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February 24, 2006

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Subject: Technical Memorandum: Well Disposition Evaluation for Inactive Supply Well PGE-7, PG&E Topock Compressor Station

Dear Mr. Shopay:

This letter transmits the technical memorandum *Well Disposition Evaluation for Inactive Supply Well PGE-7*. The technical memorandum is submitted in conformance with Condition 19 in DTSC's January 6, 2006 letter, and modifications thereto as authorized by your email dated February 17, 2006.

Please contact me at (805) 546-5243 if you have any questions.

Sincerely,

Paul Bettin for Yvonne Meeks

cc. Kate Burger/ DTSC

Enclosure

Well Disposition Evaluation for Inactive Supply Well PGE-7 PG&E Topock Compressor Station

DATE: February 23, 2006

Introduction

This technical memorandum presents an evaluation of inactive water supply well PGE-07, as requested in the Department of Toxic Substances Control (DTSC) January 6, 2006 letter, *Conditional Approval of the Draft Well Installation Work Plan for Interim Measures Performance Monitoring Program, dated November 30, 2005*. In the January 6, 2006 letter, DTSC requests: (1) an evaluation of the potential vertical migration pathway from the Alluvial Aquifer to bedrock units enabled by the design of well PGE-07, and (2) a recommendation for reconstruction or decommissioning of the well. The letter also requests that a work plan be provided for either the reconstruction or decommissioning of PGE-07 (hereafter referred to as PGE-7).

Furthermore, the DTSC has verbally requested that an evaluation of the ambient groundwater velocity be performed in the PGE-7 borehole. This evaluation will take place prior to reconstruction, because the results may alter the final design of the preferred reconstruction method.

This memorandum reviews the well conditions and groundwater monitoring and hydraulic data for PGE-7 and nearby wells, describes a proposed measure for sealing the PGE-7 well/borehole, reviews methods for evaluating borehole velocity and well reconstruction, and provides recommendations.

PGE-7 Well Construction Details

Well PGE-7 is located approximately 250 feet northwest of the north gate to the Topock Compressor Station in an area known as the MW-24 bench (Figure 1). PGE-7 was originally installed in 1964, to a depth of 182 feet below ground surface (bgs), as a replacement water supply well for the Topock Compressor Station. The original well was constructed with 14-inch steel casing, with perforations from 110 feet to 180 feet bgs. In 1969, the well was deepened to 330 feet bgs, with a 7-inch-diameter blank steel liner installed to 195 feet bgs, and the remainder of the hole uncased to 330 feet bgs. Figure 2 is a schematic well completion diagram that summarizes the original well construction details and observations from a video log recorded by PG&E's contractor in 1998. Table 1 summarizes well construction information for PGE-7 and other nearby wells PGE-6, MW-24A, MW-24B, and MW-24BR.

The depth of the contact of the Alluvial Aquifer with the Miocene conglomerate (bedrock) at the PGE-7 location is estimated at 220 feet bgs. Therefore, approximately 25 feet of the open-hole portion of PGE-7 is exposed to the base of the Alluvial Aquifer (Figure 2).

A geologic log for the drilling and deepening of PGE-7 is not available in PG&E's records to provide lithologic description of the bedrock formation in this well. However, the 1998 video log indicates that angular rock with possible fractures is visible in the open borehole from 234 feet bgs to the top of the slough presently encountered in the well at 303 feet bgs. Based on logs from nearby borings (MW-24BR and TW-1), the bedrock formation present in PGE-7 is believed to be consolidated/cemented Miocene conglomerate. The lower portion of the deepened PGE-7 borehole may have also encountered the pre-Tertiary metadiorite bedrock that was logged in the former injection well PGE-8 (located approximately 750 feet south of PGE-7).

Groundwater Monitoring Results

A review of hexavalent chromium (Cr[VI]) data from PGE-7 and the nearby MW-24 well cluster (Table 2) indicates that Cr(VI) concentrations in groundwater samples collected from Alluvial Aquifer monitoring wells MW-24A and MW-24B (averaging approximately 3,000 and 5,000 micrograms per liter [μg/L], respectively in 2001-2005 sampling) are similar to concentrations observed in the PGE-7 water samples (averaging approximately 4,900 μg/L in 2000-2003 sampling). Groundwater samples collected from monitoring well MW-24BR, screened within the bedrock formations, have been non-detect for Cr(VI) for six years of monitoring (except for one event immediately following well installation, which was probably an artifact of the drilling process). The similarity in groundwater sample results between PGE-7 and MW-24B, and the absence of Cr(VI) in MW-24BR, indicate that the Cr(VI) detected in PGE-7 samples is likely from that portion of the well that is completed across the base of the Alluvial Aquifer—and not from the bedrock units.

Summary of Vertical Gradients

Water level data from monitoring wells in the PGE-7 area indicate that a persistent upward hydraulic gradient exists between the saturated zone in the bedrock and the Alluvial Aquifer. As summarized in Table 3, the bedrock monitoring well MW-24BR consistently records a higher ground water level (corrected for salinity and temperature) than MW-24A and MW-24B. The measured upward hydraulic gradients between MW-24BR and MW-24A & B range from 0.002 to 0.006 feet per foot (Table 3). The observed vertical gradients at the MW-24 cluster are fairly consistent in magnitude over four years of monitoring, and are always upward (Figure 3). This hydraulic condition reduces the potential for downward migration of groundwater from the Alluvial Aquifer to the bedrock formations.

Water levels in other well clusters located across the site at MW-20, MW-32, MW-33, and MW-34 typically display upward hydraulic gradients up to an order of magnitude greater than the horizontal gradients, although none of these other well clusters include wells completed in bedrock (CH2M HILL 2005).

Potential for Vertical Migration

Despite the consistent upward hydraulic gradients, the influx of groundwater from bedrock to alluvium is not expected to be large because of the lower permeability of the bedrock with respect to the alluvium (e.g., well MW-24BR typically purges dry at one casing volume). As noted above, Cr(VI) concentrations have been very similar (range: 4,300 to 5,600 μg/L) in the lower alluvial well MW-24B and in PGE-7, and non-detect in bedrock well MW-24BR (in all samples collected since 1998). While hydraulic gradients are upward from the bedrock to the alluvium at PGE-7, the Cr(VI) concentrations in groundwater samples collected from the present PGE-7 well completion are likely dominated by the contribution from the basal Alluvial Aquifer, and minimally affected by bedrock water quality because of permeability differences.

The potential for downward vertical migration at well PGE-7 is very low. With upward hydraulic gradients, Cr(VI) is not able to move downward into the bedrock. In addition, the apparent low permeability of the bedrock formation would not allow Cr(VI) present within the open borehole to move a significant distance away from the well.

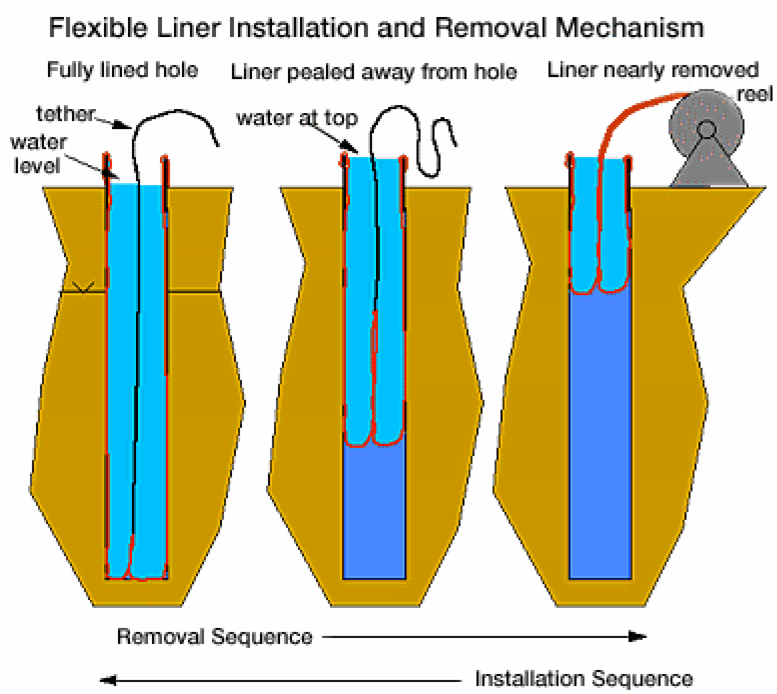
However, the use of PGE-7 in its present condition for groundwater level or groundwater quality monitoring is problematic. As the well is completed as an open hole across the basal Alluvial Aquifer and the bedrock, the static water level is influenced by both zones. As previously mentioned, the water quality in the well is likely dominated by the more permeable Alluvial Aquifer. Although the vertical hydraulic gradients suggest that migration between the alluvium and the bedrock is unlikely to occur, it would be desirable to eliminate any potential for this in the unlikely event that the direction of vertical flow changes in the future.

Considerations for Temporary Sealing of PGE-7

PGE-7 is one of only four wells that are screened in the bedrock unit at the Topock site (along with MW-24BR, MW-23, and PGE-8). An evaluation of published literature regarding the potential existence of pathways for chromium transport through bedrock is currently underway. The results of this evaluation will be used to determine the need for any future bedrock investigations at the Topock site. If further bedrock investigation is needed, well PGE-7 would be a viable candidate for reconstruction as a bedrock monitoring well. Until the need for and objectives of a bedrock investigation are more clearly identified, it is not obvious how this well should be reconstructed. Three different reconstruction options have been identified, each with advantages and disadvantages. The decision on whether PGE-7 would be used primarily for monitoring water levels or for monitoring water quality will influence the choice of reconstruction methods.

In the interim, a method by which PGE-7 could be temporarily sealed has been identified, which would eliminate any concern about the potential for cross-connection between alluvium and bedrock at this well. This method involves the installation of a flexible membrane liner manufactured by Flexible Liner Underground Technologies, LLC (FLUTe). The description and schematic of the FLUTe™ system presented below are from the company's web site (http://flut.com/meth_1.htm).

The FLUTe™ liner is usually made of a urethane coated nylon fabric in tubular form. The liner is often installed in a hole with the interior of the liner filled with water (see the diagram below). The water pressure presses the liner firmly against the borehole wall. A cord, called a tether, is attached to the bottom end of the liner. If that cord is pulled upward, the liner is peeled inside-out out of the hole. The liner is said to "invert" as it is pulled upward. The water level in the liner rises as the liner is shortened by the inversion. At the surface, the tether, followed by the liner, can be wound on a reel. The third drawing shows the liner nearly fully removed from the hole with the water spilling over the top of the pipe to which the top end of the liner is attached.



The installation of the liner is the precise reversal of this procedure. The liner is filled with water which forces it to roll out against the borehole wall as it descends into the hole. This process, the reverse of inversion, is called "eversion." By adding water and allowing the liner to pull itself to the bottom of the hole, one is back to the initial state with the liner fully extended in the hole.

A recently developed technique allows identification of permeable zones within the borehole during installation of the liner. The basis of the technique is that, as the sealing liner descends, it displaces the borehole water into the formation. The descending liner also seals the hole and therefore, it covers the flow paths from the higher portions of the hole as it descends. The descent rate is controlled by how easily the water flows from the hole back into the formation. Hence, by recording the descent rate of the liner and the level of excess head inside the liner, one can deduce the effective transmissivity of the remaining section of the hole. As each significant flow path is sealed by the liner descent, the remaining transmissivity decreases. That decrease is equal to the transmissivity of the portion of the hole just covered, and the end result is a plot of the transmissivity with depth. This technique is especially well suited to situations where flow from the hole is often dominated by a few, relatively free-flowing fractures. However, if the permeability of the bedrock is uniformly low, the everting liner technique may not be sensitive enough to identify very small changes in flow at each small fracture zone.

While the FLUTe™ system discussed here is designed to profile the hydraulic conductivity of the borehole and to provide a seal against vertical flow, the FLUTe™ system can be modified at some future date to allow for the collection of water quality samples from multiple depths in the borehole. If it is determined that PGE-7 is no longer needed, the FLUTe™ liner could be removed and the borehole permanently abandoned using conventional well abandonment techniques, such as pressure grouting. Although leakage of the liner has not been a problem for FLUTe™ users (up to ten years use in wells with no leakage), monitoring of water levels inside the liner provides a simple way to monitor liner integrity.

Reconstruction Options

Once the need for and objectives of a bedrock investigation have been identified, there are several methods that could be used to reconstruct PGE-7 to provide for monitoring of groundwater levels and quality. With proper reconstruction, PGE-7 will provide a valuable bedrock monitoring point while being protective of bedrock water quality. Three methods of reconstruction are discussed below, along with the advantages and disadvantages of each. Since there are distinct differences between the methods, PG&E recommends that the additional data that will be provided by the borehole flow logging (described below) and the FLUTe™ hydraulic conductivity profiling (described above) be reviewed before any decision is made on the best method for reconstruction of the well.

Three options for reconstructing PGE-7 as a bedrock monitoring well were evaluated:

1. Installation of a standard 2-inch diameter PVC monitoring well within the existing open borehole

2. Installation of Barcad samplers or nested 1-inch diameter mini-wells to provide multi-level sampling ports within the existing open borehole

3. Installation of the Water FLUTe™ liner equipped with multilevel sampling ports

Installing a 2-inch PVC monitoring well inside the existing borehole would use conventional techniques of filter pack and grout emplacement, via tremmie pipe. The well would be screened completely within the bedrock interval, potentially with a 60-foot screened interval (similar to bedrock well MW-24BR) from 240 to 300 feet bgs, or a longer well screen. A cement-bentonite grout seal would be placed above the filter pack, across the exposed bedrock/alluvium contact and up to the surface. This method would be performed using standard operating procedures, all of which have a proven track record.

Installation of nested wells within the existing casing and borehole would be similar in technique to the installation of a single 2-inch well, except the well casings would be of smaller diameter. Centralizers would be used to maintain the necessary open space between pipe and casing/borehole for grout emplacement. Besst Inc. manufactures a line of equipment known as Barcad samplers that can be installed in existing wells (http://www.besstinc.com/barcad_pumps.html). They have also recently developed a line of 1-inch diameter mini-wells, several of which could be installed inside the open borehole of PGE-7 to provide multilevel monitoring. Mini-wells can be used to obtain water level and quality information.

As with the FLUTe™ liner described above, the Water FLUTe™ system allows for the sealing of a borehole, but includes tubes and ports for water quality sampling and hydraulic head measurements. The tubes and ports are added to the liner at the factory at the desired depths, and spacers can be installed around the ports to increase the area of sample collection if needed. Pressure transducers can be installed in-line with the sample tubes, and slender electronic water level meters can measure hydraulic heads of up to 150 ft in the 0.5-inch tubes. Each sample tube runs from the port to a central U-shaped tube and then to the surface. A check valve ensures that water can only flow from the sample tube to the U-tube. Samples are taken by applying pressurized gas to one side of the U-tube, forcing the water up and out the other side. When the pressure is reduced, the U-tube is refilled with water from the port. Each port has a dedicated sample tube and U-tube, so no water is shared between sampling depths. Since the opening of the sample tube is in direct contact with the geologic formation, only the sample tube needs to be purged, and purge volumes are dramatically reduced (i.e., 200 feet of 0.5-inch tubing = 2 gallon volume). More information is available at http://www.flut.com/meth_2.htm.

Table 4 provides a summary of advantages and disadvantages to these well reconstruction techniques. The ultimate choice for reconstruction will depend on the results of the vertical groundwater velocity evaluation (described below) and the vertical hydraulic conductivity profiling via the FLUTe™ system.

Evaluation of Vertical Groundwater Velocity in the Borehole

Prior to installation of a temporary liner in PGE-7 as an interim sealing measure, an evaluation of natural flow within the borehole should be performed. We propose to measure flow at the uppermost section of the bedrock. This will provide an indication of the natural hydraulic gradients in the well, and the relative contributions of flow from bedrock and alluvial sections of the borehole when pumping.

Several flow metering methods were considered, including electromagnetic (EM), FloVision™, heat pulse, and impeller or spinner logging. A summary of this evaluation is presented below.

- Electromagnetic flow monitoring relies on the principle that water flowing through a magnetic field will induce an electric current (Young et al. 1998). The current is measured, and is proportional to the strength of the magnetic field (a constant) and the velocity of the moving water. The technique is steady state, can measure very low (0.1 ft/min) and very high velocities, and works comparatively better than other techniques with high salinity waters, such as those found at PGE-7.

- FloVision™ monitoring is a visual technique that relies on a down-hole video camera and analysis of particles moving past the camera lens. By having a visual log of the down-hole environment, questions regarding uncertainties such as seal integrity, interference from debris, and casing or borehole wall condition can be immediately answered. While the technique is reportedly able to quantify flows as low as 0.2 ft/min, it does not work well to measure high velocities.

- Heat pulse probes use heat as a tracer; a heat source heats a small volume of water, and heat-sensors above and below record the movement of the heated water. The technique is capable of quantifying very low velocities (to 0.2 ft/min), but the thermal regime of the heated water is subject to disturbance from falling debris and subtle equipment movements, which can result in erratic results. Measurement of high flows is problematic.
- The impeller technique relies on water movement to rotate an impeller. Despite construction with precision, low-friction bearings, a minimum flow of 3-4 ft/min is needed to generate impeller movement. This technique does work well with higher velocities generated during pumping. However, if very little water is coming from bedrock, it might not be sensitive enough to quantify this flow even under pumping conditions.

Table 5 provides a summary of the advantages and disadvantages of these techniques. Each technique would require the removal of the existing pump and hardware in the PGE-7 well. All methods require a flange or packer to seal the borehole around the instrument during velocity evaluation. Examination of the borehole video log suggests an irregularly shaped borehole (due to degradation of the borehole wall and accretion within the steel casing), and thus evaluation of borehole diameter with a precision caliper is recommended prior to the velocity evaluation, regardless of preferred technique. It is also possible that the well casing will need to be cleaned to accommodate the flange sizes for sealing of the open hole.

Recommendations

Prior to any work on PGE-7, the 1998 video log should be further reviewed by the team selected to perform the work. A caliper log is recommended in order to determine, as precisely as possible, the diameter of both the encrusted casing and the open borehole.

An evaluation of borehole velocity under both static and pumping conditions is recommended using the EM flow meter technique. This technique has been proven to be robust, and has the advantage of being able to measure very low flow as well as higher flow that might be generated under extraction conditions. The video log should be reviewed by the technical team to determine whether encrustations in the well casing will impede the descent of the proper flange for open borehole sealing during velocity measurements, and must be removed.

A FLUTe™ liner is recommended to be installed to eliminate any possibility of cross-connection between the alluvium and bedrock formations. Attempts will be made during the installation of the FLUTe™ liner to measure the transmissivity of the bedrock. The installed product will seal the casing in the interim, and can be modified as described above to provide depth-discrete groundwater sampling from the bedrock saturated zone.

With proper reconstruction, PGE-7 could provide a valuable bedrock groundwater monitoring well while eliminating the potential for cross-connection between the Alluvial Aquifer and bedrock.

Certification

This memorandum was prepared by CH2M HILL under the supervision of the professional whose seal and signature appears hereon, in accordance with currently accepted professional practices; no warranty, expressed or implied, is made.

Paul F. Bertucci
Certified Engineering Geologist

References

CH2M HILL. 2005. *Draft RCRA Facility Investigation/Remedial Investigation Report, PG&E Topock Compressor Station, Needles, California.* February 24.

Young, Steven C., Hank E. Julian, Hubert S. Pearson. 1998. Application of the Electromagnetic Borehole Flowmeter. United States EPA, Wash. DC.

Tables

TABLE 1
Well Construction Information for PGE-6, PGE-7, and MW-24 Monitoring Wells
Technical Memorandum: Well Disposition Evaluation for Inactive Supply Well PGE-7
PG&E Topock Compressor Station

Well ID monitored zone	Completion Date	Ground Elevation ft MSL	Well Depth ft bgs	Well Material	Well Perforation / Screen Interval: Depth ft bgs	Well Perforation / Screen Interval: Elevation ft MSL	Screen Length feet	Remarks
PGE-6 Upper Alluvial Aquifer	Jun-1964	562	180	14" steel	110 - 180	452 - 282	70	Installed as replacement supply well for Station March 1998 video log: casing deteriorated and silted bottom at 162' (52' open perforations)
PGE-7 Bedrock and 25' of basal interval of Alluvial Aquifer	Sep-1964 Aug-1969	563	182 330	14" steel 7" steel liner to 195'	N.A.[1] 195 - 330 6.7" openhole	--- 368 - 283	--- 135	Installed as replacement supply well for Station Re-completed as a monitoring well in 1969 as part of well PGE-8 wastewater disposal operations March 1998 video log: casing liner to 195' and openhole boring to silted bottom at 303' (108' openhole)
MW-24A Upper Alluvial Aquifer	May-1998	565	125	4" PVC	104 - 124	461 - 441	20	
MW-24B Base Alluvial Aquifer	May-1998	563	214	4" PVC	194 - 214	369 - 349	20	
MW-24BR Bedrock	Apr-1998	563	438	4" PVC	378 - 438	185 - 125	60	Boring was logged as "Red Fanglomerate (rock) and Sandstone" from 225' to 441'

Notes:

[1] Well perforation depths for **original completion of PGE-7** are not available; assume similar well completion to the 70-foot perforated completion used for PGE-6.

MSL = mean sea level. ft bgs = feet below ground surface. (--) = data not available. PVC = polyvinyl chloride.

Ground surface elevations and well screen depths are rounded-off to whole-foot.

Static water levels in PGE-6, PGE-7, and MW-24 wells typically range from approximately 106 to 108 feet bgs.

TABLE 2
Groundwater Sampling Results for PGE-7 and MW-24 Monitoring Wells
Technical Memorandum: Well Disposition Evaluation for Inactive Supply Well PGE-7
PG&E Topock Compressor Station

Well ID	Sample Date	Hexavalent Chromium (µg/L)	Dissolved Chromium (µg/L)	Lab Specific Conductance (µS/cm)	Total Dissolved Solids (mg/L)
PGE-7					
	01-Sep-00	4790	4800	14200	9120
	01-Dec-00	4290	3800	14800	---
	28-Mar-01	4530	4000	14900	---
	06-Jun-01	5080	4300	13500	---
	12-Sep-01	5400	4500	15100	---
	29-Nov-01	4800	4800	11200	8100
	10-Dec-03	4740	6780	14300	9130
	13-Oct-05	ND (1.0)	ND (1.0)FF	10800	---
MW-24A					
	29-Nov-01	3400	2900	3150	2010
	08-Mar-02	3030	2990	3650	---
	13-Jun-02	2870	3020	3650	---
	17-Sep-02	3290	3490	---	---
	11-Dec-02	3400	4100	---	---
	18-Mar-03	2770	2610	---	---
	12-Jun-03	2640 J	2510	4030	2040
	11-Sep-03	2970	2620	3430	---
	10-Dec-03	2990	3320	3350	---
	17-Mar-04	2600	2270	3480	---
	08-Jun-04	2660	2390	3450	2000
	20-Sep-04	2960	2960	3380	---
	17-Dec-04	---	2890	3400	---
	11-Jan-05	3040	---	---	---
	07-Mar-05	3390	3180	3330	---
	16-Jun-05	3280	2640	3180	---
	03-Oct-05	3120	2930 FF	3200	---
MW-24B					
	29-Nov-01	4400	4400	12500	7760
	08-Mar-02	4920	4600	13300	---
	13-Jun-02	4830	5120	12500	---
	10-Dec-02	4620	5380	---	---
	18-Mar-03	4900	4650	---	---
	12-Jun-03	4790	5570	14500	8130
	11-Sep-03	4760	4320	13000	---
	10-Dec-03	4840	6050	12700	---
	17-Mar-04	4860	3900	13100	---
	08-Jun-04	5190	4910	13300	9200
	21-Sep-04	5100	4940	13400	---
	17-Dec-04	---	4470	13400	---
	11-Jan-05	5260	---	---	---
	07-Mar-05	5320	4950	13400	---
	16-Jun-05	5640	5660	12700	---
	03-Oct-05	5240	4930 FF	14900	---
MW-24BR					
	29-Nov-01	ND (10)	ND (800)	13800	8280
	08-Mar-02	ND (10)	68.8	14300	---
	13-Jun-02	ND (10)	3.70	13800	---

TABLE 2 continued
Groundwater Sampling Results for PGE-7 and MW-24 Monitoring Wells
Technical Memorandum: Well Disposition Evaluation for Inactive Supply Well PGE-7
PG&E Topock Compressor Station, Needles, California

Well ID	Sample Date	Hexavalent Chromium (µg/L)	Dissolved Chromium (µg/L)	Lab Specific Conductance (µS/cm)	Total Dissolved Solids (mg/L)
MW-24BR					
	18-Sep-02	ND (10)	3.50	---	---
	12-Dec-02	ND (10)	3.40	---	---
	19-Mar-03	ND (10)	16.0	---	---
	13-Jun-03	ND (10)	2.90 J	14500	8470
	12-Sep-03	ND (0.2)	3.60 J	14000	---
	11-Dec-03	ND (0.2)	4.60	14000	---
	17-Mar-04	ND (1.0)	4.80	13800	---
	08-Jun-04	ND (1.0)	ND (1.0)	14000	7800
	21-Sep-04	ND (1.0)	ND (1.0)	15000	---
	17-Dec-04	ND (1.0)	3.50	14500	---
	08-Mar-05	ND (1.0)	ND (1.0)	14000	---
	15-Dec-05	ND (1.0)	ND (1.0)FF	13600	---

Notes:
µg/L = micrograms per liter
mg/L = milligrams per liter
µS/cm = microSiemens per centimeter
(---) = parameters not analyzed
ND = not detected at the listed reporting limit
J = estimated
FF = field filtered

Start date for PGE-7 data is September 2000.

Start date for for MW-24 cluster data is November 2001.

Only includes primary samples

TABLE 3
Hydraulic Gradients in MW-24 Cluster Wells
Technical Memorandum: Well Disposition Evaluation for Inactive Supply Well PGE-7
PG&E Topock Compressor Station

Shallower Well	Deeper Well	Date	Shallower Well Groundwater Elevation (feet MSL)	Deeper Well Groundwater Elevation (feet MSL)	Water Level Elevation Difference (feet)	Vertical Distance between Screens (feet)	Vertical Hydraulic Gradient (feet/foot)	Direction*
MW-24A	MW-24B	8/21/2001	455.98	456.20	0.21	89	0.002	upward
		11/27/2001	454.29	454.41	0.13		0.001	upward
		3/4/2002	454.82	454.76	-0.06		< 0.001	neutral
		6/10/2002	456.24	456.25	0.01		< 0.001	neutral
		9/16/2002	455.66	455.77	0.11		0.001	upward
		12/9/2002	454.44	454.45	0.00		< 0.001	neutral
		3/17/2003	455.12	455.17	0.05		< 0.001	neutral
		6/9/2003	456.52	456.57	0.05		< 0.001	neutral
		9/8/2003	456.10	456.18	0.08		< 0.001	neutral
		12/8/2003	455.12	455.20	0.07		< 0.001	neutral
		3/15/2004	455.19	455.25	0.06		< 0.001	neutral
		6/8/2004	456.51	456.48	-0.02		< 0.001	neutral
		9/21/2004	455.47	455.64	0.17		0.002	upward
		12/17/2004	454.58	454.60	0.02		< 0.001	neutral
		3/7/2005	454.05	454.12	0.07		< 0.001	neutral
		5/18/2005	455.38	455.43	0.06		< 0.001	neutral
MW-24B	MW-24BR	8/21/2001	456.20	456.72	0.52	205	0.003	upward
		11/27/2001	454.41	455.08	0.67		0.003	upward
		3/4/2002	454.76	455.40	0.64		0.003	upward
		6/10/2002	456.25	457.10	0.84		0.004	upward
		9/16/2002	455.77	456.41	0.63		0.003	upward
		12/9/2002	454.45	455.14	0.69		0.003	upward
		3/17/2003	455.17	456.05	0.87		0.004	upward
		6/9/2003	456.57	457.60	1.02		0.005	upward
		9/8/2003	456.18	456.92	0.74		0.004	upward
		12/8/2003	455.20	456.43	1.23		0.006	upward
		3/15/2004	455.25	455.93	0.68		0.003	upward
		6/8/2004	456.48	457.22	0.73		0.004	upward
		9/21/2004	455.64	456.66	1.02		0.005	upward
		12/17/2004	454.60	455.46	0.86		0.004	upward
		3/7/2005	454.12	455.03	0.91		0.004	upward
		5/18/2005	455.43	456.28	0.85		0.004	upward
MW-24A	MW-24BR	8/21/2001	455.98	456.72	0.73	294	0.002	upward
		11/27/2001	454.29	455.08	0.79		0.003	upward
		3/4/2002	454.82	455.40	0.58		0.002	upward
		6/10/2002	456.24	457.10	0.86		0.003	upward
		9/16/2002	455.66	456.41	0.75		0.003	upward
		12/9/2002	454.44	455.14	0.70		0.002	upward
		3/17/2003	455.12	456.05	0.92		0.003	upward
		6/9/2003	456.52	457.60	1.08		0.004	upward
		9/8/2003	456.10	456.92	0.81		0.003	upward
		12/8/2003	455.12	456.43	1.31		0.004	upward
		3/15/2004	455.19	455.93	0.74		0.003	upward
		6/8/2004	456.51	457.22	0.71		0.002	upward
		9/21/2004	455.47	456.66	1.19		0.004	upward
		12/17/2004	454.58	455.46	0.89		0.003	upward
		3/7/2005	454.05	455.03	0.98		0.003	upward
		5/18/2005	455.38	456.28	0.90		0.003	upward

Notes:

MSL = relative to mean sea level

* direction for gradients calculated as less than |0.001| were listed as "neutral"

TABLE 4

Options for Well PGE-7 Reconstruction

Technical Memorandum: Well Disposition Evaluation for Inactive Supply Well PGE-7

PG&E Topock Compressor Station

Technique	Advantages	Disadvantages
Water FLUTe™	Provides good seal over entire depth of borehole Seal integrity easily monitored via water levels in the liner Works well in conditions of varying borehole diameter Can include up to 20 discrete sampling ports Able to purge all ports simultaneously Small purge volume allows sampling of tight formations	Lining can be punctured by jagged casing or borehole wall
2-inch PVC Sleeve	Standard, proven technology Routine mobilization for installation	Limited to one screened interval Installation of filter pack and/or grout may be difficult due to small annular space and poor condition of casing Large purge volumes required May be difficult to purge volume required Large screen interval does not allow for discrete sampling Future abandonment of well may be more problematic
Barcad or Mini-well	Could allow for up to 5 discrete sampling intervals	Unable to check on integrity of seal between alluvium and bedrock Future abandonment of well may be more problematic Installation of filter pack and/or grout may be difficult due to small annular space and poor condition of casing

TABLE 5
Evaluation of Techniques to Evaluate Vertical Borehole Groundwater Velocity
Technical Memorandum: Well Disposition Evaluation for Inactive Supply Well PGE-7
PG&E Topock Compressor Station

Technique	Advantages	Disadvantages
Electromagnetic	Low minimum velocity of 0.1 ft/min Works better in high salinity water Can measure high velocity flows	
FloVision™	Low minimum velocity of 0.2 ft/min Visual technique, so no second guessing as to conditions in the hole (e.g. able to see if falling debris is problematic)	Difficult to measure high velocities
Heat Pulse	Low minimum velocity of 0.2 ft/min	Highly sensitive to disturbances which can yield erratic results
Impeller	Can measure high velocity flows	Requires minimum 3 ft/min velocity. Not sensitive enough to small flows.

Notes:
All techniques require the removal of existing pump in PGE-7, and all are dependent on the achieving a good flange or skirt seal with the borehole wall.

Figures

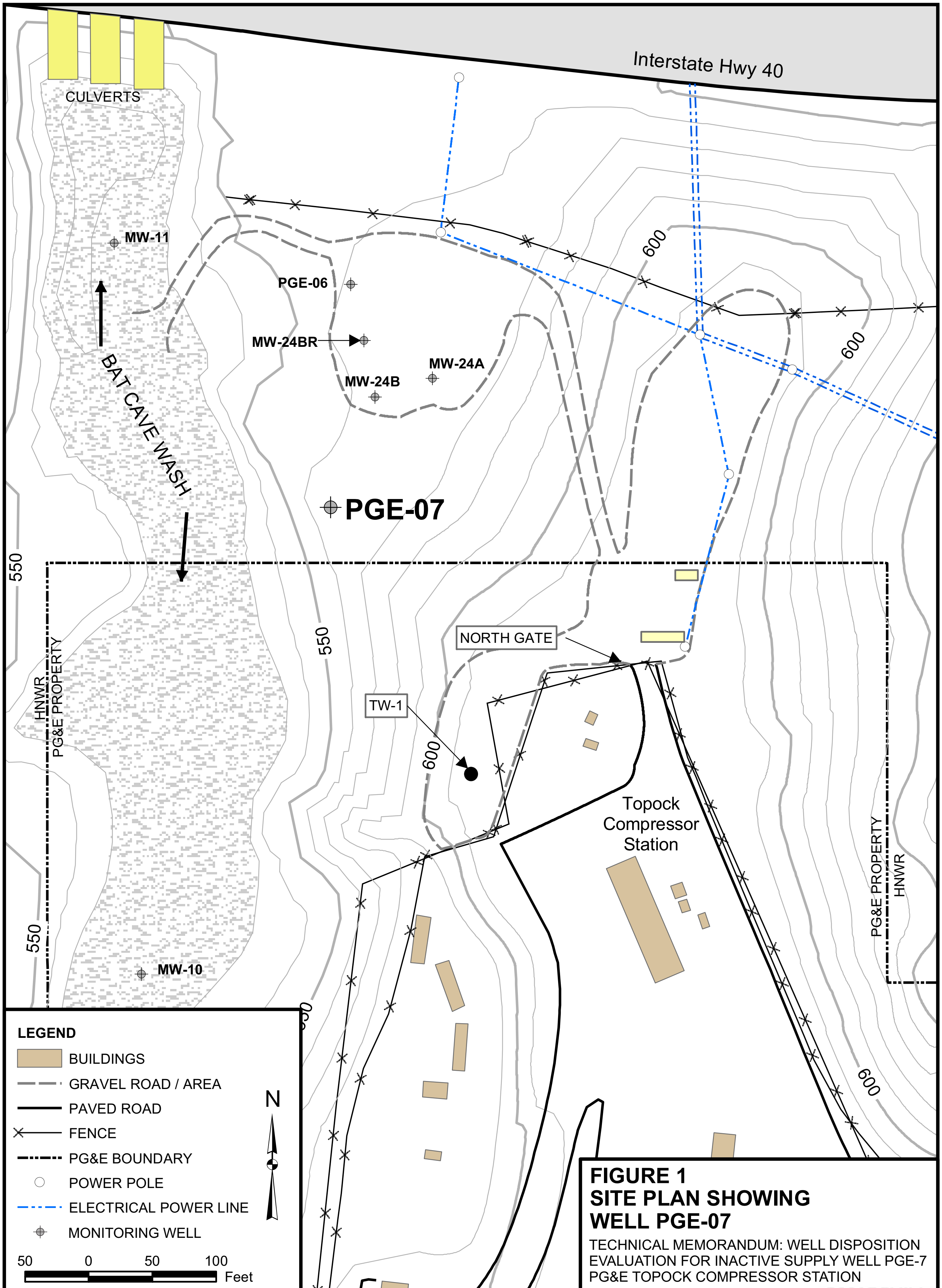


FIGURE 1
SITE PLAN SHOWING
WELL PGE-07

TECHNICAL MEMORANDUM: WELL DISPOSITION EVALUATION FOR INACTIVE SUPPLY WELL PGE-7
PG&E TOPOCK COMPRESSOR STATION

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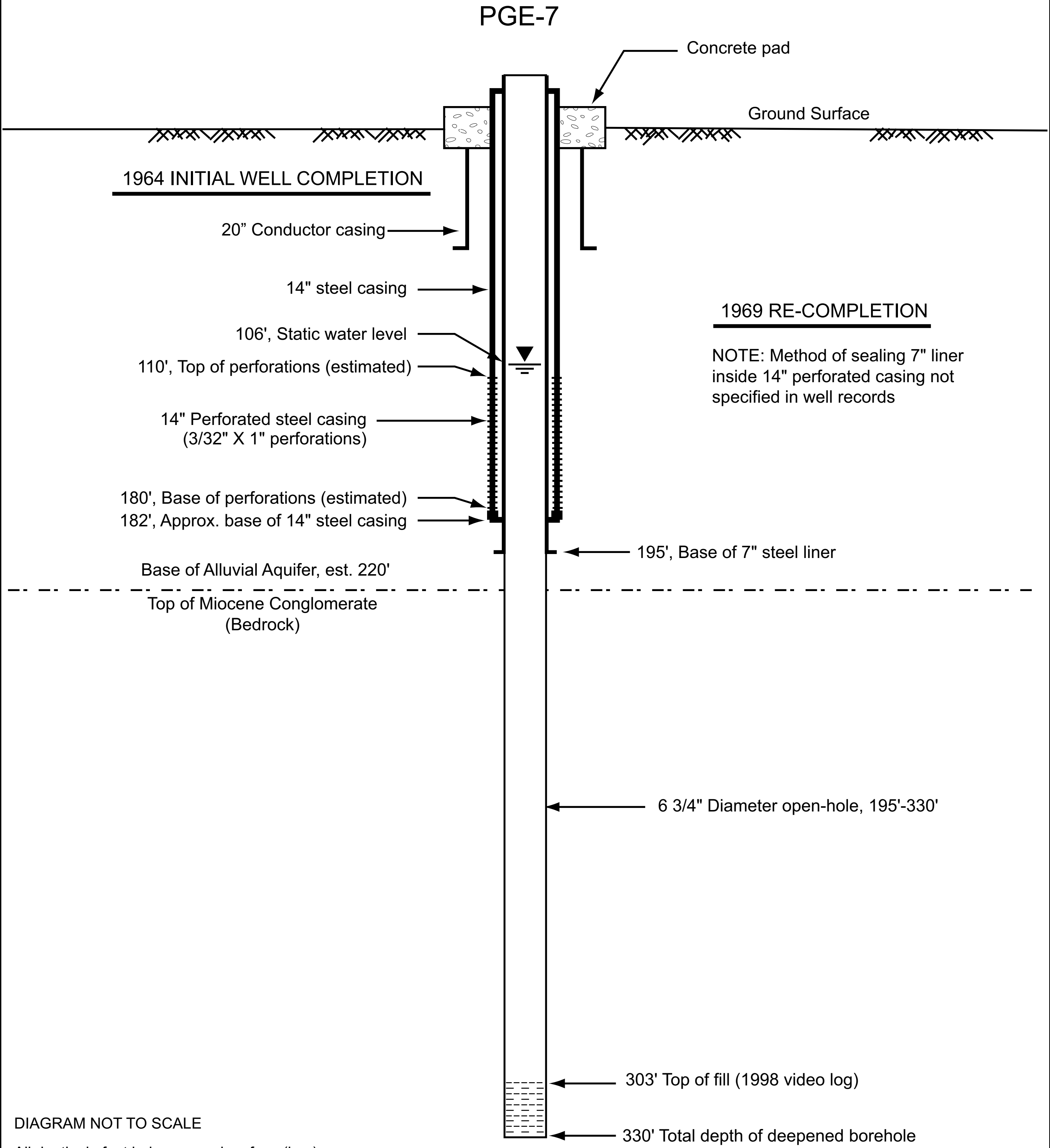

DIAGRAM NOT TO SCALE

All depths in feet below ground surface (bgs)

PGE-7 is an inactive water supply well that was deepened and re-completed in 1969 as an open-hole bedrock “monitoring well”. Well contains Grundfos submersible pump for periodic sampling.

FIGURE 2
SCHEMATIC DIAGRAM FOR INACTIVE SUPPLY WELL PGE-7
TECHNICAL MEMORANDUM: WELL DISPOSITION EVAUATION FOR WELL PGE-7
PG&E TOPOCK COMPRESSSOR STATION

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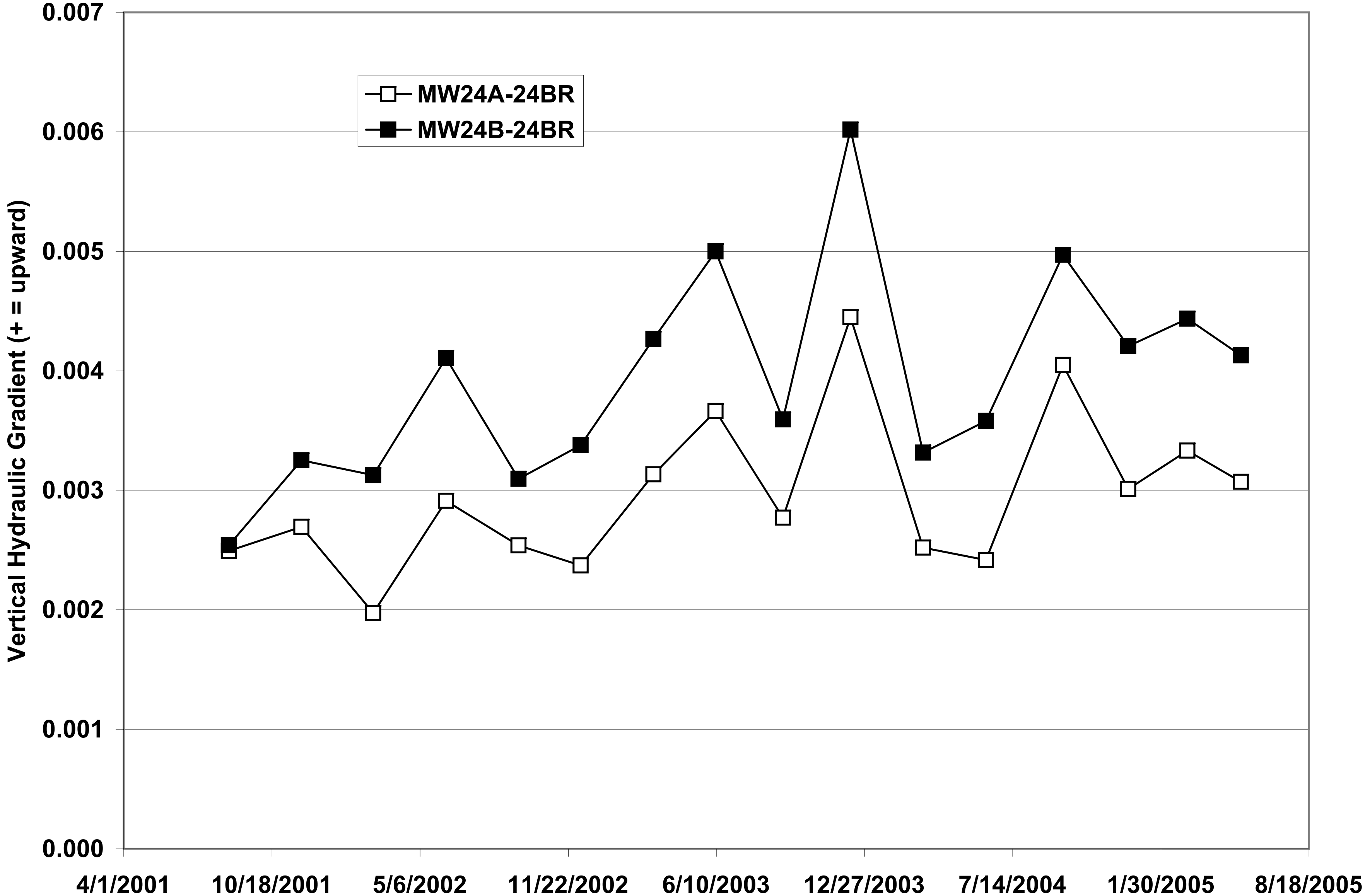

FIGURE 3
VERTICAL GRADIENTS WITHIN MW-24 CLUSTER
TECHNICAL MEMORANDUM: WELL DISPOSITION EVALUATION FOR INACTIVE SUPPLY WELL PGE-7
PG&E TOPOCK COMPRESSOR STATION

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