

October 27, 2005

L54(2380)
YOSE/General

Memorandum

To: Superintendent, Yosemite National Park

Through: William L. Jackson, Chief, Water Resources Division (WRD)
Gary Rosenlieb, Acting Chief, Water Operations Branch

From: Larry Martin, Hydrogeologist, Water Operations Branch, WRD

Subject: Evaluation of potential groundwater sources for potable supplies in the Crane Flat Area and protection of a wet meadow and fen.

Summary

Conservation and elimination of leaks in the distribution system will greatly reduce the demand for water in the Crane Flat area. Analysis of water use data indicates that leakage from the water distribution system is approximately 100,000 gallons per month. It is possible that demand could be reduced sufficiently that production from one of the new wells on Tuolumne Grove Road would meet the entire demand for the area. Further testing of the new wells (on Tuolumne Grove Road) is needed to determine whether pumping will affect water levels in the wet meadow areas at Crane Flat.

Additional storage will help meet peak demand, allow more flexibility in pumping schedules, and provide additional fire protection for facilities at Crane Flat. The current storage tank has a capacity of 50,000 gallons. Peak demand is about 20,000 gallons/day.

Construction of a well in the metamorphic bedrock formation west of Doghouse Meadow might provide all the water that is needed and greatly reduce the potential threat to the fen and other resources that are dependent on a high water table in the open meadow areas at Crane Flat.

Statement of Problem

Potable water for facilities in the Crane Flat area are supplied from a single well located in the meadow south of the YCC Camp. The well is known as the Doghouse Meadow Well. Peak demand for water in the summer is nearly 20,000 gallons/day. While the well is capable of meeting the demand, recent monitoring has shown that pumping the Doghouse Meadow Well

causes drawdown of the water table in the fen and wetland area surrounding the well. Continued and/or additional pumping from this well will lead to the decomposition of the fen peat body and likely result in a permanent loss of the unique vegetation and habitat associated with the fen.

Water Budget

The primary water users in the Crane Flat area are; the Crane Flat campground, the gas station and convenience store operated by the concessioner, Delaware North Companies (DNC), the Yosemite Institute, and a ranger residence. There are proposals to expand the Yosemite Institute, which would increase the water demand for the area. Estimates of water use by each of these users for 2001-2005 are shown on the attached table. Water delivery to the Yosemite Institute and DNC is metered. NPS use is estimated by subtracting the meter readings at the Yosemite Institute and gas station from the meter reading at the wellhead.

Water use data (monthly meter readings) for the past five years were obtained from the park (see attached table). Meter readings are not always made every month, making interpretation of the data more challenging. For example, there are no meter readings for DNC in May and June of 2001, so should the usage reported for July 2001 be spread equally over a three-month period (May-July) or should it be weighted more heavily in some months? Similar questions arise with respect to the meter readings and reported usage at Yosemite Institute in the winter months of 2001-2004. Rather than misinterpreting the data or making assumptions of how to prorate water usage, the data is presented as is, without manipulation. Fortunately, analysis of the data and comparison with a more complete dataset for FY-2005 provides enough information to make general statements regarding water use and demand in the Crane Flat area. Of particular interest is the percentage of water used for NPS facilities, which consistently accounts for 70-80% of the water pumped from the Doghouse Meadow Well. Almost all of this water is used at the Crane Flat Campground or lost to leakage in the distribution system.

Figure 1 shows a hydrograph of the total amount of water pumped from the Doghouse Meadow Well during the past five years and comparison with the calculated amount of water used by NPS facilities at Crane Flat. In general, total water demand for the area is about 500,000 gallons per month and about 150,000-175,000 gallons per month in the off-season. NPS usage is calculated as the difference between the total amount pumped from the well and the amount measured at the meters to the Yosemite Institute and the gas station. Thus, any leakage in the distribution system (other than leakage that might occur downstream of the YI and DNC meters) is attributed to NPS usage. Since the only NPS usage in the off-season is a minimal amount of consumption at the ranger residence, it appears that there is a significant amount of unaccounted water most likely being lost as leakage from the distribution system (approximately 100,000 gallons per month).

Figure 2 shows a hydrograph of water usage at the gas station and convenience store operated by DNC. Since the meter isn't read every month, some of the data points represent cumulative usage for two or more months. In general, peak usage is about 80,000 gallons per month.

Figure 3 shows a hydrograph of water usage at the Yosemite Institute. Since the meter isn't read every month, some of the data points represent cumulative usage for two or more months. In

general, peak usage is about 30,000 gallons per month. Water usage in July of 2004 was reported to be 91,000 gallons, but that appears to be an anomaly.

Figure 4 shows a hydrograph of the calculated water usage at the NPS facilities; the Crane Flat Campground and the ranger residence at the parking area for the Tuolumne Grove trailhead. In general, peak usage is about 400,000 gallons per month. During the off-season, NPS usage is computed to be around 100,000 gallons per month. The only usage by NPS facilities during the off-season is at the ranger residence, which should be a very minimal amount. Thus, it's likely that most of the reported off-season usage is actually water that is lost by leakage from the distribution system. NPS staff have learned from many years of experience that water usage at campgrounds in Yosemite Valley averages around 40 gallons/day/campsite. The Crane Flat Campground has 166 sites so we would expect water usage to average around 6600 gallons/day or 200,000 gallons per month. Data from the meters at the well, YI, and DNC indicate that actual water usage at the campground is nearly double what would be expected. The unaccounted water is likely being lost through leakage from the aging distribution system.

If leakage from the distribution system could be eliminated, the peak demand for the Crane Flat area would be reduced to about 310,000 gallons per month or 10,000 gallons per day (200,000 gallons for NPS, 80,000 gallons for DNC, 30,000 gallons for YI). Also, if leak reduction was effective, water could be made available for expansion of YI while still reducing the total amount of groundwater pumped in the area.

Existing Wells and Local Hydrogeology

The Crane Flat area is underlain by granitic rock. Granite is generally impermeable unless it is fractured. The open meadow areas at Crane Flat are basins that have been scoured in the bedrock and subsequently filled with alluvial sediments. Previously drilled wells in the Crane Flat area generally exhibit similar hydrogeologic conditions. Wells in the open meadows encounter a few tens of feet of alluvial sediments and then a few tens of feet of fractured granitic rock and then nearly solid granite for the remainder of the hole. Wells that are not located in the open meadows encounter a few tens of feet of fractured granite and then nearly solid granite for the remainder of the hole. In all of the wells, fractures decrease with depth and are nearly non-existent beyond a depth of about 100 feet. Occasionally the wells will encounter a deeper fracture that will yield a few gallons per minute.

Location of wells in the Crane Flat area is shown on Figure 5.

Wells No. 1 is located at the north edge of the open meadow area southwest of Tioga Road. The driller's log reports soil and overburden from 0-3 feet, soft decomposed granite from 3-8 feet, sand from 8-42 feet, medium hard decomposed granite from 42-69 feet, and the remainder of the hole through hard granite to a depth of 247 feet. The well was apparently the water supply for the area until other wells were constructed in the area. This well is sometimes called the YCC well due to its location at the YCC camp on the edge of Doghouse Meadow. The well reportedly produced about 15 gpm. There has been no testing of this well in association with monitoring water levels in the meadow to determine whether pumping from the well would dewater the wet meadow similar to the effects of pumping from Well No. 3 (the Doghouse Meadow Well).

However, given its proximity to Doghouse Meadow and the hydrogeologic description and well construction from the driller's log, it is likely that pumping water from this well would cause water table drawdown in the meadow, although the drawdown would probably be less and delayed compared with pumping from the Doghouse Meadow Well.

Well No.2 is located south of the Crane Flat meadow, along the entrance road to the campground. The driller's log reports overburden from 0-3 feet and the remainder of the well in granite to a depth of 400 feet. This was a dry hole. It was located south of the meadow and provides no information regarding water levels, geologic materials, or hydrogeologic conditions in the meadow area.

Well No. 3 is the currently used water supply well, also called the Doghouse Meadow Well. It is located in the open meadow southwest of Tioga Road, about 100 feet south of Well No. 1. The driller's log for Well No. 3 reports caving decomposed granite from 0-41 feet, firm decomposed granite from 41-51 feet, broken granite rock from 51-58 feet and the remainder of the hole in granite rock to a depth of 400 feet. This is the current water supply well for the Crane Flat area.

Well No. 4 is located in the meadow south of the Yosemite Institute and is also known as the Lone Willow Well. The driller's log reports caving decomposed granite from 0-60 feet and then granite rock to a depth of 400 feet. The well reportedly produced 4-5 gpm. The well is now within the designated wilderness boundary and not easily accessible. Pumping the well would probably cause water table drawdown in the meadow.

Wells 5 and 6 were constructed west of the Yosemite Institute along the road to the Tuolumne Grove. The wells are identical other than one having a diameter of 6-inches and the other 8-inches. The wells are 15 feet apart. One of the wells produces about 6 gpm and the other well produces about 3 gpm. Further testing of these two wells is needed to determine their interconnectivity with shallow water in the open meadows.

The geologic map of Yosemite National Park (Huber and others, 1989) shows metamorphic rocks underlying the area west and north of Crane Flat. The well at the fire lookout west of Crane Flat produces water from the metamorphic rocks. Springs discharge from the metamorphic rocks along the contact between the metamorphic and granite rocks west of Doghouse Meadow, in the vicinity of the weather station. The presence of springs and the productivity of the well at the fire lookout provide evidence of the potential for developing groundwater from the metamorphic rocks in this area. If a test well is to be constructed in this area, it should be preceded by geologic mapping of the area to insure that the well is constructed into the metamorphic rocks. An indication of potential water quality of a well in the metamorphic rocks could be obtained by sampling the well at the fire lookout and/or by sampling the springs west of the weather station on the west side of Doghouse Meadow. An approximate location for a test well is shown on Figures 5 and 6.

Alternative Water Sources

There are several alternative water sources and operational procedures that would lessen the current impact of groundwater pumping on the fen and wet meadow areas at Crane Flat. It is

likely that some combination of the following measures will be needed to meet the park's goal of protection of resources and providing for visitor enjoyment.

1. Conservation and leak detection. Installation of water conserving fixtures, implementation of water conservation practices, and elimination of leaks in the distribution system throughout the Crane Flat area would probably reduce water demand by 25% or more. Analysis of the pumping and water use data for the Crane Flat area indicates that unaccounted loss of water may exceed 100,000 gallons/month.
2. Increasing the volume of storage may eliminate the need for daily pumping of the Doghouse Meadow well. For example, the Doghouse Meadow well could be pumped continuously for one day to fill the storage tanks. No pumping would occur at the Doghouse Meadow well for the remainder of the week, allowing the water level to recover. Meanwhile, one of the low-yield wells would be pumped daily, providing an inflow of fresh water and maintaining chlorine residuals in the stored water. If daily pumping is not necessary, water levels in the meadow might recover sufficiently between pumping periods to protect the peat layer in the fen from further oxidation. Additional storage might also be needed to meet fire protection standards.
3. Further testing of the new wells along the Tuolumne Grove Road is needed to determine whether pumping will affect water levels in the wet meadow areas at Crane Flat. Preliminary testing indicates that one of the wells might provide 6 gpm for 18 hours per day, or 6500 gallons per day. Production from this well, in combination with increased storage might reduce the need for pumping from the Doghouse Meadow Well to one day per week, or less. Conservation might entirely eliminate the need for pumping from the Doghouse Meadow Well. Additional testing and monitoring at the new well might show that it can produce more than 6500 gpd, reducing the need for supplemental pumping from the Doghouse Meadow Well.
4. A new well could be constructed in the metamorphic rocks west of Doghouse Meadow. Indications are that this formation would be a source of groundwater. Testing would be needed to determine whether pumping from a well in the metamorphic rocks would affect water levels in the wet meadow areas.
5. A pipeline could be constructed from the Crane Flat fire lookout well to import water to the area. This option would present other problems, such as constructing a longer pipeline and possibly a need to provide water treatment.

There was some discussion about the Doghouse Meadow Well nearing the end of its useful life and the potential need to construct a replacement well. Subsequently, I have seen the same issue mentioned in some informal documents and meeting notes from park staff. This concept is totally incorrect. I would expect the well to remain useful and functional for another 50 years or more. It may be necessary to clean the well on occasion, but other than that there is very little that could go wrong with the well. The only casing in the well is from land surface to a depth of 52 feet. That annular space between the borehole and casing is filled with cement. Water enters the well through fractures in the bedrock in the uncased section of the well from 52-400 feet. There is no well screen or perforated casing that could corrode or become encrusted, no gravel pack, and no other structural features that would be prone to failure. Occasional (maybe every 10 years) jetting of the well may be needed and would be similar to sand-blasting the interior of the well, returning it to nearly new condition.

If there are any questions regarding this trip report, please call me at (970) 225-3515.

References

Cooper, David J., Evan C. Wolf, and Rodney Chimner, 2005, *Hydrological and ecological analysis of the effects of groundwater pumping on water levels, fen carbon budget, and vegetation, in Crane Flat, Yosemite National Park, California*, progress report, 24 pp.

Huber, N. King, Paul C. Bateman, and Clyde Wahrhaftig, 1989, *Geologic Map of Yosemite National Park and Vicinity, California*, U.S. Geological Survey Miscellaneous Investigations Map I-1874

cc:

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PWR – Mietek Kolipinski
2380 – Joel Wagner

Attachments:

Crane Flat Water Meter Readings and Water Use Calculations (gallons)

<u>FY-2001</u>	<u>Well</u>	<u>DNC</u>	<u>YI</u>	<u>NPS</u>	<u>NPS %</u>
Oct-00	182,600	43,000	21,000	118,600	0.65
Nov-00	83,400	23,000	14,000	46,400	0.56
Dec-00	98,000	18,000	13,000	67,000	0.68
Jan-01	111,900	24,000	8,000	79,900	0.71
Feb-01	55,300	39,000		16,300	0.29
Mar-01	72,300	39,000		33,300	0.46
Apr-01	197,600	37,000		160,600	0.81
May-01	135,200		95,000	40,200	0.30
Jun-01	264,200			264,200	1.00
Jul-01	418,700	106,000	49,000	263,700	0.63
Aug-01	451,000	102,000	27,000	322,000	0.71
Sep-01	327,500	75,000	14,000	238,500	0.73
Total	2,397,700	506,000	241,000	1,650,700	0.69

<u>FY-2002</u>	<u>Well</u>	<u>DNC</u>	<u>YI</u>	<u>NPS</u>	<u>NPS %</u>
Oct-01	279,700	50,000	24,000	205,700	0.74
Nov-01	105,300	32,000	12,000	61,300	0.58
Dec-01	104,700	30,000		74,700	0.71
Jan-02	123,900	35,000		88,900	0.72
Feb-02	148,000	31,000		117,000	0.79
Mar-02	118,300	30,000		88,300	0.75
Apr-02	180,500		91,000	89,500	0.50
May-02	198,800		37,000	161,800	0.81
Jun-02	279,800		7,000	272,800	0.97
Jul-02	486,800	63,000	29,000	394,800	0.81
Aug-02	396,700	87,000	28,000	281,700	0.71
Sep-02	336,500	78,000	13,000	245,500	0.73
Total	2,759,000	436,000	241,000	2,082,000	0.75

<u>FY-2003</u>	<u>Well</u>	<u>DNC</u>	<u>YI</u>	<u>NPS</u>	<u>NPS %</u>
Oct-02	305,200	43,000	28,000	234,200	0.77
Nov-02	163,600		24,000	139,600	0.85
Dec-02	136,900	52,000	7,000	77,900	0.57
Jan-03	172,900	25,000	7,000	140,900	0.81
Feb-03	133,800	27,000		106,800	0.80
Mar-03	171,600	9,000	46,000	116,600	0.68
Apr-03	157,500	6,000	20,000	131,500	0.83
May-03	179,500		22,000	157,500	0.88
Jun-03	368,800		29,000	339,800	0.92
Jul-03	518,400	68,000	12,000	438,400	0.85
Aug-03	515,300	81,000	17,500	416,800	0.81
Sep-03	391,600	81,000	27,000	283,600	0.72
Total	3,215,100	392,000	239,500	2,583,600	0.80

Crane Flat Water Meter Readings and Water Use Calculations (gallons)

<u>FY-2004</u>	<u>Well</u>	<u>DNC</u>	<u>YI</u>	<u>NPS</u>	<u>NPS %</u>
Oct-03	324,100	44,000	9,500	270,600	0.83
Nov-03	165,000		17,500	147,500	0.89
Dec-03	59,434			59,434	1.00
Jan-04	81,032			81,032	1.00
Feb-04	117,893			117,893	1.00
Mar-04	90,512			90,512	1.00
Apr-04	76,677	104,000	115,000		
May-04	89,367	15,000	22,000	52,367	0.59
Jun-04	315,166	75,000	17,100	223,066	0.71
Jul-04	573,200		91,300	481,900	0.84
Aug-04	353,161		27,100	326,061	0.92
Sep-04	243,856				
Total	2,489,398	238,000	299,500	1,850,365	0.74

<u>FY-2005</u>	<u>Well</u>	<u>DNC</u>	<u>YI</u>	<u>NPS</u>	<u>NPS %</u>
Oct-04	194,350	42,000		152,350	0.78
Nov-04	144,741	42,100	45,100	57,541	0.40
Dec-04	89,760	9,800	13,200	66,760	0.74
Jan-05	132,857	6,200	18,600	108,057	0.81
Feb-05	101,470	6,000	20,500	74,970	0.74
Mar-05	136,588	5,500	25,000	106,088	0.78
Apr-05	149,561	7,500	31,000	111,061	0.74
May-05	154,767	9,000	18,200	127,567	0.82
Jun-05	248,074	29,000	15,800	203,274	0.82
Jul-05	464,771	56,000	31,000	377,771	0.81
Aug-05	403,430	83,000	31,500	288,930	0.72
Sep-05	360,743	58,000	14,000	288,743	0.80
Total	2,581,112	354,100	263,900	1,963,112	0.76

Well is the meter reading at the wellhead and represents the total volume pumped.

DNC is the meter reading at the concessioner's facility (Delaware North Corp.) measuring use at the gas station/convenience store.

YI is the meter reading for use at the Yosemite Institute.

Use at NPS facilities is calculated by subtracting use at YI and DNC from the total amount pumped.

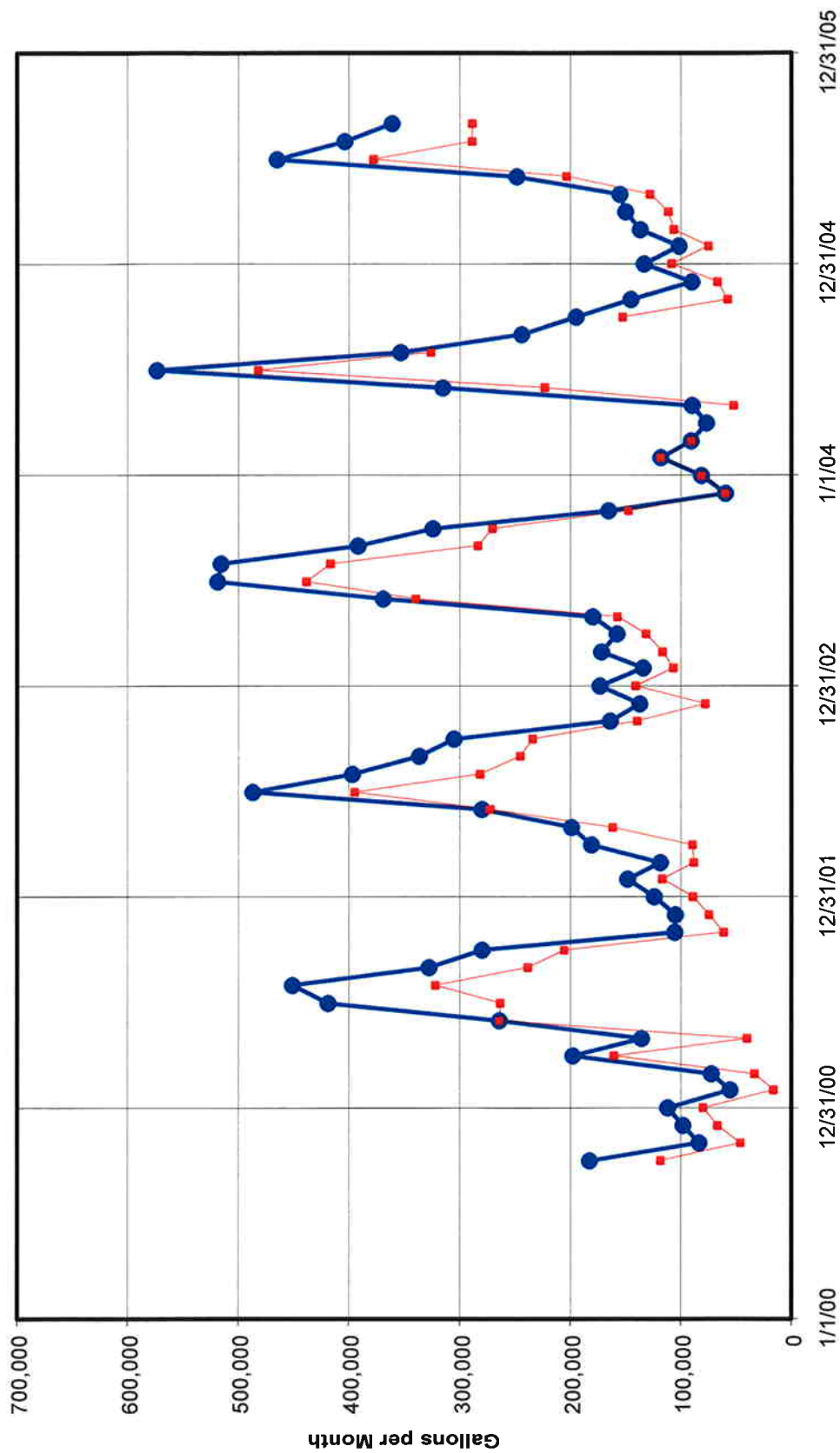


Figure 1. Total Water Pumped From Doghouse Meadow Well (large blue dots), Compared with Calculated NPS Use (small red squares)

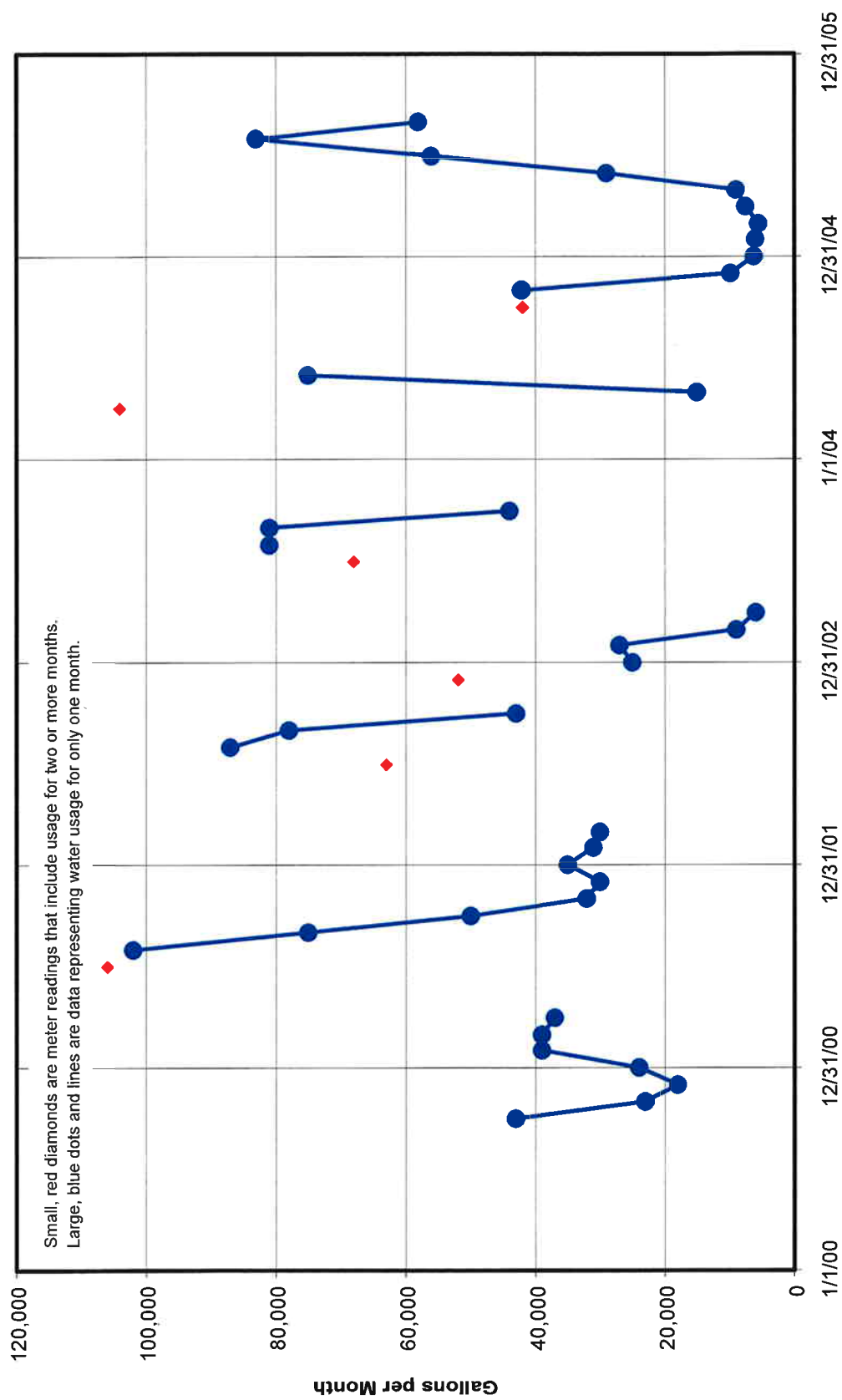


Figure 2. Water Usage by DNC at the Gas Station and Convenience Store

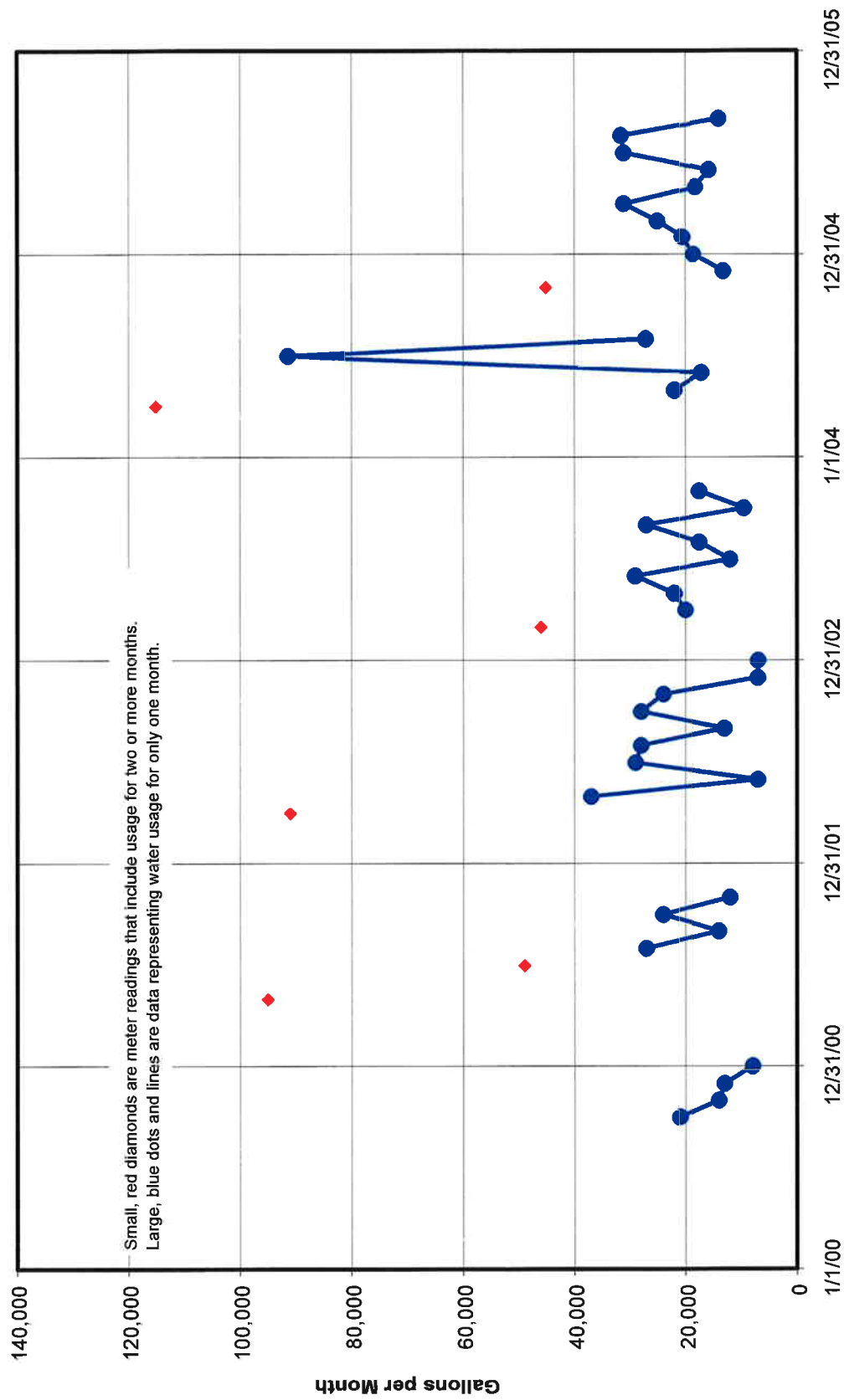


Figure 3. Water Usage at Yosemite Institute

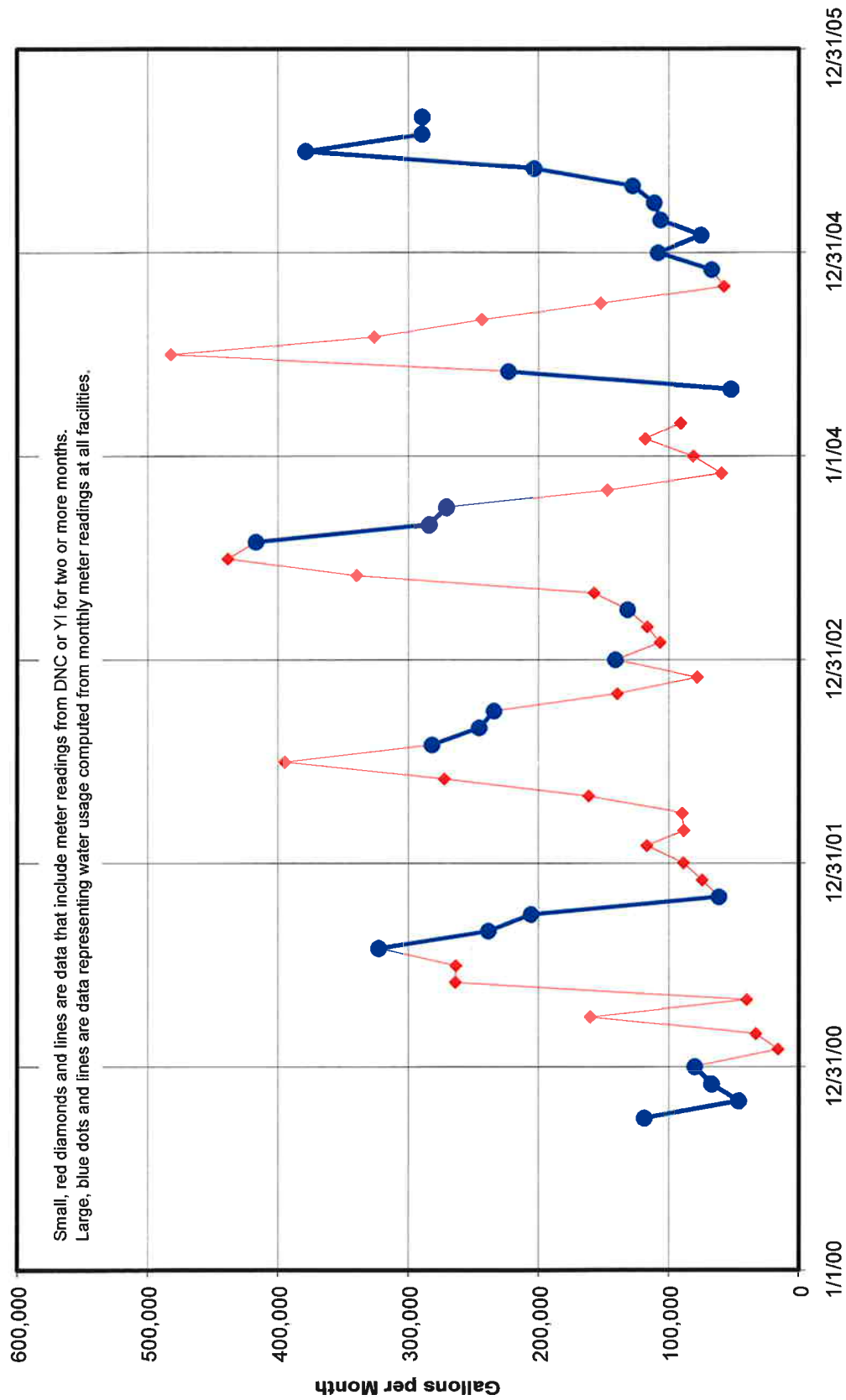


Figure 4. Calculated Usage at NPS Facilities

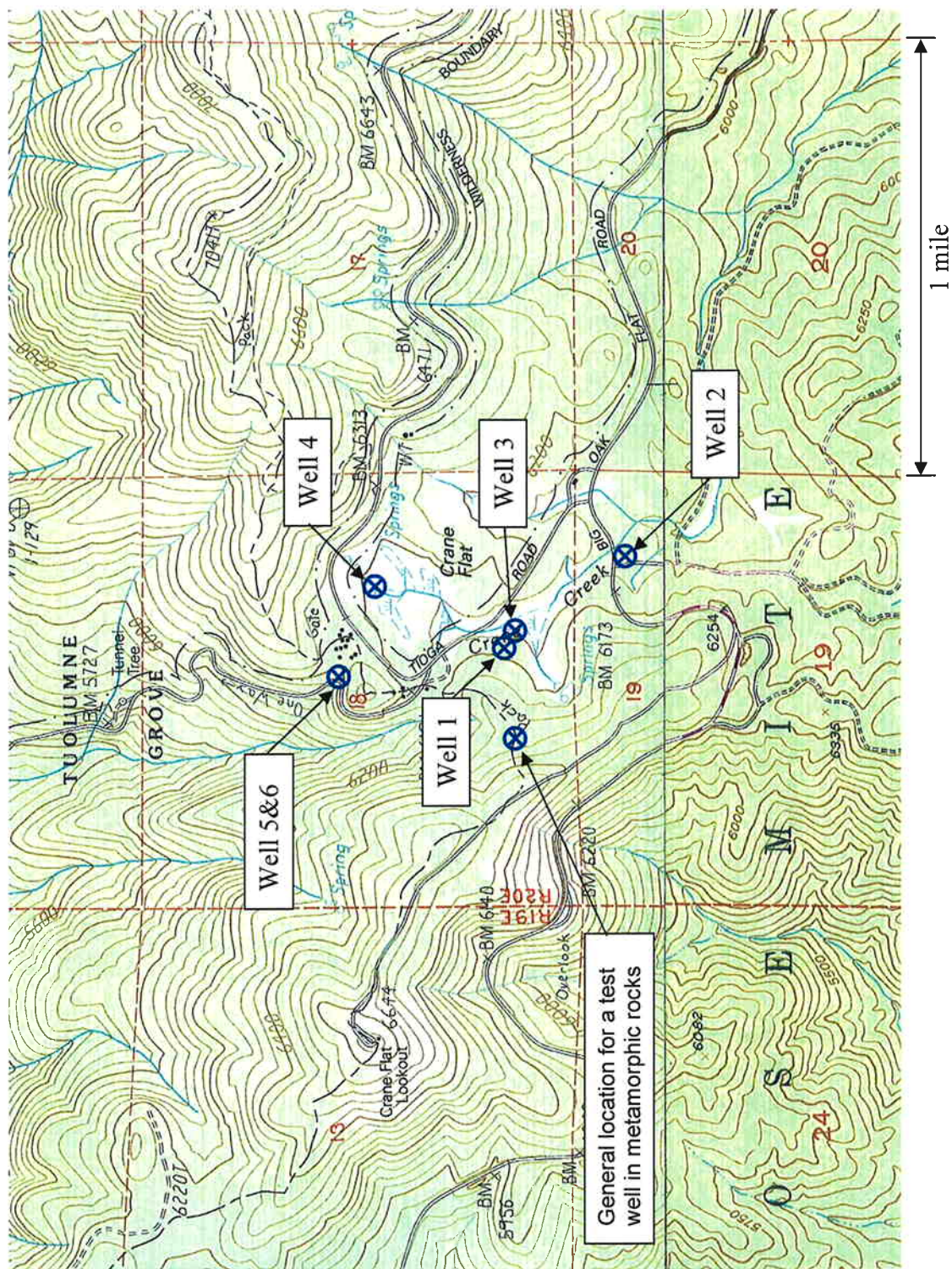


Figure 5. Location of wells in the Crane Flat area

