MEMORANDUM
OFFICE OF THE STATE ENGINEER
Hydrology Bureau

DATE: September 20, 2022

TO: Ian Hewitt, Water Rights Division, District I, Albuquerque, NM

THROUGH: Katie Zemlick, Ph.D., Hydrology Bureau Chief KZ

FROM: Christopher E. Angel, PG, Senior Hydrologist, Hydrology Bureau CEA

SUBJECT: Plugging and abandonment of well B-700-POD1 in the Bluewater Underground Water Basin, Cibola County, New Mexico.

I. Introduction and Variance Request

On November 4, 2021, Homestake Mining Company (Homestake) submitted a Well Plugging Plan of Operations (PP) to the New Mexico Office of the State Engineer (NMOSE). This PP was approved on December 21st, 2021. The plugging plan included perforating from 415 feet below ground level (fbgl) to 355 fbgl and tremie grouting the sealant from 420 fbgl to ground surface in accordance with New Mexico Administrative Code (NMAC) 19.27.4.31.K.

On August 4, 2022, Homestake requested a variance for the requirement to perforate the casing from 400 fbgl to 355 fbgl. The stated reason for this was that when they started the work to plug the well, air from the perforator was forced air through the annular space creating a collapse potential for the area surrounding the drill rig. According to the Homestake letter dated August 5, 2022, a tremie pipe was placed in the annulus to a depth of 23 fbgl. The applicant proceeded to pump between 724 and 776 gallons of grout through the tremie pipe to stabilize the area for the drill rig prior to obtaining approval from the NMOSE. This filled the 5-inch casing to a depth of 88 fbgl. This is not in compliance with NMAC 19.27.4.31.K as the grout was not placed from the bottom up. The applicant should have contacted the NMOSE prior to pumping cement into the annular space as this was not part of the approved PP. In addition, it would have been appropriate to measure the total depth of the wellbore while pumping the grout into the annular space to assure cement was being placed in the intended location.

An e-mail was received on August 16, 2022, from Homestake modifying the variance request to NMAC 19.27.4.31.K for placing the cement from the base to 88 fbgl as the tremie pipe was set at 23 fbgl. To increase the likelihood of the lower Chinle and the Alluvial aquifers being sealed off

from the San Andreas/Glorietta (SAG), Homestake is proposing to drill the cement inside the casing to a depth that allows the well to be perforated from 120 fbgl to 55 fbgl. With this design, the bottom perforations will be approximately 10 feet below the saturated portion of the lower Chinle and approximately 10 feet above the base of the alluvial aquifer. The sealant is to be the same sealant that was approved on December 21st, 2021.

II. Review of Groundwater Elevation Maps and Groundwater Quality Maps

Groundwater elevation and groundwater quality maps for the alluvial, lower Chinle and SAG aquifers were supplied to the NMOSE in the variance request dated August 12, 2022. These maps and Weaver et al. (2022) were used to evaluate the request for variance.

The alluvial aquifer appears to pinch out to the south and southwest of well B-700 (Figure 1). The groundwater flow direction north of the pinch out appears to be in a westerly direction and south of the pinch out in a southeasterly direction. Northeast of the well near the large tailings pile there appears to be a cone of depression. Based on the alluvial groundwater uranium concentration map (Figure 2), the nearest up-gradient contamination that exceeds the site standard of 0.16 mg/l is to the east of the B-700 approximately 1.0 mile. In addition, should the cone of depression cease to exist, groundwater and uranium concentrations may start to flow in the direction of well B-700.

The lower Chinle aquifer appears to subcrop below the alluvium to the west and southeast of the B-700 (Weaver et al., 2022). The groundwater flow direction in the lower Chinle is generally to the northeast of the subcrop and appears to be paralleling the West Fault. Southeast of well B-700 the lower Chinle appears to subcrop against the alluvial aquifer as well. In the area of this subcrop, the remediation system appears to be creating a mounding effect in the lower Chinle (Figure 3, Figure 4). This mounding effect has a steeper gradient in a northwesterly direction that indicates leakage across the fault (Weaver et al., 2022). Based on the Uranium Concentration Map (Figure 5), the lower Chinle appears to have been impacted by uranium leaking down through the subcrop. The uranium concentration approximately 1,280 feet to the west of the B-700 is 0.049 mg/L. This value exceeds the New Mexico groundwater standard for uranium of 0.03 mg/L (Maurer, 2022).

The SAG aquifer at the location of well B-700 appears to flow to the east. The alluvium and SAG appear to be hydraulically connected to the west of the B-700 (Figure 6). Several groundwater elevation data points were not honored in the applicant's potentiometric surface interpretation (Figure 6). No reason was found for the applicant's decision to not honor these data points. According to the applicant's potentiometric surface map, the West Fault does not appear to affect the groundwater flow as the saturated thickness of the aquifer is greater than the vertical off-set of the fault (Weaver et al., 2022). Based on Weaver et al. (2022), well 943 (Figure 6) was not

adequately sealed between the alluvial aquifer and the SAG which resulted in a slight contamination to the SAG. This appears to be occurring at the B-700 well as the March 2022 uranium concentration is 0.0566 mg/L, which greater than the New Mexico groundwater standard and surrounding wells (Figure 7).

III. B-700 Well Construction and Abandonment

The State Engineer Office Well Record indicates that well B-700 was drilled in the SW¼NW¼ of Section 34, Township 12 North, Range 10 West, N.M.P.M. in March and April of 1988. An 8-inch borehole was drilled with rotary tools to a total depth of 467 feet. According to the well log, the principal water bearing unit was encountered between 434 and 467 fbgl. The static water level rose to 102 fbgl. The well was completed with a 5-inch casing with perforations between 420 and 467 fbgl. The well was then gravel packed with no annular seal.

Three aquifers were encountered within well B-700 according to Bingham (2022a). These three aquifers from the deepest to the shallowest are the SAG, lower Chinle, and alluvial aquifers. The deepest aquifer (SAG) was encountered at approximately 434 fbgl while the base of the lower Chinle was encountered at 110 fbgl. The top of the lower Chinle aquifer is at 85 fbgl and the base of the alluvial aquifer is at 65 fbgl. If the wellbore is only perforated from 120 fbgl to 55 fbgl as requested, there would only be 10 feet of perforations below the base of the lower Chinle and 20 feet between the lower Chinle and the alluvial aquifer. No seal would occur from the ground surface to a depth of 55 fbgl. Perforating the casing is necessary to make it more likely that the annular space is sealed between the different aquifers and ground surface.

On August 4, 2022, Homestake submitted a letter stating that the plugging had started and that the initial cementing of the B-700 had occurred, and that cement was placed from the bottom of the borehole to 432 fbgl. The reported top of the SAG aquifer was at 434 fbgl. Therefore, only two feet of cement was placed above the top of the SAG. Two feet of cement above the top of the SAG is not a significant amount and can still leak into the casing. After this cement was placed, the well was perforated between 400 fbgl and 420 fbgl. During these perforations water was reportedly forced to the surface through the annular space and started to wash out the soil around the casing. Therefore, according to the August 4, 2022, letter a tremie pipe was placed in the annular space at 23 fbgl and 776 gallons of grout were pumped. The August 5, and 12, 2022 letters indicate the amount of grout pumped was 724 gallons. There is no record that NMOSE was contacted prior to performing these plugging activities.

Groundwater elevation maps (Figure 1, Figure 3 and Figure 6) indicate that there is a downward gradient from the alluvium through the lower Chinle and into the SAG. Based on the uranium

concentration maps (Figure 2, Figure 5 and Figure 7) the alluvium, lower Chinle and SAG exceed the New Mexico Groundwater Standard of 0.03 mg/L at the B-700. Therefore, if the alluvial aquifer remediation system identified in Weaver et al. (2022) was discontinued groundwater gradients would likely change increasing the possibility of even higher uranium concentrations moving towards well B-700 and possibly contaminating the SAG. Even if the contamination did not move towards the well, an improperly plugged well does not comply with NMAC 19.27.4.29 as it may result in a loss of hydraulic head, inter-aquifer exchange, and potential for contamination entering the wellbore.

Placing cement in a 432-foot-deep wellbore from 23 fbgl can lead to a poor grout quality. The increased amount of water can lead to shrinkage cracks, gaps, and channels along the casing and/or formation. The approved method for plugging a well is from the bottom upward (NMAC 19.27.4.31.K). When the grout is placed in the approved manner, it will lift the water and water laden grout to the surface, leading to higher grade cement with fewer shrinkage cracks, gaps, and/or channels and creating a seal between the different hydrogeologic units. Therefore, the wellbore will need to be drilled out to a great enough depth to allow for a minimum of 50 feet of perforations below the base of the lower Chinle aquifer. The NMOSE approved sealant will also need to be placed from 20 fbgl to ground surface.

IV. Conclusions and Recommended Conditions of Approval

The plugging of this well did not follow the permitted conditions and/or NMAC 19.27.4.31.K. Not following the permitted PP and/or NMAC 19.27.4.31.K may lead to loss of hydraulic head, inter-aquifer exchange, and/or contamination migrating into other aquifers. Therefore, the following Conditions of Approval are recommended:

1. Wellbore B-700 shall be sufficiently cleaned out to allow perforating from 160 fbgl or 50 feet below the lower Chinle aquifer, whichever is deeper.
2. The B-700 wellbore shall be perforated from 160 fbgl or 50 feet below the lower Chinle aquifer, whichever is deeper, to an upper depth of 5 fbgl or shallower.
3. The NMOSE approved sealant is an API Class B cement hydrated with 5.5 gallons of water per 94-lb sack.
4. The NMOSE approved sealant shall be placed by the tremie method from the base of the cleaned-out wellbore to ground surface. The bottom of the tremie pipe shall remain submerged in the sealant throughout the entire sealing process.
5. Should the NMED or another regulatory agency sharing jurisdiction of the project authorize, or by regulation require a more stringent well plugging procedure than herein acknowledged, the more-stringent procedure should be followed. This, in part, includes provisions regarding pre-authorization to proceed, contaminant remediation, inspection,

pulling/perforating of casing, or prohibition of free discharge of any fluid from the borehole during or related to the plugging process.

6. NMOSE witnessing of the perforating and plugging operations will be required. NMOSE witnessing may be requested during normal work hours by calling the District 1 NMOSE Office at 505-383-4000, at least 48-hours in advance. NMOSE inspection will occur dependent on personnel availability.

V. References

Bingham, B.R. (2022); RE: Homestake Mining Company – Grants Reclamation Project Well 986 (B-700) Abandonment Variance, letter to Mr. Ian Hewitt OSE District I, August 4, 2022.

Bingham, B.R. (2022); RE: Homestake Mining Company – Grants Reclamation Project Well 986 (B-700) Abandonment Variance, letter to Mr. Ian Hewitt OSE District I, August 4, 2022.

Bingham, B.R. (2022a); RE: Homestake Mining Company – Grants Reclamation Project Well 986 (B-700) Abandonment Variance, letter to Mr. Ian Hewitt OSE District I, August 12, 2022.

Maurer, A. (2022); Personal Communications, M.S. Groundwater Engineering, New Mexico Environmental Department, Ground Water Quality Bureau, Mining Environmental Compliance Section; September 8, 2022.

Weaver, B., Michel, T.G., Hoffman, G.L., (2022); 2021 Annual Monitoring Report/Performanace Review for Homestake's Grants Project Pursuant to NRC License SUA-1471 and Discharge Plan DP-200; for U.S. Nuclear Regulatory Commission and New Mexico Environmental Department; Homestake Mining Company of California, Grants, New Mexico and Hydro-Engineering, LLC, Casper Wyoming March 17, 2022.

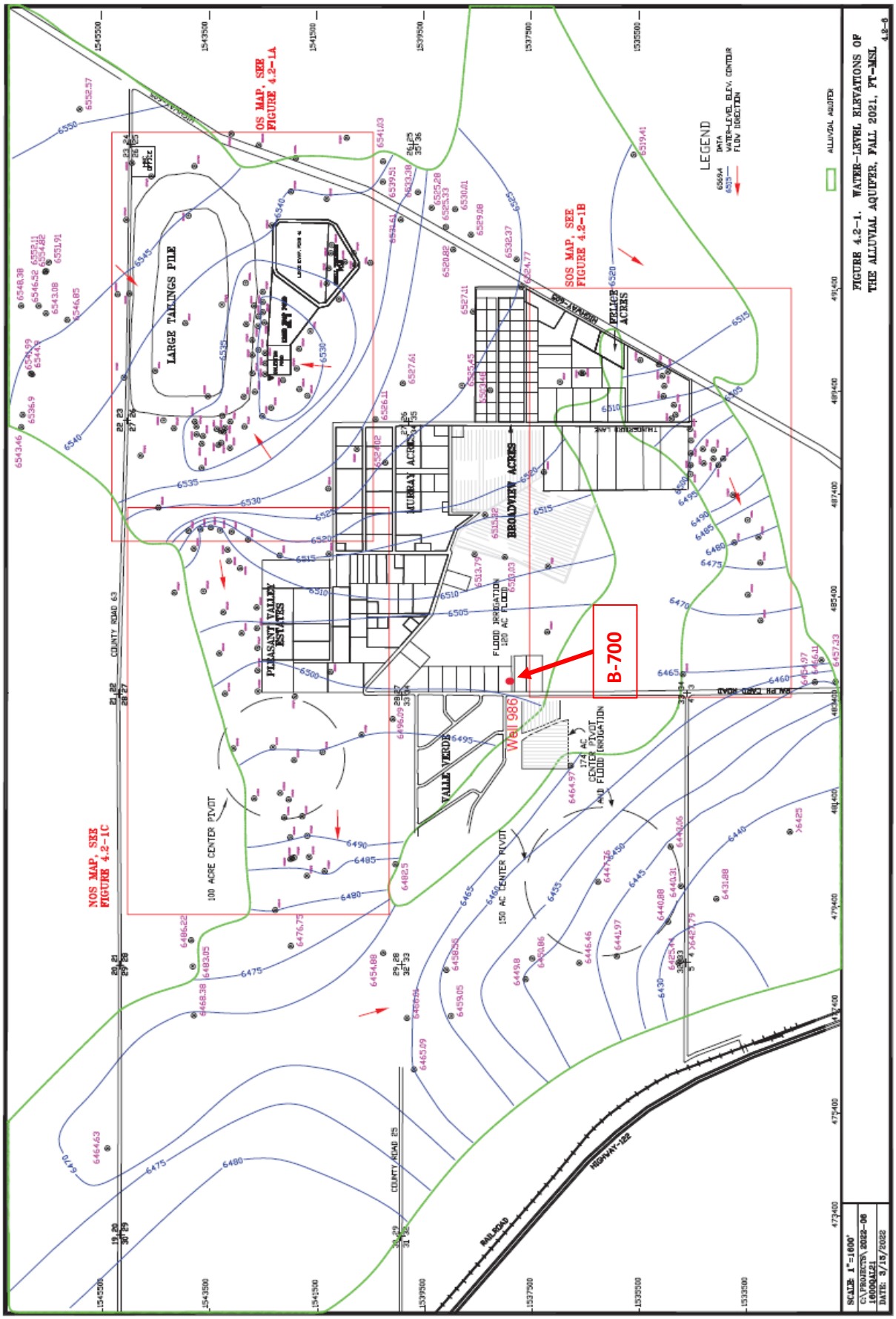

Figure 1: Alluvial Groundwater Elevation Map surrounding the B-700 well; modified from Bingham (2022a).

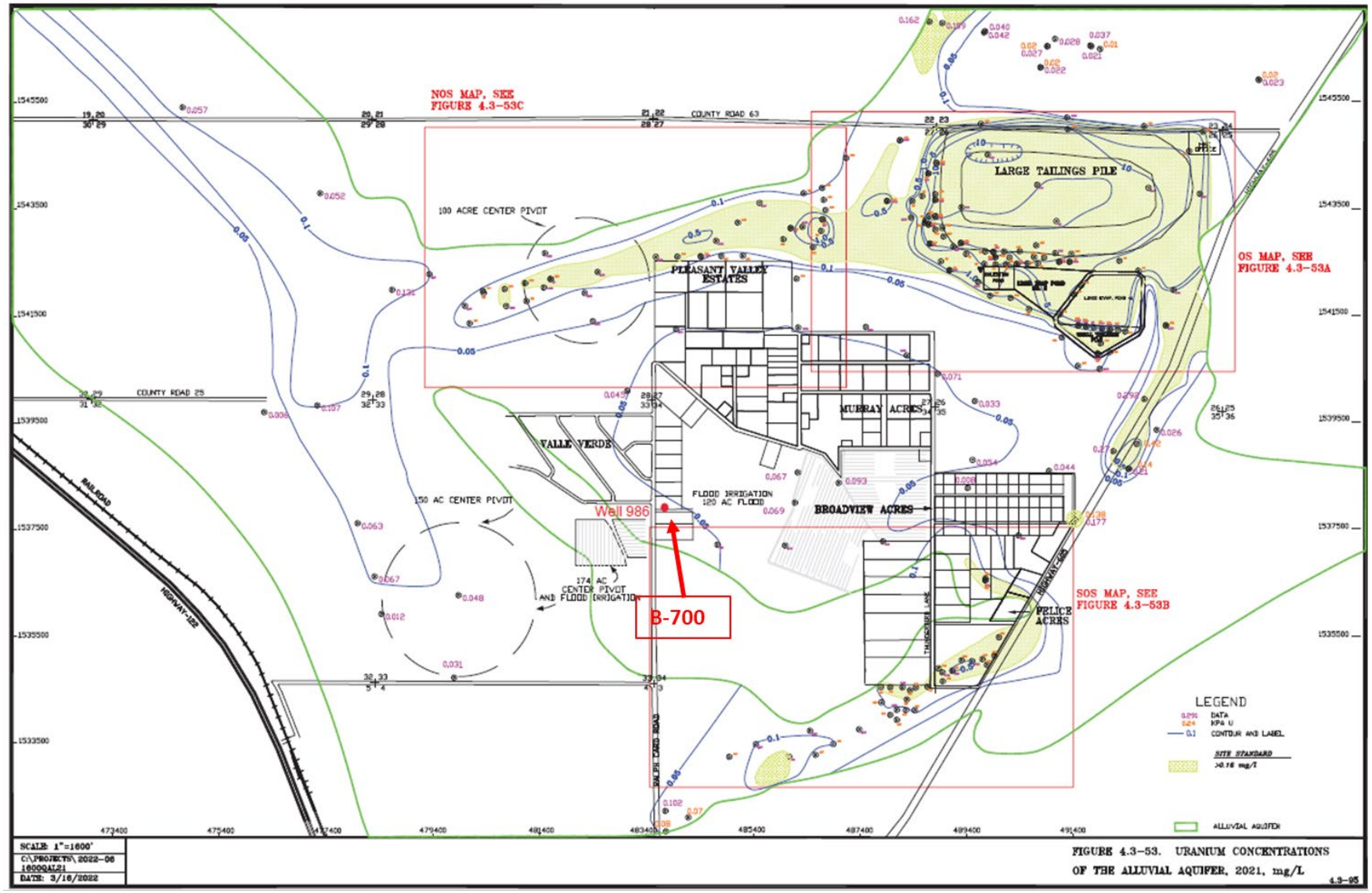

Figure 2: Alluvial Groundwater Uranium Concentration Map surrounding the B-700 well; modified from Bingham (2022a).

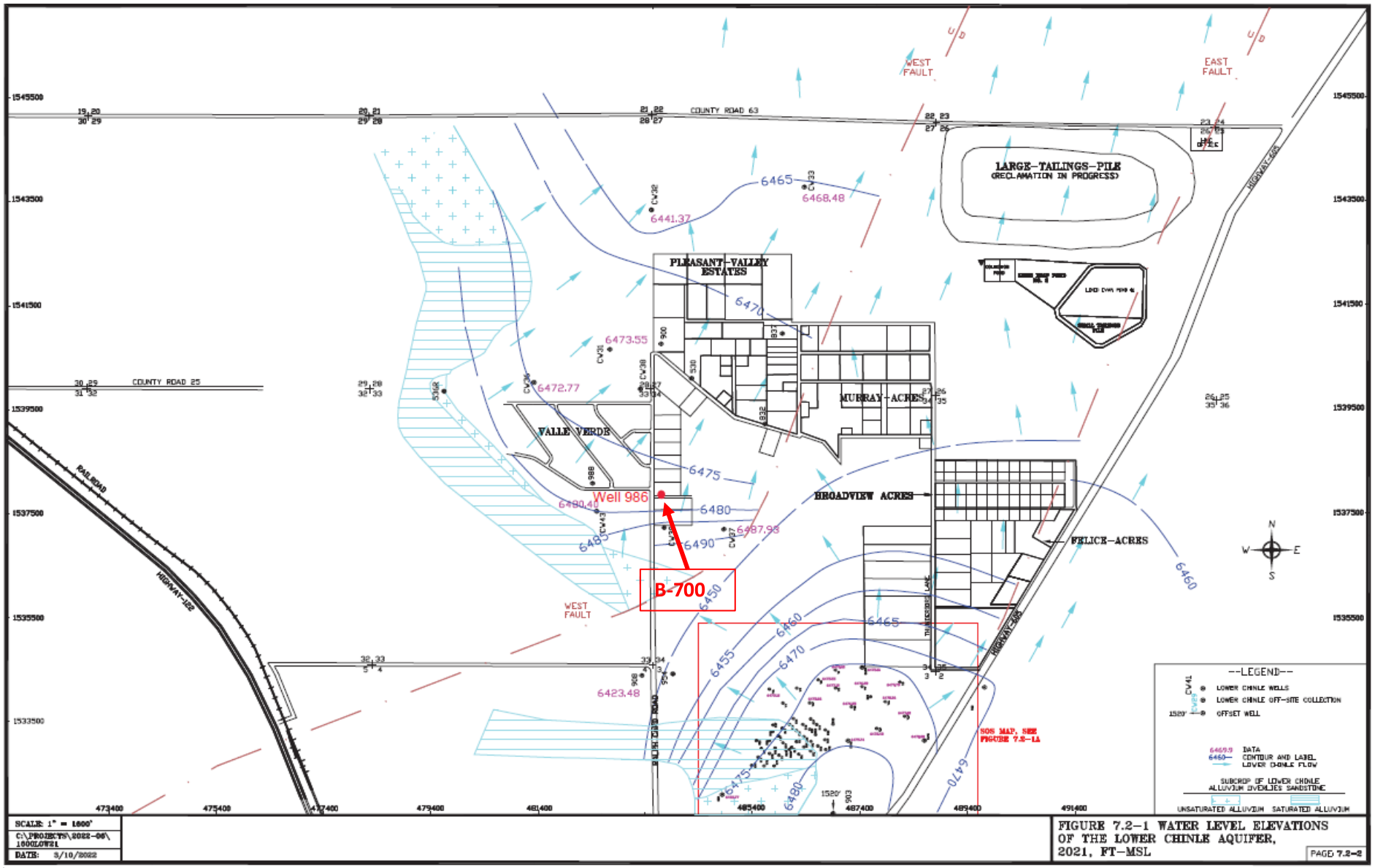

Figure 3: Lower Chinle Groundwater Elevation Map surrounding the B-700 well; modified from Bingham (2022a).

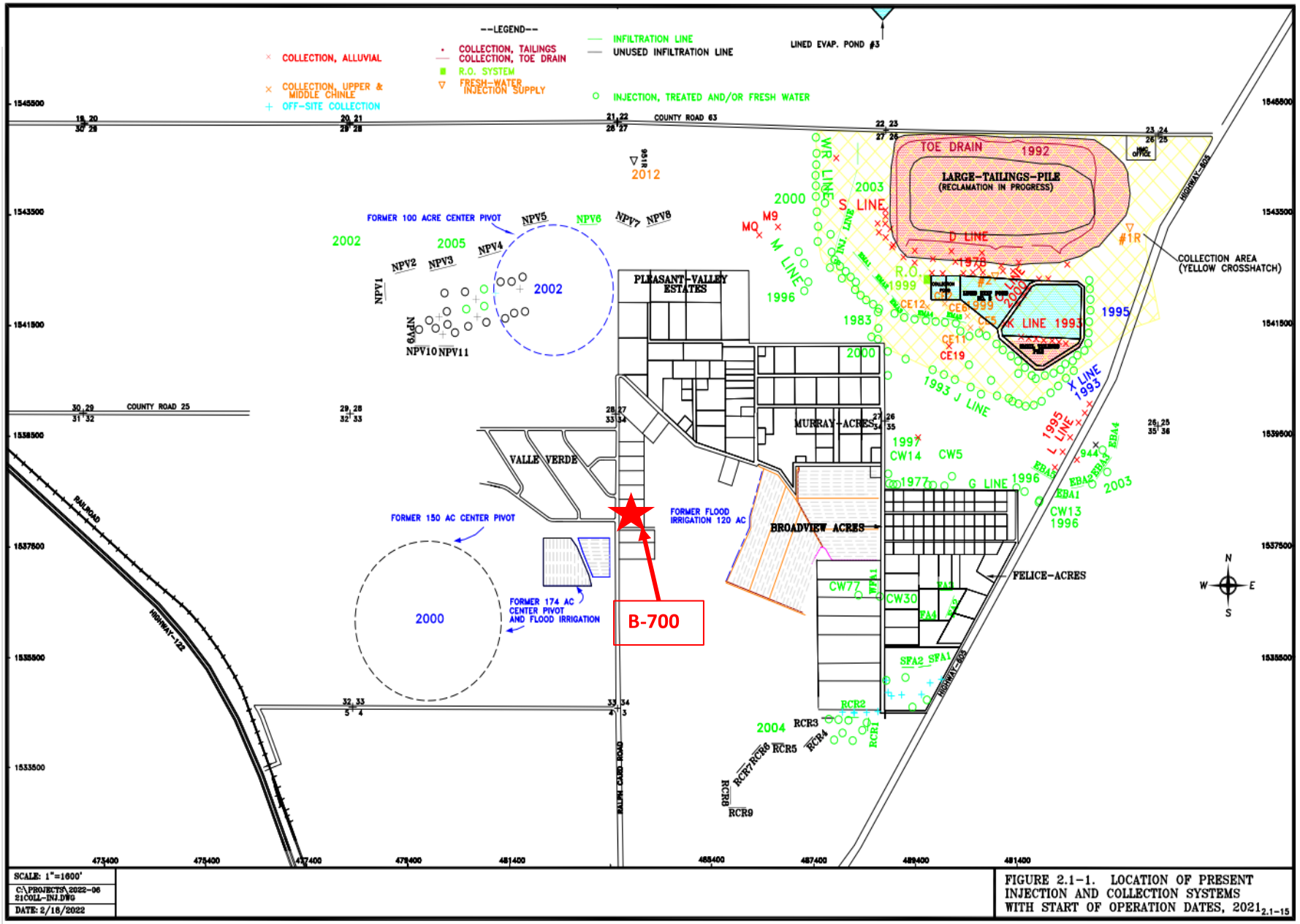

Figure 4: Homestake Remediation System; modified from Weaver et al (2022).

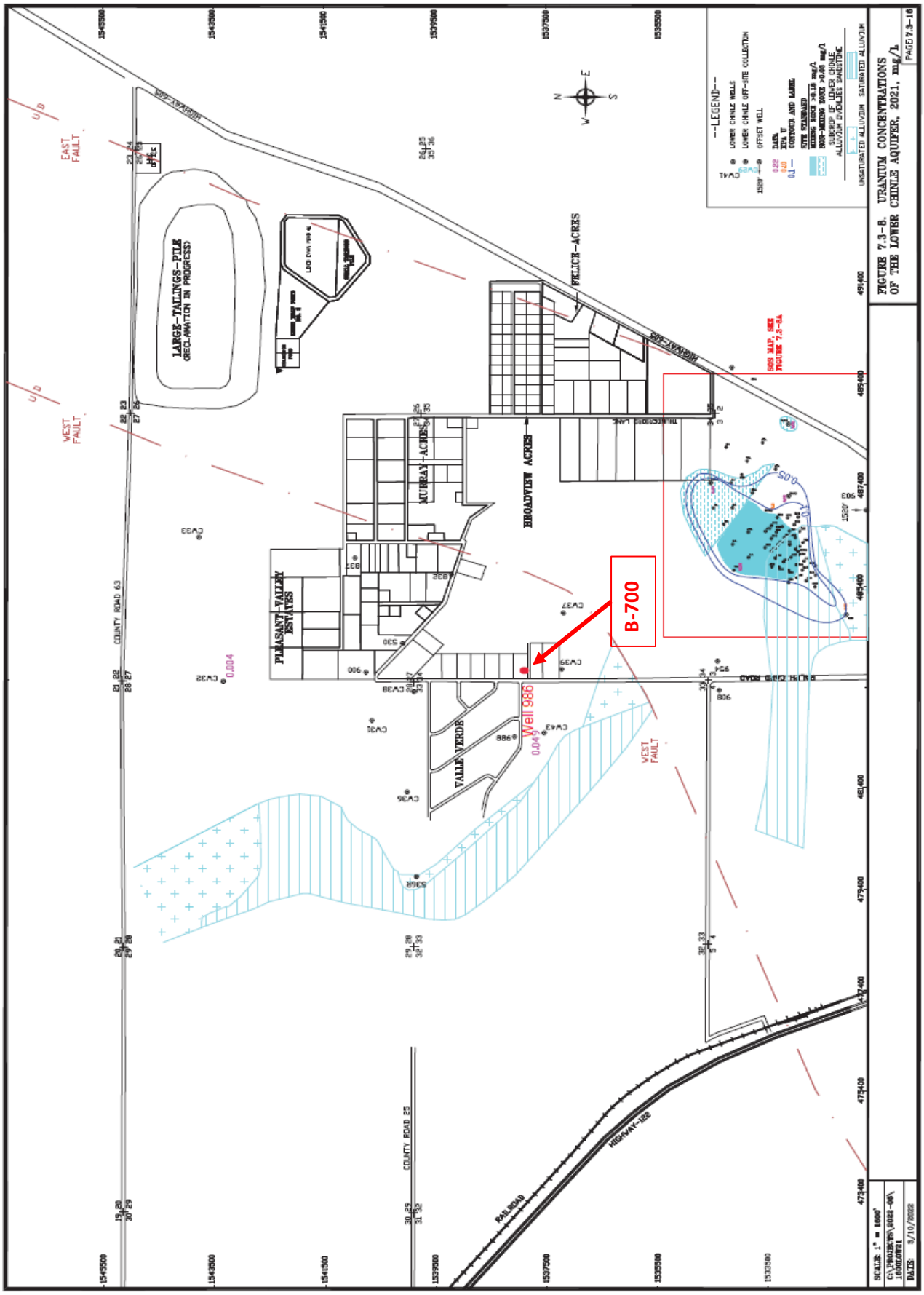

Figure 5: Lower Chinle Groundwater Uranium Concentration Map surrounding the B-700 well; modified from Bingham (2022a).

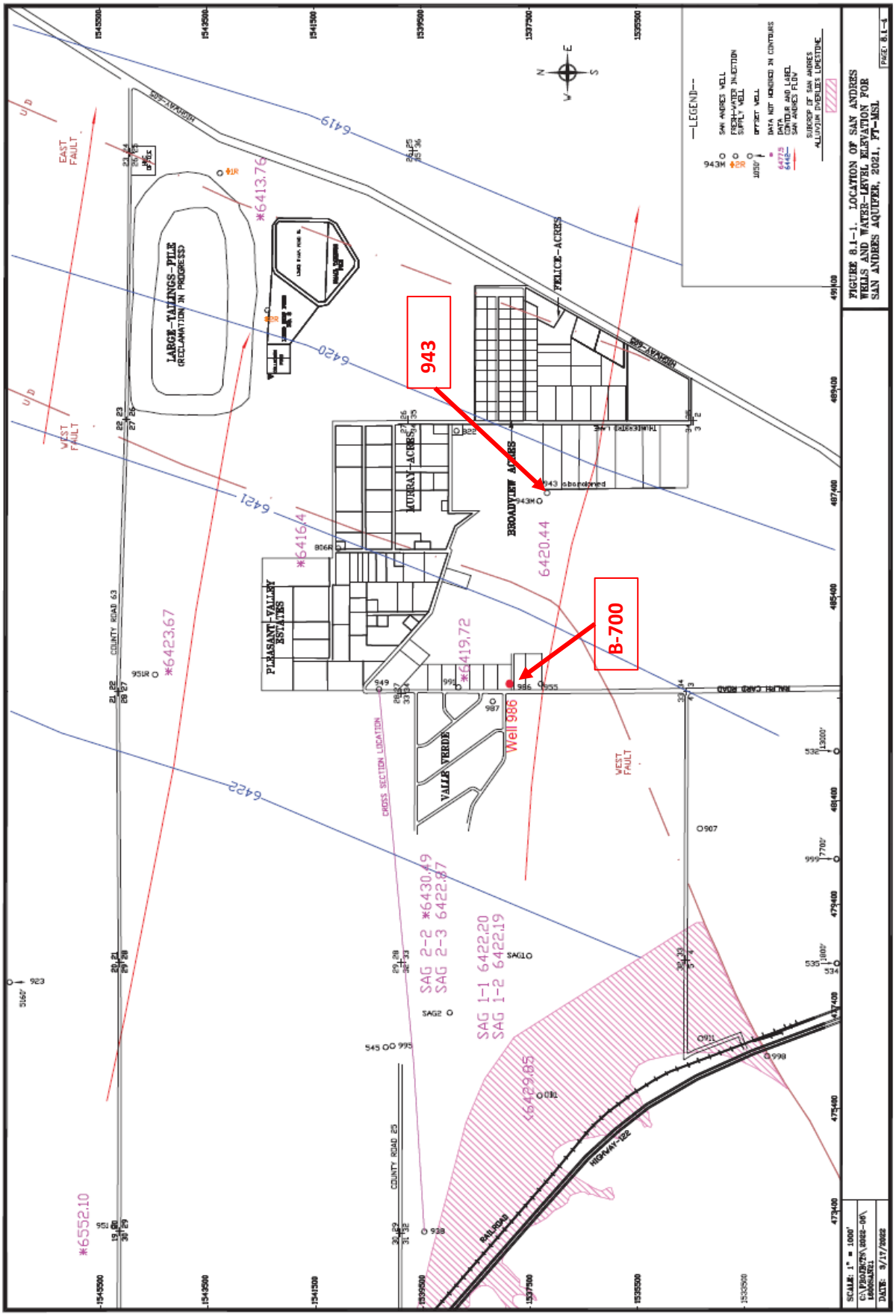

Figure 6: San Andes/Glorieta Groundwater Elevation Map surrounding the B-700 well; modified from Bingham (2022a).

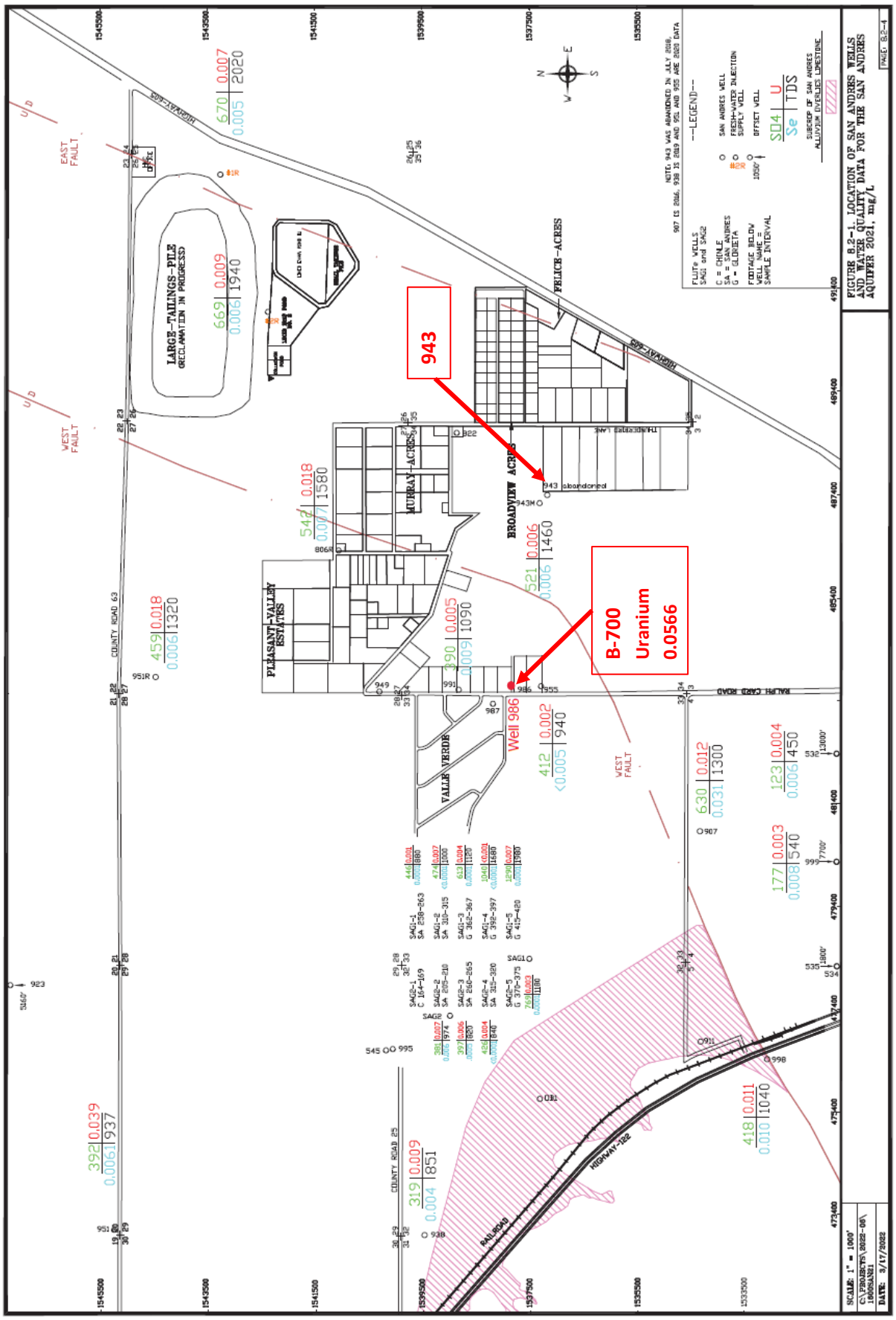

Figure 7: San Andres/Glorieta Groundwater Uranium Concentration Map surrounding the B-700 well; modified from Bingham (2022a).