Groundwater Transfer Review Summary Form

Transfer/PA # T- **14449**

GW Reviewer **Dennis Orlowski** **Date Review Completed:** **February 4, 2025**

Summary of Same Source Review:

☒ The proposed change in point of appropriation is not within the same aquifer as per OAR 690-380-2110(2).

NOTE: currently-proposed construction details for six to-be-drilled APOA wells, in addition to an existing well also proposed as an APOA (WASH 62373), would lead to all of the proposed APOA wells obtaining groundwater from a primary deeper basalt water-bearing zone ("aquifer") that is not present in the authorized POA, WASH 7651. Resolving this discrepancy – i.e., ensuring the same source for all wells, in compliance with existing well construction regulations (OAR 690-200) - would require (1) revising planned construction details for the six TBD wells accordingly, and (2) completing retroactive well alterations (i.e., sealing off a deeper water-bearing zone) in existing well WASH 62373. This issue is discussed in detail throughout this review.

Summary of Water Level Decline Condition Review:

☐ Water levels at the original point(s) of appropriation have exceeded the allowed decline threshold defined by conditions in the originating water right.

Summary of Injury Review:

☐ The proposed transfer will result in another, existing water right not receiving previously available water to which it is legally entitled or result in significant interference with a surface water source as per 690-380-0100(3).

Summary of GW-SW Transfer Similarity Review:

☐ The proposed SW-GW transfer doesn't meet the definition of "similarly" as per OAR 690-380-2130.

This is only a summary. Documentation is attached and should be read thoroughly to understand the basis for determinations.

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Ground Water Review Form:

☐ **Water Right Transfer**
☒ **Permit Amendment**
☐ **GR Modification**
☐ **Other**

Application: T-14449 Applicant Name: City of Banks

Proposed Changes: ☐ POA ☒ APOA ☐ SW→GW ☒ RA ☐ USE ☐ POU ☐ OTHER

Reviewer(s): Dennis Orlowski Date of Review: February 4, 2025

Date Reviewed by GW Mgr. and Returned to WRSD: JTI 2/7/25

The information provided in the application is insufficient to evaluate whether the proposed transfer may be approved because:

☐ The water well reports provided with the application do not correspond to the water rights affected by the transfer.

☐ The application does not include water well reports or a description of the well construction details sufficient to establish the ground water body developed or proposed to be developed.

☐ Other _____

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1. Basic description of the changes proposed in this transfer: This proposed permit amendment relates to **permit G-7593** which authorizes groundwater pumped from a single authorized POA (WASH 7651, "Well-1") for municipal uses by the City of Banks (maximum instantaneous pumping rate of 0.67 cfs, ~301 gpm).

   This amendment proposes to add the following APOA to permit G-7593 (note that only one proposed APOA is an existing well (WASH 62373), whereas the others are proposed to-be-drilled (TBD)):

   - WTP (Water Treatment Plant) well – TBD
   - AN (Aerts Rd North) well – TBD
   - AS (Aerts Rd South) well – TBD
   - Park-A (Park Primary) well – TBD
   - Park-B (Park Alternative) well – TBD
   - Park-C (Park Alternative) well – TBD
   - Well-2 (Behrman Well 2) – WASH 62373

Proposed APOA WASH 62373 ("Well-2") is also the single authorized POA for certificate 95849, which authorizes pumping (maximum 1.0 cfs) of groundwater for municipal use by the City of Banks. WASH 62373 is located only about 60 feet away from WASH 7651 ("Well-1").

2. Will the proposed POA develop the same aquifer (source) as the existing authorized POA?
☐ Yes ☒ No Comments: Authorized POA WASH 7651 is 450 feet deep, with an open interval from 210 to 450 ft below land surface (bls), and obtains groundwater from water-bearing interflow zones within the Columbia River Basalt Group aquifer system (Conlon and others, 2005; Gannett and Caldwell, 1998). The well log for WASH 7651 indicates that greater than 90 percent of inflow to the well (~325 gpm) was estimated to be from a lower water-bearing zone (WBZ) from 360-415 ft bls; shallower interflow zones between 230 and 325 ft bls were estimated to provide only about 25 gpm to WASH 7651. **Consequently, in WASH 7651 the lower interflow zone between 360-415 ft bls is considered to be the primary source of groundwater to this well**.

As currently proposed, all of the APOA for this application would obtain groundwater from an even deeper discrete WBZ that is not present in the authorized POA WASH 7651 (i.e., a different source). Resolving this discrepancy would require modifications to existing and planned construction for the APOA, as discussed in the following sections.

Source Evaluation: Proposed APOA – WASH 62373 ("Well-2")

Proposed APOA WASH 62373 ("Well-2") is 665 feet deep, with an open interval between 300 and 665 ft bls within the CRGB aquifer system. According to the WASH 62373 well log and additional documents provided by the applicant's agent (CwM-H2O, 2018), there are two principal water-bearing interflow zones in this well: 378-468 ft bls (est. 350 gpm) and 615-660 ft bls (est. 300 gpm). The uppermost interflow, or water-bearing zone (WBZ), generally corresponds to the primary zone in authorized POA WASH 7651 (360-415 ft bls). However, the lower WBZ in WASH 62373 is not present in the shallower authorized POA (WASH 7651).

Transfer application T-14449 provided attached documentation ("Interpretation of Basalt Water-Bearing Zones in the Area of Banks, Oregon") that provides additional information intended to support "…the development of all basalt WBZs encountered to a depth of 665 feet below ground surface (bgs) *as one aquifer unit*" (emphasis added). The information provided consists of (1) recent geophysical evidence (video survey, caliper log, spinner logs, temperature log); (2) evidence from area water well reports of equivalent static water levels; and (3) evidence from recent water level elevations: wells 1 and 2.

OWRD has reviewed this additional documentation and concludes that it does **not** support the applicant's request to consider "all basalt WBZs encountered to a depth of 665 feet bgs as one aquifer unit." **Instead, OWRD finds the preponderance of the evidence supports a finding that the two WBZs in WASH 62373 are discretely different aquifer sources**.

OWRD comments on the supplemental application documents, and our rationale for considering the presence of two discrete aquifers in WASH 62373, are as follows:

(1) The spinner log instrumentation used for the 2017 geophysical survey conducted in WASH 62373 has a low-flow measurement threshold of <1.0 ft/minute (pers. comm., Pacific Surveys, 1/24/2025). In WASH 62373 this threshold would equate to a potential vertical flow in the borehole of approximately 6 gpm; this flow rate is that which could exist within the borehole without being detectable by the spinner log instrumentation used for the survey of WASH 62373. The presence of *any* vertical flow in a borehole under otherwise static conditions (i.e., non-pumping) indicates a head differential between successive WBZ, which in turn indicates that each WBZ behaves as a separate "aquifer" (source).

Because vertical flow might exist in WASH 62373 that is below the threshold detection limit of the spinner log device, the interpreted results of this survey do **not** prove conclusively that the two primary WBZ in this well (378-468 ft bls and 615-660 ft bls) behave as "one aquifer unit."

(2) The application attachment asserts that the well logs for WASH 62373, nearby WASH 50693 (Quail Valley Golf Course well), and other nearby basalt wells did not indicate changes in static water levels as the wells were being drilled through multiple water-bearing zones. If present, such head changes would indicate a vertical gradient and resultant vertical flow between WBZs, which in turn would imply that each WBZ was a discretely different aquifer. Conversely, no head changes between WBZ would suggest a single aquifer unit.

However, while observed head changes during drilling *can* be an indication of different aquifers/discrete WBZs, particularly if the change is relatively large (e.g., at least several feet), the absence of such observed changes is *not* conclusive proof of a single "aquifer unit" comprised of multiple WBZs, for the following reasons: (1) in cases where the actual head differences between WBZ are relatively small (e.g., 1-2 feet), such differences might not be discernible during typically disruptive drilling activities; (2) when drilling through multiple WBZ, the head in the well becomes a composite of various heads under dynamic conditions (with interflow occurring through the borehole); thus it can be impossible to quantify, or even discern, any head changes attributable to a single WBZ; (3) pumping of other nearby CRBG wells could affect water levels measured in the well being drilled (both WASH 62373 and WASH 50693 were drilled primarily in April and May of 2005 and 1996, respectively, which is within the irrigation pumping period for this basin).

(3) After recently completing an elevation survey of the wellheads of both WASH 7651 ("Well-1") and WASH 62373 ("Well-2"), the application states that static water level elevations between the wells "differed by 0.62 – 1.12 feet." This range is comprised of three rounds of contemporaneous measurements made in both wells on March 15th, April 7th, and October 13th, 2023 (T-14449 application attachment).

A similar range of head differences between WASH 7651 and WASH 62373 was measured more recently in February and March of 2024, at 0.7 ft and 1.0 ft, respectively. As reported to OWRD, these measurements were made when the WASH 62373 pump had been idle for at least 24 hours for the February reading, and at least 7 days for the March measurement (for the March 2024 measurement in WASH 7651 it was reported that the pump had been pulled for replacement, and had not been pumped for at least one year) (T-14449 application attachment).

The range of reported static water level differences between WASH 7651 and WASH 62373, though relatively small, indicates the presence of a vertical gradient between the two major WBZ intersected by the wells. This vertical gradient in turn indicates that the two WBZ in WASH 62373 behave as discrete aquifers as defined by different head conditions.

Source Evaluation: Proposed APOA – TBD (six well locations)

The other six proposed APOA that are not yet drilled are planned to be approximately 650 to 750 feet deep, and cased and sealed to about 200-250 ft bls; consequently, the open intervals in these proposed TBD APOA wells could range from approximately 400 to 550 feet.

Because authorized POA WASH 7651 obtains groundwater primarily from the WBZ at 360-415 ft bls, all other proposed APOA are to be limited to obtaining groundwater from only that same source. However, the currently-proposed construction for the six TBD APOA wells (i.e., both the large potential range of open intervals and total depths) would also include discrete deeper WBZ that are not present in WASH 7651.

The primary WBZ present in WASH 7651 is also present in WASH 62723 and WASH 50693 (QVGC well). From information available from these three well logs, this primary WBZ exists from approximately elevation -125 to -250 ft msl in the vicinity of these and the other proposed APOA locations.

To ensure that each proposed APOA obtains groundwater only from the currently-authorized aquifer source, all of the proposed APOA wells will be limited to accessing only the basalt interflow/WBZ present between approximate elevations -125 to -250 ft msl. For the six proposed APOA not yet drilled, this will require corresponding reductions in planned total well depths, as well as revisions to the cased and sealed intervals. For proposed APOA WASH 62373, compliance would require sealing the lower WBZ in that well, with a total resultant well depth at/near elevation -250 ft msl (equal to about 485 feet bls at that location).

The following technical analyses was completed assuming these revisions to the proposed APOA wells (i.e., each accessing *only* the WBZ present from approximately elevation -125 to -250 ft msl).

3. a) Is the existing authorized POA subject to a water level decline condition?

☐ Yes ☒ No Comments: The authorized POA, WASH 7651, is not subject to water decline conditions under permit G-7593.

b) If yes, for each POA identify the reference level, most recent spring-high water level, and whether an applicable permit decline condition has been exceeded: N/A

4. a) Is there more than one source developed under the right (e.g., basalt and alluvium)?
☐ Yes ☒ No Comments: **The potential for commingling sources (i.e., multiple discrete WBZ/aquifers within the local CRBG aquifer system) can be avoided by implementing the changes to planned and existing well construction (for WASH 62373) discussed in Section 2 of this review.**

   b) If yes, estimate the portion of the right supplied by each of the sources and describe any limitations that will need to be placed on the proposed change (rate, duty, etc.): N/A

5. a) Will this proposed change, at its maximum allowed rate of use, likely result in an increase in interference with **another ground water right**?
☒ Yes ☐ No Comments: Relative to the location of authorized POA WASH 7651, several of the proposed APOA locations are nearer to existing groundwater rights. Thus, this proposed change will likely result in an increase in interference with those rights.

   b) If yes, would this proposed change, at its maximum allowed rate of use, likely result in another groundwater right not receiving the water to which it is legally entitled?
☐ Yes ☒ No If yes, explain: Each of the proposed APOA locations was evaluated for potential injury to applicable existing groundwater rights. For relevant evaluations, the Theis distance-drawdown analysis was performed to estimate the degree of additional interference at the nearest applicable existing well (Theis, 1935). The ranges of aquifer parameter values used were derived primarily from results of a 2009 aquifer test completed in proposed APOA WASH 62373 (Golder Associates, 2009) and in another separate test of WASH 50693 (QVGC well), as well as published values (Conlon et al., 2005; Gannett and Caldwell, 1998).

Potential Injury Evaluation: Proposed APOA "AN Well" and WASH 77444, WASH 79189, WASH 56924

Relative to authorized POA WASH 7651, the proposed APOA "AN Well" location is approximately 2500 feet nearer to WASH 77444 (WASH 73386 and WASH 73351 are also near WASH 77444). The "AN Well" *as assessed* (i.e., limited to the WBZ between elevation ~-125 to -250 ft msl) might impose additional drawdown interference in WASH 77444 and other nearby wells of similar completion.

The key WBZ in WASH 77444 (between elev. ~-20 to -105 ft msl) is above the assessed WBZ in the "AN Well" (between elev. ~-125 to -250 ft msl); nearby WASH 73386 is similarly completed (see attached cross-section 1). However, because WASH 77444 and WASH 73386 are located at a higher ground surface elevation than the "AN Well" location, it is possible that the WBZ in the two locations is approximately the same basalt interflow grouping, but has been vertically offset by faulting between the two locations (the fact that existing geologic maps do not show a fault at this location does not preclude the possible existence of one). Faults typically truncate basalt interflow zones/WBZ, which would reduce or eliminate hydraulic connection between wells on either side of the fault. Whether or not a fault is present at this location, it is likely that there is **not** an efficient hydraulic connection (or any whatsoever) between the "AN Well" and WASH 77444, WASH 73386, or other nearby wells of similar completion, and thus those wells are unlikely to be injured due to the proposed use of the "AN Well."

Farther to the east, the completion depths and open intervals of other wells are similar to authorized POA WASH 7651, in particular WASH 79189 and WASH 56924. These wells obtain groundwater from approximately the same primary WBZ present in WASH 7651 and are thus more likely to be adversely affected by pumping at the "AN Well" location (see attached cross-section 2).

Relative to the location of authorized POA WASH 7651, the proposed location for the "AN Well" is about 2700 feet nearer to WASH 79189. The results of the Theis interference analysis indicates that additional interference in WASH 79189 could potentially range from about 10 to 20 feet due to pumping the maximum rate (0.67 cfs) 24/7/365 from the "AN Well" (see attached Theis analysis results). Limited water level data from other nearby wells (WASH 56924) indicates that the static water level in WASH 79189 likely ranges from about elevation 180 to 200 ft msl, which would provide roughly 200 feet or more of available drawdown in both it and existing wells of similar completion (i.e., those wells that fully penetrate the upper WBZ present in WASH 7651). This approximate range of available drawdown should be sufficient to support ongoing usage of these wells with the change proposed by this application (i.e., the change will not prevent those wells from receiving the groundwater to which they are legally entitled).

Potential Injury Evaluation: Proposed APOA "AN Well" and WASH 50693

Pumping of the "AN Well" could also affect WASH 50693, the Quail Valley Golf Course well which is an authorized POA for a supplemental irrigation water right (certificate 91527). Relative to authorized POA WASH 7651, the "AN Well" location is about 1750 nearer to WASH 50693. However, during the 2009 aquifer test of WASH 62373, which is located adjacent to WASH 7651 and is constructed more like WASH 50693 (both access a key deeper WBZ that is not present in the shallower WASH 7651), only about 2 feet of additional drawdown was measured in WASH 50693 (Golder Associates, 2009). Because the assessed construction for the "AN Well" would be shallower than WASH 62373, even less drawdown would be expected in WASH 50693; thus it is unlikely that pumping of the "AN Well" would negatively affect the current usage of WASH 50693.

Potential Injury Evaluation: Proposed APOA "AS Well" and WASH 71496, WASH 73553, WASH 50693

Relative to the location of authorized POA WASH 7651, the proposed location for APOA "AS Well" is about 3600-3800 feet nearer to WASH 71496, WASH 73553 and several other domestic wells in the area. However, all of these existing wells are relatively shallow with the borehole bottoms very near, or just above, the recommended casing/seal depth elevation for all of the proposed APOA (at about -125 ft msl) (see attached cross-section 3). It is also notable that some of these same nearby wells only access the uppermost portions of the CRBG in this area, i.e., likely the flow top at the contact between alluvial sediments and the underlying basalt, and do not extend deeper into the same or another WBZ (such wells are considered by OWRD to be "alluvial aquifer" wells and not "CRBG aquifer" wells). Because these existing wells do not fully penetrate the upper WBZ present between approximately elevation -125 to -250 ft msl, or are considered to be "alluvial wells" despite partial penetration into the upper basalt unit, an injury determination would not be made due to the proposed use of the "AS Well."

Relative to the location of authorized POA WASH 7651, the proposed location for APOA "AS Well" is also much nearer to WASH 50693, the QVGC well. However, as discussed previously for the "AN Well", it is also unlikely that the proposed use of the "AS Well" will prevent WASH 50693 from receiving the groundwater to which it is legally entitled, for the same stated reasons.

Potential Injury Evaluation: Proposed APOA "Park-A Well" and WASH 52798, WASH 66773

Of the three "Park" wells proposed as APOA, the location for the "Park-A Well" is nearest to the known locations of existing wells. Relative to authorized POA WASH 7651, the "Park-A Well" location is approximately 3000 feet nearer to WASH 52798, an exempt domestic use well. WASH 52798 is reportedly 370 feet deep, but the log does not provide any other information related to well construction or local lithology (see attached cross-section 4).

However, nearby WASH 66773 is a comparable depth (410 feet deep), and like all other nearby wells of similar depth, obtains groundwater from the CRBG aquifer system. The WASH 66773 log shows a 2008 static water level elevation of 167 ft msl (depth 35 ft bgs); a similar current static water level assumed for WASH 52798 and other nearby wells indicates that these wells likely have about 200-300 feet of available drawdown. This approximate range of available drawdown should be sufficient to support ongoing usage of these wells with the change proposed by this application (i.e., pumping of the "Park-A Well" will not prevent those wells from receiving the groundwater to which they are legally entitled).

Potential Injury Evaluation: Proposed APOA "WTP Well" and WASH 8102/8089

There are several known wells relatively close to the proposed location for the "WTP Well"; however, current OWRD records indicate that these particular wells are owned by the City of Banks, and are associated with irrigation of school grounds (WASH 77871, WASH 7628, WASH 7621, WASH 3184). Consequently, it is assumed that the City can manage potential adverse interference to these existing wells resulting from pumping at the "WTP Well" location.

Relative to authorized POA WASH 7651, the proposed "WTP Well" location is approximately 2200 feet nearer to WASH 8102/8089, which is an authorized POA for quasi-municipal use by the Star Satellite Improvement District (permit G-7903). The open borehole portion of WASH 8102/8089 extends from about elevation -115 to -210 ft msl, which generally corresponds to the -125 to -250 ft msl interval stipulated for the proposed APOA wells (see attached cross-section 5).

The results of the Theis interference analysis indicates that WASH 8102/8089 could potentially experience about 5 to 10 feet of additional drawdown due to pumping the maximum rate (0.67 cfs) 24/7/365 from the "WTP Well" (see attached Theis analysis results). It is unlikely that this small additional drawdown estimated for WASH 8102/8089 would prevent it or other similarly-constructed wells in the area from receiving the groundwater to which they are legally entitled.

Potential Injury Evaluation: Proposed APOA WASH 62373 and WASH 8102/8089

WASH 62373 is a current City of Banks well authorized for year-round municipal use, pumping at a maximum instantaneous rate of 1.0 cfs (~450 gpm) (certificate 95849). As a proposed APOA for this application, WASH 62373 would be authorized to pump a stacked rate of 1.67 cfs (~750 gpm). However, for this particular transfer application, WASH 62373 would require major modifications (i.e., additional well sealing) to ensure that it would obtain groundwater only from the shallower WBZ in the authorized POA WASH 7651, or that WBZ from approximately elevation -125 to -250 ft msl (see attached cross-section 5).

The results of the Theis interference analysis indicates that WASH 8102/8089 could potentially experience about 30 to 90 feet of additional drawdown due to pumping the stacked maximum rate (1.67 cfs) 24/7/365 from WASH 62373 (see attached Theis analysis results). While this range of additional drawdown is relatively large compared to other evaluations, from available static water-level data it is likely that WASH 8102/8909 has approximately 350 to 380 feet of available drawdown. Thus it is unlikely that this additional drawdown estimated for WASH 8102/8089 would prevent it or other similarly-constructed wells in the area from receiving the groundwater to which they are legally entitled.

Conclusions: the results of the potential injury evaluations completed for this review suggest that relatively low (~10-20 feet) to moderately-high (~30-90 feet) levels of additional drawdown might be imposed in area wells due to pumping of some of the proposed APOA. It should be noted, however, that these estimates were completed using very conservative operational parameters for the Theis analytical drawdown method: pumping a single well at the full allocated rate for 24 hours a day, 7 days a week, 365 days a year. Actual pump operation will likely not be this sustained, and/or could be rotated to different locations to distribute overall pumping stresses to the CRBG aquifer system.

Furthermore, from the 2009 aquifer test of WASH 62373 ("Well-2") during which that well was pumped continuously for 47 hours at 465 gpm (~1 cfs), a total of 77 feet of drawdown was observed in adjacent WASH 7651 ("Well-1"), and only 2 feet in WASH 50693 (QVGC well) which is located about 3200 feet from WASH 62373. The results from the aquifer test generally confirm the conservative approach used for the Theis drawdown assessments, and that actual additional drawdown might be somewhat less than predicted, particularly for wells that penetrate the deeper of the two primary WBZ (at ~615 to 660 ft bls).

6. a) Will this proposed change, at its maximum allowed rate of use, likely result in an increase in interference with **another surface water source**?

☐ Yes ☒ No Comments: With the planned cased and sealed depth of about 200-250 feet for the proposed APOA not yet drilled, and 300 feet for WASH 62373, water-bearing interflow zone(s) will likely be from many tens to perhaps hundreds of feet below any nearby stream reaches. Consequently, it is unlikely that the proposed change would result in an increase in interference with local surface water sources.

b) If yes, at its maximum allowed rate of use, what is the expected change in degree of interference with any **surface water sources** resulting from the proposed change?

Stream: _____ ☐ Minimal ☐ Significant

Stream: _____ ☐ Minimal ☐ Significant

Provide context for minimal/significant impact: N/A

7. For SW-GW transfers, will the proposed change in point of diversion affect the surface water source similarly (as per OAR 690-380-2130) to the authorized point of diversion specified in the water use subject to transfer?
   ☐ Yes ☐ No Comments: N/A

8. What conditions or other changes in the application are necessary to address any potential issues identified above: **To ensure that each proposed APOA obtains groundwater only from the currently-authorized aquifer source, all of the proposed APOA wells will be limited to accessing only the WBZ present in WASH 7561 between approximate elevations -125 to -250 ft msl**. For the six proposed APOA not yet drilled, this will require corresponding reductions in planned total well depths, as well as possible revisions to the cased and sealed intervals. For existing proposed APOA WASH 62373, compliance would require sealing the lower WBZ in that well, with a total resultant well depth at/near elevation -250 ft msl (about 485 feet bls at that location).

9. Any additional comments: None

References

Application T-14449 RA

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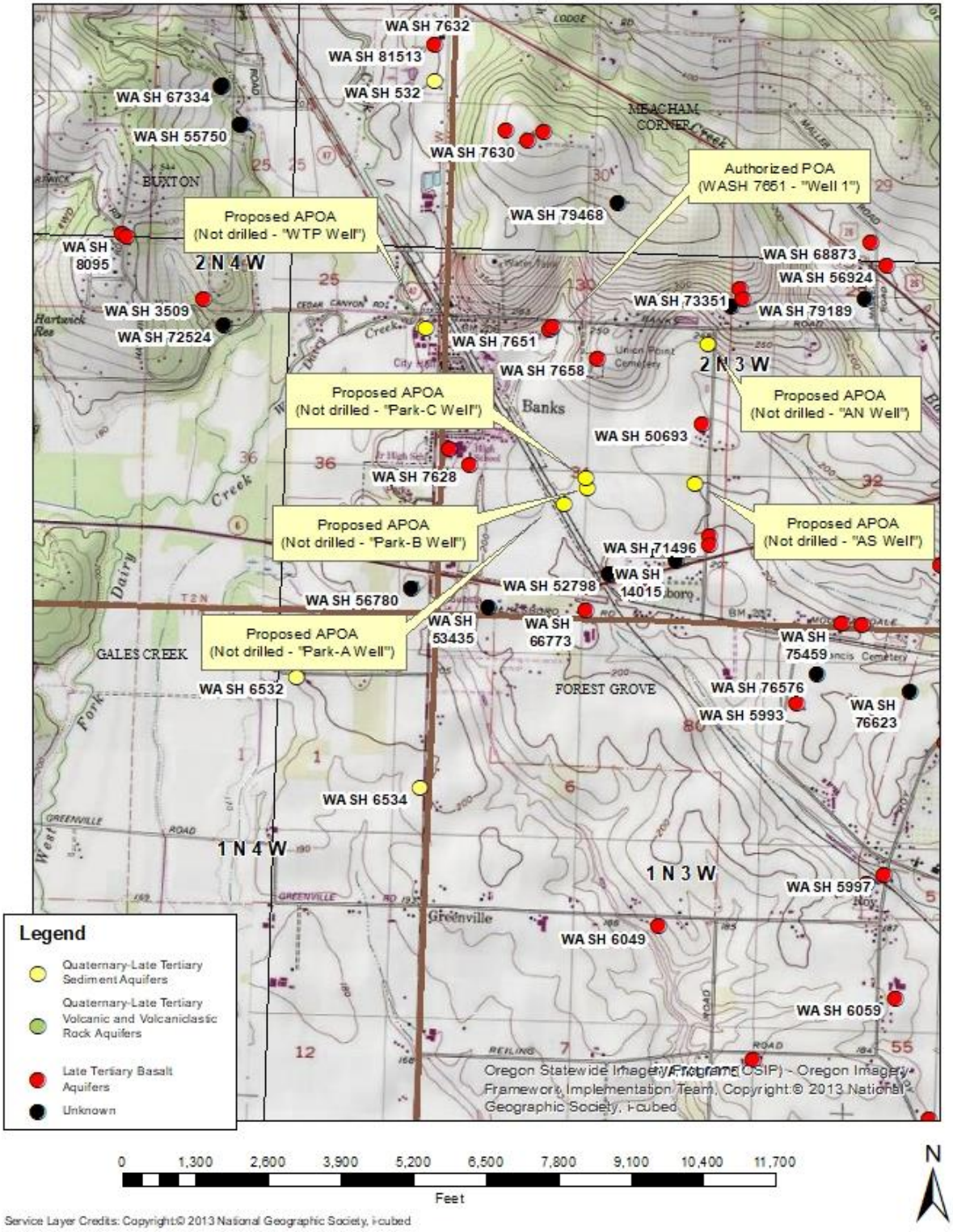
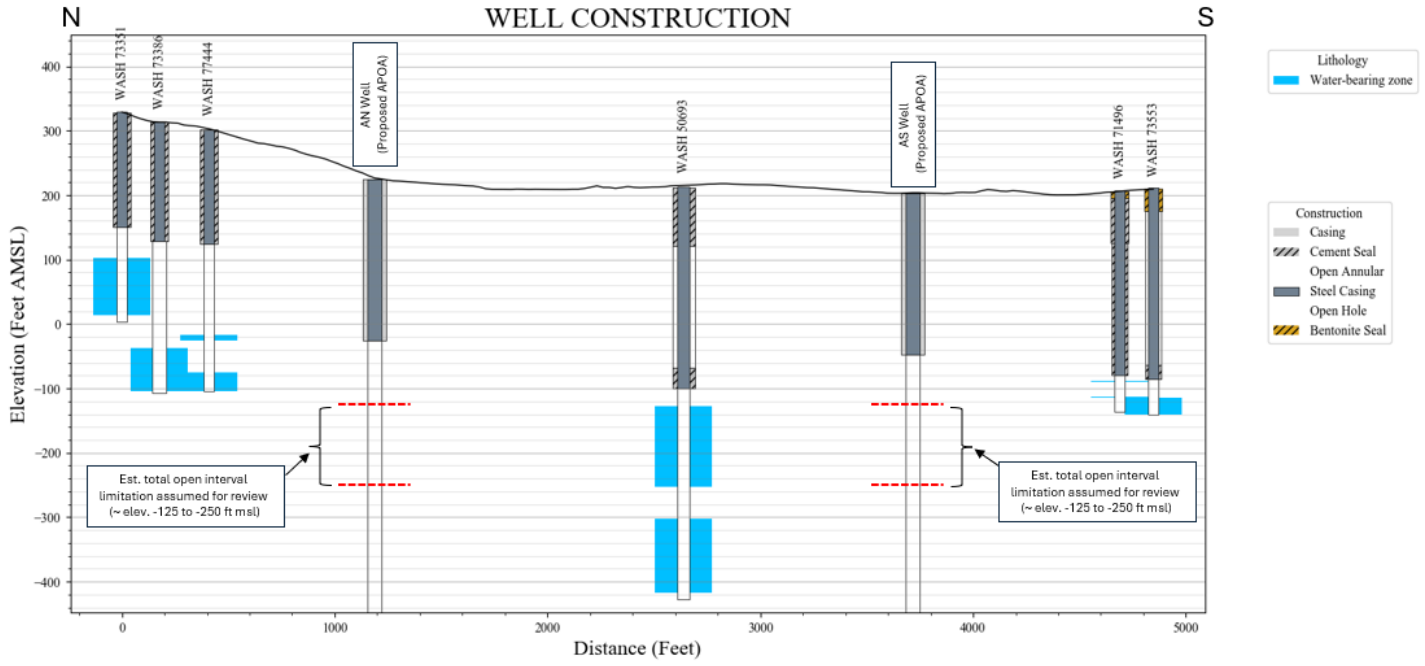
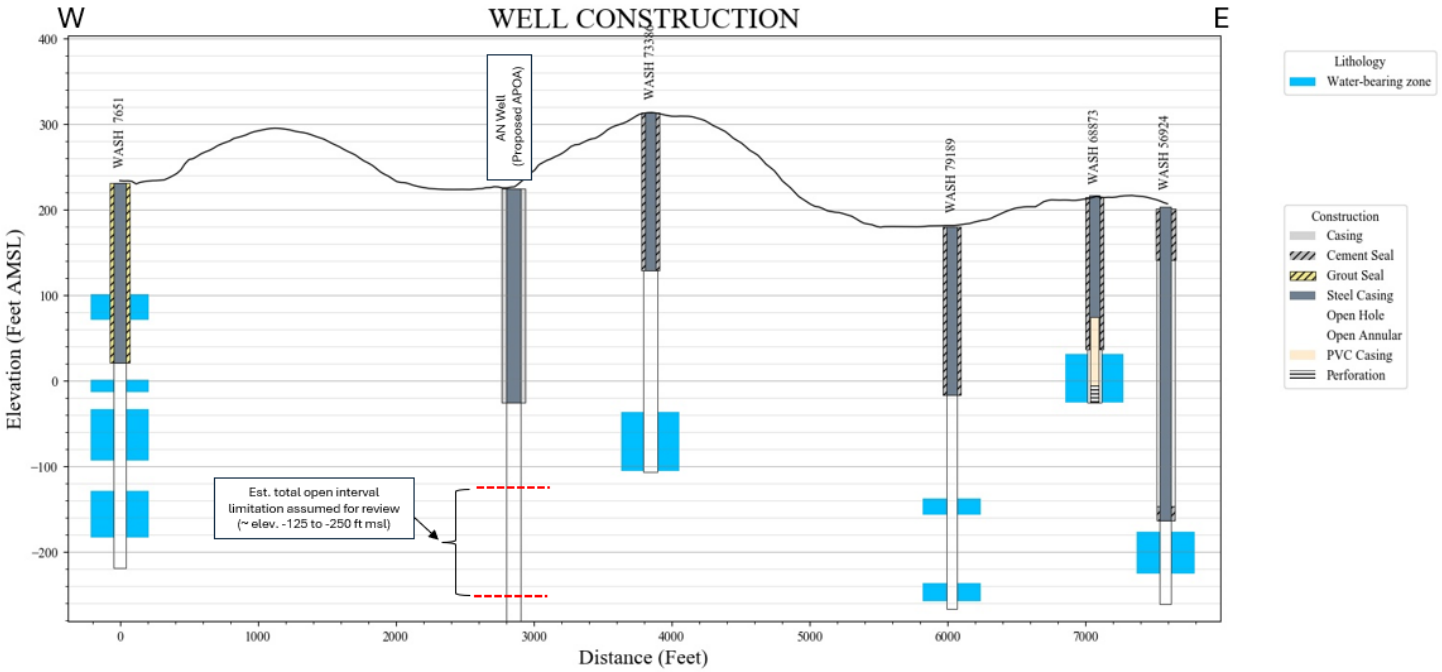
Application T-14449, City of Banks
T2N, R3W



Cross-section 1: N-S, proposed APOA "AN Well" and "AS Well" and WASH 77444, WASH 50693



Cross-section 2: W-E, proposed APOA "AN Well" and WASH 79189, WASH 56924

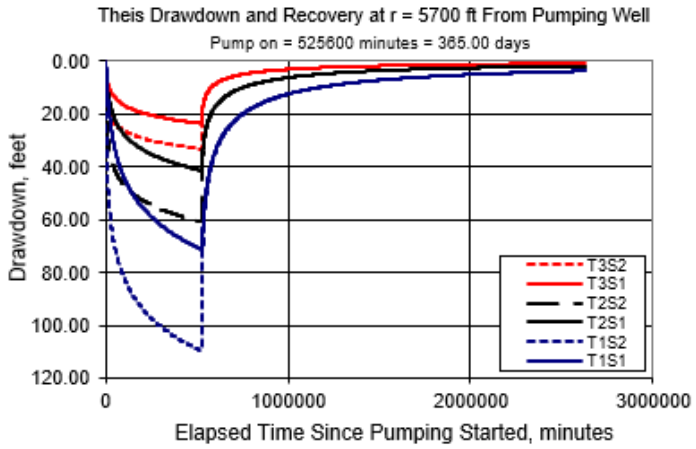


Theis Drawdown Analysis, Authorized POA WASH 7651 to WASH 79189

Theis Time-Drawdown Worksheet v.5.00
Calculates Theis nonequilibrium drawdown and recovery at any arbitrary radial distance, r, from a pumping well for 3 different T radial distance, r, from a pumping well for 3 different T values and 2 different S values.
Written by Karl C. Wozniak September 1992. Last modified December 17, 2019

Input Data:	Var Name	Scenario 1	Scenario 2	Scenario 3	Units	
Total pumping time	t		365		d	
Radial distance from pumped well:	r		5700		ft	Q conversions
Pumping rate	Q		0.67		cfs	300.70 gpm
Hydraulic conductivity	K	5	10	20	ft/day	0.67 cfs
Aquifer thickness	b		55		ft	40.20 cfm
Storativity	S_1		0.0001			57,888.00 cfd
	S_2		0.00001			1.33 af/d
Transmissivity Conversions	T_f2pd	275	550	1100	ft2/day	
	T_ft2pm	0.190972	0.381944	0.763889	ft2/min	Recalculate
	T_gpdpft	2057	4114	8228	gpd/ft	

Use the Recalculate button if recalculation is set to manual

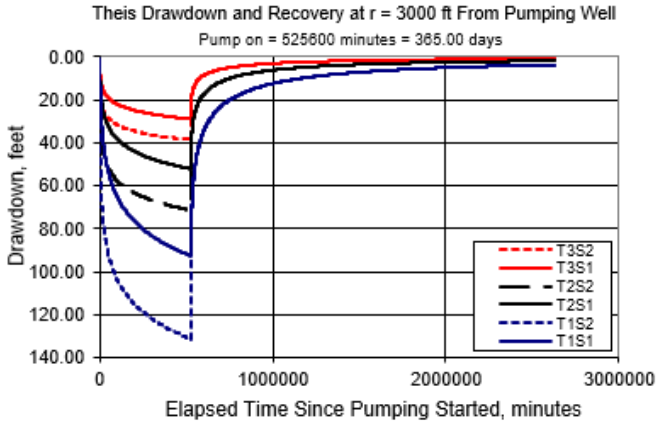


Theis Drawdown Analysis, Proposed APOA "AN Well" to WASH 79189

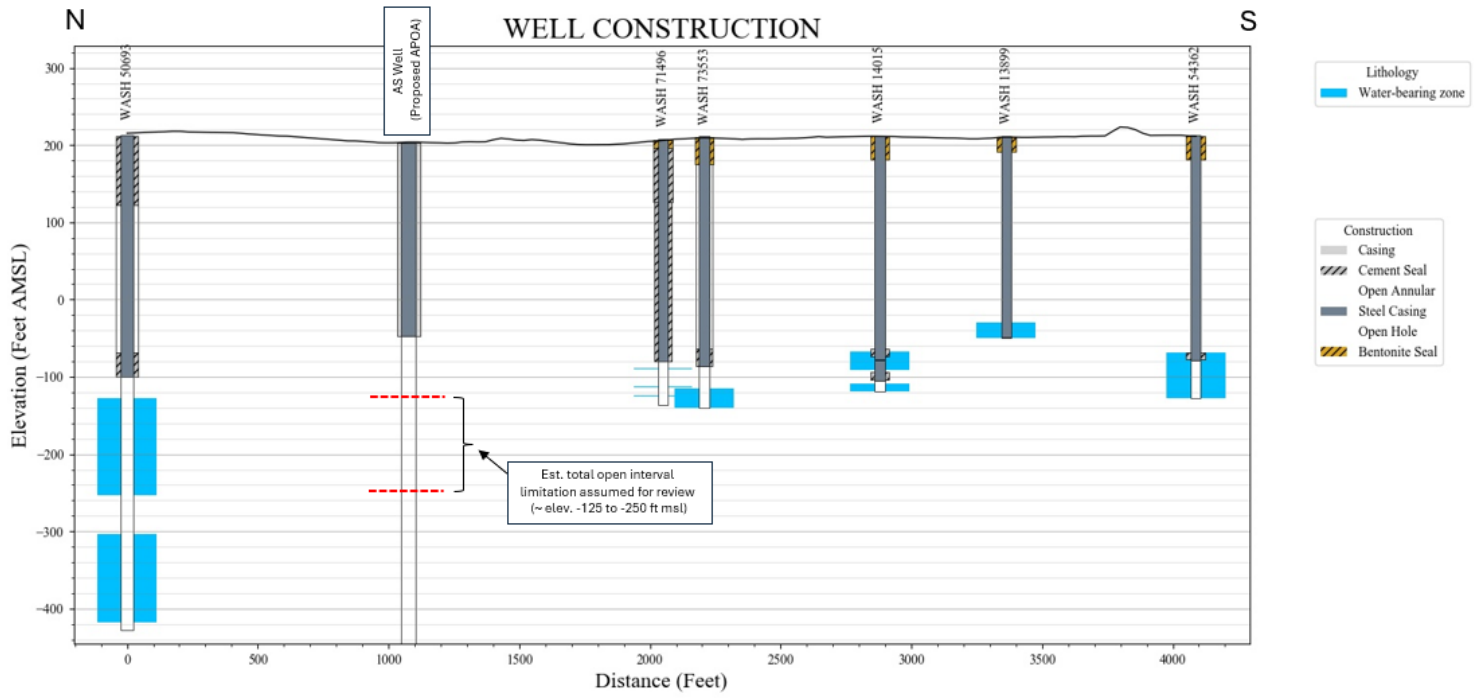
Theis Time-Drawdown Worksheet v.5.00
Calculates Theis nonequilibrium drawdown and recovery at any arbitrary radial distance, r, from a pumping well for 3 different T radial distance, r, from a pumping well for 3 different T values and 2 different S values.
Written by Karl C. Wozniak September 1992. Last modified December 17, 2019

Input Data:	Var Name	Scenario 1	Scenario 2	Scenario 3	Units	
Total pumping time	t		365		d	
Radial distance from pumped well:	r		3000		ft	Q conversions
Pumping rate	Q		0.67		cfs	300.70 gpm
Hydraulic conductivity	K	5	10	20	ft/day	0.67 cfs
Aquifer thickness	b		55		ft	40.20 cfm
Storativity	S_1		0.0001			57,888.00 cfd
	S_2		0.00001			1.33 af/d
Transmissivity Conversions	T_f2pd	275	550	1100	ft2/day	
	T_ft2pm	0.190972	0.381944	0.763889	ft2/min	Recalculate
	T_gpdpft	2057	4114	8228	gpd/ft	

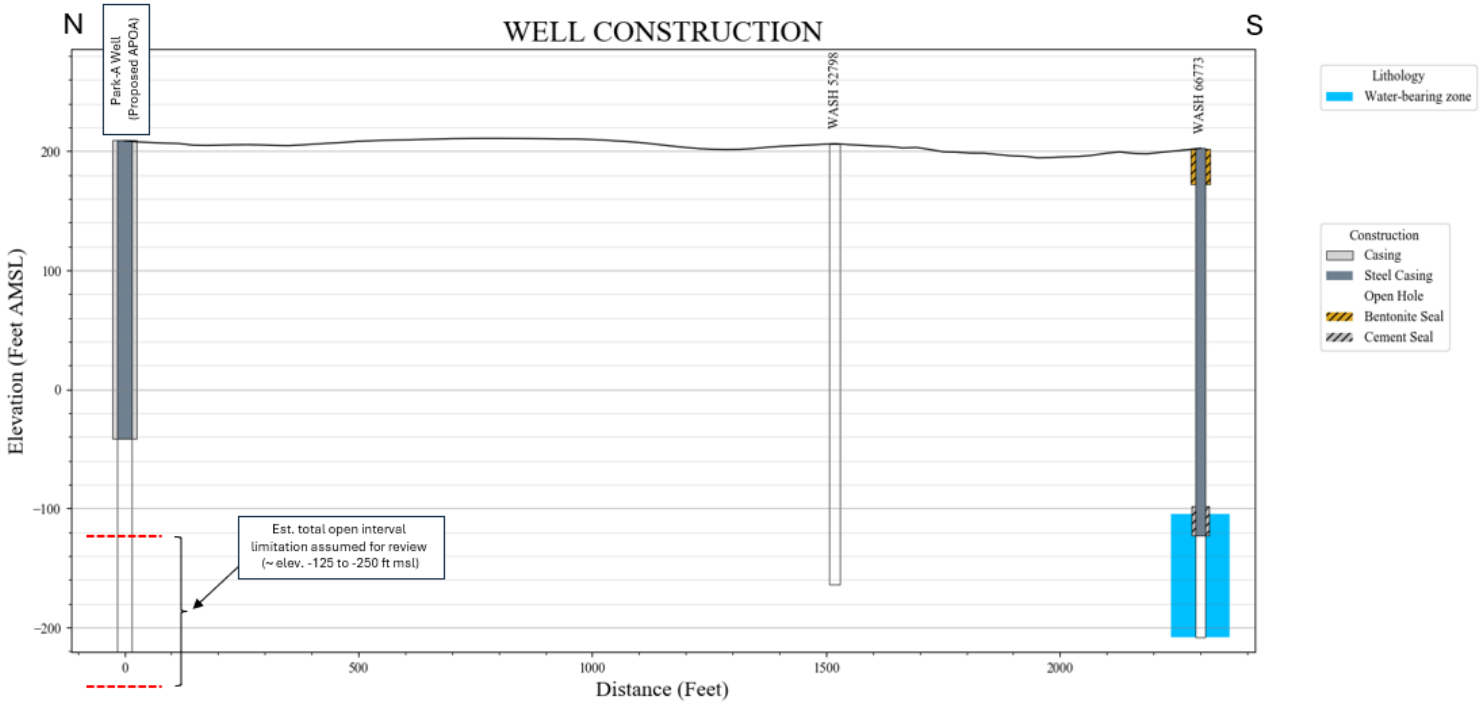
Use the Recalculate button if recalculation is set to manual



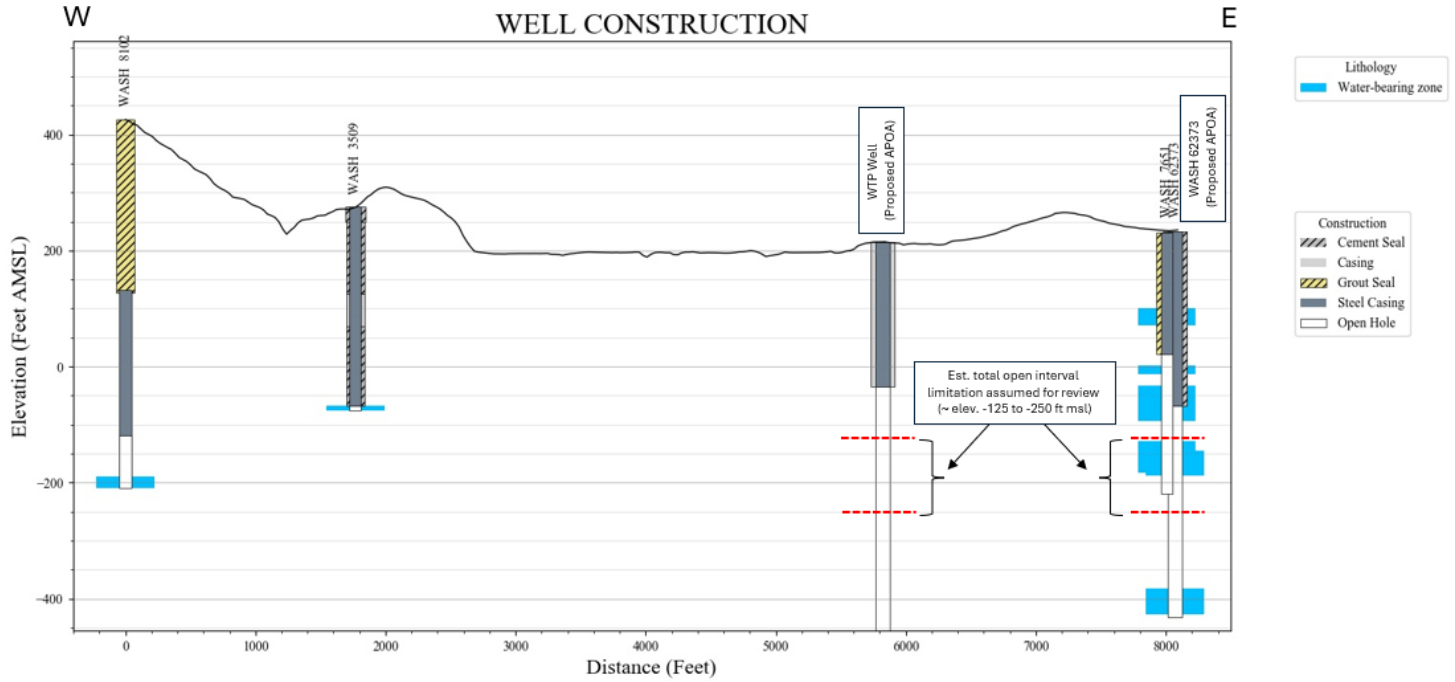
Cross-section 3: N-S, proposed APOA "AS Well" and WASH 50693, others



Cross-section 4: N-S, proposed APOA "Park-A Well" and WASH 52798



Cross-section 5: W-E, proposed APOA "WTP Well", WASH 62373 and WASH 8102/8909



Theis Drawdown Analysis, Authorized POA WASH 7651 to WASH 8102/8909

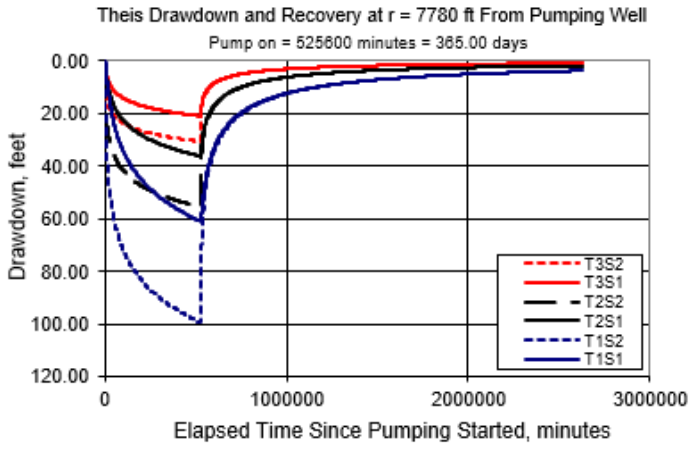
Theis Time-Drawdown Worksheet v.5.00

Calculates Theis nonequilibrium drawdown and recovery at any arbitrary radial distance, r, from a pumping well for 3 different T values and radial distance, r, from a pumping well for 3 different T values and 2 different S values.

Written by Karl C. Wozniak September 1992. Last modified December 17, 2019

Input Data:	Var Name	Scenario 1	Scenario 2	Scenario 3	Units	
Total pumping time	t		365		d	
Radial distance from pumped well:	r		7780		ft	Q conversions
Pumping rate	Q		0.67		cfs	300.70 gpm
Hydraulic conductivity	K	5	10	20	ft/day	0.67 cfs
Aquifer thickness	b		55		ft	40.20 cfm
Storativity	S_1		0.0001			57,888.00 cfd
	S_2		0.00001			1.33 af/d
Transmissivity Conversions	T_f2pd	275	550	1100	ft2/day	
	T_ft2pm	0.190972	0.381944	0.763889	ft2/min	Recalculate
	T_gpdpft	2057	4114	8228	gpd/ft	

Use the Recalculate button if recalculation is set to manual

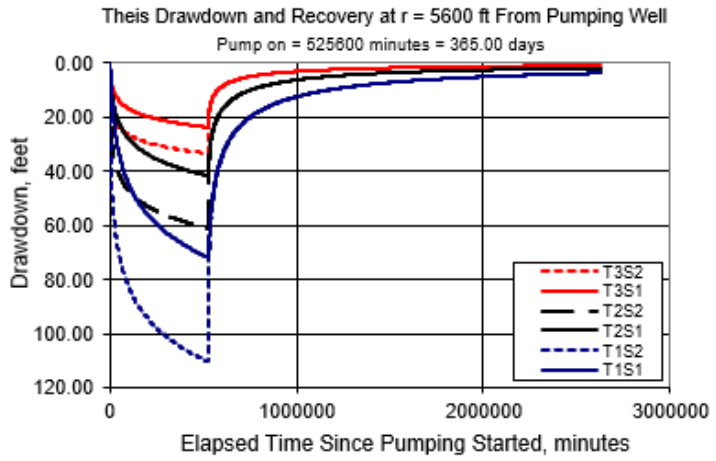


Theis Drawdown Analysis, Proposed APOA "WTP Well" to WASH 8102/8909

Theis Time-Drawdown Worksheet v.5.00
Calculates Theis nonequilibrium drawdown and recovery at any arbitrary radial distance, r, from a pumping well for 3 different T values and radial distance, r, from a pumping well for 3 different T values and 2 different S values.
Written by Karl C. Wozniak September 1992. Last modified December 17, 2019

Input Data:	Var Name	Scenario 1	Scenario 2	Scenario 3	Units	
Total pumping time	t		365		d	
Radial distance from pumped well:	r		5600		ft	Q conversions
Pumping rate	Q		0.67		cfs	300.70 gpm
Hydraulic conductivity	K	5	10	20	ft/day	0.67 cfs
Aquifer thickness	b		55		ft	40.20 cfm
Storativity	S_1		0.0001			57,888.00 cfd
	S_2		0.00001			1.33 af/d
Transmissivity Conversions	T_f2pd	275	550	1100	ft2/day	
	T_ft2pm	0.190972	0.381944	0.763889	ft2/min	Recalculate
	T_gpdpft	2057	4114	8228	gpd/ft	

Use the Recalculate button if recalculation is set to manual



Theis Drawdown Analysis, Proposed APOA WASH 62373 to WASH 8102/8909

Theis Time-Drawdown Worksheet v.5.00
Calculates Theis nonequilibrium drawdown and recovery at any arbitrary radial distance, r, from a pumping well for 3 different T values and radial distance, r, from a pumping well for 3 different T values and 2 different S values.
Written by Karl C. Wozniak September 1992. Last modified December 17, 2019

Input Data:	Var Name	Scenario 1	Scenario 2	Scenario 3	Units	
Total pumping time	t		365		d	
Radial distance from pumped well:	r		7780		ft	Q conversions
Pumping rate	Q		1.67		cfs	749.50 gpm
Hydraulic conductivity	K	5	10	20	ft/day	1.67 cfs
Aquifer thickness	b		55		ft	100.20 cfm
Storativity	S_1		0.0001			144,288.00 cfd
	S_2		0.00001			3.31 af/d
Transmissivity Conversions	T_f2pd	275	550	1100	ft2/day	
	T_ft2pm	0.190972	0.381944	0.763889	ft2/min	Recalculate
	T_gpdpft	2057	4114	8228	gpd/ft	

Use the Recalculate button if recalculation is set to manual