B4

Squaw Creek Restoration Irrigation Demands

MACKAY & SOMPS
ENGINEERS PLANNERS SURVEYORS

TECHNICAL MEMORANDUM

Date: September 24, 2015

To: Chevis Hosea, Squaw Valley USA

From: Ken Giberson

Subject: Squaw Creek Restoration Irrigation Demands

REGISTERED PROFESSIONAL ENGINEER
KENNETH C. GIBERSON
No. 25573
CIVIL
STATE OF CALIFORNIA

INTRODUCTION

The Village at Squaw Valley Specific Plan (Plan) is a proposed 93.7 acre master planned development located at the Squaw Valley ski resort in Olympic Valley, California. The Specific Plan envisions the evolution of a sustainable mountain resort that provides a diversity of residential, visitor accommodations, retail, health and well-being and recreational opportunities while preserving the unique aesthetic, cultural and environmental assets of the valley.

The Draft Environmental Impact Report (DEIR) evaluated impacts the proposed development might have, among other resources on the riparian flora along Squaw Creek and Olympic Channel due to the lower ground water table that will result from the development of the Plan. Mitigation Measure 6-1c of the Draft EIR calls for monitoring of riparian and meadow vegetation along the upper eastern channel of Squaw Creek every year from the period before construction of the Plan is initiated until 5 years after Plan buildout. If monitoring indicates that meadow habitat is lost as the result of groundwater level declines, there are several options available, including irrigation of riparian vegetation to maintain existing habitat. This memorandum addresses the question of whether there is sufficient enough water from the potable water supply to irrigate the riparian flora and resort landscaping for the 4 month period that is typically the driest period of the year.

This technical memorandum will address the following:

1. Irrigation water demands for the riparian flora planted for the Squaw Creek Restoration area based on the flora that would be planted.
2. Irrigation water demands for the portion of the eastern meadow (outside of the plan area) where the groundwater model indicates groundwater levels would be most affected (Eastern Cells A-C). The water demand for this area is also based on the type of plants that would be used for the creek restoration.
3. Irrigation water demands for the resort landscaping based on the latest project illustrative and planned plant palette.
4. Comparison of the total water demand allocated to irrigation in the Water Supply Assessment (WSA) dated July 22, 2015.

5. If required, identify and analyze a supplemental source of water to supply any shortfall in meeting the irrigation demands.

PREVIOUS WATER SUPPLY ANALYSIS

The previous analysis of the entire project's water demand was completed in the Water Supply Assessment Update (WSA) dated July 22, 2015. Within it, the irrigation demands for the proposed resort landscaping were calculated using the *Guide to Estimating Irrigation Water Needs of Landscape Plants in California* by the California Department of Water Resources following the Landscape Coefficient Method. In the WSA, the water demand calculated for the resort landscape irrigation during a dry year was calculated to be 12.7 acre feet per annum (AFA) and 7.3 AF during the critical dry period from July through October.

The analysis at that time did not include the proposed and existing Squaw Creek flora as an irrigation demand. It did, however, include a conservative allowance for the irrigation demands in and around the resort itself. This technical memorandum will test the assumption this allowance is adequate for both irrigation in and around the resort, and for the irrigation of the subject riparian habitat along Squaw Creek and Olympic Channel during a drought event.

SQUAW CREEK GROUNDWATER IMPACTS

As discussed above, the Draft EIR includes mitigation requiring that meadow vegetation be monitored. If lowered groundwater elevations due to increased groundwater pumping result in the loss of this vegetation, then measures must be taken to compensate for it. One option is to irrigate meadow vegetation. Concerns were raised in comments on the Draft EIR that this approach would further deplete groundwater levels.

Exhibit A – Groundwater Decline Under Squaw Creek delineates the lengths of Squaw Creek and Olympic Channel that could be affected by the lowered groundwater during a drought assuming full buildout conditions. Currently, the ground water table under the western lengths of Squaw Creek (West Cells B-F) is already significantly below the root zone of the riparian flora along the creek[1]. Lowering the groundwater elevation further from build-out of the Plan would not have a material impact on the existing flora. Therefore, only the Squaw Creek restoration project will require irrigation from West Cells B and D through East Cell A.

Groundwater levels in the meadow are projected to be most affected from East Cell A to East Cell C, so it is anticipated that if lowered groundwater levels do affect meadow vegetation, it would be in the area of these three cells. Therefore, this analysis assumes that irrigation would be required in the vicinity of East Cells A,B and C.

[1] Personal Conversation with Adrienne Graham (Date September 14, 2015)

IRRIGATION DEMAND ANALYSIS

This technical memorandum will analyze the water demands for the three locations:

- Proposed Resort Landscaping
- Proposed Squaw Creek Restoration
- Existing Squaw Creek East Cells A-C

Within the Creek Restoration and existing Squaw Creek areas, three (3) distinct habitats with differing flora and irrigation demands have been identified:

- Lower Bank
- Upper Bank
- Olympic Channel Meadow

Therefore, the analysis included in this Technical Memorandum will include a total of six irrigation demands during a dry year using the areas as described below:

1. Proposed Resort Landscaping
2. Squaw Creek Restoration - Olympic Channel
3. Squaw Creek Restoration - Lower Bank
4. Squaw Creek Restoration – Upper Bank
5. Existing Squaw Creek – Lower Bank
6. Existing Squaw Creek – Upper Bank

The *Guide to Estimating Irrigation Water Needs of Landscape Plants in California* by the California Department of Water Resources following the Landscape Coefficient Method will be used to determine the irrigation demands for these six zones. See **Exhibit B – Irrigation Areas & Demands** for the areas analyzed in this study.

Per the Tahoe Resource Conservation District, the recommended irrigation schedule for the resort landscaping will be from April to October. To be conservative, it has been assumed that irrigation of the flora would be required during July through October, which are typically the driest months in Squaw Valley.

Existing and proposed Squaw Creek flora throughout the remaining year will be irrigated naturally. From fall to winter, rainwater and snow melt will maintain creek and water table elevations sufficiently in the root zone. As the snow pack and runoff diminishes in the late spring

and early summer, the groundwater begins to fall. Typically, the driest periods are from July through October.[2]

The irrigation demand for each of the above described zones are estimated as follows:

1. Proposed Resort Landscaping – A plant palette for the resort has been developed to provide better drought resilience while maintaining the aesthetic qualities of the landscaping in and around a world class resort. Native and drought tolerant flora are anticipated to be used for resort landscaped.

   The proposed resort landscaping covers 5.1 acres. This area requires a total of 4.0 AFA of irrigation during a dry water year and a total of 2.3 AFA during the critical 4 month period. See **Table 1 – Proposed Resort Landscaping** below for detailed water demand calculations.

2. Squaw Creek Restoration - Olympic Channel– The plants used to calculate irrigation demand for the Olympic Channel were chosen for their ability to survive both dry and wet conditions depending on the season.

   The Olympic Channel area includes pools which will not have flora planted. The landscape density coefficient was adjusted to compensate for the non-planted areas in the pools as a result. The Olympic Channel covers a 3.5 acre area and requires a total of 2.7 AFA of irrigation only during the critical 4 month period. **See Table 2 – Squaw Creek Restoration – Olympic Channel** below for detailed water demand calculations.

[2] Personal Conversation with Adrienne Graham (Date September 24, 2015)

Table 1 - Proposed Resort Landscaping

Assumptions:

a. Area of landscaping for planning purposes (per Illustrative Land Plan September, 2015) = 5.10 Acres
b. Tahoe Resource Conservation District recommends irrigation only during months of April - October.
c. Drip Irrigation with Irrigation Efficiency (IE) of 80% assumed.
d. Use "Landscape Coefficient Method" used for estimating landscape irrigation demand (ET_L) - UC Coop Extension (August 2000)
e. Species, density and microclimate coefficients verified by Terrain Integration (personal communications, September 10, 2015)

$ET_L = K_L \times ET_O$

ET_O = Evapotranspiration Rate per CIMIS Data Base for Zone 13 (CIMIS 1999)

K_L = Landscape Coefficient = $Ks \times K_D \times K_M$

Ks = Species Landscape Coefficient =	0.25
K_D = Density Landscape Coefficient =	1.0
K_M = Microclimate Landscape Coefficient =	0.7
K_L = Landscape Coefficient = $Ks \times K_D \times K_M$ =	0.175

e. Theoretical Demand = $ET_L \div 12$ inches/foot

Monthly Irrigation Demand (Inches/Month)				Irrigation Rate (Feet/Month)					
Month	**ET_O**	**K_L**	**ET_L**	**Theoretical Demand**	**Irrigation Efficiency**	**Irrigation Demand**	**Irrigation Area (Acres)**	**Irrigation Demand / Month (AF/Mo) - Including 5% Conservation**	**Critical 4 Month Period Irrigation (AF)**
January	1.24	0.175	0.22	0.02	80%	n/a	5.10	0.0	
February	1.90	0.175	0.33	0.03	80%	n/a	5.10	0.0	
March	3.10	0.175	0.54	0.05	80%	n/a	5.10	0.0	
April	4.80	0.175	0.84	0.07	80%	0.09	5.10	0.4	
May	6.51	0.175	1.14	0.09	80%	0.12	5.10	0.6	
June	7.80	0.175	1.37	0.11	80%	0.14	5.10	0.7	
July	8.99	0.175	1.57	0.13	80%	0.16	5.10	0.8	
August	7.75	0.175	1.36	0.11	80%	0.14	5.10	0.7	**2.3**
September	5.70	0.175	1.00	0.08	80%	0.10	5.10	0.5	
October	3.72	0.175	0.65	0.05	80%	0.07	5.10	0.3	
November	1.80	0.175	0.32	0.03	80%	n/a	5.10	0.0	
December	0.93	0.175	0.16	0.01	80%	n/a	5.10	0.0	
Totals	**54.24**		**9.49**	**0.79**		**0.83**		**4.0**	**2.3**

Table 2 - Squaw Creek Restoration - Olympic Channel

Assumptions:

a. Area of Restored Squaw Creek - Upper Bank (per Squaw Creek Restoration Project) = 3.50 Acres
b. Irrigation only required during critical dry 4 month period (July-Oct). Assumed natural irrigation for remaining year.
c. Drip Irrigation with Irrigation Efficiency (IE) of 80% assumed.
d. Use "Landscape Coefficient Method" used for estimating landscape irrigation demand (ET_L) - UC Coop Extension (August 2000)
e. Species, density and microclimate coefficients verified by Terrain Integration (personal communications, September 10, 2015)

$ET_L = K_L \times ET_O$

ET_O = Evapotranspiration Rate per CIMIS Data Base for Zone 13 (CIMIS 1999)

K_L = Landscape Coefficient = $Ks \times K_D \times K_M$

Ks = Species Landscape Coefficient = 0.4

K_D = Density Landscape Coefficient = 0.75

K_M = Microclimate Landscape Coefficient = 1.0

K_L = Landscape Coefficient = $Ks \times K_D \times K_M$ = 0.3

f. Theoretical Demand = $ET_L \div 12$ inches/foot

	Monthly Irrigation Demand (Inches/Month)			Irrigation Rate (Feet/Month)					
Month	**ET_O**	**K_L**	**ET_L**	**Theoretical Demand**	**Irrigation Efficiency**	**Irrigation Demand**	**Irrigation Area (Acres)**	**Irrigation Demand / Month (AF/Mo) - Including 5% Conservation**	**Critical 4 Month Period Irrigation (AF)**
January	1.24	0.30	0.37	0.03	80%	n/a	0.00	0.0	
February	1.90	0.30	0.57	0.05	80%	n/a	0.00	0.0	
March	3.10	0.30	0.93	0.08	80%	n/a	0.00	0.0	
April	4.80	0.30	1.44	0.12	80%	n/a	0.00	0.0	
May	6.51	0.30	1.95	0.16	80%	n/a	0.00	0.0	
June	7.80	0.30	2.34	0.20	80%	n/a	0.00	0.0	
July	8.99	0.30	2.70	0.22	80%	0.28	3.50	0.9	
August	7.75	0.30	2.33	0.19	80%	0.24	3.50	0.8	**2.7**
September	5.70	0.30	1.71	0.14	80%	0.18	3.50	0.6	
October	3.72	0.30	1.12	0.09	80%	0.12	3.50	0.4	
November	1.80	0.30	0.54	0.05	80%	n/a	0.00	0.0	
December	0.93	0.30	0.28	0.02	80%	n/a	0.00	0.0	
Totals	**54.24**		**16.27**	**1.36**		**0.82**		**2.7**	**2.7**

3. Squaw Creek Restoration - Lower Bank – The plants used to calculate irrigation demand for the bottom of the Squaw Creek channel were chosen for their ability to survive both dry and wet conditions depending on the season.

   The lower bank area includes the creek bottom which will not have flora. The landscape density coefficient was adjusted to compensate for the non-planted areas at the bottom of the creek. The lower bank covers a 2.8 acre area and requires a total of 1.4 AFA of irrigation during the critical 4 month period. **See Table 3 – Squaw Creek Restoration – Lower Bank** below for the water demand calculations.

4. Squaw Creek Restoration – Upper Bank – The plants used to calculate irrigation demand for the upper banks and slopes of the Squaw Creek restoration were chosen for their low water use characteristics due to their distant from the surface water of Squaw Creek.

   The upper bank covers a 3.1 acre area and requires a total of 1.6 AFA of irrigation during the critical 4 month period. See **Table 4 – Squaw Creek Restoration Upper Bank** below.

5. Existing Squaw Creek –Lower Bank – Similar to the proposed squaw creek restoration, the plants used to calculate irrigation demand the lower banks and near the bottom of the Squaw Creek channel from East Cell A to East Cell C require more irrigation[3]. The existing Squaw Creek lower bank covers a 0.8 acre area and requires a total 0.4 AFA of irrigation during the critical 4 month period. **See Table 5 – Existing Squaw Creek – Lower Bank** below for the water demand calculations.

[3] Personal Conversation with Stephanie Shermoen with Terrain Integration (Date September 16, 2015); the existing Squaw Creek flora in the lower bank would be similar to the flora on the proposed Squaw Creek restoration, lower banks. Therefore, landscape coefficients used to calculate irrigations demands in Squaw Creek Restoration- Lower Bank will be the same as Existing Squaw Creek – Lower Bank.

Table 3 - Squaw Creek Restoration - Lower Bank

Assumptions:

a. Area of Restored Squaw Creek - Lower Bank (per Squaw Creek Restoration Project) = 2.80 Acres
b. Irrigation only required during critical dry 4 month period (July-Oct). Assumed natural irrigation for remaining year.
c. Drip Irrigation with Irrigation Efficiency (IE) of 80% assumed.
d. Use "Landscape Coefficient Method" used for estimating landscape irrigation demand (ET_L) - UC Coop Extension (August 2000)
e. Species, density and microclimate coefficients verified by Terrain Integration (personal communications, September 10, 2015)

$ET_L = K_L \times ET_O$

ET_O = Evapotranspiration Rate per CIMIS Data Base for Zone 13 (CIMIS 1999)

K_L = Landscape Coefficient = $Ks \times K_D \times K_M$

Ks = Species Landscape Coefficient = 0.4

K_D = Density Landscape Coefficient = 0.5

K_M = Microclimate Landscape Coefficient = 1.0

K_L = Landscape Coefficient = $Ks \times K_D \times K_M$ = 0.2

f. Theoretical Demand = $ET_L \div 12$ inches/foot

	Monthly Irrigation Demand (Inches/Month)			Irrigation Rate (Feet/Month)					
Month	**ET_O**	**K_L**	**ET_L**	**Theoretical Demand**	**Irrigation Efficiency**	**Irrigation Demand**	**Irrigation Area (Acres)**	**Irrigation Demand / Month (AF/Mo) - Including 5% Conservation**	**Critical 4 Month Period Irrigation (AF)**
January	1.24	0.20	0.25	0.02	80%	n/a	0.00	0.0	
February	1.90	0.20	0.38	0.03	80%	n/a	0.00	0.0	
March	3.10	0.20	0.62	0.05	80%	n/a	0.00	0.0	
April	4.80	0.20	0.96	0.08	80%	n/a	0.00	0.0	
May	6.51	0.20	1.30	0.11	80%	n/a	0.00	0.0	
June	7.80	0.20	1.56	0.13	80%	n/a	0.00	0.0	
July	8.99	0.20	1.80	0.15	80%	0.19	2.80	0.5	
August	7.75	0.20	1.55	0.13	80%	0.16	2.80	0.4	**1.4**
September	5.70	0.20	1.14	0.10	80%	0.12	2.80	0.3	
October	3.72	0.20	0.74	0.06	80%	0.08	2.80	0.2	
November	1.80	0.20	0.36	0.03	80%	n/a	0.00	0.0	
December	0.93	0.20	0.19	0.02	80%	n/a	0.00	0.0	
Totals	**54.24**		**10.85**	**0.90**		**0.55**		**1.4**	**1.4**

Table 4 - Squaw Creek Restoration - Upper Bank

Assumptions:

a. Area of Restored Squaw Creek - Upper Bank (per Squaw Creek Restoration Project) = 3.10 Acres
b. Irrigation only required during critical dry 4 month period (July-Oct). Assumed natural irrigation for remaining year.
c. Drip Irrigation with Irrigation Efficiency (IE) of 80% assumed.
d. Use "Landscape Coefficient Method" used for estimating landscape irrigation demand (ET_L) - UC Coop Extension (August 2000)
e. Species, density and microclimate coefficients verified by Terrain Integration (personal communications, September 10, 2015)

$ET_L = K_L \times ET_O$

ET_O = Evapotranspiration Rate per CIMIS Data Base for Zone 13 (CIMIS 1999)

K_L = Landscape Coefficient = $Ks \times K_D \times K_M$

Ks = Species Landscape Coefficient = 0.2

K_D = Density Landscape Coefficient = 1.0

K_M = Microclimate Landscape Coefficient = 1.0

K_L = Landscape Coefficient = $Ks \times K_D \times K_M$ = 0.2

f. Theoretical Demand = $ET_L \div 12$ inches/foot

	Monthly Irrigation Demand (Inches/Month)			Irrigation Rate (Feet/Month)					
Month	**ET_O**	**K_L**	**ET_L**	**Theoretical Demand**	**Irrigation Efficiency**	**Irrigation Demand**	**Irrigation Area (Acres)**	**Irrigation Demand / Month (AF/Mo) - Including 5% Conservation**	**Critical 4 Month Period Irrigation (AF)**
January	1.24	0.20	0.25	0.02	80%	n/a	0.00	0.0	
February	1.90	0.20	0.38	0.03	80%	n/a	0.00	0.0	
March	3.10	0.20	0.62	0.05	80%	n/a	0.00	0.0	
April	4.80	0.20	0.96	0.08	80%	n/a	0.00	0.0	
May	6.51	0.20	1.30	0.11	80%	n/a	0.00	0.0	
June	7.80	0.20	1.56	0.13	80%	n/a	0.00	0.0	
July	8.99	0.20	1.80	0.15	80%	0.19	3.10	0.6	
August	7.75	0.20	1.55	0.13	80%	0.16	3.10	0.5	**1.6**
September	5.70	0.20	1.14	0.10	80%	0.12	3.10	0.3	
October	3.72	0.20	0.74	0.06	80%	0.08	3.10	0.2	
November	1.80	0.20	0.36	0.03	80%	n/a	0.00	0.0	
December	0.93	0.20	0.19	0.02	80%	n/a	0.00	0.0	
Totals	**54.24**		**10.85**	**0.90**		**0.55**		**1.6**	**1.6**

Table 5 - Existing Squaw Creek - Lower Bank

Assumptions:

a. Area of Existing Squaw Creek - East Cells A-C - Lower Bank (per **Exhibit B**) 0.80 Acres
b. Irrigation only required during critical dry 4 month period (July-Oct). Assumed natural irrigation for remaining year.
c. Drip Irrigation with Irrigation Efficiency (IE) of 80% assumed.
d. Use "Landscape Coefficient Method" used for estimating landscape irrigation demand (ET_L) - UC Coop Extension (August 2000)
e. Species, density and microclimate coefficients verified by Terrain Integration (personal communications, September 10, 2015)

$ET_L = K_L \times ET_O$

ET_O = Evapotranspiration Rate per CIMIS Data Base for Zone 13 (CIMIS 1999)

K_L = Landscape Coefficient = $Ks \times K_D \times K_M$

Ks = Species Landscape Coefficient = 0.4

K_D = Density Landscape Coefficient = 0.5

K_M = Microclimate Landscape Coefficient = 1.0

K_L = Landscape Coefficient = $Ks \times K_D \times K_M$ = 0.2

f. Theoretical Demand = $ET_L \div 12$ inches/foot

	Monthly Irrigation Demand (Inches/Month)			Irrigation Rate (Feet/Month)					
Month	**ET_O**	**K_L**	**ET_L**	**Theoretical Demand**	**Irrigation Efficiency**	**Irrigation Demand**	**Irrigation Area (Acres)**	**Irrigation Demand / Month (AF/Mo) - Including 5% Conservation**	**Critical 4 Month Period Irrigation (AF)**
January	1.24	0.20	0.25	0.02	80%	n/a	0.00	0.0	
February	1.90	0.20	0.38	0.03	80%	n/a	0.00	0.0	
March	3.10	0.20	0.62	0.05	80%	n/a	0.00	0.0	
April	4.80	0.20	0.96	0.08	80%	n/a	0.00	0.0	
May	6.51	0.20	1.30	0.11	80%	n/a	0.00	0.0	
June	7.80	0.20	1.56	0.13	80%	n/a	0.00	0.0	
July	8.99	0.20	1.80	0.15	80%	0.19	0.80	0.1	
August	7.75	0.20	1.55	0.13	80%	0.16	0.80	0.1	**0.4**
September	5.70	0.20	1.14	0.10	80%	0.12	0.80	0.1	
October	3.72	0.20	0.74	0.06	80%	0.08	0.80	0.1	
November	1.80	0.20	0.36	0.03	80%	n/a	0.00	0.0	
December	0.93	0.20	0.19	0.02	80%	n/a	0.00	0.0	
Totals	**54.24**		**10.85**	**0.90**		**0.55**		**0.4**	**0.4**

6. Existing Squaw Creek –Upper Bank – Similar to the proposed squaw creek restoration, the plants used to calculate irrigation demand for the upper banks and at the top of the Squaw Creek channel from East Cell A to East Cell C require less irrigation[4]. The existing Squaw Creek upper bank covers a 0.8 acre area and requires a total 0.4 AFA of irrigation during the critical 4 month period. **See Table 6 – Existing Squaw Creek – Upper Bank** below for the water demand calculations.

Irrigation Demand Summary

The cumulative yearly irrigation demand for the project is 10.6 AFA. See **Table 7 – Dry Year Irrigation Demand Summary** for a summary of the dry year demands.

The cumulative irrigation demand for the critical four month period is 8.9 AFA. **Table 8 – Critical 4 Month Irrigation Demand Summary** for a summary of demands only during the critical four month period of July through October.

[4] Personal Conversation with Stephanie Shermoen with Terrain Integration (Date September 16, 2015); the existing Squaw Creek flora in the lower bank would be similar to the flora on the proposed Squaw Creek restoration, upper banks. Therefore, landscape coefficients used to calculate irrigations demands in Squaw Creek Restoration- Upper Bank will be the same as Existing Squaw Creek – Upper Bank.

Table 6 - Existing Squaw Creek - Upper Bank

Assumptions:

a. Area of Existing Squaw Creek - East Cells A-C - Upper Creek (per **Exhibit B**) 0.80 Acres
b. Irrigation only required during critical dry 4 month period (July-Oct). Assumed natural irrigation for remaining year.
c. Drip Irrigation with Irrigation Efficiency (IE) of 80% assumed.
d. Use "Landscape Coefficient Method" used for estimating landscape irrigation demand (ET_L) - UC Coop Extension (August 2000)
e. Species, density and microclimate coefficients verified by Terrain Integration (personal communications, September 10, 2015)

$ET_L = K_L \times ET_O$

ET_O = Evapotranspiration Rate per CIMIS Data Base for Zone 13 (CIMIS 1999)

K_L = Landscape Coefficient = $Ks \times K_D \times K_M$

Ks = Species Landscape Coefficient (Above Average) = 0.2

K_D = Density Landscape Coefficient (Average) = 1.0

K_M = Microclimate Landscape Coefficient (Above Average) = 1.0

K_L = Landscape Coefficient = $Ks \times K_D \times K_M$ = 0.2

f. Theoretical Demand = $ET_L \div 12$ inches/foot

	Monthly Irrigation Demand (Inches/Month)			Irrigation Rate (Feet/Month)					
Month	**ET_O**	**K_L**	**ET_L**	**Theoretical Demand**	**Irrigation Efficiency**	**Irrigation Demand**	**Irrigation Area (Acres)**	**Irrigation Demand / Month (AF/Mo) - Including 5% Conservation**	**Critical 4 Month Period Irrigation (AF)**
January	1.24	0.20	0.25	0.02	80%	n/a	0.00	0.0	
February	1.90	0.20	0.38	0.03	80%	n/a	0.00	0.0	
March	3.10	0.20	0.62	0.05	80%	n/a	0.00	0.0	
April	4.80	0.20	0.96	0.08	80%	n/a	0.00	0.0	
May	6.51	0.20	1.30	0.11	80%	n/a	0.00	0.0	
June	7.80	0.20	1.56	0.13	80%	n/a	0.00	0.0	
July	8.99	0.20	1.80	0.15	80%	0.19	0.80	0.1	
August	7.75	0.20	1.55	0.13	80%	0.16	0.80	0.1	**0.4**
September	5.70	0.20	1.14	0.10	80%	0.12	0.80	0.1	
October	3.72	0.20	0.74	0.06	80%	0.08	0.80	0.1	
November	1.80	0.20	0.36	0.03	80%	n/a	0.00	0.0	
December	0.93	0.20	0.19	0.02	80%	n/a	0.00	0.0	
Totals	**54.24**		**10.85**	**0.90**		**0.55**		**0.4**	**0.4**

Table 7 - Dry Year Irrigation Demand Summary

Month	Proposed Resort Landscaping (AF)	Squaw Creek Restoration - Olympic Channel (AF)	Squaw Creek Restoration - Upper Bank (AF)	Squaw Creek Restoration - Lower Bank (AF)	Existing Squaw Creek - Upper Bank (AF)	Squaw Creek - Lower Bank (AF)	Total Irrigation (AF)
January	0.0	0.0	0.0	0.0	0.0	0.0	0.0
February	0.0	0.0	0.0	0.0	0.0	0.0	0.0
March	0.0	0.0	0.0	0.0	0.0	0.0	0.0
April	0.4	0.0	0.0	0.0	0.0	0.0	0.4
May	0.6	0.0	0.0	0.0	0.0	0.0	0.6
June	0.7	0.0	0.0	0.0	0.0	0.0	0.7
July	0.8	0.9	0.6	0.5	0.1	0.1	3.1
August	0.7	0.8	0.5	0.4	0.1	0.1	2.6
September	0.5	0.6	0.3	0.3	0.1	0.1	1.9
October	0.3	0.4	0.2	0.2	0.1	0.1	1.3
November	0.0	0.0	0.0	0.0	0.0	0.0	0.0
December	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Totals	**4.0**	**2.7**	**1.6**	**1.4**	**0.4**	**0.4**	**10.6**

Table 8 - Critical Four Month Irrigation Demand Summary

Month	Proposed Resort Landscaping (AF)	Squaw Creek Restoration - Olympic Channel (AF)	Squaw Creek Restoration - Upper Bank (AF)	Squaw Creek Restoration - Lower Bank (AF)	Existing Squaw Creek - Upper Bank (AF)	Squaw Creek - Lower Bank (AF)	Total Irrigation (AF)
July	0.8	0.9	0.6	0.5	0.1	0.1	3.1
August	0.7	0.8	0.5	0.4	0.1	0.1	2.6
September	0.5	0.6	0.3	0.3	0.1	0.1	1.9
October	0.3	0.4	0.2	0.2	0.1	0.1	1.3
Totals	**2.3**	**2.7**	**1.6**	**1.4**	**0.4**	**0.4**	**8.9**

Comparison

The July 22, 2015 WSA estimated dry year irrigation demands to be 12.7 AFA. The new irrigation analysis estimates dry year irrigation demand to be 10.6 AFA. The new demand is 2.1 AFA less than the irrigation demand shown in the WSA. See **Table 9 – Irrigation Demand Comparison**. During the months when irrigation was assumed to be necessary (July – October), this analysis estimates demand would be 8.9 AF, an increase of 1.6 AF over the demand estimate in the July 2015 WSA. While the irrigation demand for the year is 2.1 AFA less than the WSA, the demand during the critical four month period exceeds those shown in the WSA. An additional water supply source will be required to account for the shortfall.

Three snow making wells located in the vicinity of the Squaw Valley High camp have been identified as potential sources of irrigation water. Currently the three wells provide water during the winter for snow making. The snowmaking wells remain idle during the summer. Recent analysis by Farr West Engineering has estimated a combined capacity of 325 gpm for the snow making wells for 8 to 12 hours a day during critically dry years[5]. For the purposes of this Technical Memorandum, a conservative maximum operating time of 8 hours will be assumed.

Transportation of the water from the snow making wells must rely on trucks as the existing pipe system is currently planned for improvements over the next several years. A 2,000 gallon water trucks would fill from a stand pipe connected directly to the wells, transport the water to Squaw Creek and spray water where needed. The water truck would require approximately 6.2 min to fill using the 325 gpm capacity of the snow making wells. Four truck deliveries would be required during the highest water supply short fall months of July and August. The months of September and October would need 3 and 2 truck trips, respectively. The total daily fill time for 4, 3 and 2 truck deliveries a day is 25, 18 and 12 minutes, respectively. Using the conservative maximum operating time of 8 hours (480 min), 5% of the total well capacity is required to fill trucks during the July and August. For the months of September and October, less than 4% of the total available well capacity is needed. See **Table 10 – Water Truck Analysis** for detailed calculations of truck deliveries and fill times.

Conclusion

The results of this analysis demonstrate that the irrigation demands for the six irrigation areas during the critical four month period in a dry year can be met from the potable water system and supplemental water from the snowmaking mountain wells.

[5] "Phase II Evaluation of Water supply Sources(s) Identified in Gap Analysis" Farr West Engineering dated February 13, 2015.

Table 9 - Irrigation Demand Comparison

Month	July 2015 WSA Irrigation Demand for Dry Year (AF)	September 2015 Irrigation Demand Analysis (AF)	Difference (AF)	Additional Water Supply Required?
January	0.0	0.00	0.00	No
February	0.0	0.00	0.00	No
March	0.0	0.00	0.00	No
April	1.3	0.42	-0.92	No
May	1.8	0.57	-1.25	No
June	2.2	0.69	-1.50	No
July	2.5	3.06	0.54	Yes
August	2.2	2.64	0.46	Yes
September	1.6	1.94	0.34	Yes
October	1.0	1.27	0.22	Yes
November	0.0	0.00	0.00	No
December	0.0	0.00	0.00	No
Totals	**12.7**	**10.6**		

Table 10 - Water Truck Analysis

Month	Water Supply Short Fall (AF)	Water Supply Short Fall (gal)	Working Days per Month	Gallons per Working Day	Truck Deliveries per Day[1]	Water Truck Fill Time (min/truck))[2]	Total Fill Time per Day (min)
July	0.54	175,419	22	7,974	4	6.2	25
August	0.46	151,223	22	6,874	4	6.2	25
September	0.34	111,222	22	5,056	3	6.2	18
October	0.22	72,587	22	3,299	2	6.2	12
Totals	**1.6**	**510,452**					

Notes:
1. Water Truck Capacity = 2000 gallons
2. 325 gpm capacity per **Phase II Evaluation of Water Supply Source(s) Identified in Gap Analysis, Farr West Engineering dated February 13, 2015**

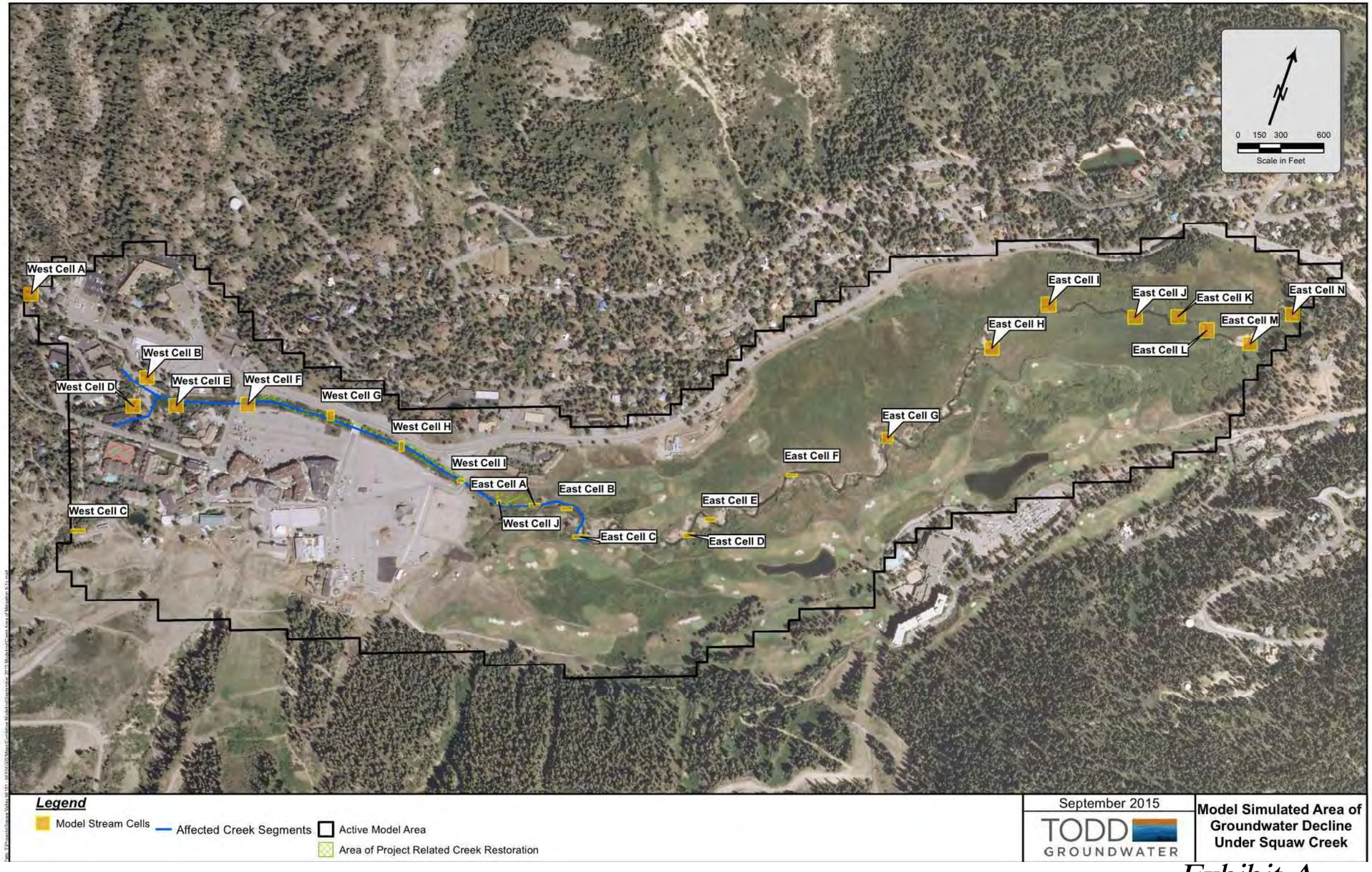


Exhibit A
Groundwater Decline Under Squaw Creek

SQUAW VALLEY

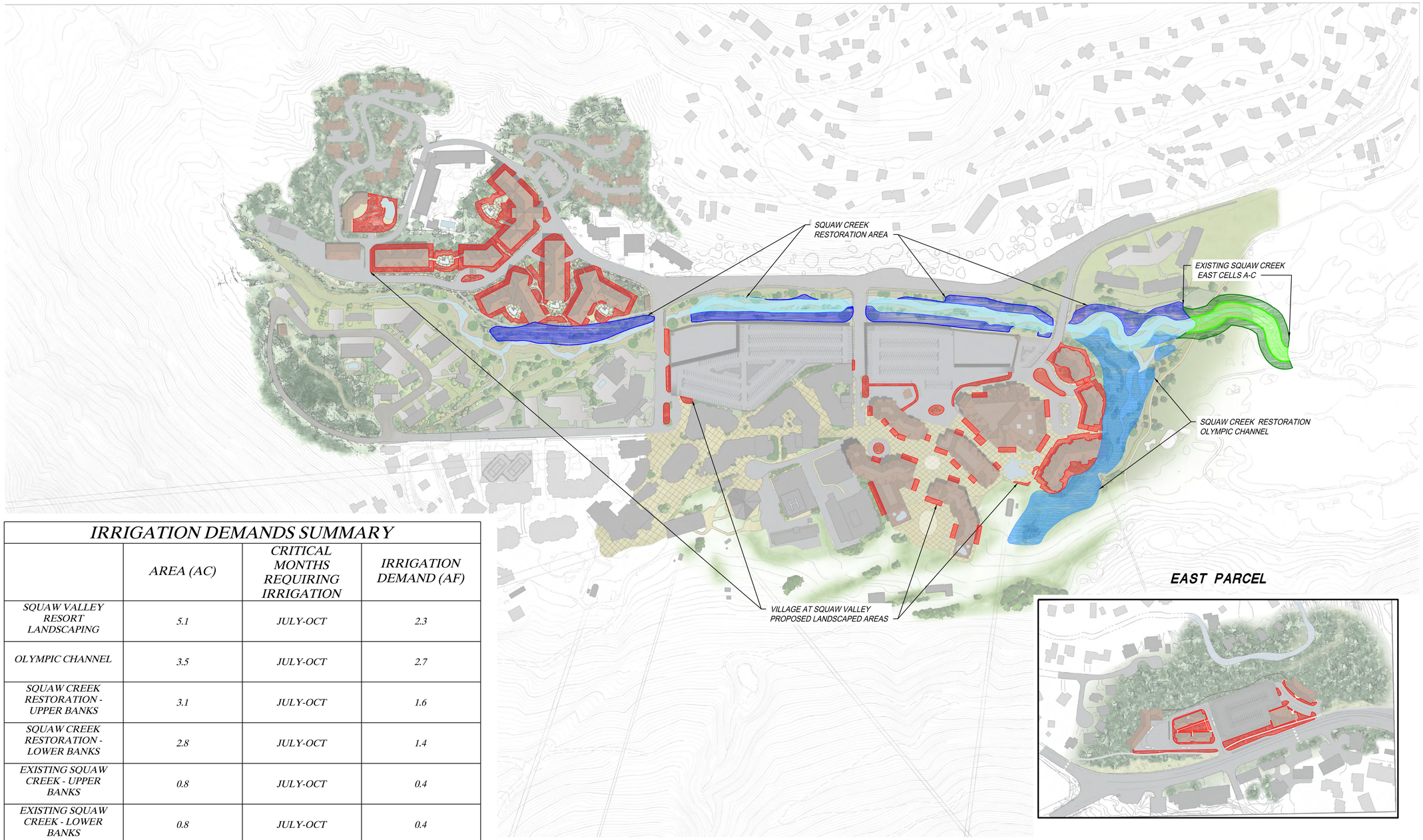
Placer County — California

MacKay & Somps — Engineering Planning Surveying — 1552 Eureka Road, Suite 100, Roseville, CA 95661 (916) 773-1180

September 22, 2015

PRELIMINARY - Subject to Revision

9-22-2015 16:03:59 ntejada P:\18446\exhibits\Irrigation Water Demands\Squaw Creek Irrigation\Exhibit A- Groundwater Decline under Squaw Creek.dwg
There are no xreferences in this drawing.
MacKay and Somps is not responsible for the accuracy or completeness of reproductions of this document generated by others from electronic media.



IRRIGATION DEMANDS SUMMARY

	AREA (AC)	CRITICAL MONTHS REQUIRING IRRIGATION	IRRIGATION DEMAND (AF)
SQUAW VALLEY RESORT LANDSCAPING	5.1	JULY-OCT	2.3
OLYMPIC CHANNEL	3.5	JULY-OCT	2.7
SQUAW CREEK RESTORATION - UPPER BANKS	3.1	JULY-OCT	1.6
SQUAW CREEK RESTORATION - LOWER BANKS	2.8	JULY-OCT	1.4
EXISTING SQUAW CREEK - UPPER BANKS	0.8	JULY-OCT	0.4
EXISTING SQUAW CREEK - LOWER BANKS	0.8	JULY-OCT	0.4
TOTAL	16.1		8.8

0 100 200 400

NOTE:

1. SQUAW CREEK RESTORATION GRADING PLAN PROVIDED BY BALANCE HYDROLOGICS, AUGUST 2015

2. SEE EXHIBIT A - GROUNDWATER DECLINE UNDER SQUAW CREEK FOR LOCATIONS OF EAST CELLS A - C

3. SEE TABLES 1-6 FOR DETAILED IRRIGATION DEMAND CALCULATIONS

EXHIBIT B
IRRIGATION AREAS & DEMANDS
SQUAW VALLEY

Placer County California

MacKay & Somps

September 22, 2015

Job No. 18446

9-23-2015 18:36:59 nlepido P:\18446\exhibits\Irrigation Water Demands\Squaw Creek Irrigation\Exhibit B - Irrigation Areas & Demands.dwg
[1] P:\18446\images\Illustrative\MS_Sept_2015_Illustrative_Blank.dwg [2] P:\18446\exhibits\Irrigation Water Demands\Squaw Creek Irrigation\Squaw Creek Restoration grading.dwg [3] P:\18446\images\Illustrative\MS_Sept_2015_Illustrative_Blank_East_Parcel.dwg

B5

Results of Initial Stormwater and Hydrology Data Review and Reconnaissance-level Site Assessment, Squaw Valley, USA

Memo

To: Chevis Hosea and Andrea Parisi, Squaw Valley Ski Holdings

From: David Shaw

Date: September 10, 2015 - ***revised 9/16/15***

Cc: Adrienne Graham and Chad Taylor

Subject: Results of initial stormwater and hydrology data review and reconnaissance-level site assessment, Squaw Valley, USA.

You have asked that Balance Hydrologics provide an analysis of monthly average streamflow in Squaw Creek and the Truckee River, so that the degree of potential impacts to Truckee River streamflow from increased groundwater pumping for the Squaw Valley Village Specific Plan (VSP) can be better understood. This analysis is requested in response to portions of 4 comment letters received by Placer County on the VSP Draft Environmental Impact Report (DEIR). We have reviewed pertinent portions of comment letters received from: The Lahontan Water Board, Friends of Squaw Creek, Squaw Valley Mutual Water Company, and Shute, Mihaly, and Weinberger (on behalf of Sierra Watch).

The remainder of this memo is in response to a comment put forth in each of those letters, which can be summarized as "*The DEIR fails to adequately describe the impacts of increased groundwater pumping on streamflow in areas downstream of Squaw Creek, including the Truckee River.*" In order to address this comment, we have examined streamflow data collected by the USGS on the Truckee River and compared these data to Squaw Creek flow data published by Sound Watershed Consulting for the period from Water Year[1] 2003 to 2013. We have also evaluated the degree to which Truckee River streamflow may be impacted by increased groundwater withdrawals associated with the SVP at buildout.

Existing Conditions

Under existing conditions, streamflow is released at the Lake Tahoe Dam to the Truckee River in Tahoe City, and flow generally increases along the "Big Chief Corridor" between Tahoe City and Truckee as several tributaries, including Squaw Creek, contribute flow. The total watershed area of the Truckee River at Tahoe City is 507 square miles, and increases to 553 square miles just upstream of the Town of Truckee. With a watershed area of roughly 8 square miles, Squaw Creek accounts for roughly 17 percent of the tributary watershed between Tahoe City and Truckee, and less than 2 percent of the total Truckee River watershed area.

---

[1] October 1 of the previous year to September 30 of the named year.

Average monthly flows in the Truckee River and Squaw Creek are summarized in Table 1. Average monthly streamflow in the Truckee River near the Town of Truckee ranges from around 170 cfs in September to nearly 400 cfs in May. The gaging record from the Truckee River at Tahoe City shows that maximum releases from Lake Tahoe tend to occur in July and August, when Squaw Creek streamflow is typically at its lowest; contributions from Squaw Creek during these times account for less than 5 percent of the total flow in the Truckee River at Truckee.

Table 1. Average Monthly flows on the Truckee River and Squaw Creek from 2003 to 2013

	Average of Monthly Flows						
	Truckee River at Tahoe City		Truckee River near Truckee		Squaw Creek		Proportion of Truckee River[1] flow from Squaw Creek
	(cfs)	*(ac-ft/mo.)*	*(cfs)*	*(ac-ft/mo.)*	*(cfs)*	*(ac-ft/mo.)*	*(%)*
October	79.7	4,898	95.1	5,850	3.6	219	4%
November	72.3	4,304	95.9	5,704	6.3	376	7%
December	74.5	4,581	145.2	8,925	17.1	1,054	12%
January	92.1	5,661	143.1	8,802	14.6	898	10%
February	81.6	4,573	132.6	7,429	14.4	805	11%
March	63.1	3,881	162.1	9,966	28.7	1,767	18%
April	70.4	4,188	254.2	15,129	52.2	3,105	21%
May	72.5	4,459	392.5	24,136	94.6	5,818	24%
June	158.3	9,422	365.4	21,742	63.8	3,794	17%
July	260.4	16,010	314.1	19,314	13.8	847	4%
August	274.1	16,855	287.9	17,702	1.5	93	1%
September	159.2	9,475	168.8	10,042	0.3	18	0%

Data Sources: USGS (Stations 10337500 and 10338000) and Sound Watershed Consulting

[1] Squaw Creek flow is compared to the monthly flow at the Truckee River above Truckee Gaging Station.

Potential impact of future groundwater demand on Truckee River flows

Existing and anticipated future groundwater demand (for the VSP alone and with other cumulative development) is shown in Table 2. Valley-wide groundwater demand associated with buildout of the VSP and other valley-wide demands is anticipated to average 0.8 to 2.7 cfs (average demand rate of 48.1 to 163.1 acre-feet per month), as summarized in Table 3. If these withdrawals from the aquifer were to come entirely from Squaw Creek streamflow (a very conservative assumption), flows could potentially be reduced by as much as 0.8 to 2.7 cfs on a monthly basis, perhaps more during shorter periods of peak demand.

Reductions in groundwater discharge from Olympic Valley of 1 to 3 cfs would not cause a discernable reduction in flow or water levels in the Truckee River. When monthly groundwater demand is highest, flows in the Truckee River are high and dominated by the release of water from Lake Tahoe, on the order of 160 to 300 cfs (Table 1). Examination of streamflow and stream stage (water depth) measurements taken by the USGS at Station 10338000 (Truckee River near Truckee) indicate that a 3 cfs reduction at these flows would result in a less than 0.01-foot decline in the water surface elevation at that location.

Table 2. Existing and Projected Olympic Valley and VSP Groundwater Demand, Placer County, California.

	Existing Demand from Valley Floor Aquifer		Anticipated VSP Demand in 2040		Total Anticipated Olympic Valley Demand in 2040	
	(ac-ft)	*(cfs)*	*(ac-ft)*	*(cfs)*	*(ac-ft)*	*(cfs)*
October	46.1	0.8	16.2	0.3	65.2	1.1
November	59.9	1.0	12.3	0.2	80.6	1.4
December	80.2	1.3	19.2	0.3	112.4	1.8
January	69.1	1.1	20.8	0.3	105.0	1.7
February	63.0	1.1	21.6	0.4	100.3	1.8
March	28.4	0.5	23.6	0.4	66.4	1.1
April	27.8	0.5	18.2	0.3	48.1	0.8
May	41.6	0.7	16.8	0.3	63.9	1.0
June	83.4	1.4	19.7	0.3	113.7	1.9
July	115.4	1.9	25.8	0.4	163.1	2.7
August	107.1	1.7	26.7	0.4	153.7	2.5
September	80.5	1.4	19.4	0.3	113.9	1.9

Demand estimates provided by Todd Groundwater.
Total Olympic Valley Demand in 2040 includes existing, VSP Project, and other anticipated future demands.

Table 3. Anticipated Project demand at buildout and potential effects of monthly streamflow, Squaw Creek and Truckee River near Truckee, Placer County, California.

	VSP Project Demand in 2040		Total Olympic Valley Demand in 2040		Potential Resulting flow in the Truckee River near Truckee[1]	
	(ac-ft)	*(cfs)*	*(ac-ft)*	*(cfs)*	*(cfs)*	*(% reduction from existing conditions)*
October	16.2	0.3	65.2	1.1	94.1	1.1%
November	12.3	0.2	80.6	1.4	94.5	1.4%
December	19.2	0.3	112.4	1.8	143.3	1.3%
January	20.8	0.3	105.0	1.7	141.4	1.2%
February	21.6	0.4	100.3	1.8	130.8	1.3%
March	23.6	0.4	66.4	1.1	161.0	0.7%
April	18.2	0.3	48.1	0.8	253.4	0.3%
May	16.8	0.3	63.9	1.0	391.5	0.3%
June	19.7	0.3	113.7	1.9	363.5	0.5%
July	25.8	0.4	163.1	2.7	311.5	0.8%
August	26.7	0.4	153.7	2.5	285.4	0.9%
September	19.4	0.3	113.9	1.9	166.8	1.1%

Demand estimates provided by Todd Groundwater.
Total Olympic Valley Demand in 2040 includes existing, VSP Project, and other anticipated future demands.
[1] Potential resulting flow in the Truckee River near Truckee is calculated by subtracting the total anticipated Olympic Valley Groundwater Demand in 2040 (column 2 of Table 3) from existing average monthly flows in the Truckee River near Truckee (Column 2 of Table 1).