ROCKY MOUNTAIN OILFIELD TESTING CENTER

PROJECT TEST RESULTS

MUD DEVIL – DEAERATOR MIXER

MARCH 30, 1995

RMOTC TEST REPORT

Mud Devil – Deaerator Mixer

Project Test Results

Prepared for:

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Prepared by:

MICHAEL R. TYLER
RMOTC Field Engineer

March 30, 1995
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ABSTRACT

The Rocky Mountain Oilfield Testing Center (RMOTC) conducted a field test on the MUD DEVIL - Deaerator Mixer (MDDM), at the Naval Oil Shale Reserve No. 3 (NOSR-3) located west of Rifle, Colorado. Industrial Screen and Maintenance of Casper, Wyoming, manufactures the MDDM high-shear pin mixing system used to blend products in drilling fluid systems. The test was a comparison between DOE Well 1 -M-1 8 drilled without the MDDM and a sidetrack Well 1-M-18 ST drilled with the MDDM. Test results show that the MDDM, when properly used, reduced the usage of drilling fluid products, decreased water requirements, allowed for easier removal of cuttings, and required less drilling rig time. The cost reductions will vary depending on formations, drilling methods, rig condition, water supply, and personnel.

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PROJECT TEST RESULTS

March 30, 1995

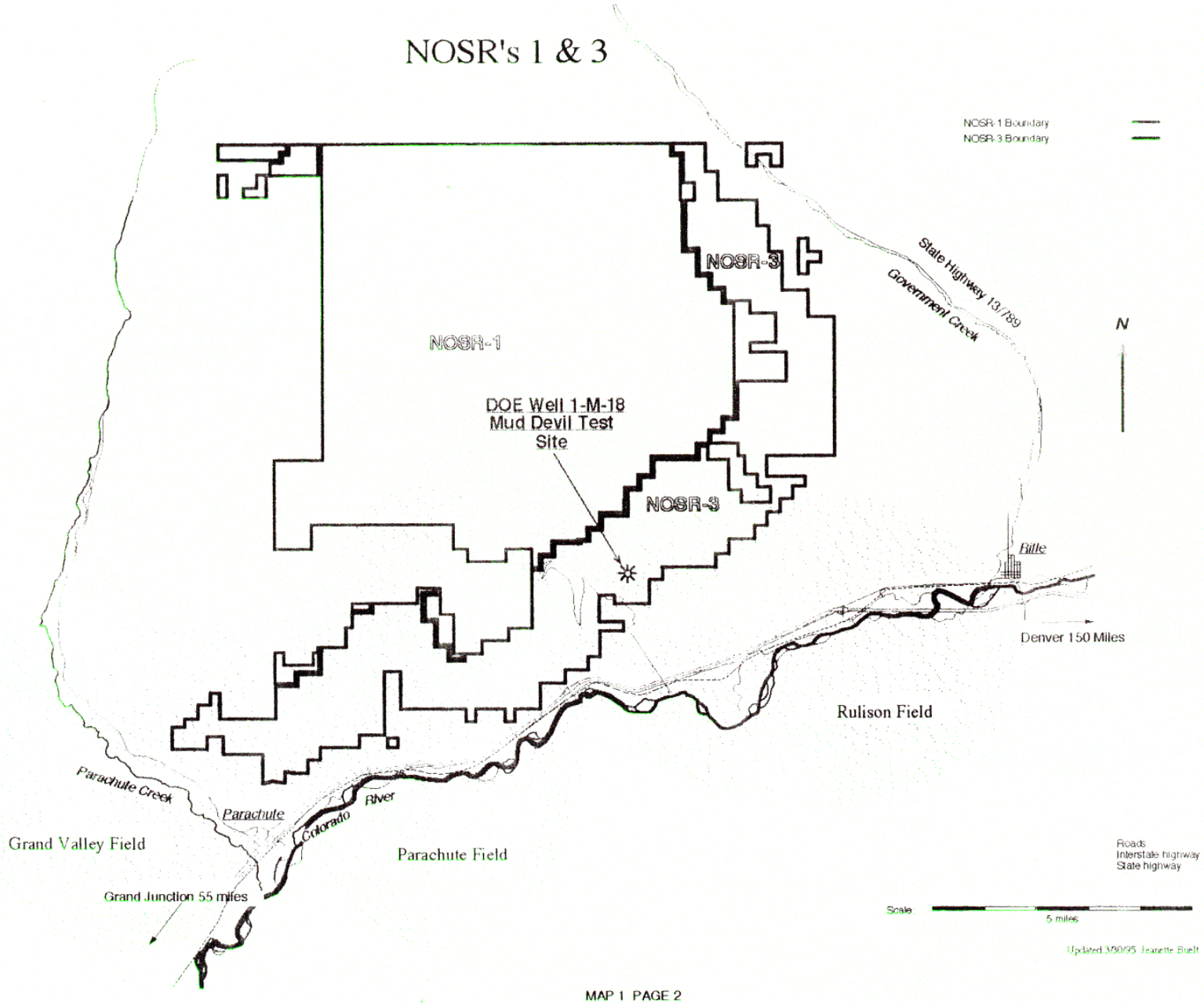
INTRODUCTION:

The Rocky Mountain Oilfield Testing Center (RMOTC) conducted a field test on the MUD DEVIL -Deaerator Mixer (MDDM) at the Naval Oil Shale Reserve No. 3 (NOSR-3) located west of Rifle, Garfield County, Colorado (NENE Sec. 18-T6S-R94W [see Map 11). Industrial Screen and Maintenance of Casper, Wyoming, manufactures the MDDM high-shear pin mixing system used to blend materials in drilling fluid systems. The MDDM operates in a continuous flow mode to remove air and gases from the fluid and prevents the addition of air normally injected by a rig hopper. The MDDM can be attached to any rig using a centrifugal pump to supply fluid to the unit.

The MDDM (Figure 1) receives drilling fluid or water from the rig at 35 to 80 psi. This fluid is fed through the hopper, into an inline screen before entering the high-shear pin mixing pump, and discharges thoroughly mixed fluid directly into the deaerator chamber. The high-shear pin mixer component contains several semi-cylindrical pins in the flow path, protruding from a vertical spinning cylinder. These rotating pins are located between static slanted pumping vanes and pump the fluid upward through the cylinder. The mixer breaks up clumps of solid particles and localized concentrations of products and thoroughly blends them before discharging into the mud tank. Recirculation through the mixer insures proper blending of the entire system.

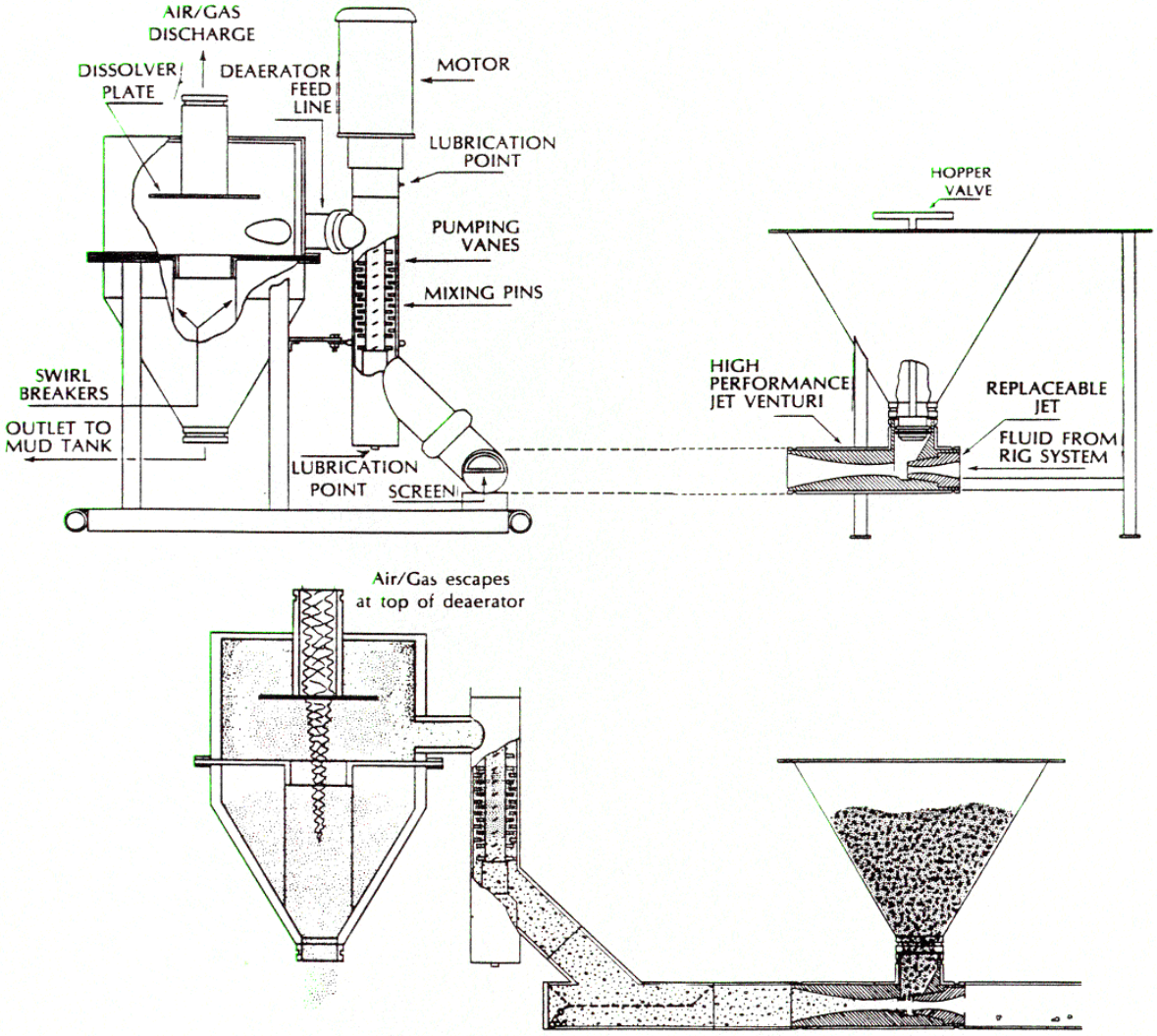
The MUD DEVIL - Deaerator Mixer, when properly used, can improve the quality and reduce costs of the entire drilling fluid system. Potential cost reductions will vary depending on formation types, drilling methods, rig condition, water supply, and rig personnel.

NOSR's 1 & 3



MAP 1 PAGE 2

MUD DEVIL DIAGRAM



Salt or other solid chemical particles dissolve in top of deaerator

PIN PUMP thoroughly mixes (blends) additives with system mud

Screen traps foreign material damaging to PIN PUMP

Additives or chemicals mixed in by high performance jet venturi

Mud or water as needed from rig

Figure 1

WELL HISTORY

The test was conducted by RMOTC on Department of Energy (DOE) Wells 1-M-18 and 1-M-18 ST in Garfield County, Colorado. The drilling contract was VECO Drilling Inc.

Well 1-M-18 was drilled directionally without the MDDM to a total measured depth of 9,157 feet in the Rollins sandstone formation. After problems were encountered on Well 1-M-18 wellbore, a decision was made to sidetrack and drill 1-M-18 ST.

The MDDM was used on Well 1-M-18 ST for directional drilling to a depth of 9,000 feet in the Mesaverde Group Williams Fork formation. Well 1-M-18 ST was kicked off at 3,804 in from the wellbore of Well 1-M-18 and was 180 feet away from the original well at the total measured depth of 9,000 feet. The Rollins/Mancos formation was not penetrated in this well.

The success of the MDDM test was determined by comparing drilling intervals in both wells that were similar in depth and lithology. In Well 1-M18, the interval studied was 3,910 to 9,157 feet for a total of 5,247 feet drilled which included two cores totaling 23 feet (see Chart 1). In Well 1-M-18 ST, the interval studied was 3,862 to 9,000 for a total of 5,138 feet drilled (see Chart 2).

Tables 1-3 show the comparison of formation lithologies, drilling parameters and mud system characteristics.

Table 1
FORMATION COMPARISON OF DOE WELLS 1-M-18 AND 1-M-18 ST

Data Compared	DOE 1-M-18 ft	DOE 1-M-18 ST ft
Interval Studied -- without Rollins section	3,910 - 9,157 = 5,247 5,004	3,862 - 9,000 = 5,138 N/A
Total Wasatch Formation Interval Studied	1,359	1,411
Gross sandstones within Wasatch interval studied	281	252.5
Total Mesaverde/Williams Fork Formation Studied	3,645	3,727
Mesaverde/Williams Fork Formation Gross Sandstones	1,020.5	1,255
Rollins/Mancos Member Formation Sandstones	106	not penetrated
Rollins/Mancos section penetrated within study interval	243	N/A
Total Sandstones Penetrated in Designated Study Interval	1,407.5	1,507.5
Total shales, siltstones, and mixed lithologies penetrated --excluding Rollins/Mancos from all totals	3,839 3,702.5	3,630.5 N/A

Table 2
TEST RESULTS

Control Variables	1-M-18	1-M-18 ST	Percentage Difference *
Footage Drilled	5,247	5,138	-02
Days Drilling[1]	23	20	-13
Hours Drilling or Coring	368.50	330.75	-10
Average Rate of Penetration, ft/hr[2]	14.02	15.44	+10
Average Drilling Fluid Cost, $/day[3]	$1,361	$901	-34
Average Water Used, BPD[4]	330	152	-54
Mixed Drilling Fluid and/or LCM, hr	46.25	15.50	-66
Drilling Fluid Lost, bbl	1,700	780	-54
Average Mud Weight, lb/gal	9.2	9.0	-02
Average Funnel Viscosity, sec	46	53	+15
Average Water Loss, ml	6.0	6.1	+02
Average Plastic Viscosity, cp	15	20	+33
Average Yield Point, lb/100 sq ft	15	17	+13
Average Percentage of Solids	6.4	5.1	-20

* Percentage difference may include benefits from MDDM, changes in drilling parameters, and reservoir characteristics.

Control Variable Considerations:

1 . Coring operations on Well I -M-1 8 increased rig time by approximately three days.

2. On Well 1 -M-1 8, an API 437 bit drilled 1,377 feet
On Well 1 -M- 18, an API 517 bit drilled 4,026 feet
On Well 1 -M-1 8 ST, an API 437 bit drilled 1,327 feet
On Well 1 -M- 18 ST, an API 517 bit drilled 3,869 feet

3. For Well 1 -M- 18, average drilling fluid cost per day includes an 800 bbl loss of drilling fluid that occurred December 9, 1994. The total cost to replace the drilling fluid was $3,646. If this day and associated costs are omitted from the test, the average drilling fluid cost per day would be $1,256, which is 28 percent higher than the $901 average on Well 1 -M-1 8 ST.

4. On Well 1 -M-1 8, the reserve pit pump failed and was not used. Fresh water was hauled in and used in the well rather than reserve pit fluid. The pump was repaired, then used on Well 1 -M- 18 ST. Fluid was recycled from the reserve pit, which reduced drilling fluid products and fresh water requirements.

Table 3
DRILLING FLUID PRODUCTS MEASURED

PRODUCT	1-M-18 lb	1-M-18 ST lb	DIFFERENCES	
			lb	%
Aqua Gel	36,600	22,900	-13,700	-37
Barite	112,900	6,000	-106,900	-95
Benex	184	32	-152	-83
Drispac	2,000	2,250	+250	+13
Lime	700	650	-50	-07
Mica	5,040	2,400	-2,640	-52
Multiseal	6,240	1,560	-4,680	-75
Paperflake	3,000	880	-2,120	-71
Sawdust	11,600	13,440	+1,840	+16
SDF 2000 (Polymer)	1,700	1,300	-400	-24

TECHNICAL OBSERVATIONS:

1. The formations penetrated in both wells were similar (see Table 1).

2. On Well 1-M-18, lost circulation was greater. A gas buster was required to control gas kicks encountered during drilling. There was a 1,700 bbl drilling fluid loss due to lost circulation.

3. On Well 1-M-18 ST, the drilling rate through the Cameo Coal formation was higher. The logs showed higher porosity and thicker gas zones. No gas problems were encountered, and lost circulation was reduced by 54 percent.

4. The drilling fluid product requirements on Well 1-M-18 ST were less due to the use of the reserve pit pump to recycle drilling fluids back into the system.

5. The MDDM rental cost is $150 per day, total $3,000 for 20 days. Including this cost, the average daily drilling fluid expense of $901 increases to $1,051. The difference between Well 1-M-18 average drillign fluid cost per day of $1,256 and Well 1-M-18 ST average drilling fluid cost per day of $1,050 is $205, or a 16 percent reduction in average drilling fluid expense per day.

POTENTIAL BENEFITS OF THE MDDM:

1. Shears bentonite properly, giving maximum yield.
2. Reduces quantity of products needed to maintain drilling fluid properties.
3. Reduces potential for overtreatment by properly dissolving chemicals.
4. Disperses barite in drilling fluid.
5. Assists in the removal of air and gas from drilling fluid.
6. Reduces water requirement.

CONCLUSION:

The MDDM proved to be efficient on Well 1 -M-1 8 ST. MDDM aided in maintaining the drilling fluid properties, allowing for easier removal of cuttings, reduction in drilling fluid product usage, decreased water requirements, faster drilling, and less rig time.

A problem was encountered in maintaining the recommended supply pressure of 35 to 80 psi of drilling fluid to the MDDM. The rig's drilling fluid mixing pump operated between 15 and 30 psi, which is normal operating supply pressure on most drilling rigs. The MDDM should be equipped with its own motor and pump to insure the required pressure.

For more information on the MUD DEVIL - Deaerator Mixer, contact R.M. (Pete) Miner, Industrial Screen & Maintenance, P.O. Box 373, Casper, WY 82601, phone (307) 234-3547.

ACKNOWLEDGEMENTS

This research was funded by the Department of Energy Related Inventions Program (ERIP) with work conducted by the Rocky Mountain Oilfield Testing Center (RMOTC). Work was directed by Michael R. Tyler, RMOTC Field Engineer, and supported by Ed Reish, NOSR Engineer, Lorraine LaFreniere Ph.D., Geologist, Jeff Clark, Drilling Supervisor, Jeanette Buelt, RMOTC Engineering Technician, and Marvin Hendricks, DOE Engineer. RMOTC is operated by Fluor Daniel (NPOSR), Inc., the Management and Operating Contractor for the Department of Energy Naval Petroleum Oil Shale Reserves in Colorado, Utah, and Wyoming (NPOSR-CUW).

RMOTC's goal is to partner with the oil industry to improve productivity through field testing of new petroleum technology, evaluate new equipment and techniques, disseminate information to the petroleum industry, and conduct training for universities, Native Americans, and private industry. For more information contact the Rocky Mountain Oilfield Testing Center, 907 North Poplar, Suite 100, Casper, Wyoming 82601 or telephone (307) 261-5000, Extension 5060.

APPENDIX

WELL 1-M-18
CHART 1

WELL 1-M-18ST
CHART 2

CHART 1

WELL 1-M-18

MRT/jb

DATE	DAY FROM SPUD	TD @ 6:00 am	FORMA-TION *	INTERVAL DRILLED ft	HOURS DRILLING OR CORING daily	API BIT **	RATE OF PENETRATION ft/hr	DRILLING FLUID COST $/day	WATER BPD	MIXED DRILLING FLUID AND/OR LCM *** hr	DRILLING FLUID LOST bbl	MUD WEIGHT lb/gal	FUNNEL VISCOSITY sec	WATER LOSS ml	PLASTIC VISCOSITY cp	YIELD POINT lb/100 sq ft	SOLIDS %
11/20/94	12	3,910	W	156	7.50	517	21.00	$847	560			8.9	40	6.0	9	10	5.0
11/21/94	13	4,354	W	444	22.25		20.00	$105	400	0.25	200	8.8	41	5.8	12	13	3.4
11/22/94	14	4,278	W	374	19.25		19.00	$1,304	480	2.75	400	8.8	45	6.0	14	10	2.0
11/23/94	15	5,100	W	372	18.75		20.00	$2,917	400	2.75	0	8.7	45	6.2	12	12	2.5
11/24/94	16	5,540	WF	440	21.75		20.00	$1,283	80	0.25	100	8.9	45	6.0	14	14	4.2
11/25/94	17	5,716	WF	176	9.50		20.00	$1,393	320	1.00	0	8.9	45	6.2	15	13	4.2
11/26/94	18	5,989	WF	273	18.00	517	18.00	$703	320			9.0	42	5.8	12	14	5.0
11/27/94	19	6,263	WF	274	22.75		12.00	$897	560			8.9	45	6.0	11	15	4.2
11/28/94	20	6,543	WF	280	20.75		2.60	$941	160	1.25	0	8.9	42	5.8	10	13	4.2
11/29/94	21	6,551	WF	8	3.00		13.00	$760	320	0.75	0	9.0	52	6.0	15	18	7.0
11/30/94	22	6,760	WF	209	13.25		16.00	$145	320			8.8	42	6.0	7	14	3.5
12/1/94	23	6,862	WF	102	7.25		14.00	$1,350	160	3.25	0	8.9	51	6.0	18	26	4.0
12/2/94	24	6,877	WF	15	4.25	437	3.50	$449	240			9.0	46	5.8	16	18	5.0
12/3/94	25	7,190	WF	313	22.50		14.00	$506	320			8.9	44	5.8	17	12	5.6
12/4/94	26	7,545	WF	355	23.50		15.00	$830	160			9.1	44	6.0	15	17	5.6
12/5/94	27	7,805	WF	260	23.00		11.00	$870	480			9.2	44	5.8	16	16	6.4
12/6/94	28	7,978	WF	173	16.50		10.50	$832	320	6.50	0	9.7	52	6.2	17	14	9.3
12/7/94	29	8,223	CC	245	20.00		12.25	$2,922	160	3.75	200	9.9	48	6.0	20	17	12.5
12/8/94	30	8,254	CC	31	2.75		11.20	$6,379	480	12.50	0	10.1	50	6.5	15	17	5.0
12/9/94	31	8,382	CC	128	10.75	517	12.00	$508	720	3.50	800	10.1	48	6.0	18	16	14.5
12/10/94	32	8,585	CC	203	16.50		12.00	$3,646	160	6.75	0	9.7	45	6.8	16	11	10.0
12/11/94	33	8,922	R	337	23.25		14.50	$931	240			9.8	43	6.5	16	9	11.7
12/12/94	34	9,157	R	235	21.50		11.00	$778	240	1.00	0	10.1	55	5.8	20	N/A	13.2
Total		5,247		5,247	368.50		322.55	$31,296	7,600	46.25	1700						
Average				235	16.02		14.02	$1,361	330			9.2	46	6.0	15	15	6.4

All calculation from November 20, 1994 to December 12, 1994 (23 days total)

* FORMATIONS:

W = Wasatch
WF = Williams Fork
CC = Cameo Coal
R = Rollins/Mancos

*** LCM = Lost Circulation Material

** BIT JETS:

11/20/94 517: 12-12-12
11/26/94 517: 12-12-12
12/02/94 437: 12-12-12
12/09/94 517: 16-16-8

4/7/95

CHART 2

WELL 1-M-18 ST

MRT/jb

DATE	DAY FROM SPUD	TD @ 6:00 am	FORMATION *	INTERVAL DRILLED ft	HOURS DRILLING OR CORING daily	API BIT **	RATE OF PENETRATION ft/hr	DRILLING FLUID COST $/day	WATER BPD	MIXED DRILLING FLUID AND/OR LCM *** hr	DRILLING FLUID LOST bbl	MUD WEIGHT lb/gal	FUNNEL VISCOSITY sec	WATER LOSS ml	PLASTIC VISCOSITY sec	YIELD POINT lb/100 sq ft	SOLIDS %
1/10/95	63	3,862	W	58	4.75	517	12.00	$436	160			8.9	55	6.0	19	14	4.3
1/11/95	64	4,185	W	323	21.50		15.00	$257	80			8.8	52	6.0	23	21	5.0
1/12/95	65	4,354	W	169	14.00		12.00	$320	240	1.00	0	8.9	54	6.4	18	14	4.3
1/13/95	66	4,443	W	89	7.00		13.00	$1,499	160	1.00	50	8.8	53	6.2	20	16	3.5
1/14/95	67	4,720	W	327	22.00		15.00	$1,503	160	0.50	50	8.7	45	6.5	16	12	2.8
1/15/95	68	5,093	W	323	20.50		15.80	$1,116	160			8.9	47	6.2	18	14	4.3
1/16/95	69	5,224	WF	131	7.50	517	14.50	$1,431	240	2.00	150	8.9	50	6.0	18	13	4.3
1/17/95	70	5,507	WF	283	16.00		18.00	$2,123	240	3.25	450	8.7	48	6.8	19	14	2.8
1/18/95	71	5,804	WF	297	22.00		13.50	$428	240			8.8	52	5.8	22	20	3.5
1/19/95	72	6,109	WF	305	21.25		14.00	$1,209	80			8.8	50	5.8	18	15	3.5
1/20/95	73	6,425	WF	316	20.50		15.40	$669	160			8.9	45	6.0	18	14	3.5
1/21/95	74	6,736	WF	311	22.25		14.80	$845	80	0.25	0	9.0	52	6.0	22	20	5.0
1/22/95	75	6,960	WF	224	12.00	437	18.70	$544	160	0.25	0	9.1	46	5.8	19	15	5.8
1/23/95	76	7,336	WF	376	20.25		18.00	$1,054	80		80	9.1	45	6.0	19	15	5.8
1/24/95	77	7,658	WF	322	23.00		14.00	$919	80			9.0	53	6.0	23	20	5.0
1/25/95	78	7,997	WF	339	23.25		14.50	$685	160			9.1	53	6.0	23	19	5.8
1/26/95	79	8,140	CC	143	8.75	517	16.00	$698	160	1.25	0	9.4	50	6.0	20	19	8.0
1/27/95	80	8,560	CC	420	22.25		18.80	$718	240			9.3	60	6.2	22	20	7.3
1/28/95	81	9,000	CC	440	19.50		20.30	$936	80	1.50	0	9.4	52	6.2	21	19	8.0
1/29/95	82	9,000	CC	0	2.50		N/A	$626	80	4.50	0	9.3	95	5.8	21	21	8.8
Total		5,138		5,138	330.75		293.30	$18,016	3,040	15.50	780						
Average				259.8	16.54		15.44	$901	152			9.0	53	6.1	20	17	5.1

All calculation from January 10, 1995 to January 29, 1995 (20 days total)

* FORMATIONS:

W = Wasatch
WF = Williams Fork
CC = Cameo Coal

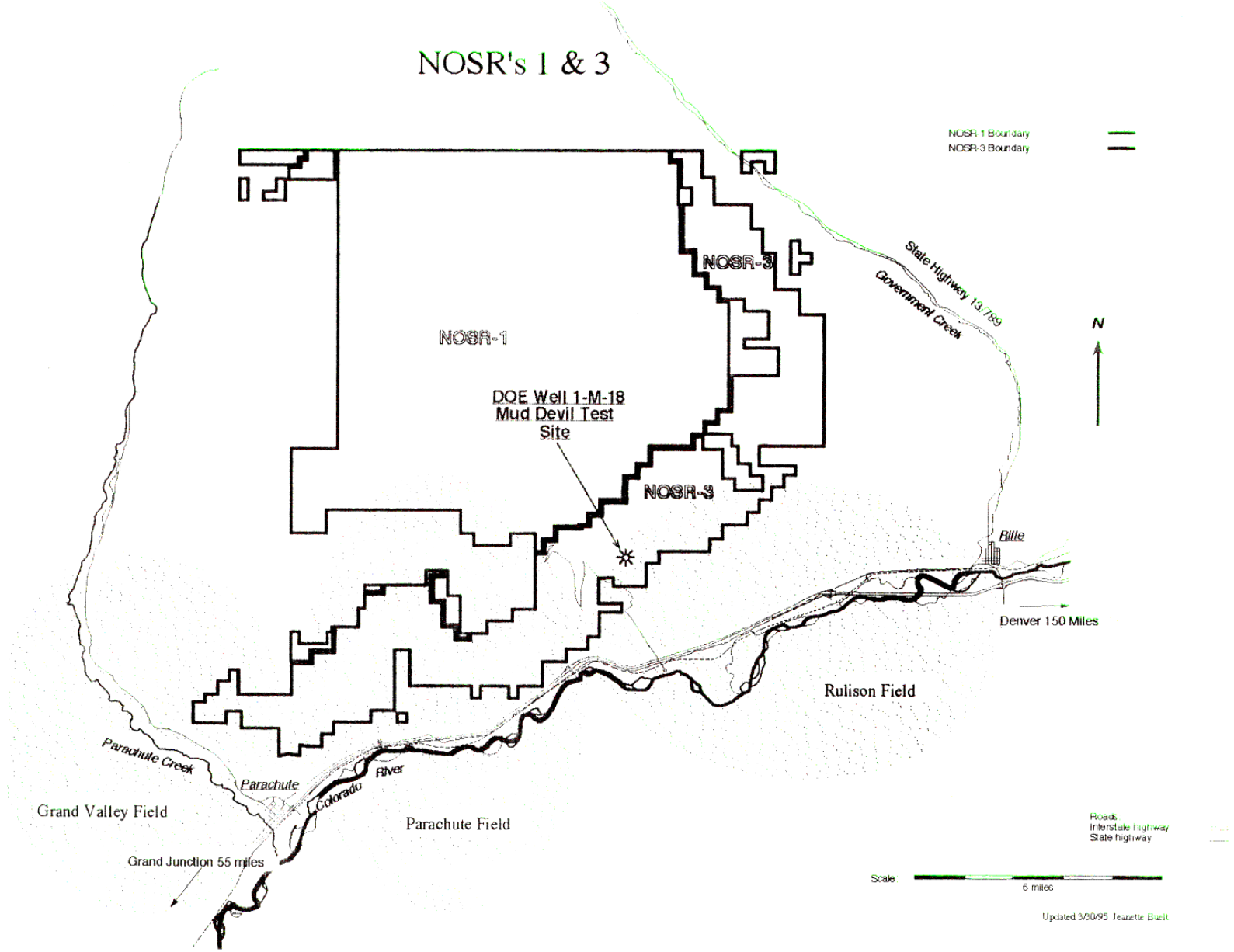
*** LCM = Lost Circulation Material

4/7/95

** BIT JETS:

1/10/95 517: 13-13-13
1/16/95 517: 12-12-12
1/22/95 437: 12-13-13
1/26/95 517: 12-13-13

NOSR's 1 & 3



MAP 1 PAGE 2