Appendix B2

Hydrogeology Cumulative Impacts Memorandum

Water Resources Assoicates, Inc.
Consulting Hydrogeology

Memorandum

To: **Luke Evans - ESA**

From: Devon F. Ayres, P.G. / Christopher Johnson, P.G. – Water Resources Associates, Inc.

Date: September 17, 2020

Re: Under Canvas – Yosemite DEIR: Cumulative Impact on Groundwater

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Cumulative Pumping Impact

From the standpoint of cumulative impact, having the two (2) Tv wells pumping simultaneously, along with one of the two UC wells, placed a purposeful above-normal strain on the overall fracture system as the testing was conducted at discharge rates (at both project locations) that exceeded the estimated maximum discharge rate.

Specifically, one of the UC wells was pumped at approximately forty (40) gallons per minute (GPM), whereas each Tv well pumped at about twenty-six (26) GPM. The UC well pumped about %35 more water than either of the two Tv wells, and about %77 of both Tv wells combined, for the eight day period that all three wells pumped simultaneously, from 10/25 to 11/2/2019 (about eight (8) days.

Based on current daily water demand projections, Terra Vi will require 16, 636 gallons per day, and Under Canvas 10,000 gallons of water per day, for a cumulative demand of 26, 636 gallons. The final allowed pumping rates for each site will be determined by the State Water Resources Control Board (SWRCB) when Water System Permits are issued for each site. Both sites conducted ten-day long pumping tests, which qualifies each site for consideration of a 50% allotment by the SWRCB of the demonstrated pumping rates.

Under Canvas operations anticipates a maximum daily demand of 7,775 gallons per day, but to be conservative, calculations rounded up to 10,000 gallons. At 20 gallons per minute (50% of the 40 GPM discharged during the pumping tests) the Under Canvas well will need to pump for 500 minutes, or roughly 8 hours and 20 minutes per day. Onsite storage can reduce the number of days the well has to pump to meet daily demands, allowing additional time at the lower pumping rate for the fractured bedrock aquifer to recharge.

Terra Vi operations anticipates a maximum daily demand of 16, 636 gallons. At 26.5 GPM gallons per minute (50% of the 53 GPM discharged during the pumping tests) the Terra Vi well will need to pump for slightly less than 630 minutes, or roughly 10 and a half hours per day. Onsite storage can reduce the number of days the well has to pump to meet daily demands, allowing additional time at the lower pumping rate for the fractured bedrock aquifer to recharge.

Recovery data collected from UC Wells No. 1 and 2 indicates good fracture storage capacity, with 90% recovery within 500 minutes, and 95% within about 2.5 days in Well 2 (recommended primary well for UC project), and about 5 days and 7days respectively, for Well 1. There is no readily apparent influence on the recovery rate for Well 1 (pumped simultaneously with the Tv wells). Recovery in the Tv wells was nearly equivalent for both wells, at 90% around 500 minutes and 95% at 700 minutes. UC wells were individually pumped at about %35 higher discharge rate than the individual Tv wells were (e.g. 40 GPM versus about 26 GPM, respectively).

Had either individual or joint pumping operations severely dewatered the fracture system, then it seems unlikely that recovery of the measured water levels in the fracture system would have been as rapid as it was, on either site.

Geosciences comment: there was a 9 day overlap of the Terra Vi and YUC pumping tests.

Cumulative Demand Impact

During the joint pumping period, the three wells discharged at a cumulative rate of about 93 gallons per minute for ten days, or about 133, 920 gallons each day, and about 1,071,360 gallons over eight day period, or 3.3-acre feet of water.

Under Canvas will be open from roughly April through September each year. If we conservatively assume six (6) months of maximum daily demand (180 days at 10,000 gallons per day), or 1,800,000 of gallons annual demand, then in that eight-day period, UC pumped 60% of their annual anticipated demand.

Our understanding is that Terra Vi will be open year-round. If we conservatively assume nine (9) months of maximum daily demand (270 days at 16, 636 gallons per day) , or roughly 4, 500,000 gallons annual demand, then in that eight-day period, Terra Vi pumped roughly 13.9% of the annual anticipated demand.

Of the daily demand (volume of water pumped from the fractured bedrock aquifer) Under Canvas' demand will be about 35.7%, with the remainder of the demand originating from

Terra Vi daily operations. Under Canvas demands will occur over a shorter duration, being a seasonal operation without significant infrastructure demands (e.g. limited kitchen facilities, low-flow showers, and toilets).

These large demands, and the relatively swift recovery, suggest that cumulatively the two sites will place a less than significant demand on the overall water-bearing fracture system.

Geosciences comment: fractured bedrock aquifer system produced approximately 93 gallons per minute (GPM) flow (or 133,920 gallons per day (GPD).

Geosciences comment: Combined calculated demand is 28,000 gpd [NTD: will be revised with final TV numbers] or 19.5 gpm – Test was 4.7 times demand.

Pumping test water level recovery

An indication of resiliency, or sustainability, for an aquifer system is the rate at which static water levels recover in wells following a sustained pumping test. Current California State Water Resources Control Board (SWRCB) guidelines state:

- Water level recovery must be to within 95% of the original static water level, within a period of ten (10) days. The SWRCB criteria can be found in Attachment C "Procedure To Determine Source Capacity" from the State Water Resources Control Board's Requirements for New Wells
(July 2016 version).

The static water levels in Terra Vi Wells 1 and 2, and Under Canvas Well 2 all recovered rapidly, between 95 to 99 percent within three days of the allowable ten-day period. Under Canvas Well 1 took about 5 and a half days to recover to within 95% of the original static water level.

Geoscience comment: Static water levels stabilized and showed recovery according to state guideline during the test

Pumping Rates

Terra Vi water demand is higher and more consistent than UC, and as such pumping both of their wells simultaneously is understandable, along with the immediate proximity of private wells. UC wells were pumped individually, as the overall demand is lower and to provide an

additional monitoring well during the tests. It should be noted however, that the Under Canvas wells, although pumped individually, were pumped at twice the anticipated demand, to deliberately "increase the impact on the groundwater system" for testing purposes.

Geosciences comment: Terra Vi wells were pumped simultaneously to increase impact on groundwater system

Offsite well impact from Terra Vi pumping

There is no evidence that the Under Canvas wells interfered with the water levels or operations of the private, offsite well near the Terra Vi site, and as such did not contribute to any potential impact to those wells.

Geosciences comment: Neighboring wells showed interference that is acceptable considering available drawdown, standard operation of fractured rock wells, and testing procedure.

Wet Year versus Dry Year

Under Canvas concurs with the assessment of wet versus dry year offered by Terra Vi. With respect to water levels, no water levels were measured by Under Canvas during 2020.

Geoscience comment: WY 2019 was wetter than average – 48.3 in vs 38.06 in average

Geoscience comment: July – September 2019 was much drier than average – 0.27 in vs 0.67 in average (testing took place following a dry period in an otherwise wet year)

Geosciences comment: Y 2020 is well below average – 23.56 in. through July (9th driest since 2019)

Wet Year versus Dry Year Water Levels

Initial indications are that during an apparently dry year, static water levels in the fracture system appear to be relatively unchanged. As such, cumulative impacts between wet and dry years, and during successive dry years may be less than significant.

Geosciences comment: Water levels measured in Sep 2020 are between 3.4 and 2.8 ft below water levels measure in Oct 2019.

Geosciences comment: here is not a significant change in water levels between a wet year and a very dry year.

Wet Year versus Dry Year Groundwater Availability

Water level recovery rates in the fracture system suggest that there is significant storage present in the overall fracture system underlying both sites, and that the water levels recover quickly, even after significant demand is placed upon the system.

The initial indications are that groundwater levels are not overly sensitive to wet versus dry years, and as such it is possible that groundwater availability will be adequate to meet anticipated demands. While the cumulative demand is asymmetrical, both sites will contribute to the overall demand from the identified fracture system.

> Geosciences comment: Groundwater system has demonstrated the ability to produce significantly greater volume than calculated demand. Wet and dry year groundwater measurements show relative lack of sensitivity to year to year changes in precipitation