Attachment 1 – Staff Verification of the Vertical Anisotropy to the HJ Horizon
Lost Creek, Wyoming

To verify effects of vertical anisotropy with respect to the proposed operations, staff developed two simple Analytical Elements Models (AEMs) for the HJ aquifer. The model consists of 24 layers each of which is 5 feet thick. Layers 1,2,3,4 comprise Zone 1; layers 6, 7, 8, 9 &10 comprise Zone 2; layers 13, 14, 15, 16 & 17 comprise Zone 3; and layers 20, 21, 22, 23 & 24 comprise Zone 4.

The hydraulic conductivity and vertical anisotropy within the AEM model was established using a transient AEM (for the model input file, see Appendix 1-A). The model simulated the October 2007 pumping test at well LC19M. The best fit model was based on minimizing the residual between observed and model-predicted drawdown at observation wells (HJMP-104, HJMP-110, HJMP-111 (renamed MP-105), HJT-104 and UKMO-102). For locations of the wells and specific information on the pumping test, see Lost Creek's License Application Attachment 2.7-2.

Staff utilized the LC19M pumping test because wells PW-101 and PW-102 are fully penetrating whereas LC19M is only partial penetrating in the HJ Horizon (portions of Layers 2, 3 and 4). The observation wells were also partial penetrating and, based on staff's evaluation, are screened as follows:

HJMP-104	Zone 2,
HJMP-110	Zones 3 & 4,
HJMP-111 renamed MP-105)	Zone 3,
HJT-104	Zone 2 & 3,and
UKMO-102	Zone 3.

Lost Creek has not identified the specific zones screened by wells in Mine Unit 1 except for wells in the perimeter ring. Staff estimated the zones screened by the wells based on the available boring logs and table of information in the MU1 Package. Staff's estimates are summarized in Attachment 1 Table 1-1.

The observed data and model predicted potentiometric heads in zones 1 through 4 at the location of the October 2007 LC19M Pumping Test observation wells are shown on Attachment Figures 1-1 through 1-5. In those figures, the red circles reflect observed data; the green line is the model predicted potentiometric head in Zone 1; the red line is the model predicted potentiometric head in Zone 2; the cyan line is the model predicted potentiometric head in Zone 3; and, the purple line is the model predicted potentiometric head in Zone 4.

Drawdown in Zone 1 was consistently less than drawdown in Zone 3 or Zone 4. The differences in drawdown between each zone vary spatially and temporally. The differences are interpreted as vertical anisotropy to the HJ Horizon. Such anisotropy is consistent with, and supports staff's early calculations for, and explanation of, the apparent anisotropy reported in

the Lost Creek License Application for the pumping test at well LC16M (see Attachment 2.7-3 of the license Application, Figure 6-13).

Staff then developed a steady-state AEM model for the production in Zones 3 and 4 in a portion of the Mine Unit 1 (For location of the production and injection wells, see Attachment 1 Figure 1-6 and 1-7). The AEM model input file is included in Appendix 1-B.

The horizontal line shown on Attachment Figure 1-6 is the location of a vertical cross-section. The model-predicted potentiometric heads along that cross-section are shown on Attachment 1 Figure 1-8. The potentiometric heads indicate that under normal operations, lixiviant migration will be limited to Zones 3 and 4, the zones of operation.

A contour map of the potentiometric heads in Zone 3 is shown on Attachment 1 Figure 1-9. The contours indicate a depression exists along the fault south of production area. The contours indicated that lixiviant in Zone 3 will migrate to the depression and similarly into the open area surrounded by the production units. Similar depressions in the piezometric surface in other areas along the fault are shown are shown by the licensee in figures in the MU-1 Attachment 5-1, Numerical Hydrologic Model of MU1.

At the present time, Lost Creek has not proposed monitoring in these areas nor have they been included in estimate in the flare factor for financial surety calculations.

Attachment 1 Table 1-1

Well Information Mine Unit 1 Aquifer Tests Lost Creek ISR, LLC

Well Name	Well Type	Monitored Sand	Ground Surface Elevation [feet amsl]	Top of Casing Elevation (feet amsl]	NAD83 Easting [feet]	NAD83 Northing [feet]	Screened Interval(s) [feet bgs]	TotalScreen Length	12108/08 Depth to Water	12108/08 Water Level Elevation
PW-101	Production Zone Pumping Well	HJ	6936.67	6,938.06	2,212,158	595,259	385 - 473, 482 - 495	101	184.56	6,753.50
PW-102	Production Zone Pumping Well	HJ	6937.16	6,938.58	2,210,906	595,846	360- 382, 387 - 393, 397 - 467	98	170.58	6,768.00
HJMP-101	Production Zone Monitor Well	HJ	6,947.36	6,948.64	2,211,610	595,711	438-465	27	179.38	6,769.26
HJMP-104	Production Zone Monitor Well	HJ	6,939.04	6,941.04	2,211,208	595,610	402-430	28	173.04	6,768.00
HJMP-105	Production Zone Monitor Well	HJ	6,936.84	6,937.38	2,211,255	595,787	425-463	38	168.99	6,768.39
HJMP-108	Production Zone Monitor Well	HJ	6,951.12	6,952.20	2,211,784	596,011	400-434	34	181.58	6,770.62
HJMP-109	Production Zone Monitor Well	HJ	6,937.89	6,939.10	2,212,218	595,543	478- 512	34	184.09	6,755.01
HJMP-110	Production Zone Monitor Well	HJ	6,945.81	6,947.02	2,212,004	595,897	431 -476	45	176.10	6,770.92
HJMP-113	Production Zone Monitor Well	HJ	6,935.26	6,937.27	2,212,596	595,510	416-462	46	179.95	6,757.32
HJT-101	Production Zone Monitor Well	HJ	6,937.12	6,937.56	2,210,883	595,323	437-477	40	172.98	6,764.58
HJT-102	Production Zone Monitor Well	HJ	6,937.82	6,939.15	2,211,209	595,409	390-417	27	171.32	6,767.83
HJT-103	Production Zone Monitor Well	HJ	6,937.56	6,938.22	2,211,502	595,383	291-327	36	189.20	6,749.02
HJT-104	Production Zone Monitor Well	HJ	6,937.48	6,940.15	2,211,976	595,605	410-460	50	170.63	6,769.52
HJT-105	Production Zone Monitor Well	HJ	6,937.45	6,938.87	2,212,760	595,740	407-438	31	171.61	6,767.26
LC16M	Production Zone Monitor Well	HJ	6,934.73	6,936.15	2,212,869	595,523	410-467	57	177.45	6,758.70
LC19M	Production Zone Monitor Well	HJ	6,949.01	6,950.02	2,211,685	596,020	412.463	51	179.85	6,770.17
M-101	Production Zone Monitor Well	HJ	6,948.49	6,949.24	2,214,619	595,288	423.438	15	175.43	6,773.81
M-102	Production Zone Monitor Well	HJ	6,951.18	6,952.73	2,214,476	594,822	421-438	17	179.38	6,773.35
M-103A	Production Zone Monitor Well	HJ	6,944.62	6,946.20	2,214,018	594,644	364.378, 414.434	34	173.87	6,772.33
M-104	Production Zone Monitor Well	HJ	6,940.66	6,942.11	2,213,543	594,565	368 - 382, 400 • 415, 437.453	45	182.24	6,759.87
M-105	Production Zone Monitor Well	HJ	6,932.91	6,933.45	2,213,052	594,631	360.372, 388.404, 410.431	49	176.71	6,756.74
M-106	Production Zone Monitor Well	HJ	6,922.20	6,922.85	2,212,578	594,746	356.401	45	167.29	6,755.56
M-107	Production Zone Monitor Well	HJ	6,927.03	6,927.93	2,212,095	594,681	373.398	25	178.00	6,749.93
M-108	Production Zone Monitor Well	HJ	6,926.33	6,927.87	2,211,633	594,853	405.425	20	179.08	6,748.79
M-109	Production Zone Monitor Well	HJ	6,919.90	6,921.72	2,211,180	594,671	379 • 391' 403 • 423	32	174.75	6,746.97
M-110	Production Zone Monitor Well	HJ	6,921.45	6,922.41	2,210,690	594,699	381 • 392, 408 • 427	30	176.62	6,745.79
M-111	Production Zone Monitor Well	HJ	6,907.84	6,909.59	2,210,270	594,451	416.429, 445.460	28	170.10	6,739.49
M-112	Production Zone Monitor Well	HJ	6,917.18	6,917.97	2,209,790	594,358	388 • 400, 420 • 488	80	179.49	6,738.48
M-113	Production Zone Monitor Well	HJ	6,926.89	6,928.01	2,209,310	594,510	396 - 406, 417- 439, 447 - 463, 472 - 480	56	190.48	6,737.53
M-114	Production Zone Monitor Well	HJ	6,929.05	6,930.75	2,208,942	594,834	465-485	20	188.75	6,742.00
M-115	Production Zone Monitor Well	HJ	6,937.30	6,939.10	2,208,879	595,321	428-451	23	184.94	6,754.16
M-116	Production Zone Monitor Well	HJ	6,932.10	6,934.00	2,208,959	595,807	430-445	15	178.70	6,755.30
M-117	Production Zone Monitor Well	HJ	6,943.06	6,944.80	2,209,308	596,148	435-453	18	185.56	6,759.24
M-118	Production Zone Monitor Well	HJ	6,944.11	6,945.16	2,209,797	596,146	430- 447, 454- 467	30	183.33	6,761.83
M-119	Production Zone Monitor Well	HJ	6,947.00	6,948.65	2,210,266	596,303	432-450	18	183.51	6,765.14
M-120a	Production Zone Monitor Well	HJ	6,944.98	6,946.52	2,210,727	596,442	410-441	31	178.20	6,768.32
M-121	Production Zone Monitor Well	HJ	6,950.21	6,951.71	2,211,199	596,595	436-455	19	181.28	6,770.43
M-122	Production Zone Monitor Well	HJ	6,950.74	6,952.39	2,211,677	596,693	433 - 447, 477- 487	24	180.16	6,772.23
M-123	Production Zone Monitor Well	HJ	6,950.75	6,951.85	2,212,165	596,647	422-444	22	178.11	6,773.74
M-124	Production Zone Monitor Well	HJ	6,955.54	6,956.46	2,212,603	596,425	406-422	16	181.51	6,774.95
M-125	Production Zone Monitor Well	HJ	6,947.01	6,947.76	2,212,970	596,111	366-397,404-419	46	172.01	6,775.75
M-126	Production Zone Monitor Well	HJ	6,948.12	6,949.67	2,213,464	596,087	331 - 348, 365- 401	53	173.18	6,776.49
M-127	Production Zone Monitor Well	HJ	6,946.21	6,947.66	2,213,932	595,954	408-418,450-471	31	172.68	6,774.98
M-128	Production Zone Monitor Well	HJ	6,947.02	6,948.55	2,214,350	595,698	427-446	19	173.10	6,775.45
MP-101	Production Zone Monitor Well	HJ	6,938.55	6,940.30	2,213,875	595,194	420-438	18	167.93	6,772.37
MP-102	Production Zone Monitor Well	HJ	6,940.18	6,941.02	2,213,299	595,400	408-423	15	176.63	6,764.39
MP-103	Production Zone Monitor Well	HJ	6,934.32	6,935.48	2,212,708	595,381	388-400	12	177.76	6,757.72
MP-104	Production Zone Monitor Well	HJ	6,936.81	6,938.45	2,212,007	595 515	424-440	16	183.29	6,755.16
MP-105	Production Zone Monitor Well	HJ	6,948.99	6,949.49	2,212,158	596,079	402-418	16	178.86	6,770.63
MP-106	Production Zone Monitor Well	HJ	6,940.20	6,941.29	2,211,488	595,980	434-454	20	172.36	6,768.93
MP-107	Production Zone Monitor Well	HJ	6,935.08	6,936.49	2,210,975	595,822	402-420	18	168.42	6,768.07
MP-108	Production Zone Monitor Well	HJ	6,934.15	6,936.15	2,210,882	595,469	424-438	14	169.64	6,766.51
MP-109	Production Zone Monitor Well	HJ	6,931.94	6,932.71	2,210,955	595,235	422-438	16	184.13	6,748.58
MP-110	Production Zone Monitor Well	HJ	6,937.29	6,938.69	2,210,185	595,648	419-438	19	176.91	6,761.78
MP-111	Production Zone Monitor Well	HJ	6,934.86	6,936.28	2,209,951	595,361	391-410	19	176.11	6,760.17
MP-112	Production Zone Monitor Well	HJ	6,935.35	6,936.64	2,209,585	595,535	422-441	19	177.27	6,759.37
MP-113	Production Zone Monitor Well	HJ	6,921.97	6,923.19	2,209,861	594,950	447-466	19	184.03	6,739.16
UKM0-101	Production Zone Monitor Well	HJ	6,940.19	6,942.28	2,212,409	595,656	465-487	22	177.76	6,764.52
UKM0-102	Production Zone Monitor Well	HJ	6,940.24	6,940.79	2,212,528	595,847	379-420	41	169.20	6,771.59
UKM0-103	Production Zone Monitor Well	HJ	6,949.28	6,950.53	2,212,823	596,269	409-430	21	176.35	6,774.18
TW1-1			6940	6941.3	2210480	596090			167	
OW1-1			6,926.00	6,927.00	2,209,877	595,075			188.00	

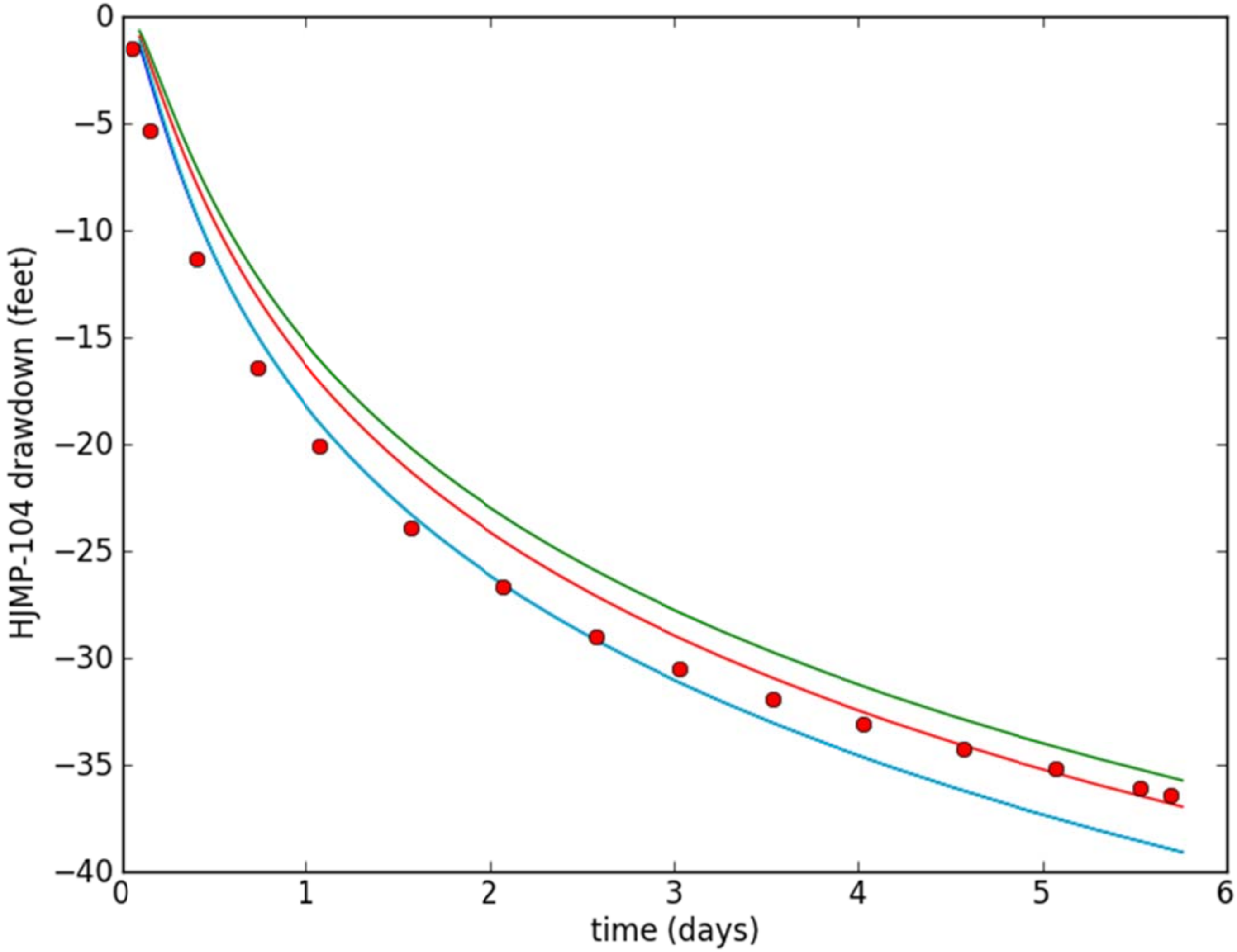
Well Name	ZONE 1					1st Mud Thickness (feet)	ZONE 2					2nd Mud Thickness (feet)	ZONE 3					3rd Mud Thickness (feet)	ZONE 4				
		top	bottom																				
PW-101		385	420			0	420	440				5	440	473				5	482	495			
PW-102		360	382			5	387	393				5	397	460				5	460	467			
HJMP-101		438	465																				
HJMP-104							402	430	6,537	6,509													
HJMP-105		425	463																				
HJMP-108		400	434																				
HJMP-109		478	512																				
HJMP-110													431	450					450	476			
HJMP-113		416	462																				
HJT-101		437	477																				
HJT-102		390	417																				
HJT-103		291	327																				
HJT-104							410	430					430	460									
HJT-105		407	438																				
LC16M						10	410	430	6,525	6,505		0	430	450	6,505	6,485		0	450	467	6,485	6,468	
LC19M						10	412	435	6,537	6,514		0	435	455	6,514	6,494		0	455	463	6,494	6,486	
M-101		370	380	6,578	6,568	5						0	423	438	6,525	6,510		10					
M-102						0						5	421	438	6,530	6,513							
M-103A		364	378	6,581	6,567	0	395	408	6,550	6,537		0	414	434	6,531	6,511		0	440	465	6,505	6,480	
M-104		368	382	6,573	6,559	0	400	415	6,541	6,526		0	415	426	6,526	6,515		10	437	453	6,504	6,488	
M-105		360	372	6,573	6,561	0	388	415	6,545	6,518		0	415	431	6,518	6,502		5	442	459	6,491	6,474	
M-106		356	372	6,566	6,550	0	372	401	6,550	6,521		0	414	430	6,508	6,492		10	440	459	6,482	6,463	
M-107		373	398	6,554	6,529	0	405	416	6,522	6,511		10	423	438	6,504	6,489			448	459	6,479	6,468	
M-108		376	390	6,550	6,536	0	405	425	6,521	6,501		0	433	444	6,493	6,482		10	457	467	6,469	6,459	
M-109		379	391	6,541	6,529	0	403	423	6,517	6,497		10											
M-110		381	392	6,540	6,529	0	408	427	6,513	6,494			435	449	6,486	6,472			461	471	6,460	6,450	
M-111		370	379	6,538	6,529	0	390	409	6,518	6,499		0	416	431	6,492	6,477		10	445	460	6,463	6,448	
M-112		388	400	6,529	6,517	0	420	430	6,497	6,487		0	430	460	6,487	6,457		10	470	488	6,447	6,429	
M-113		396	406	6,531	6,521	5	417	439	6,510	6,488		0	447	463	6,480	6,464		10	472	480	6,455	6,447	
M-114						10	410	420	6,519	6,509		0	429	449	6,500	6,480		10	465	480	6,464	6,449	
M-115						0						0	428	451	6,509	6,486							
M-116						15						5	430	445	6,502	6,487		15	462	477	6,470	6,455	
M-117						10						5	435	453	6,508	6,490			461	480	6,482	6,463	
M-118		383	392	6,561	6,552	10	403	423	6,541	6,521		0	430	447	6,514	6,497		0	454	467	6,490	6,477	
M-119						15						15	432	450	6,515	6,497		10					
M-120a		375	385	6,570	6,560	0	410	420	6,535	6,525		10	430	441	6,515	6,504		0	447	467	6,498	6,478	
M-121		393	404	6,557	6,546	0						15	436	455	6,514	6,495			468	491	6,482	6,459	
M-122						0						10	433	447	6,518	6,504		20	477	487	6,474	6,464	
M-123						0						15	422	444	6,529	6,507		0	465	495	6,486	6,456	
M-124						5						10	406	422	6,550	6,534		5					
M-125						0	366	397	6,581	6,550		0	404	419	6,543	6,528		5					
M-126		331	348	6,617	6,600	0	365	401	6,583	6,547		10											
M-127		408	418	6,538	6,528	5	435	450	6,511	6,496		0	450	471	6,496	6,475			480	495	6,466	6,451	
M-128		382	394	6,565	6,553	5						10	427	446	6,520	6,501		10	458	485	6,489	6,462	
MP-101												5	420	438	6,519	6,501	18						
MP-102						10	408	423	6,532	6,517	15												
MP-103		370	400	6,564	6,534							10											
MP-104							423	442	6,514	6,495	19	10											
MP-105												10	393	420	6,556	6,529	27						
MP-106						10						5	430	456	6,510	6,484	26						
MP-107												5	392	422	6,543	6,513	30	5					
MP-108						0						0	405	450	6,529	6,484	45						
MP-109						0	422	438	6,510	6,494	16	5											
MP-110												5	419	438	6,518	6,499	19	5					
MP-111							391	410	6,544	6,525	19	5						5					
MP-112						0						0	422	441	6,513	6,494	19						
MP-113						10						0	447	466	6,475	6,456	19	5					
UKM0-101						0						0							465	487			
UKM0-102						5						0	379	420									
UKM0-103						5	409	430															
TW1-1						0	393	415	6,547	6,525		10						5	458	483			
OW1-1						5						0						5					

Notes:

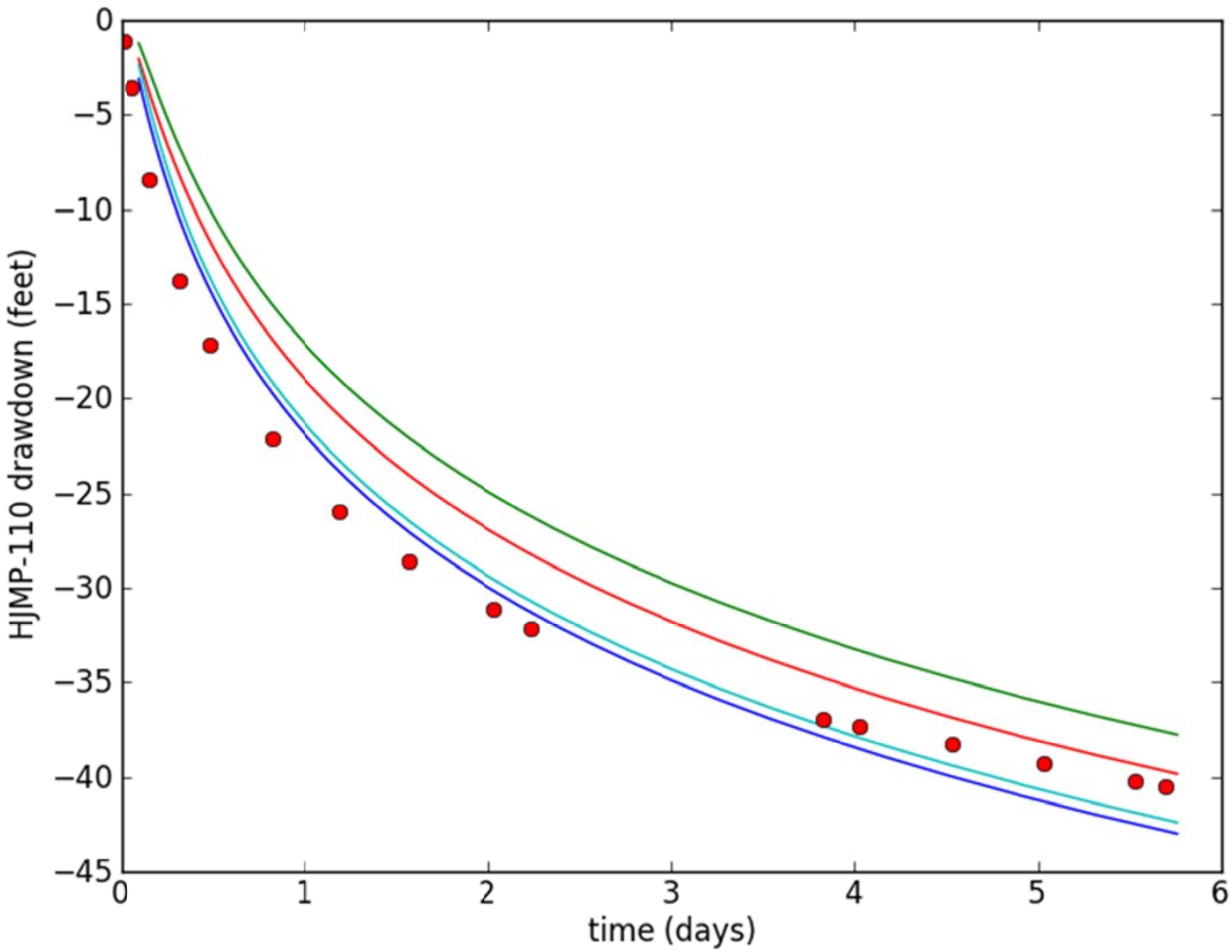
- Easting/northing are NAD 83VW State Plane coordinates.

Source: Lost Creek's WDEQ -LQD MU1 Application Table 3-1, Revision 5, dated February 2011

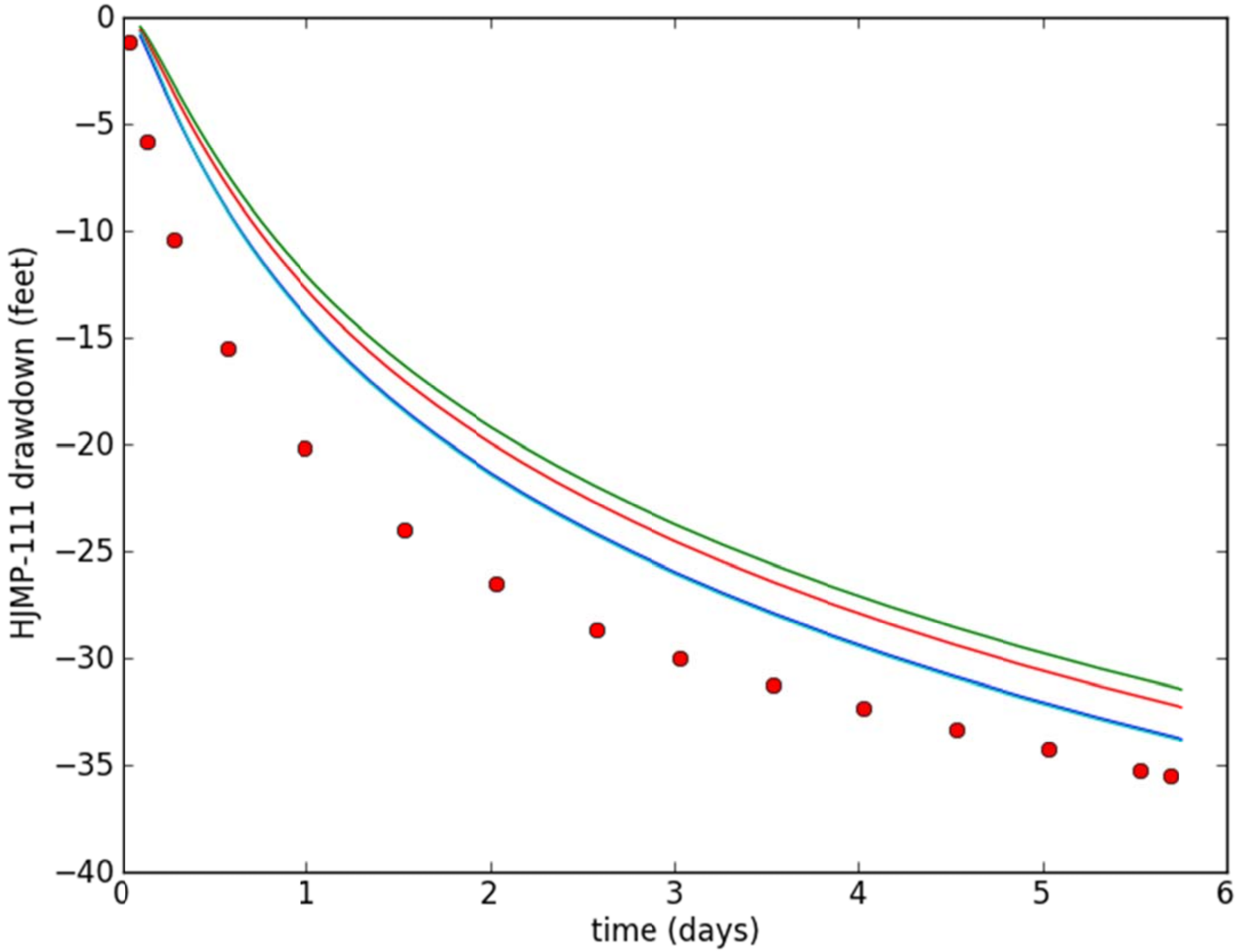
Attachment 1 Figure 1-1



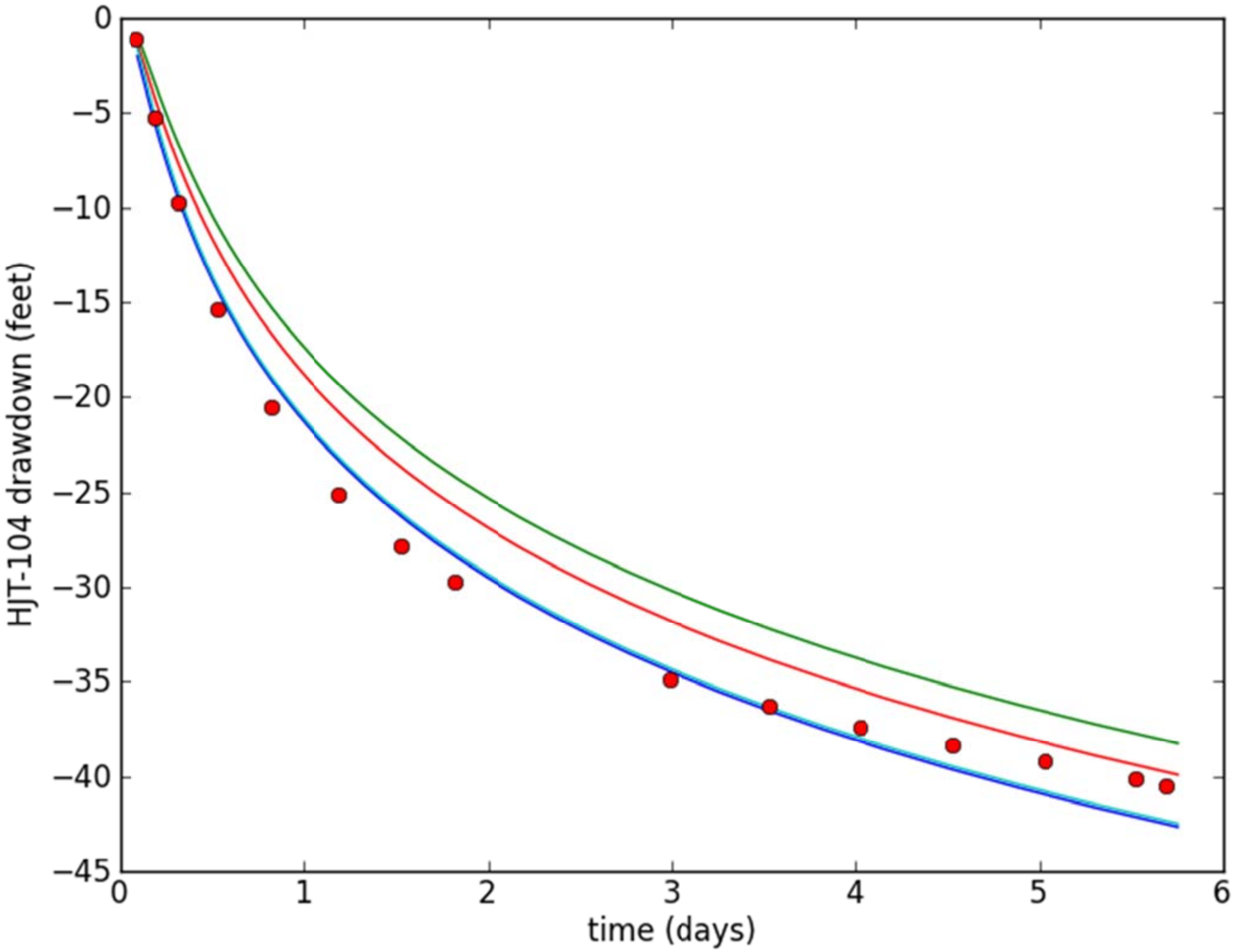
Attachment 1 Figure 1-2



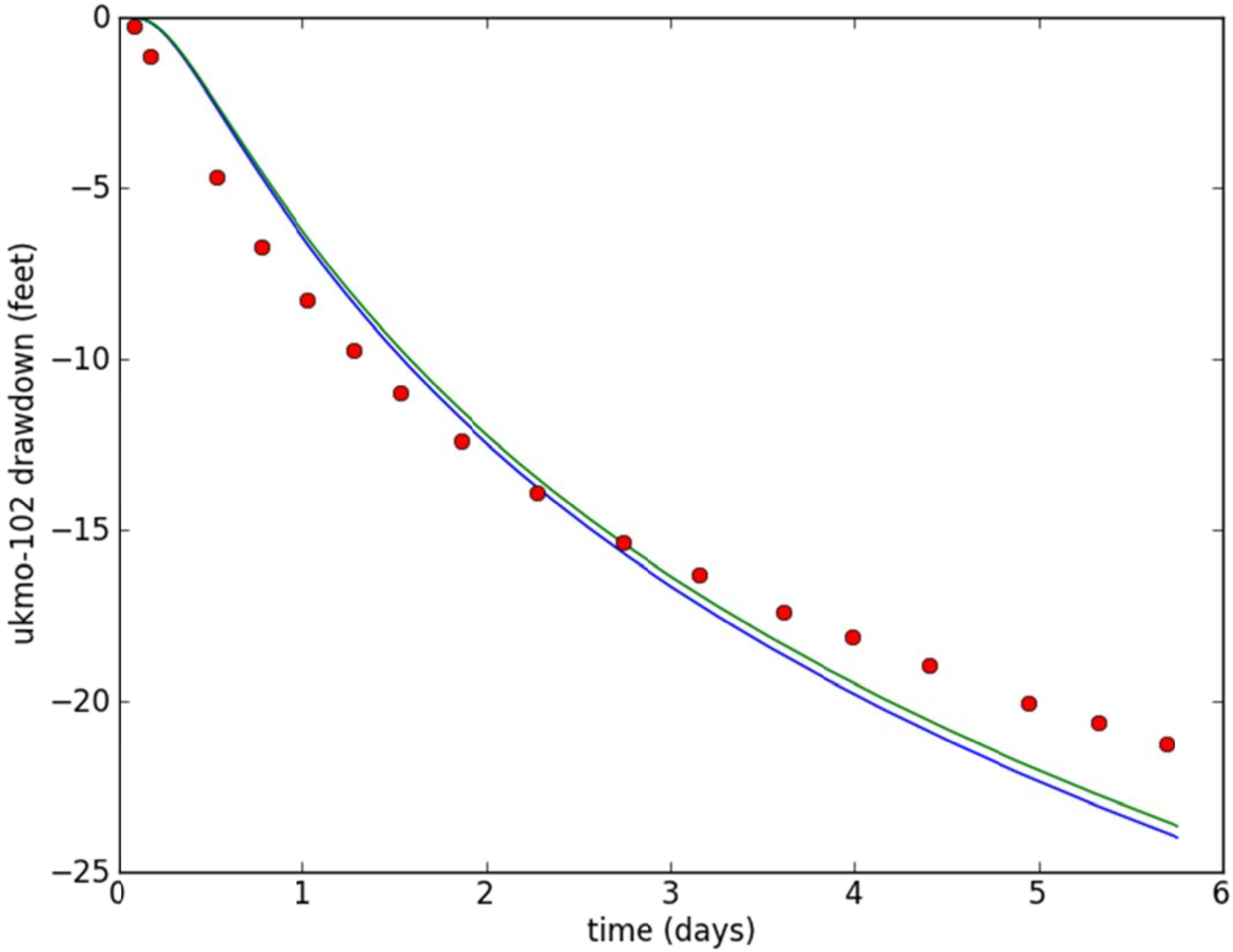
Attachment 1 Figure 1-3

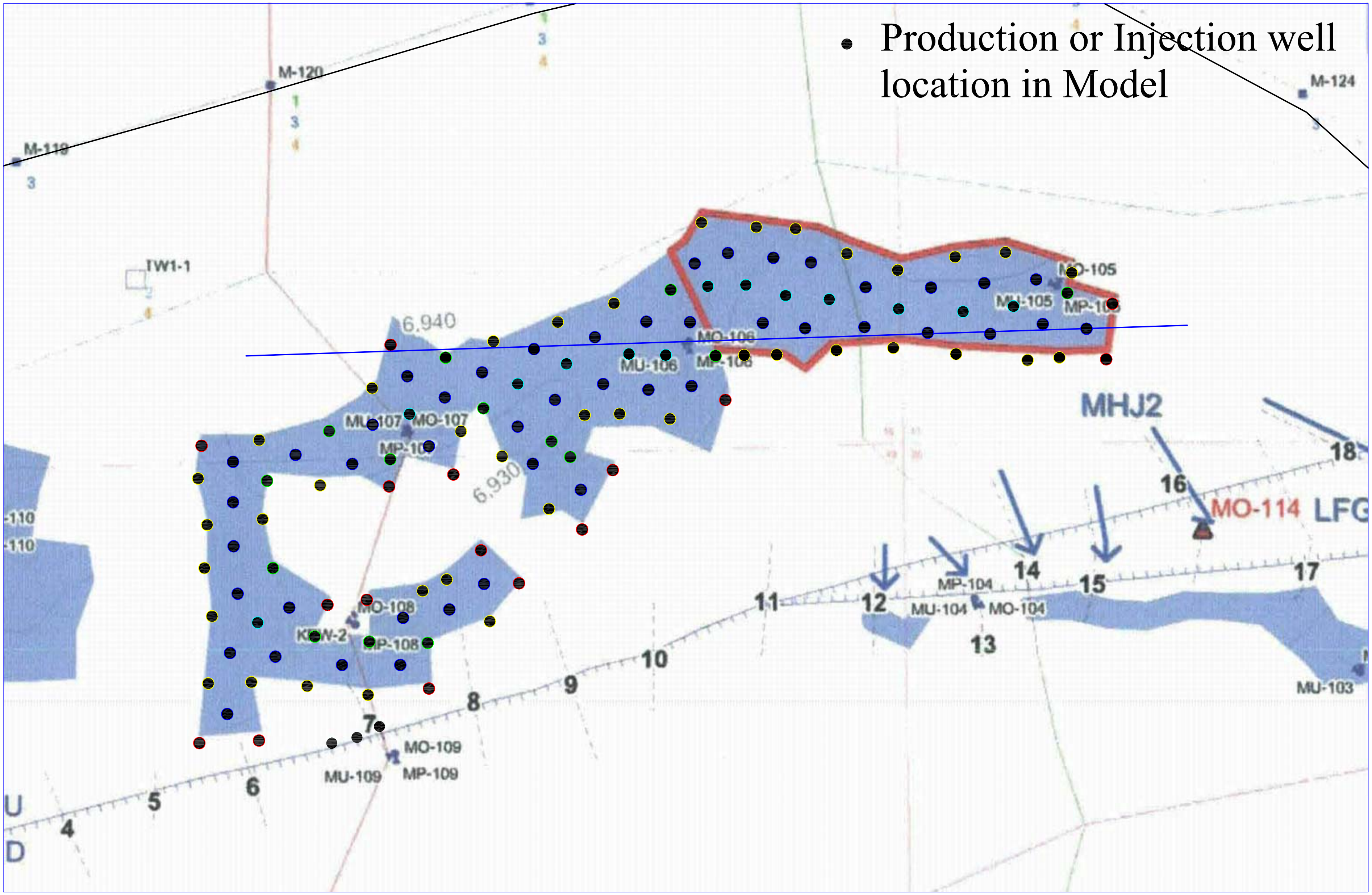


Attachment 1 Figure 1-4

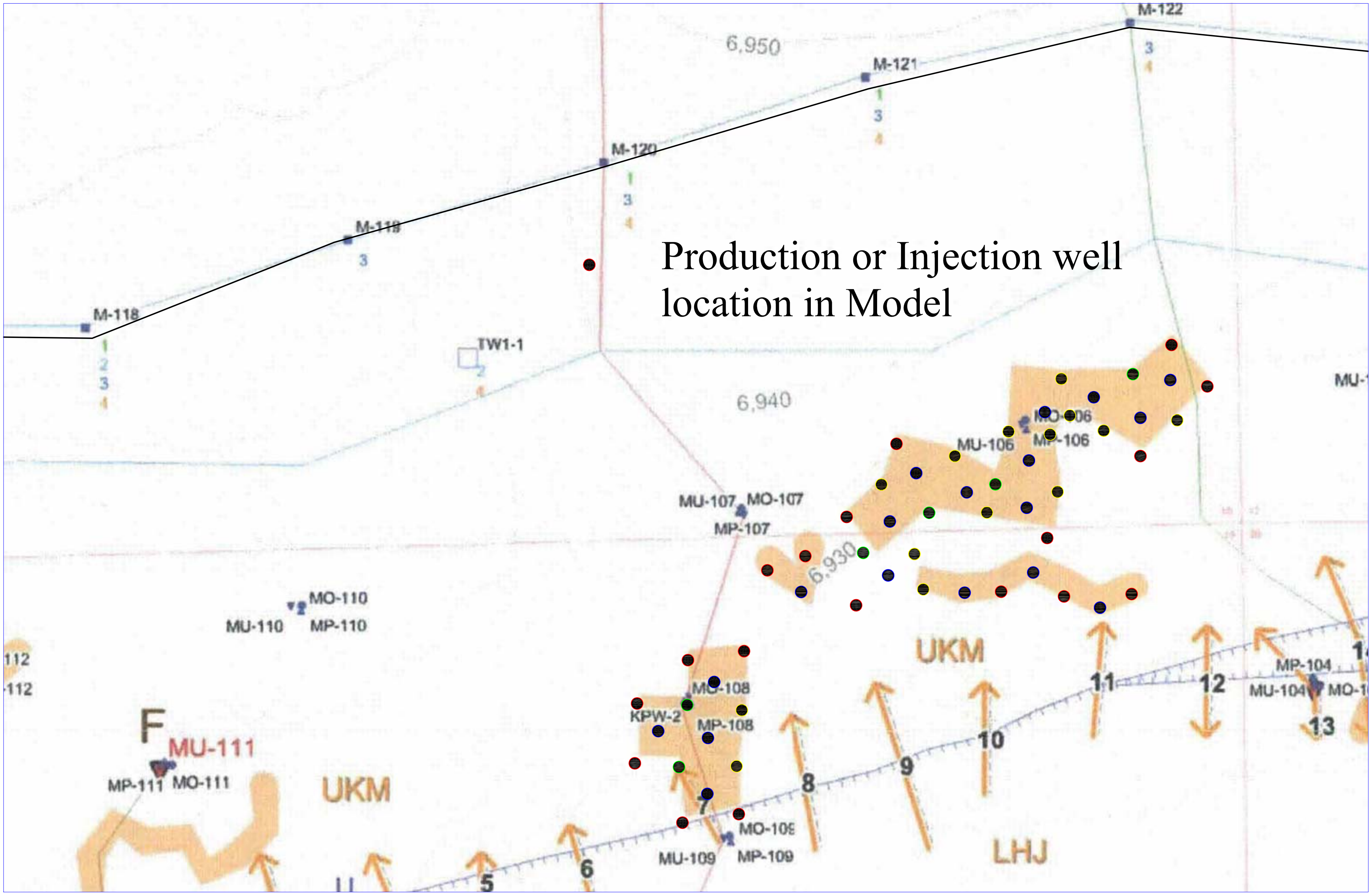


Attachment 1 Figure 1-5



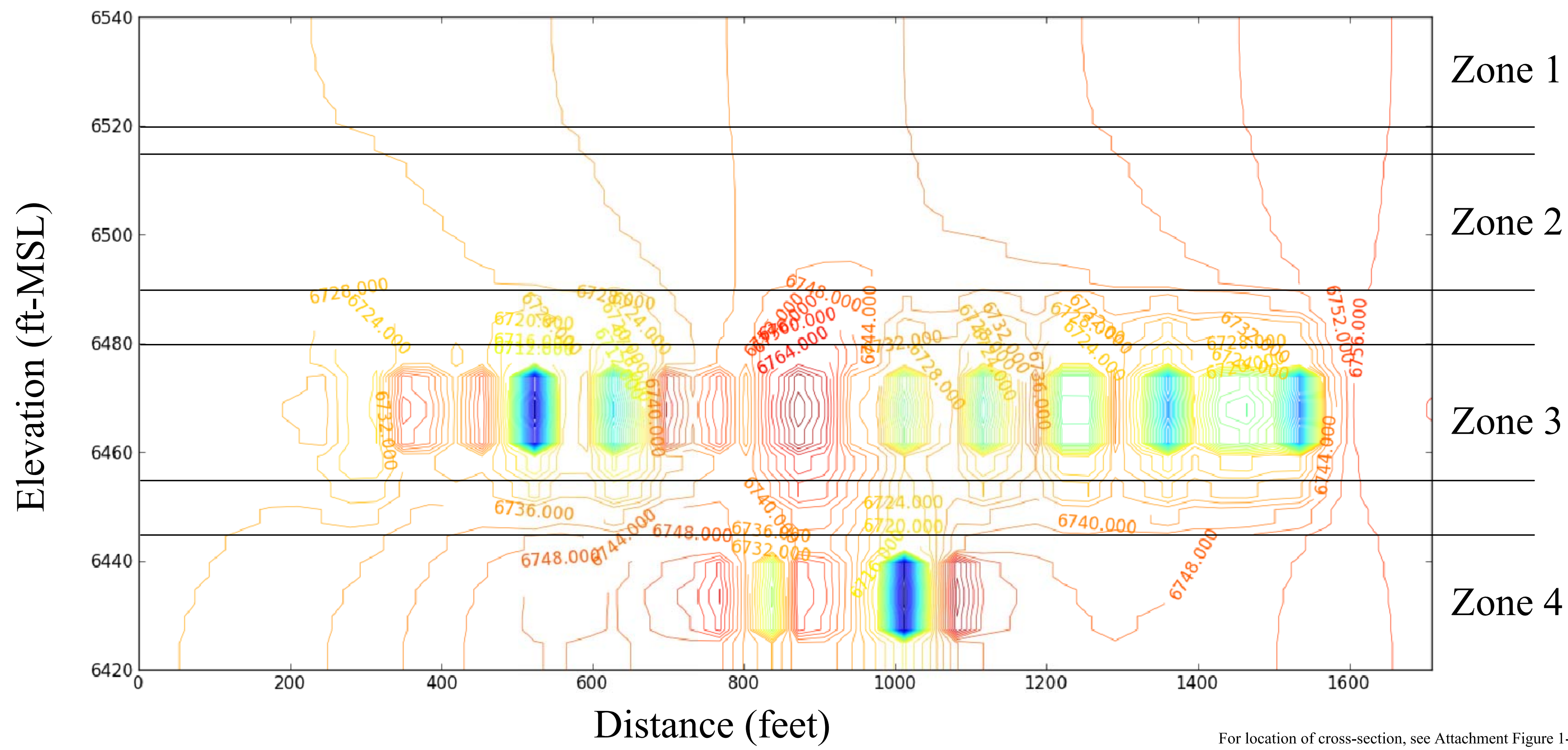


Attachment 1 Figure 1-6 NRC Modeled Production Zone 3

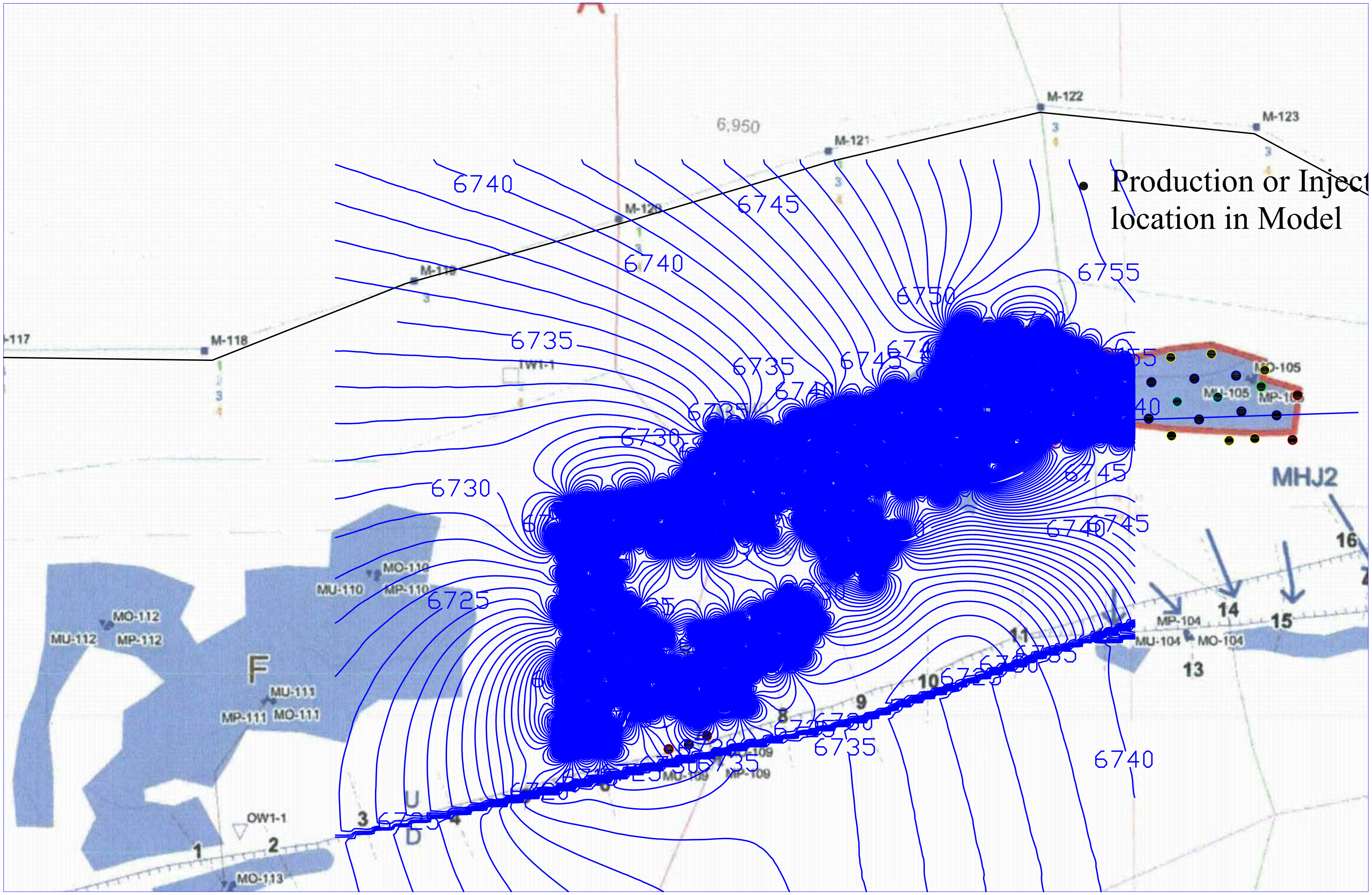


Attachment 1 Figure 1-7 NRC Modeled Production Zone 4

Attachment 1 Figure 1-8 Contour of Model-Predicted Potentiometric Head Isopleths along Cross-Section



For location of cross-section, see Attachment Figure 1-6



Attachment 1 Figure 1-9 NRC model-predicted potentiometric surface in Zone 3 with long-term operations for the Selected Modules in Zone 3 and Zone 4

Attachment 1 Appendix 1-A

```
from ttim2 import *
from pylab import *
import csv

z = [6540,6535,6530,6525,6520,6515,6510,6505,6500,6495,6490,6485,6480,6475,6470,6465,6460,6455,6450,6445,6440
,6420]
kh1 =  [1.07, 1.07, 1.07, 1.07,0.008, 1.07, 1.07, 1.07, 1.07, 1.07,0.008,0.008, 1.07, 1.07, 1.07, 1.07, 1.07,
07, 1.07, 1.07, 1.07, 1.07]
kz =  [0.02,0.02,0.02,0.02, 0.7, 0.02,0.02,0.02,0.02,0.02, 0.7, 0.7,0.02,0.02,0.02,0.02,0.02, 0.7, 0.7,0.02,0
.02]
Saq =  [0.0000022, 0.0000022, 0.0000022, 0.0000022,0.0000022, 0.0000022, 0.0000022, 0.0000022, 0.0000022, 0.0
2,0.0000022, 0.0000022, 0.0000022, 0.0000022, 0.0000022, 0.0000022,0.0000022,0.0000022, 0.0000022, 0.0000022,
000022, 0.0000022]
ml=Model3D(kh1,z,Saq,kz, tmin=0.1,tmax=5)


lc19M = MscreenWell(ml,xw=3385,yw=2420,rw=0.25,tsandQ=[0.0,8237],res=0.0,layers=
[8,9,10,11,12,13,14,15,16,17,18,19,20,21])
Mirrorlc19M = MscreenWell(ml,xw=3300,yw=1800,rw=0.25,tsandQ=[0.0,8237],res=0.0,layers=
[8,9,10,11,12,13,14,15,16,17,18,19,20,
21])
ml.solve()



result=open('lc19test.csv','wb')
writer =csv.writer(result,dialect='excel')
t=logspace(-1,0.76,51)
h=50*ones(len(t))
writer.writerow(t)
totsumres=[1,2,3,4,5]



# HJMP-104
figure(1)
for i in range(len(t)):
    h[i]=ml.head(2908,2010, t[i],layers=[14])
writer.writerow(h)
plot(t,h)
show(1)

for i in range(len(t)):
    h[i]=ml.head(2908,2010, t[i],layers=[2])
writer.writerow(h)
plot(t,h)
show(1)

for i in range(len(t)):
    h[i]=ml.head(2908,2010, t[i],layers=[7])
writer.writerow(h)
plot(t,h)
show(1)

for i in range(len(t)):
    h[i]=ml.head(2908,2010, t[i],layers=[21])
writer.writerow(h)
plot(t,h)
show(1)




xobs104=
[0.0556,0.1528,0.4028,0.7361,1.0694,1.5694,2.0694,2.5694,3.0277,3.5277,4.0277,4.5697,5.0697,5.5277,5.6947]
yobs104=
[-1.48,-5.31,-11.36,-16.4,-20.09,-23.89,-26.69,-28.97,-30.47,-31.91,-33.07,-34.22,-35.18,-36.11,-36.41]
plot(xobs104,yobs104,'ro')
xlabel('time (days)')
ylabel('HJMP-104 drawdown (feet)')
label1='HJMP-104'
show(1)



lsr=1*ones(len(xobs104))
hc=1*ones(len(xobs104))
for i in range(len(xobs104)):
    hc[i]=ml.head(2908,2010, xobs104[i],layers=[14])
for i in range(len(lsr)):
    lsr[i]=sqrt((yobs104[i]-hc[i])**2)
print lsr
asumlsr=sum(lsr)
print asumlsr
totsumres[0]=asumlsr
```

```
print totsumres



# HJMP-110
figure(2)
for i in range(len(t)):
    h[i]=ml.head(3704,2297, t[i],layers=[14])
writer.writerow(h)
plot(t,h)
show(2)

for i in range(len(t)):
    h[i]=ml.head(3704,2297, t[i],layers=[2])
writer.writerow(h)
plot(t,h)
show(2)


for i in range(len(t)):
    h[i]=ml.head(3704,2297, t[i],layers=[7])
writer.writerow(h)
plot(t,h)
show(2)


for i in range(len(t)):
    h[i]=ml.head(3704,2297, t[i],layers=[21])
writer.writerow(h)
plot(t,h)
show(2)


xobs110=
[0.0208,0.0556,0.1528,0.3194,0.4861,0.8194,1.1944,1.5694,2.0278,2.2361,3.8194,4.0278,4.5278,5.0278,5.5278,5.6944]
yobs110=
[-1.16,-3.57,-8.41,-13.74,-17.17,-22.12,-25.98,-28.6,-31.12,-32.12,-36.95,-37.28,-38.29,-39.24,-40.2,-40.48]
plot(xobs110,yobs110,'ro')
xlabel('time (days)')
ylabel('HJMP-110 drawdown (feet)')
show(2)

lsr=1*ones(len(xobs110))
hc=1*ones(len(xobs110))
for i in range(len(xobs110)):
    hc[i]=ml.head(3704,2297, xobs110[i],layers=[14])
for i in range(len(lsr)):
    lsr[i]=sqrt((yobs110[i]-hc[i])**2)
print lsr
asumlsr=sum(lsr)
print asumlsr
totsumres[1]=asumlsr
print totsumres


# HJmp-111
figure(3)
for i in range(len(t)):
    h[i]=ml.head(3858,2479, t[i],layers=[14])
writer.writerow(h)
plot(t,h)
show(3)

for i in range(len(t)):
    h[i]=ml.head(3858,2479, t[i],layers=[2])
writer.writerow(h)
plot(t,h)
show(3)


for i in range(len(t)):
    h[i]=ml.head(3858,2479, t[i],layers=[7])
writer.writerow(h)
plot(t,h)
show(3)

for i in range(len(t)):
    h[i]=ml.head(3858,2479, t[i],layers=[21])
writer.writerow(h)
plot(t,h)
show(3)


xobs111=
[0.0347,0.1319,0.2778,0.5694,0.9861,1.5278,2.0278,2.5694,3.0278,3.5278,4.0278,4.5278,5.0278,5.5278,5.6944]
```

```
yobs111=[-1.19,-5.85,-10.42,-15.46,-20.13,-23.96,-26.49,-28.7,-29.98,-31.28,-32.3,-33.32,-34.28,-35.24,-35.52]
plot(xobs111,yobs111,'ro')
xlabel('time (days)')
ylabel('HJMP-111 drawdown (feet)')
show(3)

lsr=1*ones(len(xobs111))
hc=1*ones(len(xobs111))
for i in range(len(xobs111)):
    hc[i]=ml.head(3858,2479, xobs111[i],layers=[14])
for i in range(len(lsr)):
    lsr[i]=sqrt((yobs111[i]-hc[i])**2)
print lsr
asumlsr=sum(lsr)
print asumlsr
totsumres[2]=asumlsr
print totsumres


# HJt-104

figure(4)
for i in range(len(t)):
    h[i]=ml.head(3676,2005, t[i],layers=[14])
writer.writerow(h)
plot(t,h)
show(4)

for i in range(len(t)):
    h[i]=ml.head(3676,2005, t[i],layers=[2])
writer.writerow(h)
plot(t,h)
show(4)


for i in range(len(t)):
    h[i]=ml.head(3676,2005, t[i],layers=[7])
writer.writerow(h)
plot(t,h)
show(4)

for i in range(len(t)):
    h[i]=ml.head(3676,2005, t[i],layers=[21])
writer.writerow(h)
plot(t,h)
show(4)


xobshjt104=[0.0833,0.1944,0.3194,0.5278,0.8194,1.1944,1.5278,1.8194,2.9861,3.5278,4.0278,4.5278,5.0278,5.5278,5.6944]
yobshjt104=[-1.14,-5.23,-9.78,-15.37,-20.52,-25.1,-27.86,-29.7,-34.83,-36.27,-37.36,-38.32,-39.22,-40.17,-40.48]
plot(xobshjt104,yobshjt104,'ro')
xlabel('time (days)')
ylabel('HJT-104 drawdown (feet)')
show(4)

lsr=1*ones(len(xobshjt104))
hc=1*ones(len(xobshjt104))
for i in range(len(xobshjt104)):
    hc[i]=ml.head(3676,2005, xobshjt104[i],layers=[7])
for i in range(len(lsr)):
    lsr[i]=sqrt((yobshjt104[i]-hc[i])**2)
print lsr
asumlsr=sum(lsr)
print asumlsr
totsumres[3]=asumlsr

print totsumres











# ukmo-102
figure(5)

for i in range(len(t)):
    h[i]=ml.head(4228,2247, t[i],layers=[14])
writer.writerow(h)
```

```
plot(t,h)
show(5)
for i in range(len(t)):
    h[i]=ml.head(4228,2247, t[i],layers=[7])
writer.writerow(h)
plot(t,h)
show(5)

xobs102=[0.0833,0.1736,0.5278,0.7778,1.0278,1.2778,1.5278,1.8611,2.2778,2.7361,3.1528,3.6111,3.9861,4.4028,4.9444,5.3194,5.6944]
yobs102=[-0.26,-1.16,-4.7,-6.7,-8.28,-9.76,-10.97,-12.41,-13.89,-15.35,-16.32,-17.38,-18.11,-18.98,-20.04,-20.65,-21.27]
plot(xobs102,yobs102,'ro')
xlabel('time (days)')
ylabel('ukmo-102 drawdown (feet)')
show(5)

lsr=1*ones(len(xobs102))
hc=1*ones(len(xobs102))
for i in range(len(xobs102)):
    hc[i]=ml.head(4228,2247, xobs102[i],layers=[14])
for i in range(len(lsr)):
    lsr[i]=sqrt((yobs102[i]-hc[i])**2)

print lsr
asumlsr=sum(lsr)
print asumlsr
totsumres[4]=asumlsr
print totsumres

print sum(totsumres)








# LC19
for i in range(len(t)):
    h[i]=ml.head(3388,2425, t[i],layers=[14])
writer.writerow(h)

result.close()
```

Attachment 1 Appendix 1-A

```
from TimML import *
from mlpylabutil import *
import csv

#  steady state
#  Coordinates based on NAD83 traslantion from (2208300,593600) to (0,0)



z = [6540,6535,6530,6525,6520,6515,6510,6505,6500,6495,6490,6485,6480,6475
,6420]
kh1 =  [1.07, 1.07, 1.07, 1.07,0.008, 1.07, 1.07, 1.07, 1.07, 1.07,0.008,
07, 1.07, 1.07, 1.07, 1.07]
kz =  [0.02,0.02,0.02,0.02, 0.7, 0.02,0.02,0.02,0.02,0.02, 0.7, 0.7,0.02,
.02]



ml=Model3D(z,kh1,kz)
rf= Constant(ml,0,10000,6780,[1])
uf=Uflow(ml,0.009,220)
#
# now for the hfb
LineDoubletImp(ml,3498.,1923.,4686.,2027.,order=3,layers=
[1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24])
LineDoubletImp(ml,4686.,2027.,5443.,2199.,order=3,layers=
[1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24])
LineDoubletImp(ml,7822.,3284.,6174.,2756.,order=3,layers=
[1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24])
LineDoubletImp(ml,6174.,2756.,5189.,2435.,order=3,layers=
[1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24])
LineDoubletImp(ml,5189.,2435.,4428.,2240.,order=3,layers=
[1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24])
LineDoubletImp(ml,4428.,2240.,3868.,2049.,order=3,layers=
[1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24])
LineDoubletImp(ml,3868.,2049.,3498.,1928.,order=3,layers=
[1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24])
LineDoubletImp(ml,3498.,1928.,2981.,1745.,order=3,layers=
[1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24])
LineDoubletImp(ml,2981.,1745.,2132.,1549.,order=3,layers=
[1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24])
LineDoubletImp(ml,2132.,1549.,946.,1299.,order=3,layers=
[1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24])
LineDoubletImp(ml,946.,1299.,805.,1272.,order=3,layers=
[1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24])
LineDoubletImp(ml,805.,1272.,457.,1234.,order=3,layers=
[1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24])
LineDoubletImp(ml,457.,1234.,-200.,989.,order=3,layers=
[1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24])

#  for the wells
w7 = Well(ml ,2657,2401,-1620,0.25, [14,15,16])
w8 = Well(ml ,2623,2322,-3240,0.25, [14,15,16])
w9 = Well(ml ,2691,2275,-6480,0.25, [14,15,16])
w10 = Well(ml ,2757,2378,-4860,0.25, [14,15,16])
w11 = Well(ml ,2546,2244,-4860,0.25, [14,15,16])
w12 = Well(ml ,2656,2193,-4860,0.25, [14,15,16])
w13 = Well(ml ,2654,2144,-1620,0.25, [14,15,16])
w14 = Well(ml ,2529,2146,-3240,0.25, [14,15,16])
```

```
w15 = Well(ml ,2433,2154,-4860,0.25, [14,15,16])
w16 = Well(ml ,2418,2228,-3240,0.25, [14,15,16])
w17 = Well(ml ,2314,2218,-1620,0.25, [14,15,16])
w18 = Well(ml ,2308,2158,-3240,0.25, [14,15,16])
w19 = Well(ml ,2324,2074,-3240,0.25, [14,15,16])
w20 = Well(ml ,2425,2084,-3240,0.25, [14,15,16])
w21 = Well(ml ,2443,1996,-4860,0.25, [14,15,16])
w22 = Well(ml ,2319,1996,-3240,0.25, [14,15,16])
w23 = Well(ml ,2333,1908,-3240,0.25, [14,15,16])
w24 = Well(ml ,2416,1897,-6480,0.25, [14,15,16])
w25 = Well(ml ,2519,1871,-4860,0.25, [14,15,16])
w26 = Well(ml ,2542,1929,-1620,0.25, [14,15,16])
w27 = Well(ml ,2404,1789,-3240,0.25, [14,15,16])
w28 = Well(ml ,2326,1786,-3240,0.25, [14,15,16])
w29 = Well(ml ,2310,1678,-1620,0.25, [14,15,16])
w30 = Well(ml ,2418,1683,-1620,0.25, [14,15,16])
w31 = Well(ml ,2506,1782,-3240,0.25, [14,15,16])
w32 = Well(ml ,2616,1766,-3240,0.25, [14,15,16])
w33 = Well(ml ,2726,1777,-1620,0.25, [14,15,16])
w34 = Well(ml ,2618,1862,-4860,0.25, [14,15,16])
w35 = Well(ml ,2724,1860,-4860,0.25, [14,15,16])
w36 = Well(ml ,2715,1954,-3240,0.25, [14,15,16])
w37 = Well(ml ,2614,1938,-1620,0.25, [14,15,16])
w38 = Well(ml ,2759,1975,-3240,0.25, [14,15,16])
w39 = Well(ml ,2837,1899,-3240,0.25, [14,15,16])
w40 = Well(ml ,2890,1968,-1620,0.25, [14,15,16])
w41 = Well(ml ,2821,2028,-1620,0.25, [14,15,16])
w42 = Well(ml ,2771,2166,-1620,0.25, [14,15,16])
w43 = Well(ml ,2784,2244,-3240,0.25, [14,15,16])
w44 = Well(ml ,2825,2286,-4860,0.25, [14,15,16])
w45 = Well(ml ,2888,2330,-6480,0.25, [14,15,16])
w46 = Well(ml ,2843,2407,-3240,0.25, [14,15,16])
w47 = Well(ml ,2960,2442,-3240,0.25, [14,15,16])
w48 = Well(ml ,2976,2366,-6480,0.25, [14,15,16])
w49 = Well(ml ,3009,2273,-3240,0.25, [14,15,16])
w50 = Well(ml ,2949,2226,-4860,0.25, [14,15,16])
w51 = Well(ml ,2859,2198,-3240,0.25, [14,15,16])
w52 = Well(ml ,2944,2103,-3240,0.25, [14,15,16])
w53 = Well(ml ,2983,2197,-4860,0.25, [14,15,16])
w54 = Well(ml ,3060,2174,-1620,0.25, [14,15,16])
w55 = Well(ml ,3004,2066,-1620,0.25, [14,15,16])
w56 = Well(ml ,3072,2276,-3240,0.25, [14,15,16])
w57 = Well(ml ,3089,2384,-6480,0.25, [14,15,16])
w58 = Well(ml ,3062,2476,-3240,0.25, [14,15,16])
w59 = Well(ml ,3164,2267,-3240,0.25, [14,15,16])
w60 = Well(ml ,3156,2382,-6480,0.25, [14,15,16])
w61 = Well(ml ,3165,2501,-4860,0.25, [14,15,16])
w62 = Well(ml ,3221,2623,-3240,0.25, [14,15,16])
w63 = Well(ml ,3233,2507,-6480,0.25, [14,15,16])
w64 = Well(ml ,3247,2381,-4860,0.25, [14,15,16])
w65 = Well(ml ,3264,2301,-1620,0.25, [14,15,16])
w66 = Well(ml ,3298,2382,-3240,0.25, [14,15,16])
w67 = Well(ml ,3358,2383,-3240,0.25, [14,15,16])
w68 = Well(ml ,3374,2490,-6480,0.25, [14,15,16])
w69 = Well(ml ,3301,2509,-6480,0.25, [14,15,16])
w70 = Well(ml ,3320,2615,-3240,0.25, [14,15,16])
w71 = Well(ml ,3392,2612,-3240,0.25, [14,15,16])
w72 = Well(ml ,3485,2567,-3240,0.25, [14,15,16])
w73 = Well(ml ,3453,2483,-6480,0.25, [14,15,16])
w74 = Well(ml ,3466,2391,-3240,0.25, [14,15,16])
w75 = Well(ml ,3569,2396,-3240,0.25, [14,15,16])
```

```
w76 = Well(ml ,3579,2466,-6480,0.25, [14,15,16])
w77 = Well(ml ,3577,2537,-3240,0.25, [14,15,16])
w78 = Well(ml ,3681,2561,-3240,0.25, [14,15,16])
w79 = Well(ml ,3696,2461,-6480,0.25, [14,15,16])
w80 = Well(ml ,3683,2384,-3240,0.25, [14,15,16])
w81 = Well(ml ,3787,2471,-6480,0.25, [14,15,16])
w82 = Well(ml ,3813,2373,-3240,0.25, [14,15,16])
w83 = Well(ml ,3773,2569,-3240,0.25, [14,15,16])
w84 = Well(ml ,3893,2532,-3240,0.25, [14,15,16])
w85 = Well(ml ,3885,2495,-4860,0.25, [14,15,16])
w86 = Well(ml ,3870,2378,-3240,0.25, [14,15,16])
w87 = Well(ml ,3967,2476,-1620,0.25, [14,15,16])
w88 = Well(ml ,3955,2375,-1620,0.25, [14,15,16])
w89 = Well(ml ,3828,2520,6687.5,0.25, [14,15,16])
w90 = Well(ml ,3920,2430,6687.5,0.25, [14,15,16])
w91 = Well(ml ,3840,2439,6687.5,0.25, [14,15,16])
w92 = Well(ml ,3745,2421,6687.5,0.25, [14,15,16])
w93 = Well(ml ,3734,2513,6687.5,0.25, [14,15,16])
w94 = Well(ml ,3637,2505,6687.5,0.25, [14,15,16])
w95 = Well(ml ,3631,2423,6687.5,0.25, [14,15,16])
w96 = Well(ml ,3517,2433,6687.5,0.25, [14,15,16])
w97 = Well(ml ,3519,2506,6687.5,0.25, [14,15,16])
w98 = Well(ml ,3420,2550,6687.5,0.25, [14,15,16])
w99 = Well(ml ,3409,2431,6687.5,0.25, [14,15,16])
w100 = Well(ml ,3332,2441,6687.5,0.25, [14,15,16])
w101 = Well(ml ,3351,2559,6687.5,0.25, [14,15,16])
w102 = Well(ml ,3269,2567,6687.5,0.25, [14,15,16])
w103 = Well(ml ,3209,2549,6687.5,0.25, [14,15,16])
w104 = Well(ml ,3200,2442,6687.5,0.25, [14,15,16])
w105 = Well(ml ,3203,2326,6687.5,0.25, [14,15,16])
w106 = Well(ml ,3125,2319,6687.5,0.25, [14,15,16])
w107 = Well(ml ,3121,2443,6687.5,0.25, [14,15,16])
w108 = Well(ml ,3028,2415,6687.5,0.25, [14,15,16])
w109 = Well(ml ,3043,2330,6687.5,0.25, [14,15,16])
w110 = Well(ml ,2955,2301,6687.5,0.25, [14,15,16])
w111 = Well(ml ,2917,2393,6687.5,0.25, [14,15,16])
w112 = Well(ml ,2823,2351,6687.5,0.25, [14,15,16])
w113 = Well(ml ,2887,2253,6687.5,0.25, [14,15,16])
w114 = Well(ml ,2755,2305,6687.5,0.25, [14,15,16])
w115 = Well(ml ,2726,2217,6687.5,0.25, [14,15,16])
w116 = Well(ml ,2687,2344,6687.5,0.25, [14,15,16])
w117 = Well(ml ,2624,2256,6687.5,0.25, [14,15,16])
w118 = Well(ml ,2587,2185,6687.5,0.25, [14,15,16])
w119 = Well(ml ,2484,2201,6687.5,0.25, [14,15,16])
w120 = Well(ml ,2371,2189,6687.5,0.25, [14,15,16])
w121 = Well(ml ,2371,2115,6687.5,0.25, [14,15,16])
w122 = Well(ml ,2372,2035,6687.5,0.25, [14,15,16])
w123 = Well(ml ,2379,1949,6687.5,0.25, [14,15,16])
w124 = Well(ml ,2473,1924,6687.5,0.25, [14,15,16])
w125 = Well(ml ,2366,1842,6687.5,0.25, [14,15,16])
w126 = Well(ml ,2448,1835,6687.5,0.25, [14,15,16])
w127 = Well(ml ,2569,1820,6687.5,0.25, [14,15,16])
w128 = Well(ml ,2675,1820,6687.5,0.25, [14,15,16])
w129 = Well(ml ,2680,1906,6687.5,0.25, [14,15,16])
w130 = Well(ml ,2764,1921,6687.5,0.25, [14,15,16])
w131 = Well(ml ,2827,1967,6687.5,0.25, [14,15,16])
w132 = Well(ml ,2361,1731,6687.5,0.25, [14,15,16])
w133 = Well(ml ,3002,2138,6687.5,0.25, [14,15,16])
w134 = Well(ml ,2915,2185,6687.5,0.25, [14,15,16])
w135 = Well(ml ,2583,1684,-1620,0.25, [21,22,23])
w136 = Well(ml ,2684,1699,-1620,0.25, [21,22,23])
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w137 = Well(ml ,2680,1785,-3240,0.25, [21,22,23])
w138 = Well(ml ,2577,1784,-4860,0.25, [21,22,23])
w139 = Well(ml ,2498,1790,-1620,0.25, [21,22,23])
w140 = Well(ml ,2502,1898,-1620,0.25, [21,22,23])
w141 = Well(ml ,2592,1895,-4860,0.25, [21,22,23])
w142 = Well(ml ,2690,1886,-3240,0.25, [21,22,23])
w143 = Well(ml ,2694,1992,-1620,0.25, [21,22,23])
w144 = Well(ml ,2593,1976,-1620,0.25, [21,22,23])
w145 = Well(ml ,2895,2074,-1620,0.25, [21,22,23])
w146 = Well(ml ,2908,2169,-4860,0.25, [21,22,23])
w147 = Well(ml ,3000,2167,-3240,0.25, [21,22,23])
w148 = Well(ml ,3016,2103,-3240,0.25, [21,22,23])
w149 = Well(ml ,3026,2241,-4860,0.25, [21,22,23])
w150 = Well(ml ,2941,2291,-3240,0.25, [21,22,23])
w151 = Well(ml ,2878,2233,-1620,0.25, [21,22,23])
w152 = Well(ml ,2968,2365,-1620,0.25, [21,22,23])
w153 = Well(ml ,3073,2343,-3240,0.25, [21,22,23])
w154 = Well(ml ,3145,2292,-4860,0.25, [21,22,23])
w155 = Well(ml ,3130,2241,-3240,0.25, [21,22,23])
w156 = Well(ml ,3238,2195,-1620,0.25, [21,22,23])
w157 = Well(ml ,3257,2278,-3240,0.25, [21,22,23])
w158 = Well(ml ,3244,2382,-3240,0.25, [21,22,23])
w159 = Well(ml ,3169,2387,-3240,0.25, [21,22,23])
w160 = Well(ml ,3264,2481,-3240,0.25, [21,22,23])
w161 = Well(ml ,3279,2415,-3240,0.25, [21,22,23])
w162 = Well(ml ,3340,2388,-3240,0.25, [21,22,23])
w163 = Well(ml ,3406,2343,-1620,0.25, [21,22,23])
w164 = Well(ml ,3472,2407,-3240,0.25, [21,22,23])
w165 = Well(ml ,3392,2490,-4860,0.25, [21,22,23])
w166 = Well(ml ,3462,2542,-1620,0.25, [21,22,23])
w167 = Well(ml ,3526,2468,-1620,0.25, [21,22,23])
w168 = Well(ml ,3156,2099,-1620,0.25, [21,22,23])
w169 = Well(ml ,3269,2090,-1620,0.25, [21,22,23])
w170 = Well(ml ,3390,2095,-1620,0.25, [21,22,23])
w171 = Well(ml ,2804,2163,-1620,0.25, [21,22,23])
w172 = Well(ml ,2736,2137,-1620,0.25, [21,22,23])
w173 = Well(ml ,2540,1848,5818.5,0.25, [21,22,23])
w174 = Well(ml ,2628,1735,5818.5,0.25, [21,22,23])
w175 = Well(ml ,2629,1836,5818.5,0.25, [21,22,23])
w176 = Well(ml ,2640,1937,5818.5,0.25, [21,22,23])
w177 = Well(ml ,2953,2128,5818.5,0.25, [21,22,23])
w178 = Well(ml ,2956,2225,5818.5,0.25, [21,22,23])
w179 = Well(ml ,3003,2312,5818.5,0.25, [21,22,23])
w180 = Well(ml ,3094,2277,5818.5,0.25, [21,22,23])
w181 = Well(ml ,3202,2250,5818.5,0.25, [21,22,23])
w182 = Well(ml ,3206,2335,5818.5,0.25, [21,22,23])
w183 = Well(ml ,3234,2422,5818.5,0.25, [21,22,23])
w184 = Well(ml ,3322,2448,5818.5,0.25, [21,22,23])
w185 = Well(ml ,3406,2411,5818.5,0.25, [21,22,23])
w186 = Well(ml ,3460,2479,5818.5,0.25, [21,22,23])
w187 = Well(ml ,3333,2070,5818.5,0.25, [21,22,23])
w188 = Well(ml ,3213,2133,5818.5,0.25, [21,22,23])
w189 = Well(ml ,3090,2097,5818.5,0.25, [21,22,23])
w190 = Well(ml ,2796,2098,5818.5,0.25, [21,22,23])

#lc19M = Well(ml,3363,2359,0,0.25, [8,9,10,11,12,13,14,15,16,17,18,19,20,21])
#pw102 = Well(ml,2537,2224,0,0.25, [1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24])

ml.solve()
```

```

timvertcontour(ml,2394,2381,4102,2437,50,6420,6540,50,levels=50,labels=1)
show()




result=open('l3_1b.csv','wb')
writer =csv.writer(result,dialect='excel')

x1=linspace(1800.0,3600,201)
y1=linspace(1200.0,3000,201)
dd1  = 50*ones(len(x1))

writer.writerow(x1)
writer.writerow(y1)

for j in range(len(y1)):
     print j
     for i in range(len(x1)):
        dd1[i]=ml.head3D(x1[i],y1[j],6527)
     writer.writerow(dd1)

result.close()

result=open('l8_1b.csv','wb')
writer =csv.writer(result,dialect='excel')

x1=linspace(1800.0,3600,201)
y1=linspace(1200.0,3000,201)
dd1  = 50*ones(len(x1))

writer.writerow(x1)
writer.writerow(y1)

for j in range(len(y1)):
     print j
     for i in range(len(x1)):
        dd1[i]=ml.head3D(x1[i],y1[j], 6502)
     writer.writerow(dd1)


result.close()

result=open('l14_1b.csv','wb')
writer =csv.writer(result,dialect='excel')

writer.writerow(x1)
writer.writerow(y1)

for j in range(len(y1)):
     print j
     for i in range(len(x1)):
        dd1[i]=ml.head3D(x1[i],y1[j],6472 )
     writer.writerow(dd1)


result.close()

result=open('l21_1b.csv','wb')
```

```
writer =csv.writer(result,dialect='excel')

writer.writerow(x1)
writer.writerow(y1)

for j in range(len(y1)):
     print j
     for i in range(len(x1)):
        dd1[i]=ml.head3D(x1[i],y1[j],6437)
     writer.writerow(dd1)

result.close()
```