**Table 15.** Storage and coding requirements for ground-water-quality and quality-control samples and data of the National Water-Quality Assessment Program--Continued

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**2. Sample and Data Coding on Analytical Service Request (ASR) Forms**--continued

- Use additional codes below for quality-control samples (in accordance with BTD&QS)[2]--continued

For SPIKED SAMPLES (pesticides and volatile organic compounds):

| | Coding required | | | | | |
|---|---|---|---|---|---|---|
| | Sample medium | Sample type | Replicate type (99105) | Type of spike (99106) | Source of spike (99107) | Volume of spike (mL) (99108) |
| For each spiked sample | S | 1 | 20 | 10 or 20 | 10 | 0.1 |

where S denotes a replicate ground-water sample; 1 implies a spiked sample; 20 implies a sequentially-collected sample; 10 or 20 implies spike was done in field, or at NWQL, respectively, 10 implies source of spike solution was the NWQL (required); 0.1 implies a 100-microliter volume of spike solution was used. Record lot number of spike vial on ASR form.[3]

For REFERENCE SAMPLES (of trace elements, obtained from BTD&QS):

| | Coding required | | |
|---|---|---|---|
| | Sample medium | Sample type | Reference type (99103) |
| For each reference sample | Q | 3 | 35 |

where Q denotes an artificial sample; 3 implies a reference sample; and 35 implies a reference sample that is a blend of standards. Record reference sample bottle code as received from BTD&QS on ASR form.[3]

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[1] Use different time codes to distinguish QC samples and prevent data overwrites (see table 14).

[2] Storage of ground-water-quality and quality-assurance data in NWIS, Branch of Quality Assurance Memorandums 90.03 and 92.01 (unpublished memorandums located in the USGS BTD&QS, P.O. Box 25046, Mail Stop 414, Denver Federal Center, Lakewood, CO 80225).

[3] Write message to lab on comment line on ASR form.

To easily group ground-water-quality and QC data from selected sites, the containers for these samples are coded in a systematic manner that employs some common codes (table 14--NAWQA Study-Unit code, local well-identifier code, schedule or laboratory code, and date of collection). For example, ground-water-quality and routine QC samples from the same well and time of site visit are given the same local well-identifier code (on sample containers), and the same local well and 15-digit (latitude-longitude-sequence number) identification codes in NWIS-I, and the same date of collection (on containers and in NWIS-I). These common codes facilitate linking selected types of samples (field blanks with the ground-water sample collected before the blank was taken, one replicate sample with another, or a spiked sample with an unspiked sample). If common codes are not used, recoding, or the creation of additional codes by the Study Unit, will be needed to link data requested by the National Program. In either case, the Study Unit will be adding unnecessarily to its workload.

To manage sample data efficiently, and reduce confusion, it is best if routine QC sample data are stored and managed through NWIS-I QADATA, and ground-water-quality sample data are stored and managed through NWIS-I QWDATA (table 15). Efficient data management, reduced data loss, and improved ease of interpretation also are best achieved if different routine QC-sample types, taken in relation to the same well and time of site visit, are uniquely coded in at least some respects, and ancillary information that relates to each routine QC-sample type is documented on the ASR form (tables 14 and 15). Thus, different time, medium, and QC-sample codes are used for different types of routine QC samples. Ancillary information, such as the lot number of the blank water or the spike solution, also is coded and essential to interpreting QC data correctly. Illustrations of how data and codes are to be stored are provided for each type of QC sample routinely collected (see appendix).

Consistent coding benefits each Study Unit in several ways. First, except for a few codes, such as time of sample collection, most sample containers and forms generally can be filled out before the field team departs for sampling. Most of this same information also can be logged into NWIS-I in advance. This report (tables 14 and 15 along with the appendix) provides a comprehensive summary of appropriate codes that are needed to complete these presampling coding and management activities.

The prescribed codes will reduce the loss of data through overwrites. Data overwrites can occur in several ways. For example, one of the most common overwrite problems occurs when two different sample containers and their corresponding ASR forms have the same identification, date, and time codes, and one inadvertently requests analyses that involve at least one common analyte (parameter code) for both samples. Another common problem arises when one makes corrections to NWIS-I (QADATA or QWDATA), but does not have these processed through NWQL-LIMS. In either case, corrections are overwritten and data can be lost electronically when the NWQL submits or resubmits analytical results to NWIS-I through LIMS original record or provides updates to this record. To avoid problems, the Study Unit must code samples correctly. In addition, if corrections are made in the District, the Study Unit also must request the corrections be processed through the NWQL-LIMS system.

The prescribed codes will ensure that the sample container for a particular analysis is used for that analysis. For example, if sample containers are sent for major ions (SC2750--FA) and trace elements (SC2703--FA), they must be sent under separate ASR forms with different times to ensure that the trace-element analysis is done using the SC2703 sample and not the SC2750 sample. Because of potential differences in filter loading that affect filtrate concentrations between these two samples, it is critical that trace-element data come from an analysis of the SC2703 sample.

Finally, use of the prescribed codes (tables 14 and 15) is necessary for requests from the National Program for ground-water and QC data. If alternative coding is used, the data will need to be recoded by the Study Unit before the data are forwarded to the National Program.

## Final Presampling Plans and Preparations

During the last month or two before the first field season for data collection begins, the Study Unit will complete presampling plans and preparations. This will involve a number of activities (table 16) that, in addition to scheduling water-quality and QC sampling, will include the following:

1. Creating a field file that contains copies of all the information needed for the current sampling run;
2. Preparing sample containers and filter units;
3. Checking that all the equipment and supplies needed for sample collection at each well listed in the file have been obtained and safely stored in the vehicle; and
4. Checking that the vehicle is in good and safe working condition, and that safety equipment is present and functioning properly.

In addition to the well schedule (table 7), the field file contains information critical to completing activities at each well (table 16), which could differ among wells. As sampling continues, the file is updated regularly in terms of those wells scheduled for data collection throughout the remainder of the field season.

**Table 16.** Activities related to final plans and preparations before sampling begins

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1. **Create a field file,** in part, from previously collected information, that contains:
    - A well schedule (chronological list of wells to be sampled during the scheduled run).
    - A checklist of the sample and data-collection activities to be carried out at each well--
      (a) a list of analytes to be sampled--by bottle type (for example, FA), in order of collection and processing, including quality-control samples,
      (b) a list of information required, and the necessary forms, to complete any documentation not completed during previous site visits, and
      (c) a form for noting changes in, or providing additional information on, land use.
    - Copies of site, well, measurement point, and sampling setup location maps and photographs for each well.
    - Notes on any special site conditions that could affect sample and data collection at a well, including roaming animals and locked gates, or a well, that on the basis of screening tests, might require special QC sampling and decontamination procedures.
    - The contact person's (well or land-owner's) name and telephone number for each well.
    - Field cover, well-purge, Analytical Service Request, and field-instrument calibration forms--completed to extent possible for each well. Also include some extra, blank copies of each form. (Calibration notebooks can be used instead of individual forms.)
    - Overnight-mail shipping forms and labels, completed to extent possible, and the shipper's telephone number.
    - Study-Unit (SU) sample-transfer and temperature-check form for NWQL (Sample login) with SU-addressed, stamped envelope for each well. (Also have the telephone number for NWQL (Sample login)).
    - Calibration notebook(s) for field meters.
    - Copies of the NAWQA protocols for sample and data collection, and the U.S. Geological Survey National Field Manual for Collection of Water-Quality Data (Radtke and Wilde, in press).

2. **Prepare sample containers and filter units** that are:
    - Cleaned if necessary,
    - Labeled to the extent possible, and
    - Bagged, for each well,
    - With each container tightly capped. (Recommend plastic container be half filled with DIW.)

3. **Provide routine checks** that cover the equipment and supplies stored in field vehicles (see table 3 for detailed list), for:
    - Calibration and use of field meters for temperature, pH, acid-neutralization capacity, alkalinity, specific electrical conductance, dissolved oxygen, and possibly turbidity.
    - Collection, processing, preservation, and, possibly field extraction of ground-water and quality-control samples.
    - Field-equipment decontamination.
    - Sample shipment or temporary storage.
    - Disposal or temporary storage of waste materials.

4. **Provide predeparture checks** each time the field team leaves the District office or a well that:
    - Cover vehicle safety and condition.
    - Ensure all field equipment is properly and safely stored.

As part of the final presampling preparations, some sample containers require rinsing (table 16). For example, it is required that all sample containers and caps for filtered and acidified samples (FA designation), which includes those for major ions and trace elements, be rinsed at least three times with either QWSU IBW or DIW -- ASTM Type 1 water (conductivity less than 1.0 µS/cm at 25°C). It is recommended, however, that FU, RU, and FCC containers also be rinsed as described above before use. After the final rinse, it also is recommended, as a QC measure on the container seal, that each container be half-filled with the same water used for rinsing and capped before storing the container for transport to the field. If the container is less than half full when pulled from storage in the field, the container is discarded, and another similarly rinsed container is used in its place. This implies that several additional containers for each sample type are prepared as above and in advance of at least the first field-team trip. After rinsing, sample containers can be labeled with the appropriate codes, except for date and time of collection, before they are transported to the field. This will reduce the time necessary to complete setup activities in the field before samples are collected.

Although at least three different filter units commonly will be used (table 3), only the one for filtered inorganic samples, the 0.45-µm fibrous filter (capsule), can be prepared before the field team departs for the field. It is required that 1.0 L of QWSU water or DIW (ASTM-Type-1) be passed through this filter before it is used. Preconditioning is to occur within 5 days before use. A peristaltic pump head with Tygon tubing, or a Teflon diaphragm pump head with convoluted Teflon tubing can be used to force the preconditioning water through the capsule filter. The pump also is used to force as much water as possible from the capsule after it is preconditioned. To avoid mildew, the preconditioned capsules are placed in nested, resealable plastic bags and stored in a cool environment (refrigerator or cooler with ice) before use.

Different filter units might need to be prepared to address topics of interest germane to a specific Study Unit component. A Flowpath Study that involves geochemical modeling and other techniques to interpret dissolved inorganic chemical data from ground water requires additional samples be obtained with these samples filtered through a membrane with a pore size of 0.2 or 0.1 µm or less. Currently, only flat (plate) filter membranes are available with a pore size of 0.1 µm or less. Preparation of these membranes and the equipment needed is described in an internal document (F.D. Wilde, U.S. Geological Survey, written commun., 1995--see footnote 1). To determine the appropriate filter type and pore size, it is recommended that a comparison sample analysis be made between data obtained from NAWQA samples passed through 0.45–µm capsule filters and Study-Unit samples passed through 0.1–µm membranes to determine if there is an appreciable difference in trace-element concentrations.

Final plans before sample collection include the office support effort required to maintain the field effort. The field effort typically involves repeating activities (such as those in table 16) on a regular basis during a single field season. To plan for the office support needed, consider that each time the field team returns: (1) the sampling vehicle(s) generally is (are) unloaded, cleaned, and restocked; (2) forms and other information are transferred from field to office files; (3) the field file is restocked with information on the next set of wells to be sampled; (4) samples brought from the field are archived or shipped from the office; and (5) field and sample-related data and forms are transferred to data managers, with copies being archived into NAWQA site files.

If the planning document or workplan assigns all of the above activities solely to the field team, their field schedule must allow ample time to complete these activities. The workplan also should reflect that team members could have a backlog of work pending as a result of their absence. A field team that keeps good records in the field--of supplies that are running low, or of equipment that is in need of repair or replacement--can expedite preparations for the next field effort. While in the field, mobile phones also provide an efficient means of communicating needs in advance or when emergencies arise.

During final preparations, Study-Unit data managers integrate their plans to review the data-collection process. Workplans, developed during the last month or two before sampling begins, include verification of field forms returned by field teams, the login of sample and data information from these forms, and the updating of any new information (such as changes in land use). Workplans also include regular retrievals and quality-control checks on NWQL data returns. Of particular importance is the timely retrieval and evaluation of routine QC data, which can be used to assure field teams that data collection can continue unabated. Finally, data management workplans are to include the development of NAWQA water-quality files for wells at which ground-water samples are collected. These files generally are distinct from other files, such as the GWSI file, in that they chiefly contain records and information pertaining to ground-water-quality sampling. Thus, each of these files contains copies of sample-collection field forms, NWQL and other laboratory request forms, and water-quality-data summaries (in particular, NWIS-I site and time-specific lists (WATLISTS) of water-quality data).

## Field Protocols and Recommended Procedures

A field team could spend 2 to 5 hours traveling to and from each well that is scheduled for the collection of ground-water-quality samples. At each well, the team will perform some, or all, of the following activities:

(1) Equipment setup.

(2) A well purge, to remove standing water, and field measurements.

(3) Sample collection and processing.

(4) Decontamination of field equipment, including possible breakdown and storage of sampling equipment.

(5) Preparation of blank samples.

(6) Preparation of other routine quality-control samples and field extracts for pesticide samples.

(7) Handling and shipping of samples, including completion and verification of field, laboratory, and other forms.

Each activity is described below in its approximate chronological order of occurrence.

## Equipment Setup

Upon arrival, the field team contacts the land or well owner (if necessary), and locates the well and areas for conducting on-site activities (table 17). The field team carries out the remaining setup and other on-site activities after selecting one field-team member, hereafter referred to as **Team Member A**, who is responsible for the collection of all water-quality samples throughout the day. From this point on, **Team Member A** generally performs only those on-site activities that are least likely to lead to the contamination of samples during or after collection. The other field person, **Team Member B**, also performs activities required in order to collect samples and data, but in some cases the activities performed potentially heighten the risk of sample contamination if that person also were to collect water-quality samples.

Field team roles, which are maintained throughout the day regardless of the number of wells visited, are alternated between team members on a regular, preferably day-to-day, basis. This ensures that each team member can perform all on-site activities associated with ground-water-quality data collection.

It is recommended that team members wear clothing appropriate to their assigned activities. **Team Member A** wears clothing that is tightly knit and not likely to shed lint. Powderless latex (when using methanol) or powderless vinyl gloves are required. **Team Member B** initially wears work gloves and coveralls over attire, similar to that of Team Member A. Work gloves and overalls are removed after the completion of setup activities that involve handling equipment that could be heavily soiled or contaminated (table 17). **Team Member B** also is required to wear powderless latex or vinyl gloves during sample handling and preservation. Safety goggles or glasses are worn whenever either team member is handling chemical reagents that are potentially toxic or hazardous.

## Well Purging, Grab Samples, and Field Measurements

Before water-quality samples are collected, the well is purged of standing water. Grab samples taken near the end of the purge are used to determine (1) the amount of NWQL hydrochloric acid needed to acidify the VOC samples, and (2) the normality of QWSU sulfuric acid to use for field titrations. Field data are obtained during the latter stage of the purge, immediately before sample collection. The purge, as well as grab-sample analyses and field measurements, are carried out in an efficient, and to the extent possible, consistent manner throughout the NAWQA Program (table 18).

The well purge ensures that the field-measurement and sample data that are subsequently collected reflect the chemistry of water in the aquifer, and not that of the water that has been standing in the well. The purge also conditions sampling equipment and reduces turbidity (sediment and colloids) caused by either the lowering and start-up of a portable pump, or the start-up of a water-supply pump.

**Table 17.** Initial field-team setup activities related to on-site protocols and procedures at wells used for ground-water-quality and routine quality-control data collection for the National Water-Quality Assessment Program

1. Field team arrives, consults field file (table 16), and carries out initial setup activities as follows:

    - Contacts land or well owner (if necessary)
    - Verifies following points and areas of interest (modify site-file maps and update photographs and forms as necessary):
        - Land use and land cover in vicinity of well[1]
        - Well location and water-level measurement point
        - Parking areas for vehicle(s)
        - Areas for field-equipment setup and well-water discharge

2. To provide quality assurance, the field team divides remaining setup duties, which are carried out as follows:

    - **Team Member A**
        - Calibrates and sets up field instruments for titrations, turbidity, and flowthrough chamber[2]
        - Assembles sample-wetted equipment for purge and collection[3]
        - Completes labeling of sample containers and forms (primarily by adding date and time of collection)[4]

    - **Team Member B**
        - Sets up safety cones (as needed)
        - Measures water levels (if possible, static depth to water and depth of well)[3]
        - Checks for oil residues in well (on measurement tape)
        - Calculates purge volume (from well diameter and depth measurements, otherwise assumes it equals three casing (or wellbore) volumes)[5]
        - Attaches waste lines to purge setup (see fig. 2, routes to prevent flooding in work area and near power supplies)
        - Sets up pump system (as needed, fig.2, for monitoring well, in well drained area)
        - Sets up power supply (for portable pump, avoids wastewater areas; using vehicle power, checks fuel is sufficient, attaches exhaust hose(s) to vehicle(s), and voids exhaust downwind of work areas; using portable generator, checks and, if necessary, fills fuel tank)

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[1] See appendix, figure A1, and update as necessary.

[2] According to “Field Instruments” section and appendix, figures A2 to A6.

[3] See text and figure 2.

[4] According to “Sample Coding and Data Management” section and appendix, figures A8 to A20.

[5] See appendix, figure A7.

**Table 18.** Field-team activities for purging a well for ground-water-quality and quality-control data collection

[NWQL, National Water Quality Laboratory; HCl, hydrochloric acid; VOC, volatile organic compound; QWSU, Quality Water Service Unit; mL, milliliter; $H_2SO_4$, hydrosulfuric acid; ANC, acid-neutralizing capacity; ALK, alkalinity]

1. Field team identifies approach to be used to purge well on basis of:
    - Standard purge protocol (see table 19)
    - Recent pumpage from well
    - Possible use of packers
    - Well capacity
    - Possible use of other customized purge criteria
    - Well type (monitoring or water-supply well)[1]

2. Field team divides site duties on the basis of assigned roles for the day, and carries them out as follows:

**Team Member A**

- Records flow rate and volume of flow from the well and through the equipment setup.[2]
- Collects grab samples near end of purge to determine and record:[3]
  (1) the number of drops of NWQL HCl required to reduce the pH of VOC 40-mL sample to 1.7 to 2.0 (to a maximum of 5 drops for VOC sample preservation), and
  (2) the normality (1.6 or 0.16) of QWSU $H_2SO_4$ titrant, and volume in milliliters (50 or 100) of the ground-water sample (for field titrations of ANC and ALK).
- Records field measurements, including final median values required under protocol.[2]

**Team Member B**

- Conducts purge (and routes flow as needed to obtain field measurement data (see fig.2)).
- Adjusts and measures initial and final flow rates through purging setup and pump rates in well (as required and needed)[1].
- Monitors (if necessary) pump work rate (amperage) and power supplies (fuel levels).

**Both Team Members**

- Assess stability of chemical and physical measures to determine when samples are collected.[4]
- Document decision on whether or not to sample, and why.

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[1] See text, including section on "Purging Different Types of Wells."

[2] See appendix, figure A7.

[3] See "Grab Samples for Titrations and Volatile-Sample Preservation" and appendix, figures A8 and A9.

[4] See "Final Assessment of Chemical Stability."

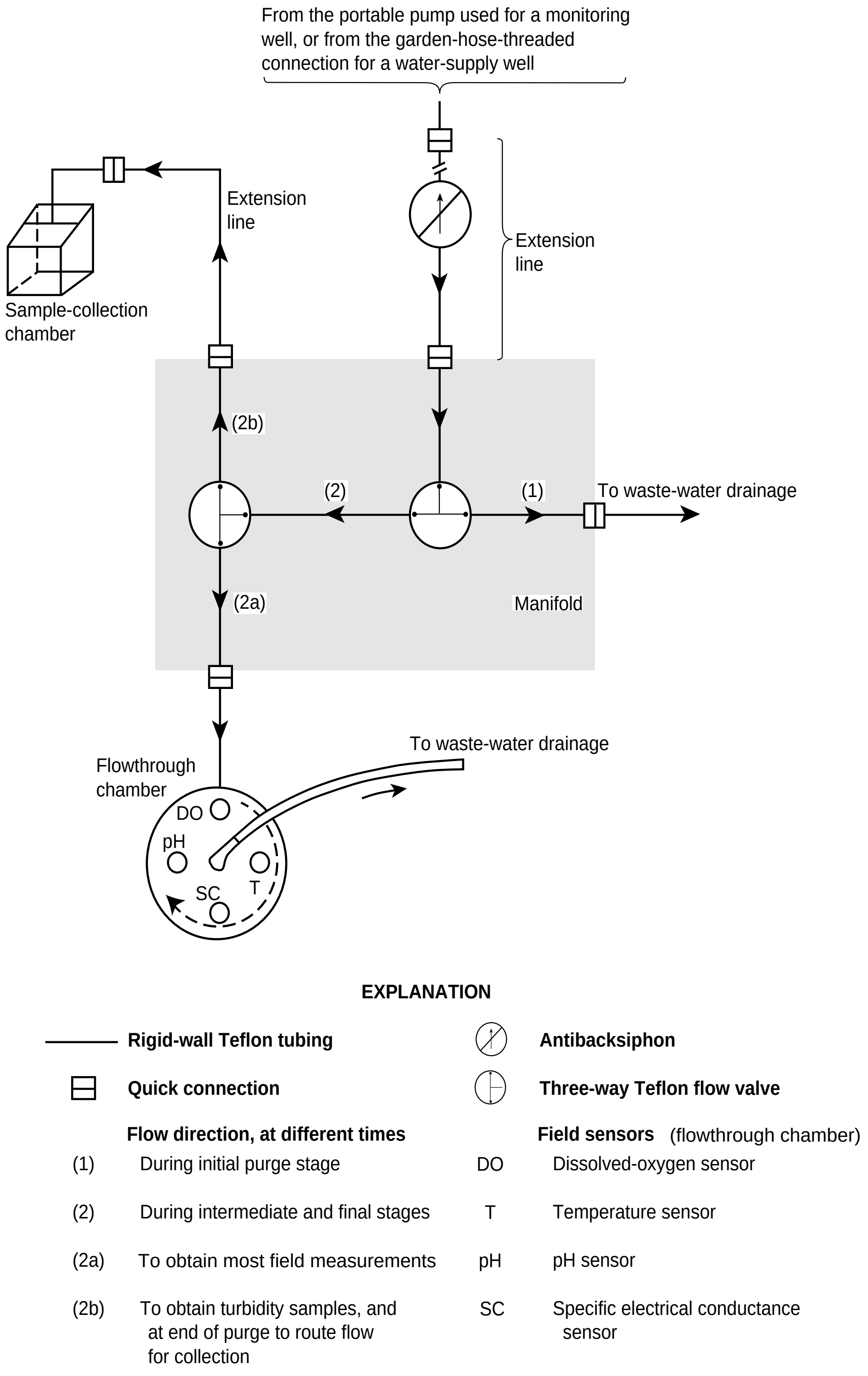

**Figure 2.** Schematic of equipment setup for well purge and sample collection.

Despite differences in scientific opinion as to when and how much purging are necessary, and the criteria used to assess when purging is complete, NAWQA field teams will use the standard USGS procedures and criteria for purging and collecting field measurements (table 19). In applying the purge protocols, the equipment and procedures used can differ in some respects on the basis of recent pumping, well capacity, study component, and well type (see below). With some exceptions, the same equipment (fig. 2), criteria (table 19), and similar procedures are used to purge and collect ground-water-quality samples. Deviations from the standard purge protocols that are not described below are discussed in advance, if possible, with the NAWQA QA Specialist.

## **Acceptable deviations from standard purge protocols**

Four possible exceptions to the standard purge procedures are recognized and accepted. The first relates to recent pumping. If it can be documented that a volume of water equivalent to the purge volume already has been pumped from a water-supply or monitoring well within the 24-hour period before the field team arrives, sample collection can begin after equipment has been flushed or "conditioned" with ground water and field measurements have been shown to be stable. This effectively reduces the purge time to that needed to achieve stable field measurements (table 19, minimally about 15 to 25 minutes).

The second exception to the standard purge protocols relates to well capacity. When the permeability of the aquifer is low, and a slow recovery limits well capacity, it often is possible to quickly evacuate the standing water from the well. For a monitoring well, the field team lowers the pump intake slowly, and evacuates the well at a pump rate that does not suspend sediments. Field measurements and samples are obtained after the water level has recovered to at least 90 percent of the level measured before evacuation, and provided recovery occurs within 24 hours of evacuation.

The third exception to the standard purge protocols also relates to well capacity. When packers have been placed in a well to restrict the zone of water withdrawal, the purge volume is equivalent to three times the volume between the packers. Given that this purge volume could be quite small, the field team again could find that only a 15- to 25-minute purge at the low flow rate is needed to remove the necessary water and obtain stable field measurements. As a quality-control measure, pressure transducers, installed above and below the packers, are recommended to determine that leakage is not occurring across packers or from above or below the zone isolated for sampling.

The fourth exception to the standard purge protocols is related to the ground-water component sampled. When purge criteria can be customized for the well and in relation to specific sampling objectives, these purge criteria can be used in place of the standard criteria. This exception is most appropriate for investigations that focus on a specific, but limited group of analytes, such as in a NAWQA Flowpath Study (table 1). In fact, it is recommended that Study Units develop and use purging procedures and criteria that best correlate with the concentrations of analytes being investigated. For example, a customized purge criteria for sampling VOCs is described by Gibs and Imbrigiotta (1990).

**Table 19.** Standard protocols and recommended procedures for conducting and assessing well purging for the National Water-Quality Assessment Program (modified from F.D. Wilde, U.S. Geological Survey, written commun., 1995--see footnote 1)

[Assumes that well capacity is not a limiting factor; see text for further discussion of exceptions. °C, degrees Celsius; %, percent; ≤, less than or equal to; >, greater than; <, less than; µS/cm, microsiemens per centimeter at 25°C; mg/L, milligrams per liter; NTU, nephelometric turbidity units]

1. Purge a minimum volume of water equal to three times the casing (or wellbore) volume.[1]
2. Reduce rate of flow from well, if possible, but at least through setup, to no more than about 0.1 gallon (~500 milliliters) per minute for 15 to 25 minutes near end of purge (sample-collection rate).[2]
3. Monitor pH, temperature, specific electrical conductance, and dissolved oxygen throughout the purging process, but particularly during last 15 to 25 minutes. (If trace-element samples are being collected, include turbidity measurements as part of monitoring.)
4. The well is considered purged after at least three casing volumes have been removed and values of monitored parameters between 5 successive measurements separated by about 3- to 5-minute time intervals are within the allowable difference specified below:

| Parameter | Allowable difference or value |
|---|---|
| pH | ± 0.1 units (± 0.05 units if instrument displays 2 or more digits to the right of the decimal) |
| Temperature | ± 0.2°C (thermistor) |
| Specific electrical conductance (SC) | ± 5%, for SC ≤ 100 µS/cm<br>± 3%, for SC > 100 µS/cm |
| Dissolved oxygen (DO) | ± 0.3 mg/L |
| Turbidity (TU) | ± 10%, for TU < 100 NTU: ambient TU is <5NTU for most ground-water systems (visible TU > 5 NTU) |

- If measurements appear stable, the median value of the last five measurements for each parameter (except for pH) is recorded on the appropriate forms (see appendix, figs. A7 and A8), and the field team proceeds with sample collection. For pH, only the last measurement is recorded.
- If criteria for stability is not achieved, purging is continued until either the field measurements stabilize, or the equivalent of five or more wellbore or casing volumes have been removed, depending on the judgment of the field team. The field team records the final field measurements in the manner noted above, and notes any parameters which remain unstable.
- If measurements remain unstable, the field team must decide whether or not to continue with sample collection.
- A lack of stability, indicated by a consistent trend in values upward or downward for pH, SC, DO, and TU, indicates possible problems in well design, or purging setup or technique. It is recommended that samples not be collected from a well if the setup or technique cannot be altered to obtain stable measurements.

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[1] Standing volume is calculated from depth to water and depth of well measurements (see appendix, fig. A7).

[2] If a high initial rate is used, reduce rate of flow from well and through purge-collection setup to this rate.

Each of the above exceptions actually fulfills the intent of the standard protocols. In each case, the procedures and criteria used ensure the removal of stagnant water, and the chemical and physical stability in flow before samples are collected. In addition, and regardless of what purge criteria are used, the standard field measurements (DO, SC, T, pH, and, if trace-element samples are collected, TU) also are determined and documented. They are part of the NAWQA data collected at each well (table 1). Thus, except for pH, the median value of the last five stable values for each standard measurement, and any customized purge criterion, are recorded as part of the data of record. For pH, only the last measurement is recorded.

## Purging with different flow rates

With the exception of some Study-Unit Survey Flowpath-Study components (table 1), wells used by NAWQA generally are completed at relatively shallow depths in water-table aquifers. As a general rule, the purge procedures described above are completed within about 2 to 2 1/2 hours, which includes the 15- to 25-minute period at the low flow rate required for sample collection (about 0.1 gal/min or 500 mL).

A low flow rate is required at the end of the purge (and during sample collection) for consistency and technical reasons. In combination with a portable, submersible pump, a low flow rate:

(1) is obtainable and maintainable for most, if not all, wells;
(2) reflects a discharge that can be sustained at low pump amperage and without surging;
(3) reduces the likelihood that sources of ground water entering the well will change (Reilly and others, 1989);
(4) is likely to lead to uniform, or at least less turbulent, flow;
(5) reduces the potential for degassing of some constituents, such as VOCs and radon;
(6) reduces the likelihood of entraining colloids and other artifacts dislodged and suspended by turbulence; and
(7) provides a rate of flow that is manageable during sample collection.

To achieve some of the above in sampling water-supply wells when the rate of flow through the well is high and uncontrollable, part of the flow is diverted (through the equipment setup) at the required low rate.

Although use of a higher rate of flow throughout the purge and sample-collection period than that required near the end of the purge reduces purge and sample-collection times, it also reduces the likelihood that the benefits described above will be achieved. As a compromise that aids in reducing field times, while maintaining some consistency and quality control, higher flow rates (during the initial part of the purge) than the required low flow rate (near the end of the purge) can be used provided these conditions are met: (1) that the high flow is sustainable, (2) that the high flow is not highly turbulent, (3) that field measurements, including turbidity, which could change precipitously at first under the high flow, stabilize relatively quickly, and remain about the same (no abrupt changes), and (4) that turbidity, in particular, does not remain elevated, but approaches a generally acceptable value (table 19).

## Purging different types of wells

Perhaps the most substantial differences among wells that the field team could encounter in applying the standard purging protocol (table 19), or one of the acceptable deviations to that protocol, occurs in relation to well type (monitoring or water-supply well). Because water-supply wells for NAWQA are chosen on the basis of suitable construction for ground-water-quality data collection (Lapham and others, in press), they are equipped with pumps that can be used to obtain water samples. The location of the well pump intake and the pump rate, however, generally cannot be controlled by the field team. This implies that the field team only has limited control of some aspects of the purge and sample-collection process at these wells. This is not the case for most monitoring wells. Because data collection at most monitoring wells selected by NAWQA will require the use of a portable pump whose intake location and flow rate can be modified, the field team has considerable control over the purge and sample collection process for this type of well. Despite the differences in level of control between water-supply and monitoring wells, and to promote consistency in purging and data collection from these two types of wells, it is required that field teams follow the standard procedures (table 19), when possible, or follow acceptable alternative procedures for purging each type of well. Further guidance on purging either type of well is provided below.

**Water-Supply Wells.** Water-supply wells used by NAWQA are selected, in part, because they have pumps deemed suitable for producing samples of suitable quality. The field team, however, generally cannot alter the rate at which these pumps operate, nor the location of the pump intake. Generally, the field team only can control the flow rate through their own equipment when purging or collecting samples.

To determine the manner in which the purge of a water-supply well is conducted, the field team first estimates the volume of water that will be removed from the well using the ground-water supply-pump rate and the final 15 to 25 minutes of purging (when stability measurements must be made). If the estimated volume is about equal to or exceeds the required purge volume, then evacuation of the required purge volume will take only about 15 to 25 minutes. In this case, the field team sets up the equipment and then conducts the purge. This situation commonly arises for small water-supply wells, such as those used for single dwellings. Setting the equipment up first, and then purging this type of well will prevent overpurging, which could adversely affect the quality of data obtained by NAWQA for some VOCs (Gibs and Imbrigotta, 1990).

For a water-supply well that requires a purge time considerably longer than 15 to 25 minutes (for example, more than 2 hours), the field team has the option to request that the well pump be turned on before they arrive. This approach commonly is needed for high-capacity wells used for irrigation or drinking-water supplies. The field team arrives, however, in time to set up equipment, complete the final 15- to 25-minute phase of purging using the low flow rate through their equipment, and obtain stable field measurements before the required purge volume is evacuated. If this option is used, the field team also requests that static water-level data be collected by the pump operator before pumping begins.

As a final consideration in purging a water-supply well, the field team keeps the water-supply pump operating throughout the purge and sample collection. This ensures the removal of standing water from the well, and clears standing water from any plumbing lines leading to the sampling equipment.

To ensure the water-supply well continues to operate, the field team can open more flow valves than just the one connected to their equipment. This also will reduce the likelihood of backflow of water stored in plumbing lines that could be connected to the line that transports water to the sample-collection setup. Backflow often occurs if the plumbing system is not equipped with antibacksiphons. Antibacksiphons generally are absent in secondary distribution lines on low-capacity supply wells, such as those used by rural homeowners for local supplies.

Since water-supply pumps operate continuously during the purge and sample collection, there is a chance that the supply pump could burn out. Although most commercial pumps are designed to operate for hours without problems, old, worn pumps are a potential problem. If a pump burns out, the field team generally should expect to replace it upon the owner's request. To limit the chance of pump burnout, the field team needs to work quickly and efficiently to keep the total pumping time required to purge and sample as short as possible. If this is achieved by using a high flow rate, through setup equipment, this flow rate is reduced to about 0.1 gal (500 mL) per minute during the final stage of the purge and during sample collection.

**Monitoring Wells**. Because the field team supplies the pump, they control the rate at which water is pumped from the well and through their equipment, as well as the location of the pump intake in the well. During the purge of a monitoring well, it is important to recognize that pump intake rate, emplacement, and location can influence the quality of the water obtained. Thus, it is important that these pumps be used in a consistent manner for the purge and sample collection at different monitoring wells.

As in the case of a water-supply well, the first step in applying the purge protocol to a monitoring well is to determine if the required purge volume can be evacuated in the 15 to 25 minutes needed for field measurements at the required low-flow rate for sample collection. For this 15- to 25-minute period, and a rate of about 0.1 gal (500 mL) per minute, about 1.5-2.5 gal (7-11 L) will be evacuated from the well. If the required purge volume is less than or equal to this volume, the field team sets up all equipment and then purges the well at this low rate. If the required purge volume exceeds about 1.5-2.5 gal, the field team can purge the well at an initially high, but acceptable, flow rate (as described earlier) to reduce the purge time, and then reduce the flow rate to the sample-collection rate for the final 15 to 25 minutes of the purge, and take and document final field measurements.

Pump intake emplacement is a consideration in the purge of a monitoring well. To reduce the suspension of sediments in the well, the pump intake always is lowered slowly into the well. Initially, the intake is placed just below the surface of the water standing in the well.

With the setup equipment properly configured to route flow directly to waste (fig. 2), the pump is turned on at an initially low rate to avoid sediment suspension in the well. If the required purge volume is small, and the entire purge can be conducted within 2 hours at the low rate required for final field measurements and sample collection, the pump rate is slowly adjusted to a rate of about 0.1 gal (500 mL) per minute. This rate is verified by measuring the outflow from the waste line, and recorded (appendix, fig. A7).

If the required purge volume is high, and an initially high pump rate is desired, the pump rate is slowly increased until either the maximum acceptable flow (as described earlier) or pumping capacity is reached (because of pump limitations or well capacity). In general, unless the well capacity is extremely low and purging cannot be completed within 2 to 2 1/2 hours, rapid evacuation of the standing water in the well is avoided. As noted earlier, the initial flow rate is measured at the waste-line outflow and recorded (appendix, fig. A7).

After the initial flow rate has been measured, the flow is rerouted through the instrumented flowthrough chamber (fig. 2) and the purge continues. Field measurements are made and recorded from this point on (appendix, fig. A7).

As the purge continues, and to enhance the evacuation of all standing water, the pump intake in unpacked wells is lowered slowly until it resides a distance above the open (perforated, or screened) interval that is equal to 7 to 10 times the diameter of the well casing (borehole). Assuming the monitoring well was designed correctly with a short open interval of 2 to 10 ft (Lapham and others, in press), this final location of the intake aids in promoting the flow of water from the entire screened interval to the pump intake.

Any substantial changes in pump intake location (lift) could affect the flow rate. Thus, all changes in pump intake location are completed before the final 15- to 25-minute stage of the purge. At this time, any high pump intake rate is reduced to about 0.1 gal (500 mL) per minute, and the last five sets of successive field measurements are taken, while the last of the required purge volume is evacuated from the monitoring well.

### Grab samples for titrations and volatile-sample preservation

During the final 15 to 25 minutes of the purge, or whenever measurements appear stable in relation to the purge criteria (table 19), two grab samples are taken**.** The first is a 100-mL sample which, if the pH exceeds 4.5, is quickly titrated to roughly determine the acid neutralizing capacity (ANC) of the sample (Radtke and Wilde, in press). From the ANC value, the field team determines the optimum sample volumes and titrant normality (1.6 *N* or 0.16 *N* sulfuric acid) to be used for subsequent, quantitative field titrations (table 20). If the sample pH is 4.5 or less, no field titrations for ANC or alkalinity are required.

If VOC samples are scheduled for collection at the well, a second 40-mL grab sample is obtained in a clean glass beaker to determine the amount of NWQL hydrochloric acid needed to preserve VOC samples (from March 31, 1993 to January 31, 1994, samples were preserved with NWQL-concentrated hydrochloric acid). The acid is added drop by drop to this beaker, the sample is stirred or mixed, and the pH is measured after each acid addition until it is between 1.7 and 2.0. The number of drops of NWQL acid used must be recorded on field forms (appendix, figs. A8, A10-A, A11-A, A12-A, and A13-A). To avoid damage to NWQL instruments, however, no more than 5 drops of NWQL hydrochloric acid are to be added to a VOC sample (Bruce Darnel, VOC National Synthesis Team, U.S. Geological Survey, written commun., 1995).

**Table 20.** Field-titration procedures for ground-water samples of the National Water-Quality Assessment Program

[mg/L, milligrams per liter; mL, milliliters]

- Except when replicate titrations are scheduled at selected wells, one filtered, and (optionally) one unfiltered, sample will be titrated at each site.[1]

- The unfiltered sample is titrated for acid-neutralizing capacity (ANC, mg/L[2]). The filtered sample is titrated for alkalinity (ALK, as mg/L $CaCO_3$; carbonate, as mg/L $CO_3^{-2}$, bicarbonate, as mg/L $HCO_3^-$; and hydroxide, as mg/L $OH^-$).

- Conducted in the field on fresh samples by the incremental addition of titrant, generally with digital equipment, and the recommended volume of sample and normality of titrant, as follows:

| Parameter(s) | Expected Value | Sample Volume | Titrant Normality |
|---|---|---|---|
| ANC or ALK | 0.0-50 mg/L as $CaCO_3$ | 100 mL | 0.16 |
| ANC or ALK | 50-200 mg/L as $CaCO_3$ | 50 mL | 0.16 |
| ANC or ALK | 200-1,000 mg/L as $CaCO_3$ | 100 mL | 1.6 |
| ANC or ALK | Exceeds 1,000 mg/L as $CaCO_3$ | 50 mL | 1.6 |

- Estimates of ANC, ALK, and contributing species are determined by the Inflection-Point Method (Radtke and Wilde, in press). Inflection points to determine ANC or ALK and contributing species are near pH values of about 8.2 and 4.5 for most waters buffered by the carbonate system.

- If difficulties arise in determining titration endpoints--which could be encountered for saline, low-conductivity, low-alkalinity, anoxic, or organic-rich ground waters--the Gran-Function Plot Method is recommended (Radtke and Wilde, in press).

- Field titration data are recorded (appendix, fig. A9) and later stored electronically under the appropriate parameter codes in NWIS-I QWDATA (for primary ground-water samples) or NWIS-I QADATA (for replicate ground-water samples).

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[1] Before 1996, titration of an unfiltered sample was required and titration of a filtered sample was optional.

[2] Reporting values above assigns carbonate chemical species as the primary sources of neutralizing capacity. At this writing, appropriate parameter codes are not available to enter data above in NWIS-I in milliequivalent units.

### Final assessment of chemical stability

The field team decides whether or not to collect ground-water-quality samples on the basis of the relative stability of field measurements taken near the end of the purge, as the last of the required purge volume is evacuated from the well (table 19). It is recommended that samples not be collected if unstable field measurements persist. Unstable measurements generally indicate one or more of the following is true: (1) that the source of water entering the well is changing with time, (2) that a decreasing proportion of water leaving the well is water that initially was standing in the well, or (3) that water is entering the well in a disproportionate manner as time elapses from a new source or from several sources. Thus, the resulting water-quality data obtained from sampling a well with unstable field measurements may or may not relate to the land use, aquifer, or other conditions being investigated.

## Sample Collection and Processing

Sample collection begins when purge criteria have been met. The type and number of individual ground-water-quality and QC samples obtained, however, depend on the ground-water component (Study Unit Survey, Land-Use Study, or Flowpath Study) for which samples are being collected (table 1). Study-Unit (or Subunit) Surveys and Land-Use Studies commonly include the collection of samples for organic, inorganic, and possibly trace-element, radiochemical, and isotopic analyses. Flowpath Studies generally are limited in scope and require fewer samples than either Surveys or Land-Use Studies. For each component, routine, and possibly topical, quality-control samples also are scheduled for collection at selected wells.

Regardless of the particular component under investigation, protocols and procedures are followed in a consistent, timely, efficient, and quality-controlled manner. The protocols and procedures that follow describe the sample-collection methods to be used for NAWQA ground-water-quality studies (table 21), and include the collection and processing (filtration, preservation, handling, and shipment) of water-quality and QC samples for a given analysis. In addition, the protocols also specify an order or sequence in which groups of samples for different analytes are collected under these protocols, which generally is to be similar at each well in a given component, and among components with similar data-collection requirements.

Overall, the NAWQA sample-collection protocols and recommended procedures (table 21) follow USGS protocols and procedures (F.D. Wilde, U.S. Geological Survey, written commun., 1995--see footnote 1). Thus, samples for organic analytes (unfiltered, then filtered) are collected first, followed by samples for inorganic analytes (filtered, then unfiltered), which in turn are followed by the collection of samples for other (ancillary) analytes--isotopes, radiochemicals, and chlorofluorocarbons (table 21). Routine replicate ground-water-quality samples, including those for field spikes, are collected in conjunction with the primary ground-water-quality samples (table 21). (Routine QC samples that use blank water are collected in the field after ground-water-quality samples and after the decontamination of sample-collection equipment.)

**Table 21.** Collection order, processing, preservation, and field storage required for ground-water-quality and replicate samples for the National Water-Quality Assessment Program

[Except as noted, equipment used is described earlier (table 3). Except as noted, samples are (possibly filtered and) obtained in a collection chamber, and (if necessary) chemically preserved in another chamber. Except for filtered inorganic samples (see below), all routine replicate samples, including those for field spikes, are obtained sequentially for each National Water Quality Laboratory (NWQL) schedule or laboratory code. Replicate samples for filtered inorganics (FA, FCC, FU, and alkalinity) are collected after the first set of these samples are obtained, and with a second Quality Water Service Unit (QWSU) capsule.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| GCV | glass chilled volatile | GCC | glass chilled chromatograph | SC | (NWQL) schedule | LC | (NWQL) lab code |
| HCl | (NWQL) hydrochloric acid | **CG** | change gloves | mL | milliliter | mm | millimeters |
| µm | micrometers | L | liters | $N_2(g)$ | nitrogen gas | lb/in$^2$ | pounds/square inch |
| PBW | (NWQL) pesticide blank water | FA | filtered acidified | FCC | filtered chilled | $HNO_3$ | (NWQL) nitric acid |
| DIW | deionized water | FU | filtered untreated | RU | raw untreated | U | Uranium |
| Ra | Radium | ASR | analytical service request | °C | degrees Celsius | ≤ | less than or equal to] |

| | Team Member A | | | Team Member B | |
|---|---|---|---|---|---|
| Sample type (SC, LC) and order of collection | Filtration | Collect, by filling | Quality-assurance checks or measures | Chemical preservation | Temporary storage |
| 1. Organic filtered and unfiltered | | | | | |
| • Volatile organics (SC2090, SC2091, or SC2092 with SC1306) | None | 3, GCV, 40-mL amber, glass vials, sequentially; using Teflon tube to fill each vial from its base until overflow occurs | Avoid sample aeration when filling. Replace vial if gas bubble appears after capping. (Team Member B, re-check, immediately after preserving) | Add 1 to 5 drops HCl to each vial, and record amount [on field and ASR forms] | Sleeve and chill[1] |
| • Organic carbon (SC2085) | **CG**, use tweezers, and place a QWSU, 0.45 µm, 47-mm-diameter silver filter in cylinder. Fill with sample, cap, and (outside of chamber) pressure-filter [$N_2(g)$, ≤15 lb/in$^2$][2] | 1, GCC, 125-mL, amber bottle to neck base after first discarding the initial 25 mL of filtrate to waste (do not rinse bottle) | Do not include plastic filter separator, or flip filter over during removal from package. Do not overpressurize filter cylinder | None | Sleeve and chill[1] |
| • Pesticides (SC2001 or SC2010, SC2050 or SC2051)[3] | **CG**, use tweezers, and place a NWQL, 0.7 µm, 142-mm-diameter, baked, glass-fiber filter in plate unit, prewet the filter, close unit, and void air[4] | 1, GCC, 1.0-L, amber glass bottle for each SC after first discarding the initial 125 mL of filtrate to waste (do not rinse bottle) | Prewet membrane with 10 - 20 mL of NWQL PBW. Do not fill bottle beyond neck to reduce breakage if sample volume expands on chilling | None | Sleeve and chill[1] |

**Table 21.** Collection order, processing, preservation, and field storage required for ground-water-quality and replicate samples for the National Water-Quality Assessment Program--Continued

| | Team Member A | | | Team Member B | |
|---|---|---|---|---|---|
| Sample type (SC, LC) and order of collection | Filtration | Collect, by filling | Quality-assurance checks or measures | Chemical preservation | Temporary storage |
| 2. Inorganic, filtered | | | | | |
| • Trace elements (SC2703-FA) | **CG**, and attach QWSU 0.45-µm, preconditioned Supor capsule filter with flexible Teflon tubing, and void air[3] from capsule. | 1, FA, 250-ml, clear, prerinsed, poly bottle to neck base after a 25-mL filtrate rinse (include cap) | Invert capsule (arrow up), and tap to evacuate air while filling. Verify DIW is still in sample bottle from office prerinse before use; otherwise replace bottle | Add 1-mL ampoule of $HNO_3$ | In dry cooler, avoid extreme heat or cold |
| • Major ions (SC2750-FA and archive) | If possible, use same capsule as above, otherwise replace with another preconditioned capsule in manner above. | 2, FA, 250-mL, clear, prerinsed, poly bottles to necks after 3, 25-mL filtrate rinses on each (include cap) | Verify DIW is still in each bottle from office prerinse before use; otherwise replace bottle | Add 1-ml ampoule $HNO_3$ to each bottle, **CG** | In dry cooler, avoid extreme heat or cold |
| • Nutrients (SC2752-FCC) | **CG**, and, if possible, use the same capsule as above, otherwise replace in manner above. | 1, FCC, 125-mL amber, prerinsed, poly bottle to neck base after 3, 25-mL filtrate rinses (include cap) | Verify DIW is still in bottle from office prerinse before use; otherwise replace bottle | None | Sleeve and chill[1] |
| • Major ions (SC2750-FU) | If possible, use same capsule as above, otherwise replace in manner above. | 1, FU, 250-mL, clear, prerinsed, poly bottle to neck base after 3, 25-mL filtrate rinses (include cap) | Verify DIW is still in bottle from office prerinse before use; otherwise replace bottle | None | In dry cooler, avoid extreme heat or cold |
| • Alkalinity (ALK) | If possible, use same capsule as above, otherwise replace in manner above. | 1, FA, 250-mL, clear, prerinsed, poly bottle to top after 3, 25-mL filtrate rinses (include cap), and cap bottle | Verify DIW is still in bottle from office prerinse before use; otherwise replace bottle | On basis of grab sample, pipette the required volume of filtrate into 250-mL beaker, titrate, and record data[5] | None |

**Table 21.** Collection order, processing, preservation, and field storage required for ground-water-quality and replicate samples for the National Water-Quality Assessment Program--Continued

| | Team Member A | | | Team Member B | |
|---|---|---|---|---|---|
| Sample type (SC, LC) and order of collection | Filtration | Collect, by filling | Quality-assurance checks or measures | Chemical preservation | Temporary storage |
| 2. Inorganic unfiltered | | | | | |
| • Major ions (SC2750-RU) | None | 1, RU, 500-ml, clear, prerinsed poly bottle to neck base after 3 25-mL rinses with raw sample (include cap) | Verify DIW is still in bottle from office prerinse before use; otherwise replace bottle | None | In dry cooler, avoid extreme heat or cold. |
| • Acid-neutralization capacity (ANC), recommended | None | 1, FA, 250-mL, clear, prerinsed poly bottle to top after 3, 25-mL rinses with raw sample (include cap) | Verify DIW is still in bottle from office prerinse before use; otherwise replace bottle | On basis of grab sample, pipette the required volume into a clean, 250-mL beaker, titrate, and record data[5] | None |
| 3. Other Samples | | | | | |
| • Trace elements (1.0-L samples, for example, U, and Ra) | **CG**, and attach preconditioned capsule in manner similar to that used for SC2703 above[3] | 1, FA, 1-L, clear, prerinsed, poly bottle to neck base for each element after a 25-mL rinse of bottle and cap | Verify DIW is still in bottle from office prerinse before use, otherwise replace bottle | **CG**, and add 2 $HNO_3$ ampoules to each bottle | In dry cooler, avoid extreme heat or cold. |
| • Tritium isotopes | None | 1, 1.0-L, clear, prerinsed poly bottle, filled to top after 3, 25-mL rinses (include cap with conical insert) | Verify DIW is still in bottle from office prerinse before use, otherwise replace bottle. Leave no headspace in bottle | None | In dry cooler, avoid extreme cold or heat. |
| • Deuterium-Oxygen isotopes | None | 1, 125-ml, glass, amber bottle to top after 3, 25-ml rinses (include cap with conical insert) | Leave no headspace in bottle | None | In dry cooler, avoid extreme heat or cold. |

**Table 21.** Collection order, processing, preservation, and field storage required for ground-water-quality and replicate samples for the National Water-Quality Assessment Program--Continued

| Sample type (SC, LC) and order of collection | Team Member A | | | Team Member B | |
|---|---|---|---|---|---|
| | Filtration | Collect, by filling | Quality-assurance checks or measures | Chemical preservation | Temporary storage |
| 3. Other, continued | | | | | |
| • Radon (LC1369) | Disconnect extension line to sample chamber, attach radon-collection unit to manifold, partly close valve on unit. Check all sample-wetted lines up to unit for gas bubbles, and dislodge any by tapping lines with hard object. (Record on ASR form if bubbles reform before samples are obtained) | 1, radon scintillation vial, after rinsing syringe barrel twice with sample before injecting 10.0 mL of sample into vial at base of mineral oil. Cap and shake 10 seconds. Note and record actual time on ASR form (comments-to-NWQL line) | Compare oil level in vial before use to that in vial from another tube. Return vial unused to NWQL if oil level is low. Create sufficient back-pressure in device to create easy with-drawal of sample without degassing. Void all air from syringe after second rinse before inserting syringe needle into septum of device. Initially withdraw 15 mL of sample, invert syringe [needle up], void sample to leave 10.0 mL in syringe barrel, re-insert needle (down) into vial to collect | None | Repack vial in shipping tube, wrap ASR form (with collection time) around tube, fix with rubber band, and place tube in resealable plastic bag. |
| • Chlorofluorocarbons (CFCs) | Modify setup to attach CFC--collection unit (Busenberg and Plummer, 1992) to manifold or pump tubing outlet | Three to five CFC vials filled according to procedures used by Busenberg and Plummer (1992) | Critical to avoid air entrainment or sample degassing during collection (See radon above) | None; can be stored indefinitely if not biologically active | In partitioned box to reduce breakage |

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[1] Glass containers are placed in foam sleeves, and chilled samples generally stored in ice. Desired temperature of chilled samples is 0 to 4 °C

[2] Cylinder and nitrogen-gas filtration system are available from Hydrologic Instruments Facility (table 3, in this report).

[3] Possible flow adjustment could be required to increase flow from filtration unit to about 0.1 gallon (500 mL) per minute.

[4] Samples under schedules SC2010 and SC2051 require Study Unit to extract water samples and send extracts to NWQL (see section on Pesticide Solid-Phase Extraction).

[5] Volume of filtrate and normality of titrant determined from grab sample taken near end of purge (table 20, in this report). National Field Manual (Radtke and Wilde, in press) discusses incremental and Gran titration methods and calculations. For NWIS-I, recommend using parameter codes as indicated in appendix (fig. A8).

## Field-team functions

The setup (fig. 2) used to purge the well is modified slightly for sample collection. The short turbidity-collection line is replaced by an extension line that runs to the sample-collection chamber. The flow, which has been passing through an instrumented flowthrough chamber, is rerouted (for example, using the second three-way flow valve as shown in fig. 2) through this extension line that is connected to the sample-collection chamber. The rate of flow through the sample-collection setup is about 0.1 gal (500 mL) per minute.

In general, samples are obtained and, with one or two exceptions, processed (for example, filtered) by **Team Member A** (table 21). Except for radon and chlorofluorocarbons, which require special collection equipment, and dissolved organic carbon, which requires a pressurized filtration, samples are obtained (sample containers are opened, if necessary, final rinsed, filled, and closed) only within the collection chamber. As each sample container is removed from the chamber, it is set aside on a clean surface, and not handed directly to **Team Member B**. This reduces the likelihood of contamination of **Team Member A**, the chamber, and subsequent samples, as collection continues.

In general, **Team Member B**, who has removed coveralls and work gloves, preserves (if necessary) and temporarily stores samples (table 21). **Team Member B** also performs field titrations.

Chemical preservation of NAWQA samples currently (1995) requires a single preservation chamber (for NWQL hydrochloric and nitric acids). This chamber is separate from that used to collect samples (table 3). During preservation, samples are opened, preserved, and closed in this chamber by **Team Member B**.

Throughout the collection process, the field-team members frequently replace their gloves at logical intervals to further reduce sample contamination (table 21, CG). If either one leaves the collection or preservation areas to perform other tasks, gloves must be replaced before activities in these areas are resumed.

Near the end of the sample-collection process, field titrations (particularly when replicate filtered (ALK) or unfiltered (ANC) samples are taken) generally will require most of **Team Member B's** time**.** Therefore, **Team Member A** often will complete the collection of all samples after that for ANC with little or no assistance (table 21).

## Special considerations for selected sample types

With adequate training and preparation, collection procedures for most sample types require no more than a conscientious effort to rinse and fill a bottle in a clean setting to obtain high-quality data. Situations arise, however, which necessitate processing samples simultaneously with their collection, or which require modifications to the general field-equipment setup and protocols described (table 21).

**Filtered Samples.** To obtain high-quality samples, care must be taken in the use of filter units and to avoid overpressurizing these units. The NWQL aluminum plate filter (for pesticide samples) is prepared in the collection chamber (table 21) and has a simple nipple fitting, which is connected to the sample outflow orifice inside the sample chamber by a short piece of Teflon tube. Air is evacuated from the plate unit using the trip valve on top of the unit as it is filled by raw sample flow. After evacuating the air, the trip valve is closed. Initially, some filtrate is discarded before any samples are collected (table 21).

The sample for dissolved (filtered) organic carbon (DOC) is collected directly in the DOC filter cylinder in the collecting chamber. The DOC cylinder subsequently is capped, removed from the chamber, and the sample filtered under $N_2$ gas at a low (15 lbs/$in^2$ or less) internal pressure. (Pressures in excess of 15 lbs/$in^2$ can be hazardous and can rupture the filter membrane and invalidate the sample.)

Routine NAWQA 0.45-µm-filtered inorganic samples are obtained using the QWSU capsule filter (for inorganic samples). The capsule is preconditioned before use (see “Final Presampling Plans and Preparations”). The capsule nipples are attached to flexible Teflon lines, which allow the capsule to be inverted (arrow on capsule denotes direction of flow) during its final rinse and use. Inverting the capsule so that the flow is vertically upward while the capsule initially fills with water, combined with tapping the side of the capsule several times while it fills, forces most air out of the capsule. Purging most of the air from the capsule filter helps prevent oxidation and possible precipitation of redox-sensitive analytes (for example, iron, manganese, aluminum, and uranium) that would (negatively) bias filtrate concentrations. Procedures for filtering inorganic samples that require filters with 0.2-µm or smaller pores are described in an internal document (F.D. Wilde, U.S. Geological Survey, written commun., 1995--see footnote 1).

In some instances, filter clogging by fine sediment, or even finer colloids, could markedly reduce the rate of sample flow through the filter units described. Field teams are not to increase flow by forcing water through a filter unit under increasing pressure. Instead, either clean the clogged unit (see “Decontamination of Field Equipment” below) and reinstall the cleaned filter, or simply replace the clogged unit with a second filter unit of similar type. It is most efficient to have a second unit available. A second capsule filter unit also is required for the collection of replicate, filtered inorganic ground-water samples.

**Radon and Chlorofluorocarbon (CFC) Samples.** Collection of these samples occurs outside the sample-collection chamber and requires modifying the sample collection setup--replace the extension line from the flow manifold to the sample-collection chamber with the appropriate collection device (fig. 2). In either case, sample extension and pump-reel lines are inspected to determine if gas bubbles are forming inside the line, or if any air is being drawn into the sample flow at any connection. If these lines are adequately insulated to prevent warming of the sample flow and connections are air tight, bubbles generally are not present. The presence of bubbles indicates possible degassing of radon and CFCs from sample flow or entrainment of CFCs from air that enters loose connections. Initially, bubbles often can be dislodged and evacuated with sample flow by striking the extension or pump-reel line sharply with a hard, blunt object. Connections can be tightened to prevent air entrainment. This, combined with backpressure created by partially closing the valve on the radon-collection unit or backpressure created in the operation of the CFC collection unit, often will reduce degassing during sample collection.

For radon samples, the collection unit valve is partially closed, the glass syringe needle is inserted through the septum port of the unit, and the unit valve is further closed until there is sufficient backpressure to create an almost effortless withdrawal of water into the syringe. The syringe is partially filled, withdrawn from the septum, inverted (needle up), and the water ejected to waste. This syringe rinse is repeated at least one time. After the final rinse, and with the syringe plunger completely depressed (no air or water in syringe barrel) the needle is reinserted through the septum, and about 15 mL of sample are withdrawn slowly into the syringe barrel to avoid suction and degassing. The needle is withdrawn from the septum, the syringe inverted (needle up), and the sample slowly ejected to waste until only 10.0 mL remains in syringe barrel. The syringe needle is tipped downwards, and the needle tip inserted into the mineral oil, and to the bottom of the radon sample vial. The 10.0 mL sample is injected slowly, the syringe removed, the vial firmly capped, and the actual time (in military format) of sample collection is recorded (see appendix, fig. A10). If no replicate sample is taken, the vial is shaken for 15 seconds, repacked in tube, the tube capped, and the NWQL-ASR form (lab copy) for radon (LC1369) is wrapped around the tube, secured with a rubber band, and the tube temporally stored (table 21). If a replicate sample also is collected, the height of the oil levels in the two vials is compared before either sample is collected and should be similar. If levels are noticeably different, return the vial with the low oil level to NWQL with a note explaining the problem.

Because it can take a considerable amount of time to set up and collect samples for chlorofluorocarbons (CFCs), they generally are the last samples collected at a well. As in the case of radon, their collection requires that the sample-collection setup be modified. The CFC unit used to collect samples (Busenberg and Plummer, 1992) replaces the extension line and sample-collection chamber, or the CFC unit can be connected directly to the portable pump outlet (fig. 2). Before connecting the CFC unit, it is recommended that flow be routed through the flowthrough chamber, and field measurements be taken to characterize conditions at the onset of CFC sampling. The procedures for collecting CFC samples are described in Busenberg and Plummer (1992).

## Decontamination of Field Equipment

Decontamination is the cleaning process used to remove contaminants from equipment. Sample-wetted equipment used by NAWQA is decontaminated after sample collection at each well, preferably before the equipment dries. Decontamination is conducted in clean and protected environments (in field area, vehicle, or chamber) as is appropriate to the equipment being cleaned. If this is not possible, the equipment is at least flushed and rinsed, preferably with a low-phosphate detergent, followed by a clean water (DIW) rinse, before it is temporarily stored for thorough cleaning at a later date and before it is reused to collect samples.

On the basis of NAWQA pilot studies, studies conducted by the Office of Water Quality, and data reported from other sources, the decontamination protocols and procedures for NAWQA (tables 22 and 23) generally are capable of removing a broad suite of contaminants from equipment affected by (a) milligram-per-liter contaminant levels for metals and metal complexes, and (b) microgram per liter contaminant levels for pesticides and volatile organic compounds. The decontamination protocols and recommended procedures for NAWQA assume equipment was (or will be) used to collect filtered and unfiltered samples for most analytes (table 1). The actual efficiency of these protocols and recommended procedures to remove contaminants to below NAWQA method-detection or reporting levels can differ depending on the type of equipment used, the solubility and concentration of the contaminant, and the length of time equipment is exposed to the contaminant.

**Table 22.** Decontamination of small equipment used for sample collection

[Volumes of solutions used (detergent, deionized water-DIW, methanol, and final rinse water) depend on Study-Unit equipment setup. DIW used for rinses must have a conductivity that does not exceed 1.0 microsiemens per centimeter at 25 degrees Celsius. A 0.1- to 0.2-percent detergent solution is prepared by adding about 5 to 10 drops of detergent concentrate to each gallon of DIW. **CG** indicates field-team members are to change to clean, powderless, latex or vinyl gloves before proceeding. Latex gloves are used when handling methanol. DOC, dissolved (filtered) organic carbon; VOCs, volatile organic compounds]

| | SMALL FIELD-EQUIPMENT CATEGORIES[1] | | |
|---|---|---|---|
| DECONTAMINATION STEPS BY CATEGORY | Equipment with nonmetallic parts (for inorganics only). Includes convoluted Teflon tubing used on capsule filter, turbidity sample vials, and field-titration Teflon stir bars, glass beakers, volumetric pipettes, graduated cylinders, and polyethylene bottle for ALK (ANC) sample collection. | Equipment with metal parts and for inorganics, but not exposed to methanol. Includes the DOC filter unit, the short Teflon line with metal quick-connect used to obtain turbidity samples, and the radon-collection equipment--syringe with metal leur-lock fitting, syringe needles, and the sample-collection unit. | Equipment with nonmetallic parts, and rinsed with methanol for organics. Includes pesticide filter unit, the short Teflon tubes for VOC sample-collection and for attaching pesticide filter unit to a sample-chamber outflow port, tweezers, and the short Teflon-metal hook-up line (without plastic garden-hose-threaded fitting to well). |
| 1. PREPARATION | For each equipment category, disassemble parts, and place them in a small, clean, colorless, polypropylene basin dedicated to that category. | | |
| 2. DETERGENT WASH | Cover and fill parts in each basin with detergent, and let stand at least 10 minutes; then scrub each part gently with a soft-bristled brush that contains no metal parts and is dedicated to that basin. | | |
| 3. DIW RINSE | Rinse each part thoroughly with DIW at least three times to remove detergent solution and any particulate matter. Complete rinsing of equipment, and also rinse basin and brush, in one category, and **CG** before proceeding to equipment in the next category. Place rinsed equipment on a non-contaminating surface dedicated to the equipment in that category, and loosely cover equipment to prevent recontamination. Plastic sheets can be used for equipment in the first category; aluminum foil can be used for equipment in the other categories. **Complete decontamination step (5) below for first two categories before proceeding with the methanol rinse (4) of equipment in the last category)**. | | |
| 4. METHANOL RINSE | **(Third equipment category only) CG (latex),** wear safety glasses; in a well-ventilated area free of open flames or sparks, rinse each piece of equipment at least three times with small amounts of methanol from a Teflon squeeze bottle. Place each rinsed part on a clean, noncontaminating surface (such as aluminum foil) and loosely cover rinsed parts (with foil sheet) to avoid recontamination. Rinse each part over the basin previously used for detergent and DIW rinse. Transfer used methanol from this basin to a waste container after all parts are rinsed, and before drying parts. | | |
| 5. DRY, INSPECT, and STORE | **CG** and use a portable dryer, or air dry, each part, in clean area. After each part is dried, inspect it. Replace chipped or cracked glassware, or scratched turbidity vials. Replace tubing if mold, mildew, or imbedded sediment are present. Replace filter seals if cracked or severely crimped. Store equipment in the first category in two nested, resealable plastic bags, and that from other categories in Teflon bags or wrap in aluminum foil and then place in a resealable plastic bag. | | |

[1] Field sensors are each thoroughly rinsed with DIW, blotted dry, inspected along with field meters, and (if necessary) reconditioned and stored according to manufacturers' recommendations.

## **Table 23.** Decontamination of setup equipment used for sample collection

[Volumes of solutions used (detergent, deionized water (DIW), methanol, and final-rinse water) depend on the Study-Unit equipment setup used. DIW used for final rinse must have a specific conductance that does not exceed 1.0 microsiemens per centimeter at 25 degrees Celsius. For methanol-rinsed equipment, it also should be volatile-organic-compound-free and pesticide-free. A 0.1- to 0.2-percent detergent solution is prepared by adding about 5 to 10 drops of detergent concentrate to each gallon of DIW. **CG** indicates the field-team members are to change to clean, powderless latex or vinyl gloves before proceeding. Use latex gloves when handling methanol.]

| DECONTAMINATION STEP | Exterior of portable pump intake and pump tubing drawn from pump reel | Interior of pump intake and sample-wetted tubing[1]; including that from reel, flow manifold, flowthrough chamber, and all extension lines |
|---|---|---|
| 1. PREPARATION | **CG**, raise intake from well, coil tubing onto plastic sheet set to drain, or into plastic basin, and disconnect tubing at pump-reel that runs to remainder of setup. | Place pump intake[2] in clean standpipe.[3] Route flow from pump intake through setup to sample chamber. Temporarily attach one end of a Teflon return-flow line to the outflow tube in the sample chamber, and run the other end of this line back to the standpipe. |
| 2. DETERGENT WASH | Pour detergent solution over pump intake and tubing. Scrub both gently with a soft-bristled brush that has no metal parts. | Fill standpipe with detergent solution to level above pump intake. Begin pumping, and note the time when return-flow line has filled. Direct flow from this line back into standpipe, and cycle detergent at 500 milliliters per minute for at least 5 cycles, or 10 minutes. At end of cycling, add more detergent to the standpipe, route flow to partially fill field-instrument flowthrough chamber and waste lines. Stop pump. |
| 3. DIW RINSE | **CG**, raise intake and tubing above sheet or basin, and rinse at least 3 times with DIW to remove detergent and any particulates. Proceed to inspection and storage (Steps No. 6 and 7). | **CG**, rinse standpipe and intake, individually, at least 3 times to remove detergent. Reroute flow back to sample chamber, add DIW to standpipe, and pump, without cycling, until grab samples from the open end of return-flow line (now directed to waste) indicate DIW rinse is detergent free (no sudsing). Halt pump. Shake flowthrough chamber to suspend any sediment, then drain detergent from this chamber and waste lines. Add more DIW to standpipe, start pump, route flow to the flowthrough chamber, and rinse chamber several times to remove detergent. Repeat for waste lines. (Flowthrough chamber and waste lines are inspected and stored at this time, see below. If methanol is not required, go to Step No. 5, FINAL RINSE, second paragraph). |
| 4. METHANOL RINSE[4] | None. (Detergent scrub considered effective for cleaning exterior of pump intake and pump tubing.) | Reroute flow to sample chamber, and put free end of return-flow line near the methanol waste container. **CG,** rinse intake and standpipe, individually 3 times, place intake in standpipe, and, if possible, force air into first several feet of pump tubing (to mark end of DIW and beginning of methanol rinse.) Fill the stand pipe with methanol to level above pump intake. Add and pump at least 2 liters of methanol into setup. If the setup storage is less than 2 liters, collect methanol as it leaves from end of return-flow line in waste container. Halt pump. Put methanol left in standpipe into waste container. Pump air if possible into tubing (to mark end of methanol). Proceed to final rinse. |

**Table 23.** Decontamination of setup equipment used for sample collection--Continued

| DECONTAMINATION STEP | Exterior of portable pump intake and pump tubing drawn from pump reel | Interior of pump intake, and sample-wetted tubing, including that from reel, flow manifold, flowthrough chamber, and all extension lines |
|---|---|---|
| 5. FINAL RINSE) (DIW) | None | **CG**, and DIW rinse standpipe and intake individually at least 3 times. Add and pump DIW through setup to sample-collection chamber and out return-flow line. On basis of air marking, line storage, and pump rate, collect methanol from return-flow line as it is forced out by final rinse. Pump at least an additional 0.1 gallons of DIW through setup for every 10 feet of methanol-wetted tubing, including return-flow line, to waste after used methanol is collected.<br>Disconnect sample chamber from manifold, discard used chamber bag, DIW-rinse chamber frame, and dry. Repeat above for the preservation chamber. DIW rinse and dry exterior of extension lines and flow manifold. Inspect and store each piece of equipment as it is dried according to procedures below. |
| 6. INSPECTION | Simultaneously dry, inspect, and recoil tubing on pump reel. Dry with large, disposable, lint-free towels. Check for stains, cuts, or abrasions, and repair or replace as necessary. Check and repair pump intake and antibacksiphon for loose or missing screws. | Inspect to ensure flowthrough chamber and waste lines are free of sediment. Extensions lines also are inspected for stains, cuts, or serious abrasions. and sediment. The flow manifold also is checked for stains or sediment, and to ensure valves and quick-connect fittings are in good working order. Repair or replace as necessary to eliminate any problems. |
| 7. STORAGE | Except for pump intake and sufficient pump tubing to place intake in standpipe, cover the pump reel and recoiled tubing with a clean, plastic sheet or bag or other noncontaminating material. Clean pump intake as described on right. | Store flowthrough chamber, waste lines, looped and recoupled extension lines, and flow manifold in clean plastic bags. Place pump intake inside Teflon or other noncontaminating bag, and then under material used to cover pump-reel assembly. Fit sample and preservation chambers with clean bags. Unless field blanks are taken, store equipment in vehicle for transport. |

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[1] Before their initial use, all sample lines are acid washed to remove oils and other manufacturing residues. (See table 3.)

[2] Pump intake and reel tubing are that used on-site to collect samples. For a hook-up connection that attached setup to a garden-threaded-hose valve on a water-supply pump, a small, portable pump, such as a Teflon diaphragm pump head mounted on a 12-volt electric drive pump, or a valveless metering pump with a ceramic piston (for example, Fluid Metering Instrument Model QB1-CSC or CSV) with 12-volt power can be used. Either pump is fitted with Teflon convoluted or rigid-wall tubing (acid-washed when first obtained). The outflow tube from the pump is fitted with the appropriate quick-connect to attach it to the extension line that ran from the hook-up connection to the flow manifold (fig. 2).

[3] Standpipe is of sufficient height to supply necessary head for pump intake to operate. For some pumps, such as the Grundfos Redi-Flo2, this head requirement is critical. Standpipe also must not absorb methanol (table 3).

[4] Performed when it is known or suspected that equipment was exposed to pesticides or volatile organic compounds.

In general, decontamination by NAWQA field teams includes a low-phosphate, dilute-detergent wash and scrub of equipment, followed by multiple rinses with DIW (tables 22 and 23). A methanol wash also is used on selected equipment that is likely to have been contaminated by volatile organic compounds or pesticides.

Except for CFCs, the equipment required for decontamination, including that for safe handling of methanol, has been described (table 3). Decontamination of CFC sample-collection equipment is to be done by the supplier of that equipment (Eurybiades Busenberg, U.S. Geological Survey, written commun., 1995).

During field decontamination of NAWQA equipment, it is essential that the cleaning solutions used be completely removed as part of the decontamination process before equipment is reused. The residual presence in sample-collection equipment of detergent and methanol can bias some measurements. Reports of organic carbon samples being affected by residues of detergent and methanol have been verified. Removal of methanol and detergent from pump-reel lines or the purge and collection setup (fig.2) requires that adequate volumes of rinse water are passed through these lines. Study Units can calculate the storage volume of these lines (table 24). The sample-collecting setup storage volume is not only useful in estimating the amount of dilute detergent and DIW needed for decontamination, but also is needed to determine the volume of high-purity water needed for field blanks.

Ideally, the final rinse water after the methanol rinse (table 23) should not contain detectable quantities of the analytes of interest. Study Units need to ensure that rinse-water composition does not lead to equipment contamination that can ultimately compromise the interpretation of the water-quality data.

To obtain the suitable quality of DIW final rinse water for methanol-rinsed equipment, ASTM Type 1 DIW is passed through a charcoal filtration system, stored in noncontaminating containers under noncontaminating conditions, and periodically analyzed to ascertain that it is free of the compounds of interest at the method detection limit. Alternatively, NWQL volatile- and pesticide-free blank water (VPBW) can be used for the final DIW rinse.

Decontamination of equipment exposed to high concentrations of contaminants (for example, VOCs in excess of 10 μg/L) could require procedures that are more rigorous than the protocols and recommended procedures described here and involve cleaning agents that differ from those commonly used (such as hexane). Whatever procedures are used, they must be documented by the Study Unit. This enables the National Program to identify potential problems and modify procedures accordingly. Questions regarding equipment decontamination and the use of other decontamination procedures can be directed to the NAWQA QA Specialist.

**Table 24.** Estimation of decontamination solution volumes for standpipe and sample-wetted tubing

The storage volume, Vs, of a set of pump-reel and extension lines can be estimated as follows:

Vs = [(Lp x Cp) + (Le x Ce)] + [Csp x Vsp]

where Vs is storage volume, in gallons
Lp is length of pump-line segment being cleaned, in feet
Le is length of extension lines, in feet
Cp (or Ce) = 0.023 gallons per foot for a 3/8-inch internal-diameter (ID) line
or = 0.041 gallons per foot for a 1/2-inch ID line
Csp = 0.264 gallons per liter,
Vsp is volume of solution needed to fill standpipe to minimum level required to operate pump, in liters.[1]

Examples:

Given: (1) Lp; the sample-wetted line segment is 100 feet for a pump-reel system that has a 1/2-inch ID line;
(2) Le; two 10-foot, 3/8-inch ID extension lines, one running from the pump-reel outlet to the sample collection chamber, and another running from the chamber back to the pump-reel (return-flow line to standpipe), and
(3) Lsp; that the minimum volume of solution required in the standpipe to operate the pump is 0.8 liter.

(A) Estimate the volume of detergent solution needed for the detergent wash cycle.
Answer:
Vs= [(100 x 0.041)+ (20 x 0.023)] + [0.264 x 0.8] = 4.87 gallons

(B) Estimate volume of District deionized water needed to displace detergent solution.
Answer: Vs, ideally.[2]

(C) Estimate volume of high-purity water needed to displace 2 liters of methanol just pumped into the system.
Answer: Vs, ideally.[3]

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[1] The minimal volume is that which corresponds to a level of solution in the standpipe which, if maintained, allows the pump to operate without entraining air into flow. Once this level is reached, remove pump and measure this volume.

[2] Estimate assumes no mixing of the two solutions and ignores potential for detergent to adhere to tubing walls. As a general rule, it is recommended that outflow from end of return-flow line be checked for sudsing to determine when detergent has been removed.

[3] Estimate assumes no mixing at the interface of the two solutions and ignores potential for methanol to adhere to tubing walls. As a general rule, it is recommended that an additional 0.1 gallons (~ 0.4 liters) of high-purity water for each 10 feet of pump and extension line used be displaced from sample-wetted lines (pump-reel line-to-sample chamber) to remove methanol residues. Thus in the example above, another 0.2 (= [(100 + 10) x (0.1/20)]) gallons (4 L) of DIW would be pumped from the system. This implies a total of about 6.1 (= 4.9 + 1.2) gallons (24 L) of water would be used to remove methanol from the setup equipment.

## Preparation of Blank Samples

To verify that decontamination is adequate, field and possibly other blanks are prepared at selected well sites in each ground-water component (see “Routine Quality-Control Samples: Type, Number, Site Selection, and Timing”; and appendix, figs. A13 (A,B), A14, A18, and A19). These field blanks are collected immediately after the equipment that was used to collect samples at the well has been decontaminated. Methods used to obtain, process, preserve, temporarily store, and analyze field blanks (table 25) generally are similar to those used for corresponding ground-water samples (table 21). With the exception of trace-element field blanks, field blanks are analyzed using the same NWQL schedules used to analyze ground-water-quality samples.

Study Units are required to use specific types of water for field blanks (table 3). Generally, NWQL VPBW is required for VOC field blanks, and either NWQL VPBW or NWQL PBW is required for pesticide field blanks. Field blanks for dissolved organic carbon are obtained using either NWQL water types, but a DOC source-solution blank also must be taken (table 25, footnote 3; and appendix, fig. A14). The QWSU IBW is required for trace-element, major-ion, and nutrient field blanks. These blank solutions are analyzed regularly (by lot number) by the NWQL to certify that they are free of measurable concentrations of NAWQA analytes. Lot numbers are recorded by the field team as part of the required data record for NAWQA field, solution, and trip blanks (see appendix, figs. A13, A14, and A19).

Except for trace elements, all field blanks are analyzed using the analytical NWQL schedule or laboratory code used for the corresponding ground-water-quality samples. For trace-element field blanks, NWQL schedule SC172 and laboratory codes LC0112 (As) and LC0087 (Se) are used in lieu of SC2703 to obtain concentration data at method detection limits (equal to or in excess of 0.1 μg/L).

## Preparation of Other Routine Quality-Control Samples and Field Extracts of Pesticide Samples

As part of their data-collection activities, field teams will sometimes need to obtain, prepare, or process selected types of samples at some sites on the basis of required routine QC sampling for each ground-water component (for example, table 12). For example, the field team occasionally will collect replicate ground-water-quality samples at selected wells and field spike these samples with known amounts of selected VOCs or pesticides. If VOC samples are being collected for a Study-Unit (or Subunit) Survey or Land-Use Study, spiked VOC ground-water samples are required at selected sites. The field team also will submit at least one trip blank per field season for VOCs from the field. If pesticide ground-water samples are being collected, pesticide field spikes are required. The field team also has the option of either extracting pesticides (under NWQL schedules SC2010 and SC2051) from spiked or unspiked ground-water samples, or sending these water-quality samples to the NWQL for extraction (under NWQL schedules SC2001 and SC2050). Finally, if trace-element samples (SC2703) are collected, the field team will send three standard reference samples per field season from the field to the NWQL for analysis. Each of these activities requires that special equipment be used, or that specific procedures be followed (described below). It is strongly recommended that field spikes, solid-phase extraction, and the preparation of trip-blank and reference samples be done after all ground-water samples have been collected, equipment has been decontaminated, and (if applicable) field blanks have been collected.

**Table 25.** Field-blank sample-collection protocols and procedures for ground-water components of the National Water-Quality Assessment Program

[DIW, District deionized water with specific conductance less than 1.0 microsiemens per liter; NWQL-VPBW, National Water Quality Laboratory volatile organic and pesticide-free blank water; NWQL-PBW, pesticide-free blank water; QWSU-IBW, Quality Water Service Unit inorganic-free blank water; DOC, dissolved (filtered) organic carbon; gal, gallons; L, liters; ~, approximately]

1. **Assumptions:** Equipment just used to collect ground-water samples has been decontaminated and, except for the pump intake being in a standpipe, is set up on site in the same manner as it was for the collection of ground-water samples.

2. **Determine Blank-Solution Types and Volumes Required[1]:**

| Field blank(s) collected | Required blank-solution type | Minimum volume in gal (L) | Required procedure |
|---|---|---|---|
| VOCs and DOC[2] or pesticides and DOC | NWQL-VPBW<br>NWQL-PBW | 1.5 (~ 6) | Waste 0.5 gal, then collect field blanks; can use DIW to force last of VPBW or PBW water through the system. |
| VOCs, DOC, and pesticides | NWQL-VPBW | 2.0 (~ 8) | Waste 0.5 gal, then collect field blanks; can use DIW to force last of VPBW or PBW water through the system. |
| Major ions, and nutrients, or trace elements | QWSU-IBW | 1.0 (~ 4) | Waste 0.5 gal, then collect field blanks; can use DIW to force last of IBW water through the system. |
| Major ions and nutrients, and trace elements | QWSU-IBW | 1.5 (~ 6) | Waste 0.5 gal, then collect field blanks; if necessary, use DIW to force last of IBW water through the system. |
| Combinations of organics and inorganics above | NWQL-VPBW or NWQL-PBW and<br>QWSU-IBW | 1.5 to 2.0<br>1.0 to 1.5 | Waste 0.5 gal of the VPBW or PBW water, then collect organic field blanks; can use the IBW water to force the VPBW or PBW water through the system; waste 0.5 gal of IBW water, then can collect inorganic field blanks using DIW to force IBW water through the system. |

**Table 25.** Field-blank sample-collection protocols and procedures for ground-water components of the National Water-Quality Assessment Program--Continued

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3. **General Field-Blank Collection Procedure**--The procedure for collection of blanks assumes organic (VOC--SC2090, SC2091, or SC2092, Pesticide--SC2001 or SC2010 and SC2050 or SC2051, and DOC--SC2085) and inorganic (Trace-element--SC2703, Major ion--SC2750, and Nutrient--SC2752) field blanks are collected. This is the most complex type of field-blank collection.[3]

- Divide Field-Team Duties--Recommend that a three-person team be used. The standard two-person field team collects samples in a manner similar to that used to collect ground.-water samples; the third person adds blank water(s) to standpipe, and controls flow through system as needed to facilitate field-blank collection.

- Check Flow Setup--from standpipe to sample collection chamber (fig.2), ensure that adequate volumes of DIW and the required blank water(s) are arranged in order and within easy reach of person stationed at standpipe.

- Set Low Flow Rate--Once pumping is initiated, set flow (on basis of measurement at chamber outflow) to about 0.1 gal. (500 mL) per minute or less to avoid wasting excessive amounts of blank water.

- Route blank solutions in presorted manner--As solutions are changed, pump operator should change to clean gloves, empty residual solution from standpipe, and rinse pump intake and standpipe, individually, at least three times each, with the next solution, and attempt to pump air segment into pump line before adding next solution to standpipe to mark change in solution type.

  If air segment cannot be used to mark end of one solution and beginning of next, then the change in solutions is determined solely on the basis of the storage volume in lines (table 24) divided by the pumping rate (estimated above) to determine the time it takes for the solution to travel from the standpipe to the outflow chamber. Once pump is started, and this time has elapsed, it is assumed the correct solution is flowing from chamber outflow.

  Regardless of whether air segments or timed flow or both are used to assess when the desired solution arrives at the chamber, 0.5 gal (~ 2 L) of the solution are passed to waste before the field blanks that require that water type are collected.

  To limit the amount of blank water used, and left standing in pump-reel or extension lines after all samples that require that blank-water type have been collected, one type of water can be used to force the last of another type from the lines and to the chamber for collection.

- Collect field blanks in prescribed manner --The order, manner, and quality-control measures and checks associated with obtaining, processing, preserving, and temporarily storing field blanks are identical to the order, manner, and quality-control measures and checks that would be used to collect a corresponding set of ground-water-quality samples (see table 21).

**Table 25.** Field-blank sample-collection protocols and procedures for ground-water components of the National Water-Quality Assessment Program--Continued

4. **Break Down Equipment Setup**--After field blanks have been collected, equipment is broken down and stored, accordingly (see tables 22 and 23). Exceptions include filter units using filter membranes that are removed and discarded, and the sample preservation chamber. If filters for organics (pesticides and DOC) were used, the units are opened and filters discarded. Units are final rinsed, reassembled and stored (see table 22, step 5, and table 23, step 7). The sample-preservation chamber also is decontaminated before it is stored.

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[1] If portable pump was used, the same pump and length of pump line used to collect ground-water samples is decontaminated and used to obtain field blanks.

[2] Note that VPBW and PBW are not certified free of organic carbon. A solution blank of that lot of water used for the DOC field blank is sent to the NWQL for DOC analysis (see footnote no. 3 below).

[3] NWQL-PBW cannot be used for VOC field blanks. Either NWQL water type can be used for DOC field blank, but both water types contain about 0.1 mg/L of organic carbon. A solution blank sample of water from the same lot of NWQL water used for DOC field blank, poured directly into DOC 125-mL amber sample bottle) is required for every DOC field blank. The lot number of the water used for the solution blank is recorded on the ASR form (see appendix, fig. A14).

[4] With one exception, samples are analyzed using NAWQA schedules. The exception is trace-element field blanks, for which the low-level NWQL blank schedule (SC172 with laboratory codes added for arsenic and selenium) is recommended (see appendix, fig. A18).

## Pesticide and volatile-organic-compound (VOC) spiked samples

Required equipment and procedures to spike ground-water samples in the field are obtained from the NWQL in kits prepared for the NAWQA Program (table 3). Training in field spiking is required, and can be obtained through the basic course required for NAWQA ground-water field teams (table 6). Because of the need for recovery and variability data on field spikes for the National Program, Study Units that wish to modify spike equipment or procedures as described below, or in NWQL kits for the NAWQA Program, by using different spike solutions or volumes for routine QC spiked samples, are to discuss their plans with the National Program (NAWQA QA Specialist).

At each site where pesticide field spikes are scheduled, at least three 1.0-L ground-water sample bottles are required for each NWQL pesticide schedule (SC2001 or SC2010 and SC2050 or SC2051). These samples are collected sequentially during the collection of ground-water-quality samples and chilled (table 21). One bottle for each schedule serves as the ground-water-quality sample for the well. It also serves as a background sample (to determine what pesticides, if any, were present in the other two sample bottles before they were spiked). The other two sample bottles are used for replicate field spikes. Each of these is spiked with 100 µL of NWQL-pesticide-spike solution.

Currently, for VOC field spikes (SC2090, SC2091, or SC2092), at least seven sample vials of ground water are collected sequentially and chilled (table 21). Three vials are needed for the ground-water-quality sample, which also is the background sample for the field-spiked samples. Replicate, field-spiked VOC samples (consisting of two vials each) are prepared by spiking each vial with 100 µL of NWQL-VOC-spike solution.

In general, all samples (pesticide or VOC) are spiked with 100 µL of spike solution, which results in a concentration of about 1 to 3 mg/L, depending on the analyte. If the background sample concentration of the analyte (in the unspiked sample) exceeds about one-tenth the concentration in spiked samples, the recovery data from spiked samples generally is considered positively biased (dependent in part on the amount of analyte present before spiking). Use of a volume of spike solution in excess of 100 µL, or a spike solution with higher concentrations than that commonly prepared by the NWQL, could reduce the bias. Recovery data from the use of such a spike solution, however, will relate only to the high, and not the low, concentrations of the analyte.

Once prepared, field-spiked samples are chilled to 0 to 4°C, and generally treated in a manner identical to that of the corresponding background sample. Important information that relates to the spiked sample (lot number, volume, and source of spike solution) are recorded on field and NWQL ASR forms (appendix, fig. A12).

## Pesticide solid-phase extractions

The option is available for Study Units to extract pesticides from ground-water-quality samples (unspiked and spiked) or field blanks in the field, rather than having extractions done at the NWQL. Extracts are collected on solid-phase cartridges and sent to the NWQL for analysis under SC2010 and SC2051. Extraction equipment and procedures, prepared by the NWQL for

NAWQA, can be obtained from HIF or NWQL (table 3). Training in the extraction procedure is required, and is obtained through the basic course required for NAWQA ground-water sampling field teams (table 6).

The decision to submit solid-phase extracts instead of water samples to the NWQL requires careful consideration. Field extractions are practical and should be considered in situations where transporting glass bottles, shipping weights, or shipping times pose a serious problem. Extraction is recommended if pesticide water samples (for SC2001 and SC2050) cannot be shipped and reach the laboratory within 72 hours after collection, or when information is available that indicates the analytes of interest could degrade rapidly during transit. Field extractions also are recommended if the transportation of large, glass, sample bottles, or the sheer weight of water samples, poses a hazard for the samples or the field team (for example, if wells are located in remote areas that are accessible only by foot or light plane).

For Study Units that require a quick turnaround time on analytical results, sending field extractions rather than water samples, particularly at peak production times at the NWQL, could expedite data returns. The Study Unit should contact the NWQL in advance of adopting this strategy, however, as there may be no backlog in analysis. In addition, special handling to expedite analysis can be arranged with the NWQL at an additional cost.

Sending field extractions instead of water samples has another potential benefit. Field extractions allow the field team to extract less than a liter of sample, which is useful if water samples are known or suspected to contain concentrations that exceed the linear operating range of NWQL methods (currently about 100 µg/L). In such cases, a measured (by weight difference) sub-volume of the original 1-L water sample can be extracted. As an alternative, however, the field team can request that the NWQL extract only part of a water sample (use comment line on NWQL ASR form), and thereby achieve the same results.

Field extractions can reduce the costs of NWQL analysis and overnight shipping, particularly if the Study Unit is some distance from the NWQL. Whether or not sending field extractions instead of water samples is cost effective depends on whether or not the reduced costs in analysis and shipping are less than the cost of obtaining, using, and maintaining extraction equipment and related supplies. The cost and time of labor associated with extracting samples also should be factored into the decision. A 1-L sample typically requires one field-team member about 45 minutes to extract, not including the time and labor cost needed for equipment assembly and decontamination. Overall, Johnson and Swanson (1994) found laboratory processing required 32 percent fewer hours than on-site processing of extracts by a field team for each of two prototype sites in the Central Nebraska Study Unit.

The time involved to set up equipment, conduct the extraction, and decontaminate, disassemble, and store this equipment can make it difficult for a two-person field team to perform extractions on-site at every well, given all the other on-site activities that the field team typically is required to perform. Therefore, extractions usually are performed after most other on-site activities are completed. Alternatively, extractions can be performed by a third person, perhaps off-site at a designated facility. This is probably the only practical method to field extract numerous pesticide samples in the field. For example, each routine QC site for pesticides requires a minimum of six field extractions (one 1-L ground-water sample, plus two 1-L spiked ground-water samples for each of the two pesticide schedules).

### VOC trip-blank and trace-element standard reference samples

Two types of routine QC samples require no sample collection, but are routinely sent from selected sites in the field--the VOC trip blank and the standard trace-element reference sample (table 10). Neither is ever opened by Study Unit personnel.

The VOC trip blank can be found in the box in which NWQL VOC vials are shipped. When shipped by the NAWQA team from the field, the lot number (if not on the vial) can be found on the box, and is recorded on the NWQL ASR form sent with the vial (appendix, fig. A15).

Each Study Unit that conducts trace-element sampling in a given field season must request three standard trace-element reference samples from the BTD&QS (table 10). These reference samples are sent from different ground-water sites by the field team during that field season. At each site, the field team records on the NWQL ASR form the original sample identification code found on each bottle and relabels the bottle with the site identification code (appendix, fig. A19) before the sample is shipped.

## Handling and Shipping of Samples

Handling and shipping protocols divide ground-water-quality and routine QC samples collected at a well into three groups (table 26). One group requires samples be shipped overnight at less than 4°C. Another group can be shipped by surface (first class) mail at an ambient temperature. The third group is stored by the Study Unit, and possibly shipped for analysis at a later date by surface mail.

To ensure that the samples collected will provide the data desired, the field team verifies that all sample containers required from the well are present, and that all the information required on container labels and field, NWQL-ASR, and other forms, is complete. It is important that the containers are properly labeled, and that all forms contain the information needed by the NWQL and the Study-Unit data manager (see appendix).

Samples that require overnight shipping (table 26, Group One) can undergo physical, biological, or radiochemical transformation or degradation within a short period of time. This is reflected in their maximum holding times (elapsed time between sample collection and analysis). The maximum holding time for Group One samples is 3 to 5 days, except for VOCs, which have a 14-day holding time. Holding times for most of these samples are dependent on maintaining low sample temperature (less than 4°C). During the period when most samples are being sent to the NWQL (about April through October), at least half the holding time can expire after these samples reach NWQL login and before they are analyzed. Thus, all of these samples must be shipped without delay. In addition, and except for radon, these samples also must be packed in a sufficient amount of ice to maintain low temperatures until received at NWQL and refrigerated.

**Table 26.** Sample handling for shipment of ground-water-quality and quality-control samples

[°C, degrees Celsius; lbs, pounds; mil, manufacturer bag thickness; SASE, self addressed and stamped envelope; NWQL, National Water Quality Laboratory; ASR, Analytical Service Request; SC or LC, NWQL schedule or laboratory code; FCC, FA, FU, and RU are bottle-type designations; CFC, chlorofluorocarbon]

| Sample | Shipping | Procedures |
|---|---|---|
| Group One: | | |
| Volatiles--SC2090, SC2091, and SC2092<br>Pesticides--SC2001 and SC2050 or SC2010 and SC2051<br>Nutrients--SC2752-FCC<br>Organic Carbon--SC2085<br>(Add small (250-mL) polyethylene bottle filled with water and labeled “For Temperature Check, at Login.”) | Overnight at 0 to 4°C, and for safe handling, at weight less than 50 lbs. | Place samples in mesh bag and place “Temperature Check” bottle in middle of sample containers. Place a large, 4-mil plastic bag in cooler, add layer of ice, and place mesh bag on ice inside plastic bag. Surround and cover mesh bag with ice, then twist and seal outer plastic bag with waterproof tape. |
| Radon--LC1369 | Overnight (with above or separate from above). | Place resealable plastic bag containing radon tube(s) atop large plastic bag above. Combine ASR forms with Study-Unit Login reply form and SASE in nested, resealable, plastic bags, and tape to inside of cooler lid. Put return address on inside of lid. Close lid, secure it, and cooler drain cap with strong tape. Attach air bill. |
| Group Two: | | |
| Major ions--SC2750--FA FU, and RU<br>Trace elements--samples SC2703 (blanks--SC172) | Surface, first-class mail, at ambient temperature and, for safe handling, weight less than 50 lbs. | Place trace-element samples in two nested, resealable plastic bags and place sealed bags in a heavy cardboard container; pack in bubble pack, enclose forms (ASR and login-reply forms, and SASE) in nested, resealable plastic bags. Seal container with strong tape and attach mailing label with return address. |
| Group Three: | | |
| Isotopes of tritium, deuterium, and oxygen; major-ion (archive) sample (SC2750--FA); and possibly CFC samples | Initially archive in a dry, cool, and clean storage area; possibly ship (via regular surface mail). | Archive individual samples in a partitioned, heavy cardboard container. List sample types and date on side of container. Also archive ASR and any other forms. |

To verify that low temperatures are maintained, each overnight shipment includes a small (250-mL) polyethylene bottle filled with uncontaminated water (for example, deionized), marked “For Temperature Check at Login.” This bottle is placed in the middle of the other samples being shipped. The NWQL login personnel will check the temperature of the water in this bottle, record it on the Study-Unit’s “Login-Reply Return Form” (appendix, fig. A20), and return this form via the self-addressed and stamped envelope provided by the Study Unit. This form and envelope initially are included with the NWQL ASR forms, which are double bagged in resealable plastic bags, and taped to the inside of the shipping cooler (table 26). Study-Unit data managers are to file the return forms, and keep a record of sample temperatures, particularly those that exceeded 4°C.

As a rule, water-quality samples with 3- to 5-day holding times should not be collected on a Friday, particularly Fridays associated with 3-day weekends, because 3 to 5 days could elapse before samples are analyzed. Radon, with a short half-life of approximately 3.6 days, is definitely not collected if it cannot be shipped within 24 hours of collection and arrive at NWQL login before 12:00 p.m. on any Friday.

Samples sent by regular surface mail (first class) have longer holding times than overnight samples and do not need to be chilled (table 26, Group Two). It is recommended, however, that these samples be shipped within a week or two of collection.

Samples archived by the Study Unit (table 26, Group Three) can include replicates (distinct from those required for routine QC samples) of major ions (SC2750, FA bottle only), trace elements (for example, SC2703), isotope samples (for tritium, deuterium, and oxygen), and chlorofluorocarbon (CFC) samples. Archived major-ion and trace-element samples should be discarded as soon as it is known that analytical reruns are not required. Isotope samples can be held for several years provided bottles remain sealed. Samples for CFCs can be held for at least several years, provided they are not biologically active (Eurybiades Busenberg, U.S. Geological Survey, written commun., 1995).

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# APPENDIX. EXAMPLES OF FIELD FORMS FOR THE COLLECTION OF GROUND-WATER DATA AND SAMPLES FOR THE NATIONAL WATER-QUALITY ASSESSMENT PROGRAM

Examples of field and analytical service request forms for the National Water Quality Laboratory are provided in this appendix. Included are forms for the following:

A1. Land-use and land-cover field sheet for the 1991 Study Units, National Water-Quality Assessment Program.[1]
A2. Example of quality-control and calibration form for the dissolved-oxygen sensor and meter.
A3. Example of quality-control and calibration form for the specific electrical conductance sensor and meter.
A4. Example of quality-control form for a thermistor thermometer.
A5. Example of quality-control form for a pH sensor and meter.
A6. Theoretical slope values of Nerst equation for pH electrode (modified from Plummer and Busenberg, 1981).
A7. Example of a purge form for a well.
A8. Example of a ground-water-quality sample-collection field form.
A9. Example of field-titration form.
A10-A. Example of an analytical service request form for primary ground-water-quality samples that require overnight shipping.
A10-B. Example of an analytical service request form for primary ground-water-quality samples that can be shipped surface (first class) mail.
A11-A. Example of an analytical service request form for replicate ground-water-quality samples that require overnight shipping.
A11-B. Example of an analytical service request form for replicate ground-water-quality samples that can be shipped surface (first class) mail.
A12-A. Example of an analytical service request form for replicate field-spiked, ground-water samples for pesticides and volatile organic compounds: first set, TIME: HH:02.
A12-B. Example of analytical service request form for replicate field-spiked, ground-water samples for pesticides and volatile organic compounds: second set, TIME: HH:03. (If optional third set is taken, use a third form similar to the one above but with TIME: HH:04.)
A13-A. Example of analytical service request form for field blanks that require National Water Quality Laboratory blank water <u>and</u> overnight shipping.
A13-B. Example of an analytical service request form for field blanks that require Quality of Water Service Unit inorganic-free blank water (QWSU-IBW) <u>and</u> surface mail shipping.
A14. Example of an analytical service request form for dissolved (filtered) organic carbon (DOC) solution blank composed of either NWQL volatile pesticide-free blank water (VPBW) or pesticide-free blank water (PBW).
A15. Example of an analytical service request form for a volatile-organic-compound (VOC) trip blank.
A16. Example of an analytical service request form for a primary trace-element ground-water sample (SC2703).
A17. Example of an analytical service request form for a replicate trace-element ground-water sample (SC2703).
A18. Example of an analytical service request form for a ground-water trace-element (SC2703) field blank.
A19. Example of an analytical service request form for a standard-reference trace-element (SC2703) sample for ground water.
A20. Example of Study Unit login reply form sent with samples shipped by overnight mail.

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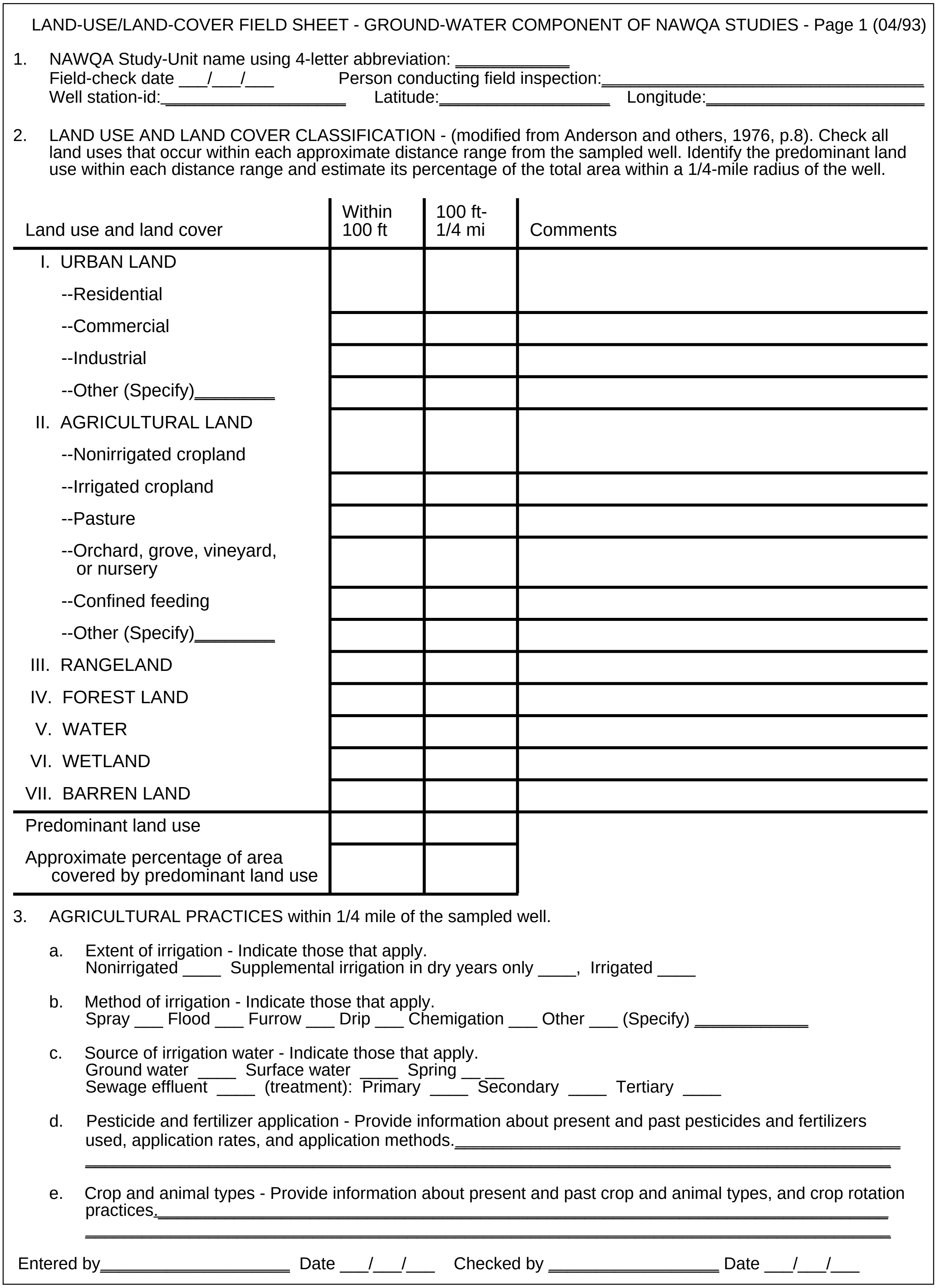
[1] Land-use and land-cover field sheet for the 1991 Study Units is being evaluated for use by the 1994 Study Units.



LAND-USE/LAND-COVER FIELD SHEET - GROUND-WATER COMPONENT OF NAWQA STUDIES - Page 1 (04/93)

1. NAWQA Study-Unit name using 4-letter abbreviation: ____________
Field-check date ___/___/___ Person conducting field inspection:________________________________
Well station-id:____________________ Latitude:__________________ Longitude:______________________

2. LAND USE AND LAND COVER CLASSIFICATION - (modified from Anderson and others, 1976, p.8). Check all land uses that occur within each approximate distance range from the sampled well. Identify the predominant land use within each distance range and estimate its percentage of the total area within a 1/4-mile radius of the well.

| Land use and land cover | Within 100 ft | 100 ft-1/4 mi | Comments |
|---|---|---|---|
| I. URBAN LAND<br>--Residential | | | |
| --Commercial | | | |
| --Industrial | | | |
| --Other (Specify)________ | | | |
| II. AGRICULTURAL LAND<br>--Nonirrigated cropland | | | |
| --Irrigated cropland | | | |
| --Pasture | | | |
| --Orchard, grove, vineyard, or nursery | | | |
| --Confined feeding | | | |
| --Other (Specify)________ | | | |
| III. RANGELAND | | | |
| IV. FOREST LAND | | | |
| V. WATER | | | |
| VI. WETLAND | | | |
| VII. BARREN LAND | | | |
| Predominant land use | | | |
| Approximate percentage of area covered by predominant land use | | | |

3. AGRICULTURAL PRACTICES within 1/4 mile of the sampled well.

a. Extent of irrigation - Indicate those that apply.
Nonirrigated ____ Supplemental irrigation in dry years only ____, Irrigated ____

b. Method of irrigation - Indicate those that apply.
Spray ___ Flood ___ Furrow ___ Drip ___ Chemigation ___ Other ___ (Specify) ____________

c. Source of irrigation water - Indicate those that apply.
Ground water ____ Surface water ____ Spring ____
Sewage effluent ____ (treatment): Primary ____ Secondary ____ Tertiary ____

d. Pesticide and fertilizer application - Provide information about present and past pesticides and fertilizers used, application rates, and application methods.________________________________________________
________________________________________________________________________________

e. Crop and animal types - Provide information about present and past crop and animal types, and crop rotation practices.________________________________________________________________________
________________________________________________________________________________

Entered by____________________ Date ___/___/___ Checked by _________________ Date ___/___/___

**Figure A1.** Land-use and land-cover field sheet for the 1991 Study Units, National Water-Quality Assessment Program.

LAND-USE/LAND-COVER FIELD SHEET - GROUND-WATER COMPONENT OF NAWQA STUDIES-Page 2 (04/93)

Well station-id: ______________________________ Field-check date: ____/____/____

4. LOCAL FEATURES - Indicate all local features that may affect ground-water quality which occur within each approximate distance range from the sampled well.

| Feature | within 100 ft | 100 ft - 1/4 mi | Comments |
|---|---|---|---|
| Gas station | | | |
| Dry cleaner | | | |
| Chemical plant or storage facility | | | |
| Airport | | | |
| Military base | | | |
| Road | | | |
| Pipeline or fuel storage facility | | | |
| Septic field | | | |
| Waste disposal pond | | | |
| Landfill | | | |
| Golf course | | | |
| Stream, river, or creek<br>Perennial __<br>Ephemeral __ | | | |
| Irrigation canal<br>Lined __ Unlined __ | | | |
| Drainage ditch<br>Lined __ Unlined __ | | | |
| Lake<br>Natural __ Manmade __ | | | |
| Reservoir<br>Lined __ Unlined __ | | | |
| Bay or estuary | | | |
| Spring<br>Geothermal (> 25 C)__<br>Nongeothermal__ | | | |
| Salt flat or playa<br>Dry __ Wet __ | | | |
| Mine, quarry, or pit<br>Active __Abandoned__ | | | |
| Oil well | | | |
| Major withdrawal well | | | |
| Waste injection well | | | |
| Recharge injection well | | | |
| Other ______________ | | | |

**Figure A1.** Land-use and land-cover field sheet for the 1991 Study Units, National Water-Quality Assessment Program--Continued.

LAND-USE/LAND-COVER FIELD SHEET - GROUND-WATER COMPONENT OF NAWQA STUDIES -Page 3 (04/93)

Well station-id: ______________________________ Field-check date: ____/____/____

5. LAND-USE CHANGES - Have there been major changes in the last 10 years in land use within 1/4 mile of the sampled well? Yes __, Probably __, Probably not __, No __ If yes, describe major changes.

6. ADDITIONAL COMMENTS - Emphasize factors that might influence local ground-water quality.

Remarks

**Figure A1**. Land-use and land-cover field sheet for the 1991 Study Units, National Water-Quality Assessment Program--Continued

Model ____________________________; Serial Number (W) ____________________

| Date | Time | Electrode Condition | | | | | Calibration | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Membrane | Membrane changed last | Gold cathode and silver anode | Electrolyte | Battery | Red-line | Zero | Meter[1] temperature (°C) | Saturated DO at temperature (mg/L) | Atmospheric. pressure (mm Hg) | Correction factor | Calibration DO (mg/L) | Adjusted (Y or N) | Initials of testor |
| | | | | | | | | | | | | | | | |
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°C = degrees Celsius; mg/L = milligram per liter; mm Hg = millimeters of mercury

[1] See temperature quality-control form for thermistor used with this instrument (fig. A4).

**Figure A2.** Example of quality-control and calibration form for the dissolved-oxygen (DO) sensor and meter.

Model ____________________; Serial number (W) ____________________

| | Condition of: | | | Conductance calibration: | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Date | Electrode | Meter | Therm-istor[1] | Standard # 1 less than 100 µS/cm | Reading µS/cm at 25°C | Within 5% of standard | Standard # 2 greater than 100 µS/cm | Reading µS/cm at 25°C | Within 3% of standard | Initials and action taken |
| | | | | | | | | | | |
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[1] See thermistor form for quality-control tests on thermistor, all readings at 25° Celsius ( 25°C) in microsiemens per centimeter (µS/cm).

**Figure A3.** Example of quality-control and calibration form for the specific electrical conductance sensor and meter.

**Model ____________________ Serial number (W) __________________**

| Date | Low temperature (0 to 5$^{o}$C) | | | High temperature (15 to 35$^{o}$C) | | | Action taken | Initials |
|---|---|---|---|---|---|---|---|---|
| | ASTM thermometer[1] reading ($^{o}$C) | Meter reading ($^{o}$C) | Within 0.2$^{o}$C? | ASTM thermometer reading ($^{o}$C) | Meter reading ($^{o}$C) | Within 0.2$^{o}$C? | | |
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[1] American Society for Testing and Materials (ASTM) thermometer, serial number _______________________.
Specify thermistor use by checking one below:
pH ____ Specific electrical conductance ____ Dissolved oxygen ____ Turbidity ____ Temperature _____

**Figure A4.** Example of quality-control form for a thermistor thermometer measuring degrees Celsius ($^{o}$C).

| | | | Reading | | Reading | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | Low pH buffer | High pH buffer | mV low | mV high | pH low | pH high | Buffer temperature (°C) | Actual slope[1] $\Delta$mV/ $\Delta$pH | Theoretical slope at temperature[2] | Slope ratio[3] (%) | Pass (Y or N) | Response time[4] (seconds) | Initials/ action taken[5] |
| | | | | | | | | | | | | | |
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[1] Actual slope = $\Delta$mV/$\Delta$pH, where $\Delta$mV is difference in millivolt readings between low and high pH buffers, and $\Delta$pH is difference in measured pH (that meter locks on) between low and high pH buffers.

[2] Theoretical slope of Nernst equation (see fig. A6) as function of buffer temperature in degrees Celsius (°C).

[3] Slope ratio in percent = (actual slope/theoretical slope) x 100. An acceptable ratio is one greater than or equal to 95.0 percent.

[4] Response time for meter to lock onto low pH buffer after calibration on high pH buffer. An acceptable value is less than or equal to 15 seconds.

[5] Initials of person performing quality control, and action taken by that person. See temperature quality-control form for thermistor used with this instrument (fig. A4).

**Figure A5.** Example of quality-control form for a pH sensor and meter.

| Temperature[1] | Theoretical slope[2] | Temperature | Theoretical slope |
|---|---|---|---|
| 0 | 54.197 | 21 | 58.364 |
| 1 | 54.396 | 22 | 58.562 |
| 2 | 54.594 | 23 | 58.761 |
| 3 | 54.792 | 24 | 58.959 |
| 4 | 54.991 | 25 | 59.157 |
| 5 | 55.189 | 26 | 59.356 |
| 6 | 55.388 | 27 | 59.554 |
| 7 | 55.586 | 28 | 59.753 |
| 8 | 55.784 | 29 | 59.951 |
| 9 | 55.983 | 30 | 60.149 |
| 10 | 56.181 | 31 | 60.348 |
| 11 | 56.380 | 32 | 60.546 |
| 12 | 56.578 | 33 | 60.745 |
| 13 | 56.777 | 34 | 60.943 |
| 14 | 56.975 | 35 | 61.141 |
| 15 | 57.173 | 36 | 61.340 |
| 16 | 57.372 | 37 | 61.538 |
| 17 | 57.570 | 38 | 61.737 |
| 18 | 57.769 | 39 | 61.935 |
| 19 | 57.967 | 40 | 62.133 |
| 20 | 58.165 | | |

[1] Degrees Celsius, record to nearest tenth of degree.

[2] Interpolate theoretical slope for buffer temperatures between whole degree values.

**Figure A6.** Theoretical slope values of Nerst equation for pH electrode at temperature specified (modified from Plummer and Busenberg, 1981).

**WATER-LEVEL MEASUREMENTS, PURGE VOLUME, AND FIELD MEASUREMENTS BEFORE SAMPLING**

USGS I.D.: ______________________________ Date ____________________________ Time ____________________

Local Well I.D.: ___________________________ Field Team I.D.: _________________________

Well diameter (D, inches): _____________ Depth to water[1] (feet): ______________ Depth of well[1] (feet):_______________

Height of water column (H, feet): ___________________ Casing (borehole) wetted volume (= $0.0408HD^2$, gallons) __________________________________________

Purge volume (= 3 x casing volume, gallons): _____________________ Pump type: __________________________________

| Time (min.) | Pump depth (feet) | Pump rate (gpm) | Volume pumped (gal) | Water appearance (clear, cloudy, etc.) | Temper- ature ($^oC$) | Dissolved oxygen (mg/L) | pH | Specific conductance (µS/cm at $25^oC$) | Turbidity (NTU) |
|---|---|---|---|---|---|---|---|---|---|
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| Except for pH, median values of final 5 measurements; to be used on ASR forms and field sample-collection forms (fig. A9).[2] | | | | | | | | | |

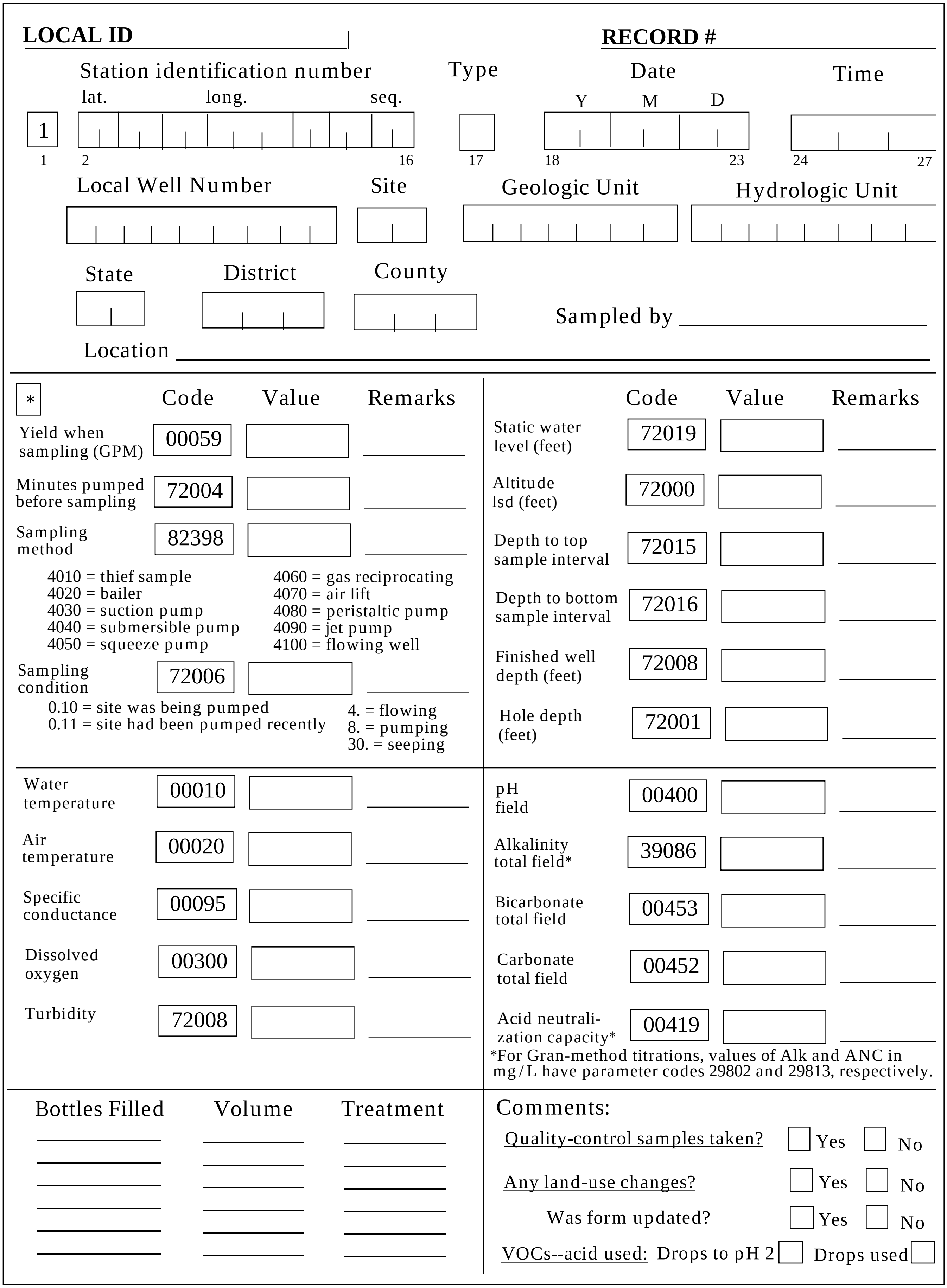
min. = minutes; gpm = gallons per minute; gal = gallons; $^oC$ = degrees Celsius; mg/L = milligrams per liter; µS/cm at $25^oC$ = microsiemens per centimeter at $25^oC$; NTU = nephelometric turbidity unit

[1] Reference datum was measurement point ___________________ Land surface datum (surveyed) _____________________

Equipment used _____________________________________________________ Accuracy _______________________

[2] For pH, after other final measurements are taken, temporarily divert flow and use final pH value obtained on standing water in flowthrough chamber.

**Figure A7.** Example of purge form for a well.



**LOCAL ID** ____________________ **RECORD #** ____________________

Station identification number (lat. long. seq.) | Type | Date (Y M D) | Time

1 ☐ (1) | ☐ (2–16) | ☐ (17) | ☐ (18–23) | ☐ (24–27)

Local Well Number ☐ | Site ☐ | Geologic Unit ☐ | Hydrologic Unit ☐

State ☐ | District ☐ | County ☐

Sampled by ____________________

Location ____________________

| * | Code | Value | Remarks |
|---|---|---|---|
| Yield when sampling (GPM) | 00059 | ☐ | ______ |
| Minutes pumped before sampling | 72004 | ☐ | ______ |
| Sampling method | 82398 | ☐ | ______ |

4010 = thief sample
4020 = bailer
4030 = suction pump
4040 = submersible pump
4050 = squeeze pump
4060 = gas reciprocating
4070 = air lift
4080 = peristaltic pump
4090 = jet pump
4100 = flowing well

| | Code | Value | Remarks |
|---|---|---|---|
| Sampling condition | 72006 | ☐ | ______ |

0.10 = site was being pumped
0.11 = site had been pumped recently
4. = flowing
8. = pumping
30. = seeping

| | Code | Value | Remarks |
|---|---|---|---|
| Static water level (feet) | 72019 | ☐ | ______ |
| Altitude lsd (feet) | 72000 | ☐ | ______ |
| Depth to top sample interval | 72015 | ☐ | ______ |
| Depth to bottom sample interval | 72016 | ☐ | ______ |
| Finished well depth (feet) | 72008 | ☐ | ______ |
| Hole depth (feet) | 72001 | ☐ | ______ |

| | Code | Value | Remarks |
|---|---|---|---|
| Water temperature | 00010 | ☐ | ______ |
| Air temperature | 00020 | ☐ | ______ |
| Specific conductance | 00095 | ☐ | ______ |
| Dissolved oxygen | 00300 | ☐ | ______ |
| Turbidity | 72008 | ☐ | ______ |
| pH field | 00400 | ☐ | ______ |
| Alkalinity total field* | 39086 | ☐ | ______ |
| Bicarbonate total field | 00453 | ☐ | ______ |
| Carbonate total field | 00452 | ☐ | ______ |
| Acid neutralization capacity* | 00419 | ☐ | ______ |

*For Gran-method titrations, values of Alk and ANC in mg/L have parameter codes 29802 and 29813, respectively.

| Bottles Filled | Volume | Treatment |
|---|---|---|
| ______ | ______ | ______ |
| ______ | ______ | ______ |
| ______ | ______ | ______ |
| ______ | ______ | ______ |
| ______ | ______ | ______ |
| ______ | ______ | ______ |

Comments:

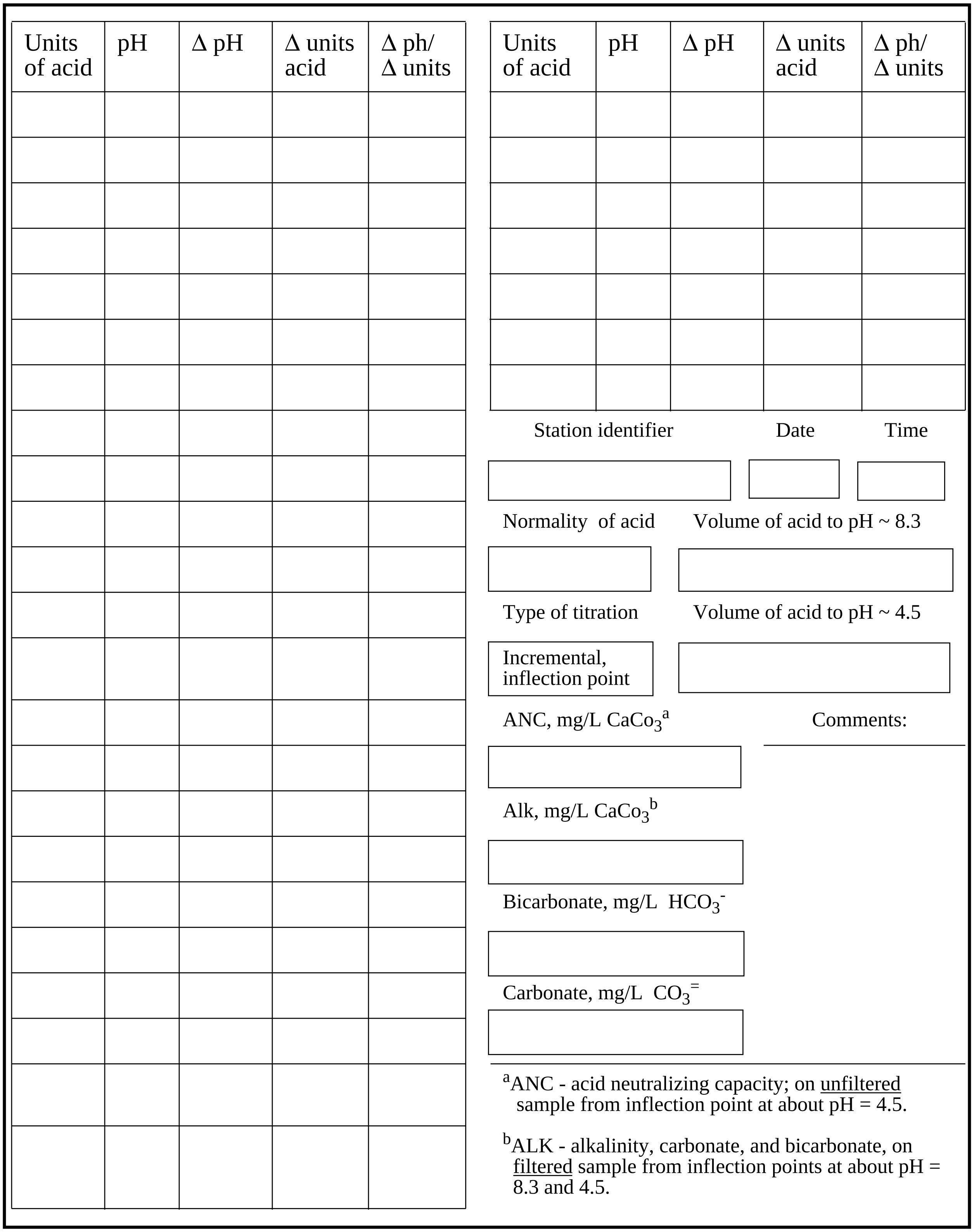
Quality-control samples taken? ☐ Yes ☐ No

Any land-use changes? ☐ Yes ☐ No

Was form updated? ☐ Yes ☐ No

VOCs--acid used: Drops to pH 2 ☐ Drops used ☐

**Figure A8.** Example of a ground-water-quality sample-collection field form.



| Units of acid | pH | Δ pH | Δ units acid | Δ ph/ Δ units |
|---|---|---|---|---|
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| Units of acid | pH | Δ pH | Δ units acid | Δ ph/ Δ units |
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| Station identifier | Date | Time |
|---|---|---|
| | | |

| Normality of acid | Volume of acid to pH ~ 8.3 |
|---|---|
| | |

| Type of titration | Volume of acid to pH ~ 4.5 |
|---|---|
| Incremental, inflection point | |

ANC, mg/L $CaCo_3$[a]

Comments:

Alk, mg/L $CaCo_3$[b]

Bicarbonate, mg/L $HCO_3^-$

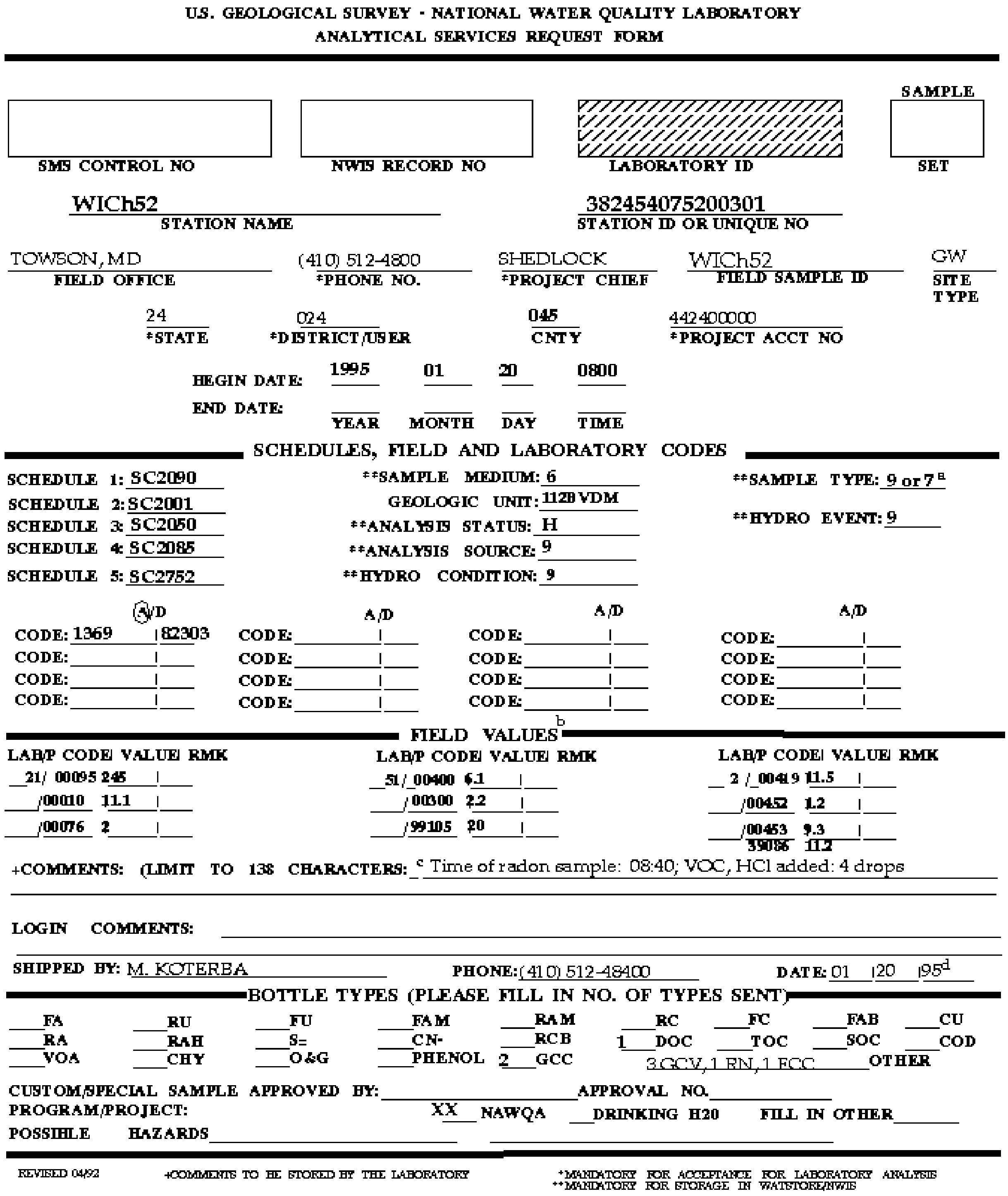
Carbonate, mg/L $CO_3^=$

---

[a] ANC - acid neutralizing capacity; on unfiltered sample from inflection point at about pH = 4.5.

[b] ALK - alkalinity, carbonate, and bicarbonate, on filtered sample from inflection points at about pH = 8.3 and 4.5.

**Figure A9.** Example of field-titration form.



US. GEOLOGICAL SURVEY - NATIONAL WATER QUALITY LABORATORY
ANALYTICAL SERVICES REQUEST FORM

SMS CONTROL NO: ____
NWIS RECORD NO: ____
LABORATORY ID: ▨
SAMPLE SET: ____

STATION NAME: WICh52
STATION ID OR UNIQUE NO: 382454075200301

FIELD OFFICE: TOWSON, MD
*PHONE NO.: (410) 512-4800
*PROJECT CHIEF: SHEDLOCK
FIELD SAMPLE ID: WICh52
SITE TYPE: GW

*STATE: 24
*DISTRICT/USER: 024
CNTY: 045
*PROJECT ACCT NO: 442400000

| | YEAR | MONTH | DAY | TIME |
|---|---|---|---|---|
| BEGIN DATE: | 1995 | 01 | 20 | 0800 |
| END DATE: | | | | |

**SCHEDULES, FIELD AND LABORATORY CODES**

SCHEDULE 1: SC2090
SCHEDULE 2: SC2001
SCHEDULE 3: SC2050
SCHEDULE 4: SC2085
SCHEDULE 5: SC2752

**SAMPLE MEDIUM: 6
GEOLOGIC UNIT: 112BVDM
**ANALYSIS STATUS: H
**ANALYSIS SOURCE: 9
**HYDRO CONDITION: 9

**SAMPLE TYPE: 9 or 7[a]
**HYDRO EVENT: 9

| [✓ A]/D | A/D | A/D | A/D |
|---|---|---|---|
| CODE: 1369 \| 82303 | CODE: ____ \| ____ | CODE: ____ \| ____ | CODE: ____ \| ____ |
| CODE: ____ \| ____ | CODE: ____ \| ____ | CODE: ____ \| ____ | CODE: ____ \| ____ |
| CODE: ____ \| ____ | CODE: ____ \| ____ | CODE: ____ \| ____ | CODE: ____ \| ____ |
| CODE: ____ \| ____ | CODE: ____ \| ____ | CODE: ____ \| ____ | CODE: ____ \| ____ |

**FIELD VALUES**[b]

| LAB/P CODE/ VALUE/ RMK | LAB/P CODE/ VALUE/ RMK | LAB/P CODE/ VALUE/ RMK |
|---|---|---|
| 21/ 00095 245 \| | 51/ 00400 6.1 \| | 2 / 00419 11.5 \| |
| /00010 11.1 \| | /00300 2.2 \| | /00452 1.2 \| |
| /00076 2 \| | /99105 20 \| | /00453 9.3 \|<br>39086 11.2 |

+COMMENTS: (LIMIT TO 138 CHARACTERS: [c] Time of radon sample: 08:40; VOC, HCl added: 4 drops

LOGIN COMMENTS: ____

SHIPPED BY: M. KOTERBA
PHONE: (410) 512-48400
DATE: 01 |20 |95[d]

**BOTTLE TYPES (PLEASE FILL IN NO. OF TYPES SENT)**

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| ___FA | ___RU | ___FU | ___FAM | ___RAM | ___RC | ___FC | ___FAB | ___CU |
| ___RA | ___RAH | ___S= | ___CN- | ___RCB | 1 DOC | ___TOC | ___SOC | ___COD |
| ___VOA | ___CHY | ___O&G | ___PHENOL | 2 GCC | 3 GCV, 1 FN, 1 FCC OTHER | | | |

CUSTOM/SPECIAL SAMPLE APPROVED BY: ____ APPROVAL NO. ____
PROGRAM/PROJECT: XX NAWQA ___DRINKING H20 FILL IN OTHER ____
POSSIBLE HAZARDS ____

REVISED 04/92
+COMMENTS TO BE STORED BY THE LABORATORY
*MANDATORY FOR ACCEPTANCE FOR LABORATORY ANALYSIS
**MANDATORY FOR STORAGE IN WATSTORE/NWIS

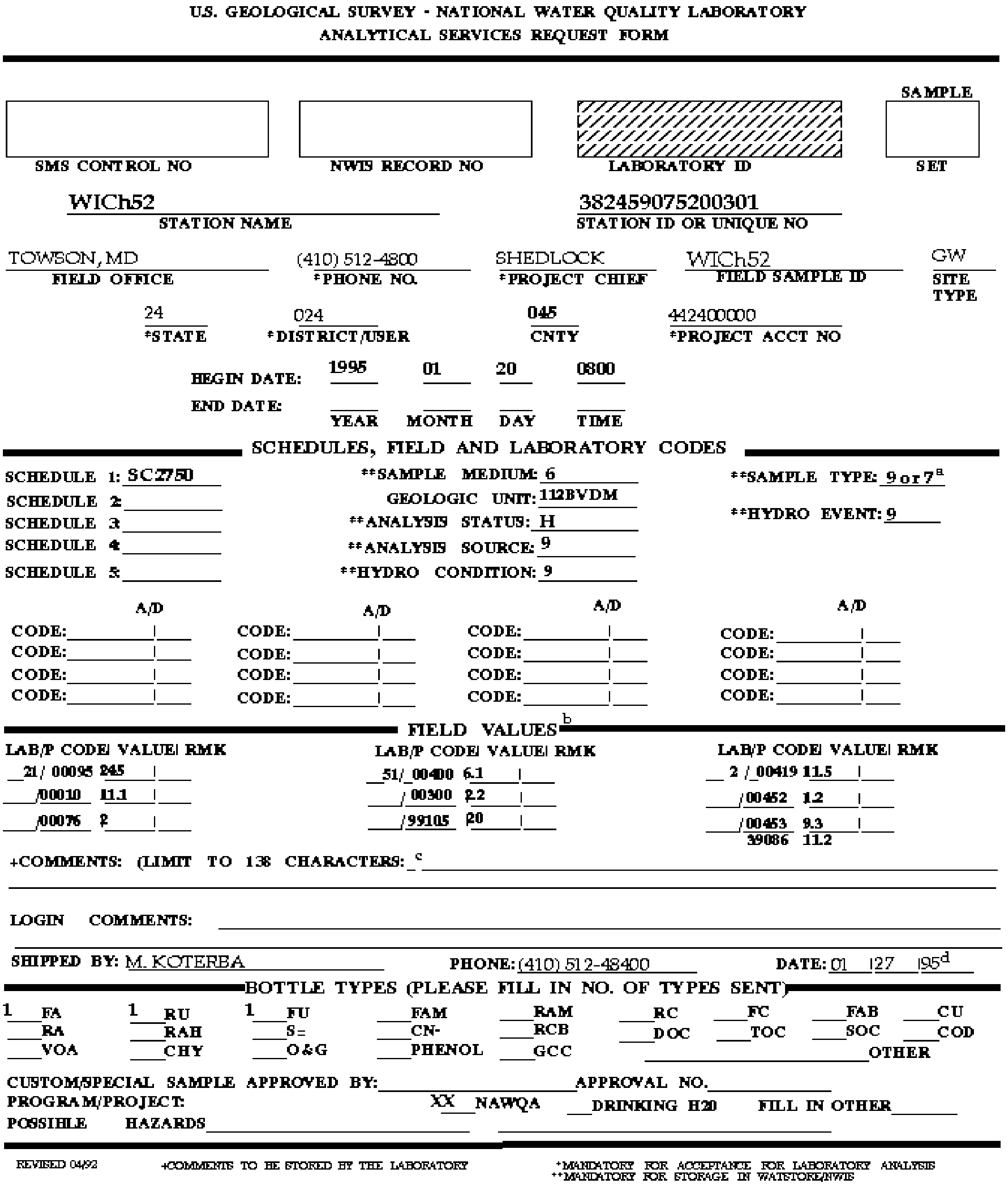
[a]Use 7 if any replicate ground-water samples are taken for the above schedules or those on figure A10-B.

[b]If 9 used for sample type, add all P-codes, including those under field values, except for 99105, which is left blank. If 7 used for sample type, inlcude P code 99105. Also add P codes to QWDATA record for sample.

[c]This is a priority message, must appear.

[d]Overnight shipping is recommended for all samples. Do not put radon tube in ice.

**Figure A10-A.** Example of an analytical service request form for primary ground-water-quality samples (including radon) that require overnight shipping.



US. GEOLOGICAL SURVEY - NATIONAL WATER QUALITY LABORATORY
ANALYTICAL SERVICES REQUEST FORM

SMS CONTROL NO:
NWIS RECORD NO:
LABORATORY ID:
SAMPLE SET:

STATION NAME: WICh52
STATION ID OR UNIQUE NO: 382459075200301

FIELD OFFICE: TOWSON, MD
*PHONE NO.: (410) 512-4800
*PROJECT CHIEF: SHEDLOCK
FIELD SAMPLE ID: WICh52
SITE TYPE: GW

*STATE: 24
*DISTRICT/USER: 024
CNTY: 045
*PROJECT ACCT NO: 442400000

| | YEAR | MONTH | DAY | TIME |
|---|---|---|---|---|
| BEGIN DATE: | 1995 | 01 | 20 | 0800 |
| END DATE: | | | | |

SCHEDULES, FIELD AND LABORATORY CODES

SCHEDULE 1: SC2750
SCHEDULE 2:
SCHEDULE 3:
SCHEDULE 4:
SCHEDULE 5:

**SAMPLE MEDIUM: 6
GEOLOGIC UNIT: 112BVDM
**ANALYSIS STATUS: H
**ANALYSIS SOURCE: 9
**HYDRO CONDITION: 9

**SAMPLE TYPE: 9 or 7[a]
**HYDRO EVENT: 9

| | A/D | | A/D | | A/D | | A/D |
|---|---|---|---|---|---|---|---|
| CODE: | | CODE: | | CODE: | | CODE: | |
| CODE: | | CODE: | | CODE: | | CODE: | |
| CODE: | | CODE: | | CODE: | | CODE: | |
| CODE: | | CODE: | | CODE: | | CODE: | |

FIELD VALUES[b]

| LAB/P CODE | VALUE | RMK | LAB/P CODE | VALUE | RMK | LAB/P CODE | VALUE | RMK |
|---|---|---|---|---|---|---|---|---|
| 21/ 00095 | 245 | | 51/ 00400 | 6.1 | | 2 / 00419 | 11.5 | |
| /00010 | 11.1 | | / 00300 | 2.2 | | /00452 | 1.2 | |
| /00076 | 2 | | /99105 | 20 | | /00453 | 9.3 | |
| | | | | | | 39086 | 11.2 | |

+COMMENTS: (LIMIT TO 138 CHARACTERS: [c]

LOGIN COMMENTS:

SHIPPED BY: M. KOTERBA
PHONE: (410) 512-48400
DATE: 01 /27 /95[d]

BOTTLE TYPES (PLEASE FILL IN NO. OF TYPES SENT)

1 FA
RA
VOA
1 RU
RAH
CHY
1 FU
S=
O&G
FAM
CN-
PHENOL
RAM
RCB
GCC
RC
DOC
FC
TOC
FAB
SOC
CU
COD
OTHER

CUSTOM/SPECIAL SAMPLE APPROVED BY:
APPROVAL NO.
PROGRAM/PROJECT: XX NAWQA ___ DRINKING H20 FILL IN OTHER
POSSIBLE HAZARDS

REVISED 04/92
+COMMENTS TO BE STORED BY THE LABORATORY
*MANDATORY FOR ACCEPTANCE FOR LABORATORY ANALYSIS
**MANDATORY FOR STORAGE IN WATSTORE/NWIS

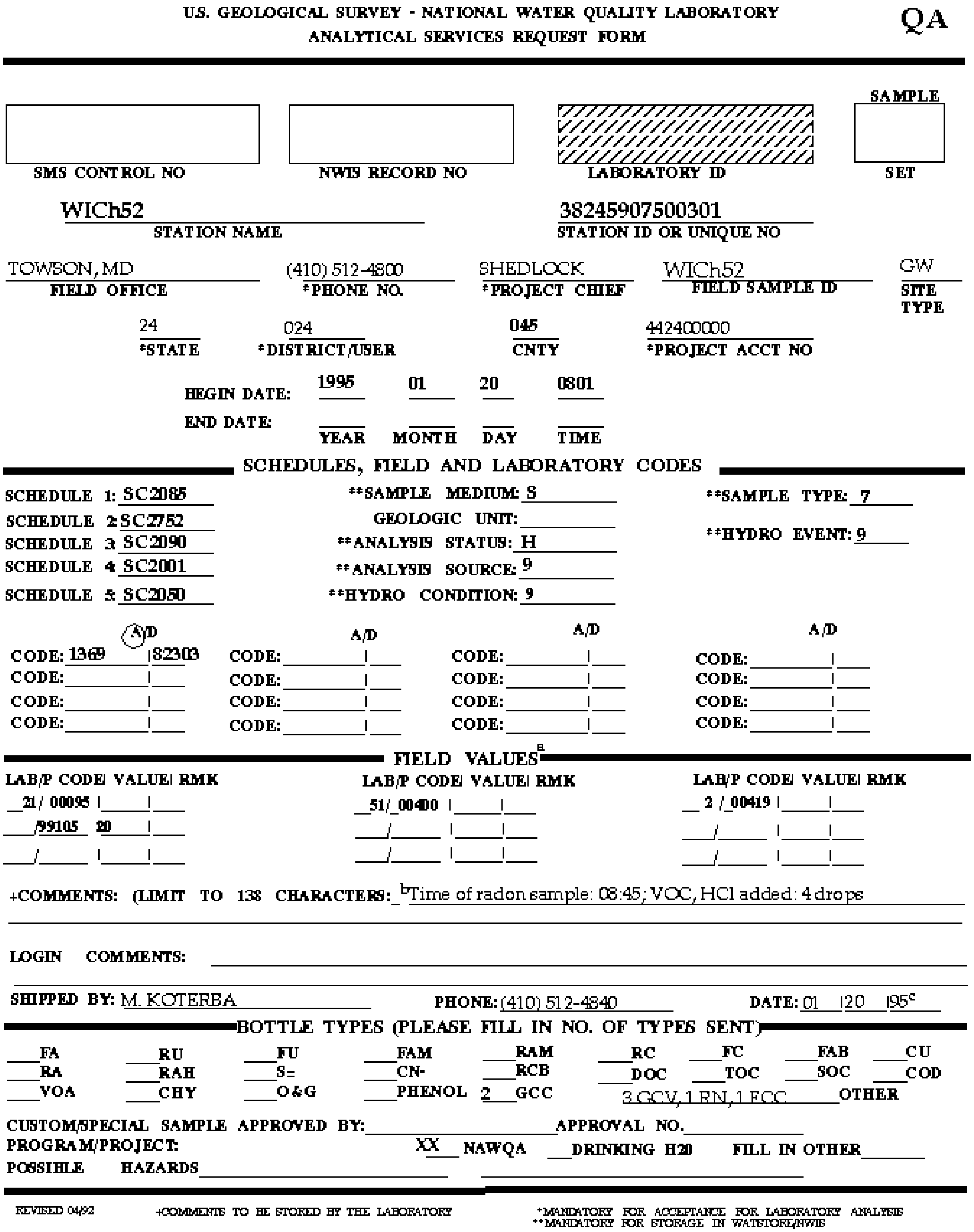
[a] Use 7 if any replicate ground-water samples are taken for the above schedules or those on figure A10-A.

[b] If 9 used for sample type, add all P codes, including those under field values, except for 99105, which is left blank. If 7 used for sample type, include P code 99105. Also add P-codes to QWDATA record for sample.

[c] No comments; otherwise, priority comments on figure A10-A could be overwritten.

[d] Recommend samples be sent surface mail within 2 weeks of collection date.

**Figure A10-B.** Example of an analytical service request form for primary ground-water-quality samples that can be shipped surface (first class) mail.



U.S. GEOLOGICAL SURVEY - NATIONAL WATER QUALITY LABORATORY
ANALYTICAL SERVICES REQUEST FORM

QA

SMS CONTROL NO: 
NWIS RECORD NO: 
LABORATORY ID: 
SAMPLE SET:

STATION NAME: WICh52
STATION ID OR UNIQUE NO: 382459075003O1

FIELD OFFICE: TOWSON, MD
*PHONE NO.: (410) 512-4800
*PROJECT CHIEF: SHEDLOCK
FIELD SAMPLE ID: WICh52
SITE TYPE: GW

*STATE: 24
*DISTRICT/USER: 024
CNTY: 045
*PROJECT ACCT NO: 442400000

| | YEAR | MONTH | DAY | TIME |
|---|---|---|---|---|
| BEGIN DATE: | 1995 | 01 | 20 | 0801 |
| END DATE: | | | | |

SCHEDULES, FIELD AND LABORATORY CODES

SCHEDULE 1: SC2085
SCHEDULE 2: SC2752
SCHEDULE 3: SC2090
SCHEDULE 4: SC2001
SCHEDULE 5: SC2050

**SAMPLE MEDIUM: S
GEOLOGIC UNIT: 
**ANALYSIS STATUS: H
**ANALYSIS SOURCE: 9
**HYDRO CONDITION: 9

**SAMPLE TYPE: 7
**HYDRO EVENT: 9

[✓ A]/D
CODE: 1369 | 82303
CODE: |
CODE: |
CODE: |

A/D
CODE: |
CODE: |
CODE: |
CODE: |

A/D
CODE: |
CODE: |
CODE: |
CODE: |

A/D
CODE: |
CODE: |
CODE: |
CODE: |

FIELD VALUES[a]

| LAB/P CODE | VALUE | RMK | LAB/P CODE | VALUE | RMK | LAB/P CODE | VALUE | RMK |
|---|---|---|---|---|---|---|---|---|
| 21/ 00095 | | | 51/ 00400 | | | 2 / 00419 | | |
| /99105 | 20 | | / | | | / | | |
| / | | | / | | | / | | |

+COMMENTS: (LIMIT TO 138 CHARACTERS: [b]Time of radon sample: 08:45; VOC, HCl added: 4 drops

LOGIN COMMENTS:

SHIPPED BY: M. KOTERBA
PHONE: (410) 512-4840
DATE: 01 |20 |95[c]

BOTTLE TYPES (PLEASE FILL IN NO. OF TYPES SENT)

___FA ___RA ___VOA
___RU ___RAH ___CHY
___FU ___S= ___O&G
___FAM ___CN- ___PHENOL
___RAM ___RCB 2 GCC
___RC ___DOC
___FC ___TOC
___FAB ___SOC
___CU ___COD
3 GCV, 1 RN, 1 FCC OTHER

CUSTOM/SPECIAL SAMPLE APPROVED BY: 
APPROVAL NO. 
PROGRAM/PROJECT: XX NAWQA ___ DRINKING H20 FILL IN OTHER 
POSSIBLE HAZARDS

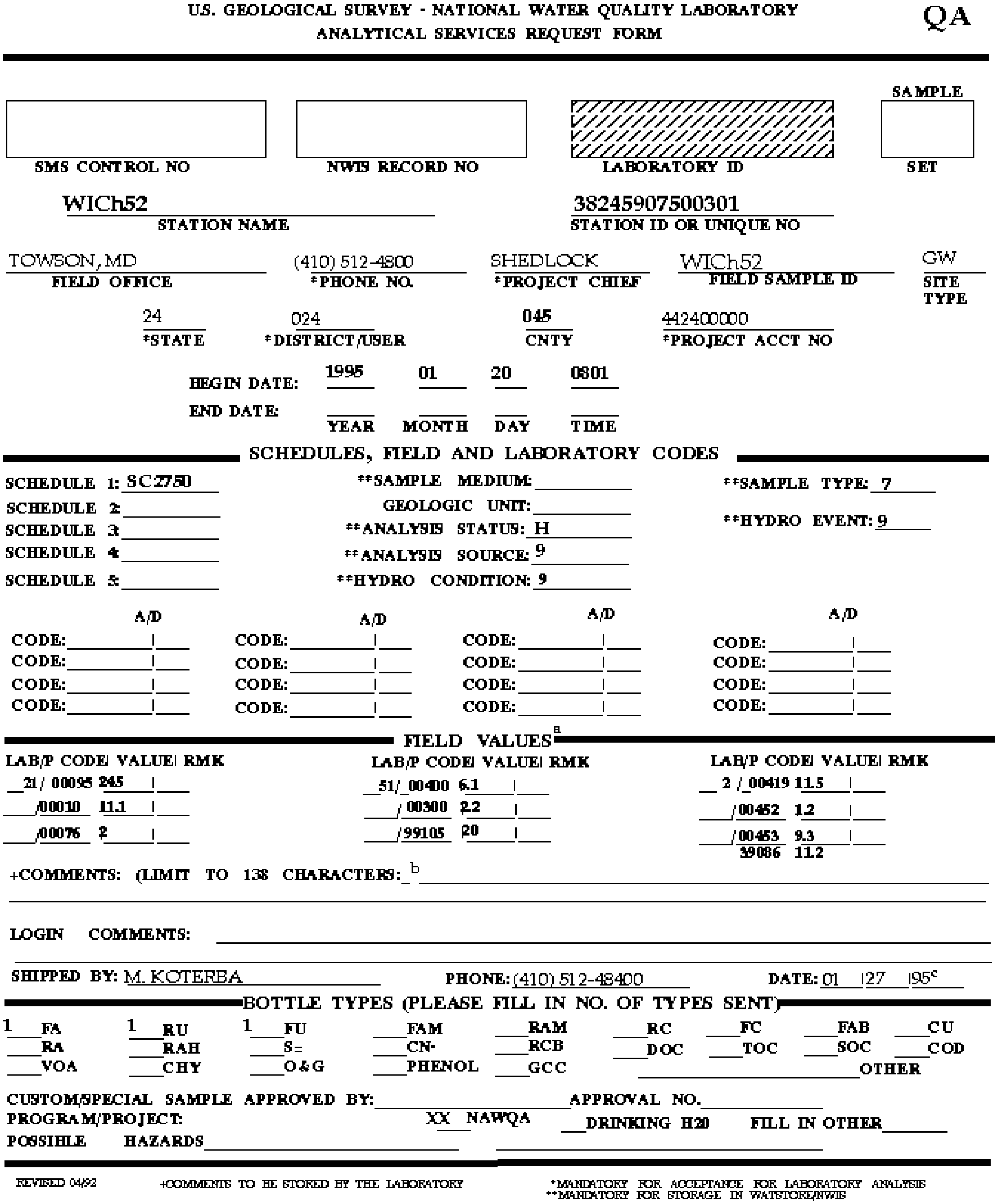
REVISED 04/92
+COMMENTS TO BE STORED BY THE LABORATORY
*MANDATORY FOR ACCEPTANCE FOR LABORATORY ANALYSIS
**MANDATORY FOR STORAGE IN WATSTORE/NWIS

[a] Add P codes noted above to form and to QADATA record for this sample.

[b] This is a priority message, must appear.

[c] Overnight shipping with primary samples (fig. A10-A) is recommended.

**Figure A11-A.** Example of an analytical service request form for replicate ground-water-quality samples (including radon) that require overnight shipping.



**U.S. GEOLOGICAL SURVEY - NATIONAL WATER QUALITY LABORATORY**
**ANALYTICAL SERVICES REQUEST FORM** **QA**

SMS CONTROL NO: 
NWIS RECORD NO: 
LABORATORY ID: 
SAMPLE SET:

STATION NAME: WICh52
STATION ID OR UNIQUE NO: 38245907500301

FIELD OFFICE: TOWSON, MD
*PHONE NO.: (410) 512-4800
*PROJECT CHIEF: SHEDLOCK
FIELD SAMPLE ID: WICh52
SITE TYPE: GW

*STATE: 24
*DISTRICT/USER: 024
CNTY: 045
*PROJECT ACCT NO: 442400000

| | YEAR | MONTH | DAY | TIME |
|---|---|---|---|---|
| BEGIN DATE: | 1995 | 01 | 20 | 0801 |
| END DATE: | | | | |

**SCHEDULES, FIELD AND LABORATORY CODES**

SCHEDULE 1: SC2750
SCHEDULE 2: 
SCHEDULE 3: 
SCHEDULE 4: 
SCHEDULE 5:

**SAMPLE MEDIUM: 
GEOLOGIC UNIT: 
**ANALYSIS STATUS: H
**ANALYSIS SOURCE: 9
**HYDRO CONDITION: 9

**SAMPLE TYPE: 7
**HYDRO EVENT: 9

| | A/D | | A/D | | A/D | | A/D |
|---|---|---|---|---|---|---|---|
| CODE: | | CODE: | | CODE: | | CODE: | |
| CODE: | | CODE: | | CODE: | | CODE: | |
| CODE: | | CODE: | | CODE: | | CODE: | |
| CODE: | | CODE: | | CODE: | | CODE: | |

**FIELD VALUES**[a]

| LAB/P CODE | VALUE | RMK | LAB/P CODE | VALUE | RMK | LAB/P CODE | VALUE | RMK |
|---|---|---|---|---|---|---|---|---|
| 21/ 00095 | 245 | | 51/ 00400 | 6.1 | | 2 / 00419 | 11.5 | |
| /00010 | 11.1 | | / 00300 | 2.2 | | /00452 | 1.2 | |
| /00076 | 2 | | /99105 | 20 | | /00453 | 9.3 | |
| | | | | | | 39086 | 11.2 | |

+COMMENTS: (LIMIT TO 138 CHARACTERS:[b]

LOGIN COMMENTS:

SHIPPED BY: M. KOTERBA
PHONE: (410) 512-48400
DATE: 01 /27 /95[c]

**BOTTLE TYPES (PLEASE FILL IN NO. OF TYPES SENT)**

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 1 FA | 1 RU | 1 FU | FAM | RAM | RC | FC | FAB | CU |
| RA | RAH | S= | CN- | RCB | DOC | TOC | SOC | COD |
| VOA | CHY | O&G | PHENOL | GCC | OTHER | | | |

CUSTOM/SPECIAL SAMPLE APPROVED BY: 
APPROVAL NO. 
PROGRAM/PROJECT: XX NAWQA __DRINKING H20 FILL IN OTHER 
POSSIBLE HAZARDS

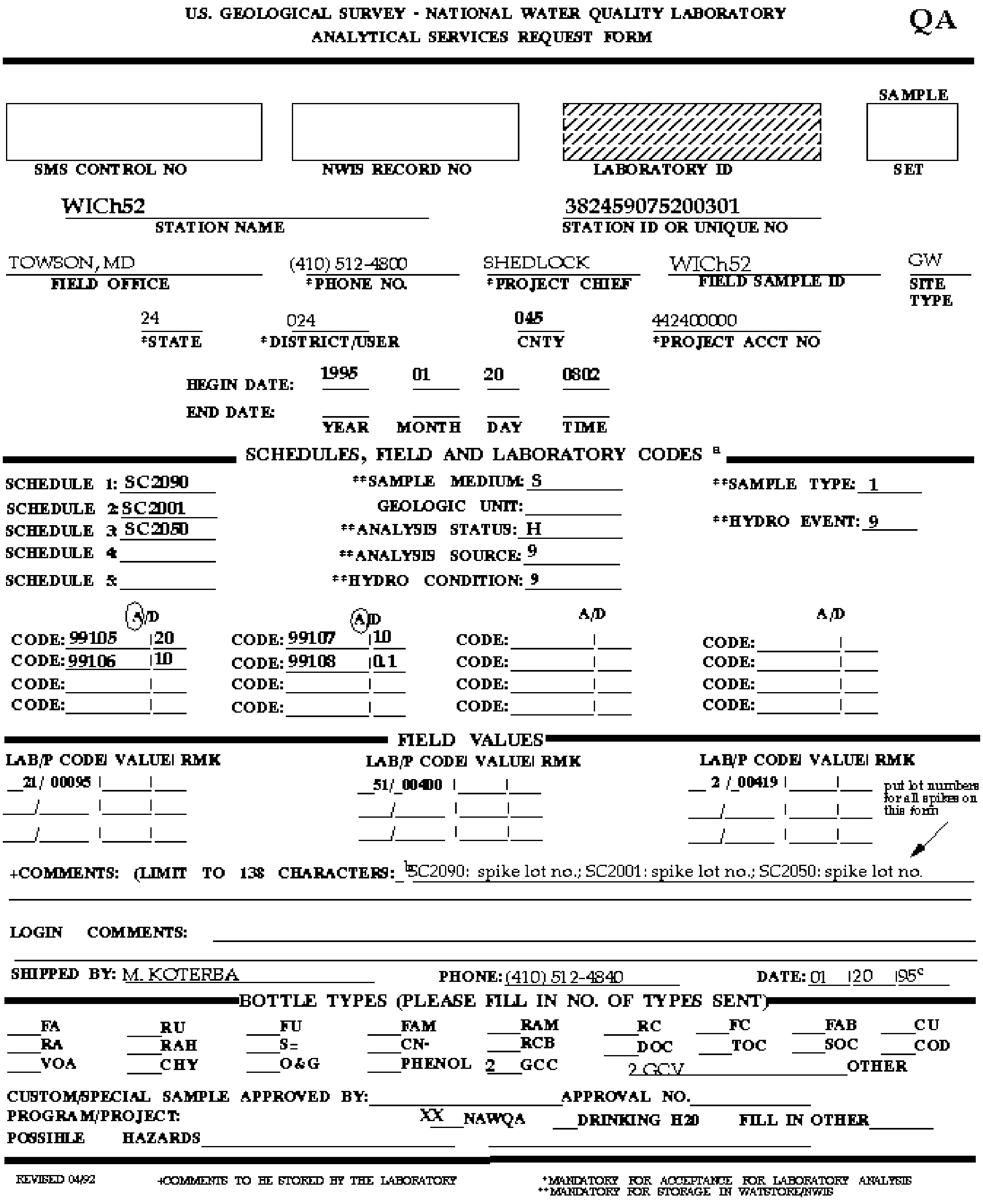
REVISED 04/92
+COMMENTS TO BE STORED BY THE LABORATORY
*MANDATORY FOR ACCEPTANCE FOR LABORATORY ANALYSIS
**MANDATORY FOR STORAGE IN WATSTORE/NWIS

[a] Add P codes noted above to form and to QADATA record for this sample.

[b] No comments; otherwise, priority comments on figure A11-A could be overwritten.

[c] Surface (first-class) shipping with primary samples (fig. A10-B) is recommended.

**Figure A11-B.** Example of an analytical service request form for replicate ground-water-quality samples that can be shipped surface (first class) mail.



U.S. GEOLOGICAL SURVEY - NATIONAL WATER QUALITY LABORATORY
ANALYTICAL SERVICES REQUEST FORM

QA

SMS CONTROL NO
NWIS RECORD NO
LABORATORY ID
SAMPLE SET

STATION NAME: WICh52
STATION ID OR UNIQUE NO: 382459075200301

FIELD OFFICE: TOWSON, MD
*PHONE NO.: (410) 512-4800
*PROJECT CHIEF: SHEDLOCK
FIELD SAMPLE ID: WICh52
SITE TYPE: GW

*STATE: 24
*DISTRICT/USER: 024
CNTY: 045
*PROJECT ACCT NO: 442400000

| | YEAR | MONTH | DAY | TIME |
|---|---|---|---|---|
| BEGIN DATE: | 1995 | 01 | 20 | 0802 |
| END DATE: | | | | |

SCHEDULES, FIELD AND LABORATORY CODES [a]

SCHEDULE 1: SC2090
SCHEDULE 2: SC2001
SCHEDULE 3: SC2050
SCHEDULE 4:
SCHEDULE 5:

**SAMPLE MEDIUM: S
GEOLOGIC UNIT:
**ANALYSIS STATUS: H
**ANALYSIS SOURCE: 9
**HYDRO CONDITION: 9

**SAMPLE TYPE: 1
**HYDRO EVENT: 9

| | [✓ A]/D | | [✓ A]/D | | A/D | | A/D |
|---|---|---|---|---|---|---|---|
| CODE: 99105 | 20 | CODE: 99107 | 10 | CODE: | | CODE: | |
| CODE: 99106 | 10 | CODE: 99108 | 0.1 | CODE: | | CODE: | |
| CODE: | | CODE: | | CODE: | | CODE: | |
| CODE: | | CODE: | | CODE: | | CODE: | |

FIELD VALUES

| LAB/P CODE | VALUE | RMK | LAB/P CODE | VALUE | RMK | LAB/P CODE | VALUE | RMK |
|---|---|---|---|---|---|---|---|---|
| 21/ 00095 | | | 51/ 00400 | | | 2 / 00419 | | |
| / | | | / | | | / | | |
| / | | | / | | | / | | |

put lot numbers for all spikes on this form

+COMMENTS: (LIMIT TO 138 CHARACTERS: [b]SC2090: spike lot no.; SC2001: spike lot no.; SC2050: spike lot no.

LOGIN COMMENTS:

SHIPPED BY: M. KOTERBA
PHONE: (410) 512-4840
DATE: 01 20 95[c]

BOTTLE TYPES (PLEASE FILL IN NO. OF TYPES SENT)

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| ___FA | ___RU | ___FU | ___FAM | ___RAM | ___RC | ___FC | ___FAB | ___CU |
| ___RA | ___RAH | ___S= | ___CN- | ___RCB | ___DOC | ___TOC | ___SOC | ___COD |
| ___VOA | ___CHY | ___O&G | ___PHENOL | 2 GCC | 2 GCV OTHER | | | |

CUSTOM/SPECIAL SAMPLE APPROVED BY:
APPROVAL NO.
PROGRAM/PROJECT: XX NAWQA ___DRINKING H20 FILL IN OTHER
POSSIBLE HAZARDS

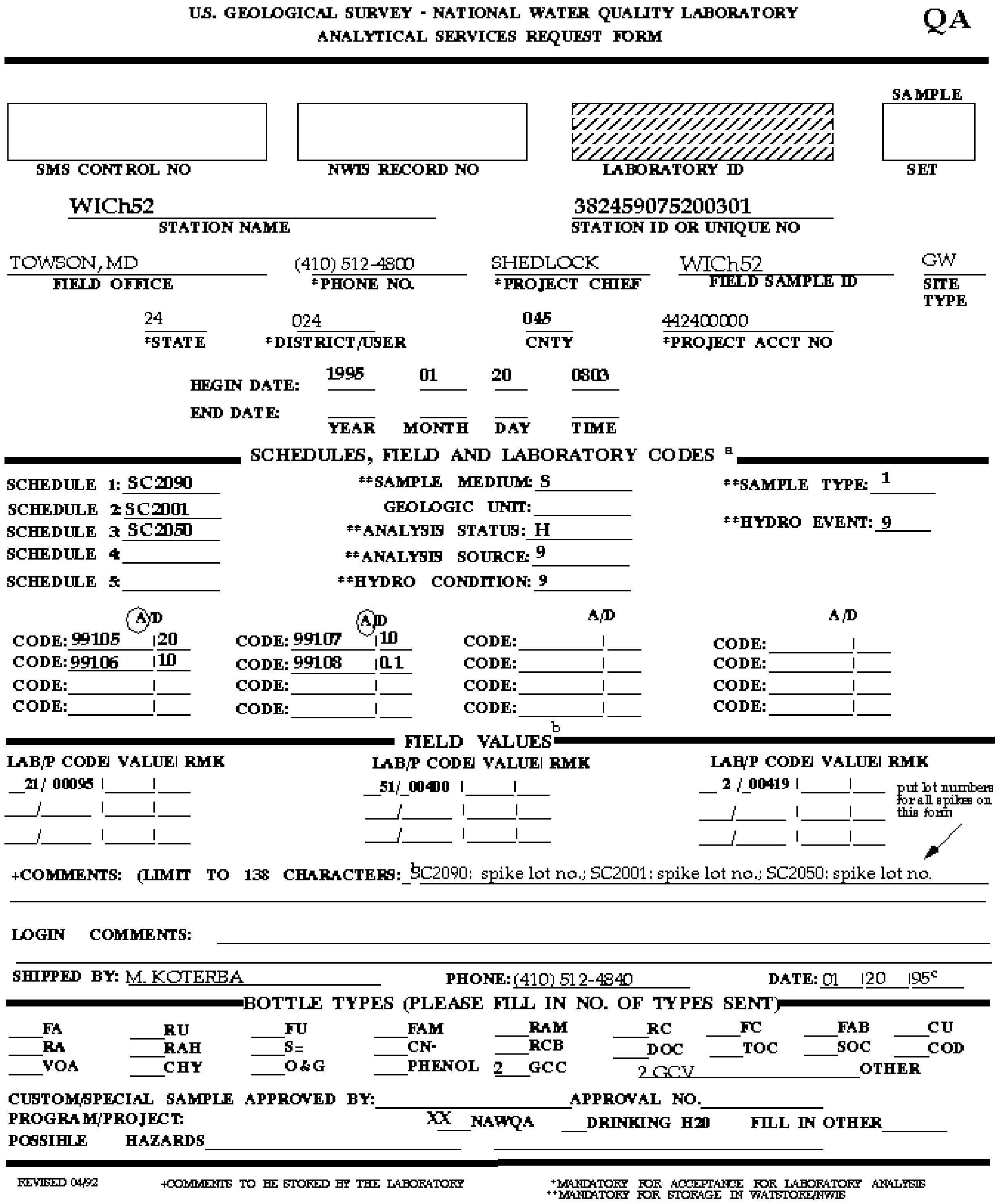
REVISED 04/92
+COMMENTS TO BE STORED BY THE LABORATORY
*MANDATORY FOR ACCEPTANCE FOR LABORATORY ANALYSIS
**MANDATORY FOR STORAGE IN WATSTORE/NWIS

[a] Use indicated spiked-sample P codes; include in QADATA record for sample.

[b] Include lot number of each spike vial used with each schedule.

[c] Ship overnight with primary unspiked (background) ground-water samples (fig. A10-A).

**Figure A12-A.** Example of an analytical service request form for replicate field-spiked, ground-water samples for pesticides and volatile organic compounds; first set, TIME: HH:02.



U.S. GEOLOGICAL SURVEY - NATIONAL WATER QUALITY LABORATORY
ANALYTICAL SERVICES REQUEST FORM

QA

SMS CONTROL NO
NWIS RECORD NO
LABORATORY ID
SAMPLE SET

STATION NAME: WICh52
STATION ID OR UNIQUE NO: 382459075200301

FIELD OFFICE: TOWSON, MD
*PHONE NO.: (410) 512-4800
*PROJECT CHIEF: SHEDLOCK
FIELD SAMPLE ID: WICh52
SITE TYPE: GW

*STATE: 24
*DISTRICT/USER: 024
CNTY: 045
*PROJECT ACCT NO: 442400000

| | YEAR | MONTH | DAY | TIME |
|---|---|---|---|---|
| BEGIN DATE: | 1995 | 01 | 20 | 0803 |
| END DATE: | | | | |

**SCHEDULES, FIELD AND LABORATORY CODES [a]**

SCHEDULE 1: SC2090
SCHEDULE 2: SC2001
SCHEDULE 3: SC2050
SCHEDULE 4:
SCHEDULE 5:

**SAMPLE MEDIUM: S
GEOLOGIC UNIT:
**ANALYSIS STATUS: H
**ANALYSIS SOURCE: 9
**HYDRO CONDITION: 9

**SAMPLE TYPE: 1
**HYDRO EVENT: 9

| | [✓ A]/D | | [✓ A]/D | | A/D | | A/D |
|---|---|---|---|---|---|---|---|
| CODE: 99105 | 20 | CODE: 99107 | 10 | CODE: | | CODE: | |
| CODE: 99106 | 10 | CODE: 99108 | 0.1 | CODE: | | CODE: | |
| CODE: | | CODE: | | CODE: | | CODE: | |
| CODE: | | CODE: | | CODE: | | CODE: | |

**FIELD VALUES [b]**

| LAB/P CODE | VALUE | RMK | LAB/P CODE | VALUE | RMK | LAB/P CODE | VALUE | RMK |
|---|---|---|---|---|---|---|---|---|
| 21/ 00095 | | | 51/ 00400 | | | 2 / 00419 | | |
| / | | | / | | | / | | |
| / | | | / | | | / | | |

put lot numbers for all spikes on this form

+COMMENTS: (LIMIT TO 138 CHARACTERS: [b]SC2090: spike lot no.; SC2001: spike lot no.; SC2050: spike lot no.

LOGIN COMMENTS:

SHIPPED BY: M. KOTERBA
PHONE: (410) 512-4840
DATE: 01 /20 /95[c]

**BOTTLE TYPES (PLEASE FILL IN NO. OF TYPES SENT)**

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| ___FA | ___RU | ___FU | ___FAM | ___RAM | ___RC | ___FC | ___FAB | ___CU |
| ___RA | ___RAH | ___S= | ___CN- | ___RCB | ___DOC | ___TOC | ___SOC | ___COD |
| ___VOA | ___CHY | ___O&G | ___PHENOL | 2 GCC | 2 GCV OTHER | | | |

CUSTOM/SPECIAL SAMPLE APPROVED BY: APPROVAL NO.
PROGRAM/PROJECT: XX NAWQA ___DRINKING H20 FILL IN OTHER
POSSIBLE HAZARDS

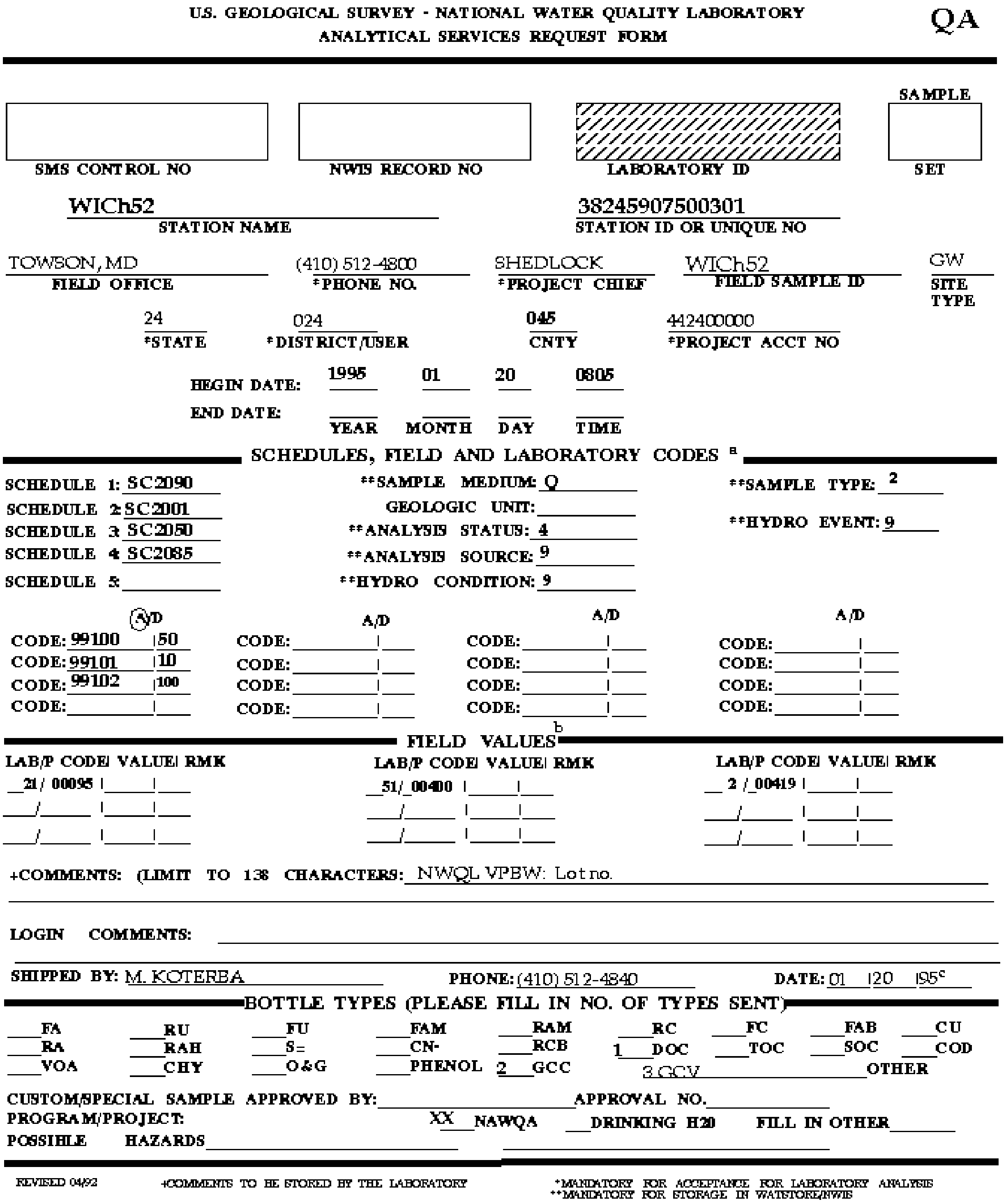
REVISED 04/92
+COMMENTS TO BE STORED BY THE LABORATORY
*MANDATORY FOR ACCEPTANCE FOR LABORATORY ANALYSIS
**MANDATORY FOR STORAGE IN WATSTORE/NWIS

[a] Use indicated spiked-sample P codes; include in QADATA record for sample.

[b] Include lot number of each spike vial used with each schedule.

[c] Ship overnight with primary unspiked (background) ground-water samples (fig. A10-A).

**Figure A12-B.** Example of an analytical service request form for replicate field-spiked, ground-water samples for pesticides and volatile organic compounds; second set, TIME: HH:03. (If optional third set is taken, use a third form similar to the one above but with TIME: HH:04.)



**U.S. GEOLOGICAL SURVEY - NATIONAL WATER QUALITY LABORATORY**
**ANALYTICAL SERVICES REQUEST FORM**

**QA**

SMS CONTROL NO: 
NWIS RECORD NO: 
LABORATORY ID: 
SAMPLE SET:

STATION NAME: WICh52
STATION ID OR UNIQUE NO: 382459075003O1

FIELD OFFICE: TOWSON, MD
*PHONE NO.: (410) 512-4800
*PROJECT CHIEF: SHEDLOCK
FIELD SAMPLE ID: WICh52
SITE TYPE: GW

*STATE: 24
*DISTRICT/USER: 024
CNTY: 045
*PROJECT ACCT NO: 442400000

BEGIN DATE: YEAR 1995 MONTH 01 DAY 20 TIME 0805
END DATE:

**SCHEDULES, FIELD AND LABORATORY CODES** [a]

SCHEDULE 1: SC2090
SCHEDULE 2: SC2001
SCHEDULE 3: SC2050
SCHEDULE 4: SC2085
SCHEDULE 5:

**SAMPLE MEDIUM: Q
GEOLOGIC UNIT: 
**ANALYSIS STATUS: 4
**ANALYSIS SOURCE: 9
**HYDRO CONDITION: 9

**SAMPLE TYPE: 2
**HYDRO EVENT: 9

[✓ A]/D
CODE: 99100 | 50
CODE: 99101 | 10
CODE: 99102 | 100
CODE: |

**FIELD VALUES**[b]

LAB/P CODE| VALUE| RMK
21/ 00095 | |
51/ 00400 | |
2 / 00419 | |

+COMMENTS: (LIMIT TO 138 CHARACTERS: NWQL VPBW: Lot no.

LOGIN COMMENTS:

SHIPPED BY: M. KOTERBA
PHONE: (410) 512-4840
DATE: 01 |20 |95[c]

**BOTTLE TYPES (PLEASE FILL IN NO. OF TYPES SENT)**

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| ___FA | ___RU | ___FU | ___FAM | ___RAM | ___RC | ___FC | ___FAB | ___CU |
| ___RA | ___RAH | ___S= | ___CN- | ___RCB | 1 DOC | ___TOC | ___SOC | ___COD |
| ___VOA | ___CHY | ___O&G | ___PHENOL | 2 GCC | 3 GCV OTHER | | | |

CUSTOM/SPECIAL SAMPLE APPROVED BY: APPROVAL NO.
PROGRAM/PROJECT: XX NAWQA ___DRINKING H20 FILL IN OTHER
POSSIBLE HAZARDS

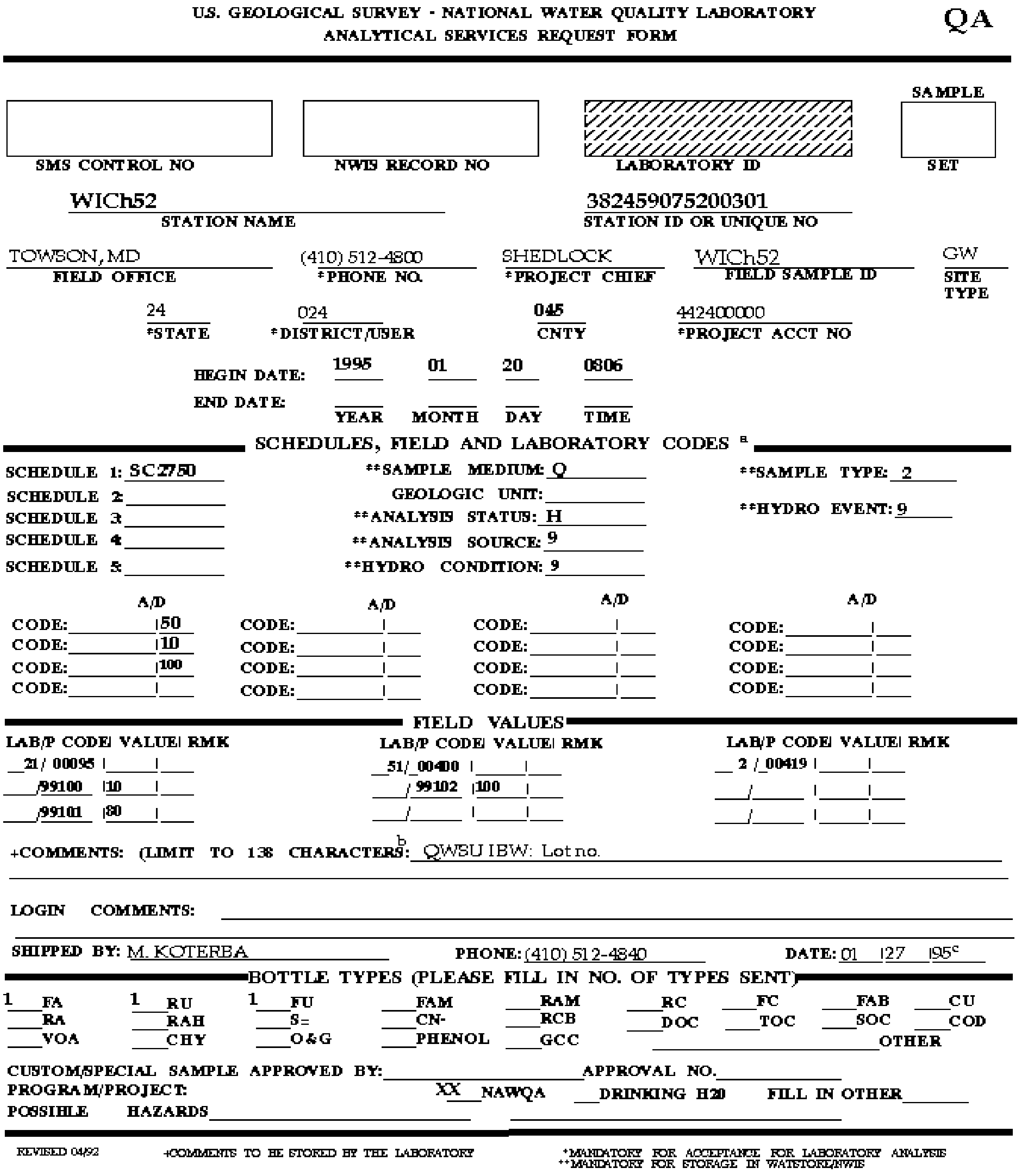
REVISED 04/92
+COMMENTS TO BE STORED BY THE LABORATORY
*MANDATORY FOR ACCEPTANCE FOR LABORATORY ANALYSIS
**MANDATORY FOR STORAGE IN WATSTORE/NWIS

[a] Add all P-codes to form and to QADATA record for sample.

[b] Priority comment, blank water lot number. If SC2090 not taken, NWQL pesticide-free blank water can be used, and if it is used, change the P code 99100 to "40" and the comment to "NWQL PBW: lot no."

[c] Ship blank samples with corresponding ground-water-quality samples.

**Figure A13-A.** Example of an analytical service request form for field blanks that require National Water Quality Laboratory blank water and overnight shipping.



U.S. GEOLOGICAL SURVEY - NATIONAL WATER QUALITY LABORATORY
ANALYTICAL SERVICES REQUEST FORM

QA

SMS CONTROL NO: 
NWIS RECORD NO: 
LABORATORY ID: 
SAMPLE SET:

STATION NAME: WICh52
STATION ID OR UNIQUE NO: 382459075200301

FIELD OFFICE: TOWSON, MD
*PHONE NO.: (410) 512-4800
*PROJECT CHIEF: SHEDLOCK
FIELD SAMPLE ID: WICh52
SITE TYPE: GW

*STATE: 24
*DISTRICT/USER: 024
CNTY: 045
*PROJECT ACCT NO: 442400000

| | YEAR | MONTH | DAY | TIME |
|---|---|---|---|---|
| BEGIN DATE: | 1995 | 01 | 20 | 0806 |
| END DATE: | | | | |

SCHEDULES, FIELD AND LABORATORY CODES $^{a}$

SCHEDULE 1: SC2750
SCHEDULE 2: 
SCHEDULE 3: 
SCHEDULE 4: 
SCHEDULE 5:

**SAMPLE MEDIUM: Q
GEOLOGIC UNIT: 
**ANALYSIS STATUS: H
**ANALYSIS SOURCE: 9
**HYDRO CONDITION: 9

**SAMPLE TYPE: 2
**HYDRO EVENT: 9

| CODE: | A/D | CODE: | A/D | CODE: | A/D | CODE: | A/D |
|---|---|---|---|---|---|---|---|
| | 50 | | | | | | |
| | 10 | | | | | | |
| | 100 | | | | | | |
| | | | | | | | |

FIELD VALUES

| LAB/P CODE | VALUE | RMK | LAB/P CODE | VALUE | RMK | LAB/P CODE | VALUE | RMK |
|---|---|---|---|---|---|---|---|---|
| 21/ 00095 | | | 51/ 00400 | | | 2 / 00419 | | |
| /99100 | 10 | | / 99102 | 100 | | / | | |
| /99101 | 80 | | / | | | / | | |

+COMMENTS: (LIMIT TO 138 CHARACTERS$^{b}$: QWSU IBW: Lot no.

LOGIN COMMENTS:

SHIPPED BY: M. KOTERBA
PHONE: (410) 512-4840
DATE: 01 /27 /95$^{c}$

BOTTLE TYPES (PLEASE FILL IN NO. OF TYPES SENT)

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 1 FA | 1 RU | 1 FU | FAM | RAM | RC | FC | FAB | CU |
| RA | RAH | S= | CN- | RCB | DOC | TOC | SOC | COD |
| VOA | CHY | O&G | PHENOL | GCC | | | | OTHER |

CUSTOM/SPECIAL SAMPLE APPROVED BY: 
APPROVAL NO.: 
PROGRAM/PROJECT: XX NAWQA ___ DRINKING H20 FILL IN OTHER 
POSSIBLE HAZARDS:

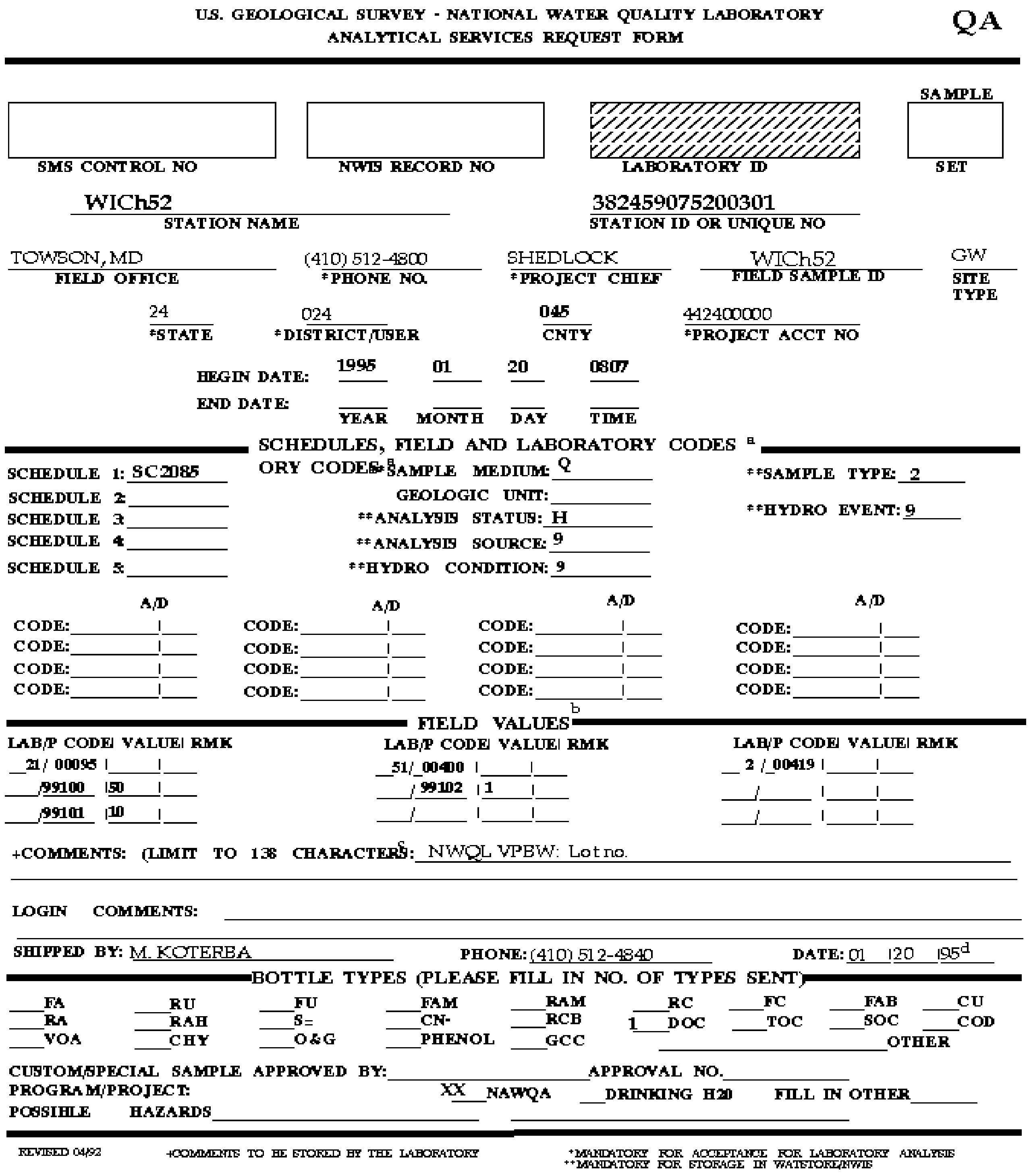
REVISED 04/92
+COMMENTS TO BE STORED BY THE LABORATORY
*MANDATORY FOR ACCEPTANCE FOR LABORATORY ANALYSIS
**MANDATORY FOR STORAGE IN WATSTORE/NWIS

[a] Add all P codes to form and to QADATA record for this sample.

[b] Priority comment, must appear.

[c] Recommend field-blank samples be shipped surface mail with corresponding ground-water samples (see figs. A10-A,B).

**Figure A13-B.** Example of an analytical service request form for field blanks that require Quality of Water Service Unit inorganic-free blank water (QWSU-IBW) <u>and</u> surface mail shipping.



U.S. GEOLOGICAL SURVEY - NATIONAL WATER QUALITY LABORATORY
ANALYTICAL SERVICES REQUEST FORM

QA

SMS CONTROL NO

NWIS RECORD NO

LABORATORY ID

SAMPLE SET

STATION NAME: WICh52

STATION ID OR UNIQUE NO: 382459075200301

FIELD OFFICE: TOWSON, MD

*PHONE NO.: (410) 512-4800

*PROJECT CHIEF: SHEDLOCK

FIELD SAMPLE ID: WICh52

SITE TYPE: GW

*STATE: 24

*DISTRICT/USER: 024

CNTY: 045

*PROJECT ACCT NO: 442400000

| | YEAR | MONTH | DAY | TIME |
|---|---|---|---|---|
| BEGIN DATE: | 1995 | 01 | 20 | 0807 |
| END DATE: | | | | |

SCHEDULES, FIELD AND LABORATORY CODES [a]

SCHEDULE 1: SC2085
SCHEDULE 2:
SCHEDULE 3:
SCHEDULE 4:
SCHEDULE 5:

ORY CODES**SAMPLE MEDIUM: Q
GEOLOGIC UNIT:
**ANALYSIS STATUS: H
**ANALYSIS SOURCE: 9
**HYDRO CONDITION: 9

**SAMPLE TYPE: 2
**HYDRO EVENT: 9

| CODE: | A/D | CODE: | A/D | CODE: | A/D | CODE: | A/D |
|---|---|---|---|---|---|---|---|
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |

FIELD VALUES [b]

| LAB/P CODE | VALUE | RMK | LAB/P CODE | VALUE | RMK | LAB/P CODE | VALUE | RMK |
|---|---|---|---|---|---|---|---|---|
| 21/ 00095 | | | 51/ 00400 | | | 2 / 00419 | | |
| /99100 | 50 | | / 99102 | 1 | | / | | |
| /99101 | 10 | | / | | | / | | |

+COMMENTS: (LIMIT TO 138 CHARACTERS)[c]: NWQL VPBW: Lot no.

LOGIN COMMENTS:

SHIPPED BY: M. KOTERBA

PHONE: (410) 512-4840

DATE: 01 |20 |95[d]

BOTTLE TYPES (PLEASE FILL IN NO. OF TYPES SENT)

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| FA | RU | FU | FAM | RAM | RC | FC | FAB | CU |
| RA | RAH | S= | CN- | RCB | 1 DOC | TOC | SOC | COD |
| VOA | CHY | O&G | PHENOL | GCC | | | OTHER | |

CUSTOM/SPECIAL SAMPLE APPROVED BY: APPROVAL NO.

PROGRAM/PROJECT: XX NAWQA DRINKING H20 FILL IN OTHER

POSSIBLE HAZARDS

REVISED 04/92

+COMMENTS TO BE STORED BY THE LABORATORY

*MANDATORY FOR ACCEPTANCE FOR LABORATORY ANALYSIS
**MANDATORY FOR STORAGE IN WATSTORE/NWIS

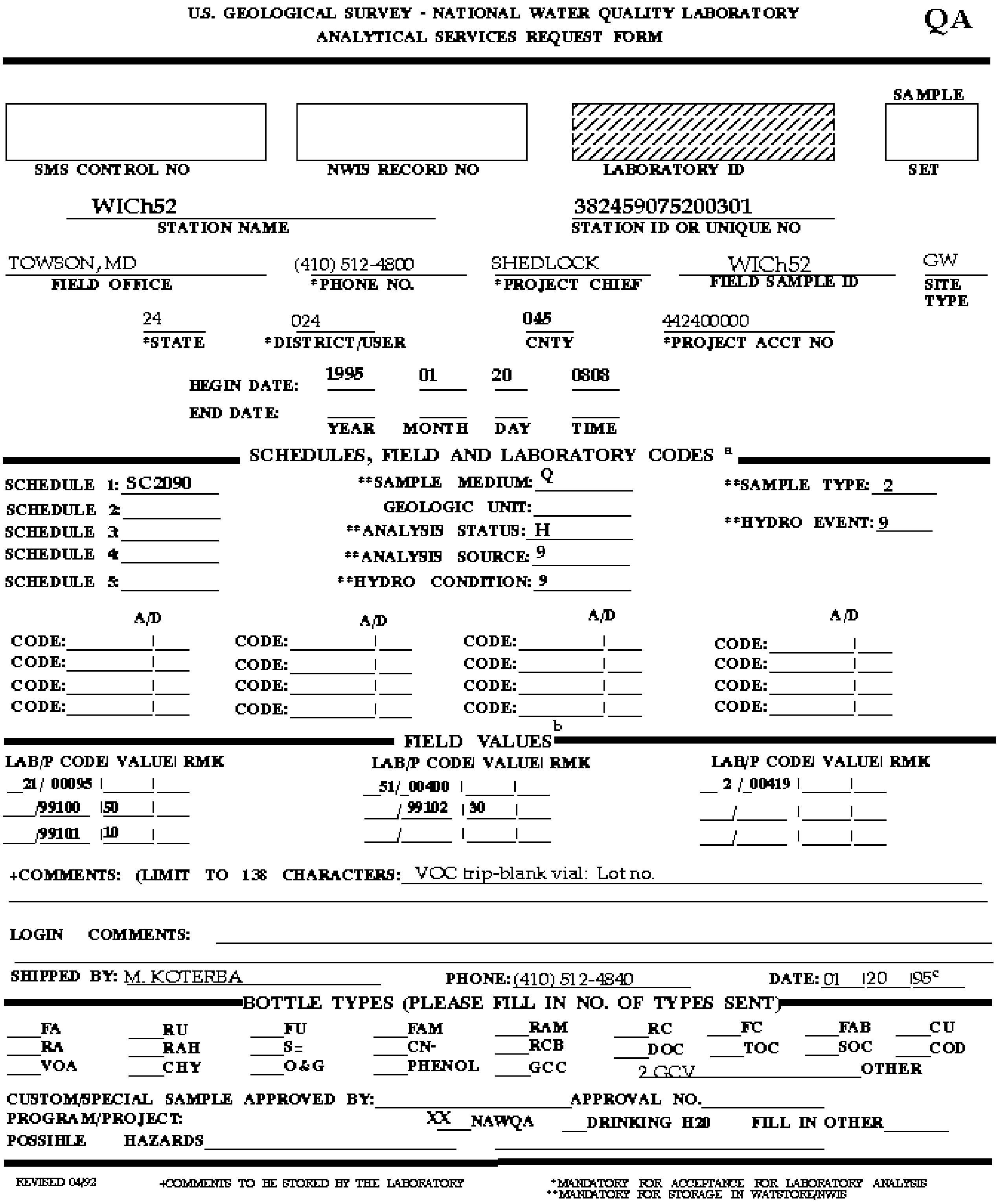
[a] Add all P codes noted to form and to QADATA record for this sample.

[b] If DOC field blank (fig. A13-A) taken with NWQL PBW, instead of NWQL VPBW, change the P code 99100 to "40" and the comment to "NWQL PBW: lot no."

[c] Priority comment, must appear in relation to blank water used (NWQL PBW or NWQL VPBW).

[d] This DOC solution blank is shipped overnight with the corresponding DOC field blank (fig. A13-A).

**Figure A14.** Example of an analytical service request form for dissolved (filtered) organic carbon (DOC) solution blank composed of either NWQL volatile pesticide-free blank water (VPBW) or pesticide-free blank water (PBW).



U.S. GEOLOGICAL SURVEY - NATIONAL WATER QUALITY LABORATORY
ANALYTICAL SERVICES REQUEST FORM

QA

SMS CONTROL NO ☐
NWIS RECORD NO ☐
LABORATORY ID ▨
SAMPLE SET ☐

STATION NAME: WICh52
STATION ID OR UNIQUE NO: 382459075200301

FIELD OFFICE: TOWSON, MD
*PHONE NO.: (410) 512-4800
*PROJECT CHIEF: SHEDLOCK
FIELD SAMPLE ID: WICh52
SITE TYPE: GW

*STATE: 24
*DISTRICT/USER: 024
CNTY: 045
*PROJECT ACCT NO: 442400000

| | YEAR | MONTH | DAY | TIME |
|---|---|---|---|---|
| BEGIN DATE: | 1995 | 01 | 20 | 0808 |
| END DATE: | | | | |

SCHEDULES, FIELD AND LABORATORY CODES [a]

SCHEDULE 1: SC2090
SCHEDULE 2: ____
SCHEDULE 3: ____
SCHEDULE 4: ____
SCHEDULE 5: ____

**SAMPLE MEDIUM: Q
GEOLOGIC UNIT: ____
**ANALYSIS STATUS: H
**ANALYSIS SOURCE: 9
**HYDRO CONDITION: 9

**SAMPLE TYPE: 2
**HYDRO EVENT: 9

| | A/D | | A/D | | A/D | | A/D |
|---|---|---|---|---|---|---|---|
| CODE: | | CODE: | | CODE: | | CODE: | |
| CODE: | | CODE: | | CODE: | | CODE: | |
| CODE: | | CODE: | | CODE: | | CODE: | |
| CODE: | | CODE: | | CODE: | | CODE: | |

FIELD VALUES[b]

| LAB/P CODE | VALUE | RMK | LAB/P CODE | VALUE | RMK | LAB/P CODE | VALUE | RMK |
|---|---|---|---|---|---|---|---|---|
| 21/ 00095 | | | 51/ 00400 | | | 2 / 00419 | | |
| /99100 | 50 | | / 99102 | 30 | | / | | |
| /99101 | 10 | | / | | | / | | |

+COMMENTS: (LIMIT TO 138 CHARACTERS: VOC trip-blank vial: Lot no.

LOGIN COMMENTS: ____

SHIPPED BY: M. KOTERBA
PHONE: (410) 512-4840
DATE: 01 |20 |95[c]

BOTTLE TYPES (PLEASE FILL IN NO. OF TYPES SENT)

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| ___FA | ___RU | ___FU | ___FAM | ___RAM | ___RC | ___FC | ___FAB | ___CU |
| ___RA | ___RAH | ___S= | ___CN- | ___RCB | ___DOC | ___TOC | ___SOC | ___COD |
| ___VOA | ___CHY | ___O&G | ___PHENOL | ___GCC | 2 GCV ___OTHER | | | |

CUSTOM/SPECIAL SAMPLE APPROVED BY: ____ APPROVAL NO. ____
PROGRAM/PROJECT: XX NAWQA ___DRINKING H20 FILL IN OTHER ____
POSSIBLE HAZARDS ____

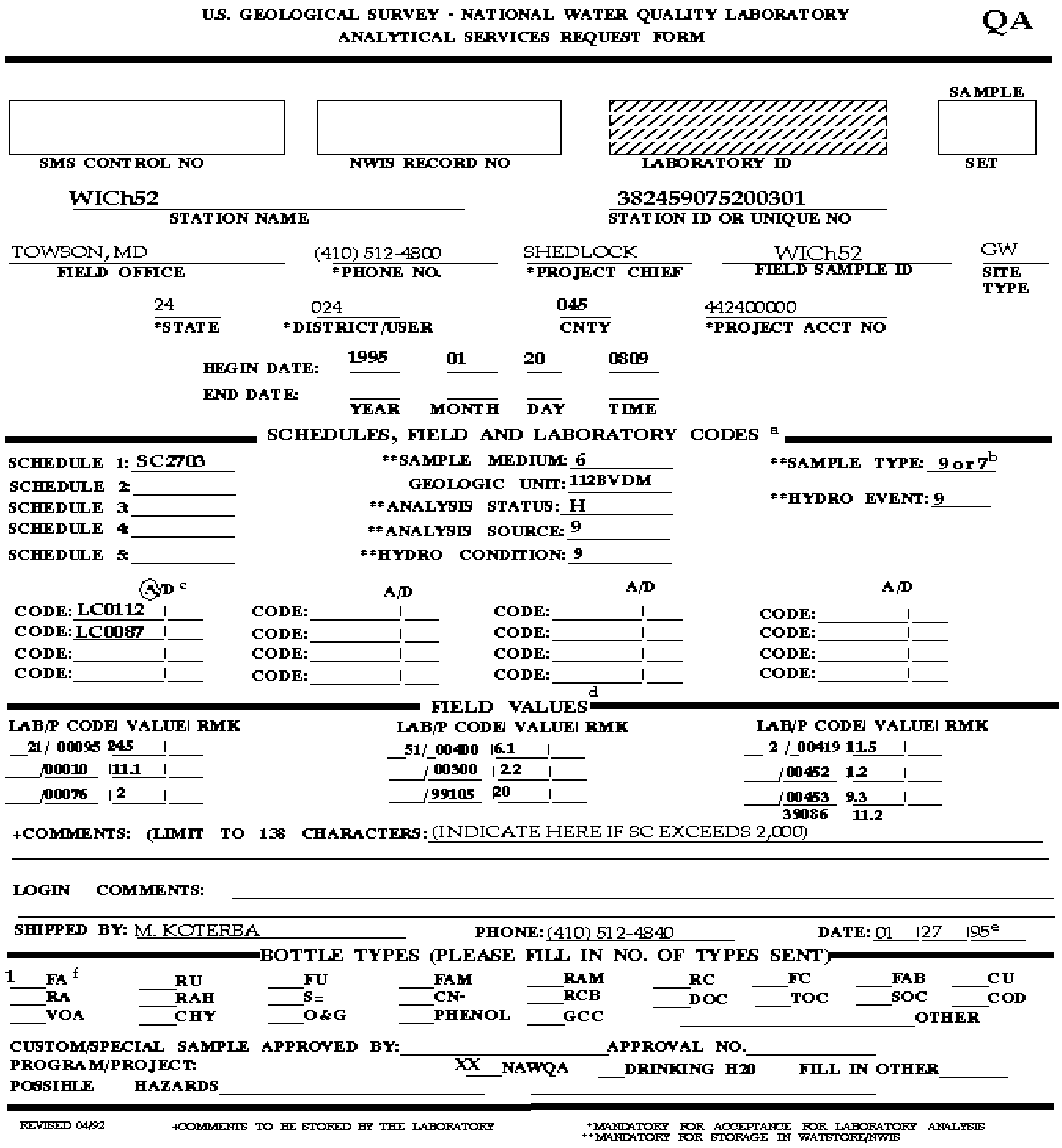
REVISED 04/92
+COMMENTS TO BE STORED BY THE LABORATORY
*MANDATORY FOR ACCEPTANCE FOR LABORATORY ANALYSIS
**MANDATORY FOR STORAGE IN WATSTORE/NWIS

[a] Add all P codes noted to form and to QADATA record for this sample.

[b] NWQL VPBW is assumed for trip blanks; priority comment, lot no. of VOC trip blank vials.

[c] Ship overnight with corresponding volatile ground-water samples collected in vials from same lot (fig. A10-A).

**Figure A15.** Example of an analytical service request form for a volatile-organic-compound (VOC) trip blank.



U.S. GEOLOGICAL SURVEY - NATIONAL WATER QUALITY LABORATORY
ANALYTICAL SERVICES REQUEST FORM

QA

SMS CONTROL NO
NWIS RECORD NO
LABORATORY ID
SAMPLE SET

STATION NAME: WICh52
STATION ID OR UNIQUE NO: 382459075200301

FIELD OFFICE: TOWSON, MD
*PHONE NO.: (410) 512-4800
*PROJECT CHIEF: SHEDLOCK
FIELD SAMPLE ID: WICh52
SITE TYPE: GW

*STATE: 24
*DISTRICT/USER: 024
CNTY: 045
*PROJECT ACCT NO: 442400000

| | YEAR | MONTH | DAY | TIME |
|---|---|---|---|---|
| BEGIN DATE: | 1995 | 01 | 20 | 0809 |
| END DATE: | | | | |

SCHEDULES, FIELD AND LABORATORY CODES [a]

SCHEDULE 1: SC2703
SCHEDULE 2:
SCHEDULE 3:
SCHEDULE 4:
SCHEDULE 5:

**SAMPLE MEDIUM: 6
GEOLOGIC UNIT: 112BVDM
**ANALYSIS STATUS: H
**ANALYSIS SOURCE: 9
**HYDRO CONDITION: 9

**SAMPLE TYPE: 9 or 7[b]
**HYDRO EVENT: 9

| | [✓ A]/D [c] | | A/D | | A/D | | A/D |
|---|---|---|---|---|---|---|---|
| CODE: LC0112 | | CODE: | | CODE: | | CODE: | |
| CODE: LC0087 | | CODE: | | CODE: | | CODE: | |
| CODE: | | CODE: | | CODE: | | CODE: | |
| CODE: | | CODE: | | CODE: | | CODE: | |

FIELD VALUES[d]

| LAB/P CODE | VALUE | RMK | LAB/P CODE | VALUE | RMK | LAB/P CODE | VALUE | RMK |
|---|---|---|---|---|---|---|---|---|
| 21/ 00095 | 245 | | 51/ 00400 | 6.1 | | 2 / 00419 | 11.5 | |
| /00010 | 11.1 | | / 00300 | 2.2 | | /00452 | 1.2 | |
| /00076 | 2 | | /99105 | 20 | | /00453 | 9.3 | |
| | | | | | | 39086 | 11.2 | |

+COMMENTS: (LIMIT TO 138 CHARACTERS: (INDICATE HERE IF SC EXCEEDS 2,000)

LOGIN COMMENTS:

SHIPPED BY: M. KOTERBA
PHONE: (410) 512-4840
DATE: 01 /27 /95[e]

BOTTLE TYPES (PLEASE FILL IN NO. OF TYPES SENT)

1 FA [f]
RA
VOA
RU
RAH
CHY
FU
S=
O&G
FAM
CN-
PHENOL
RAM
RCB
GCC
RC
DOC
FC
TOC
FAB
SOC
CU
COD
OTHER

CUSTOM/SPECIAL SAMPLE APPROVED BY:
APPROVAL NO.
PROGRAM/PROJECT: XX NAWQA
DRINKING H20
FILL IN OTHER
POSSIBLE HAZARDS

REVISED 04/92
+COMMENTS TO BE STORED BY THE LABORATORY
*MANDATORY FOR ACCEPTANCE FOR LABORATORY ANALYSIS
**MANDATORY FOR STORAGE IN WATSTORE/NWIS

[a] Add all P codes noted to form and to QADATA record for this sample.

[b] If a replicate trace-element sample is collected (fig. A17), code sample type as 7; otherwise, code as 9.

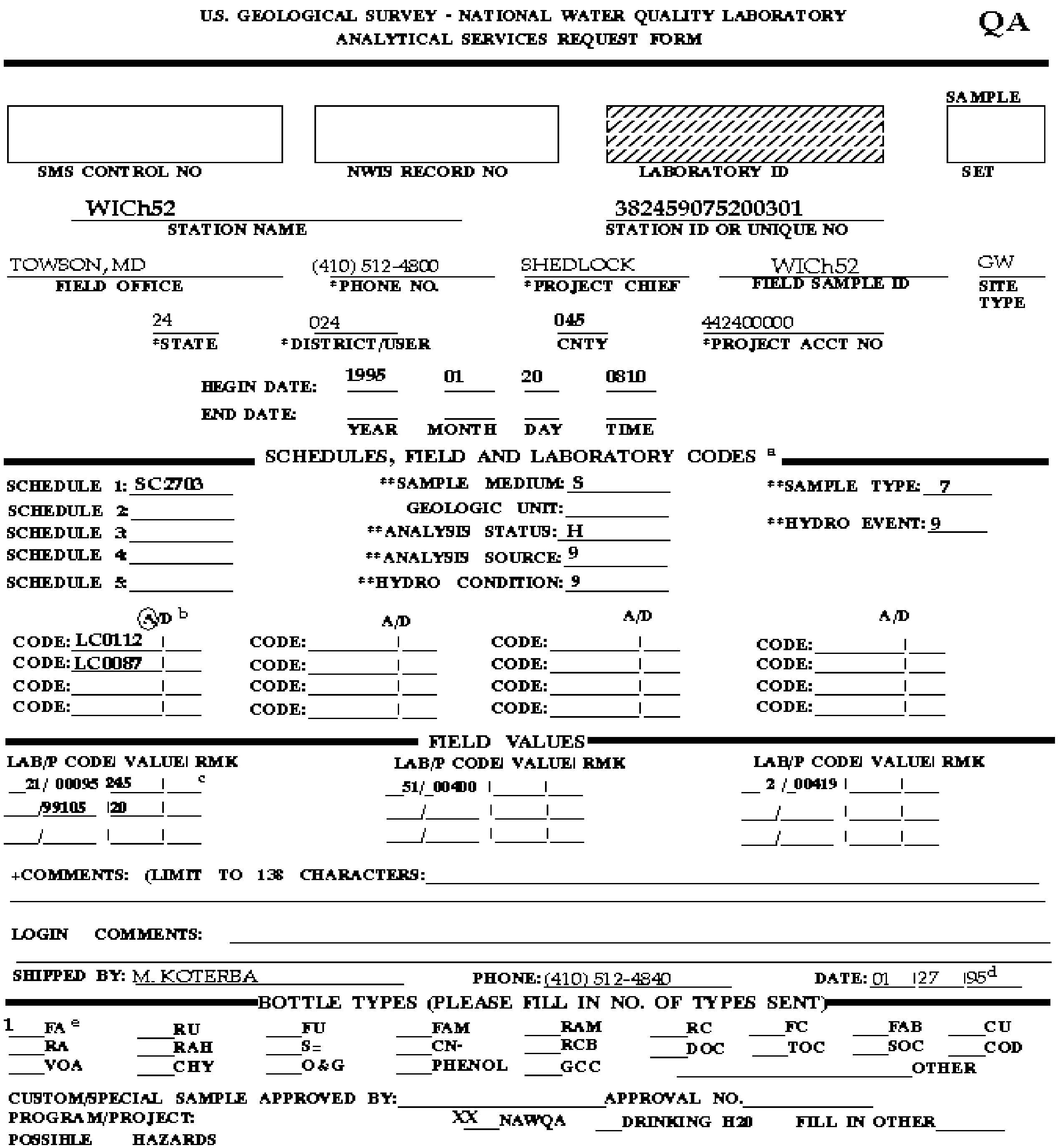
[c] Add labcodes for arsenic (LC0112) and selenium (LC0087).

[d] Include field measurements (median values), particularly for specific electrical conductance (SC) at 25 degrees Celsius (P code 00095), and note on comment line if SC exceeds 2,000.

[e] Recommend sample be shipped surface mail with other primary inorganic samples (see fig. A10-B).

[f] Only the FA sample bottle is required if Study Unit acidifies sample, provides field SC value, and indicates in comment field if SC exceeds 2,000 microsiemens per centimeter at 25 degrees Celsius.

**Figure A16.** Example of an analytical service request form for a primary trace-element ground-water sample (SC2703).



**U.S. GEOLOGICAL SURVEY - NATIONAL WATER QUALITY LABORATORY**
**ANALYTICAL SERVICES REQUEST FORM**

**QA**

SMS CONTROL NO: 
NWIS RECORD NO: 
LABORATORY ID: 
SAMPLE SET:

STATION NAME: WICh52
STATION ID OR UNIQUE NO: 382459075200301

FIELD OFFICE: TOWSON, MD
*PHONE NO.: (410) 512-4800
*PROJECT CHIEF: SHEDLOCK
FIELD SAMPLE ID: WICh52
SITE TYPE: GW

*STATE: 24
*DISTRICT/USER: 024
CNTY: 045
*PROJECT ACCT NO: 442400000

| | YEAR | MONTH | DAY | TIME |
|---|---|---|---|---|
| BEGIN DATE: | 1995 | 01 | 20 | 0810 |
| END DATE: | | | | |

**SCHEDULES, FIELD AND LABORATORY CODES** [a]

SCHEDULE 1: SC2703
SCHEDULE 2: 
SCHEDULE 3: 
SCHEDULE 4: 
SCHEDULE 5:

**SAMPLE MEDIUM: S
GEOLOGIC UNIT: 
**ANALYSIS STATUS: H
**ANALYSIS SOURCE: 9
**HYDRO CONDITION: 9

**SAMPLE TYPE: 7
**HYDRO EVENT: 9

| CODE: | [✓ A]/D [b] | CODE: | A/D | CODE: | A/D | CODE: | A/D |
|---|---|---|---|---|---|---|---|
| LC0112 | | | | | | | |
| LC0087 | | | | | | | |
| | | | | | | | |
| | | | | | | | |

**FIELD VALUES**

| LAB/P CODE | VALUE | RMK | LAB/P CODE | VALUE | RMK | LAB/P CODE | VALUE | RMK |
|---|---|---|---|---|---|---|---|---|
| 21/ 00095 | 245 | [c] | 51/ 00400 | | | 2 / 00419 | | |
| /99105 | 20 | | / | | | / | | |
| / | | | / | | | / | | |

+COMMENTS: (LIMIT TO 138 CHARACTERS:

LOGIN COMMENTS:

SHIPPED BY: M. KOTERBA
PHONE: (410) 512-4840
DATE: 01 /27 /95[d]

**BOTTLE TYPES (PLEASE FILL IN NO. OF TYPES SENT)**

1 FA [e]
RA
VOA
RU
RAH
CHY
FU
S=
O&G
FAM
CN-
PHENOL
RAM
RCB
GCC
RC
DOC
FC
TOC
FAB
SOC
CU
COD
OTHER

CUSTOM/SPECIAL SAMPLE APPROVED BY: 
APPROVAL NO.: 
PROGRAM/PROJECT: XX NAWQA   DRINKING H20   FILL IN OTHER 
POSSIBLE HAZARDS

REVISED 04/92
+COMMENTS TO BE STORED BY THE LABORATORY
*MANDATORY FOR ACCEPTANCE FOR LABORATORY ANALYSIS
**MANDATORY FOR STORAGE IN WATSTORE/NWIS

[a] Add all P codes noted to form and to QADATA record for this sample.

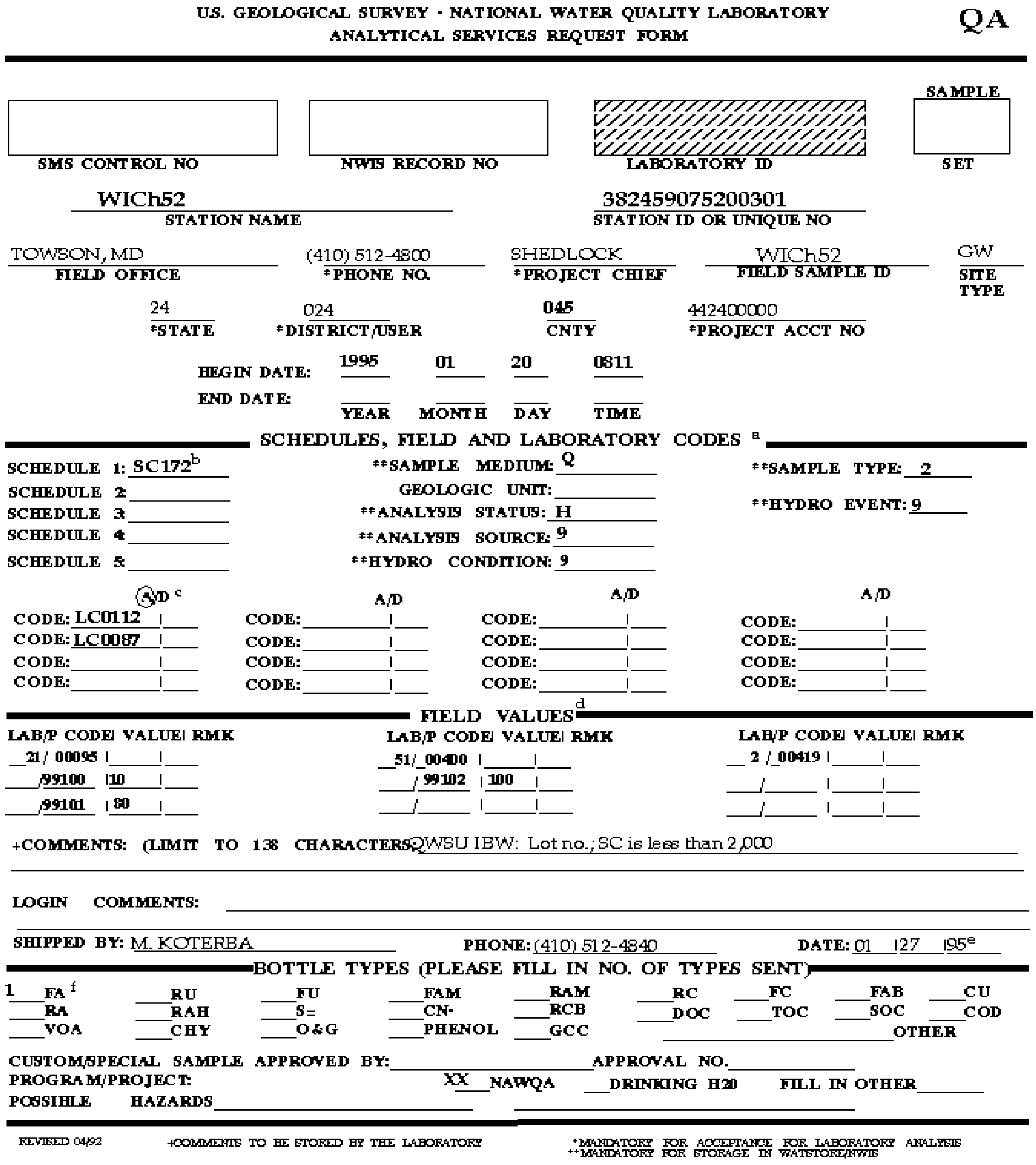
[b] Add labcodes for arsenic (LC0112) and selenium (LC0087).

[c] Include field measurements (median values), particularly for specific electrical conductance (SC) at 25 degrees Celsius (P code 00095), and note on comment line if SC exceeds 2,000.

[d] Recommend sample be shipped surface mail with other primary inorganic samples (see fig. A10-B).

[e] Only the FA sample bottle is required if Study Unit acidifies sample, provides field SC value, and indicates in comment field if SC exceeds 2,000 microsiemens per centimeter at 25 degrees Celsius.

**Figure A17.** Example of an analytical service request form for a replicate trace-element ground-water sample (SC2703).



U.S. GEOLOGICAL SURVEY - NATIONAL WATER QUALITY LABORATORY
ANALYTICAL SERVICES REQUEST FORM

**QA**

SMS CONTROL NO: 
NWIS RECORD NO: 
LABORATORY ID: 
SAMPLE SET:

STATION NAME: WICh52
STATION ID OR UNIQUE NO: 382459075200301

FIELD OFFICE: TOWSON, MD
*PHONE NO.: (410) 512-4800
*PROJECT CHIEF: SHEDLOCK
FIELD SAMPLE ID: WICh52
SITE TYPE: GW

*STATE: 24
*DISTRICT/USER: 024
CNTY: 045
*PROJECT ACCT NO: 442400000

|  | YEAR | MONTH | DAY | TIME |
|---|---|---|---|---|
| BEGIN DATE: | 1995 | 01 | 20 | 0811 |
| END DATE: |  |  |  |  |

**SCHEDULES, FIELD AND LABORATORY CODES [a]**

SCHEDULE 1: SC172[b]
SCHEDULE 2: 
SCHEDULE 3: 
SCHEDULE 4: 
SCHEDULE 5:

**SAMPLE MEDIUM: Q
GEOLOGIC UNIT: 
**ANALYSIS STATUS: H
**ANALYSIS SOURCE: 9
**HYDRO CONDITION: 9

**SAMPLE TYPE: 2
**HYDRO EVENT: 9

|  | A/D[c] |  | A/D |  | A/D |  | A/D |
|---|---|---|---|---|---|---|---|
| CODE: LC0112 |  | CODE: |  | CODE: |  | CODE: |  |
| CODE: LC0087 |  | CODE: |  | CODE: |  | CODE: |  |
| CODE: |  | CODE: |  | CODE: |  | CODE: |  |
| CODE: |  | CODE: |  | CODE: |  | CODE: |  |

**FIELD VALUES[d]**

| LAB/P CODE | VALUE | RMK | LAB/P CODE | VALUE | RMK | LAB/P CODE | VALUE | RMK |
|---|---|---|---|---|---|---|---|---|
| 21 / 00095 |  |  | 51/ 00400 |  |  | 2 / 00419 |  |  |
| / 99100 | 10 |  | / 99102 | 100 |  | / |  |  |
| / 99101 | 80 |  | / |  |  | / |  |  |

+COMMENTS: (LIMIT TO 138 CHARACTERS) QWSU IBW: Lot no.; SC is less than 2,000

LOGIN COMMENTS:

SHIPPED BY: M. KOTERBA
PHONE: (410) 512-4840
DATE: 01 |27 |95[e]

**BOTTLE TYPES (PLEASE FILL IN NO. OF TYPES SENT)**

|  |  |  |  |  |  |  |  |  |
|---|---|---|---|---|---|---|---|---|
| 1 FA[f] | RU | FU | FAM | RAM | RC | FC | FAB | CU |
| RA | RAH | S= | CN- | RCB | DOC | TOC | SOC | COD |
| VOA | CHY | O&G | PHENOL | GCC |  |  | OTHER |  |

CUSTOM/SPECIAL SAMPLE APPROVED BY: 
APPROVAL NO. 
PROGRAM/PROJECT: XX NAWQA ☐ DRINKING H20 FILL IN OTHER 
POSSIBLE HAZARDS

REVISED 04/92
+COMMENTS TO BE STORED BY THE LABORATORY
*MANDATORY FOR ACCEPTANCE FOR LABORATORY ANALYSIS
**MANDATORY FOR STORAGE IN WATSTORE/NWIS

[a] Add all P codes noted to form and to QADATA record for this sample.

[b] SC172 required for field blanks instead of SC2703--provides detection-level or higher concentration data.

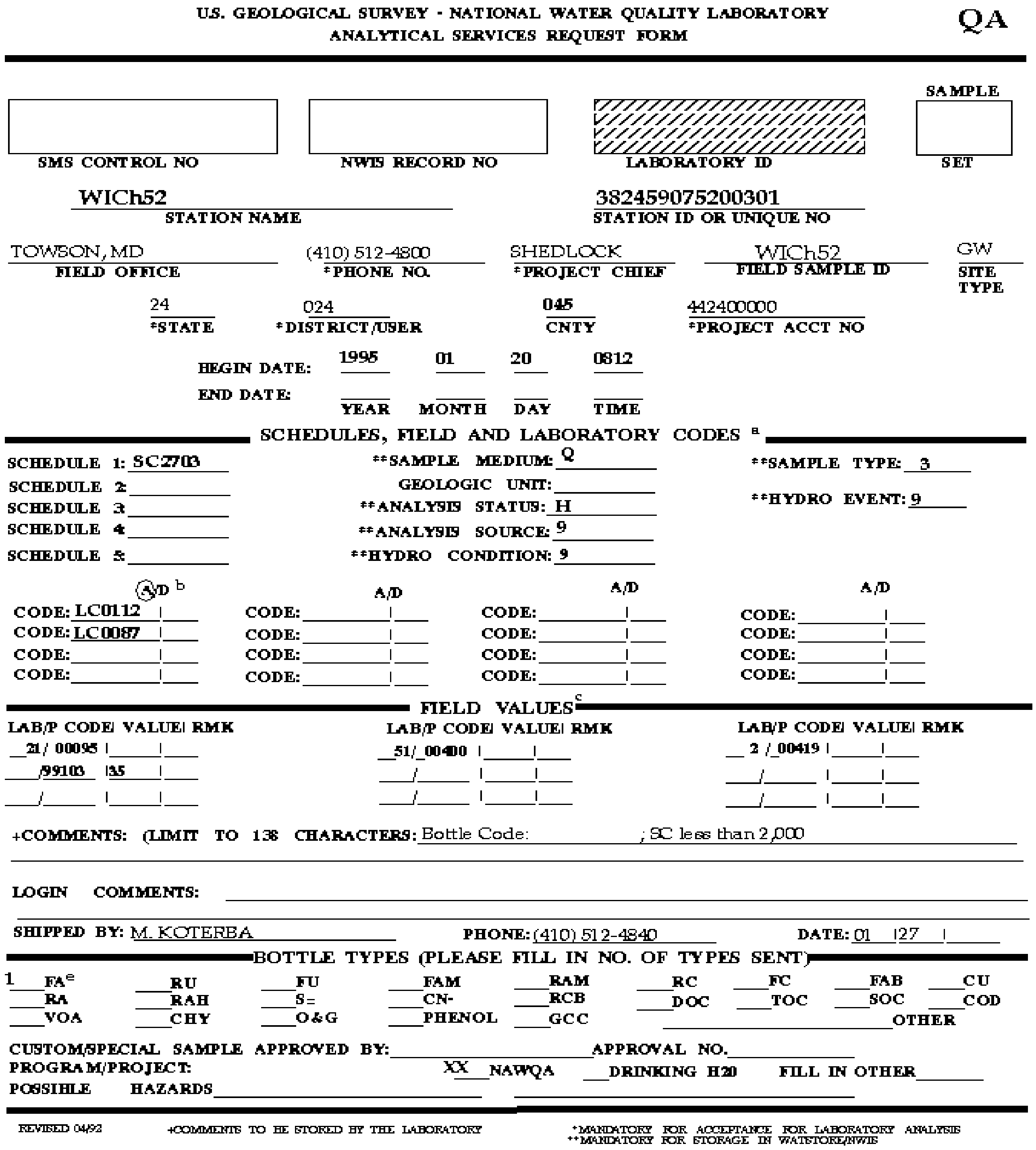
[c] Add labcodes for arsenic (LC0112) and selenium (LC0087).

[d] Include priority comments; note that SC value is not given under the P code (this is blank water).

[e] Recommend sample be shipped surface mail with other primary inorganic samples (fig. A10-B).

[f] Only the FA sample bottle is required if the Study Unit acidifies sample and provides SC comment.

**Figure A18.** Example of an analytical service request form for a ground-water trace-element (SC2703) field blank.



U.S. GEOLOGICAL SURVEY - NATIONAL WATER QUALITY LABORATORY
ANALYTICAL SERVICES REQUEST FORM

QA

SMS CONTROL NO:
NWIS RECORD NO:
LABORATORY ID:
SAMPLE SET:

STATION NAME: WICh52
STATION ID OR UNIQUE NO: 382459075200301

FIELD OFFICE: TOWSON, MD
*PHONE NO.: (410) 512-4800
*PROJECT CHIEF: SHEDLOCK
FIELD SAMPLE ID: WICh52
SITE TYPE: GW

*STATE: 24
*DISTRICT/USER: 024
CNTY: 045
*PROJECT ACCT NO: 442400000

| | YEAR | MONTH | DAY | TIME |
|---|---|---|---|---|
| BEGIN DATE: | 1995 | 01 | 20 | 0812 |
| END DATE: | | | | |

SCHEDULES, FIELD AND LABORATORY CODES [a]

SCHEDULE 1: SC2703
SCHEDULE 2:
SCHEDULE 3:
SCHEDULE 4:
SCHEDULE 5:

**SAMPLE MEDIUM: Q
GEOLOGIC UNIT:
**ANALYSIS STATUS: H
**ANALYSIS SOURCE: 9
**HYDRO CONDITION: 9

**SAMPLE TYPE: 3
**HYDRO EVENT: 9

| CODE: | (A)/D [b] | CODE: | A/D | CODE: | A/D | CODE: | A/D |
|---|---|---|---|---|---|---|---|
| LC0112 | | | | | | | |
| LC0087 | | | | | | | |
| | | | | | | | |
| | | | | | | | |

FIELD VALUES [c]

| LAB/P CODE | VALUE | RMK | LAB/P CODE | VALUE | RMK | LAB/P CODE | VALUE | RMK |
|---|---|---|---|---|---|---|---|---|
| 21/ 00095 | | | 51/ 00400 | | | 2 / 00419 | | |
| /99103 | 35 | | / | | | / | | |
| / | | | / | | | / | | |

+COMMENTS: (LIMIT TO 138 CHARACTERS: Bottle Code: ; SC less than 2,000

LOGIN COMMENTS:

SHIPPED BY: M. KOTERBA
PHONE: (410) 512-4840
DATE: 01 |27 |

BOTTLE TYPES (PLEASE FILL IN NO. OF TYPES SENT)

1 FA[e]
RU
FU
FAM
RAM
RC
FC
FAB
CU
RA
RAH
S=
CN-
RCB
DOC
TOC
SOC
COD
VOA
CHY
O&G
PHENOL
GCC
OTHER

CUSTOM/SPECIAL SAMPLE APPROVED BY:
APPROVAL NO.
PROGRAM/PROJECT: XX NAWQA
DRINKING H20
FILL IN OTHER
POSSIBLE HAZARDS

REVISED 04/92
+COMMENTS TO BE STORED BY THE LABORATORY
*MANDATORY FOR ACCEPTANCE FOR LABORATORY ANALYSIS
**MANDATORY FOR STORAGE IN WATSTORE/NWIS

[a] Add all P codes noted to form and to QADATA record for this sample.

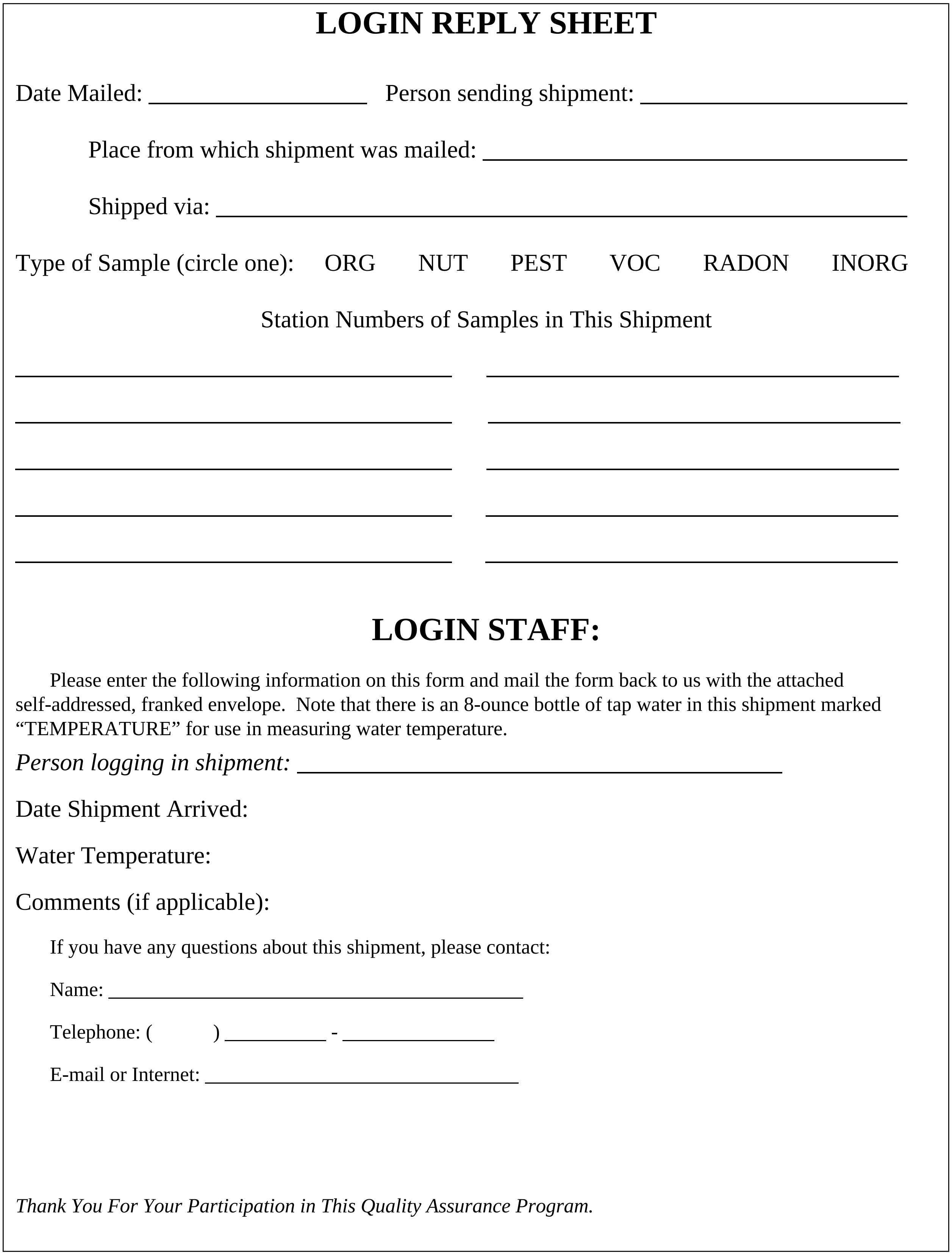
[b] Add labcodes for arsenic (LC0112) and selenium (LC0087).

[c] Include priority comments; note that SC value is not given under the P code (this is blank water). Specify bottle code originally found on bottle as received from BTD&QS.

[d] Recommend sample be shipped surface mail with other primary inorganic samples (fig. A10-B).

[e] Only the FA sample bottle is required if the Study Unit acidifies sample and provides the SC comment.

**Figure A19.** Example of an analytical service request form for a standard-reference trace-element (SC2703) sample for ground water.



# LOGIN REPLY SHEET

Date Mailed: ____________________ Person sending shipment: _________________________

Place from which shipment was mailed: ________________________________________

Shipped via: _________________________________________________________________

Type of Sample (circle one): ORG NUT PEST VOC RADON INORG

Station Numbers of Samples in This Shipment

________________________________________ ______________________________________

________________________________________ ______________________________________

________________________________________ ______________________________________

________________________________________ ______________________________________

________________________________________ ______________________________________

## LOGIN STAFF:

Please enter the following information on this form and mail the form back to us with the attached self-addressed, franked envelope. Note that there is an 8-ounce bottle of tap water in this shipment marked “TEMPERATURE” for use in measuring water temperature.

*Person logging in shipment:* _____________________________________________

Date Shipment Arrived:

Water Temperature:

Comments (if applicable):

If you have any questions about this shipment, please contact:

Name: ________________________________________

Telephone: (          ) __________ - _______________

E-mail or Internet: _______________________________

*Thank You For Your Participation in This Quality Assurance Program.*

**Figure A20**. Example of Study Unit login reply form sent with samples shipped by overnight mail.

# Errata for Open-File Report 95-399

Corrections are by Michael Koterba; January 24, 1996

Page 16, Table 3, Footnote 21, Item (1)--**change from:**

"For assistance with (1) isotope, radiochemical, and other specialized equipment, contact the NAWQA Quality Assurance Specialist;"

**to:**

"For assistance with (1) deuterium-oxygen isotopes, and quality-assured sample bottles and caps for these isotopes, contact Tyler Coplen, Isotope Fractionation, USGS National Research Program, MS 431, Reston, Va. (via isotopes@usgs.gov); for assistance with tritium isotopes, and quality-assured sample bottles and caps for these isotopes, contact Robert Michel, Isotope Tracers, MS 434, USGS National Research Program, Menlo Park, Calif. (via tritium@mailrcamnl.wr.usgs.gov);"

Page 66, Table 21, 3. Other Samples--Columns for Tritium isotopes and Deuterium-Oxygen isotopes **change from:**

**Team Member A**

| Sample type (SC, LC) and order of collection | Collect, by filling | Quality-assurance checks or measures |
|---|---|---|
| • Tritium isotopes | 1, 1.0-L, clear, prerinsed poly bottle, filled to top after 3, 25-mL rinses (include cap with conical insert) | Verify DIW is still in bottle from office prerinse before use, otherwise replace bottle. Leave no headspace in bottle |
| • Deuterium-Oxygen isotopes | 1, 125-ml, glass, amber bottle to top after 3, 25-ml rinses (include cap with conical insert) | Leave no headspace in bottle |

**to:**

**Team Member A**

| Sample type (SC, LC) and order of collection | Collect, by filling | Quality-assurance checks or measures |
|---|---|---|
| • Tritium isotopes | 1, 1.0-L, dry, high-density-poly (preferred) or glass bottle, without prerinsing, until it overflows, and seal with a cap with conical insert | To reduce breakage of glass bottles caused by samples freezing during shipment, pour out sample until the water level is at the bottle shoulder seam. |
| • Deuterium-Oxygen isotopes | 1, 60-mL, dry, clear, glass (preferred) or poly bottle, without prerinsing, until it overflows, and seal with a cap with conical insert | To reduce breakage of glass bottles caused by samples freezing during shipment, pour out sample until the water level is at the bottle shoulder seam. Samples collected in poly bottles are sent immediately for analysis, and are unsuitable for archiving. |

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# Chapter 5 Appendix

# Chapter 5
# Appendix A

## Hydrographs Showing Minimum Thresholds, Measurable Objectives and Interim Milestones

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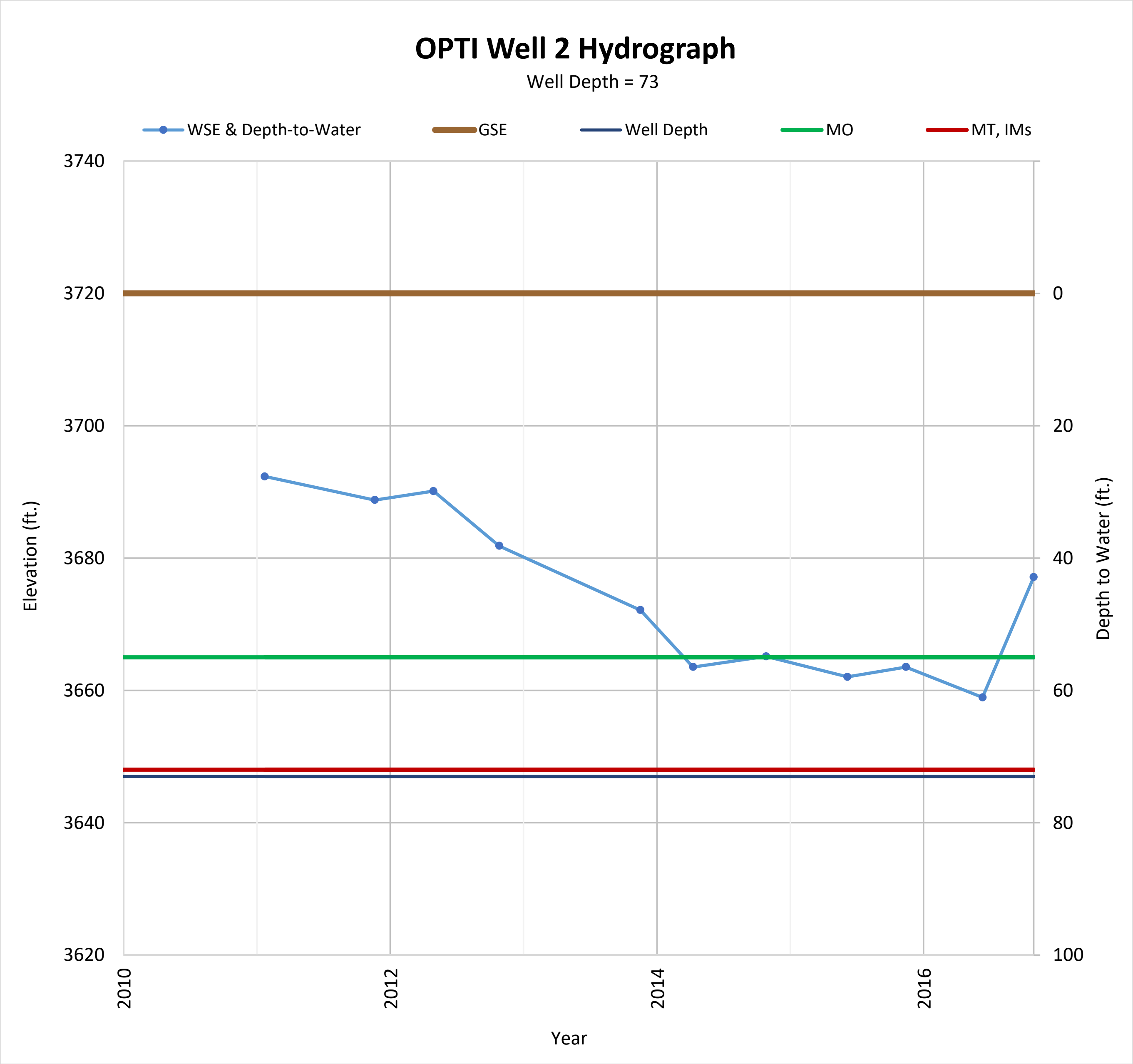
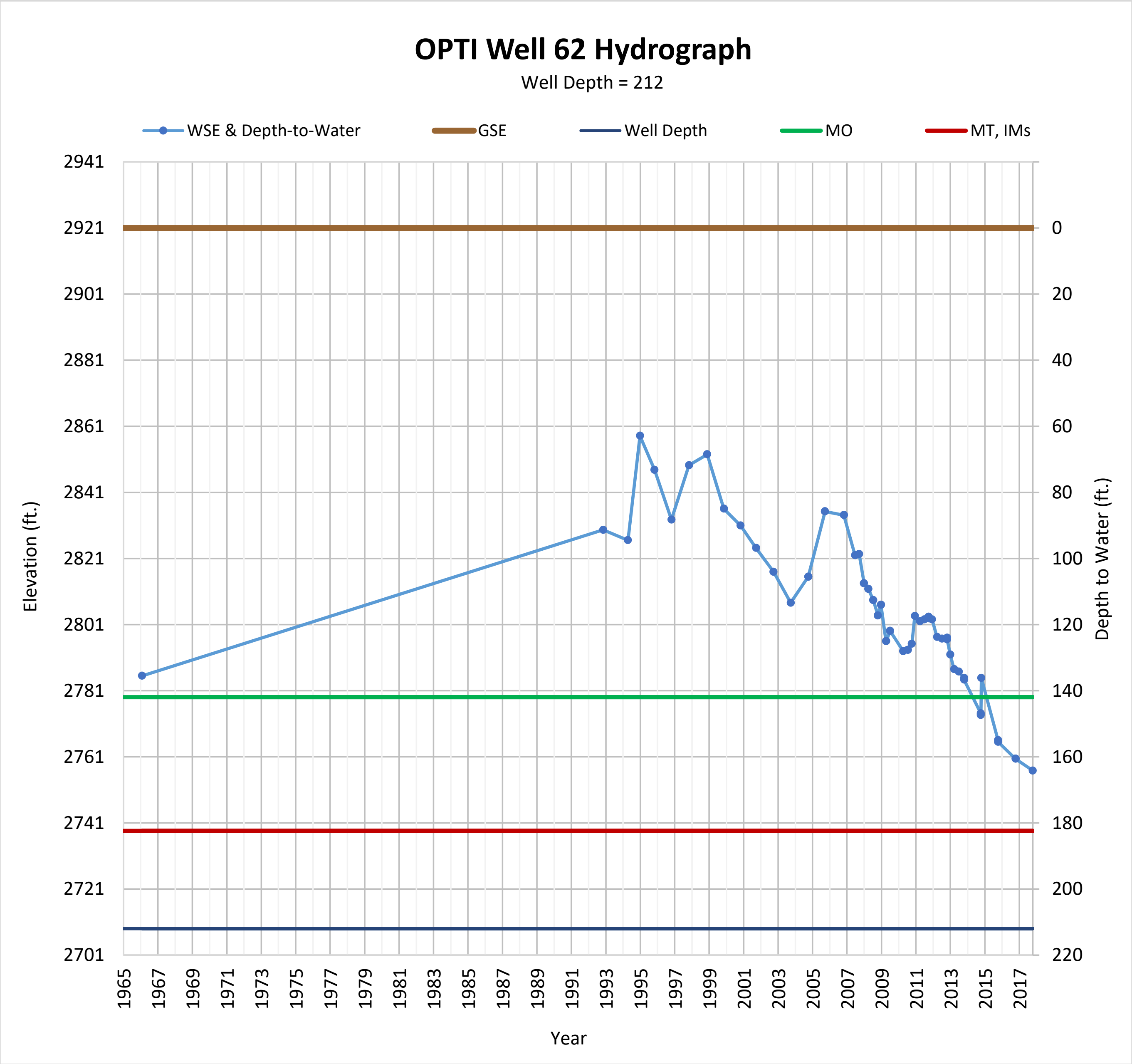
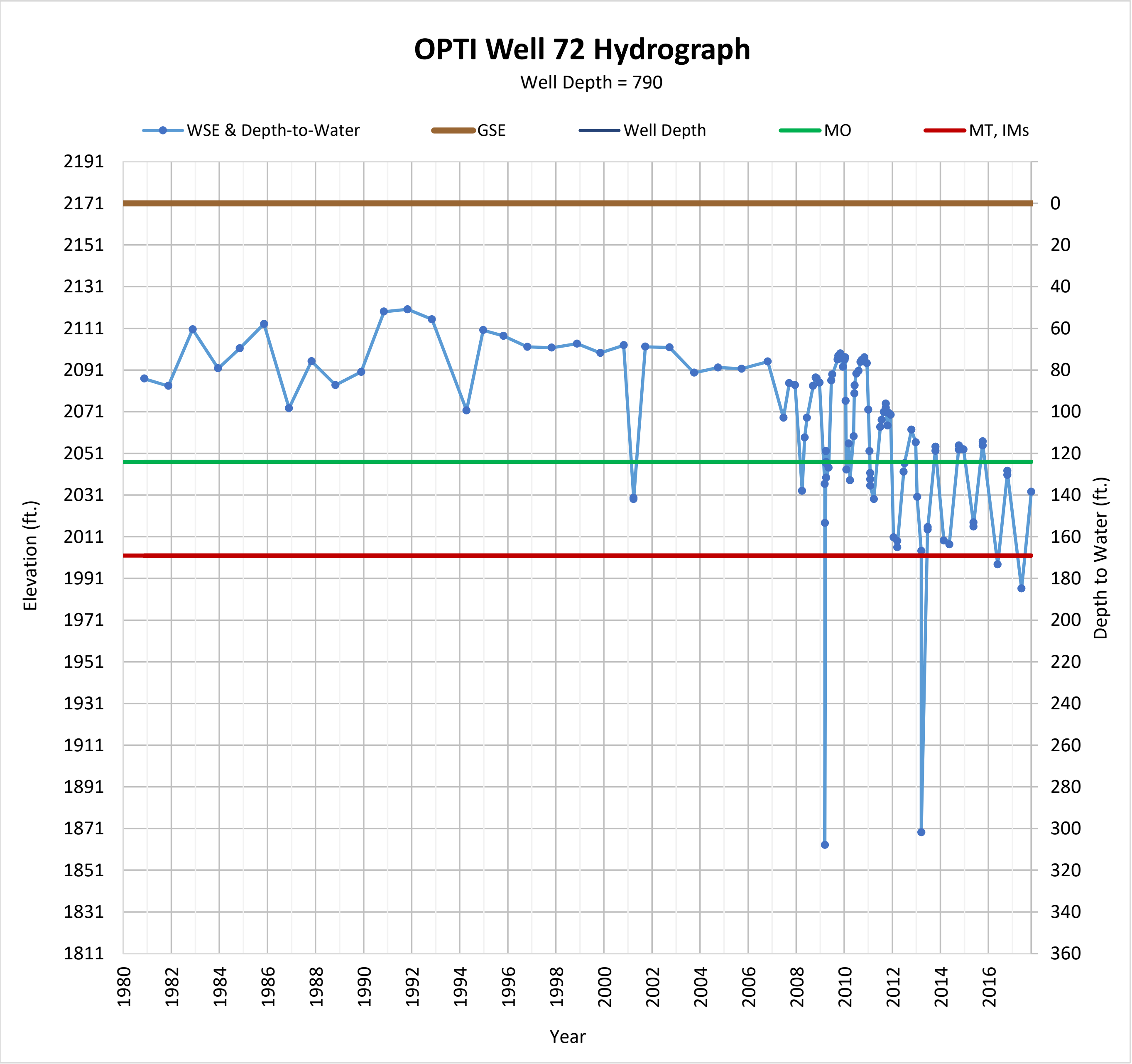
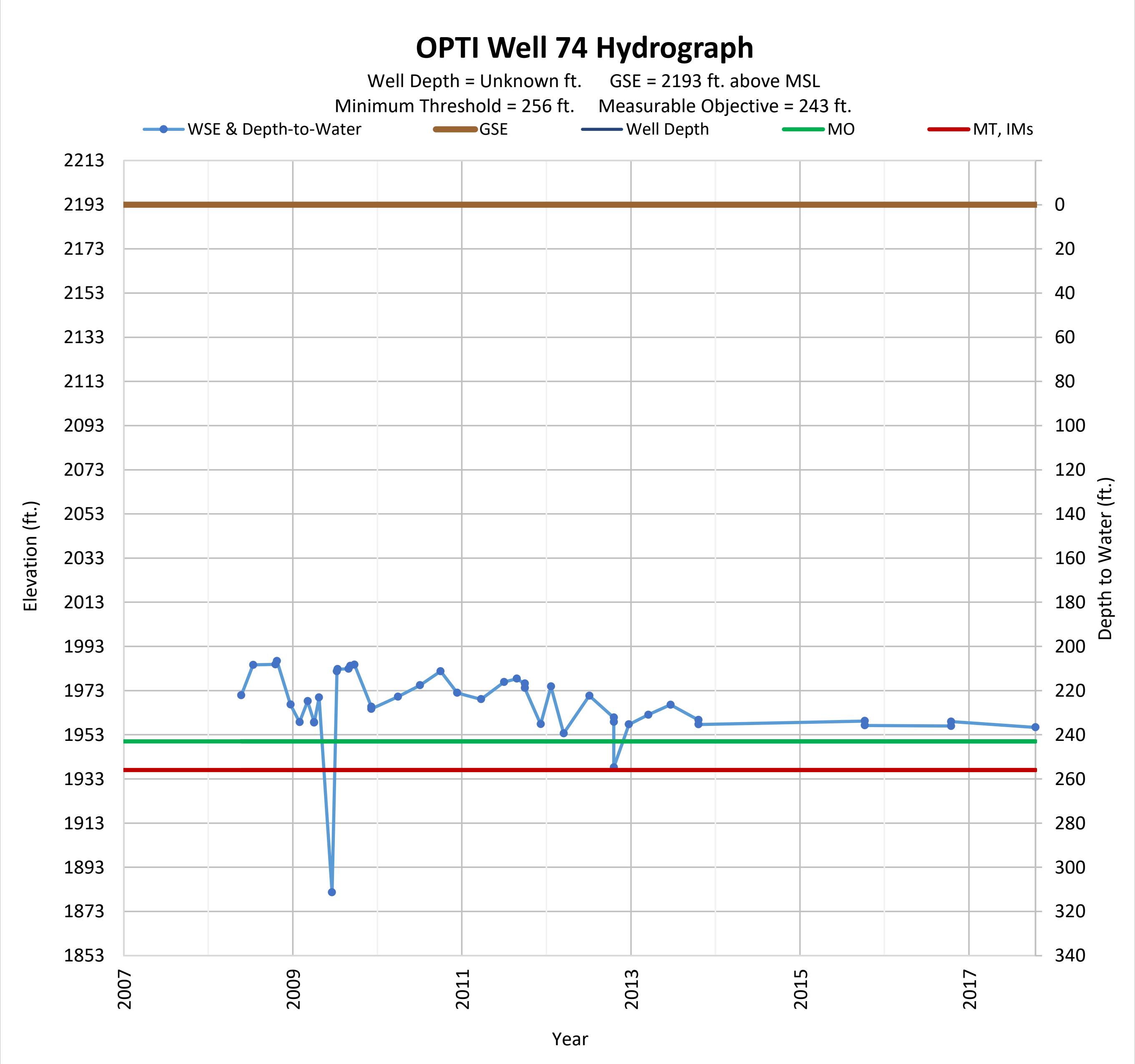
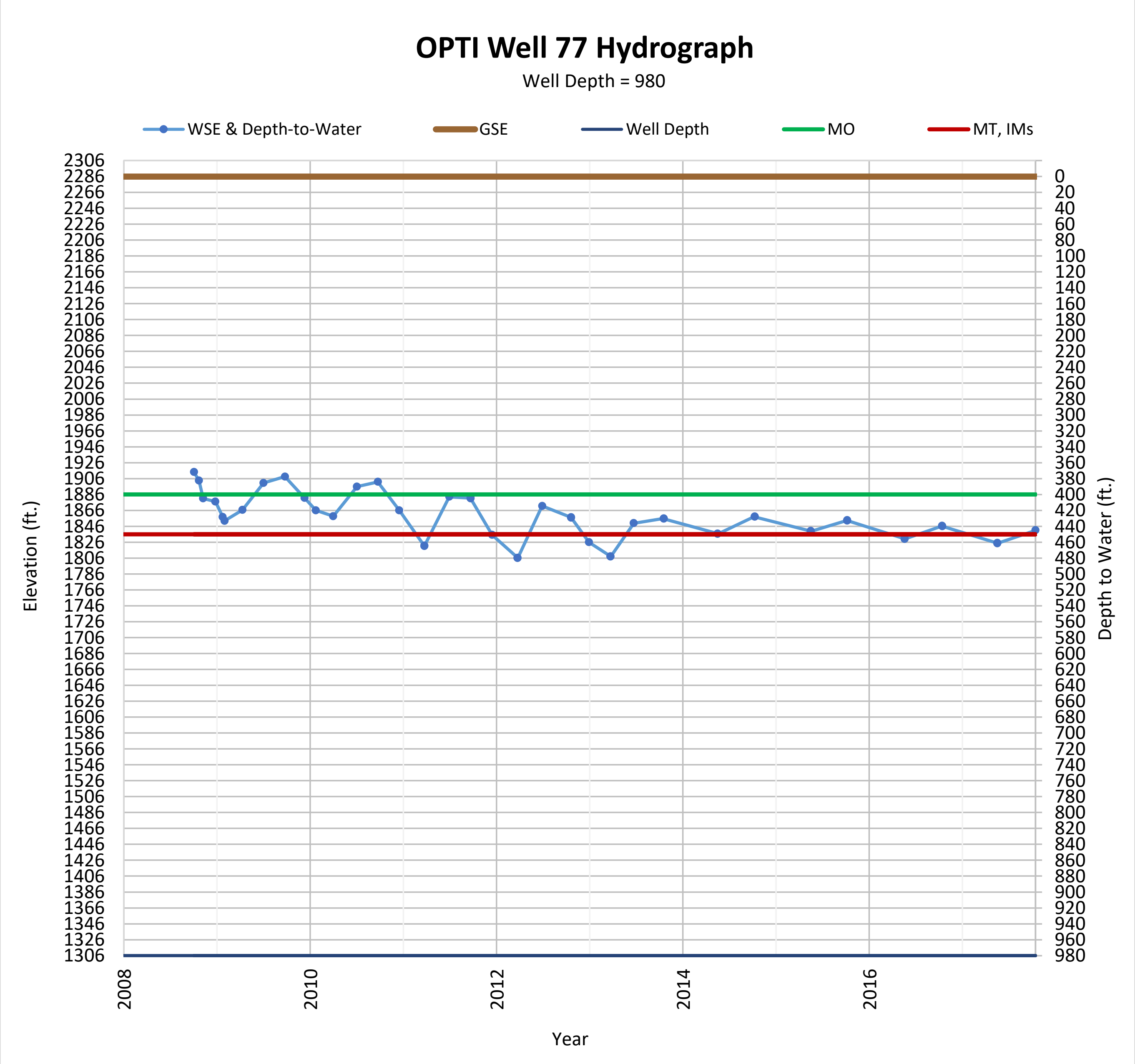

OPTI Well 2 Hydrograph
Well Depth = 73
WSE & Depth-to-Water
GSE
Well Depth
MO
MT, IMs
3740
3720
3700
3680
3660
3640
3620
Elevation (ft.)
0
20
40
60
80
100
Depth to Water (ft.)
2010
2012
2014
2016
Year

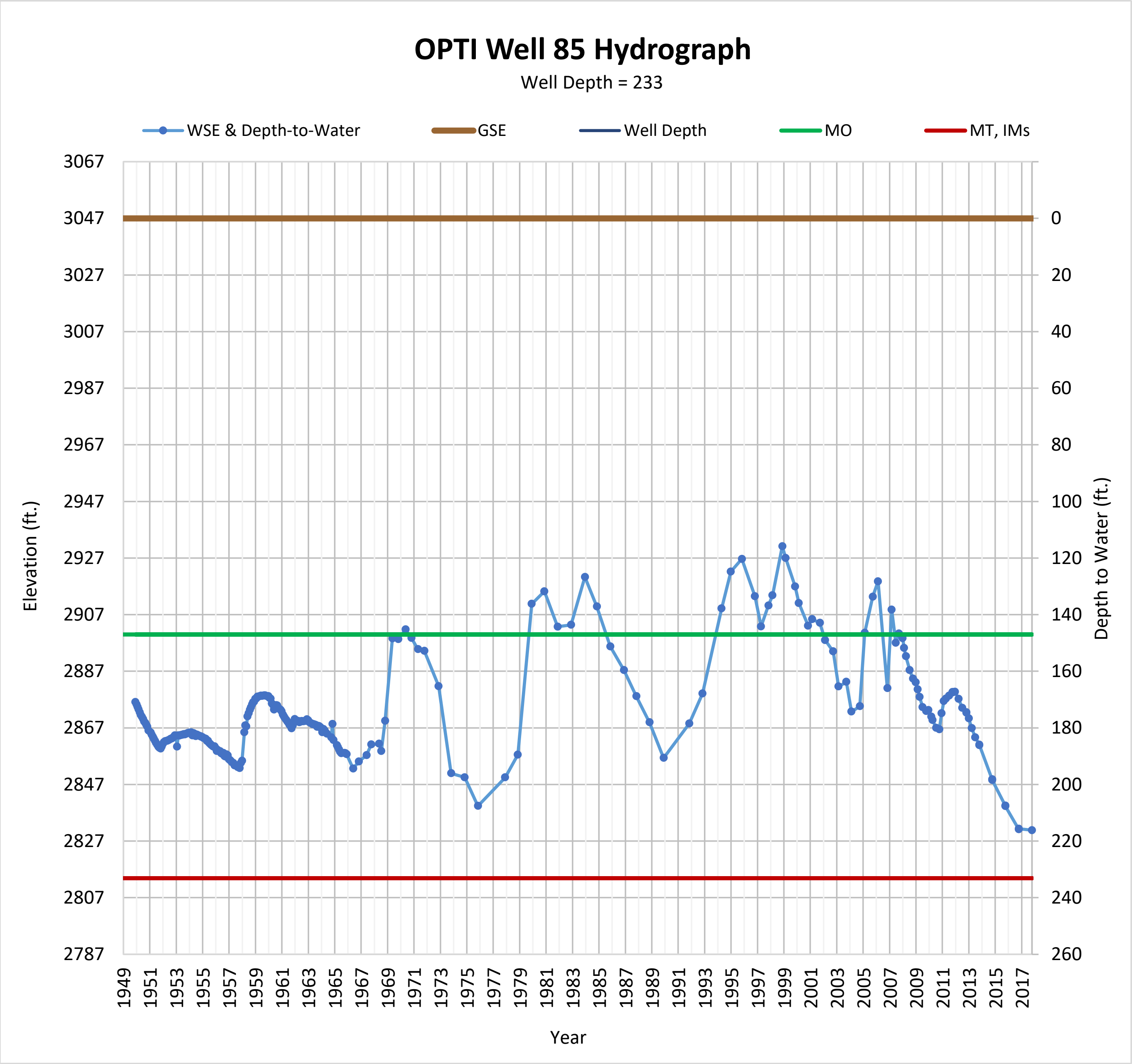

OPTI Well 62 Hydrograph
Well Depth = 212
WSE & Depth-to-Water
GSE
Well Depth
MO
MT, IMs
Elevation (ft.)
2941
2921
2901
2881
2861
2841
2821
2801
2781
2761
2741
2721
2701
Depth to Water (ft.)
0
20
40
60
80
100
120
140
160
180
200
220
Year
1965
1967
1969
1971
1973
1975
1977
1979
1981
1983
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017

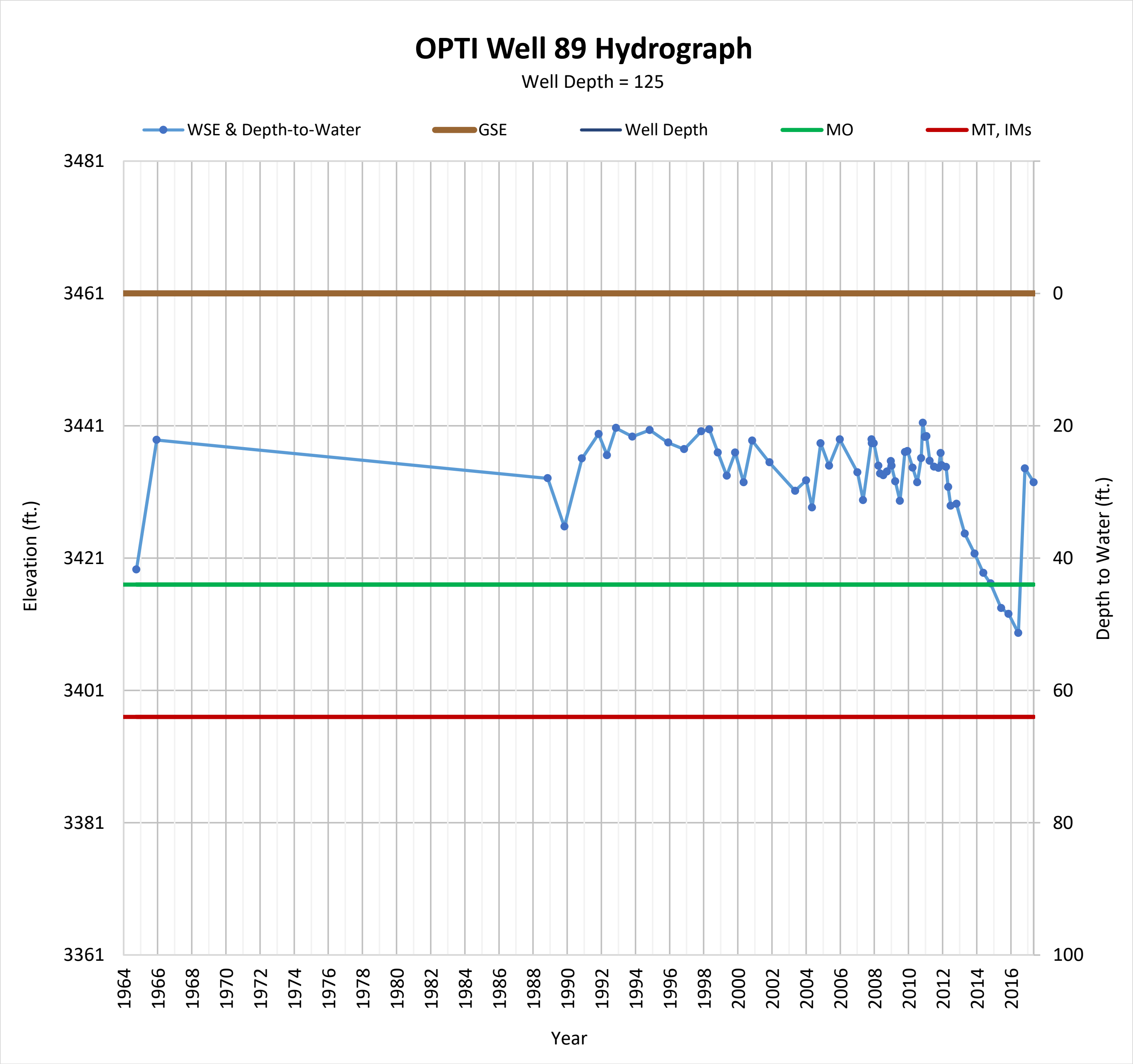

OPTI Well 72 Hydrograph
Well Depth = 790
WSE & Depth-to-Water
GSE
Well Depth
MO
MT, IMs
Elevation (ft.)
2191
2171
2151
2131
2111
2091
2071
2051
2031
2011
1991
1971
1951
1931
1911
1891
1871
1851
1831
1811
Depth to Water (ft.)
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
360
Year
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

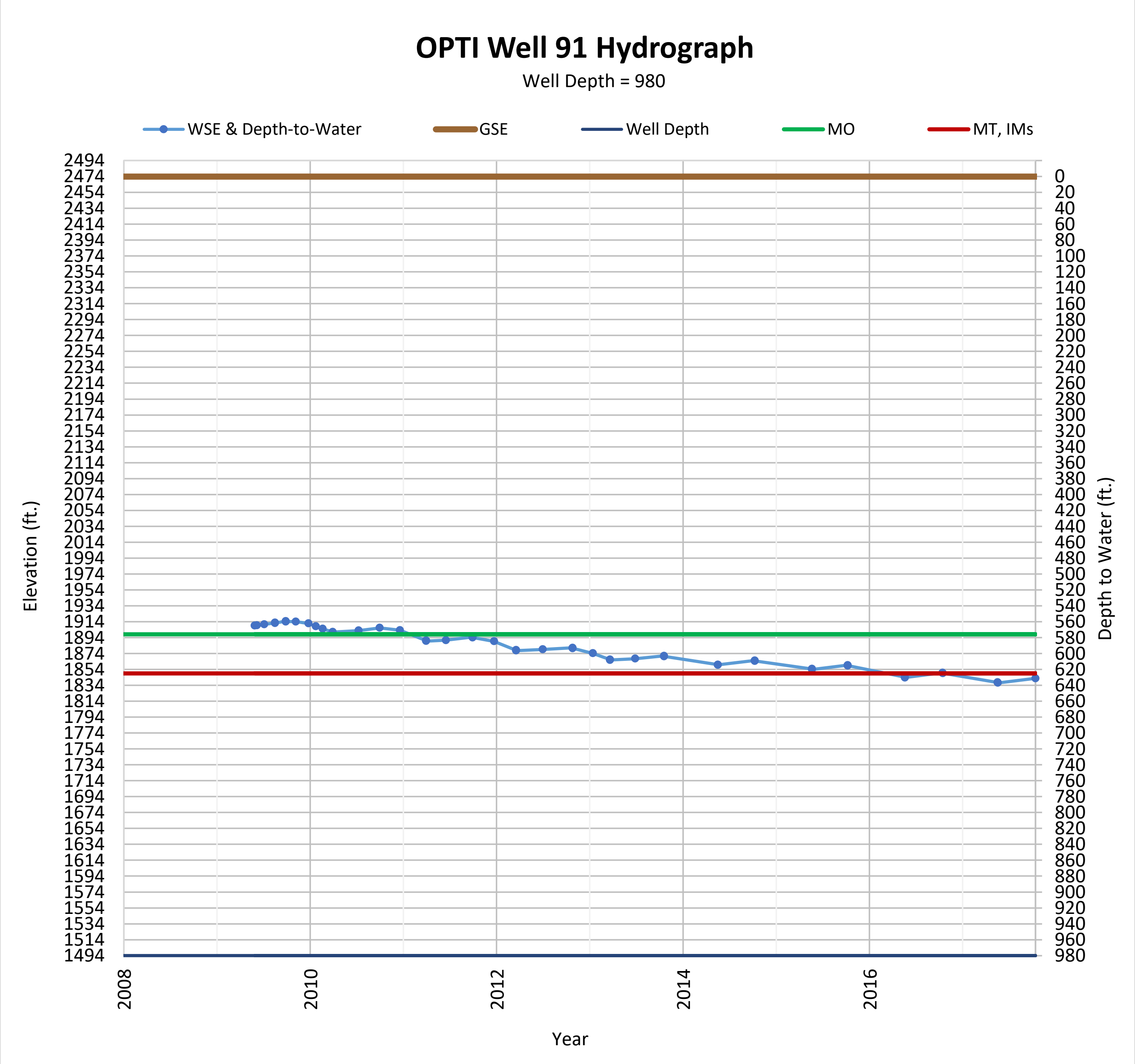


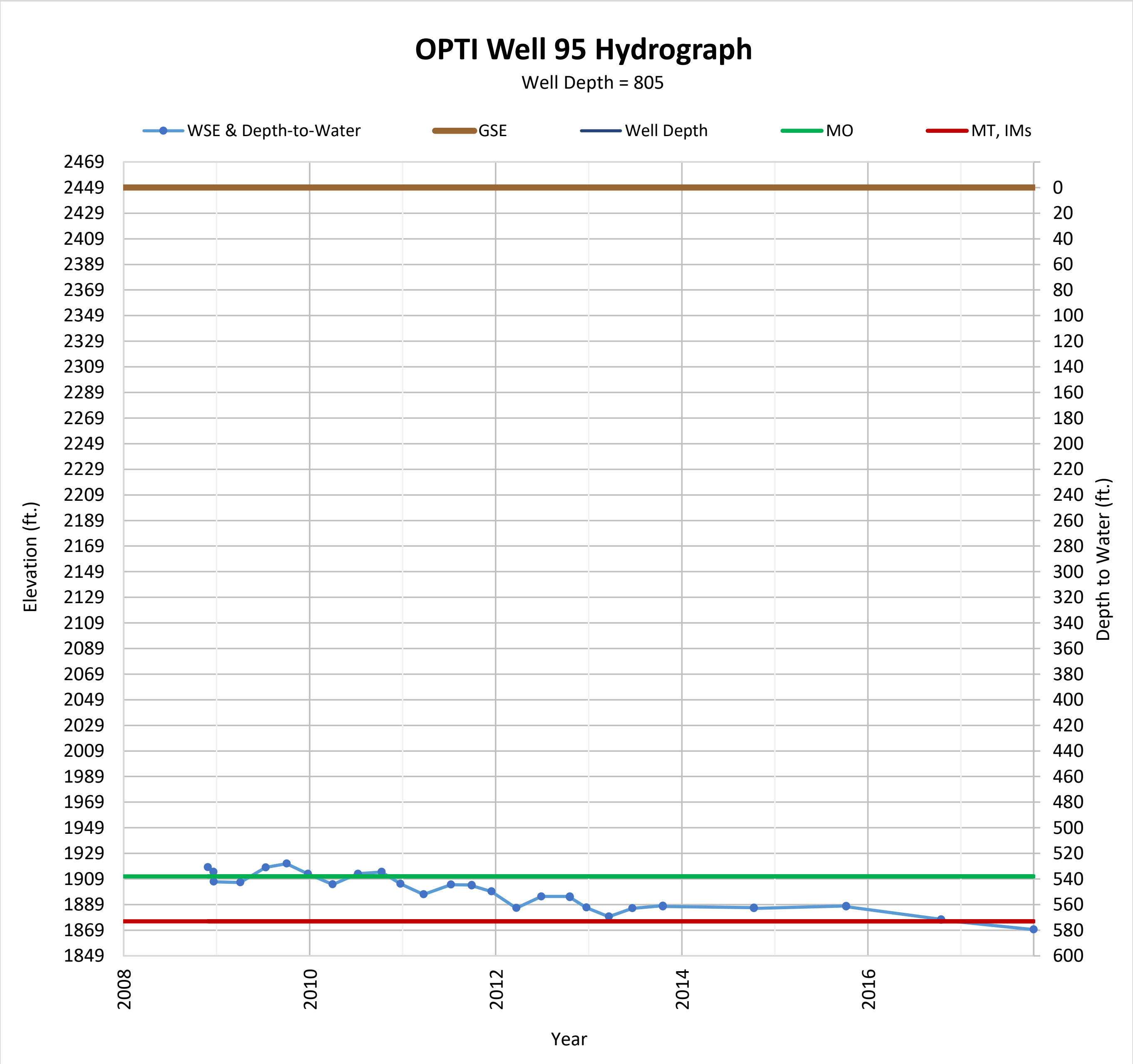
OPTI Well 74 Hydrograph
Well Depth = Unknown ft.
GSE = 2193 ft. above MSL
Minimum Threshold = 256 ft.
Measurable Objective = 243 ft.
WSE & Depth-to-Water
GSE
Well Depth
MO
MT, IMs
Elevation (ft.)
2213
2193
2173
2153
2133
2113
2093
2073
2053
2033
2013
1993
1973
1953
1933
1913
1893
1873
1853
Depth to Water (ft.)
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
2007
2009
2011
2013
2015
2017
Year

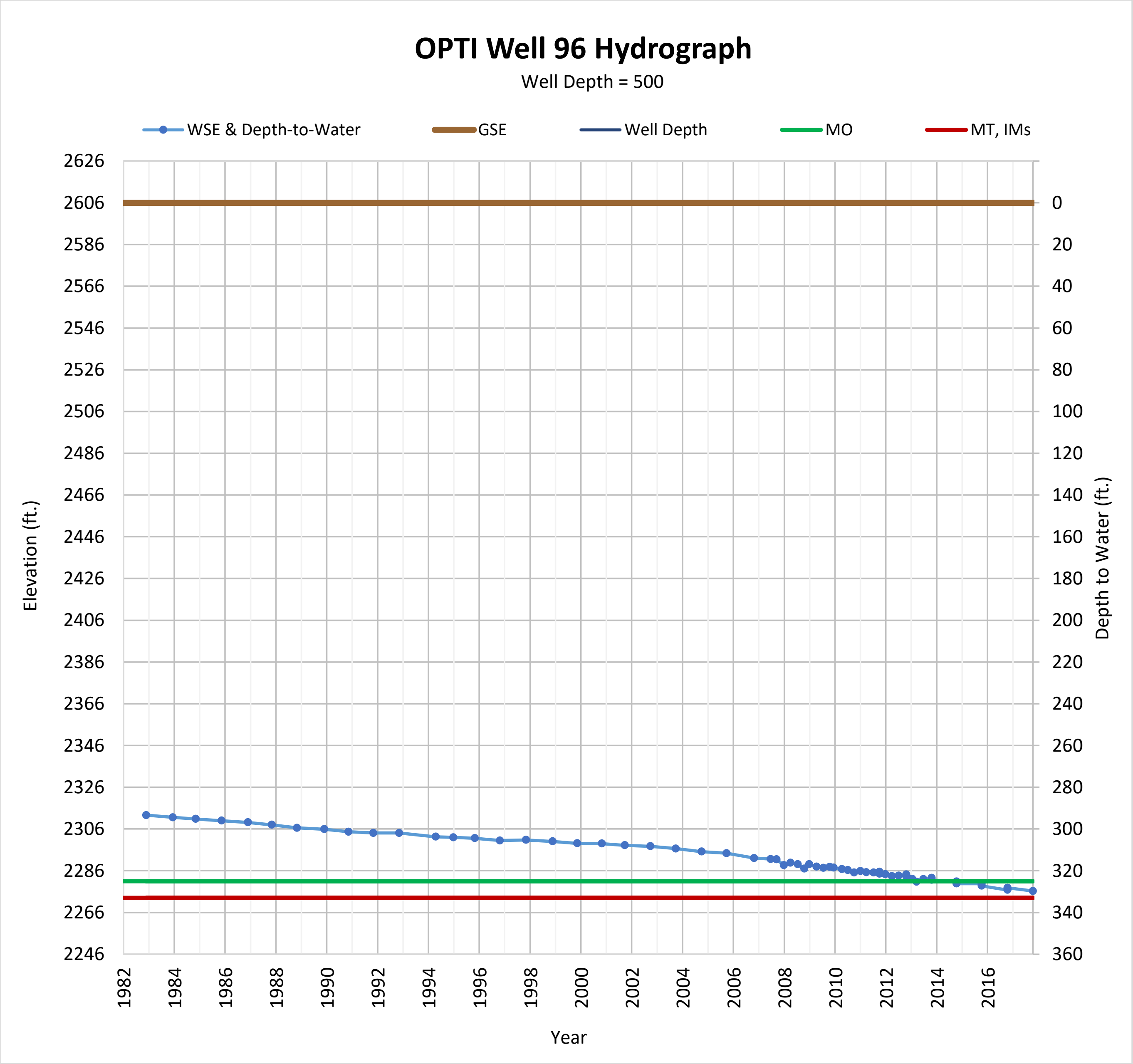

OPTI Well 77 Hydrograph
Well Depth = 980
WSE & Depth-to-Water
GSE
Well Depth
MO
MT, IMs
Elevation (ft.)
Depth to Water (ft.)
Year
2306
2286
2266
2246
2226
2206
2186
2166
2146
2126
2106
2086
2066
2046
2026
2006
1986
1966
1946
1926
1906
1886
1866
1846
1826
1806
1786
1766
1746
1726
1706
1686
1666
1646
1626
1606
1586
1566
1546
1526
1506
1486
1466
1446
1426
1406
1386
1366
1346
1326
1306
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
360
380
400
420
440
460
480
500
520
540
560
580
600
620
640
660
680
700
720
740
760
780
800
820
840
860
880
900
920
940
960
980
2008
2010
2012
2014
2016

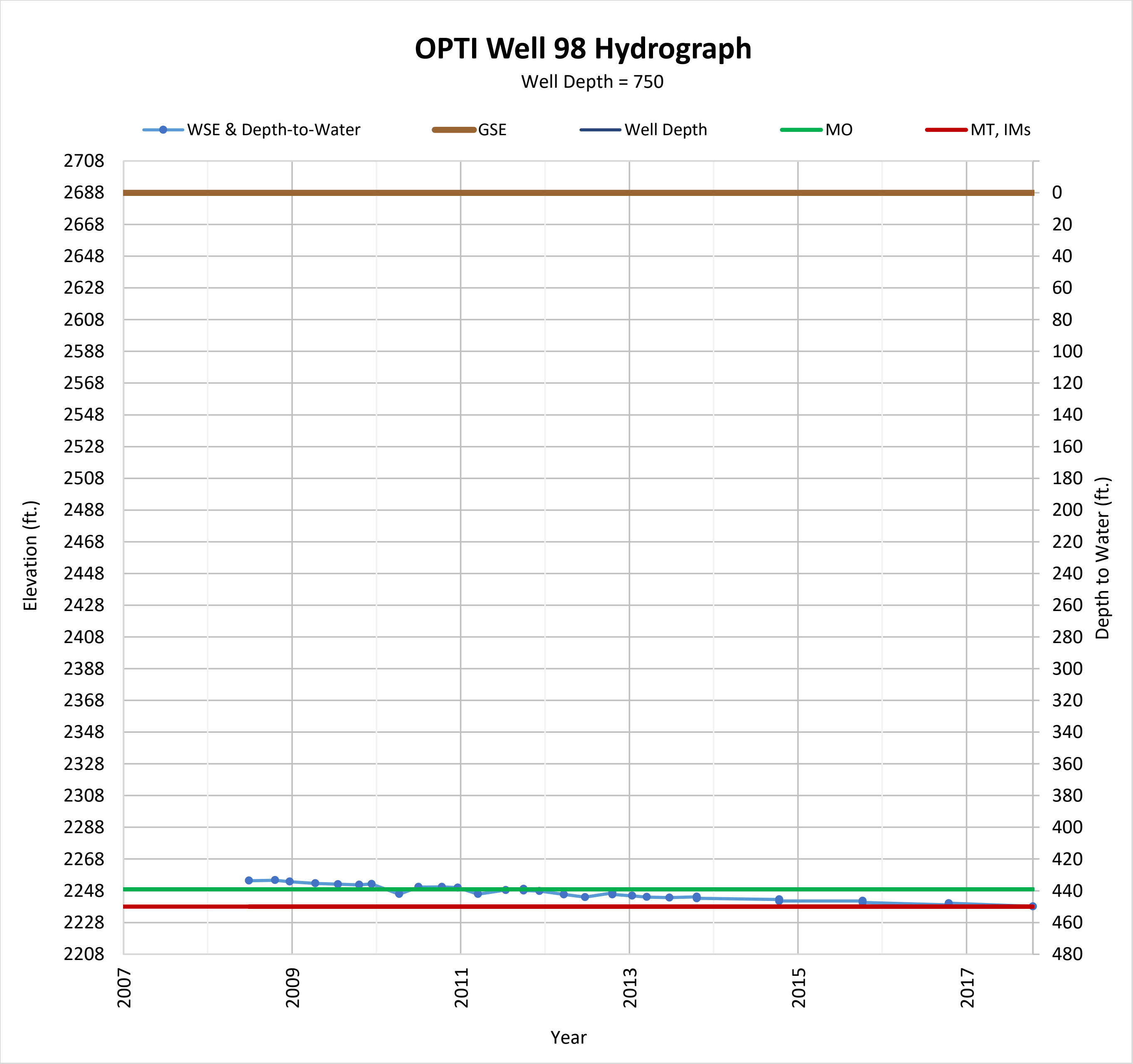

OPTI Well 85 Hydrograph
Well Depth = 233
WSE & Depth-to-Water
GSE
Well Depth
MO
MT, IMs
Elevation (ft.)
3067
3047
3027
3007
2987
2967
2947
2927
2907
2887
2867
2847
2827
2807
2787
Depth to Water (ft.)
0
20
40
60
80
100
120
140
160
180
200
220
240
260
Year
1949
1951
1953
1955
1957
1959
1961
1963
1965
1967
1969
1971
1973
1975
1977
1979
1981
1983
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017

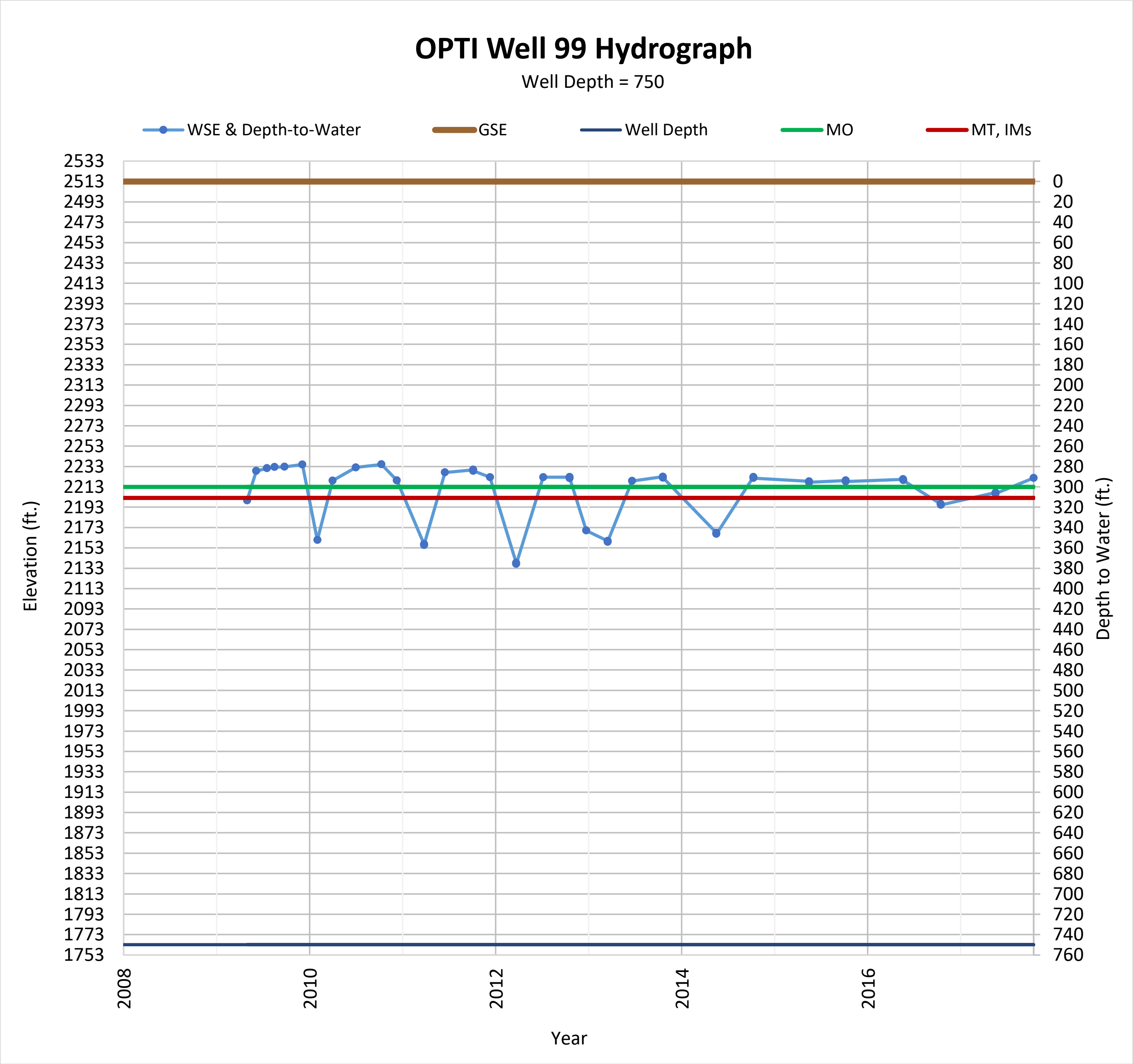

OPTI Well 89 Hydrograph
Well Depth = 125
WSE & Depth-to-Water
GSE
Well Depth
MO
MT, IMs
Elevation (ft.)
3481
3461
3441
3421
3401
3381
3361
Depth to Water (ft.)
0
20
40
60
80
100
Year
1964
1966
1968
1970
1972
1974
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

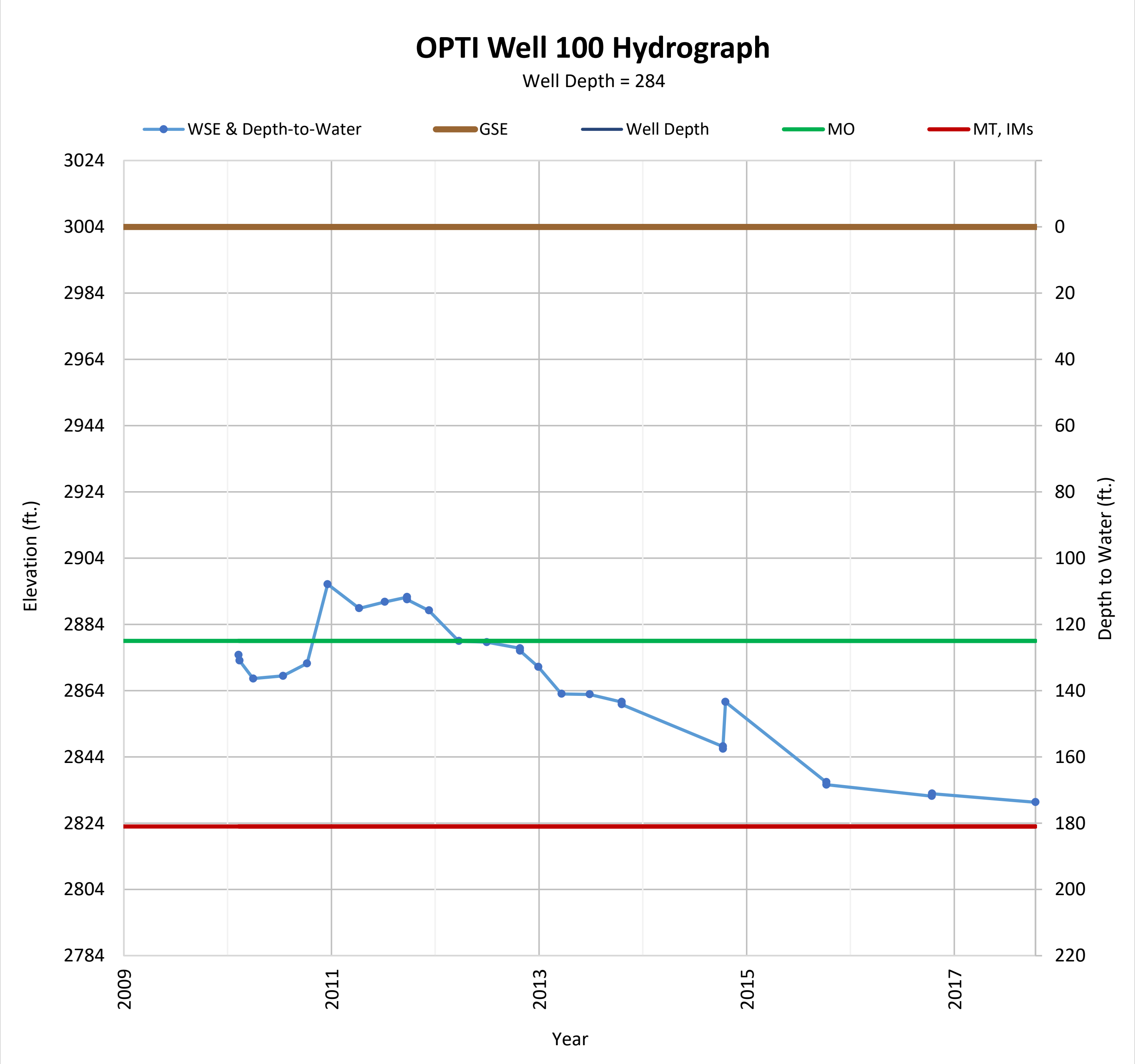
OPTI Well 91 Hydrograph
Well Depth = 980
WSE & Depth-to-Water
GSE
Well Depth
MO
MT, IMs
Elevation (ft.)
Depth to Water (ft.)
2494
2474
2454
2434
2414
2394
2374
2354
2334
2314
2294
2274
2254
2234
2214
2194
2174
2154
2134
2114
2094
2074
2054
2034
2014
1994
1974
1954
1934
1914
1894
1874
1854
1834
1814
1794
1774
1754
1734
1714
1694
1674
1654
1634
1614
1594
1574
1554
1534
1514
1494
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
360
380
400
420
440
460
480
500
520
540
560
580
600
620
640
660
680
700
720
740
760
780
800
820
840
860
880
900
920
940
960
980
2008
2010
2012
2014
2016
Year

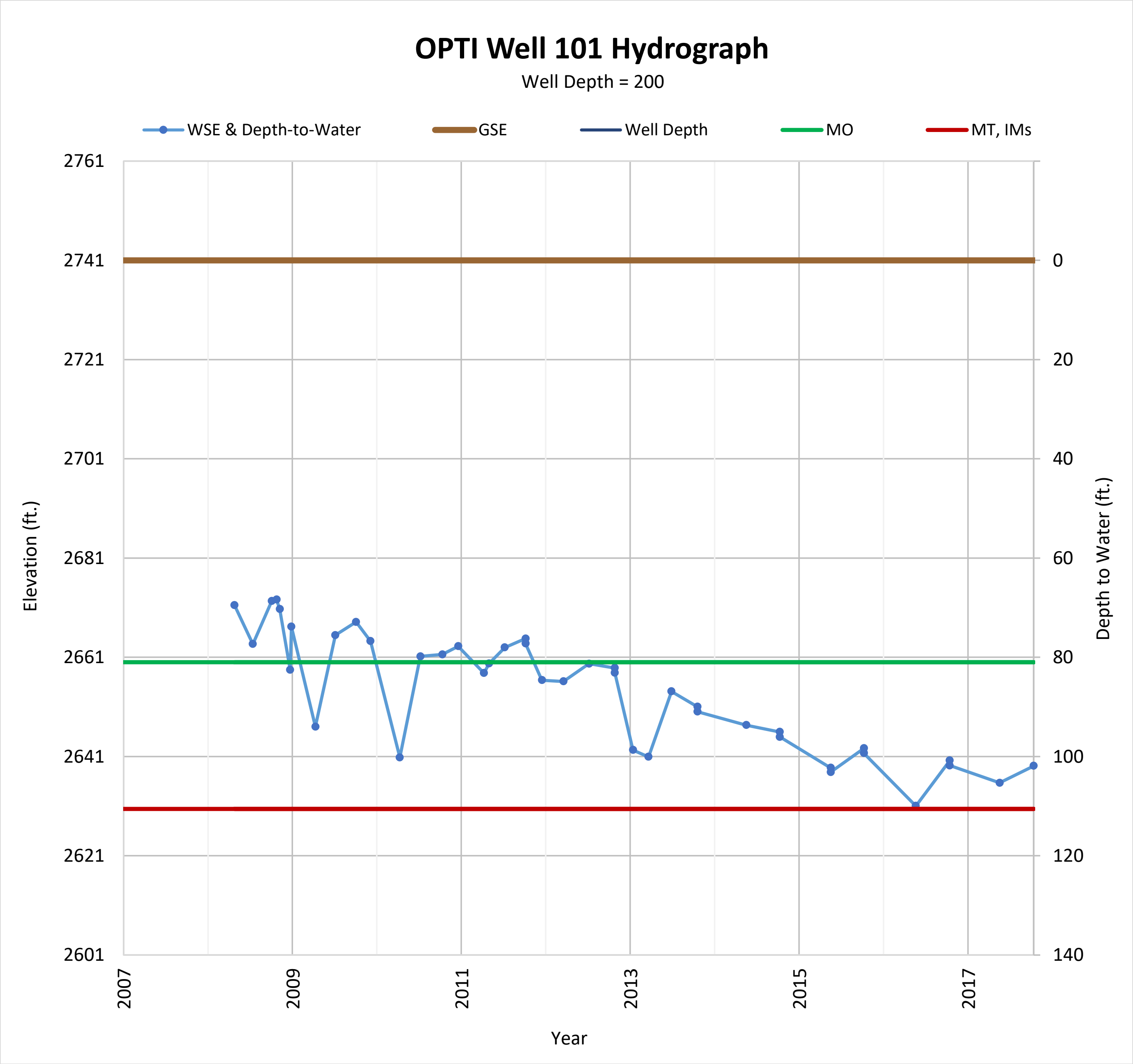

OPTI Well 95 Hydrograph
Well Depth = 805
WSE & Depth-to-Water
GSE
Well Depth
MO
MT, IMs
Elevation (ft.)
2469
2449
2429
2409
2389
2369
2349
2329
2309
2289
2269
2249
2229
2209
2189
2169
2149
2129
2109
2089
2069
2049
2029
2009
1989
1969
1949
1929
1909
1889
1869
1849
Depth to Water (ft.)
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
360
380
400
420
440
460
480
500
520
540
560
580
600
2008
2010
2012
2014
2016
Year


OPTI Well 96 Hydrograph
Well Depth = 500
WSE & Depth-to-Water
GSE
Well Depth
MO
MT, IMs
Elevation (ft.)
2626
2606
2586
2566
2546
2526
2506
2486
2466
2446
2426
2406
2386
2366
2346
2326
2306
2286
2266
2246
Depth to Water (ft.)
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
360
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
Year

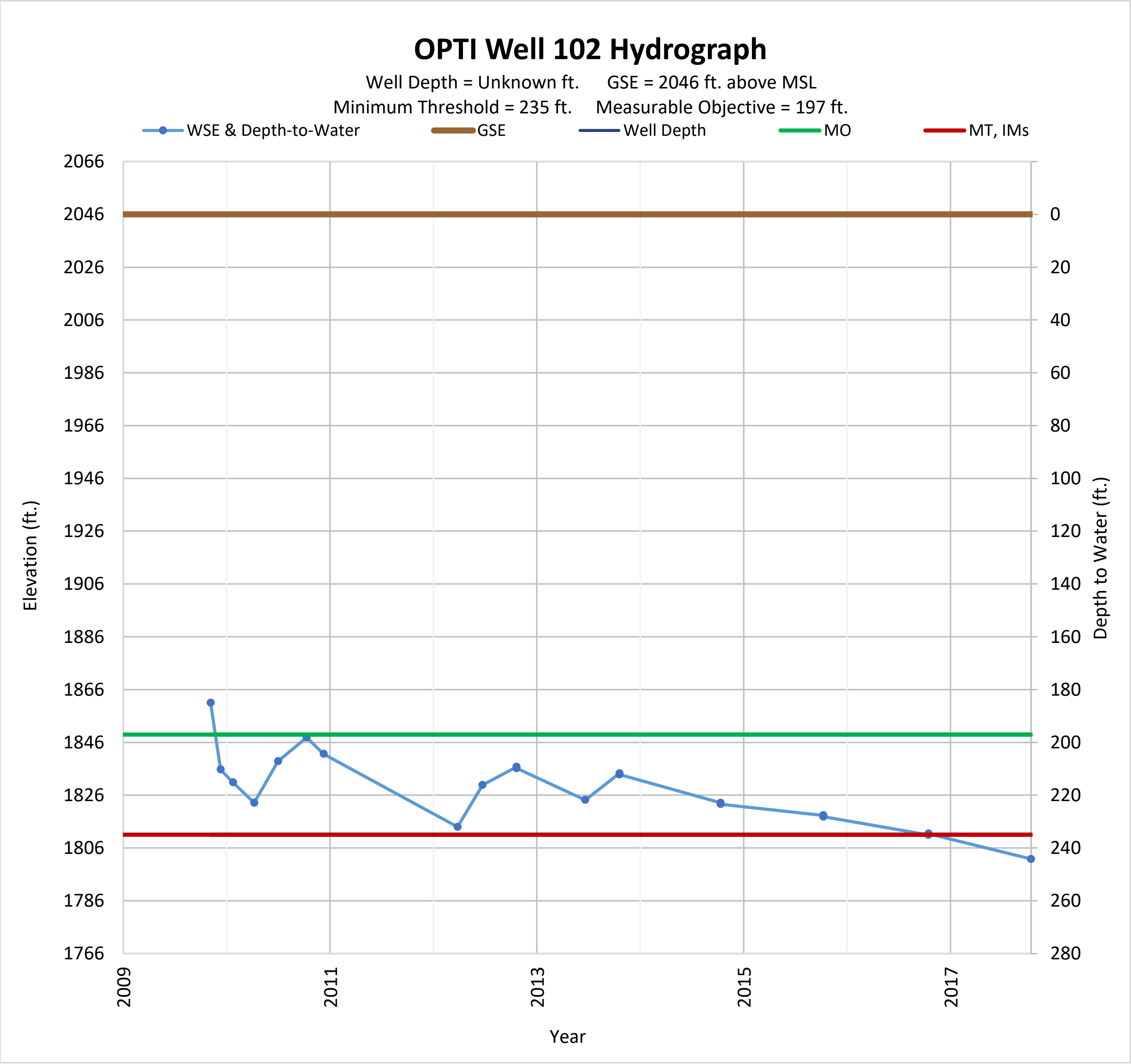

OPTI Well 98 Hydrograph
Well Depth = 750
WSE & Depth-to-Water
GSE
Well Depth
MO
MT, IMs
Elevation (ft.)
2708
2688
2668
2648
2628
2608
2588
2568
2548
2528
2508
2488
2468
2448
2428
2408
2388
2368
2348
2328
2308
2288
2268
2248
2228
2208
Depth to Water (ft.)
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
360
380
400
420
440
460
480
2007
2009
2011
2013
2015
2017
Year

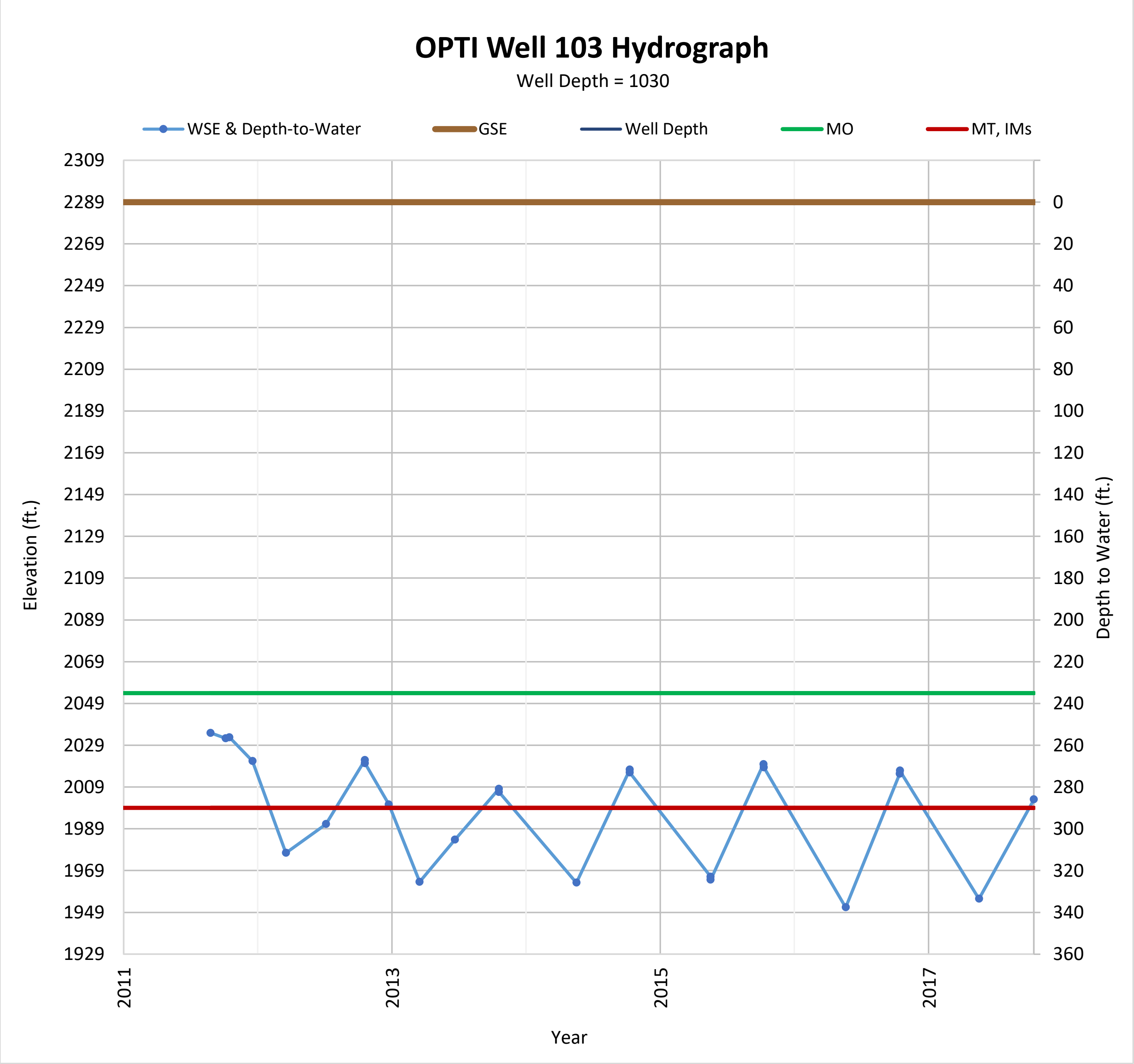

OPTI Well 99 Hydrograph
Well Depth = 750
WSE & Depth-to-Water
GSE
Well Depth
MO
MT, IMs
Elevation (ft.)
2533
2513
2493
2473
2453
2433
2413
2393
2373
2353
2333
2313
2293
2273
2253
2233
2213
2193
2173
2153
2133
2113
2093
2073
2053
2033
2013
1993
1973
1953
1933
1913
1893
1873
1853
1833
1813
1793
1773
1753
Depth to Water (ft.)
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
360
380
400
420
440
460
480
500
520
540
560
580
600
620
640
660
680
700
720
740
760
2008
2010
2012
2014
2016
Year

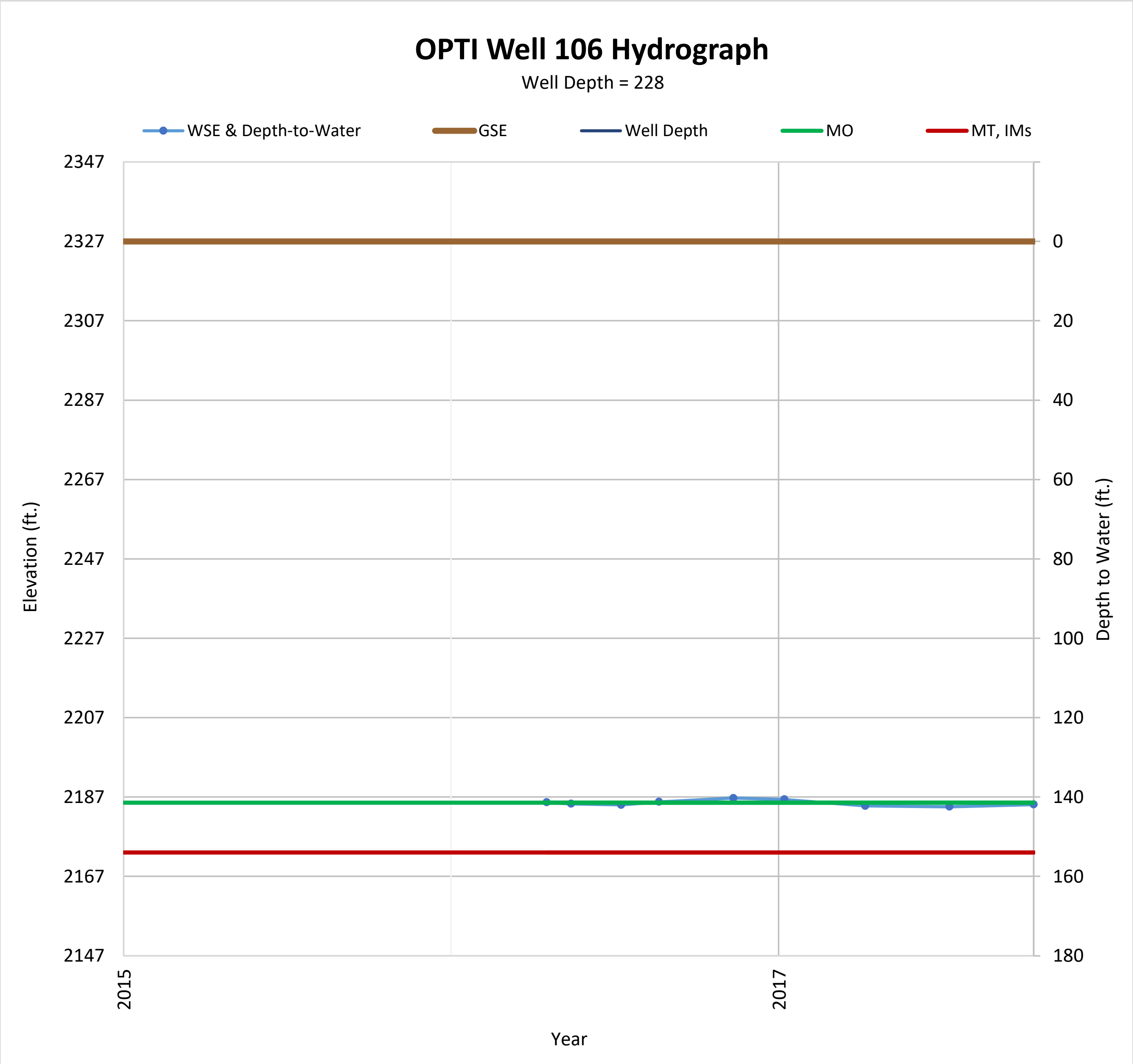

OPTI Well 100 Hydrograph
Well Depth = 284
WSE & Depth-to-Water
GSE
Well Depth
MO
MT, IMs
Elevation (ft.)
3024
3004
2984
2964
2944
2924
2904
2884
2864
2844
2824
2804
2784
Depth to Water (ft.)
0
20
40
60
80
100
120
140
160
180
200
220
2009
2011
2013
2015
2017
Year



OPTI Well 101 Hydrograph
Well Depth = 200
WSE & Depth-to-Water
GSE
Well Depth
MO
MT, IMs
Elevation (ft.)
2761
2741
2721
2701
2681
2661
2641
2621
2601
Depth to Water (ft.)
0
20
40
60
80
100
120
140
Year
2007
2009
2011
2013
2015
2017


OPTI Well 102 Hydrograph
Well Depth = Unknown ft.
GSE = 2046 ft. above MSL
Minimum Threshold = 235 ft.
Measurable Objective = 197 ft.
WSE & Depth-to-Water
GSE
Well Depth
MO
MT, IMs
Elevation (ft.)
2066
2046
2026
2006
1986
1966
1946
1926
1906
1886
1866
1846
1826
1806
1786
1766
Depth to Water (ft.)
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
2009
2011
2013
2015
2017
Year


OPTI Well 103 Hydrograph
Well Depth = 1030
WSE & Depth-to-Water
GSE
Well Depth
MO
MT, IMs
Elevation (ft.)
2309
2289
2269
2249
2229
2209
2189
2169
2149
2129
2109
2089
2069
2049
2029
2009
1989
1969
1949
1929
Depth to Water (ft.)
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
360
2011
2013
2015
2017
Year

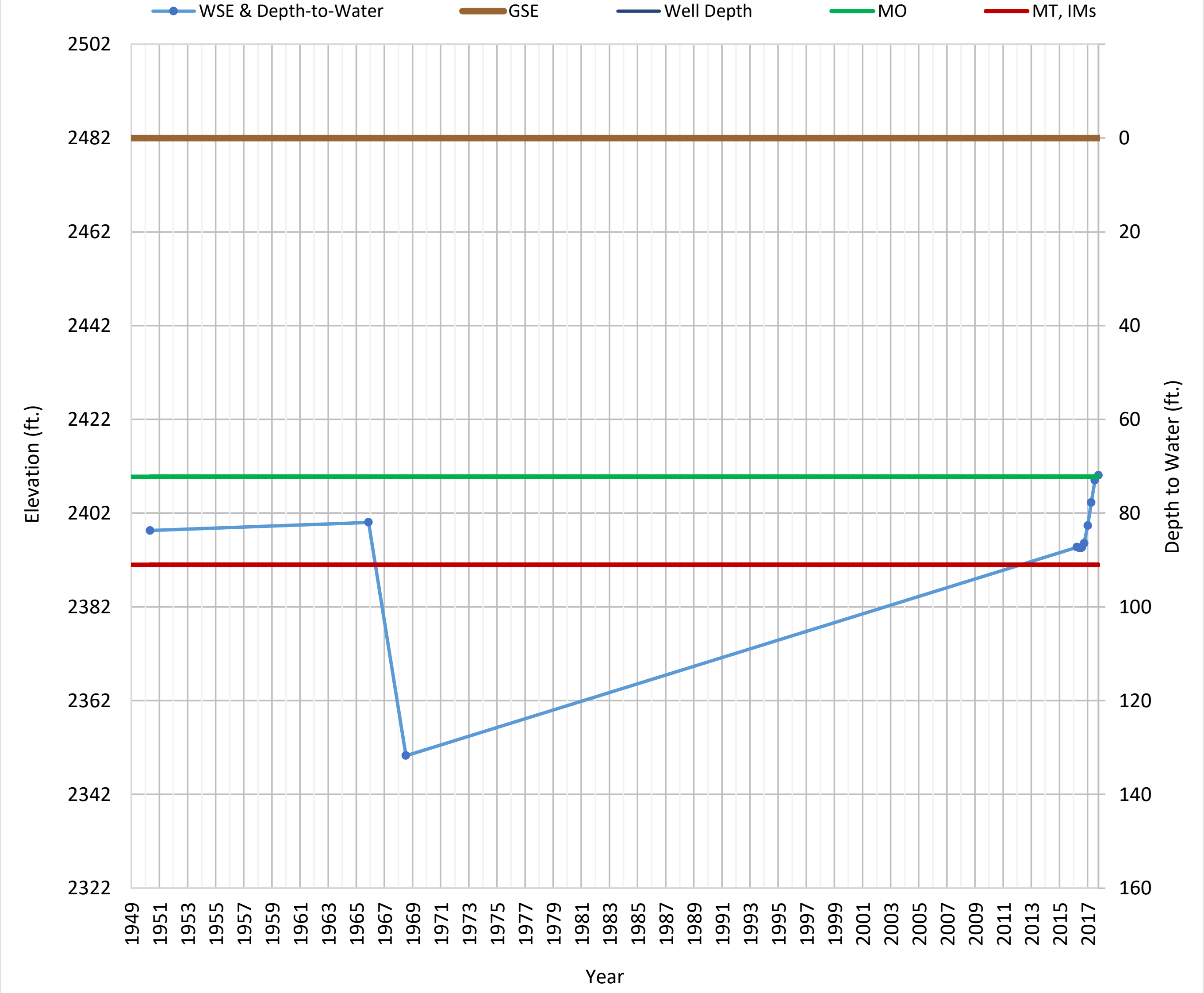


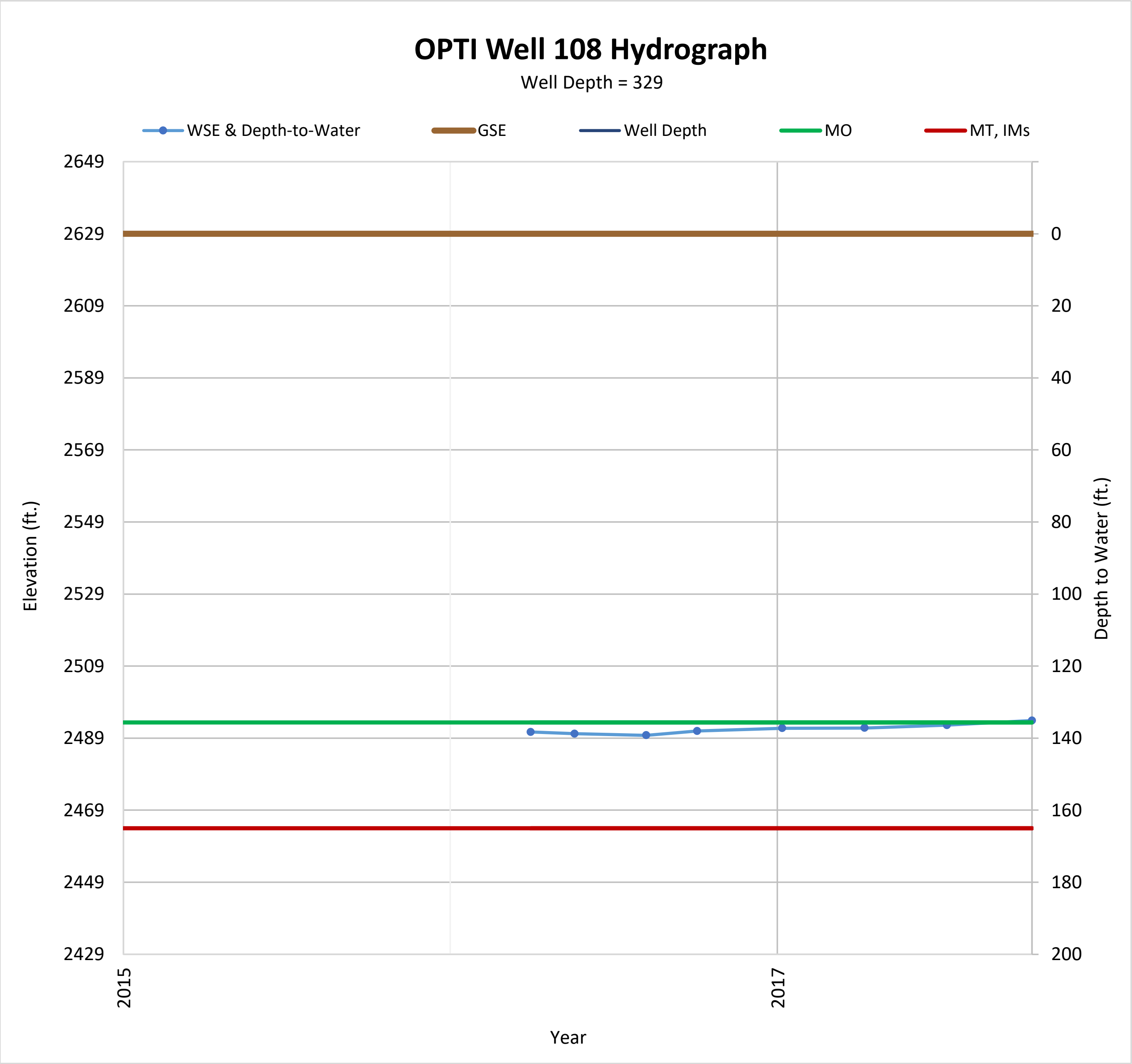
OPTI Well 106 Hydrograph

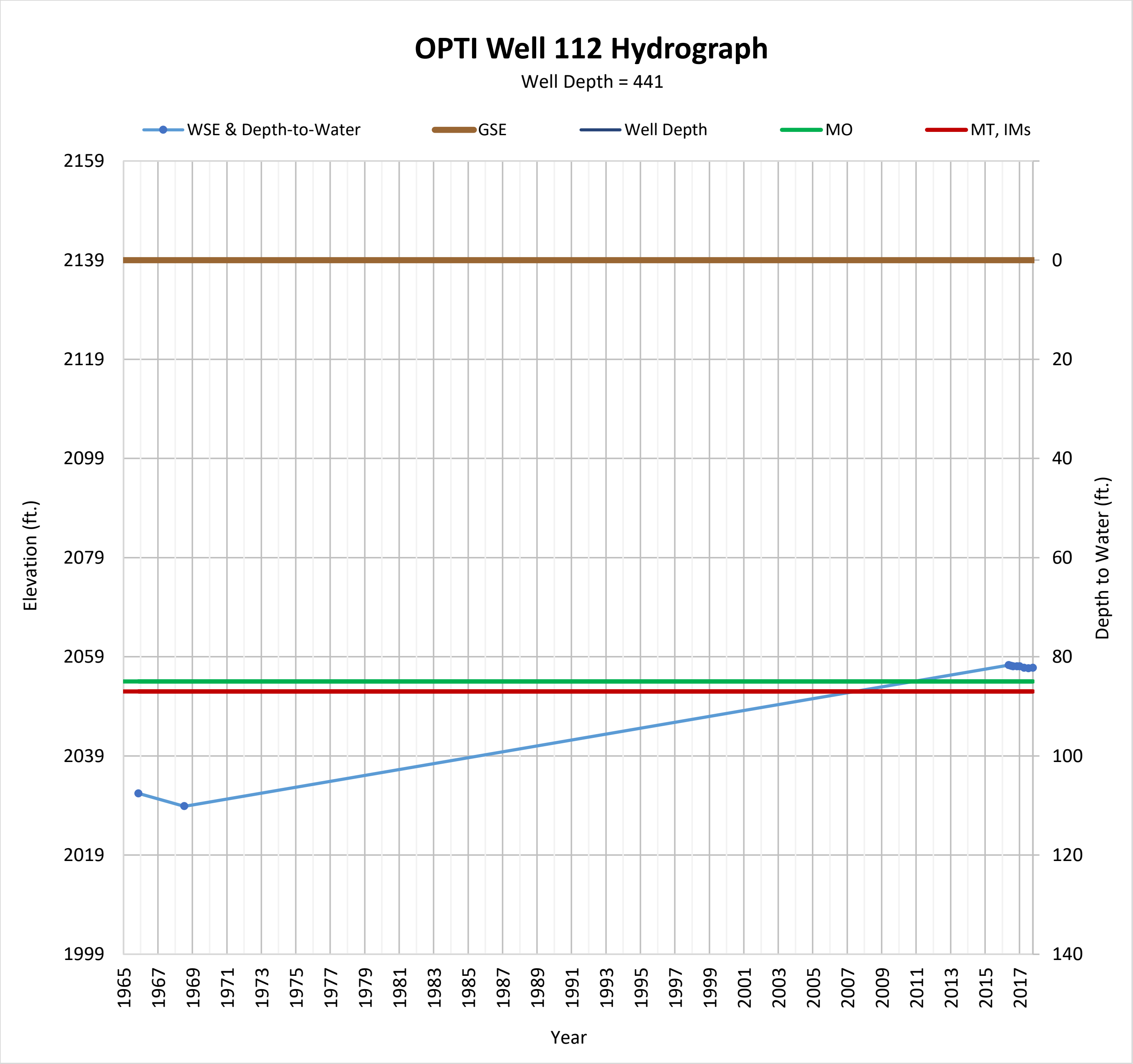
Well Depth = 228

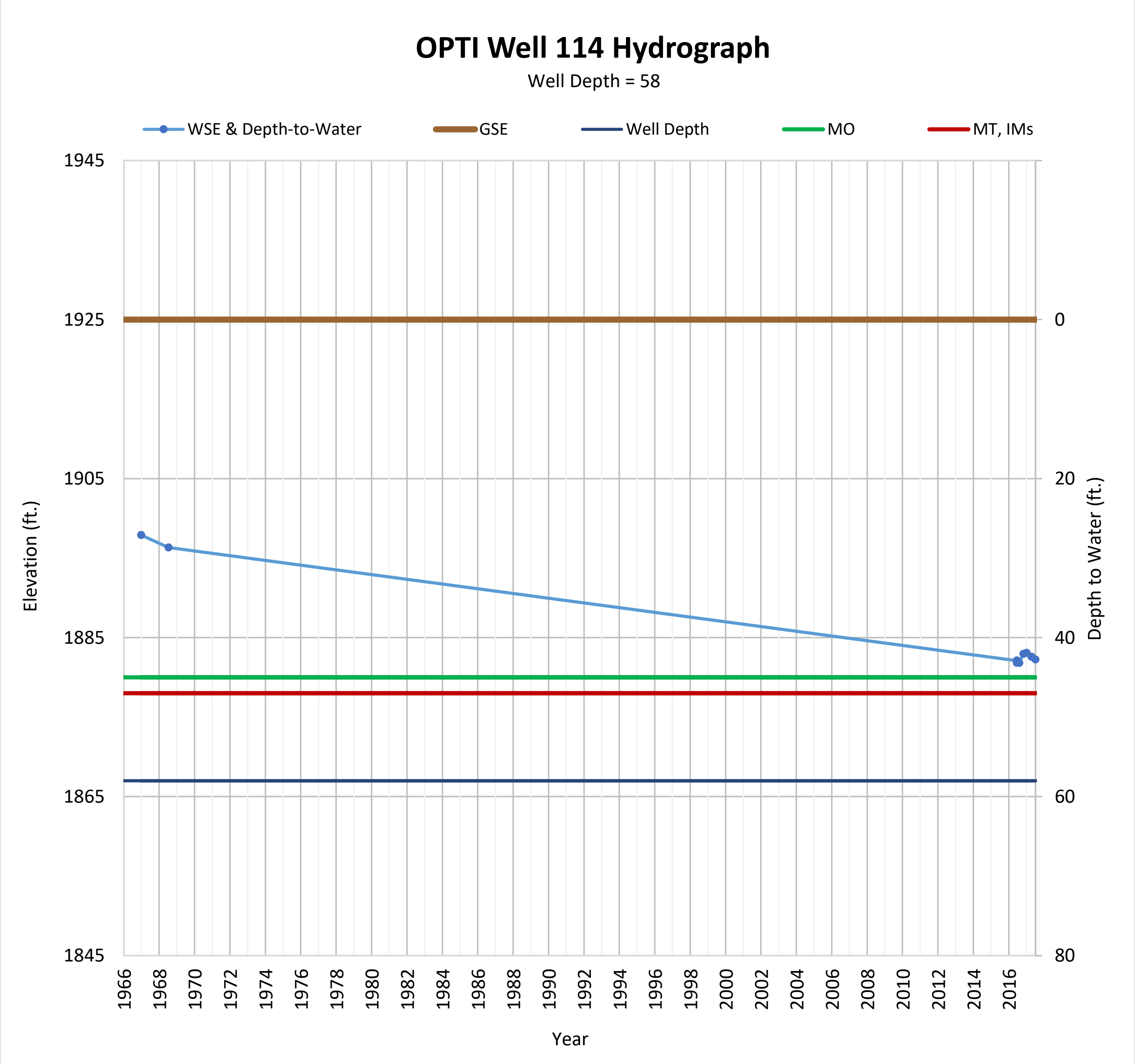
## OPTI Well 107 Hydrograph

Well Depth = 200

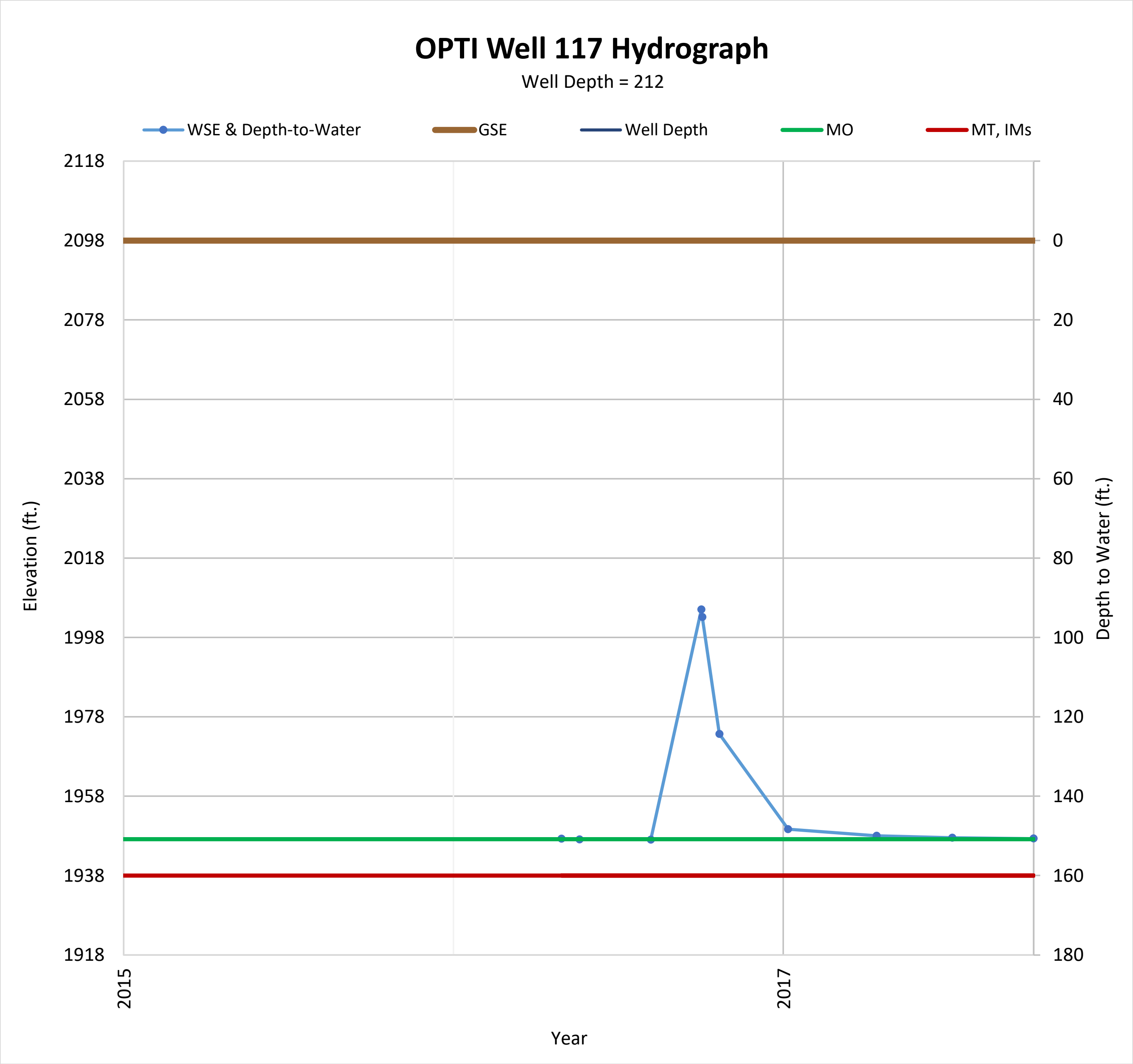


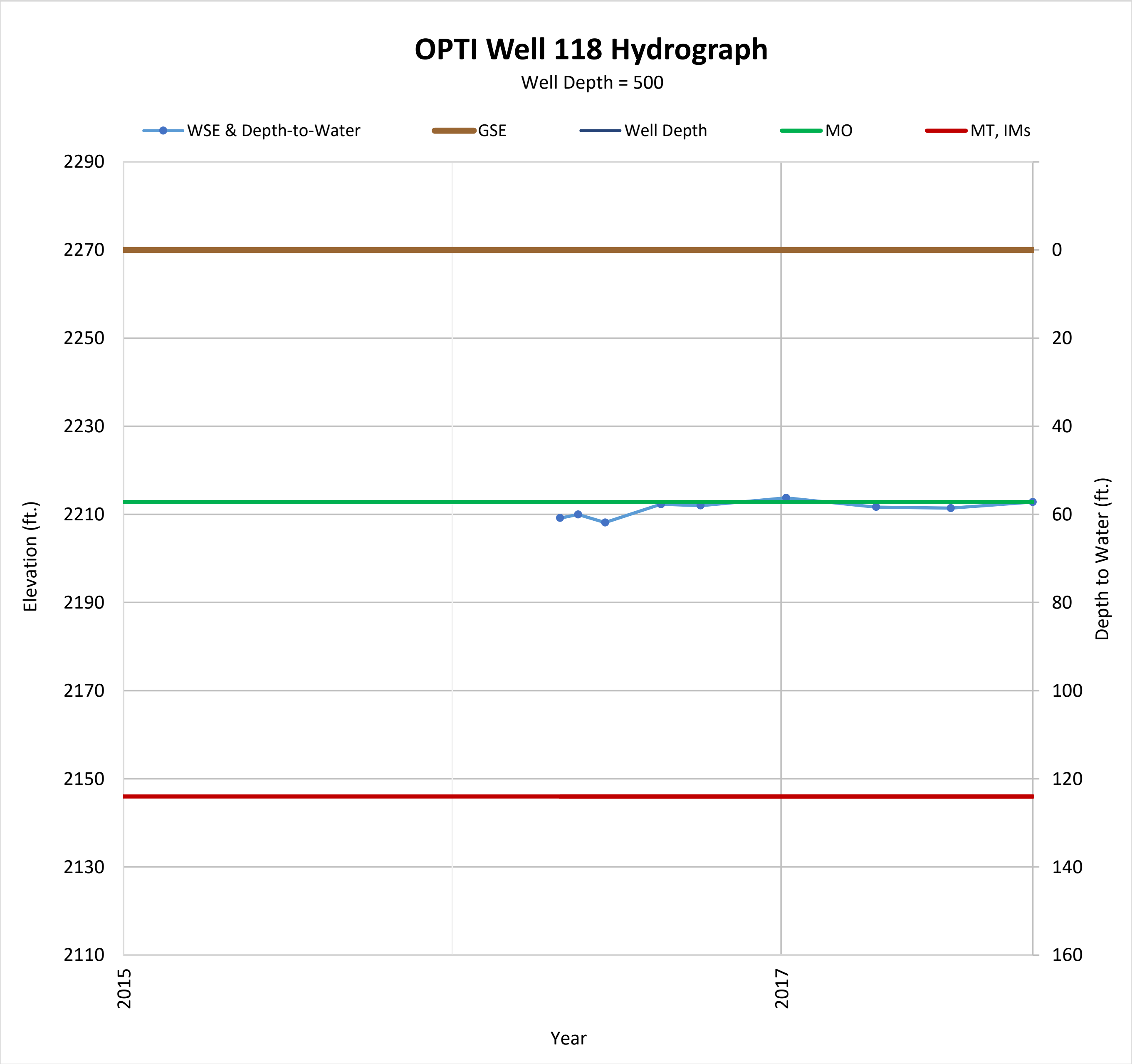

OPTI Well 108 Hydrograph
Well Depth = 329
WSE & Depth-to-Water
GSE
Well Depth
MO
MT, IMs
Elevation (ft.)
2649
2629
2609
2589
2569
2549
2529
2509
2489
2469
2449
2429
Depth to Water (ft.)
0
20
40
60
80
100
120
140
160
180
200
2015
2017
Year


OPTI Well 112 Hydrograph
Well Depth = 441
WSE & Depth-to-Water
GSE
Well Depth
MO
MT, IMs
Elevation (ft.)
2159
2139
2119
2099
2079
2059
2039
2019
1999
Depth to Water (ft.)
0
20
40
60
80
100
120
140
1965
1967
1969
1971
1973
1975
1977
1979
1981
1983
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017
Year



OPTI Well 114 Hydrograph
Well Depth = 58
WSE & Depth-to-Water
GSE
Well Depth
MO
MT, IMs
Elevation (ft.)
1945
1925
1905
1885
1865
1845
Depth to Water (ft.)
0
20
40
60
80
Year
1966
1968
1970
1972
1974
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016


OPTI Well 117 Hydrograph
Well Depth = 212
WSE & Depth-to-Water
GSE
Well Depth
MO
MT, IMs
2118
2098
2078
2058
2038
2018
1998
1978
1958
1938
1918
Elevation (ft.)
0
20
40
60
80
100
120
140
160
180
Depth to Water (ft.)
2015
2017
Year

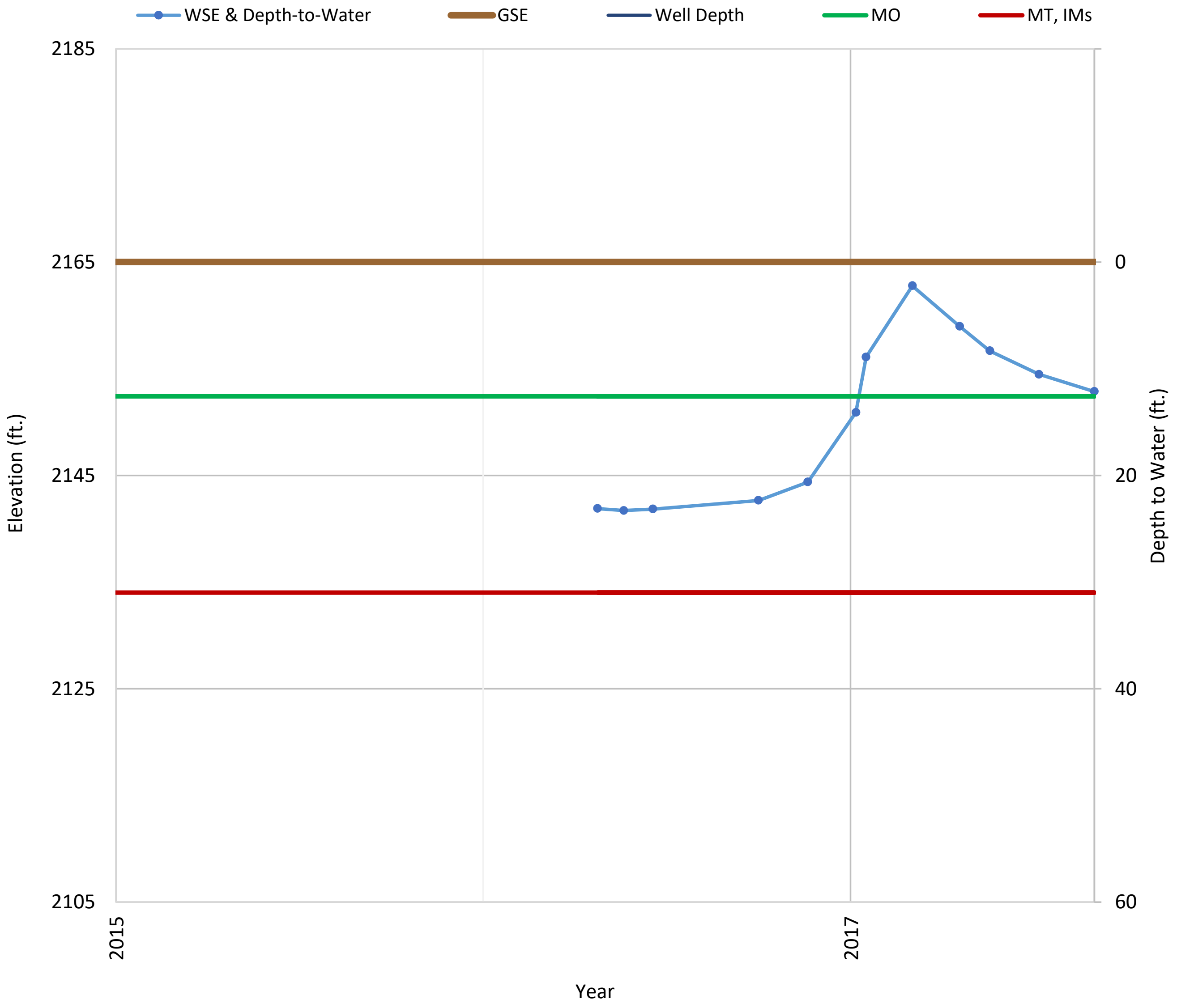


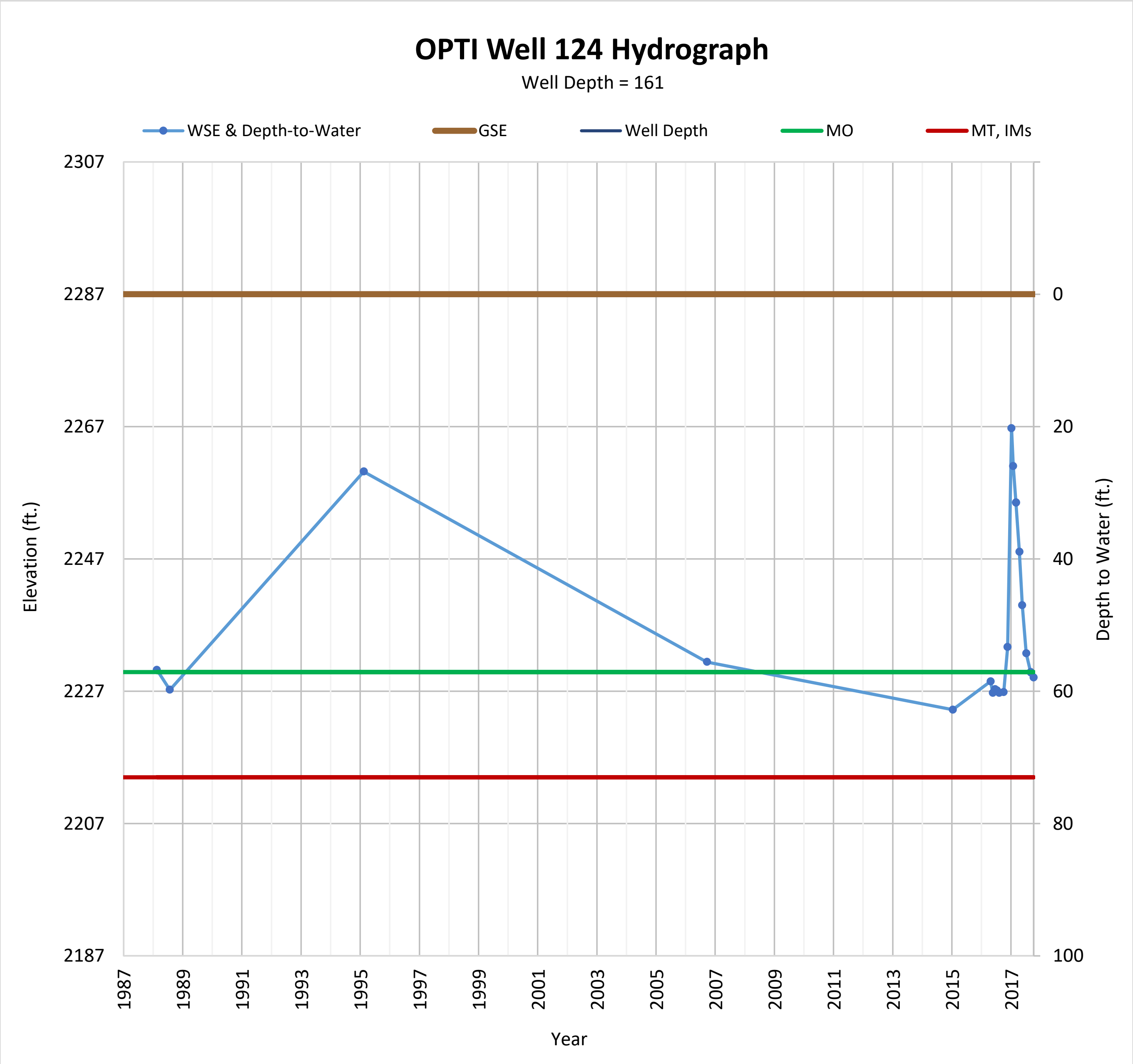
OPTI Well 118 Hydrograph

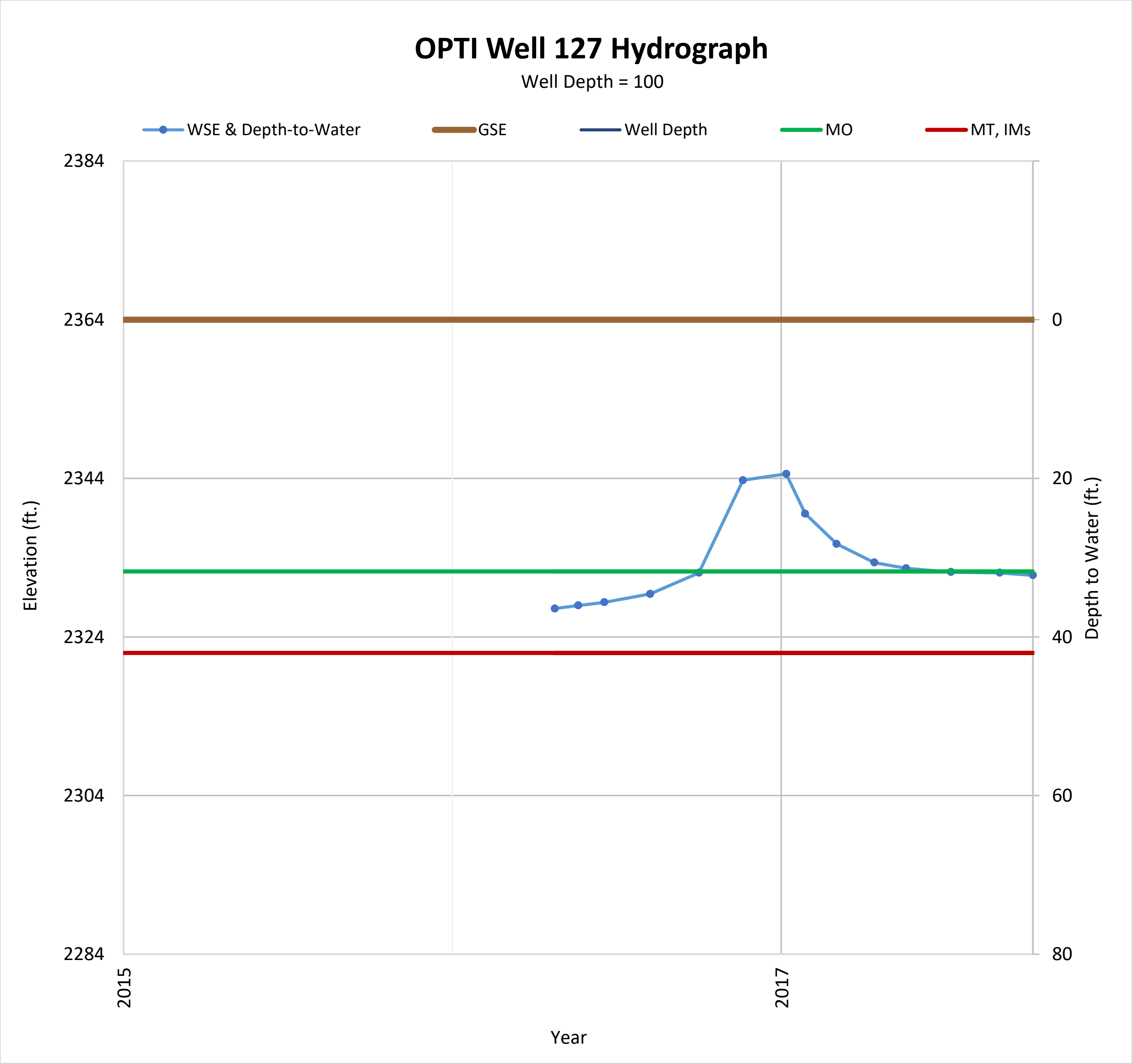
Well Depth = 500

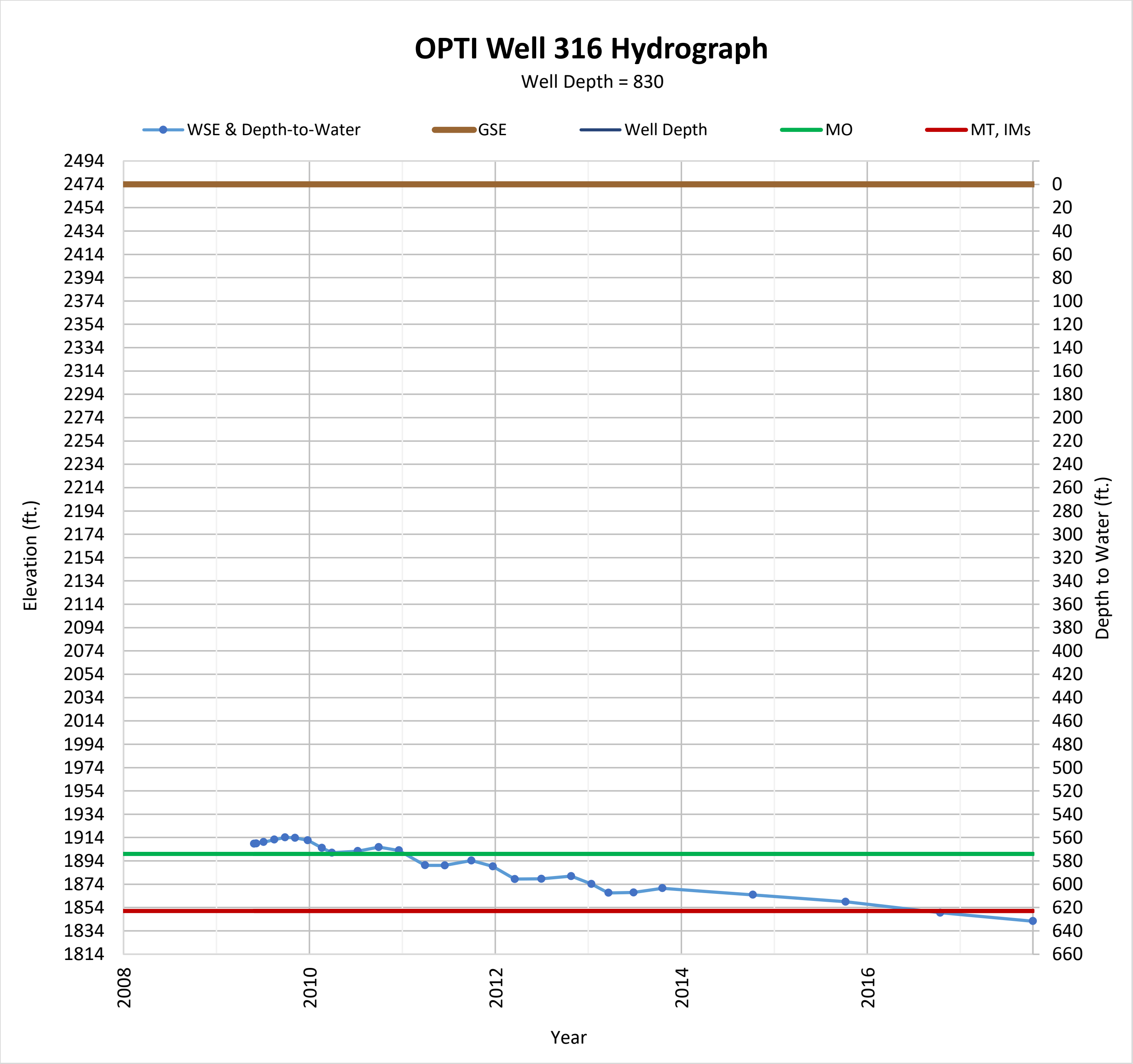
# OPTI Well 123 Hydrograph

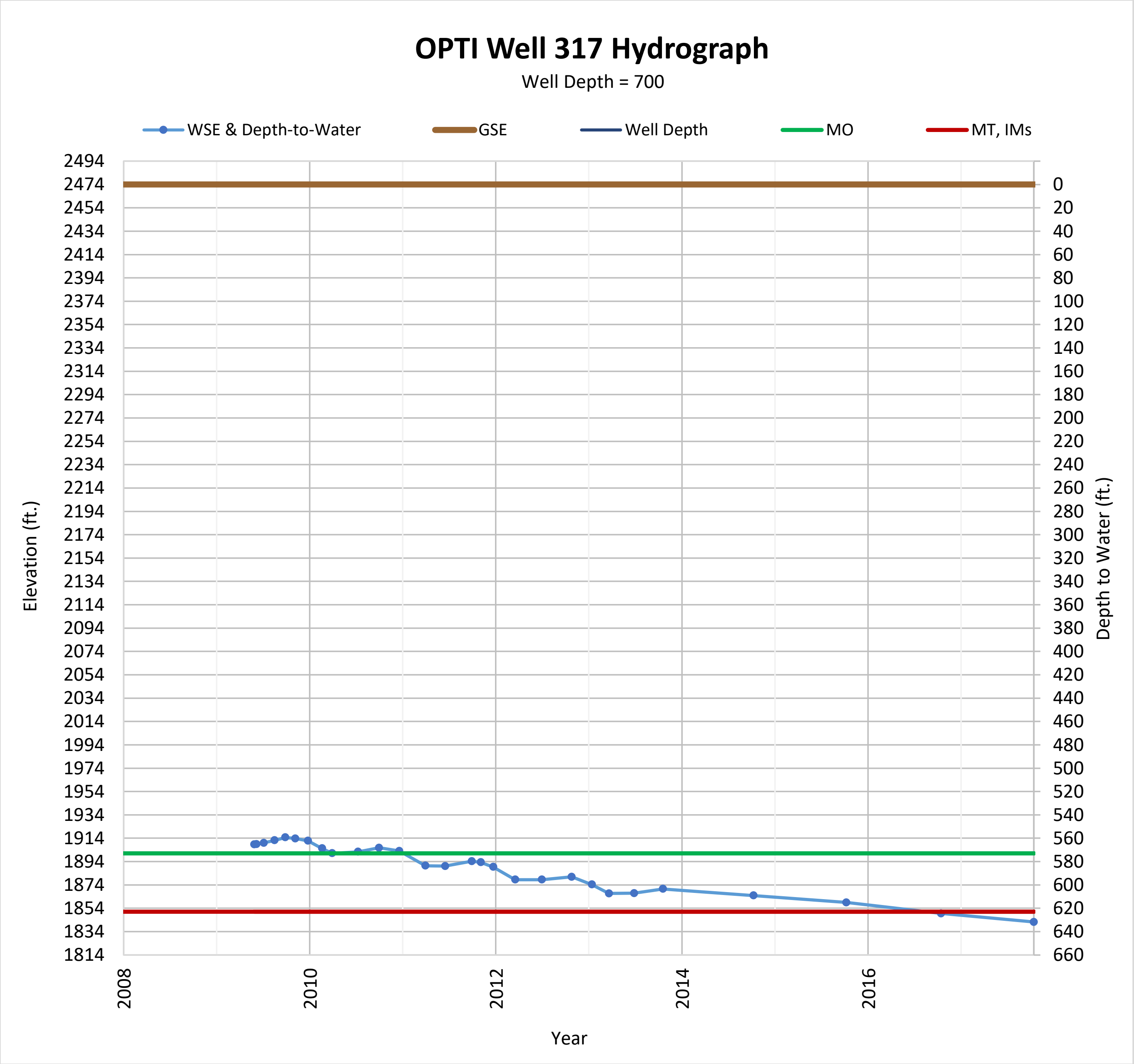
Well Depth = 138




OPTI Well 124 Hydrograph
Well Depth = 161
WSE & Depth-to-Water
GSE
Well Depth
MO
MT, IMs
Elevation (ft.)
2307
2287
2267
2247
2227
2207
2187
Depth to Water (ft.)
0
20
40
60
80
100
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017
Year

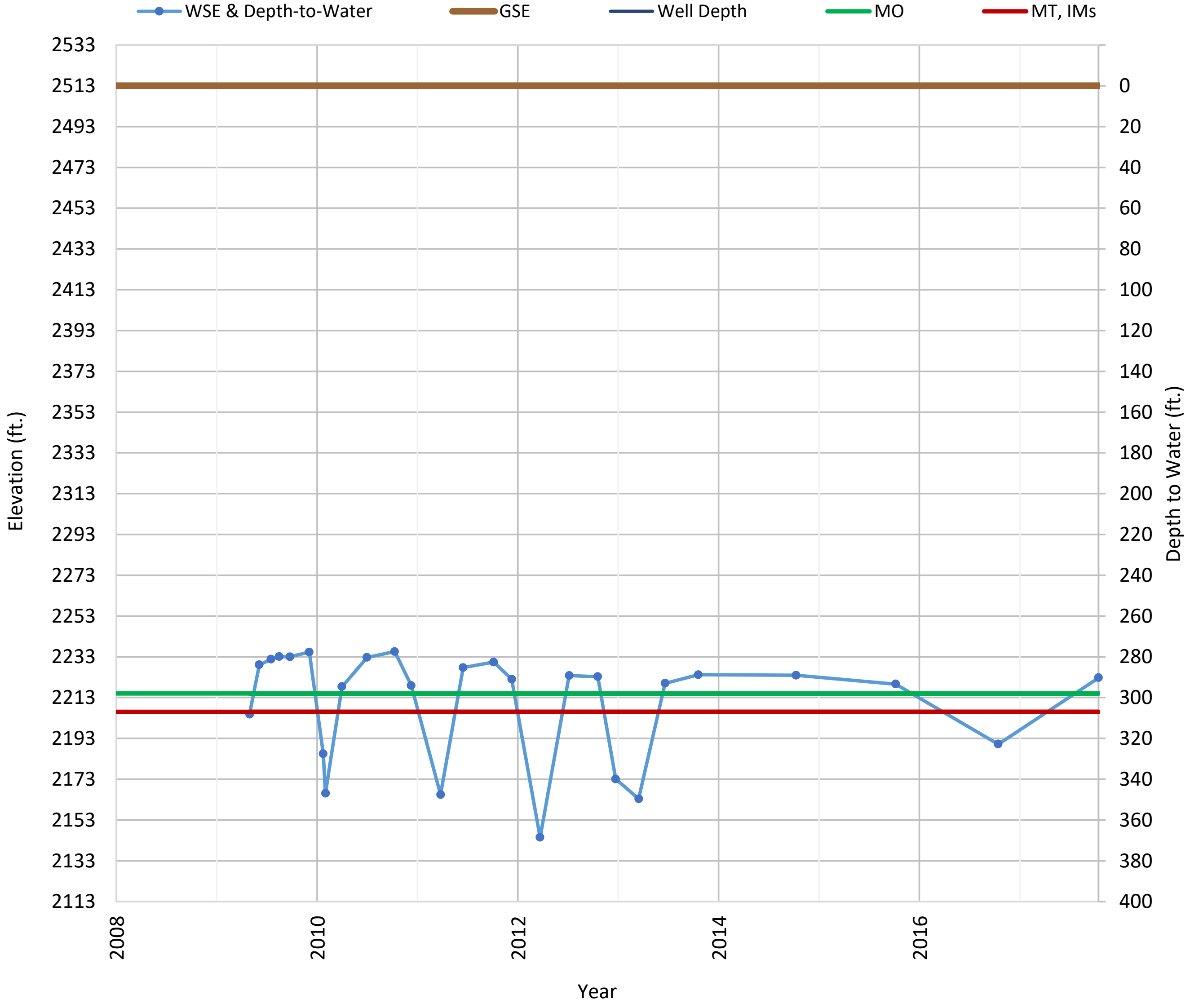

OPTI Well 127 Hydrograph
Well Depth = 100
WSE & Depth-to-Water
GSE
Well Depth
MO
MT, IMs
2384
2364
2344
2324
2304
2284
0
20
40
60
80
Elevation (ft.)
Depth to Water (ft.)
2015
2017
Year

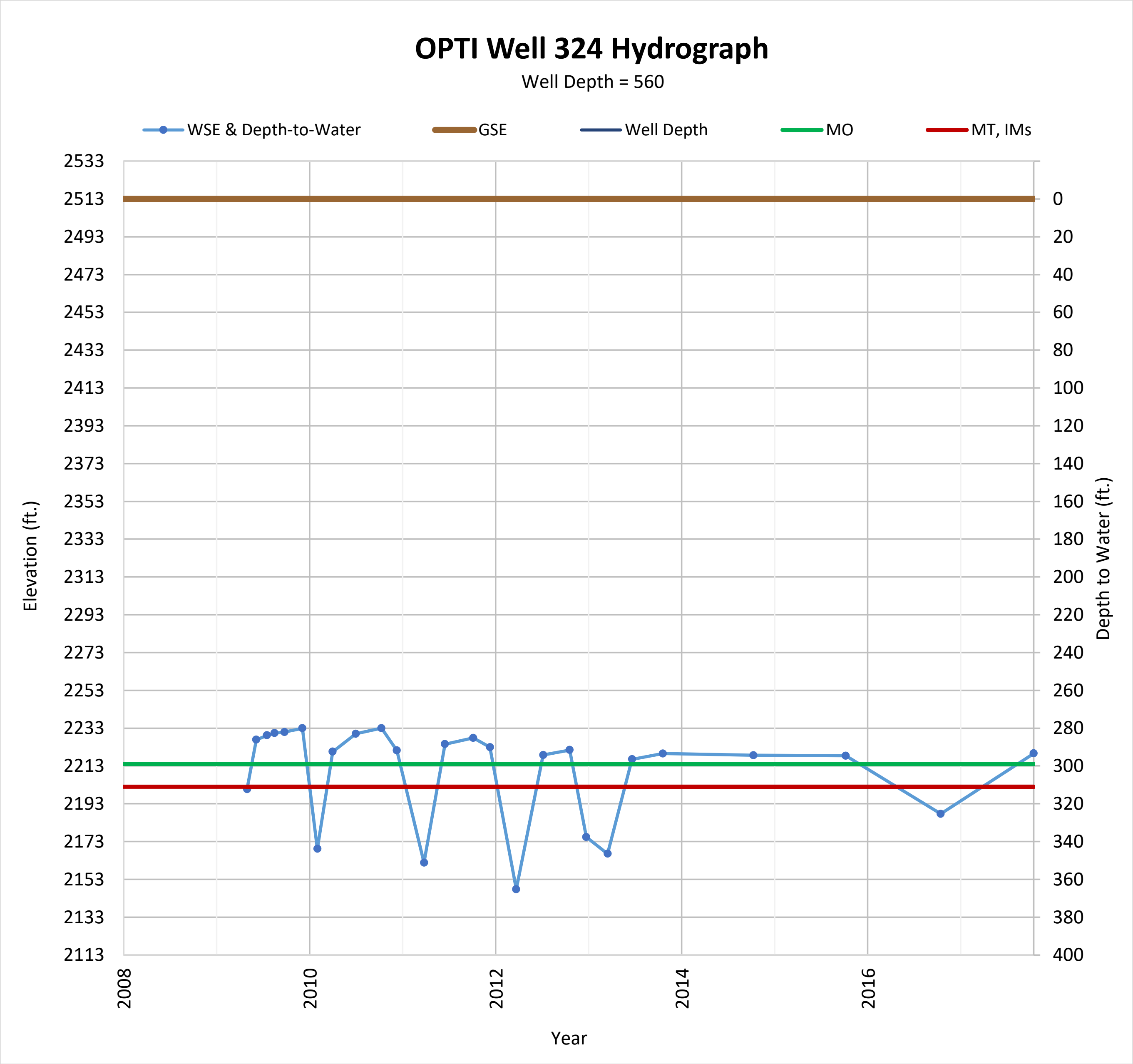

OPTI Well 316 Hydrograph
Well Depth = 830
WSE & Depth-to-Water
GSE
Well Depth
MO
MT, IMs
Elevation (ft.)
2494
2474
2454
2434
2414
2394
2374
2354
2334
2314
2294
2274
2254
2234
2214
2194
2174
2154
2134
2114
2094
2074
2054
2034
2014
1994
1974
1954
1934
1914
1894
1874
1854
1834
1814
Depth to Water (ft.)
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
360
380
400
420
440
460
480
500
520
540
560
580
600
620
640
660
2008
2010
2012
2014
2016
Year

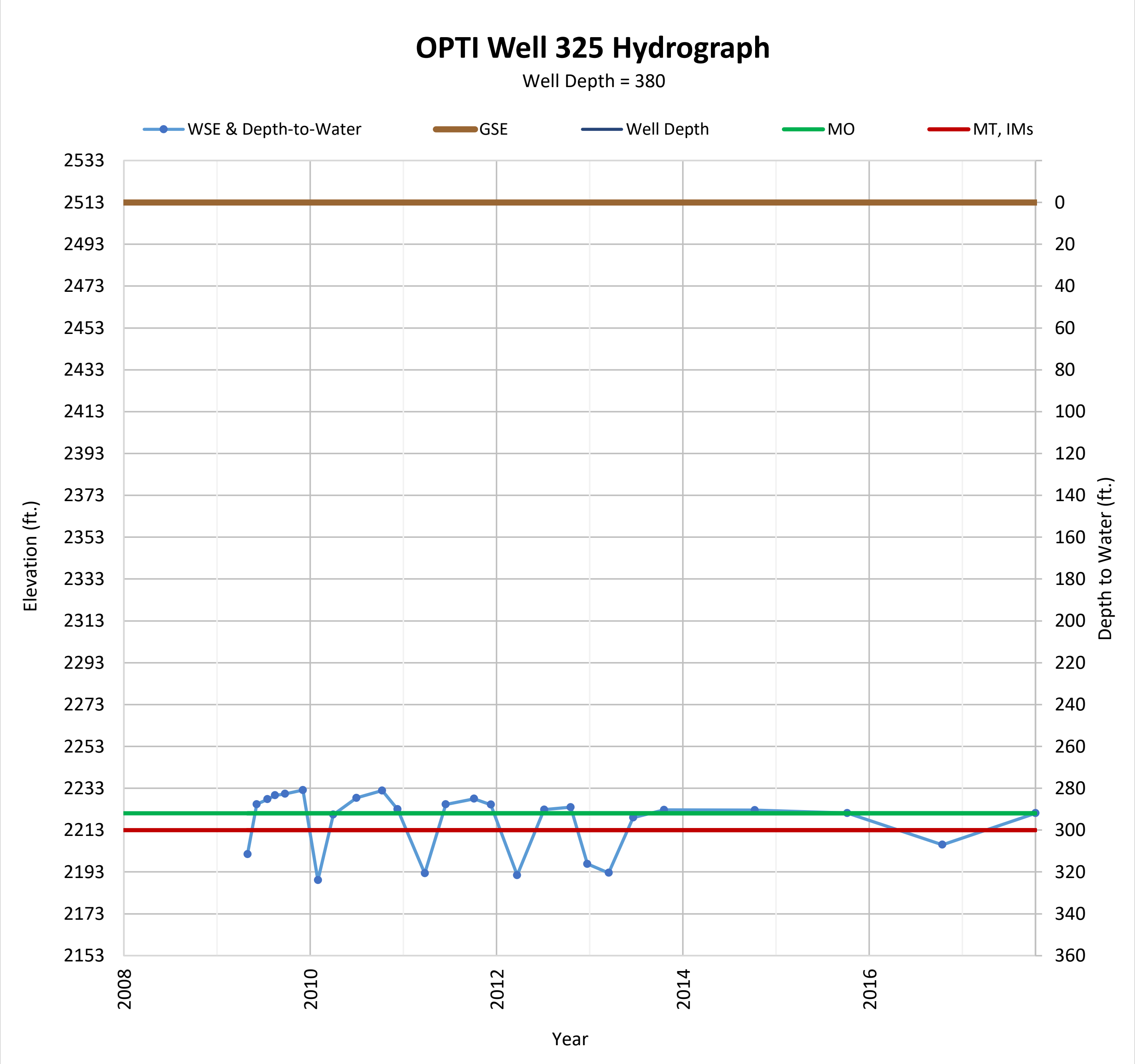

OPTI Well 317 Hydrograph
Well Depth = 700
WSE & Depth-to-Water
GSE
Well Depth
MO
MT, IMs
Elevation (ft.)
2494
2474
2454
2434
2414
2394
2374
2354
2334
2314
2294
2274
2254
2234
2214
2194
2174
2154
2134
2114
2094
2074
2054
2034
2014
1994
1974
1954
1934
1914
1894
1874
1854
1834
1814
Depth to Water (ft.)
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
360
380
400
420
440
460
480
500
520
540
560
580
600
620
640
660
2008
2010
2012
2014
2016
Year

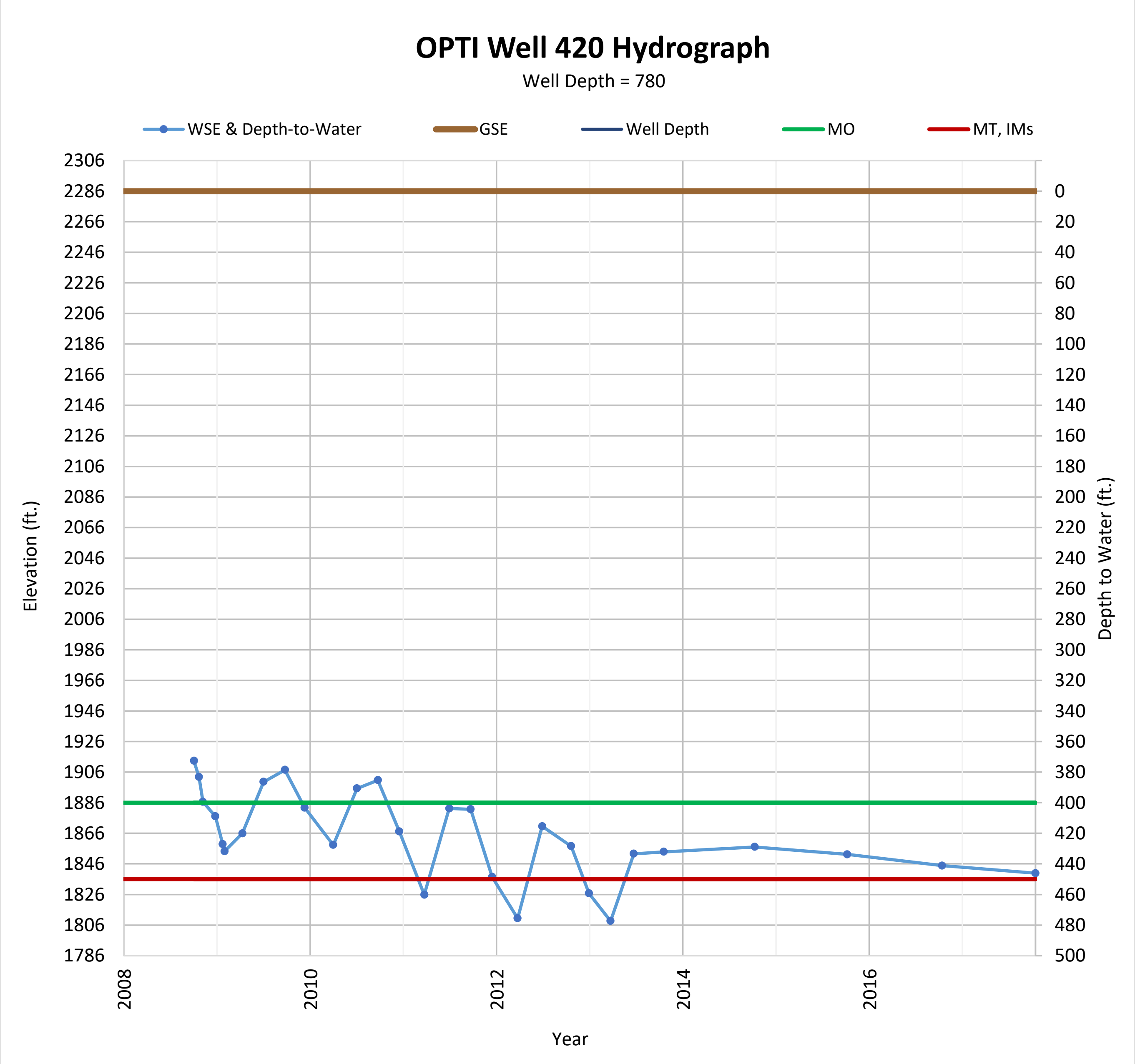
## OPTI Well 322 Hydrograph

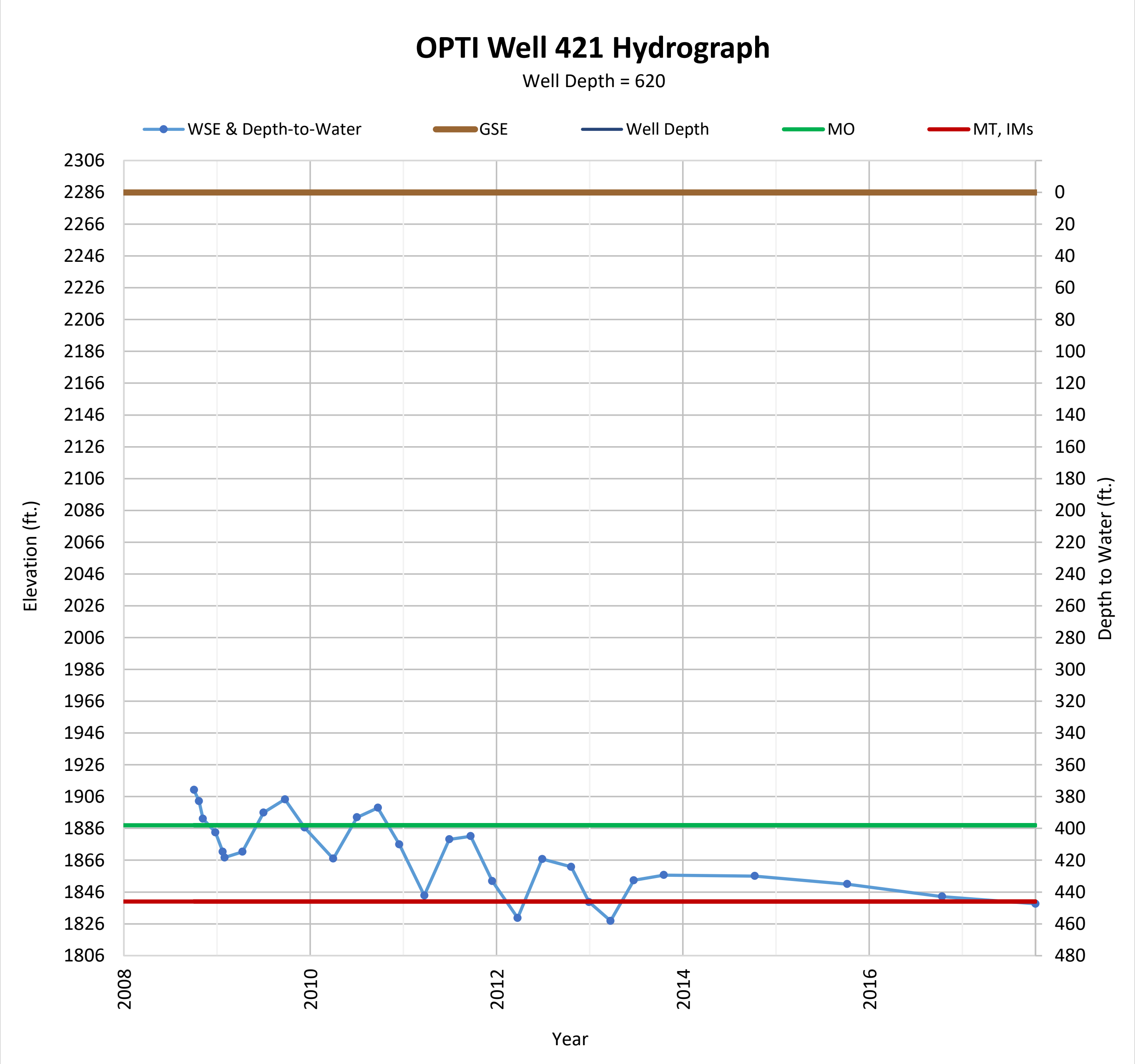
Well Depth = 850

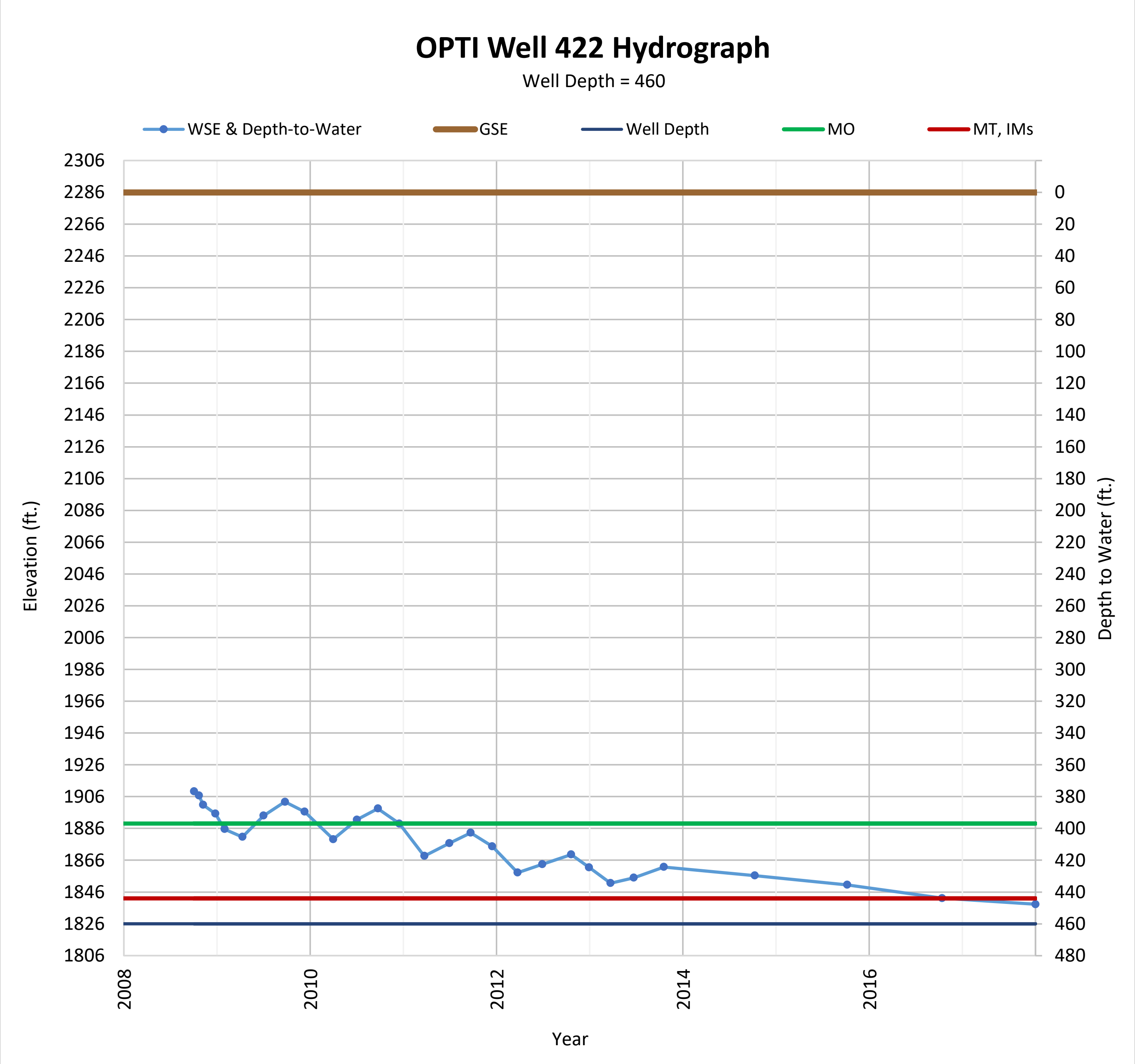


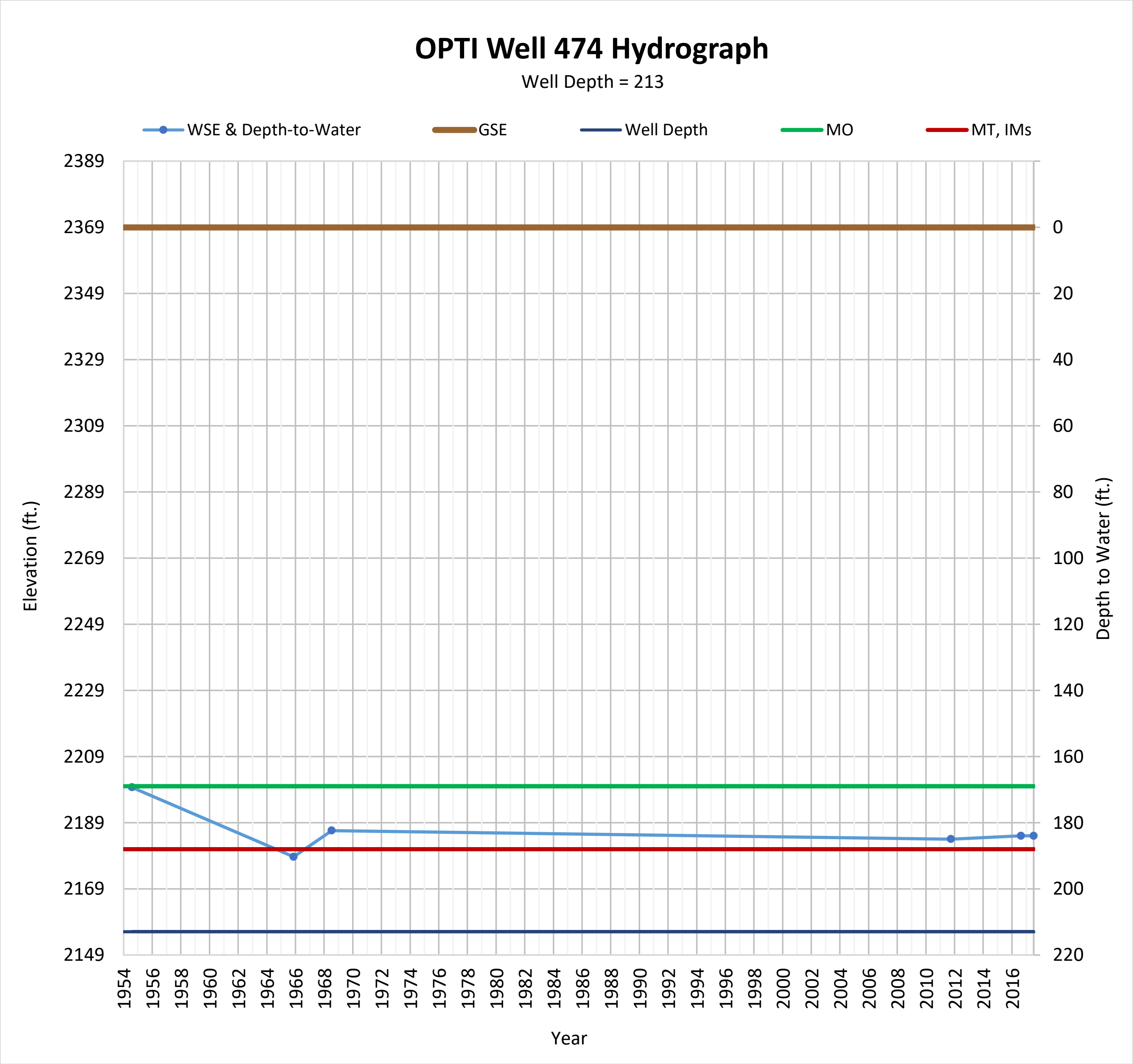

OPTI Well 324 Hydrograph
Well Depth = 560
WSE & Depth-to-Water
GSE
Well Depth
MO
MT, IMs
Elevation (ft.)
2533
2513
2493
2473
2453
2433
2413
2393
2373
2353
2333
2313
2293
2273
2253
2233
2213
2193
2173
2153
2133
2113
Depth to Water (ft.)
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
360
380
400
2008
2010
2012
2014
2016
Year

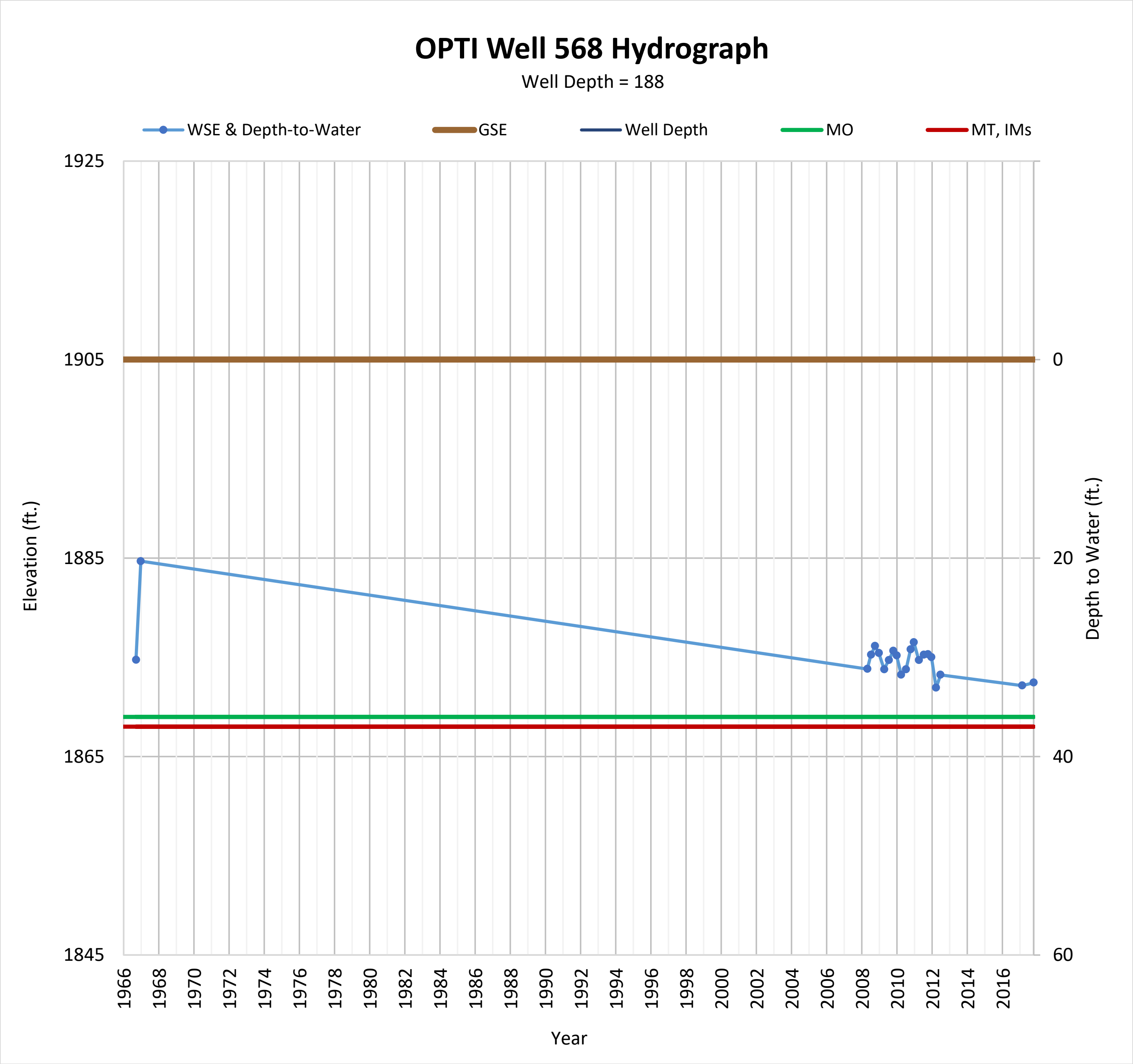

OPTI Well 325 Hydrograph
Well Depth = 380
WSE & Depth-to-Water
GSE
Well Depth
MO
MT, IMs
2533
2513
2493
2473
2453
2433
2413
2393
2373
2353
2333
2313
2293
2273
2253
2233
2213
2193
2173
2153
Elevation (ft.)
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
360
Depth to Water (ft.)
2008
2010
2012
2014
2016
Year

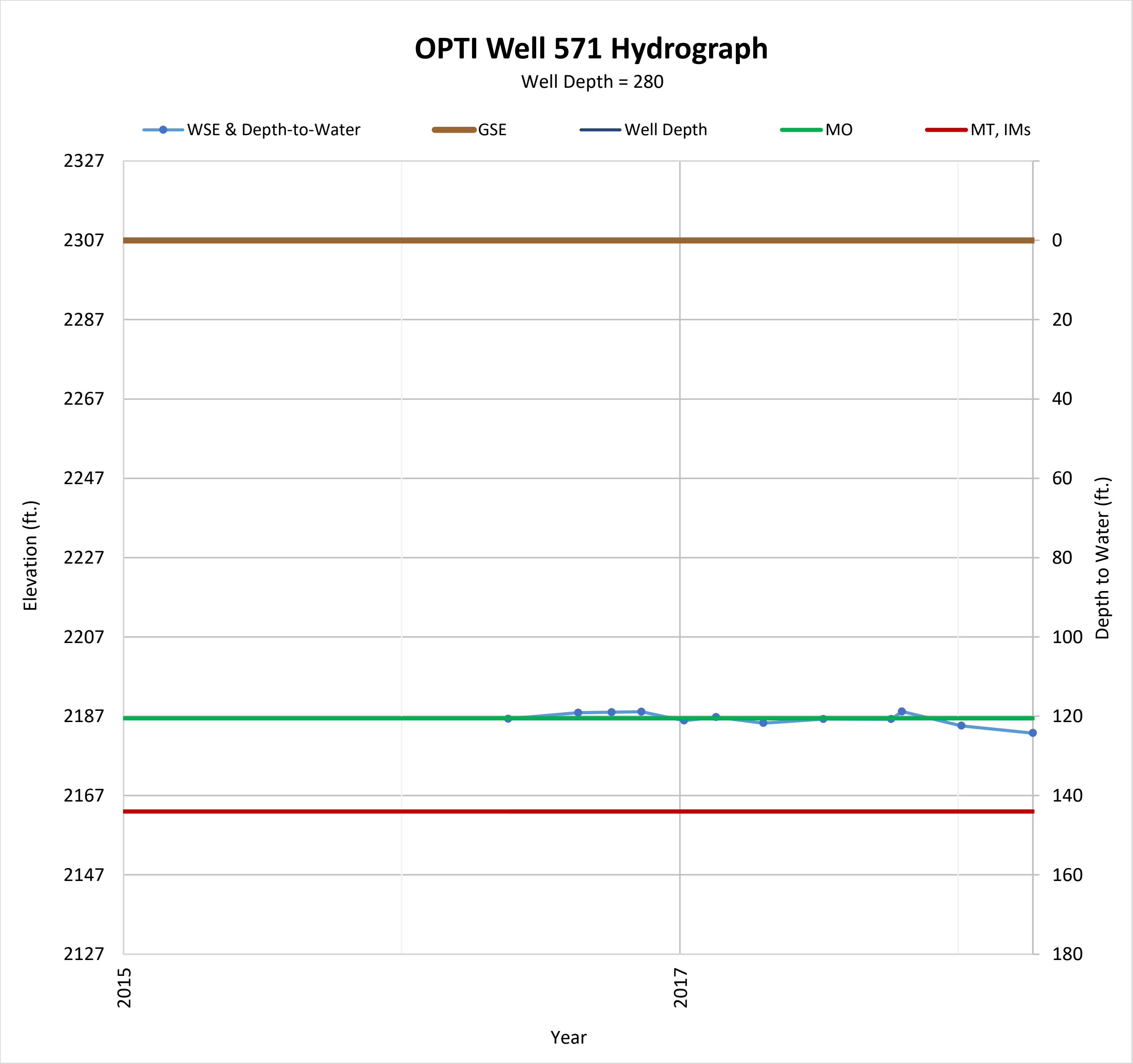

OPTI Well 420 Hydrograph
Well Depth = 780
WSE & Depth-to-Water
GSE
Well Depth
MO
MT, IMs
Elevation (ft.)
2306
2286
2266
2246
2226
2206
2186
2166
2146
2126
2106
2086
2066
2046
2026
2006
1986
1966
1946
1926
1906
1886
1866
1846
1826
1806
1786
Depth to Water (ft.)
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
360
380
400
420
440
460
480
500
2008
2010
2012
2014
2016
Year

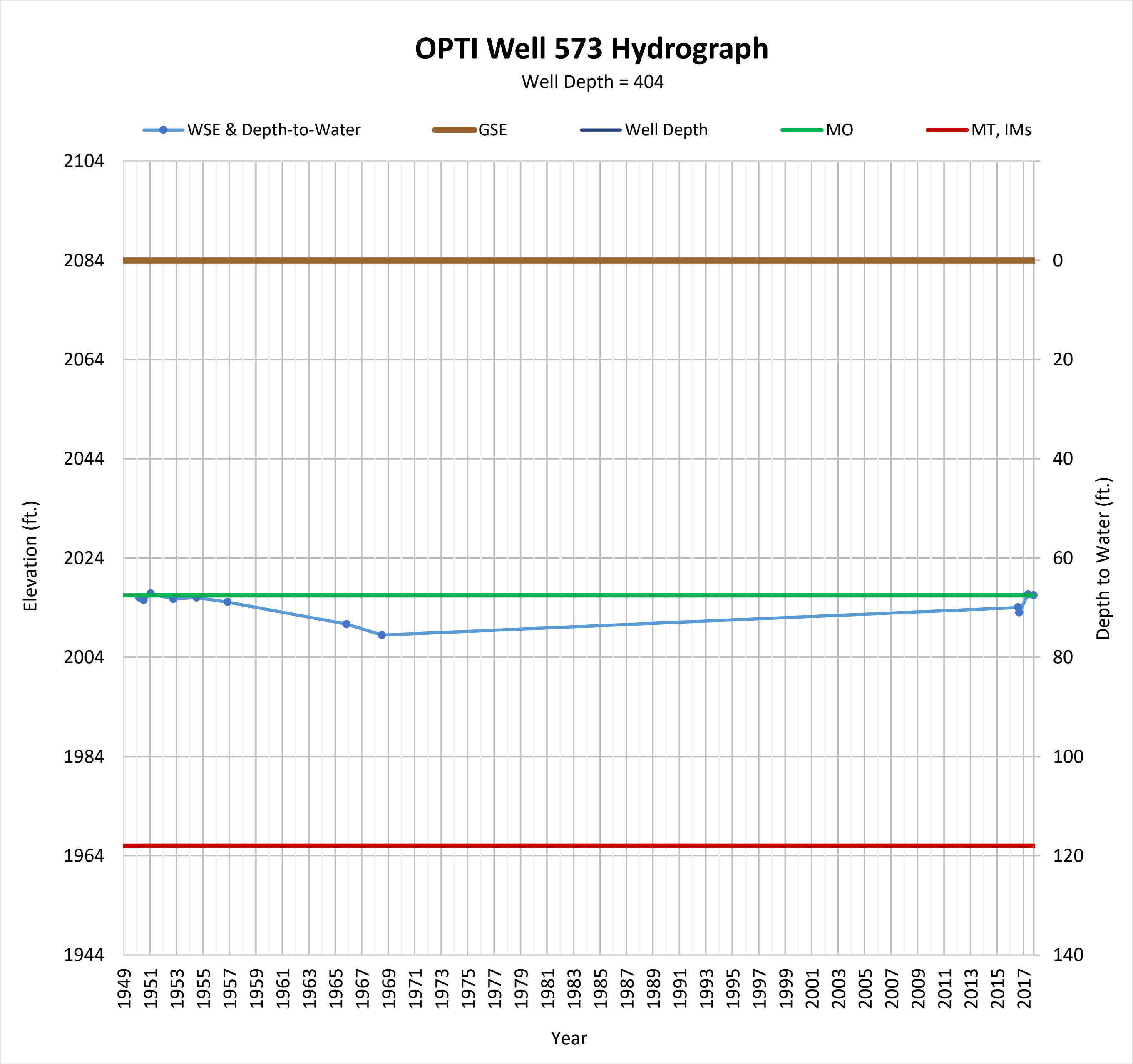

OPTI Well 421 Hydrograph
Well Depth = 620
WSE & Depth-to-Water
GSE
Well Depth
MO
MT, IMs
Elevation (ft.)
2306
2286
2266
2246
2226
2206
2186
2166
2146
2126
2106
2086
2066
2046
2026
2006
1986
1966
1946
1926
1906
1886
1866
1846
1826
1806
Depth to Water (ft.)
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
360
380
400
420
440
460
480
2008
2010
2012
2014
2016
Year


OPTI Well 422 Hydrograph
Well Depth = 460
WSE & Depth-to-Water
GSE
Well Depth
MO
MT, IMs
Elevation (ft.)
2306
2286
2266
2246
2226
2206
2186
2166
2146
2126
2106
2086
2066
2046
2026
2006
1986
1966
1946
1926
1906
1886
1866
1846
1826
1806
Depth to Water (ft.)
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
360
380
400
420
440
460
480
2008
2010
2012
2014
2016
Year


OPTI Well 474 Hydrograph
Well Depth = 213
WSE & Depth-to-Water
GSE
Well Depth
MO
MT, IMs
Elevation (ft.)
2389
2369
2349
2329
2309
2289
2269
2249
2229
2209
2189
2169
2149
Depth to Water (ft.)
0
20
40
60
80
100
120
140
160
180
200
220
Year
1954
1956
1958
1960
1962
1964
1966
1968
1970
1972
1974
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016


OPTI Well 568 Hydrograph
Well Depth = 188
WSE & Depth-to-Water
GSE
Well Depth
MO
MT, IMs
1925
1905
1885
1865
1845
0
20
40
60
Elevation (ft.)
Depth to Water (ft.)
1966
1968
1970
1972
1974
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
Year

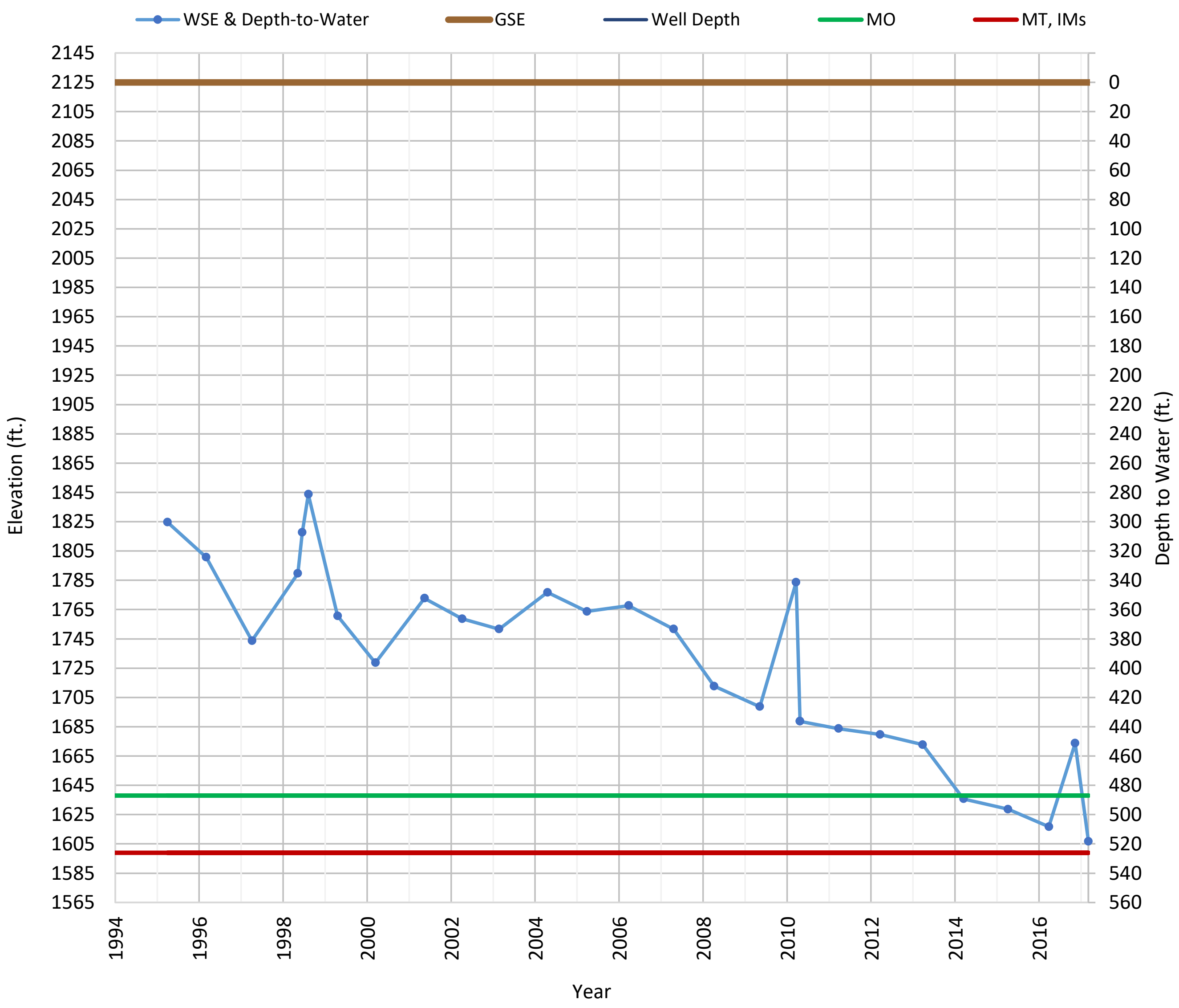

OPTI Well 571 Hydrograph
Well Depth = 280
WSE & Depth-to-Water
GSE
Well Depth
MO
MT, IMs
Elevation (ft.)
2327
2307
2287
2267
2247
2227
2207
2187
2167
2147
2127
Depth to Water (ft.)
0
20
40
60
80
100
120
140
160
180
2015
2017
Year

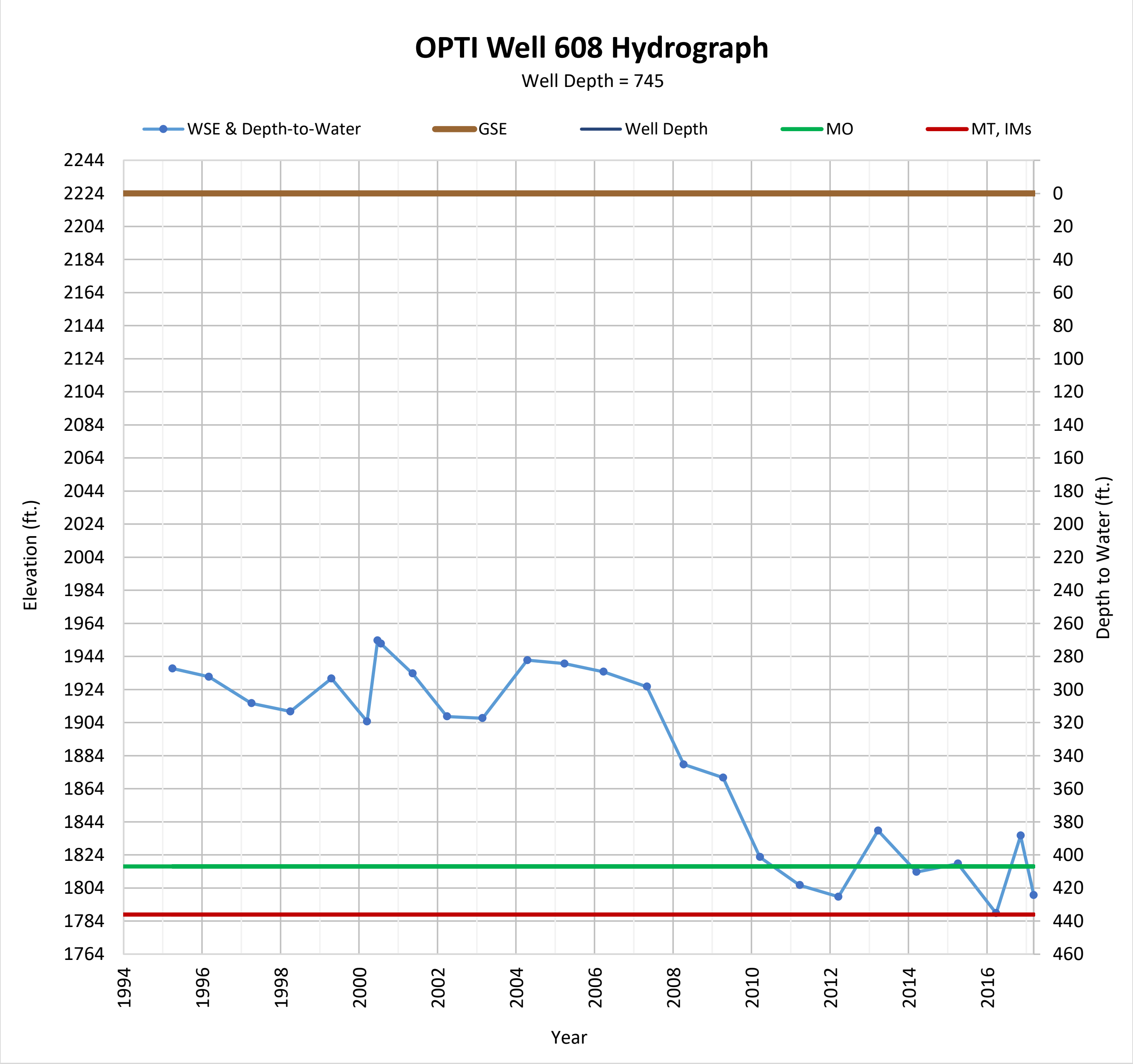


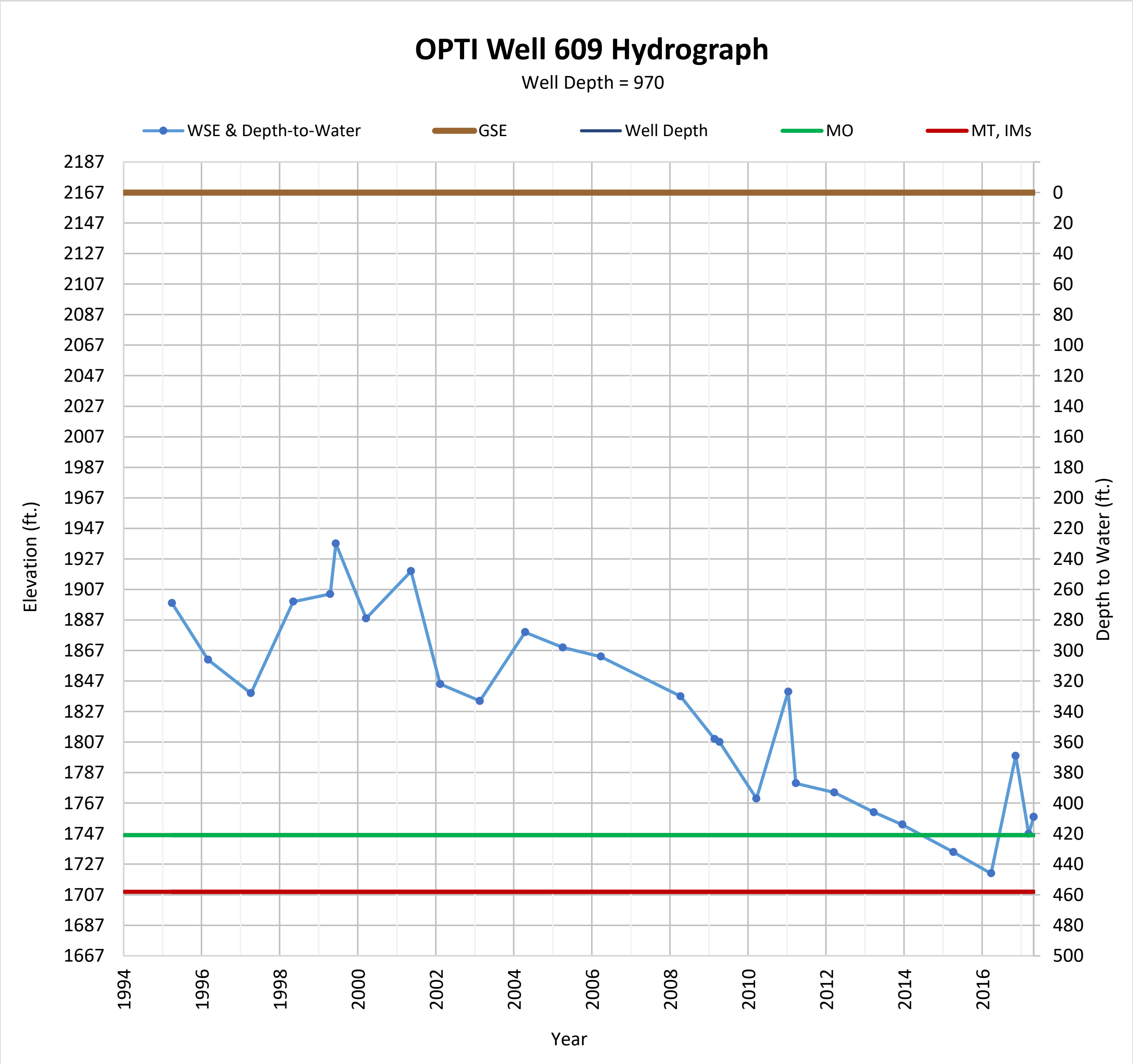
OPTI Well 573 Hydrograph
Well Depth = 404
WSE & Depth-to-Water
GSE
Well Depth
MO
MT, IMs
Elevation (ft.)
2104
2084
2064
2044
2024
2004
1984
1964
1944
Depth to Water (ft.)
0
20
40
60
80
100
120
140
Year
1949
1951
1953
1955
1957
1959
1961
1963
1965
1967
1969
1971
1973
1975
1977
1979
1981
1983
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017

## OPTI Well 604 Hydrograph

Well Depth = 924

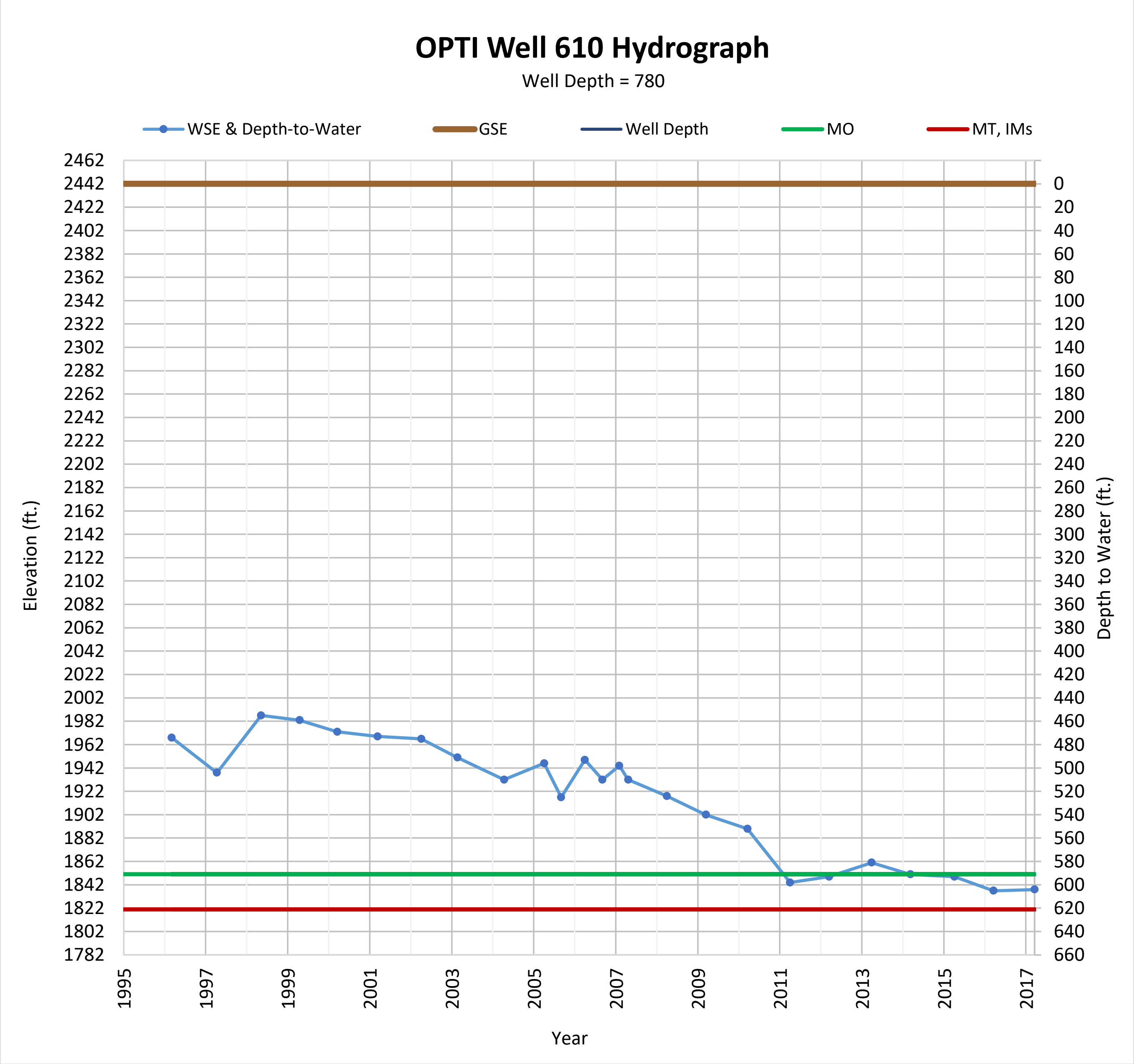


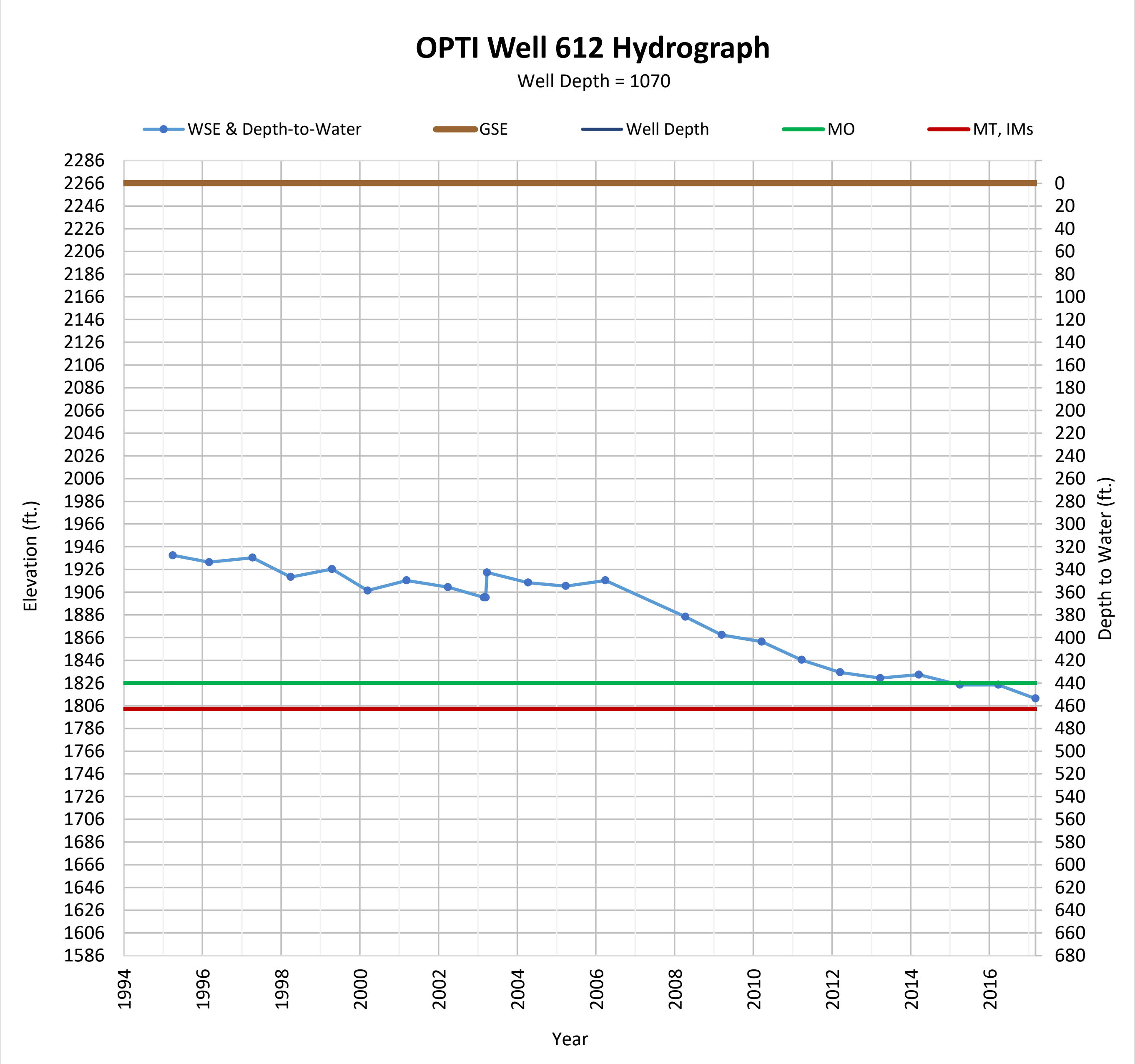

OPTI Well 608 Hydrograph
Well Depth = 745
WSE & Depth-to-Water
GSE
Well Depth
MO
MT, IMs
Elevation (ft.)
2244
2224
2204
2184
2164
2144
2124
2104
2084
2064
2044
2024
2004
1984
1964
1944
1924
1904
1884
1864
1844
1824
1804
1784
1764
Depth to Water (ft.)
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
360
380
400
420
440
460
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
Year

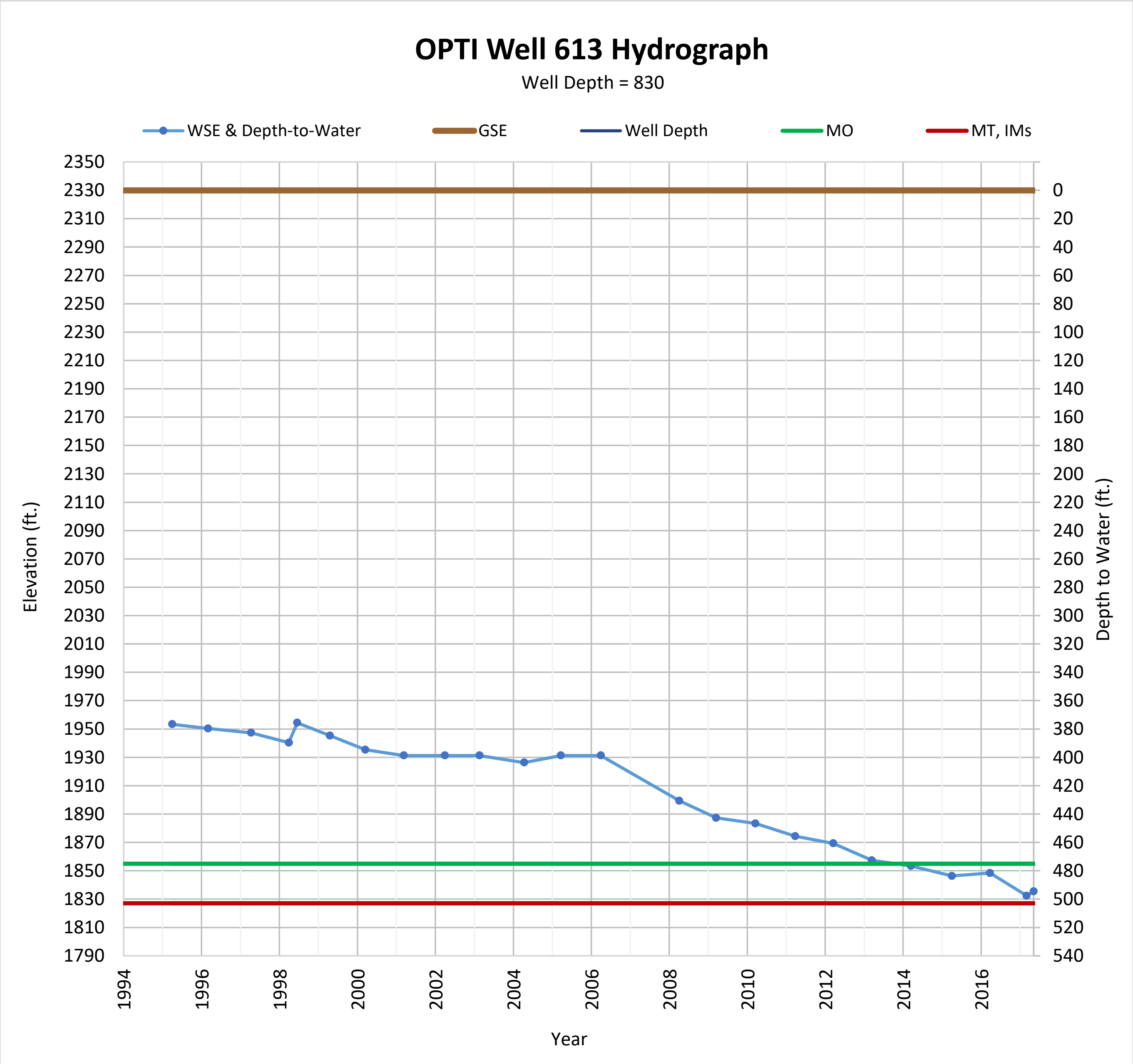


## OPTI Well 609 Hydrograph

Well Depth = 970

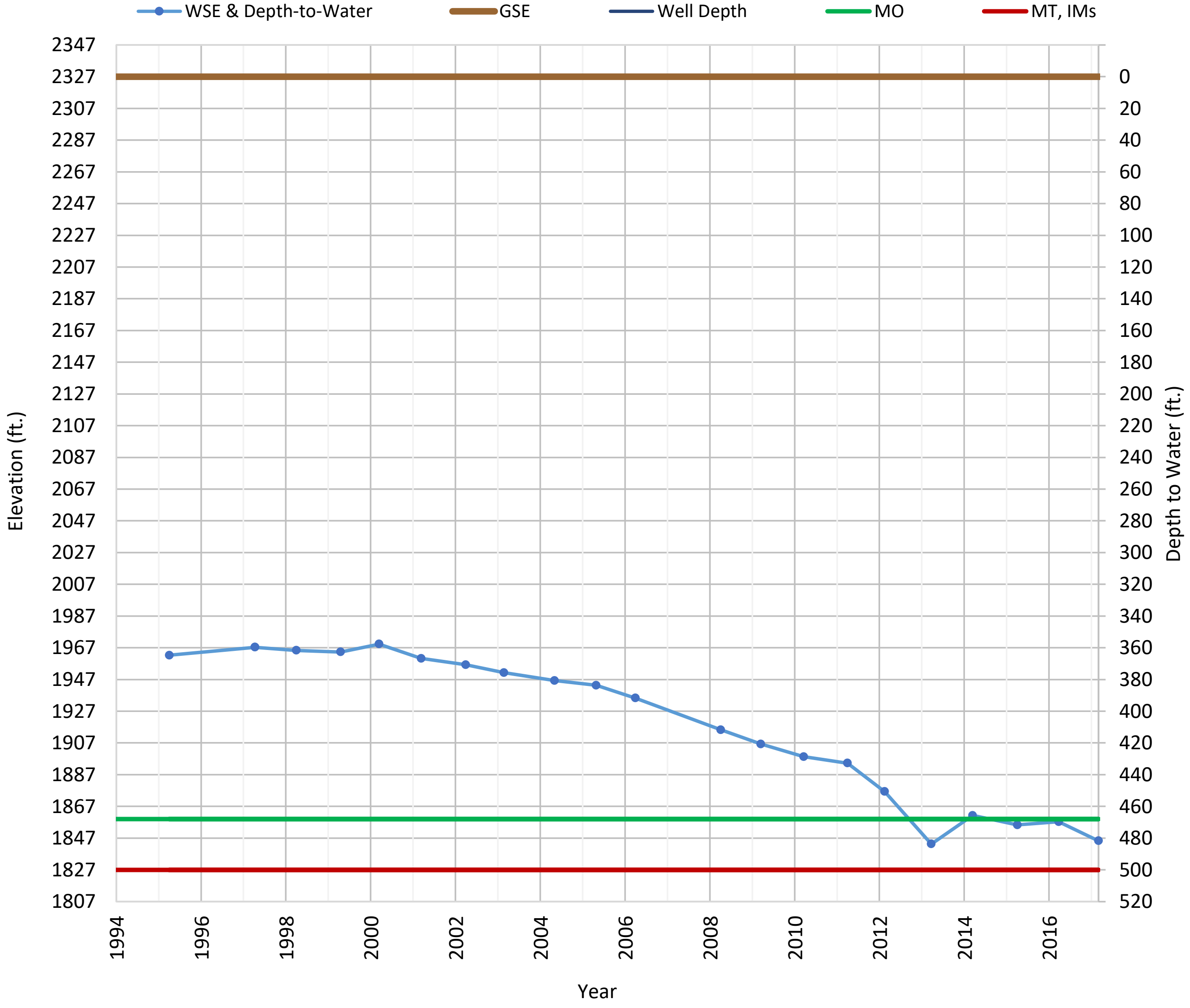

OPTI Well 610 Hydrograph
Well Depth = 780
WSE & Depth-to-Water
GSE
Well Depth
MO
MT, IMs
Elevation (ft.)
2462
2442
2422
2402
2382
2362
2342
2322
2302
2282
2262
2242
2222
2202
2182
2162
2142
2122
2102
2082
2062
2042
2022
2002
1982
1962
1942
1922
1902
1882
1862
1842
1822
1802
1782
Depth to Water (ft.)
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
360
380
400
420
440
460
480
500
520
540
560
580
600
620
640
660
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017
Year


OPTI Well 612 Hydrograph
Well Depth = 1070
WSE & Depth-to-Water
GSE
Well Depth
MO
MT, IMs
Elevation (ft.)
2286
2266
2246
2226
2206
2186
2166
2146
2126
2106
2086
2066
2046
2026
2006
1986
1966
1946
1926
1906
1886
1866
1846
1826
1806
1786
1766
1746
1726
1706
1686
1666
1646
1626
1606
1586
Depth to Water (ft.)
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
360
380
400
420
440
460
480
500
520
540
560
580
600
620
640
660
680
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
Year


OPTI Well 613 Hydrograph
Well Depth = 830
WSE & Depth-to-Water
GSE
Well Depth
MO
MT, IMs
Elevation (ft.)
2350
2330
2310
2290
2270
2250
2230
2210
2190
2170
2150
2130
2110
2090
2070
2050
2030
2010
1990
1970
1950
1930
1910
1890
1870
1850
1830
1810
1790
Depth to Water (ft.)
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
360
380
400
420
440
460
480
500
520
540
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
Year

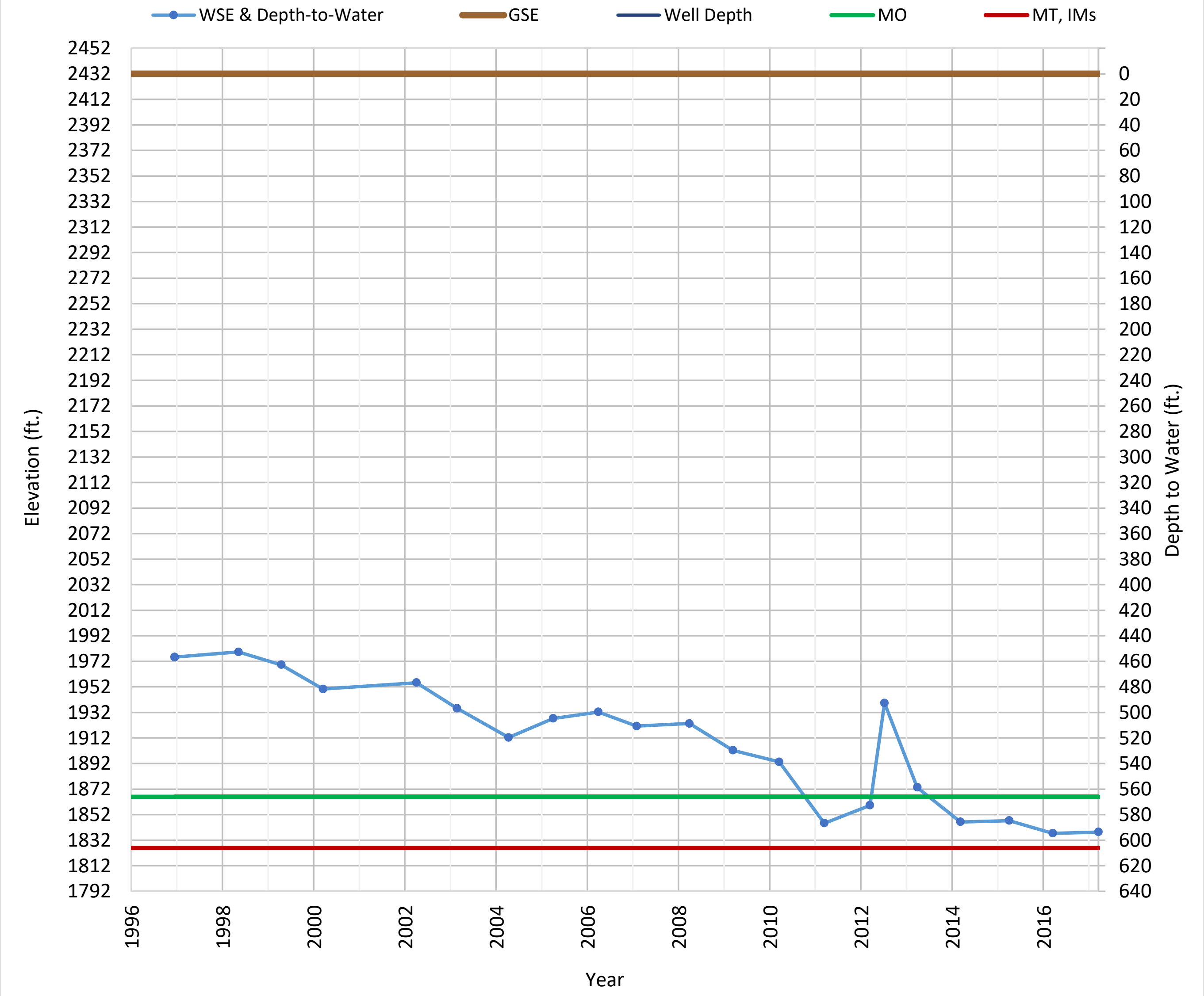
## OPTI Well 615 Hydrograph

Well Depth = 865



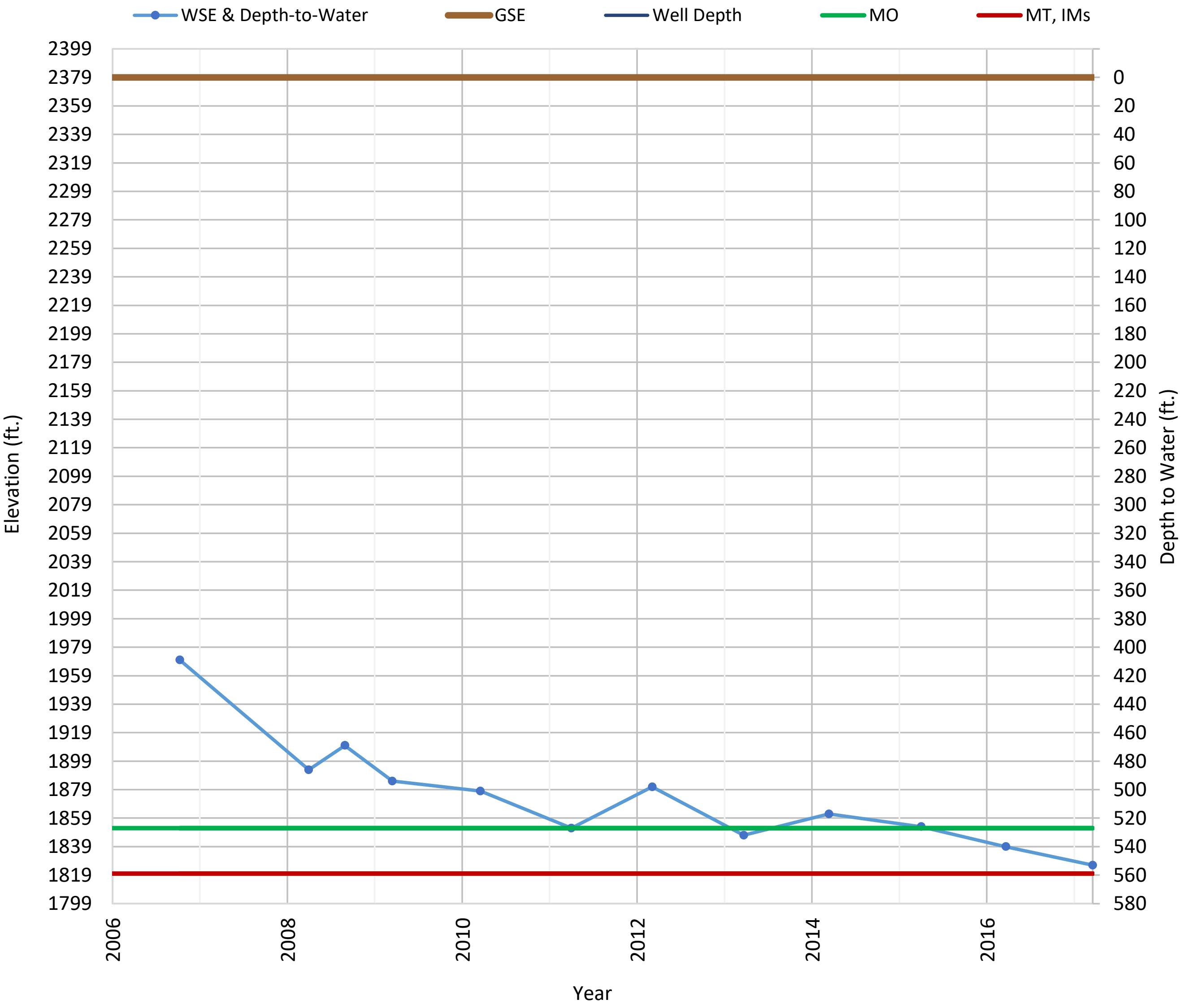
# OPTI Well 620 Hydrograph

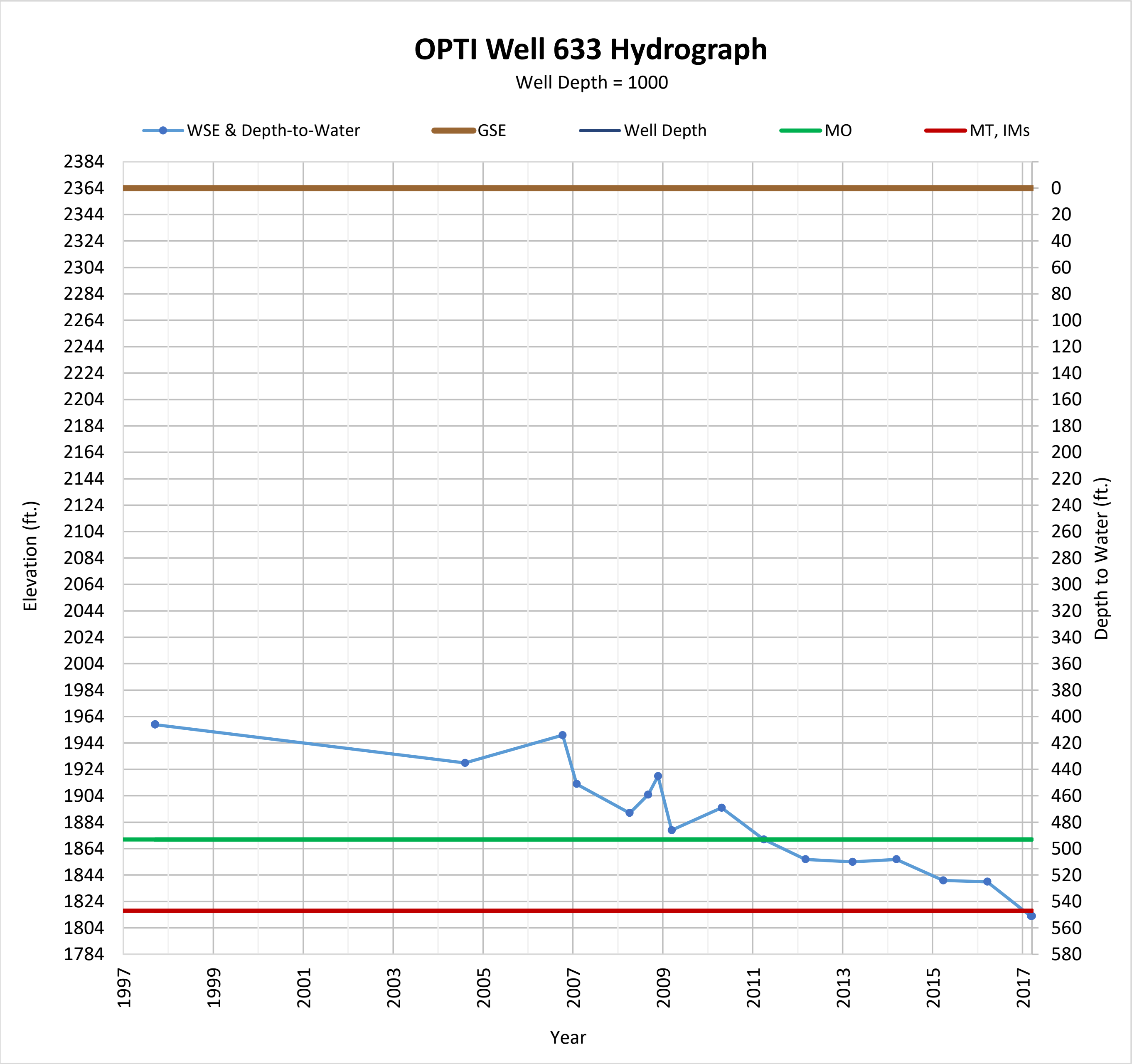
Well Depth = 1035

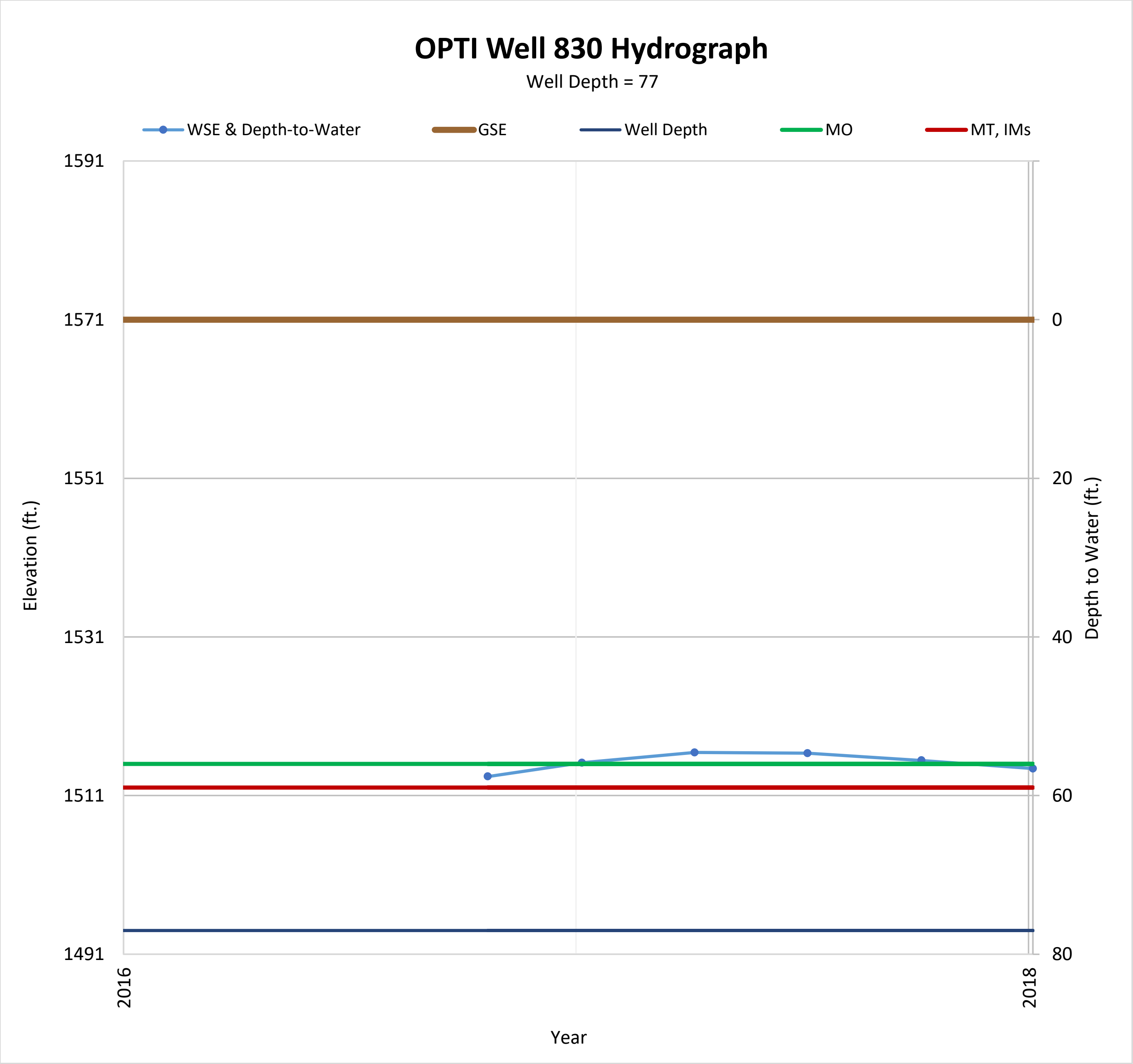


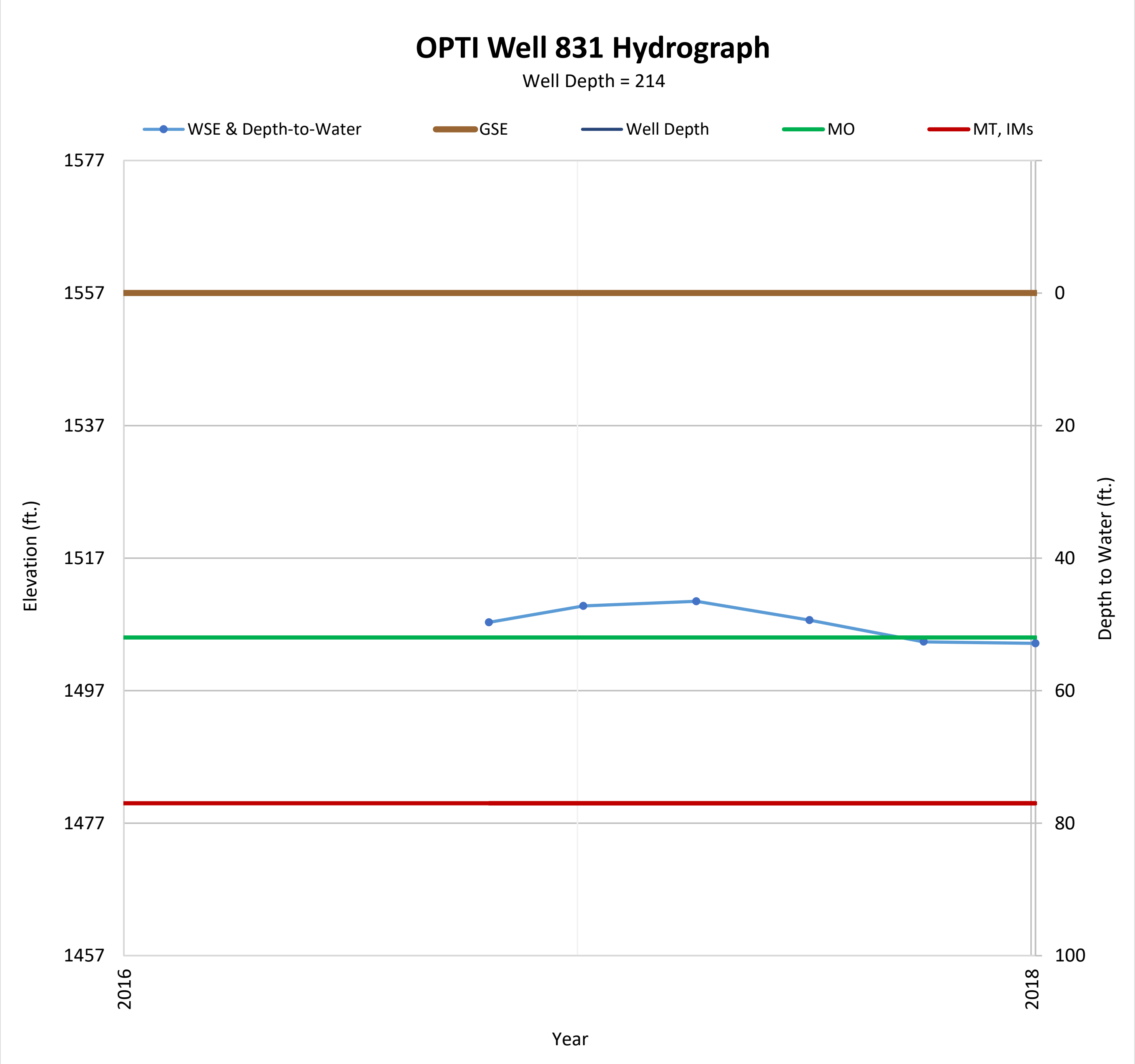
# OPTI Well 629 Hydrograph

Well Depth = 1000

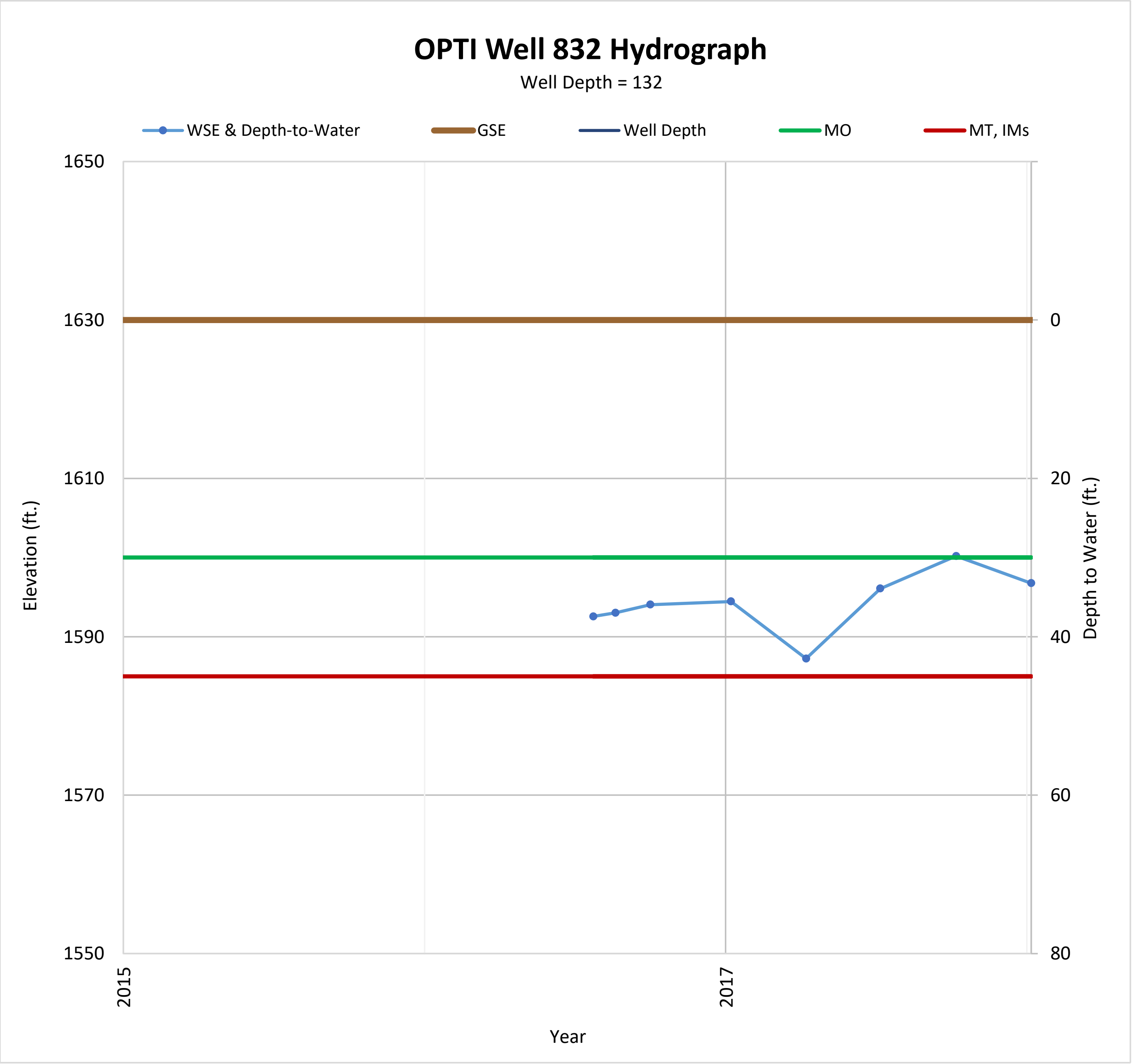


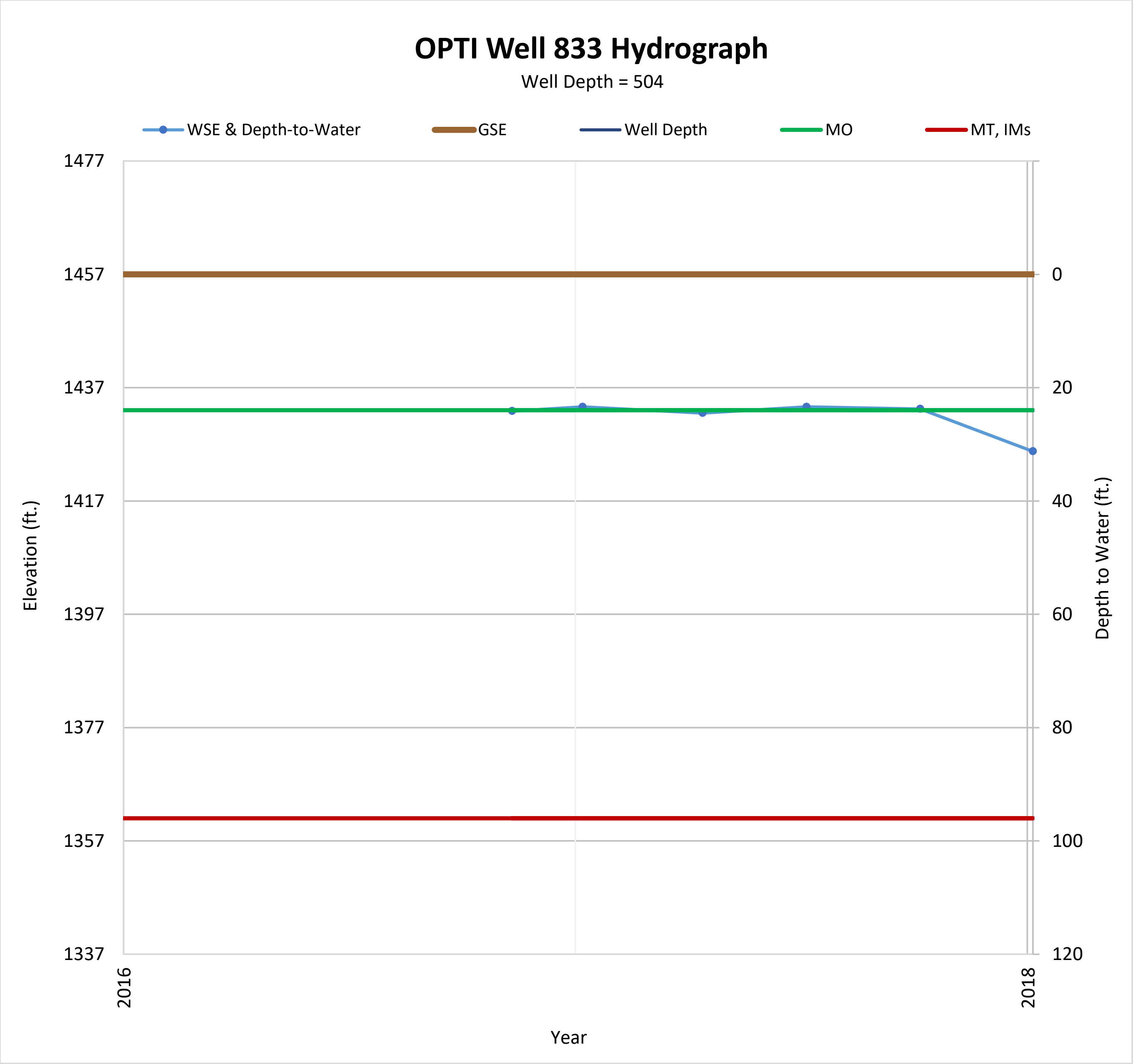

OPTI Well 633 Hydrograph
Well Depth = 1000
WSE & Depth-to-Water
GSE
Well Depth
MO
MT, IMs
Elevation (ft.)
2384
2364
2344
2324
2304
2284
2264
2244
2224
2204
2184
2164
2144
2124
2104
2084
2064
2044
2024
2004
1984
1964
1944
1924
1904
1884
1864
1844
1824
1804
1784
Depth to Water (ft.)
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
360
380
400
420
440
460
480
500
520
540
560
580
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017
Year

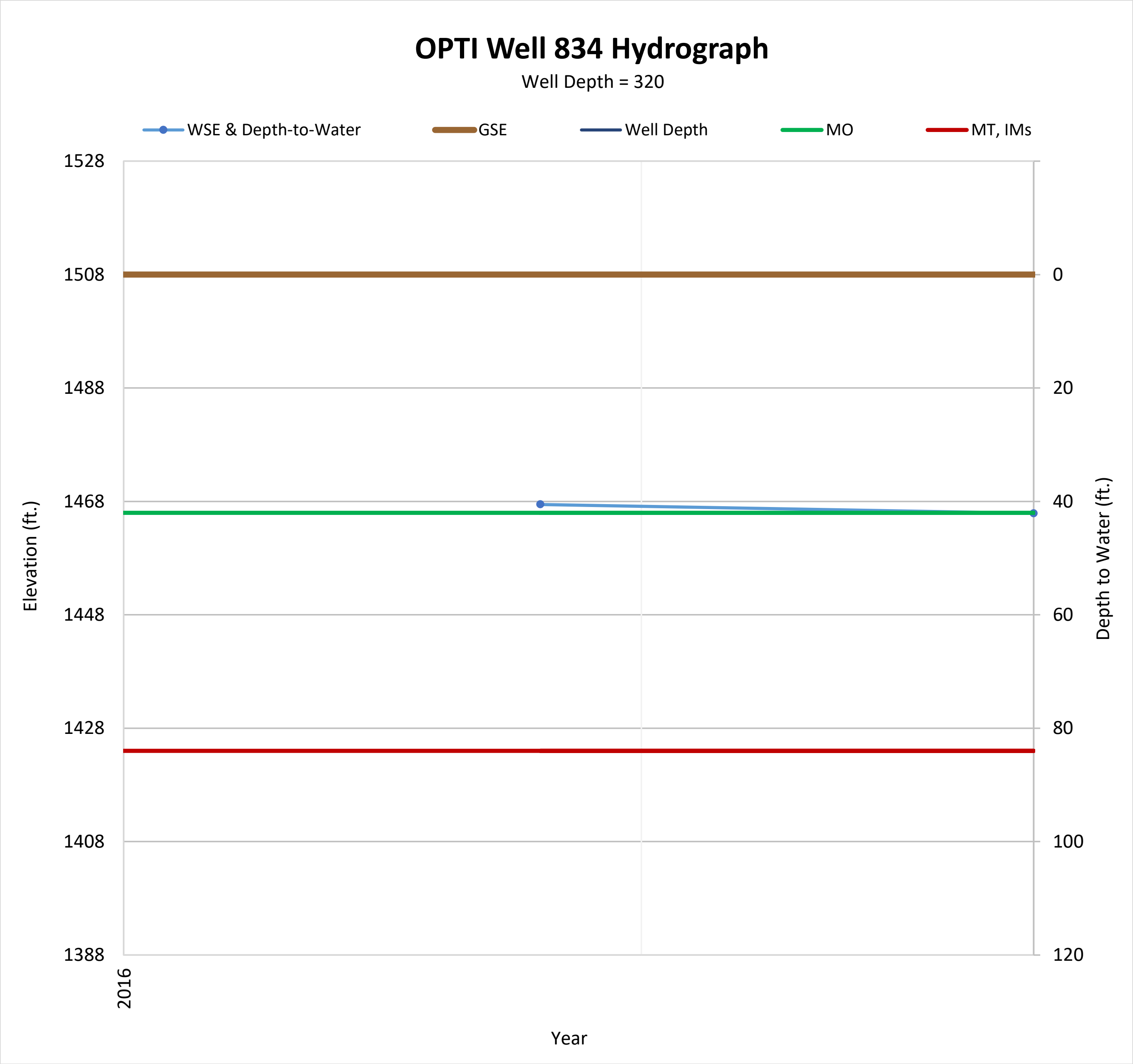

OPTI Well 830 Hydrograph
Well Depth = 77
WSE & Depth-to-Water
GSE
Well Depth
MO
MT, IMs
1591
1571
1551
1531
1511
1491
Elevation (ft.)
0
20
40
60
80
Depth to Water (ft.)
2016
2018
Year



OPTI Well 831 Hydrograph
Well Depth = 214
WSE & Depth-to-Water
GSE
Well Depth
MO
MT, IMs
1577
1557
1537
1517
1497
1477
1457
Elevation (ft.)
0
20
40
60
80
100
Depth to Water (ft.)
2016
2018
Year

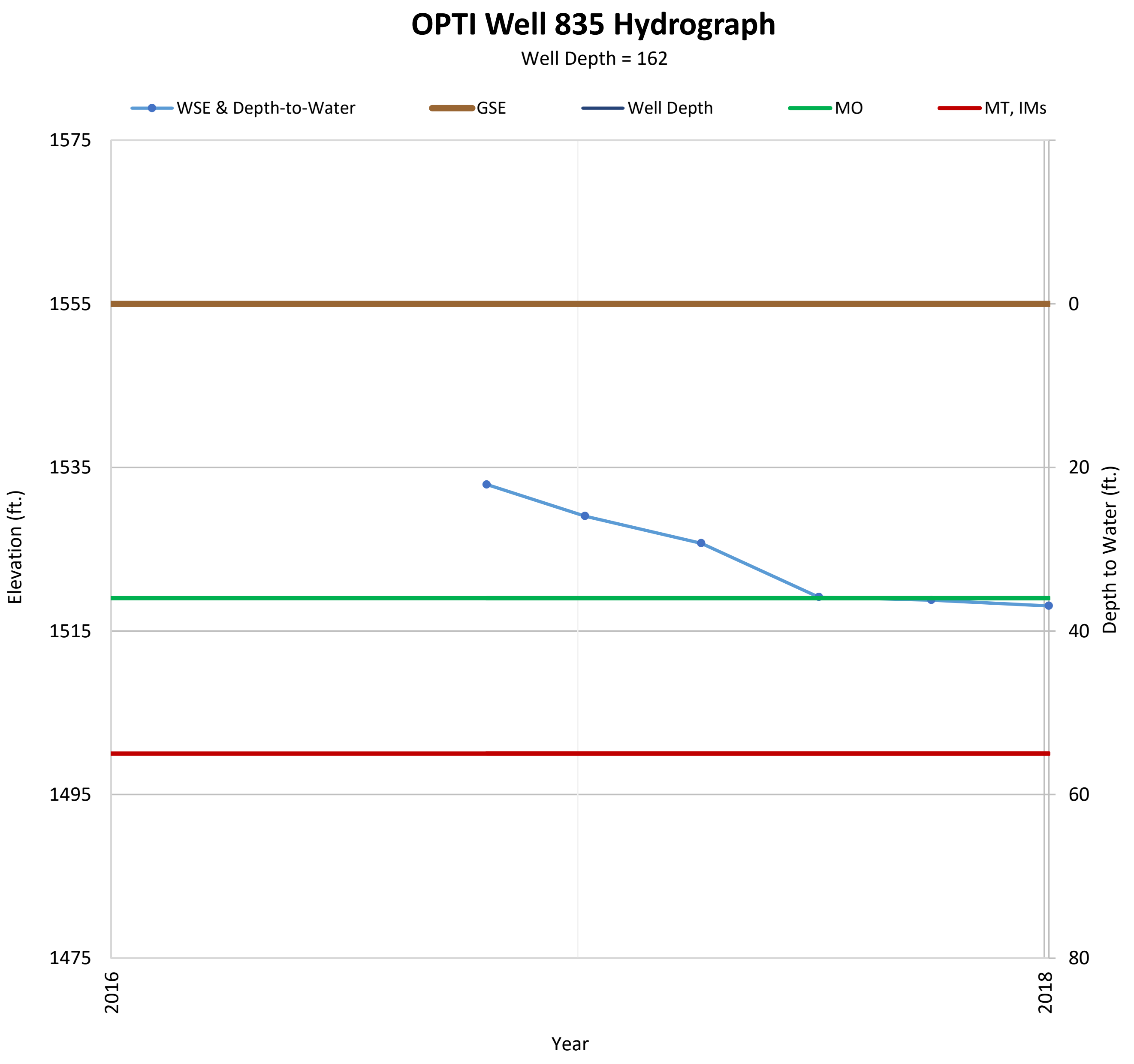

OPTI Well 832 Hydrograph
Well Depth = 132
WSE & Depth-to-Water
GSE
Well Depth
MO
MT, IMs
Elevation (ft.)
1650
1630
1610
1590
1570
1550
Depth to Water (ft.)
0
20
40
60
80
2015
2017
Year

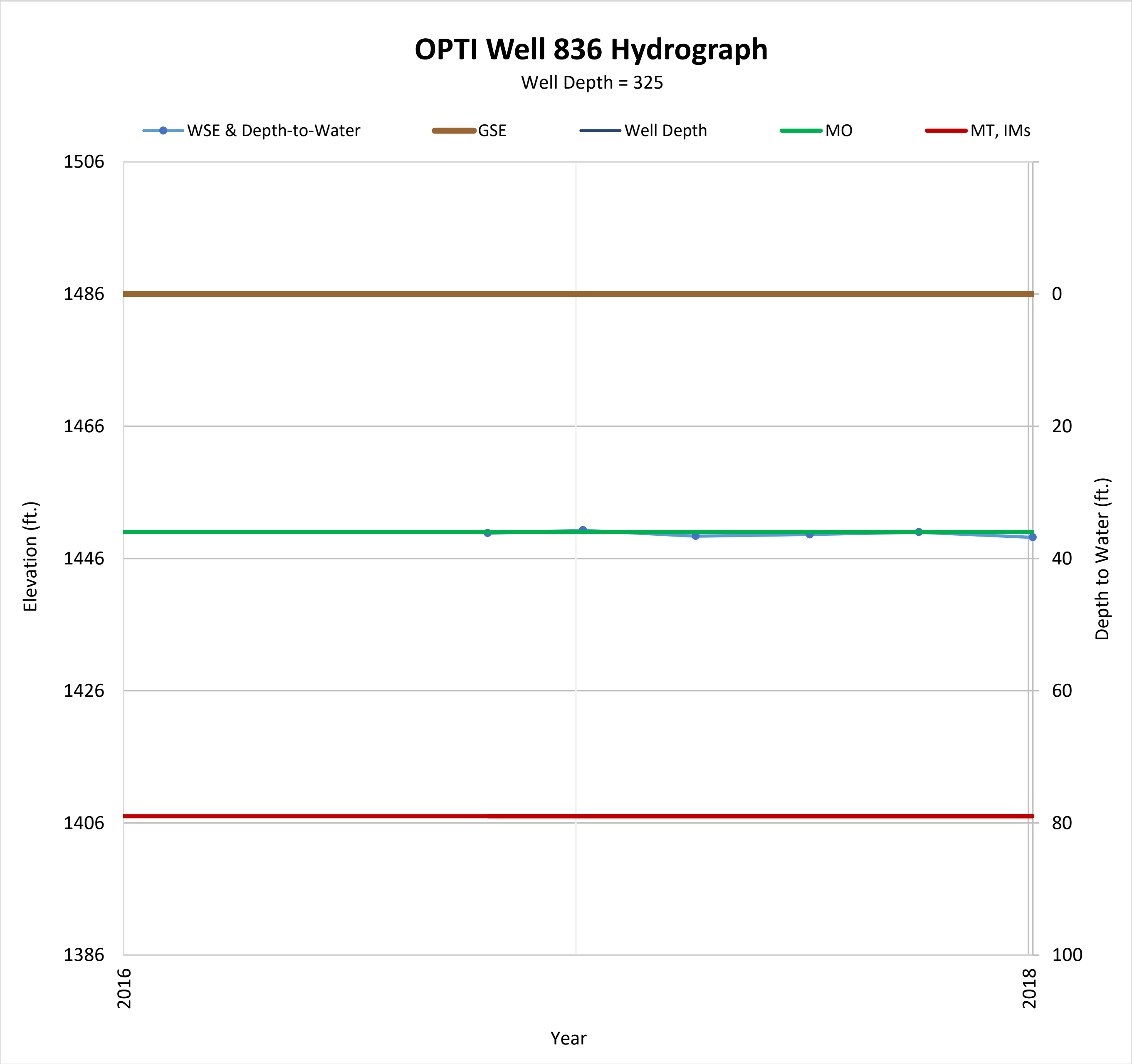

OPTI Well 833 Hydrograph
Well Depth = 504
WSE & Depth-to-Water
GSE
Well Depth
MO
MT, IMs
Elevation (ft.)
1477
1457
1437
1417
1397
1377
1357
1337
Depth to Water (ft.)
0
20
40
60
80
100
120
2016
2018
Year

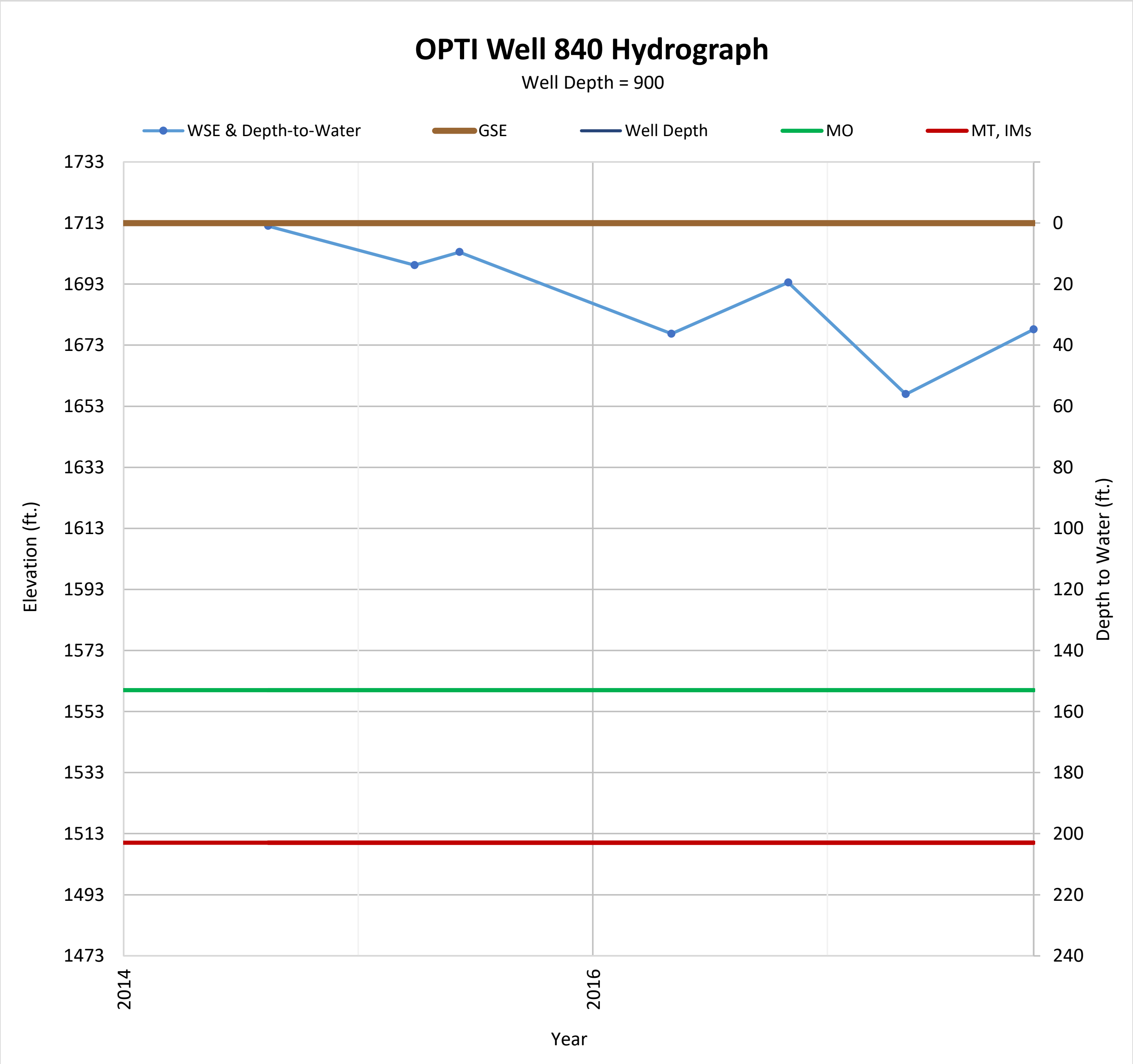


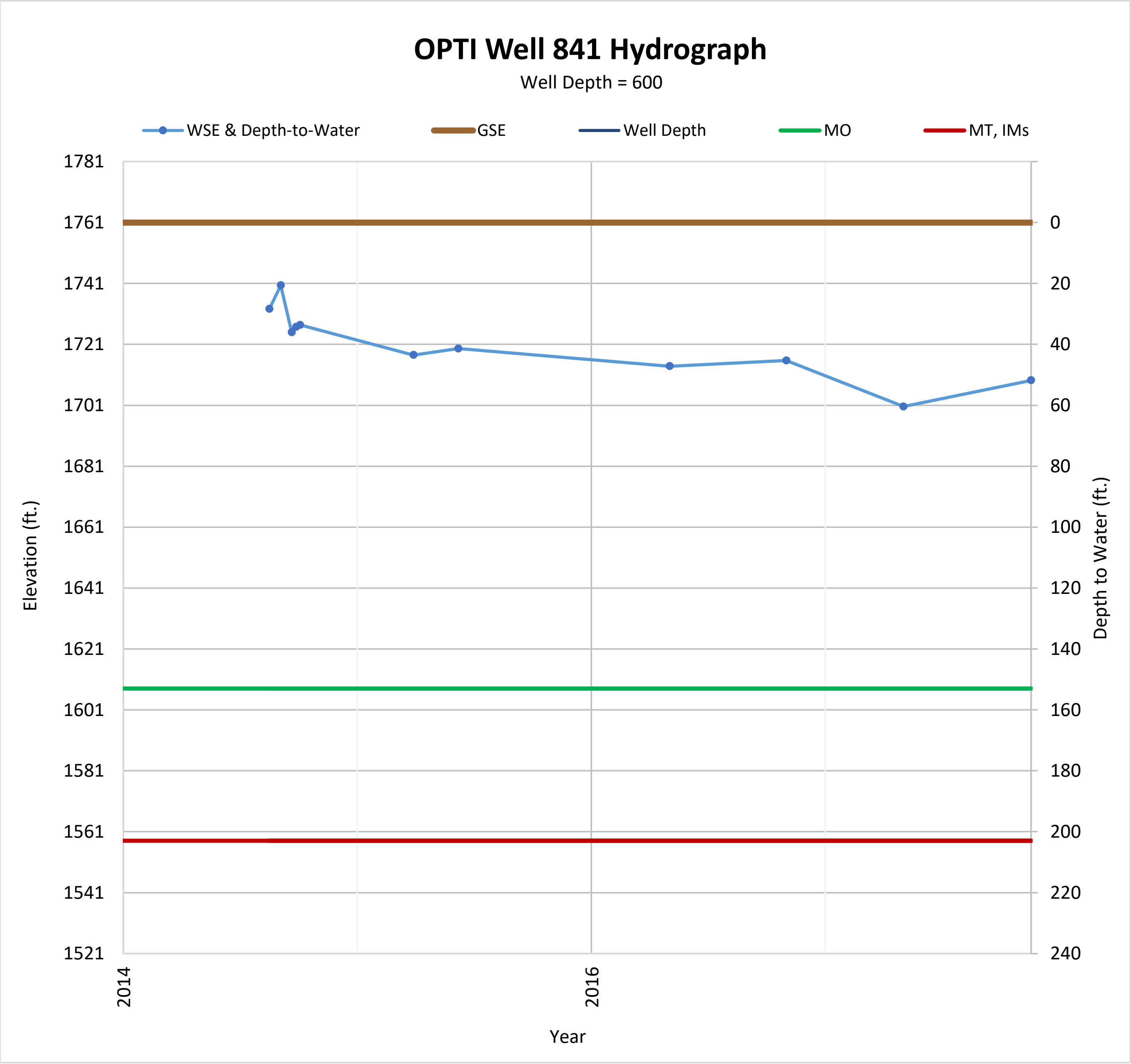
OPTI Well 834 Hydrograph

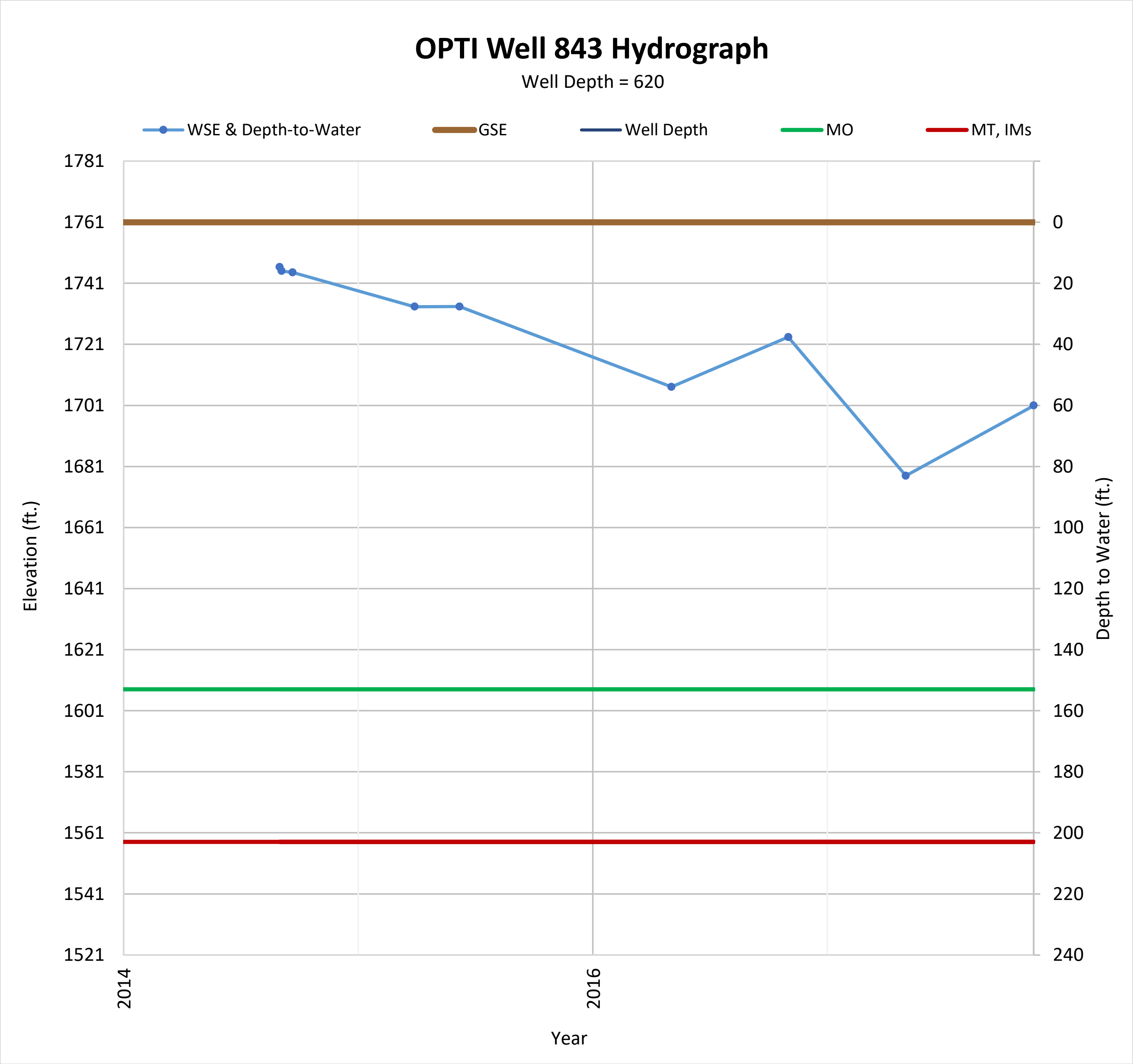
Well Depth = 320


OPTI Well 835 Hydrograph
Well Depth = 162
WSE & Depth-to-Water
GSE
Well Depth
MO
MT, IMs
Elevation (ft.)
1575
1555
1535
1515
1495
1475
Depth to Water (ft.)
0
20
40
60
80
2016
2018
Year


OPTI Well 836 Hydrograph
Well Depth = 325
WSE & Depth-to-Water
GSE
Well Depth
MO
MT, IMs
1506
1486
1466
1446
1426
1406
1386
Elevation (ft.)
0
20
40
60
80
100
Depth to Water (ft.)
2016
2018
Year

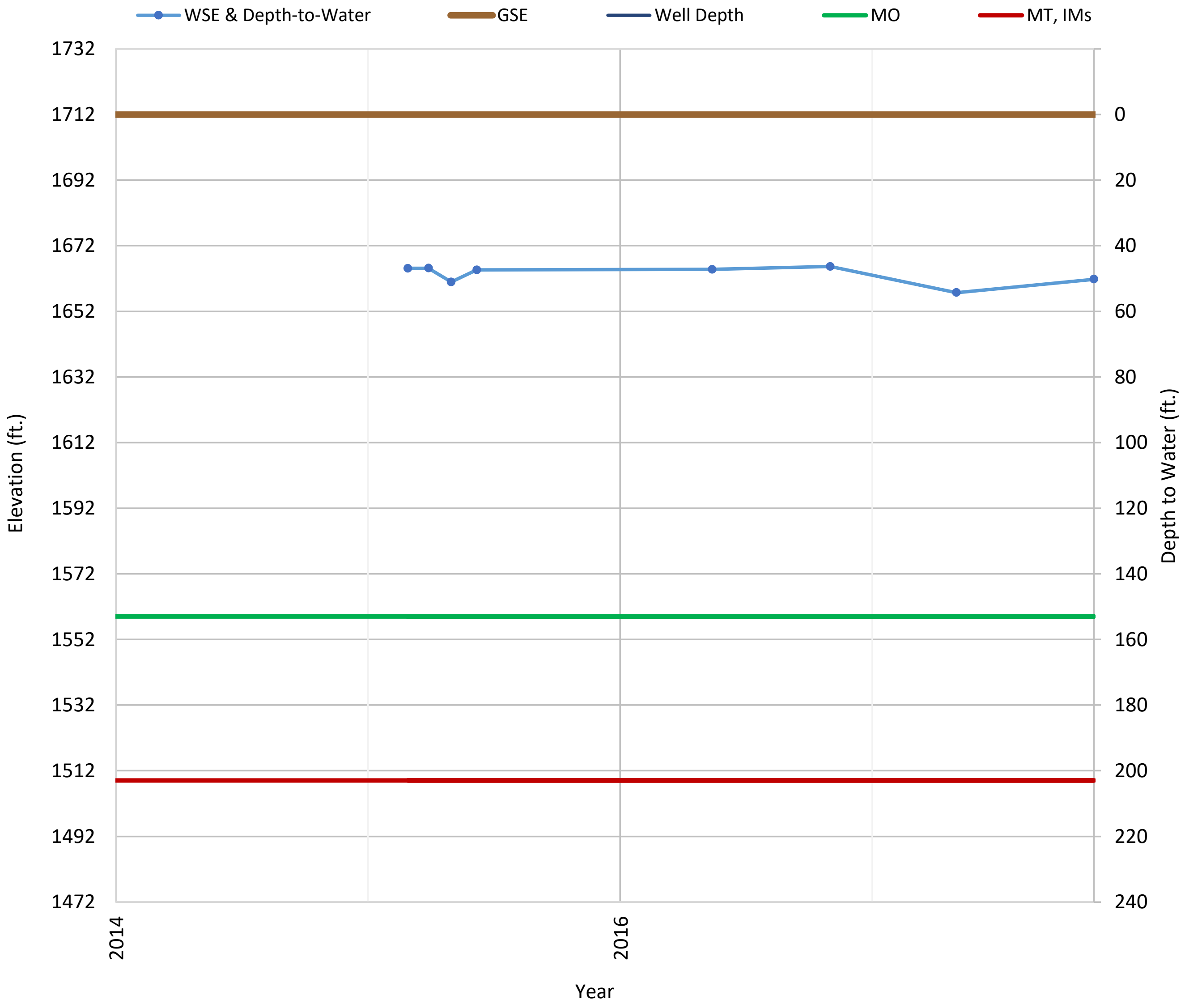

OPTI Well 840 Hydrograph
Well Depth = 900
WSE & Depth-to-Water
GSE
Well Depth
MO
MT, IMs
Elevation (ft.)
1733
1713
1693
1673
1653
1633
1613
1593
1573
1553
1533
1513
1493
1473
Depth to Water (ft.)
0
20
40
60
80
100
120
140
160
180
200
220
240
2014
2016
Year

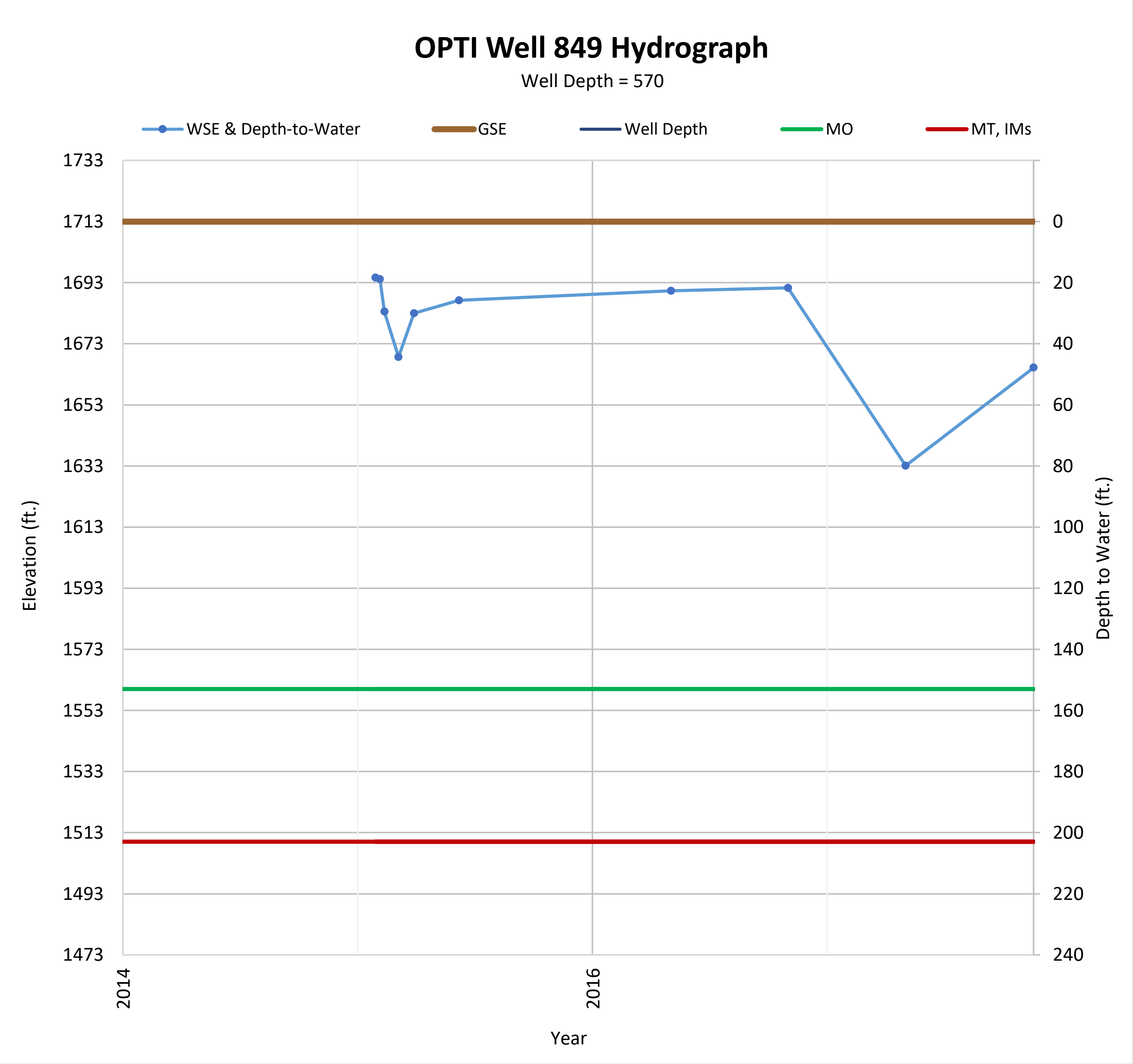

OPTI Well 841 Hydrograph
Well Depth = 600
WSE & Depth-to-Water
GSE
Well Depth
MO
MT, IMs
Elevation (ft.)
1781
1761
1741
1721
1701
1681
1661
1641
1621
1601
1581
1561
1541
1521
Depth to Water (ft.)
0
20
40
60
80
100
120
140
160
180
200
220
240
2014
2016
Year


OPTI Well 843 Hydrograph
Well Depth = 620
WSE & Depth-to-Water
GSE
Well Depth
MO
MT, IMs
Elevation (ft.)
1781
1761
1741
1721
1701
1681
1661
1641
1621
1601
1581
1561
1541
1521
Depth to Water (ft.)
0
20
40
60
80
100
120
140
160
180
200
220
240
2014
2016
Year

## OPTI Well 845 Hydrograph

Well Depth = 380




OPTI Well 849 Hydrograph
Well Depth = 570
WSE & Depth-to-Water
GSE
Well Depth
MO
MT, IMs
Elevation (ft.)
1733
1713
1693
1673
1653
1633
1613
1593
1573
1553
1533
1513
1493
1473
Depth to Water (ft.)
0
20
40
60
80
100
120
140
160
180
200
220
240
2014
2016
Year

# Chapter 6 Appendix

# Chapter 6
# Appendix A

## Cuyama Basin Data Management System
## Opti Data Public User Guide

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# Cuyama Basin Data Management System

# opti DATA

## Public User Guide

Cuyama Basin Groundwater Sustainability Agency

Woodard & Curran

# Opti Public User Guide

Opti is a one-stop-shop for transparent data management and analysis that enables integrated performance tracking to support sustainable water management. This Public User Guide has been developed to assist you with navigation and usage of the Cuyama Basin Data Management System (DMS). Please see the Appendix for specific data types and quality codes configured in this implementation.

The DMS may be accessed at: http://opti.woodardcurran.com/cuyama

Please click on Guest Login to access the DMS as a guest user. If you would like to gain additional access to the DMS for data updates and management, please contact: Taylor Blakslee (tblakslee@hgcpm.com).

Public usage of the DMS is explained in the following modules:

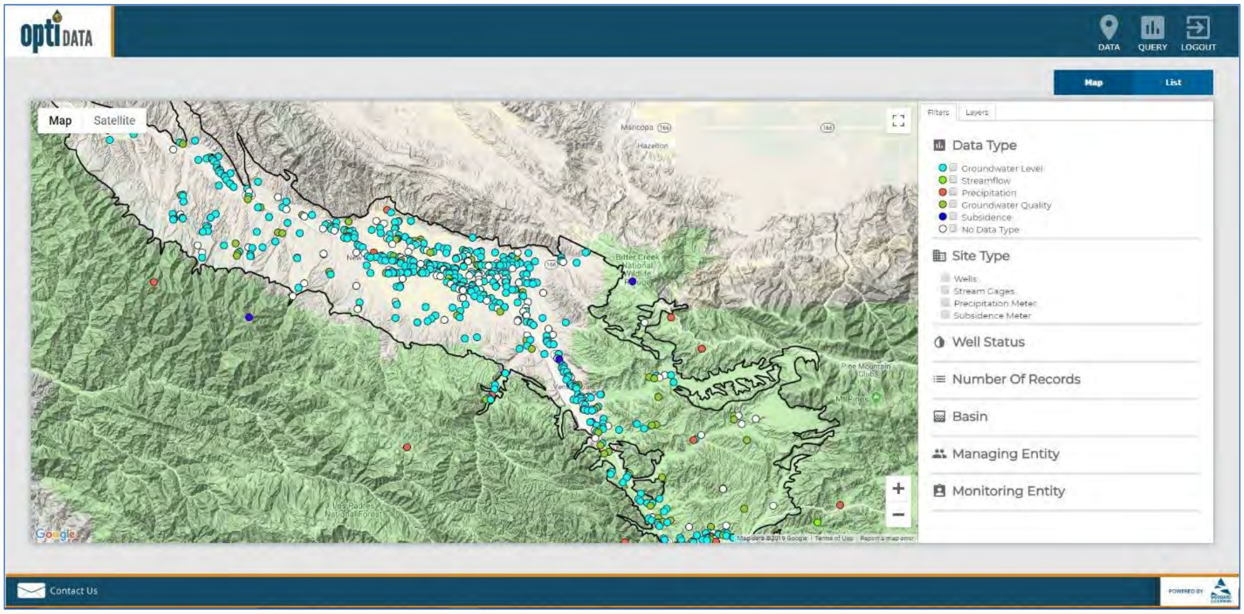
- Data
- Query

## Module: Data (Top)

The Data module contains two available submodules that allow you to view water resources data and their associated site information: Map and List. Upon entering the DMS, a welcome message will be displayed. Click Close to continue to the Map.

### *Submodule: Map*

The Map submodule displays the sites (wells, stream gages, facilities, etc.) as point locations on the map.

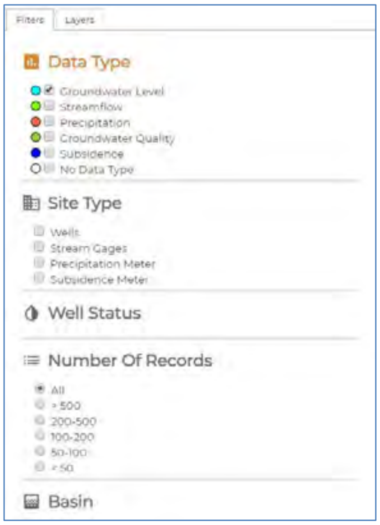


**Feature: Change the Google Map display**

- To move the location or extent of the map display, use the “+” and “-“ icons in the lower right-hand corner of the map. You may use the pan tool to move the focal location of the display.
- To change the base layer of the map display, select an option from the upper left-hand side of the map display (Map or Satellite).

**Feature: Filter the results displayed on the map**

- On the Filters tab on the right-hand panel, select the checkboxes for the options for which you would like to filter the results.
- Select sites based on:
  - data type associated with the site,
  - site type,
  - number of data records,
  - entity, or
  - a combination of any filter.



Please note that sites may have more than one data type associated with them, e.g., groundwater level and groundwater quality.

**Feature: Change the layers displayed on the map**

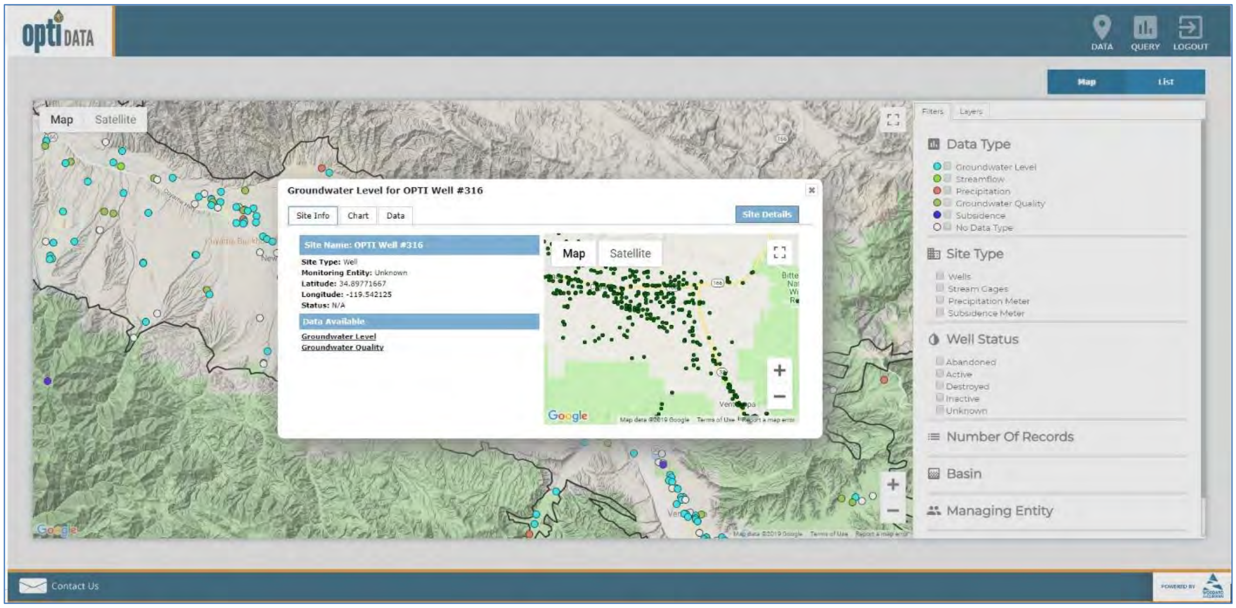
- Click on the Layers tab on the right-hand panel.
- Select the layers that you wish to have displayed. Upon selection, the map will be updated to show the selected layers.
- You may click on features on the layer to view information on that feature.

**Feature: View site information on the map**

- Click on a site on the map. The site information will be displayed with tabs for Site Info, Chart, and Data.
- To view site detailed information, click on the Details link. The Site Details page will open.
- To view a chart of the data, click on the Chart tab. You may change the parameter by selecting a parameter from the drop-down list in the upper right-hand corner. You may update the chart timeline by selecting the Start Date and End Date and clicking Update. You may export the data to Excel by clicking Export.
- To view a table of the data, click on the Data tab. You may change the parameter by selecting a parameter from the drop-down list in the upper right-hand corner. You may narrow the tabular

list by selecting the Start Date and End Date and clicking Update. You may export the data by clicking Export.

- To select a different data type for the site, click on the data type available under “Data Available” on the Site Info tab.



**Groundwater Level for OPTI Well #316**

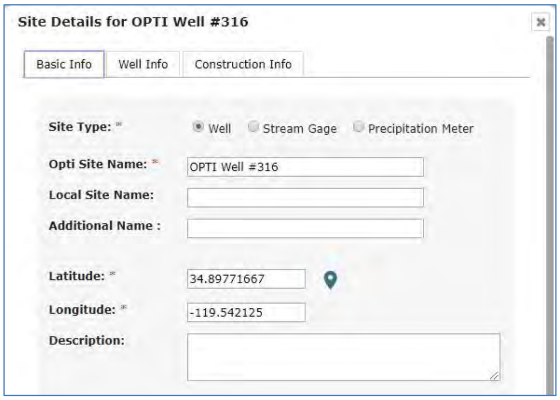
Site Info | Chart | Data | Site Details

**Site Name: OPTI Well #316**

**Site Type:** Well
**Monitoring Entity:** Unknown
**Latitude:** 34.89771667
**Longitude:** -119.542125
**Status:** N/A

**Data Available**

Groundwater Level
Groundwater Quality

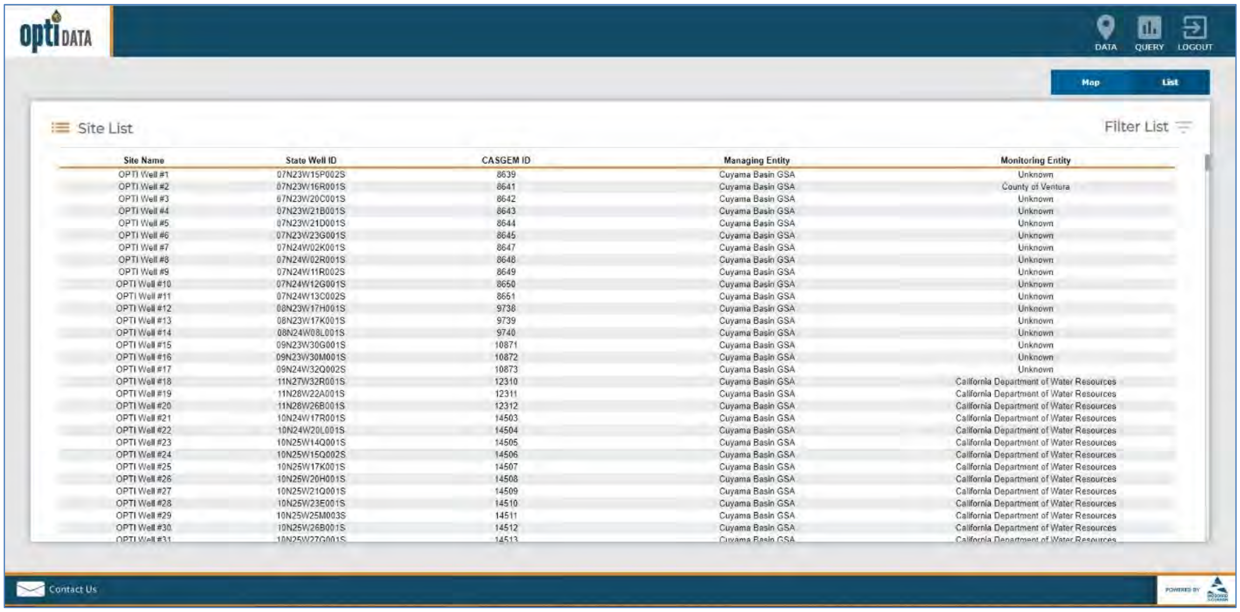

**Site Details for OPTI Well #316**

Basic Info | Well Info | Construction Info

**Site Type:** * ● Well ○ Stream Gage ○ Precipitation Meter
**Opti Site Name:** * OPTI Well #316
**Local Site Name:**
**Additional Name :**
**Latitude:** * 34.89771667
**Longitude:** * -119.542125
**Description:**

## *Submodule: List*

The List submodule contains a list of sites in a sortable, tabular format.



| Site Name | State Well ID | CASGEM ID | Managing Entity | Monitoring Entity |
|---|---|---|---|---|
| OPTI Well #1 | 07N23W15P002S | 8639 | Cuyama Basin GSA | Unknown |
| OPTI Well #2 | 07N23W16R001S | 8641 | Cuyama Basin GSA | County of Ventura |
| OPTI Well #3 | 07N23W20C001S | 8642 | Cuyama Basin GSA | Unknown |
| OPTI Well #4 | 07N23W21B001S | 8643 | Cuyama Basin GSA | Unknown |
| OPTI Well #5 | 07N23W21D001S | 8644 | Cuyama Basin GSA | Unknown |
| OPTI Well #6 | 07N23W23G001S | 8645 | Cuyama Basin GSA | Unknown |
| OPTI Well #7 | 07N24W02K001S | 8647 | Cuyama Basin GSA | Unknown |
| OPTI Well #8 | 07N24W02R001S | 8648 | Cuyama Basin GSA | Unknown |
| OPTI Well #9 | 07N24W11R002S | 8649 | Cuyama Basin GSA | Unknown |
| OPTI Well #10 | 07N24W12G001S | 8650 | Cuyama Basin GSA | Unknown |
| OPTI Well #11 | 07N24W13C002S | 8651 | Cuyama Basin GSA | Unknown |
| OPTI Well #12 | 08N23W17H001S | 9738 | Cuyama Basin GSA | Unknown |
| OPTI Well #13 | 08N23W17K001S | 9739 | Cuyama Basin GSA | Unknown |
| OPTI Well #14 | 08N24W08L001S | 9740 | Cuyama Basin GSA | Unknown |
| OPTI Well #15 | 09N23W30G001S | 10871 | Cuyama Basin GSA | Unknown |
| OPTI Well #16 | 09N23W30M001S | 10872 | Cuyama Basin GSA | Unknown |
| OPTI Well #17 | 09N24W32Q002S | 10873 | Cuyama Basin GSA | Unknown |
| OPTI Well #18 | 11N27W32R001S | 12310 | Cuyama Basin GSA | California Department of Water Resources |
| OPTI Well #19 | 11N28W22A001S | 12311 | Cuyama Basin GSA | California Department of Water Resources |
| OPTI Well #20 | 11N28W26B001S | 12312 | Cuyama Basin GSA | California Department of Water Resources |
| OPTI Well #21 | 10N24W17R001S | 14503 | Cuyama Basin GSA | California Department of Water Resources |
| OPTI Well #22 | 10N24W20L001S | 14504 | Cuyama Basin GSA | California Department of Water Resources |
| OPTI Well #23 | 10N25W14Q001S | 14505 | Cuyama Basin GSA | California Department of Water Resources |
| OPTI Well #24 | 10N25W15Q002S | 14506 | Cuyama Basin GSA | California Department of Water Resources |
| OPTI Well #25 | 10N25W17K001S | 14507 | Cuyama Basin GSA | California Department of Water Resources |
| OPTI Well #26 | 10N25W20H001S | 14508 | Cuyama Basin GSA | California Department of Water Resources |
| OPTI Well #27 | 10N25W21Q001S | 14509 | Cuyama Basin GSA | California Department of Water Resources |
| OPTI Well #28 | 10N25W23E001S | 14510 | Cuyama Basin GSA | California Department of Water Resources |
| OPTI Well #29 | 10N25W25M003S | 14511 | Cuyama Basin GSA | California Department of Water Resources |
| OPTI Well #30 | 10N25W26B001S | 14512 | Cuyama Basin GSA | California Department of Water Resources |
| OPTI Well #31 | 10N25W27G001S | 14513 | Cuyama Basin GSA | California Department of Water Resources |

### Feature: Filter and/or sort sites

- Select data type, site type, number of records, or entity from the drop-down menu at the top of the table to filter sites.
- Click on the table headers to alphabetically or numerically sort the selected column.

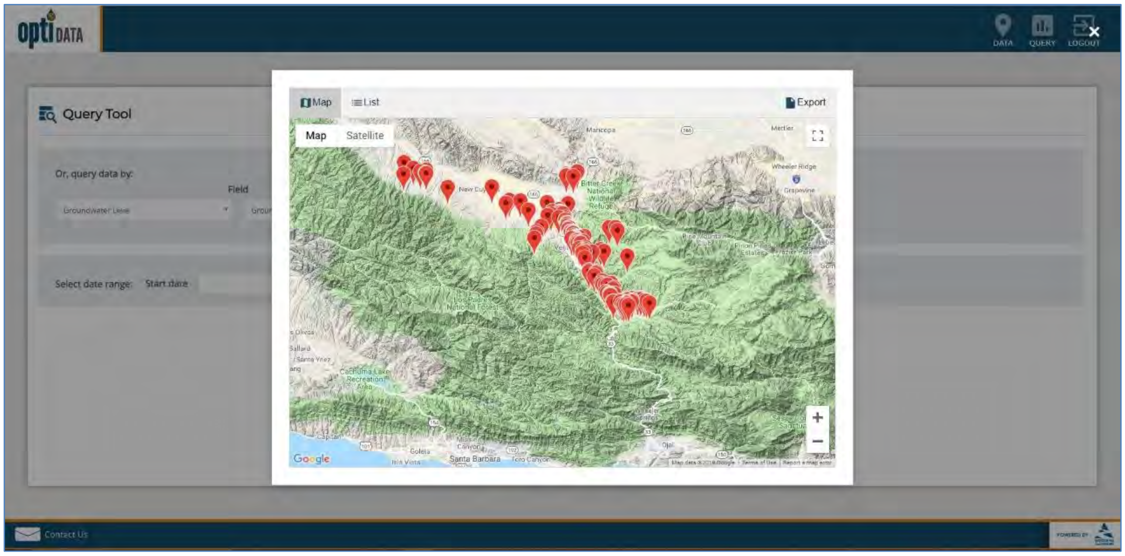
### Feature: View site information from list

- Click on the selected site name in the list. The site information will be displayed with tabs for Site Info, Chart, and Data. The Site Details page is available through this dialogue box. The following information may be available:

| Basic Info | Well Info | Construction Info |
|---|---|---|
| Site Type<br>Opti Site Name<br>Local Site Name<br>Additional Name<br>Latitude/Longitude<br>Description<br>County<br>Managing Entity<br>Monitoring Entity<br>Type of Monitoring<br>Type of Measurement<br>Monitoring Frequency | State Well ID<br>MSC (Master State Well Code)<br>USGS Code<br>CASGEM ID<br>Ground Surface Elevation (ft)<br>Reference Point Elevation (ft)<br>Reference Point Location<br>Reference Point Description<br>Well Use<br>Well Status<br>Well Type<br>Aquifers Monitored<br>Groundwater Basin Name/Code<br>Groundwater Elevation Begin/End Date<br>Groundwater Elevation Measurement Count<br>Water Level Measurement Method<br>Groundwater Quality Begin/End Date<br>Groundwater Quality Measurement Count<br>Comments | Total Well Depth<br>Borehole Depth<br>Casing Perforations<br>Top/Bottom Elevation<br>Casing Diameter<br>Casing Modifications<br>Well Capacity<br>Well Completion Report Number<br>Comments |

## Module: Query (Top)

The Query module allows users to search for sites and data using different parameters and values.



### Feature: Create new query

- Click on the Query icon in the menu.
- To create a new query:
  - Select the following options from the drop-down menu under “Or, query data by:”:
    - Entity
    - Site Name
    - Groundwater Level
    - Streamflow
    - Precipitation
    - Groundwater Quality
    - Surface Water Quality
  - If the selected option has associated parameters, select a parameter in the second drop-down menu.
  - Select an Operator. Please note that for text searches, you may use the “Like” option with wildcards (%).
  - To add additional rows to the query, click on the blue “+” button and complete.
  - To remove rows from the query, click on the red “-“ button.
- To select data within a particular date range, complete the Start date and End date fields.
- Click Run. A window will open with a map view of the results.
  - Click on the site in the map to view the data for the site.
  - Click on the List tab to view the data in a list format. You may click on a site to view the data.
  - Click on Export to export the data to Excel.
- To clear the query, click the Clear button at the bottom of the page.

## Appendix – Cuyama Basin Specific Implementation Information

### Data Types

The following data types are currently configured in the DMS. Please note that this list may change as more data becomes available.

| Data Type | Parameter | Units | Currently Has Data in DMS |
|---|---|---|---|
| Groundwater Elevation | Depth to Groundwater | feet | Yes |
| | Groundwater Elevation | feet | Yes |
| Groundwater Quality | Total Dissolved Solids (TDS) | MG/L | Yes |
| | Nitrate (NO3) | MG/L | Yes |
| | Arsenic | UG/L | Yes |
| | Benzene | UG/L | |
| | Chloride | MG/L | |
| | Hexavalaent Chromium (CR6) | UG/L | |
| | Dibromochloropropane (DBCP) | UG/L | |
| | Methyl Tertiary Butyl Ether (MTBE) | UG/L | |
| | Perchlorate | UG/L | |
| | Tetrachloroethylene (PCE) | UG/L | |
| | Specific Electrical Conductivity (SC) | UMHOS/CM | |
| | 1,1,1-Trichloroethane (111-TCA) | UG/L | |
| | Trichloroethylene (TCE) | UG/L | |
| | 1,2,3-Trichloropropane (123-TCP) | UG/L | |
| | CL | PPM | |
| | EC | Mmhos | |
| | TDS | PPM | |
| Streamflow | Streamflow | CFS | Yes |
| Precipitation | Precipitation | inches | Yes |
| | Reference Evapotranspiration (ETo) | | |
| | Average Air Temperature | | |
| Subsidence | Subsidence | Vertical (mm) | Yes |

## Quality Flags for Measurement Data

The following quality flags are currently configured in the DMS. Please note that this list may change as more data becomes available.

| ID | Quality Flag | Associated Data Type |
|---|---|---|
| 1 | Caved or deepened | Groundwater Level |
| 2 | Pumping | Groundwater Level |
| 3 | Nearby pump operating | Groundwater Level |
| 4 | Casing leaking or wet | Groundwater Level |
| 5 | Pumped recently | Groundwater Level |
| 6 | Air or pressure gauge measurement | Groundwater Level |
| 7 | Other | Groundwater Level |
| 8 | Recharge or surface water effects near well | Groundwater Level |
| 9 | Oil or foreign substance in casing | Groundwater Level |
| 10 | Acoustical sounder | Groundwater Level |
| 11 | Recently flowing | Groundwater Level |
| 12 | Flowing | Groundwater Level |
| 13 | Nearby flowing | Groundwater Level |
| 14 | Nearby recently flowing | Groundwater Level |
| 15 | Measurement Discontinued | Groundwater Level |
| 16 | Pumping | Groundwater Level |
| 17 | Pump house locked | Groundwater Level |
| 18 | Tape hung up | Groundwater Level |
| 19 | Can't get tape in casing | Groundwater Level |
| 20 | Unable to locate well | Groundwater Level |
| 21 | Well has been destroyed | Groundwater Level |
| 22 | Special/Other | Groundwater Level |
| 23 | Casing leaking or wet | Groundwater Level |
| 24 | Temporarily inaccessible | Groundwater Level |
| 25 | Dry well | Groundwater Level |
| 26 | Flowing artesian well | Groundwater Level |

# 2022 Update Appendices

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# 2022 Update
# Appendix A

## DWR “Incomplete” Determination of the 2020 Cuyama Valley Basin GSP

CALIFORNIA DEPARTMENT OF WATER RESOURCES
SUSTAINABLE GROUNDWATER
MANAGEMENT OFFICE
715 P Street | Sacramento, CA 95814 | P.O. Box 942836 | Sacramento, CA 94236-0001

January 21, 2022

Taylor Blakslee
Groundwater Sustainability Agency Project Coordinator
4900 California Ave, Tower B, 2nd Floor
Bakersfield, CA 93309
tblakslee@hgcpm.com

RE: "Incomplete" Determination of the 2020 Cuyama Valley Basin Groundwater Sustainability Plan

Dear Taylor Blakslee,

The Department of Water Resources (Department) has evaluated the groundwater sustainability plan (GSP) submitted for the Cuyama Valley Basin (Basin) and has determined that the GSP is "Incomplete". The Department based its determination on recommendations from the Staff Report, included as an enclosure to the attached Statement of Findings, which describes that the Cuyama Valley Basin GSP does not satisfy the objectives of the Sustainable Groundwater Management Act (SGMA) nor substantially comply with the GSP Regulations. The Staff Report also provides corrective actions which the Department recommends to address the identified deficiencies.

The Basin's Groundwater Sustainability Agency (GSA) has 180 days, the maximum allowed by GSP Regulations, to address the identified deficiencies. Where addressing the deficiencies requires modification of the GSP, the GSA must adopt those modifications into the Basin's GSP or otherwise demonstrate that those modifications are part of the GSP before resubmitting it to the Department for evaluation no later than July 20, 2022. The Department understands that much work has occurred to advance sustainable groundwater management since the GSA submitted the GSP in January 2020. To the extent to which those efforts are related or responsive to the Department's identified deficiencies, we encourage you to document that as part of your resubmittal. The Department prepared a Frequently Asked Questions document to provide general information and guidance on the process of addressing deficiencies in an "Incomplete" Determination.

Department staff will work expeditiously to review the revised components of your GSP resubmittal. If the revisions address the identified deficiencies, the Department will determine that the GSP is "Approved". In that scenario, Department staff will identify additional recommended corrective actions that the GSA should address early in implementing their GSP (i.e., no later than the first required periodic evaluation). Among other items, those recommendations will include for the GSA to provide more detail on their plans and schedules to address data gaps. Those recommendations will also call for significantly expanded documentation of the plans and schedules to implement specific projects and management actions. Regardless of those recommended corrective actions, the Department expects the first periodic evaluations, required no later than January 2025 – one-quarter of the way through the

20-year implementation period – to document significant progress toward achieving sustainable groundwater management.

If the GSA cannot address the deficiencies identified in this letter by July 20, 2022, then the Department, after consultation with the State Water Resources Control Board, will determine the GSP to be "Inadequate". In that scenario, the State Water Resources Control Board may identify additional deficiencies that the GSA would need to address in the state intervention processes outlined in SGMA.

Please contact Sustainable Groundwater Management staff by emailing sgmps@water.ca.gov if you have any questions about the Department's assessment, implementation of your GSP, or to arrange a meeting with the Department.

Thank You,

Paul Gosselin

Paul Gosselin
Deputy Director of Sustainable Groundwater Management

Attachment:

1. Statement of Findings Regarding the Determination of Incomplete Status of the Cuyama Valley Basin Groundwater Sustainability Plan

# STATE OF CALIFORNIA
# DEPARTMENT OF WATER RESOURCES

## STATEMENT OF FINDINGS REGARDING THE DETERMINATION OF INCOMPLETE STATUS OF THE CUYAMA VALLEY BASIN GROUNDWATER SUSTAINABILITY PLAN

The Department of Water Resources (Department) is required to evaluate whether a submitted groundwater sustainability plan (GSP or Plan) conforms to specific requirements of the Sustainable Groundwater Management Act (SGMA or Act), is likely to achieve the sustainability goal for the basin covered by the Plan, and whether the Plan adversely affects the ability of an adjacent basin to implement its GSP or impedes achievement of sustainability goals in an adjacent basin. (Water Code § 10733.) The Department is directed to issue an assessment of the Plan within two years of its submission. (Water Code § 10733.4.) This Statement of Findings explains the Department's decision regarding the Plan submitted by the Cuyama Basin Groundwater Sustainability Agency (GSA) for the Cuyama Valley Basin (No. 3-013).

Department management has reviewed the enclosed Staff Report, which recommends that the identified deficiencies should preclude approval of the GSP. Based on its review of the Staff Report, Department management is satisfied that staff have conducted a thorough evaluation and assessment of the Plan and concurs with, and hereby adopts, staff's recommendation and all the corrective actions provided. The Department thus deems the Plan incomplete based on the Staff Report and the findings contained herein.

A. The GSP lacks justification for the sustainable management criteria for groundwater levels, particularly the minimum thresholds and undesirable results, and an explanation of the effects of those criteria on the interests of beneficial uses and users of groundwater.

   1. The GSP does not discuss, or appear to address, the specific significant and unreasonable effects caused by chronic lowering of groundwater levels that would constitute undesirable results. In the absence of a specific explanation of those effects, and the conditions that would cause those effects, the GSP states that an undesirable result would occur if groundwater level minimum thresholds are exceeded in 30 percent of monitoring wells for two consecutive years. The Department cannot assess the reasonableness of the whether the quantitative, 30-percent definition would avoid undesirable results because the GSAs have not defined the specific conditions that would be significant and unreasonable.

   2. The GSP lacks explanation of the justification for setting its site-specific minimum thresholds and also lacks explanation of the anticipated effects

of groundwater conditions at those thresholds on the interests of the beneficial uses and users of groundwater.

B. The GSP does not reasonably describe how groundwater levels will be used as a proxy to monitor for, and avoid, undesirable results associated with depletion of interconnected surface water. The GSP uses levels established for the chronic lowering of groundwater levels sustainability indicator in representative wells across the entire basin, regardless of proximity to rivers and tributaries, as a proxy for depletion of interconnected surface water. The GSP does not demonstrate, with adequate evidence, that the groundwater level thresholds are a reasonable proxy for the rate or volume of surface water depletions caused by groundwater use that has adverse impacts on beneficial uses of the surface water and may lead to undesirable results.

C. The GSP does not appear to fully address degraded water quality. Public comments received by the Department suggest that the GSA did not consider certain publicly available water quality data. The Department finds that there is a reasonable likelihood that consideration of that data could lead the GSA to alter their assessment of groundwater quality, including the need to develop monitoring programs and sustainable management criteria.

D. The GSP does not provide sufficient explanation for how overdraft will be mitigated in the basin. Two primary management areas are identified by the GSA to continue experiencing declines in groundwater in storage, but the GSA only intends to reduce groundwater pumping in one of those management areas. The GSP does not explain how continued overdraft in the remaining management area would be mitigated through projects and actions. Additionally, an area of the basin that was not identified as a management area (the Northwestern threshold region) was, nonetheless, projected to experience more than 140 feet of groundwater level decline, relative to 2015, during implementation of the GSP. The GSP did not describe how the apparently allowable overdraft in this region would affect beneficial uses and users of groundwater and avoid undesirable results.

Based on the above, the GSP submitted by the GSA for the Cuyama Valley Basin is determined to be incomplete because the GSP does not satisfy the requirements of SGMA, nor does it substantially comply with the GSP Regulations. The corrective actions provided in the Staff Report are intended to address the deficiencies that, at this time, preclude approval. The GSA has up to 180 days to address the deficiencies outlined above and detailed in the Staff Report. Once the GSA resubmits its Plan, the Department will review the revised GSP to evaluate whether the deficiencies were adequately addressed. Should the GSA fail to take sufficient actions to correct the deficiencies identified by the Department in this assessment, the Department shall disapprove the Plan if, after consultation with the State Water Resources Control Board, the Department determines the Plan inadequate pursuant to 23 CCR § 355.2(e)(3)(C).

Signed:

Karla Nemeth, Director

Date: January 21, 2022

Enclosure: Groundwater Sustainability Plan Assessment Staff Report – Cuyama Valley Basin

# State of California
# Department of Water Resources
# Sustainable Groundwater Management Program
# Groundwater Sustainability Plan Assessment Staff Report

| | |
|---|---|
| Groundwater Basin Name: | Cuyama Valley Basin (No. 3-013) |
| Submitting Agency: | Cuyama Basin Groundwater Sustainability Agency |
| Recommendation: | Incomplete |
| Date: | January 21, 2022 |

The Sustainable Groundwater Management Act (SGMA)[1] allows for any of the three following planning scenarios: a single groundwater sustainability plan (GSP) developed and implemented by a single groundwater sustainability agency (GSA); a single GSP developed and implemented by multiple GSAs; and multiple GSPs implemented by multiple GSAs and coordinated pursuant to a single coordination agreement.[2] Here, as presented in this staff report, a single GSP covering the entire basin was adopted and submitted to the Department of Water Resources (Department) for review.[3]

The Cuyama Basin GSA submitted the Cuyama Valley Basin Groundwater Sustainability Plan (GSP or Plan) to the Department for evaluation and assessment as required by SGMA and the GSP Regulations.[4] The GSP covers the entire Cuyama Valley Basin (Cuyama Basin or Basin) for the implementation of SGMA.

Evaluation and assessment by the Department is based on whether the adopted and submitted GSP, either individually or in coordination with other adopted and submitted GSPs, complies with SGMA and substantially complies with GSP Regulations. Department staff base their assessment on information submitted as part of an adopted GSP, public comments submitted to the Department, and other materials, data, and reports that are relevant to conducting a thorough assessment. Department staff have evaluated the Cuyama Basin GSP and have identified deficiencies that staff recommend should preclude its approval.[5] In addition, consistent with the GSP Regulations, Department staff have provided corrective actions[6] that the GSA should review while determining how and whether to address the deficiencies. The deficiencies and corrective actions are explained in greater detail in Section 3 of this staff report and are generally related to the need to justify the established sustainable management criteria and the

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[1] Water Code § 10720 *et seq*.
[2] Water Code § 10727.
[3] Water Code §§ 10727(b)(1), 10733.4; 23 CCR § 355.2.
[4] 23 CCR § 350 *et seq*.
[5] 23 CCR §355.2(e)(2).
[6] 23 CCR §355.2(e)(2)(B).

effects of those criteria on the beneficial uses and users in the manner required by SGMA and the GSP Regulations.

This assessment includes four sections:

- **Section 1 – Evaluation Criteria:** Describes the legislative requirements and the Department's evaluation criteria.
- **Section 2 – Required Conditions:** Describes the submission requirements, Plan completeness, and basin coverage required for a GSP to be evaluated by the Department.
- **Section 3 – Plan Evaluation:** Provides a detailed assessment of deficiencies identified in the GSP which may be capable of being corrected by the GSA. Consistent with the GSP Regulations, Department staff have provided corrective actions for the GSA to address the deficiencies.
- **Section 4 – Staff Recommendation:** Provides the recommendation of Department staff regarding the Department's determination.

# 1 EVALUATION CRITERIA

The Department evaluates whether a GSP conforms to the statutory requirements of SGMA[7] and is likely to achieve the basin's sustainability goal.[8] To achieve the sustainability goal, the GSP must demonstrate that implementation of its groundwater sustainability program will lead to sustainable groundwater management, which means the management and use of groundwater in a manner that can be maintained during the planning and implementation horizon without causing undesirable results.[9] Undesirable results are required to be defined quantitatively by the GSAs overlying a basin and occur when significant and unreasonable effects for any of the applicable sustainability indicators are caused by groundwater conditions occurring throughout the basin.6[10] The Department is also required to evaluate whether the GSP will adversely affect the ability of an adjacent basin to implement its groundwater sustainability program or achieve its sustainability goal.[11]

To evaluate a GSP, the Department must first determine a GSP was submitted by the statutory deadline,[12] is complete,[13] and covers the entire basin.[14] For those GSAs choosing to develop multiple GSPs, the GSPs must be coordinated pursuant to a single coordination agreement that covers the entire basin.[15] If these conditions are satisfied, the Department evaluates the GSP to determine whether it complies with SGMA and substantially complies with the GSP Regulations.[16] As stated in the GSP Regulations, "[s]ubstantial compliance means that the supporting information is sufficiently detailed and the analyses sufficiently thorough and reasonable, in the judgment of the Department, to evaluate the Plan, and the Department determines that any discrepancy would not materially affect the ability of the Agency to achieve the sustainability goal for the basin, or the ability of the Department to evaluate the likelihood of the Plan to attain that goal."[17]

When evaluating whether implementation of the GSP is likely to achieve the sustainability goal for the basin, Department staff review the information provided and relied upon in the GSP for sufficiency, credibility, and consistency with scientific and engineering professional standards of practice.[18] The Department's review considers whether there is a reasonable relationship between the information provided by the GSA and the

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[7] Water Code §§ 10727.2, 10727.4.
[8] Water Code §§ 10733(a).
[9] Water Code § 10721(v).
[10] 23 CCR § 354.26 *et seq*.
[11] Water Code § 10733(c).
[12] Water Code § 10720.7; 23 CCR § 355.4(a)(1).
[13] 23 CCR §§ 355.4(a)(2).
[14] 23 CCR § 355.4(a)(3).
[15] Water Code §§ 10727(b)(3), 10727.6; 23 CCR § 357.4.
[16] 23 CCR § 350 *et seq*.
[17] 23 CCR § 355.4(b).
[18] 23 CCR § 351(h).

assumptions and conclusions presented in the GSP, including whether the interests of the beneficial uses and users of groundwater in the basin have been considered; whether sustainable management criteria and projects and management actions described in the GSP are commensurate with the level of understanding of the basin setting; and whether those projects and management actions are feasible and likely to prevent undesirable results.[19] The Department also considers whether the GSA has the legal authority and financial resources necessary to implement the GSP.[20]

To the extent that overdraft is present in a basin, the Department evaluates whether the GSP provides a reasonable assessment of the overdraft and includes reasonable means to mitigate it.[21] When applicable, the Department will assess whether coordination agreements have been adopted by all relevant parties and satisfy the requirements of SGMA and the GSP Regulations.[22] The Department also considers whether the GSP provides reasonable measures and schedules to eliminate identified data gaps.[23] Lastly, the Department's review considers the comments submitted on the GSP and evaluates whether the GSA adequately responded to the comments that raise credible technical or policy issues with the GSP.[24]

The Department is required to evaluate the GSP within two years of its submittal date and issue a written assessment.[25] The assessment is required to include a determination of the GSP's status.[26] The GSP Regulations provide three options for determining the status of a GSP: approved,[27] incomplete,[28] or inadequate.[29]

After review of the GSP, Department staff may find that the information provided is not sufficiently detailed, or the analyses not sufficiently thorough and reasonable, to evaluate whether the GSP is likely to achieve the sustainability goal for the basin. If the Department determines the deficiencies precluding approval may be capable of being corrected by the GSA in a timely manner,[30] the Department will determine the status of the GSP to be incomplete. A formerly deemed incomplete GSP may be resubmitted to the Department for reevaluation after all deficiencies have been addressed by the GSA within 180 days after the Department makes its incomplete determination. The Department will review the revised GSP to evaluate whether the identified deficiencies were sufficiently addressed. Depending on the outcome of that evaluation, the Department may determine the resubmitted GSP is approved. Alternatively, the Department may find a formerly deemed

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[19] 23 CCR §§ 355.4(b)(1), (3), (4) and (5).
[20] 23 CCR § 355.4(b)(9).
[21] 23 CCR § 355.4(b)(6).
[22] 23 CCR § 355.4(b)(8).
[23] 23 CCR § 355.4(b)(2).
[24] 23 CCR § 355.4(b)(10).
[25] Water Code § 10733.4(d); 23 CCR § 355.2(e).
[26] Water Code § 10733.4(d); 23 CCR § 355.2(e).
[27] 23 CCR § 355.2(e)(1).
[28] 23 CCR § 355.2(e)(2).
[29] 23 CCR § 355.2(e)(3).
[30] 23 CCR § 355.2 (e)(2)(B)(i).

incomplete GSP is inadequate if, after consultation with the State Water Resources Control Board, it determines that the GSA has not taken sufficient actions to correct any identified deficiencies.[31]

Even when the Department determines a GSP is approved, indicating that it satisfies the requirements of SGMA and is in substantial compliance with the GSP Regulations, the Department may still recommend corrective actions.[32] Recommended corrective actions are intended to facilitate progress in achieving the sustainability goal within the basin and the Department's future evaluations, and to allow the Department to better evaluate whether implementation of the GSP adversely affects adjacent basins. While the issues addressed by the recommended corrective actions in an approved GSP do not, at the time the determination was made, preclude its approval, the Department recommends that the issues be addressed to ensure the GSP's implementation continues to be consistent with SGMA and the Department is able to assess progress in achieving the basin's sustainability goal.[33] Unless otherwise noted, the Department proposes that recommended corrective actions be addressed by the submission date for the first five-year assessment.[34]

The staff assessment of the GSP involves the review of information presented by the GSA, including models and assumptions, and an evaluation of that information based on scientific reasonableness. In conducting its assessment, the Department does not recalculate or reevaluate technical information provided in the GSP or perform its own geologic or engineering analysis of that information. The recommendation to approve a GSP does not signify that Department staff, were they to exercise the professional judgment required to develop a GSP for the basin, would make the same assumptions and interpretations as those contained in the GSP, but simply that Department staff have determined that the assumptions and interpretations relied upon by the submitting GSA are supported by adequate, credible evidence, and are scientifically reasonable.

Lastly, the Department's review of an approved GSP is a continual process. Both SGMA and the GSP Regulations provide the Department with the ongoing authority and duty to review the implementation of the GSP.[35] Also, GSAs have an ongoing duty to reassess their GSPs, provide annual reports to the Department and, when necessary, update or amend their GSPs.[36] The passage of time or new information may make what is reasonable and feasible at the time of this review to not be so in the future. The emphasis of the Department's periodic reviews will be to assess the progress toward achieving the sustainability goal for the basin and whether GSP implementation adversely affects the ability of adjacent basins to achieve its sustainability goals.

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[31] 23 CCR § 355.2 (e)(3)(C).

[32] Water Code § 10733.4(d).

[33] Water Code § 10733.8.

[34] 23 CCR § 356.4.

[35] Water Code § 10733.8; 23 CCR § 355.6 *et seq*.

[36] Water Code §§ 10728 *et seq.*, 10728.2.

# 2 REQUIRED CONDITIONS

A GSP, to be evaluated by the Department, must be submitted within the applicable statutory deadline.[37] The GSP must also be complete and must, either on its own or in coordination with other GSPs, cover the entire basin. If a GSP is determined to be incomplete, Department staff may require corrective actions that address minor or potentially significant deficiencies identified in the GSP. The GSAs in a basin, whether developing a single GSP covering the basin or multiple GSPs, must sufficiently address those required corrective actions within the time provided, not to exceed 180 days, for the GSP to be reevaluated by the Department and potentially approved.

## 2.1 SUBMISSION DEADLINE

SGMA required basins categorized as high- or medium-priority as of January 1, 2017 and that were subject to critical conditions of overdraft to submit a GSP no later than January 31, 2020.[38]

The GSA submitted the Cuyama GSP on January 28, 2020, in compliance with the statutory deadline.

## 2.2 COMPLETENESS

GSP Regulations specify that the Department shall evaluate a GSP if that GSP is complete and includes the information required by SGMA and the GSP Regulations.[39]

The GSA submitted an adopted GSP for the entire Cuyama Basin. Department staff found the GSP to be complete and include the required information, sufficient to warrant an evaluation by the Department. The Department posted the GSP to its website on January 31, 2020.

## 2.3 BASIN COVERAGE

A GSP, either on its own or in coordination with other GSPs, must cover the entire basin.[40] A GSP that intends to cover the entire basin may be presumed to do so if the basin is fully contained within the jurisdictional boundaries of the submitting GSAs.

The GSP intends to manage the entire Cuyama Basin, and the jurisdictional boundary of the submitting GSA covers the Basin.

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[37] Water Code § 10720.7.

[38] Water Code § 10720.7(a)(1).

[39] 23 CCR § 355.4(a)(2).

[40] Water Code § 10727(b); 23 CCR § 355.4(a)(3)

# 3 PLAN EVALUATION

As stated in Section 355.4 of the GSP Regulations, a basin "shall be sustainably managed within 20 years of the applicable statutory deadline consistent with the objectives of the Act." The Department's assessment is based on a number of related factors including whether the elements of a GSP were developed in the manner required by the GSP Regulations, whether the GSP was developed using appropriate data and methodologies and whether its conclusions are scientifically reasonable, and whether the GSP, through the implementation of clearly defined and technically feasible projects and management actions, is likely to achieve a tenable sustainability goal for the basin.

Department staff have identified deficiencies in the GSP, the most serious of which preclude staff from recommending approval of the GSP at this time. Department staff believe the GSAs may be able to correct the identified deficiencies within 180 days. Consistent with the GSP Regulations, Department staff are providing corrective actions related to the deficiencies, detailed below, including the general regulatory background, the specific deficiency identified in the GSP, and the specific actions to address the deficiency.

Following receipt of a letter regarding potential deficiencies and corrective actions issued by the Department on June 3, 2021, the Cuyama Basin GSA submitted a Technical Memorandum (Tech Memo) to the Department on November 5, 2021. Although the Tech Memo states that the "memorandum is intended to supplement the Cuyama Basin GSP that was submitted in January 2020 and fill potential gaps identified in the Letter provided by DWR," Department staff are unclear whether the Tech Memo is part of the GSP because no description of the process to incorporate the Tech Memo into the GSP was provided to the Department. Therefore, while Department staff acknowledge the steps taken by the GSA to begin to address deficiencies, the content provided in the Tech Memo is not incorporated into this assessment of the GSP submitted to the Department for review.

## 3.1 DEFICIENCY 1. THE GSP LACKS JUSTIFICATION FOR, AND EFFECTS ASSOCIATED WITH, THE SUSTAINABLE MANAGEMENT CRITERIA FOR GROUNDWATER LEVELS.

### 3.1.1 Background

SGMA defines sustainable groundwater management as the management and use of groundwater in a manner that can be maintained during the planning and implementation horizon without causing undesirable results.[41] The avoidance of undesirable results is thus explicitly part of sustainable groundwater management, as established by SGMA, and critical to the success of a GSP. To achieve sustainable groundwater management

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[41] Water Code § 10721(v).

under SGMA, the basin must experience no undesirable results by the end of the 20-year GSP implementation period and be able to demonstrate an ability to maintain those defined sustainable conditions over the 50-year planning and implementation horizon.

The definition of undesirable results is thus critical to the establishment of an objective method to define and measure sustainability for a basin. As an initial matter, SGMA provides a qualitative definition of undesirable results as “one or more” of six specific “effects caused by groundwater conditions occurring throughout the basin.”[42] SGMA identifies the effects related to chronic lowering of groundwater levels as those “…indicating a significant and unreasonable depletion of supply if continued over the planning and implementation horizon.”

It is up to GSAs to define, in their GSPs, the specific significant and unreasonable effects that would constitute undesirable results and to define the groundwater conditions that would produce those results in their basins.[43] The GSA’s definition needs to include a description of the processes and criteria relied upon to define undesirable results and must describe the effect of undesirable results on the beneficial uses and users of groundwater. From this definition, the GSA establishes minimum thresholds, which are quantitative values that represent groundwater conditions at representative monitoring sites that, when exceeded individually or in combination with minimum thresholds at other monitoring sites, may cause the basin to experience undesirable results.[44]

SGMA leaves the task of establishing undesirable results and setting thresholds largely to the discretion of the GSA, subject to review by the Department. In its review, the Department requires a thorough and reasonable analysis of the groundwater conditions the GSA is trying to avoid, and the GSA’s stated rationale for setting objective and quantitative sustainable management criteria to prevent those conditions from occurring. If a Plan does not meet this requirement, the Department is unable to evaluate the likelihood of the Plan in achieving its sustainability goal. This does not necessarily mean that the GSP or its objectives are inherently unreasonable; however, it is unclear which conditions the GSA seeks to avoid, making it difficult for the Department to monitor whether the GSA will be successful in that effort when implementing its GSP.

### 3.1.2 Deficiency Details

The first deficiency relates to the GSP’s lack of explanation and justification for selecting sustainable management criteria for groundwater levels, particularly the minimum thresholds and undesirable results, and the effects of those criteria on the interests of beneficial uses and users of groundwater. Based on its evaluation, Department staff are concerned that although the GSP appears to realistically quantify the water budget and identify the extent of overdraft in the Basin using the best available information, and while the GSP proposes projects and management actions that appear likely to eventually

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[42] Water Code § 10721(x).

[43] 23 CCR § 354.26.

[44] 23 CCR § 354.28, DWR Best Management Practices for the Sustainable Management of Groundwater: Sustainable Management Criteria (DRAFT), November 2017.

eliminate overdraft in portions of the Basin, the GSP has not defined sustainable management criteria in the manner required by SGMA and the GSP Regulations.

#### 3.1.2.1 Undesirable Results

The GSP provides quantitative values for the minimum thresholds and includes a combination of those minimum threshold exceedances that the GSA considers causing an undesirable result. However, the GSP does not discuss, or appear to address, the critical first step of identifying the specific significant and unreasonable effects that would constitute undesirable results. The GSP provides general statements about undesirable results (e.g., "The Undesirable Result for the chronic lowering of groundwater levels is a result that causes significant and unreasonable reduction in the long-term viability of domestic, agricultural, municipal, or environmental uses over the planning and implementation horizon of this GSP."[45]) and generic descriptions of the effects of undesirable results (e.g., "…the Undesirable Results could cause potential de-watering of existing groundwater infrastructure, starting with the shallowest wells…"[46]), but does not provide an explanation for the specific significant and unreasonable condition(s) that the GSA intends to avoid in the Basin through implementation of the GSP (e.g., a level of impact to well infrastructure or to environmental uses).

The GSP states undesirable results for chronic lowering of groundwater levels would occur when groundwater level minimum thresholds are exceeded in 30 percent of monitoring wells for two consecutive years. The same criterion of 30 percent for two consecutive years is used for reduction in storage, degradation of groundwater quality, land subsidence, and depletion of interconnected surface water.

However, the GSP does not provide an explanation for why the criterion is consistent with avoiding significant and unreasonable effects that constitute undesirable results or how the GSA may respond should these conditions have potential for occurring.

#### 3.1.2.2 Minimum Thresholds

The GSP lacks explanation of the justification for setting its minimum thresholds and also lacks explanation of the anticipated effects of groundwater conditions at those thresholds on the interests of the beneficial uses and users of groundwater in nearly all threshold regions. The GSP describes that each threshold region has its own formula to determine the quantitative minimum threshold (e.g., in the Central threshold region it is determined by subtracting 20 percent of the historical range in groundwater levels from the groundwater level observed in early 2015). While it is acceptable to set minimum thresholds differently in portions of a basin, all minimum thresholds must, by the definition of that term in the GSP Regulations, relate to the conditions that could cause undesirable results.

This lack of information is particularly notable in the Northwestern threshold region. The GSP states that the intention of the sustainable management criteria for the Northwestern

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[45] Cuyama Basin GSP, Section 3.2.1, p. 260.
[46] *Ibid*.

region is to "…protect the water levels from declining significantly, while allowing beneficial land surface uses (including domestic and agricultural uses) and using the storage capacity of this region."[47] However, the Northwestern region is the only region in the Basin where the sustainable management criteria indicate a plan to substantially lower groundwater levels, relative to conditions at the time of GSP preparation (i.e., the minimum thresholds for groundwater levels are up to 140 to 160 feet lower[48]), in an area with the highest concentration of potential GDEs[49] in Cuyama Valley and with interconnected surface water, which is evidenced by a gaining reach of the river.[50] The GSP did not quantify the expected depletions of surface water over time or assess or disclose the anticipated effects of the established minimum thresholds on beneficial uses and users of groundwater, which, based on Department staff's review, appear to include nearby domestic users, potential GDEs, and users of the interconnected surface water.

The absence of this information and related discussion precludes meaningful disclosure to, and participation by, interested parties and residents in the Basin. In addition, without this discussion it is difficult for Department staff to determine whether it is appropriate or reasonable for the GSA to conclude that undesirable results in the Basin would not occur unless nearly a third of representative monitoring points exceed their minimum thresholds for two consecutive years.

### 3.1.3 Corrective Actions

The GSA must provide more detailed information, as required in the GSP Regulations, regarding undesirable results and minimum thresholds for all applicable threshold regions.[51] The GSA should describe the anticipated effects of the established minimum thresholds and undesirable results on the interests of beneficial uses and users and how the GSA determined that those thresholds would avoid undesirable results in the Basin. Department staff suggest the GSA consider and address the following:

1. The GSA should describe the specific undesirable results they aim to avoid through implementing the GSP. For example, if the long-term viability of domestic, agricultural, municipal, or environmental uses is a concern with respect to lowering of groundwater levels, then the GSA should describe the specific effects on those users that the GSA considers significant and unreasonable and define groundwater conditions that would lead to those effects. Clarify how the criteria defining when undesirable results occur in the Basin (i.e., 30 percent exceedance of minimum thresholds for two consecutive years) was established, the rationale behind the approach, and why it is consistent with avoiding the significant and unreasonable effects identified by the GSA.

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[47] Cuyama Basin GSP, Section 5.2.2, p. 352.

[48] Cuyama Basin GSP, Chapter 5 Appendix A, p. 1505-1509.

[49] Cuyama Basin GSP, Section 2.2.9, p. 227, Figures 2-63 and 2-64, p. 230-231, Chapter 2-Appendix D, p. 1258-1279.

[50] Cuyama Basin GSP, Section 2.2.8, p. 222, Figure 2-61, p. 223.

[51] 23 CCR §§ 354.26, 354.28.

2. The GSA should either explain how the existing minimum threshold groundwater levels are consistent with avoiding undesirable results or they should establish minimum thresholds at the representative monitoring wells that account for the specific undesirable results the GSA aims to avoid. For each threshold region, the GSA should evaluate and disclose the anticipated effects of the GSP's minimum thresholds and undesirable results on:

    a. Well infrastructure, including domestic wells, community and public water supply wells, and agricultural wells. The GSA may utilize the Department's well completion report dataset[52] or other similar data to estimate the number and kinds of wells expected to be impacted at the minimum thresholds identified in the GSP. Public water system well locations and water quality data can currently be obtained using the State Water Resource Control Board's (State Water Board) Geotracker website.[53] Administrative contact information for public water systems and well locations and contacts for state small water systems and domestic wells can be obtained by contacting the State Water Board's Needs Analysis staff.[54] The State Water Board is currently developing a database to allow for more streamlined access to this data in the future.

       Should wells be identified as at risk of going dry at or near minimum threshold conditions, describe the extent of those impacts on beneficial users including:location, number, and type of wells impacted; the beneficial uses and users effected; and any identified project or management action that may be taken to address the condition. If the GSA identifies potential impacts to drinking water wells, including de minimis users and disadvantaged communities, those impacts should be described in the GSP.

       By the first five-year update, the GSA should inventory and better define the location of active wells in the Basin. The GSA should document known impacts to drinking water users caused by groundwater management, should they occur, in annual reports and subsequent periodic updates.

    b. Environmental uses and users of groundwater. If data are not available to support evaluation of the effects of established minimum thresholds on environmental uses and users, the GSA should clarify the strategy,

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[52] Well Completion Report Map Application. California Department of Water Resources, https://www.arcgis.com/apps/webappviewer/index.html?id=181078580a214c0986e2da28f8623b37.

[53] GeoTracker Application. California State Water Resources Control Board, https://geotracker.waterboards.ca.gov/map/#; select "Public Water Wells" under the "Other Sites" option and navigate to the area of interest.

[54] DDW-SAFER-NAU@Waterboards.ca.gov.

mechanism, and timeline for acquiring that data and incorporating that data into management of the Basin.[55]

## 3.2 DEFICIENCY 2. THE GSP DOES NOT FULLY DESCRIBE THE USE OF GROUNDWATER LEVELS AS A PROXY FOR DEPLETION OF INTERCONNECTED SURFACE WATER.

### 3.2.1 Background

SGMA identifies six effects of groundwater conditions occurring throughout the basin that GSAs must evaluate to achieve sustainable groundwater management. The GSP Regulations refer to these effects as sustainability indicators and they are chronic lowering of groundwater levels, reduction of groundwater storage, seawater intrusion, degraded water quality, land subsidence, and depletions of interconnected surface water.[56] Generally, when any of these effects are significant and unreasonable, as defined in SGMA, they are referred to as undesirable results.[57] SGMA requires GSAs to sustainably manage groundwater, which is defined as avoiding undesirable results for any sustainability indicator during the planning and implementation horizon.[58] Specifically, for each applicable indicator a GSA must develop sustainable management criteria, describe the process used to develop those criteria, and establish a monitoring network to adequately monitor conditions.[59]

A GSA that is able to demonstrate one or more sustainability indicators are not present and are not likely to occur in the basin is not required to develop sustainable management criteria for those indicators.[60] Absent an explanation of why a sustainability indicator is not applicable, the Department assumes all sustainability indicators apply.[61] Demonstration of applicability (or non-applicability) of sustainability indicators must be supported by best available information and science and should be provided in descriptions throughout the GSP (e.g. information describing basin setting, discussion of the interests of beneficial users and uses of groundwater).

The Department's assessment of a Plan's likelihood to achieve its sustainability goal for its basin is based, in part, on whether a GSP provides sufficiently detailed and reasonable supporting information and analysis for all applicable indicators. The GSP Regulations require the Department to evaluate whether establishment of sustainable management criteria is commensurate with the level of understanding of the basin setting.[62]

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[55] 23 CCR §§ 355.4(b)(2), 355.4(b)(3).
[56] 23 CCR § 351(ah).
[57] Water Code § 10721(x).
[58] Water Code §§ 10721(v), 10721(r).
[59] 23 CCR §§ 354.22, 354.32.
[60] 23 CCR §§ 354.22, 354.26(d), 354.28(e).
[61] DWR Best Management Practices for the Sustainable Management of Groundwater: Sustainable Management Criteria (DRAFT), November 2017.
[62] 23 CCR § 355.4(b)(3).

The GSP Regulations require a GSP to identify interconnected surface water systems in the basin and evaluate the quantity and timing of depletions of those systems using the best available information.[63] As noted above, absent a demonstration of the inapplicability of the depletion of interconnected surface water sustainability indicator, GSAs in basins with interconnected surface waters must develop sustainable management criteria for those depletions as described in the GSP Regulations.

### 3.2.2 Deficiency Details

The second deficiency relates to the GSP lacking a demonstration, with supporting evidence, of the reasonableness of using groundwater level thresholds as a proxy for depletion of interconnected surface water. The GSP states that "[b]y setting minimum thresholds on shallow groundwater wells near surface water, the [GSA] can to (*sic)* monitor and manage [the hydraulic gradient between surface water and groundwater], and in turn, manage potential changes in depletions of interconnected surface [water]."[64] However, in defining the groundwater level proxies for depletion of interconnected surface water, the GSA appears to have used all the groundwater level thresholds it defined for chronic lowering of groundwater levels regardless of depth of the well or proximity to surface water. It is not obvious to Department staff why managing the Basin to the complete set of chronic lowering of groundwater level thresholds is sufficient to avoid undesirable results for depletion of interconnected surface water, especially since many of those groundwater level thresholds represent conditions that are lower than current conditions.

### 3.2.3 Corrective Action

The GSA should provide a demonstration, with supporting evidence, for why using the basinwide groundwater level minimum thresholds is a reasonable proxy for thresholds for depletion of interconnected surface water. If the representative monitoring network for interconnected surface water is modified, discuss how the definition of an undesirable result is affected.

## 3.3 DEFICIENCY 3. THE GSP DOES NOT FULLY ADDRESS DEGRADED WATER QUALITY.

### 3.3.1 Background

SGMA and the GSP Regulations do not require a GSP to address undesirable results associated with degraded water quality that occurred before, and have not been corrected by, January 1, 2015. However, management of a basin pursuant to an adopted GSP should not result in further water quality degradation that is significant and unreasonable, either due to routine groundwater use or as a result of implementing projects or management actions called for in the GSP.[65] SGMA provides GSAs with legal authority

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[63] 23 CCR §§ 354.28(c)(6)(A), 354.28(c)(6)(B).
[64] Cuyama Basin GSP, Section 3.2.6, p. 263.
[65] Water Code § 10721(x)(4); 23 CCR § 354.28(c)(4).

to regulate and affect pumping and groundwater levels, which have the potential to affect the concentration or migration of water quality constituents and result in degradation of water quality. Additionally, the GSP Regulations state that GSAs should consider local, state, and federal water quality standards when establishing sustainable management criteria,[66] and SGMA provides GSAs with the authority to manage and control polluted water and use authorities under existing laws to implement its GSP.[67] Thus, establishing sustainable management criteria and performing routine monitoring of water quality constituents known to affect beneficial uses and users is within the purview of a GSA.

### 3.3.2 Deficiency Details

The third deficiency relates to the GSP's role in monitoring for, managing, and avoiding degraded water quality. Department staff believe the GSA's decision to not set sustainable management criteria for arsenic and nitrates may not be reasonable because the findings were not supported by the best available information.[68] The GSP focused on total dissolved solids (TDS), nitrates, and arsenic as a result of public comments received during GSP development.[69] The GSP includes sustainable management criteria for TDS but, despite acknowledging that nitrate and arsenic have exceeded maximum contaminant levels (MCL) prescribed by the State Water Board, the GSP did not establish sustainable management criteria for those constituents. Furthermore, the GSA does not intend to perform routine monitoring for nitrates and arsenic on the basis that they determined there is no "causal nexus" between the GSA's authority to implement projects and management actions and concentrations of arsenic or nitrate.[70]

In its justification for the lack of sustainable management criteria for nitrates and arsenic, the GSP explains that there were relatively few detections of those constituents above drinking water regulatory limits—two nitrate samples and three arsenic samples.[71] Regarding arsenic, the GSP states that the three arsenic detections above the MCL came from an inactive well and from groundwater deeper than 700 feet below ground surface, which the GSP states is below the range of pumping depths for drinking water.[72] In other words, the GSP states that arsenic was not detected above MCL in active wells shallower than 700 feet.[73] However, credible public comments submitted to the Department raised concerns about this claim and the data the GSA may or may not have considered, the GSA's interpretation of that data, and the decision of the GSA to not monitor or develop management criteria for those constituents. For example, a comment submitted to the

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[66] 23 CCR § 354.28(c)(4).

[67] Water Code §§ 10726.2(e), 10726.8(a).

[68] While there is no definition of best available information, the GSP Regulations define best available science as the use of sufficient and credible information and data, specific to the decision being made and the time frame available for making that decision, that is consistent with scientific and engineering professional standards of practice.

[69] Cuyama Basin GSP, Section 2.2.7, p. 208.

[70] Cuyama Basin GSP, Section 4.8, p. 321.

[71] Cuyama Basin GSP, Section 5.5, p. 360-361.

[72] Cuyama Basin GSP, Section 2.2.7 and Section 4.8, p. 209 and 321.

[73] Cuyama Basin GSP, Section 2.2.7, p. 209.

Department indicates the State Water Board's Groundwater Ambient Monitoring and Assessment (GAMA) Program's Groundwater Information System contains records of arsenic concentrations exceeding the MCL in drinking water wells screened as shallow as 340 feet below ground surface.[74] Department staff confirmed that this claim appears to be true.

Regarding nitrates, a public comment submitted to the Department indicates that potentially 13 of 109 nitrate samples (12 percent) have exceeded the MCL in the past ten years,[75] which conflicts with the GSP's statement that only two samples during 2011 to 2018 exceeded the MCL.

### 3.3.3 Corrective Actions

Having identified them as constituents of concern, the GSA should reasonably and thoroughly address nitrate and arsenic in the GSP using best available information. Specifically, the GSA should consider the following:

1. Groundwater conditions. The Department received comments that raise credible technical issues regarding groundwater quality data that apparently were not considered when developing the GSP but are available to the public and likely, in the opinion of Department staff, to alter the GSA's assessment of the Basin conditions. The GSA should coordinate with interested parties that submitted comments, in particular with the Regional Water Quality Control Board, to obtain best available information regarding basinwide water quality. The GSA should evaluate this data, along with their existing data, and update the description of basinwide water quality in the GSP as appropriate.

2. Sustainable management criteria. After updating the information regarding existing groundwater quality conditions, the GSA should revise its discussion of groundwater quality sustainable management criteria to either include criteria for arsenic and nitrate or provide thorough, evidence-based analysis and description for why groundwater management is not likely to cause significant and unreasonable degradation of groundwater by increasing concentrations of those constituents.

   Monitoring networks. The GSA should appropriately revise its groundwater quality monitoring network based on updates to the GSP noted above. Department staff believe that, at a minimum, the GSA should include monitoring for arsenic and nitrates, as they have been identified as constituents of concern and both appear to be relatively widespread. Monitoring will be important for the GSA to assess whether groundwater quality degradation for those constituents is occurring

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[74] Central Coast Water Board Comments on Final Cuyama Valley Groundwater Sustainability Plan. Central Coast Regional Water Quality Control Board Comment Letter Submitted to the Department, 15 May 2020, https://sgma.water.ca.gov/portal/service/gspdocument/download/4021.

[75] Central Coast Water Board Comments on Final Cuyama Valley Groundwater Sustainability Plan. Central Coast Regional Water Quality Control Board Comment Letter Submitted to the Department, 15 May 2020, https://sgma.water.ca.gov/portal/service/gspdocument/download/4021.

throughout the planning and implementation horizon. The GSA may leverage existing programs that collect and disseminate water quality data and information. The GSA should address any data gaps in the groundwater quality monitoring network and provide specific schedules to address those data gaps.

## 3.4 DEFICIENCY 4. THE GSP DOES NOT PROVIDE EXPLANATION FOR HOW OVERDRAFT WILL BE MITIGATED IN THE BASIN.

### 3.4.1 Background

GSP Regulations require that a GSP include a description of projects and management actions that the GSA has determined will achieve the sustainability goal for the basin, the timeline of implementation, and the sustainability indicators that are expected to benefit, including the circumstances in which they would be implemented.[76] For basins in overdraft, the description shall include a quantification of demand reduction or other methods for mitigating the overdraft.[77]

### 3.4.2 Deficiency Details

The fourth deficiency is related to the lack of a complete discussion of how overdraft will be mitigated in the entire Basin through implementation of the GSP. The GSP identifies two management areas, Central Basin and Ventucopa, as the primary pumping areas in the Cuyama Valley that have the highest water demand. Groundwater levels in the Central Basin management area decline by a modeled 2 to 7.7 feet per year, whereas the Ventucopa management area decline by 2 to 3 feet per year.[78]

To meet the sustainability goal of the Basin, the GSA explains in detail throughout the GSP that a pumping reduction of 50 to 67 percent will be required.[79] Pumping reductions would begin in 2023 and become progressively larger each successive year, with full implementation of the total pumping reduction in 2038.[80]

However, the GSP only intends to implement those pumping reductions in the Central Basin management area and does not explain why pumping reductions will not be implemented in the Ventucopa management area. The GSP executive summary states that “[p]umping reductions are not currently recommended for the Ventucopa Area” and instead recommends “to perform additional monitoring, incorporate new monitoring wells, and further evaluate groundwater conditions in the area over the next two to five years” and that “[o]nce additional data are obtained and evaluated, the need for any reductions in pumping will be determined.”[81] These cited details from the executive summary are the extent of the GSP’s description of the plans for possible demand management in the

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[76] 23 CCR § 354.44.
[77] 23 CCR § 354.44(b)(2).
[78] Cuyama Basin GSP, Figure 7-1, p. 387.
[79] Cuyama Basin GSP, Executive Summary and Table 2-7, p. 26 and 254.
[80] Cuyama Basin GSP, Figures ES-15 and 8-1, p. 32 and 419-420.
[81] Cuyama Basin GSP, Executive Summary, p. 32.

Ventucopa management area.[82] Lack of detail for this area is concerning because it appears to Department staff as though the GSA's defined minimum thresholds, which should represent a point in the Basin that, if exceeded, may cause undesirable results,[83] in the Ventucopa management area could be exceeded in as soon as two years if two feet per year of groundwater level decline continues.[84] It is also concerning because the GSP explains that "[d]omestic water users in [the Ventucopa and Central Basin management areas] are experiencing water supply challenges, and in the 2012-2016 drought experienced well failures."[85]

In addition to the Ventucopa Area, the GSP does not discuss why projects and management actions were not considered in the Northwestern threshold region, where, as noted above in Corrective Action 1 (Section 3.1), it appears that overdraft will occur for some time and the allowable groundwater-level decline is over 100 feet in some representative wells.[86]

### 3.4.3 Corrective Actions

The GSA should explain the rationale for not implementing pumping reductions in the overdrafted Ventucopa management area or any other portion of the Basin where overdraft is expected to continue, and explain the timeline and criteria that may be used to determine whether future pumping reduction allocations are needed.[87] If the criteria to implement pumping reductions are related to the effects on beneficial uses and users, as mentioned in Corrective Action 1, the GSP should clarify what those effects are that would necessitate pumping reductions. If data gaps are known to exist they should be explained and include a timeline to address them and how they may affect management actions for the Ventucopa management area.

The GSP states well failures occurred during the 2012-2016 drought and projects a lowering of groundwater levels beyond those observed during the drought and below 2015 conditions. If, after considering this deficiency and the deficiency associated with Corrective Action 1 (Section 3.1), the GSA retains minimum thresholds that allow for continued lowering of groundwater levels, then it is reasonable to assume that additional wells may be impacted during implementation of the Plan. While SGMA does not require all impacts to groundwater uses and users be mitigated, the GSA should consider including projects and management actions strategies describing how they may support

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[82] Cuyama Basin GSP, Executive Summary and Section 7.3.2, p. 32 and 410.

[83] 23 CCR § 354.28(a).

[84] Maps in the GSP appear to indicate two representative monitoring wells are located in the Ventucopa Management Area, OPTI wells 62 and 101. The minimum threshold at OPTI Well 62 is 182 feet below ground surface and the water level as of December 2020 was 158.4 feet below ground surface; at two feet per year the minimum threshold will be exceeded in approximately 12 years. The minimum threshold at OPTI Well 101 is 111 feet below ground surface and the water level as of December 2020 was 108.6 feet below ground surface; at two feet per year the minimum threshold could be exceeded in approximately 2 years.

[85] Cuyama Basin GSP, Section 7.2.4, p. 405.

[86] Cuyama Basin GSP, p. 1505-1509.

[87] 23 CCR §§ 355.4(b)(3), 355.4(b)(4), 355.4(b)(5), 355.4(b)(6).

drinking water impacts that may occur due to continued overdraft during the period between the start of GSP implementation and achievement of the sustainability goal will be addressed. If mitigation strategies are not included, the GSP should contain a thorough discussion, with supporting facts and rationale, explaining how and why the GSA determined not to include specific actions to mitigate drinking water impacts from continued groundwater lowering below 2015 levels.

# 4 STAFF RECOMMENDATION

Department staff believe that the deficiencies identified in this assessment should preclude approval of the GSP for the Cuyama Valley Basin. Department staff recommend that the GSP be determined incomplete.

# 2022 Update
# Appendix B

## CBGSA Response to DWR's Determination Letter

# TECHNICAL MEMORANDUM

TO: Paul Gosselin, California Department of Water Resources Deputy Director

PREPARED BY: Woodard & Curran on Behalf of the Cuyama Valley Groundwater Basin Groundwater Sustainability Agency

DATE: July 6, 2022

RE: Cuyama Basin GSA Response to DWR's January 21, 2022, Determination Letter

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## 1. INTRODUCTION

The Cuyama Valley Groundwater Basin Groundwater Sustainability Agency (CBGSA) received a GSP Determination Letter (Letter) on January 21, 2022 (Supplemental Appendix A), from the California Department of Water Resources (DWR). The Letter provided the CBGSA with the final determination of the Cuyama Basin Groundwater Sustainability Plan (GSP) and the necessary corrective actions required for approval. Per SGMA regulations, the CBGSA was given a 180-day correction period to update and address any deficiencies in the GSP.

DWR previously provided an initial consultation letter on June 3, 2021, previewing the results specified in the Letter. During the August 18, 2021, Board Meeting, the CBGSA laid out a framework for responding to the initial consultation letter and provided that framework in a response addressed to Mr. Craig Altare (Groundwater Sustainability Plan Review Section Chief), dated August 27, 2021.

This memorandum is the culmination of the analysis and work outlined in the framework provided to Mr. Altare as well as additional analyses based on direction provided by the CBGSA and is intended to supplement the Cuyama Basin GSP that was submitted in January 2020 and fill potential gaps identified in the Letter provided by DWR. While this memorandum is attached to the GSP as an appendix, sections of text from this memorandum are included in revised GSP sections where appropriate in blue font to indicate which text has been added. Those reading the GSP will be able to see what text and analysis has been added to ensure the GSP addresses the deficiencies identified by DWR while reviewing the original text. No additional changes have been made to the GSP approved by the CBGSA Board in December 2019.

The following sections provide a thorough response to each corrective action.

# 2. POTENTIAL CORRECTIVE ACTION 1: PROVIDE JUSTIFICATION FOR, AND EFFECTS ASSOCIATED WITH, THE SUSTAINABLE MANAGEMENT CRITERIA

DWR requests additional information regarding the justification for the sustainable management criteria included in the GSP and the effects of those criteria on beneficial users in the Basin. DWR identified two issues as part of this corrective action:

1. Provide a more detailed description of the criterion used to identify undesirable results (URs); and
2. Provide additional information regarding how the groundwater level minimum thresholds (MTs) are consistent with avoiding undesirable results, with a particular emphasis on the MTs in the Northwestern Region.

The following subsections address each of these issues by providing:

- A summary of this Potential Corrective Action in the Letter
- A brief review of information, justification, and data provided in the GSP
- A discussion with supplemental information, justification, and data as needed to support the GSP.

## 2.1 Defining the Criterion Used to Identify Undesirable Results

### 2.1.1 Initial Review and Opinion Provided by DWR

The Letter states that UR statements do not, "identify the specific significant and unreasonable effects that would constitute undesirable results… [and do] not provide an explanation for the specific significant and unreasonable condition(s) that the GSA intends to avoid in the Basin through implementation of the GSP." Although the GSP includes subsections in Section 3: Undesirable Results, titled *Identification of Undesirable Results*, the Letter states there is no, "explanation for why the criterion is consistent with avoiding significant and unreasonable effects that constitute undesirable results."

### 2.1.2 Review of Information and Data Provided in Submitted GSP

The GSP provides a description of URs and Identification of URs for each of the applicable sustainability indicators in Section 3. For example, UR subsections for groundwater levels are as follows:

> ***"Description of Undesirable Results***
>
> *The Undesirable Result for the chronic lowering of groundwater levels is a result that causes significant and unreasonable reduction in the long-term viability of domestic, agricultural, municipal, or environmental uses over the planning and implementation horizon of this GSP.*
>
> ***Identification of Undesirable Results***
>
> *This result is considered to occur during GSP implementation when 30 percent of representative monitoring wells (i.e., 18 of 60 wells) fall below their minimum groundwater elevation thresholds for two consecutive years.*

**Quantifiable Criterion**

**Cause**

> ***Potential Causes of Undesirable Results***
>
> *Potential causes of Undesirable Results for the chronic lowering of groundwater levels are groundwater pumping that exceeds the average sustainable yield in the Basin, and changes in precipitation in the Cuyama Watershed in the future.*
>
> ***Potential Effects of Undesirable Results***
>
> *If groundwater levels were to reach Undesirable Results levels, the Undesirable Results could cause potential de-watering of existing groundwater infrastructure, starting with the shallowest wells, could potentially adversely affect groundwater dependent ecosystems, and could potentially cause changes in irrigation practices, crops grown, and adverse effects to property values. Additionally, reaching Undesirable Results for groundwater levels could adversely affect domestic and municipal uses, including uses in disadvantaged communities, which rely on groundwater in the Basin.”*

**Potential Effects**

Each applicable sustainability indicator has been provided the same level of discussion in the GSP. The following are the *Identification of Undesirable Results* statements for each of the applicable sustainability indicators.

- **Chronic Lower of Groundwater Levels -** This result is considered to occur during GSP implementation when 30 percent of representative monitoring wells (i.e., 18 of 60 wells) fall below their minimum groundwater elevation thresholds for two consecutive years.
- **Reduction of Groundwater Storage** - This result is considered to occur during GSP implementation when 30 percent of representative monitoring wells (i.e., 18 of 60 wells) fall below their minimum groundwater elevation thresholds for two consecutive years.
- **Degraded Water Quality** - This result is considered to occur during GSP implementation when 30 percent of the representative monitoring points (i.e., 20 of 64 sites) exceed the minimum threshold for a constituent for two consecutive years.
- **Land Subsidence** - This result is detected to occur during GSP implementation when 30 percent of representative subsidence monitoring sites (i.e., 1 of 2 sites) exceed the minimum threshold for subsidence over two years.
- **Depletions of Interconnected Surface Water -** This result is considered to occur during GSP implementation when 30 percent of representative monitoring wells (i.e., 18 of 60 wells) fall below their minimum groundwater elevation thresholds for two consecutive years.

It should be noted that as planned in the GSP Implementation, some monitoring networks have been modified for efficiency, access agreement obstructions, and to minimize burden on the GSA and its operating budget. These adjustments are ongoing and the CBGSA has continued to utilize the same percent criteria as above in its management of the Basin.

### 2.1.3 Supplemental GSP Information in Response to DWR Letter

The following text has been added to the GSP:

#### Supplemental to Section 3.3 – Evaluation of the Presence of Undesirable Results

SGMA requires the description of URs to include the following information:

1. The **cause** of the UR.
2. A **quantifiable criterion** used to describe when a UR occurs.
3. **Potential effects** on beneficial uses and users, on land uses and property interests, and other potential effects that may occur from URs.

(Cal. Code Regs., tit. 23, § 354.26, subd. (b)(1) – (3).)

The information currently provided in the Section 3 of the GSP satisfies this regulation by providing the text, explanations, and quantitative descriptions and justifications for URs. Each of these three descriptive characteristics are labeled in the excerpt from Section 3 of the GSP provided in Subsection 2.1.2 of the Response Technical Memorandum using the left-hand bubble callout labels. Furthermore, the GSP provides a quantifiable criterion (ratio of wells) to describe the conditions it would expect to see the potential effects as described.

To address the concerns raised in the Letter, the following additional information is provided regarding the rationale for the criteria used in the GSP (i.e., "30% of exceedances over 24 consecutive months") to define the point at which Basin conditions cause *significant and unreasonable* effects to occur.

The term "significant and unreasonable" is not defined by SGMA regulations. Instead, the conditions leading to this classification are determined by the GSA, beneficial users, and other interested parties in each basin. In the Basin, the identification of URs were developed through an extensive stakeholder-driven process that included:

- Careful consideration of input from local stakeholders and landowners;
- A conceptualization of the hydrogeological conceptual model;
- An assessment of current and historical conditions and best available data; and
- Local knowledge and professional opinion.

The CBGSA recognizes the lack of reliable historical data and acknowledges the limitations and uncertainties it causes (see *Data Gaps* and *Plan to Fill Data Gap* subsections of *Section 4 – Monitoring Networks* and *Section 8 – Implementation Plan* for addressing those limitations). However, the re-assessment of thresholds and UR statements will be a likely component of future GSP updates. These future revisions will utilize the detailed and reliable data collected by the GSA during the first five years of GSP implementation.

The 30 percent of wells exceeding their MT for 24 consecutive months criteria included in the GSP allows the CBGSA the flexibility to identify the cause of MT exceedances and to develop a plan for response (per the Adaptive Management approach described in Section 7.6 of the GSP). Potential causes of MT exceedances could include:

- Prolonged drought;
- Pumping nearby the representative well; and
- Unreliable and non-representative data used to calculate the MT.

Minimum threshold exceedances in multiple wells is considered more indicative of a basin-scale decline in groundwater levels and potential adverse impacts on groundwater infrastructure, as opposed to more localized groundwater level declines, which could be associated with nearby pumping. Furthermore, groundwater levels in areas of the Basin change in response to climatic conditions and therefore sustained exceedances of minimum thresholds are considered to be more significant than short-term exceedances. Setting the *Identification of Undesirable Results* criteria at 30 percent or more of wells exceeding their MT is intended to reflect undesirable results at the basin-scale and using 24 consecutive months allows the GSA time to address issues, perform investigations, and implement projects and management actions as needed.

With respect to the Depletions of Interconnected Surface Water (ISW) – in conjunction with a representative monitoring network specific to ISW - the UR for ISW has been modified to be considered to occur during GSP implementation when at least 30 percent of representative ISW monitoring wells (i.e., 3 of 9) fall below their minimum groundwater elevation thresholds for two consecutive years.

**Supplemental to Section 7.6 – Adaptive Management**

Adaptive management strategies may also be triggered for other reasons, such as reports by stakeholders of Basin conditions that have impacted beneficial uses or users. Stakeholders may notify the CBGSA of their concerns by (i) submitting a publicly available well reporting form (available on the CBGSA website) to the GSA, (ii) contacting the Basin manager as described in Section 1.1.1 – Contact Information, or (iii) bringing the concerns to public meetings.

If an investigation based on monitoring data and/or stakeholder reporting indicates that groundwater management in the Basin may be adversely affecting beneficial users, the CBGSA Board will determine if a response by the CBGSA is required. This will include the formation of an ad hoc committee to investigate the cause(s) of changing Basin conditions, conducting data analysis, and discussion of potential adaptive management response strategies. If appropriate, the CBGSA will implement response strategies to correct the issue; these strategies could include localized pumping management plans, installation of additional monitoring, installation of replacement wells, potential changes to sustainability criteria or pumping reduction schedule included in the GSP, or other solutions to address specific concerns and Basin conditions.

## 2.2 Additional Information on Groundwater Level Minimum Thresholds

### 2.2.1 Initial Review and Opinion Provided by DWR

The second part of this potential corrective action seeks additional information to explain how each threshold region's groundwater level MTs are consistent with avoiding URs, "particularly… in the Northwestern threshold region." For every threshold region, DWR requests that the CBGSA evaluate and provide the potential effects that MTs and URs would have on:

- Well infrastructure, including domestic, community, public, and agricultural wells; and
- Environmental uses and users of groundwater.

### 2.2.2 Review of Information and Data Provided in Submitted GSP

The CBGSA developed six specific Threshold Regions for the development of thresholds for chronic lowering of groundwater levels. The six threshold regions were defined to allow areas with similar conditions to be grouped together for calculating Measurable Objectives (MOs), MTs, and Interim Milestones (IMs). These threshold regions are shown in Figure 2-1, and a detailed description of each threshold region is provided in *GSP Section 5.2 – Chronic Lower of Groundwater Levels*. Table 2-1 provides a summary of the approach used to establish the MT for chronic lowering of groundwater levels for each Threshold Region.

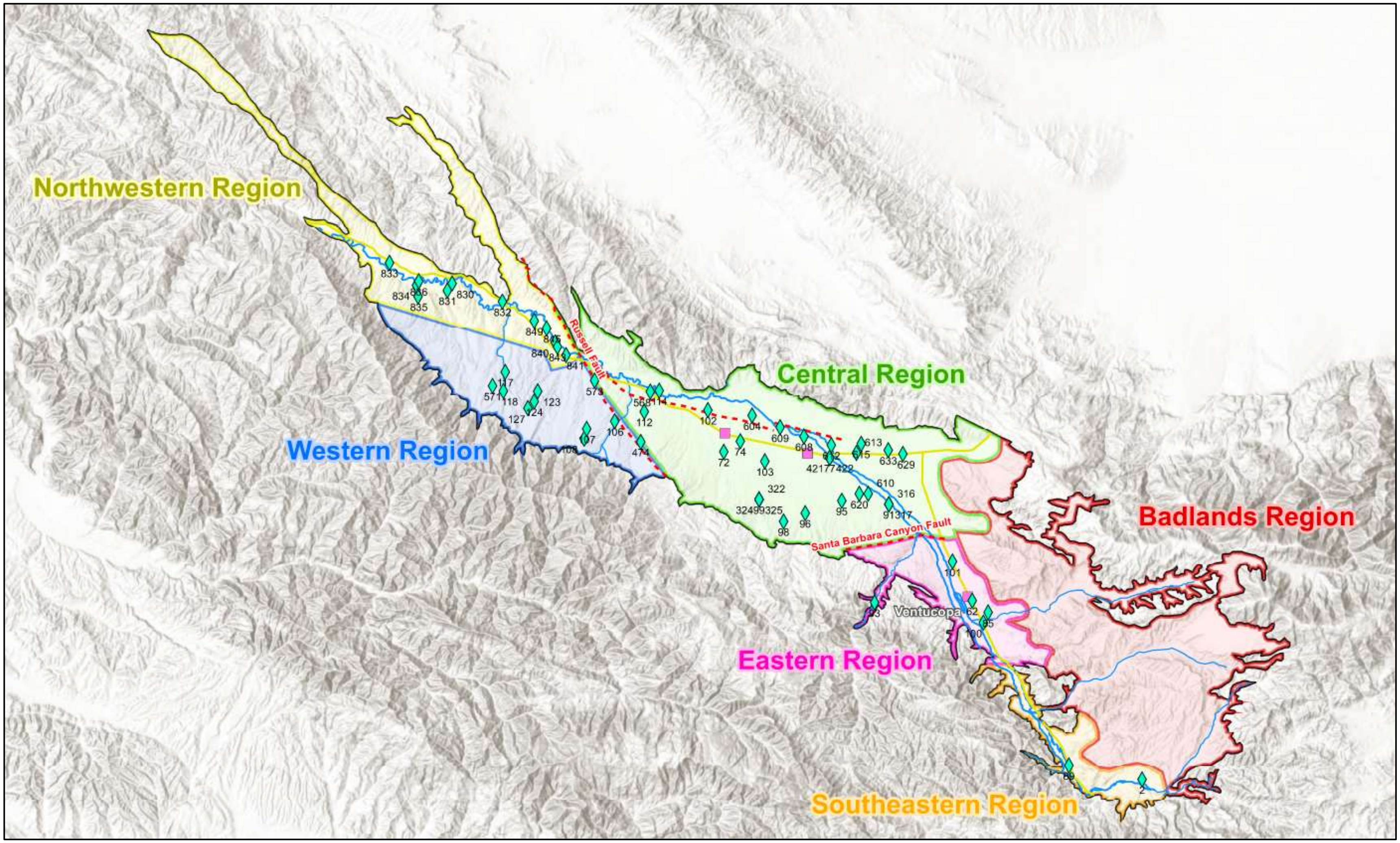


Figure 2-1. Cuyama Basin Threshold Regions

## Table 2-1. Summary of MT Calculations for Chronic Lowering of Groundwater Levels for Each Threshold Region

| Threshold Region | MT Calculation Approach | Justification |
|---|---|---|
| Northwestern | The MT for this region was found by estimating the region's total average saturated thickness for the primary storage area and subtracting 15 percent of that depth from the 2015 water level in each representative monitoring well. This water level elevation was then set as the MT. | Monitoring in this threshold region indicates levels are stable, with some declines in the area where new agriculture is established. Due to these hydrologic conditions, the MT was set to protect the water levels from declining significantly, while allowing beneficial land surface uses (including domestic and agricultural uses) and using the storage capacity of this region. |
| Western | The MT was calculated by taking the difference between the total well depth and the value closest to mid-February 2018 and calculating 15 percent of that depth. That value was then subtracted from the mid-February 2018 measurement to calculate the MT. | Monitoring in this threshold region indicates groundwater levels are stable, and levels varied significantly depending on where representative wells were in the region. The most common use of groundwater in this region is for domestic use. Due to these hydrologic conditions, the MT was set to protect the water levels from declining significantly, while allowing beneficial land surface uses of the groundwater and protection of current well infrastructure.<br>Values from mid-February 2018, are used because data collected during this time represent a full Basin condition. This calculation allows users in this region to use their groundwater supply without increasing the risk of running a well beyond acceptable limits, and this methodology is responsive to the variety of conditions and well depths in this region. |
| Central | The MT was calculated by finding the maximum and minimum groundwater levels for each representative well and calculating 20 percent of the historical range. This 20 percent was then added to the depth to water measurement closest to, but not before, January 1, 2015, and no later than April 30, 2015. | Monitoring in this threshold region indicates a decline in groundwater levels, indicating an extraction rate that exceeds recharge rates. The MT for this region is set to allow current beneficial uses of groundwater while reducing extraction rates over the planning horizon to meet sustainable yield. The MO is intended to allow sufficient operational flexibility for future drought conditions. |

| Threshold Region | MT Calculation Approach | Justification |
|---|---|---|
| Eastern | The MT was calculated by taking the total historical range of recorded groundwater levels and used 35 percent of the range. This 35 percent was then added below the value closest to January 1, 2015 (as described above). | Monitoring in this threshold region indicates a downward trend in groundwater levels. However, much of this downward trend is due to hydrologic variability and may be recovered in the future. Therefore, MTs have been set to allow for greater flexibility as compared to other regions. The MT for wells in this region intends to protect domestic, private, public, and environmental uses of the groundwater by allowing for managed extraction in areas that have beneficial uses and protecting those with at risk infrastructure. |
| Southeastern | MT was calculated by subtracting five years of groundwater storage from the MO. MO was calculated by finding the measurement taken closest to (but not before) January 1, 2015, and not after April 30, 2015. | Per SGMA Regulations, the CBGSA is not required to improve conditions prior to those seen when SGMA was enacted on January 1, 2015. Historical data also shows that groundwater levels are static except during drought conditions (experienced from 2013 to 2018) indicating this area of the Basin is generally at capacity. Because URs were not experienced during this last drought, setting MTs at five years of drought storage will provide the CBGSA a threshold that is protective of domestic, private, public, and environmental uses while providing operational flexibility during drought conditions. |
| Badlands | None | This threshold region has no groundwater use or active wells. As a result, no MO, MT, or IM was calculated. |

### 2.2.3 Supplemental GSP Information in Response to DWR Letter

The following text has been added to the GSP:

**Supplemental to Section 5.2 – Minimum Thresholds, Measurable Objectives, and Interim Milestones for the Chronic Lowering of Groundwater Levels**

The groundwater levels MTs included in the GSP were developed with the intention of avoiding the URs of excessive drawdowns in the Basin while minimizing the number of domestic wells that could go dry and the potential impacts on GDEs in the Basin. Following receipt of DWR's letter, two technical analyses were performed to provide additional information related to the effects of the GSP's groundwater levels MTs and URs definitions on well infrastructure (i.e., domestic, public, and other production wells) and on environmental uses of groundwater (i.e., GDEs).

The results of these analyses demonstrate that the MTs included in the GSP achieve the goals of avoiding URs in the Basin. In particular, the following conclusions can be made:

- The sustainability criteria are protective of production wells (including domestic wells) in the Basin. Only five wells (two percent of all wells in the Basin) are at risk of going dry if MTs are reached throughout the Basin (i.e., at all representative wells). The CBGSA will strive to prevent domestic wells in the Basin from going dry through the Adaptive Management approach included in the GSP (Section 7.6) which calls for an investigation of the potential causes of groundwater level declines and the development of appropriate response strategies. Therefore, the potential for a small number of domestic wells to be at risk is not considered to be a significant and unreasonable result.
- A numerical modeling analysis of proposed MTs at Wells 841 and 845 show that these thresholds would have no negative impact on local domestic wells and only minimal impact at a single GDE location. Stream depletions could potentially increase by a small amount.

The results of these technical analyses demonstrate that the MTs included in the GSP are protective against significant and unreasonable results for production wells and GDEs in the Basin. The approach and results of each technical analysis are described below.

**Assessment of Minimum Thresholds as Compared to Domestic and Production Well Screen Intervals**

An assessment was performed of the MT levels included in the GSP as compared to the well screen intervals of production wells throughout the Basin to try to determine how many production wells may be at risk of going dry if the groundwater levels were to fall to MT levels at monitoring well locations throughout the Basin. This assessment scenario is conservative, as groundwater levels throughout the Basin are unlikely to fall to MT levels simultaneously. The assessment was performed using well location and construction information provided by the counties that overlie the Basin, including Santa Barbara, San Luis Obispo, Ventura, and Kern. To accomplish this, the CBGSA collected all available well data from public sources and the four counties in tabular formats. In the Northwestern Region, well completion reports were also individually collected, processed, and included in the analysis.

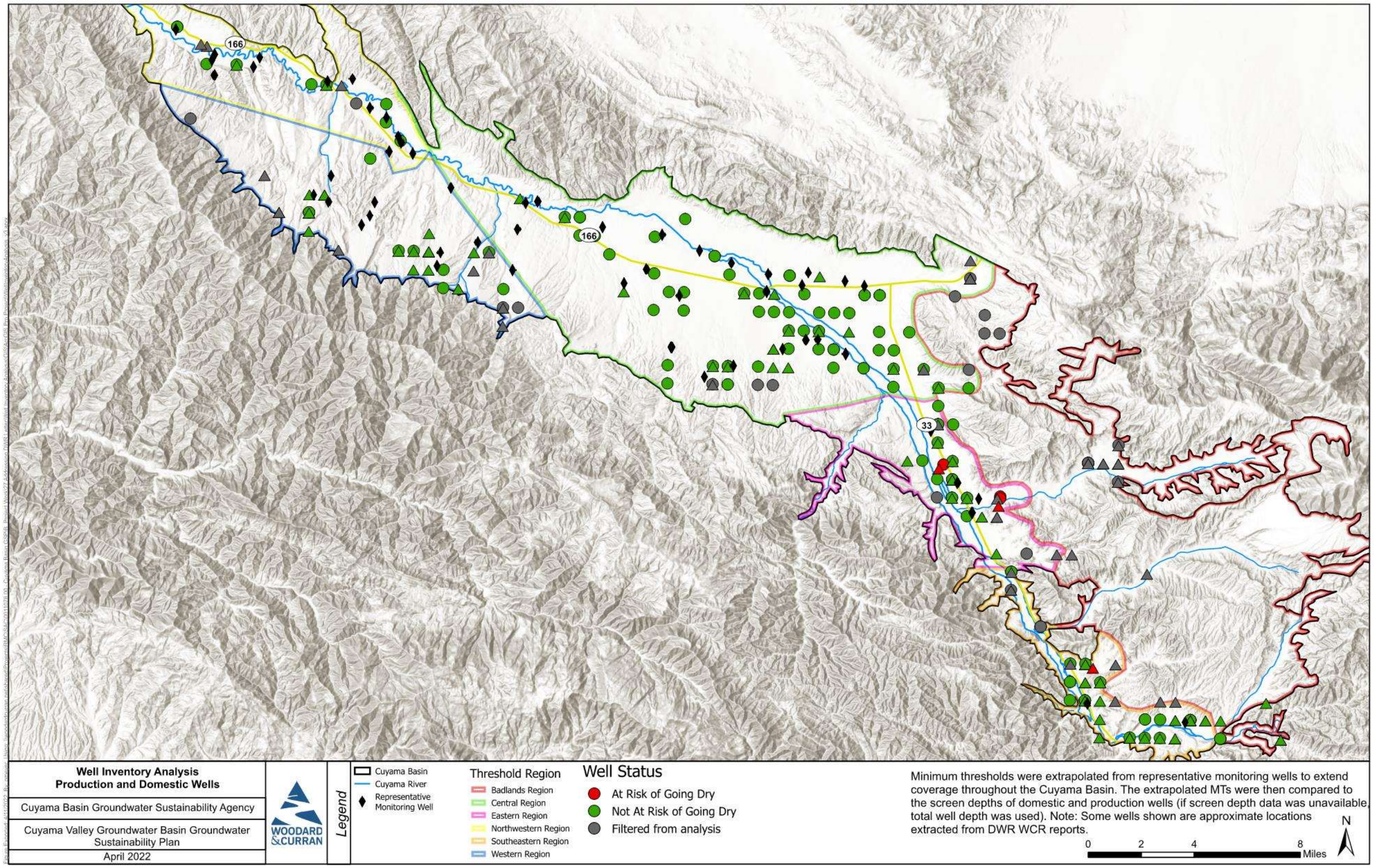
Since pump depth data was not available, wells were processed in GIS by utilizing their screen interval (or well depth if screen interval data was unavailable) to compare those values with MTs at monitoring wells located throughout for the Basin. Some basic filtering criteria were applied to the analysis to remove wells from consideration, including those wells that are destroyed or non-compliant in the county datasets, wells that are far away from active groundwater management and monitoring (e.g., the Badlands region), and wells that were already dry as of January 1, 2015.

The results of the analysis are shown in Table 2-2 and Figure 2-2. Out of a total of 250 production wells that were evaluated, a total of five (two percent of the total) are at risk of going dry if MTs are reached. Three of these five wells are domestic wells. As noted above, the CBGSA will strive to use adaptive management to prevent these domestic wells from going dry.

The CBGSA conducted an investigation to determine the potential impacts if these wells were to go dry. The three domestic wells appear to serve approximately four or five households between them. The two production wells serve vineyards with a total irrigated acreage of approximately two acres. Given that the entire basin encompasses about 18,000 irrigated acres, two acres represents about 0.01 percent and would appear to be a less than significant impact. Based on data developed for the direct economic impact analysis conducted for the Cuyama Basin, it is estimated that loss of production in these acres would represent a loss of about $10,000-15,000 per year.

**Table 2-2. Domestic and Production Wells and MT Summary Statistics**

| Threshold Region | Total Number of Production Wells | Domestic Wells at Risk to Go Dry if GWLs reach MTs | Total Production Wells at Risk to Go Dry if GWLs reach MTs | Percentage of Wells at Risk of Going Dry |
|---|---|---|---|---|
| Northwestern | 16 | 0 | 0 | 0% |
| Western | 40 | 0 | 0 | 0% |
| Central | 89 | 0 | 0 | 0% |
| Eastern | 39 | 2 | 4 | 10% |
| Southeastern | 66 | 1 | 1 | 2% |
| ***Whole Basin*** | ***250*** | ***3*** | ***5*** | ***2%*** |



Minimum thresholds were extrapolated from representative monitoring wells to extend coverage throughout the Cuyama Basin. The extrapolated MTs were then compared to the screen depths of domestic and production wells (if screen depth data was unavailable, total well depth was used). Note: Some wells shown are approximate locations extracted from DWR WCR reports.

**Supplemental Figure 2-2. Well Status Based on Minimum Threshold Analysis**

### Modeling Analysis of Northwestern Threshold Groundwater Levels Minimum Thresholds

Concern was presented in DWR's Letter about whether the thresholds established in the Northwestern Threshold Region at Opti wells 841 and 845 are protective of nearby beneficial users of water. Specifically, DWR questioned what impact(s) may occur to nearby domestic wells and GDEs if groundwater levels were to reach MTs in representative wells. To address this, the Cuyama Basin Water Resources Model (CBWRM) was used to simulate groundwater level conditions by artificially dropping groundwater levels near Opti Wells 841 and 845 to the set MTs. This was done by assigning specified head boundary conditions at the MT levels for the model nodes near these well locations. The simulation was run for 10 years over the historical period between water years (WY) 2011 to 2020 during which the specified head boundary conditions at the MT levels were continuously active.

Figure 2-3 shows the modeled change in groundwater elevations resulting from setting groundwater levels at the MTs at wells 841 and 845. Areas shaded in red or tan color on the figure had reduced groundwater elevations as compared to the baseline condition. Areas shaded in lime green were unaffected by the change in groundwater elevations at the well 841 and 845 locations. As shown in the figure, there are no active domestic wells within the area affected by the lowered groundwater elevations at wells 841 and 845. The only GDE which may be affected is the GDE located at the confluence of Cottonwood Creek and the Cuyama River, which has an expected impact of less than 5 feet. However, even with this difference, the estimated depth to water at this GDE location would be shallower than 30 feet. Potential impacts on this GDE location will be monitored at nearby Opti well 832.

As noted above, the other potential beneficial use that may be affected comes from Cuyama River inflows into Lake Twitchell. The model simulation also showed an increase in stream depletion in the affected portion of the aquifer of about 1,200 acre-feet per year. This represents about 12 percent (out of 10,200 AFY) of the modeled streamflow in the Cuyama River at this location during the WY 2011-2020 model simulation period. However, the actual change in inflows into Lake Twitchell would be less than 1,200 AFY because of stream depletions that would occur between Cottonwood Creek and Lake Twitchell. For comparison, during the same period the USGS gage on the Cuyama River just upstream of Lake Twitchell (11136800) recorded an average annual flow of 7,900 AFY, only a portion of which comes from the Cuyama Basin. Given the lack of data regarding the hydrology and stream seepage between Cottonwood Creek and Lake Twitchell, it is uncertain how much of an impact this would have on the flows that ultimately are stored in Lake Twitchell.

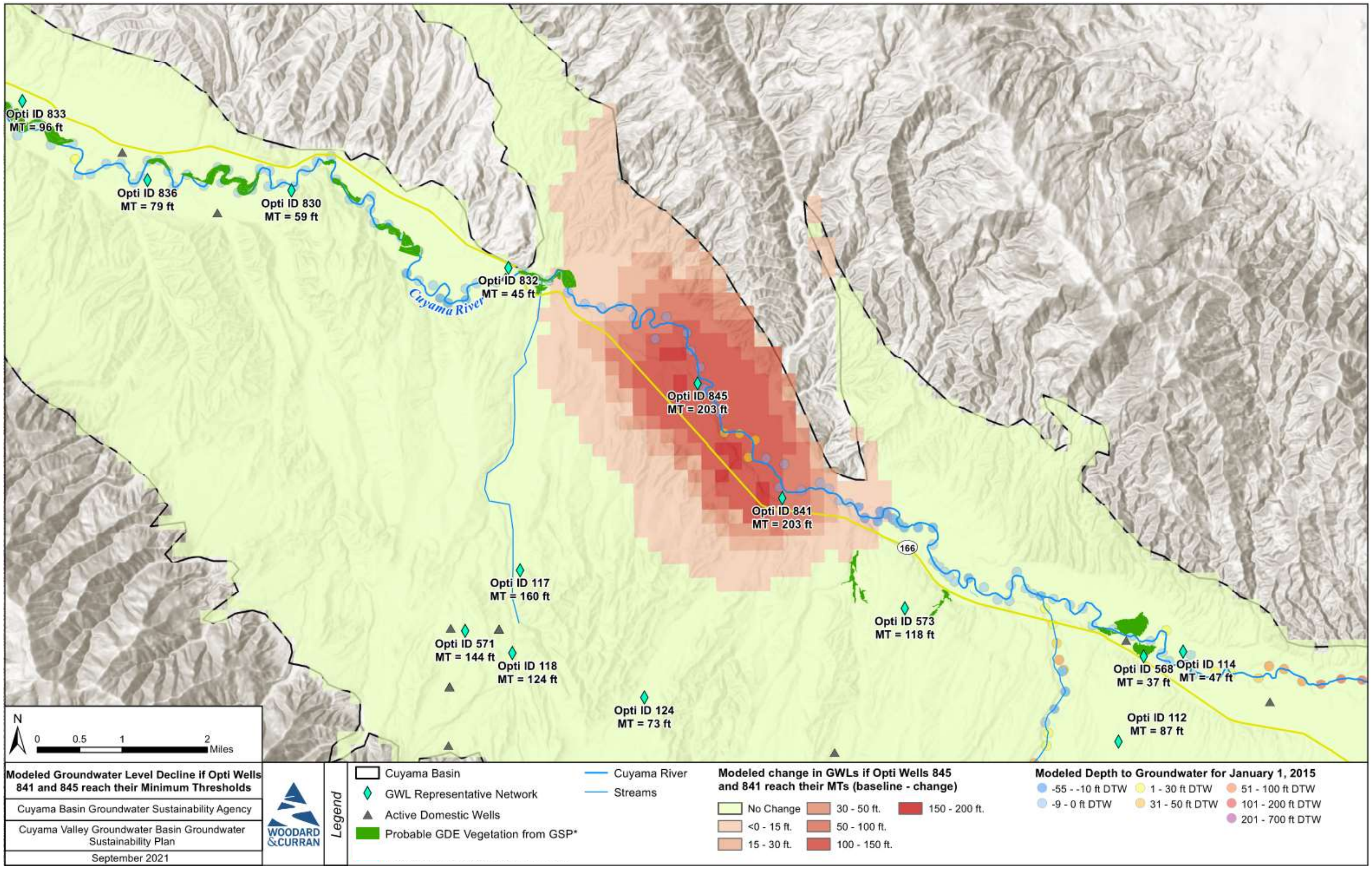


**Figure 2-3. Change in Groundwater Levels in Northwestern Region from CBWRM Test Simulation**

# 3. POTENTIAL CORRECTIVE ACTION 2: USE OF GROUNDWATER LEVELS AS A PROXY FOR DEPLETION OF INTERCONNECTED SURFACE WATER

## 3.1 Initial Review and Opinion Provided by DWR

As described in the Letter, DWR requests supporting evidence to justify the CBGSA's use of the basin-wide groundwater level MTs as a reasonable proxy for thresholds for depletions of ISW. It is the understanding of the CBGSA that the primary objection to the CBGSA's approach was the utilization of the entire groundwater level representative network as a one-for-one proxy for ISWs. This is because not all groundwater representative monitoring sites are necessarily appropriate for monitoring for depletion of ISWs.

## 3.2 Review of Information and Data Provided in Submitted GSP

As stated in the SGMA regulations, as well as mentioned in the Letter, utilizing a sustainability indicator as a proxy for another is allowed if supported by adequate evidence. The submitted GSP provides justification for using groundwater levels thresholds as a proxy for ISWs in Sections 3.2.6 and 5.7 with supporting descriptions of surface water and groundwater interactions in Sections 2.1.9 and 2.2.8.

As described in Sections. 2.1.9 of the GSP, the primary surface water body in the Basin is the Cuyama River. Flows in the Cuyama River are perennial, with most dry seasons seeing little to no flow. There are also four main contributing streams and other minor contributing streams. The Cuyama River and all contributing streams are dry during most of the year, with flows occurring only during precipitation events during the winter months. Nearly all precipitation in the Basin and contributing watersheds percolate into the primary aquifer. The Cuyama River and four primary contributing streams were modeled, with the estimates of gaining and losing quantities provided in Table 2-2 of the GSP.

As noted in the plan, there is limited data available pertaining to the shallow aquifer system or to the quantity and timing of streamflows in the Basin. To help address this deficiency, the CBGSA recently installed new streamflow gages on the Cuyama River. In addition, in Section 2.2.9, the GSP recommended the installation of piezometers in the vicinity of the streambed to provide additional shallow aquifer groundwater level measurements.

## 3.3 Updates to GSP in Response to DWR Letter

The following text has been added to the GSP:

**Supplemental to Section 4.10 – Depletions of Interconnected Surface Water Monitoring Network**

The CBGSA believes that identifying a subset of groundwater level representative monitoring wells for use in ISW monitoring, and providing a rationale for their selection, adequately addresses concerns provided in the Letter and provides adequate data collection and monitoring for ISWs.

### 3.3.1 Summary of Potential Undesirable Results for Interconnected Surface Waters

Depletions of ISW are related to chronic lowering of groundwater levels via changes in the hydraulic gradient and piezometric surface elevation. Therefore, declines in groundwater elevations in portions of the river system that are hydrologically connected to the river system can lead to increased stream losses and depletion of surface water flows. As shown in Figure 3-1, an analysis of the results of the historical simulation of the Cuyama Basin Water Resources Model (CBWRM) reveals that many portions of the stream system in the Basin were already disconnected as of 2015 and therefore ISW flows in these stream reaches would not be affected by further changes in groundwater levels. The primary areas of concern for ISW are on stretches of the Cuyama River upstream of Ventucopa and downstream of the Russell Fault, and on the four major contributing streams to the Cuyama River, including Aliso Creek, Santa Barbara Creek, Quantal Canyon Creek, and Cuyama Creek.

Because the Cuyama River does not flow during most days of the year and the river is not subject to environmental flow regulations, the primary beneficial uses of Cuyama River streamflows are GDEs and water users who utilize water that may flow into Lake Twitchell downstream of the Basin boundary. Lowering groundwater levels could result in reduced streamflows for beneficial use by these users. Therefore, the intent of the ISW monitoring network and sustainability criteria are to ensure that long-term groundwater level declines do not occur in the vicinity of these interconnected surface water flow reaches of the Cuyama River system.

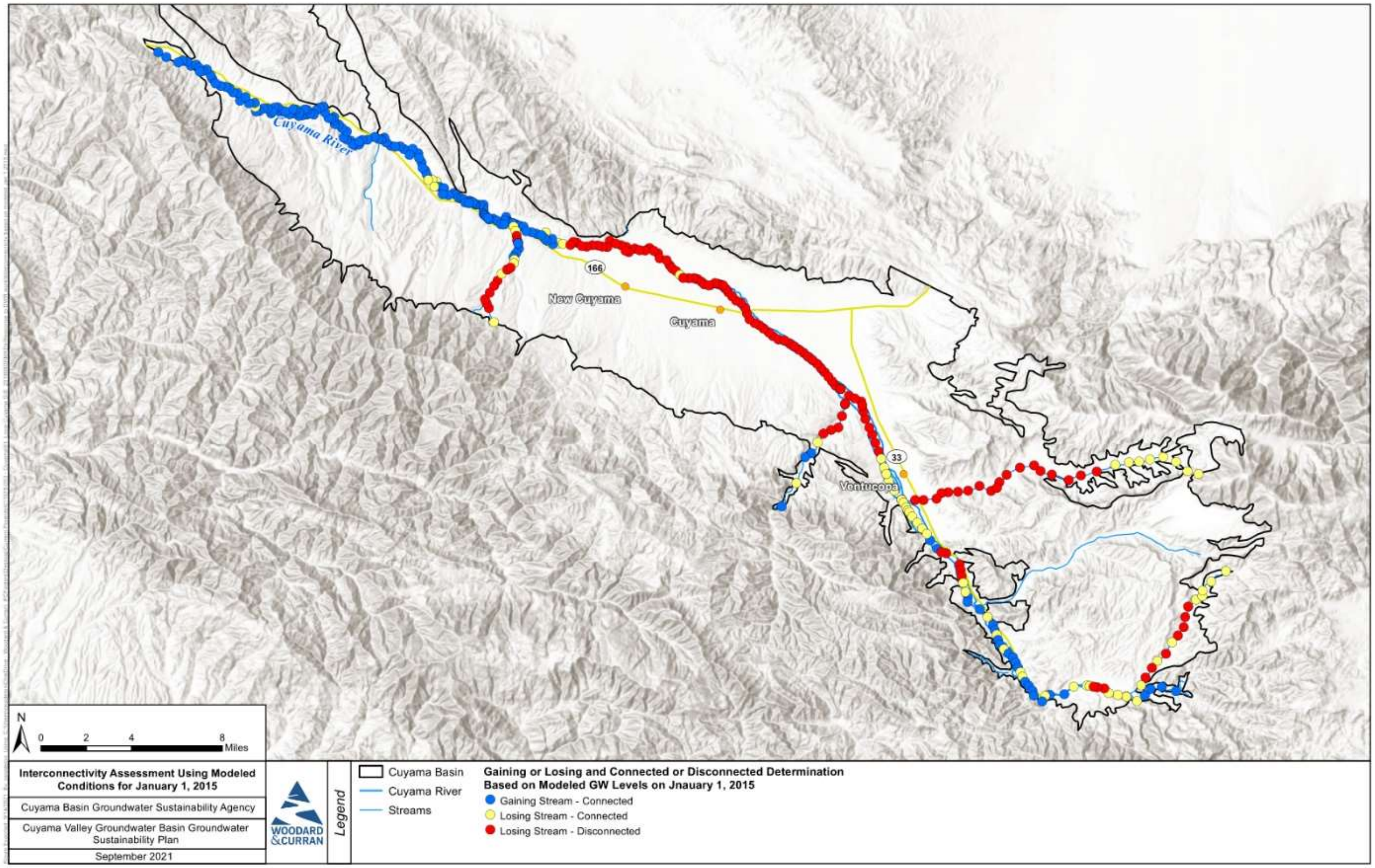


Figure 3-1. Potential Stream Interconnectivity using Historical Modeled Groundwater Levels in January 2015

### 3.3.2 Approach for ISW Monitoring and Sustainability Criteria

To develop an ISW monitoring network, a subset of wells from the groundwater levels representative monitoring network has been used to create a depletion of ISW representative monitoring network. Wells not included in the groundwater levels monitoring network were also considered; but no additional wells were identified that would be suitable for ISW monitoring. After consulting DWR's BMPs for Monitoring Networks and Identification of Data Gaps, the following criteria were used to select wells to be included in the ISW representative network:

1. Wells that are within 1.5-miles of the Cuyama River and/or 1-mile of one of the four major contributing streams to the Cuyama River, including Aliso Creek, Santa Barbara Creek, Quantal Canyon Creek, and Cuyama Creek,
2. Wells that have screen intervals within 100 feet below ground surface (bgs). In some cases, wells without screen interval information but with well depths greater than 100 feet bgs were included, under the assumption that the top of the screen interval was likely to be less than 100 feet bgs. In many of these wells, recent groundwater depth to water measurements were 40 feet bgs or less.

DWR BMP *Monitoring Networks and Identification of Data Gaps*, provides the following guidance for well selection: "Identify and quantify both timing and volume of groundwater pumping within approximately 3 miles of the stream or as appropriate for the flow regime." However, the CBGSA has chosen to use a 1.5-mile buffer around the Cuyama River and a 1-mile buffer around the major contributing streams because the Basin's unique and variable geology and topography require a narrower window so that the ISW monitoring network wells would cover just the portion of the Valley in the vicinity of the River system (and not extend into foothill areas with significant topographic relief and no alluvial aquifers).

In addition, depletions of ISWs occur at the interaction of surface and groundwater, which is in the shallow portion of the aquifer. In general, wells with completions or depths within 100 feet bgs are preferable to provide more useful information about this near surface interaction. Common practice is to also only include wells that are in areas of interconnectivity or areas where interconnectivity conditions are close to those that define interconnectivity (for example, areas with groundwater levels between 30 to 50-feet below ground surface). Due to the limited number of available wells in the Cuyama Basin with screen intervals (or where screen interval data is not available, well depth) of less than 100 feet bgs, the proposed ISW network includes only five wells. Additional monitoring locations will need to be identified to fill data gaps in the ISW network as discussed below.

The resulting ISW monitoring network is shown in Table 3-1 and Figure 3-2 below. The monitoring network includes 12 wells, nine of which are representative wells for which minimum thresholds and measurable objective have been defined. The MT, MO, and UR criteria (30 percent of representative wells below their MTs for two consecutive years) are the same as those calculated and provided in the groundwater level representative network for the groundwater level monitoring. MTs at the representative well locations are protective of GDE locations in the upper and lower portions of the river, with MTs less than 30 feet from the bottom of the river channel in the vicinity of four wells (89, 114, 830 and 832). Note that Well 906 is part of a new multi-completion well that was constructed in the summer of 2021 under DWR's Technical Support Services; while Well 906 is a representative well, sustainability criteria will not be developed for this well until a history of groundwater level measurements has been established. While the three non-representative wells in the central portion of the Basin are too deep for direct monitoring of ISW flows, they are included to allow the GSA to monitor potential groundwater level increases that could result in reconnection between the river and aquifer in the central Basin going forward.

## Table 3-1. Interconnected Surface Water Monitoring Network

| Opti ID | Threshold Region | Well Depth (feet bgs) | Screen Interval | Minimum Threshold (feet bgs) | Measurable Objective (feet bgs) |
|---|---|---|---|---|---|
| **Representative Wells** | | | | | |
| 2 | Southeastern | 73 | Unknown | 72 | 55 |
| 89 | Southeastern | 125 | Unknown | 64 | 44 |
| 114 | Central | 58 | Unknown | 47 | 45 |
| 568 | Central | 188 | Unknown | 37 | 36 |
| 830 | Northwestern | 77 | Unknown | 59 | 56 |
| 832 | Northwestern | 132 | Unknown | 45 | 30 |
| 833 | Northwestern | 504 | Unknown | 96 | 24 |
| 836 | Northwestern | 325 | Unknown | 79 | 36 |
| 906 | Northwestern | Unknown | 50-70 | TBD | TBD |
| **Other Monitoring Network Wells** | | | | | |
| 101 | Central | 200 | Unknown | n/a | n/a |
| 102 | Central | Unknown | Unknown | n/a | n/a |
| 421 | Central | 620 | Unknown | n/a | n/a |

The proposed network includes the following data gaps which will need to be filled in the future:

- Due to the shortage of shallow monitoring wells available to include in the network, additional shallow aquifer measurement devices will be needed. As noted above, the CBGSA has called for the installation of piezometers in the vicinity of the streambed.
- A spatial data gap exists along the Cuyama River between Well 89 and Ventucopa. Note that significant stretches of the Cuyama River (particularly in the central area of the Basin) were already disconnected from the groundwater aquifer in 2015 (as discussed in Section 2.2.8 of the GSP).

The CBGSA has requested funding for the installation of six piezometers under the recently awarded DWR SGMA grant. The specific locations for these additional piezometers will be determined through technical analysis and stakeholder and landowner engagement with the goals of filling gaps in the ISW monitoring network and of providing better information regarding the condition of GDEs in the Basin.

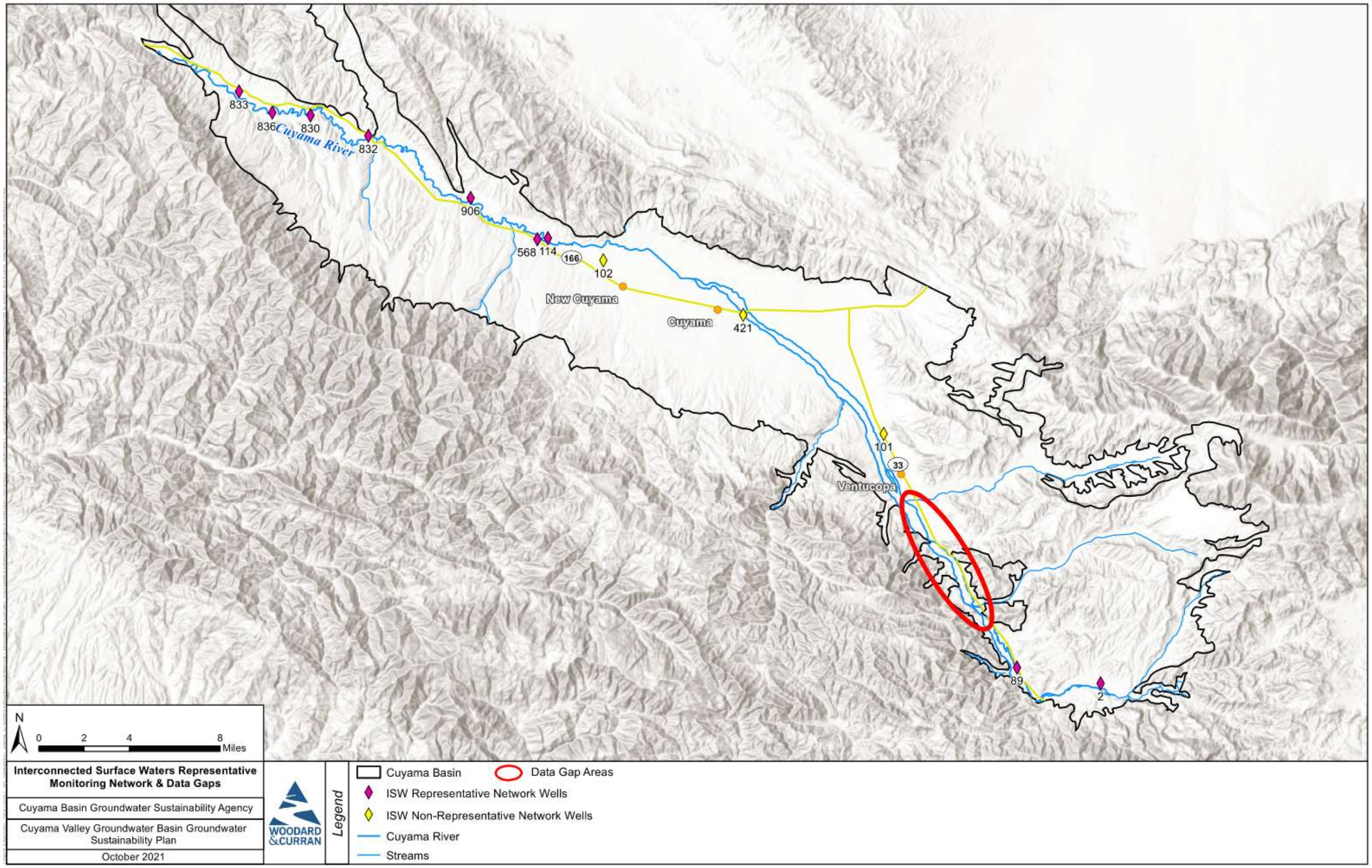


Figure 3-2. Interconnected Surface Water Monitoring Network

# 4. POTENTIAL CORRECTIVE ACTION 3: FURTHER ADDRESS DEGRADED WATER QUALITY

## 4.1 Initial Review and Opinion Provided by DWR

DWR's Letter expressed two main concerns about the water quality analysis and constituent thresholds used in the GSP. First, the GSP acknowledges that nitrate and arsenic have been historical constituents of concern, but due to regulatory limitations, did not set thresholds for these two constituents. Second, based on feedback provided in a public comment, there was concern that some public data was not included in the water quality analysis conducted for the Basin. DWR believes that the GSA may have approached the management strategies differently (through setting thresholds for these constituents) if this data had been utilized. DWR recommended the following to address the concerns raised in the letter:

- Groundwater conditions information related to water quality should be updated to include all available data, in particular as recommended by the Regional Water Quality Control Board, so as to reflect the best available information regarding water quality.
- The GSA should either develop sustainable management criteria for arsenic and nitrate or provide a thorough, evidence-based description for why groundwater management is unlikely to cause significant and unreasonable degradation of groundwater.
- The GSA should appropriately revise its monitoring network based on the above updates. At a minimum, the GSA should include monitoring for arsenic and nitrates as they have been identified as constituents of concern in the Basin.

## 4.2 Review of Information and Data Provided in Submitted GSP

As discussed in Section 4.3.3 of the GSP, water quality data for the Basin was collected from the Irrigated Lands Program (ILP), Groundwater Ambient Monitoring and Assessment (GAMA) Program, United States Geological Survey (USGS), Cuyama Community Services District (CCSD), Ventura County Water Protection District, and private landowners. Staff performed detailed analysis to ensure that wells included in multiple datasets were paired correctly to the best of their ability and remove duplicate measurements and data.

The GSP includes a monitoring network (Section 4.8) and sustainability criteria (Section 5.5) for management of TDS in the Basin.

The GSP discussion noted that the CBGSA does not have the ability or authority to perform actions to address nitrate or arsenic levels in the Basin. Nitrate concentrations are directly related to fertilizer application on agricultural crops, and SGMA regulations do not provide GSAs the regulatory authority to manage fertilizer application. This regulatory authority is, however, held by the SWRCB through the ILP. Additionally, arsenic is a naturally occurring constituent, and has only been measured in limited regions of the Basin.

## 4.3 Updates to GSP in Response to DWR Letter

The following sections provided updated information in response to the three actions recommended by DWR.

### 4.3.1 Updates to Groundwater Conditions Descriptions

The following text has been added to the GSP:

### Supplemental to Section 2.2.7 – Basin Settings: Groundwater Conditions for Groundwater Quality

Additional data collection efforts were performed for nitrate and arsenic measurements, including collecting updated data from publicly available data portals such as GAMA, CEDEN, GeoTracker, and the National Water Quality Monitoring Council that were previously accessed during GSP development. In addition to accessing the public portals for each program, staff coordinated with RWQCB staff to ensure that all publicly available data was collected. It was confirmed by RWQCB staff that all available data for the ILP program were included in the online GAMA data portal download. Some of these public portals have overlapping data that, where possible, were removed, to develop a comprehensive data set for the Basin.

Summary statistics for nitrate (as N) and arsenic measurements taken from 2010-2020 are shown in Table 4-1. For nitrates, 41 of the 102 wells with measurements during this period recorded a measurement exceeding the MCL of 10 mg/L. For arsenic, five of the 23 wells with measurement recorded a measurement exceeding the MCL of 10 µg/L. Figures 4.1 and 4.2 show the locations of wells with monitoring measurements for nitrates and arsenic during the 2010-2020 period and the average concentrations measured in each well. In each case, the wells with average values exceeding the MCLs correspond with the wells tabulated in Table 4-1. A review of the data for wells with measurements both before and after 2015 showed little change in concentrations, with no wells showing water quality degradation through increases in nitrate or arsenic sufficient to change from below the MCL before 2015 to above the MCL in 2020.

**Table 4-1. Summary Statistics for Nitrate (as N) and Arsenic**

| | Nitrate (as N) | Arsenic |
|---|---|---|
| Number of monitoring wells | 102 | 23 |
| Number of wells with recorded MCL exceedances from 2010-2020 | 41 | 5 |

As shown in Figures 4-1 and 4-2, most wells with nitrate and arsenic concentrations exceeding MCLs are located in the central threshold region. The locations in the Basin of high arsenic concentrations are focused to the south of the town of New Cuyama near the existing Cuyama Community Services District (CCSD) well. This is a known issue for the CCSD that will be mitigated by the construction of a replacement well for the district, which was included as a project in the GSP (see section 7.4.4).

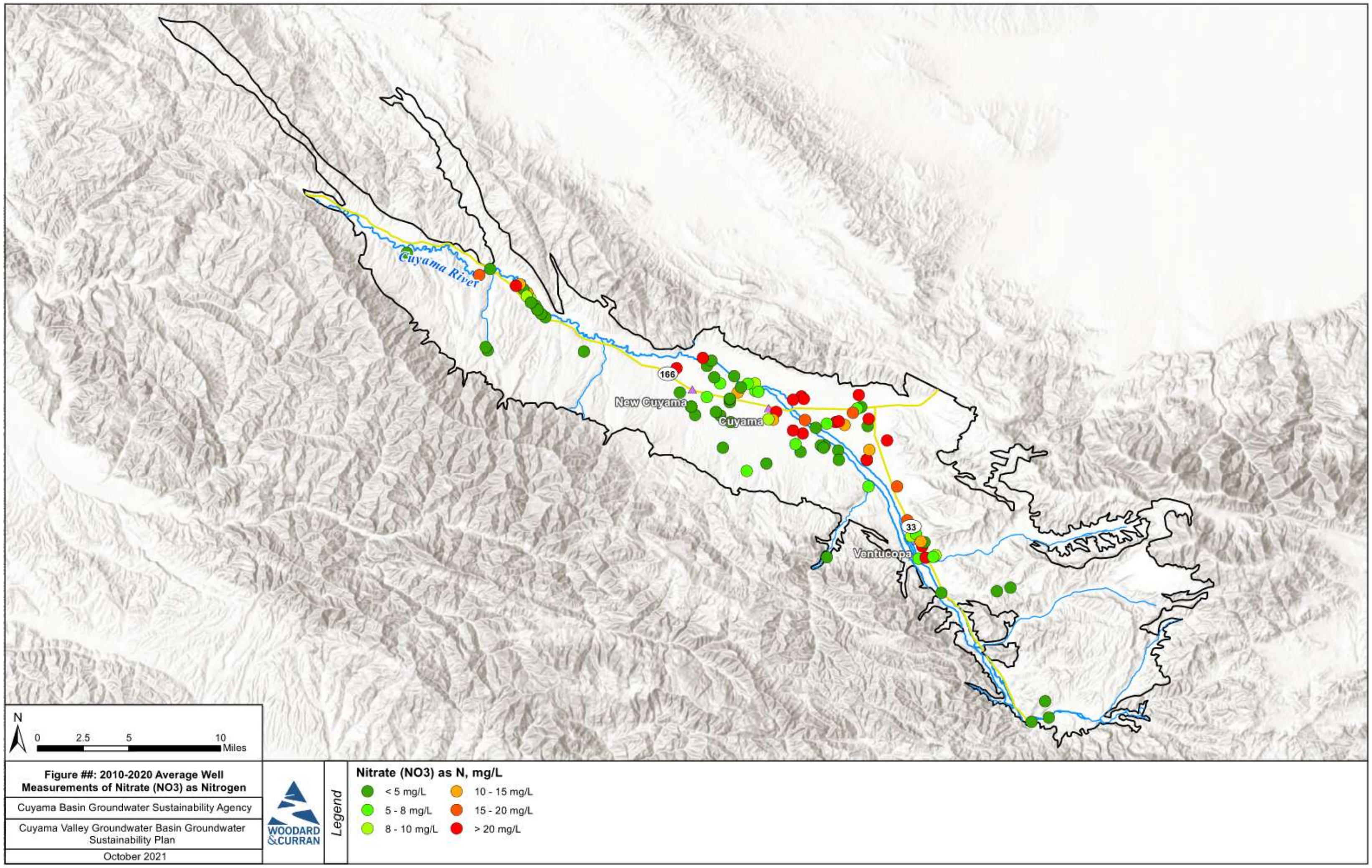


Figure 4-1. Average Well Measurements of Nitrate (as N) from 2010 through 2020

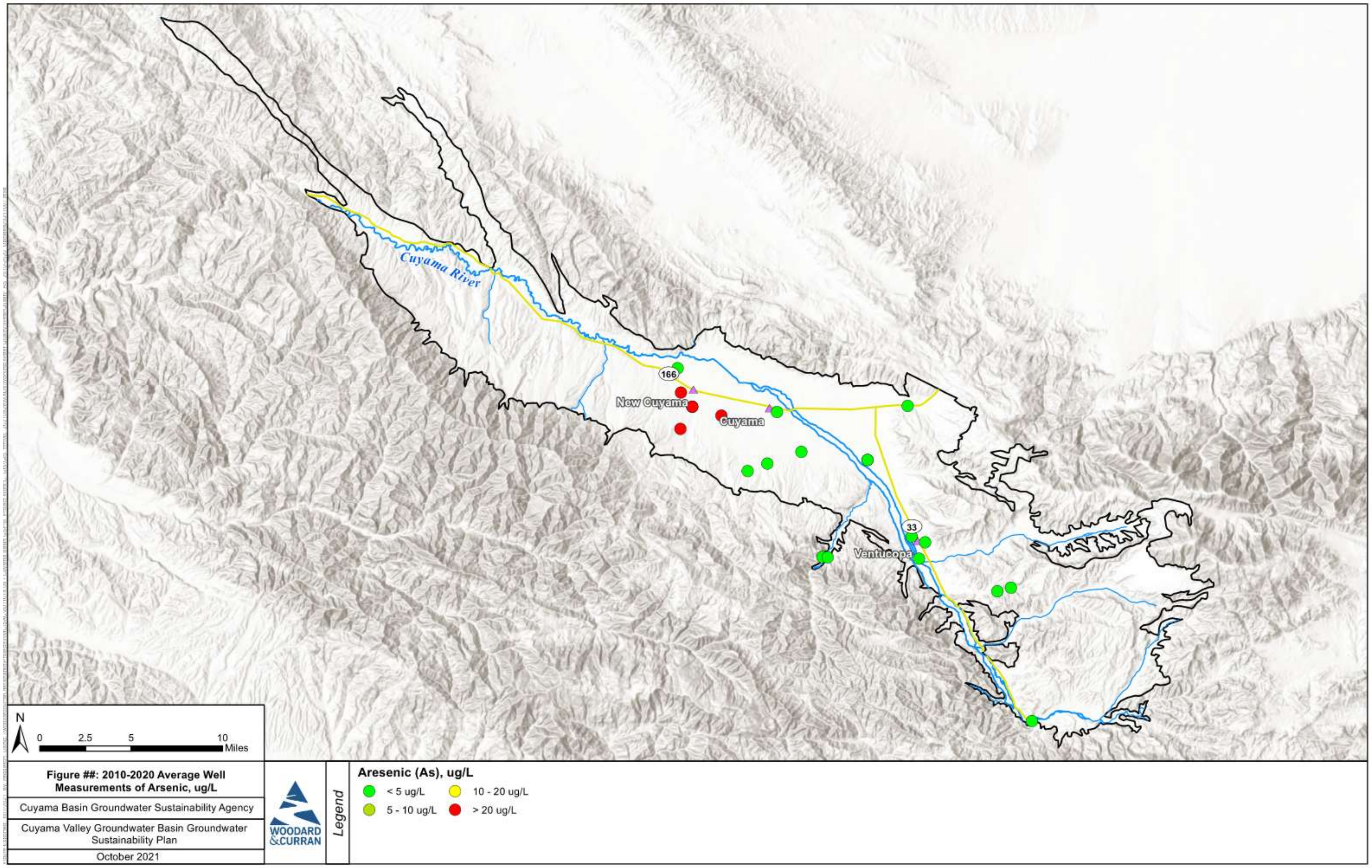


Figure 4-2. Average Well Measurements of Arsenic from 2010 through 2020

The following text has been added to the GSP:

**Supplemental to Section 5.5 – Minimum Thresholds, Measurable Objectives, and Interim Milestones for Degraded Water Quality**

### 4.3.2 Why Groundwater Management is Unlikely to Affect Nitrate and Arsenic Concentrations

As discussed in the submitted GSP, nitrates are the result of fertilizer application on agricultural land. The CBGSA does not have the regulatory authority granted through SGMA to regulate the application of fertilizer. This regulatory authority is held by the SWRCB through the Irrigated Lands Program (ILP). The CBGSA can encourage agricultural users in the Basin to use best management practices when using fertilizers but cannot limit their use. Because the CBGSA has no mechanism to directly control nitrate concentrations, the GSA believes that setting thresholds for nitrates is not appropriate. However, it should be noted that GSP implementation will likely have an indirect effect on nitrates in the central Basin due to the reduction in pumping allocations that were included in the GSP. This will likely reduce the application of fertilizers in the central part of the Basin as agricultural production in the Basin is reduced over time.

Similarly, because arsenic is naturally occurring, the CBGSA does not believe the establishment of thresholds for arsenic is appropriate. As shown in Figure 4-2, wells with high arsenic concentrations are located in a relatively small area of the Basin south of New Cuyama. A review of production well data provided by the counties (discussed in Section 2) indicates that there are no active private domestic wells located in this part of the Basin. The only operational public well that that is located in this part of the Basin serves the Cuyama Community Services District (CCSD). As noted above, the CCSD is currently pursuing the drilling of a new production well, which was included as a project in the GSP. Once this well is completed, it is not believed that any domestic water users will be using a well that accesses groundwater with known high arsenic concentrations.

### 4.3.3 Monitoring Approach for Nitrates and Arsenic

The CBGSA intends to leverage and make use of existing monitoring programs for nitrates and arsenic, in particular ILP for nitrates and USGS for arsenic. Wells in the Basin where recent monitoring data is available for these constituents are shown in Figures 4-1 and 4-2. The CBGSA intends to collect data from the ILP and USGS and perform analysis at each 5-year GSP update to monitor constituent level changes and reassess their impacts on the Basin and its beneficial uses and users. In addition to the planned data collection and analysis efforts, the CBGSA plans to collect water quality data for nitrate and arsenic at each water quality well identified in the GSP (GSP Figure 4-20) during calendar year 2022. This will provide a baseline constituent level in all groundwater quality representative monitoring network locations that can be utilized for future Basin planning. Additional measurements may be considered by the GSA in the future in anticipation of five-year updates.

The CBGSA will continue to monitor TDS and utilize the undesirable results statement and UR triggers identified in Section 3.2.4 to determine the appropriate actions and timing of applicable actions to address water quality concerns. As discussed in Section 7.6 Adaptive Management, the CBGSA has also set adaptive management triggers. Adaptive management triggers are thresholds that, if reached, initiate the process for considering implementation of adaptive management actions or projects. During GSP implementation, regular monitoring reports will be prepared for the CBGSA that summarize and provide updates on groundwater conditions, including groundwater quality.

Although nitrate and arsenic concentrations in groundwater do not currently fall within the regulatory authority of the CBGSA, as stated above, nitrates are regulated by ILP. In addition, the CBGSA will reevaluate nitrate and arsenic concentrations at each 5-year GSP update. The CBGSA will continue to coordinate and work with the Regional Water Quality Control Board and other responsible regulatory programs on a regular basis for the successful and sustainable management of water resources that protect against undesirable conditions related to nitrates and arsenic.

In the event groundwater conditions related to nitrate and arsenic begin to impact the beneficial uses and users of groundwater in the Basin, the CBGSA will notify the appropriate regulatory program and/or agency and initiate more frequent coordination to address those conditions and support their regulatory actions to address those conditions. If undesirable groundwater conditions for nitrate and arsenic are found to be the result of Basin management by the CBGSA, a process may be developed to help mitigate or assist those uses and users by utilizing adaptive management strategies, including pumping management or well rehabilitation or replacement. At this time, however, the CBGSA will rely on the current processes and programs set forth to manage nitrate and arsenic in a sustainable manner.

# 5. POTENTIAL CORRECTIVE ACTION 4: PROVIDE EXPLANATION FOR HOW OVERDRAFT WILL BE MITIGATED IN THE BASIN

## 5.1 Initial Review and Opinion Provided by DWR

This potential corrective action is related to the lack discussion of how overdraft will be mitigated in the entire Basin. In particular, DWR requests additional information for why the GSP does not include pumping reductions in the Ventucopa management area (where the Cuyama Basin Water Resources Model (CBWRM) predicts long-term groundwater level declines) and why projects and management actions are not included to prevent groundwater level declines in the northwest region.

## 5.2 Review of Information and Data Provided in Submitted GSP

The Water budget section of the GSP (Section 2.3) includes a sustainability analysis that estimates that basin-wide groundwater pumping (currently estimated at about 60-64 TAF per year) would need to be reduced by somewhere between 55% and 67% (depending on whether climate change and/or water supply projects are included).

The GSP defined management areas in the central Basin and in the Ventucopa region because those were the two regions in which the model predicted long-term overdraft (Section 7.1). The modeling results did not predict overdraft or groundwater declines in any other portion of the Basin, including the northwest region. The Projects and Management Actions section includes an action to implement pumping allocations in the Central Basin management area to address projected overdraft in that portion of the Basin. However, as described in the Executive Summary, pumping reductions were not recommended in the Ventucopa management area because of the need to "perform additional monitoring, incorporate new monitoring wells, and further evaluate groundwater conditions" before the need for pumping reductions can be determined.

The CBWRM model documentation (Appendix 2-C) estimated the range of uncertainty of basin wide model results and included recommendations for future model updates, including additional hydrogeological characterization, improved streamflow data collection, an assessment of groundwater pumping levels and incorporating future collected data into model calibration – each of which is relevant to the model's representation of the Ventucopa region.

## 5.3 Updates to GSP in Response to DWR Letter

The following text has been added to the GSP:

**Supplemental to Section 7 – Projects and Management Actions**

The following sections provide additional information regarding the Ventucopa management area and the northwestern region of the Basin.

### 5.3.1 Ventucopa Management Area

As noted in the Executive Summary of the GSP, the CBGSA intends to re-evaluate the need for pumping reductions in the Ventucopa region of the Basin after further evaluating groundwater conditions over a two-to-five-year period following submission of the GSP. At the time that the GSP was submitted, the CBGSA felt that it was premature to prescribe pumping reductions in the Ventucopa region on the basis of CBWRM model results because the development of the model in that portion of the Basin posed significant challenges:

- Limited groundwater level data was available for model calibration. Only three calibration wells were available in that area of the Basin (wells 62, 85, and 617). Since submission of the GSP, a new multi-completion monitoring well has been installed in the area, which will provide additional information for model calibration going forward.

- Characterization of streamflows and their effect on the groundwater aquifer was challenging because there were no streamflow gages on the Cuyama River with measurements taken during the calibration period and limited information was available regarding stream geometry in the region. Since submission of the GSP, a new streamflow gage has been installed on the Cuyama River upstream of the Ventucopa region.
- Groundwater pumping levels in the region were based on estimates from available land use information. However, unlike the central area of the Basin, cropping patterns in this portion of the Basin were not provided by local landowners but were instead estimated using satellite imagery. Furthermore, specific well locations were not available in this portion of the Basin. The CBGSA has addressed these shortcomings through the requirement of landowners to install meters on production wells and to report well information starting in calendar year 2022.
- The magnitude of water budget estimates in the region were relatively small as compared to the Basin as a whole, which meant that a small change in the estimate for a single water budget component could have a large effect on the estimated change in storage (and corresponding estimates of long-term groundwater elevation change). In particular, some Basin stakeholders have raised a concern that the model may be underestimating stream seepage into the aquifer in this stretch of the Cuyama River.
- Due to time and budget constraints during GSP development, model development and calibration prioritized development of an accurate representation of the central Basin portion of the aquifer (where long-term overdraft was known to occur) with lesser emphasis on other parts of the model. The primary model calibration objective during CBWRM development of the Ventucopa region was to ensure that groundwater levels matched historical trends at the boundary of the central Basin and Ventucopa region.

Table 5-1 shows the average annual groundwater budget in the Eastern threshold region for the 50-year current and projected simulation (without climate change) included in the GSP. While the historical simulation showed a small surplus in the region, the future projected simulation showed a deficit of about 700 acre-feet per year (AFY), which corresponded to the groundwater level declines shown in Figure 7-1 of the GSP. This quantity is small compared to an overall Basin groundwater storage deficit of 25,000 AFY, and it is approximately 10% of the total groundwater inflow in this region. This can be well within the range of uncertainties in any of the water budget components, and the range of overdraft can be +/- 10%. In light of the uncertainties, and lack of sufficient data on the water budget components to verify the model projected water budget, the CBGSA determined that implementing a management action in the region at this early stage may be premature. Instead, the CBGSA is determined to compile and analyze additional data and information on groundwater levels, surface water flows, groundwater pumping, as well as information on channel geometry and subsurface conditions. This information will be used to further enhance the capabilities of the model for analysis of projected water budgets and groundwater conditions in the region, and to determine possible management actions to address any possible projected overdraft conditions.

**Table 5-1. Eastern Region Groundwater Budget Summary (Acre-feet per year)**

| | Current and Projected Simulation (2018-2067) |
|---|---|
| **Inflows** | |
| Deep percolation | 4,100 |
| Stream seepage | 1,300 |
| Subsurface inflow | 700 |
| **Total Inflows** | **6,100** |
| **Outflows** | |
| Groundwater pumping | 6,800 |
| **Total Outflows** | **6,800** |
| **Change in Storage** | **-700** |

### 5.3.2 Northwestern Region

In the northwestern region, management actions were not included in the GSP because the available information did not indicate a projected overdraft in that region. The following information was considered during development of the GSP:

- The CBWRM model indicated a balance between groundwater inflows and outflows in the region in all of the water budget scenarios that were simulated.
- The Cleath-Harris Geologists (CHG) document *Sustainability Thresholds for Northwestern Region, Cuyama Valley*, dated December 7, 2018[1], developed under contract with the North Fork Vineyard. This document identified minimum thresholds for this area that would be protective of groundwater pumping capacity for production wells in this area. CHG proposed minimum thresholds for the region would result in a twenty percent reduction in the saturated thickness screened by the production wells, which would produce a similar reduction in transmissivity and pumping capacity of the production wells. As discussed above, the CBGSA set thresholds that are somewhat more conservative than this, representing a fifteen percent reduction in saturated thickness.

The technical analyses described in Section 2 regarding Potential Corrective Action 1 indicates that the potential drawdown due to the minimum thresholds set for wells 841 and 845 could have a small effect on GDEs and domestic wells in the area. However, the thresholds set in the monitoring wells located in the vicinity of these Basin resources are set at protective levels that would be indicative of any issues that may arise, allowing the CBGSA to make an appropriate adaptive management response (per section 7.6 of the GSP). Therefore, the available evidence indicates that management actions are not required in this region at this time.

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[1] Posted at the Cuyama Basin GSA website here: https://cuyamabasin.org/assets/pdf/Cleath-Harris-Sustainability-Thresholds-for-Northwestern-Region.pdf

# 2022 Update
# Appendix C

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## PDF Comparison of Section 7 Versions (as Submitted vs Board Approved)

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# Summary of Comments on Cuyama Valley Groundwater Basin Groundwater Sustainability Plan NOI

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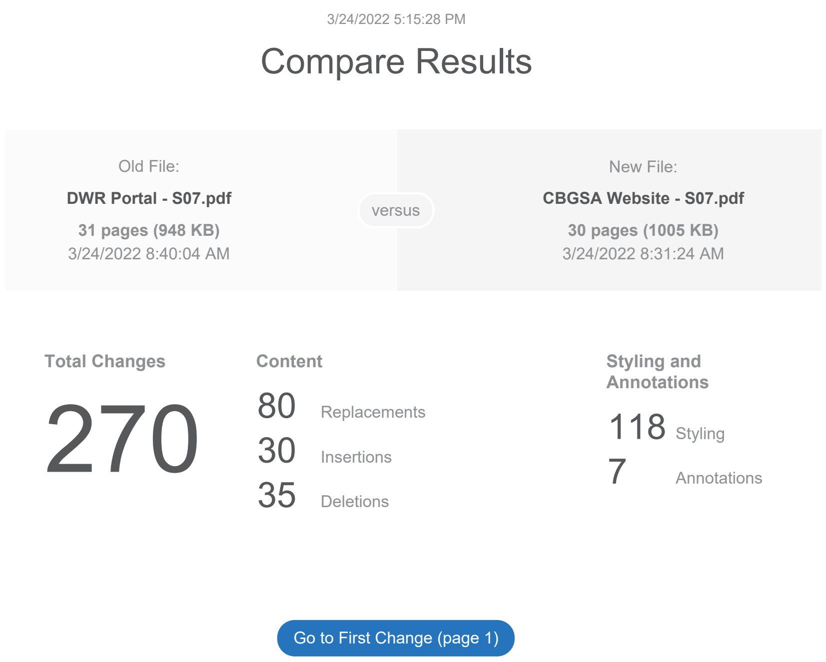

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## Compare Results

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|---|---|---|
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| **31 pages (948 KB)** | | **30 pages (1005 KB)** |
| 3/24/2022 8:40:04 AM | | 3/24/2022 8:31:24 AM |

**Total Changes**

270

**Content**

80 Replacements

30 Insertions

35 Deletions

**Styling and Annotations**

118 Styling

7 Annotations

Go to First Change (page 1)

# 7. Projects and Management Actions

## 7.1 Introduction

This chapter of the Cuyama Basin Groundwater Sustainability Agency's (CBGSA's) *Groundwater Sustainability Plan* (GSP) includes the Projects, Management Actions and Adaptive Management information that satisfies Sections 354.42 and 354.44 of the Sustainable Groundwater Management Act (SGMA) regulations.[1] These projects and their benefits will help achieve sustainable management goals in the Cuyama Groundwater Basin (Basin).

## 7.2 Management Areas

The CBGSA has designated two areas in the Basin as management areas: the Central Basin Management Area and the Ventucopa Management Area, which are both defined as regions with modeled overdraft conditions greater than 2 feet per year that are projected by the model to drop below minimum threshold levels before 2040 (see Figure 7-1). Management actions and projects within these management areas may be managed by the CBWD pursuant to any agreement with the CBGSA. Future changes in management area boundaries will be considered based on updates to numerical modeling as additional information is collected. The Central Basin Management Area is located in the middle of the CBGSA area, and includes the community of Cuyama as well as the surrounding agricultural land uses that are located in areas with greater than 2 feet overdraft. While the Cuyama Community Service District (CCSD) service area also has modeled overdraft exceeding 2 feet, it is not included in the management area because it is a domestic user of relatively small quantity (i.e., about 150 AFY). The Ventucopa Management Area is located south of the Central Basin Management Area and includes the community of Ventucopa. The two management areas are generally separated from one another by the Santa Barbara Canyon Fault. Both are located nearly entirely within the boundaries of the Cuyama Basin Water District. The remaining areas in the Basin are not included in a management area, and generally operate with balanced groundwater pumping and recharge, based on modeling of Basin water budgets.

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[1] SGMA's requirements for GSPs can be read here: https://water.ca.gov/LegacyFiles/groundwater/sgm/pdfs/GSP_Emergency_Regulations.pdf

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# 7. Projects and Management Actions

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[1] SGMA's requirements for GSPs can be read here: https://water.ca.gov/LegacyFiles/groundwater/sgm/pdfs/GSP_Emergency_Regulations.pdf

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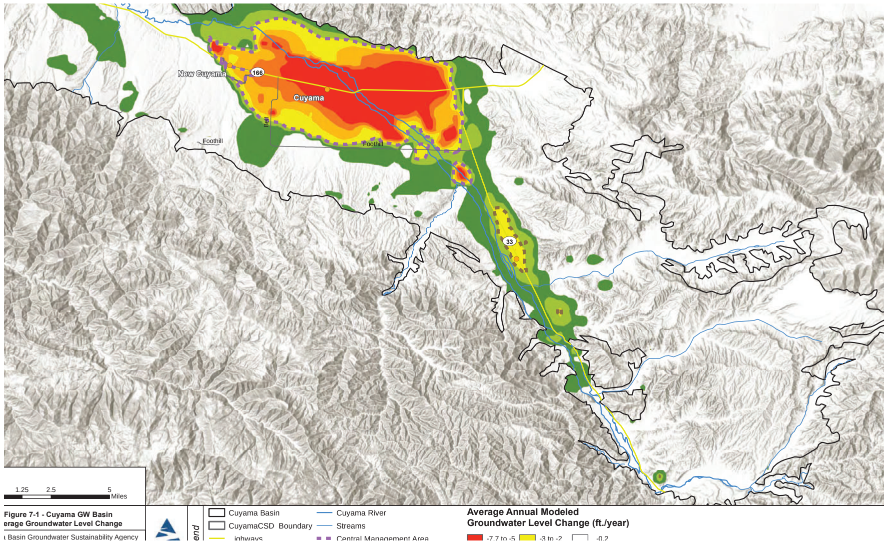

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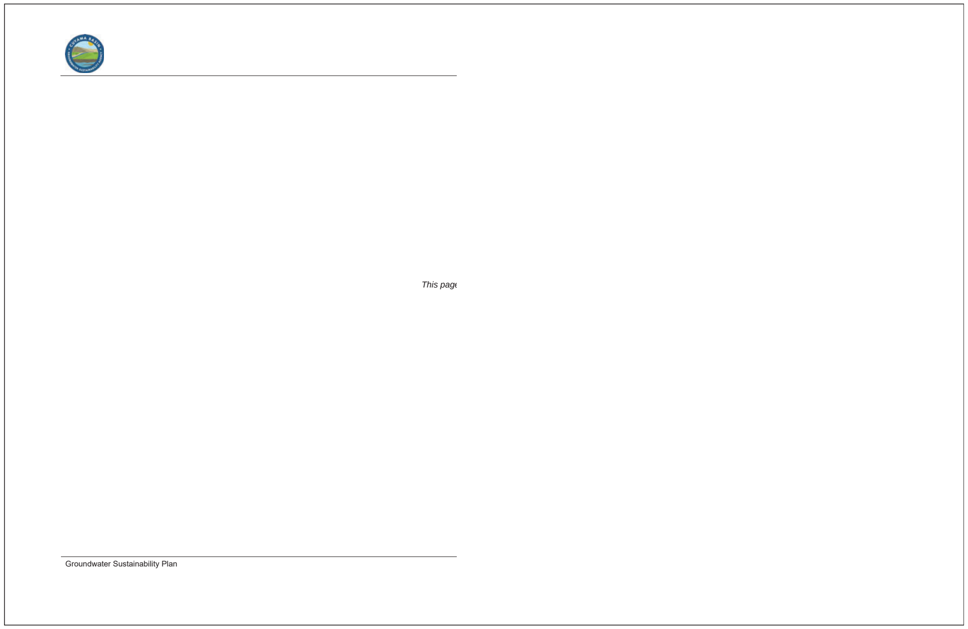

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Groundwater Sustainability Plan

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## 7.3 Overview of Projects and Management Actions

The CBGSA evaluated a range of potential projects and management actions to help address overdraft and move the Basin toward sustainability. Evaluation of the identified projects and management actions has resulted in a set of proposed activities. These proposed activities are shown in Table 7-1, along with their current status, potential timing, and anticipated costs. Benefits are summarized in Section 7.2 and discussed in detail in Sections 7.3 and 7.4.

**Table 7-1: Proposed Projects, Management Actions, and Adaptive Management Strategies**

| Activity | Current Status | Anticipated Timing | Estimated Cost$^a$ |
|---|---|---|---|
| Project 1: Flood and Stormwater Capture | Conceptual project evaluated in 2015 | • Feasibility study: 0 to 5 years<br>• Design/Construction: 5 to 15 years | • Study: $1,000,000<br>• Flood and Stormwater Capture Project: $600-$800 per AF ($2,600,000 – 3,400,000 per year) |
| Project 2: Precipitation Enhancement | Initial Feasibility Study completed in 2016 | • Refined project study: 0 to 2 years<br>• Implementation of Precipitation Enhancement: 0 to 5 years | • Study: $200,000<br>• Precipitation Enhancement Project: $25 per AF ($150,000 per year) |
| Project 3: Water Supply Transfers/Exchanges | Not yet begun | • Feasibility study/planning: 0 to 5 years<br>• Implementation in 5 to 15 years | • Study: $200,000<br>• Transfers/Exchanges: $600-$2,800 per AF (total cost TBD) |
| Project 4: Improve Reliability of Water Supplies for Local Communities | Preliminary studies/planning complete | • Feasibility studies: 0 to 2 years<br>• Design/Construction: 1 to 5 years | • Study: $100,000<br>• Design/Construction:<br>• $1,800,000 |
| Management Action 1: Basin-Wide Economic Analysis | Not yet begun | 2020-2021 | $100,000 |
| Management Action 2: Pumping Allocations in Central Basin Management Area | Preliminary coordination begun | • Pumping Allocation Study completed: 2022<br>• Allocations implemented: 2023 through 2040 | • Plan: $300,000<br>• Implementation: $150,000 per year |
| Adaptive Management | Not yet begun | Only implemented if triggered; timing would vary | TBD |

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## 7.3 Overview of Projects and Management Actions

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| Project 4: Improve Reliability of Water Supplies for Local Communities | Preliminary studies/planning complete | • Feasibility studies: 0 to 2 years<br>• Design/Construction: 1 to 5 years | • Study: $100,000<br>• Design/Construction:<br>• $1,800,000 |
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| Adaptive Management | Not yet begun | Only implemented if triggered; timing would vary | TBD |

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**Table 7-1: Proposed Projects, Management Actions, and Adaptive Management Strategies**

| Activity | Current Status | Anticipated Timing | Estimated Cost[a] |
|---|---|---|---|

[a] Estimated cost based on planning documents and professional judgment

AF = acre-feet

### 7.3.1 Addressing Sustainability Indicators

The proposed projects would contribute toward eliminating the projected groundwater overdraft described in the Chapter 2’s Water Budget section and in maintaining groundwater levels above those identified in Chapter 5 by reducing groundwater pumping or enhancing net recharge into the groundwater aquifer. The sustainability indicators are measured directly or by proxy, with groundwater elevation used as either the direct or proxy indicator for all sustainability indicators with the exception of water quality and subsidence. Table 7-2 summarizes of how the projects and management actions in this GSP will address the applicable sustainability indicators for the Basin. Seawater intrusion is not applicable to the Basin, due to distance from the Pacific Coast.

Physical benefits of the projects and management actions in the GSP are described under each project and action in Section 7.3 and Section 7.4, below.

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**Table 7-2: Summary of How Projects and Management Actions Address Sustainability Indicators**

| Activity | Sustainability Indicator | | | | |
|---|---|---|---|---|---|
| | Chronic Lowering of Groundwater Levels | Reduction of Groundwater Storage | Degraded Water Quality | Subsidence | Depletions of Interconnected Surface Water |
| Project 1: Flood and Stormwater Capture | Would increase recharge in the Basin, directly contributing to groundwater levels. | Would increase recharge in the Basin, directly contributing to groundwater storage. | Would contribute to groundwater levels through increased recharge, reducing groundwater quality degradation associated with declining groundwater levels. | Would support maintaining groundwater levels in the Basin, reducing potential for subsidence. | Increasing groundwater recharge with flood and stormwater capture would reduce the potential for groundwater levels to decline and negatively impact surface water flows. |
| Project 2: Precipitation Enhancement | Increases precipitation and associated groundwater recharge; reduces groundwater pumping because increased precipitation would reduce irrigation needs. | Increases volume of stored groundwater; reduces groundwater pumping | Would increase groundwater recharge, reducing groundwater quality degradation associated with declining groundwater levels. | Reduced groundwater pumping and increased groundwater recharge reduces the cause of subsidence | Would increase surface water flows in the Basin and increase groundwater recharge, which together would reduce the potential for negative surface water flow impacts associated with decreasing groundwater levels. |
| Project 3: Water Supply Transfers/Exports | Would allow for increased stormwater capture without interfering with downstream water rights, directly contributing to groundwater levels. | Would allow additional groundwater recharge of stormwater, directly contributing to groundwater storage. | Would allow for increased groundwater recharge, reducing groundwater quality degradation associated with lowering of groundwater levels. | Would increase potential groundwater recharge, reducing the potential for subsidence. | Would increase groundwater recharge, which would reduce the potential for negative surface water flow impacts associated with decreasing groundwater levels. |
| Project 4: Improve Reliability of Water Supplies for Local Communities | Would provide an alternate pumping supply for CCSD, CMWC and VWSC customers to reduce water supply reliability issues caused by historical groundwater level reductions in the Basin. | N/A | Provides for improved water quality in the potable water system, and through construction of compliant wells, reduces potential for groundwater quality impacts of improperly designed/constructed wells and failing wells within CCSD and VWSC systems. | N/A | N/A |
| Management Action 1: Basin-Wide Economic Analysis | Would evaluate the long-term economic impacts of project implementation, which will allow the region to plan for economic changes if implementation is pursued and help avoid economically catastrophic decision-making that could result in dramatic changes to groundwater use and levels. | | | | |
| Management Action 2: Pumping Allocations in Central Basin Management Area | Would limit groundwater pumping, with allocations decreasing over time until groundwater pumping reaches sustainability | Reducing groundwater pumping will help decrease the reduction of groundwater storage associated with high levels of pumping. | Reducing groundwater pumping will help alleviate groundwater degradation associated with lowering of groundwater levels. | Reduced groundwater pumping would reduce the risk of subsidence associated with lowering of groundwater levels. | Reduced groundwater pumping would help protect groundwater levels, thereby reducing the potential for negative impacts to surface water flows associated with lowering groundwater levels. |
| Adaptive Management | Adaptive management actions would be triggered if groundwater levels decrease sufficiently or do not demonstrate adequate recovery as projects are implemented. Adaptive management projects that are implemented would be selected because they would help address these sustainability indicators. | | | | |

Notes:
CCSD = Cuyama Community Services District
CMWC = Cuyama Mutual Water Company
VWSC = Ventucopa Water Supply Company

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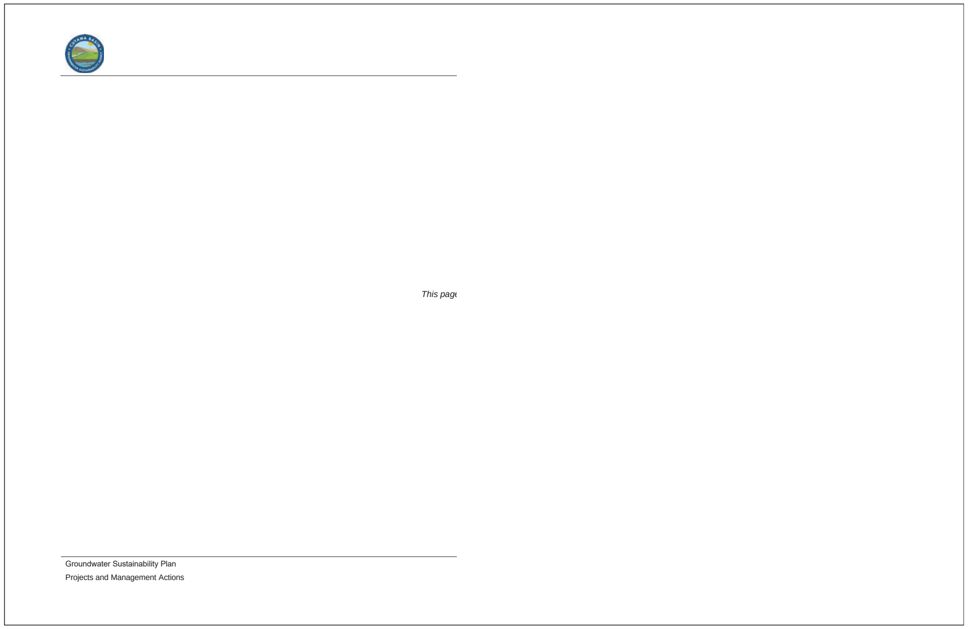

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### 7.3.2 Overdraft Mitigation

The proposed projects and management actions would support maintenance of groundwater levels above minimum thresholds through increased recharge or through reductions in pumping. Overdraft is caused when pumping exceeds recharge and inflows in the Basin over a long period of time. Improving the water balance in the Basin will help to mitigate overdraft.

### 7.3.3 Water Balance Management for Drought Preparedness

Communities in the Basin rely on groundwater to meet water needs. During drought, groundwater becomes more important due to limited precipitation. Projects that support groundwater levels through increased recharge help to protect groundwater resources for use during future drought, as well as help protect the Basin from the impacts of drought on groundwater storage. Projects that reduce pumping will help manage the Basin for drought preparedness by reducing demands on the Basin both before and during drought, supporting groundwater levels in non-drought years, and decreasing the impacts of drought on users, reducing the need to increase pumping when precipitation levels are low.

## 7.4 Projects

Projects included in this GSP are generally capital projects that could be implemented by the CBGSA or its member agencies on a volunteer basis that provide physical benefits to enhance supplies.

### 7.4.1 Flood and Stormwater Capture

Flood and stormwater capture would include infiltration of stormwater and flood waters to the groundwater basin using spreading facilities (recharge ponds or recharge basins) or injection wells. Spreading basins are generally more affordable than injection wells because water does not need to be treated prior to recharge into the Basin. While specific recharge areas have not yet been selected, areas of high potential for recharge were identified north and east of the Cuyama River near the Ventucopa Management Area, as well as in select areas of the Central Management Area. It is likely that locating spreading facilities near the Cuyama River represents the easiest method of capturing and recharging flood and stormwaters. Agricultural lands may be used in lieu of or in addition to specialized spreading facilities, or installation of “mini dams” on the Cuyama river to slow flows and increase in-stream recharge. The likeliest of these flood and stormwater capture and recharge options to be implemented is the use of spreading basins, because it will maximize volumes of water captured and recharged into the groundwater basin. Agricultural spreading is usually achieved through intentional overirrigation; in the Basin, agricultural irrigation uses groundwater, and new facilities would still be required to implement agricultural spreading that would not negatively impact groundwater levels. Mini dams could have negative environmental impacts and would not capture as much flow as dedicated spreading basins.

This project would include development of a feasibility study to identify specific flood capture and recharge locations and to refine the potential yield and cost, as well as determine the downstream impacts of implementation and how to address those potential impacts..

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## Public Notice and Outreach

Project notice and outreach would likely be conducted during implementation of a flood and stormwater capture project. Some of this outreach would likely occur as part of the California Environmental Quality Act (CEQA) process (see below), though additional outreach may be conducted depending on public perception of the proposed project. Public notice and outreach is not anticipated during development of the feasibility study, beyond potential outreach to landowners whose property is identified as potential sites for spreading facilities.

## Permitting and Regulatory Processes

Completion of a feasibility study would not require any permits or regulatory approvals beyond approval of the governing board for the agency funding the study or contracting with any potential consultant who may be retained to complete the analysis.

Implementation of a flood and stormwater capture and recharge project would require construction permits, streambed alteration agreements from the California Department of Fish and Wildlife for diversions from the Cuyama River, CEQA compliance, and potential 401 permits from U.S. Army Corps of Engineers. Additional permits may be required to complete construction and initiate operation of spreading facilities. The CBGSA would need to secure easements to or purchase the land for the spreading facilities. Additionally, the CBGSA may need to obtain surface water rights agreements from the California State Water Resources Control Board. Any water rights would need to address water rights existing downstream water rights.

## Project Benefits

Implementation of flood and stormwater capture projects would provide additional infiltration into the Basin, which would increase the volume of groundwater in the Basin, reducing overdraft and increasing available supply. The 2015 *Long Term Supplemental Water Supply Alternatives Report* (Santa Barbara County Water Agency [SBCWA], 2015), completed an analysis of potential stormwater recharge options along multiple rivers in Santa Barbara County, including Cuyama River. The analysis assumed the Cuyama River would experience sufficient flows for stormwater recharge three of every 10 years, and a maximum available stormwater volume during those events as 14,700 acre-feet (AF). Capturing this volume of water would require 300 acres of land for spreading facilities, and could provide a up to 4,400 acre-feet per year (AFY) of stormwater (averaged over 10 years), assuming the maximum event year supply is captured. Benefits of an implemented floodwater/stormwater capture project would be measured by the volume of flow entering the spreading facility, less an assumed percentage of evaporative loss.

Actual benefits could be lower once evaporative loss is accounted for, and if the final design for spreading facilities is not sized for the maximum storm event, or if the maximum event year is not realized as frequently as anticipated. If coupled with precipitation enhancement (see Section 7.3.2), additional benefits may be realized, though some overlap in benefits may occur.

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### Project Implementation

The circumstance of implementation for a flood or stormwater capture project would be if the refined feasibility study recommends a project and finds it is both cost effective and would result in a meaningful volume of incremental supply.

Completion of the feasibility study would be undertaken by the CBGSA, which would hire a consultant to perform the analysis. In addition, the CBGSA would initiate coordination activities with downstream users to evaluate the potential for a stormwater capture project in the Basin to affect downstream users' supply reliability and develop potential projects or actions to offset supplies that may be diverted by stormwater capture and recharge in the Basin.

Implementation of spreading facilities for stormwater capture would require land acquisition, construction of spreading facilities, diversion from Cuyama River, and associated pipelines and pumps. If pursued, the CBGSA anticipates implementing the project either directly or through one of its member agencies.

### Supply Reliability

The success of a flood and stormwater capture project depends on the frequency of precipitation events that result in sufficient flows for capture and recharge, the recharge capacity of the spreading facilities, and the location of flows in relation to the diversion point to the spreading facilities. Rainfall is generally limited to November through March in the region, and total rainfall is low, averaging 13 inches over the last 50 years (see Water Budget section of Chapter 2). The project would allow for the limited surface water flows to be captured and used, and if implemented, a flood and stormwater capture project would improve supply reliability in the Basin by increasing groundwater recharge, allowing more water to be available to Basin users.

### Legal Authority

The CBGSA has the legal authority to conduct a feasibility study for flood and stormwater capture and recharge project. Once a preferred alternative is identified by the feasibility study, the project would be implemented by the CBGSA or one of its member agencies . Implementation of the project would also depend on the outcomes of a water rights evaluation to clarify the CBGSA's ability capture flood and stormwater without impacting downstream water rights. If this project would affect downstream water rights, the CBGSA would need to negotiate an exchange with downstream users to avoid adverse downstream effects.

Implementation would require acquisition of targeted land for spreading facilities, which may require purchase or an easement to allow for project implementation. As public water supply agencies, any of the CBGSA members have authority to implement the project once land is acquired and applicable permits secured.

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### Project Costs

Implementation costs would vary depending on the ultimate size and location of the spreading facilities, and any compensatory measures required for downstream users. Per acre-foot costs would also vary depending on the amount of stormwater captured and successfully recharged. The primary cost for implementation of spreading facilities is the land purchase cost. Because the project would capture flood and stormwater (as opposed to imported or purchased water), there would be no supply costs to operate the project. The 2015 report estimated flood and stormwater capture and recharge from Cuyama River using spreading basins would cost $600 to $800 per AF (SBCWA, 2015).

### Technical Justification

The use of spreading facilities for groundwater recharge is common in many areas across the state where groundwater basins are used for storage. The 2015 *Long Term Supplemental Water Supply Alternatives Report* (SBCWA, 2015) provides the basis for the estimated maximum volume of water that could be recharged by a flood or stormwater capture and recharge project. The storage potential of the Basin is based on the highest historical storage less the current storage, with the difference being unused storage potential. The Cuyama Basin has a high storage potential, greater than 100,000 AF, meaning it would be able to accommodate recharge of more than 100,000 AF. The size of the spreading facilities is based on the volume of water available for capture, and the recharge factor of a proposed site. The volume of water that could be recharged is based on the volume of water that could be diverted off of the river during peak storm flow events. Recharge potential was determined by analyzing the existing groundwater depth and hydrological soil type, and infiltration rates based on relative infiltration rate for hydrologic soil groups. High recharge potential were areas with hydrologic soils in group A/B, and had infiltration rates of 0.6 feet per day. As shown in Figure 7-2, the majority of the Basin located in Santa Barbara County has medium or high potential for groundwater recharge, with the highest potential east of the Cuyama River in the Ventucopa Management Area. The 2015 report was limited to Santa Barbara County and does not cover the portions of the Basin located in Ventura, San Luis Obispo, and Kern counties.

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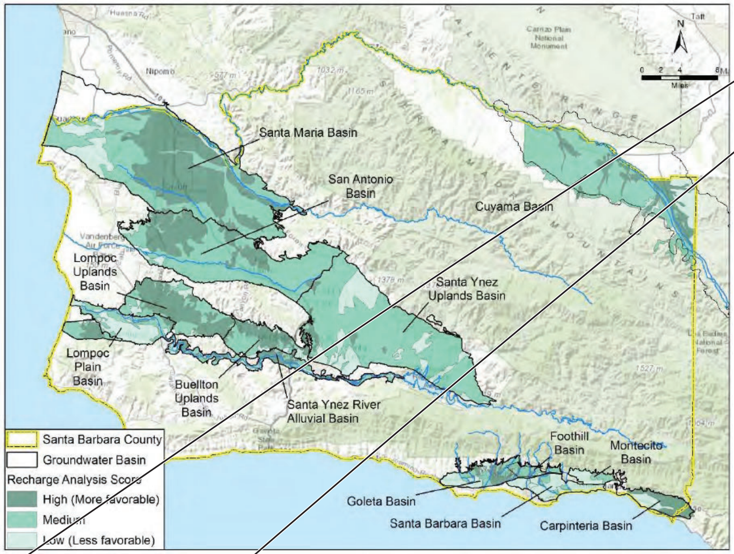

*Source: SBCWA, 2015*

Figure 7-2: Groundwater Recharge Potential in Santa Barbara County

The 2015 report recommended additional studies to refine the high-level analysis in the report. Under this project, the CBGSA would develop a study to refine the areas of potential recharge, including areas of the Basin with potential to provide land for spreading facilities that were excluded from the 2015 report due to being located outside of Santa Barbara County. The feasibility study would, calculate the potential evaporative loss, evaluate alternatives to determine the preferred size and location of spreading facilities, refine costs for the alternatives, and calculate the potential supply from implementation of the preferred alternative.

### Basin Uncertainty

This project would take advantage of the uncertain rainfall in the region and capture it for future use when precipitation levels are high. This would help bolster groundwater supplies and improve supply reliability in the Basin.

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### CEQA/NEPA Considerations

The feasibility study would not trigger CEQA or National Environmental Policy Act (NEPA) actions because it does not qualify as a project under either program. If a flood and stormwater capture project is implemented, CEQA would be required and completed prior to construction. NEPA would only be required if federal permitting, such as a 401 permit from U.S. Army Corps of Engineers, or if federal funding is pursued.

## 7.4.2 Precipitation Enhancement

A precipitation enhancement project would involve implementation of a cloud seeding program to increase precipitation in the Basin. This project would target cloud seeding in the upper Basin, southeast of Ventucopa, and would include introduction of silver iodide into clouds to increase nucleation (the process by which water in clouds freeze to then precipitate out). Based on the findings of the *Feasibility/Design Study for a Winter Cloud Seeing Program in the Upper Cuyama River Drainage, California* (SBCWA, 2016), such a program would use both ground-based seeding and aerial seeding to improve the outcomes of the program. Ground-based seeding would be conducted using remote-controlled flare systems, set up along key mountain ridges and could be automated. Aerial seeding would use small aircraft carrying flare racks along its wings to release silver iodide into clouds while flying through and above them.

Precipitation enhancement modeling assumed cloud seeding would increase precipitation by 10 percent from November through March, the time of the year with highest potential for rainfall in the Basin, for an average annual increase in precipitation of about 16,000 AF. With this assumption regarding precipitation increase, the numerical modeling estimated that an increase of 1,500 AF of additional annual average supply within the Basin over 50 years could be achieved. The portion of the increased precipitation would potentially benefit areas downstream of the Cuyama Basin.

This project would complete a detailed study to refine the potential yield and cost of implementation in the Basin.

### Public Notice and Outreach

Completion of a detailed study would include at least one public meeting (potentially at a regularly scheduled CBGSA Board meeting) to present the details of a precipitation enhancement project, costs and benefits, as well as provide an opportunity to receive comments from the public about potential concerns. If a precipitation enhancement project is pursued for implementation, it would not require public notice or outreach, except for approval by a governing body for the CBGSA that would occur in a public meeting.

### Permitting and Regulatory Processes

Completion of a study to refine the feasibility of a precipitation enhancement project would not require any permits or undergo a regulatory process. If a precipitation enhancement project is pursued for implementation, it is expected to be implemented under the existing SBCWA program, and would be covered under existing permits for that program.

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## Project Benefits

The *Feasibility/Design Study for a Winter Cloud Seeing Program in the Upper Cuyama River Drainage, California* (SBCWA, 2016) found that cloud seeding activities both in the region and in other locations around the world resulted in increased precipitation. This increase was found to be an increase in duration, rather than intensity. The existing cloud seeding program in Santa Barbara County was estimated to increase precipitation between 9 and 21 percent between December and March. The feasibility study estimated average seasonal increases of 5 to 15 percent if this program is implemented.

Based on a 10 percent increase in precipitation between November and March, modeling demonstrates an average annual benefit of 1,500 AF per year could be achieved over a 50 year period. This includes an annual average of 400 AF of deep percolation, 400 AF available in stream seepage, and 700 AF in boundary flow. There would also be an average annual increase in Cuyama River outflow of 2,700 AF. Figure 7-3 shows the potential long-term benefits of a precipitation enhancement program. Actual benefits would be measured by evaluating rainfall data after seeding compared to long-term average rainfall in non-seeded years.

The project would complete a refined feasibility study to determine the expected precipitation yield and costs of a precipitation enhancement project. Expected benefits would be refined in that study, prior to the CBGSA making a decision to implement a precipitation enhancement program.

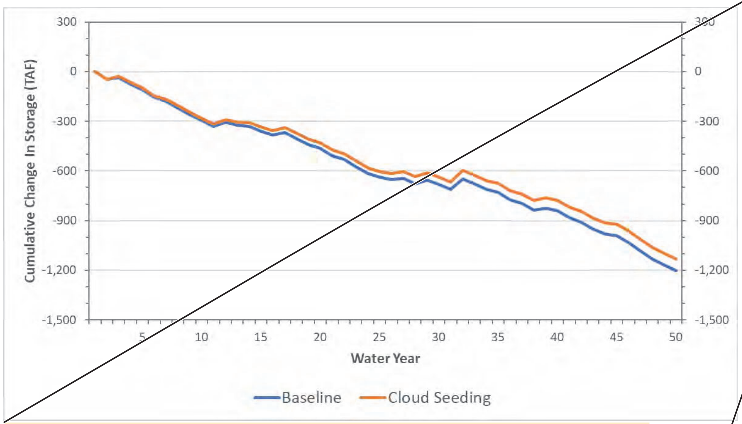

Figure 7-3: Potential Change in Groundwater Storage from Precipitation Enhancement

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### Project Implementation

The circumstance of implementation for a precipitation enhancement project would be if the refined project study determines it is a cost-effective measure likely to result in meaningful increases in precipitation in the Basin. The circumstance of implementation for the refined study is current conditions, where the CBGSA is ready to consider implementation of precipitation enhancement to support reduced overdraft in the Basin.

Implementation of this project would require installation of two or three additional ground-based seeding sites, referred to as an Automated High Output Ground Seeding System (AHOGS). Each AHOGS site would include:

- Two flare masts, which each hold 32 flares and includes spark arrestors to minimize fire risk
- A control box with communications system, firing sequence relays and controls, data logger, and battery
- A solar panel/charge regulation system to power the site
- Cell phone antenna
- Lightning protection

Aerial seeding would require outfitting the appropriate plane with flare racks.

Implementation of this project would likely be achieved by incorporating it into the existing precipitation enhancement activities being implemented by the SBCWA. Because implementation would be achieved through an existing program, the CBGSA does not anticipate needing to purchase and install new models or control systems beyond those necessary for the additional seeding sites and equipment.

### Supply Reliability

Precipitation enhancement has been shown to provide measurable benefit to regions when implemented thoughtfully. Although the amount of precipitation increase that the project could provide is uncertain, evidence suggests potential for an average annual increase of 0.5 to 2.5 inches if this project is implemented (SBCWA, 2016), which would help to improve overall supply reliability in the Basin by increasing precipitation, reducing the need for groundwater pumping and increasing groundwater recharge. This project is not dependent on existing supplies or imported supplies for successful implementation and benefits to the Basin.

### Legal Authority

The project would be implemented by the SBCWA, one of the member agencies of the CBGSA. The SBCWA already implements precipitation enhancement in the region, and has the legal authority to expand the program within its service area, which includes the Basin.

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### Project Costs

The 2016 *Feasibility Study* (SBCWA, 2016) recommended installing two or three AHOGS units for ground-based seeding. Each AHOGS unit would cost $30,000 to build and test, and between $4,000 and $6,000 each to install. Annual maintenance was estimated at $10,000 each. There would be minimal costs associated with initiating aerial seeding for the Basin because it would be implemented as part of the existing precipitation enhancement efforts in the region. Operational costs for aerial seeding would include flight costs ($550 per hour in 2016), and the cost of the seeding flares. Seeding flares in 2016 cost $90 apiece, and up to 50 flares used aerially and approximately 25 flares per AHOGS site in the four-month project period. Annual set-up, take-down, and reporting costs for this project are estimated at $15,000 for a combined ground-based and aerial seeding effort for the Basin, as well as personnel costs of $5,000 per month.

The 2015 *Feasibility Study* estimated that ground-based seeding would cost $45,500 to $67,500 for four months, and aerial seeding would cost $37,750 for four months, assuming that aircraft costs are funded by the existing program.

Total costs are expected to be between $20 and $30 per AF of water under this project, though exact costs would depend on the success of the program in a given year, and market conditions for project materials and aircraft time.

### Technical Justification

Cloud seeding as a concept has existed for decades, and target nucleation of supercooled water droplets that exist in clouds. Supercooled water is water that has been cooled below freezing temperatures (0 degrees Celsius or 32 degrees Fahrenheit), but remains in liquid form, rather than frozen. Supercooled water above -39 degrees Celsius must encounter an impurity to freeze, referred to as freezing nuclei. In the 1940s, particles of silver iodide were discovered to be able to cause freezing of supercooled water droplets in clouds. Silver iodide is the most common freezing nuclei used for cloud seeding in which silver iodide is injected into clouds to promote precipitation. A research program in Santa Barbara County on cloud seeding was conducted in the 1960-70s in which silver iodide was released into “convective bands” as random “seeded” or “non-seeded” (no iodide) convective bands, and resulting precipitation measured by a large network of precipitation gauges. This study evaluated both ground-based seeding and seeding by aircraft. Both methods found seeding resulted in a large area of increased precipitation. Additional studies in other regions in the 1990s found that additional precipitation from cloud seeding was a result of the increased duration of the precipitation event, rather than an increase in intensity. Cloud seeding has been conducted most winters since 1981 in portions of Santa Barbara County, which have had an estimated benefit of 9 to 21 percent increase in precipitation. The 2016 *Feasibly Study* for precipitation enhancement in the Upper Cuyama River Basin estimated a potential 5 to 15 percent increase in rainfall if a seeding project was implemented (SBCWA, 2016).

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### Basin Uncertainty

This project would improve precipitation yields in the Basin, helping to reduce the impacts of variable precipitation and providing for increased opportunities for groundwater recharge and stormwater capture. Further, increased precipitation duration and yields would reduce demands for groundwater for irrigation, reducing the risk of crop failure associated with water supply reliability challenges.

### CEQA/NEPA Considerations

If this project is implemented, it is anticipated to be incorporated into the existing cloud seeding program implemented by SBCWA. The existing seeding program achieved CEQA coverage under the Santa Barbara Mitigated Negative Declaration (MND), finalized in 2013. This project would achieve CEQA coverage either under this existing MND, or Santa Barbara Water Agency would be required to prepare an addendum to the MND to incorporate the Cuyama Basin target area for the seeding program. Unless the project pursues federal funding, NEPA is not anticipated to be required.

## 7.4.3 Water Supply Transfers/Exchanges

This project would evaluate the feasibility of purchasing transferred water and exchanging it with downstream users (downstream of Lake Twitchell) to allow for additional stormwater and floodwater capture in the Basin to protect water rights of downstream users. Because this action is intended only as a complement to a potential stormwater or floodwater capture project, all potential purchase transfer water would originate outside of the Cuyama River watershed, and this action would not include the transfer or sale of existing Cuyama Basin groundwater out of the watershed. The study would be coordinated with the floodwater and stormwater capture in Section 7.3.1, as the feasibility of such an exchange would affect the maximum volumes of stormwater that would be captured under that project. If the feasibility study finds there is limited interest from downstream users, implementation would not be pursued.

### Public Notice and Outreach

Public noticing would not be required for the feasibility study though outreach would be conducted as part of the study to determine willingness of downstream users to participate in an exchange.

### Permitting and Regulatory Processes

No permits or regulatory processes would be necessary for development of the feasibility study. Agreements would need to be executed to secure additional water supply for use in a transfer/exchange, as well as to exchange water with downstream users. No other permits are anticipated to be required to implemented water transfers/exchanges.

### Project Benefits

Implementation of a water transfer/exchange program would allow the CBGSA to increase stormwater capture if the Flood and Stormwater Capture project (see Section 7.3.1) is implemented because it would reduce the potential water rights conflicts that could arise from increased stormwater capture. The Basin does not have a physical connection to supplies outside the Basin, and is therefore limited in the types of

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projects that could be implemented to increase supplies. This project would allow the CBGSA to maximize the new water supply that could be available to the Basin if flood and stormwater capture is implemented. This project would be limited to the feasibility study, and would not have direct benefits. If a water transfer/exchange program is implemented as a result of the outcomes of the feasibility study, benefits would be measured by the successful execution of transfer/exchange agreements and the increased capacity of the stormwater capture and spreading facilities made possible by these agreements. Water supply benefits would be measured by the volume of water captured above the volume that would have been allowed had the transfer/exchange agreements not been implemented.

### Project Implementation

The circumstance for implementation of the feasibility study would be exploration of the feasibility of flood and stormwater capture and recharge (see Section 7.3.1). Implementation of this project would occur if downstream users expressed interest in participation in water transfers/exchanges and the feasibility study determined the potential increase in supply that transfer/exchanges would provide is cost effective for achieving supply reliability and groundwater sustainability goals.

The CBGSA would develop the feasibility study in coordination with the Flood and Stormwater Capture Project's feasibility study. Based on the outcomes of the two feasibility studies and the level of interest of downstream users, the CBGSA would determine whether implementation of a transfer/exchange project is a preferred action for the CBGSA. Implementation of the transfer/exchange program would entail coordination amongst participants: the CBGSA, agencies who own the water to be used in the transfer, and downstream users who participate in the exchange.

### Supply Reliability

Transfers and exchanges would require access to a reliable water supply from outside the Basin currently owned by an agency that has sufficient water rights to be willing to sell a portion of their water to the CBGSA for this project. Because this project would be used to increase the capacity of the stormwater capture project, benefits would be experienced only following a heavy precipitation event. It is likely that in years with large precipitation events, other parts of the state will also experience wet winters, increasing available supplies from sources like the State Water project, or other surface water supplies. The feasibility study would require an evaluation of supply reliability, and explore the potential mechanisms for a successful transfer/exchange program that would account for the uncertainty of precipitation events on a year-to-year basis and available supply and potential benefit to the Basin.

### Legal Authority

The CBGSA, through its member water supply agencies, has the legal authority to enter into transfer and exchange agreements with other water suppliers and users. The CBGSA does not have the authority to increase its stormwater capture at a level that would impede downstream senior water rights holders from accessing their water rights, making this project a critical component of an expanded capacity stormwater project (beyond what could be achieved without this project).

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### Project Costs

A feasibility study would likely cost between $100,000 and $200,000 to complete, including outreach to downstream water users and potential sources of supply for the transfer/exchange program. Costs to implement a transfer and exchange program would be evaluated in the feasibility study and are estimated to range from $600 to $2,800 per AF. Costs would vary depending on the details of the transfer/exchange, source of new water, and parties involved.

### Technical Justification

A transfer/exchange program would be at minimum a one-to-one exchange, meaning for each AF of water provided to downstream users through the program, the CBGSA could capture an additional AF of stormwater. The feasibility study would identify which supplies could be purchased to exchange with downstream users, based on supply availability, connectivity to downstream users, willingness of supply owners to participate, and cost. One purpose of the feasibility study would be to determine a preferred alternative for the transfer/exchange program, and provide a technical justification of the preferred program. If technical justification cannot be made, the program would be considered infeasible and would not be pursued.

### Basin Uncertainty

The transfer/exchange project would help address uncertainty in the basin by allowing the CBGSA to increase groundwater recharge, using years with surplus surface water flows to supplement groundwater during dry years by increasing the volume of stormwater that can be captured without interfering with downstream users' water rights.

### CEQA/NEPA Considerations

Development of a feasibility study would not trigger CEQA or NEPA. Water exchanges or transfers are not anticipated to include construction of new facilities. However, since a water exchange or transfer is a discretionary action, they are likely to be considered projects under CEQA or NEPA. NEPA documentation may be required if any of the water being exchanged or transferred is federal agency (i.e., Reclamation or USACE).

## 7.4.4 Improve Reliability of Water Supplies for Local Communities

The Basin is experiencing overdraft in the Central Basin and Ventucopa management areas, which are the population centers of the Basin. Domestic water users in these areas are experiencing water supply reliability challenges, and in the 2012-2016 drought experienced well failures. While the following actions would not affect the water budget in the Basin, they are intended to address ongoing water supply reliability issues affecting these communities. CCSD only has a single well to serve its customers, and no redundancy in its system. This management action would include consideration of opportunities to improve water supply reliability for Ventucopa and within the CCSD service area. Potential projects that would be considered under this management action include a replacement well for CCSD Well 2, which is currently abandoned, and improvements to Ventucopa Water Supply Company's (VWSC's) existing

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well. While specific information is not available for improvements (and are therefore not discussed below) for the town of Cuyama, which is served by the CMWC, the CBGSA also supports potential future actions to benefit the town of Cuyama as well.

### CCSD Replacement Well

The CCSD Replacement Well would drill a new well in CCSD's service area to replace Well 2, which has been abandoned due to an electrical failure that damaged the well and pumping equipment and subsequent damage the well incurred when an attempt was made to remove the pump. A replacement well for Well 2 was attempted, but found to produce water that was unsuitable for potable use due to the design and construction of the well. Construction of the new well would include:

- Drilling, installing, and testing a new well
- Installing a well head, submersible well pump, and electrical panel
- Construction of an 8-inch pipeline to connect the new well to CCSD's system

### Ventucopa Well Improvements

The Ventucopa Well Improvements would construct a new water supply pump, pipelines, and meters for the existing Ventucopa Well 2 and seek approval for the well's use for drinking water from the County of Santa Barbara's Department of Health Services (DHS). These improvements would:

- Install a pump, electrical service, and controls at Well 2
- Construct an 8-inch pipeline from Well 2 to Ventucopa's existing hydropneumatic tank
- Install meters at Well #1 and Well 2
- Install a SCADA system for Well 2
- Install piping, valves, and inline mixer to blend water from Well 1 and Well 2

### Public Notice and Outreach

Public notice and outreach would not be required beyond that necessary for approval at a public Board of Directors meeting or applicable CEQA.

### Permitting and Regulatory Processes

CCSD's new well construction would require acquisition of a well drilling permit and approval of well design and well completion report. It would also require well testing that demonstrates the new well is capable of producing water that is suitable for drinking water. In addition to a well drilling permit from Santa Barbara County, CCSD's existing water system permits would need to be revised to include the new well and associated features.

Improvements to VWSC's well would require compliance with Santa Barbara County's regulations for water systems in the unincorporated county. VWSC would need to acquire the appropriate well drilling

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permits from the County as well as receive DHS certification of the suitability of the upgraded well for potable use before water from Well 2 can be delivered to customers.

### Project Benefits

These projects would improve supply reliability for Ventucopa and CCSD residents and customers by creating system redundancies and upgrades to address challenges with meeting existing demands associated with aging and failing infrastructure. As planned, up to 460 gallons per minute could be made available to CCSD and up to 55 gallons per minute available to VWSC as a result of this project. Benefits of this project would be measured by the volume of water produced by the two improved wells and reduction in the number of days system failures threaten access to water supplies.

### Project Implementation

The circumstance of implementation for this project is identified need for system improvements to meet public health and safety concerns. Both CCSD and VWSC have documented challenges with their water supply systems, including lack of redundancy, wells that do not adequately meet domestic water supply requirements, and limited capacity (CCSD, 2018; VWSC, 2007).

The two components of this project would be implemented by their respective system owners, CCSD and VWSC. CCSD would be responsible for planning, design, construction, testing, and permitting of the new Well 4, while VWSC would be responsible for planning, design, construction, testing, and permitting of the Well 2 improvements.

### Supply Reliability

This project would improve supply reliability to customers through system improvements designed to address known issues with accessing and conveying groundwater suitable for potable use.

### Legal Authority

CCSD owns the property for the proposed well site, and has the legal authority to design and construct a new well. As the owner-operator of the CCSD system, CCSD also has the legal authority to connect the new well to its existing distribution system and deliver water from the new well to customers once all appropriate permits have been acquired.

VWSC already owns Well 2 and the other existing components of the proposed project. It has the legal authority to implement projects that serve the water supply needs of its customers, and once all appropriate permits have been acquired, is legally able to connect Well 2 to its existing system.

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### Project Costs

In total, these improvements are expected to cost approximately $1,175,000.

CCSD's 2018 Engineering Report for Well 4 estimated project costs of $489,800 for drilling and $485,280 for equipping, for a total cost of $975,080 (CCSD, 2018).

VWSC's 2007 *Ventucopa Water System Evaluation Report* estimated the well improvements included in this GSP would cost $191,200 (VWSC, 2007). Costs are assumed to have increased since 2007, and well improvements are currently expected to cost approximately $200,000 to implement.

### Technical Justification

Both components of this project have completed initial planning efforts. Preliminary engineering and design has been completed for the CCSD Well 4 improvements, including the 2018 Engineering Report and preliminary design drawings. VWSC's well improvements were described and evaluated in the 2007 Evaluation Report. Implementation of this project would include final design for all components, as well as testing to ensure that well improvements meet the needs they are designed to address.

### Basin Uncertainty

These improvements would reduce uncertainty associated with supply reliability in CCSD and VSWC's service areas.

### CEQA/NEPA Considerations

Well drilling permits are a discretionary action in Santa Barbara County, which would trigger CEQA. CCSD and VSWC would need to complete the appropriate CEQA document to comply with these requirements prior to construction of this project. The project would not trigger NEPA unless federal funding or permits are required for completion of the project. The size and location of the project indicates it is unlikely to require federal permits, and NEPA is likely to only be required if federal funding is pursued.

## 7.5 Water Management Actions

Water management actions are generally administrative locally implemented actions that the CBGSA or its member agencies could take that affect groundwater sustainability. Typically, management actions do not require outside approvals, nor do they generally involve capital projects.

### 7.5.1 Basin-Wide Economic Analysis

Changes to pumping in the Basin and access to water supplies may have economic consequences given that the Basin is dominated by agricultural land uses that are dependent on groundwater availability. Implementation of stormwater capture may require purchase of agricultural land for the spreading facilities, which could affect agricultural output in the region. The small population of the Basin limits the available revenue to fund projects. This Project would entail developing a study of the economic impacts

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of the projects and management actions included in the GSP. This would include an evaluation of how implementation of the project could affect the economic health of the region and on local agricultural industry. It would also consider the projected changes to the region's land uses and population and whether implementation of these projects would support projected and planned growth. The economic analysis would be considered by the CBGSA when deciding whether to implement a proposed project and potential when to implement the projects.

### Public Notice and Outreach

This project is a study and would not require public notice or outreach. The results of the economic analysis will be presented at Stakeholder Advisory Committee (SAC) and CBGSA Board meetings.

### Permitting and Regulatory Processes

No permits or regulatory approvals would be required to complete the economic analysis.

### Project Benefits

The economic analysis would provide information to the CBGSA regarding the potential economic benefits and drawbacks to implementation of different projects under the GSP. This project would not provide direct benefits as related to water supply or groundwater sustainability, but would allow the CBGSA to move forward with implementation of projects that would continue to sustain local economies and would not inadvertently cause substantial economic harm, which could affect the ability of a proposed project to continue to provide benefits.

### Project Implementation

The circumstance of implementation for this project would be consideration of the implementation of any project included in this GSP or otherwise considered by the CBGSA. The CBGSA would implement this project with the assistance of an economic consultant that would complete the analysis based on data for the region and information provided by the CBGSA.

### Supply Reliability

This project is a study and does not depend on any water supply for implementation or successful completion.

### Legal Authority

The CBGSA is a joint-powers authority with authority to authorize an economic study for the projects in this GSP.

### Project Costs

A basin-wide economic analysis is expected to range from $50,000 to $100,000 in costs, depending on the available data and level of analysis desired. Exact costs would be determined during selection of the economic analyst.

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### Technical Justification

This project is a study that would use economic methods and analysis tools consistent with the standards and practices of the industry.

### Basin Uncertainty

This project would help understand the economic uncertainty around implementation of the projects in this GSP. Improved understanding of the economic implications of a project would help the CBGSA decide which projects should move forward to support basin sustainability without unintended consequences that could increase overall uncertainty in the basin, including uncertainty regarding groundwater demands in the basin associated with the local and regional economy.

### CEQA/NEPA Considerations

As a study, the basin-wide economic analysis would not trigger CEQA or NEPA.

## 7.5.2 Pumping Allocations in Central Basin Management Area

As described in Section 2.3 of this GSP, the Basin is in overdraft conditions and to achieve balanced pumping and recharge groundwater users must decrease pumping by approximately 67 percent, in the absence of projects that increase recharge in the Basin or otherwise offset demands. While the projects identified in Section 7.3 would increase the water available to users in the Basin through increased recharge and precipitation, they are not expected to reduce the groundwater deficit sufficiently to achieve the Basin's sustainability goals. As such, the CBGSA will implement pumping allocations.

Outlined here is a framework for how CBGSA would develop and implement pumping allocations in the Basin. This project would involve development of pumping allocations in the Central Basin Management Area. Consistent with the magnitude of projected overdraft estimated by the numerical model, pumping allocations would not apply to the Ventucopa Management Area or to users outside of a Management Area. CCSD would be provided allocations based on historical water use, and would not be required to reduce pumping over time, but would be limited in how much pumping could increase in the future.

There are four key steps to developing pumping allocations:

1. Determine the Sustainable Yield of the Basin
2. Allocate sustainable yield of native groundwater to users based on:
    a. Historical use
    b. Land uses and irrigated areas
3. Determine how new/additional supplies would be allocated
4. Develop a timeline for reducing pumping to achieve allocations over time

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### Sustainable Yield of the Basin Absent Projects and Water Management Actions

The sustainable yield of the Basin absent projects and water management actions is the volume of water that can be extracted from the Basin annually without affecting overall groundwater storage. and the sustainable yield of the Basin is estimated to be approximately 20,000 AFY, as described in the Water Budget section of Chapter 2. The sustainable yield of the Basin represents the volume of groundwater that can be allocated. Because pumping allocations would only be imposed on users in the Central Basin Management Area, the CBGSA would need to determine the sustainable yield for only the Central Basin Management Area, which would be less than the overall sustainable yield of the Basin.

### Develop Allocations

The CBGSA would develop allocations based on estimated historical use, existing land uses, and total irrigated acreage. The CBGSA would determine historical use by analyzing data about water use during the 20-year historical period from 1998 to 2017. This period aligns with the historical period of the water budget analysis described in Chapter 2. Water use would be estimated either using remote sensing and land use data to estimate agricultural consumption or from data provided by pumpers in the Basin, including private pumpers and water agencies. CCSD's allocation would be based on historical use, with an allowance for changes in population in the CCSD service area. CCSD would not be required to reduce use in the future under this action. As such, once CCSD's allocation has been determined, it would be removed from the total volume of groundwater available for allocation to non-CCSD users in the Central Basin Management Area.

A specific approach for allocation of pumping volumes among agricultural users in the Central Basin management area has not been determined. Potential options include allocation on the basis of historical use, on irrigated acreage, or on total acreage. The CBGSA would work with landowners and agencies to determine the appropriate approach for pumping allocations for agricultural users.

### Determine Allocation of New or Additional Supplies

As the CBGSA implements projects in this GSP, additional groundwater supplies are expected to become available. These supplies would be used to reduce groundwater overdraft. The CBGSA anticipates that any new supplies made available through project implementation would be added to the total volume of water that would be allocated to the beneficiaries of those projects identified during project development. The mechanism for accounting for additional water made available by project implementation would be determined when the allocation method is refined.

### Timeline for Implementation

The required decreases in pumping volumes to achieve balanced groundwater use in the Basin may result in substantial reductions in water availability over current use. The CBGSA plans to complete the pumping allocation plan in 2022, with pumping reductions beginning in 2023 at 5 percent of the total required reduction to achieve sustainability, and an additional 5 percent reduction in 2024. From 2025 to 2038, pumping would be reduced by 6.5 percent annually, so as to achieve sustainability in the Basin in 2038. Figure 7-4 shows the planned pumping reduction in the Basin. Individual users would be expected

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to reduce pumping at different rates to achieve the overall pumping reductions and meet their individual pumping allocations. The pumping allocation plan would identify how much each user or user-type would be required to reduce pumping annually to achieve the allocation and the overall Basin sustainability goals.

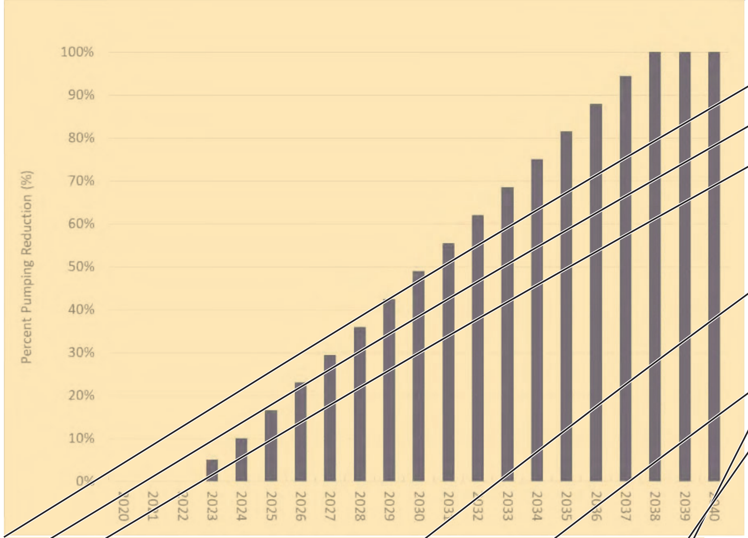

Figure 7-4: Glide Path for Central Basin Management Area Groundwater Pumping Reductions

### Public Notice and Outreach

Development of a pumping allocation plan would require substantial public input to understand the potential impacts of pumping allocations and baseline needs that should be accounted for. The CBGSA anticipates that public outreach would include multiple public workshops and meetings potential website and/or email announcements, along with other public notices for the workshops. The pumping allocation plan would be circulated for public comment before finalized, though final approval of the plan would be made by CBGSA in partnership with its member agencies.

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### Permitting and Regulatory Processes

Development of a pumping allocation plan would not require any permitting, but would require consideration of existing water rights and applicable permits and regulations associated with groundwater pumping in the Basin.

### Management Action Benefits

A pumping allocation plan would identify how the region will achieve sustainable pumping in the Basin. Implementation and enforcement of a pumping allocation plan would directly reduce groundwater pumping. Benefits would be measured by the change in total volume of groundwater pumped from the Basin and how many users are in compliance with their pumping allocations.

### Management Action Implementation

The circumstance of implementation for developing a pumping allocation plan is identification of unsustainable groundwater pumping practices in the Basin. The CBGSA recognizes recharge and pumping in the Basin are not balanced, and action must be taken to achieve sustainability. CBGSA would lead development of a pumping allocation plan, in partnership with its member agencies and local groundwater users. The planning process is expected to be completed in 2022, with allocations implemented beginning in 2023. Successful implementation would require compliance from groundwater users with the pumping allocation plan, and enforcement by the CBGSA and its member agencies. Successful roll-out of the pumping allocation plan would require substantial public outreach to inform users of their annual allocation and expected annual reduction in groundwater pumping. Mechanisms for enforcement would be outlined in the pumping allocation plan, and are expected to be enforced by CBGSA's member agencies.

### Supply Reliability

This project does not rely on the supplies from outside the Basin because it is a planning effort that will result in conservation. It will support overall supply reliability by reducing overdraft in the Basin and moving the Basin towards sustainability.

### Legal Authority

CBGSA has the authority to develop a pumping allocation plan, and will perform implementation and enforcement of allocations through metering, water accounting, and implementing pumping fees.

### Management Action Costs

Development and initiation of a pumping allocation management and tracking program is expected to cost up to $300,000 to conduct the analysis, set up the measurement and tracking system and conduct outreach. Costs to implement the plan would depend on the level of enforcement required to achieve allocation targets and the level of outreach required annually to remind users of their allocation for a given year. The pumping allocation plan would include a cost estimate for enforcement and implementation. Annual management of the program is estimated to cost about $150,000 per year.

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### Technical Justification

Pumping allocations would provide direct reductions of groundwater pumping. The pumping allocation plan would develop allocations based on historical use data and land use data, and would clearly describe the methodology and justification for the methodology used when setting pumping allocations.

### Basin Uncertainty

The Basin is currently experiencing overdraft, and if current pumping practices continue conditions in the Basin are expected to worsen, increasing uncertainty regarding the availability of reliable groundwater supplies. Development of a pumping allocation plan would provide an opportunity to reduce overdraft-related uncertainty in the Basin by shifting pumping towards sustainable levels over time.

### CEQA/NEPA Considerations

Development of a pumping allocation plan is most likely not a project as defined by CEQA and NEPA and would therefore not trigger either. Reducing pumping over time is also not expected to trigger CEQA or NEPA because it does not meet the definition of a CEQA or NEPA project. As any plan is developed, CEQA and NEPA will be considered to determine if compliance is required.

## 7.6 Adaptive Management

Adaptive management allows the CBGSA to react to the success or lack of success of actions and projects implemented in the Basin and make management decisions to redirect efforts in the Basin to more effectively achieve sustainability goals. The GSP process under SGMA requires annual reporting and updates to the GSP at minimum every 5 years. These requirements provide opportunities for the CBGSA to evaluate progress towards meeting its sustainability goals and avoiding undesirable results.

Adaptive management triggers are thresholds that, if reached, initiate the process for considering implementation of adaptive management actions or projects. For CBGSA, the trigger for adaptive management and CBGSA's next steps would be as follows:

- **Pumping reductions are more than 5 percent off the glide path identified in the pumping allocation plan:** CBGSA would evaluate why pumping allocations are not being met and implement additional outreach or enforcement, as appropriate
- **If the Basin is within the Margin of Operational Flexibility, but trending toward Undesirable Results, *and* within 10 percent of the Minimum Threshold:** CBGSA will investigate the cause and determine appropriate actions.

## 7.7 References

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