Feasibility Considerations

of an

Optimal Pumping Strategy to Capture TCE/PCE Plume

at

March AFB, CA

Prepared for
Earth Technology Corporation

Prepared by

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FEASIBILITY STUDY OF AN OPTIMAL PUMPING STRATEGY TO CAPTURE TCE/PCE PLUME AT MARCH AFB

TCE/PCE contaminated groundwater from March AFB has reached off-base supply wells. Further migration of the contaminants can endanger other downstream water supply wells.

USU is developing an optimal groundwater pumping strategy to halt migration of the plume across MAFB's eastern border. USU is utilizing tentatively calibrated aquifer parameters and data (including plume extent) provided by Tetra Tech; the US/REMAX simulation/optimization (S/O) model; and SWIFT and STLINE simulation codes (GeoTrans, Inc., 1993). The results presented here are preliminary and might change as aquifer parameter estimates, management goals, or problem understanding improves.

The management goal is to minimize total pumping needed to prevent more contaminants from crossing the eastern base boundary (this goal and other constraints are expressed in text (Appendix A) and mathematically (Appendix B). Head control locations were placed along the base boundary to reverse the existing outward gradient. A minimum inward head difference of 0.50 ft (between adjacent cells) was used as a constraint during optimization. All control locations listed in Table 2 were active for the presented pumping strategy. These are the same locations used for the strategy presented on August 13, 1996. Pathline analysis predicted that the previous strategy would capture the plume.

Head difference constraints were imposed to control groundwater movement between columns from cell (i,j,k) to cell (i,j+1,k). Head difference pairs of control locations are listed in Table 3. Head difference control locations could differ for another strategy. About 306 potential pumping cells and 20 potential reinjection cells were considered. Potential well locations considered by the model are listed in Table 4.

The model was run for Scenario A (the normal conditions scenario) of Appendix A. Assumed were potentiometric surface boundary conditions of Spring 1995, and normal weather conditions and background groundwater pumping. For this scenario, no constraints were imposed on the groundwater elevation beneath the Site 4 Landfill. There the water table should not be permitted to rise higher than 8 ft below the bottom of the landfill or Spring '95 groundwater elevations, whichever is higher. This condition is not limiting in the normal condition or the dry year scenario because with no recharge in the landfill area the water table below the landfill will probably be lower than the water table of Spring 1995. However, this constraint should be used for the wet year scenario or if injection wells are considered near the landfill.

The optimal strategy achieved plume capture by pumping at 45,626 cubic feet per day, cfd (237 gallons per minute, gpm) and reinjecting 1,166 cfd (6 gpm). The uninjected water is surface disposed into Heacock Drain. Optimal pumping rates are listed in Table 1 and the resulting head at control locations and the head difference between control pairs is listed in Table 5.

The optimal strategy causes head differences at control locations above 0.50 at all head difference control locations. The head difference ranged from 0.51 - 4.85 ft. The pumping strategy is within the 300 gpm potential capacity of the treatment facility.

The strategy employed existing and new wells. It calls for eliminating and/or improving most existing wells for better plume containment. However, if some existing wells should be utilized in the final strategy we can use a weight to cause the model to pump from those locations. In any future work, capture will be proven using streamlines in addition to head contours. For the stream line analysis, particles will be placed at the center of each border cell within the plume. In the lowest contaminated layer, particles are going to be placed at 1/10th of the thickness of the layer. Particles will be tracked to make sure that they do not move off-base.

Because USU never received the final calibrated groundwater model, and because funds are exhausted, USU has halted at the present of pumping strategy development. This report describes what was most recently done and what was planned for the future.

Table 1 Computed Groundwater Pumping/Injection Rates (cfd)

CELL #	Row (i)	Column (j)	Layer (k)	Computed Pumping (cfd)
16	45	53	3	1205.13
29	33	63	4	1202.94
85	30	66	4	787.79
93	32	65	4	6000.00
101	35	62	4	6000.00
104	36	62	3	6000.00
105	36	62	4	1123.33
140	48	52	3	3433.61
149	51	49	4	5343.00
153	52	48	4	2082.04
157	53	47	4	4635.21
180	59	41	3	146.77
205	77	28	4	405.88
221	81	25	4	958.10
225	82	23	4	172.68
228	83	23	3	822.83
229	83	23	4	617.65
233	84	22	4	809.57
237	85	21	4	1725.40
244	87	19	3	498.86
276	95	13	3	871.63
281	96	12	4	128.91
285	97	11	4	382.74
293	99	10	4	272.01
310	65	40	1	-1044.89
321	71	34	4	-120.94

APPENDIX A

OPTIMIZATION SCENARIOS

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Optimization Scenarios for GETS Pump and Treat System

General formulation common to all scenarios.

1. Objective function is to minimize total pumping extraction from GETS wells. The model does this subject to the below constraints.

2. Only steady-state optimization is performed.

3. No pumping in any existing well should exceed the sustainable rate determined recently in field tests. Earth Tech/Tetra Tech was to have provided estimates of the maximum injection rate physically sustainable for the well locations, based on water quality or other considerations.

4. USU initially considered only existing wells, and tried to capture the plume using less than 200 gpm. When this was impossible, we considered using newly planned monitoring wells or even adding additional wells at new locations. In this case, total pumping was not to exceed 300 gpm. New potential wells were generally placed on the same North-South line as existing wells. None of the potential wells was placed east of the base boundary fence.

5. Groundwater is not permitted to get closer to the bottom of Site 4 landfill than 10', or current (1995) distance, whichever is closest. Earth Technology Corporation (ETC) provided landfill bottom elevation.

6. For existing wells tapping multiple layers (unenhanced by recent changes), the proportion of total extraction assigned to each layer is the same proportion used in the groundwater model calibration. For new wells, the proportion assigned to a layer is that

layer's proportion of the total screened transmissivity. In this draft study, we did not recompute the transmissivity proportions for existing wells enhanced by having their pump intakes lowered.

7. Extracted water can be reinjected to the aquifer after treatment via wells along the Heacock Storm Drain, unless constraints would be violated. Water can be injected to any layer, as needed, on base. Water that cannot be injected can be surface-discharged to the Heacock Storm Drain. Of the surface-discharged flow USU will assume no additional water will infiltrate to the aquifer in the minimum GETS pumping scenario. Tetra Tech (TT) was to provide the proportion of the surface discharged water that will infiltrate during the existing condition and maximum GETS pumping scenarios. ETC provided potential injection well locations.

8. The developed pumping strategy captures 5 ppb and higher contamination contours delineated on a composite contour map developed by TT from Spring 1995 sampling. The single contour map represents the greatest area of 5 ppb or greater) concentrations found in any of the vertical zones (low, medium, and great depths) currently used by TT for contouring.

If capturing the composite plume in all layers requires too much pumping, USU might explore capturing different contours in each of four different model layers. These four separate contours would need to be provided by TT.

9. Capture will be demonstrated using head contours or particle tracking. Because of the model uncertainty, we might eventually want to assure horizontal capture by using a factor of safety represented by obvious recharge mounds and cones of depression. Unless

this is necessary, we will rely on horizontal and vertical particle tracking. When using particle tracking, a particle is placed at the center (x,y,z) of contaminated cells, except for the lowest layer. In the lowest contaminated layer, the particle is placed 1/10 of that layer's saturated thickness above the layer's base.

Scenario-Specific Assumptions

The current plan is to eventually perform optimization to assure capture for three distinct scenarios. These scenarios differ in how they consider activities that might significantly affect the water table and the gradient at the base boundary. Any activity that contributes to a higher water table on-base and higher gradients toward the outside along the base boundary will be considered in the worst-case scenario (maximum pumping scenario). Any activity that contributes to lower water table on-base or lower gradients towards the outside on the base boundary will be considered in the most favorable scenario (minimum pumping scenario). Eventually, USU will present one or more pumping strategies to address the different scenarios.

A. Existing condition GETS pumping scenario

- Boundary conditions are the current (August 1995) water levels.
- Pumping is that in currently calibrated OU1 Model (including 62 gpm at Site 31). There is no additional pumping in the regional model (i.e. none at Perry or Iris/Perris wells).
- No additional recharge due to surface discharge to Heacock Storm Drain is assumed.

B. Minimum GETS pumping scenario

- Boundary heads will be the current (August 1995) water levels.
- Calibrated on-base pumping at Site 31 will be increased to 300 gpm (as specified by Earth Tech).
- Additional recharge due to surface discharge to Heacock Storm Drain will be assumed.

C. Maximum GETS pumping scenario

- Boundary heads will be decreased (as specified by Tetra Tech) to reflect increased future off-base pumping at Perry and Iris/Perris wells.
- Calibrated on-base pumping will be decreased so there is no pumping at Site 31.
- No additional recharge due to surface discharge to Heacock Storm Drain will be assumed.

Post-Optimization Efforts

After strategies are developed, and depending on time constraints, sensitivity of capture to assumptions could be evaluated. For example, USU could predict whether capture will still be achieved if actual transmissivities are only 70% of those assumed doing the optimization.

Agreement and Data Needed by USU

We assume concurrence by the AF, contractors, and regulators on the optimization problem formulation. We have received or should have been provided the following data from the indicated company.

a. Design scenarios--situations for which steady pumping strategy(ies) must be able to capture the plume. By situation or scenario we mean a set of assumed boundary conditions (heads and weather) and background pumping rates. (TT)

b. Outline(s) of plume(s) to be captured in all pertinent layers. (TT)

c. Maximum physically feasible pumping from existing GETS wells. (ETC)

d. Upper limit(s) on potential individual well pumping in all existing or potential new wells. (ETC)

e. Upper limit on total extraction for desired treatment facility size(s). (ETC)

f. All input data and SWIFT output files for revised basewide and OU1 models. (TT)

g. AUTOCAD or other graphics files as appropriate for a report (i.e. new plume outline). (TT)

h. Elevation of base of Site 4 landfill, and outline of Site 4 landfill on a map showing MAFB and the GETS model grid. (ETC)

I. Eastern-most model cells suitable for injection wells. (ETC)

j. Proportion of water surface discharged to Heacock Storm Drain that will recharge the aquifer. (TT)

APPENDIX B

OPTIMIZATION MODEL FORMULATION

Optimization Problem Formulation

A mathematical representation of the March AFB base boundary pumping minimization problem is shown below. The model computes a pumping strategy that minimizes the value of the objective function (Eq. B1), while simultaneously satisfying Eqs. B2-B8. The problem considers 305 possible extraction cells (Eq. B2), 20 possible injection cells (Eq. B3), 192 locations at which head differences are constrained (Eq. B4 and B5), and 116 Site 4 Landfill locations (Eq. B6).

$$\text{MINIMIZE:} \quad \sum_{\hat{a}=1}^{305} \left(p(\hat{a},1) \right) \qquad \text{(B1)}$$

Subject to:

$$0 \text{ gpm} \leq p(\hat{a},1) \leq 31\text{gpm} \quad \text{for } \hat{a} = 1 \ldots 305 \qquad \text{(B2)}$$

$$-26 \text{ gpm} \leq p(\hat{a},1) \leq 0 \text{ gpm} \quad \text{for } \hat{a} = 306\text{-}325 \qquad \text{(B3)}$$

$$\Omega^{L}(\grave{o},1) \leq \Omega(\grave{o},1) \leq \Omega^{H}(\grave{o},1) \quad \text{for } \grave{o} = 1 \ldots 192 \qquad \text{(B4)}$$

$$\Omega(\grave{o},1) = 1 \left[h(\hat{o}_{\grave{o},1},1) - h(\hat{o}_{\grave{o},2},1) \right] \qquad \text{(B5)}$$

$$h(\hat{o},1) \leq h^{U} \text{ for landfill cells} \qquad \text{(B6)}$$

$$- \sum_{\hat{a}=306}^{325} p(\hat{a},1) \leq \sum_{\hat{a}=1}^{305} p(\hat{a},1) \qquad \text{(B7)}$$

$$\sum_{\hat{a}=1}^{305} p(\hat{a},1) \leq 300 \text{ gpm} \qquad \text{(B8)}$$

where:

â	=Index designating location of potential groundwater extraction or injection;
p(â,1)	=Steady-state groundwater pumping rate $[L^3T^{-1}]$. This is extraction (+) at pumping locations 1-305, and injection (-) in locations 306-325;
L, U	=Superscripts designating lower and upper limits, respectively;
ô	=Index designating head observation location;
h(ô,1)	=Potentiometric surface elevation at location ô;
$h(ô_{ò,1}, 1)$	= steady-state potentiometric surface elevation at point 1 (a location ô) of HGV pair ò at end of period 1 (where period 1 represents steady-state conditions), [L];
$h(ô_{ò,2}, 1)$	= steady-state potentiometric surface elevation at point 2 (a second location ô) of HGV pair ò, [L];
ò	=Index designating location of HGV (head difference, gradient or groundwater velocity) constraint.
h^U	= highest of either Spring 95 head or the elevation corresponding to 8ft below the bottom of Site 4 Landfill.

Equation B2 bounds the extraction rate from every cell. The model has the freedom to select any extraction rate between 0 and 31 gpm (6000 cfd) for the cells containing extraction wells, unless the cell cannot sustain this pumping amount.

We assume the cell can sustain an extraction rate if at least 15% of its thickness remains saturated after pumping. If the cell cannot sustain 31 gpm the upper limit on pumping for that cell is reduced to the rate that can be extracted while maintaining a saturated thickness of 15% of the cell vertical thickness. Results are summarized in Table 4.

Equation B3 limits injection per cell to not exceed 26 gpm (5000 cfd). Equation B4 defines the lower and upper limits on the difference in head between two cells Equation B5 defines the difference in final steady-state heads that will result between two cells considered together as a control location.

Equation B6 sets upper bounds on head under the Site 4 Landfill. The head under the Site 4 Landfill should not exceed the highest of groundwater elevation of Spring 95 or the elevation corresponding to 8ft below the bottom of the landfill. No lower bounds are imposed on head.

Equation B7 assures that we do not inject more water than we extract. Equation B8 sets an upper limit on total groundwater extraction. Initially we used an upper limit of 200 gpm (the maximum capacity of the existing GETS system), but could not achieve containment. Thereafter, an upper limit of 300 gpm (maximum potential GETS expansion) was used.

APPENDIX C

CONTROL LOCATIONS
HEAD DIFFERENCE CONTROL PAIRS
POTENTIAL AND EXISTING WELLS
HEAD DIFFERENCE VALUES ACHIEVED

Table C-1. Control Locations.

Location #	Row (i)	Column (j)	Layer (k)
1	31	64	4
2	31	65	4
3	32	63	4
4	32	64	4
5	33	62	4
6	33	63	4
7	34	61	3
8	34	62	3
9	34	61	4
10	34	62	4
11	35	60	3
12	35	61	3
13	35	60	4
14	35	61	4
15	36	59	2
16	36	60	2
17	36	59	3
18	36	60	3
19	36	59	4
20	36	60	4
21	37	59	2
22	37	60	2
23	37	59	3
24	37	60	3
25	37	59	4
26	37	60	4
27	38	58	2
28	38	59	2
29	38	58	3
30	38	59	3
31	38	58	4
32	38	59	4
33	39	57	2
34	39	58	2
35	39	57	3
36	39	58	3
37	39	57	4
38	39	58	4
39	40	56	2
40	40	57	2
41	40	56	3
42	40	57	3
43	40	56	4
44	40	57	4
45	41	55	2

Table C-1. Control Locations, cont'd

Location #	Row (i)	Column (j)	Layer (k)
46	41	56	2
47	41	55	3
48	41	56	3
49	41	55	4
50	41	56	4
51	42	54	2
52	42	55	2
53	42	54	3
54	42	55	3
55	42	54	4
56	42	55	4
57	43	53	2
58	43	54	2
59	43	53	3
60	43	54	3
61	43	53	4
62	43	54	4
63	44	52	2
64	44	53	2
65	44	52	3
66	44	53	3
67	44	52	4
68	44	53	4
69	45	52	2
70	45	53	2
71	45	52	3
72	45	53	3
73	45	52	4
74	45	53	4
75	46	51	2
76	46	52	2
77	46	51	3
78	46	52	3
79	46	51	4
80	46	52	4
81	47	50	2
82	47	51	2
83	47	50	3
84	47	51	3
85	47	50	4
86	47	51	4
87	48	49	2
88	48	50	2
89	48	49	3
90	48	50	3

Table C-1. Control Locations, cont'd

Location #	Row (i)	Column (j)	Layer (k)
91	48	49	4
92	48	50	4
93	49	48	2
94	49	49	2
95	49	48	3
96	49	49	3
97	49	48	4
98	49	49	4
99	50	47	2
100	50	48	2
101	50	47	3
102	50	48	3
103	50	47	4
104	50	48	4
105	51	46	2
106	51	47	2
107	51	46	3
108	51	47	3
109	51	46	4
110	51	47	4
111	52	46	2
112	52	47	2
113	52	46	3
114	52	47	3
115	52	46	4
116	52	47	4
117	53	45	3
118	53	46	3
119	53	45	4
120	53	46	4
121	54	44	1
122	54	45	1
123	54	44	2
124	54	45	2
125	54	44	3
126	54	45	3
127	54	44	4
128	54	45	4
129	55	43	1
130	55	44	1
131	55	43	2
132	55	44	2
133	55	43	3
134	55	44	3
135	55	43	4

Table C-1. Control Locations, cont'd

Location #	Row (i)	Column (j)	Layer (k)
136	55	44	4
137	56	42	1
138	56	43	1
139	56	42	2
140	56	43	2
141	56	42	3
142	56	43	3
143	56	42	4
144	56	43	4
145	57	41	1
146	57	42	1
147	57	41	2
148	57	42	2
149	57	41	3
150	57	42	3
151	57	41	4
152	57	42	4
153	58	41	1
154	58	42	1
155	58	41	2
156	58	42	2
157	58	41	3
158	58	42	3
159	58	41	4
160	58	42	4
161	59	40	1
162	59	41	1
163	59	40	2
164	59	41	2
165	59	40	3
166	59	41	3
167	59	40	4
168	59	41	4
169	60	39	2
170	60	40	2
171	60	39	3
172	60	40	3
173	60	39	4
174	60	40	4
175	63	42	3
176	63	43	3
177	63	42	4
178	63	43	4
179	64	42	3
180	64	43	3

Table C-1. Control Locations, cont'd

Location #	Row (i)	Column (j)	Layer (k)
181	64	42	4
182	64	43	4
183	65	41	3
184	65	42	3
185	65	41	4
186	65	42	4
187	66	40	3
188	66	41	3
189	66	40	4
190	66	41	4
191	67	39	3
192	67	40	3
193	67	39	4
194	67	40	4
195	68	38	4
196	68	39	4
197	69	37	4
198	69	38	4
199	70	36	4
200	70	37	4
201	71	35	4
202	71	36	4
203	72	34	4
204	72	35	4
205	73	33	4
206	73	34	4
207	74	32	4
208	74	33	4
209	74	28	3
210	74	29	3
211	74	28	4
212	74	29	4
213	75	28	3
214	75	29	3
215	75	28	4
216	75	29	4
217	76	27	3
218	76	28	3
219	76	27	4
220	76	28	4
221	77	26	3
222	77	27	3
223	77	26	4
224	77	27	4
225	78	26	3

Table C-1. Control Locations, cont'd

Location #	Row (i)	Column (j)	Layer (k)
226	78	27	3
227	78	26	4
228	78	27	4
229	79	25	3
230	79	26	3
231	79	25	4
232	79	26	4
233	80	24	3
234	80	25	3
235	80	24	4
236	80	25	4
237	81	23	2
238	81	24	2
239	81	23	3
240	81	24	3
241	81	23	4
242	81	24	4
243	82	22	2
244	82	23	2
245	82	22	3
246	82	23	3
247	82	22	4
248	82	23	4
249	83	22	2
250	83	23	2
251	83	22	3
252	83	23	3
253	83	22	4
254	83	23	4
255	84	21	2
256	84	22	2
257	84	21	3
258	84	22	3
259	84	21	4
260	84	22	4
261	85	20	2
262	85	21	2
263	85	20	3
264	85	21	3
265	85	20	4
266	85	21	4
267	86	19	2
268	86	20	2
269	86	19	3
270	86	20	3

Table C-1. Control Locations, cont'd

Location #	Row (i)	Column (j)	Layer (k)
271	86	19	4
272	86	20	4
273	87	18	2
274	87	19	2
275	87	18	3
276	87	19	3
277	87	18	4
278	87	19	4
279	88	17	2
280	88	18	2
281	88	17	3
282	88	18	3
283	88	17	4
284	88	18	4
285	88	16	2
286	88	17	2
287	88	16	3
288	88	17	3
289	88	16	4
290	88	17	4
291	89	15	1
292	89	16	1
293	89	15	2
294	89	16	2
295	89	15	3
296	89	16	3
297	89	15	4
298	89	16	4
299	90	15	1
300	90	16	1
301	90	15	2
302	90	16	2
303	90	15	3
304	90	16	3
305	90	15	4
306	90	16	4
307	91	15	1
308	91	16	1
309	91	15	2
310	91	16	2
311	91	15	3
312	91	16	3
313	91	15	4
314	91	16	4
315	92	14	1

Table C-1. Control Locations, cont'd

Location #	Row (i)	Column (j)	Layer (k)
316	92	15	1
317	92	14	2
318	92	15	2
319	92	14	3
320	92	15	3
321	92	14	4
322	92	15	4
323	93	13	1
324	93	14	1
325	93	13	2
326	93	14	2
327	93	13	3
328	93	14	3
329	93	13	4
330	93	14	4
331	94	12	1
332	94	13	1
333	94	12	2
334	94	13	2
335	94	12	3
336	94	13	3
337	94	12	4
338	94	13	4
339	95	11	2
340	95	12	2
341	95	11	3
342	95	12	3
343	95	11	4
344	95	12	4
345	96	10	2
346	96	11	2
347	96	10	3
348	96	11	3
349	96	10	4
350	96	11	4
351	97	10	2
352	97	11	2
353	97	10	3
354	97	11	3
355	97	10	4
356	97	11	4
357	98	10	2
358	98	11	2
359	98	10	3
360	98	11	3

Table C-1. Control Locations, cont'd

Location #	Row (i)	Column (j)	Layer (k)
361	98	10	4
362	98	11	4
363	99	9	2
364	99	10	2
365	99	9	3
366	99	10	3
367	99	9	4
368	99	10	4
369	100	8	2
370	100	9	2
371	100	8	3
372	100	9	3
373	100	8	4
374	100	9	4
375	101	7	2
376	101	8	2
377	101	7	3
378	101	8	3
379	101	7	4
380	101	8	4
381	102	7	3
382	102	8	3
383	102	7	4
384	102	8	4

Table C-2. Head Difference Control Locations.

Pair #	Control Location #'s	
1	1	2
2	3	4
3	5	6
4	7	8
5	9	10
6	11	12
7	13	14
8	15	16
9	17	18
10	19	20
11	21	22
12	23	24
13	25	26
14	27	28
15	29	30
16	31	32
17	33	34
18	35	36
19	37	38
20	39	40
21	41	42
22	43	44
23	45	46
24	47	48
25	49	50
26	51	52
27	53	54
28	55	56
29	57	58
30	59	60
31	61	62
32	63	64
33	65	66
34	67	68
35	69	70
36	71	72
37	73	74
38	75	76
39	77	78
40	79	80
41	81	82
42	83	84
43	85	86
44	87	88
45	89	90

Table C-2. Head Difference Control Locations, cont'd

Pair #	Control Location #'s	
46	91	92
47	93	94
48	95	96
49	97	98
50	99	100
51	101	102
52	103	104
53	105	106
54	107	108
55	109	110
56	111	112
57	113	114
58	115	116
59	117	118
60	119	120
61	121	122
62	123	124
63	125	126
64	127	128
65	129	130
66	131	132
67	133	134
68	135	136
69	137	138
70	139	140
71	141	142
72	143	144
73	145	146
74	147	148
75	149	150
76	151	152
77	153	154
78	155	156
79	157	158
80	159	160
81	161	162
82	163	164
83	165	166
84	167	168
85	169	170
86	171	172
87	173	174
88	175	176
89	177	178
90	179	180

Table C-2. Head Difference Control Locations, cont'd

Pair #	Control Location #'s	
91	181	182
92	183	184
93	185	186
94	187	188
95	189	190
96	191	192
97	193	194
98	195	196
99	197	198
100	199	200
101	201	202
102	203	204
103	205	206
104	207	208
105	209	210
106	211	212
107	213	214
108	215	216
109	217	218
110	219	220
111	221	222
112	223	224
113	225	226
114	227	228
115	229	230
116	231	232
117	233	234
118	235	236
119	237	238
120	239	240
121	241	242
122	243	244
123	245	246
124	247	248
125	249	250
126	251	252
127	253	254
128	255	256
129	257	258
130	259	260
131	261	262
132	263	264
133	265	266
134	267	268
135	269	270

Table C-2. Head Difference Control Locations, cont'd

Pair #	Control Location #'s	
136	271	272
137	273	274
138	275	276
139	277	278
140	279	280
141	281	282
142	283	284
143	285	286
144	287	288
145	289	290
146	291	292
147	293	294
148	295	296
149	297	298
150	299	300
151	301	302
152	303	304
153	305	306
154	307	308
155	309	310
156	311	312
157	313	314
158	315	316
159	317	318
160	319	320
161	321	322
162	323	324
163	325	326
164	327	328
165	329	330
166	331	332
167	333	334
168	335	336
169	337	338
170	339	340
171	341	342
172	343	344
173	345	346
174	347	348
175	349	350
176	351	352
177	353	354
178	355	356
179	357	358
180	359	360

Table C-2. Head Difference Control Locations, cont'd

Pair #	Control Location #'s	
181	361	362
182	363	364
183	365	366
184	367	368
185	369	370
186	371	372
187	373	374
188	375	376
189	377	378
190	379	380
191	381	382
192	383	384

Table C-3. Potential and Existing Wells.

Well #	i	j	Screened From Layer #	to Layer #	Description
1	50	50	1	3	* EX 1 *
2	45	53	1	2	* EX 2 *
3	42	56	1	2	* EX 3 *
4	38	59	1	2	* EX 4 *
5	33	63	1	2	* EX 5A *
6	25	71	2	3	* EX 7 *
7	22	75	2	3	* EX 8 *
8	89	16	4	4	* 4 MW 1 *
9	29	67	2	3	* EX 6 *
10	50	50	1	1	*NEW WELL E1*
11	50	50	2	2	*NEW WELL E1*
12	50	50	3	3	*NEW WELL E1*
13	50	50	4	4	*NEW WELL E1*
14	45	53	1	1	*NEW WELL E2*
15	45	53	2	2	*NEW WELL E2*
16	45	53	3	3	*NEW WELL E2*
17	45	53	4	4	*NEW WELL E2*
18	42	56	1	1	*NEW WELL E3*
19	42	56	2	2	*NEW WELL E3*
20	42	56	3	3	*NEW WELL E3*
21	42	56	4	4	*NEW WELL E3*
22	38	59	1	1	*NEW WELL E4*
23	38	59	2	2	*NEW WELL E4*
24	38	59	3	3	*NEW WELL E4*
25	38	59	4	4	*NEW WELL E4*
26	33	63	1	1	*NEW WELL E5*
27	33	63	2	2	*NEW WELL E5*
28	33	63	3	3	*NEW WELL E5*
29	33	63	4	4	*NEW WELL E5*
30	25	71	1	1	*NEW WELL E6*
31	25	71	2	2	*NEW WELL E6*
32	25	71	3	3	*NEW WELL E6*
33	25	71	4	4	*NEW WELL E6*
34	22	75	1	1	*NEW WELL E7*
35	22	75	2	2	*NEW WELL E7*
36	22	75	3	3	*NEW WELL E7*
37	22	75	4	4	*NEW WELL E7*
38	89	16	1	1	*NEW WELL E8*
39	89	16	2	2	*NEW WELL E8*
40	89	16	3	3	*NEW WELL E8*
41	89	16	4	4	*NEW WELL E8*
42	29	67	1	1	*NEW WELL E9*
43	29	67	2	2	*NEW WELL E9*
44	29	67	3	3	*NEW WELL E9*
45	29	67	4	4	*NEW WELL E9*

Table C-3. Potential and Existing Wells, cont'd

Well #	i	j	Screened From Layer #	to Layer #	Description
46	20	77	1	1	*NEW WELL 1*
47	20	77	2	2	*NEW WELL 1*
48	20	77	3	3	*NEW WELL 1*
49	20	77	4	4	*NEW WELL 1*
50	21	76	1	1	*NEW WELL 2*
51	21	76	2	2	*NEW WELL 2*
52	21	76	3	3	*NEW WELL 2*
53	21	76	4	4	*NEW WELL 2*
54	23	74	1	1	*NEW WELL 3*
55	23	74	2	2	*NEW WELL 3*
56	23	74	3	3	*NEW WELL 3*
57	23	74	4	4	*NEW WELL 3*
58	24	73	1	1	*NEW WELL 4*
59	24	73	2	2	*NEW WELL 4*
60	24	73	3	3	*NEW WELL 4*
61	24	73	4	4	*NEW WELL 4*
62	25	72	1	1	*NEW WELL 5*
63	25	72	2	2	*NEW WELL 5*
64	25	72	3	3	*NEW WELL 5*
65	25	72	4	4	*NEW WELL 5*
66	26	71	1	1	*NEW WELL 6*
67	26	71	2	2	*NEW WELL 6*
68	26	71	3	3	*NEW WELL 6*
69	26	71	4	4	*NEW WELL 6*
70	27	70	1	1	*NEW WELL 7*
71	27	70	2	2	*NEW WELL 7*
72	27	70	3	3	*NEW WELL 7*
73	27	70	4	4	*NEW WELL 7*
74	28	69	1	1	*NEW WELL 8*
75	28	69	2	2	*NEW WELL 8*
76	28	69	3	3	*NEW WELL 8*
77	28	69	4	4	*NEW WELL 8*
78	28	68	1	1	*NEW WELL 9*
79	28	68	2	2	*NEW WELL 9*
80	28	68	3	3	*NEW WELL 9*
81	28	68	4	4	*NEW WELL 9*
82	30	66	1	1	*NEW WELL 10*
83	30	66	2	2	*NEW WELL 10*
84	30	66	3	3	*NEW WELL 10*
85	30	66	4	4	*NEW WELL 10*
86	31	65	1	1	*NEW WELL 11*
87	31	65	2	2	*NEW WELL 11*
88	31	65	3	3	*NEW WELL 11*
89	31	65	4	4	*NEW WELL 11*
90	32	65	1	1	*NEW WELL 12*

Table C-3. Potential and Existing Wells, cont'd

Well #	i	j	Screened From Layer #	to Layer #	Description
91	32	65	2	2	*NEW WELL 12*
92	32	65	3	3	*NEW WELL 12*
93	32	65	4	4	*NEW WELL 12*
94	34	62	1	1	*NEW WELL 13*
95	34	62	2	2	*NEW WELL 13*
96	34	62	3	3	*NEW WELL 13*
97	34	62	4	4	*NEW WELL 13*
98	35	62	1	1	*NEW WELL 14*
99	35	62	2	2	*NEW WELL 14*
100	35	62	3	3	*NEW WELL 14*
101	35	62	4	4	*NEW WELL 14*
102	36	62	1	1	*NEW WELL 15*
103	36	62	2	2	*NEW WELL 15*
104	36	62	3	3	*NEW WELL 15*
105	36	62	4	4	*NEW WELL 15*
106	37	60	1	1	*NEW WELL 16*
107	37	60	2	2	*NEW WELL 16*
108	37	60	3	3	*NEW WELL 16*
109	37	60	4	4	*NEW WELL 16*
110	39	58	1	1	*NEW WELL 17*
111	39	58	2	2	*NEW WELL 17*
112	39	58	3	3	*NEW WELL 17*
113	39	58	4	4	*NEW WELL 17*
114	40	58	1	1	*NEW WELL 18*
115	40	58	2	2	*NEW WELL 18*
116	40	58	3	3	*NEW WELL 18*
117	40	58	4	4	*NEW WELL 18*
118	41	57	1	1	*NEW WELL 19*
119	41	57	2	2	*NEW WELL 19*
120	41	57	3	3	*NEW WELL 19*
121	41	57	4	4	*NEW WELL 19*
122	43	55	1	1	*NEW WELL 20*
123	43	55	2	2	*NEW WELL 20*
124	43	55	3	3	*NEW WELL 20*
125	43	55	4	4	*NEW WELL 20*
126	44	54	1	1	*NEW WELL 21*
127	44	54	2	2	*NEW WELL 21*
128	44	54	3	3	*NEW WELL 21*
129	44	54	4	4	*NEW WELL 21*
130	46	52	1	1	*NEW WELL 22*
131	46	52	2	2	*NEW WELL 22*
132	46	52	3	3	*NEW WELL 22*
133	46	52	4	4	*NEW WELL 22*
134	47	51	1	1	*NEW WELL 23*
135	47	51	2	2	*NEW WELL 23*

Table C-3. Potential and Existing Wells, cont'd

Well #	i	j	Screened From Layer #	to Layer #	Description
136	47	51	3	3	*NEW WELL 23*
137	47	51	4	4	*NEW WELL 23*
138	48	52	1	1	*NEW WELL 24*
139	48	52	2	2	*NEW WELL 24*
140	48	52	3	3	*NEW WELL 24*
141	48	52	4	4	*NEW WELL 24*
142	49	50	1	1	*NEW WELL 25*
143	49	50	2	2	*NEW WELL 25*
144	49	50	3	3	*NEW WELL 25*
145	49	50	4	4	*NEW WELL 25*
146	51	49	1	1	*NEW WELL 26*
147	51	49	2	2	*NEW WELL 26*
148	51	49	3	3	*NEW WELL 26*
149	51	49	4	4	*NEW WELL 26*
150	52	48	1	1	*NEW WELL 27*
151	52	48	2	2	*NEW WELL 27*
152	52	48	3	3	*NEW WELL 27*
153	52	48	4	4	*NEW WELL 27*
154	53	47	1	1	*NEW WELL 28*
155	53	47	2	2	*NEW WELL 28*
156	53	47	3	3	*NEW WELL 28*
157	53	47	4	4	*NEW WELL 28*
158	54	46	1	1	*NEW WELL 29*
159	54	46	2	2	*NEW WELL 29*
160	54	46	3	3	*NEW WELL 29*
161	54	46	4	4	*NEW WELL 29*
162	55	45	1	1	*NEW WELL 30*
163	55	45	2	2	*NEW WELL 30*
164	55	45	3	3	*NEW WELL 30*
165	55	45	4	4	*NEW WELL 30*
166	56	44	1	1	*NEW WELL 31*
167	56	44	2	2	*NEW WELL 31*
168	56	44	3	3	*NEW WELL 31*
169	56	44	4	4	*NEW WELL 31*
170	57	43	1	1	*NEW WELL 32*
171	57	43	2	2	*NEW WELL 32*
172	57	43	3	3	*NEW WELL 32*
173	57	43	4	4	*NEW WELL 32*
174	58	42	1	1	*NEW WELL 33*
175	58	42	2	2	*NEW WELL 33*
176	58	42	3	3	*NEW WELL 33*
177	58	42	4	4	*NEW WELL 33*
178	59	41	1	1	*NEW WELL 34*
179	59	41	2	2	*NEW WELL 34*
180	59	41	3	3	*NEW WELL 34*

Table C-3. Potential and Existing Wells, cont'd

Well #	i	j	Screened From Layer #	to Layer #	Description
181	59	41	4	4	*NEW WELL 34*
182	60	40	1	1	*NEW WELL 35*
183	60	40	2	2	*NEW WELL 35*
184	60	40	3	3	*NEW WELL 35*
185	60	40	4	4	*NEW WELL 35*
186	73	31	1	1	*NEW WELL 36*
187	73	31	2	2	*NEW WELL 36*
188	73	31	3	3	*NEW WELL 36*
189	73	31	4	4	*NEW WELL 36*
190	74	30	1	1	*NEW WELL 37*
191	74	30	2	2	*NEW WELL 37*
192	74	30	3	3	*NEW WELL 37*
193	74	30	4	4	*NEW WELL 37*
194	75	29	1	1	*NEW WELL 38*
195	75	29	2	2	*NEW WELL 38*
196	75	29	3	3	*NEW WELL 38*
197	75	29	4	4	*NEW WELL 38*
198	76	28	1	1	*NEW WELL 39*
199	76	28	2	2	*NEW WELL 39*
200	76	28	3	3	*NEW WELL 39*
201	76	28	4	4	*NEW WELL 39*
202	77	28	1	1	*NEW WELL 40*
203	77	28	2	2	*NEW WELL 40*
204	77	28	3	3	*NEW WELL 40*
205	77	28	4	4	*NEW WELL 40*
206	78	27	1	1	*NEW WELL 41*
207	78	27	2	2	*NEW WELL 41*
208	78	27	3	3	*NEW WELL 41*
209	78	27	4	4	*NEW WELL 41*
210	79	26	1	1	*NEW WELL 42*
211	79	26	2	2	*NEW WELL 42*
212	79	26	3	3	*NEW WELL 42*
213	79	26	4	4	*NEW WELL 42*
214	80	25	1	1	*NEW WELL 43*
215	80	25	2	2	*NEW WELL 43*
216	80	25	3	3	*NEW WELL 43*
217	80	25	4	4	*NEW WELL 43*
218	81	25	1	1	*NEW WELL 44*
219	81	25	2	2	*NEW WELL 44*
220	81	25	3	3	*NEW WELL 44*
221	81	25	4	4	*NEW WELL 44*
222	82	23	1	1	*NEW WELL 45*
223	82	23	2	2	*NEW WELL 45*
224	82	23	3	3	*NEW WELL 45*
225	82	23	4	4	*NEW WELL 45*

Table C-3. Potential and Existing Wells, cont'd

Well #	i	j	Screened From Layer #	to Layer #	Description
226	83	23	1	1	*NEW WELL 46*
227	83	23	2	2	*NEW WELL 46*
228	83	23	3	3	*NEW WELL 46*
229	83	23	4	4	*NEW WELL 46*
230	84	22	1	1	*NEW WELL 47*
231	84	22	2	2	*NEW WELL 47*
232	84	22	3	3	*NEW WELL 47*
233	84	22	4	4	*NEW WELL 47*
234	85	21	1	1	*NEW WELL 48*
235	85	21	2	2	*NEW WELL 48*
236	85	21	3	3	*NEW WELL 48*
237	85	21	4	4	*NEW WELL 48*
238	86	20	1	1	*NEW WELL 49*
239	86	20	2	2	*NEW WELL 49*
240	86	20	3	3	*NEW WELL 49*
241	86	20	4	4	*NEW WELL 49*
242	87	19	1	1	*NEW WELL 50*
243	87	19	2	2	*NEW WELL 50*
244	87	19	3	3	*NEW WELL 50*
245	87	19	4	4	*NEW WELL 50*
246	88	18	1	1	*NEW WELL 51*
247	88	18	2	2	*NEW WELL 51*
248	88	18	3	3	*NEW WELL 51*
249	88	18	4	4	*NEW WELL 51*
250	89	18	1	1	*NEW WELL 52*
251	89	18	2	2	*NEW WELL 52*
252	89	18	3	3	*NEW WELL 52*
253	89	18	4	4	*NEW WELL 52*
254	90	17	1	1	*NEW WELL 53*
255	90	17	2	2	*NEW WELL 53*
256	90	17	3	3	*NEW WELL 53*
257	90	17	4	4	*NEW WELL 53*
258	91	16	1	1	*NEW WELL 54*
259	91	16	2	2	*NEW WELL 54*
260	91	16	3	3	*NEW WELL 54*
261	91	16	4	4	*NEW WELL 54*
262	92	15	1	1	*NEW WELL 55*
263	92	15	2	2	*NEW WELL 55*
264	92	15	3	3	*NEW WELL 55*
265	92	15	4	4	*NEW WELL 55*
266	93	14	1	1	*NEW WELL 56*
267	93	14	2	2	*NEW WELL 56*
268	93	14	3	3	*NEW WELL 56*
269	93	14	4	4	*NEW WELL 56*
270	94	13	1	1	*NEW WELL 57*

Table C-3. Potential and Existing Wells, cont'd

Well #	i	j	Screened From Layer #	to Layer #	Description
271	94	13	2	2	*NEW WELL 57*
272	94	13	3	3	*NEW WELL 57*
273	94	13	4	4	*NEW WELL 57*
274	95	13	1	1	*NEW WELL 58*
275	95	13	2	2	*NEW WELL 58*
276	95	13	3	3	*NEW WELL 58*
277	95	13	4	4	*NEW WELL 58*
278	96	12	1	1	*NEW WELL 59*
279	96	12	2	2	*NEW WELL 59*
280	96	12	3	3	*NEW WELL 59*
281	96	12	4	4	*NEW WELL 59*
282	97	11	1	1	*NEW WELL 60*
283	97	11	2	2	*NEW WELL 60*
284	97	11	3	3	*NEW WELL 60*
285	97	11	4	4	*NEW WELL 60*
286	98	11	1	1	*NEW WELL 61*
287	98	11	2	2	*NEW WELL 61*
288	98	11	3	3	*NEW WELL 61*
289	98	11	4	4	*NEW WELL 61*
290	99	10	1	1	*NEW WELL 62*
291	99	10	2	2	*NEW WELL 62*
292	99	10	3	3	*NEW WELL 62*
293	99	10	4	4	*NEW WELL 62*
294	100	9	1	1	*NEW WELL 63*
295	100	9	2	2	*NEW WELL 63*
296	100	9	3	3	*NEW WELL 63*
297	100	9	4	4	*NEW WELL 63*
298	101	8	1	1	*NEW WELL 64*
299	101	8	2	2	*NEW WELL 64*
300	101	8	3	3	*NEW WELL 64*
301	101	8	4	4	*NEW WELL 64*
302	102	8	1	1	*NEW WELL 65*
303	102	8	2	2	*NEW WELL 65*
304	102	8	3	3	*NEW WELL 65*
305	102	8	4	4	*NEW WELL 65*
306	62	42	1	1	*INJ WELL 1*
307	62	42	2	2	*INJ WELL 1*
308	62	42	3	3	*INJ WELL 1*
309	62	42	4	4	*INJ WELL 1*
310	65	40	1	1	*INJ WELL 2*
311	65	40	2	2	*INJ WELL 2*
312	65	40	3	3	*INJ WELL 2*
313	65	40	4	4	*INJ WELL 2*
314	68	37	1	1	*INJ WELL 3*
315	68	37	2	2	*INJ WELL 3*

Table C-3. Potential and Existing Wells, cont'd

Well #	i	j	Screened From Layer #	to Layer #	Description
316	68	37	3	3	*INJ WELL 3*
317	68	37	4	4	*INJ WELL 3*
318	71	34	1	1	*INJ WELL 4*
319	71	34	2	2	*INJ WELL 4*
320	71	34	3	3	*INJ WELL 4*
321	71	34	4	4	*INJ WELL 4*
322	74	31	1	1	*INJ WELL 5*
323	74	31	2	2	*INJ WELL 5*
324	74	31	3	3	*INJ WELL 5*
325	74	31	4	4	*INJ WELL 5*

Table C-4. Head difference values achieved by the pumping strategy.

Pair #	Control Loc. #1 (i1,j1,k1)		Control Loc. #2 (i2,j2,k2)	Head #1 (ft)	Head #2 (ft)	Head diff (ft)
1	1 @ (31,64,4)	&	2 @ (31,65,4)	1353.18	1352.46	0.72
2	3 @ (32,63,4)	&	4 @ (32,64,4)	1353.84	1352.99	0.85
3	5 @ (33,62,4)	&	6 @ (33,63,4)	1354.55	1353.89	0.66
4	7 @ (34,61,3)	&	8 @ (34,62,3)	1356.00	dry	NA
5	9 @ (34,61,4)	&	10 @ (34,62,4)	1355.21	1354.45	0.76
6	11 @ (35,60,3)	&	12 @ (35,61,3)	1357.12	1356.50	0.61
7	13 @ (35,60,4)	&	14 @ (35,61,4)	1356.40	1355.28	1.12
8	15 @ (36,59,2)	&	16 @ (36,60,2)	dry	dry	NA
9	17 @ (36,59,3)	&	18 @ (36,60,3)	1359.14	1358.12	1.02
10	19 @ (36,59,4)	&	20 @ (36,60,4)	1358.89	1357.65	1.24
11	21 @ (37,59,2)	&	22 @ (37,60,2)	dry	dry	NA
12	23 @ (37,59,3)	&	24 @ (37,60,3)	1360.73	1359.60	1.13
13	25 @ (37,59,4)	&	26 @ (37,60,4)	1360.60	1359.35	1.25
14	27 @ (38,58,2)	&	28 @ (38,59,2)	1364.90	dry	NA
15	29 @ (38,58,3)	&	30 @ (38,59,3)	1364.58	1362.92	1.65
16	31 @ (38,58,4)	&	32 @ (38,59,4)	1364.66	1362.94	1.72
17	33 @ (39,57,2)	&	34 @ (39,58,2)	1370.06	1368.48	1.58
18	35 @ (39,57,3)	&	36 @ (39,58,3)	1369.78	1368.14	1.64
19	37 @ (39,57,4)	&	38 @ (39,58,4)	1370.01	1368.25	1.76
20	39 @ (40,56,2)	&	40 @ (40,57,2)	1375.52	1373.18	2.34
21	41 @ (40,56,3)	&	42 @ (40,57,3)	1375.54	1373.06	2.48
22	43 @ (40,56,4)	&	44 @ (40,57,4)	1375.69	1373.22	2.48
23	45 @ (41,55,2)	&	46 @ (41,56,2)	dry	1377.30	NA
24	47 @ (41,55,3)	&	48 @ (41,56,3)	1379.09	1377.50	1.59
25	49 @ (41,55,4)	&	50 @ (41,56,4)	1379.10	1377.52	1.59
26	51 @ (42,54,2)	&	52 @ (42,55,2)	dry	dry	NA
27	53 @ (42,54,3)	&	54 @ (42,55,3)	1381.00	1379.69	1.31
28	55 @ (42,54,4)	&	56 @ (42,55,4)	1381.04	1379.73	1.30
29	57 @ (43,53,2)	&	58 @ (43,54,2)	dry	dry	NA
30	59 @ (43,53,3)	&	60 @ (43,54,3)	1383.15	1382.15	1.00
31	61 @ (43,53,4)	&	62 @ (43,54,4)	1383.17	1382.19	0.98
32	63 @ (44,52,2)	&	64 @ (44,53,2)	dry	dry	NA
33	65 @ (44,52,3)	&	66 @ (44,53,3)	1385.46	1384.50	0.96
34	67 @ (44,52,4)	&	68 @ (44,53,4)	1385.47	1384.53	0.93
35	69 @ (45,52,2)	&	70 @ (45,53,2)	dry	dry	NA
36	71 @ (45,52,3)	&	72 @ (45,53,3)	1386.37	1385.38	0.99
37	73 @ (45,52,4)	&	74 @ (45,53,4)	1386.42	1385.65	0.77
38	75 @ (46,51,2)	&	76 @ (46,52,2)	dry	dry	NA
39	77 @ (46,51,3)	&	78 @ (46,52,3)	1387.83	1387.17	0.66
40	79 @ (46,51,4)	&	80 @ (46,52,4)	1387.88	1387.26	0.62
41	81 @ (47,50,2)	&	82 @ (47,51,2)	dry	dry	NA
42	83 @ (47,50,3)	&	84 @ (47,51,3)	1389.06	1388.37	0.69
43	85 @ (47,50,4)	&	86 @ (47,51,4)	1389.14	1388.50	0.64
44	87 @ (48,49,2)	&	88 @ (48,50,2)	dry	dry	NA
45	89 @ (48,49,3)	&	90 @ (48,50,3)	1390.45	1389.71	0.74
46	91 @ (48,49,4)	&	92 @ (48,50,4)	1390.52	1389.85	0.67
47	93 @ (49,48,2)	&	94 @ (49,49,2)	dry	dry	NA
48	95 @ (49,48,3)	&	96 @ (49,49,3)	1392.09	dry	NA
49	97 @ (49,48,4)	&	98 @ (49,49,4)	1392.08	1391.32	0.76

Table C-4. Head difference values achieved by the pumping strategy, cont'd

Pair #	Control Loc. #1 (i1,j1,k1)	Control Loc. #2 (i2,j2,k2)	Head #1 (ft)	Head #2 (ft)	Head diff (ft)
50	99 @ (50,47,2)	&100 @ (50,48,2)	dry	dry	NA
51	101 @ (50,47,3)	&102 @ (50,48,3)	1393.72	1392.79	0.93
52	103 @ (50,47,4)	&104 @ (50,48,4)	1393.99	1392.89	1.10
53	105 @ (51,46,2)	&106 @ (51,47,2)	dry	dry	NA
54	107 @ (51,46,3)	&108 @ (51,47,3)	1395.61	dry	NA
55	109 @ (51,46,4)	&110 @ (51,47,4)	1396.16	1395.46	0.71
56	111 @ (52,46,2)	&112 @ (52,47,2)	dry	dry	NA
57	113 @ (52,46,3)	&114 @ (52,47,3)	dry	dry	NA
58	115 @ (52,46,4)	&116 @ (52,47,4)	1397.50	1396.85	0.65
59	117 @ (53,45,3)	&118 @ (53,46,3)	dry	dry	NA
60	119 @ (53,45,4)	&120 @ (53,46,4)	1399.34	1398.83	0.52
61	121 @ (54,44,1)	&122 @ (54,45,1)	dry	dry	NA
62	123 @ (54,44,2)	&124 @ (54,45,2)	dry	dry	NA
63	125 @ (54,44,3)	&126 @ (54,45,3)	1405.83	dry	NA
64	127 @ (54,44,4)	&128 @ (54,45,4)	1404.42	1401.05	3.38
65	129 @ (55,43,1)	&130 @ (55,44,1)	dry	dry	NA
66	131 @ (55,43,2)	&132 @ (55,44,2)	1414.96	dry	NA
67	133 @ (55,43,3)	&134 @ (55,44,3)	1414.34	1410.78	3.55
68	135 @ (55,43,4)	&136 @ (55,44,4)	1412.48	1408.39	4.09
69	137 @ (56,42,1)	&138 @ (56,43,1)	dry	dry	NA
70	139 @ (56,42,2)	&140 @ (56,43,2)	1418.02	1416.89	1.14
71	141 @ (56,42,3)	&142 @ (56,43,3)	1417.80	1416.60	1.20
72	143 @ (56,42,4)	&144 @ (56,43,4)	1416.85	1414.90	1.94
73	145 @ (57,41,1)	&146 @ (57,42,1)	dry	dry	NA
74	147 @ (57,41,2)	&148 @ (57,42,2)	1419.16	1418.02	1.14
75	149 @ (57,41,3)	&150 @ (57,42,3)	1419.00	1417.83	1.17
76	151 @ (57,41,4)	&152 @ (57,42,4)	1418.65	1417.10	1.55
77	153 @ (58,41,1)	&154 @ (58,42,1)	dry	dry	NA
78	155 @ (58,41,2)	&156 @ (58,42,2)	1418.71	1417.70	1.02
79	157 @ (58,41,3)	&158 @ (58,42,3)	1418.66	1417.63	1.03
80	159 @ (58,41,4)	&160 @ (58,42,4)	1418.68	1417.37	1.31
81	161 @ (59,40,1)	&162 @ (59,41,1)	dry	dry	NA
82	163 @ (59,40,2)	&164 @ (59,41,2)	1421.39	1417.76	3.63
83	165 @ (59,40,3)	&166 @ (59,41,3)	1421.47	1417.36	4.11
84	167 @ (59,40,4)	&168 @ (59,41,4)	1421.94	1418.72	3.22
85	169 @ (60,39,2)	&170 @ (60,40,2)	dry	dry	NA
86	171 @ (60,39,3)	&172 @ (60,40,3)	1423.92	1423.41	0.51
87	173 @ (60,39,4)	&174 @ (60,40,4)	1424.39	1423.58	0.81
88	175 @ (63,42,3)	&176 @ (63,43,3)	dry	dry	NA
89	177 @ (63,42,4)	&178 @ (63,43,4)	1424.61	1423.83	0.78
90	179 @ (64,42,3)	&180 @ (64,43,3)	dry	dry	NA
91	181 @ (64,42,4)	&182 @ (64,43,4)	1425.91	1425.23	0.68
92	183 @ (65,41,3)	&184 @ (65,42,3)	dry	dry	NA
93	185 @ (65,41,4)	&186 @ (65,42,4)	1427.96	1427.22	0.75
94	187 @ (66,40,3)	&188 @ (66,41,3)	dry	dry	NA
95	189 @ (66,40,4)	&190 @ (66,41,4)	1429.71	1429.05	0.66
96	191 @ (67,39,3)	&192 @ (67,40,3)	dry	dry	NA
97	193 @ (67,39,4)	&194 @ (67,40,4)	1431.21	1430.68	0.53
98	195 @ (68,38,4)	&196 @ (68,39,4)	1432.84	1432.24	0.60

Table C-4. Head difference values achieved by the pumping strategy, cont'd

Pair #	Control Loc. #1 (i1,j1,k1)	Control Loc. #2 (i2,j2,k2)	Head #1 (ft)	Head #2 (ft)	Head diff (ft)
99	197 @ (69,37,4)	&198 @ (69,38,4)	1434.47	1433.82	0.65
100	199 @ (70,36,4)	&200 @ (70,37,4)	1436.00	1435.36	0.64
101	201 @ (71,35,4)	&202 @ (71,36,4)	1437.43	1436.82	0.61
102	203 @ (72,34,4)	&204 @ (72,35,4)	1438.79	1438.25	0.54
103	205 @ (73,33,4)	&206 @ (73,34,4)	1440.60	1439.71	0.89
104	207 @ (74,32,4)	&208 @ (74,33,4)	1442.74	1441.70	1.04
105	209 @ (74,28,3)	&210 @ (74,29,3)	dry	dry	NA
106	211 @ (74,28,4)	&212 @ (74,29,4)	1451.27	1450.56	0.72
107	213 @ (75,28,3)	&214 @ (75,29,3)	dry	dry	NA
108	215 @ (75,28,4)	&216 @ (75,29,4)	1451.79	1451.00	0.79
109	217 @ (76,27,3)	&218 @ (76,28,3)	dry	dry	NA
110	219 @ (76,27,4)	&220 @ (76,28,4)	1453.03	1452.01	1.02
111	221 @ (77,26,3)	&222 @ (77,27,3)	dry	dry	NA
112	223 @ (77,26,4)	&224 @ (77,27,4)	1454.39	1453.28	1.10
113	225 @ (78,26,3)	&226 @ (78,27,3)	dry	dry	NA
114	227 @ (78,26,4)	&228 @ (78,27,4)	1454.77	1453.84	0.94
115	229 @ (79,25,3)	&230 @ (79,26,3)	dry	dry	NA
116	231 @ (79,25,4)	&232 @ (79,26,4)	1455.52	1454.93	0.59
117	233 @ (80,24,3)	&234 @ (80,25,3)	1456.69	dry	NA
118	235 @ (80,24,4)	&236 @ (80,25,4)	1456.25	1455.15	1.11
119	237 @ (81,23,2)	&238 @ (81,24,2)	dry	dry	NA
120	239 @ (81,23,3)	&240 @ (81,24,3)	1457.33	1456.80	0.52
121	241 @ (81,23,4)	&242 @ (81,24,4)	1456.64	1456.07	0.57
122	243 @ (82,22,2)	&244 @ (82,23,2)	dry	1457.33	NA
123	245 @ (82,22,3)	&246 @ (82,23,3)	1457.79	1457.17	0.62
124	247 @ (82,22,4)	&248 @ (82,23,4)	1456.95	1456.43	0.52
125	249 @ (83,22,2)	&250 @ (83,23,2)	1457.70	1456.70	1.00
126	251 @ (83,22,3)	&252 @ (83,23,3)	1457.70	1456.51	1.19
127	253 @ (83,22,4)	&254 @ (83,23,4)	1456.68	1456.17	0.51
128	255 @ (84,21,2)	&256 @ (84,22,2)	1459.13	1458.30	0.82
129	257 @ (84,21,3)	&258 @ (84,22,3)	1458.94	1458.26	0.68
130	259 @ (84,21,4)	&260 @ (84,22,4)	1456.71	1456.20	0.51
131	261 @ (85,20,2)	&262 @ (85,21,2)	1462.01	1460.11	1.90
132	263 @ (85,20,3)	&264 @ (85,21,3)	1460.93	1459.70	1.23
133	265 @ (85,20,4)	&266 @ (85,21,4)	1457.28	1454.86	2.41
134	267 @ (86,19,2)	&268 @ (86,20,2)	1463.96	1461.93	2.03
135	269 @ (86,19,3)	&270 @ (86,20,3)	1462.87	1461.74	1.13
136	271 @ (86,19,4)	&272 @ (86,20,4)	1460.28	1459.17	1.11
137	273 @ (87,18,2)	&274 @ (87,19,2)	1465.93	1462.11	3.82
138	275 @ (87,18,3)	&276 @ (87,19,3)	1465.30	1460.45	4.85
139	277 @ (87,18,4)	&278 @ (87,19,4)	1462.32	1461.80	0.52
140	279 @ (88,17,2)	&280 @ (88,18,2)	1470.04	1467.19	2.84
141	281 @ (88,17,3)	&282 @ (88,18,3)	1468.81	1466.59	2.22
142	283 @ (88,17,4)	&284 @ (88,18,4)	1464.01	1463.49	0.51
143	285 @ (88,16,2)	&286 @ (88,17,2)	1471.37	1470.04	1.33
144	287 @ (88,16,3)	&288 @ (88,17,3)	1470.10	1468.81	1.29
145	289 @ (88,16,4)	&290 @ (88,17,4)	1464.62	1464.01	0.61
146	291 @ (89,15,1)	&292 @ (89,16,1)	1473.74	1472.85	0.90
147	293 @ (89,15,2)	&294 @ (89,16,2)	1472.38	1471.60	0.78

Table C-4. Head difference values achieved by the pumping strategy, cont'd

Pair #	Control Loc. #1 (i1,j1,k1)	Control Loc. #2 (i2,j2,k2)	Head #1 (ft)	Head #2 (ft)	Head diff (ft)
148	295 @ (89,15,3)	&296 @ (89,16,3)	1471.88	1471.11	0.77
149	297 @ (89,15,4)	&298 @ (89,16,4)	1466.47	1465.78	0.69
150	299 @ (90,15,1)	&300 @ (90,16,1)	1473.73	1472.47	1.26
151	301 @ (90,15,2)	&302 @ (90,16,2)	1472.65	1471.76	0.89
152	303 @ (90,15,3)	&304 @ (90,16,3)	1472.31	1471.49	0.83
153	305 @ (90,15,4)	&306 @ (90,16,4)	1467.71	1467.01	0.70
154	307 @ (91,15,1)	&308 @ (91,16,1)	1473.61	1472.31	1.30
155	309 @ (91,15,2)	&310 @ (91,16,2)	1472.75	1471.85	0.89
156	311 @ (91,15,3)	&312 @ (91,16,3)	1472.49	1471.67	0.82
157	313 @ (91,15,4)	&314 @ (91,16,4)	1468.94	1468.26	0.68
158	315 @ (92,14,1)	&316 @ (92,15,1)	1473.98	1473.15	0.83
159	317 @ (92,14,2)	&318 @ (92,15,2)	1473.43	1472.73	0.69
160	319 @ (92,14,3)	&320 @ (92,15,3)	1473.24	1472.58	0.66
161	321 @ (92,14,4)	&322 @ (92,15,4)	1470.71	1470.13	0.58
162	323 @ (93,13,1)	&324 @ (93,14,1)	1474.67	1473.71	0.96
163	325 @ (93,13,2)	&326 @ (93,14,2)	1473.97	1473.32	0.65
164	327 @ (93,13,3)	&328 @ (93,14,3)	1473.72	1473.19	0.53
165	329 @ (93,13,4)	&330 @ (93,14,4)	1472.34	1471.79	0.55
166	331 @ (94,12,1)	&332 @ (94,13,1)	1476.07	1474.48	1.59
167	333 @ (94,12,2)	&334 @ (94,13,2)	1474.93	1473.37	1.56
168	335 @ (94,12,3)	&336 @ (94,13,3)	1474.61	1472.60	2.01
169	337 @ (94,12,4)	&338 @ (94,13,4)	1473.79	1473.28	0.51
170	339 @ (95,11,2)	&340 @ (95,12,2)	1475.93	1474.74	1.18
171	341 @ (95,11,3)	&342 @ (95,12,3)	1475.62	1474.00	1.62
172	343 @ (95,11,4)	&344 @ (95,12,4)	1475.04	1474.53	0.51
173	345 @ (96,10,2)	&346 @ (96,11,2)	1476.96	1476.03	0.94
174	347 @ (96,10,3)	&348 @ (96,11,3)	1476.58	1475.84	0.74
175	349 @ (96,10,4)	&350 @ (96,11,4)	1476.00	1475.36	0.65
176	351 @ (97,10,2)	&352 @ (97,11,2)	1477.16	1476.19	0.97
177	353 @ (97,10,3)	&354 @ (97,11,3)	1476.81	1476.05	0.76
178	355 @ (97,10,4)	&356 @ (97,11,4)	1476.16	1475.25	0.91
179	357 @ (98,10,2)	&358 @ (98,11,2)	1477.37	1476.41	0.96
180	359 @ (98,10,3)	&360 @ (98,11,3)	1477.07	1476.33	0.75
181	361 @ (98,10,4)	&362 @ (98,11,4)	1476.46	1475.93	0.53
182	363 @ (99, 9,2)	&364 @ (99,10,2)	1478.03	1477.35	0.68
183	365 @ (99, 9,3)	&366 @ (99,10,3)	1477.92	1477.27	0.65
184	367 @ (99, 9,4)	&368 @ (99,10,4)	1477.44	1476.65	0.79
185	369 @ (100,8,2)	&370 @ (100,9,2)	1479.29	1478.22	1.07
186	371 @ (100,8,3)	&372 @ (100,9,3)	1479.00	1478.19	0.81
187	373 @ (100,8,4)	&374 @ (100,9,4)	1478.43	1477.90	0.53
188	375 @ (101,7,2)	&376 @ (101,8,2)	1480.59	1479.33	1.26
189	377 @ (101,7,3)	&378 @ (101,8,3)	1480.22	1479.28	0.94
190	379 @ (101,7,4)	&380 @ (101,8,4)	1479.47	1478.87	0.60
191	381 @ (102,7,3)	&382 @ (102,8,3)	1480.76	1479.64	1.13
192	383 @ (102,7,4)	&384 @ (102,8,4)	1479.92	1479.29	0.63

NA means at least one of the wells is in a dry cell