FLOODED REVERSE CIRCULATION DRILLING NGWA EXPO 2017

TOM DOWNEY, CWD / PI

OVERVIEW

- PROCESS & TOOLING OF FLOODED RC DRILLING
- FEATURES FLOODED RC DRILLING RIG
- SIERRA MADRE PROJECT – WELL #7

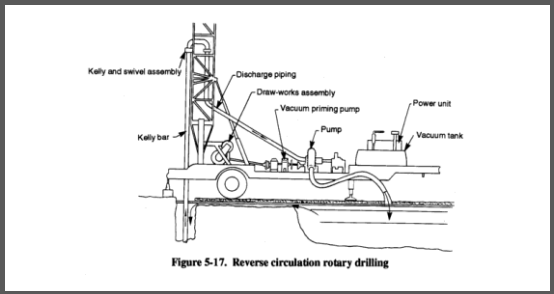
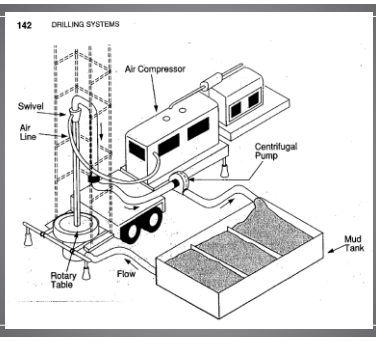


Figure 5-17. Reverse circulation rotary drilling



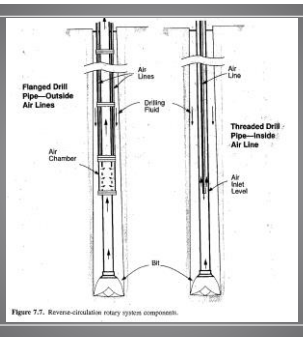
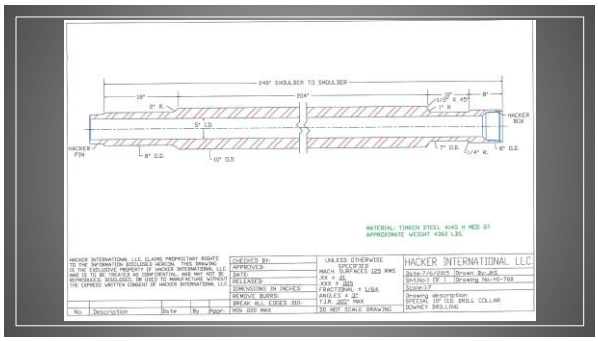


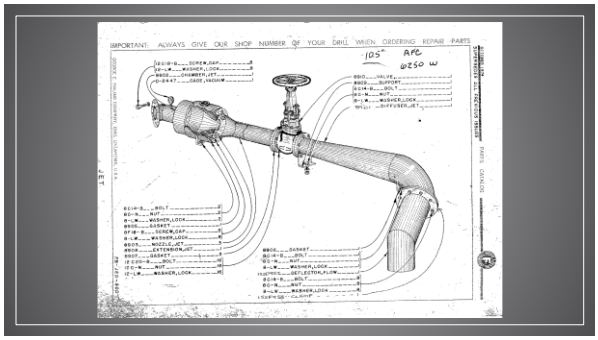
Figure 7.7. Reverse-circulation rotary system components.

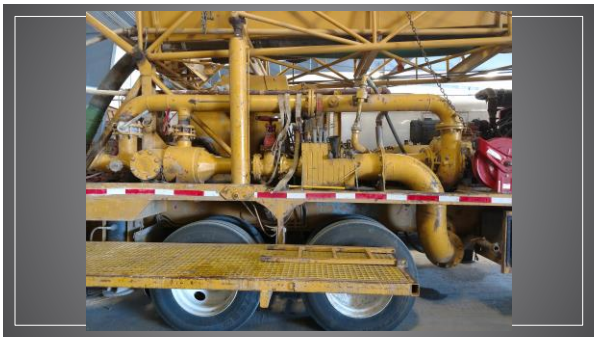
DRILL BITS

2 WING

3 WING


240" SHOULDER TO SHOULDER
HACKER PIN
HACKER BOX
MATERIAL: TIMKEN STEEL 4145 H MOD QT
APPROXIMATE WEIGHT 4360 LBS
HACKER INTERNATIONAL LLC


IMPORTANT: ALWAYS GIVE OUR SHOP NUMBER OF YOUR DRILL WHEN ORDERING REPAIR PARTS
105" APE
6250 W



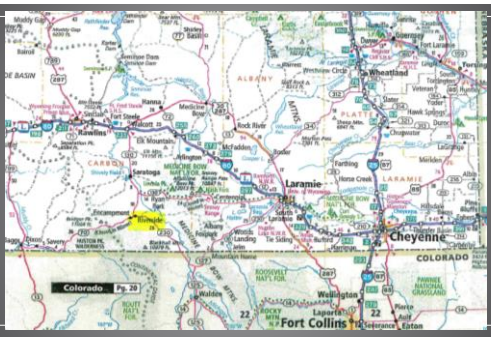
EDSI / EWBANK
M100 RC
DRILL RIG

- ✓ FLOODED REVERSE CIRCULATION
- ✓ DEPTHS TO 2000 FT
- ✓ 7" H/F DRILL PIPE
- ✓ INTERNAL AIR
- ✓ SULLAIR 1150 / 350 COMPRESSOR

CASING / SCREEN

SETTING CASING AND SCREEN

Sierra Madre Project, Carbon, WY – Well #7



FINAL REPORT

SIERRA MADRE WATER AND SEWER JOINT POWERS BOARD GROUNDWATER EXPLORATION PROGRAM RIVERSIDE NO. 7 WELL

May, 2011

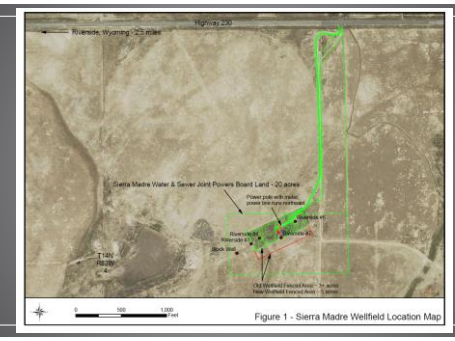
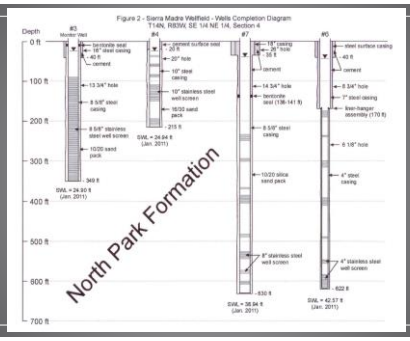


Figure 1 - Sierra Madre Wellfield Location Map



Lithologic Sample Descriptions
Riverside No. 7 Well – U.W. 194100

Footages are referenced to ground level. Reverse circulation drilling reduces lag time between bit and surface and reduces side-wall contamination relative to direct circulation drilling. Details compiled only for the potential screened sections, i.e. below 170 ft.

Footage	Principal Lithology	Description	Drilling Notes
170 - 275	Siltstone/	sticky, sl. fn sandy siltst/mudst;	smooth, steady drilling throughout
	Mudstone	vfn sndy 180-90, vfn mica 230-40	
275 - 340	Mudstone	dk gry, sl indurated mudst, vfn sndy 290-300	
340 - 360	Mudstone	grey, mod ind, mudst	
360 - 370	Mudstone	as, minor vfn snd	
370 - 380	Sandstone	brn, mod ind, vfgr, slty sndst	
380 - 400	Sand	sand (to 1/4"), poorly sorted, subangular, qtz & lithic grains, fn gravel, all in sticky matrix	good-looking material
400 - 410	Mudstone	grey mudstone	
410 - 420	Sandstone	vf-fgr, sticky sand	
420 - 430	Sandstone	brn, hard, vfgr, slty, sticky sst	
430 - 450	Sandstone	hard, brn, vfgr, slty, sticky sst	
450 - 460	Clay	soft, brn-dk brown, vfgr sndy, sticky clay	drilling character – same all hole so far, i.e. smooth, steady, fast, drilling w/string weight, including two drill collars
460 - 470	Sandstone	soft, white, fn-mgr, sticky, qtz & lithic sst w/white clay marbling	~470 ft. – first rough drilling of hole

C - 1

470 - 480	Sandstone	as, clayier	smoother at 475 ft.; nothing hard in cuttings, drilling suggests layering
480 - 484	Sand	crs snd & fine gravel, qtz & lithics, clayey	
484 - 490	Sandstone	soft, brn, vfgr, slty sst; crs snd & clay as; one 1" granite pebble	
490 - 500	Mudstone	soft, tan, vfn, sndy mudst w/white clay	
500 - 510	Sandstone	soft, lgt grey, vfn, dirty, slty, sticky sst	
510 - 516	Sandstone	mod ind, grey, vfngr, dirty sst, very calcareous	
516 - 526	Clay	vfn sndy, clay; lgt grey	
526 - 529	Sand	fn snd to fn gravel, angular-subround; qtz and lithics	
529 - 538	Sandstone	soft-mod ind, lgt brn, vfgr, dirty, sticky sst	
538 - 541	Sand	med-crs snd, angular-subrnd, qtz & lithics	good looking material
541 - 560	Sand	tan, clayey, vfn snd	
560 - 570	Sandstone	as; w/mod ind, vf-fgr, sltp sst	
570 - 602	Clay	tan, vf sndy clay, mica-rich	mica common throughout this very immature sediment
602 - 612	Sand	gravel & crs snd, qtz & lithics	rough at 602 ft., gravel sample
612 - 630	Clay	tan, vfn sndy clay; w/minor white ash	

C - 2

Penetration Rates
Riverside No. 7 Well – U.W. 194100

The following penetration rates are average values for 20-ft. intervals as recorded during drilling of the 14 3/4-inch diameter borehole in **minutes per twenty feet**.

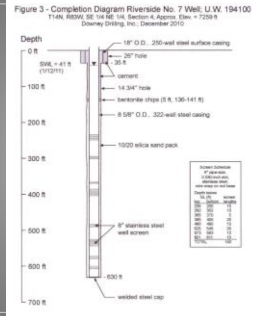
Depth (ft.)	00	20	40	60	80
0				49	23
100	17	9	15	14	15
200	8	26	16	17	21
300	17	17	23	26	21
400	15	25	35	34	31
500	29	32	22	23	23
600	23	21			

Notes:
0 - 35 ft. - Done with bucket rig (surface casing)
35 - 40 ft. - 14 minutes
620 - 630 ft. (TD) - 38 minutes

Source: Test Hole Log & Well Design, Downey Drilling, Inc.

B - 1

Figure 3 - Completion Diagram Riverside No. 7 Well; U.W. 194100
T14N, R83W, SE 1/4 NE 1/4, Section 4; Approx. Elev. = 7259 ft
Downey Drilling, Inc.; December 2010



Well History
Riverside No. 7 Well – U.W. 194100

Drilling Contractor: Downey Drilling, Lexington, Nebraska
Project Engineering: PMPC Engineers, Saratoga, Wyoming
Project Geology: Hinckley Consulting; Laramie, Wyoming

Dec. 10, 2010
Install surface casing to 35 ft. with bucket auger - 0.250-wall steel cemented into 26-inch hole; water at approx. 20 ft.

Dec. 13, 2010
Main mobilization and site preparation.

Dec. 14, 2010
Drill 14-3/8 inch borehole to 630 ft. (14.5 hours drilling); reverse-circulation with airlift from 200 ft.; 30-second mud viscosity (70 bags "Quik-Gel" bentonite and 6 bags soda ash; 70# "Quick Trol Gold", 80# "EZ Mud Gold", and ½ gal. "EZ Mud" added over the course of drilling), circulation approx. 350 gpm; 7-inch stem w/ three drill collars, steel-tooth tri-cone bit. Run geophysical logs.

Dec. 15, 2010
Install 8-5/8" OD, 0.322-wall steel casing to 630 ft., with 100 ft. of Johnson stainless-steel, wire-wrap well screen, 0.030-slot (see completion diagram for placement), hung in tension from surface casing; "10/20" Colorado Silica sand pack tremied in with clear water, from 630 to 141 ft., mixed with approx. 150 lb. of chlorine powder during installation.

Dec. 16, 2010
Install 5 ft. of bentonite chips and tremie neat cement seal 136 ft to 8 ft.; partial pumping of drilling mud from casing; demobilization of most equipment.

Dec. 22, 2010
Install pump at 210 ft., pump for 2 hrs. at approx. 350 gpm to remove drilling fluid from casing. Approximate specific capacity = 2.5 gpm/ft.

Jan. 5, 2011
Trip in to 600 ft. to airlift remaining drilling fluid from screen and casing; remove fluids to 610 ft., unable to proceed into casing (610 - 630 ft.) due to snarl of sounder cable in hole; trip out for development tool; re-enter hole to 610 ft. with 10-ft isolation tool.

Jan. 6, 2011
Airlift screens in 10-ft intervals using isolation tool (gaskets on ends of 10-ft. of 4-in pipe, into which air injected at 100 - 300 ft.) until discharge clarity, including surging cycles, working from bottom to top. Airlift approx. 50 gpm from all sections; no drawdown measurements possible.

Jan. 11, 2011
Set test pump to 315 ft.; complete step testing.

Jan. 12, 2011
Start constant-rate pump test.

Jan. 13, 2011
Complete constant-rate pump test.

Week of Jan. 27, 2011
Bail drilling fluids from 610-630 casing; disinfect entire casing/screen with chlorine tablets from surface.

Table 1 - Riverside Well No. 7 Pump Test Summary

Discharge (gpm)	Duration (min)	Drawdown (ft)	Specific Capacity (gpm/ft)	Notes
61	40	20.3	3.03	
151	40	60.5	2.50	cont. from previous step
291	40	112.6	2.58	cont. from previous step
340	40	144.7	2.35	cont. from previous step
280	40	97.7	2.87	test following overnight recovery
280	1980	136.9	2.05	continuation of pumping; transmissivity = 3,300 gpd/ft

test period, i.e. horizontal groundwater flow within the individual water-bearing strata common to the two wells is vastly more than the vertical groundwater flow draining overlying strata.

Calculation of the theoretical drawdown at Well No. 7 using the aquifer parameters derived from the Well No. 6 observations indicates Well No. 7 as an efficient well at the 280-gpm production rate, i.e. without substantial head losses due to formation damage, inadequate development, "skin" effects, etc. This is consistent with the similar 40-minute specific capacities measured at 60 gpm and 280 gpm (Table 1).

ACKNOWLEDGMENTS

- HANDBOOK OF GROUNDWATER DEVELOPMENT
- GROUNDWATER AND WELLS, SECOND EDITION
- GROUNDWATER AND WELLS, THIRD EDITION
- SIERRA MADRE WATER AND SEWER JOINT POWERS BOARD GROUNDWATER EXPLORATION PROGRAM RIVERSIDE NO. 7 WELL, FINAL REPORT, MAY, 2011

POWERPOINT PRESENTATION – JOSIE BAUER, ADMIN. ASSISTANT FOR DOWNEY DRILLING, INC., LEXINGTON, NE

NEBRASKA THUNDERSTOM

QUESTIONS?

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