign. If the head at a flowing site is unknown, if the water level can not be measured, the site is dry, or the well destroyed then this field is left blank and the appropriate code must be placed in the associated Water Level Remarks Code field (Wlwa_Remarks). (By default there can be no 0.00 depth to water.)

Water Level Elevation (Wlwa_Water_Level_Elevation)
This field contains the elevation of the water table above mean sea level datum. This field is calculated by subtracting the depth to water from the well altitude as entered in the Sites Data table. Except for flowing wells, water level elevations are blank for records that have no depth to water measurements.

A well site must be inventoried by ADWR, BOR, or the USGS. During the inventory, such basic data such as well elevation is collected to create the well Site ID and thus the original well record in the database. If a well already has a Site ID, already is in GWSI, then the water level elevation is not needed for submittal. Discrepancies observed between the Well Site Elevation the Cooperator provides and what is contained in the Sites Data table should be brought to the attention of the ADWR submittal contact.

Method of Water Level Measurement (Wlwa_Method Code)
This field contains the code for the method used to measure the depth to water. GWSI Codes will be provided on-line through list or drop-box along with help file, GWSI Data Dictionary

Remarks (Wlwwa_Remarks)
This field contains letter codes that describe the status of the site at the time of the water level measurement. GWSI Codes will be provided on-line through list or drop-box along with help file, GWSI Data Dictionary.

Source of Water Level Measurement (Wlwa_Source)
This field contains the letter codes for the source of the water level measurement.

Water Level Measuring Point Data Table (WM_POINTS)

The Water Level Measuring Point Data Table contains a description of the point used to measure the depth to water in a well.

Date Measured (Welm_Date_Measured)
This field records the date that the water level measuring point was established for the site. The associated Date Valid field indicates the accuracy of the Measuring Point Date.

Measuring Point Height (Welm_Measure_Point_Height)
This entry is the height [ft] above the land surface from which the depth to water measurement was made. If the measurement point is below land surface, the measurement height is preceded by a minus sign (-).

Measuring Point Descriptions (Welm_Mp_Description)

This field contains a description of the point use to measure the depth to water. Listed below are some of the common measuring point descriptions.

HTCA, W - Hole in Top of Casing, West Side
BOP, N - Access under Base of Pump, North Side
HSCA, N - Hole in Side of Casing, North Side
ACTB, S - Measuring (Access) Tube, South Side
TCA, SE - Top of Casing, Southeast Side
AIRL, S - Airline, South Side
HBOP, S - Hole in Pump Base, South Side
HISP, NE - Hole in Submersible Plate, Northeast Side

Water level data collection protocols and methods used by ADWR and USGS are described in publications including:

Ground-Water-Level Monitoring and the Importance of Long-Term Water-Level Data (U.S. GEOLOGICAL SURVEY CIRCULAR 1217) http://pubs.usgs.gov/circ/circ1217/html/contents.html

Ground-Water Data-Collection Protocols and Procedures for the National Water-Quality Assessment Program: Selection, Installation, and Documentation of Wells, and Collection of Related Data (U.S. Geological Survey Open-File Report 95-398)
http://pubs.usgs.gov/of/1995/ofr-95-398/

For additional industry standards, see:

U.S. Geological Survey, 1980, Ground Water, Chapter 2 of National Handbook of Recommended Methods for Water-Data Acquisition: Office of Water Data Coordination, 149 p.

U.S. Bureau of Reclamation, 1977, Ground Water Manual: U.S. Department of Interior, Bureau of Reclamation, United States Government Printing Office, Denver, CO., 480 p.

U.S. Geological Survey, (L. J. Mann), 1982. Operational Guidelines for Measuring Ground-water Levels—Arizona District, 10 p.

Appendix G : Minimum Data Set Requirements for Submittal of Well Site Details to ADWR Groundwater Site Inventory (GWSI)

Purpose

Collect groundwater level data from sources other than ADWR or from entities for which the collection methods are unknown or otherwise not fully comparable by GWSI standards such as data collection and reporting techniques of many water providers, power plant operators, RGR reporters, community water systems, and other sources of groundwater data in varying forms of data validation. Data supplied by verified Groundwater Data Cooperators will be input into the Departments Oracle Groundwater Site Inventory database.

Process

The first step in processing groundwater level data received from a non-ADWR source is to ensure the accuracy and correctness of the specific well site for which data is intended to be submitted to the Department. Validating the correct well identification for the submitted data is the first step in receiving outside groundwater level data. Wells that have a registry number, 55-xxxxxx, may or may not have a GWSI Site_ID number. Each well site in GWSI is assigned a unique 15-character identification number by the Department, the SITE ID, which is the common field (primary key) in all the GWSI data tables.

The Department will assign a Site_ID to wells that do not currently have a SITE_ID assigned to them through submittal of basic well information from the outside entity and a SITE INVENTORY will subsequently be conducted by the Department (unless USGS or BOR have already created) after submitted data is verified on-line. An on-line data portal will be used by Cooperators to input the Basic Well information required (see Fig. 1.). The Department will then review the Basic Well information submitted with existing GWSI SITE_IDs and confirm validation of matching GWSI & registry IDs. Once a well has received confirmation of validation of existing IDs, water-level data can then be submitted on-line with a validation code received from a confirmation email by the Department.

Summary of process:

1) Cooperator submittal of basic well info;
2) Validation of GWSI SITE_ID if existing;
3) ADWR Site Inventory if GWSI SITE_ID does not exist utilizing Cooperator submitted basic well info;
4) ADWR will create a SITE_ID when an Inventory is complete;
5) ADWR will send confirmation email to potential Cooperators with validated SITE_ID;
6) Cooperators can submit data on-line using validated SITE_ID.

Please note, data portals will provide two different mechanisms for submittal; 1) Batch Format for large numbers of well sites, and 2) Data Entry Screen for individual well entries.

Data supplied by verified Groundwater Data Cooperator well sites will be input into the Department's Oracle Groundwater Site Inventory (GWSI) database. The following descriptions provide explanation of the Mandatory and Optional Data Elements (fields and formats) needed to complete a record.

Site Detail Data Table (SITES)

The Site Detail Data Table is used for recording general information about the site, including location information, general well construction, and well use information. The Sites data table is the main table in the GWSI system. All other GWSI tables are linked to it by the Site Id field.

Site Id (SITE_WELL_SITE_ID) MANDATORY

Each well site in GWSI is assigned a unique 15-character identification number by the Department, the SITE ID, which is a common field in all the GWSI data tables. Although the Site Identification Number is derived initially from the latitude and longitude of the site, the number is a unique identifier and not a locator.

The site identification number is assigned by using a method (map, Global Positioning System (GPS), Geographic Information System (GIS), etc.) that will provide the most precise location for a point representing the site. The latitude and longitude of the point are determined to the nearest 100th of a second. The first six digits of the Site ID are the value of latitude, the 7th through 13th digits are the value of longitude, and the 14th and 15th digits are sequence numbers used to distinguish between sites at the same location. Leading zeros are used if the value of latitude is less than 10 degrees, if the value of longitude is less than 100 degrees, or the sequence number is less than 10.

Cadastral Location (Site_Local_Id) MANDATORY

This is a 20 character-long site location based on the U. S. Bureau of Land Management's system of land subdivision. The land survey in Arizona is based on the Gila and Salt River Baseline and Meridian, which divides the state into four quadrants. These quadrants are designated A, B, C, and D in a counterclockwise direction starting in the upper right hand corner (Figure 1). All land with north Townships and east Ranges are in the A quadrant, north Townships and west Ranges in the B quadrant , south Townships and west Ranges in the C quadrant, and south Townships and east Ranges in the D quadrant. The first number in the cadastral location is the Township, the second is the Range, and the third is the Section in which the site is located. The letters following the section number indicate the well location within the section. The first letter indicates the 160-acre quarter section, the second letter the 40-acre quarter-quarter section, and the third letter the 10-acre quarter-quarter-quarter section. More explanation will be provided by on-line help file, GWSI Data Dictionary.

Land Net Meridian (Site_Meridian) MANDATORY

This field records the land net meridian that is used to establish the Local Id or cadastral location of the site. In general all sites located in Arizona, except those on the Navajo and Hopi Indian Reservation, use the Gila and Salt River Meridian and Baseline. GWSI Codes will be provided on-line through list or drop-box along with help file, GWSI Data Dictionary.

Latitude (Site_Latit_Degree, Site_Latit_Min, Site_Latit_Sec) MANDATORY

Longitude(Site_Longit_Degree, Site_Longit_Min, Site_Longit_Sec) MANDATORY

The three latitude fields and the three longitude fields contain the best available value for the latitude and longitude of the site in degrees, minutes, and seconds. Seconds may be entered to 100ths of a second. Use leading zeros for values <100. The position of the site is encouraged to be measured in the field by global positioning system (G.P.S.) equipment. Each value for the degrees, minutes and seconds should be entered into the appropriate field. The location should be entered as precisely as it is known, and the accuracy of the location should be indicated by a suitable entry in the lat/long accuracy.

Latitude/Longitude Accuracy (Site_Llaccr_Code) MANDATORY

This field records the accuracy of the latitude/longitude location for the site. If the site cannot be determined within 2 seconds, then the field person will indicate the appropriate accuracy. In general a site can be located to within five seconds on a map, Two seconds on an orthophoto with a templet, and one second if it is digitized. GWSI Codes will be provided on-line through list or drop-box along with help file, GWSI Data Dictionary.

Lat/Long Datum MANDATORY

Enter the horizontal datum code for the latitude/longitude coordinates. GWSI uses NAD-27(North American Datum of 1927). The only datums that can be converted on output are NAD27 (North American Datum of 1927) and NAD83 (North American Datum of 1983). GWSI uses the North American Datum Conversions (NADCON) of the National Geodetic Survey to convert from NAD27 to NAD83 or vice-versa.

State Well Registration Number (Site_Well_Reg_Id) CONDITIONALLY MANDATORY

This field contains the State Well Registration (55) number of the well if the site can be positively matched to a registered well. The 55 number is matched with a GWSI well only when the field investigator is absolutely positive that the wells are the same. If there is any doubt about the match, the 55 number is not entered until those doubts are resolved.

Site Altitude (Site_Well_Altitude) MANDATORY

This field contains the altitude of the site in feet above NGVD, precision to two decimals can be coded if available. The altitude of land surface is the altitude in feet of a fixed reference point (RP) at the well near land surface that can be used to measure the height of the measuring point (MP) and can be surveyed if desired. Examples of the land surface reference point description are; a brass marker installed in the concrete pad, or an etched mark at the base of the surface casing. Enter the altitude, in
feet above the specific Vertical Datum, of the land surface at the site. Altitudes below the specific Vertical Datum should be preceded by a minus sign (-).

Method of Altitude Measurement (Site_Altmeth_Code_Entry) MANDATORY

This field records the method used to determine the altitude of the site. GWSI Codes will be provided on-line through list or drop-box along with help file, GWSI Data Dictionary.

Altitude Accuracy (Site_Altit_Accuracy) MANDATORY
This field contains the level of accuracy, in feet, of the site altitude. Site altitudes taken from a map are generally accurate to one half the maps contour interval. Sites that are leveled in from a bench mark are considered accurate to within 1.0 foot.

Altitude Datum MANDATORY
Enter the datum used to collect altitude. GWSI uses NGVD29 (National Geodetic Vertical Datum of 1929). The only vertical datums that can be converted on output are NGVD29 (National Geodetic Vertical Datum of 1929) and NAVD88 (North American Vertical Datum of 1988). GWSI uses the North American Vertical Datum Conversions (VERTCON) of the National Geodetic Survey to convert from NGVD29 to NAVD88 or vice-versa.

Depth of Hole (Site_Hole_Depth) CONDITIONALLY MANDATORY
This field records the total depth to which the hole was drilled in feet, below the land surface datum, even though it may have been plugged back in completing the well. For collector or Ranney-type wells, the depth of the central shaft should be entered. For multiple-well fields, ponds, tunnels, springs, or drains, the field should be blank. If the hole depth is given, all other depths associated with the site will be compared with it for validity.

Depth of Well   (Site_Well_Depth) CONDITIONALLY MANDATORY
This field contains the depth of the finished, or cased, portion of the well in feet below land surface datum. The depth of the well is usually taken from the completed well drillers report.

Source of Depth Data (Site_Adwrs_Code) CONDITIONALLY MANDATORY
This field contains the source of the reported depth of a well. GWSI Codes will be provided on-line through list or drop-box along with help file, GWSI Data Dictionary to ensure consistency in data format.

Appendix H : Non-Arizona Well Identification Systems

Well Numbering System

The local well identification (Local_Id) system for GWSI sites located in California, Colorado, Nevada, New Mexico, and Utah is based on the system of land subdivision used by the Bureau of Land Management. This system uses a surveyed base line and principal meridian from which townships and ranges are located. Townships are located north or south of the base line and ranges are located east or west of the principal meridian. Sections are designated 1 through 36 and are numbered in rows following a serpentine pattern beginning in the northeast corner of a township and ending in the southeast corner of the township. The method of locating sites within a section varies with each state and is described in detail below.

California Well Numbering System

The California well numbering system is based in the San Bernardino Baseline and Meridian. A GWSI site located in California in the *NW*1/4 of the *NE*1/4 of the *NE*1/4 of *Section* 35, *Township* 15 *South*, *Range* 23 *East*, would be identified as **15S/23E-35 Jb**. The number preceding the slash (/) is the township and the letter after the township (**N** or **S**) indicates its position north or south of the San Bernardino Baseline. The number after the slash is the range and the letter following the range (**E** or **W**) indicates its position east or west of the San Bernardino Meridian. The number following hyphen (-) is the section and the two letters following the section number identify the 40-acre and 10-acre subdivisions. The 40-acre subdivisions are identified using the same serpentine pattern used to identify section numbers in a township (Figure 1). Each 40-acre subdivision is assigned a capital letter *A* through *R*, omitting *I* and *O*. The 10-acre tracts are assigned the lowercase letters *a*, *b*, *c*, or *d* in a counter-clockwise direction in the same manner as the 10-acre subdivisions in the Arizona. In some cases a second lowercase letter is added if the 21/2 acre location is known.

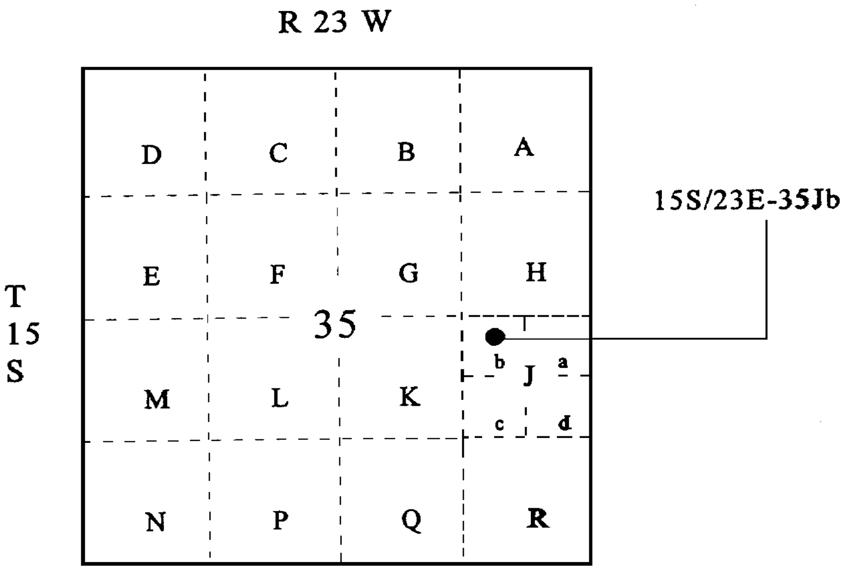
Colorado Well Numbering System

The southwestern corner of Colorado, the part closest to Arizona, is part of the New Mexico Baseline and Meridian. The New Mexico Well Numbering System is used and described below.

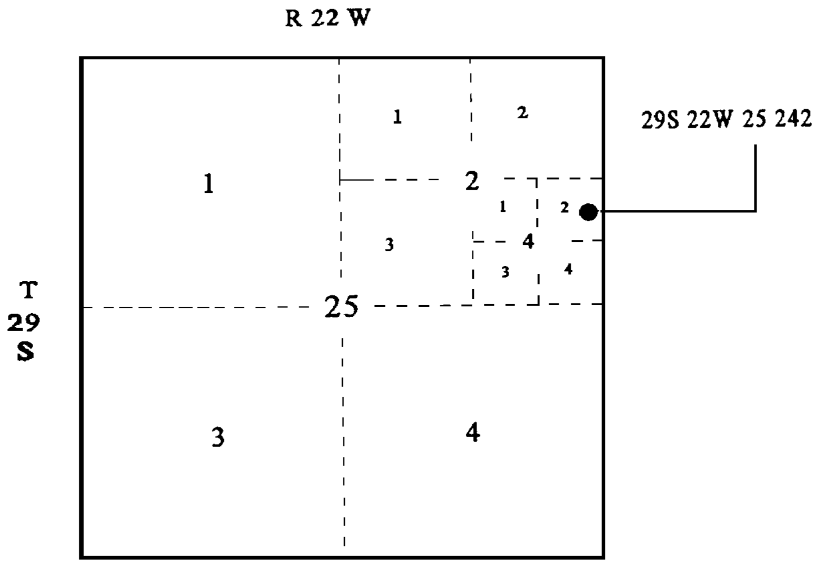
New Mexico Well Numbering System

The New Mexico well numbering system is based on the New Mexico Principal Baseline and Meridian. The local identifications (Local_Id) based on this well numbering system consists of four parts, each separated by spaces (Figure 2). The first three parts are the township number, the range number, and the section number, respectively. The township number is followed by the letters **N** or **S** to indicate if the township lies north or south of the New Mexico Base Line. The range number is followed by the letters **E** or **W** to indicate if the range lies east or west of the New Mexico Principal Meridian. The letters **T** and **R**, for **T**ownship and **R**ange, are omitted from the GWSI local identification. Hence, a site located in *Township* 29 *South, Range* 22 *West, Section* 25 would be identified as **29S 22W 25**.

The fourth part of the well identification consists of three numbers that identify the 10-acre tract within the section in which the site is located. The method of numbering the tracts within the section is different that used in Arizona and is shown in Figure 2. The section is divided into four 160-acre quarters, numbered 1, 2, 3, and 4, using a normal reading order from left to right, for the northwest, northeast, southwest and southeast quarters, respectively. Each 160-acre quarter section is subdivided in the same manner to produce the second number, which defines a 40-acre quarter-quarter section. The 40-acre tract is divided in the same manner to produce the third number, which identifies the 10-acre quarter-quarter-quarter section tract. Thus a site in the *NE* 1/4 of the *SE* 1/4 of the *NE* 1/4 *of Section* 25, *Township* 29 *South*, *Range* 22 *West*, would be identified as **29S 22W 25 242**. If multiple sites are located within a 10-acre tract, consecutive letters starting with the letter *a* are added as a suffix, with *a* being the oldest known site.



California Well Identification System



New Mexico Well Identification System

Figure 8. California and New Mexico Well Location System

Nevada Well Numbering System

GWSI local identifications in Nevada are determined using the Mount Diablo Base Line and Principal Meridian. The subdivision of sections is the same as in Arizona, except that Nevada sections are divided four times to specify the site location to within a 21/2 acre tract. A numerical suffix to denote multiple wells within a section is used just as in Arizona. Letters denoting the township or range location relative to the base line and meridain, **N** or **S** for the township**,** **E** or **W** for the range, precede the township and range numbers. A prefix of three numbers, **222**, is added to identify GWSI wells in Nevada. For example, a site located in the *SW* 1/4 of the *NW* 1/4 of the *SE* 1/4 of the *SE* 1/4 of *Section* 28, *Township* 13 *South, Range* 71 *East*, would be identified as **222 S13 E71 28DDBC**.

Utah Well Numbering System

In Utah GWSI site locations are based on the Salt Lake Base Line and Meridian. The method of land subdivision is the same as is used in Arizona. The base line and meridian are used to divide the state into four quadrants, **A**, **B**, **C**, and **D**, starting in the upper right corner (northeast) and moving counter-clockwise to the southeast quadrant. Sections are divided down to quarter-quarter-quarter sections in the same manner as in Arizona. For example, a site located in the *NW* 1/4 of the *NW* 1/4 of the *NW* 1/4 of *Section* 25, *Township* 43 *South*, *Range* 19 *West*, would be identified as **C-43-19 25BBB**.

The well-numbering system used in Utah is based on the Bureau of Land Management's system of land subdivision. The well – numbering system is familiar to most water users in Utah, and the well number shows the location of the well by quadrant. township, range, section, and position within the section. Well number for most of the State are derived from the Salt Lake Base Line and the Salt Lake Meridian. Well numbers for wells located inside the area of the Utah Base Line and Meridian are designated in the same manner as those based on the Salt Lake Base Line and Meridian, with the addition of the "U" preceding the parentheses. The numbering system is illustrated below in Figure 9.

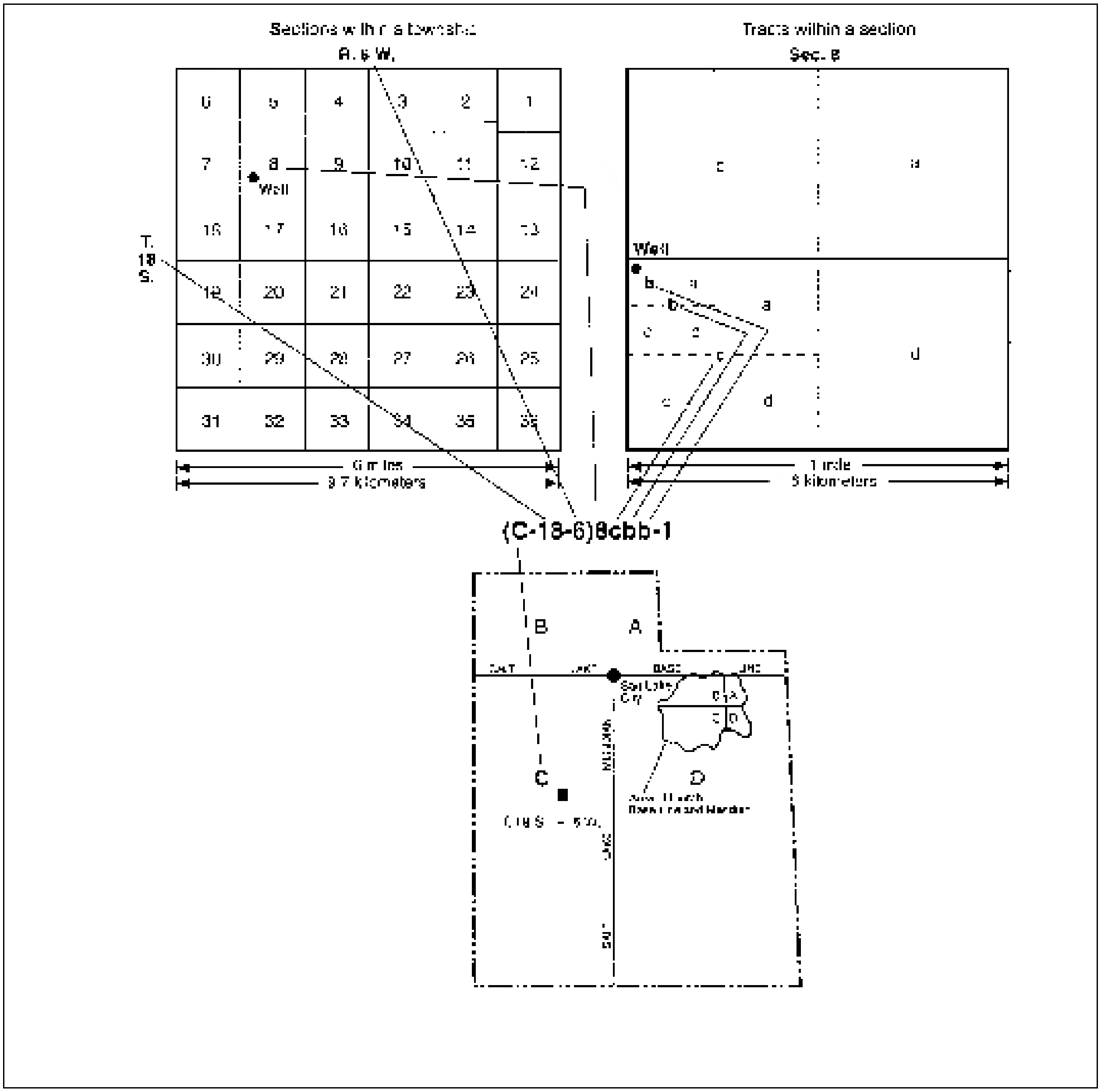


Figure 9. Utah Well Location System

Groundwater Site Inventory (GWSI) Database

Appendix I : Oracle Database Map

Description in GWSI	Table Name	Column Name	Code Lookup Table
Site Identification Number	GWSI_Sites	Site_Well_Site_Id	N/A
Local Identification Number	GWSI_Sites	Site_Local_Id	N/A
Land Net Meridian	GWSI_Sites	Site_Meridian	N/A
Site Type	GWSI_Sites	Site_Sittyp_Code_Entry	GWSI_Site_Types
Reliability	GWSI_Sites	Site_Rely_Code_Entry	GWSI_Reliabilities
Topo Setting	GWSI_Sites	Site_Toposet_Code_Entry	GWSI_Topo_Settings
Site Data Source	GWSI_Sites	Site_Sisrc_Code	GWSI_Site_Sources
Topographic Quad Name	GWSI_Sites	Site_Tqnam_Quad_Name	N/A
Map Scale	GWSI_Sites	Site_Map_Scale	N/A
ALRIS Quadrangle Number	GWSI_Sites	Site_Quad_No	N/A
Latitude Degree	GWSI_Sites	Site_Latit_Degree	N/A
Latitude Minute	GWSI_Sites	Site_Latit_Min	N/A
Latitude Second	GWSI_Sites	Site_Latit_Sec	N/A
Longitude Degree	GWSI_Sites	Site_Longit_Degree	N/A
Longitude Minute	GWSI_Sites	Site_Longit_Min	N/A
Longitude Second	GWSI_Sites	Site_Longit_Sec	N/A
Latitude/Longitude Accuracy	GWSI_Sites	Site_Llaccr_Code_Entry	GWSI_Lon_Lat_Accuracies
Method of Latitude/Longitude Measurement	GWSI_Sites	Site_Latlong_Meth_Code	GWSI_Latlong_Method_Codes
Decimal Latitude	GWSI_Sites	Site_Latitude_Decimal	N/A
Decimal Longitude	GWSI_Sites	Site_Longit_Decimal	N/A
UTM Coordinates	GWSI_Sites	N/A	N/A
State Well Registration Number	GWSI_Sites	Site_Well_Reg_Id	N/A
Site Altitude	GWSI_Sites	Site_Well_Altitude	N/A
Method of Altitude Measurement	GWSI_Sites	Site_Altmeth_Code_Entry	GWSI_Altitude_Methods
Altitude Accuracy	GWSI_Sites	Site_Altit_Accuracy	N/A
ADWR Basin Codes	GWSI_Sites	Site_Ama_Code_Entry	N/A
ADWR Sub-Basin Codes	GWSI_Sites	Site_Adwbas_Code_Entry	N/A
USGS Basin Codes	GWSI_Sites	Site_Usbasn_Code_Entry	N/A
State Codes	GWSI_Sites	Site_State_Code_Entry	GWSI_States
County Codes	GWSI_Sites	Site_Cnty_Code	GWSI_Countys
Site Use 1	GWSI_Sites	Site_Use_1	GWSI_Site_Use_Codes
Site Use 2	GWSI_Sites	Site_Use_2	GWSI_Site_Use_Codes
Site Use 3	GWSI_Sites	Site_Use_3	GWSI_Site_Use_Codes
Water Use 1	GWSI_Sites	Water_Use_1	GWSI_Water_Use_Codes
Water Use 2	GWSI_Sites	Water_Use_2	GWSI_Water_Use_Codes
Water Use 3	GWSI_Sites	Water_Use_3	GWSI_Water_Use_Codes
Depth of Hole	GWSI_Sites	Site_Hole_Depth	N/A

Groundwater Site Inventory (GWSI) Database

Description in GWSI	Table Name	Column Name	Code Lookup Table
Depth of Well	GWSI_Sites	Site_Well_Depth	N/A
Source of Depth Data	GWSI_Sites	Site_Adwrs_Code	GWSI_ADWR_Sources
Geological Unit	GWSI_Sites	Site_Geo_Unit	N/A
Site Creation Date	GWSI_Sites	Site_Create_Date	N/A
Site Update Date	GWSI_Sites	Site_Update_Date	N/A
Last Action Date	GWSI_Sites	Site_Last_Act_Date	N/A
Last Action Operator	GWSI_Sites	Site_Last_Act_Oper	N/A
Site Creation Valid Entry Date	GWSI_Sites	Site_Cdate_Valid	N/A
Site Update Valid Entry Date	GWSI_Sites	Site_Udate_Valid	N/A
Arizona Watershed Codes	GWSI_Sites	Site_Wshd_Code	N/A
Index Book	GWSI_Sites	Site_Idx_Book	N/A
Construction Entry Number	GWSI_Well_Completions	Wlco_Id	N/A
Well Completion Date	GWSI_Well_Completions	Wlco_Completion_Date	N/A
Drill Method	GWSI_Well_Completions	Wlco_Drilmth_Code_Entry	GWSI_Drill_Methods
Well Finish	GWSI_Well_Completions	Wlco_Wlcase_Code_Entry	GWSI_Well_Finishes
Source of Construction Data	GWSI_Well_Completions	Wlco_Adwrs_Code	GWSI_ADWR_Sources
Name of Driller	GWSI_Well_Completions	Wlco_Driller_Name	N/A
Last Action Date	GWSI_Well_Completions	Wlco_Last_Act_Date	N/A
Last Action Operator	GWSI_Well_Completions	Wlco_Last_Act_Oper	N/A
Valid Completion Date	GWSI_Well_Completions	Wlco_Valid_Date	N/A
Construction Entry Number	GWSI_Bore_Completions	Bore_Wlcomp_Id	N/A
Bore Hole Interval	GWSI_Bore_Completions	Bore_Hold_Interval	N/A
Top of Bore Hole	GWSI_Bore_Completions	Bore_Hole_Top	N/A
Bottom of Bore Hole	GWSI_Bore_Completions	Bore_Hole_Bottom	N/A
Diameter of Bore Hole	GWSI_Bore_Completions	Bore_Hole_Diameter	N/A
Last Action Date	GWSI_Bore_Completions	Bore_Last_Act_Date	N/A
Last Action Operator	GWSI_Bore_Completions	Bore_Last_Act_Oper	N/A
Construction Entry Number	GWSI_Casing_Completions	Case_Wlcomp_Id	N/A
Casing Interval	GWSI_Casing_Completions	Case_Interval	N/A
Top of Casing	GWSI_Casing_Completions	Case_Top	N/A
Bottom of Casing	GWSI_Casing_Completions	Case_Bottom	N/A
Diameter of Casing	GWSI_Casing_Completions	Case_Diameter	N/A
Casing Material	GWSI_Casing_Completions	Case_Finish_Code	GWSI_Casing_Finishes
Last Action Date	GWSI_Casing_Completions	Case_Last_Act_Date	N/A
Last Action Operator	GWSI_Casing_Completions	Case_Last_Act_Oper	N/A
Construction Entry Number	GWSI_Perforation_Completions	Perf_Wlcomp_Id	N/A
Perforation Interval	GWSI_Perforation_Completions	Perf_Interval	N/A
Top of Perforation	GWSI_Perforation_Completions	Perf_Top	N/A
Bottom of Perforation	GWSI_Perforation_Completions	Perf_Bottom	N/A

Description in GWSI	Table Name	Column Name	Code Lookup Table
Diameter of Perforation Casing	GWSI_Perforation_Completions	Perf_Diameter	N/A
Screening Material	GWSI_Perforation_Completions	Perf_Material_Code	GWSI_Screen_Materials
Perforation Type	GWSI_Perforation_Completions	Perf_Type_Code	GWSI_Perforation_Types
Length of Perforations	GWSI_Perforation_Completions	Perf_Length	N/A
Width of Perforations	GWSI_Perforation_Completions	Perf_Width	N/A
Last Action Date	GWSI_Perforation_Completions	Perf_Last_Act_Date	N/A
Last Action Operator	GWSI_Perforation_Completions	Perf_Last_Act_Oper	N/A
Discharge Number	GWSI_Flowing_Discharges	Flwd_Id	N/A
Measurement Date	GWSI_Flowing_Discharges	Flwd_Measure_Date	N/A
Discharge Rate	GWSI_Flowing_Discharges	Flwd_Discharge_Rate	N/A
Flowing Discharge Measurement Method	GWSI_Flowing_Discharges	Flwd_Dscmth_Code_Entry	GWSI_Discharge_Methods
Discharge_Data_Source	GWSI_Flowing_Discharges	Flwd_Datasrc_Code_Entry	GWSI_Data_Sources
Last Action Date	GWSI_Flowing_Discharges	Flwd_Last_Act_Date	N/A
Last Action Operator	GWSI_Flowing_Discharges	Flwd_Last_Act_Oper	N/A
Flow Valid Date	GWSI_Flowing_Discharges	Flwd_Date_Valid	N/A
Discharge Number	GWSI_Pumping_Discharges	Pmpd_Id	N/A
Measurement Date	GWSI_Pumping_Discharges	Pmpd_Measure_Date	N/A
Discharge_Rate	GWSI_Pumping_Discharges	Pmpd_Discharge_Rate	N/A
Pumping Discharge Measurement Method	GWSI_Pumping_Discharges	Pmpd_Pmpdmth_Code_Entry	GWSI_Pump_Discharge_Methods
Discharge Data Source	GWSI_Pumping_Discharges	Pmpd_Data_Source	GWSI_Data_Sources
Production Water Level	GWSI_Pumping_Discharges	Pmpd_Production_Water_Level	N/A
Static Water Level	GWSI_Pumping_Discharges	Pmpd_Static_Water_Level	N/A
Static Water Level Method	GWSI_Pumping_Discharges	Pmpd_Statmth_Code_Entry	GWSI_Static_Methods
Static Water Level Source	GWSI_Pumping_Discharges	Pmpd_Static_Source	GWSI_Data_Sources
Pumping Period	GWSI_Pumping_Discharges	Pmpd_Pumping_Period	N/A
Well Drawdown	GWSI_Pumping_Discharges	Pmpd_Well_Drawdown	N/A
Specific Capacity	GWSI_Pumping_Discharges	Pmpd_Specific_Capacity	N/A
Last Action Date	GWSI_Pumping_Discharges	Pmpd_Last_Act_Date	N/A
Last Action Operator	GWSI_Pumping_Discharges	Pmpd_Last_Act_Oper	N/A
Pumping Valid Date	GWSI_Pumping_Discharges	Pmpd_Date_Valid	N/A
Lift Number	GWSI_Well_Lifts	Wlli_Id	N/A
Lift Inventory Date	GWSI_Well_Lifts	Wlli_Entry	N/A
Lift Type	GWSI_Well_Lifts	Wlli_Type_Code	GWSI_Lift_Types
Lift Power Type	GWSI_Well_Lifts	Wlli_Power_Type	GWSI_Power_Types
Lift Meter Number	GWSI_Well_Lifts	Wlli_Meter_Num	N/A
Power Company	GWSI_Well_Lifts	Wlli_Power_Company	GWSI_Power_Companies
Lift Horsepower	GWSI_Well_Lifts	Wlli_Horsepower	N/A
Lift Account Number	GWSI_Well_Lifts	Wlli_Account_Num	N/A
Lift Power Divider	GWSI_Well_Lifts	Wlli_Divider	N/A
Source of Lift Measurement	GWSI_Well_Lifts	Wlli_Source_Code	GWSI_Data_Sources

Description in GWSI	Table Name	Column Name	Code Lookup Table
Method of Lift Measurement	GWSI_Well_Lifts	Wlli_Method_Code	GWSI_Lift_Measure_Methods
Last Action Date	GWSI_Well_Lifts	Wlli_Last_Act_Date	N/A
Last Action Operator	GWSI_Well_Lifts	Wlli_Last_Act_Oper	N/A
Valid Date	GWSI_Well_Lifts	Wlli_Valid_Date	N/A
Log Type	GWSI_Well_Logs	Wllo_Logtyp_Code_Entry	GWSI_Log_Types
Log Start	GWSI_Well_Logs	Wllo_Log_Start	N/A
Log End	GWSI_Well_Logs	Wllo_Log_End	N/A
Source of Log Data	GWSI_Well_Logs	Wllo_Adwrs_Code	GWSI_ADWR_Sources
Last Action Date	GWSI_Well_Logs	Wllo_Last_Act_Date	N/A
Last Action Operator	GWSI_Well_Logs	Wllo_Last_Act_Oper	N/A
Owner Id	GWSI_Well_Owners	Wlow_Id	N/A
Owner Entry Date	GWSI_Well_Owners	Wlow_Entry_Date	N/A
Owners Last Name	GWSI_Well_Owners	Wlow_Last_Name	N/A
Owners First Name	GWSI_Well_Owners	Wlow_First_Name	N/A
Owners Middle Initial	GWSI_Well_Owners	Wlow_Middle_Initial	N/A
Last Action Date	GWSI_Well_Owners	Wlow_Last_Act_Date	N/A
Last Action Operator	GWSI_Well_Owners	Wlow_Last_Act_Oper	N/A
Valid Date	GWSI_Well_Owners	Wlow_Valid_Date	N/A
Other Site Id	GWSI_Owner_Site_Names	Owns_Other_Id	N/A
Other Site Name Assigner	GWSI_Owner_Site_Names	Owns_Assigner	N/A
Last Action Date	GWSI_Owner_Site_Names	Owns_Last_Act_Date	N/A
Last Action Operator	GWSI_Owner_Site_Names	Owns_Last_Act_Oper	N/A
Remarks Id	GWSI_Remarks	Rem_Id	N/A
Remarks Date	GWSI_Remarks	Rem_Remarks_Date	N/A
Remarks	GWSI_Remarks	Rem_Remarks	N/A
Last Action Date	GWSI_Remarks	Rem_Last_Act_Date	N/A
Last Action Operator	GWSI_Remarks	Rem_Last_Act_Oper	N/A
Valid Date	GWSI_Remarks	Rem_Date_Valid	N/A
Site Inventory Id	GWSI_Site_Inventories	Siti_Id	N/A
Site Inventory Date	GWSI_Site_Inventories	Siti_Inventory_Date	N/A
Inventoried By	GWSI_Site_Inventories	Siti_Inventoried_By	N/A
Last Action Date	GWSI_Site_Inventories	Siti_Last_Act_Date	N/A
Last Action Operator	GWSI_Site_Inventories	Siti_Last_Act_Oper	N/A
Valid Date	GWSI_Site_Inventories	Siti_Valid_Date	N/A
Spring Name	GWSI_Spring_Names	Spna_Spring_Name	N/A
Permanence	GWSI_Spring_Names	Spna_Spperm_Code_Entry	GWSI_Spring_Permanences
Type of Spring	GWSI_Spring_Names	Spna_Sptype_Code_Entry	GWSI_Spring_Types
Spring_Improvements	GWSI_Spring_Names	Spna_Spimprv_Code_Entry	GWSI_Spring_Improvements
Last Action Date	GWSI_Spring_Names	Spna_Last_Act_Date	N/A
Last Action_Operator	GWSI_Spring_Names	Spna_Last_Act_Oper	N/A
Water Level Id	GWSI_WW_Levels	Wlwa_Id	N/A
Date Measured	GWSI_WW_Levels	Wlwa_Measurement_Date	N/A

Groundwater Site Inventory (GWSI) Database

Description in GWSI	Table Name	Column Name	Code Lookup Table
Depth to Water	GWSI_WW_Levels	Wlwa_Depth_to_Water	N/A
Water Level Elevation	GWSI_WW_Levels	Wlwa_Water_Level_Elevation	N/A
Method of Water Level Measurement	GWSI_WW_Levels	Wlwa_Remark_Code	GWSI_MM_Codes
Water Level Measurement Remarks	GWSI_WW_Levels	Wlwa_Remark_Code	GWSI_MR_Codes
Unable to Measure (UTM) Remarks	GWSI_WW_Levels	Wlwa_UTM_Code	GWSI_UTM_Codes
Water Level Source Code	GWSI_WW_Levels	Wlwa_Source_Code	GWSI_Data_Sources
Last Action Date	GWSI_WW_Levels	Wlwa_Last_Act_Date	N/A
Last Action Operator	GWSI_WW_Levels	Wlwa_Last_Act_Oper	N/A
Valid Date	GWSI_WW_Levels	Wlwa_Valid_Date	N/A
Water Level Point Id	GWSI_WM_Points	Welm_Id	N/A
Date Established	GWSI_WM_Points	Welm_Date_Measured	N/A
Measuring Point Height	GWSI_WM_Points	Welm_Measure_Point_Height	N/A
Measuring Point Descriptions	GWSI_WM_Points	Welm_Mp_Description	N/A
Last Action Date	GWSI_WM_Points	Welm_Last_Act_Date	N/A
Last Action Operator	GWSI_WM_Points	Welm_Last_Act_Oper	N/A
Valid Date	GWSI_WM_Points	Welm_Date_Valid	N/A
Water Quality Id	GWSI_WQ_Reports	Watq_Id	N/A
Date Collected	GWSI_WQ_Reports	Watq_Date_Measured	N/A
Specific Conductance	GWSI_WQ_Reports	Watq_Specific_Conductance	N/A
Fluoride	GWSI_WQ_Reports	Watq_Fluoride	N/A
Temperature	GWSI_WQ_Reports	Watq_Temperature_Celcius	N/A
pH	GWSI_WQ_Reports	Watq_Ph	N/A
Alkalinity	GWSI_WQ_Reports	Watq_Alkalinity	N/A
Dissolved Oxygen	GWSI_WQ_Reports	Watq_Dissolved_Oxygen	N/A
Last Action Date	GWSI_WQ_Reports	Watq_Last_Act_Date	N/A
Last Action Operator	GWSI_WQ_Reports	Watq_Last_Act_Oper	N/A
Valid Date	GWSI_WQ_Reports	Watq_Date_Valid	N/A

Appendix J : Protocol for Documenting “Unable to Measure” (UTM) in GWSI

History:

Inconsistent practices exist when it comes to documentation of an attempt to measure a Water Level (WL) in a well that results in “Unable to Measure” (UTM). Some staff document the UTM and any notes regarding why a measurement was not possible only in the Index Book on the Water Level Measurements form with no record created in GWSI while others create a record in GWSI with the date entered, no depth-to-water, and enter a Remark such as Well Destroyed and leave Measurement Method to the default, Calibrated Electric Sounder/Tape (V). While other entries in GWSI include the date entered, no depth-to-water, Measurement Method as OTHER (EXPLAIN IN COMMENTS FIELD or UTM Remark) with no Measurement Remark entered and enter a comment in the Comments field. This protocol is intended to clarify the use of the Measurement Method equal to OTHER (EXPLAIN IN COMMENTS FIELD or UTM Remark) and when to use Measurement Remark equal to OTHER, while documenting UTMs consistently.

Explanation:

Measurement Remarks will continue to record the conditions observed in the field in relation to water level measurements. If you attempted a measurement and were UTM for any reason, then you will select the reason from the UTM Remark drop down menu. If the following reasons apply to the attempt: Dry, Obstructed, Measurements Discontinued, Other, Well Destroyed or Well Plugged, you will use the UTM Remark field or the Measurement Remark field to document these conditions and the other field will automatically populate. Do not forget If no measurement attempt was made, then select in Measurement Method dropdown list either OBSERVED, OTHER (EXPLAIN IN COMMENTS FIELD or UTM Remark), or REPORTED.

Examples would include if a well is destroyed and you observed this in the field, select from the Measurement Remark or the UTM Remark dropdown list: Well Destroyed and then select in Measurement Method dropdown list OBSERVED. If you did not verify by observation, then select OTHER (EXPLAIN IN COMMENTS FIELD or UTM Remark) and explain in the comments field. Note, no other Measurement Method would be applicable such as a steel tape method did not determine the well destroyed status.

Another example would be if you used the sounder to determine that a well is dry, select from the Measurement Remark or the UTM Remark dropdown list: DRY and then select in Measurement Method: CALIBRATED ELECTRIC SOUNDER/TAPE (V). There are No changes in these procedures.

If, a pumping water level was obtained, continue to use the Measurement Remarks field to record a pumping water level by selecting PUMPING from the Measurement Remarks drop-down list. The same is true for cascading conditions or surface water effects observed while a measurement was made; again, no change in these procedures. However, if a water level was unobtainable due to cascading then Depth to Water should be left blank and Cascading should be selected in the UTM Remark drop down list, and the measurement method will be selected from the dropdown list.

Step by Step guide:

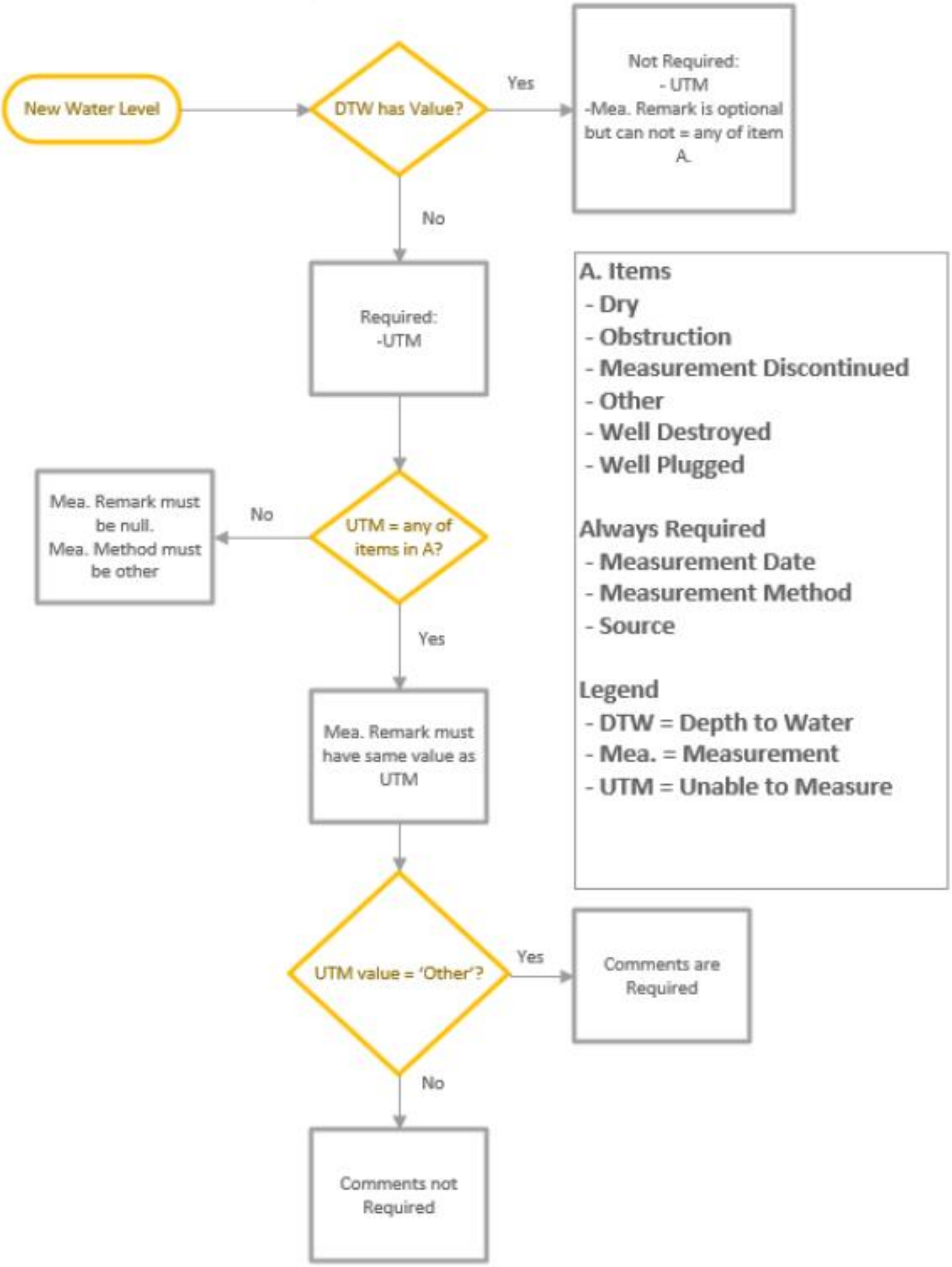
Water level was obtained:

1) Date: DATE you obtained or attempted to get a measurement
2) Depth to Water: Enter DTW below LSD
3) Measurement Method: If no measurement was made and you are entering a remark, then select either OBSERVED or OTHER
4) Measurement Remark: Applicable remark (Clarification: If no measurement was made, depth to water is blank, and Measurement Method equals OTHER, then always make sure that UTM Remark is NOT left blank.)
5) UTM Remark: Applicable remark only if there is no Depth to Water (Clarification: If no measurement was made, depth to water is blank then a selection must be made within UTM Remark. Please note, select the appropriate Measurement Method when the UTM Remark field is populated.)
6) Source of Measurement: ADWR
7) Measurement Operator: Applicable Entry
8) Comments: Comment on what conditions were encountered in the field that may have influenced the water level at the time the measurement was made. Or, special notes on why you got a UTM where applicable.

No water level was obtained (UTM):

1) Date: DATE you obtained or attempted to get a measurement
7) Depth to Water: Leave BLANK
2) Measurement Method: If no measurement was made and you are entering a remark, then select either OBSERVED or OTHER
3) Measurement Remark: Will auto populate based on UTM Remark selection or will be Null
4) UTM Remark: Select from the drop down list the best match for the reason you got a UTM if no selection in the list applies to the reason select UTM Remark of "OTHER" and then explain in the comments field.
5) Source of Measurement: ADWR
6) Measurement Operator: Applicable Entry
7) Comments: Use this field if greater detail is needed to explain the UTM or if Measurement Method of "OTHER" is selected.

UTM flow chart:



By following this protocol, we will gain consistency in documenting and recording in GWSI when a site is visited, and an attempt was made to make a measurement; however, no measurement was possible. Entering this information in GWSI will provide documentation that a site was visited and allow for quick review of conditions encountered at the site for any given time.

UTM codes and definition:

1) BEES (BE) - There are bees near the site or in the well that pose a risk to the safety of a field personnel.
2) CASCADING WATER (K) - Water was cascading down the well from some point above the water table that prevents an accurate measurement.
3) DRY (D) - The site was dry and no water level could be obtained.
4) LOCKED GATE (LG) - A locked gate prevented access to a site.
5) LOCKED WELL SITE (LS) - A measurement can not be obtained due to a locked building, structure, well cap, or MP.
6) MEASUREMENTS DISCONTINUED (N) - Measurements are discontinued at the site.
7) NO CONTACT (NC) - A water level was not obtained due to the necessity to contact the owner, business, or property before a water level is to be obtained.
8) NO MP ACCESS (MP) - A water level can not be obtained because there is no equipment access at the site to gain access to the water table.
9) NO PERMISSION (NP) - An owner or responsible party has denied and/or refused access to the site or water table.
10) NO SITE ACCESS (NA) - Something that hinders, impedes, and prevents getting to the site and cannot be defined by any other UTM Remark.
11) OBSTRUCTION (O) - A blockage in the well prevents a water level from being obtained.
12) OIL (V) - Oil located on the surface of the water table has prevented an accurate water level from being obtained.
13) OTHER (Z) - Any site visit where a measurement was not obtained and can not be defined by any other UTM Remark.
14) PUMPING (P) - The site is being pumped at time of measurement.
15) ROAD CONDITION (RC) - All roads or drivable paths to a site are unsafe for equipment or personnel.
16) SITE HAZARD (SH) - The environment at or around the site pose a risk to personnel and cannot be defined by any other UTM Remark.
17) UNABLE TO LOCATE (UL) - The site location cannot be verified and/or there is no site at the best-known location.
18) WELL DESTROYED (W) - The well hole and casing has been destroyed and any future water levels would be impossible.
19) WELL PLUGGED (M) - Well has visible cement, debris, dirt, or other material blocking access to the water table and is not in hydraulic contact with formation. However, a well casing is still visible.

Groundwater Site Inventory (GWSI) Database

Appendix K : Validation Instructions for Site Inventory Sheets

Validator: Mark in red all corrections on site inventory sheet. Mark in pencil all fields needed to be checked by staff. Once the inventory sheet has been reviewed, if there are corrections to be made in GWSI or info to be checked, return the sheet to field staff. They will make any corrections needed in GWSI and return the Inventory Sheet to you for review once again. Once all corrections have been made, then initial-date in the Validated By space at end of the sheet.

General Instructions:

☐ Check that all information (fields) on Inventory Sheet match what is in GWSI. For ex., check that the lat/long on the Inventory Sheet is typed the same in GWSI; do this for everything.
☐ Check all Site Detail fields for consistency and reasonability on all tabs.
☐ Check the cadastral format in GWSI is correct; no extra spaces or missing – dashes, etc.
☐ Check that GWSI Report and any imaged records are attached to Inventory Sheet before filing in Master File.

Specific Instructions:

☐ Check that the latitude/longitude on the Sheet matches what's in GWSI.
☐ Check Local ID (cadastral) and compare with topo map well mark; is the cadastral correct based on topo map check?
☐ Check 55 Reg ID matched correctly? Is 55 imaged record attached?
☐ Check other fields and see if they make sense such as Accuracy and Methods are reasonable.
☐ Is the Altitude reasonable and does it match what's in GWSI?
☐ Does the Water and Site Use match the Sheet?
☐ Right Basin, State, County?
☐ Check Source is correct.
☐ Check Lift Tab- entered correctly?
☐ Check Owner Tab is entered correctly.
☐ Check Site Names Tab if Other Site is filled out on Sheet.
☐ Check WM Points Tab if MP is filled out.
☐ Check WW Levels Tab if water level is filled out on Sheet.
☐ Check Images Tab if Pictures is marked Y on Sheet.
☐ Check MISC form Drillers Tab is completed if known.
☐ Check COMP form and Well, Borehole, Casing, Perforation tabs are filled out correctly from attached driller's report/log.
☐ Check MISC form and Site Inventories tab is filled out correctly using this format:
Inventoried By: Last Name, Initial For example (Perez, MK)

Groundwater Site Inventory (GWSI) Database

Appendix L : Well Matching Check List

1) Does WELLS55 have a GWSI ID matched to registry number REG ID?

- Check WELLS55WEB,
- Check GWSIWEB,
- Check Access DB table named: WELLS.OTHER_NAMES_IDS
- Check Access DB table named: GWSI_OWNER_SITE_NAMES
- Check in GWSI App (aka PENTAB)
- Check in WELLS55 Browser

a. If “Yes” then **verify** match and **document verified match**

- To document a match use table named: WELLS REVISED Tab; Well Names/Ids form

b. If “No” continue

2) If WELLS55 has no GWSI ID then search for wells near Cadastral for possible match. Can a match be found by searching wells nearby Local ID?

- Check WELLS55WEB,
- Check GWSIWEB,
- Check County Assessor Records
- You can create an Arcmap project to assist you.

a. If “Yes” then **verify** match and **document verified match**

- To document a match use table named: WELLS REVISED Tab; Well Names/Ids form

b. If “No” continue

3) If maps do not work then look at well construction. Can a match be found by searching wells with similar construction?

- Check Access DB tables by filtering for unique well construction such as a date, hole depth, well depth or diameter. Again, always look at scanned images of WELLS files and if a 35 match then WELLS35 Driller’s Logs.

a. If “Yes” then **verify** match and **document verified match**

- To document a match use table named: WELLS REVISED Tab; Well Names/Ids form

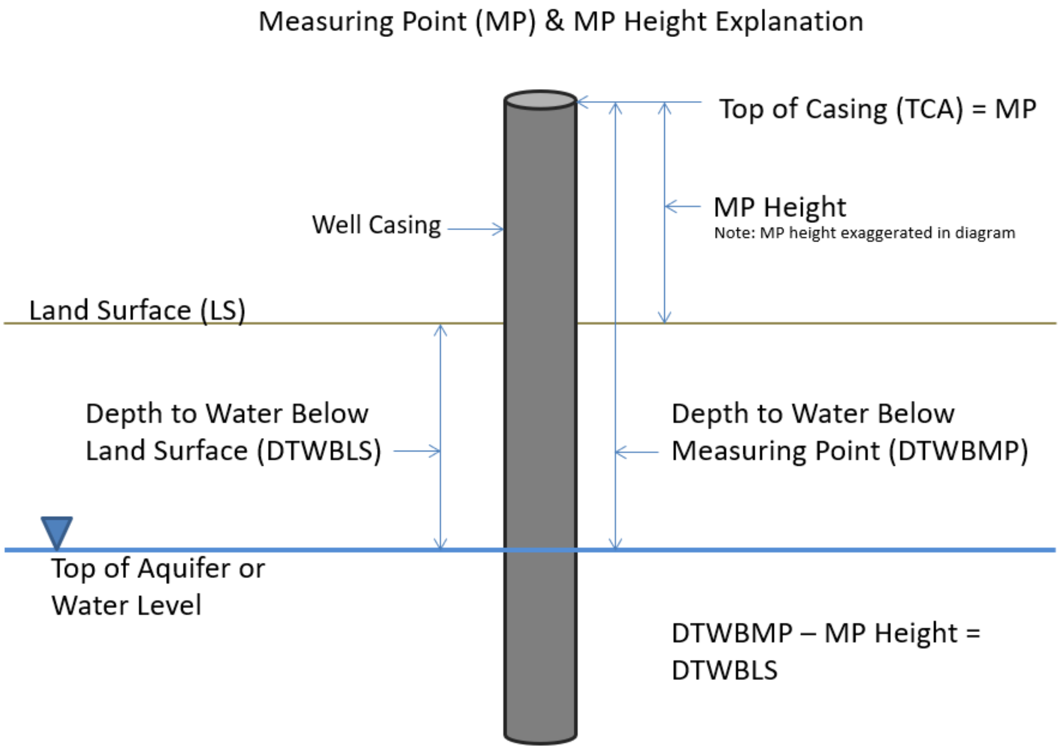
b. If “No” continue

4) If construction does not work then look at well owner. Can a match be found by searching wells with similar owners?

- Check Access DB tables by filtering for owners. Again always look at scanned images of WELLS files and if a 35 match then WELLS35 Driller’s Logs.
- Check County Assessor Records
- Check WELLS55WEB,
- Check GWSIWEB,
- Check PERTRACK

a. If “Yes” then verify match and document verified match

- To document a match use table named: WELLS REVISED Tab; Well Names/Ids form

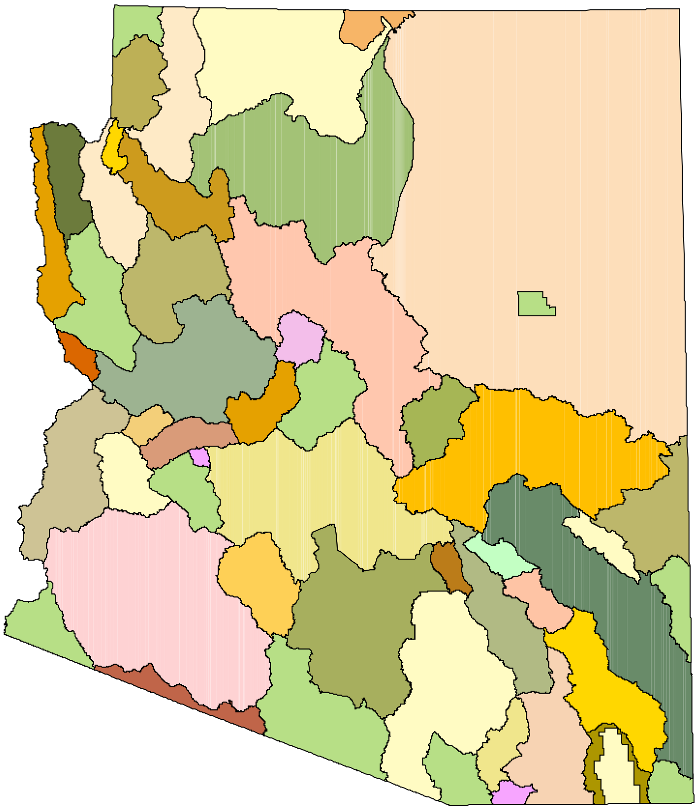


Measuring Point (MP) & MP Height Explanation

The Depth to Water (DTW) to be reported in the 3rd Party Water Level Portal is below Land Surface (LS) which equals the difference between the DTW below the Measuring Point (MP) and the MP Height.

Figure 10. Measuring Point Description

ARIZONA DEPARTMENT OF WATER RESOURCES



GROUNDWATER SITE INVENTORY (GWSI) DATABASE HANDBOOK

HYDROLOGY DIVISION

2020

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Introduction

The Groundwater Site Inventory (GWSI) database is ADWR's main repository for state-wide groundwater data. The GWSI consists of field-verified data regarding wells and springs collected by personnel from Hydrology Division's Field Services Section, the U.S. Geological Survey, and other co-operating agencies. The information in GWSI is constantly being updated by ongoing field investigations and through a state-wide network of water level and water quality monitoring sites.

This handbook has been developed for use by both the Field Services section and other Department personnel. With the Department's move to a PC based client–server network, the data in GWSI have become more readily available to everyone within the Department. This handbook has been developed to help department personnel understand the GWSI database system, the data available in the system, and how the different data tables in the system can be used to extract meaningful information from the GWSI.

The GWSI data reside in 17 separate ORACLE data tables, with each table containing a unique set of data. For example, the SITES data table contains the cadastral location (township, range, section, and quarter, quarter, quarter section), latitude/longitude, site elevation, well use, well depth, and other general information for each GWSI site. There are also a number of other tables in the GWSI database. These tables contain letter codes associated with fields in the main GWSI data tables and other data related to the GWSI system. A full list of the main GWSI data tables, along with a brief description of the data they contain, is presented throughout this document.

Each data site in GWSI is assigned a unique 15-character identification number, the SITE ID, which is a common field in all the GWSI data tables. All the information available for a specific site can be obtained by using the SITE ID number. Site specific information can be accessed by using either the ORACLE Application Forms or a relational database query tool such as ORACLE Browser, Access, or Paradox. The SITES data table is the main data table in the GWSI system and can be linked to other GWSI tables using the SITE ID when using relational database query tools. Data in any of the GWSI tables can be retrieved for any given geographic area using the townships and ranges, groundwater area designations, latitudes and longitudes, or UTM coordinates located in the SITES data table. In addition to the data tables, there is an ORACLE view, the TRS view, that can be used to aid in designing queries based on a site's township, range, and section.

Listed below are the commonly used GWSI data tables and a general description of the information available in each table. The main body of this report presents each data table and lists each field in the table, then the acceptable codes for each field are listed and explained.

Table Name	**Table Description**
Sites	General Location Data, Well Depth, Well Altitude, and Water Use Data
Well_Completions	Well Construction and Finish Data, Driller’s Name, and Completion Date
Bore_Completions	Bore Hole Data
Casing_Completions	Well Casing Data
Perforation_Completions	Well Casing Perforation Data
Flowing_Discharges	Flowing Discharge Data – for flowing wells and springs
Pumping_Discharges	Instantaneous Pumped Discharges from Wells
Well_Lifts	Well Lift (Pump) Data
Well_Logs	Well Log Data
Well_Owners	Well Ownership Data
Owner_Site_Names	Other Well Identification Data
Remarks	Pertinent Notes about Site
Site_Inventories	Personnel Who Inventoried Site
Spring_Names	Name of Spring and other Data Pertaining to the Spring (if Site is a Spring)
WW_Levels	Historic Water Level Measurements
WQ_Reports	Water Quality Data
WM_Points	Well Measurement Height and Location point
TRS	ORACLE View with Local Id broken into Quadrant, Township, and Range – used for queries based on township and range.

Site Detail (GWSI_SITES)

The SITES data table is used for recording general information about the site, including location information, general well construction, and well use information. The SITES data table is the main table in the GWSI system. All other GWSI tables are linked to it by the Site ID field.

Location

Latitude / Longitude:

(GWSI_SITES . SITE_LATIT_DEGREE, SITE_LATIT_MIN, SITE_LATIT_SEC)

(GWSI_SITES . SITE_LONGIT_DEGREE, SITE_LONGIT_MIN, SITE_LONGIT_SEC)

The three latitude fields and the three longitude fields contain the best available value for the latitude and longitude of the site in degrees, minutes, and seconds. The position of the site must be measured in the field by global positioning system (G.P.S.) equipment if available. The longitude and latitude can be determined, if needed, from a map or orthophoto by the field person in the office. Each value for the degrees, minutes and seconds should be entered in the appropriate field.

Latitude/Longitude Measurement Accuracy:

(GWSI_SITES . SITE_LLACCR_CODE_ENTRY)

(CODE LOOKUP TABLE: GWSI_LON_LAT_ACCURACIES)

This field records the accuracy of the latitude/longitude location for the site. Once the GPS accuracy is determined the field person will indicate the appropriate accuracy in this data field. For alternative methods, in general, a site can be located to within five seconds on a map, two seconds on an orthophoto with a template, and one second if it is digitized. The appropriate codes are listed below:

1 – ± 0.1 seconds

2 - ± 2 seconds

5 – ± 0.5 seconds

B – ± 0.2 seconds

O – ± 0.001 seconds

Q – ± 0.4 seconds

R – ± 3 seconds

S – ± 1 second

Latitude/Longitude Measurement Accuracy cont.:

F – ± 5 seconds

H – ± 0.01 seconds

M – ± 1 minute

T – ± 10 seconds

U – Undetermined

V – ± 0.005 seconds

Latitude/Longitude Measurement Method:

(GWSI_SITES . SITE_LATLONG_METH_CODE)

(CODE LOOKUP TABLE: GWSI_LATLONG_METHOD_CODES)

This field records the method used to determine the latitude and longitude of the site.

C – Calculated from Land Net

D – Differential Global Positioning System (DGPS)

E – Reported

F – Calculated from Cadastral

G – Global Positioning System (GPS)

H – Reported by Source Agency

K – Post-Processed Static Survey System

L – Long-Range Navigation System

M – Interpolated from Map

N – Interpolated from Digital Map

O – Other

P – Photo

R – Real-Time Kinematic GPS Position

U – Unknown Source

V – Instrument Survey Method

X – Visually Interpolated from USGS 7.5’ Map

Y – Calculated Using GIS TRS Cover

Latitude/Longitude Measurement Datum:

(GWSI_SITES.SITE_LATLONG_DATUM_CODE)

(CODE LOOKUP TABLE: GWSI_DATUM_CODES)

This field records the datum used to determine the latitude/longitude of the site. GWSI uses NAD-27 (North American Datum of 1927). The only datums that can be converted on output are

NAD27 (North American Datum of 1927) and NAD83 (North American Datum of 1983). GWSI uses the North American Datum Conversions (NADCON) of the National Geodetic Survey to convert from NAD27 to NAD83 or vice-versa.

Latitude/Longitude Measurement Datum:

A – NGVD 29
B – NAVD 88
C – WGS 84
D – NAD 27
E – NAD 83
F – NAD 83 Harn
O – Other
Z – UNKNOWN

Latitude/Longitude Measurement Date:

(GWSI_SITES . SITE_LATLONG_MEASURE_DATE)

(CODE LOOKUP TABLE: N/A)

This field records the date on which the latitude and longitude were measured in the format M/D/YYYY.

Latitude/Longitude Measurement Source:

(GWSI_SITES . SITE_LATLONG_SOURCE_CODE)

(CODE LOOKUP TABLE: GWSI_SITE_SOURCES)

This field contains the agency that took the latitude and longitude measurement, usually ADWR or DRILR.

ADWR – Arizona Department of Water Resources
DRILR – Driller
USBR – U.S. Bureau of Reclamation
USGS – U.S. Geological Survey

GWSI Site

Local ID:

(GWSI_SITES . SITE_LOCAL_ID)

(CODE LOOKUP TABLE: N/A)

The well numbers and letters used by the Geological Survey in Arizona are in accordance with the Bureau of Land Management's system of land subdivision. The land survey in Arizona is based on the Gila and Salt River Baseline and Meridian, which divide the state into four quadrants. These quadrants are designated **A**, **B**, **C**, and **D** in a counterclockwise direction starting in the upper right-hand corner, as shown in Figure 1, below. All land with both north *Townships* and east *Ranges* is in the **A** quadrant, north *Townships* and west *Ranges* are in the **B** quadrant, south *Townships* and west *Ranges* is in the **C** quadrant, and south *Townships* and east *Ranges* is in the **D** quadrant.

The first two-digit number in the cadastral location is the *Township*, the second is the *Range*, and the third is the *Section* in which the site is located. The letters following the section number indicate the well location within the section. The first letter indicates the 160-acre quarter section, the second letter the 40-acre quarter-quarter section, and the third letter the 10-acre quarter-quarter-quarter section. These letters are also assigned in a counterclockwise direction, beginning with the northeast quarter of the section.

For example, a well with the cadastral location **D-04-05 16CAA** is located in *Township* 4 South, *Range* 5 East, *Section* 16 in the southwest quarter section, the northeast quarter-quarter section, and the northeast quarter-quarter-quarter section. Leading zeros are included in the township, range, and section numbers. If more than one well or site is located within a 10-acre tract, consecutive numbers beginning with 1 are added as suffixes, with the oldest known well labeled as 1.

Piezometer nests have a unique convention where the "primary hole" will be assigned a Local ID without any suffix, and each of the individual piezometers will be assigned a suffix consisting of a single space plus a PZ number of PZ1, PZ2 or PZ3, and so on. The PZ number needs to match the last number the piezometer was assigned in the site ID. For example, if the SITE ID for a piezometer ends with 01, the PZ will be PZ1 and the Local ID would be A-00-00 00AAA PZ1.

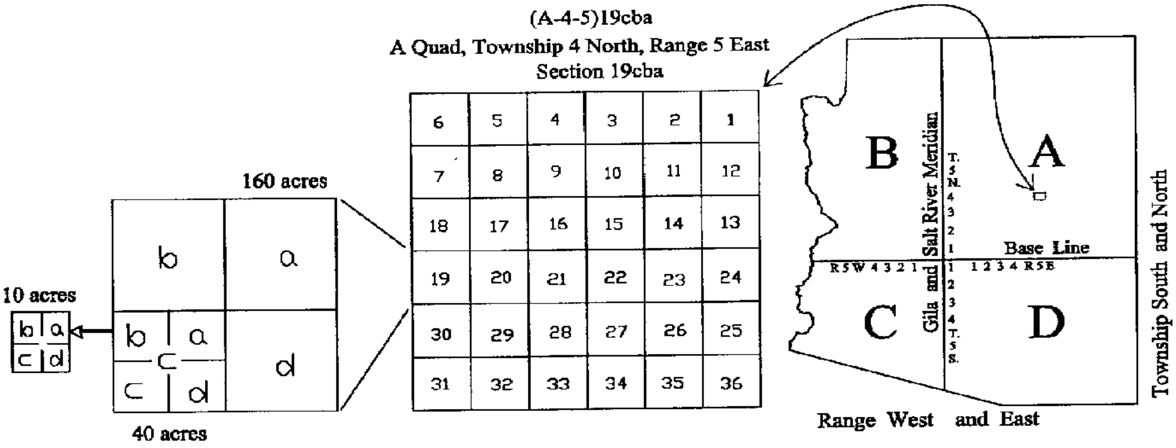


Figure 1 – Arizona Well numbering System

Oversized sections occur in several areas of the state. If a section is more than a mile in the north/south or east/west dimension, the excess area is considered a part of that section and has the same section number. A control corner is established for the section on the section corner that is closest to the center of the township (see Figures 2a and 2b). The oversized section is divided so that a full square-mile unit is adjacent to the control corner, and the rest of the section is considered a separate unit of land. Appropriate N, S, E, W, or X letters are assigned to the separate units of land depending on where they lie in relation to the full square-mile land unit. A well is designated with the appropriate letter following the section number in which the well is located.

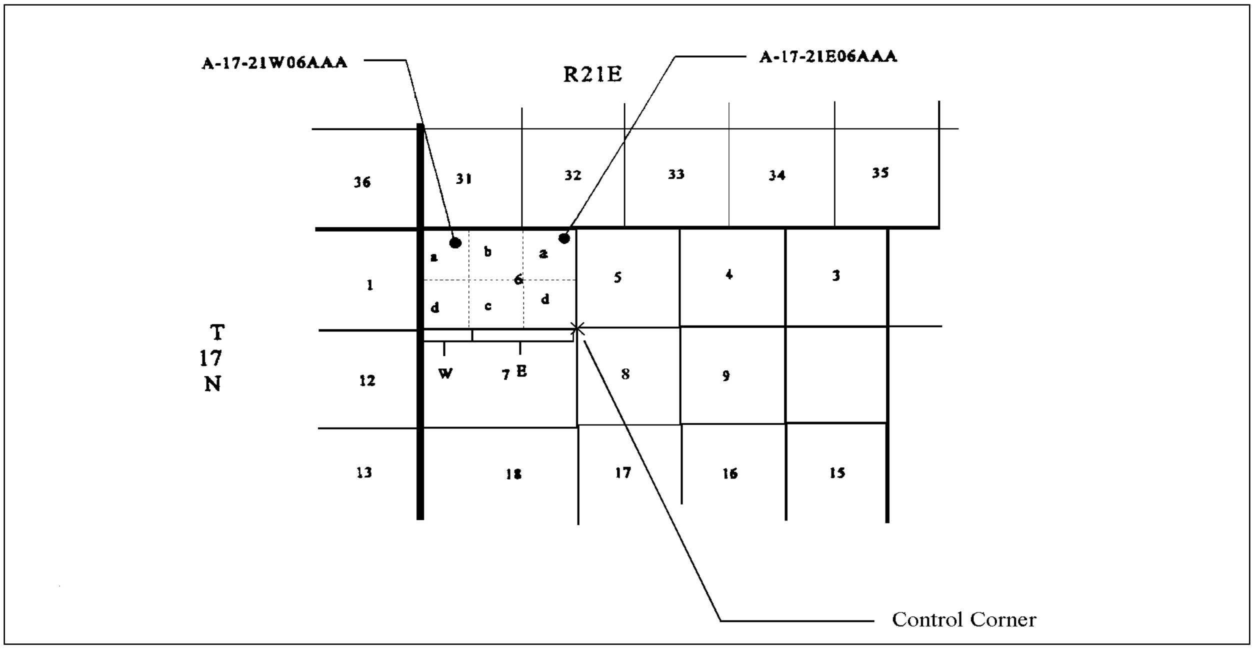


Figure 2a Cadastral Location of over-sized section in one direction

For example, in Figure 2a, the section is over-sized in only one direction (East-West). Well A-17-21E06AAA is in the northeast quarter, of the northeast quarter, of the northeast quarter, of the *eastern* unit of Section 6, Township 17 North, Range 21 East. The well location is determined by placing the lower right-hand corner of the map locator on the control corner and reading the location within the full-sized section of land. The location of well A-17-21W06AAA is determined by moving the lower right-hand corner of the map locator to the lower right-hand corner of the *western* unit of Section 6 and reading the location within the over-sized unit of land (Figure 2a). Sections that are over-sized in the north-south direction use the same general procedure.

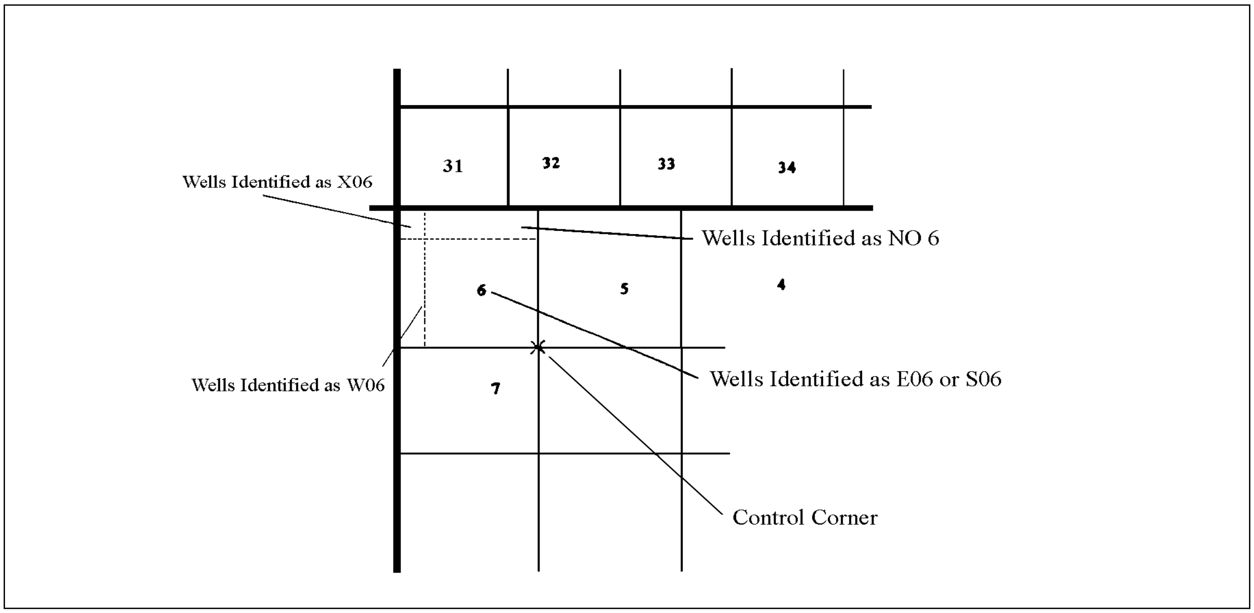


Figure 2b Cadastral Locations of over-sized section in two directions

Figure 2b illustrates how wells are identified for sections that are over-sized in both east-west and north-south directions. Wells in the full section can be identified as being in either the *eastern* or *southern* unit of Section 6. A well located in the unit of land north of the full section is in the *northern* unit, and a well located in the unit of land to the west of the full unit is in the *western* unit of section six. A well in the small unit of land to the *north* and *west* of the full section uses an X as identifier, for example, X06 (Figure 2b).

Some areas of the state have half townships and half ranges. Half township and half ranges are designated by the letter **H** following the township or range. In some areas of the state, survey lines have not been established. Sites in these areas have the suffix UNSURV in the last six spaces of the LOCAL ID field to indicate that the location is in an unsurveyed area. The cadastral location of a site in an unsurveyed area may not be as accurate as in a surveyed area and may only be identified to the 160 or 40-acre location.

Listed below are examples of some typical cadastral locations:

A-09-12 19ADD2	A-10H05 06ACD
D-05-04N27CDD	B-24-12 13BA UNSURV

A different numbering system is used to locate GWSI sites on the Navajo and Hopi Indian Reservations. The Navajo Indian Reservation is divided into 17 administrative districts, numbered 1 to 5 and 7 to 18, and the Hopi Indian Reservation comprises District 6. The Reservation is further divided into 15-minute quadrangles arbitrarily numbered from 1 to 151, starting in the northeast corner of the area and numbering consecutively in a row from east to west. Within the 15-minute quadrangle, a site is located in miles south and west from the northeast corner of the quadrangle. The first two numbers in the well number represent the district, the next three numbers are the quadrangle, the decimal numbers are miles west by (X) miles south of the northeast corner of the quadrangle. For example, the site identified as 02 021-05.28X10.68 identifies a well that is in district 2, quadrangle 21, and is 5.28 miles west by 10.68 miles south of the northeast corner of the map.

GWSI sites located in California, New Mexico, Nevada, and Utah use different baselines and meridians. Cadastral identifications for non-Arizona GWSI sites are presented in Appendix H. The complete list of land net meridians is listed below. Some land in Arizona falls in the California Survey, because changes in the Colorado River have left parts of California on the Arizona side of the river.

Local ID Date:

(GWSI_SITES . SITE_LOCAL_ID_MEASURE_DATE)

(CODE LOOKUP TABLE: N/A)

This field records the date on which the local ID was determined in the format M/D/YYYY.

Local ID Source:

(GWSI_SITES . SITE_LOCAL_ID_SOURCE_CODE)

(CODE LOOKUP TABLE: GWSI_SITE_SOURCES)

This field contains the agency that determined the Local ID, usually ADWR or DRILR.

Local ID Source cont :

ADWR – Arizona Department of Water Resources

DRILR – Driller

USBR – U.S. Bureau of Reclamation

USGS – U.S. Geological Survey

Site Address:

The address associated with the site location can be documented in Site Remarks.

Reliability:

(GWSI_SITES . SITE_RELY_CODE_ENTRY)

(CODE LOOKUP TABLE: GWSI_RELIABILITIES)

This field is used to describe the reliability of the data available for the site.

C – Field Checked. The data have been field checked by the reporting agency.

L – Location Not Accurate. Location of the latitude and/or longitude is not accurate.

M – Minimal Data. Used when modifying an existing record when the investigator is unsure if the site has been field checked.

U – Unchecked. The data have not been field checked by the reporting agency, but the reporting agency considers the data reliable.

Topo Setting:

(GWSI_SITES . SITE_TOPOSET_CODE_ENTRY)

(CODE LOOKUP TABLE: GWSI_TOPO_SETTINGS)

The Topographic Setting field contains codes that best describe the topographic setting of the area in which the site is located. A sketch of the various topographic settings is shown in Figure 3.

A – **Alluvial Fan.** Refers to a sloping mass of material, shaped like an open fan or cone, deposited by a stream or wash at a place where it issues from a narrow mountain valley onto a plain or broad valley.

B – **Playa.** Refers to a dried-up, vegetation-free, flat-floored area composed of thin, evenly stratified sheets of fine clay, silt, or sand, that represents the bottom of a shallow, enclosed or undrained desert lake basin in which water accumulates and is quickly evaporated, usually leaving deposits of soluble salts.

C – **Stream Channel.** Refers to the bed in which a natural stream of water runs. The stream may be perennial, intermittent, or ephemeral. The term includes washes, arroyos, and coulees.

D – **Local Depression.** Refers to an area that has no external surface drainage. Depressions can range from a few acres to several square miles and should be considered local features. Do not use for regional features such as the large closed basins found in the Basin and Range province, or on the undulating surface of glacial drift (use undulating).

E – **Dunes.** Refers to mounds or ridges of windblown, or eolian sand. This term should not be used for an isolated mound unless it has a rather extensive area and is of hydrologic significance to the site.

F – **Flat Surface.** Refers to a flat surface that may be part of a larger feature, such as an upland flat, mesa or plateau, coastal plain, lake plain, or pediment. Terraces and valley flats, which are special varieties of flat surfaces, are classified separately.

G – **Floodplain.** Refers to the surface or strip of relatively smooth land adjacent to a river channel, constructed by the present river in its existing flow regime and covered with water when the river overflows its banks at flood stage.

H – **Hilltop.** A hilltop is the upper part of a hill or ridge above a well-defined break in slope.

Topo setting cont.:

K – **Sinkhole.** A sinkhole is a special type of depression that results from the dissolution of soluble rock (salt, gypsum, limestone) and the subsequent collapse of the earth into the solution cavity.

L – **Lake, Swamp, or Marsh.** This code stands for any inland body of water where the ground may be saturated, or water may stand above the land surface for an extended period of time.

M – **Mangrove Swamp.** Refers to a tropical or subtropical marine swamp containing abundant mangrove trees.

P – **Pediment.** Refers to a plain of combined erosional material that forms at the foot of a mountain range.

S – **Hillside.** Refers to the sloping side of a hill, i.e., the area between a hilltop and valley flat.

T – **Terrace.** Refers to an alluvial or marine terrace that is generally a flat surface, usually parallel to but elevated above a stream valley or coastline. Due to the effects of erosion, the terrace surface may not be as smooth as a valley flat, and within the general terrace area there may be undulating areas.

U – **Undulating.** Refers to topography characteristic of areas which have many small depressions and low mounds. An undulating surface is primarily a depositional feature, not an erosional one. The term should not be used for areas that have a slightly irregular shape due to erosion.

V – **Valley Flat.** Refers to a low flat area between valley walls and bordering a stream channel. It includes the stream floodplain and is generally the flattest area in the valley. A valley flat may have a slight slope towards the main drainage, towards the valley walls, or may be cut by smaller streams. Typically, the valley flat is separated from alluvial terraces or the upland by a pronounced break in slope.

W – **Upland Draw.** Refers to a small natural drainage or depression, usually dry, on a hillside or upland area.

* – **Undetermined.**

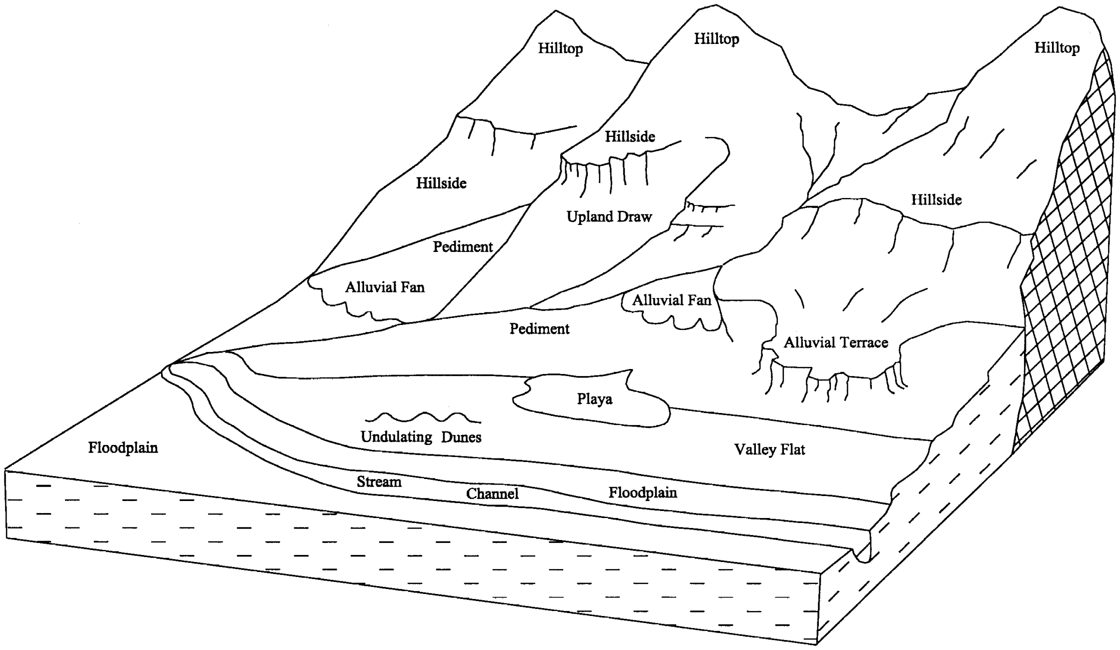


Figure 3. Diagrammatic sketch of Topographic features.

Figure 3. Diagrammatic sketch of Topographic features.

Quad Name:

(GWSI_SITES . SITE_TQNAM_QUAD_NAME)

(CODE LOOKUP TABLE: N/A)

This field contains the name of the U.S. Geological Survey Topographic Quadrangle map on which the site is located. Use the drop-down list to select the proper map name.

Map Scale:

(GWSI_SITES . SITE_MAP_SCALE)

(CODE LOOKUP TABLE: N/A)

This field records the scale of the topographic quadrangle map on which the site is located.

Site ID:

(GWSI_SITES . SITE_WELL_SITE_ID)

(CODE LOOKUP TABLE: N/A)

This field contains the 15-digit identification number assigned to the site. The SITE ID contains no blanks or alphabetic characters. It is used as a unique identification number that allows users to link records in the SITES data table with records in other GWSI data tables. By linking across to other GWSI data tables, all of the data for one specific site can be retrieved. Although the Site Identification Number is derived initially from the latitude and longitude of the site, the number is a unique ***identifier*** and not a ***locator***. It cannot be too strongly emphasized that the site identification number, once assigned, is a pure number and has no locational significance. The site identification number never changes once it is established except under unusual conditions.

The site identification number is automatically derived from the original latitude and longitude acquired when the site was first inventoried. The location of this point is always scaled to the nearest second of latitude and longitude, even if there is doubt as to the exact location of the site or the accuracy of the map. The first six digits of the site identification number are the value of the latitude, the seventh through thirteenth digits are the value of the longitude, and the value 01 is used for the fourteenth and fifteenth numbers. Leading zeros are used if the value of the minutes, or seconds of the latitude or longitude is less than 10, for example, 01, 02, ...09. No blanks or alphabetic letters are to be used in the Site ID. The site identification number usually ends in 01; however, specific instances require sequential numbers such as, 00, 02, 03, ..., are assigned to these last two digits. Generally, this happens when more than one well occupies the same latitude and longitude, commonly occurring in nested piezometers.

With piezometers, the hole and casing that contains the nested piezometers (primary hole), is assigned a site identification that meets the minimum site requirements, and the site identification will end in 00 but will have no water levels associated with it. Each piezometer or casing in the nest then has its own unique site identification meeting minimum site requirements and will contain detailed construction information (perforations, etc.), water levels, and a measuring point for each of the inner casings. Latitude and longitude for each piezometer and the “primary hole” is the same down to the Second. The “primary hole” and the piezometer’s site identifications share the same first 13 characters in the site identification and require that each piezometer is assigned a unique identification ending in 01, 02, 03, and so on while the “primary hole” ends in “00” as stated above.

Well Reg. ID:

(GWSI_SITES . SITE_WELL_REG_ID)

(CODE LOOKUP TABLE: (WELLS . WELL_REGISTRY)

This field contains the State Well Registration (55) number of the well, if the site can be positively matched to a registered well. The 55 number is matched with a GWSI well only when the field investigator is positive that the wells are the same. If there is any doubt about the match, the 55 number is not entered until those doubts are resolved.

Site Type:

(GWSI_SITES . SITE_SITTYP_CODE_ENTRY)

(CODE LOOKUP TABLE: GWSI_SITE_TYPES)

This field is used to describe what is at the location of the site. Generally, ADWR is interested only in wells and springs, however, several different types of sites have been entered in the past. The site codes and their descriptions are listed below.

C – Collector or Ranney type well.

D – Drain dug to intercept the water table or potentiometric surface to either lower the water table or serve as a water supply.

E – Excavation

G – Gravity data

M – Multiple Wells. Used for well fields consisting of a group of wells that are pumped through a single header and for which little or no data are available. available.

S – Spring

Site Type, cont.:

T – Tunnel or Shaft. Tunnel, shaft, or mine from which groundwater is obtained.

W – Well. For single wells other than wells of the collector or Ranney type.

X – GPS data

Y – Stream flow

Meridian:

(GWSI_SITES . SITE_MERIDIAN)

(CODE LOOKUP TABLE: N/A)

This field records the land net meridian that is used to establish the Local ID or cadastral location of the site. In general, all sites located in Arizona, except those on the Navajo and Hopi Indian Reservation, use the Gila and Salt River Meridian and Baseline. There are six meridian codes in GWSI.

B – San Bernardino Meridian and Baseline

D – Mount Diablo Meridian and Baseline

G – Gila and Salt River Meridian and Baseline

N – Navajo Meridian and Baseline

P – New Mexico Principal Meridian and Baseline

S – Salt Lake Meridian and Baseline

Basin/Location

USGS Basin:

(GWSI_SITES . SITE_USBASN_CODE_ENTRY)

(CODE LOOKUP TABLE: GWSI_USGS_BASINS)

This field contains the appropriate three letter code for the U S Geological Survey groundwater area in which the site is located. See Appendix C, which contains the USGS area codes.

ADWR Sub-Basin:

(GWSI_SITES . SITE_ADWBAS_CODE_ENTRY)

(CODE LOOKUP TABLE: GWSI_ADWR_BASINS)

Many of the ADWR groundwater basins and AMAs are subdivided into smaller sub-basins, based on hydrologic conditions. This field contains the appropriate three letter code for the ADWR designated groundwater sub-basin. For sites that are in basins or AMAs with no Sub-basins, i.e., non-subdivided basins, the three-letter basin or AMA code is entered into this field. Sites that are located in Irrigation Non-Expansion Areas (INAs) have the three-letter INA code entered into this field. See Appendix B, which contains the ADWR Basin, Sub-basin, AMA, and INA Codes.

ADWR Basin:

(GWSI_SITES . SITE_AMA_CODE_ENTRY)

(CODE LOOKUP TABLE: GWSI_AMA_CODES)

This field contains the appropriate letter code for the ADWR groundwater basin or Active Management Area (AMA) in which the site is located. For sites that are in either subdivided or non-subdivided basins, the appropriate basin code is entered into this field. For sites that are in Active Management Areas (AMAs), the appropriate AMA code is entered. Sites that are located in Irrigation Non-Expansion Areas (INAs) have the three-letter code of the groundwater basin within which the INA occurs entered in this field, and the three letter INA code entered into the ADWR Sub-basin field. See Appendix B for the appropriate ADWR Basin, Sub-basin, AMA, and INA Codes.

State:

(GWSI_SITES . SITE_STATE_CODE_ENTRY)

(CODE LOOKUP TABLE: GWSI_STATES)

This field contains the appropriate letter code for the state in which the site is located.

AZ – Arizona
CA – California
CO – Colorado
NM – New Mexico
NV – Nevada
SO – Sonora
UT – Utah

County:

(GWSI_SITES . SITE_CNTY_CODE)

(CODE LOOKUP TABLE: GWSI_COUNTYS)

This field contains the appropriate numeric code for the county in which the site is located.

Arizona

01 – Apache
03 – Cochise
05 – Coconino
07 – Gila
09 – Graham
11 – Greenlee
12 – La Paz
13 – Maricopa
15 – Mohave
17 – Navajo
19 – Pima
21 – Pinal
23 – Santa Cruz
25 – Yavapai
27 – Yuma

New Mexico

03 – Catron
17 – Grant
23 – Hidalgo
31 – McKinley
45 – San Juan
61 – Valencia

Nevada

03 – Clark

Utah

25 – Kane

California

25 – Imperial
65 – Riverside
71 – San Bernardino

Colorado

83 – Montezuma

Well Info

Hole Depth:

(GWSI_SITES . SITE_HOLE_DEPTH)

(CODE LOOKUP TABLE: N/A)

This field records the total depth to which the hole was drilled in feet, below the land surface datum, even though it may have been plugged back in completing the well. For collector or Ranney-type wells, the depth of the central shaft should be entered. For multiple-well fields, ponds, tunnels, springs, or drains, the field should be blank. If the hole depth is given, all other depths associated with the site will be compared with it for validity.

Well Depth:

(GWSI_SITES . SITE_WELL_DEPTH)

(CODE LOOKUP TABLE: N/A)

This field contains the depth of the finished, or cased, portion of the well in feet below land surface datum. The depth of the well is usually taken from the completed well drillers report.

Depth Src:

(GWSI_SITES . SITE_ADWRS_CODE)

(CODE LOOKUP TABLE: GWSI_ADWR_SOURCES)

This field contains the source of the reported depth of a well.

A – Arizona Department of Water Resources.
B – U.S. Bureau of Reclamation.
C – Consultant.
D – Driller. Depth taken from a drillers log or report.
E – New Mexico Office of State Engineer.
F – Arizona Geologic Survey.
G – Geologist.
L – Logs.
M – Memory. Depth from owner, driller, or well operator.
O – Owner. Depth reported by well owner.

Depth Src, cont.:

R – Other Reported. Depth reported by person other than owner, driller, or another governmental agency.

S – Reporting Agency. Depth reported by a reporting agency.

U – U.S. Geological Survey. Depth reported by personnel from the U. S. Geological Survey.

Z – Other. Depth reported by other source. Explain source in Remarks section.

* – Undetermined

Geological Unit (Geo Unit):

(GWSI_SITES . SITE_GEO_UNIT)

(CODE LOOKUP TABLE: LOGS_CD_GEO_UNITS)

This field contains an 8-character code that identifies the lithologic unit in which the well is finished. See Appendix D for the appropriate Geological Unit Codes.

Altitude

Altitude:

(GWSI_SITES . SITE_WELL_ALTITUDE)

(CODE LOOKUP TABLE: N/A)

This field contains the altitude of the site in feet above NGVD (National Geographic Vertical Datum), precision to two decimals can be coded if available. This value is determined by the person field checking the site, generally based on interpolation of topographic maps.

Altitude Accuracy:

(GWSI_SITES . SITE_ALTIT_ACCURACY)

(CODE LOOKUP TABLE: N/A)

This field contains the level of accuracy, in feet, of the site altitude. Site altitudes taken from a map are generally accurate to one half the map's contour interval. Sites that are leveled in from a benchmark are considered accurate to within 1.0 foot.

Method of Altitude Measurement:

(GWSI_SITES . SITE_ALTMETH_CODE_ENTRY)

(CODE LOOKUP TABLE: GWSI_ALTITUDE_METHODS)

This field records the method used to determine the altitude of the site.

A – Altimeter

D – Differential G.P.S.

E – Reported

G – Hand-held G.P.S. unit

H – Reported by source agency

I – Interferometric synthetic aperture radar (I.F.S.A.R.)

M – Interpolated from topographic map

N – Interpolated from digital elevation model (D.E.M.)

O – Other

P – Photo

R – Real-time kinematic G.P.S.

S – Transit, theodolite, or other surveying method

T -- Undifferentiated Survey Grade GPS

Method of Altitude Measurement cont.:

J – Light detection and ranging (L.I.D.A.R.)

K – Post-Processed static survey G.P.S.

L – Level or other surveying method

U – Unknown

V – Instrument surveying method

X – Interpolated from USGS 7.5’ map

Altitude Measurement Datum:

(GWSI_SITES.SITE_ALT_DATUM_CODE)

(CODE LOOKUP TABLE: GWSI_DATUM_CODES)

This field records the datum used to determine the altitude of the site. GWSI uses the North American Vertical Datum of 1929 (NGVD 29). GWSI uses the North American Datum Conversions (NADCON) of the National Geodetic Survey to convert from NGVD 29 to NAVD 88 or vice-versa. Lookup table as shown on p.5, above.

Altitude Measurement Date:

(GWSI_SITES . SITE_ALT_MEASURE_DATE)

(CODE LOOKUP TABLE: N/A)

This field records the date on which the altitude was measured in the format M/D/YYYY.

Altitude Measurement Source:

(GWSI_SITES . SITE_ALT_SOURCE_CODE)

(CODE LOOKUP TABLE: GWSI_SITE_SOURCES)

This field contains the agency that took the altitude measurement, usually ADWR or DRILR.

ADWR -- Arizona Department of Water Resources

DRILR -- Driller

USBR -- U.S. Bureau of Reclamation

USGS -- U.S. Geological Survey

Record Information

Site Source:

(GWSI_SITES . SITE_SISRC_CODE)

(CODE LOOKUP TABLE: GWSI_SITE_SOURCES)

This field contains the agency making the original field check and initial data entry, usually ADWR or USGS.

ADWR -- Arizona Department of Water Resources

DRILR -- Driller

USBR -- U.S. Bureau of Reclamation

USGS -- U.S. Geological Survey

Index Book:

(GWSI_SITES . SITE_IDX_BOOK)

(CODE LOOKUP TABLE: GWSI_IDX_BK_CODES)

If the site is an active index well, the number of the index book is entered in this field or chosen from the drop-down menu. It should be noted that this field only includes active index wells or previously active index wells. Wells that were index wells and then were removed from the index lines are listed as BK 00. Wells that are on the index lines are a good place to start when looking for long-term water level records. However, other wells in the area of interest still need to be checked. A well that has been removed from the index line may still contain a very useful water level history.

Quasi-Index Well:

(GWSI.SITES)

Quasi-Index wells have been determined not to meet index well criteria. This field was created to programmatically review and track whether an Index Well meets the criteria to monitor a specific aquifer category, such as an aquifer or hydrogeologic unit (see Appendix E). Current Index Wells that do not meet all the criteria, in their entirety. To monitor a specific aquifer category and/or are used to monitor specified conditions in the area will be designated as Quasi-Index wells. A Quasi-Index Well does not meet the objectives for aquifer category monitoring; however, there may be other purposes for monitoring, such as measuring the effects of artificial recharge or pumpage, regulatory or statute driven monitoring requirements, etc.

Site/Water Uses

Site Use:

(GWSI_SITES . SITE_USE_1, SITE_USE_2, SITE_USE_3)

(CODE LOOKUP TABLE: GWSI_SITE_USE_CODES)

The three Site Use fields contain the appropriate letter codes for the use of the site. SITE_USE1 is the principal use of the site at the time of the last field visit. If the site is used for more than one purpose, then the second and third Site Use entries can be coded with the appropriate letter codes.

* – Undetermined

A – Anode. An anode is a hole used as an electrical anode. Included in this category are wells used solely for cathodic protection of pipelines or electronic relays and other installations.

C – Standby, Emergency Supply. This refers to a water supply source that is used only when the principal source of water is unavailable.

D – Drain. Refers to the drainage of surface water underground.

E – Geothermal. A geothermal well is a hole drilled for geothermal energy development. Use this category for dry geothermal wells or wells into which water is injected for heating. For a wet geothermal well, from which water is withdrawn, use W – Withdrawal of water for the site use, and E – Power Generation as the primary use of water.

G – Seismic. A seismic hole is one drilled for seismic exploration. A seismic hole converted for other uses should be coded based on its current use.

H – Heat Reservoir. Refers to a well in which a fluid is circulated in a closed system. Water is neither added nor withdrawn from the well.

M – Mine. A mine includes any tunnel, shaft, or other excavation constructed for minerals extraction.

N – Non-exempt well in AMA/INA

O – Observation - Water Level. An observation well is a well that is used for water level observations. Do not use this category for oil test holes or water-supply wells used only occasionally as observation wells. ADWR state-wide water level monitoring wells are identified by convention with the code O only in the Site_Use_ 2 or Site_Use_3 fields.

Site Use cont.:

P – Oil or Gas. Refers to any well or hole drilled in search of, or for production of, petroleum or gas. This category includes any oil or gas production well, dry hole, core-hole, or injection well drilled for secondary recovery of oil and/or gas. An oil-test hole converted to a water supply hole should be classified as Withdrawal.

Q – Water Quality Monitoring. An observation well is a well that is used for water-quality observations. Do not use this category for oil test-holes or water supply wells used only occasionally as observation wells. ADWR state-wide water quality monitoring wells are identified by convention by the code Q only in the Site_Use_2, or Site_Use_3 fields.

R – Recharge. A recharge site is a site constructed for, or converted for, use in replenishing the aquifer. Use this category for wells that are used only to place water into an aquifer.

S – Repressurized. Refers to pumping water into an aquifer in order to increase the pressure in the aquifer for a specific purpose, for example, water flood purposes in an oil field.

T – Test. Refers to either an uncased or temporarily cased hole, that was drilled for water, or for geologic or hydrogeologic testing. The hole may be temporarily equipped with a pump in order to make a pump test, but if the well is developed after testing it is still a test hole. A core hole that is part of mining or quarrying exploration work should be in this class.

U – Unused. Refers to an abandoned site or one for which no use is contemplated. At an abandoned farmstead a domestic, or stock well equipped with a pump may be classed as unused. An irrigation well that is not equipped with a pump, nor used for other reasons, also may be classified unused.

W – Withdrawal. Refers to a site that withdraws water for one of the purposes listed under water use. It includes a dewatering well if the dewatering is accomplished by pumping groundwater.

X – Waste. Refers to a site used to convey industrial waste, domestic sewage, oil-field brine, mine drainage, radioactive waste, or other waste fluid into an underground zone. An oil-test or deep-water well converted to waste disposal should be in this category.

Z – Well Destroyed. Refers to a site that is has been destroyed and is no longer in existence.

Water Use:

(GWSI_SITES . SITE_WATER_USE_1, SITE_WATER_USE_2, SITE_WATER_USE_3)

(CODE LOOKUP TABLE: GWSI_WATER_USE_CODES)

The three Water Use fields are used to indicate to what purpose any water withdrawn from the site is used. Use WATER_USE_1 to indicate the principal use of the water from the site. Other uses are entered in the other two water use fields.

* – Undetermined

A – Air Conditioning. Refers to water supplied solely or principally for the heating or cooling of a building. Water used to cool industrial machinery should be coded as J – Industrial Cooling, not as Air Conditioning.

B – Bottling. Refers to the storage of water in bottles and use of the water for potable purposes.

C – Commercial. Refers to use by a business that does not fabricate or produce a product. Filling stations and motels are examples of commercial establishments. If some product is manufactured, assembled, remodeled, or otherwise fabricated, use of water at the plant should be considered as N - Industrial, even though the water is not used directly in the production and/or manufacture of the product.

D – Dewatering. Refers to water pumped for dewatering a construction or mining site, or to lower the water table for agricultural purposes. In this respect, it differs from a drainage well that is used to drain surface water underground. If the main purpose for which the water is withdrawn is to provide drainage, Dewatering should be indicated even though the water may be discharged into an irrigation ditch and subsequently used to irrigate land.

E – Power. Refers to water withdrawn for the use of generating any type of power.

F – Fire. Refers to the principal use of the water and should be indicated if the site was constructed principally for this purpose, even though the water may be used at times for other purposes.

H – Domestic. Refers to water used to supply household needs, principally for drinking, cooking, washing, and sanitary purposes, but includes watering a lawn and caring for pets. Most domestic wells will be in suburban or farm homes, but wells supplying small quantities of water for domestic purposes to one-room schools, turnpike gates, and similar installations, should also be included in the category.

I – Irrigation. Refers to water used to irrigate cultivated crops. Most irrigation sites will supply water for farm crops, but this category should include wells used to water the grounds of schools, industrial plants, cemeteries, or golf courses if more than a small amount is used and that is the sole use of the water.

J – Industrial Cooling. Refers to a well that supplies water used solely for industrial cooling.

K – Mining. Refers to a well that supplies water used solely for mining purposes.

M – Medicinal. Refers to water believed to have therapeutic value. Water may be used for bathing and/or drinking. If use of water is mainly because of its claimed therapeutic value, use this category even if the water is bottled.

N – Industrial. Refers to water used within a plant that manufactures or fabricates a product. The water may or may not be incorporated into the product being manufactured. Industrial water may be used to cool machinery, to provide sanitary facilities, to air condition the plant, or to irrigate the grounds at the plant.

O – Observation. Refers to water that is used for water quality sampling or water levels.

P – Public Supply. Refers to water that is pumped and distributed through a network that supplies several homes. Such supplies may be owned by a municipality or community, a water district, or a private water company. If the system supplies five or more homes it should be considered "Public Supply"; for four or fewer homes classify use as H - Domestic. Wells that supply motels and hotels should be classified as C - Commercial. Many public supply wells also supply water for a variety of uses, such as industrial, institutional, and commercial.

Q – Aquaculture. Refers to water used solely for aquaculture, such as fish farms.

R – Recreation. Refers to water discharged into pools, or channels, which are dammed to form pools, that are used for swimming, boating, fishing, ice rinks, or other recreational uses. Also used for wells that irrigate golf courses and parks.

S – Stock. Refers to a well pumped to supply water to livestock.

T – Institution. Refers to water used in the maintenance and operation of institutions such as large schools, universities, hospitals, or rest homes. Owners of the institutions may be individuals, corporations, churches, or government bodies.

U – Unused. Means that water is not being removed from the site for one of the purposes listed above. A test hole, oil or gas well, recharge, drainage, observation, or waste-disposal well will be in the category. Do not use this classification for a stock, irrigation, domestic, or other well during off season or other temporary periods of nonuse.

Z – Other.

Water Levels WW Levels (GWSI_WW_LEVELS)

The Water Levels Data Table contains information related to the depth to water at the site. Data that is contained includes depth to water, water table elevation, measurement date, method of measurement, measurement remarks, and source of the water level measurement.

Measurement Date:

(GWSI_WW_LEVELS . WLWA_MEASUREMENT_DATE)

(CODE LOOKUP TABLE: N/A)

This field records the date that the water level was recorded for the site.

Depth to Water (feet):

(GWSI_WW_LEVELS . WLWA_DEPTH_TO_WATER)

(CODE LOOKUP TABLE: N/A)

This field records the depth to water, in feet, below land surface. Depth to water can be carried out to two decimal places. If the water level is above land surface, enter the water level in feet above land surface preceded by a minus (-) sign. If the head at a flowing site is unknown, if the water level cannot be measured, the site is dry, or the well destroyed, then this field is left blank and the appropriate code must be placed in the associated UTM Remark Code field.

Water Level Elevation:

(GWSI_WW_LEVELS . WLWA_WATER_LEVEL_ELEVATION)

(CODE LOOKUP TABLE: N/A)

This field contains the elevation of the water table above mean sea level datum. This field is calculated by subtracting the depth to water from the well altitude, as entered in the Sites Data table. Except for flowing wells, water level elevations are blank for records that have no depth to water measurements.

Source of Measurement:

(GWSI_WW_LEVELS . WLWA_SOURCE_CODE)

(CODE LOOKUP TABLE: GWSI_DATA_SOURCES)

This field contains letter codes for the source of the water level measurement.

* – Undetermined

3 – Third Party

A – Arizona Department of Water Resources

B –U.S. Bureau of Reclamation

C – Consultant

D – Driller

E – New Mexico Office of the State Engineer

F – Arizona State Land Department

G – University of Arizona

J – Military

L – Arizona State Land Department

M – Bureau of Land Management

O – Owner

R – Other Reported

S – Salt River Project

T – City of Tucson

U – U.S. Geological Survey

W – Wellton-Mohawk Irrigation and Drainage District

Z – Other

Method of Water Level Measurement:

(GWSI_WW_LEVELS . WLWA_METHOD CODE)

(CODE LOOKUP TABLE: GWSI_MM_CODES)

This field contains the code for the method used to measure the depth to water.

A – Airline

B – Analog or Graphic Recorder

C – Calibrated Airline

D – Differential G.P.S.

G – Pressure Gauge

H – Calibrated Pressure Gauge

L – Geophysical Logs

M – Manometer

R – Reported

S – Steel Tape

T – Electric Tape (Uncalibrated)

U – Undetermined

Method of Water Level Measurement cont.:

DC – Downhole Camera

E – Estimated

F – Automated Device

N – Non-Recording Gauge

O – Observed

P – Acoustic Pulse

V – Electric Sounder or Non-Electric Tape

VT – Electric Tape (Calibrated)

Z – Other

Water Level Measurement Remarks:

(GWSI_WW_LEVELS . WLWA_REMARK_CODE)

(CODE LOOKUP TABLE: GWSI_MR_CODES)

This field contains letter codes that describe the status of the site at the time of the water level measurement. If the water level measured represents a static level, this field is blank.

A – Atmospheric Pressure.

C – Ice.

D – Dry. The site was dry, and no water level was recorded.

E – Recently Flowing. The site had recently been flowing.

F – Flowing. The site was flowing, but no head could be measured (no water level is recorded).

G – Nearby Flowing. A nearby site was flowing at the time of measurement.

H – Nearby Recently Flowing. A nearby site had recently flowed.

I – Well Injecting. The well was being used to inject water into the aquifer at the time of the measurement attempt. Examples of injection wells are wells used to recharge water into an aquifer.

J – Nearby Injecting.

K – Cascading Water. Water was cascading down the well casing from some point above the water table.

L – Brackish Saline.

M – Well Plugged.

N – Measurements Discontinued at the site.

Water Level Measurement Remarks cont.:

O – Obstructed. An obstruction in the well casing prevented a measurement (no water level is recorded).

P – Pumping. The site was being pumped at the time of measurement.

R – Recently Pumped. The site had been pumped recently.

S – Nearby Pumping. A site nearby was being pumped at the time of measurement.

T – Nearby Recently Pumped. A nearby site had recently been pumped.

U – Undetermined.

V – Foreign Material (Oil). A foreign material, usually oil, was encountered on the surface of the water table.

W – Well Destroyed. The well has been destroyed and no water level is recorded.

X – Surface Water Effects. The water level may be affected by a nearby surface water site.

Z – Other. Other conditions that may affect the measured water level. (Explain in the Remarks Data Table).

Unable to Measure (UTM) Remarks:

(GWSI_WW_LEVELS . WLWA_UTM_CODE)

(CODE LOOKUP TABLE: GWSI_UTM_CODES)

This field contains letter codes that describe the reason why a site was unable to be measured. This field is only used when a water level is not obtained.

BE – Bees. There are bees near the site or in the well that pose a risk to the safety of a field personnel.

D – Dry. The site was dry, and no water level could be obtained.

K – Cascading Water. Water was cascading down the well from some point above the water table that prevents an accurate measurement.

LG – Locked Gate. A locked gate prevented access to a site.

Unable to Measure (UTM) Remarks cont.:

LS – Locked Well Site. A measurement cannot be obtained due to a locked building, structure, well cap, or measuring point (MP).

M – Well Plugged. Well has visible cement, debris, dirt, or other material blocking access to the water table and is not in hydraulic contact with formation; however, a well casing is still visible.

MP – No Measuring Point (MP) Access. A water level cannot be obtained because there is no equipment access at the site to gain access to the water table.

N – Measurements Discontinued. Measurements are discontinued at the site.

NA – No Site Access. Something that hinders, impedes, and prevents getting to the site and cannot be defined by any other UTM remark.

NC – No Contact. A water level was not obtained due to the necessity to contact the owner, business, or property before a water level is to be obtained.

NP – No Permission. An owner or responsible party has denied and/or refused access to the site or water table.

O – Obstruction. A blockage in the well prevents a water level from being obtained.

P – Pumping. The site is being pumped at time of measurement.

RC – Road Condition. All roads or drivable paths to a site are unsafe for equipment or personnel.

SH – Site Hazard. The environment at or around the site poses a risk to personnel and cannot be defined by any other UTM remark.

UL – Unable to Locate. The site location cannot be verified and/or there is no site at the best-known location.

V – Oil. Oil located on the surface of the water table has prevented an accurate water level from being obtained.

W – Well Destroyed. The well hole and casing has been destroyed and any future water levels would be impossible.

Water Level Comments:

(GWSI_WW_LEVELS . WLWA_COMMENT)

(CODE LOOKUP TABLE: N/A)

The comments section field can be used to help clarify an entered Depth To Water, Method, Measurement Remark, UTM remark, or other information related to the entry. Note that this field is only for comments directly related to the water level or UTM. Comments or useful information about the site should go in the Remarks tab.

Water Level ID:

(GWSI_WW_LEVELS . WLWA_ID)

(CODE LOOKUP TABLE: N/A)

Each water level entry for a site is assigned a unique identifying number by ORACLE that is a sequential variation of the construction entry number. This information cannot be viewed or edited in the GWSI application.

Last Action Date:

(GWSI_WW_LEVELS . WLWA_LAST_ACT_DATE)

(CODE LOOKUP TABLE: N/A)

This field is filled by ORACLE with the date when any field in the Water Levels Data Table is changed or modified. This information cannot be viewed or edited in the GWSI application.

Last Action Operator:

(GWSI_WW_LEVELS . WLWA_LAST_ACT_OPER)

(CODE LOOKUP TABLE: N/A)

This field is filled by ORACLE with the user ID of the last person to modify or change any field in the Water Levels Data Table.

Valid Date:

(GWSI_WW_LEVELS . WLWA_VALID_DATE)

(CODE LOOKUP TABLE: N/A)

This field contains a flag that indicates the accuracy of the Water Levels Date. See the previous explanation of the Valid Date field.

Water Level Measuring Point Data Table (WM_POINTS)

The Water Level Measuring Point Data Table contains a description of the point used to measure the depth to water in a well.

Date Established:

(GWSI_WM_POINTS . WELM_DATE_MEASURED)

(CODE LOOKUP TABLE: N/A)

This field records the date that the water level measuring point was established for the site.

Measuring Point Height (feet):

(GWSI_WM_POINTS . WELM_MEASURE_POINT_HEIGHT)

(CODE LOOKUP TABLE: N/A)

This entry is the height above the land surface from which the depth to water measurement was made. If the measurement point is below land surface, the measurement height is preceded by a minus sign (-).

Measuring Point Descriptions:

(GWSI_WM_POINTS . WELM_MP_DESCRIPTION)

(CODE LOOKUP TABLE: N/A)

This field contains a description of the point used to measure the depth to water. Figure 4, below, illustrates some of the common measuring point descriptions.

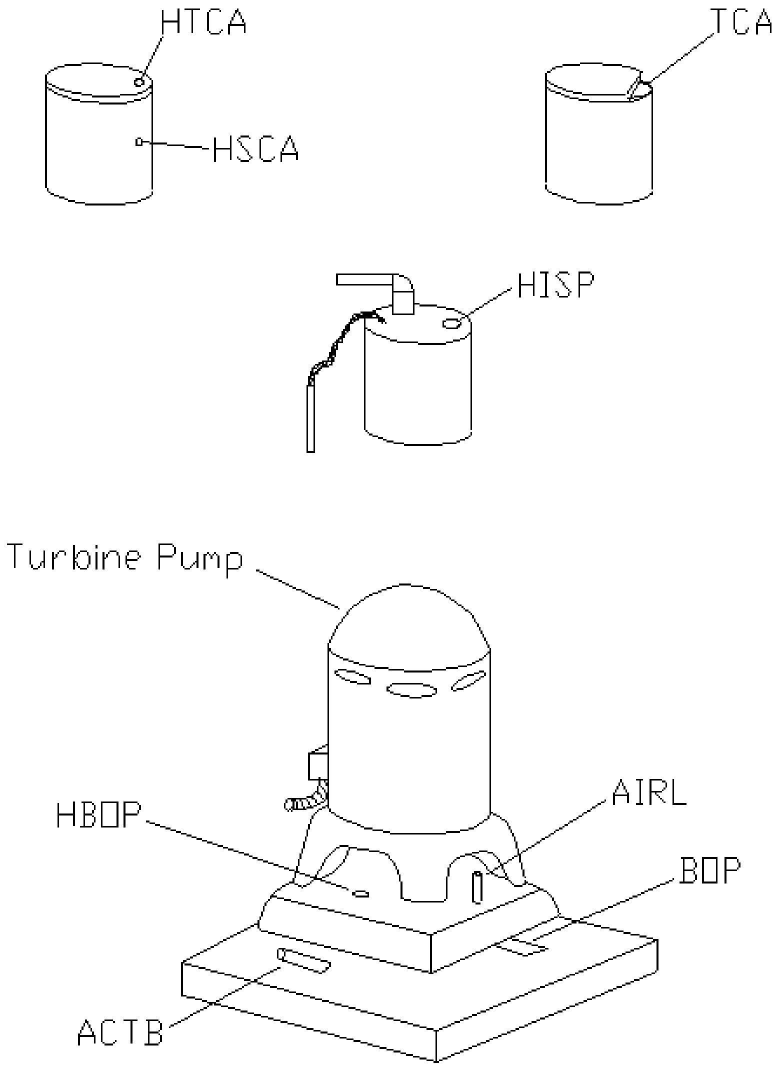


Figure 4. Well Casing Measurement Descriptions.

HTCA, W – Hole in Top of Casing, West Side

HSCA, N – Hole in Side of Casing, North Side

TCA, SE – Top of Casing, Southeast Side

HBOP, S – Hole in Pump Base, South Side

BOP, N – Access under Base of Pump, North Side

ACTB, S – Measuring (Access) Tube, South Side

AIRL, S – Airline, South Side

HISP, NE – Hole in Submersible Plate, Northeast Side

Water Level Point ID :

(GWSI_WM_POINTS . WELM_ID)

(CODE LOOKUP TABLE: N/A)

Each water level measuring point entry for a site must have a unique identifying number that is used only once at a site. This cannot be viewed or edited within the GWSI application.

Last Action Date:

(GWSI_WM_POINTS . WELM_LAST_ACT_DATE)

(CODE LOOKUP TABLE: N/A)

This field is filled by ORACLE with the date when any field in the Measuring Point Data Table is changed or modified. This cannot be viewed or edited within the GWSI application.

Last Action Operator:

(GWSI_WM_POINTS . WELM_LAST_ACT_OPER)

(CODE LOOKUP TABLE: N/A)

This field is filled by ORACLE with the user ID of the last person to modify or change any field in the Measuring Point Data Table. This cannot be viewed or edited within the GWSI application.

Valid Date:

(GWSI_WM_POINTS . WELM_DATE_VALID)

(CODE LOOKUP TABLE: N/A)

This field contains a flag that indicates the accuracy of the Measuring Point Date. See the previous explanation of the Date Valid Field.

Well Lifts Data Table (WELL_LIFTS)

The Well Lifts Data Table contains information about the pump that is used to bring water to the surface at the site. Please note, if no lift was present at time of a field visit, then create a new lift inventory with Lift Type equal to "N - None. The well has no pump".

<u>Lift Inventory Date:</u>

(GWSI_WELL_LIFTS . WLLI_ENTRY)

(CODE LOOKUP TABLE: N/A)

This entry is the date on which the well lift was observed. The associated data field Date Valid indicates whether the date has been modified to be accepted by ORACLE.

<u>Lift Type:</u>

(GWSI_WELL_LIFTS . WLLI_TYPE_CODE)

(CODE LOOKUP TABLE: GWSI_LIFT_TYPES)

This field contains the code for the type of pump or lift that brings water to the surface.

* – Undetermined.

A – Air lift. An air lift is a jet of air pumped below the water table that causes a stream of mixed air and water to flow from the well.

B – Bucket. This type of lift includes a rope and bucket, chain and bucket lifts, and a small bailer lifted by a rope or chain and pulley.

C – Centrifugal. Centrifugal pumps have rotating impellers in a closed chamber that draw the water into the pump. The water is then discharged from the pump, under pressure, by centrifugal force. Centrifugal pumps have a maximum lift of about 25 feet.

J – Jet. Jet pumps have two pipes extending from the pump into the well. One pipe forces air down the well bore under pressure while the other pipe discharges water that has been forced to the surface by the jet.

N – None. The well has no pump.

P – Piston. Piston pumps include the familiar lift and pitcher pumps, reciprocating pumps, and deep-wells with "walking-beam jacks" pumps.

Lift Type, cont.:

R – Rotary. Rotary pumps operate on the principle that direct pressure is created by squeezing water between specially designed runners. A high vacuum is created on the intake side so that a suction lifts the water to the surface. Rotary pumps have a maximum lift of about 25 feet.

S – Submersible. A submersible pump is a special type of turbine pump that is designed to be submerged in water. An electric motor is connected directly to impellers and then submerged in water.

T – Turbine. There are several types of turbine pumps that are designed for either deep or shallow wells. In a turbine pump, a series of impellers are placed below the surface of the water and rotated by a vertical shaft connected to a power source at the land surface. The impellers pick up the water and force it to the surface through the pump column. Turbine pumps are capable of lifting large amounts of water at high pressure. Most high capacity public supply, industrial, and irrigation wells use turbine pumps.

U – Unknown. If the pump type is unknown or cannot be identified.

V – Not Assigned.

Z – Other. Any lifting device that is not listed above.

Method of Lift Measurement:

(GWSI_WELL_LIFTS . WLLI_METHOD_CODE)

(CODE LOOKUP TABLE: GWSI_LIFT_MEASURE_METHODS)

This field contains the method of the measurement that determined the power divider, or pump rating.

* – Undetermined

A – Dedicated power meter, instantaneous discharge with approved equipment/method, with static pressure <10 psi

B – Dedicated power meter, instantaneous discharge with approved device with static pressure <10 psi

D – Non–Dedicated power meter, instantaneous discharge with approved equipment/method, with static pressure <10 psi

Method of Lift Measurement cont.:

E – Non–Dedicated power meter, instantaneous discharge with approved device with static pressure <10 psi

P – Dedicated power meter, instantaneous discharge with approved equipment/method, with static pressure > = 10 psi

Q – Dedicated power meter, instantaneous discharge with approved device with static pressure > = 10 psi

R – Non–Dedicated power meter, instantaneous discharge with approved equipment/method, with static pressure > = 10 psi

S – Non–Dedicated power meter, instantaneous discharge with approved device, with static pressure > = 10 psi

Power Company:

(GWSI_WELL_LIFTS . WLLI_POWER_COMPANY)

(CODE LOOKUP TABLE: GWSI_POWER_COMPANIES)

This field contains a three letter code for the name of the company that provides electrical, natural gas, or other power for the pump. For a complete list, use the pull/down menu in the ORACLE forms application.

* – Undetermined
APS – Arizona Public Service
CAL – Calapco
CIT – Citizens Utility
COM – City of Mesa
DIX – Dixelette (Utah)
DVE – Duncan Valley Electric Co–Op
ED1 – Electrical District 1
ED2 – Electrical District 2
MWE – Morenci Water and Electric
NAE – Navapache Electric Co–Op
NAV – Navajo Tribal Utility Authority
NEV – Nevada Power Company
PHS – Public Health Service
PTU – Papago Tribal Utility
RD1 – Electrical Dist. RD1 (Roosevelt District)
REA – Rural Electrification Administration
SCP – San Carlos Project

Power Company cont.:

ED3 – Electrical District 3

ED4 – Electrical District 4

ED5 – Electrical District 5

ED7 – Electrical District 7

ED8 – Electrical District 8

GAR – Garkane Power Association

GCE – Graham County Electric Co–Op

IID – Imperial Irrigation District

INT – Interstate Utility

MAG – Magma Gas Company

MEC – Mohave Electric Co–Op

SOU – Southern Union Gas

SRP – Salt River Project

SSV – Sulphur Springs Valley Elect. Co–Op

SWG – Southwest Gas

TEP – Tucson Electric and Power

TGE – Tucson Gas and Electric

TPE – Tucson Electric and Power – Use TEP

TRI – Trico Electric Co–Op

USB – U.S. Bureau of Reclamation

WD1 – Electric District WD1 (Maricopa Water District)

WEM – Wellton Mohawk Irrigation and Power

Lift Power Type:

(GWSI_WELL_LIFTS . WLLI_POWER_TYPE)

(CODE LOOKUP TABLE: GWSI_POWER_TYPES)

This field contains the code for the type of power used to power the pump.

* – Undetermined

D – Diesel

E – Electric

G – Gasoline

H – Hand

L – LP Gas

N – Natural Gas

W – Wind

Z – Other

Source of Lift Measurement:

(GWSI_WELL_LIFTS . WLLI_SOURCE_CODE)

(CODE LOOKUP TABLE: GWSI_DATA_SOURCES)

This field contains source that the lift information was derived from.

* – Undetermined
3 – Third Party
A – Arizona Department of Water Resources
B – U.S. Bureau of Reclamation
C – Consultant
D – Driller
E – New Mexico Office of the State Engineer
F – Arizona Public Service
G – University of Arizona
J – Military
L – Arizona State Land Department
M – Bureau of Land Management
O – Owner
R – Other Reported
S – Salt River Project
T – City of Tucson
U – U.S. Geological Survey
W – Wellton–Mohawk Irrigation and Drainage District
Z – Other

Pump Horsepower:

(GWSI_WELL_LIFTS . WLLI_HORSEPOWER)

(CODE LOOKUP TABLE: N/A)

This field contains the power rating, in horsepower, of the wells primary power source. Two decimal places are provided for small motors.

Power Meter Number:

(GWSI_WELL_LIFTS . WLLI_METER_NUM)

(CODE LOOKUP TABLE: N/A)

This field can contain the meter number of the gas or electric meter which records the power consumption of the pump. The information in this field can be used as a cross reference to help identify a well.

Lift Power Divider:

(GWSI_WELL_LIFTS . WLLI_DIVIDER)

(CODE LOOKUP TABLE: N/A)

This field contains the pump rating as the unit of power consumed per volume of water lifted. The value should be expressed as kilowatt-hours per acre-foot of electricity or therms per acre-feet of water, depending on the type of power used by the pump.

Lift Account Number:

(GWSI_WELL_LIFTS . WLLI_ACCOUNT_NUM)

(CODE LOOKUP TABLE: N/A)

This field contains the account number under which the power company stores power consumption rates for the site.

Valid Date:

(GWSI_WELL_LIFTS . WLLI_VALID_DATE)

(CODE LOOKUP TABLE: N/A)

This field contains a flag that indicates the accuracy of the Well Lifts date. See the previous explanation of the Valid Date field.

Lift Number:

(GWSI_WELL_LIFTS . WLLI_ID)

(CODE LOOKUP TABLE: N/A)

Each lift entry for a site is assigned a unique identifying number by ORACLE that is a sequential variation of the well construction entry number. This cannot be viewed or edited within the GWSI application.

Last Action Date:

(GWSI_WELL_LIFTS . WLLI_LAST_ACT_DATE)

(CODE LOOKUP TABLE: N/A)

This field is filled by ORACLE with the date when any field in the Well Lifts Data table is changed or modified. This cannot be viewed or edited within the GWSI application.

Last Action Operator:

(GWSI_WELL_LIFTS . WLLI_LAST_ACT_OPER)

(CODE LOOKUP TABLE: N/A)

This field is filled by ORACLE with the user ID of the last person to modify or change any field in the Well Lifts Data table. This cannot be viewed or edited within the GWSI application.

Well Owners Data Table (WELL_OWNERS)

The Well Owners Data Table contains the name of the site owner and the date of their known ownership of the site. It should be emphasized that the last entry in this data table may <u>not</u> be the current owner of the site, but is the owner at the time indicated in the Owner Entry Date Field.

<u>Owner Entry Date:</u>

(GWSI_WELL_OWNERS . WLOW_ENTRY_DATE)

(CODE LOOKUP TABLE: N/A)

This entry is the date that the owner acquired ownership of the site, or the earliest date on which the owner was known to own the site.

<u>Owners Last Name:</u>

(GWSI_WELL_OWNERS . WLOW_LAST_NAME)

(CODE LOOKUP TABLE: N/A)

This field is used for recording the last name, second line of a business name, or the type of business (LLC, INC, CORP, and others) of the well owner.

<u>Owners First Name:</u>

(GWSI_WELL_OWNERS . WLOW_FIRST_NAME)

(CODE LOOKUP TABLE: N/A)

This field is used for recording the first name or the first line of a business name of the well owner.

<u>Owners Middle Initial:</u>

(GWSI_WELL_OWNERS . WLOW_MIDDLE_INITIAL)

(CODE LOOKUP TABLE: N/A)

This field contains one (1) space for recording the middle initial of the well owner.

Valid Date:

(GWSI_WELL_OWNERS . WLOW_VALID_DATE)

(CODE LOOKUP TABLE: N/A)

This field contains a flag that indicates the accuracy of the Well Owners date. See the previous explanation of the Date Valid Field.

Owner ID:

(GWSI_WELL_OWNERS . WLOW_ID)

(CODE LOOKUP TABLE: N/A)

Each ownership entry for a site is assigned a unique identifying number by ORACLE that is a sequential variation of the construction entry number. This cannot be viewed or edited within the GWSI application.

Last Action Date:

(GWSI_WELL_OWNERS . WLOW_LAST_ACT_DATE)

(CODE LOOKUP TABLE: N/A)

This field is filled by ORACLE with the date when any field in the Well Owners Data Table is changed or modified. This cannot be viewed or edited within the GWSI application.

Last Action Operator:

(GWSI_WELL_OWNERS . WLOW_LAST_ACT_OPER)

(CODE LOOKUP TABLE: N/A)

This field is filled by ORACLE with the user id of the last person to modify or change any field in the Well Owners Data Table. This cannot be viewed or edited within the GWSI application.

Site Names (OWNER_SITE_NAMES)

The Owner Site Id Data Table contains identifying numbers or names that have been assigned to a site, usually by the site owner. For example, a city or town may assign a number to each of its wells.

Other Site ID:

(GWSI_OWNER_SITE_NAMES . OWNS_OTHER_ID)

(CODE LOOKUP TABLE: N/A)

This field is used for recording the name or number used by the owner to identify the site.

Other Site Name Assigner:

(GWSI_OWNER_SITE_NAMES . OWNS_ASSIGNER)

(CODE LOOKUP TABLE: N/A)

This field contains thirty (30) spaces for recording the person or organization that assigned the other ID.

Last Action Date:

(GWSI_OWNER_SITE_NAMES . OWNS_LAST_ACT_DATE)

(CODE LOOKUP TABLE: N/A)

This field is filled by ORACLE with the date when any field in the Owners Site Name Data Table is changed or modified. This cannot be viewed or edited within the GWSI application.

Last Action Operator:

(GWSI_OWNER_SITE_NAMES . OWNS_LAST_ACT_OPER)

(CODE LOOKUP TABLE: N/A)

This field is filled by ORACLE with the user ID of the last person to modify or change any field in the Owner Site Name Data Table. This cannot be viewed or edited within the GWSI application.

Remarks

The Remarks data table contains remarks from field investigators that may help clarify data entered in other data tables regarding the site.

Remarks Date:

(GWSI_REMARKS . REM_REMARKS_DATE)

(CODE LOOKUP TABLE: N/A)

This entry is the date that the remarks for the site were recorded.

Remark:

(GWSI_REMARKS . REM_REMARKS)

(CODE LOOKUP TABLE: N/A)

This field contains 40 spaces per line to record remarks used to clarify information associated with the site. More than one line can be used to record the site remarks.

Valid Date:

(GWSI_REMARKS . REM_DATE_VALID)

(CODE LOOKUP TABLE: N/A)

This field contains a flag that indicates the accuracy of the Remarks Date. See the previous explanation of the Date Valid Field.

Remarks ID:

(GWSI_REMARKS . REM_ID)

(CODE LOOKUP TABLE: N/A)

Each remarks entry for a site is assigned a unique identifying number by ORACLE that is a sequential variation of the construction entry number. This cannot be viewed or edited within the GWSI application.

Last Action Date:

(GWSI_REMARKS . REM_LAST_ACT_DATE)

(CODE LOOKUP TABLE: N/A)

This field is filled by ORACLE with the date when any field in the Remarks Data Table is changed or modified. This cannot be viewed or edited within the GWSI application.

Last Action Operator:

(GWSI_REMARKS . REM_LAST_ACT_OPER)

(CODE LOOKUP TABLE: N/A)

This field is filled by ORACLE with the user ID of the last person to change or modify any field in the Remarks Data Table. This cannot be viewed or edited within the GWSI application.

Images (GWSI_SITE_IMAGES)

The Images table contains images taken by field investigators that may help clarify location, access, or measuring information regarding the site. Each site should have a minimum of three associated pictures.

Image Date:

(GWSI_SITE_IMAGES . IMAGE_DATE)

(CODE LOOKUP TABLE: N/A)

This entry is the date that the images for the site were recorded.

Image Directions:

(GWSI_SITE_IMAGES . DIRECTIONS)

(CODE LOOKUP TABLE: N/A)

This entry is the view direction that the images for the site were recorded. These directions are in the form of compass quadrant bearings.

Image Comments:

(GWSI_SITE_IMAGES . COMMENTS)

(CODE LOOKUP TABLE: N/A)

This comment describes in short detail the significance of the image for the site.

Stretch Image:

This is a GWSI application function that allows for the image to be stretched to fit the windows scale.

Image ID:

(GWSI_SITE_IMAGES . IMAGE_ID)

(CODE LOOKUP TABLE: N/A)

Each image entry for a site is assigned a unique identifying number by ORACLE. This cannot be viewed or edited within the GWSI application.

Hydro Graph

The Hydro Graph tab is a built-in application tool that automatically plots water levels from the WW Levels tab over time.

History

The History tab automatically tracks and stores changes to latitude, longitude, altitude, cadastral and associated meta data that have been made to a site over time.

Lat-Long History

Lat-Long History Measure Date:

(GWSI_SITE_LOCATION_HISTORY . SITE_LATLONG_MEASURE_DATE)

(CODE LOOKUP TABLE: N/A)

Displays previous location date for a site.

Lat-Long History Latitude (Degree, Minute, Second):

(GWSI_SITE_LOCATION_HISTORY . SITE_LATIT_(DEGREE, MIN, or SEC)

(CODE LOOKUP TABLE: N/A)

Displays previous latitude history for a site.

Lat-Long History Longitude (Degree, Minute, Second):

(GWSI_SITE_LOCATION_HISTORY . SITE_LONGIT_(DEGREE, MIN, or SEC)

(CODE LOOKUP TABLE: N/A)

Displays previous longitude history for a site.

Lat-Long History Method:

(GWSI_SITE_LOCATION_HISTORY . SITE_LATLONG_METHOD_CODE)

(CODE LOOKUP TABLE: GWSI_LATLONG_METHOD_CODES)

Displays previous location method data for a site.

The codes are derived from the GWSI_LATLONG_METHOD_CODES lookup table and are the same as those listed on p.4 above, as shown under ‘Latitude/ Longitude Measurement Method’.

Lat-Long History Accuracy:

(GWSI_SITE_LOCATION_HISTORY . SITE_LLACCR_CODE_ENTRY)

(CODE LOOKUP TABLE: GWSI_LON_LAT_ACCURACIES)

Displays previous location accuracy data for a site. The fields are derived from the GWSI_LON_LAT_ACCURACIES code lookup table and are shown under ‘Latitude/ Longitude Measurement Accuracy’ on p.3.

Lat-Long History Datum:

(GWSI_SITE_LOCATION_HISTORY . SITE_LAT_LONG_DATUM_CODE)

(CODE LOOKUP TABLE: GWSI_DATUM_CODES)

Displays previous location datum data for a site. The datum codes are the same as those shown on page 5.

Lat-Long History Source:

(GWSI_SITE_LOCATION_HISTORY . SITE_LATLONG_SOURCE_CODE)

(CODE LOOKUP TABLE: GWSI_SITE_SOURCES)

Displays previous location source data for a site. The codes are derived from the GWSI_SITE_SOURCES lookup table and are the same as those shown on p.5.

Lat-Long History Lat-Long Date:

(GWSI_SITE_LOCATION_HISTORY . CREATEDT)

(CODE LOOKUP TABLE: N/A)

The date which the location change was made.

Lat-Long History CREATEBY:

(GWSI_SITE_LOCATION_HISTORY . CREATEBY)

(CODE LOOKUP TABLE: N/A)

This field is filled by ORACLE with the user ID of the last person to modify or change any field in the Well Completions data table. This cannot be viewed or edited within the GWSI application.

Lat-Long History ID:

(GWSI_SITE_LOCATION_HISTORY . ID)

(CODE LOOKUP TABLE: N/A)

Each location entry for a site is assigned a unique identifying number by ORACLE. This cannot be viewed or edited within the GWSI application.

Altitude History

Altitude History Measure Date:

(GWSI_SITE_ALTITUDE_HISTORY . SITE_ALT_MEASURE_DT)

(CODE LOOKUP TABLE: N/A)

Displays previous altitude date for a site.

Altitude History Altitude:

(GWSI_SITE_ALTITUDE_HISTORY . SITE_WELL_ALTITUDE

(CODE LOOKUP TABLE: N/A)

Displays previous altitude history for a site.

Altitude History Accuracy:

(GWSI_SITE_ALTITUDE_HISTORY . SITE_ACCURACY)

(CODE LOOKUP TABLE: N/A)

Displays previous altitude accuracy data for a site.

Altitude History Method:

(GWSI_SITE_ALTITUDE_HISTORY . SITE_ALTMETH_CODE)

(CODE LOOKUP TABLE: GWSI_ALTITUDE_METHODS)

Displays previous altitude method data for a site. The codes are derived from the GWSI_ALTITUDE_METHOD lookup table and are the same as those shown on p. 23.

Altitude History Datum:

(GWSI_SITE_ALTITUDE_HISTORY . SITE _DATUM_CODE)

(CODE LOOKUP TABLE: GWSI_DATUM_CODES)

Displays previous altitude datum data for a site, using codes derived from the GWSI_DATUM_CODES lookup table as shown on p.5.

Altitude History Source:

(GWSI_SITE_ALTITUDE_HISTORY . SITE_ SOURCE_CODE)

(CODE LOOKUP TABLE: GWSI_SITE_SOURCES)

Displays previous altitude source data for a site. The codes are derived from the GWSI_SITE_SOURCES lookup table and are the same as those shown on p.5.

Altitude History Altitude Date:

(GWSI_SITE_ALTITUDE_HISTORY . CREATEDT)

(CODE LOOKUP TABLE: N/A)

The date which the altitude change was made.

Altitude History CREATEBY:

(GWSI_SITE_ALTITUDE_HISTORY . CREATEBY)

(CODE LOOKUP TABLE: N/A)

This field is filled by ORACLE with the user ID of the last person to modify or change any field in the Well Completions data table. This cannot be viewed or edited within the GWSI application.

Altitude History ID:

(GWSI_SITE_ALTITUDE_HISTORY . ID)

(CODE LOOKUP TABLE: N/A)

Each altitude entry for a site is assigned a unique identifying number by ORACLE. This cannot be viewed or edited within the GWSI application.

Cadastral History

Cadastral History Date:

(GWSI_SITE_ CADASTRAL _HISTORY . SITE_LOCAL_ID_MEASURE_DATE)

(CODE LOOKUP TABLE: N/A)

Displays previous cadastral date for a site.

Cadastral History Cadastral:

(GWSI_SITE_ CADASTRAL _HISTORY . SITE_LOCAL_ID)

(CODE LOOKUP TABLE: N/A)

Displays previous cadastral for a site.

Cadastral History Source:

(GWSI_SITE_ CADASTRAL _HISTORY . SITE_CADASTRAL_SOURCE_CODE)

(CODE LOOKUP TABLE: GWSI_SITE_SOURCES)

Displays previous cadastral source for a site. The codes are derived from the GWSI_SITE_SOURCES lookup table and are the same as those shown on p.5.

Cadastral History Date:

(GWSI_SITE_CADASTRAL_HISTORY . CREATEDT)

(CODE LOOKUP TABLE: N/A)

The date which the local ID change was made.

Cadastral History CREATEBY:

(GWSI_SITE_CADASTRAL_HISTORY . CREATEBY)

(CODE LOOKUP TABLE: N/A)

This field is filled by ORACLE with the user ID of the last person to modify or change any field in the Well Completions data table. This cannot be viewed or edited within the GWSI application.

Cadastral History ID:

(GWSI_SITE_CADASTRAL_HISTORY . ID)

(CODE LOOKUP TABLE: N/A)

Each cadastral entry for a site is assigned a unique identifying number by ORACLE. This cannot be viewed or edited within the GWSI application.

Completion Details

Well Completions Data Table (WELL_COMPLETIONS)

The Well Completions Data Table is used to record detailed information about the construction of a site that is a well. The information includes the drillers' names, dates of completion, drilling methods, casing finishes, and sources of the data. Completion information can include field measurements or other sources (see page 20). Make sure to create new completion details including Date, Finish, and Source as a minimum for each source of data. For example, if a case diameter was measured in the field and driller completion information already exist in GWSI, a new completion Date, Finish, and Source related to the field measurement needs to be created and the known casing information in the Casing Completion tab need to be populated.

Well (GWSI_Well_COMPLETIONS)

Well Completion Date:

(GWSI_WELL_COMPLETIONS . WLCO_COMPLETION_DATE)

(CODE LOOKUP TABLE: N/A)

This entry is the date the drilling was completed. If the day or month are not known, enter 01 for the month and 01 for the day, and enter the appropriate letter code into the Date Valid Field.

Well Finish:

(GWSI_WELL_COMPLETIONS . WLCO_WLCASE_CODE_ENTRY)

(CODE LOOKUP TABLE: GWSI_WELL_CASINGS)

This data field is used to describe the method of finish or the nature of the openings that allow water to enter the well. The allowable codes are listed below.

* – Undetermined

C – Porous Concrete. This is a concrete casing that is pervious enough to allow groundwater to seep into the well.

Well Finish cont.:

F – Gravel Pack with Perforations. Refers to a well that has a gravel envelope opposite a casing section with perforations which allows water to enter the well.

G – Gravel Pack with Screen. Refers to a well that has a gravel envelope opposite a commercially available casing section, with screening material which allows water to enter the well.

H – Horizontal Gallery. This type of finish is a horizontal-type well in which the screen, slotted pipe, or gravel-filled trench is horizontal. All horizontal wells should be in this class, including Ranney collectors and infiltration galleries.

O – Open Ended. Refers to a well that is cased to the bottom of the hole so that water can enter the well only through the bottom of the hole.

P – Perforated or Slotted. Refers to casing that has had holes punched or slots cut into it to allow water to enter. Do not use this classification if the well has a gravel pack; use F or G, whichever is appropriate.

S – Screened. Refers to commercially available well screen manufactured for the purpose of allowing water to enter the well casing. Common types of screen are wire mesh, wrapped trapezoidal wire, or shutter screen. Do not use this classification if the well also has gravel pack; use G instead.

T – Sand Point. Refers to the screen part of a drive point and usually is part of a driven well.

W – Walled. Refers to a dug well that has walls that have been shored up with open-jointed fieldstone, brick, tile, concrete blocks, wood cribbing, or other material. A dug well that is mostly open hole but has even a few feet of cribbing, corrugated pipe, or other shoring to prevent caving should be in this category. Wells of this type with gravel walls belong in this category, not in the F or G.

X – Open Hole. Refers to a well that has a finished open hole in the aquifer. A well belongs in this classification even if the casing does not actually extend to the geologic unit or zone from which the water is obtained.

Z – Other. Any other well finish that may be used. The method may be described in the Remark Field.

Drill Method:

(GWSI_WELL_COMPLETIONS . WLCO_DRILMTH_CODE_ENTRY)

(CODE LOOKUP TABLE: GWSI_DRILL_METHODS)

This field describes the method by which the site was constructed. Allowable entries are:

* – Undetermined.

A – Air Rotary. This method uses a stream of air to cool the bit and bring the rock cuttings to the surface.

B – Bored or Augured. This method uses an auger to cut and remove the earth material. The auger may be powered by hand or by machinery.

C – Cable Tool. Refers to a well drilled by the percussion or churn-drill method whereby a heavy drilling tool is raised and lowered with enough force to pulverize the rock. The rock debris is commonly removed from the hole with a bailer.

D – Dug. Hand dug holes are excavated by hand tools or power-driven digging equipment. Caissons, Ranney–type collectors, and galleries belong in this classification including if they may have laterals that are driven or jetted.

E – Rotary.

H – Hydraulic Rotary. With this method, a well is constructed by rotating a length of pipe (drill stem) equipped with a drill bit that cuts or grinds the rocks. Water or drilling mud is pumped down the drilling stem. Cuttings are carried to the surface in the annular space between the drilling stem and the wall of the hole. Note that separate categories are provided for air-rotary and reverse-rotary.

J – Jetted. Jetted wells are excavated by using high velocity streams of water that are pumped through a pipe having a restricted opening or jetting nozzle. For some types of earth material, a cutting bit is attached to the end of the jetting nozzle. The material cut or washed from the hole is carried to the surface in the annular space outside the pipe as in the hydraulic-rotary method.

M – Mud.

P – Air Percussion. This method uses a cutting tool powered by compressed air. A rapid percussion effect, coupled with rotary action, is used to drill through the earth material. Compressed air is also used to blow cuttings from the drill hole. Air-percussion drills are generally used in conjunction with air-rotary drilling rigs.

Drill Method cont.:

R – Reverse Rotary. This method is similar to the hydraulic rotary method, except that the water or drilling mud flows down the annular space between the drilling stem and the walls of the hole, and the cuttings are pumped out through the drill stem

X – Dual Rotary.

T – Trenching. Refers to the construction of a sump or open pit from which groundwater may be pumped. Trenching may be done by hand, but more commonly by using power equipment, such as a bulldozer, power shovel, or back-hoe is used. Ponds and drains belong in this category.

V – Driven. A well constructed by driving a length of pipe, usually of a small diameter and generally equipped with a sand point, to a desired depth. These wells may be driven by hand or with an air hammer or other power equipment. An essential feature of a driven well is that no earth material is removed as the well is constructed.

W – Drive and Wash. These wells are constructed by driving a small diameter open-ended casing a few feet into the earth and then washing the material inside the casing out with a jet of water. The process is repeated until the well is at the desired depth.

Z – Other. Any other drilling method that may be used. The method may be described in the Remark Field.

Source of Construction Data:

(GWSI_WELL_COMPLETIONS . WLCO_ADWRS_CODE)

(CODE LOOKUP TABLE: GWSI_ADWR_SOURCES)

This field contains the source of the construction data and has the same letter codes as those found in the GWSI_ADWR_SOURCES field in the Sites Data Table. See page 20 for the appropriate letter codes.

Name of Driller:

(GWSI_WELL_COMPLETIONS . WLCO_DRILLER_NAME)

(CODE LOOKUP TABLE: N/A)

This field contains the name of the driller or drilling company that constructed the well. For very long company names, use meaningful abbreviations as needed to fit the name into the space provided.

Valid Completion Date:

(GWSI_WELL_COMPLETIONS . WLCO_VALID_DATE)

(CODE LOOKUP TABLE: N/A)

This field contains a flag that indicates the accuracy of the well completion date. See the previous explanation of the Valid Date field. This cannot be viewed or edited within the GWSI application.

Construction Entry Number:

(GWSI_WELL_COMPLETIONS . WLCO_ID)

(CODE LOOKUP TABLE: N/A)

Construction data can be entered more than once for a given site, such as when a well is deepened, or some other major work is done. Therefore, a unique identifying control number is assigned by ORACLE for each construction data entry. The number need not be sequential but needs to be unique for the site. The unique construction number is also assigned to any related construction information that is entered into the Bore Completions, Casing Completions, and Perforation Completions Data Tables.

Last Action Date:

(GWSI_WELL_COMPLETIONS . WLCO_LAST_ACT_DATE)

(CODE LOOKUP TABLE: N/A)

This field is filled by ORACLE with the date when any field in the Well Completions data table is changed or modified. This cannot be viewed or edited within the GWSI application.

Last Action Operator:

(GWSI_WELL_COMPLETIONS . WLCO_LAST_ACT_OPER)

(CODE LOOKUP TABLE: N/A)

This field is filled by ORACLE with the user ID of the last person to modify or change any field in the Well Completions data table. This cannot be viewed or edited within the GWSI application.

Bore Hole Completions Data Table (BORE_COMPLETIONS)

The Bore Hole Completions Data Table is used to record specific data describing the drill hole for a well site.

Bore Hole Completion Date:

(GWSI_BORE_COMPLETIONS . BORE_WLCOMP_DATE)

(CODE LOOKUP TABLE: N/A)

This entry is the date the drilling was completed. If the day or month are not known enter 01 for the month and 01 for the day and enter the appropriate letter code into the Date Valid Field.

Top of Bore Hole:

(GWSI_BORE_COMPLETIONS . BORE_HOLE_TOP)

(CODE LOOKUP TABLE: N/A)

This is the depth to the point at which the top of a segment of the hole begins, in feet below land surface. The first section of the hole begins at zero (0).

Bottom of Bore Hole:

(GWSI_BORE_COMPLETIONS . BORE_HOLE_BOTTOM)

(CODE LOOKUP TABLE: N/A)

This is the depth to the bottom of the hole segment, in feet below land surface.

Diameter of Bore Hole:

(GWSI_BORE_COMPLETIONS . BORE_HOLE_DIAMETER)

(CODE LOOKUP TABLE: N/A)

This is the normal diameter of the bit used to drill this section of the hole, or the diameter to which the hole was reamed, in inches. Two decimal places are provided for fractional sizes.

Construction Entry Number:

(GWSI_BORE_COMPLETIONS . BORE_WLCOMP_ID)

(CODE LOOKUP TABLE: N/A)

The construction entry is the unique control number assigned by ORACLE to well construction data in the Well Completions Data Table. This control number is assigned to the corresponding bore hole construction information.

Bore Hole Interval:

(GWSI_BORE_COMPLETIONS . BORE_HOLE_INTERVAL)

(CODE LOOKUP TABLE: N/A)

This field contains a sequential number assigned by ORACLE to each separate bore hole diameter record for a specific construction entry number. For example, a bore hole that is drilled at 16 inches in diameter from land surface to 500 feet below land surface and then drilled at 12 inches in diameter from 500 feet below land surface to 750 feet below land surface would have two bore hole intervals. The first interval is 0 to 500 feet, the second bore hole interval is 500 to 750 feet. The interval numbers for the bore hole completions data table are assigned sequentially and generally start from the construction entry number. For example, for a well with a construction entry number of 451384, the first bore hole interval would be assigned 451385, and a second bore hole interval would be assigned 451386.

Last Action Date:

(GWSI_BORE_COMPLETIONS . BORE_LAST_ACT_DATE)

(CODE LOOKUP TABLE: N/A)

This field is filled by ORACLE with the date when any field in the Bore Completions data table is changed or modified. This cannot be viewed or edited within the GWSI application.

Last Action Operator:

(GWSI_BORE_COMPLETIONS . BORE_LAST_ACT_OPER)

(CODE LOOKUP TABLE: N/A)

This field is filled by ORACLE with the user id of the last person to modify or change any field in the Bore Completions data table. This cannot be viewed or edited within the GWSI application.

Casing Completion Data Table (CASING_COMPLETIONS)

The Casing Completions Data Table describes information about the casing of a well. Please note, that if field completion measurements are taken for a site then a new completion record needs to be created with ADWR as the source.

Top of Casing:

(GWSI_CASING_COMPLETIONS . CASE_TOP)

(CODE LOOKUP TABLE: N/A)

This is the depth to the point at which the top of a casing segment begins, in feet below land surface. The first section of casing begins at zero (0). A new entry should be created for each change in casing diameter or material.

Bottom of Casing:

(GWSI_CASING_COMPLETIONS . CASE_BOTTOM)

(CODE LOOKUP TABLE: N/A)

This is the depth to the bottom of the casing segment, in feet below land surface.

Diameter of Casing:

(GWSI_CASING_COMPLETIONS . CASE_DIAMETER)

(CODE LOOKUP TABLE: N/A)

This is the outside diameter of the casing segment in inches. Two decimal places are provided for fractional sizes. If the diameter was measured in the field set the top of casing to equal zero (0) and list the diameter that was measured. No bottom depth will be necessary.

Casing Material:

(GWSI_CASING_COMPLETIONS . CASE_FINISH_CODE)

(CODE LOOKUP TABLE: GWSI_CASING_FINISHES)

This data table indicates the material from which the casing is made. The codes and their meanings are:

* – Undetermined
A - ABS
U – Coated Steel
W – Wood
Z – Other
I – Wrought Iron
B – Brick
C – Concrete
D – Copper
G – Galvanized Iron
T – Tile
M – Other Metal
P – PVC or Any Plastic
R – Rock or Stone
S – Steel

Construction Entry Number:

(GWSI_CASING_COMPLETIONS . CASE_WLCOMP_ID)

(CODE LOOKUP TABLE: N/A)

The construction entry number is the unique control number assigned by ORACLE to well construction data in the Well Completions Data Table. This control number is assigned to the corresponding well casing information.

Casing Interval:

(GWSI_CASING_COMPLETIONS . CASE_INTERVAL)

(CODE LOOKUP TABLE: N/A)

This is a sequential number assigned to each casing diameter for a specific construction entry number. For example, a well that is cased at 16 inches in diameter from land surface to 500 feet below land surface and then cased at 12 inches in diameter from 500 feet below land surface to 750 feet below land surface would have two casing intervals. The first casing interval is 0 to 500 feet, the second casing interval is 500 to 750 feet. The casing interval numbers are assigned sequentially and generally start from the construction entry number.

Last Action Date:

(GWSI_CASING_COMPLETIONS . CASE_LAST_ACT_DATE)

(CODE LOOKUP TABLE: N/A)

This field is filled by ORACLE with the date when any field in the Casing Completions Data Table is changed or modified. This cannot be viewed or edited within the GWSI application.

Last Action Operator:

(GWSI_CASING_COMPLETIONS . CASE_LAST_ACT_OPER)

(CODE LOOKUP TABLE: N/A)

This field is filled by ORACLE with the user ID of the last person to change or modify the Casing Completions Data Table. This cannot be viewed or edited within the GWSI application.

Perforation Completion Data Table (PERFORATION_COMPLETION)

The Perforation Completion Data Table is used to record information about the openings through which water enters a well.

Top of Perforation:

(GWSI_PERFORATION_COMPLETIONS . PERF_TOP)

(CODE LOOKUP TABLE: N/A)

This field contains the depth to the point at which the top of a perforated segment begins, in feet below land surface.

Bottom of Perforation:

(GWSI_PERFORATION_COMPLETIONS . PERF_BOTTOM)

(CODE LOOKUP TABLE: N/A)

This field contains the depth to the bottom of the perforated segment, in feet below land surface.

Diameter of Perforation Casing:

(GWSI_PERFORATION_COMPLETIONS . PERF_DIAMETER)

(CODE LOOKUP TABLE: N/A)

This field records the outside diameter, in inches, of the perforated casing or slotted pipe, the diameter of a screen, or the diameter of the hole, if the well is finished as an open hole. Two decimal places are provided for fractional sizes.

Width of Perforations:

(GWSI_PERFORATION_COMPLETIONS . PERF_WIDTH)

(CODE LOOKUP TABLE: N/A)

This field records the short dimension of the perforations or slots, or the mesh size of the screen, in inches.

Length of Perforations:

(GWSI_PERFORATION_COMPLETIONS . PERF_LENGTH)

(CODE LOOKUP TABLE: N/A)

This field records the long dimension of the perforations or slots, in inches, or the individual openings in the screen or slotted pipe.

Screening Material:

(GWSI_PERFORATION_COMPLETIONS . PERF_MATERIAL_CODE)

(CODE LOOKUP TABLE: GWSI_SCREEN_MATERIALS)

This is a code that indicates the type of material from which the screen or other open section is made. The codes and their meanings are:

* – Undetermined
B – Brass or Bronze
C – Concrete
G – Galvanized Iron
I – Wrought Iron
M – Other Metal
P – PVC or Any Plastic
R – Stainless Steel
S – Steel
T – Tile
Z – Other

Perforation Type:

(GWSI_PERFORATION_COMPLETIONS . PERF_TYPE_CODE)

(CODE LOOKUP TABLE: GWSI_PERFORATION_TYPES)

This entry indicates the type of open section that allows groundwater to enter the well. The codes and their meanings are:

* – Undetermined
F – Fracture
K -- Mills Knife
L – Louvered or Shuttered
M – Mesh
P – Perforated or Slotted
R – Wire Wound
S – Screen (Type Unknown)
T – Sand Point
W – Walled
X – Open Hole
Z – Other

Construction Entry Number:

(GWSI_PERFORATION_COMPLETIONS . PERF_WLCOMP_ID)

(CODE LOOKUP TABLE: N/A)

The construction entry number is the unique control number assigned by ORACLE to well construction data in the Well Completions Data Table. This control number is assigned to the corresponding well perforation information.

Perforation Interval:

(GWSI_PERFORATION_COMPLETIONS . PERF_INTERVAL)

(CODE LOOKUP TABLE: N/A)

This is a sequential number assigned to each perforation interval for a specific construction entry number. For example, a well that is perforated from 200 feet below land surface to 500 feet below land surface and then perforated from 600 feet below land surface to 750 feet below land surface would have two perforation intervals. The first perforated interval is 200 to 500 feet, the second perforated interval is 600 to 750 feet. The interval numbers are assigned sequentially and generally start from the construction entry number.

Last Action Date:

(GWSI_PERFORATION_COMPLETIONS . PERF_LAST_ACT_DATE)

(CODE LOOKUP TABLE: N/A)

This field is filled by ORACLE with the date, when any field in the Perforation Completions Data Table is changed or modified. This cannot be viewed or edited within the GWSI application.

Last Action Operator:

(GWSI_PERFORATION_COMPLETIONS . PERF_LAST_ACT_OPER)

(CODE LOOKUP TABLE: N/A)

This field is filled by ORACLE with the user ID of the last person to modify or change any field in the Perforation Completions Data Table. Not viewed in GWSI.

Miscellaneous Details (MISC)

This includes the fields for the following tables: Site Inventories; Spring Names; WQ Reports; Well Logs and Monitoring.

Site Inventories Data Table (SITE_INVENTORIES)

The Site Inventories Data Table contains information on the date of the site visit and the name of the person who made the site visit.

Site Inventory Date:

(GWSI_SITE_INVENTORIES . SITI_INVENTORY_DATE)

(CODE LOOKUP TABLE: N/A)

This field records the date that the site was visited.

Inventoried By:

(GWSI_SITE_INVENTORIES . SITI_INVENTORIED_BY)

(CODE LOOKUP TABLE: N/A)

This field is used to record the name of the person making the site inventory or visit. (The last name is entered first followed by a comma, a space, and the first and middle initials. Do not include periods or extra spaces. Examples are listed below.)

BARNES, RL BLACK, K MASON, DA RASCONA, S

Complete ? :

Includes two possible options:

Day was missing in original date Month and day missing in original date

Inventory Valid Date:

(GWSI_SITE_INVENTORIES . SITI_VALID_DATE)

(CODE LOOKUP TABLE: N/A)

This field contains a flag that indicates the accuracy of the Inventory Date. See the previous explanation of the Date Valid Field.

Site Inventory ID:

(GWSI_SITE_INVENTORIES . SITI_ID)

(CODE LOOKUP TABLE: N/A)

Each site inventory visit is assigned a unique identifying number by ORACLE that is a sequential variation of the construction entry number.

Last Action Date:

(GWSI_SITE_INVENTORIES . SITI_LAST_ACT_DATE)

(CODE LOOKUP TABLE: N/A)

This field is filled by ORACLE with the date when any field in the Site Inventories Data Table is changed or modified. This cannot be viewed or edited within the GWSI application.

Last Action Operator:

(GWSI_SITE_INVENTORIES . SITI_LAST_ACT_OPER)

(CODE LOOKUP TABLE: N/A)

This field is filled by ORACLE with the user id of the last person to change or modify any field in the Site Inventories Data Table. This cannot be viewed or edited within the GWSI application.

Spring Names Data Table (SPRING_NAMES)

The Spring Names Data Table is used to record the name of flowing springs that have been inventoried. Additional data, such as spring type, flow variability, spring name, and any site improvements may also be entered into the record.

<u>Spring Name:</u>

(GWSI_SPRING_NAMES . SPNA_SPRING_NAME)

(CODE LOOKUP TABLE: N/A)

This field is used to record the name, if any is given, that has been assigned to the spring.

<u>Flow Variability:</u>

(GWSI_SPRING_NAMES . SPNA_FLOW_VARIABILITY)

(CODE LOOKUP TABLE: N/A)

This field is for recording the variability of a spring.

<u>Permanence:</u>

(GWSI_SPRING_NAMES . SPNA_SPPERM_CODE_ENTRY)

(CODE LOOKUP TABLE: GWSI_SPRING_PERMANENCES)

This field is used to describe the dependability of the spring flow, if it is known, at the site.

* – Undetermined
E – Periodic- Ebb and Flow
G – Geyser
I – Intermittent
P – Perennial
R – Response to Precipitation
S – Seasonal
Z – Other

Spring Improvements:

(GWSI_SPRING_NAMES . SPNA_SPIMPRV_CODE_ENTRY)

(CODE LOOKUP TABLE: GWSI_SPRING_IMPROVMENTS)

This field contains the record of any improvements that have been made to the site to improve, impound or redirect the spring flow.

* – Undetermined
B – Boxed Basin
C – Concrete Gallery
G – Gallery
H – Spring House
L – Lined
N – None
P – Pond
R – Pipe
T – Trough
Z – Other

Type of Spring:

(GWSI_SPRING_NAMES . SPNA_SPTYPE_CODE_ENTRY)

(CODE LOOKUP TABLE: GWSI_SPRING_TYPES)

This field is used to describe the type of spring found at the site.

* – Undetermined
A – Artesian
B – Perched or Contact
C – Contact
D – Depression
E – Perched and Depression
F – Fracture
H – Perched or Tubular
J – Artesian and Depression
K – Artesian and Seepage
L – Fracture and Depression
O – Perched and Fracture
P – Perched
R – Perched Seepage
S – Seepage of Filtration
T – Tubular Cave
Z – Other

Last Action Date:

(GWSI_SPRING_NAMES . SPNA_LAST_ACT_DATE)

(CODE LOOKUP TABLE: N/A)

This field is filled by ORACLE with the date when any field in the Spring Name Data Table is changed or modified. This cannot be viewed or edited within the GWSI application.

Last Action Operator:

(GWSI_SPRING_NAMES . SPNA_LAST_ACT_OPER)

(CODE LOOKUP TABLE: N/A)

This field is filled by ORACLE with the user ID of the last person to modify or change any field in the Spring Name Data Table. This cannot be viewed or edited within the GWSI application.

Water Quality Reports Data Table (WQ_REPORTS)

The Water Quality Data table contains six (6) basic water quality parameters that are gathered by Department personnel during field investigations. The six parameters are specific conductance, in microsiemens per centimeter at 25 degrees Celsius; fluoride, in milligrams per liter (mg/L); temperature, in degrees Celsius; pH; alkalinity as $CaCO_3$, in milligrams per liter; and dissolved oxygen, in milligrams per liter. Not all parameters may have been tested for at any given site and at any given time. Blank data in the water quality fields indicate that the parameter was not tested for at the time of sampling.

Water Quality ID:

(GWSI_WQ_REPORTS . WATQ_ID)

(CODE LOOKUP TABLE: N/A)

Each water quality measurement entry for a site is assigned a unique identifying number by ORACLE that is a sequential variation of the construction entry number.

Date Collected:

(GWSI_WQ_REPORTS . WATQ_DATE_MEASURED)

(CODE LOOKUP TABLE: N/A)

This field records the date that the water quality sample was analyzed at the site.

Specific Conductance:

(GWSI_WQ_REPORTS . WATQ_SPECIFIC_CONDUCTANCE)

(CODE LOOKUP TABLE: N/A)

Specific conductance is a measure of the electrical conductance of a water sample, and as such, is an indicator of the amount of total dissolved solids (TDS) in a sample. The specific conductance value is reported as microsiemens per centimeter at 25 degrees Celsius.

Fluoride:

(GWSI_WQ_REPORTS . WATQ_FLUORIDE)

(CODE LOOKUP TABLE: N/A)

Fluoride is measured to one decimal point in milligrams per liter (mg/L).

Temperature:

(GWSI_WQ_REPORTS . WATQ_TEMPERATURE_CELCIUS)

(CODE LOOKUP TABLE: N/A)

Temperature is the water temperature in degrees Celsius (^oC) at the time of sampling. The temperature can be entered to one decimal point.

pH:

(GWSI_WQ_REPORTS . WATQ_PH)

(CODE LOOKUP TABLE: N/A)

The pH is a measure of the hydrogen activity of the sample. The pH can be entered to one decimal point.

Alkalinity:

(GWSI_WQ_REPORTS . WATQ_ALKALINITY)

(CODE LOOKUP TABLE: N/A)

Alkalinity is a measure of metallic ions, principally calcium and magnesium, in the water sample and is reported as milligrams per liter (mg/L) of calcium carbonate ($CaCO_3$).

Dissolved Oxygen:

(GWSI_WQ_REPORTS . WATQ_DISSOLVED_OXYGEN)

(CODE LOOKUP TABLE: N/A)

Dissolved oxygen is the measure of the amount of oxygen dissolved in water and is measured in milligrams per liter (mg/L).

Last Action Date:

(GWSI_WQ_REPORTS . WATQ_LAST_ACT_DATE)

(CODE LOOKUP TABLE: N/A)

This field is filled by ORACLE with the date when any field in the Water Quality Data Table is changed or modified. This cannot be viewed or edited within the GWSI application.

Last Action Operator:

(GWSI_WQ_REPORTS . WATQ_LAST_ACT_OPER)

(CODE LOOKUP TABLE: N/A)

This field is filled by ORACLE with the user ID of the last person to modify or change any field in the Water Quality Data Table. This cannot be viewed or edited within the GWSI application.

Valid Date:

(GWSI_WQ_REPORTS . WATQ_DATE_VALID)

(CODE LOOKUP TABLE: N/A)

This field contains a flag that indicates the accuracy of the Water Quality Date. See the previous explanation of the Date Valid Field. This cannot be viewed or edited within the GWSI application.

Well Log Data Table (WELL_LOGS)

The Well Log Data Table contains information about the types of geophysical and/or other log data available for the site.

Log Type:

(GWSI_WELL_LOGS . WLLO_LOGTYP_CODE_ENTRY)

(CODE LOOKUP TABLE: GWSI_LOG_TYPES)

This field contains letter codes for the types of logs that are available for a site.

* – Undetermined
A – Time
B – Collar
C – Caliper
D – Driller
E – Electric
F – Fluid Conductance
G – Geologist
I – Induction
J – Gamma Ray
K – Dipmeter
L – Lathering
M – Microlog
N – Neutron
O – U Later
P – Photo
Q – Radioactive
S – Sonic
T – Temperature
U – Gamma–Gamma
V – Fluid Velocity
X – Core
Z – Other

Log Start:

(GWSI_WELL_LOGS . WLLO_LOG_START)

(CODE LOOKUP TABLE: N/A)

This field contains the depth to the top of the logged interval, in feet below land surface.

Log End:

(GWSI_WELL LOGS . WLLO_LOG_END)

(CODE LOOKUP TABLE: N/A)

This field contains the depth to the bottom of the logged interval, in feet below land surface.

Source of Log Data:

(GWSI_WELL_LOGS . WLLO_ADWRS_CODE)

(CODE LOOKUP TABLE: GWSI_ADWR_SOURCES)

This fields contains information that indicates who provided the log information. The codes are the same as those found in the Sites_Adwrs_Code field in Sites Data Table found on page 20.

Last Action Date:

(GWSI_WELL_LOGS . WLLO_LAST_ACT_DATE)

(CODE LOOKUP TABLE: N/A)

This field is filled by ORACLE with the date when any field in the Well Logs Data table is changed or modified.

Last Action Operator:

(GWSI_WELL_LOGS . WLLO_LAST_ACT_OPER)

(CODE LOOKUP TABLE: N/A)

This field is filled by ORACLE with the user ID of the last person to modify or change any field in the Well Logs Data Table.

Monitoring

Monitoring ID:

(GWSI_GWSI_MONITORING . MON_ID)

(CODE LOOKUP TABLE: N/A)

Each monitoring entry for a site is assigned a unique identifying number by ORACLE that is a sequential variation of the construction entry number.

Monitoring Start Date:

(GWSI_GWSI_MONITORING . MON_START_DATE)

(CODE LOOKUP TABLE: N/A)

The date for which the selected type of monitoring started.

Monitoring End Date:

(GWSI_GWSI_MONITORING . MON_END_DATE)

(CODE LOOKUP TABLE: N/A)

The date for which the selected type of monitoring ended.

Monitoring CREATEDT:

(GWSI_GWSI_MONITORING . MON_CREATEDT)

(CODE LOOKUP TABLE: N/A)

The date which the monitoring code was added.

Monitoring Program Supported:

(GWSI_GWSI_MONITORING . MON_PROG_SUPPORTED)

(CODE LOOKUP TABLE: GWSI_GWSI_MON_CODES)

This field contains letter codes for the types of monitoring for a site, as shown below.

Code Entry	Code Description
AZ001	D Aquifer
AZ002	N Aquifer
AZ003	R Aquifer
AZ004	C Aquifer
AZ005	Modeling - Phoenix AMA
AZ006	Modeling - Tucson AMA
AZ007	Modeling - Prescott AMA
AZ008	Modeling – Santa Cruz AMA
AZ009	Modeling – Pinal AMA
AZ010	Bowie Power Plant Agreement
AZ011	Drought
AZ012	Queen Valley Governor’s Inquiry
AZ013	Recharge Estimate – Near Gaging Station
AZ014	Buckeye Water Logged Area
AZ015	Big Chino – Verde Headwaters Support
AZ016	Annual Statewide Monitoring
AZ017	Seasonal Statewide Monitoring
AZ018	Del Rio Springs – Hydraulic Connection Investigation
AZ019	Joseph City INA Support
AZ020	Douglas City INA Support
AZ021	Arizona State Land Agreement - McMullen Valley
AZ022	Land Subsidence – Tonopah Recharge Project
AZ023	Willcox Basin – Water Level Declines
AZ024	USGS RWI Request – Mohave County
AZ025	USGS RWI Request - Middle San Pedro
AZ026	Picacho Pecan Groves – Director’s Request
AZ027	Management Goal Assessment
AZ028	Flood Monitoring
AZ029	National Groundwater Monitoring Network
AZ030	Water Quality State-Wide Monitoring

Monitoring Statute Required:

(GWSI_GWSI_MONITORING . MON_STATUTE_REQ)

(CODE LOOKUP TABLE: N/A)

This field contains the statute code, if one exists, for the selected monitoring purpose.

Monitoring Comments:

(GWSI_GWSI_MONITORING . MON_COMMENTS)

(CODE LOOKUP TABLE: N/A)

This field contains any related comments for the selected monitoring purpose.

Monitoring CREATEBY:

(GWSI_GWSI_MONITORING . MON_CREATEBY)

(CODE LOOKUP TABLE: N/A)

This field is filled by ORACLE with the user ID of the last person to modify or change any field in the well monitoring data table.

Last Action Date:

(GWSI_GWSI_MONITORING . MON_LAST_ACT_DATE)

(CODE LOOKUP TABLE: N/A)

This field is filled by ORACLE with the date when any field in the Data table is changed or modified.

Last Action Operator:

(GWSI_GWSI_MONITORING . MON_LAST_ACT_OPER)

(CODE LOOKUP TABLE: N/A)

This field is filled by ORACLE with the user ID of the last person to modify or change any field in the Data Table.

Transducer Details

Transducer Levels

Measurement Date:

(GWSI_TRANSDUCER_LEVELS . MEASUREMENT_DATE)

(CODE LOOKUP TABLE: N/A)

This field records the date and time that the discrete water level was recorded for the site.

Depth to Water (feet):

(GWSI_TRANSDUCER_LEVELS . DEPTH_TO_WATER)

(CODE LOOKUP TABLE: N/A)

This field records the depth to water, in feet, below land surface. Depth to water can be carried out to two decimal places. If the water level is above land surface, enter the water level in feet above land surface preceded by a minus (-) sign. If the head at a flowing site is unknown, if the water level cannot be measured, the site is dry, or the well destroyed, then this field is left blank and the appropriate code must be placed in the associated Water Level Remarks Code field (Measurement_Remark).

Water Level Elevation:

(GWSI_TRANSDUCER_LEVELS. WATER_LEVEL_ELVATION)

(CODE LOOKUP TABLE: N/A)

This field contains the elevation of the water table above mean sea level datum. This field is calculated by subtracting the depth to water from the well altitude as entered in the Sites Data table. Except for flowing wells, water level elevations are blank for records that have no depth to water measurements.

Source of Measurement:

(GWSI_TRANSDUCER_LEVELS. SOURCE_CODE)

(CODE LOOKUP TABLE: GWSI_DATA_SOURCES)

This field contains letter codes for the source of the water level measurement.

* – Undetermined
3 – Third Party
A – Arizona Department of Water Resources
B – U.S. Bureau of Reclamation
C – Consultant
D – Driller
E – New Mexico Office of the State Engineer
F – Arizona State Land Department
G – University of Arizona
J – Military
L – Arizona State Land Department
M – Bureau of Land Management
O – Owner
R – Other Reported
S – Salt River Project
T – City of Tucson
U – U.S. Geological Survey
W – Wellton-Mohawk Irrigation and Drainage District
Z – Other

Method of Water Level Measurement:

(GWSI_TRANSDUCER_LEVELS. METHOD CODE)

(CODE LOOKUP TABLE: GWSI_MM_CODES)

This field contains the code for the method used to measure the depth to water.

A – Airline
B – Analog or Graphic Recorder
C – Calibrated Airline
D – Differential G.P.S.
G – Pressure Gauge
H – Calibrated Pressure Gauge
L – Geophysical Logs
M – Manometer
R – Reported
S – Steel Tape
T – Electric Tape (Uncalibrated)
U – Undetermined

Method of Water Level Measurement cont.:

DC – Downhole Camera

E – Estimated

F – Automated Device

N – Non-Recording Gauge

O – Observed

P – Acoustic Pulse

V – Electric Sounder or Non-Electric Tape

VT – Electric Tape

Z – Other

Water Level Measurement Remarks:

(GWSI_TRANSDUCER_LEVELS. REMARK_CODE)

(CODE LOOKUP TABLE: GWSI_MR_CODES)

This field contains letter codes that describe the status of the site at the time of the water level measurement. If the water level measured represents a static level, this field is blank.

A – Atmospheric Pressure.

C – Ice.

D – Dry. The site was dry, and no water level was recorded.

E – Recently Flowing. The site had recently been flowing.

F – Flowing. The site was flowing, but no head could be measured (no water level is recorded).

G – Nearby Flowing. A nearby site was flowing at the time of measurement.

H – Nearby Recently Flowing. A nearby site had recently flowed.

I – Well Injecting. The well was being used to inject water into the aquifer at the time of the measurement attempt. Examples of injection wells are wells used to recharge water into an aquifer.

J – Nearby Injecting.

K – Cascading Water. Water was cascading down the well casing from some point above the water table.

L – Brackish Saline.

M – Well Plugged.

N – Measurements Discontinued at the site.

Water Level Measurement Remarks, cont.:

O – Obstructed. An obstruction in the well casing prevented a measurement (no water level is recorded).

P – Pumping. The site was being pumped at the time of measurement.

R – Recently Pumped. The site had been pumped recently.

S – Nearby Pumping. A site nearby was being pumped at the time of measurement.

T – Nearby Recently Pumped. A nearby site had recently been pumped.

U – Undetermined.

V – Foreign Material (Oil). A foreign material, usually oil, was encountered on the surface of the water table.

W – Well Destroyed. The well has been destroyed and no water level is recorded.

X – Surface Water Effects. The water level may be affected by a nearby surface water site.

Z – Other. Other conditions that may affect the measured water level. (Explain in the Remarks Data Table).

Temperature:

(GWSI_TRANSDUCER_LEVELS . TEMPERATURE)

(CODE LOOKUP TABLE: N/A)

This field records the water temperature in degrees Celsius at the time the discrete water level was recorded for the site.

Battery Voltage:

(GWSI_TRANSDUCER_LEVELS . BATTERY_VOLTAGE)

(CODE LOOKUP TABLE: N/A)

This field records the battery voltage of the digital recorder at the time the discrete water level was recorded for the site.

PSI:

(GWSI_TRANSDUCER_LEVELS . PSI)

(CODE LOOKUP TABLE: N/A)

This field records the pressure per square inch of the digital recorder at the time the discrete water level was recorded for the site.

Water Level Comments:

(GWSI_TRANSDUCER_LEVELS. COMMENTS)

(CODE LOOKUP TABLE: N/A)

The comments section field can be used to help clarify an entered Depth To Water, Method, Measurement Remark, UTM remark, or other information related to the entry.

Water Level ID:

(GWSI_TRANSDUCER_LEVELS . ID)

(CODE LOOKUP TABLE: N/A)

Each water level entry for a site is assigned a unique identifying number by ORACLE that is a sequential variation of the construction entry number.

Last Action Date:

(GWSI_TRANSDUCER_LEVELS . LAST_ACT_DATE)

(CODE LOOKUP TABLE: N/A)

This field is filled by ORACLE with the date when any field in the Water Levels Data Table is changed or modified. This cannot be viewed or edited within the GWSI application.

Last Action Operator:

(GWSI_TRANSDUCER_LEVELS . LAST_ACT_OPER)

(CODE LOOKUP TABLE: N/A)

This field is filled by ORACLE with the user id of the last person to modify or change any field in the Water Levels Data Table. This cannot be viewed or edited within the GWSI application.

Field Load

Tab for uploading automated data (Field Data). Automated data files are downloaded from each automated site and are quality checked before being uploaded to GWSI using this tab.

Extract Date:

(GWSI_TRANSDUCER_PARAMETERS . EXTRACT_DATE)

(CODE LOOKUP TABLE: N/A)

The date the automated data were downloaded from the automated site (equivalent to Measurement Date in WW Levels).

Measure Point If Not 0 (Surface Level):

(GWSI_TRANSDUCER_PARAMETERS)

(CODE LOOKUP TABLE: N/A)

Measuring point height of automated water level data ONLY IF the measuring point height was not properly accounted for at the site. Auto-populates with 0. This field should ALWAYS BE 0, except in extremely rare cases. Consult with the Automated Groundwater Monitoring Unit supervisor or the Field Services Section manager before uploading data with a non-0 Measure Point.

User Who Performed QC:

(GWSI_TRANSDUCER_PARAMETERS . HEADER)

(CODE LOOKUP TABLE: N/A)

User who performed the quality control of the automated data. Auto-populates with user that is signed into the GWSI application.

Data Source:

(GWSI_TRANSDUCER_LEVELS. SOURCE_CODE)

(CODE LOOKUP TABLE: GWSI_DATA_SOURCES)

Agency/Organization that is the source of the automated data. The codes are derived from the GWSI_DATA_SOURCES code lookup table, as shown under 'Source of Measurement', found on page 30.

Load Data box:

Relevant automated data files are displayed here. Automated data files are uploaded from L:\LOADFIELD (\\adwrtest\trans\LOADFIELD). User must select the file to upload and then click "Load Data" to upload file. The naming convention for data files is XXYYMMDD.csv, where XX is the two letter 'Other Site ID' assigned to the automated site, YY is the two digit year, MM is the two digit month, and DD is the two digit day that should correspond to the 'Extract Date'.

The automated data are stored in GWSI_TRANSDUCER_LEVELS.

Telemetry Load

Tab for uploading Telemetry Data. Telemetry data files are received daily and typically contain 4 records/measurements per site. These files are uploaded to GWSI automatically and do not require any user action, except in rare cases.

Extract Date:

(GWSI_TEL_TRANSDUCER_PARAMETERS . EXTRACT_DATE)

(CODE LOOKUP TABLE: N/A)

The date the automated data were transmitted from the automated site.

Measure Point If Not 0 (Surface Level):

(GWSI_TEL_TRANSDUCER_PARAMETERS)

(CODE LOOKUP TABLE: N/A)

Measuring point height of automated water level data ONLY IF the measuring point height was not properly accounted for at the site. Auto-populates with 0. This field should ALWAYS BE 0, except in extremely rare cases. Consult with the Automated Groundwater Monitoring Unit supervisor or the Field Services Section manager before uploading data with a non-0 Measure Point.

User Who Performed QC:

(GWSI_TEL_TRANSDUCER_PARAMETERS LAST_ACT_OPER)

(CODE LOOKUP TABLE: N/A)

User who performed the quality control on the automated data. Auto-populates with user that is signed into GWSI application.

Data Source:

(GWSI_TEL_TRANSDUCER_LEVELS . SOURCE_CODE)

(CODE LOOKUP TABLE: N/A)

Agency/Organization that is the source of the automated data.

Load Data box:

Relevant automated data files are displayed here. Automated data files are uploaded from L:\LOADTELEMETRY (\\adwrtest\trans\LOADTELEMETRY). User must select the file to upload and then click “Load Data” to upload file. The naming convention for data files is XX.csv, where XX is the two letter ‘Other Site ID’ assigned to the automated site.

The automated data are stored in GWSI_TEL_TRANSDUCER_LEVELS.

Hydro Graph

The Hydrograph tab is a built-in application tool that automatically plots water levels from the WW Levels tab over time.

Discharge

This tab contains fields for recording flowing and pumping discharges.

Flowing Discharge Data Table (FLOWING_DISCHARGES)

The Flowing Discharge Data Table is used to record data for water discharges or for naturally flowing springs. Occasionally, data for both flowing and pumped conditions will be collected for the same site. In the event that data are collected at a flowing site during natural flow and while pumping (to increase discharge or during a time of no natural flow), the pumped data should be entered in the Well Production Data Table.

Discharge Number:

(GWSI_FLOWING_DISCHARGES . FLWD_ID)

(CODE LOOKUP TABLE: N/A)

Each flowing discharge entry for a site is assigned a unique identifying number by ORACLE. The discharge numbers are assigned sequentially starting from the construction entry number and including any sequential numbers already assigned to records in other data tables with the same sites ID.

Measurement Date:

(GWSI_FLOWING_DISCHARGES . FLWD_MEASURE_DATE)

(CODE LOOKUP TABLE: N/A)

This field records the date on which the discharge was measured. The associated data field Date Valid indicates the accuracy of the measurement date. See the previous explanation of the Valid Date field.

Discharge Rate:

(GWSI_FLOWING_DISCHARGES . FLWD_DISCHARGE_RATE)

(CODE LOOKUP TABLE: N/A)

This is the discharge rate of the site in gallons per minute. If discharge is determined in other units (such as cfs or other metric units), convert to gallons per minute. Two decimal places are provided for very small discharges.

Flowing Discharge Measurement Method:

(GWSI_FLOWING_DISCHARGES . FLWD_DSCMTH_CODE_ENTRY)

(CODE LOOKUP TABLE: GWSI_DISCHARGE_METHODS)

This is the method by which the discharge was measured. The methods and their codes are:

* – Undetermined
B – Bailer
C – Current Meter [1]
E – Estimated
F – Flume
M – Totaling Meter
O – Orifice Plate
P – Pitometer
R – Reported
S – Ultrasonic Transit Time
T – Trajectory
V – Volumetric
W – Weir
Z – Other

[1] A current meter may be either a propeller-type meter in a discharge pipe, or an induction-type in a channel (e.g. Marsh-McBirney).

Discharge Data Source:

(GWSI_FLOWING_DISCHARGES . FLWD_DATASRC_CODE_ENTRY)

(CODE LOOKUP TABLE: GWSI_DATA_SOURCES)

This entry indicates who provided the discharge data. The codes are listed below:

* – Undetermined
3 – Third Party
A – Arizona Department of Water Resources
B – U.S. Bureau of Reclamation
C – Consultant
D – Driller
E – New Mexico Office of the State Engineer
F – Arizona Public Service
G – University of Arizona
J – Military
L – Arizona State Land Department
M – Bureau of Land Management
O – Owner
R – Other Reported
S – Salt River Project
T – City of Tucson
U – U.S. Geological Survey
W – Wellton Mohawk Irrigation and Power
Z – Other

Last Action Date:

(GWSI_FLOWING_DISCHARGES . FLWD_LAST_ACT_DATE)

(CODE LOOKUP TABLE: N/A)

This field is filled by ORACLE with the date when any field in the Flowing Discharges data table is changed or modified. This cannot be viewed or edited within the GWSI application.

Last Action Operator:

(GWSI_FLOWING_DISCHARGES . FLWD_LAST_ACT_OPER)

(CODE LOOKUP TABLE: N/A)

This field is filled by ORACLE with the user ID of the last person to modify or change any field in the Flowing Discharges data table. This cannot be viewed or edited within the GWSI application.

Flow Valid Date:

(GWSI_FLOWING_DISCHARGES . FLWD_DATE_VALID)

(CODE LOOKUP TABLE: N/A)

This field contains a flag that indicates the accuracy of the flowing discharge date. See the previous explanation of the Valid Date field.

Pumping Discharge Data Table (PUMPING_DISCHARGE)

The Pumping Discharge Data Table is used to record water levels and discharge data needed to estimate well performance for pumped well sites. Occasionally, data for both flowing and pumped conditions will be collected for the same site. In the event data are collected at a flowing site during natural flow while also being pumped (to increase discharge or during a time of no natural flow), the pumped data should be entered in this data table.

Discharge Number:

(GWSI_PUMPING_DISCHARGES . PMPD_ID)

(CODE LOOKUP TABLE: N/A)

Each discharge entry for a site is assigned a unique identifying number by ORACLE. The discharge numbers are assigned sequentially starting from the construction entry number and including any sequential numbers already assigned to records in other data tables with the same site ID.

Measurement Date:

(GWSI_PUMPING_DISCHARGES . PMPD_MEASURE_DATE)

(CODE LOOKUP TABLE: N/A)

This field records the date on which the discharge was measured. The associated data field Date Valid indicates the accuracy of the pumping discharge measurement date.

Discharge Rate:

(GWSI_PUMPING_DISCHARGES . PMPD_DISCHARGE_RATE)

(CODE LOOKUP TABLE: N/A)

This field contains the discharge rate of the site in gallons per minute. If discharge is determined in other units (such as cfs or other metric units), convert to gallons per minute. Two decimal places are provided for very small discharges.

Pumping Discharge Measurement Method:

(GWSI_PUMPING_DISCHARGES . PMPD_PMPDMTH_CODE_ENTRY)

(CODE LOOKUP TABLE: GWSI_PUMP_DISCHARGE_METHODS)

This field records the method by which the discharge was measured. The methods and their codes are listed below:

* – Undetermined
B – Bailer
C – Current Meter
E – Estimated
F – Flume
M – Totaling Meter
O – Orifice Plate
P – Pitometer
R – Reported
S – Ultrasonic Transit Time
T – Trajectory
U – Venturi
V – Volumetric
W – Weir
Z – Other

Discharge Data Source:

(GWSI_PUMPING_DISCHARGES . PMPD_DATA_SOURCE)

(CODE LOOKUP TABLE: GWSI_DATA_SOURCES)

This field indicates who provided the discharge data. The codes are derived from the GWSI_DATA_SOURCES code lookup table, as shown under ‘Source of Measurement’ found on page 30.

Production Water Level:

(GWSI_PUMPING_DISCHARGES . PMPD_PRODUCTION_WATER_LEVEL)

(CODE LOOKUP TABLE: N/A)

This field records the water level, in feet below land surface, while the well was discharging. The difference between this value and the static water level is the production drawdown.

Static Water Level:

(GWSI_PUMPING_DISCHARGES . PMPD_STATIC_WATER_LEVEL)

(CODE LOOKUP TABLE: N/A)

This field records the static, or pre-pumping, water level, in feet below land surface. If the static water level is above the land surface, the head (if measurable) is preceded by a minus sign (-).

Static Water Level Method:

(GWSI_PUMPING_DISCHARGES . PMPD_STATMTH_CODE_ENTRY)

(CODE LOOKUP TABLE: GWSI_STATIC_METHODS)

This field records the code that indicates the method by which the static water level was measured. If the static and production water levels were measured by different methods, record the method considered least accurate. The water level measurement codes are listed below.

* – Undetermined
A – Airline
B – Analog
C – Calibrated Airline
E – Estimated
G – Pressure Gauge
H – Calibrated Pressure Gauge
M – Manometer
N – Non-Recording Gauge
R – Reported
S – Steel Tape
T – Electric Tape
V – Electric Sounder
Z – Other

Static Water Level Source:

(GWSI_PUMPING_DISCHARGES . PMPD_STATIC_SOURCE)

(CODE LOOKUP TABLE: GWSI_DATA_SOURCES)

This field contains the code that indicates the source of the static water level measurement. The codes are derived from the GWSI_DATA_SOURCES code lookup table, as shown under ‘Source of Measurement’ found on page 30.

Pumping Period:

(GWSI_PUMPING_DISCHARGES . PMPD_PUMPING_PERIOD)

(CODE LOOKUP TABLE: N/A)

This field contains the length of time, in hours, that the well was pumped prior to the measurement of the production levels. Two decimal points are provided for times less than an hour.

Well Drawdown:

(GWSI_PUMPING_DISCHARGES . PMPD_WELL_DRAWDOWN)

(CODE LOOKUP TABLE: N/A)

This field contains the drawdown, in feet, of the pumping well (static level - pumping level).

Specific Capacity:

(GWSI_PUMPING_DISCHARGES . PMPD_SPECIFIC_CAPACITY)

(CODE LOOKUP TABLE: N/A)

The specific capacity is calculated by ORACLE from the Pumping level and the discharge rate.

Last Action Date:

(GWSI_PUMPING_DISCHARGES . PMPD_LAST_ACT_DATE)

(CODE LOOKUP TABLE: N/A)

This field is filled by ORACLE with the date when any field in the Pumping Discharges data table is changed or modified. This cannot be viewed or edited within the GWSI application.

Last Action Operator:

(GWSI_PUMPING_DISCHARGES . PMPD_LAST_ACT_OPER)

(CODE LOOKUP TABLE: N/A)

This field is filled by ORACLE with the user ID of the last person to modify or change any field in the Pumping Discharges data table. This cannot be viewed or edited within the GWSI application.

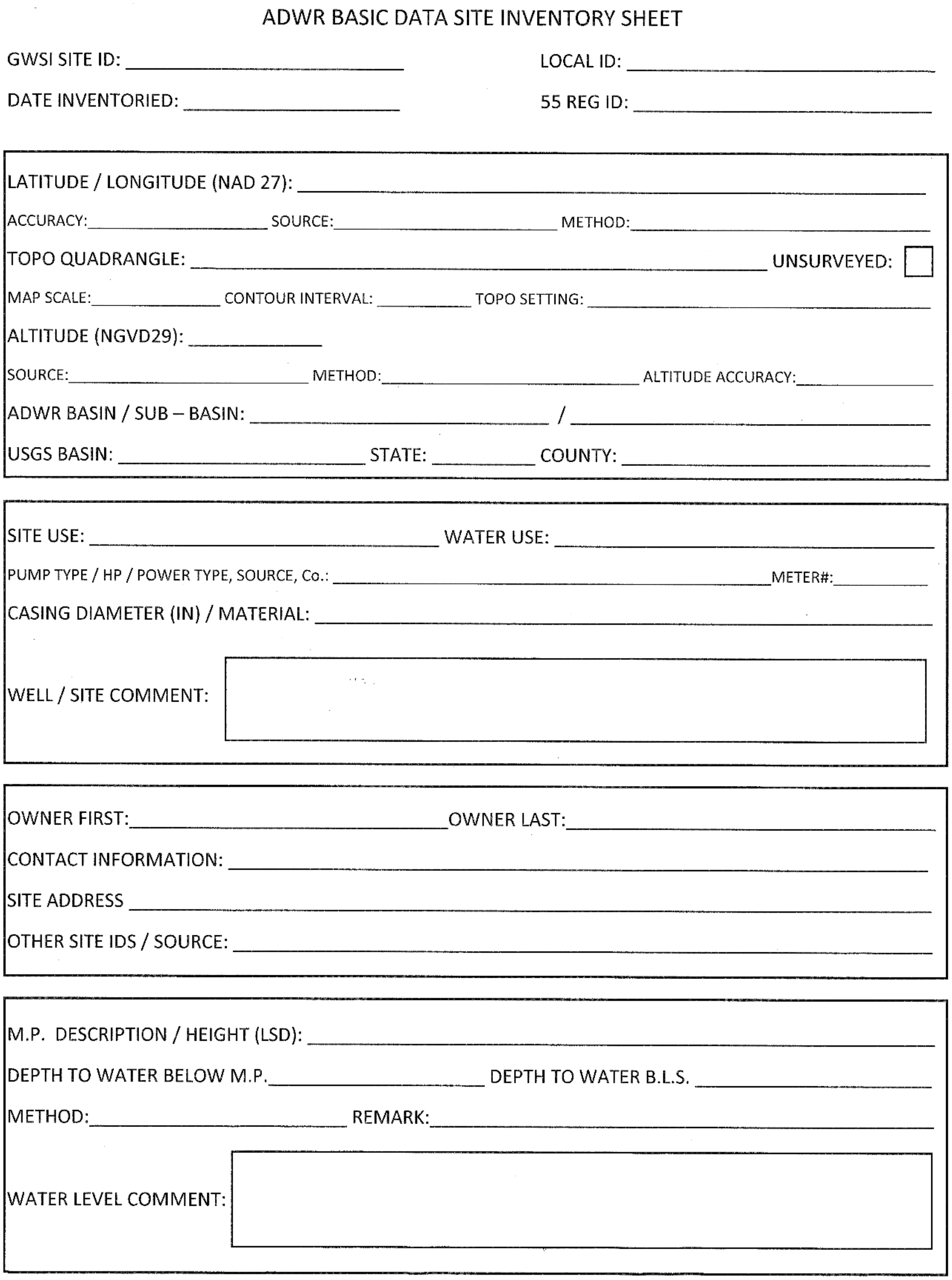
Pumping Valid Date:

(GWSI_PUMPING_DISCHARGES . PMPD_DATE_VALID)

(CODE LOOKUP TABLE: N/A)

This field contains a flag that indicates the accuracy of the Pumping Discharge date. See the previous explanation of the Valid Date field.

Appendix A: ADWR Basic Data Site Inventory Sheet



ADWR BASIC DATA SITE INVENTORY SHEET

GWSI SITE ID: ____________________ LOCAL ID: ____________________

DATE INVENTORIED: ________________ 55 REG ID: ____________________

LATITUDE / LONGITUDE (NAD 27): ______________________________

ACCURACY: __________ SOURCE: __________ METHOD: __________

TOPO QUADRANGLE: ______________________________ UNSURVEYED: ☐

MAP SCALE: ________ CONTOUR INTERVAL: ______ TOPO SETTING: ____________

ALTITUDE (NGVD29): ________

SOURCE: __________ METHOD: __________ ALTITUDE ACCURACY: ________

ADWR BASIN / SUB – BASIN: ________________ / ________________

USGS BASIN: ____________ STATE: ______ COUNTY: ____________

SITE USE: ________________ WATER USE: ________________

PUMP TYPE / HP / POWER TYPE, SOURCE, Co.: ______________________ METER#: ______

CASING DIAMETER (IN) / MATERIAL: ______________________________

WELL / SITE COMMENT: ☐

OWNER FIRST: ________________ OWNER LAST: ________________

CONTACT INFORMATION: ______________________________

SITE ADDRESS ______________________________

OTHER SITE IDS / SOURCE: ______________________________

M.P. DESCRIPTION / HEIGHT (LSD): ______________________________

DEPTH TO WATER BELOW M.P. ____________ DEPTH TO WATER B.L.S. ____________

METHOD: ____________ REMARK: ______________________

WATER LEVEL COMMENT: ☐

PICTURES: Y N PICTURE INFO: ______________________________

SKETCH

HAS REGISTRATION ID BEEN RESEARCHED? Y N

FIELD CHECKED BY: ______________________________

ENTERED INTO GWSI DATE: ______________________________

ENTERED BY (INITIALS): ______________________________

VALIDATED BY: ____________ DATE: ___________

Appendix A2: ADWR Basic Data Site Inventory Sheet, with GWSI table references

ADWR BASIC DATA SITE INVENTORY SHEET

GWSI SITE ID: Site – Site Detail-GWSI Site-Site ID LOCAL ID: Site – Site Detail – GWSI Site – Local ID

DATE INVENTORIED: Misc – Inventory Date 55 REG ID: Site – Site Detail – GWSI Site-Well Reg ID

LATITUDE / LONGITUDE (NAD 27): Site – Site Details – Location – Latitude/ Longitude_ ± Feet

ACCURACY: Site – Site Details – Location – Accuracy SOURCE: Site – Site Details – Location – Source METHOD: Site – Site Details – Location - Method

TOPO QUADRANGLE: _ Site – Site Details – GWSI Site-Quad Name UNSURVEYED: ☐

MAP SCALE: Site – Site Details – GWSI Site -Map Scale CONTOUR INTERVAL: =2 x Accuracy (Site – Site Details – Altitude- Accuracy)
TOPO SETTING: Site – Site Details – GWSI Site – Topo Setting

ALTITUDE (NGVD29): Site – Site Details – Altitude - Altitude

SOURCE: Site – Site Details – Altitude- Source METHOD: Site – Site Details – Altitude-Method ALTITUDE ACCURACY: Site – Site Details – Altitude- Accuracy

ADWR BASIN / SUB – BASIN: Site – Site Details – Basin/ Location – ADWR Basin / Site – Site Details – Basin/ Location – Sub-Basin

USGS BASIN: Site – Site Details – Basin/ Location -USGS Basin STATE: Site – Site Details – Basin/ Location -State
COUNTY: Site – Site Details – Basin/ Location - County

SITE USE: Site – Site Details - Site/Water Uses – Site WATER USE: Site – Site Details - Site/Water Uses - Water

PUMP TYPE / HP / POWER TYPE, SOURCE, Co.: Site – Site Details- Lifts – Lift Type/Pump Horse Power / Power Type/ Source
METER#: Site – Site Details- Lifts – Power Meter Number

CASING DIAMETER (IN) / MATERIAL: Comp – Casing – Diameter / Material

WELL / SITE COMMENT: Site – Site Details – Remarks – Remark

OWNER FIRST: Site – Site Details-Owners OWNER LAST: Site-Site Details-Owners

CONTACT INFORMATION: ________N/A____

SITE ADDRESS ______ N/A____

OTHER SITE IDS / SOURCE: Site – Site Details – Site Names - Other Site ID/ Other Site Name Assigner

M.P. DESCRIPTION / HEIGHT (LSD): **Site – Site Details – WM Points – Description/ MP Height**

DEPTH TO WATER BELOW M.P. **Site – Site Details – WW Levels – Depth to Water** DEPTH TO WATER B.L.S.

METHOD: **Site – Site details– WW Levels – Measurement Method** REMARK: **Site – Site details– WW Levels – Measurement Remark**

WATER LEVEL COMMENT **Site – Site details – WW levels - Comments**

PICTURES: Y N PICTURE INFO: ____

SKETCH

Site – Site details – Images

Check for pictures

HAS REGISTRATION ID BEEN RESEARCHED? Y N

Note – either 'Y' or 'N' should be circled above

FIELD CHECKED BY: **Misc – Site Inventories - Inventoried By**

ENTERED INTO GWSI DATE: **- should be populated**

ENTERED BY (INITIALS): **- should be populated**

VALIDATED BY: DATE: **Validation Date**

ADWR BASIC DATA SITE INVENTORY SHEET Revised: 8/26/2019 By: JMD N:\Basic Data\ Forms\Field Inventory Sheet V3.0

Appendix B: ADWR Groundwater Basin Codes

Listed below are the letter codes used to identify the ADWR Groundwater Basins, Sub-basins and Active Management Areas (AMAs). The locations of these areas are shown in Figures 5 and 6, below.

ADWR Non-Subdivided Groundwater Basins

Basin Name	Basin Code	Basin Name	Basin Code
Agua Fria	AGF	McMullen Valley	MMU
Aravaipa Canyon	ARA	Meadview	MEA
Bonita Creek	BON	Morenci	MOR
Butler Valley	BUT	Paria	PAR
Cienega Creek	CCK	Peach Springs	PSC
Coconino Plateau	COP	Ranagras Plain	RAN
Detrital Valley	DET	Sacramento Valley	SAC
Donnelly Wash	DON	San Bernardino Valley	SBV
Douglas	DOU	San Rafael	SRF
Dripping Springs Wash	DSW	San Simon Valley	SSV
Duncan Valley	DUN	San Simon Wash	SSW
New Mexico section of Duncan Valley Basin	DNM	Shivwits Plateau	SHV
Gila Bend	GIL	Tiger Wash	TIG
Grand Wash	GWA	Tonto Creek	TON
Hualapai Valley	HUA	Upper Hassayampa	UHA
Kanab Plateau	KAN	Virgin River	VRG
Lake Havasu	LKH	Western Mexican Drainage	WMD
Lake Mohave	MHV	Willcox	WIL
Little Colorado River Plateau	LCR	Yuma	YUM

ADWR Subdivided Groundwater Basins

Basin	Sub-basin	Basin Code
Big Sandy		**BIS**
	Fort Rock	FTR
	Wikieup	WIK
Bill Williams		**BWM**
	Alamo Reservoir	ALR
	Burro Creek	BUR
	Clara Peak	CLA
	Santa Maria	SMR
	Skull Valley	SKU
Lower Gila		**LGB**
	Childs Valley	CHV
	Dendora Valley	DEN
	Mohawk-Wellton	WEM
Lower San Pedro		**LSP**
	Camp Grant Wash	CGW
	Big Chino	BIC
	Verde Canyon	LVR
	Verde Valley	VER
	Mammoth	MAM

Basin Name	Sub-basin	Basin Code
Parker		**PKB**
	Colorado River Indian Reservation	CRI
	Cibola Valley	CIB
	La Posa Plains	LPC
Safford		**SAF**
	San Carlos Valley	GSK
	San Simon Valley	SSI
	Gila Valley	SAF
Salt River		**SRB**
	Black River	BRB
	White River	WRB
	Salt River Canyon	USR
	Salt River Lakes	SRL
Upper San Pedro		**USP**
	Allen Flat	ALF
	Sierra Vista	SEV
Verde River		**VRB**

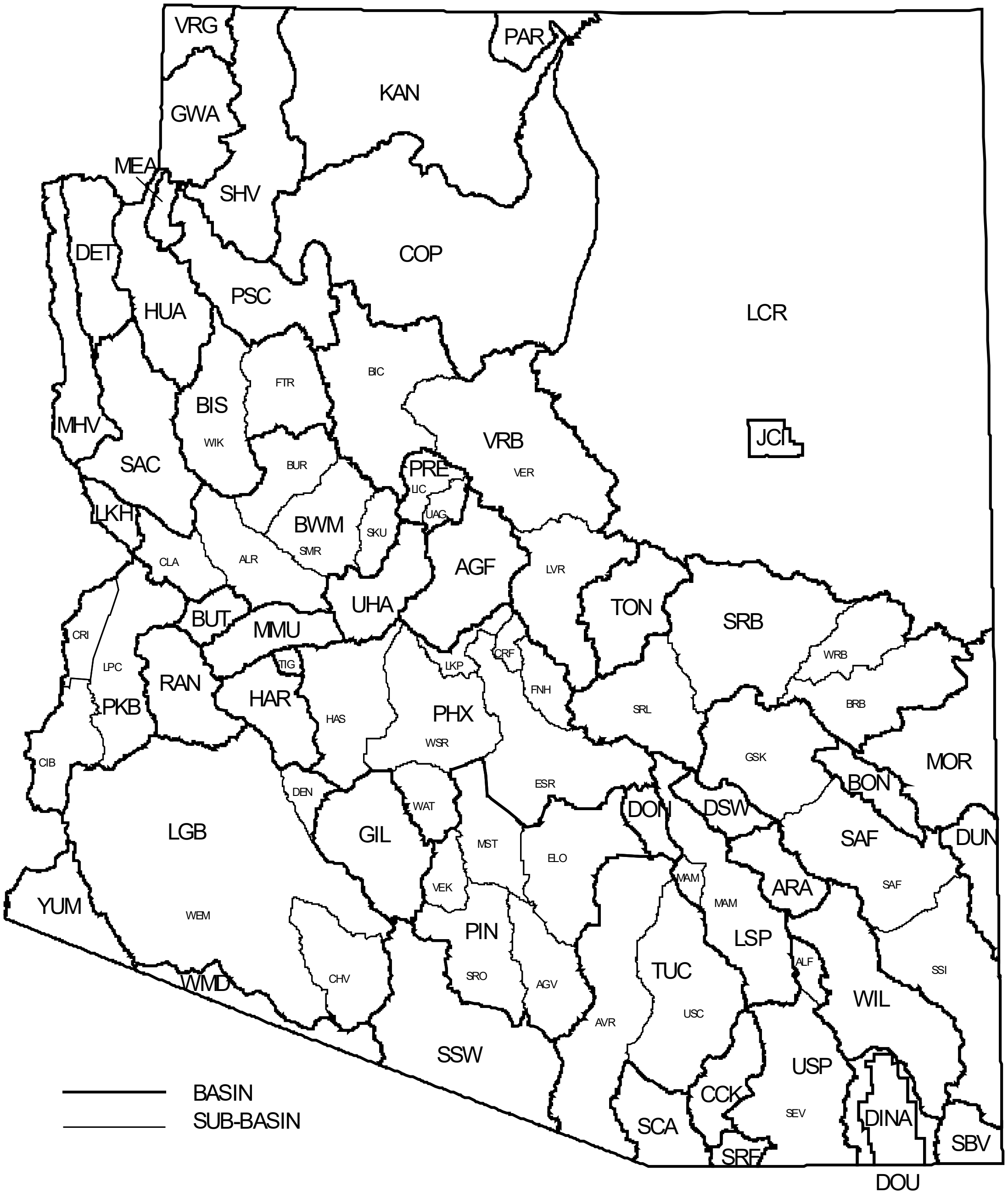


Figure 5. ADWR Groundwater Basins and Sub-basins Map.

ADWR Active Management Areas (AMA)

AMA Name	Sub-basin	**Code**
Phoenix AMA		**PHX**
	West Salt River Valley	WSR
	East Salt River Valley	ESR
	Carefree	CRF
	Lake Pleasant	LKP
	Fountain Hills	FNH
	Hassayampa	HAS
	Rainbow Valley	WAT
Pinal AMA		**PIN**
	Aguirre Valley	AGV
	Eloy	ELO
	Maricopa-Stanfield	MST
	Santa Rosa Valley	SRO
	Vekol Valley	VEK
Prescott AMA		**PRE**
	Upper Agua Fria	UAG
	Little Chino Valley	LIC
Santa Cruz AMA		**SCA**
Tucson AMA		**TUC**
	Avra Valley	AVR
	Upper Santa Cruz	USC

ADWR Irrigated Non-Expansion Areas (INA)

INA Name	**Code**
Douglas INA	DIN
Harquahala INA	HAR
Joseph City INA	JCI

Figure 6. ADWR Active Management Areas and Sub-basins Map.

Appendix C: U.S. Geological Survey Groundwater Area Codes

The letter codes used to identify the U.S. Geological Groundwater Areas, as shown in Figure 7.

Basin Name	Basin Code	Basin Name	Basin Code
Agua Fria Basin	AGF	Lower San Pedro	LSP
Altar Valley	ALT	Lower Santa Cruz	LSC
Aravaipa Valley	ARA	Lower Verde River	LHA
Avra Valley	AVR	McMullen Valley	MMU
Big Chino Valley	BIC	Monument Valley	MNV
Big Sandy Valley	BIS	New River-Cave Creek	N-C
Bill Williams	BWM	Peach Springs Canyon	PSC
Black Mesa	BLM	Puerco-Zuni	PRZ
Black River Basin	BRB	Ranegras Plain	RAN
Bodaway Mesa	BOD	Sacramento Valley	SAC
Butler Valley	BUT	Safford Basin	SAF
Canyon Diablo	CDI	Saint Johns	STJ
Chevelon	CHV	Salt River Valley	SRV
Chinle	CHN	San Bernardino Valley	SBV
Coconino Plateau	COP	San Francisco Peaks	SFP
Colorado River, Hoover Dam to Imperial Dam	CHI	San Francisco River Basin	SFR
Concho	CON	San Simon Basin	SSI
Douglas Basin	DOU	San Simon Wash	SSW
Duncan Basin	DUN	Shivwits	SHV
Gila Bend Basin	GIL	Snowflake	SNO
Gila River, Painted Rock Dam to Texas Hill	GRD	Tonto Basin	TON
Gila River, San Carlos Reservoir to Kelvin	GSK	Tuba City	TUB
Gila River, Texas Hill to Dome	GTD	Upper Salt River Basin	USR
Grand Wash	GRA	Upper San Pedro Basin	USP
Harquahala Plains	HAR	Upper Santa Cruz Basin	USC
Hassayampa Basin	HAS	Upper Verde River	VER
Holbrook	HOL	Virgin River	VRG
Hopi	HOP	Waterman Wash	WAT
House Rock	HOU	Western Mexican Drainage	WMD
Hualapai Valley	HUA	White Mountains	WHM
Kaibito	KAI	White River Basin	WRB
Kanab	KAN	Willcox Basin	WIL
Little Chino Valley	LIC	Williamson Valley	WMN
Lower Hassayampa	LHA	Yuma	YUM

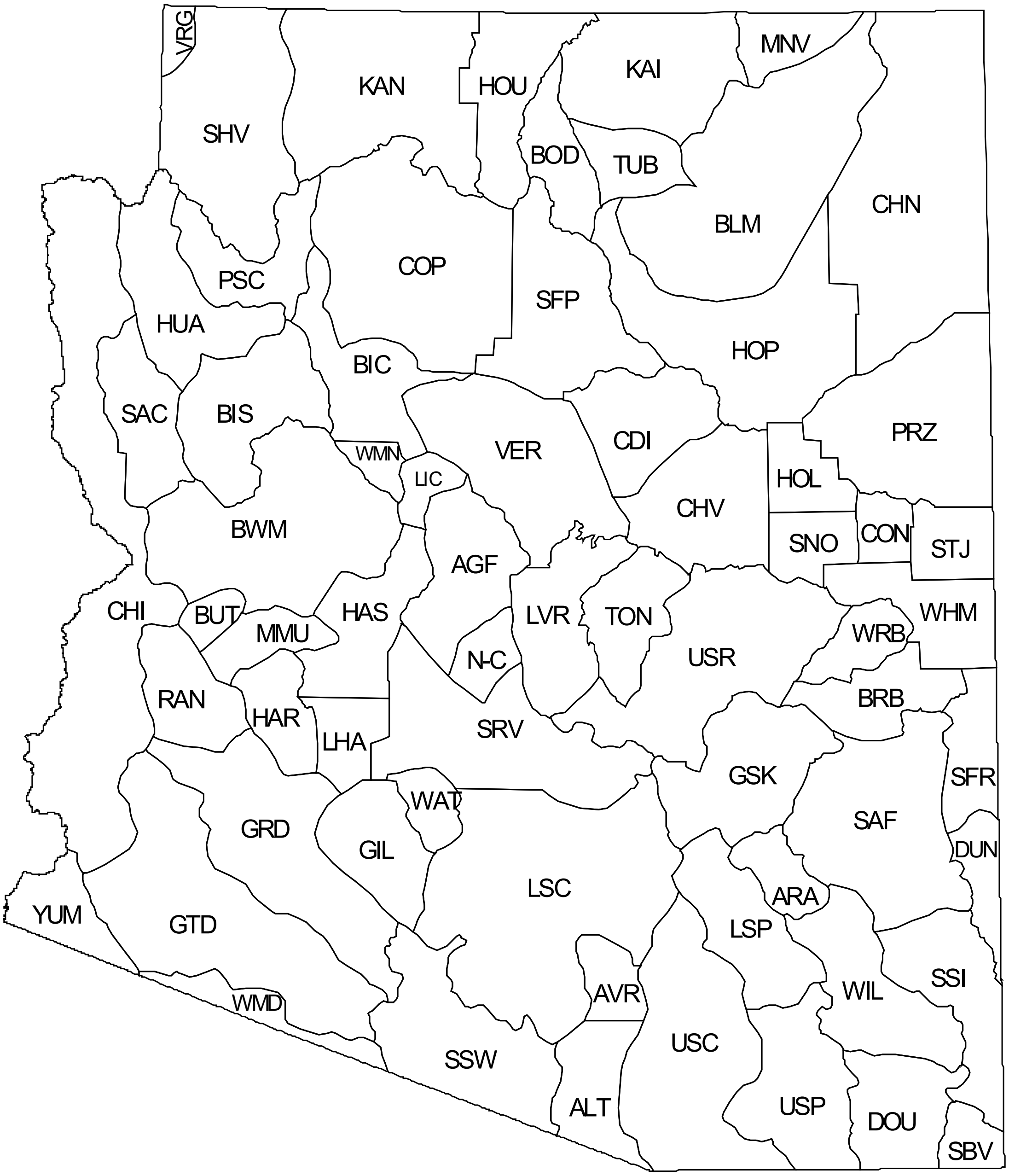


Figure 7. U. S. Geological Survey Groundwater Areas

Appendix D: Geological Unit Codes

Geological Unit Codes

Cenozoic	Quaternary		
		Holocene Alluvium (Flood-Plain and Stream Channel)	111ALVM
		Pleistocene	
		Basaltic Flows	112BLCF
		Basin Fill - Upper, Lower, Undifferentiated	112BSFL
		Basin Fill - Upper	112BSFLU
		Sand and Gravel - Upper	112SDGVU
		Terrace (and Surficial) Deposits	112TRRC
	Tertiary	Consolidated Sedimentary Rocks, Tertiary and Mesozoic Undifferentiated	120CDSM
		Datil Formation	120DATIL
		Felsic Volcanic Rocks	120FCVC
		Intrusive Rocks	120IRSV
		Mafic Volcanic Rocks	120MFCV
		Mafic and Felsic Volcanic Rocks	120MFFV
		Sedimentary Rocks	120SDMR
		Volcanic Rocks	120VLCC
		Pliocene	
		Bidahochi Formation	121BDHC
		Bidahochi Formation - Lower	121BDHCL
		Bidahochi Formation - Middle	121BDHCM
		Bidahochi Formation - Upper	121BDHCU
		Basaltic Flows	121BLCF
		Basin Fill - Lower	121BSFLL
		Chuska Sandstone	121CHSK
		Lower Basin Fill and Miocene Sedimentary Rocks - Undifferentiated	121LBFM
		Miocene	
		Basalt-Andesite Flows	122BLAD

		Sedimentary Rocks	122SDMR
		Volcanic Breccias, Agglomerates, and Tuffs	122VBAT
		Muddy Creek Formation	121MDCK
		Verde Formation	121VERD
		Oligocene	
		Felsic Flows or Welded Tuffs	123FFTW
		Sedimentary Rocks	123KDMR
		Mafic Flows	123MFCF
		Volcanic Breccias, Agglomerates, or Tuffs	123VBAT
		Volcanic Rocks	123VLCC
		Eocene	
		Felsic Volcanic Rocks	124FCVC
		Mafic Volcanic Rocks	124MFCV
		Sedimentary Rocks	124SDMR
		Paleocene	
		Nacimiento Formation	125NCMN
		Ojo Alamo Formation	125OJAM
Mesozoic		Felsic Intrusive Rocks	200FCIV
		Felsic Volcanic Rocks	200FCVC
		Mafic Volcanic Rocks	200MFCV
		Mafic Intrusive Rocks	200MFIV
		Sedimentary Rocks	200SDMR
		Volcanic Rocks	200VLCC
	Cretaceous	*Upper Cretaceous*	
		Allison Member of Menefee Formation of the Mesaverde Group	211ALSN
		Bartlett Barren Member of Crevasse Canyon Formation of the Mesaverde Group	211BRLB
		Cliff House Sandstone of the Mesaverde Group	211CLFH
		Cleary Coal Member of Menefee Formation of the Mesaverde Group	211CLRY
		Crevasse Canyon Formation of the Mesaverde Group	211CRVC

	Dilco Coal Member of Crevasse Canyon Formation of the Mesaverde Group	211DLCO
	Dalton Sandstone Member of Crevasse Canyon Formation of the Mesaverde Group	211DLTN
	Dakota Sandstone	211DOKT
	Fruitland Formation	211FRLD
	Farmington Sandstone Member of Kirkland Shale	211FRMG
	Gallup Sandstone	211GLLP
	Hosta Tongue of Point Lookout Sandstone of the Mesaverde Group	211HOST
	Juana Lopez Member of Mancos Shale	211JLPZ
	Kirkland Shale - Upper	211KRLDU
	Lewis Shale	211LWIS
	Menefee Formation	211MENF
	Mulatto Tongue of Mancos Shale	211MLTT
	Mancos Shale	211MNCS
	Pictured Cliffs Sandstone	211PCCF
	Point Lookout Sandstone	211PNLK
	Pescado Tongue of Mancos Shale	211PSCD
	Santan Tongue of Mancos Shale	211SATN
	Sedimentary Rocks - Undifferentiated	211SDMR
	Toreva Formation	211TORV
	Wepo Formation	211WEPO
	Yale Point Sandstone	211YLPN
	Lower Cretaceous	
	Burro Canyon Formation	217BRCN
Jurassic	Navajo Sandstone	220NVJO
	Upper Jurassic	
	Bluff Sandstone	221BLFF
	Brushy Basin Shale Member of Morrison Formation	221BRSB
	Carmel Formation	221CRML
	Cow Springs Sandstone	221CSPG
	Entrada Sandstone	221ENRD
	Entrada Sandstone - Lower	221ENRDL

	Entrada Sandstone - Middle	221ENRDM
	Entrada Sandstone - Upper	221ENRDU
	Morrison Formation	221MRSN
	Recapture Shale Member of the Morrison Formation	221RCPR
	Salt Wash Sandstone Member of the Morrison Formation	221SLWS
	Summerville Formation	221SMVL
	Todilto Limestone	221TDLT
	Westwater Canyon Sandstone Member of the Morrison Formation	221WSRC
<u>Triassic</u>	Hoskinnini Member of the Moenkopi Formation	230HSKN
	Moenkopi Formation	230MNKP
	Upper Triassic	
	Church Rock Member of Chinle Formation	231CCRK
	Chinle Formation	231CHNL
	Correo Sandstone Bed of Petrified Forest Member of Chinle Formation	231CORR
	Dinosaur Canyon Sandstone Member of Moenave Formation	231DSRC
	Kayenta Formation	231KYNT
	Lukachukai Member of Wingate Sandstone	231LKCK
	Monitor Butte Member of Chinle Formation	231MNRB
	Moenave Formation	231MOONV
	Mesa Redondo Member of Chinle Formation	231MRDD
	Owl Rock Member of Chinle Formation	231ORCK
	Petrified Forest Member - Lower - of Chinle Formation	231PFDFL
	Petrified Forest Member - Upper - of Chinle Formation	231PFDFU
	Rock Point Member of Wingate Sandstone	231RCKP
	Sonsela Sandstone Bed of Petrified Forest Member of Chinle Formation	231SNSL
	Springdale Sandstone Member of Moenave Formation	231SPGD
	Shinarump Member of Chinle Formation	231SRMP
	Wingate Sandstone	231WNGT
	Middle Triassic	
	Holbrook Sandstone Member of Moenkopi Formation	224HLBK

		Lower Triassic	
		Moqui Member of Moenkopi Formation	237MOQU
		Wapatki Member of Moenkopi Formation	237WPTK
Paleozoic		Limestone	300LMSN
		Quartzite	300QRTZ
		Sandstone	300SNDS
	Permian	Abo Formation	310ABO
		Coconino Formation	310CCNN
		Cedar Mesa Sandstone Member of Cutler Formation	310CDRM
		Cutler Formation	310CTLR
		De Chelly Sandstone	310DCLL
		Glorieta Sandstone	310GLRT
		Halgaito Tongue of Cutler Formation	310HLGT
		Hermit Shale	310HRMT
		Kaibab Limestone	310KIBB
		Meseta Blanca Sandstone Member of Yeso Formation	310MBLC
		Naco Formation	310NACO
		Organ Rock Tongue of Cutler Formation	310OGRK
		Rico Formation	310RICO
		Supai Formation	310SUPI
		Supai Formation - Lower	310SUPIL
		Supai Formation - Middle	310SUPIM
		Supai Formation - Upper	310SUPIU
		San Ysidro Member of Yeso Formation	310SYDR
		Toroweap Formation	310TRWP
		Yeso Formation	310YESO
		Guadalupian	
		San Andres Limestone	313SADR
		Pennsylvanian	
		Hermosa Formation	320HRMS
		Molas Formation	320MOLS

		Mississippian	
		Redwall Limestone	330RDLL
	Devonian	*Upper Devonian*	
		Martin Limestone	341MRTN
	Cambrian	*Middle Cambrian*	
		Bright Angle Shale	374BGAG
		Muav Limestone	374MUAV
		Tapeats Sandstone	374TPTS
Proterozoic	Pre-Cambrian	Granitic Gneiss	400GRCG
		Granite	400GRNT
		Schist	400SCST
		Sedimentary Rocks	400SDMR

Appendix E: GWSI Index Well Siting Criteria

In general, ADWR Index wells historically have been selected to provide good spatial distribution or coverage within a groundwater basin and to assess vertical gradients if possible. ADWR GWSI Index wells are selected based on guidelines developed by the USGS Office of Ground Water for the Collection of Basic Records (CBR) Program: https://groundwaterwatch.usgs.gov/usgsgwnetworks.asp#

Specific criteria for Index well selection can include at a minimum the following:

- Open to a single, known hydrogeologic unit
- Known well construction that allows good water-level measurements
- Located in unconfined aquifers or near-surface confined aquifers that respond to climatic fluctuations
- Minimally affected by pumpage and likely to remain so
- Essentially unaffected by irrigation, canals, and other potential sources of artificial recharge
- Long-term accessibility
- Well has never gone dry (not susceptible to going dry)

Additional desired characteristics:

- Representative of broad area (e.g., a regional aquifer)
- Complete characterization of the site is available
- A long record of water-level measurements exists
- Lithologic and geophysical logs available

Please note that selection criteria may vary for GWSI Index wells depending on area specific monitoring objectives. For example, wells may be selected that are located in confined conditions versus unconfined for specific regional data needs.

Appendix F: Mandatory Data Elements for Water-Level Measurements for Submittal to ADWR Groundwater Site Inventory (GWSI)

Data supplied by verified Groundwater Data Cooperator well sites will be entered into the Department's ORACLE Groundwater Site Inventory (GWSI) database. The following descriptions provide an explanation of the Mandatory Data Elements (fields and formats) needed to complete a record.

Water Levels Data Table (WW_LEVELS)

The Water Levels Data Table contains information related to the depth to water at the site. Data types include depth to water, water table elevation, measurement date, method of measurement, measurement remarks, and source of the water level measurement.

Date Measured (Wlwa_Measurement_Date)

This field records the date that the water level was recorded for the site.

Depth to Water (Wlwa_Depth_To_Water)

This field records the depth to water, in feet, below land surface. Depth to water can be carried out to two decimal places. If the water level is above land surface, enter the water level in feet above land surface preceded by a minus (-) sign. If the head at a flowing site is unknown, if the water level cannot be measured, the site is dry, or the well destroyed, then this field is left blank and the appropriate code must be placed in the associated Water Level Remarks Code field (Wlwa_Remarks). By default, there can be no 0.00 depth to water.

Water Level Elevation (Wlwa_Water_Level_Elevation)

This field contains the elevation of the water table above mean sea level datum. This field is calculated by subtracting the depth to water from the well altitude as entered in the Sites Data Table. Except for flowing wells, water level elevations are blank for records that have no depth to water measurements.

A well site must be inventoried by ADWR, BOR, or the USGS. During the inventory, basic data such as well elevation, are collected to create the well Site ID and thus the original well record in the database. If a well already has a Site ID, already is in GWSI, then the water level elevation is not needed for submittal. Discrepancies observed between the Well Site Elevation the Cooperator provides and what is contained in the Sites Data Table should be brought to the attention of the ADWR submittal contact.

Method of Water Level Measurement (Wlwa_Method Code)

This field contains the code for the method used to measure the depth to water. GWSI Codes will be provided on-line through list or drop-box along with the help file, in the GWSI Data Dictionary.

Remarks (Wlwwa_Remarks)

This field contains letter codes that describe the status of the site at the time of the water level measurement. GWSI Codes will be provided on-line through list or drop-box along with the help file, in the GWSI Data Dictionary.

Source of Water Level Measurement (Wlwa_Source)

This field contains the letter codes for the source of the water level measurement.

Water Level Measuring Point Data Table (WM_POINTS)

The Water Level Measuring Point Data Table contains a description of the point used to measure the depth to water in a well.

Date Measured (Welm_Date_Measured)

This field records the date that the water level measuring point was established for the site.

Measuring Point Height (Welm_Measure_Point_Height)

This entry is the height, in feet, above the land surface from which the depth to water measurement was made. If the measurement point is below land surface, the measurement height is preceded by a minus sign (-).

Measuring Point Descriptions (Welm_Mp_Description)

This field contains a description of the point use to measure the depth to water. Listed below are some of the common measuring point descriptions.

HTCA, W – Hole in Top of Casing, West Side

BOP, N – Access under Base of Pump, North Side

HSCA, N – Hole in Side of Casing, North Side

ACTB, S – Measuring (Access) Tube, South Side

TCA, SE – Top of Casing, Southeast Side

AIRL, S – Airline, South Side

HBOP, S – Hole in Pump Base, South Side

HISP, NE – Hole in Submersible Plate, Northeast Side

Water level data collection protocols and methods used by ADWR and USGS are described in publications including:

Ground-Water-Level Monitoring and the Importance of Long-Term Water-Level Data (U.S. GEOLOGICAL SURVEY CIRCULAR 1217) http://pubs.usgs.gov/circ/circ1217/html/contents.html

Ground-Water Data-Collection Protocols and Procedures for the National Water-Quality Assessment Program: Selection, Installation, and Documentation of Wells, and Collection of Related Data (U.S. Geological Survey Open-File Report 95-398) http://pubs.usgs.gov/of/1995/ofr-95-398/

For additional industry standards, see:

U.S. Geological Survey, 1980, Ground Water, Chapter 2 of National Handbook of Recommended Methods for Water-Data Acquisition: Office of Water Data Coordination, 149 p.

U.S. Bureau of Reclamation, 1977, Ground Water Manual: U.S. Department of Interior, Bureau of Reclamation, United States Government Printing Office, Denver, CO., 480 p.

U.S. Geological Survey, (L. J. Mann), 1982. Operational Guidelines for Measuring Ground-water Levels—Arizona District, 10 p.

Appendix G: Minimum Data Set Requirements for Submittal of Well Site Details to ADWR Groundwater Site Inventory (GWSI)

Purpose

Groundwater level data from sources other than ADWR, from entities for which the collection methods are unknown, or which differ from ADWR procedures, may not be fully comparable with GWSI standards. Examples include data collection and reporting techniques for many water providers, power plant operators, RGR reporters and community water systems, as well as other sources of groundwater data with varying forms of data validation. Data supplied by verified Groundwater Data Cooperators will be entered into the Department's ORACLE Groundwater Site Inventory database.

Process

The first step in processing groundwater level data received from a non-ADWR source is to ensure the accuracy and correctness of the specific well site for which data is intended to be submitted to the Department. Validating the correct well identification for the submitted data is the first step in receiving external groundwater level data. Wells that have a registry number, 55-xxxxxx, may or may not have a GWSI Site_ID number. Each well site in GWSI is assigned a unique 15-character identification number by the Department, the SITE ID, which is the common field (primary key) in all the GWSI data tables.

The Department will assign a Site_ID to wells that do not currently have a SITE_ID assigned to them through submittal of basic well information from the outside entity and a SITE INVENTORY will subsequently be conducted by the Department (unless USGS or BOR have already created) after submitted data is verified online. An online data portal will be used by Cooperators to input the Basic Well information required. The Department will then review the Basic Well information submitted with existing GWSI SITE_IDs and confirm validation of matching GWSI & registry IDs. Once a well has received confirmation of validation of existing IDs, water-level data can then be submitted online with a validation code received from a confirmation email by the Department.

Summary of process:

1) Cooperator submittal of basic well info;
2) Validation of GWSI SITE_ID if existing;
3) ADWR Site Inventory if GWSI SITE_ID does not exist utilizing Cooperator submitted basic well info;
4) ADWR will create a SITE_ID when an Inventory is complete;
5) ADWR will send confirmation email to potential Cooperators with validated SITE_ID;
6) Cooperators can submit data on-line using validated SITE_ID.

Please note, data portals will provide two different mechanisms for submittal: 1) Batch Format for large numbers of well sites, and 2) Data Entry Screen for individual well entries.

Data supplied by verified Groundwater Data Cooperator well sites will be entered into the Department's ORACLE Groundwater Site Inventory (GWSI) database. The following descriptions provide explanation of the Mandatory and Optional Data Elements (fields and formats) needed to complete a record.

Site Detail Data Table (SITES)

The Site Detail Data Table is used for recording general information about the site, including location information, general well construction, and well use information. The Sites data table is the main table in the GWSI system. All other GWSI tables are linked to it by the Site ID field.

Site Id (SITE_WELL_SITE_ID) MANDATORY

Each well site in GWSI is assigned a unique 15-character identification number by the Department, the SITE ID, which is a common field in all the GWSI data tables. Although the Site Identification Number is derived initially from the latitude and longitude of the site, the number is a unique identifier and not a locator.

The site identification number is assigned by using a method (map, Global Positioning System (GPS), Geographic Information System (GIS), etc.) that will provide the most precise location for a point representing the site. The latitude and longitude of the point are determined to the nearest 100th of a second. The first six digits of the Site ID are the value of latitude, the 7th through 13th digits are the value of longitude, and the 14th and 15th digits are sequence numbers used to distinguish between sites at the same location. Leading zeros are used if the value of latitude is less than 10 degrees, if the value of longitude is less than 100 degrees, or the sequence number is less than 10.

Cadastral Location (Site_Local_Id) MANDATORY

This is a 20 character-long site location based on the U. S. Bureau of Land Management's system of land subdivision. The land survey in Arizona is based on the Gila and Salt River Baseline and Meridian, which divides the state into four quadrants. These quadrants are designated A, B, C, and D in a counterclockwise direction starting in the upper right-hand corner (see Figure 1). All land with north Townships and east Ranges are in the A quadrant, north Townships and west Ranges in the B quadrant, south Townships and west Ranges in the C quadrant, and south Townships and east Ranges in the D quadrant. The first number in the cadastral location is the Township, the second is the Range, and the third is the Section in which the site is located. The letters following the section number indicate the well location within the section. The first letter indicates the 160-acre quarter section, the second letter the 40-acre quarter-quarter section, and the third letter the 10-acre quarter-quarter-quarter section. More explanation will be provided by the online help file, in the GWSI Data Dictionary.

Land Net Meridian (Site_Meridian) MANDATORY

This field records the land net meridian that is used to establish the Local ID or cadastral location of the site. In general, all sites located in Arizona, except those on the Navajo and Hopi Indian Reservation, use the Gila and Salt River Meridian and Baseline. GWSI Codes will be provided on-line through list or drop-box along with the help file, in the GWSI Data Dictionary.

Latitude (Site_Latit_Degree, Site_Latit_Min, Site_Latit_Sec) MANDATORY

Longitude(Site_Longit_Degree, Site_Longit_Min, Site_Longit_Sec) MANDATORY

The three latitude fields and the three longitude fields contain the best available value for the latitude and longitude of the site in degrees, minutes, and seconds. Seconds may be entered to 100ths of a second. Use leading zeros for values <100. The position of the site is encouraged to be measured in the field by global positioning system (G.P.S.) equipment. Each value for the degrees, minutes and seconds should be entered into the appropriate field. The location should be entered as precisely as it is known, and the accuracy of the location should be indicated by a suitable entry in the lat/long accuracy.

Latitude/Longitude Accuracy (Site_Llaccr_Code) MANDATORY

This field records the accuracy of the latitude/longitude location for the site. If the site cannot be determined within 2 seconds, then the field person will indicate the appropriate accuracy. In general, a site can be located to within five seconds on a map, two seconds on an orthophoto with a template and one second if it is digitized. GWSI Codes will be provided on-line through list or drop-box along with the help file, in the GWSI Data Dictionary.

Lat/Long Datum MANDATORY

Enter the horizontal datum code for the latitude/longitude coordinates. GWSI uses NAD-27 (North American Datum of 1927). The only datums that can be converted on output are NAD27 (North American Datum of 1927) and NAD83 (North American Datum of 1983). GWSI uses the North American Datum Conversions (NADCON) of the National Geodetic Survey to convert from NAD27 to NAD83 or vice-versa.

State Well Registration Number (Site_Well_Reg_Id) CONDITIONALLY MANDATORY

This field contains the State Well Registration (55) number of the well if the site can be positively matched to a registered well. The 55 number is matched with a GWSI well only when the field investigator is absolutely positive that the wells are the same. If there is any doubt about the match, the 55 number is not entered until those doubts are resolved.

Site Altitude (Site_Well_Altitude) MANDATORY

This field contains the altitude of the site in feet above NGVD, precision to two decimals can be coded if available. The altitude of land surface is the altitude in feet of a fixed reference point (RP) at the well near land surface that can be used to measure the height of the measuring point (MP) and can be surveyed if desired. Examples of the land surface reference point description are a brass marker installed in the concrete pad, or an etched mark at the base of the surface casing. Enter the altitude, in feet, above the specific Vertical Datum of the land surface at the site. Altitudes below the specific Vertical Datum should be preceded by a minus sign (-).

Method of Altitude Measurement (Site_Altmeth_Code_Entry) MANDATORY

This field records the method used to determine the altitude of the site. GWSI Codes will be provided online through list or drop-box along with the help file, in the GWSI Data Dictionary.

Altitude Accuracy (Site_Altit_Accuracy) MANDATORY

This field contains the level of accuracy, in feet, of the site altitude. Site altitudes taken from a map are generally accurate to one half the map’s contour interval. Sites that are leveled in from a benchmark are considered accurate to within 1.0 foot.

Altitude Datum MANDATORY

Enter the datum used to collect altitude. GWSI uses NGVD29 (National Geodetic Vertical Datum of 1929). The only vertical datums that can be converted on output are NGVD29 (National Geodetic Vertical Datum of 1929) and NAVD88 (North American Vertical Datum of 1988). GWSI uses the North American Vertical Datum Conversions (VERTCON) of the National Geodetic Survey to convert from NGVD29 to NAVD88 or vice-versa.

Depth of Hole (Site_Hole_Depth) CONDITIONALLY MANDATORY

This field records the total depth to which the hole was drilled in feet, below the land surface datum, even though it may have been plugged back in completing the well. For collector or Ranney-type wells, the depth of the central shaft should be entered. For multiple-well fields, ponds, tunnels, springs, or drains, the field should be blank. If the hole depth is given, all other depths associated with the site will be compared with it for validity.

Depth of Well (Site_Well_Depth) CONDITIONALLY MANDATORY

This field contains the depth of the finished, or cased, portion of the well, in feet below land surface datum. The depth of the well is usually taken from the completed well drillers report.

Source of Depth Data (Site_Adwrs_Code) CONDITIONALLY MANDATORY

This field contains the source of the reported depth of a well. GWSI Codes will be provided online through a list or drop-box along with the help file, in the GWSI Data Dictionary, to ensure consistency in data format.

Appendix H: Non-Arizona Well Identification Systems

Well Numbering System

The local well identification (Local_ID) system for GWSI sites located in California, Colorado, Nevada, New Mexico, and Utah is based on the system of land subdivision used by the Bureau of Land Management. This system uses a surveyed base line and principal meridian from which townships and ranges are located. Townships are located north or south of the base line and ranges are located east or west of the principal meridian. Sections are designated 1 through 36 and are numbered in rows following a serpentine pattern beginning in the northeast corner of a township and ending in the southeast corner of the township. The method of locating sites within a section varies with each state and is described in detail below.

California Well Numbering System

The California well numbering system is based in the San Bernardino Baseline and Meridian. A GWSI site located in California in the *NW*1/4 of the *NE*1/4 of the *NE*1/4 of *Section* 35, *Township* 15 *South*, *Range* 23 *East*, would be identified as **15S/23E-35 Jb**. The number preceding the slash (/) is the township and the letter after the township (**N** or **S**) indicates its position north or south of the San Bernardino Baseline. The number after the slash is the range and the letter following the range (**E** or **W**) indicates its position east or west of the San Bernardino Meridian. The number following hyphen (-) is the section and the two letters following the section number identify the 40-acre and 10-acre subdivisions. The 40-acre subdivisions are identified using the same serpentine pattern used to identify section numbers in a township (see Figure 1). Each 40-acre subdivision is assigned a capital letter *A* through *R*, omitting *I* and *O*. The 10-acre tracts are assigned the lowercase letters *a*, *b*, *c*, or *d* in a counter-clockwise direction in the same manner as the 10-acre subdivisions in the Arizona. In some cases, a second lowercase letter is added if the 2 1/2-acre location is known.

Colorado Well Numbering System

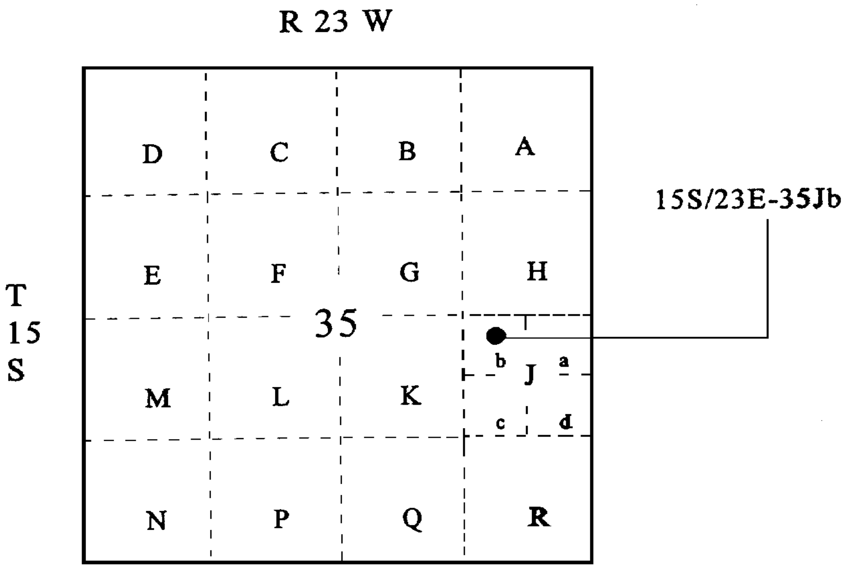
The southwestern corner of Colorado, the part closest to Arizona, is part of the New Mexico Baseline and Meridian. The New Mexico Well Numbering System is used and described below.

New Mexico Well Numbering System

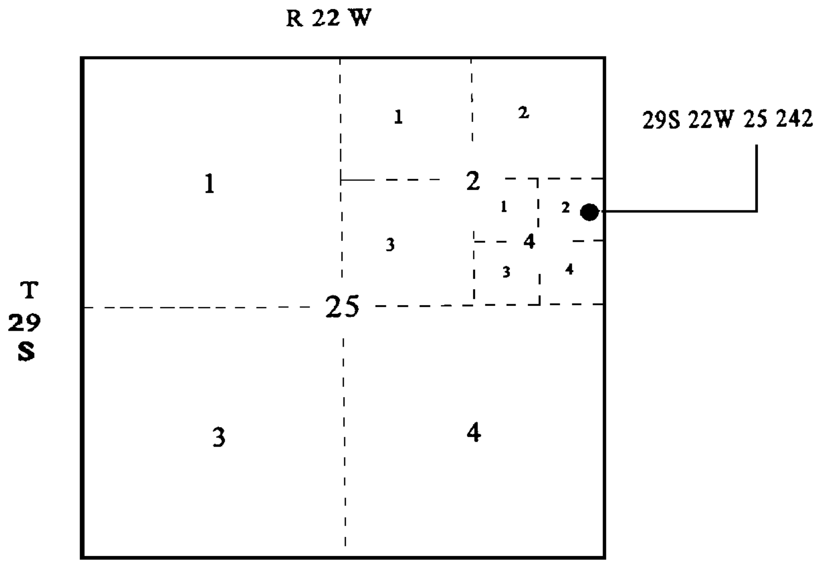
The New Mexico well numbering system is based on the New Mexico Principal Baseline and Meridian. The local identification (Local_Id) based on this well numbering system consists of four parts, each separated by spaces (see Figure 8, below). The first three parts are the township number, the range number, and the section number, respectively. The township number is followed by the letters **N** or **S** to indicate if the township lies north or south of the New Mexico

Base Line. The range number is followed by the letters **E** or **W** to indicate if the range lies east or west of the New Mexico Principal Meridian. The letters **T** and **R**, for **T**ownship and **R**ange, are omitted from the GWSI local identification. Hence, a site located in *Township* 29 *South*, *Range* 22 *West*, *Section* 25 would be identified as **29S 22W 25**.

The fourth part of the well identification consists of three numbers that identify the 10-acre tract within the section in which the site is located. The method of numbering the tracts within the section is different that used in Arizona and is shown in Figure 8, below The section is divided into four 160-acre quarters, numbered 1, 2, 3, and 4, using a normal reading order from left to right, for the northwest, northeast, southwest and southeast quarters, respectively. Each 160-acre quarter section is subdivided in the same manner to produce the second number, which defines a 40-acre quarter-quarter section. The 40-acre tract is divided in the same manner to produce the third number, which identifies the 10-acre quarter-quarter-quarter section tract. Thus, a site in the *NE* 1/4 of the *SE* 1/4 of the *NE* 1/4 *of Section* 25, *Township* 29 *South*, *Range* 22 *West*, would be identified as **29S 22W 25 242**. If multiple sites are located within a 10-acre tract, consecutive letters starting with the letter *a* are added as a suffix, with *a* being the oldest known site.



California Well Identification System



New Mexico Well Identification System

Figure 8. California and New Mexico Well Location System

Nevada Well Numbering System

GWSI local identifications in Nevada are determined using the Mount Diablo Base Line and Principal Meridian. The subdivision of sections is the same as in Arizona, except that Nevada sections are divided four times to specify the site location to within a 2 1/2-acre tract. A numerical suffix to denote multiple wells within a section is used, just as in Arizona. Letters denoting the township or range location relative to the base line and meridian, **N** or **S** for the township**, E** or **W** for the range, precede the township and range numbers. A prefix of three numbers, **222**, is added to identify GWSI wells in Nevada. For example, a site located in the *SW* 1/4 of the *NW* 1/4 of the *SE* 1/4 of the *SE* 1/4 of *Section* 28, *Township* 13 *South*, *Range* 71 *East*, would be identified as **222 S13 E71 28DDBC**.

Utah Well Numbering System

In Utah, GWSI site locations are based on the Salt Lake Base Line and Meridian. The method of land subdivision is the same as is used in Arizona. The base line and meridian are used to divide the state into four quadrants, **A**, **B**, **C**, and **D**, starting in the upper right corner (northeast) and moving counterclockwise to the southeast quadrant. Sections example, a site located in the *NW* 1/4 of the *NW* 1/4 of the *NW* 1/4 of *Section* 25, *Township* 43 *South*, *Range* 19 are divided down to quarter-quarter-quarter sections in the same manner as in Arizona. For *West*, would be identified as **C-43-19 25BBB**.

The well-numbering system used in Utah is based on the Bureau of Land Management's system of land subdivision. The well-numbering system is familiar to most water users in Utah, and the well number shows the location of the well by quadrant, township, range, section, and position within the section. Well numbers for most of the State are derived from the Salt Lake Base Line and the Salt Lake Meridian. Well numbers for wells located inside the area of the Utah Base Line and Meridian are designated in the same manner as those based on the Salt Lake Base Line and Meridian, with the addition of the "U" preceding the parentheses. The numbering system is illustrated below in Figure 9.

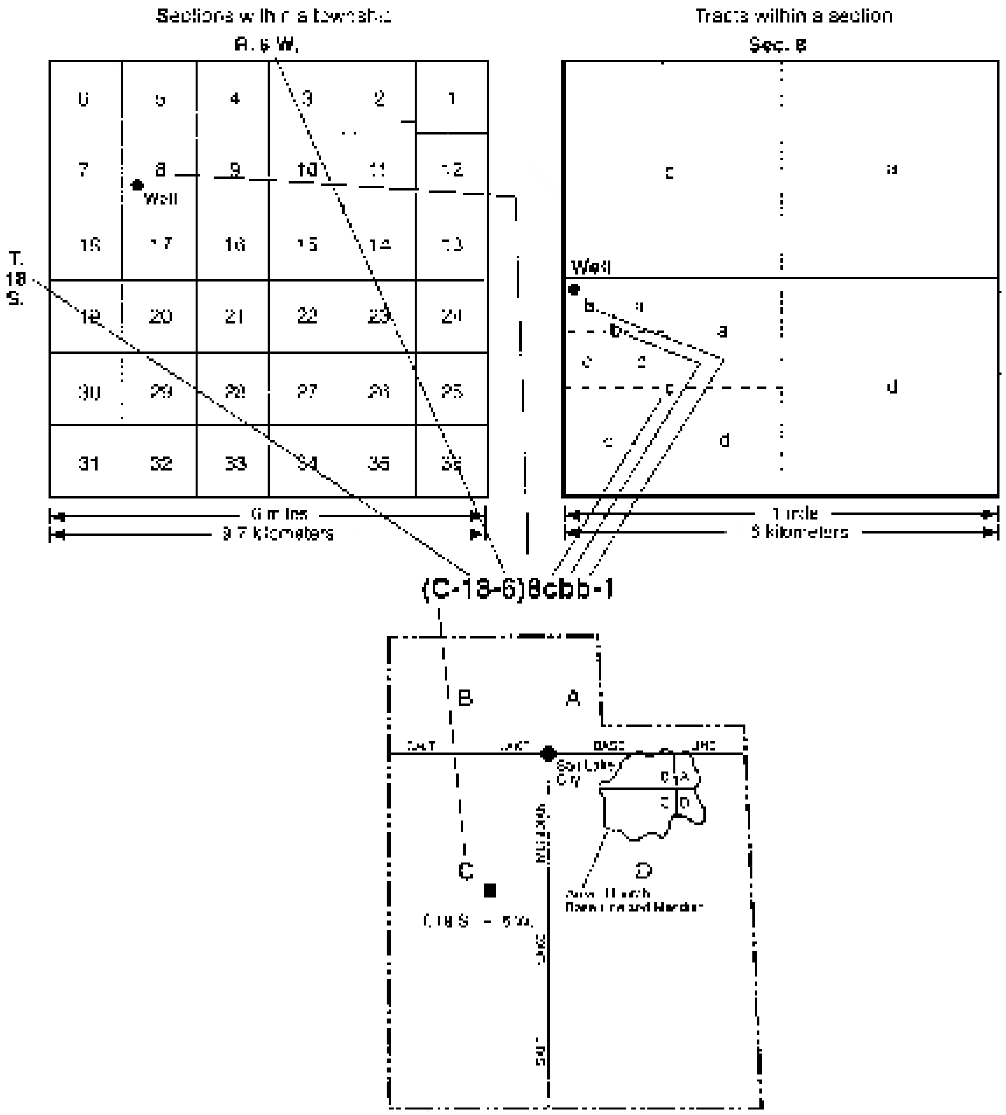


Figure 9. Utah Well Location System

Appendix I: ORACLE Database Map

Description in GWSI	Table Name	Column Name	Code Lookup Table
Site Identification Number	GWSI_SITES	SITE_WELL_SITE_ID	N/A
Local Identification Number	GWSI_SITES	SITE_LOCAL_ID	N/A
Land Net Meridian	GWSI_SITES	SITE_MERIDIAN	N/A
Site Type	GWSI_SITES	SITE_SITTYP_CODE_ENTRY	GWSI_SITE_TYPES
Reliability	GWSI_SITES	SITE_RELY_CODE_ENTRY	GWSI_RELIABILITIES
Topo Setting	GWSI_SITES	SITE_TOPOSET_CODE_ENTRY	GWSI_TOPO_SETTINGS
Site Data Source	GWSI_SITES	SITE_SISRC_CODE	GWSI_SITE_SOURCES
Topographic Quad Name	GWSI_SITES	SITE_TQNAM_QUAD_NAME	N/A
Map Scale	GWSI_SITES	SITE_MAP_SCALE	N/A
ALRIS Quadrangle Number	GWSI_SITES	SITE_QUAD_NO	N/A
Latitude Degree	GWSI_SITES	SITE_LATIT_DEGREE	N/A
Latitude Minute	GWSI_SITES	SITE_LATIT_MIN	N/A
Latitude Second	GWSI_SITES	SITE_LATIT_SEC	N/A
Longitude Degree	GWSI_SITES	SITE_LONGIT_DEGREE	N/A
Longitude Minute	GWSI_SITES	SITE_LONGIT_MIN	N/A
Longitude Second	GWSI_SITES	SITE_LONGIT_SEC	N/A
Latitude/Longitude Accuracy	GWSI_SITES	SITE_LLACCR_CODE_ENTRY	GWSI_LON_LAT_ACCURACIES
Method of Latitude/Longitude Measurement	GWSI_SITES	SITE_LATLONG_METH_CODE	GWSI_LATLONG_METHOD_CODES
Decimal Latitude	GWSI_SITES	SITE_LATITUDE_DECIMAL	N/A
Decimal Longitude	GWSI_SITES	SITE_LONGIT_DECIMAL	N/A
UTM Coordinates	GWSI_SITES	N/A	N/A
State Well Registration Number	GWSI_SITES	SITE_WELL_REG_ID	N/A
Site Altitude	GWSI_SITES	SITE_WELL_ALTITUDE	N/A

Description in GWSI	Table Name	Column Name	Code Lookup Table
Method of Altitude Measurement	GWSI_SITES	SITE_ALTMETH_CODE_ENTRY	GWSI_ALTITUDE_METHODS
Altitude Accuracy	GWSI_SITES	SITE_ALTIT_ACCURACY	N/A
ADWR Basin Codes	GWSI_SITES	SITE_AMA_CODE_ENTRY	N/A
ADWR Sub-Basin Codes	GWSI_SITES	SITE_ADWBAS_CODE_ENTRY	N/A
USGS Basin Codes	GWSI_SITES	SITE_USBASN_CODE_ENTRY	N/A
State Codes	GWSI_SITES	SITE_STATE_CODE_ENTRY	GWSI_STATES
County Codes	GWSI_SITES	SITE_CNTY_CODE	GWSI_COUNTYS
Site Use 1	GWSI_SITES	SITE_USE_1	GWSI_SITE_USE_CODES
Site Use 2	GWSI_SITES	SITE_USE_2	GWSI_SITE_USE_CODES
Site Use 3	GWSI_SITES	SITE_USE_3	GWSI_SITE_USE_CODES
Water Use 1	GWSI_SITES	WATER_USE_1	GWSI_WATER_USE_CODES
Water Use 2	GWSI_SITES	WATER_USE_2	GWSI_WATER_USE_CODES
Water Use 3	GWSI_SITES	WATER_USE_3	GWSI_WATER_USE_CODES
Depth of Hole	GWSI_SITES	SITE_HOLE_DEPTH	N/A
Depth of Well	GWSI_SITES	SITE_WELL_DEPTH	N/A
Source of Depth Data	GWSI_SITES	SITE_ADWRS_CODE	GWSI_ADWR_SOURCES
Geological Unit	GWSI_SITES	SITE_GEO_UNIT	N/A
Site Creation Date	GWSI_SITES	SITE_CREATE_DATE	N/A
Site Update Date	GWSI_SITES	SITE_UPDATE_DATE	N/A
Last Action Date	GWSI_SITES	SITE_LAST_ACT_DATE	N/A
Last Action Operator	GWSI_SITES	SITE_LAST_ACT_OPER	N/A
Site Creation Valid Entry Date	GWSI_SITES	SITE_CDATE_VALID	N/A
Site Update Valid Entry Date	GWSI_SITES	SITE_UDATE_VALID	N/A
Arizona Watershed Codes	GWSI_SITES	SITE_WSHD_CODE	N/A
Index Book	GWSI_SITES	SITE_IDX_BOOK	N/A
Construction Entry Number	GWSI_WELL_COMPLETIONS	WLCO_ID	N/A
Well Completion Date	GWSI_WELL_COMPLETIONS	WLCO_COMPLETION_DATE	N/A

Description in GWSI	Table Name	Column Name	Code Lookup Table
Drill Method	GWSI_WELL_COMPLETIONS	WLCO_DRILMTH_CODE_ENTRY	GWSI_DRILL_METHODS
Well Finish	GWSI_WELL_COMPLETIONS	WLCO_WLCASE_CODE_ENTRY	GWSI_WELL_CASINGS
Source of Construction Data	GWSI_WELL_COMPLETIONS	WLCO_ADWRS_CODE	GWSI_ADWR_SOURCES
Name of Driller	GWSI_WELL_COMPLETIONS	WLCO_DRILLER_NAME	N/A
Last Action Date	GWSI_WELL_COMPLETIONS	WLCO_LAST_ACT_DATE	N/A
Last Action Operator	GWSI_WELL_COMPLETIONS	WLCO_LAST_ACT_OPER	N/A
Valid Completion Date	GWSI_WELL_COMPLETIONS	WLCO_VALID_DATE	N/A
Construction Entry Number	GWSI_BORE_COMPLETIONS	BORE_WLCOMP_ID	N/A
Bore Hole Interval	GWSI_BORE_COMPLETIONS	BORE_HOLD_INTERVAL	N/A
Top of Bore Hole	GWSI_BORE_COMPLETIONS	BORE_HOLE_TOP	N/A
Bottom of Bore Hole	GWSI_BORE_COMPLETIONS	BORE_HOLE_BOTTOM	N/A
Diameter of Bore Hole	GWSI_BORE_COMPLETIONS	BORE_HOLE_DIAMETER	N/A
Last Action Date	GWSI_BORE_COMPLETIONS	BORE_LAST_ACT_DATE	N/A
Last Action Operator	GWSI_BORE_COMPLETIONS	BORE_LAST_ACT_OPER	N/A
Construction Entry Number	GWSI_CASING_COMPLETIONS	CASE_WLCOMP_ID	N/A
Casing Interval	GWSI_CASING_COMPLETIONS	CASE_INTERVAL	N/A
Top of Casing	GWSI_CASING_COMPLETIONS	CASE_TOP	N/A
Bottom of Casing	GWSI_CASING_COMPLETIONS	CASE_BOTTOM	N/A
Diameter of Casing	GWSI_CASING_COMPLETIONS	CASE_DIAMETER	N/A
Casing Material	GWSI_CASING_COMPLETIONS	CASE_FINISH_CODE	GWSI_CASING_FINISHES
Last Action Date	GWSI_CASING_COMPLETIONS	CASE_LAST_ACT_DATE	N/A
Last Action Operator	GWSI_CASING_COMPLETIONS	CASE_LAST_ACT_OPER	N/A
Construction Entry Number	GWSI_PERFORATION_COMPLETIONS	PERF_WLCOMP_ID	N/A
Perforation Interval	GWSI_PERFORATION_COMPLETIONS	PERF_INTERVAL	N/A
Top of Perforation	GWSI_PERFORATION_COMPLETIONS	PERF_TOP	N/A
Bottom of Perforation	GWSI_PERFORATION_COMPLETIONS	PERF_BOTTOM	N/A
Diameter of Perforation Casing	GWSI_PERFORATION_COMPLETIONS	PERF_DIAMETER	N/A

Description in GWSI	Table Name	Column Name	Code Lookup Table
Screening Material	GWSI_PERFORATION_COMPLETIONS	PERF_MATERIAL_CODE	GWSI_SCREEN_MATERIALS
Perforation Type	GWSI_PERFORATION_COMPLETIONS	PERF_TYPE_CODE	GWSI_PERFORATION_TYPES
Length of Perforations	GWSI_PERFORATION_COMPLETIONS	PERF_LENGTH	N/A
Width of Perforations	GWSI_PERFORATION_COMPLETIONS	PERF_WIDTH	N/A
Last Action Date	GWSI_PERFORATION_COMPLETIONS	PERF_LAST_ACT_DATE	N/A
Last Action Operator	GWSI_PERFORATION_COMPLETIONS	PERF_LAST_ACT_OPER	N/A
Discharge Number	GWSI_FLOWING_DISCHARGES	FLWD_ID	N/A
Measurement Date	GWSI_FLOWING_DISCHARGES	FLWD_MEASURE_DATE	N/A
Discharge Rate	GWSI_FLOWING_DISCHARGES	FLWD_DISCHARGE_RATE	N/A
Flowing Discharge Measurement Method	GWSI_FLOWING_DISCHARGES	FLWD_DSCMTH_CODE_ENTRY	GWSI_DISCHARGE_METHODS
Discharge_Data_Source	GWSI_FLOWING_DISCHARGES	FLWD_DATASRC_CODE_ENTRY	GWSI_DATA_SOURCES
Last Action Date	GWSI_FLOWING_DISCHARGES	FLWD_LAST_ACT_DATE	N/A
Last Action Operator	GWSI_FLOWING_DISCHARGES	FLWD_LAST_ACT_OPER	N/A
Flow Valid Date	GWSI_FLOWING_DISCHARGES	FLWD_DATE_VALID	N/A
Discharge Number	GWSI_PUMPING_DISCHARGES	PMPD_ID	N/A
Measurement Date	GWSI_PUMPING_DISCHARGES	PMPD_MEASURE_DATE	N/A
Discharge_Rate	GWSI_PUMPING_DISCHARGES	PMPD_DISCHARGE_RATE	N/A
Pumping Discharge Measurement Method	GWSI_PUMPING_DISCHARGES	PMPD_PMPDMTH_CODE_ENTRY	GWSI_PUMP_DISCHARGE_METHODS
Discharge Data Source	GWSI_PUMPING_DISCHARGES	PMPD_DATA_SOURCE	GWSI_DATA_SOURCES
Production Water Level	GWSI_PUMPING_DISCHARGES	PMPD_PRODUCTION_WATER_LEVEL	N/A
Static Water Level	GWSI_PUMPING_DISCHARGES	PMPD_STATIC_WATER_LEVEL	N/A
Static Water Level Method	GWSI_PUMPING_DISCHARGES	PMPD_STATMTH_CODE_ENTRY	GWSI_STATIC_METHODS
Static Water Level Source	GWSI_PUMPING_DISCHARGES	PMPD_STATIC_SOURCE	GWSI_DATA_SOURCES
Pumping Period	GWSI_PUMPING_DISCHARGES	PMPD_PUMPING_PERIOD	N/A
Well Drawdown	GWSI_PUMPING_DISCHARGES	PMPD_WELL_DRAWDOWN	N/A
Specific Capacity	GWSI_PUMPING_DISCHARGES	PMPD_SPECIFIC_CAPACITY	N/A
Last Action Date	GWSI_PUMPING_DISCHARGES	PMPD_LAST_ACT_DATE	N/A
Last Action Operator	GWSI_PUMPING_DISCHARGES	PMPD_LAST_ACT_OPER	N/A

Description in GWSI	Table Name	Column Name	Code Lookup Table
Pumping Valid Date	GWSI_PUMPING_DISCHARGES	PMPD_DATE_VALID	N/A
Lift Number	GWSI_WELL_LIFTS	WLLI_ID	N/A
Lift Inventory Date	GWSI_WELL_LIFTS	WLLI_ENTRY	N/A
Lift Type	GWSI_WELL_LIFTS	WLLI_TYPE_CODE	GWSI_LIFT_TYPES
Lift Power Type	GWSI_WELL_LIFTS	WLLI_POWER_TYPE	GWSI_POWER_TYPES
Lift Meter Number	GWSI_WELL_LIFTS	WLLI_METER_NUM	N/A
Power Company	GWSI_WELL_LIFTS	WLLI_POWER_COMPANY	GWSI_POWER_COMPANIES
Lift Horsepower	GWSI_WELL_LIFTS	WLLI_HORSEPOWER	N/A
Lift Account Number	GWSI_WELL_LIFTS	WLLI_ACCOUNT_NUM	N/A
Lift Power Divider	GWSI_WELL_LIFTS	WLLI_DIVIDER	N/A
Source of Lift Measurement	GWSI_WELL_LIFTS	WLLI_SOURCE_CODE	GWSI_DATA_SOURCES
Method of Lift Measurement	GWSI_WELL_LIFTS	WLLI_METHOD_CODE	GWSI_LIFT_MEASURE_METHODS
Last Action Date	GWSI_WELL_LIFTS	WLLI_LAST_ACT_DATE	N/A
Last Action Operator	GWSI_WELL_LIFTS	WLLI_LAST_ACT_OPER	N/A
Valid Date	GWSI_WELL_LIFTS	WLLI_VALID_DATE	N/A
Log Type	GWSI_WELL_LOGS	WLLO_LOGTYP_CODE_ENTRY	GWSI_LOG_TYPES
Log Start	GWSI_WELL_LOGS	WLLO_LOG_START	N/A
Log End	GWSI_WELL_LOGS	WLLO_LOG_END	N/A
Source of Log Data	GWSI_WELL_LOGS	WLLO_ADWRS_CODE	GWSI_ADWR_SOURCES
Last Action Date	GWSI_WELL_LOGS	WLLO_LAST_ACT_DATE	N/A
Last Action Operator	GWSI_WELL_LOGS	WLLO_LAST_ACT_OPER	N/A
Owner Id	GWSI_WELL_OWNERS	WLOW_ID	N/A
Owner Entry Date	GWSI_WELL_OWNERS	WLOW_ENTRY_DATE	N/A
Owners Last Name	GWSI_WELL_OWNERS	WLOW_LAST_NAME	N/A
Owners First Name	GWSI_WELL_OWNERS	WLOW_FIRST_NAME	N/A
Owners Middle Initial	GWSI_WELL_OWNERS	WLOW_MIDDLE_INITIAL	N/A
Last Action Date	GWSI_WELL_OWNERS	WLOW_LAST_ACT_DATE	N/A
Last Action Operator	GWSI_WELL_OWNERS	WLOW_LAST_ACT_OPER	N/A
Valid Date	GWSI_WELL_OWNERS	WLOW_VALID_DATE	N/A

Description in GWSI	Table Name	Column Name	Code Lookup Table
Other Site Id	GWSI_OWNER_SITE_NAMES	OWNS_OTHER_ID	N/A
Other Site Name Assigner	GWSI_OWNER_SITE_NAMES	OWNS_ASSIGNER	N/A
Last Action Date	GWSI_OWNER_SITE_NAMES	OWNS_LAST_ACT_DATE	N/A
Last Action Operator	GWSI_OWNER_SITE_NAMES	OWNS_LAST_ACT_OPER	N/A
Remarks Id	GWSI_REMARKS	REM_ID	N/A
Remarks Date	GWSI_REMARKS	REM_REMARKS_DATE	N/A
Remarks	GWSI_REMARKS	REM_REMARKS	N/A
Last Action Date	GWSI_REMARKS	REM_LAST_ACT_DATE	N/A
Last Action Operator	GWSI_REMARKS	REM_LAST_ACT_OPER	N/A
Valid Date	GWSI_REMARKS	REM_DATE_VALID	N/A
Site Inventory Id	GWSI_SITE_INVENTORIES	SITI_ID	N/A
Site Inventory Date	GWSI_SITE_INVENTORIES	SITI_INVENTORY_DATE	N/A
Inventoried By	GWSI_SITE_INVENTORIES	SITI_INVENTORIED_BY	N/A
Last Action Date	GWSI_SITE_INVENTORIES	SITI_LAST_ACT_DATE	N/A
Last Action Operator	GWSI_SITE_INVENTORIES	SITI_LAST_ACT_OPER	N/A
Valid Date	GWSI_SITE_INVENTORIES	SITI_VALID_DATE	N/A
Spring Name	GWSI_SPRING_NAMES	SPNA_SPRING_NAME	N/A
Permanence	GWSI_SPRING_NAMES	SPNA_SPPERM_CODE_ENTRY	GWSI_SPRING_PERMANENCES
Type of Spring	GWSI_SPRING_NAMES	SPNA_SPTYPE_CODE_ENTRY	GWSI_SPRING_TYPES
Spring_Improvements	GWSI_SPRING_NAMES	SPNA_SPIMPRV_CODE_ENTRY	GWSI_SPRING_IMPROVEMENTS
Last Action Date	GWSI_SPRING_NAMES	SPNA_LAST_ACT_DATE	N/A
Last Action_Operator	GWSI_SPRING_NAMES	SPNA_LAST_ACT_OPER	N/A
Water Level Id	GWSI_WW_LEVELS	WLWA_ID	N/A
Date Measured	GWSI_WW_LEVELS	WLWA_MEASUREMENT_DATE	N/A
Depth to Water	GWSI_WW_LEVELS	WLWA_DEPTH_TO_WATER	N/A
Water Level Elevation	GWSI_WW_LEVELS	WLWA_WATER_LEVEL_ELEVATION	N/A
Method of Water Level Measurement	GWSI_WW_LEVELS	WLWA_REMARK_CODE	GWSI_MM_CODES
Water Level Measurement Remarks	GWSI_WW_LEVELS	WLWA_REMARK_CODE	GWSI_MR_CODES

Description in GWSI	Table Name	Column Name	Code Lookup Table
Unable to Measure (UTM) Remarks	GWSI_WW_LEVELS	WLWA_UTM_CODE	GWSI_UTM_CODES
Water Level Source Code	GWSI_WW_LEVELS	WLWA_SOURCE_CODE	GWSI_DATA_SOURCES
Last Action Date	GWSI_WW_LEVELS	WLWA_LAST_ACT_DATE	N/A
Last Action Operator	GWSI_WW_LEVELS	WLWA_LAST_ACT_OPER	N/A
Valid Date	GWSI_WW_LEVELS	WLWA_VALID_DATE	N/A
Water Level Point Id	GWSI_WM_POINTS	WELM_ID	N/A
Date Established	GWSI_WM_POINTS	WELM_DATE_MEASURED	N/A
Measuring Point Height	GWSI_WM_POINTS	WELM_MEASURE_POINT_HEIGHT	N/A
Measuring Point Descriptions	GWSI_WM_POINTS	WELM_MP_DESCRIPTION	N/A
Last Action Date	GWSI_WM_POINTS	WELM_LAST_ACT_DATE	N/A
Last Action Operator	GWSI_WM_POINTS	WELM_LAST_ACT_OPER	N/A
Valid Date	GWSI_WM_POINTS	WELM_DATE_VALID	N/A
Water Quality Id	GWSI_WQ_REPORTS	WATQ_ID	N/A
Date Collected	GWSI_WQ_REPORTS	WATQ_DATE_MEASURED	N/A
Specific Conductance	GWSI_WQ_REPORTS	WATQ_SPECIFIC_CONDUCTANCE	N/A
Fluoride	GWSI_WQ_REPORTS	WATQ_FLUORIDE	N/A
Temperature	GWSI_WQ_REPORTS	WATQ_TEMPERATURE_CELCIUS	N/A
pH	GWSI_WQ_REPORTS	WATQ_PH	N/A
Alkalinity	GWSI_WQ_REPORTS	WATQ_ALKALINITY	N/A
Dissolved Oxygen	GWSI_WQ_REPORTS	WATQ_DISSOLVED_OXYGEN	N/A
Last Action Date	GWSI_WQ_REPORTS	WATQ_LAST_ACT_DATE	N/A
Last Action Operator	GWSI_WQ_REPORTS	WATQ_LAST_ACT_OPER	N/A
Valid Date	GWSI_WQ_REPORTS	WATQ_DATE_VALID	N/A

Appendix J: Protocol for Documenting "Unable to Measure" (UTM) in GWSI

History:

Inconsistent practices exist when it comes to the documentation of an attempt to measure a Water Level (WL) in a well that results in "Unable to Measure" (UTM). Some staff document the UTM and any notes regarding why a measurement was not possible only in the Index Book on the Water Level Measurements form, with no record created in GWSI. Other staff create a record in GWSI with the date entered, no depth-to-water, and enter a Remark such as Well Destroyed and leave Measurement Method to the default, Calibrated Electric Sounder/Tape (V). Other entries in GWSI include the date entered, no depth-to-water, Measurement Method as OTHER (EXPLAIN IN COMMENTS FIELD or UTM Remark), with no Measurement Remark entered, with a comment in the Comments field. This protocol is intended to clarify the use of the Measurement Method equal to OTHER (EXPLAIN IN COMMENTS FIELD or UTM Remark) and when to use Measurement Remark equal to OTHER, while documenting UTMs consistently.

Explanation:

Measurement Remarks will continue to record the conditions observed in the field in relation to water level measurements. If you attempted a measurement and were UTM for any reason, then you will select the reason from the UTM Remark drop down menu. If the following reasons apply to the attempt: Dry, Obstructed, Measurements Discontinued, Other, Well Destroyed or Well Plugged, you will use the UTM Remark field or the Measurement Remark field to document these conditions and the other field will automatically populate. Do not forget, if no measurement attempt was made, then select in the Measurement Method dropdown list either OBSERVED, OTHER (EXPLAIN IN COMMENTS FIELD or UTM Remark), or REPORTED.

Examples would include if a well is destroyed and you observed this in the field, select from the Measurement Remark or the UTM Remark dropdown list: Well Destroyed, and then select in Measurement Method dropdown list: OBSERVED. If you did not verify by observation, then select: OTHER (EXPLAIN IN COMMENTS FIELD or UTM Remark) and explain in the comments field. Note, no other Measurement Method, such as a steel tape, would be applicable, as this would not determine the well destroyed status.

Another example would be if you used the sounder to determine that a well is dry, select from the Measurement Remark or the UTM Remark dropdown list: DRY and then select in Measurement Method: CALIBRATED ELECTRIC SOUNDER/TAPE (V). There are no changes in these procedures.

If a pumping water level was obtained, continue to use the Measurement Remarks field to record a pumping water level by selecting PUMPING from the Measurement Remarks drop-down list. The same is true for cascading conditions or surface water effects observed while a measurement was made. Once again, there are no change in these procedures. However, if a water level was unobtainable due to cascading water, then Depth to Water should be left blank and Cascading should be selected in the UTM Remark drop-down list, and the measurement method will be selected from the dropdown list.

Step by Step Guide:

Water level was obtained:

1) Date: DATE you obtained or attempted to get a measurement

2) Depth to Water: Enter DTW below LSD

3) Measurement Method: If no measurement was made and you are entering a remark, then select either OBSERVED or OTHER

4) Measurement Remark: Applicable remark (Clarification: If no measurement was made, depth to water is blank, and Measurement Method equals OTHER, then always make sure that UTM Remark is NOT left blank.)

5) UTM Remark: Applicable remark only if there is no Depth to Water (Clarification: If no measurement was made, depth to water is blank then a selection must be made within UTM Remark. Please note, select the appropriate Measurement Method when the UTM Remark field is populated.)

6) Source of Measurement: ADWR

7) Measurement Operator: Applicable Entry

8) Comments: Comment on what conditions were encountered in the field that may have influenced the water level at the time the measurement was made. Or, special notes on why you got a UTM, where applicable.

No water level was obtained (UTM):

1) Date: DATE you obtained or attempted to get a measurement

2 Depth to Water: Leave BLANK

3) Measurement Method: If no measurement was made and you are entering a remark, then select either OBSERVED or OTHER

4) Measurement Remark: Will auto populate based on UTM Remark selection or will be Null

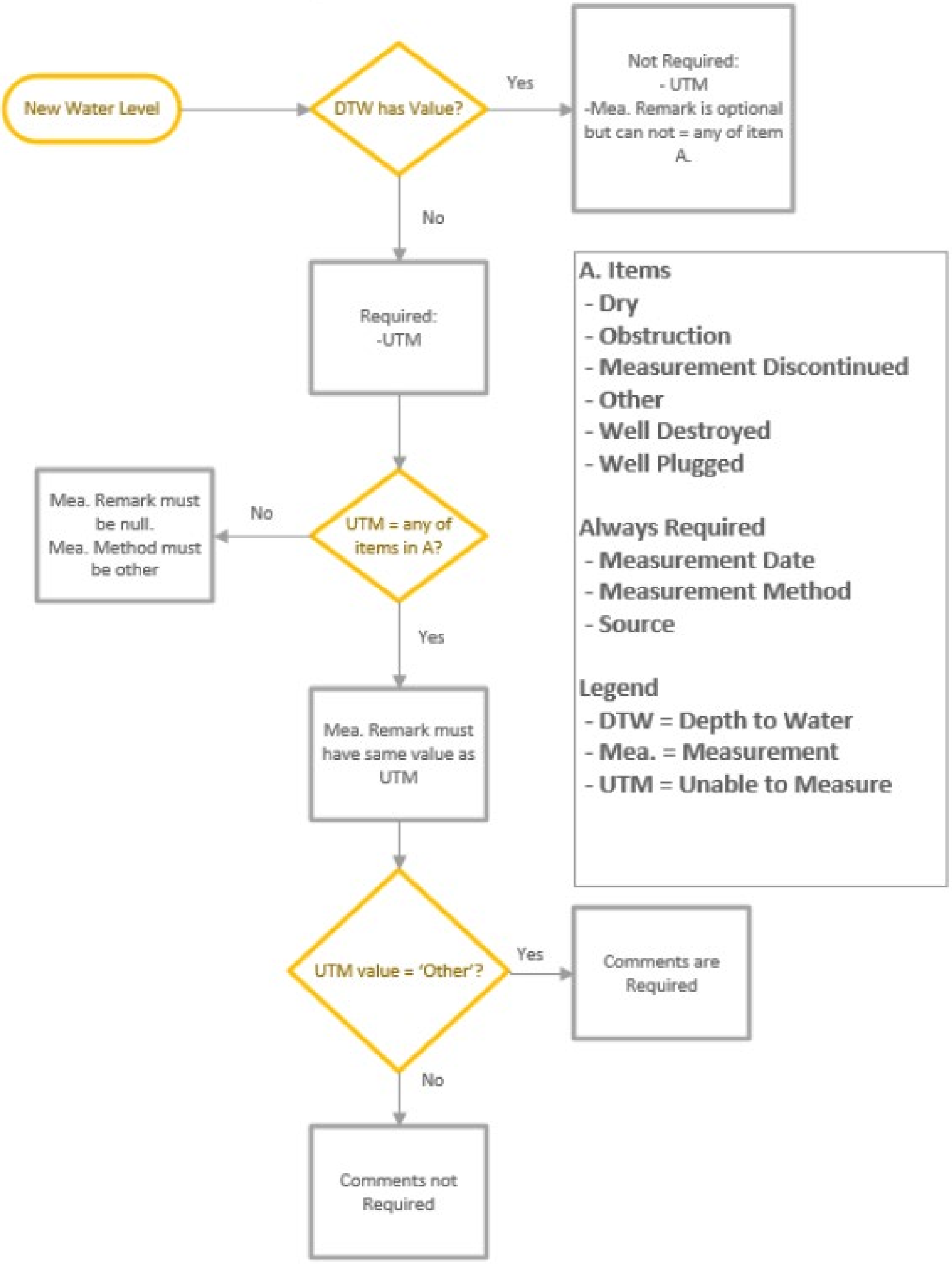
5) UTM Remark: Select from the drop down list the best match for the reason you got a UTM. If no selection in the list applies to the reason, select UTM Remark of “OTHER” and then explain in the comments field.

6) Source of Measurement: ADWR

7) Measurement Operator: Applicable Entry

8) Comments: Use this field if greater detail is needed to explain the UTM or if Measurement Method of “OTHER” is selected.

UTM flow chart:



By following this protocol, we will gain consistency in documenting and recording in GWSI when a site is visited, and an attempt was made to make a measurement, however, no measurement was possible. Entering this information in GWSI will provide documentation that a site was visited and allow for a quick review of conditions encountered at the site for any given time.

UTM codes and definition:

1) BEES (BE) - There are bees near the site or in the well that pose a risk to the safety of field personnel.

2) CASCADING WATER (K) - Water was cascading down the well from some point above the water table that prevents an accurate measurement.

3) DRY (D) - The site was dry, and no water level could be obtained.

4) LOCKED GATE (LG) - A locked gate prevented access to a site.

5) LOCKED WELL SITE (LS) - A measurement cannot be obtained due to a locked building, structure, well cap, or MP.

6) MEASUREMENTS DISCONTINUED (N) - Measurements are discontinued at the site.

7) NO CONTACT (NC) - A water level was not obtained due to the necessity to contact the owner, business, or property before a water level is to be obtained.

8) NO MP ACCESS (MP) - A water level cannot be obtained because there is no equipment access at the site to gain access to the water table.

9) NO PERMISSION (NP) - An owner or responsible party has denied and/or refused access to the site or water table.

10) NO SITE ACCESS (NA) - Something that hinders, impedes, and prevents getting to the site and cannot be defined by any other UTM Remark.

11) OBSTRUCTION (O) - A blockage in the well prevents a water level from being obtained.

12) OIL (V) - Oil located on the surface of the water table has prevented an accurate water level from being obtained.

13) OTHER (Z) - Any site visit where a measurement was not obtained and cannot be defined by any other UTM Remark.

14) PUMPING (P) - The site is being pumped at time of measurement.

15) ROAD CONDITION (RC) - All roads or drivable paths to a site are unsafe for equipment or personnel.

16) SITE HAZARD (SH) - The environment at or around the site poses a risk to personnel and cannot be defined by any other UTM Remark.

17) UNABLE TO LOCATE (UL) - The site location cannot be verified and/or there is no site at the best-known location.

18) WELL DESTROYED (W) - The well hole and casing has been destroyed and any future water levels would be impossible.

19) WELL PLUGGED (M) - Well has visible cement, debris, dirt, or other material blocking access to the water table and is not in hydraulic contact with the formation. However, a well casing is still visible.

Appendix K: Validation Instructions for Site Inventory Sheets

Validator:

Mark in red all corrections on site inventory sheet. Mark in pencil all fields needing to be checked by staff. Once the inventory sheet has been reviewed, if there are corrections to be made in GWSI or info to be checked, return the sheet to field staff. They will make any corrections needed in GWSI and return the Inventory Sheet to you for review once again. Once all corrections have been made, then initial-date in the Validated By space at end of the sheet.

General Instructions:

☐ Check that all information fields on Inventory Sheet match what is in GWSI. For example, check that the lat/long on the Inventory Sheet is typed the same in GWSI; do this for everything.

☐ Check all Site Detail fields for consistency and reasonability on all tabs.

☐ Check the cadastral format in GWSI is correct; no extra spaces or missing dashes, etc.

☐ Check that GWSI Report and any imaged records are attached to Inventory Sheet before filing in Master File.

Specific Instructions:

☐ Check that the latitude/longitude on the Sheet matches what's in GWSI.

☐ Check Local ID (cadastral) and compare with topo map well mark; is the cadastral correct based on topo map check?

☐ Check that 55 Reg ID matched correctly. Is 55 imaged record attached?

☐ Check other fields, such as Accuracy and Methods, and see if they make sense.

☐ Is the Altitude reasonable and does it match what's in GWSI?

☐ Does the Water and Site Use match the Sheet?

☐ Correct Basin, State, County?

☐ Check Source is correct.

☐ Check Lift Tab is entered correctly.

☐ Check Owner Tab is entered correctly.

☐ Check Site Names Tab if Other Site is filled out on Sheet.

☐ Check WM Points Tab if MP is filled out.

☐ Check WW Levels Tab if water level is filled out on Sheet.

☐ Check Images Tab if Pictures is marked Y on Sheet.

☐ Check that MISC form Drillers Tab is completed if known.

☐ Check COMP form and Well, Borehole, Casing, Perforation tabs are filled out correctly from attached driller's report/log.

☐ Check MISC form and Site Inventories tab is filled out correctly using this format:

Inventoried By: Last Name, Initial For example (Perez, MK)

Appendix L: Well Matching Check List

1) Does WELLS55 have a GWSI ID matched to registry number REG ID?
   - Check WELLS55WEB,
   - Check GWSIWEB,
   - Check Access DB table named: WELLS.OTHER_NAMES_IDS
   - Check Access DB table named: GWSI_OWNER_SITE_NAMES
   - Check in GWSI App (aka PENTAB)
   - Check in WELLS55 Browser
     a. If “Yes”, then **verify** match and **document verified match**
   - To document a match use table named: WELLS REVISED Tab; Well Names/IDs form
     b. If “No”, continue

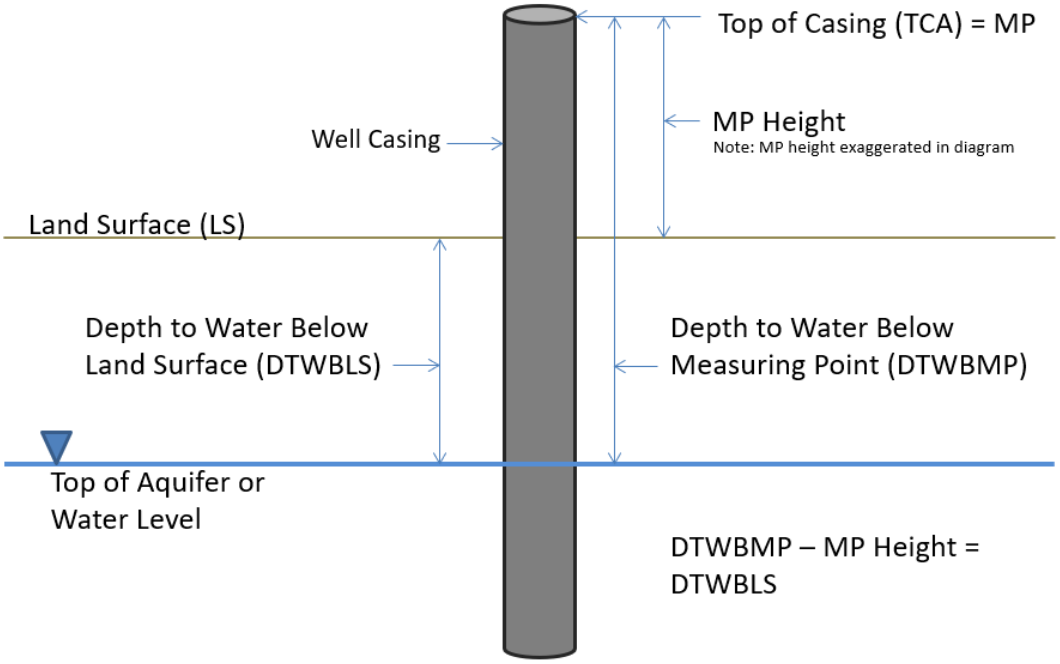
2) If WELLS55 has no GWSI ID, then search for wells near Cadastral for possible match. Can a match be found by searching wells nearby Local ID?
   - Check WELLS55WEB,
   - Check GWSIWEB,
   - Check County Assessor Records
   - You can create an Arcmap project to assist you.
     a. If “Yes”, then **verify** match and **document verified match**
   - To document a match use table named: WELLS REVISED Tab; Well Names/IDs form
     b. If “No”, continue

3) If maps do not work, then look at well construction. Can a match be found by searching wells with similar construction?
   - Check Access DB tables by filtering for unique well construction such as a date, hole depth, well depth or diameter. Again, always look at scanned images of WELLS files and if a 35 match, then WELLS35 Driller’s Logs.
     a. If “Yes”, then **verify** match and **document verified match**
   - To document a match use table named: WELLS REVISED Tab; Well Names/Ids form
     b. If “No”, continue

4) If construction does not work then look at well owner. Can a match be found by searching wells with similar owners?
   - Check Access DB tables by filtering for owners. Again, always look at scanned images of WELLS files and if a 35 match then WELLS35 Driller’s Logs.
   - Check County Assessor Records
   - Check WELLS55WEB,
   - Check GWSIWEB,
   - Check PERTRACK
     a. If “Yes”, then verify match and document verified match
   - To document a match use table named: WELLS REVISED Tab; Well Names/IDs form

Appendix M: Measuring Point Diagram

Measuring Point (MP) & MP Height Explanation



The Depth to Water (DTW) to be reported in the 3rd Party Water Level Portal is below Land Surface (LS) which equals the difference between the DTW below the Measuring Point (MP) and the MP Height.

Figure 10. Measuring Point Description