Groundwater Review Summary Form

Application # G- 18365

GW Reviewer D. ORLOWSKI **Date Review Completed:** 2/6/12

Summary of GW availability and Injury Review:

[ ] Groundwater for the proposed use is either over appropriated, will not likely be available in the amounts requested without injury to prior water rights, OR will not likely be available within the capacity of the groundwater resource per Section B of the attached review form.

Summary of Potential for Substantial Interference Review:

[ ] There is the potential for substantial interference per Section C of the attached review form.

Summary of Well Construction Assessment:

[ ] The well does not appear to meet current well construction standards per Section D of the attached review form. Route through Well Construction and Compliance Section.

This is only a summary. Documentation is attached and should be read thoroughly to understand the basis for determinations and for conditions that may be necessary for a permit (if one is issued).

PUBLIC INTEREST REVIEW FOR GROUNDWATER APPLICATIONS

TO: Water Rights Section Date February 6, 2017

FROM: Groundwater Section Dennis Orlowski
Reviewer's Name

SUBJECT: Application G- 18365 Supersedes review of _____
Date of Review(s)

PUBLIC INTEREST PRESUMPTION; GROUNDWATER

OAR 690-310-130 (1) *The Department shall presume that a proposed groundwater use will ensure the preservation of the public welfare, safety and health as described in ORS 537.525.* Department staff review groundwater applications under OAR 690-310-140 to determine whether the presumption is established. OAR 690-310-140 allows the proposed use be modified or conditioned to meet the presumption criteria. **This review is based upon available information and agency policies in place at the time of evaluation.**

A. GENERAL INFORMATION: Applicant's Name: **Mars Enterprises, LLC** County: **Marion**

A1. Applicant(s) seek(s) 0.3095 cfs from 1 well(s) in the Willamette Basin, Pudding River subbasin

A2. Proposed use Commercial Seasonality: Year-round

A3. Well and aquifer data **(attach and number logs for existing wells; mark proposed wells as such under logid):**

Well	Logid	Applicant's Well #	Proposed Aquifer*	Proposed Rate(cfs)	Location (T/R-S QQ-Q)	Location, metes and bounds, e.g. 2250' N, 1200' E fr NW cor S 36
1	Proposed	MARS well	Alluvium	0.3095	7S/2W-14 NE-NE	1235 ft S, 1185 ft W from NE cor S 14
2						
3						
4						
5						

* Alluvium, CRB, Bedrock

Well	Well Elev ft msl	First Water ft bls	SWL ft bls	SWL Date	Well Depth (ft)	Seal Interval (ft)	Casing Intervals (ft)	Liner Intervals (ft)	Perforations Or Screens (ft)	Well Yield (gpm)	Draw Down (ft)	Test Type
1	205		30-40		170	0-50	0-170		75-170			

Use data from application for proposed wells.

A4. **Comments:** The location for proposed Well 1 is 3-4 miles due east of Salem in the Howell Prairie area.

The requested allocation of 0.3095 cfs shown in Section A1 is the applicant's anticipated maximum peak demand during the summer months (200,000 gpd). Applicant estimated an annual average daily demand of 62,000 gpd (0.096 cfs), from which they based their requested annual duty of 69.0 acre-feet/yr. **However, for this review, the maximum peak demand (0.3095 cfs) was used to provide conservative estimates of potential injury and stream interference (Section C4a).**

The estimated range of SWLs was obtained from nearby observation well measurements and from a regional USGS groundwater map (Gannett and Caldwell, 1998).

A5. ☐ **Provisions of the** Willamette Basin rules relative to the development, classification and/or management of groundwater hydraulically connected to surface water ☐ **are**, *or* ☒ **are not**, activated by this application. (Not all basin rules contain such provisions.)
Comments: The well will produce from a confined aquifer so pertinent basin rules do not apply (OAR 690-502-0240).

A6. ☐ **Well(s) #** _____, _____, _____, _____, _____, tap(s) an aquifer limited by an administrative restriction.
Name of administrative area: _____
Comments: _____

B. GROUNDWATER AVAILABILITY CONSIDERATIONS, OAR 690-310-130, 400-010, 410-0070

B1. **Based upon available data,** I have determined that groundwater* for the proposed use:

a. ☐ **is** over appropriated, ☒ **is not** over appropriated, *or* ☐ **cannot be determined to be** over appropriated during any period of the proposed use. * This finding is limited to the groundwater portion of the over-appropriation determination as prescribed in OAR 690-310-130;

b. ☐ **will not** *or* ☐ **will** likely be available in the amounts requested without injury to prior water rights. * This finding is limited to the groundwater portion of the injury determination as prescribed in OAR 690-310-130;

c. ☐ **will not** *or* ☐ **will** likely to be available within the capacity of the groundwater resource; or

d. ☒ **will, if properly conditioned**, avoid injury to existing groundwater rights or to the groundwater resource:
   i. ☒ The permit should contain condition #(s) **7c, medium water-use reporting**;
   ii. ☒ The permit should be conditioned as indicated in item 2 below.
   iii. ☐ The permit should contain special condition(s) as indicated in item 3 below;

B2. a. ☐ **Condition** to allow groundwater production from no deeper than _____ ft. below land surface;

b. ☐ **Condition** to allow groundwater production from no shallower than _____ ft. below land surface;

c. ☒ **Condition** to allow groundwater production only from the **alluvial** groundwater reservoir ~~between approximately _____ ft. and _____ ft. below land surface;~~

d. ☐ **Well reconstruction** is necessary to accomplish one or more of the above conditions. The problems that are likely to occur with this use and without reconstructing are cited below. Without reconstruction, I recommend withholding issuance of the permit until evidence of well reconstruction is filed with the Department and approved by the Groundwater Section.

Describe injury – as related to water availability– that is likely to occur without well reconstruction (interference w/ senior water rights, not within the capacity of the resource, etc): _____

B3. **Groundwater availability remarks:** The applicant proposes the installation of one well that will produce groundwater from an alluvial aquifer. The alluvial aquifer in this area is comprised of 100-120 feet of water-bearing sand and gravel deposits overlain by approximately 60-80 feet of Willamette Silt that extends to ground surface. Below the alluvial aquifer is a deeper section of mostly silt and clay up to several hundred feet thick. Static groundwater levels in wells tapping this alluvial aquifer are at approximately 30-40 feet below land surface.

Water-level trends in nearby wells appear to be related to decadal climate trends and show no obvious progressive declines. These trends indicate that the alluvial aquifer is likely not over appropriated in the area (see attached hydrograph). However, because of the short period of record, water-level monitoring is recommended in the proposed well. Interference in nearby irrigation and domestic wells is not expected to be excessive if those wells fully penetrate the aquifer.

C. GROUNDWATER/SURFACE WATER CONSIDERATIONS, OAR 690-09-040

C1. **690-09-040 (1):** Evaluation of aquifer confinement:

Well	Aquifer or Proposed Aquifer	Confined	Unconfined
1	**Alluvial**	☒	☐
		☐	☐
		☐	☐
		☐	☐
		☐	☐

Basis for aquifer confinement evaluation: Proposed Well 1 will tap water-bearing sands and gravels that are confined by 60-80 feet of low-permeability, fine-grained sediments (Willamette Silt). In the central Willamette Valley, Conlon and others (2005) report that fine-grained deposits (silt and clay) of 'more than 40 ft' thickness typically create confined conditions in the underlying water-bearing sand/gravel deposits. Additionally, water levels in nearby wells rise above the level of water-bearing layers. These factors suggest that proposed Well 1 will produce from a confined aquifer.

C2. **690-09-040 (2) (3):** Evaluation of distance to, and hydraulic connection with, surface water sources. All wells located a horizontal distance less than ¼ mile from a surface water source that produce water from an unconfined aquifer shall be assumed to be hydraulically connected to the surface water source. Include in this table any streams located beyond one mile that are evaluated for PSI.

Well	SW #	Surface Water Name	GW Elev ft msl	SW Elev ft msl	Distance (ft)	Hydraulically Connected? YES	NO	ASSUMED	Potential for Subst. Interfer. Assumed? YES	NO
1	**1**	**Little Pudding River**	**165-175**	**160-170**	**5750**	☒	☐	☐	☐	☒
1	**2**	**Pudding River**	**165-175**	**170-180**	**6350**	☒	☐	☐	☐	☒
						☐	☐	☐	☐	☐
						☐	☐	☐	☐	☐
						☐	☐	☐	☐	☐
						☐	☐	☐	☐	☐

Basis for aquifer hydraulic connection evaluation: Water level elevations in the alluvial aquifer are essentially equivalent to the elevations of both nearby creeks (SW1 and SW2). Furthermore, water table maps in the area indicate that groundwater in the alluvial aquifer system flows towards and discharges into local streams incised in the Howell Prairie plateau (Conlon and others, 2005; Gannett and Caldwell, 1998). These facts indicate that the alluvial aquifer and local streams are hydraulically connected.

The depletion of local streams by proposed Well 1 will be buffered, but not eliminated, by the low vertical hydraulic conductivity (permeability) of the Willamette Silt and other clays and silts that lie between the deeper sands and gravels and the stream beds (Herrera and others, 2014). Net impacts will be small at the onset of pumping but will increase with time until a new equilibrium between local recharge and discharge is reached. At that time depletion is expected to be relatively constant throughout the year.

Note: an ephemeral reach of Howell Prairie Creek is located about 475 ft due east of the proposed Well 1 location. Howell Prairie Creek, as well as other small streams in the area, have their headwaters in the terrace underlain by the Willamette Silt. As these stream drainages traverse the terrace toward the north and east (often artificially channelized), they progressively cut into the Willamette Silt until they intersect the water table, at which point they transition from ephemeral to perennial streams. Observation of recent aerial photographs and topographic data suggest that Howell Prairie Creek becomes perennial at a location about 1.5-2 miles north of the proposed Well 1 location. Thus, consideration of PSI was performed for only the Pudding River and Little Pudding River, both closer than the nearest perennial reach of Howell Prairie Creek.

Water Availability Basin the well(s) are located within: #151 Pudding River > Molalla River – above Mill Creek & #152 Pudding River > Molalla River – above Howell Prairie

C3a. **690-09-040 (4):** Evaluation of stream impacts for each well that has been determined or assumed to be **hydraulically connected and less than 1 mile** from a surface water source. Limit evaluation to instream rights and minimum stream flows that are pertinent to that surface water source, and not lower SW sources to which the stream under evaluation is tributary. Compare the requested rate against the 1% of 80% *natural* flow for the pertinent Water Availability Basin (WAB). If Q is not distributed by well, use full rate for each well. Any checked ☒ box indicates the well is assumed to have the potential to cause PSI.

Well	SW #	Well < ¼ mile?	Qw > 5 cfs?	Instream Water Right ID	Instream Water Right Q (cfs)	Qw > 1% ISWR?	80% Natural Flow (cfs)	Qw > 1% of 80% Natural Flow?	Interference @ 30 days (%)	Potential for Subst. Interfer. Assumed?
		☐	☐			☐		☐		☐
		☐	☐			☐		☐		☐
		☐	☐			☐		☐		☐
		☐	☐			☐		☐		☐
		☐	☐			☐		☐		☐
		☐	☐			☐		☐		☐

C3b. **690-09-040 (4):** Evaluation of stream impacts by total appropriation for all wells determined or assumed to be **hydraulically connected and less than 1 mile** from a surface water source. **Complete only if Q is distributed among wells.** Otherwise same evaluation and limitations apply as in C3a above.

	SW #		Qw > 5 cfs?	Instream Water Right ID	Instream Water Right Q (cfs)	Qw > 1% ISWR?	80% Natural Flow (cfs)	Qw > 1% of 80% Natural Flow?	Interference @ 30 days (%)	Potential for Subst. Interfer. Assumed?
			☐			☐		☐		☐
			☐			☐		☐		☐
			☐			☐		☐		☐
			☐			☐		☐		☐

Comments: Both SW1 (Little Pudding River) and SW2 (Pudding River) are greater than one mile from the proposed Well 1 location. Therefore, those streams were not evaluated in section C3, but instead in section C4.

C4a. **690-09-040 (5):** Estimated impacts on **hydraulically connected surface water sources greater than one mile** as a percentage of the proposed pumping rate. Limit evaluation to the effects that will occur up to one year after pumping begins. This table encompasses the considerations required by 09-040 (5)(a), (b), (c) and (d), which are not included on this form. Use additional sheets if calculated flows from more than one WAB are required.

SW1 – Little Pudding River (Watershed ID #151)

Non-Distributed Wells													
Well	SW#	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	1	6.31%	7.08%	7.83%	8.58%	9.36%	10.09%	10.78%	11.42%	12.15%	4.12%	4.85%	5.59%
Well Q as CFS		0.3095	0.3095	0.3095	0.3095	0.3095	0.3095	0.3095	0.3095	0.3095	0.3095	0.3095	0.3095
Interference CFS		0.002	0.003	0.003	0.003	0.004	0.004	0.004	0.005	0.005	0.001	0.002	0.002
Distributed Wells													
Well	SW#	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
		%	%	%	%	%	%	%	%	%	%	%	%
Well Q as CFS													
Interference CFS													
		%	%	%	%	%	%	%	%	%	%	%	%
Well Q as CFS													
Interference CFS													
(A) = Total Interf.		0.002	0.003	0.003	0.003	0.004	0.004	0.004	0.005	0.005	0.001	0.002	0.002
(B) = 80 % Nat. Q		1040.00	1180.00	1010.00	787.00	425.00	224.00	109.00	71.00	67.30	91.60	363.00	957.00
(C) = 1 % Nat. Q		10.40	11.80	10.10	7.87	4.25	2.24	1.09	0.71	0.673	0.916	3.63	9.57
(D) = (A) > (C)		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
(E) = (A / B) x 100		<<1%	<<1%	<<1%	<<1%	<<1%	<<1%	<<1%	<<1%	<<1%	<<1%	<<1%	<<1%

SW2 – Pudding River (Watershed ID #152)

Non-Distributed Wells													
Well	SW#	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	2	5.46%	6.16%	6.83%	7.52%	8.14%	8.81%	9.56%	10.16%	10.84%	3.49%	4.12%	4.82%
Well Q as CFS		0.3095	0.3095	0.3095	0.3095	0.3095	0.3095	0.3095	0.3095	0.3095	0.3095	0.3095	0.3095
Interference CFS		0.003	0.003	0.004	0.004	0.005	0.005	0.006	0.006	0.006	0.002	0.002	0.002
Distributed Wells													
Well	SW#	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
		%	%	%	%	%	%	%	%	%	%	%	%
Well Q as CFS													
Interference CFS													
		%	%	%	%	%	%	%	%	%	%	%	%
Well Q as CFS													
Interference CFS													
(A) = Total Interf.		0.003	0.003	0.004	0.004	0.005	0.005	0.006	0.006	0.006	0.002	0.002	0.002
(B) = 80 % Nat. Q		603.00	649.00	587.00	451.00	235.00	111.00	43.60	24.70	22.70	38.90	233.00	608.00
(C) = 1 % Nat. Q		6.03	6.49	5.87	4.51	2.35	1.11	0.436	0.247	0.227	0.389	2.33	6.08
(D) = (A) > (C)		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
(E) = (A / B) x 100		<<1%	<<1%	<<1%	<<1%	<<1%	<<1%	<<1%	<<1%	<<1%	<<1%	<<1%	<<1%

(A) = total interference as CFS; (B) = WAB calculated natural flow at 80% exceed. as CFS; (C) = 1% of calculated natural flow at 80% exceed. as CFS; (D) = highlight the checkmark for each month where (A) is greater than (C); (E) = total interference divided by 80% flow as percentage.

Basis for impact evaluation: Potential depletion of SW1 (Little Pudding River) and SW2 (Pudding River) was estimated using the Hunt 2003 analytical stream depletion model (Hunt, 2003).

For both model scenarios (SW1 and SW2), it was assumed that the pumping rate corresponding to the applicant's maximum daily demand (0.3095 cfs) was applied constantly for 365 days. This is a very conservative approach from a stream interference perspective because the applicant anticipates only pumping at that rate for short durations during the summer months. Furthermore, the model simulation assumes pumping at the maximum anticipated rate beginning in October (beginning of the wet season), such that the maximum cumulative impact 12 months later would occur in September, the end of the dry season with lowest flow conditions in the streams. Even with these very conservative inputs, the Hunt analytical model results summarized in Table C4a show that estimated interference is much less than 1% of the 80% natural flow for both SW1 and SW2, for the entire year-long analysis period.

C4b. **690-09-040 (5) (b) The potential to impair or detrimentally affect the public interest is to be determined by the Water Rights Section.**

C5. ☐ **If properly conditioned**, the surface water source(s) can be adequately protected from interference, and/or groundwater use under this permit can be regulated if it is found to substantially interfere with surface water:

i. ☐ The permit should contain condition #(s)_____;

ii. ☐ The permit should contain special condition(s) as indicated in "Remarks" below;

C6. **SW / GW Remarks and Conditions:** _____

References Used: Application file: G-18365

Conlon, T.D., Wozniak, K.C., Woodcock, D., Herrera, N.B., Fisher, B.J., Morgan, D.S., Lee, K.K., and Hinkle, S.R., 2005, Ground-water hydrology of the Willamette Basin, Oregon: U.S. Geological Survey Scientific Investigations Report 2005-5168.

Conlon, T.D., Lee, K.K., and Risley, J.R., 2003, Heat tracing in streams in the central Willamette Basin, Oregon, *in* Stonestrom, D.A. and Constantz, Jim, eds., Heat as a tool for studying the movement of groundwater near streams: U.S. Geological Survey Circular 1260, chapter 5, p. 29-34.

Gannett, M.W. and Caldwell, R., 1998, Geologic framework of the Willamette Lowland aquifer system, Oregon and Washington: U.S. Geological Survey Professional Paper 1424-A, 32 p.

Herrera, N.B., Burns, E.R., and Conlon, T.D., 2014, Simulation of groundwater flow and the interaction of groundwater and surface water in the Willamette Basin and Central Willamette subbasin, Oregon: U.S. Geological Survey Scientific Investigations Report 2014–5136, 152 p., *http://dx.doi.org/10.3133/sir20145136*.

Hunt, B., 1999, Unsteady stream depletion from ground water pumping: Ground Water, v. 37, no. 1, p. 98-102.

Hunt, B., 2003, Unsteady stream depletion when pumping from semiconfined aquifer: Journal of Hydrologic Engineering, January/February, 2003.

Woodward, D.G., Gannett, M.W., and Vaccaro, J.J., 1998, Hydrogeologic framework of the Willamette Lowland aquifer system, Oregon and Washington: U.S. Geological Survey Professional Paper 1424-B, 82 p.

D. WELL CONSTRUCTION, OAR 690-200

D1. **Well #:** _____ **Logid:** _____

D2. **THE WELL does not appear to meet current well construction standards based upon:**

a. ☐ review of the well log;
b. ☐ field inspection by _____;
c. ☐ report of CWRE _____;
d. ☐ other: (specify) _____

_____

D3. **THE WELL construction deficiency or other comment is described as follows:** _____

_____

_____

_____

_____

D4. ☐ **Route to the Well Construction and Compliance Section for a review of existing well construction.**

Water Availability Tables

Water Availability Analysis
Detailed Reports

PUDDING R > MOLALLA R - AB MILL CR
WILLAMETTE BASIN
Water Availability as of 2/3/2017

Watershed ID #: 151 (Map)
Date: 2/3/2017

Exceedance Level: 80%
Time: 12:53 PM

Water Availability Calculation | Consumptive Uses and Storages | Instream Flow Requirements | Reservations | Water Rights | Watershed Characteristics

Water Availability Calculation

Monthly Streamflow in Cubic Feet per Second
Annual Volume at 50% Exceedance in Acre-Feet

Month	Natural Stream Flow	Consumptive Uses and Storages	Expected Stream Flow	Reserved Stream Flow	Instream Flow Requirement	Net Water Available
JAN	1,040.00	124.00	916.00	0.00	36.00	880.00
FEB	1,180.00	114.00	1,070.00	0.00	36.00	1,030.00
MAR	1,010.00	75.70	934.00	0.00	36.00	898.00
APR	787.00	51.50	735.00	0.00	36.00	699.00
MAY	425.00	49.00	376.00	0.00	36.00	340.00
JUN	224.00	69.90	154.00	0.00	36.00	118.00
JUL	109.00	110.00	-1.01	0.00	36.00	-37.00
AUG	71.00	90.30	-19.30	0.00	36.00	-55.30
SEP	67.30	51.50	15.80	0.00	36.00	-20.20
OCT	91.60	11.00	80.60	0.00	36.00	44.60
NOV	363.00	48.30	315.00	0.00	36.00	279.00
DEC	957.00	118.00	839.00	0.00	36.00	803.00
ANN	706,000.00	55,100.00	651,000.00	0.00	26,100.00	627,000.00

Water Availability Analysis
Detailed Reports

PUDDING R > MOLALLA R - AB HOWELL PRAIRIE
WILLAMETTE BASIN
Water Availability as of 2/3/2017

Watershed ID #: 152 (Map)
Date: 2/3/2017

Exceedance Level: 80%
Time: 12:52 PM

Water Availability Calculation | Consumptive Uses and Storages | Instream Flow Requirements | Reservations | Water Rights | Watershed Characteristics

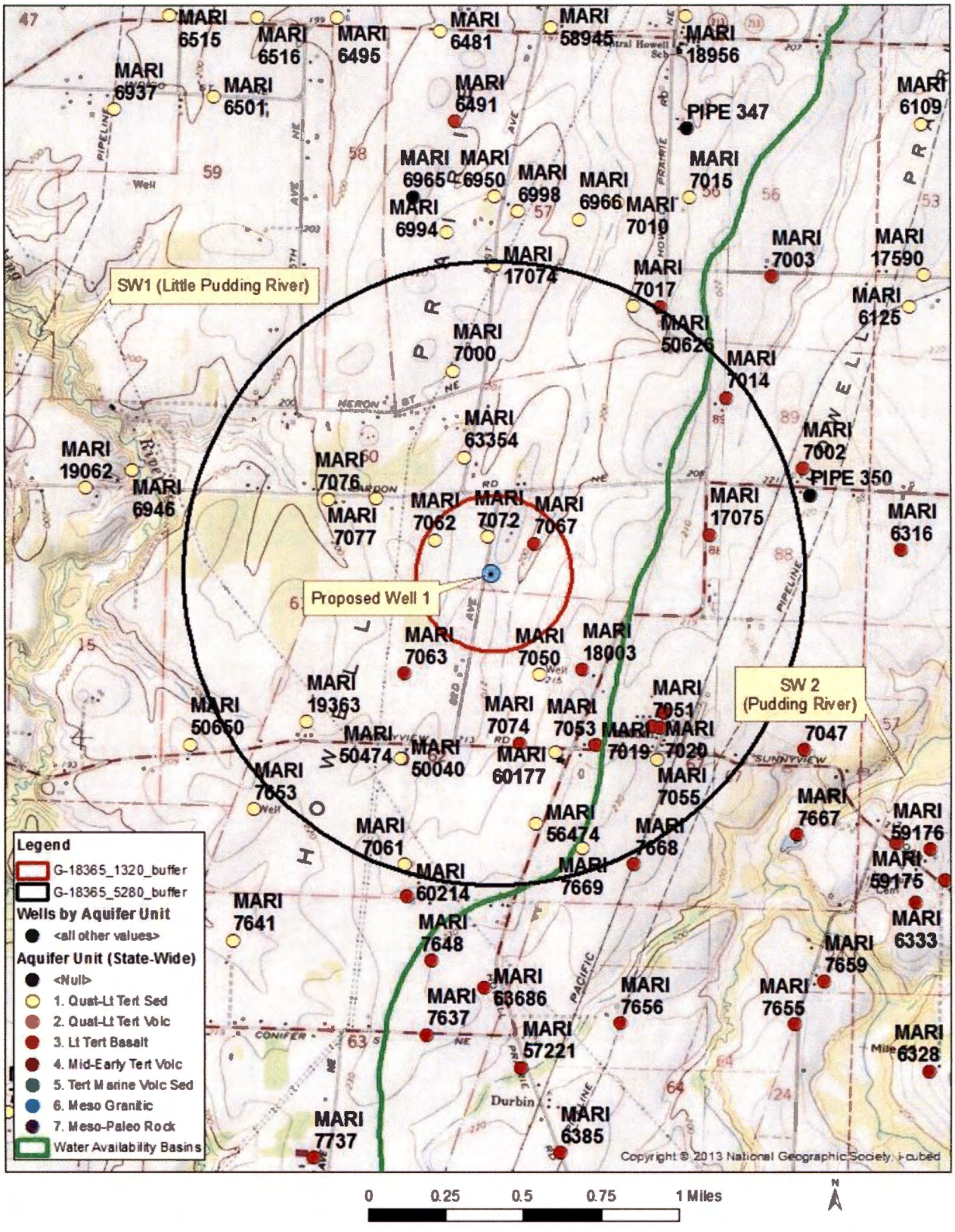
Water Availability Calculation

Monthly Streamflow in Cubic Feet per Second
Annual Volume at 50% Exceedance in Acre-Feet

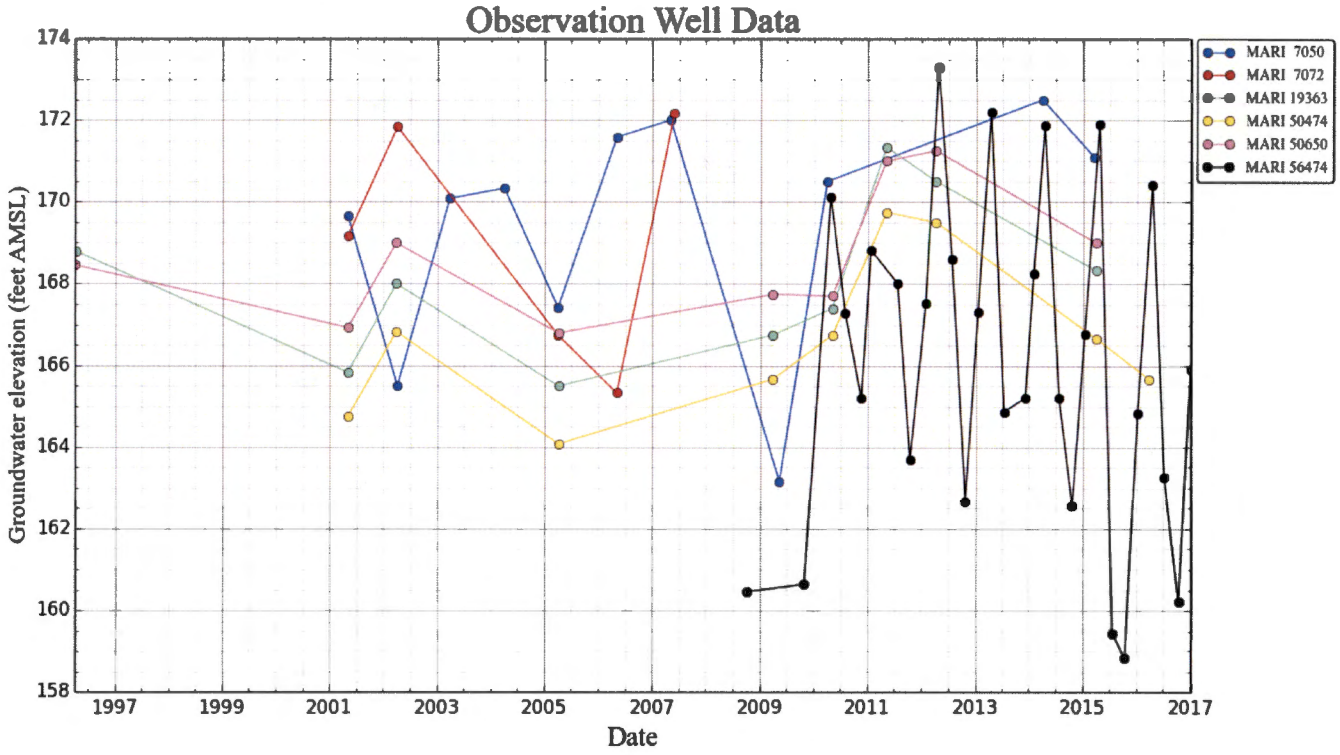
Month	Natural Stream Flow	Consumptive Uses and Storages	Expected Stream Flow	Reserved Stream Flow	Instream Flow Requirement	Net Water Available
JAN	603.00	69.80	533.00	0.00	10.00	523.00
FEB	649.00	60.90	588.00	0.00	10.00	578.00
MAR	587.00	40.00	547.00	0.00	10.00	537.00
APR	451.00	21.40	430.00	0.00	10.00	420.00
MAY	235.00	14.30	221.00	0.00	10.00	211.00
JUN	111.00	29.30	81.70	0.00	10.00	71.70
JUL	43.60	44.80	-1.17	0.00	10.00	-11.20
AUG	24.70	37.20	-12.50	0.00	10.00	-22.50
SEP	22.70	22.30	0.42	0.00	10.00	-9.58
OCT	38.90	4.35	34.50	0.00	10.00	24.50
NOV	233.00	18.80	214.00	0.00	10.00	204.00
DEC	608.00	63.80	544.00	0.00	10.00	534.00
ANN	385,000.00	25,700.00	360,000.00	0.00	7,240.00	353,000.00

Well Location Map

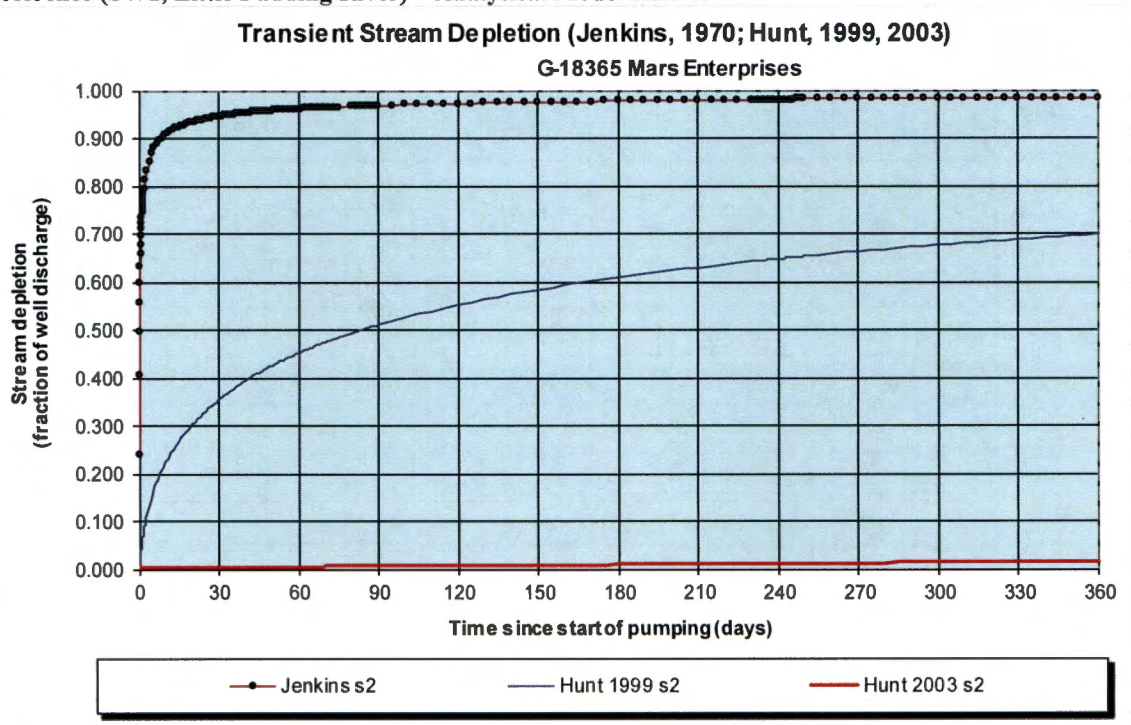
G-18365 Mars Enterprises



Water-Level Trends in Nearby Wells



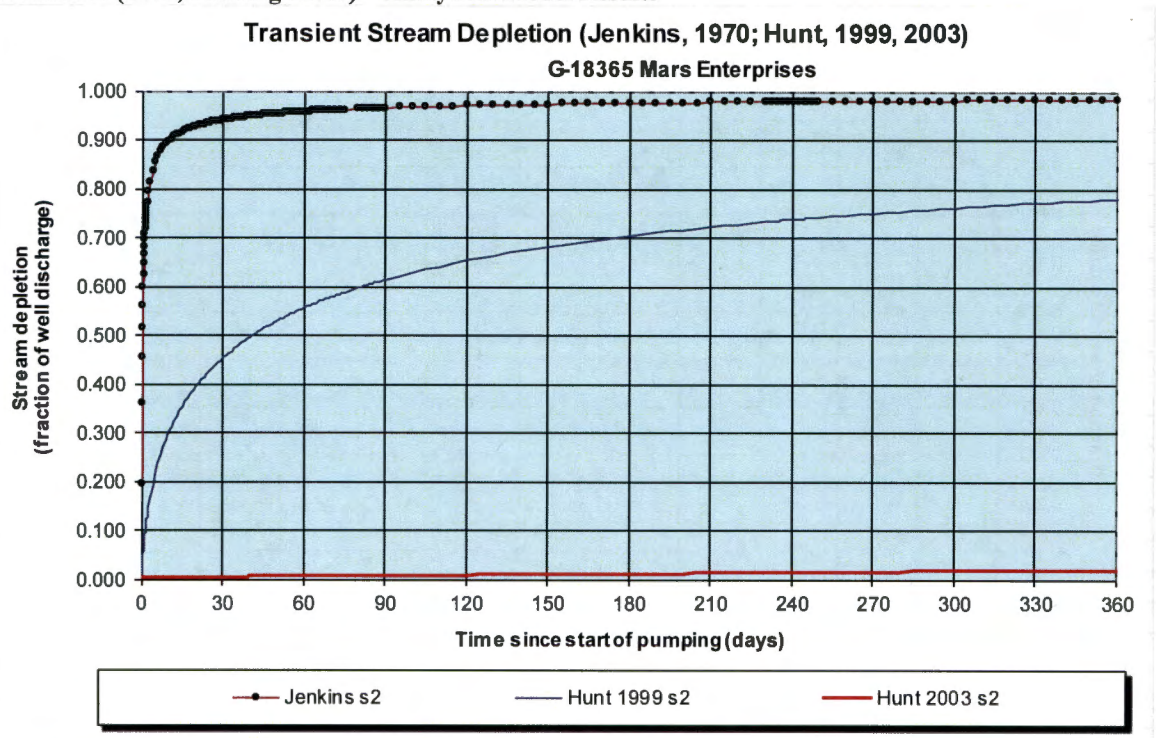
Stream Interference (SW1, Little Pudding River) – Analytical Model Results



Output for Stream Depletion, Scenario 2 (s2):						Time pump on (pumping duration) = 365 days						
Days	30	60	90	120	150	180	210	240	270	300	330	360
J SD	94.6%	96.2%	96.9%	97.3%	97.6%	97.8%	98.0%	98.1%	98.2%	98.3%	98.4%	98.4%
H SD 1999	35.5%	45.2%	51.1%	55.2%	58.4%	60.9%	63.0%	64.8%	66.3%	67.6%	68.8%	69.9%
H SD 2003	0.43%	0.53%	0.64%	0.74%	0.85%	0.96%	1.06%	1.17%	1.27%	1.38%	1.48%	1.59%
Qw, cfs	0.310	0.310	0.310	0.310	0.310	0.310	0.310	0.310	0.310	0.310	0.310	0.310
H SD 99, cfs	0.110	0.140	0.158	0.171	0.181	0.189	0.195	0.200	0.205	0.209	0.213	0.216
H SD 03, cfs	0.001	0.002	0.002	0.002	0.003	0.003	0.003	0.004	0.004	0.004	0.005	0.005

Parameters:		Scenario 1	Scenario 2	Scenario 3	Units
Net steady pumping rate of well	Qw	0.31	0.31	0.31	cfs
Time pump on (pumping duration)	tpon	365	365	365	days
Perpendicular from well to stream	a	5750	5750	5750	ft
Well depth	d	170	170	170	ft
Aquifer hydraulic conductivity	K	12	120	1200	ft/day
Aquifer saturated thickness	b	100	100	100	ft
Aquifer transmissivity	T	1200	12000	120000	ft*ft/day
Aquifer storativity or specific yield	S	0.0001	0.0001	0.0001	
Aquitard vertical hydraulic conductivity	Kva	0.1	0.1	0.1	ft/day
Aquitard saturated thickness	ba	70	70	70	ft
Aquitard thickness below stream	babs	30	30	30	ft
Aquitard porosity	n	0.2	0.2	0.2	
Stream width	ws	60	60	60	ft
Streambed conductance (lambda)	sbc	0.200000	0.200000	0.200000	ft/day
Stream depletion factor	sdf	2.755208	0.275521	0.027552	days
Streambed factor	sbf	0.958333	0.095833	0.009583	
input #1 for Hunt's Q_4 function	t'	0.362949	3.629490	36.294896	
input #2 for Hunt's Q_4 function	K'	39.360119	3.936012	0.393601	
input #3 for Hunt's Q_4 function	epsilon'	0.000500	0.000500	0.000500	
input #4 for Hunt's Q_4 function	lamda'	0.958333	0.095833	0.009583	

Stream Interference (SW2, Pudding River) – Analytical Model Results



Output for Stream Depletion, Scenerio 2 (s2):						Time pump on (pumping duration) = 365 days						
Days	30	60	90	120	150	180	210	240	270	300	330	360
J SD	94.0%	95.8%	96.6%	97.0%	97.3%	97.6%	97.7%	97.9%	98.0%	98.1%	98.2%	98.3%
H SD 1999	45.4%	55.6%	61.4%	65.3%	68.2%	70.4%	72.3%	73.8%	75.1%	76.2%	77.1%	78.0%
H SD 2003	0.52%	0.66%	0.80%	0.94%	1.08%	1.22%	1.36%	1.50%	1.65%	1.79%	1.93%	2.07%
Qw, cfs	0.310	0.310	0.310	0.310	0.310	0.310	0.310	0.310	0.310	0.310	0.310	0.310
H SD 99, cfs	0.140	0.172	0.190	0.202	0.211	0.218	0.224	0.228	0.232	0.236	0.239	0.241
H SD 03, cfs	0.002	0.002	0.002	0.003	0.003	0.004	0.004	0.005	0.005	0.006	0.006	0.006

Parameters:		Scenario 1	Scenario 2	Scenario 3	Units
Net steady pumping rate of well	Qw	0.31	0.31	0.31	cfs
Time pump on (pumping duration)	tpon	365	365	365	days
Perpendicular from well to stream	a	6350	6350	6350	ft
Well depth	d	170	170	170	ft
Aquifer hydraulic conductivity	K	12	120	1200	ft/day
Aquifer saturated thickness	b	100	100	100	ft
Aquifer transmissivity	T	1200	12000	120000	ft*ft/day
Aquifer storativity or specific yield	S	0.0001	0.0001	0.0001	
Aquitard vertical hydraulic conductivity	Kva	0.1	0.1	0.1	ft/day
Aquitard saturated thickness	ba	70	70	70	ft
Aquitard thickness below stream	babs	20	20	20	ft
Aquitard porosity	n	0.2	0.2	0.2	
Stream width	ws	60	60	60	ft
Streambed conductance (lambda)	sbc	0.300000	0.300000	0.300000	ft/day
Stream depletion factor	sdf	3.360208	0.336021	0.033602	days
Streambed factor	sbf	1.587500	0.158750	0.015875	
input #1 for Hunt's Q_4 function	t'	0.297601	2.976006	29.760060	
input #2 for Hunt's Q_4 function	K'	48.002976	4.800298	0.480030	
input #3 for Hunt's Q_4 function	epsilon'	0.000500	0.000500	0.000500	
input #4 for Hunt's Q_4 function	lamda'	1.587500	0.158750	0.015875	