Kinder Morgan Linnton Terminal – Extraction Well Step Drawdown Testing Results

PREPARED FOR: Oregon Department of Environmental Quality

PREPARED BY: CH2M HILL

DATE: August, 2014

1.0 Introduction

This Technical Memorandum summarizes the results of the step drawdown testing that took place in May and September of 2014 at the Kinder Morgan Liquids Terminals (KMLT) Linnton Terminal (the Site), located 11400 NW Saint Helens Road in Portland, Oregon (Figure C-1). Step drawdown testing was conducted at the following extraction wells:

- EW-1 and EW-3 in May 2014 prior to redevelopment
- EW-1, EW-3 in September 2014 after redevelopment
- New wells EW-6 and EW-7 in September 2014 after installation.

As detailed in the *Extraction Well Installation and Redevelopment Report* (CH2M HILL, 2014), these extraction wells comprise part of the hydraulic gradient control system for the source control measures at the site (consisting of eight extraction wells [EW-1 through EW-7, and MW-19], 10 piezometers [PZ-1 through PZ-10] and sheet pile barrier wall) (Figure C-2).

The impermeable sheet pile barrier wall is 216-feet-long, approximately 30 feet deep, and terminates within the low conductivity fine-grained unit underlying the shallow sand in this area. In August 2014, extraction wells EW-6 and EW-7 were installed approximately 10 feet on either end of the barrier wall to augment the existing extraction well system and maintain hydraulic containment behind the barrier wall. The wells are screened to the base of the shallow sand that overlies the low conductivity fine-grained unit that the barrier wall is anchored into.

Following installation and development of EW-6 and EW-7, existing extraction wells EW-1 though EW-4 were redeveloped in September 2014, using mechanical methods (i.e., brushing and surging) in conjunction with application of sulfamic and hydroxyacetic (glycolic) acid to improve hydraulic connection between the wells and the surrounding aquifer. Additional details on well redevelopment methods are included in the *Extraction Well Installation and Redevelopment Report* (CH2M HILL, 2014).

The purpose of this technical memorandum is to:

- Estimate expected drawdown in observation wells under different pumping conditions
- Determine baseline well efficiencies of new extraction wells EW-6 and EW-7
- Evaluate well efficiency improvements in EW-1 and EW-3 after redevelopment
- Confirm hydraulic conductivity (K) in vicinity of the barrier wall
- Optimize pump settings at extraction wells EW-1 through EW-7 to maintain capture and minimize over-pumping

The following tables, figures, and attachments are included as part of this Technical Memorandum.

Tables

C-1 – Manual Water Level and Flow Rate Measurement Frequency

C-2 – Step Drawdown Test Overview
C-3 – Drawdown at Pumping and Observation Wells
C-4 – Transmissivity and Storativity Estimates
C-5 – Radius of Influence

Figures

C-1 – Site Location
C-2 – Step Test Locations
C-3 – Step Drawdown Tests and River Stage
C-4 – Drawdown during EW-1 Tests (May and September 2014)
C-5 – Drawdown during EW-3 Tests (May and September 2014)
C-6 – Drawdown during EW-6 and EW-7 Tests (September 2014)
C-7 – EW-1 Efficiency (May and September 2014)
C-8 – EW-3 Efficiency (May and September 2014)
C-9 – EW-6 and EW-7 Efficiency (September 2014)
C-9a – EW-6 Predicted Drawdown (Distance Drawdown Plot)
C-10 – EW-1 Parameter Estimation (May and September 2014)
C-11 – EW-3 Parameter Estimation (May and September 2014)
C-12 – EW-6 and EW-7 Parameter Estimation
C-13 – EW-1 Distance vs. Drawdown (May and September 2014)

Attachments

C-1 – Field Sheets
C-2 – Lithology and Drawdown

2.0 Field Procedures

Step drawdown testing took place at EW-1 and EW-3 on May 13 to 14, 2014 and at EW-1, EW-3, EW-6 and EW-7 on September 15 to 18, 2014 (Figure C-2 and C-3). Field sheets for each step drawdown test are included in Attachment C-1.

All extraction wells on-site were shut off at least 48 hours prior to the beginning of the tests to allow the groundwater levels to equilibrate. A flow-meter on the discharge line of each pumping well was installed to measure the flow rate at each well; the flow rate was also measured occasionally during the tests through timed discharge into a graduated 5-gallon container. For each test, a pressure transducer was placed in the pumping well and at two (2) nearby observation wells (Figure C-2). Depth to water and depth to NAPL measurements were collected before, during, and after each pumping test as indicated in Table C-1.

Step testing was comprised of four to six constant drawdown steps for each well; water levels and discharge rates were recorded in each pumping well (Table C-2). At each pumping well, the pump was adjusted to maintain a constant head (e.g., 1ft, 3ft, 5ft and 7ft below static level) until flow rates and drawdown levels stabilized. Wells were purged using air diaphragm QED AutoPumps. Each test was run between four and seven hours. Subsequent tests were spaced at least 16 hours apart to allow for recovery of the system.

3.0 Results

Results from the step drawdown tests were evaluated using several methods, including:

- Time versus drawdown plots
- Specific capacity & efficiency
- Hydraulic conductivity estimates
- Distance vs. drawdown plots

The following assumptions were applied in this analysis. Wells where these assumptions are not valid were not included in the analytical models used in this analysis.

- Pumping exerts dominant influence on drawdown in pumping wells and observation wells
- The sheet pile wall effectively decreases the measured transmissivity (T) at each pumping well behind the barrier wall by half (i.e., at EW-1 and EW-3)
- Drawdown at observation wells decreases with increasing distance from the pumping well

3.1 Time versus Drawdown

Time versus drawdown plots for each pumping test are included in Figures C-4 to C-6[1]. A summary of stable pumping rates and drawdown levels at each pumping well is included in Table C-2; a summary of observed drawdown in each pumping and observation well for each step is included in Table C-3. The following is a summary of notable observations from the tests:

- Maximum pumping rates at all wells in May and September 2014 were less than two gallons per minute. September pumping rates at EW-1 and EW-3 were roughly half the rates observed in May (Table C-2), likely due to lower water levels (see Attachment C-2).
- Pumping rates at the two new extraction wells on either end of the barrier wall (EW-6 and EW-7) were nearly double the pumping rates observed at wells behind the barrier wall (EW-1 and EW-3). This was expected, as the barrier wall acts as a no-flow boundary, decreasing apparent transmissivity in wells behind the wall by approximately half.
- A comparison of drawdown at observation wells from the EW-1 and EW-3 tests in May and September (Figure C-4 to C-5, and Table C-3) indicates equal or greater drawdown at observation wells (PZ-2 and MW-10) in September than in May, which may be due to increased well efficiency following redevelopment and reduced saturated thickness due to seasonally declining water levels in September 2014.
- Maximum observed drawdown at observation wells varied from a tenth of a foot to several feet (Table C-3). Observation wells with significant drawdown included PZ-2 (EW-1 test), PZ-8 and PZ-2 (EW-6 test), MW-10 (EW-3 test), and PZ-7 and MW-10 (EW-3 test).

The time versus drawdown plots also indicate that various factors such as the river stage, local heterogeneities, and the barrier wall likely influence flow patterns. In general, the pumping test appears to be the dominant influence on drawdown in observation wells, with the following exceptions:

- EW-1 test (May and September): Observation well PZ-9 appears to be predominantly influenced by river stage fluctuations; drawdown was assumed to be less than 0.05 feet.
- EW-3 test (May and September): Despite being located within 10 feet of the pumping well, observation well PZ-6 does not appear to be significantly influenced by the pumping test or river level fluctuations. This may be due to localized heterogeneity or other factors influencing flow.
- EW-7 test (September): Drawdown at observation wells PZ-8 and MW-10 does not decrease with distance from the pumping well; localized heterogeneity or other factors may be influencing flow.

[1] The Willamette River stage shown in these figures was adjusted to show zero displacement at the beginning of each pump test. A positive displacement slope indicates decreasing river stage elevation; negative slope indicates increasing river stage elevation.

3.2 Specific Capacity and Well Efficiency

Using stable pumping rates and drawdown (i.e., from the end of each step) in the pumping wells, the percent efficiency was calculated for each pumping well. Specific capacity and well efficiency plots are presented in Figures C-7 to C-9. Well efficiency is calculated via the following formulas (Freeze and Cherry, 1979):

$$Efficiency\ (E) = \frac{Aquifer\ Losses}{Total\ Drawdown}$$

$$Efficiency\ (E) = \frac{Aquifer\ Losses\ (BQ)}{Aquifer\ Losses\ (BQ) + Well\ Losses\ (CQ^2)}$$

$$\%\ Efficiency\ (\%E) = 100\ x\ \frac{(BQ)}{(BQ + CQ^2)}$$

Efficiency in both EW-1 and EW-3 improved after well redevelopment. Calculated percent efficiency improved at EW-1 from 20-40% in May to 70-90% in September, and both EW-1 and EW-3 observation wells had increased drawdown in September despite lower pumping rates.

The percent efficiency in EW-7 was 70-90% and the observed drawdown at EW-6 corresponds very well with predicted drawdown in the distance-drawdown curve presented in Figure C-9a.

Low well efficiency observed in September 2014 (at EW-3 and EW-6) is likely due to low water levels.

3.3 Hydraulic Conductivity Estimates

To evaluate the range of hydraulic conductivities in the vicinity of the barrier wall, the drawdown and recovery data was analyzed in AQTESOLV (Duffield, 2007) using the Theis solution for a pumping test in an unconfined aquifer with variable pumping rates. Curve fitting was performed visually with the highest weight placed on observation well drawdowns. A summary of the results of the parameter estimation in AQTESOLV is included in Table C-4.

To account for the effect of the no-flow boundary for wells behind the barrier wall (i.e., EW-1 and EW-3), the transmissivity values estimated in AQTESOLV were divided by 2. Hydraulic conductivity was estimated by dividing the transmissivity by the thickness of the saturated aquifer (i.e., bottom of the screen to the water table). All wells were assumed to be fully penetrating.

Results indicate hydraulic conductivity in the vicinity of the barrier wall ranges from 4 to 40 feet per day (ft/d), which is comparable to a previous estimates of 19 ft/dy (Delta, 2003) and within the range of literature values for alluvial sands (Freeze and Cherry, 1979). Hydraulic conductivity estimates for EW-1 and EW-3 from the September tests are lower than estimates from the May tests, which is expected, since the tests were conducted within the finer-grained part of the aquifer (see Attachment C-2).

3.4 Radius of Influence

Based on distance drawdown plots and the extent of observed drawdown, the radius of influence for each pumping well was approximated (see Table C-5).

Distance versus drawdown plots were created for EW-1 (Figure C-13) and EW-6 (Figure C-9a). Using distance versus drawdown plots at EW-1 and EW-6, the radius of influence was estimated to range from 50 to 70 feet at EW-1 and at least 25 feet at EW-6. The radius of influence from EW-6 is likely larger than predicted; there appears to be less drawdown at PZ-2 than expected, likely due to interference from the barrier wall. The radius of influence does not appear to vary significantly for pumping drawdowns greater than five feet.

Distance drawdown plots were not created for EW-3 and EW-7 in the south barrier wall area where drawdown was greater at the more distant observation wells, violating a key assumption of the distance versus drawdown calculations. For these wells, the radius of influence was assumed to extend to at least the distance of the furthest observation well where significant drawdown was observed.

4.0 Conclusions

Results from this study indicate that the step drawdown testing method is an effective method for assessment of extraction well efficiency and aquifer conditions on-site. Multiple lines of evidence were used to evaluate efficiency, hydraulic conductivity and radius of influence. Atypical trends observed during the testing are likely a result of the influence of the barrier wall, local heterogeneities and variation in lithology, and influence from the river. Key conclusions from the analysis include:

- Well redevelopment was successful at improving well efficiencies.
- Results from step testing at new extraction wells EW-6 and EW-7 indicate equal or better baseline efficiencies have been achieved, compared to wells EW-1 and EW-3. .
- Hydraulic conductivity estimates for the shallow aquifer in the vicinity of the barrier wall range from four to 40 ft/dy, which compares well with previous estimates at former extraction well RW-2 and literature values.
- Generally the radius of influence does not increase significantly for drawdowns greater than five feet from static. To improve capture and reduce well fouling, pump intakes will initially be set at 5 ft below static water levels and adjusted as needed based on site observations.
- This study has helped update the Conceptual Site Model in the vicinity of the barrier wall and to refine the understanding of the hydraulic conductivity distribution on-site

Recommendations for optimization of extraction well system operations include:

- Extraction well intakes should be positioned at five feet below static water levels to reduce well fouling
- Single well (pumping well) test are an appropriate method to use to evaluate changes in efficiency against baseline. However, extraction well performance testing should be performed at similar starting static water levels to provide comparable results.

5.0 References

CH2M HILL, 2014. *Extraction Well Installation and Redevelopment Installation Report,* Kinder Morgan Linnton Terminal. November 24.

Delta Environmental Consultants, Inc. (Delta). 2003. *IRAM Design Report, Kinder Morgan Liquids Terminals Linnton Terminal, Portland, Oregon.* Prepared for Oregon Department of Environmental Quality, DEQ ECSI No. 1096. November 13.

Duffield, G.M., 2007. *AQTESOLV for Windows Version 4.5 User's Guide*, HydroSOLVE, Inc., Reston, VA.

Freeze, R.A. and J.A. Cherry. 1979. *Groundwater*. Prentice-Hall, Inc., Englewood Cliffs, N.J. 604 pp.

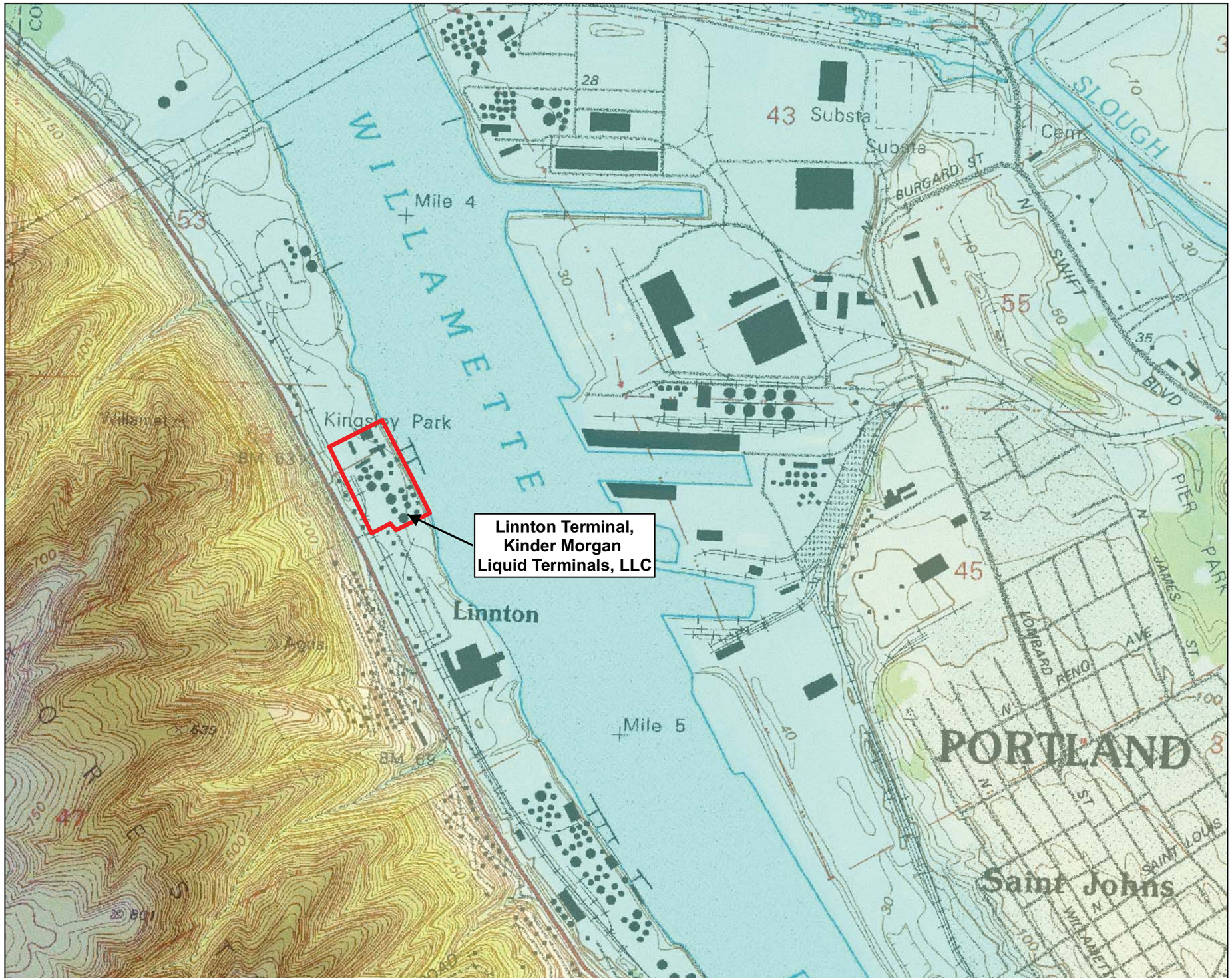
TABLE C-1

Manual Water Level and Flow Rate Measurement Frequency

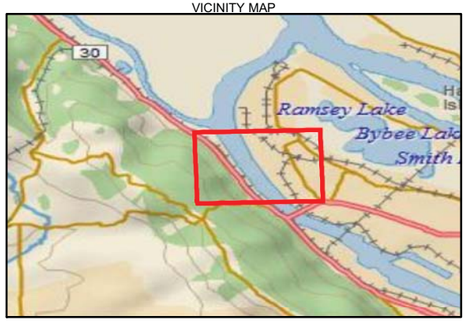
Kinder Morgan Liquids Terminals, Linnton Terminal

Time since pump is turned on at the beginning of each step (in minutes)	Manual Water Level Measurements Interval at Pumping Well [(1)] (in minutes)	Flow Rate Measurement Interval (in minutes)
0 – 5	1	1
5 – 60	5	5
60 – 120	10	10

1) At each measurement interval the time, minutes elapsed since pumping step began, depth to water, depth to NAPL, and flow rate will be recorded in the field sheets



VICINITY MAP



LEGEND

Site Boundary

Elevation (ft)

High : 1144 ft

Low : 8 ft

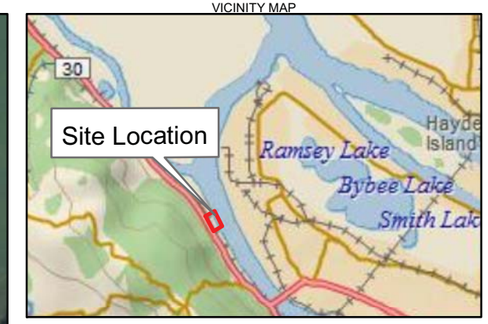
N

0 500 1,000 1,500
Feet

1 inch = 1,000 feet

FIGURE C-1
Site Map
Kinder Morgan Liquid Terminals, LLC
Linnton Terminal
11400 NW St. Helens Road *Portland, Oregon*

VICINITY MAP



LEGEND

- Barrier Wall
- Railroad

Linnton Terminal Wells

- Hydraulic Control Well
- Shallow Monitoring Well/Extraction Well
- Monitoring Well - Shallow
- Monitoring Well - Deep
- Piezometer
- 3-Foot Diameter Cistern

EW-1 Pumping Well Used in Step Tests

PZ-1 Observation Well Used in Step Tests

N

0 50 100
Feet

FIGURE C-2

Step Test Locations

Kinder Morgan Liquid Terminals LLC
Linnton Terminal
11400 NW St. Helens Road
Portland, Oregon

CH2MHILL

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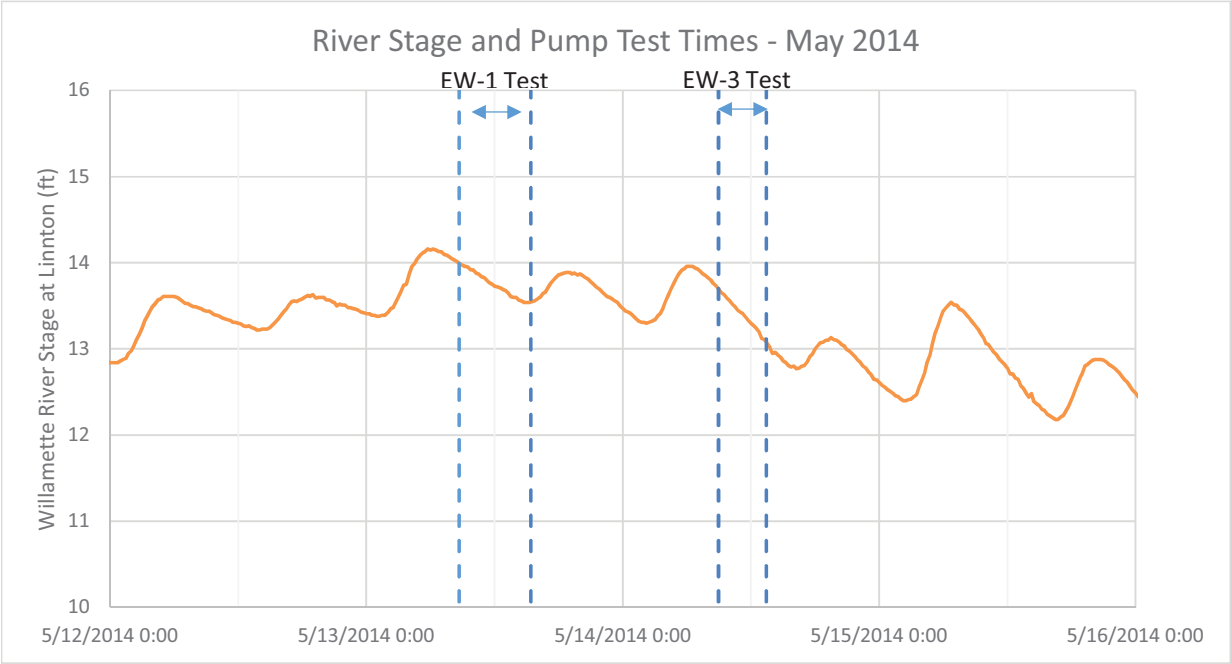


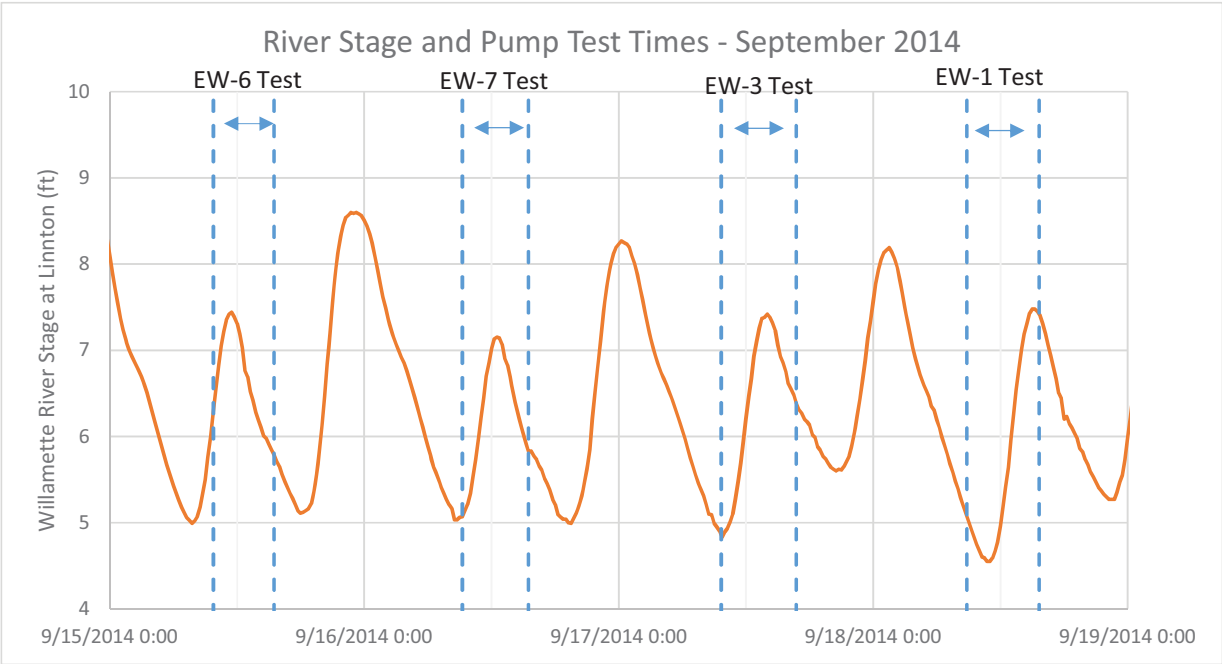
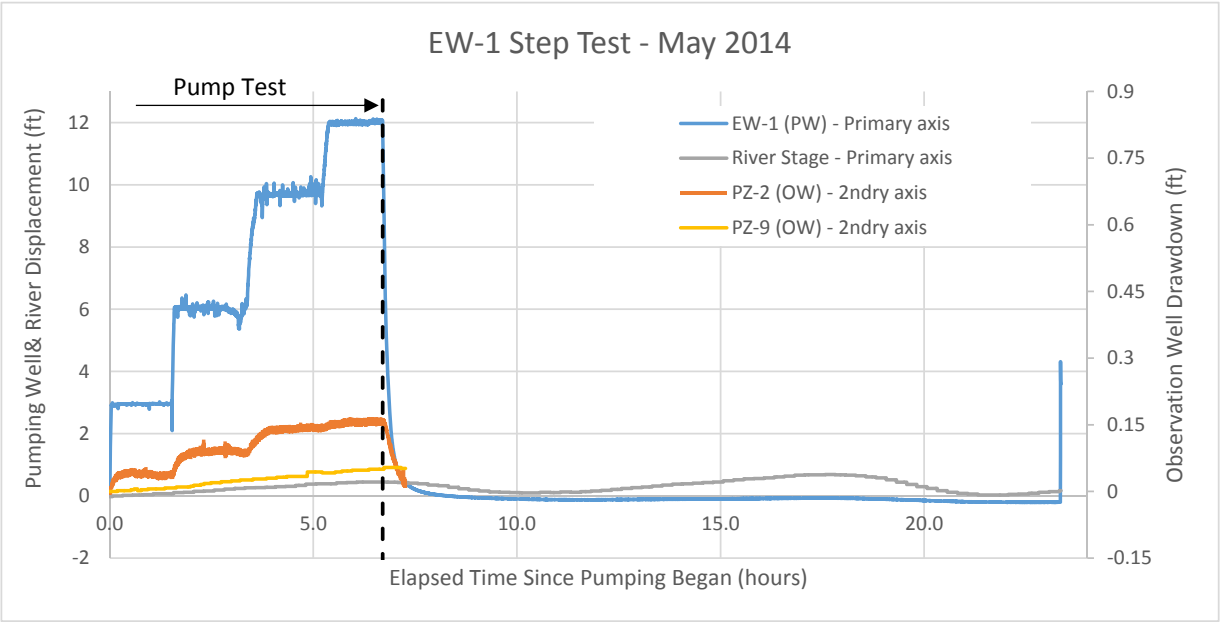


Figure C-3
Step Drawdown Tests and River Stage
Kinder Morgan Linnton Terminal
Portland, Oregon



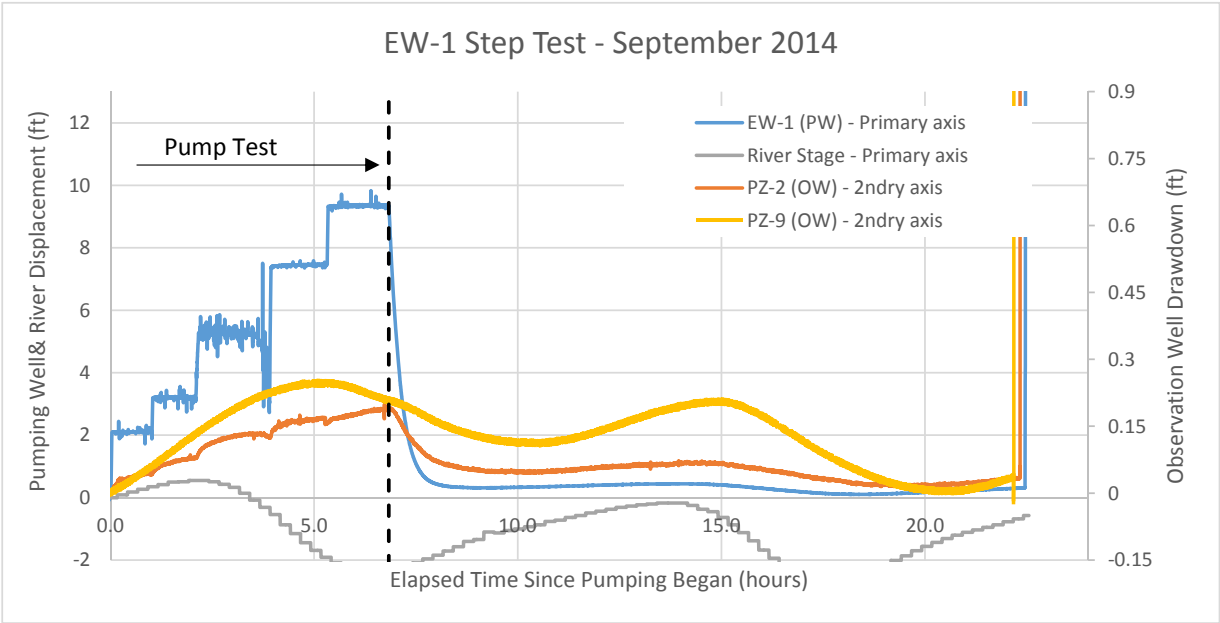
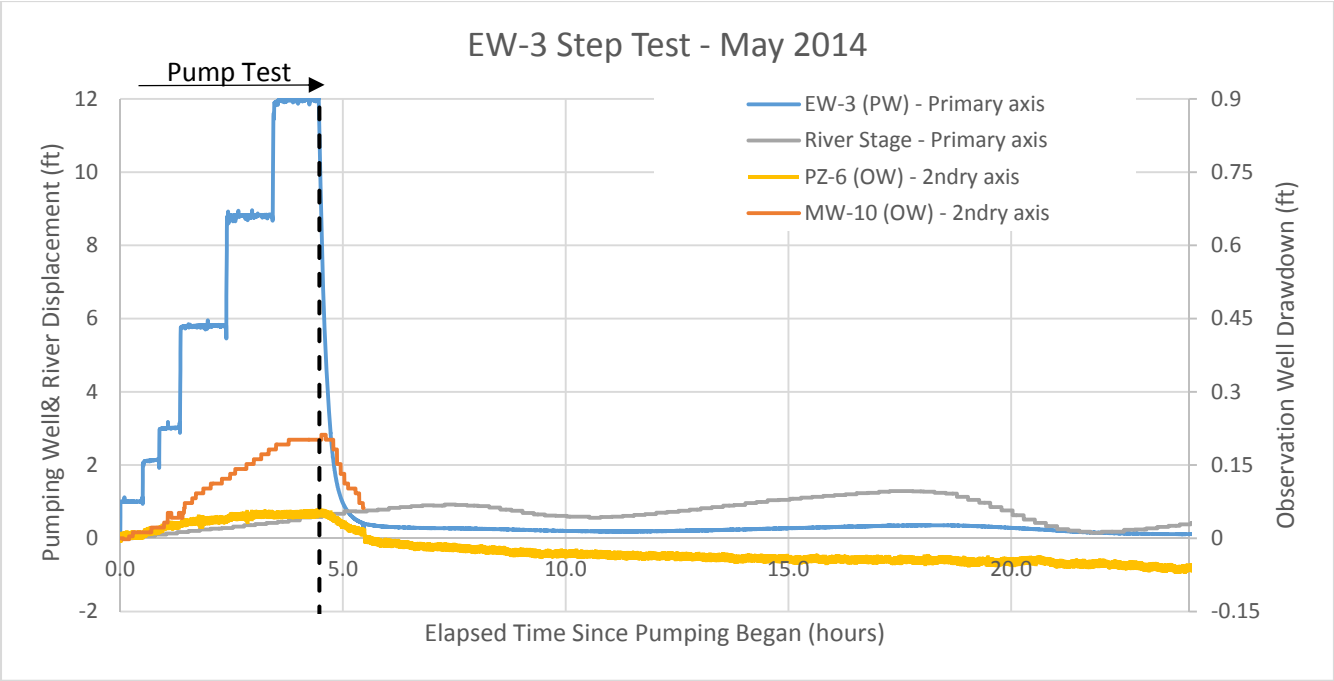


Figure C-4
Drawdown during EW-1 Tests
May and September 2014
Kinder Morgan Liquids Terminals, Linnton Terminal



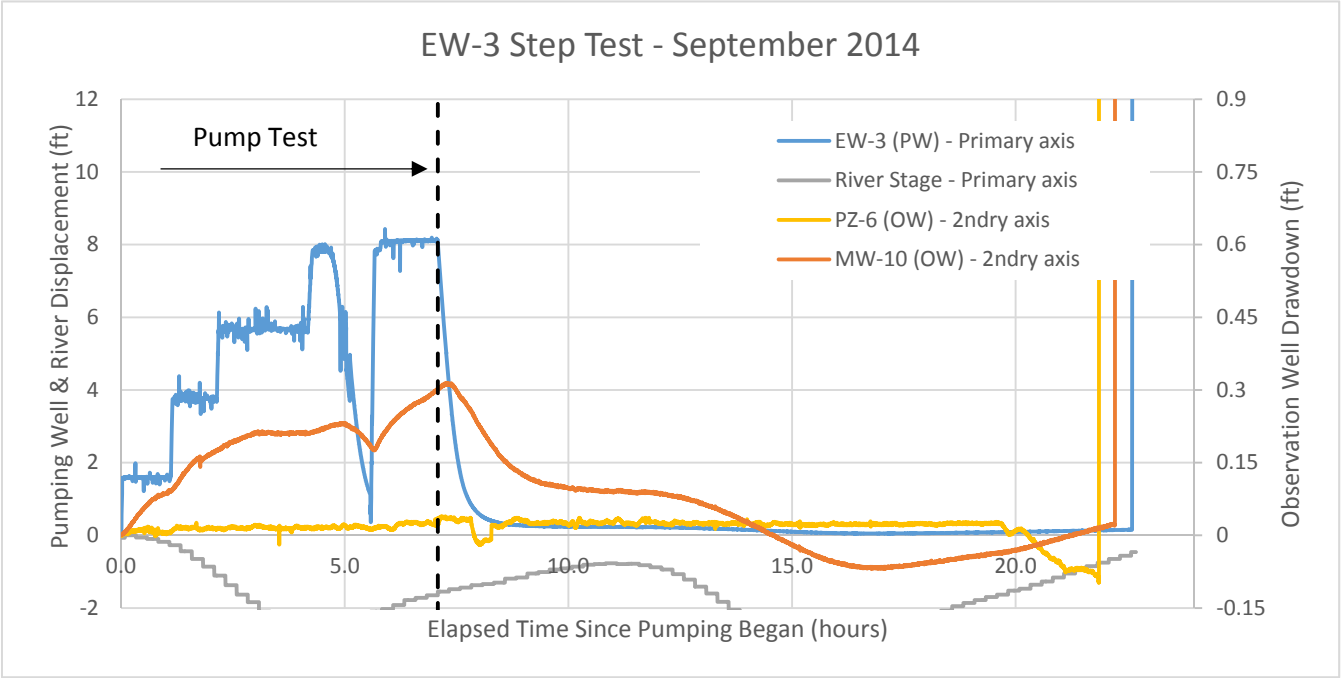
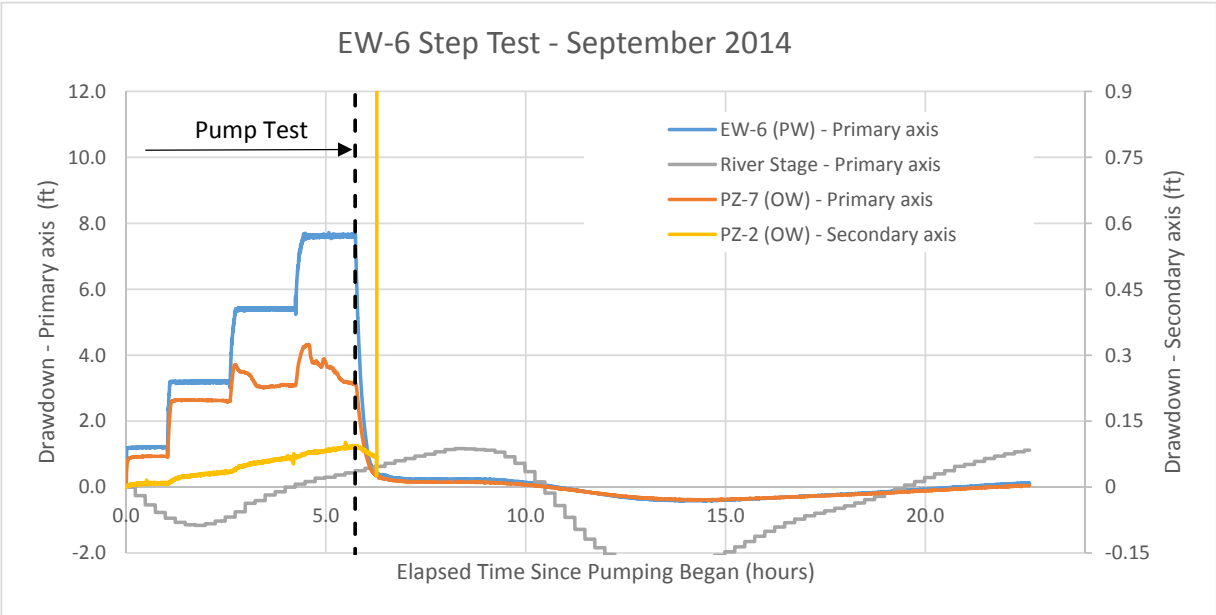


Figure C-5
Drawdown during EW-3 Tests
May and September 2014
Kinder Morgan Liquids Terminals, Linnton Terminal



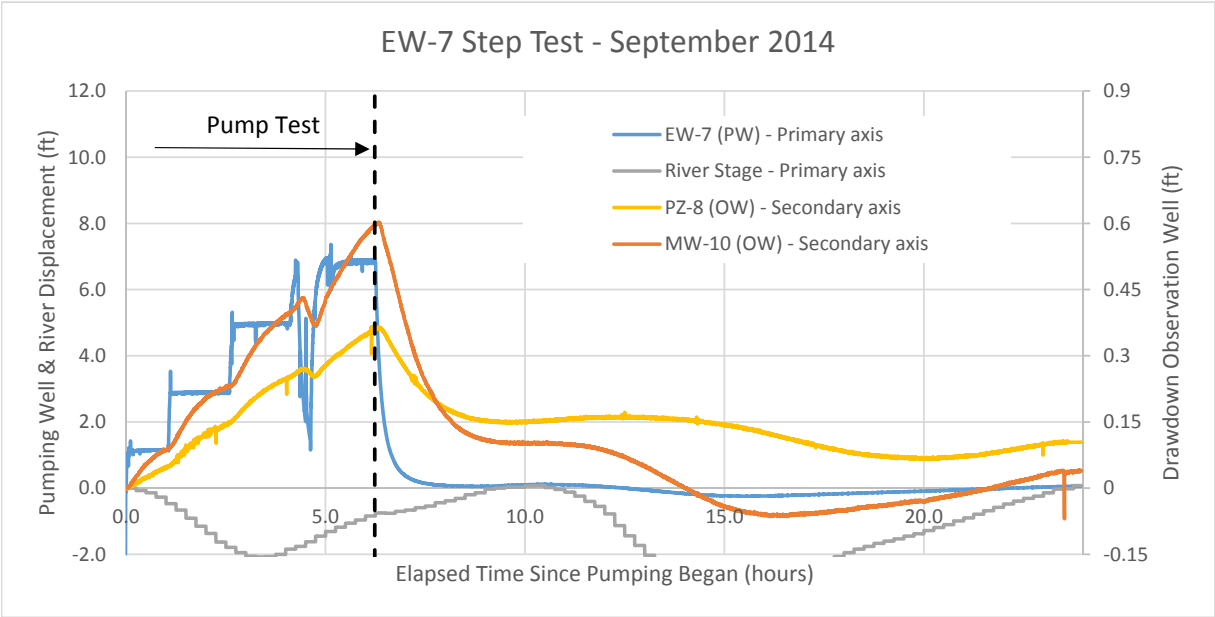
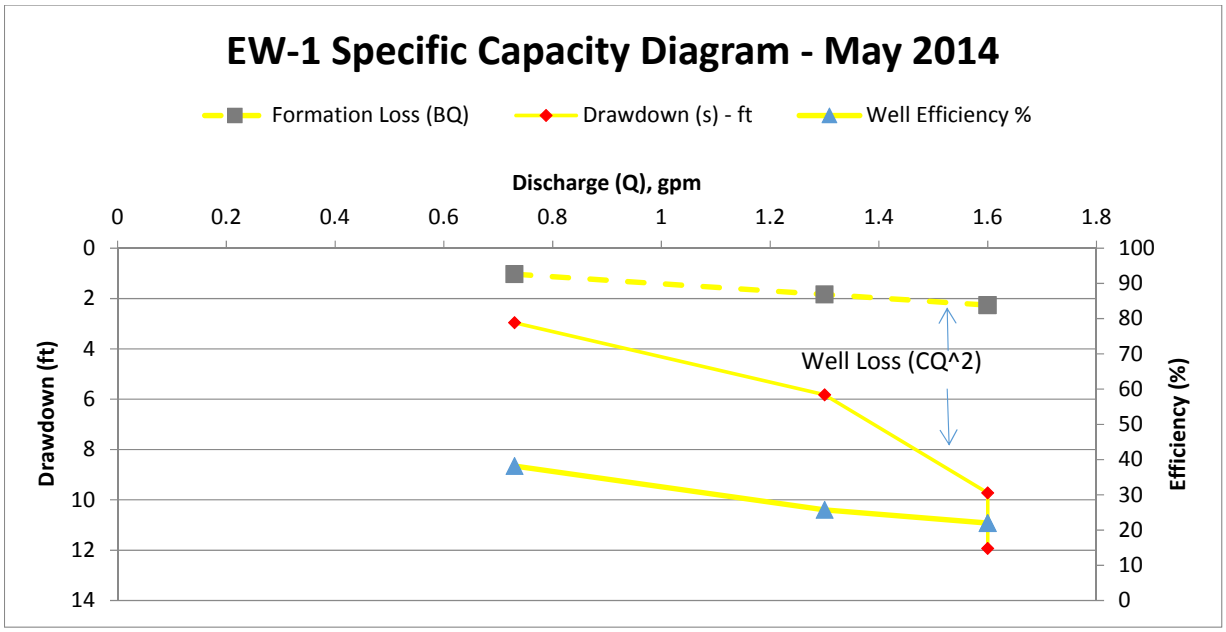


Figure C-6
Drawdown during EW-6 and EW-7 Tests
September 2014
Kinder Morgan Liquids Terminals, Linnton Terminal



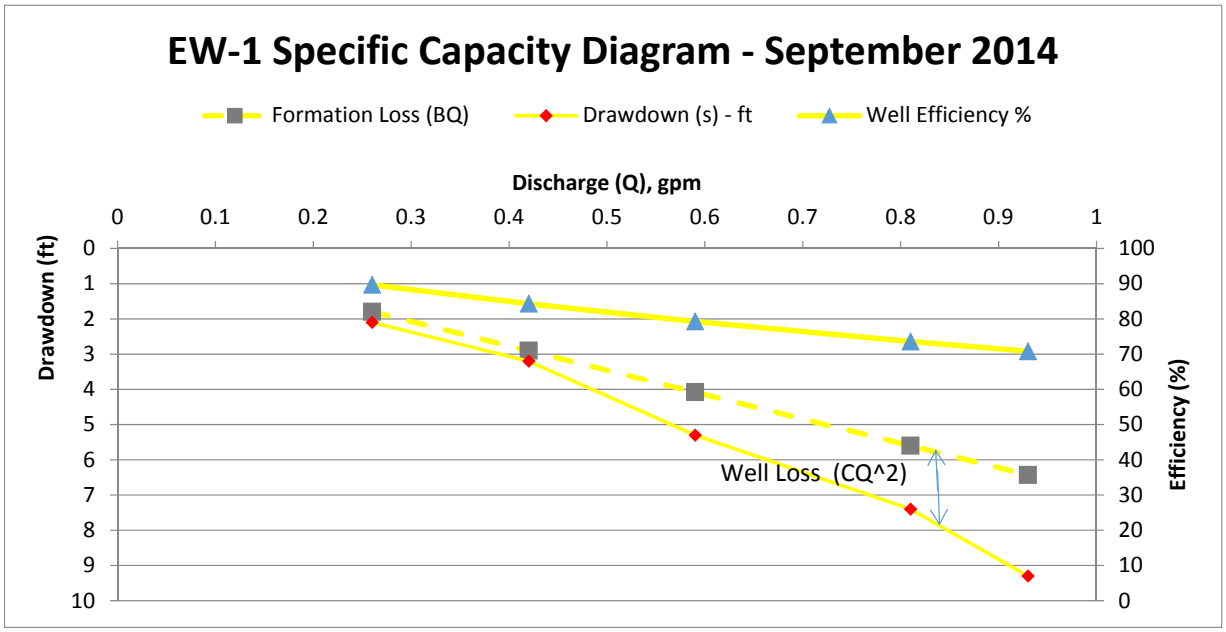
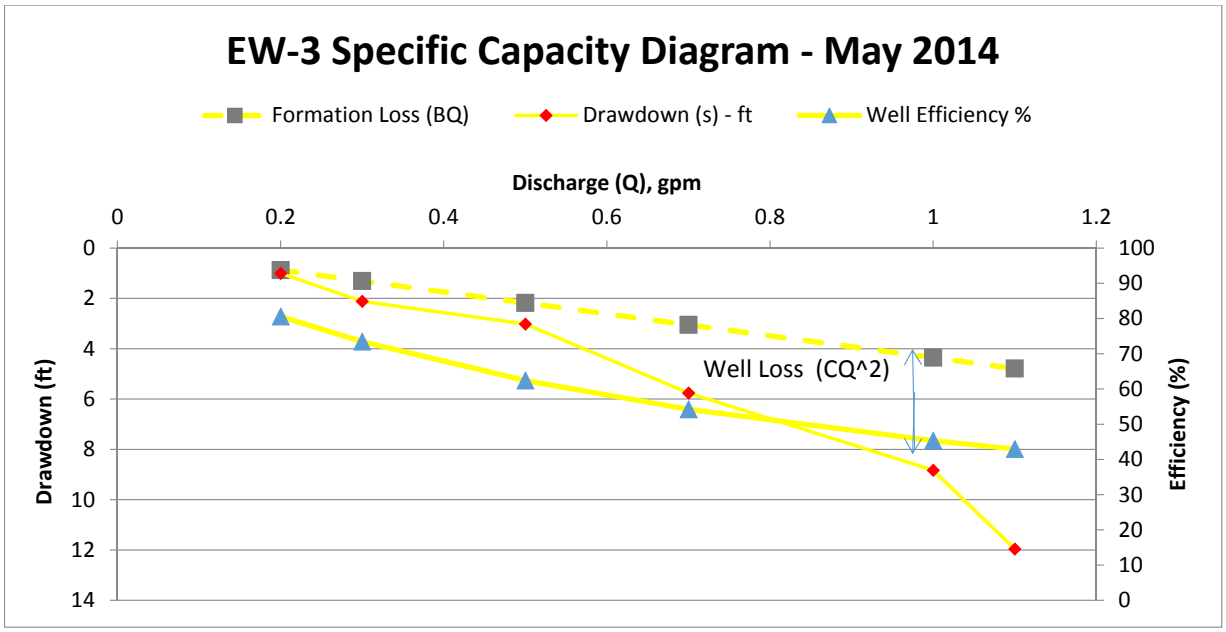


Figure C-7

EW-1 Well Efficiency

Kinder Morgan Liquids Terminals, Linnton Terminal



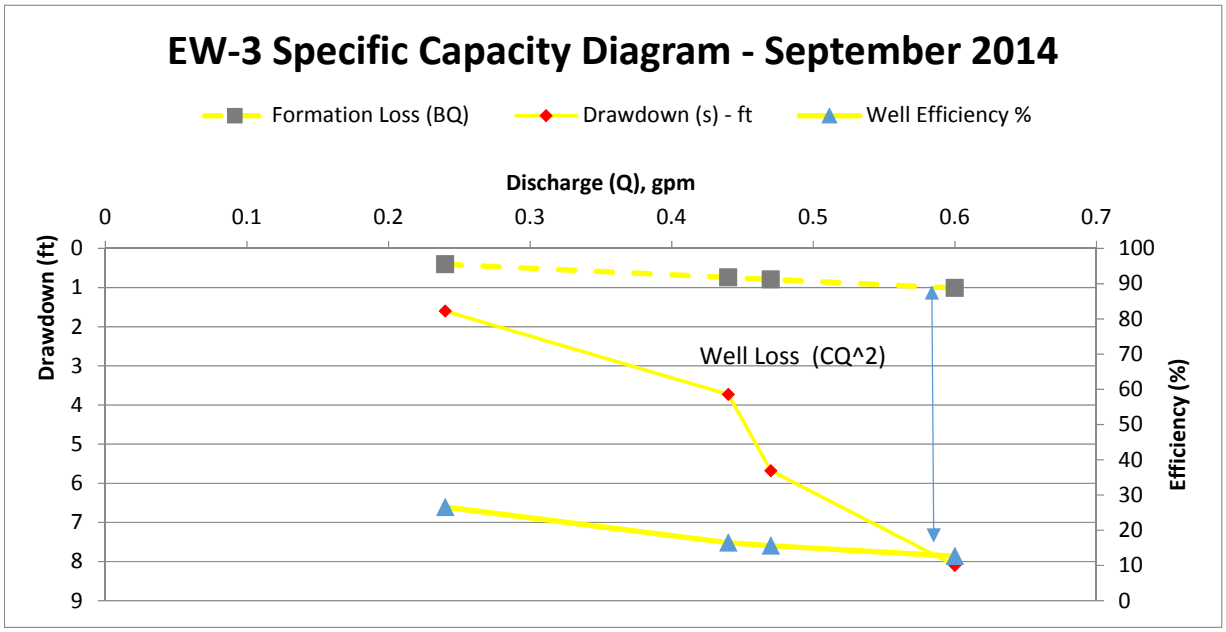
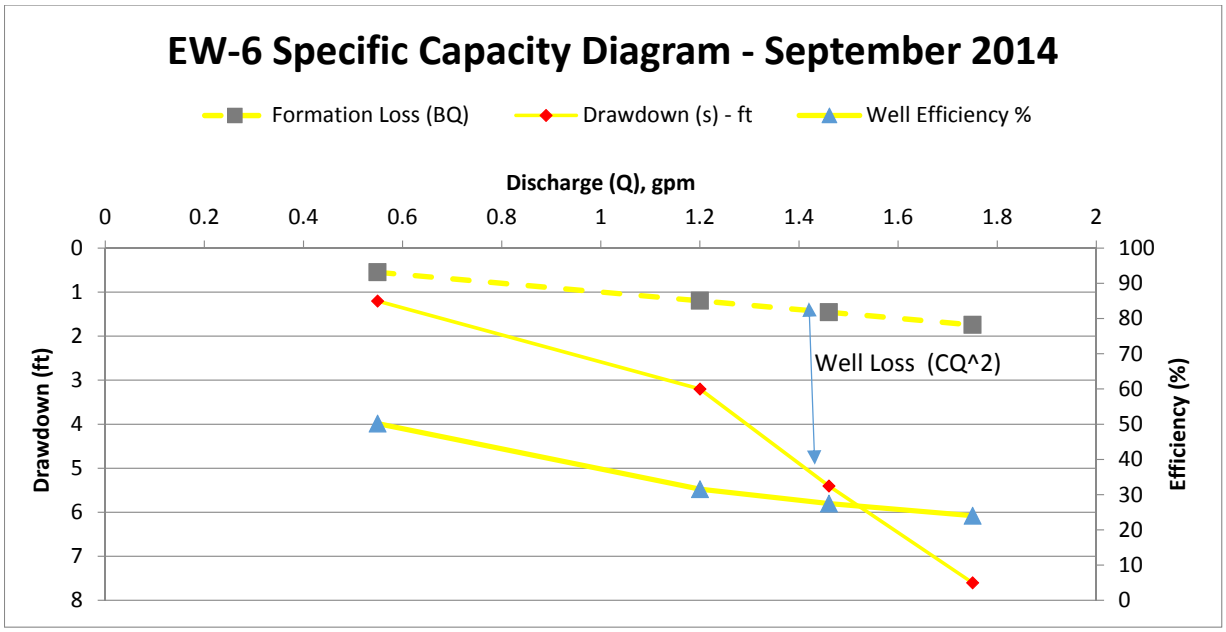


Figure C-8

EW-3 Well Efficiency

Kinder Morgan Liquids Terminals, Linnton Terminal



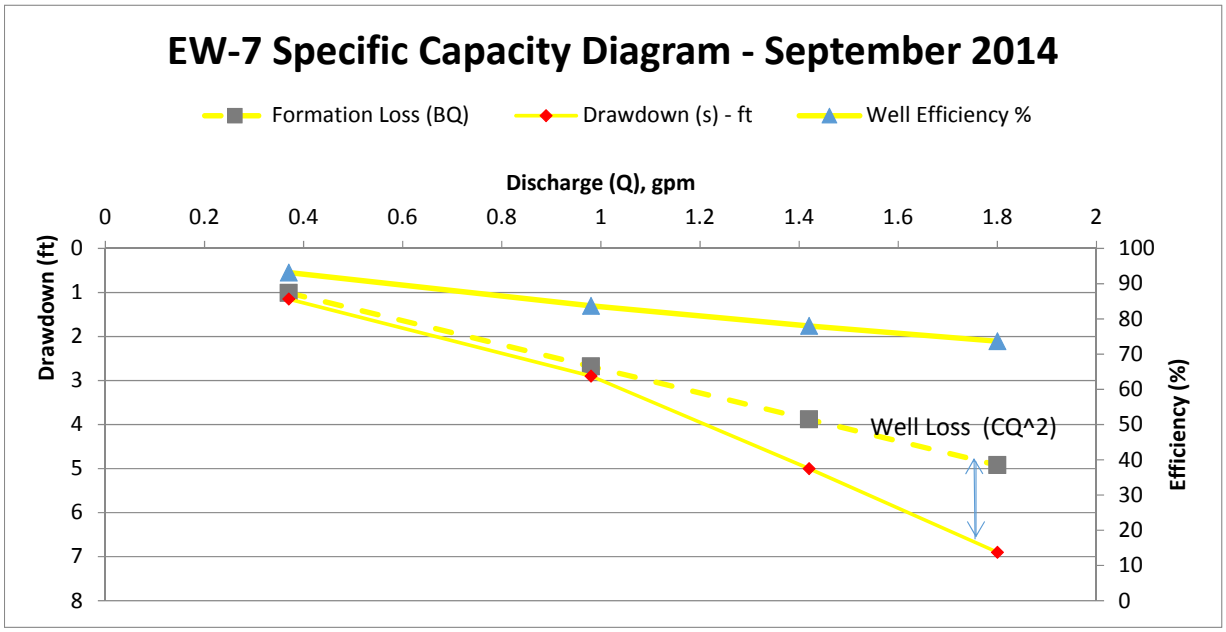


Figure C-9

EW-6 and EW-7 Well Efficiency

Kinder Morgan Liquids Terminals, Linnton Terminal

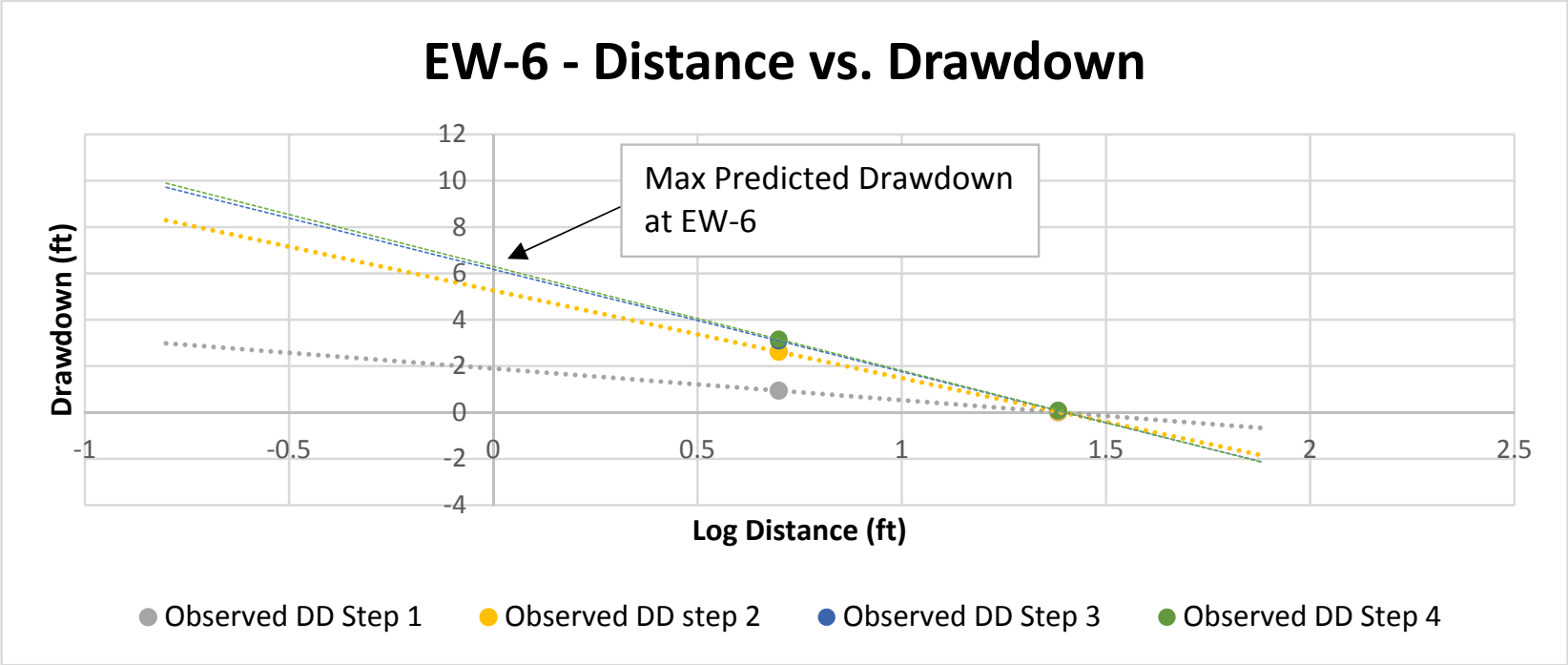
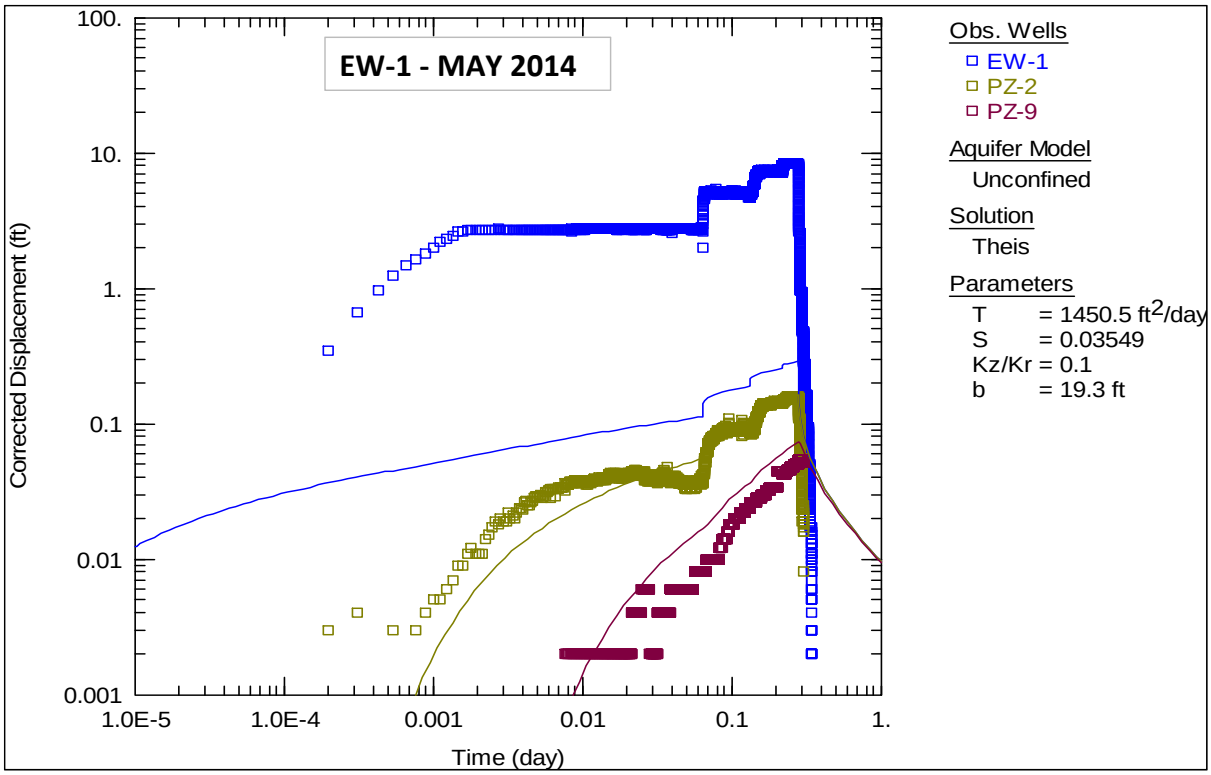


Figure C-9a

EW-6 - Predicted Drawdown (Distance Drawdown Plot)

Kinder Morgan Liquids Terminals, Linnton Terminal



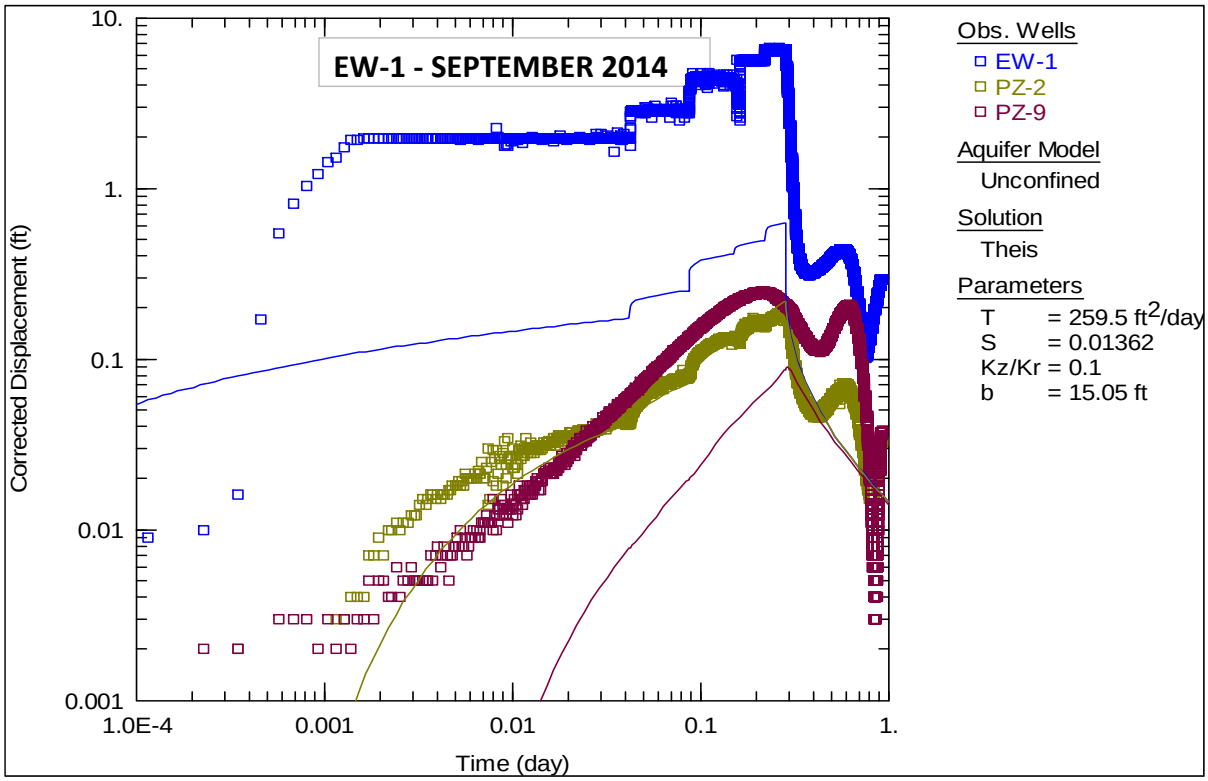
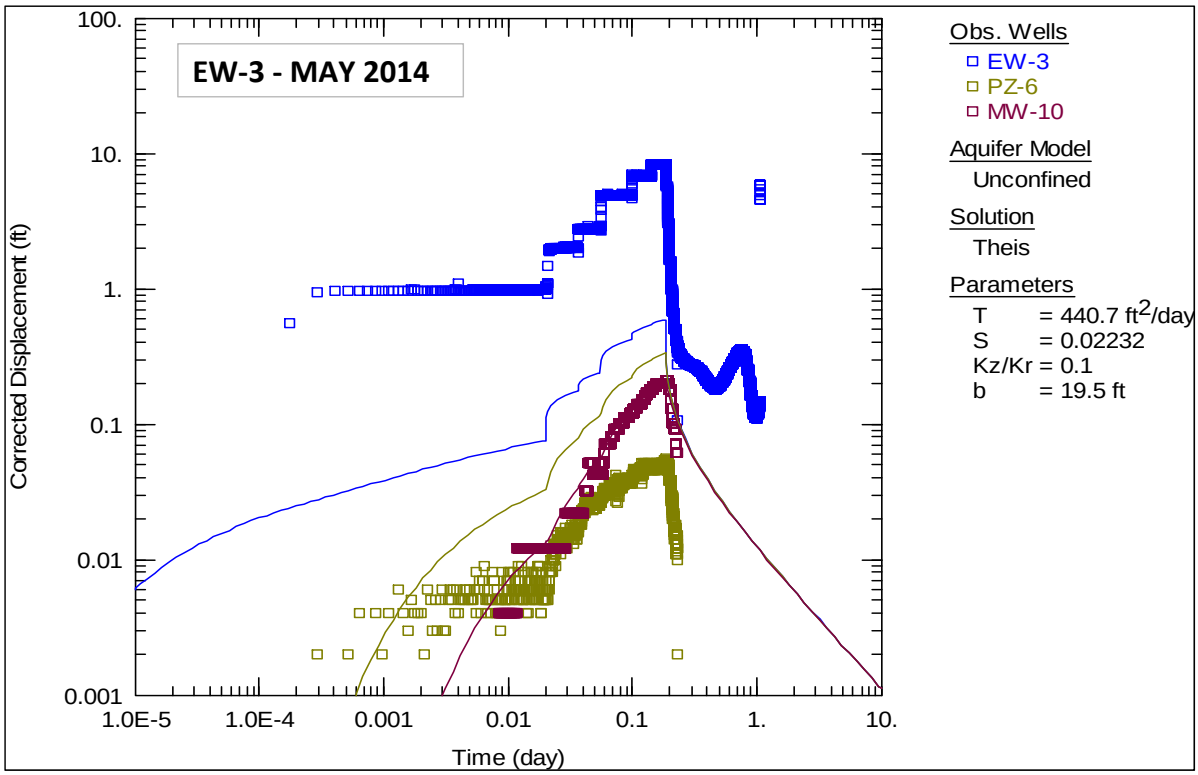


Figure C-10
EW-1 Parameter Estimation
May and September 2014
Kinder Morgan Liquids Terminals, Linnton Terminal



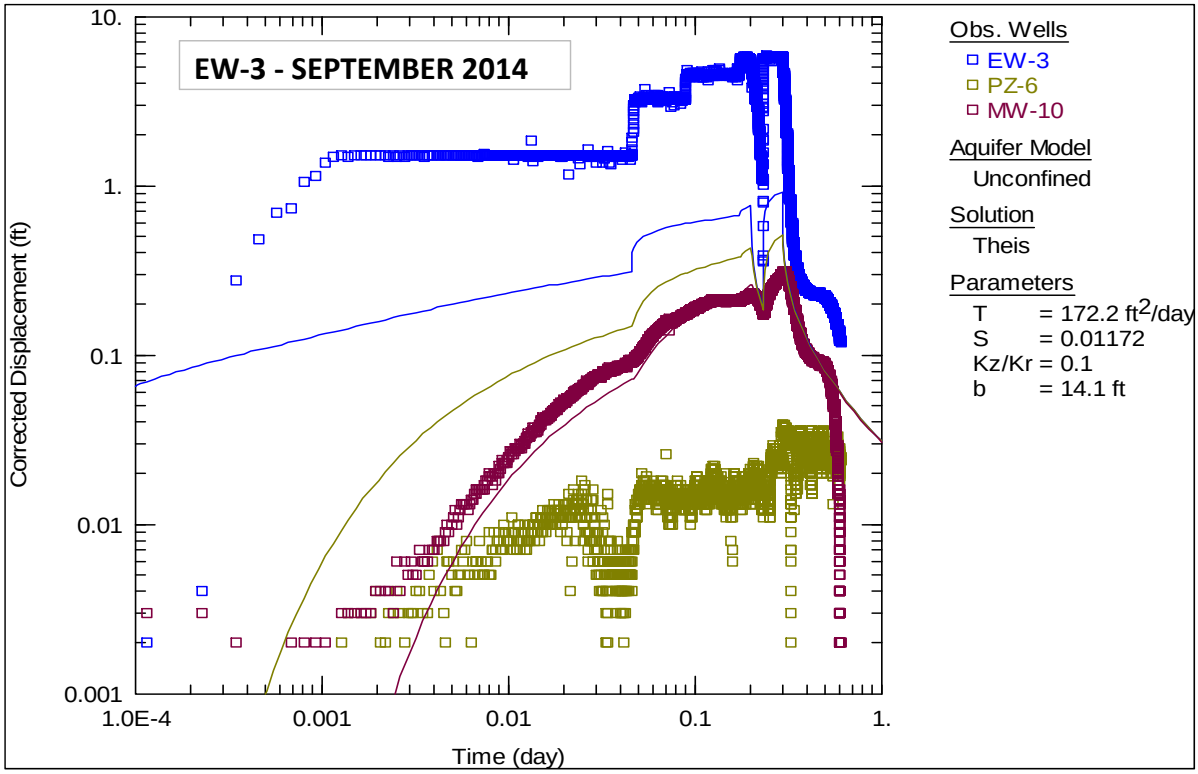
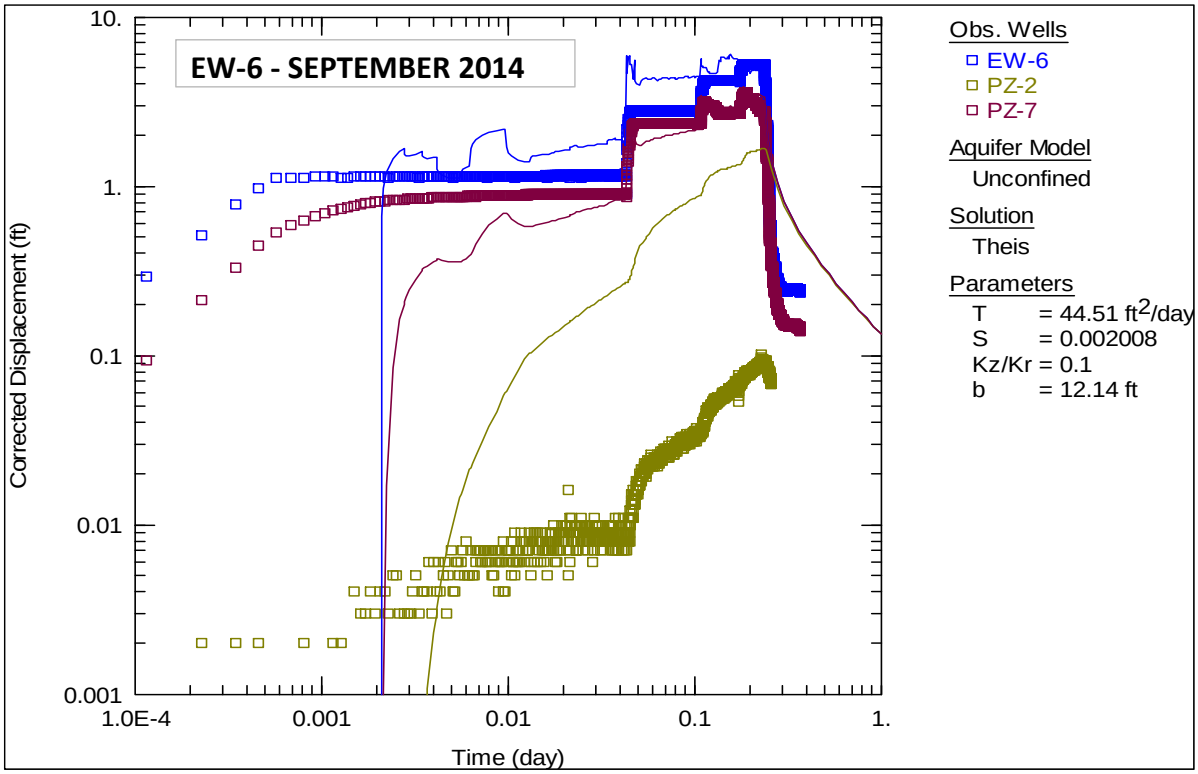


Figure C-11
EW-3 Parameter Estimation
May and September 2014
Kinder Morgan Liquids Terminals, Linnton Terminal



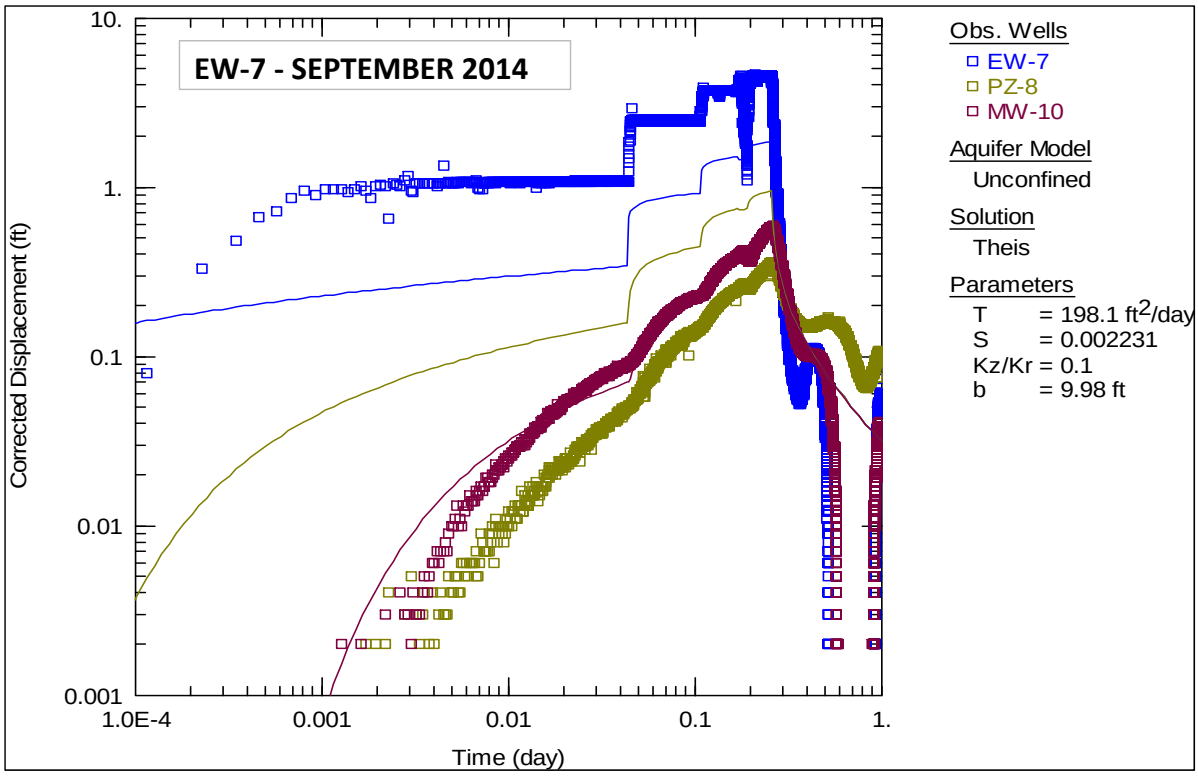
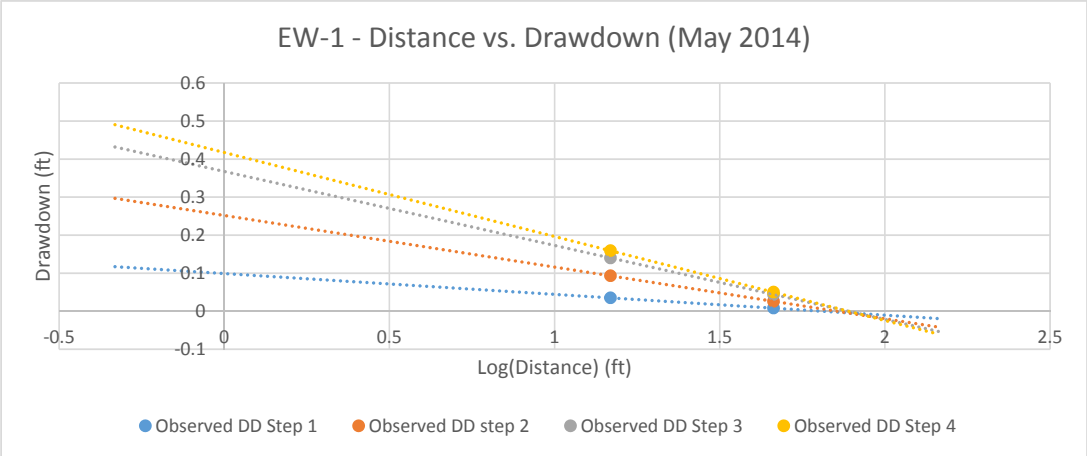


Figure C-12
EW-6 and EW-7 Parameter Estimation
September 2014
Kinder Morgan Liquids Terminals, Linnton Terminal



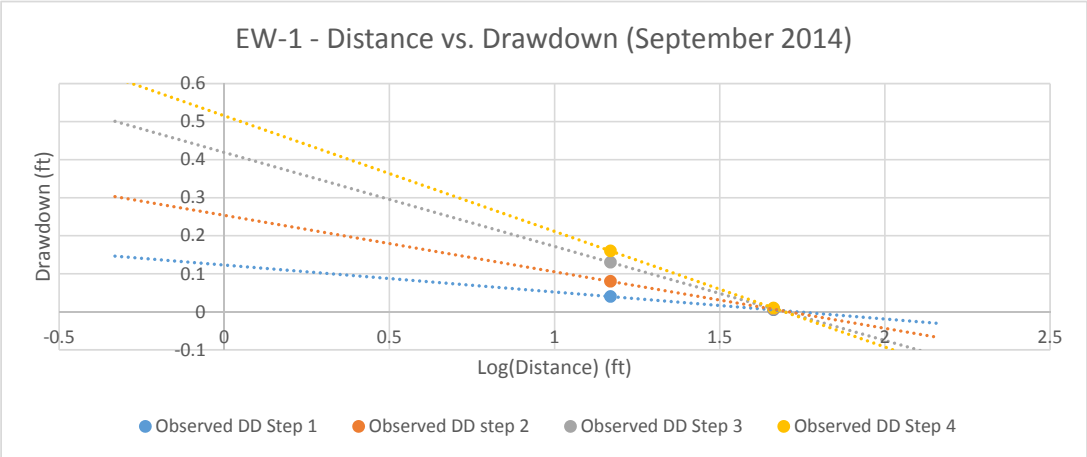


Figure C-13
EW-1 Distance vs. Drawdown
May and September 2014
Kinder Morgan Liquids Terminals, Linnton Terminal

CH2MHILL

PROJECT NUMBER 497639.01.02

PUMPING WELL

Step Drawdown Test - Field Log

Linnton Terminal - Kinder Morgan Liquids Terminals, LLC

Field Crew: Jeannette Sager / Cheryl Hill ; Nolan Lewis / Antea

Date: 9-18-14

Weather: CLOUDY, LIGHT RAIN ~70°F

PUMPING WELL ID:	EW-1	Well Diameter(in):	6
Initial DTW (ft):	16.73	Borehole Diameter (in):	12
Initial DTNAPL (ft):	15.95	Sump Length (ft):	3
Initial NAPL Layer Thickness (ft):	0.78	Begin Pump Test Time:	08:50
Well Depth (ft):	33.2 BELOW GRADE ⇒ 31.2 BTOC	End Pump Test Time:	15:39

TIME (HR:MIN)	# MIN SINCE PUMPING BEGAN	DEPTH TO WATER (FT BMP)	DEPTH TO LNAPL (FT BMP)	FLOW RATE (gpm) or TOTALIZER READING (gal)	Notes:
0828	—	16.73	15.95	—	INSTALL TRANSDUCER
0829	—	16.72	15.95	—	
0850:00	0	NM	NM	1954.4	STEP #1 - 18 FT BTOC
0851:00	1	17.70	JS ~~17.~~ 16.75	1956.5	≈ 1 FT DD
0852:00	2	17.86	SKM ~~19.57~~	1957.9	
0853:00	3	17.87	17.86	1958.4	±0.02 FT w/ PUMP CYCLE
0854:00	4	17.87	17.86	1958.6	
0855:00	5	17.87	17.86	1959.0	
0900:00	10	17.87	17.86	1960.6	
0905:00	15	17.87	17.86	1962.2	
0910:00	20	17.87	17.86	1963.6	
0915:00	25	17.87	17.86	1964.9	
0920:00	30	17.87	17.86	1966.1	0.24 gpm
0925:00	35	17.87	17.86	1967.5	
0930:00	40	17.87	17.86	1968.9	0.28 gpm
0935:00	45	17.87	17.86	1970.2	0.26 gpm
0940:00	50	17.87	17.86	1971.6	0.28 gpm
0945:00	55	17.87	17.86	1972.9	0.26 gpm
0950:00	60	17.86	NP	1974.2	0.26 gpm
0951:00	0	—	—	—	STEP #2 - 19 FT BTOC
0952:00	1	18.96	NP	1977.0	≈ 2 FT DD
0953:00	2	18.94	NP	1977.5	±0.02 FT w/ PUMP CYCLE
0954:00	3	18.94	NP	1977.9	
0955:00	4	18.96	NP	1978.4	
0956:00	5	18.96	NP	1978.8	pH = 6.12
JS ~~09~~ 1001:00	10	18.96	NP	1981.0	0.44 gpm
1006:00	15	18.96	NP	1983.25	0.45 gpm
1011:00	20	18.96	NP	1985.3	
1016:00	25 ~~23~~ ~~24~~ JS	18.96	NP	1987.2	
1021:00	30	18.96	NP	1989.1	0.38 gpm
1026:00	35	18.96	NP	JS ~~198~~ 1991.1	0.4 gpm
1031:00	40	18.96	NP	1993.2	0.42 gpm
1036:00	45	18.96	NP	1995.4	0.44 gpm

Notes: AP 4 + PUMP, TRANSDUCER LOGGING ~10 SEC INTERVALS; TRANSDUCER SET ~6 IN FROM BOTTOM OF WELL

CH2MHILL	PROJECT NUMBER	497639.01.02		
	PUMPING WELL	**Step Drawdown Test - Field Log**		PAGE 2 OF 4
Linnton Terminal - Kinder Morgan Liquids Terminals, LLC	Field Crew: Jeannette Soger/CH2MHill; Nolan Lewis/Antea			
	Date: 9-18-14		Weather: CLOUDY; LIGHT RAIN ~70°F	
PUMPING WELL ID:	EW-1		Well Diameter(in):	6
Initial DTW (ft):	16.73		Borehole Diameter (in):	12
Initial DTNAPL (ft):	15.95		Sump Length (ft):	3
Initial NAPL Layer Thickness (ft):	0.78		Begin Pump Test Time:	08:50
Well Depth (ft):	~31.2		End Pump Test Time:	15:39

TIME (HR:MIN)	# MIN SINCE PUMPING BEGAN	DEPTH TO WATER (FT BMP)	DEPTH TO LNAPL (FT BMP)	FLOW RATE (gpm) or TOTALIZER READING (gal)	Notes:
1041:00	50	18.96	NP	1997.25	
1046:00	55	18.96	SHEEN	1999.4	0.43 gpm
1051:00	60	18.96	SHEEN	JS ~~19~~ 2001.5	0.42 gpm
1055:00	0	—	—	—	STEP #3 - PUMP TO 21 FT BTOC
1056:00	1	19.25	SHEEN	2004.9	≈ 4 FT OD
1057:00	2	JS ~~19~~ 20.31	NP	2006.5	
1100 ~~1102:00~~ JS	JS ~~3~~ 4	20.90	NP	2010.4	
1101:00	5	21.00	NP	2011.25	
1102:00	6	21.00	NP	2011.8	
1107:00	10	21.00	NP	2014.9	
1111:00	15	21.00	NP	2018.25	0.67 gpm
1116:00	20	21.00	NP	2021.8	0.71 gpm
1121:00	25	21.00	NP	2026.1	
1126:00	30	21.00	NP	2028.8	
1131:00	35	21.00	NP	2032.2	0.68 gpm
1136:00	40	21.01	NP	2035.6	
1141:00	45	21.00	NP	2038.6	0.6 gpm
1146:00	50	21.00	NP	2041.8	0.64 gpm
1151:00	55 ~~60~~ JS	21.00	NP	2045.0	0.64 gpm
1156:00	60 ~~70~~ JS	21.00	NP	2047.9	0.58 gpm
1206:00	70 ~~80~~ JS	21.00	NP	2054.0	0.61 gpm
1216:00	80 ~~90~~ JS	21.00	NP	2059.8	0.58 gpm
1226:00	90	21.00	NP	2065.8	0.60 gpm
1227:00	0	—	—	—	STEP #4 - PUMP TO 23 FT BTOC
1228:00	1	20.90	NP	2066.9	≈ 6 FT OD
1229:00	2	20.85	NP	2067.2	
1230:00	3	20.80	NP	2067.8	
1231:00	4	20.65	NP	2068.25	PUMP SLOWING, WATER RISING
1232:00	5				PUMP OFF
1243:00	REPLACED AP4+ w/ REGULAR AP4 PUMP				PUMP ON
1244:00	1	20.40	NP	2072.3	
1245:00	2	21.45	NP	2076.5	
1246:00	3	22.45	NP	2080.3	

Notes:

NOTE AP4+ ≈ 0.1 gal/cycle → (best for low pump rates but has some issues @ 73 ft OD for some reason)
AP4 ≈ 0.5 gal/cycle

CH2MHILL

PROJECT NUMBER 497639.01.02

Step Drawdown Test - Field Log

Linnton Terminal - Kinder Morgan Liquids Terminals, LLC

Field Crew: Jeannette Sager/CH2M Hill ; Nolan Lewis/Antea

Date: 9-18-14

Weather: CLOUDY ~70°F

PUMPING WELL ID :	EW-1	Well Diameter(in):	6
Initial DTW (ft):	16.73	Borehole Diameter (in):	12
Initial DTNAPL (ft):	15.95	Sump Length (ft):	3
Initial NAPL Layer Thickness (ft):	0.78	Begin Pump Test Time:	08:50
Well Depth (ft):	~31.2	End Pump Test Time:	15:39

TIME (HR:MIN)	# MIN SINCE PUMPING BEGAN	DEPTH TO WATER (FT BMP)	DEPTH TO LNAPL (FT BMP)	FLOW RATE (gpm) or TOTALIZER READING (gal)	Notes:
1247:00	4	23.04→23.11	NP	2081.5	
1248:00	5	"	NP	2082.6	
1253:30	10.5	23.11	23.12	2087.25	SHEEN
1254:00	11	23.10	23.10 (SHEEN)	2087.85	
1258:00	15	23.16→23.15	SHEEN	2091.3	~0.7 gpm
1303:30	JS ~~20~~ 19.5	"	SHEEN	2094.8	0.6 gal/cycle
1303:00	20	23.15	SHEEN	2095.4	0.72 gpm
1308:00	25	23.15	SHEEN	2099.4	
1312:30 ~~1312:00~~	JS ~~30~~ 29.5	23.15	SHEEN	2102.9	
1313:00	30	23.15	SHEEN	2102.5	0.82 gpm
1318:00	35	23.15	SHEEN	2107.55	
1323:00	40	23.15	SHEEN	2111.6	0.81 gpm
1328:00	45	23.14→17	SHEEN	2115.7	±0.03 FT WHEN PUMP CYCLES
1333:00	50	23.17	SHEEN	2120.3	→ cycled right @ minute was 2119.7 just before
1338:00	55	23.17	SHEEN	2124.4	0.82 gpm
1343:00	60	23.19→23.15	SHEEN	2128.4	0.88 gpm
1353:00	70	23.15	SHEEN	2136.6	0.82 gpm
1403:00	80	23.15	SHEEN	2144.7	0.81 gpm
1408:00	JS ~~90~~ 0	—	—	~~2149.3~~ JS	STEP #5 - 25 FT BTOC
1409:30	1	NM	NM	2153.1	⇒ 8.27 FT DD
1410:00	2	25.05	NP	2154.5	
1411:00	3	24.98→25.03	NP	2155.7	
1412:00	4	"	NP	2156.25	
1413:00	5	"	NP	2157.4	
1418:00	10	25.07	NP	2162.0	
1423:00	15	25.08	NP	2166.6	0.92 gpm
1428:00	20	25.08	NP	2171.75	1.03 gpm
1433:00	25	25.03→25.08	NP	2176.4	0.93 gpm
1438:00	30	"	NP	2181.0	0.92 gpm
1443:00	35	25.08	NP	2185.6	
1448:00	40	25.08	NP	2190.25	0.93 gpm
1453:00	45	25.08	NP	2194.75	

Notes:

CH2MHILL

PROJECT NUMBER 497639.01.02

Step Drawdown Test - Field Log

Linnton Terminal - Kinder Morgan Liquids Terminals, LLC

Field Crew: Jeannette Sager/CH2M Hill; Nolan Lewis/Antea

Date: 9-18-14

Weather: CLOUDY ~75°F

PUMPING WELL ID:	EW-1	Well Diameter(in):	6
Initial DTW (ft):	16.73	Borehole Diameter (in):	12
Initial DTNAPL (ft):	15.95	Sump Length (ft):	3
Initial NAPL Layer Thickness (ft):	0.78	Begin Pump Test Time:	08 50
Well Depth (ft):	~31.2	End Pump Test Time:	15:39

TIME (HR:MIN)	# MIN SINCE PUMPING BEGAN	DEPTH TO WATER (FT BMP)	DEPTH TO LNAPL (FT BMP)	FLOW RATE (gpm) or TOTALIZER READING (gal)	Notes:
1450:00	50	25.08	~~25~~ NP	2199.5	0.95 gpm
1503:00	55	25.08	NP	~~2205~~ 2204.0	
1508:00	60	25.08	NP	2208.6	0.92 gpm
1518:00	70	25.10 ~~25.08~~	NP	2218.4	0.98 gpm
1528:00	80	25.10	NP	2227.65	0.93 gpm
1538:00	90	25.10	NP	2236.9	0.93 gpm
1539:00	91	—	—	2238.0	PUMP OFF

Notes:

CH2MHILL

PROJECT NUMBER 497639.01.02

Step Drawdown Test - Field Log

PUMPING WELL

Linnton Terminal - Kinder Morgan Liquids Terminals, LLC

Field Crew: Jeannette Sayer/CH2M Hill ; NATE HEMPHILL/ANTEA

Date: 9-17-14 | Weather: SUNNY → PART CLOUDY ~75°F

PUMPING WELL ID :	EW-3	Well Diameter(in):	6
Initial DTW (ft):	17.4	Borehole Diameter (in):	12
Initial DTNAPL (ft):	NP	Sump Length (ft):	3
Initial NAPL Layer Thickness (ft):	0.0	Begin Pump Test Time:	0940
Well Depth (ft):	32.4 BELOW GRADE ≈ 30.4 BTOC	End Pump Test Time:	1644

TIME (HR:MIN)	# MIN SINCE PUMPING BEGAN	DEPTH TO WATER (FT BMP)	DEPTH TO LNAPL (FT BMP)	FLOW RATE (gpm) or TOTALIZER READING (gal)	Notes:
0830	—	17.4	17.4	1750.0	PUMP AND
0930	—				INSTALL TRANSDUCER
0937	—	17.24	17.24	1750.0	~6 IN FROM BOTTOM
0940:00	0	NM	NM	1750.0	STEP #1 PUMP ON -
0941:00	1	18.42	NP	1751.6	19 FT BTOC
0942:00	2	18.86	NP	1752.8	
0943:00	3	18.85	NP	~~15~~ 15 1753.2	
0944:00	4	18.86	NP	1753.6	
0945:00	5	18.86	NP	1753.8	111 gal/min 0.3 → 0.4 gpm
0950:00	10	18.84 → 18.86	NP	1755.2	
~~0955~~ 0957:00 ~~15~~ 17		18.85 ±0.02	NP	1757.2	0.28 gpm
1000:00	20	18.85	NP	1758.0	
1005:00	25	18.85	NP	1759.15	pH = 5.5 → 6.0
1010:00	30	18.86	NP	1760.5	
1015:00	35	18.85	NP	1761.5	0.2 gpm
1020:00	40	18.86	NP	1762.75	
1025:00	45	18.86	NP	1764.0	0.25 gpm
1030:00	50	18.85	NP	1765.0	0.2 gpm
1035:00	55	18.86	NP	1766.5	0.3 gpm
1040:00	60	18.85	NP	1767.7	0.24 gpm
1045:00	65	18.86	NP	1768.9	0.24 gpm
1046:00	0	NM	NM	NM	STEP #2 PUMP ON -
1047:00	1	19.72	NP	1770.75	21 FT BTOC
1048:00	2	20.82	NP	1773.0	
1049:30	3.5	21.02	NP	1774.8	
1050:00	4	21.02	NP	1775.15	
1051:00	5	21.03	NP	1775.6	
1056:00	10	21.03	NP	1778.0	
1100:00	14	21.03	NP	1780.3	pH = 5.5 → 6.2
1106	20	21.03	NP	1783.1	
1113:00	27	21.03	NP	1786.5	
1116:00	30	21.03	NP	1787.9	0.46 gpm
1121:00	35	21.03	NP	1790.~~25~~ 20	
1126:00	40	21.03	NP	1792.2	0.44 gpm

Notes:

AP 4 PLUS PUMP

CH2MHILL

PROJECT NUMBER 497639.01.02

Step Drawdown Test - Field Log

PUMPING WELL

Linnton Terminal - Kinder Morgan Liquids Terminals, LLC

Field Crew: Jeannette Sayer / CH2M Hill ; NATE HEMPHILL / AMTEA

Date: 9-17-14

Weather: SUN / PARTCLOUD, ~75°F

PUMPING WELL ID :	EW-3	Well Diameter(in):	6
Initial DTW (ft):	17.4	Borehole Diameter (in):	12
Initial DTNAPL (ft):	NP	Sump Length (ft):	3
Initial NAPL Layer Thickness (ft):	0.0	Begin Pump Test Time:	0940
Well Depth (ft):	32.4 BGS ≈ 30.4 FT BMP	End Pump Test Time:	1644

TIME (HR:MIN)	# MIN SINCE PUMPING BEGAN	DEPTH TO WATER (FT BMP)	DEPTH TO LNAPL (FT BMP)	FLOW RATE (gpm) or TOTALIZER READING (gal)	Notes:
1131:00	45	21.03	21.03	1794.6	0.44 gpm
1139:00 ~~1138:00~~	~~50~~ 52	21.03	NP	1798.2	
1141:00	55	21.04	NP	~~180~~ 1799.0	
1146:00	60	21.03	NP	1801.2	0.44 gpm
1148:00	0	—	—	—	STEP #3 - 23 FT BTOC
1149:00	1	22.44	NP	1803.9	
1150:00	2	22.64	NP	1805.9	
1151:00	3	22.95	NP	1807.1	
1152:00	4	22.96	NP	1807.5	
1153:00	5	22.96	NP	1808.9	
1158:00	10	22.95	NP	1810.8	PUMP CYCLES & WL ± 0.02
1203:00	15	22.96	NP	1813.4	
1208:00	20	22.96	NP	1816.1	
1213:00	25	22.97	NP	1818.8	0.54 gpm
1218:00	30	22.97	NP	1821.4	
1225:00 ~~1223:00~~	~~35~~ 37	22.97	NP	1824.25	
1228:00	40	22.97	NP	1826.25	
1233:00	45	22.98	NP	1828.7	
1238:00	50	22.98	NP	1831.2	0.5 gpm ; pH = 5.76
1243:00	55.5	22.98	NP	1833.75	
1244:00	56	22.98	NP	1834.0	0.46 gpm
1248:00	60	22.98	NP	1835.9	
1253:00	65	22.98	NP	1838.5	0.52 gpm
1258:00	70	22.98	NP	1840.75	0.45 gpm
1308:00	80	22.98	NP	1845.4	0.46 gpm
1318:00	90	22.98	NP	1850.25	0.48 gpm
1325 ~~1328:00~~	100	22.98	NP	1856.3	0.46 gpm
1329:00	~~110~~ 115	~~7~~			
1339:00	110 ~~120~~ 115	22.98	NP	1860.2	0.49 gpm
1343 ~~1348:00~~	~~120~~ 115	22.98	NP	1861.9	
1349:00	120	22.98	NP	1864.2	0.46 gpm
1350:00	0	—	—	—	STEP #4 - 25 FT BTOC
1350:00	1	23.15	NP	1866.2	

Notes:
EW-1 15.90 DTP
9/17 13:20 16.58 DTW

APY PLUS PUMP

CH2MHILL

PROJECT NUMBER 497639.01.02

Step Drawdown Test - Field Log

Linnton Terminal - Kinder Morgan Liquids Terminals, LLC

Field Crew: Jeannette Sayler

Date: 9-17-14 Weather: CLOUDY ~80°F

PUMPING WELL ID :	FW-3	Well Diameter(in):	6
Initial DTW (ft):	17.4	Borehole Diameter (in):	12
Initial DTNAPL (ft):	NP	Sump Length (ft):	3
Initial NAPL Layer Thickness (ft):	0.0	Begin Pump Test Time:	0940
Well Depth (ft):	32.4 BELOW GRADE & 30.4 FT BMP	End Pump Test Time:	1644

TIME (HR:MIN)	# MIN SINCE PUMPING BEGAN	DEPTH TO WATER (FT BMP)	DEPTH TO LNAPL (FT BMP)	FLOW RATE (gpm) or TOTALIZER READING (gal)	Notes:
1352:00	2	23.63	NP	1867.3	
1353:00	3	24.00	NP	1868.6	
1354:00	4	24.34	NP	1869.8	
1355:00	5	24.76	NP	1870.8	
1400:00	10	25.10	NP	1873.8	0.6 gpm pH=5.49
1405:00	15	25.10	NP	1876.8	
1410:00	20	25.10	NP	15 ~~1880~~ 1879.75	0.59 gpm
1415:00	25	25.10	NP	1882.3	0.51 gpm
1420:00	30	25.10	NP	1884.9	0.52 gpm
1425:30	35.5	25.10	NP	1887.3	SLOWED THEN
1430:00	40 +24	~~25.10~~	NP	1888.25	PUMP STOPPED CYCLING
1432				1888.8	PUMP OFF, 60 PSI AIR ok
					PULLED PUMP - INLET CLEAN
					CYCLING ~1x/MIN
					WL ~21.4 FT BTOC
1445					PULLED PUMP, CLEANED AI
~~1515~~ 1513					PUT PUMP BACK IN @ 8FT
1514	0	—	—	—	PUMP ON
1515:30	1.5	—	—	1898.0	
1518:00	4	22.50	NP	1900.25	
1519:00	5	15 ~~24.5~~ 24.25	NP	1903.4	
1521:30 ~~1524:00~~ 15	15 ~~10~~ 7.5	25.15	NP	1906.75	5-7 cycles/min (~0.1 gal/cycle)
1524:00	10	25.15	NP	1908.4	TIED OFF PUMP @ 1527
1529:00	15	25.38	NP	1911.75	PUMP INTAKE SHIFTED BY
1534:00	20	25.58	NP	1914.6	0.2 FT WHEN TIED OFF
1539:00	25	25.38	NP	1917.6	0.6 gpm
1544:00	30	25.41 ~~25.38~~ 25.75	NP	1920.6	
1549:00	35	25.42	NP	1923.5	0.58 gpm
1554:00	40	25.42	NP	1926.4	0.58 gpm
1559:00	45	25.40 → 25.42	NP	~~1937.25~~	1929.25
1604:00	50	25.40	NP	1931.90	0.53 gpm
1608:00	55	25.40	NP	1934.25	0.47 gpm
1613:00	60	25.40	NP	1937.71	
1618:00	65	25.40	NP	1940.0	

Notes: USED AP 4 PLUS PUMP

NOTE ON PUMP MALFUNCTION: PULLED PUMP; TOOK APART; NO SAND IN PUMP, NO EVIDENCE LARGE DEBRIS; ADJUSTED AIR CONTROL VALVE

CH2MHILL

PROJECT NUMBER 497639.01.02

Step Drawdown Test - Field Log

Linnton Terminal - Kinder Morgan Liquids Terminals, LLC

Field Crew: Jeannette Sager

Date: 9-17-14

Weather:

PUMPING WELL ID :	EW-3	Well Diameter(in):	6
Initial DTW (ft):	17.4	Borehole Diameter (in):	12
Initial DTNAPL (ft):	NP	Sump Length (ft):	3
Initial NAPL Layer Thickness (ft):	0.0	Begin Pump Test Time:	0940
Well Depth (ft):	30.4 FT BMP	End Pump Test Time:	1644

TIME (HR:MIN)	# MIN SINCE PUMPING BEGAN	DEPTH TO WATER (FT BMP)	DEPTH TO LNAPL (FT BMP)	FLOW RATE (gpm) or TOTALIZER READING (gal)	Notes:
1623:50	70.5	25.40	NP	1943.0	
1624:00 ~~1628:00~~	~~75~~ 71	25.40	NP	1943.25	.54 gpm
1628:00 ~~1633:00~~	~~80~~ 75	25.40	NP	1945.5	0.56 gpm
1633:00	80	25.40	NP	1948.5	0.60 gpm
1638:00	85	25.40	NP	1951.25	0.55 gpm
1643:00	90	25.40	NP	1954.1	0.57 gpm
1644:00	—	—	—	—	PUMP OFF
1/10					

CH2MHILL

PROJECT NUMBER 497639.01.02

Step Drawdown Test - Field Log

Linnton Terminal - Kinder Morgan Liquids Terminals, LLC

Field Crew: Jeannette Sayer / CH2MHill, Nolan Lewis / Antea

Date: 9/15/14

Weather: SUNNY 75→95°F

PUMPING WELL ID:	EW-6	Well Diameter(in):	~~14~~ JS ~~6~~ JS 4
Initial DTW (ft):	17.86	Borehole Diameter (in):	~~14~~ JS 12
Initial DTNAPL (ft):	17.86 (NO PRODUCT)	Sump Length (ft):	5
Initial NAPL Layer Thickness (ft):	0.00	Begin Pump Test Time:	09:46
Well Depth (ft):	~34 FT BELOW TOC	End Pump Test Time:	15:30

TIME (HR:MIN)	# MIN SINCE PUMPING BEGAN	DEPTH TO WATER (FT BMP)	DEPTH TO LNAPL (FT BMP)	FLOW RATE (gpm) or TOTALIZER READING (gal)	Notes:
W-6 0905		17.86	17.86		Rental # R26051
					Level 500
0932		INSTALL PUMP; LET STABILIZE			PUMP @ 19.05 FT BMP
0943		17.79	17.79		
0946	—	—	—	810.0	Lot 0000810
0946:30	0	19.00	NP	PUMP ON	pH = 6.45 → 6.37 STEP #1
					JS
0949:30	3.0	19.00	NP	812.5	
0950:30	4	19.00	NP	813.2	
0951:30	5	19.00	NP	813.8	
0952:30	6	19.00	NP	814.2	
0954:30	8	19.00	NP	815.2	20sec, 35sec, 40sec, 50sec,
0955:30	9	19.00	NP	816.0	03sec, 15sec
1000:30	14	19.00	NP	818.2	~0.1 gal/cycle
1005:30	19	19.00	NP	820.7	6 cycles/min
JS					BUCKET TEST 8 cycles/min
JS					2.89 TS
1011:30	25	19.00	NP	823.8	5→6 cycles/min
1017	31	19.00	NP	827.1	
1020:30	34	19.00	NP	828.7	
1025:30	39	19.00	NP	~~830~~ 831.4	1 cycles/min
1030:30	44	19.00	NP	834.1	~0.1 gal/cycle
~~1030:30~~ 1035:30	49	19.00	NP	JS ~~836~~ 837.0	1 cycles/min
1040:30	54	19.00	NP	839.8	
1045:30	59	19.00	NP	842.4	1
1048:00	0	—	—	843.6	STEP #2 DROP TO 21 FT BMP
1048:30	0.5	NM	NM	845.0	
1049:30	1.5	20.23	NP	847.2	
1050:30	2.5	20.64	NP	849.4	
1051:30	3.5	20.87	NP	851.2	
1052:30	4.5	20.98	NP	853.0	
1053:30	5.5	21.02	NP	854.3	
JS ~~1054:30~~	~~6.5~~ JS				

Notes: Transducers set to log every 10 sec

CH2MHILL

PROJECT NUMBER 497639.01.02

Step Drawdown Test - Field Log

Linnton Terminal - Kinder Morgan Liquids Terminals, LLC

Field Crew: Jeannette Sager/CH2M Hill; Nolan Lewis/Antea

Date: 9/15/14

Weather:

PUMPING WELL ID:	EW-6	Well Diameter(in):	~~6~~ 4
Initial DTW (ft):	17.86	Borehole Diameter (in):	~~6~~ ~~4~~ 12
Initial DTNAPL (ft):	NP	Sump Length (ft):	5
Initial NAPL Layer Thickness (ft):	0.0	Begin Pump Test Time:	09:46
Well Depth (ft):	~34 FT BTOC	End Pump Test Time:	15:30

TIME (HR:MIN)	# MIN SINCE PUMPING BEGAN	DEPTH TO WATER (FT BMP)	DEPTH TO LNAPL (FT BMP)	FLOW RATE (gpm) or TOTALIZER READING (gal)	Notes:
1054 30	6.5	19.97 → 21.02	NP	856.3	
1055 30	7.5	"		857.5	pH = 6.44
1100 30	12.5	21.02		~~869.42~~ 864.2	
1106 30	18.5			~~871.4~~ 872.0	
1110 30	22.5			877.2	
1115 30	27.5	21.00		883.4	
1120 30	32.5	21.00		889.8	
1125 30	37.5	21.00		896.1	
1130 30	42.5			902.3	
1135 30	47.5	21.00		908.5	
1140 30	52.5	21.00		914.6	
1145 30	57.5	21.00		920.8	
1150 30	62.5	21.00		927.0	
1200 30	72.5	21.00		939.2	
1210 30	82.5	21.02		951.3	~~IIII~~ ~~IIII~~ I cycles/min
1220 30	92.5	21.02		963.2	~0.1 gal/cycle
1222 00	0	—	—	—	STEP #3 PUMP TO 23 FT BMP
1222 30	00:30	21.36	NP	966.5	
1223 30	1.5	21.88		968.9	
1224 30	2.5	22.20		971.1	
1225 30	3.5	22.40		973.25	
1226 30	4.5	22.80		975.30	
1230 30	8.5	23.20		983.50	
1235 30	13.5	23.22		992.40	
1240 30	18.5	23.22		~~1000~~ 1000.8	
1245 30	23.5	23.22		1009.2	~~IIII~~ ~~IIII~~ IIII cycles/min
1250 30	28.5			~~1010~~ 1017.6	~0.125 gal/cycle
1255 30	33.5			~~1020~~ 1026.8	
1300 30	38.5	23.24		1033.55	
1305 30	43.5	23.26		1041.3	
1310 30	48.5	23.23		1048.9	
1315 30	53.5	23.21 → 23.30		1056.4	
1321 30	59.5	23.20		1065.5	

Notes:

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Step Drawdown Test - Field Log

Linnton Terminal - Kinder Morgan Liquids Terminals, LLC

Field Crew: Jeannette Sager / CH2M Hill ; Nolan Lewis / Antea

Date: 9/15/14 Weather:

PUMPING WELL ID:	EW-6	Well Diameter(in):	JS ~~6~~ 4
Initial DTW (ft):	17.86	Borehole Diameter (in):	JS ~~14~~ 12
Initial DTNAPL (ft):	NP	Sump Length (ft):	5
Initial NAPL Layer Thickness (ft):	0.0	Begin Pump Test Time:	09:46
Well Depth (ft):	~39 BTOC	End Pump Test Time:	15:30

TIME (HR:MIN)	# MIN SINCE PUMPING BEGAN	DEPTH TO WATER (FT BMP)	DEPTH TO LNAPL (FT BMP)	FLOW RATE (gpm) or TOTALIZER READING (gal)	Notes:
1325:00	64.0	23.20→23.23	NP	1072.1	
1326:30	64.5	↓	↓	1072.9	pH=6.33
1332:30	70.5			1081.8	
1342:30	80.5			1096.6	~~IIII~~ ~~IIII~~ IIII cycles/min
1352:30	90.5	↓	↓	1110.9	~0.1→0.125 gal/cycle
1400:00	0	NM	NM	1121.5	STEP #4 25 FT BTOC
1401:00	1 ~~23.55~~ JS	23.55	NP	1124.1	
1402:00	2	24.10	NP	1126.3	
1403:00	3	24.40	NP	1128.6	
1404:00	4	24.60	NP	1130.3	
1405:00	5	24.95	NP	1132.9	
1410:00	10	25.3 ~~24.95→25.0~~	NP	1143.45	
1415:00	15	25.42	NP	1153.0	~~IIII~~ ~~IIII~~ IIII cycles/min
1420:00	20	25.42→25.44	NP	1162.4	~0.15 gal/cycle
*1425:00	25	25.42	NP	1171.8	* taken at 1425:30
1430:00	30	25.42	NP	1179.6	
1435:00	35	25.42	NP	1188.2	1.7 gpm
1440:00	40	25.42	NP	1196.7	
1445:00	45	25.42-25.45	NP	1205.6	
1450:00	50	25.42	NP	1214.2	1.7 gpm
1455:00	55	25.42	NP	1222.8	
1500:00	60		NP	1231.3	
1510:00	70	25.42	NP	1247.7	
1520:00	80	25.46	NP	1263.2	wiggled pump
1530:00	90	25.46	NP	1278.6	
1531	91	NM	NM	1279.8	PUMP OFF / BEGIN RECOVERY
1538	98	20.91	NP	NA	
1600	120	18.32	NP	NA	
9/16/14 0814	FINAL READING	17.97	NP	NA	REMOVE TRANSDUCER

Notes:

CH2MHILL

PROJECT NUMBER 497639.01.02

Step Drawdown Test - Field Log

PUMPING WELL

Linnton Terminal - Kinder Morgan Liquids Terminals, LLC

Field Crew: Jeannette Sager/CH2M Hill ; Brad Jackson/Antea

Date: 9/16/14

Weather: SUNNY ~80°F HAZE FROM FIRES

PUMPING WELL ID:	EW-7	Well Diameter(in):	4
Initial DTW (ft):	20.02	Borehole Diameter (in):	12
Initial DTNAPL (ft):	NP	Sump Length (ft):	5
Initial NAPL Layer Thickness (ft):	0.0	Begin Pump Test Time:	0913 00
Well Depth (ft):	~34.5 FT BTOC	End Pump Test Time:	1529 30

TIME (HR:MIN)	# MIN SINCE PUMPING BEGAN	DEPTH TO WATER (FT BMP)	DEPTH TO LNAPL (FT BMP)	FLOW RATE (gpm) or TOTALIZER READING (gal)	Notes:
9/16 0840	NA	20.02	NP	PRE-TRANSDUCER	R26051 - INSTALL TRANSDUCER
0845	NA	20.02	JS ~~NM~~ NP	POST-TRANSDUCER	
0905	NA	NM	NM	1279.5	DROP PUMP TO 21 FT BTOC
0913 00	0	~~NM~~	~~NM~~	NM	START PUMP; SUCKING AIR
0914 00	1	~~NM~~	~~NM~~	~~1280.5~~ JS	STARTED PUMPING
0915 00	2	>20.5	NP	1280.5	PROBE STUCK IN WELL
0917 00	4	NM	NM	1281.2	↓
0918 00	5	NM	NM	1281.8	
JS ~~0920 00~~ 0919 00	JS ~~7~~ 6	21.07	NP	1282.3	
0920 00	7	21.15	NP	1282.9	IIII cycles/min, 0.1 gal/cycle
0925 00	12	21.09	NP	1284.9	~0.4 gal/min
0930 00	17	21.13	NP	1287.0	pH = 6.3
0935 00	22	21.14	NP	1288.9	
0940 00	27	21.14	NP	1290.8	
0945 00	32	21.15	NP	1292.7	
0950 00	37	21.16	NP	1294.5	
0955 00	42	21.15	NP	1296.5	
1000 00	47	21.15	NP	1298.4	
1005 00	52	21.16	NP	1300.2	IIII cycles/min
1010 00	57	21.17	NP	1302.1	
1016 30	63.5	21.16	NP	1304.5	END STEP #1
1018 00	0	NM	NM	NM	DROP PUMP TO 23 FT BTOC
1019 00	1	22.09	NP	~~1303~~ 1307.2	
1020 00	2	22.56	NP	1309.2	
1021 00	3	JS ~~22.~~ NM	NP	1311.1	
1022 00	4	22.89	NP	1312.3	
1023 00	5	22.86	NP	JS ~~13~~ 1313.5	~~IIII~~ IIII cycles/min
1028 30	10.5	22.89	NP	1319.1	~1 GAL/MIN INTO BUCKET
1033 00	15	22.90	NP	1323.4	pH = 6.5
1038 00	20	22.90	NP	1328.1	~~IIII~~ IIII cycles/min
1043 30	25.5	22.90	NP	1332.9	
1048 00	30	22.90	NP	1336.9	
1053 00	35	22.92	NP	1341.4	

Notes: TRANSDER SET TO RECORD EVERY 5 MIN FOR BG, EVERY 10 SEC DURING TEST

AP 3 PUMP

CH2MHILL

PROJECT NUMBER 497639.01.02

Step Drawdown Test - Field Log

PUMPING WELL

Linnton Terminal - Kinder Morgan Liquids Terminals, LLC

Field Crew: Jeannette Sager / CH2M Hill; Brad Jackson / Antea

Date: 9/16/14

Weather: SUNNY ~80°F HAZE FROM FIRES

PUMPING WELL ID:	EW-7	Well Diameter(in):	4
Initial DTW (ft):	20.02	Borehole Diameter (in):	12
Initial DTNAPL (ft):	NP	Sump Length (ft):	5
Initial NAPL Layer Thickness (ft):	0.0	Begin Pump Test Time:	0913
Well Depth (ft):	~34.5 FT BTOC	End Pump Test Time:	1529 30

TIME (HR:MIN)	# MIN SINCE PUMPING BEGAN	DEPTH TO WATER (FT BMP)	DEPTH TO LNAPL (FT BMP)	FLOW RATE (gpm) or TOTALIZER READING (gal)	Notes:
1058 00	40	22.90	NP	1346.1	
1103 00	45	22.91	NP	1350.8	
1108 00	50	22.93	NP	1355.8	
1113 00	55	22.91	NP	1360.4	
1118 00	60	22.91	NP	1365.6	
1128 00	70	22.93	NP	~~1374~~ 1375.3	
1138 00	80	22.91	NP	1385.0	卌 |||| cycles/min (0.97gpm)
1148 00	90	22.92	NP	1394.9	卌 |||| cycles/min
1150 00	0	NM	NM	~~1396.2~~ JS	STEP #3 PUMP TO 25 FT BTO
1151 00	1	23.45	NP	1398.9	
1152 00	2	24.17	NP	1401.1	
1153 00	3	24.24	NP	1403.4	
1154 00	4	24.40	NP	1405.5	
1155 00	5	24.63	NP	1407.1	
1200 00	10	24.99	NP	1416.0	卌 卌 ||| cycle/min
1205 00	15	25.00	NP	1424.25	卌 卌 ||| cycle/min 1.65 gpm
1210 00	20	24.9 → 25.10	NP	1431.8	~0.125 gal/cycle
1215 00	25	"	NP	1439.6	
1220 00	30	"	NP	1447.6	
1225 00	35	"	NP	1455.4	@12:27 PM AIR HOSE DISCONNEC
1230 00	40	"	NP	1461.75	FOR 1→2 MIN
1235 00	45	25.02	NP	JS ~~1476~~ 1470.1	
1240 00	50	FLUCT ± 0.2 FT	NP	1477.9	
1245 00	55	25.04	NP	1485.75	pH = 6.43
1250 00	60	25.04	NP	1493.2	
1300 00	70	25.03	NP	1508.2	
1310 00	80	25.05	NP	1524.2	PZ-6 = 17.59' DTW | PZ-8 = 20.36 | 20.87
1320 00	90	25.04	NP	1538.4	~1.4 GPM
1322 00	0	NM	NM	1541.6	STEP #4, PUMP TO 27 FT BMP
1323 00	1	25.53	NP	1544.0	
1324 00	2	25.80	NP	1546.5	PID @ TOC = VOC = 20.3 ppm
1325 00	3	26.16	NP	1548.2	
1326 00	4	26.20	NP	1550.5	

Notes:

AP 3 PUMP

CH2MHILL

PROJECT NUMBER 497639.01.02

Step Drawdown Test - Field Log

Linnton Terminal - Kinder Morgan Liquids Terminals, LLC

Field Crew: Jeannette Sager / CH2MHILL ; BRAD JACKSON / ANTHA

Date: 9/16/14

Weather: SUNNY w/ HAZE FROM FIRES ~80°F

PUMPING WELL ID :	EW-7	Well Diameter(in):	4
Initial DTW (ft):	20.02	Borehole Diameter (in):	12
Initial DTNAPL (ft):	NP	Sump Length (ft):	5
Initial NAPL Layer Thickness (ft):	0.0	Begin Pump Test Time:	0913
Well Depth (ft):	~34.5 FT BMP (TOC)	End Pump Test Time:	1529 30

TIME (HR:MIN)	# MIN SINCE PUMPING BEGAN	DEPTH TO WATER (FT BMP)	DEPTH TO LNAPL (FT BMP)	FLOW RATE (gpm) or TOTALIZER READING (gal)	Notes:
1327 00	5	26.24	NP	1552.4	
1332 00	10	NM	NM	~~1560.0~~ JS 1561.8	PROBE STUCK
1334 00	12	25.87	NP	NM	PUMP OFF ; PULL PUMP
1337 00	15	NM	NM	1564.4	EFFLUENT LINE DISCONNECTED
1352	0	~22.50	NP	NM	PUMP ON AGAIN ; RESTART
1353	2	23.50	NP	1571.5	STEP #4
1355 00	3	24.55	NP	1573.5	
1356 00	4	24.85	NP	1576.3	
1357 00	5	25.17	NP	1578.7	
1358 00	6	25.80	NP	1581.1	
1400 00	8	26.00	NP	~~1584~~ 1585.5	
1402 00	10	26.20	NP	1590.2	PROBE STUCK ; CAN'T
1407 00	15	NM	NM	1600.4	MOVE FURTHER IN
1412 00	20	NM	NM	1610.4	~2 GPM
1417 00	25	NM	NM	NM	
1425 00	33	26.50	NP	1634.5	GOT NEW METER FOR WL
1427 00	35	26.67	NP	1636.5	PUMP WAS JOSTLED GETTING
JS					METER OUT
1432 00	40	26.74	NP	1645.5	WL APPEARS TO BE AT
1437 00	45	26.75	NP	1659.5	INTAKE ; PUMP TAPE @
1442 00	50	26.81	NP	1663.8	~~27.02~~ JS 27.07 FT
1447 00	55	26.81	NP	1672.5	
1452 00	60	26.83	NP	1681.6	~1.8 GPM
1457 00	65	26.83	NP	1690.6	
1502 00	70	26.79	NP	1699.6	
1509 00	~~JS 75~~ 77	26.77 → 26.86	NP	1712.1	
1514 00 ~~1512 00~~	~~JS 80~~ 82	"	NP	1721.2	~1.8 GPM
1519	87	"	NP	1730.2	~1.8 GPM
1527 ~~1524~~ JS	~~92~~ 95 JS	26.87	NP	1744.6	1.8 GPM pH = 6.5
1529 30	97.5	NM	NM	1759.6	PUMP OFF
					~~Electric~~ JS

Notes: 6+ drums (55 gallon) purged today ; pH > 6.0 on ALL

CH2MHILL

PROJECT NUMBER

Step Drawdown Test - Field Log

Linnton Terminal - Kinder Morgan Liquids Terminals, LLC

Field Crew: Jeannette Sager / CH2M Hill, NOLAN LEWIS / ANTEA, BRAD JACKSON / ANTEA

Date: 5/14/14

Weather: SUNNY ~80→90°F

PUMPING WELL ID:	EW-3	Well Diameter(in):	6
Initial DTW (ft):	~~11.~~ 11.91	Borehole Diameter (in):	
Initial DTNAPL (ft):	11.91	Sump Length (ft):	2
Initial NAPL Layer Thickness (ft):	—	Begin Pump Test Time:	09:00
Well Depth (ft):	~30 FT BTOC	End Pump Test Time:	13:26

TIME (HR:MIN)	# MIN SINCE PUMPING BEGAN	DEPTH TO WATER (FT BMP)	DEPTH TO LNAPL (FT BMP)	FLOW RATE (gpm) or TOTALIZER READING (gal) → 557.75	Notes:
08:20	—	11.91	11.91	~~548.0~~ GAL	INITIAL STATIC
08:37	—	—	—	—	ADJUST PUMP TO 12.90 FT BTOC
08:52	—	12.0	12.0	~~548.0~~ 557.75	
08:58	—	11.97	11.97	~~548.0~~	
~~08:59~~					
09:00	PUMP ON	11.98	11.98	~~548.0~~ 557.75	
09:01	1	12.98	12.98	548.0	2 pump cycles tot
09:02	2	12.98	12.98	548.0	
09:03	3	12.98	12.98	548.0	3 pump cycles tot
09:04	4	12.98	12.98	548.0	4 pump cycles tot
09:05	5	12.98	12.98	548.0	
09:07	7	12.98	12.98	548.0	5 pump cycles tot
09:11	11	12.98	12.98	548.0	6 pump cycles tot
09:14	14	12.98	12.98	548.0	7 pump cycles tot
09:17	17	12.98	12.98	DISCONNECT	DISCHARGE TO BUCKET
09:18	18	12.98	12.98	0.5 GAL	8 pump cycles tot *
09:19	19	—	—	RECONNECT	HOSED TO TOTALIZER
09:20	20	12.98	12.98	548.0 **	9 pump cycles
09:24	24	12.98	12.98	TOT DISCONNECTED	10 pump cycles (0.5 GAL/cycle)
09:27					11 pump cycles
09:28				581.20 NEW TOT READING	
09:29	TO STEP 2	12.98	12.98	581.20	MOVE PUMP TO 13.90 FT BTOC
09:29:45	00:15	—	—	582.5	
09:30:30	1	14.04	14.04	582.7	
09:31	2	14.05	14.04	583.25	
09:32	3	14.06	14.06	583.9	
09:33	4	14.08	14.08	584.5	
09:35	5	14.08	14.08	585.0	~1/2 GAL / CYCLE
09:36	6	14.09	14.09	585.5	
09:37	7	14.09	14.09	586.0	
09:38	8	14.09	14.09	586.5	
09:40	10	14.10	14.10	587	
09:42	12	14.10	14.10	~~587.56~~ 587.6	

Notes:
* 1/2 gal per cycle into bucket
** TOTALIZER NOT WORKING - removed @ 09:24 for cleaning - FIXED 09:28

CH2MHILL

PROJECT NUMBER

Step Drawdown Test - Field Log

Linnton Terminal - Kinder Morgan Liquids Terminals, LLC

Field Crew: Jeannette Sager/CH2MHill, Nolan Lewis/Antea, Brad Jackson/Antea

Date: 5/14/14

Weather:

PUMPING WELL ID:	EW-3	Well Diameter(in):	
Initial DTW (ft):		Borehole Diameter (in):	
Initial DTNAPL (ft):		Sump Length (ft):	
Initial NAPL Layer Thickness (ft):		Begin Pump Test Time:	
Well Depth (ft):		End Pump Test Time:	

TIME (HR:MIN)	# MIN SINCE PUMPING BEGAN	DEPTH TO WATER (FT BMP)	DEPTH TO LNAPL (FT BMP)	FLOW RATE (gpm) or TOTALIZER READING (gal)	Notes:
~~09:40~~ 09:43	13	14.10	14.10	588.2	
09:44	14	14.10	14.10	588.5	
09:46	16	14.10	14.10	589.2	
09:47	17	14.10	14.10	589.7	
09:49	19	14.11	14.11	590.25	
09:51	21	14.11	14.11	590.75	
09:52	STEP 3	—	—	590.75	MOVE TO 14.90 FT BTOC
09:52:30	0:30	14.97	14.97	592.50	
09:53	1	14.97	14.97	593.30	
09:54	2	14.97	14.97	593.75	
09:55	3	14.97	14.97	594.25	
09:56	4	14.97	14.97	594.8	
09:57	5	14.97	14.97	595.4	
09:58	6			596	
10:00	8	14.97	14.97	597	
10:01	9	14.97	14.97	597.5	
10:05	13	14.97	14.97	599.0	
10:06	14	14.97	14.97	599.5	
10:07	15	14.97	14.97	600	~1 cycle/min (0.5 gpm/min)
10:08	16	14.98	14.98	600.5	
10:12	20	14.98	14.98	602.75	~0.5 gpm
10:15	22	14.98	14.98	604	
10:16	23	14.98	14.98	604.5	
10:17	24	14.98	14.98	605	STABLE @ 0.5 gpm
10:20	STEP 4	—	—	606	MOVE TO 17.90 FT BTOC
10:20:30	0:30	16.66	16.66	610	
10:21	1	17.68	17.68	611	
10:22	2	17.77	17.77	612	
10:23	3	17.78	17.78	613.5	
10:24	4	17.78	17.78	614.75	
10:25	5	17.78	17.78	615.75	
10:30	10	17.78	17.780	619.5	0.75 gpm AVG
10:35	15	17.78	17.78	624	

Notes:

CH2MHILL

PROJECT NUMBER

Step Drawdown Test - Field Log

Linnton Terminal - Kinder Morgan Liquids Terminals, LLC

Field Crew: Jeannette Sager/CH2M Hill, Nolan Lewis/Autea, Brad Jackson/Autea

Date: 5/14/14

Weather:

PUMPING WELL ID:	EW-3	Well Diameter(in):	
Initial DTW (ft):		Borehole Diameter (in):	
Initial DTNAPL (ft):		Sump Length (ft):	
Initial NAPL Layer Thickness (ft):		Begin Pump Test Time:	
Well Depth (ft):		End Pump Test Time:	

TIME (HR:MIN)	# MIN SINCE PUMPING BEGAN	DEPTH TO WATER (FT BMP)	DEPTH TO LNAPL (FT BMP)	FLOW RATE (gpm) or TOTALIZER READING (gal)	Notes:
10:40	20	17.78	17.78	628.25	
10:41	21	17.78	17.78	628.75	
10:41:30	21:30	17.78	17.78	629.25	±0.04 FT FLUCT WHEN PUMP CYCL
10:45	25	17.78	17.78	632.5	cycles ~ every 40 sec
10:50	30	17.78	17.78	636.75	
10:55	35	17.78	17.78	JS ~~640~~ 641.0	
11:00	40	17.78	17.78	645.5	
11:05	45	17.78	17.78	648.75	cycles ~ every 40 sec
11:10	50	17.78	17.78	653.25	w/ 0.5 gpm/cycle
11:15	55	17.78	17.78	657.5	
11:20	60	17.78	17.78	661.1	cycling
11:22	STEP 5	17.78	17.78	662.25	MOVE PUMP - 20.90 FT BTOC
11:22:30	0:30	18.70	18.70	665	
11:23	1	20.80	20.80	667.5	SKIMMING
11:24	2	20.75	20.75	668.6	FLUCT ± 0.05 WATER LEVEL
11:25	3	20.70	20.70	669.7	
11:26	4	20.80	20.80	670.75	cycle @ 10sec, 40sec,
11:27	5	20.80	20.80	672.25	cycle every 30 sec
11:29	7	20.75	20.75	674.5	FLUCT TWEEN 20.65 → 20.80
11:30	8	20.80	20.80	675.5	(DTW) FT BTOC
11:35	13	20.80	20.00	680.6	just cycled
11:40	18	20.76	20.76	686.4	cycle every 30 seconds
11:45	23	20.83	20.83	691.0	
11:50	28	20.82	20.82	696.2	cycle every 30 seconds
11:55	33	20.82	20.82	701.4	
12:00	38	20.82	20.82	706.5	cycle every 30 sec, ~0.5 GAL/cycle
12:07	45	20.82	20.82	713.75	
12:10	48	20.84	20.84	717.9	cycle every 30 sec
12:15	53	20.82	20.82	722.0	
12:20	58	20.85	20.85	727.25	STABLE @ ~1 GPM
12:23	61	20.85	20.85	730.25	~~M~~ JS
12:25	STEP 6	—	—	731	MOVE PUMP TO 23.90
12:25:30	0:30	21.70	21.70	735	

Notes:

CH2MHILL

PROJECT NUMBER

Step Drawdown Test - Field Log

Linnton Terminal - Kinder Morgan Liquids Terminals, LLC

Field Crew: Jeannette Sagee/CH2M Hill, Nolan Lewis/Antea, Brad Jackson/Antea

Date: 5/14/14

Weather:

PUMPING WELL ID :	EW-3	Well Diameter(in):	
Initial DTW (ft):		Borehole Diameter (in):	
Initial DTNAPL (ft):		Sump Length (ft):	
Initial NAPL Layer Thickness (ft):		Begin Pump Test Time:	
Well Depth (ft):		End Pump Test Time:	

TIME (HR:MIN)	# MIN SINCE PUMPING BEGAN	DEPTH TO WATER (FT BMP)	DEPTH TO LNAPL (FT BMP)	FLOW RATE (gpm) or TOTALIZER READING (gal)	Notes:
12:26	1	23.73	23.73	736.75	SKIMMING
12:27	2	~~23.66~~ 24.0	~~23.66~~ 24.0	737.75	
12:28	3	23.96	23.96	739.25	±0.05 WATER LEVEL FLUCT
12:29	4	24.02	24.02	740.25	
12:30	5	24.02	24.02	741.50	±0.04 WATER LEVEL FLUCT
12:35	10 ~~12:35~~	24.01	24.01	746.6	
12:40	15	24.02	24.02	751.75	
12:45	20	24.03	24.03	757.5	cycle ~ every 30 sec
12:50	25	24.04	24.04	762.5	
12:55	30	24.03	24.03	767.5	
13:00	35	24.03	24.03	773.5	
13:05	40	24.04	24.04	778.5	cycle ~ every 30 sec
13:10	45	24.02	24.02	784.0	
13:15	50	24.03	24.03	788.9	
13:20	55	24.06	24.06	794.3	cycle every 30 seconds just
13:25	60	24.06	24.06	799.75	
13:26	PUMP OFF	—	—	800.25	FINAL READING

Notes:

CH2MHILL

PROJECT NUMBER

Step Drawdown Test - Field Log

Linnton Terminal - Kinder Morgan Liquids Terminals, LLC

Field Crew: Jeannette Sagee/CH2M Hill Brad Nolan > Antea

Date: 5/13/14 Weather: SUNNY ~80°F

PUMPING WELL ID:	EW-1	Well Diameter(in):	6
Initial DTW (ft):	11.80	Borehole Diameter (in):	
Initial DTNAPL (ft):	11.62	Sump Length (ft):	2
Initial NAPL Layer Thickness (ft):	0.18	Begin Pump Test Time:	08:42
Well Depth (ft):	33 ft bgs (~30ft bTOC)	End Pump Test Time:	15:24

TIME (HR:MIN)	# MIN SINCE PUMPING BEGAN	DEPTH TO WATER (FT BMP)	DEPTH TO LNAPL (FT BMP)	FLOW RATE (gpm) or TOTALIZER READING (gal)	Notes: → ref -.3 gallons FWT TOT READING
08:10	—	11.80	11.62	—	14.75'
08:25	—	11.80	11.64	—	~~14.80'~~ from TOC to middle of inlet of pump
					moved @ 08:25
08:38	—	11.76	11.76	—	No product now, likely removed w/ probe?
15 ~~08:40~~					AP 4 PLUS PUMP
08:42	PUMP ON	~~12.30~~	—	-0.3 GAL	
08:43	1	12.30	12.30	5.0	
08:43	1.5	14.02	14.02	5.0	
08:44	2	14.35	14.35	6.0	
08:44	2.5	14.63	14.63	6.5	
08:45	3	14.58	14.58	7.5	
08:46	4	—	—	8.5	
08:47	5	—	—	9.5	
08:48	6	14.61	14.61	10.5	
08:49	7	14.61	14.61	11.5	
08:52	10	14.61	14.61	14.5	
08:57	15	14.68	14.68	18.5	
08:58	16	—	—	19.5	
09:02	20	14.70	14.70	23.5	
09:06	24	—	—	26.0 tot reading	
09:07	25	—	—		empty into bucket:
09:10	28	—	—	3 gallons	into bucket 1gpm/min*
09:12	30	14.66	14.66	30.5	
9:14 ~~09:13~~	32	14.58	14.58	32.5	
09:17	35	14.70	14.70	35.5	
09:24	42	14.70	14.70	40.5	
09:26	44	14.70	14.70	42.5	
09:27	45	14.72	14.72	43.5	
9:34 ~~09:33~~	51	14.69	14.69	48.5	> Now pumping @ ~0.75 gpm
09:37	54	—	—	50.5	
09:39	56	14.71	14.71	52.0	

Notes: Need stopwatch

* totalizer continued to run; reading @ 9:12 is true

CH2MHILL

PROJECT NUMBER

Step Drawdown Test - Field Log

Linnton Terminal - Kinder Morgan Liquids Terminals, LLC

Field Crew: Jeannette Sagee / CH2M Hill, Nolan Lewis / Brad Jackson (Antea)

Date: 5/13/14 | Weather: SUNNY ~80°F

PUMPING WELL ID:	EW-1 CONT'D	Well Diameter(in):	
Initial DTW (ft):		Borehole Diameter (in):	
Initial DTNAPL (ft):		Sump Length (ft):	
Initial NAPL Layer Thickness (ft):		Begin Pump Test Time:	
Well Depth (ft):		End Pump Test Time:	

TIME (HR:MIN)	# MIN SINCE PUMPING BEGAN	DEPTH TO WATER (FT BMP)	DEPTH TO LNAPL (FT BMP)	FLOW RATE (gpm) or TOTALIZER READING (gal)	Notes:
	60	14.71	14.71	54.0	
09:46	64	—	—	57.5	~0.75 gpm
09:48	68	14.71	14.71	59.0	58.1 start 58.8 end
					0.7 gpm
09:54	JS ~~70~~ 72	14.71	14.71	64.5	63.75 start 64.5 end
					0.75 gpm
10:04	JS ~~80~~ 82	14.72		71.5 ~~70.5~~ JS	~~70.5 start~~
10:05	83	—	—	JS ~~72.5~~ 73	72.2 start 73.0 end
10:12	90	14.68	14.68	77.75	77 10:11 start 77.75 10:12 end
10:12:30	90.5	—	—	78.00	
10:13	91				BEGIN ADJ PUMP
				~~8~~	To 17.75
10:15	START	16.75	16.75	80.25	
	STEP 2			~~86~~	
10:16	1	17.27	17.27	86.	
10:17	2	17.78	17.78	89	87.5 start 89 end
10:18	3	17.81	17.81	91	
10:19	4	17.82	17.82	92.25	
10:20	5	17.82	17.82	93.75	
10:25	~~6~~ 10	17.81	17.81	99.50	~1.5 gpm
10:30	15	17.81	17.81	105.75	~~108.25~~ JS
10:35	20	17.80	17.80	~~110.75~~ JS	
				113.75	
10:36	21	—	—	115.25	> 1.5 gpm
10:40	25	17.83	17.83	120	
				~~122.25~~	
10:42	27	—	—	123.75	> 1.25 gpm
10:43	28	—	—	125	
10:45	30	17.80	17.80	128	
10:46	31	—	—	129.25	
10:50	35	17.80	17.80	135	
10:51	36	—	—	136.25	
10:57	42	17.80	17.80	144.5	
10:58	43	—	—	146.0	

Notes:

CH2MHILL

PROJECT NUMBER

Step Drawdown Test - Field Log

Linnton Terminal - Kinder Morgan Liquids Terminals, LLC

Field Crew:

Date: 5/13/14 Weather: SUNNY

PUMPING WELL ID:	EW-1 CONTD	Well Diameter(in):	
Initial DTW (ft):		Borehole Diameter (in):	
Initial DTNAPL (ft):		Sump Length (ft):	
Initial NAPL Layer Thickness (ft):		Begin Pump Test Time:	
Well Depth (ft):		End Pump Test Time:	

TIME (HR:MIN)	# MIN SINCE PUMPING BEGAN	DEPTH TO WATER (FT BMP)	DEPTH TO LNAPL (FT BMP)	FLOW RATE (gpm) or TOTALIZER READING (gal)	Notes:
11:00	45	17.81	17.81	148.75	>1.25 gpm
11:01	46	—	—	150.00	
11:09	54	17.81	17.81	160.25	
11:10	55	—	—	162.50	
11:15	60	17.81	17.81	169.50	
11:16	61			170.75	
11:25	70	17.83	17.83	183.15	
11:26	71	—	—	184.5	
11:30	~~81~~ 76	17.82	17.82	191.25	
11:32	~~82~~ 77	—	—	192.50	
11:40	85	17.75	17.75	203	water tone instead of product tone
11:41	86	—	—	204.5	
11:45	90	17.76	17.76	209.75	Note: may have started clogging @ elbow ~11:40am
				210	
11:50 ~~11:49~~		17.66	17.66	216.5	
11:51 ~~11:50~~		—	—	217.75	
11:51	LOWER PUMP				LOWER TO 21.75'
11:52	BEGIN STEPS	17.22	17.22	219.0	
11:53	1	17.34	17.34	220.0	
11:54	2	17.45	17.45	221.5	
11:55	3	17.60	17.60	222.75	
11:58	6	17.70		227.	
11:59	7			228.5	
12:04	12	17.97	17.97	236.0	troubleshoot totalizer to check if blocked
12:05	13	18.45	18.45		emptying water into buckets
12:06	14	18.78	18.78	+4 gal	
12:06:30	14.5	18.90	18.90		TROUBLESHOOTING
12:07	15	19.23	19.23	+3 gal	"
12:08	16	—	—	+1 gal	"
12:10	17	20.30	20.30	+4 gal	"
12:12	19	—	—	+4 gal	"
		20.60	20.60		"
12:14	21			+4 gal	
12:16	23	20.90	20.90	—	"
12:18	25	21.50	21.50	+4 gal	"

Notes:

CH2MHILL

PROJECT NUMBER

Step Drawdown Test - Field Log

Linnton Terminal - Kinder Morgan Liquids Terminals, LLC

Field Crew:

Date: 5/13/14

Weather:

PUMPING WELL ID:	EW-1 cont'd	Well Diameter(in):	
Initial DTW (ft):		Borehole Diameter (in):	
Initial DTNAPL (ft):		Sump Length (ft):	
Initial NAPL Layer Thickness (ft):		Begin Pump Test Time:	
Well Depth (ft):		End Pump Test Time:	

TIME (HR:MIN)	# MIN SINCE PUMPING BEGAN	DEPTH TO WATER (FT BMP)	DEPTH TO LNAPL (FT BMP)	FLOW RATE (gpm) or TOTALIZER READING (gal)	Notes:
12:20	27 ~~0~~ *	21.50	21.50	+4 gal	skimmy now
				INT 248.0	start w/ totalizer
					reconnected
12:24	31 ~~4~~	21.40	21.40	250	backing up at the
12:26	33	21.10	21.10	2	elbow
12:28	35	21.45	21.45	256.5	skimmy now,
					issue w/ elbow
					bend resolved **
12:31	38	21.53	21.53	261.5	
12:32	39	~~21.53~~	—	263.5	>2gpm
12:37	45	21.53	21.53	275.5	~2gpm
12:46	54	21.51	21.51	298.0	~2gpm
12:50	58	21.49	21.49	294.5	
12:56	64	21.53	21.53	304.5	
13:00	68	21.53	21.53	311.5	
13:05	73	21.47	21.47	319.0	fluct. tween 21.47 +
					21.53 DTW
13:10	78	21.45	21.45	325.5	
13:11 ~~13:12~~ JS	80	—	—	~~330~~ 329.5	
3:12 ~~13:14~~ JS	81	21.50	21.50	330.5	
13:15	84	21.53	12.53	336	
13:20	89	21.56	21.56	342.5	>1.5 ⇒ 2.0 gpm
13:21	90	—	—	344	
13:29	98	21.49	21.49	357.25	
13:30	99	—	—	358.75	
~~13:39~~	13:40 109	21.53	21.53	375.00	
~~13:40~~	13:41 110	~~21.5~~	—	376.75	
13:49	118	21.50	21.50	390.0	
13:50	128	—	—	391.5	
	~~STEP 4~~				~~DROP TO 24 FT~~
13:53	131	21.54	21.54	397.5	FINAL STEP 3 READING
	STEP 4				DROP TO 24 FT
13:54	0 ~~132~~ JS	21.51	21.51	399.5	

Notes:

* Considered 12:20pm the revised start of STEP 3; ran for 90 min from this point no further troubleshooting req. USE THIS TOT READING AS START!

** connected discharge line to 1" hose that went aboveground to OWS

~~13:17 337.5~~ JS

~~13:18 339.5~~ JS

CH2MHILL

PROJECT NUMBER

Step Drawdown Test - Field Log

Linnton Terminal - Kinder Morgan Liquids Terminals, LLC

Field Crew:

Date: 5/13/14

Weather:

PUMPING WELL ID:	EW-1 CONTD	Well Diameter(in):	
Initial DTW (ft):		Borehole Diameter (in):	
Initial DTNAPL (ft):		Sump Length (ft):	
Initial NAPL Layer Thickness (ft):		Begin Pump Test Time:	
Well Depth (ft):		End Pump Test Time:	

TIME (HR:MIN)	# MIN SINCE PUMPING BEGAN	DEPTH TO WATER (FT BMP)	DEPTH TO LNAPL (FT BMP)	FLOW RATE (gpm) or TOTALIZER READING (gal)	Notes:
13:56	2	21.74	21.74	402	running @ 60 psi
13:57	3	22.10	22.10	405	
13:58	4	22.55	22.55	406	
13:59	5	—	—	408	
14:00	6	23.15	—	410	
14:01	7	—	—	412.25	
14:08	14	23.85	23.85	425.5	
14:09	15	—	—	427.5	
14:13	19	~~24.87~~ 23.87	23.87	434.5	
14:14	20	—	—	436.25	
14:19	25	23.82	23.82	445.0	
14:20	26	—	—	446.75	
14:25	31			455.5	
14:26	32	23.89	23.89	457.50	
14:31	37	23.91	23.91	466.0	
14:32	38	—	—	467.75	
14:39	45	23.91	23.91	480.0	
14:40	46	—	—	482.0	
14:46	52	23.89	—	492.0	
14:50	56	23.89	—	500.2	
15:00	66	23.90	—	514.75 → 516.5	14:59 → 15:00
15:02	68	—	—	—	TIE OFF PUMP
15:10	76	23.83	—	536.0	
15:20	86	23.87	23.87	552	
15:23	~~90~~ 89	23.90	23.90	557	
15:24	PUMP OFF	—	—	~~555~~ 557.75	FINAL READING

Notes:

BRAD JACKSON CELL:
971 777 0241

CH2MHILL

PROJECT NUMBER: 434697.01.01

BORING NUMBER: EW-01

Sheet: 1 of 1

Piezometer Completion Diagram

PROJECT: Kinder Morgan - Linton Terminal

LOCATION: 11400 NW St. Helens Road, Portland, OR

ELEVATION:

DRILLING CONTRACTOR: Major Drilling

DRILLING METHOD AND EQUIPMENT: Rotosonic

DRILLER:

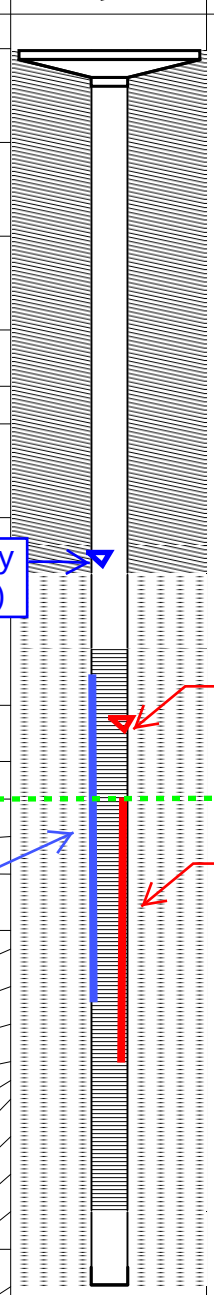
WATER LEVELS:

START: 1/12/12

FINISH: 1/12/12

LOGGER: Maria F.

Depth (ft)	Soil Description
0	light brown, moist, medium stiff plastic, 80% clay, 20% fine sand, 0.0 ppm
	same as above, 0.0 ppm
5	light brown/red clay with 20% fine sand, semi-plastic, medium stiff, 5 - 6' some red, 0.0 ppm
	light gray clay, stiff, semi-plastic, 0.0 ppm
	loose fine sand, well graded with 10% silts
10	loose sand, well graded, light gray, 85.9 ppm
	well graded fine sand, very loose, 12.5 - 13' = 157 ppm, 13 -14' = 26.1 ppm, 14 - 15' = 26 ppm
15	moist, loose fine sand, well graded, light gray, 16' = 117 ppm, 17' = 194 ppm
	moist, fine sand, well graded, with 5% clay, loose, 140 ppm
	50% fine sand, 50% clay, wet, light gray, plastic
20	sheen, clay, light gray, wet, 5% fine sand, plastic, soft, 80 ppm
	same as above, wet
	saturated, sheen observed
	wet, light gray clay, plastic, semi-stiff
25	light gray, wet clay, very stiff, plastic with drops of oil
	sandy clay, moist, light gray, oil droplets
	sheen observed, sandy clay, non-plastic, stiff
	light gray clay, 5% very fine sand
	plastic, medium stiff
	very soft plastic, wet, light gray clay
30	stiff, plastic, light gray clay, sheen observed
	soft, plastic, wet clay
	loose clay with 100% very fine sand, very stiff, non-plastic, sheen observed, droplets of oil can be seen down to 33'
	End of Log
35	



Well Construction Notes

TOC is ~2ft below grade

Based on required connections
Traffic-Rated Vault
Dimensions based on other criteria

Bentonite Chips

6-in. dia. Sch 80 PVC; flush threaded
6-in. dia.; 2-ft long Sch 80 PVC with flush-threaded bottom cap

Static Head in Sept 2014 (16 ft btoc)

6-inch dia.; Schedule 80; 0.040-inch slot size mill-slotted screen

transition from sand to clay/sandy clay

2 to 9 ft DD

10-20 Colorado Sand

Stainless steel centralizer; top and bottom of screen

CH2MHILL

PROJECT NUMBER: 434697.01.01

BORING NUMBER: EW-03

Sheet: 1 of 1

Piezometer Completion Diagram

PROJECT: Kinder Morgan - Linton Terminal

LOCATION: 11400 NW St. Helens Road, Portland, OR

ELEVATION:

DRILLING CONTRACTOR: Major Drilling

DRILLING METHOD AND EQUIPMENT: Rotosonic

DRILLER:

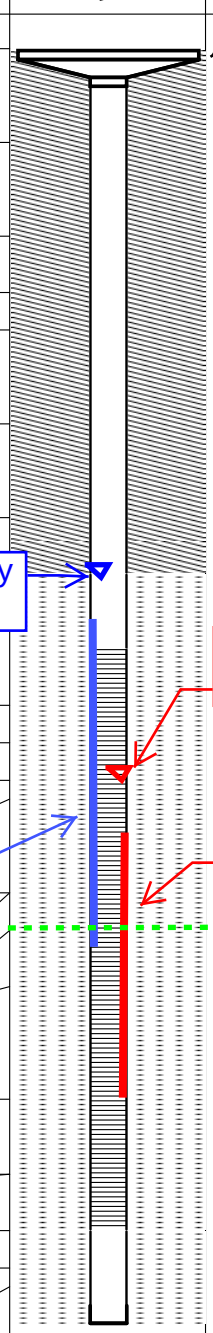
WATER LEVELS:

START: 3/5/12

FINISH: 3/6/12

LOGGER: Maria F.

Depth (ft)	Soil Description
0	no recovery
	brown, coarse sand and gravel, 278 ppm
5	brown fine sand, 281 ppm
	abrupt change in color, brown to gray fine sand
	gray well graded sand, loose, moist, 103.7 ppm
10	
	No recovery, expecting recovery, but nothing was recovered
15	loose, coarse sand, moist, gray, 15' - 909 ppm, 15.5' - 420 ppm
	wet, loose, gray, well graded fine sand, 510 ppm
20	saturated, loose, gray, well graded sand with clay, 314 ppm
	wet, gray sand, 11.3 ppm
	sheen observed and wood debris throughout core, 35.4 ppm
	moist, gray, fine sand with 40% clay, dense sand
25	medium dense sand, moist
	very saturated core
	stiff clay with well graded fine sand
	soft gray clay with well graded very fine sand
30	moist, very stiff clay, gray with 10% very fine sand
	plastic, moist, stiff, gray clay
	wet plastic, soft gray clay
	End of Log
35	



Well Construction Notes

TOC is ~2ft below grade

Based on required connections
Traffic-Rated Vault
Dimensions based on other criteria

Bentonite Chips

6-in. dia. Sch 80 PVC; flush threaded
6-in. dia.; 2-ft long Sch 80 PVC with flush-threaded bottom cap

Static Head in Sept 2014 (17.5 ft btoc)

6-inch dia.; Schedule 80; 0.040-inch slot size mill-slotted screen

1.5 to 8 ft DD

transition to finer sand/sandy clay

10-20 Colorado Sand

Stainless steel centralizer; top and bottom of screen

PROJECT NUMBER	BORING NUMBER	
497639.01.02	EW-6	SHEET 1 OF 1

CH2MHILL

SOIL BORING LOG and WELL CONSTRUCTION

PROJECT : Kinder Morgan Linnton Terminals Extraction Wells Installation LOCATION : Portland, Oregon
DRILLING CONTRACTOR Cascade Drilling LP
DRILLING METHOD AND EQUIPMENT USED : Hollow Stem Auger, CME-85 Truck-Mounted Rig (8.25"/12.25" AUGER)
WATER LEVELS : -- START : 8/28/2014 END : 8/28/2014 LOGGER : J. Sager

TOC is ~0.5ft below grade

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL (FT)	RECOVERY (FT)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	CORE DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	WELL CONSTRUCTION DIA: CASING MATERIAL, SCREEN TYPE, SE SAND TYPE	PID READING (ppm)
0	0.0		Air Knife		Air Knife to 5.0 ft bgs	Flush-mount vault and cement seal (to 3.0' bgs)	BZ Oxygen = 20.9% LEL = 0% VOCs = 0.0 ppm H_2S = 0 ppm
						3.0' to 12.0' Bentonite Chip Seal	
5	5.0						
	6.5	1.5/1.5	SPT-1		**Silt (ML)** 5.0-15.5' - dark brown (10YR 3/3), moist, medium stiff, non-plastic (0/0/100)		
10	10.0	1.5/1.5	SPT-2		10.0' - becomes medium plasticity		
	11.5					12.0' Top Depth of Filter Pack	
15	15.0	1.0/1.5	SPT-3			15.0' Top Depth of Screen	
	16.5				**Sand with Silt (SM)** 15.5-21.0' - black (N 2.5/), moist, loose, fine to medium sand, strong odor (0/80/20)		
20	20.0	1.0/1.5	SPT-4				
	21.5				**Silt (ML)** 21.0-35.0' - greenish black (10 GY 2.5/1), medium soft, non-plastic, strong odor (0/0/100)		
25	25.0	1.5/1.5	SPT-5		25.0' - becomes medium plasticity, visible product		
	26.5	1.0/1.5	SPT-6				
	28.0	1.5/2.0	SPT-7				
30	30.0	2.0/2.0	SPT-8		30.0' - abundant oil mottled through sample	30.0' Bottom of Screen 30.0-35.0' - Sump	
	32.0	1.5/1.5	SPT-9		31.5' - grades to very dark greyish brown (10 YR 3/2)		BZ Oxygen = 20.9% LEL = 0% VOCs = 0.0 ppm H_2S = 0 ppm
	33.5	1.5/1.5	SPT-10				
35	35.0				End Drilling on 8/28/2014 Total Borehole Depth: 35.0 ft bgs	35.0' Bottom Depth of Well	

Static Head in Sept 2014 (18 ft btoc)

1 to 8 ft DD

transition from sand to silt

12"

Well Casing and Screen Materials
Casing Material: Sch 40 PVC
Casing Diameter: 4-in
Seal Type: 3/8" Bentonite Chips
Pack Type: 10x20 Colorado Sand
Screen Length: 15 ft
Screen Type: Sch 40, 0.020" Milled Slots

ABBREVIATIONS
' = Feet
BZ = Breathing Zone
VOCs = Volatile Organic Compounds

PROJECT NUMBER	BORING NUMBER	
497639.01.02	EW-7	SHEET 1 OF 1

CH2MHILL

SOIL BORING LOG and WELL CONSTRUCTION

PROJECT : Kinder Morgan Linnton Terminals Extraction Wells Installation LOCATION : Portland, Oregon
DRILLING CONTRACTOR Cascade Drilling LP
DRILLING METHOD AND EQUIPMENT USED : Hollow Stem Auger, CME-85 Truck-Mounted Rig (8.25"/12.25" AUGER)
WATER LEVELS :-- START : 8/28/2014 END : 8/29/2014 LOGGER : J. Sager

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL (FT)	RECOVERY (FT)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	CORE DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	WELL CONSTRUCTION DIAG: CASING MATERIAL, SCREEN TYPE, SEAL, SAND TYPE	PID READING
0	0.0		Air Knife		Air Knife to 5.0 ft bgs on 8/28/2014	Flush-mount vault and cement seal (to 3.0' bgs) 3.0' to 13.0' Bentonite Chip Seal	
5	5.0	1.5/1.5	SPT-1	13-15-16	**Silty Sand (SM)** 5.0-25.5' - brown (10 YR 2/3), slightly moist, loose, fine to medium sand with <10% angular to subangular gravel 5.5' - grades to black (N 2.5/), strong hydrocarbon odor		**HS** VOCs = 2.63 ppm **BZ** Oxygen = 20.9% LEL = 0% VOCs = 0.0 ppm H_2S = 0 ppm
	6.5						
10	10.0	1.5/1.5	SPT-2	7-10-11	10.0-11.5' - strong hydrocarbon odor	13.0' Top Depth of Filter Pack	**HS** VOCs = 165 ppm **BZ** Oxygen = 20.9% LEL = 0% VOCs = 0.0 ppm H_2S = 0 ppm
	11.5						
15	15.0	1.5/1.5	SPT-3	7-11-13	15.0-16.5' - strong hydrocarbon odor	15.0' Top Depth of Screen	**HS** VOCs = 312 ppm **BZ** Oxygen = 20.9% LEL = 0%
	16.5						
20	20.0	1.5/1.5	SPT-4	4-6-7	20.0-21.5' - strong hydrocarbon odor 21.0' - wood fragments		**HS** VOCs = 143 ppm **BZ** Oxygen = 20.9% LEL = 0% VOCs = 0.0 ppm H_2S = 0 ppm
	21.5						
25	25.0	1.5/1.5	SPT-5	4-5-7	**Silt (ML)** 25.5-26.5' - brown (10 YR 4/3), soft		**HS** VOCs = 10
	26.5	1.5/1.5	SPT-6	4-6-8	26.5-27.0 - with interbedded silty sand (SM) 27.0-28.0' - medium stiff		**HS** VOCs = 88.0 ppm
	28.0	2.0/2.0	SPT-7	6-10-12-14	28.0' - interbedded with black (N 2.5/) stringers of silty sand (SM)		**HS** VOCs = 12.5 ppm
30	30.0	1.5/1.5	SPT-8	2-2-3		30.0' Bottom Depth of Screen 30.0-35.0' - Sump **BZ** Oxygen = 20.9% LEL = 0% VOCs = 0.0 ppm H_2S = 0 ppm	**HS** VOCs = 0.40 ppm
	31.5	1.5/1.5	SPT-9	1-2-4	31.5' - interbedded with 1-2" stringers of brown silt		**HS** VOCs = 2.90 ppm
	33.0	2.0/2.0	SPT-10	2-3-4-6	34.0' - interbedded with sand stringers		**HS** VOCs = 0.40 ppm
35	35.0				34.5-35.0' - grades to medium stiff End Drilling on 8/29/2014 Total Borehole Depth: 35.0 ft bgs ***Abbreviations:*** ' = Feet, BZ = Breathing Zone, HS = Head Space, VOCs = Volatile Organic Compounds	35.0' Bottom Depth of Well 12"	

TOC is ~0.5ft below grade

Static Head in Sept 2014 (20 ft btoc)

1 to 7 ft DD

transition from sand to silt

Well Casing and Screen Materials
Casing Material: Sch 80 PVC
Casing Diameter: 4-in
Seal Type: 3/8" Bentonite Chips
Pack Type: 10x20 Colorado Sand
Screen Length: 15 ft
Screen Type: Sch 80, 0.020" Milled Slots