30-015-34941

DISTRICT I
1625 N. French Dr., Hobbs, NM 88240
DISTRICT II
1301 W. Grand Avenue, Artesia, NM 88210
DISTRICT III
1000 Rio Brazos Rd., Aztec, NM 87410
DISTRICT IV
1220 S. St. Francis Dr., Santa Fe, NM 87505

State of New Mexico
Energy, Minerals and Natural Resources Department

OIL CONSERVATION DIVISION
1220 South St. Francis Dr.
Santa Fe, New Mexico 87505

Form C-102
Revised October 12, 2005

Submit to Appropriate District Office
State Lease - 4 Copies
Fee Lease - 3 Copies

☐ AMENDED REPORT

WELL LOCATION AND ACREAGE DEDICATION PLAT

API Number	Pool Code	Pool Name
30-015-34941		Sheep Draw; Morrow

Property Code	Property Name	Well Number
	OCOTILLO "6" STATE	1

OGRID No.	Operator Name	Elevation
6137	DEVON ENERGY PRODUCTION CO., L.P.	3379'

Surface Location

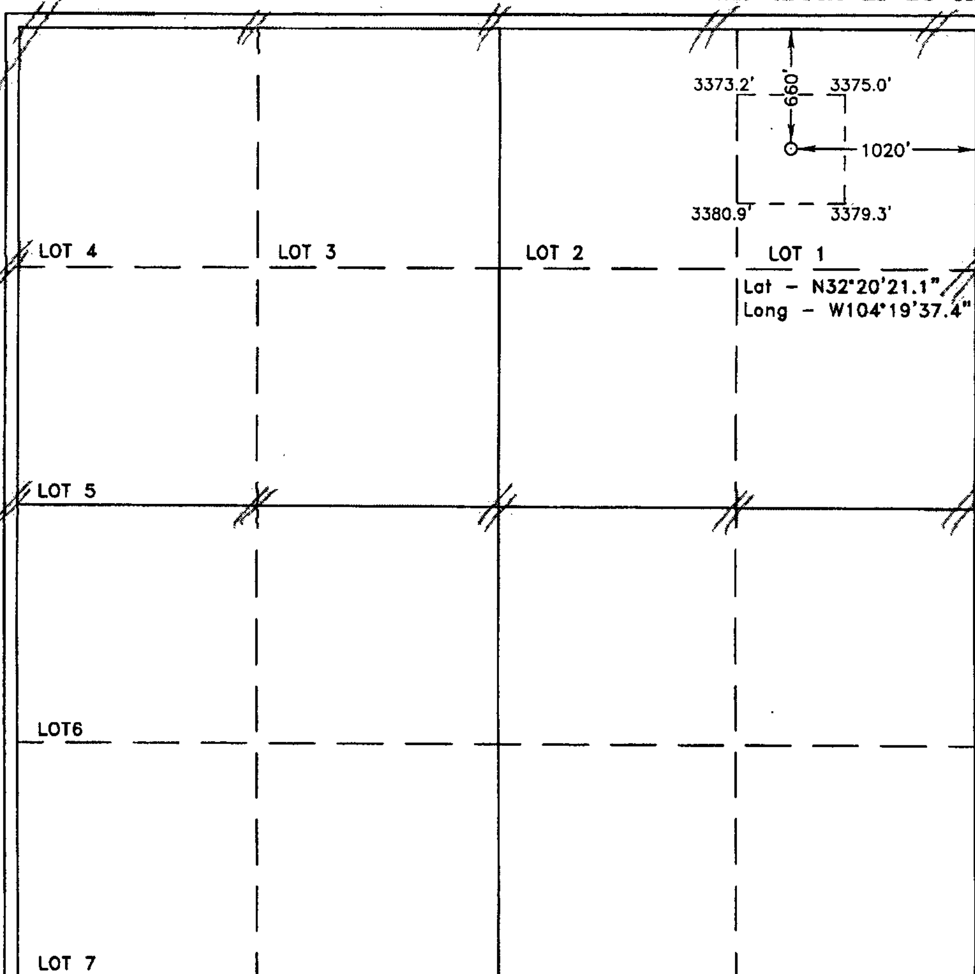
UL or lot No.	Section	Township	Range	Lot Idn	Feet from the	North/South line	Feet from the	East/West line	County
LOT 1	6	23 S	26 E		660	NORTH	1020	EAST	EDDY

Bottom Hole Location If Different From Surface

UL or lot No.	Section	Township	Range	Lot Idn	Feet from the	North/South line	Feet from the	East/West line	County

Dedicated Acres	Joint or Infill	Consolidation Code	Order No.
320.31			

NO ALLOWABLE WILL BE ASSIGNED TO THIS COMPLETION UNTIL ALL INTERESTS HAVE BEEN CONSOLIDATED OR A NON-STANDARD UNIT HAS BEEN APPROVED BY THE DIVISION



OPERATOR CERTIFICATION

I hereby certify that the information contained herein is true and complete to the best of my knowledge and belief, and that this organization either owns a working interest or unleased mineral interest in the land including the proposed bottom hole location pursuant to a contract with an owner of such a mineral or working interest, or to a voluntary pooling agreement or a compulsory pooling order heretofore entered by the division.

Signature: [signature] Date: 6/15/06

Printed Name: Stephanie Ysasaga

SURVEYOR CERTIFICATION

I hereby certify that the well location shown on this plat was plotted from field notes of actual surveys made by me or under my supervision, and that the same is true and correct to the best of my belief.

MARCH 17, 2006

Date Surveyed

Signature & Seal of Professional Surveyor

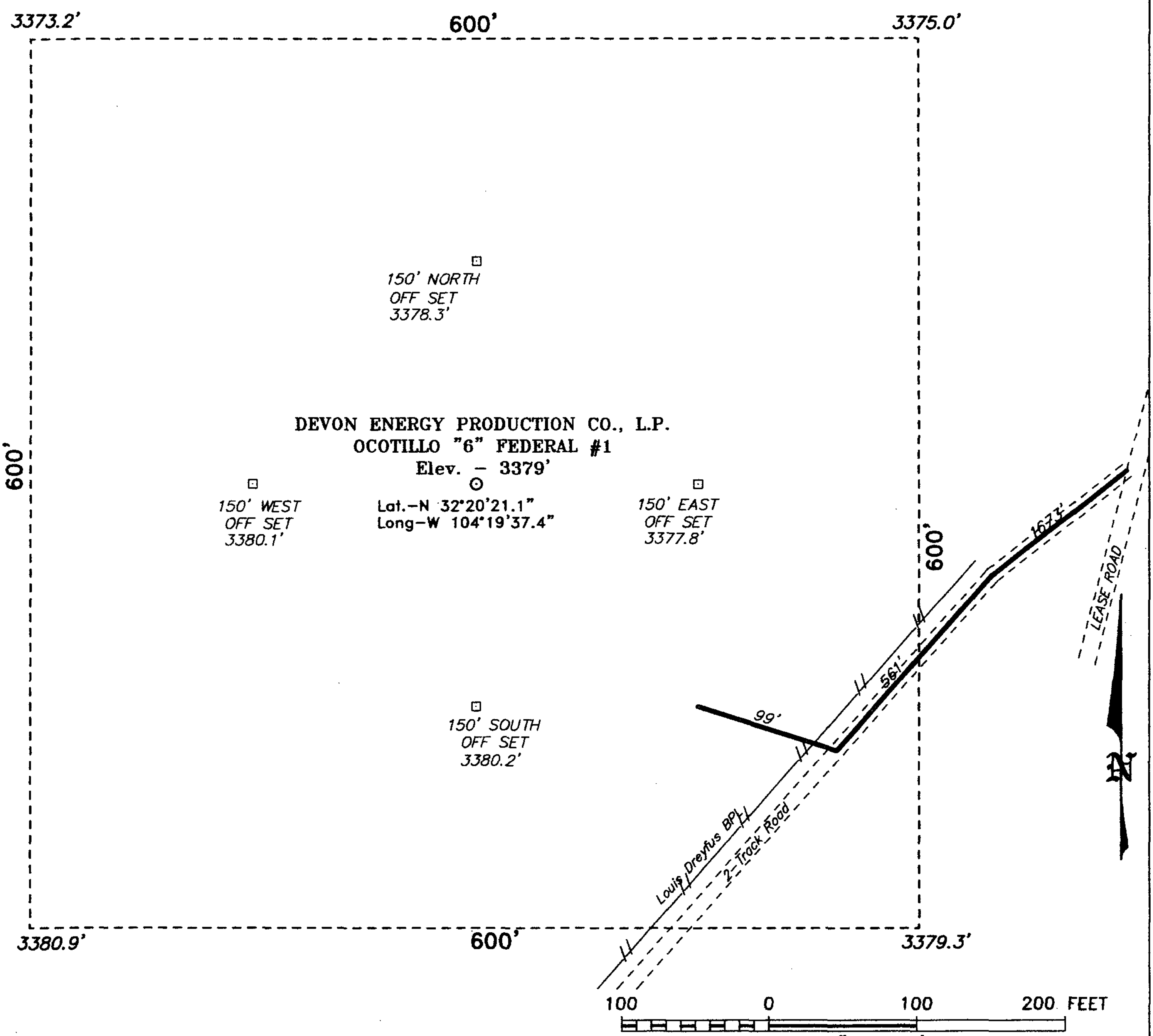
GARY L. JONES NEW MEXICO 7977 REGISTERED PROFESSIONAL LAND SURVEYOR

W.O. No. 638

Certificate No. Gary L. Jones 7977

BASIN SURVEYS

SECTION 6, TOWNSHIP 23 SOUTH, RANGE 26 EAST, N.M.P.M., EDDY COUNTY, NEW MEXICO.



Directions to Location:

FROM THE JUNCTION OF US HWY 62/180 AND CO. RD. 672, GO EAST ON 672 FOR 5.0 MILES TO LEASE ROAD; THENCE NORTHEAST ON LEASE ROAD FOR 0.5 MILE TO PROPOSED LEASE ROAD.

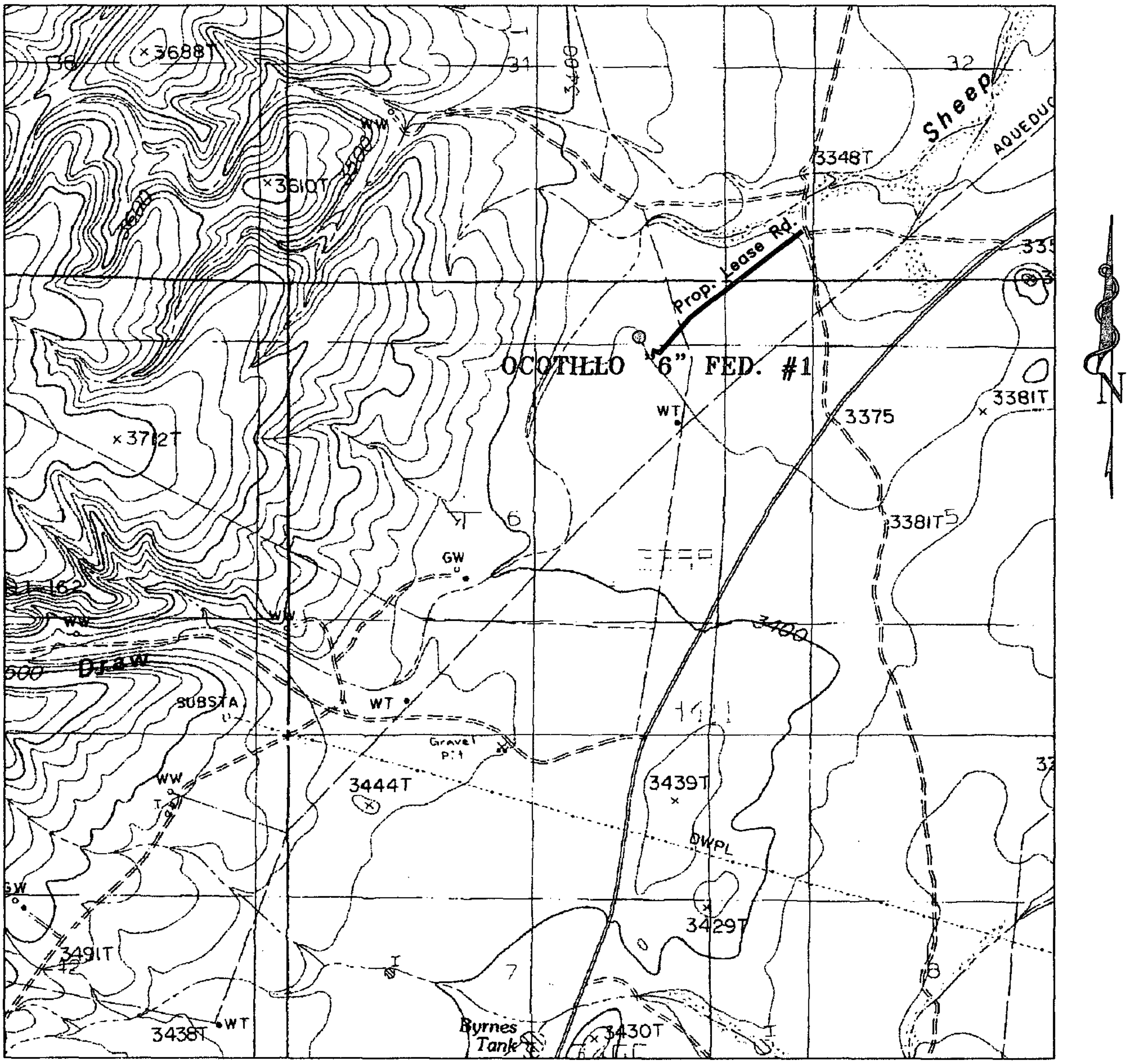
BASIN SURVEYS P.O. BOX 1786–HOBBS, NEW MEXICO

DEVON ENERGY PROD. CO., L.P.

REF: OCOTILLO "6" FEDERAL No. 1 / Well Pad Topo

THE OCOTILLO "6" FED. No. 1 LOCATED 660' FROM THE NORTH LINE AND 1020' FROM THE EAST LINE OF SECTION 6, TOWNSHIP 23 SOUTH, RANGE 26 EAST, N.M.P.M., EDDY COUNTY, NEW MEXICO.

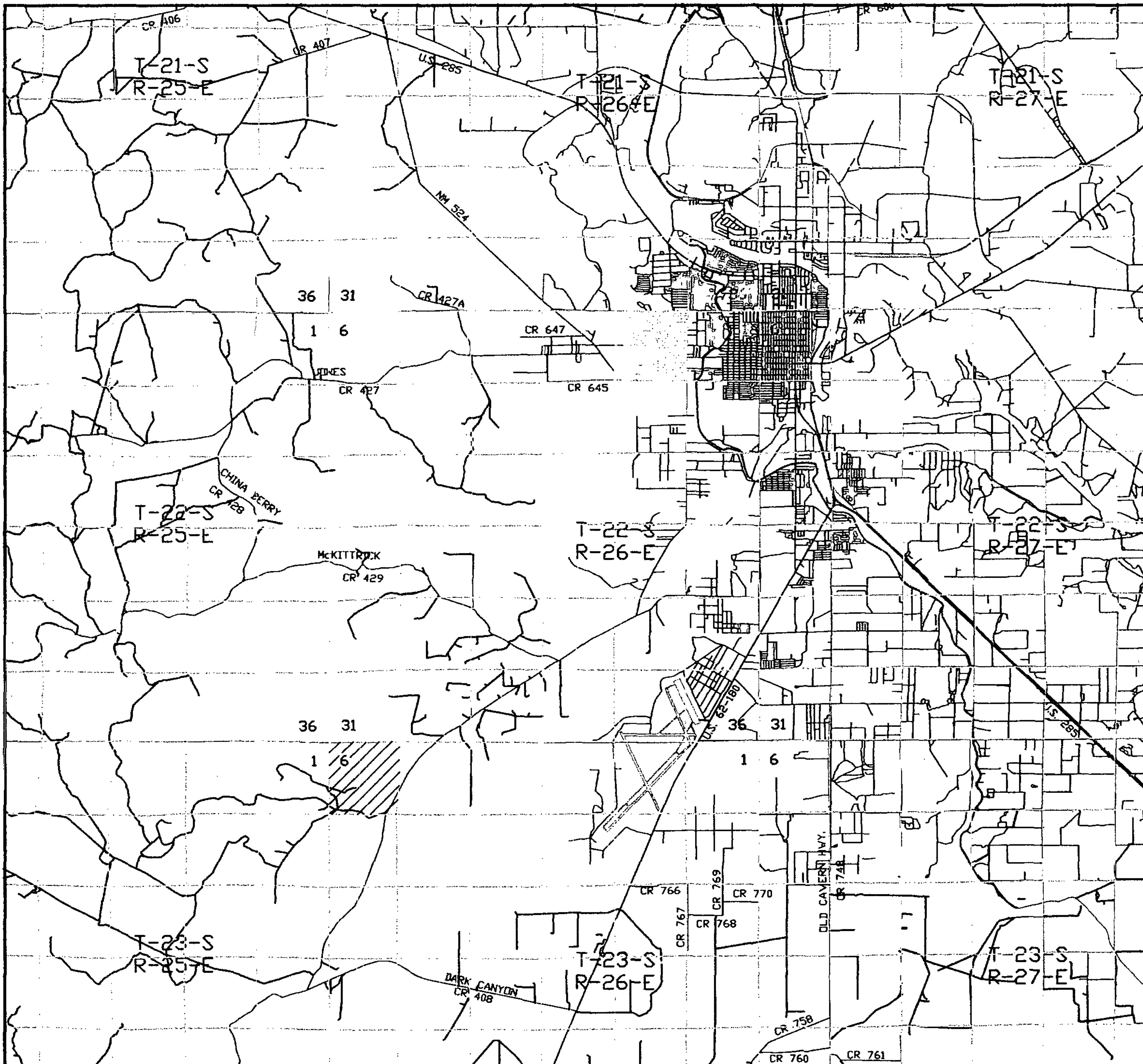
W.O. Number: 6361	Drawn By: K. GOAD
Date: 03-20-2006	Disk: KJG CD#4 – 6361A.DWG
Survey Date: 03-17-2006	Sheet 1 of 1 Sheets



OCOTILLO "6" FEDERAL #1

Located at 660' FNL AND 1020' FEL
Section 6, Township 23 South, Range 26 East,
N.M.P.M., Eddy County, New Mexico.

basin surveys — focused on excellence in the oilfield P.O. Box 1786 1120 N. West County Rd. Hobbs, New Mexico 88241 (505) 393-7316 – Office (505) 392-3074 – Fax basinsurveys.com	W.O. Number: 6361AA – KJG CD#4 Survey Date: 03-17-2006 Scale: 1" = 2000' Date: 03-20-2006	DEVON ENERGY PROD. CO., L.P.



OCOTILLO "6" FEDERAL #1

Located at 660' FNL AND 1020' FEL
Section 6, Township 23 South, Range 26 East,
N.M.P.M., Eddy County, New Mexico.

basin surveys
focused on excellence in the oilfield

P.O. Box 1786
1120 N. West County Rd.
Hobbs, New Mexico 88241
(505) 393-7316 – Office
(505) 392-3074 – Fax
basinsurveys.com

W.O. Number:	6361AA – KJG CD#4
Survey Date:	03-17-2006
Scale: 1" = 2 MILES	
Date: 03-20-2006	

DEVON ENERGY PROD. CO., L.P.

devon

Devon Energy Corporation
20 North Broadway
Oklahoma City, Oklahoma 73102-8260

Hydrogen Sulfide (H_2S) Contingency Plan

For

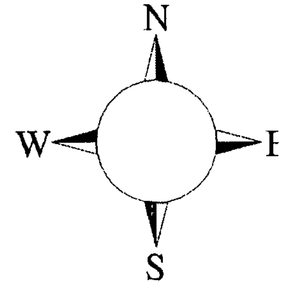
Ocotillo"6" State Well # 1

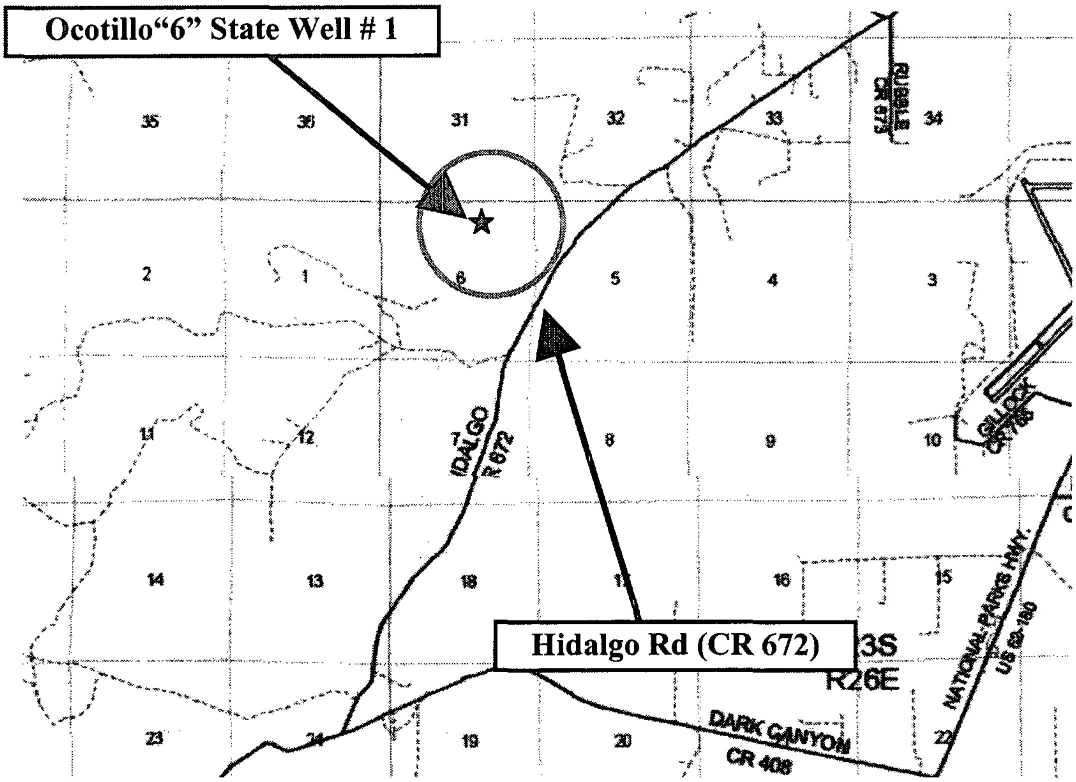
660' FNL & 1020' FEL,
Sec-6, T-23S R-26E

Eddy County NM

Ocotillo"6" State Well # 1

This is an open drilling site. H_2S monitoring equipment and emergency response equipment will be used within 500' of zones known to contain H_2S, including warning signs, wind indicators and H_2S monitor.





Assumed 100 ppm ROE = 3000' (Radius of Exposure)
100 ppm H2S concentration shall trigger activation of this plan.

Escape

Crews shall escape upwind of escaping gas in the event of an emergency release of gas. Escape can be facilitated East on the lease road to Hidalgo Road.. Crews should then move to block access to the lease Road so as not to allow anyone traversing into a hazardous area. Crews will then need to minor the perimeter of escaping gas to make certain the ROE does not encompass Hidalgo Road. The blockade should be at a safe distance outside of the ROE. <u>There are no homes or buildings in the ROE</u>.

Emergency Procedures

In the case of a release of gas containing H_2S, the first responder(s) must isolate the area and prevent entry by other persons into the 100 ppm ROE. Additionally the first responder(s) must evacuate any public places encompassed by the 100 ppm ROE. First responder(s) must take care not to injure themselves during this operation. Company and/or local officials must be contacted to aid in this operation. Evacuation of the public should be beyond the 100 ppm ROE.

All responders must have training in the detection of H_2S, measures for protection against the gas, equipment used for protection and emergency response. Additionally, responders must be equipped with H_2S monitors and air packs in order to control the release. Use the "buddy system' to ensure no injuries during the response.

Ignition of Gas Source

Should control of the well be considered lost and ignition considered, take care to protect against exposure to Sulfur Dioxide (SO_2). Intentional ignition must be coordinated with the NMOCD and local officials. Additionally the NM State Police may become involved. NM State Police shall be the Incident Command on scene of any major release. Take care to protect downwind whenever there is an ignition of the gas

Characteristics of H_2S and SO_2

Common Name	Chemical Formula	Specific Gravity	Threshold Limit	Hazardous Limit	Lethal Concentr-ation
Hydrogen Sulfide	H_2S	1.189 Air = 1	10 ppm	100 ppm/hr	600 ppm
Sulfur Dioxide	SO_2	2.21 Air = 1	2 ppm	N/A	1000 ppm

Contacting Authorities

Devon Energy Corp. personnel must liaison with local and state agencies to ensure a proper response to a major release. Additionally, the OCD must be notified of the release as soon as possible but no later than 4 hours. Agencies will ask for information such as type and volume of release, wind direction, location of release, etc. Be prepared with all information available. The following call list of essential and potential responders has been prepared for use during a release. Devon Energy Corp. Company response must be in coordination with the State of New Mexico's 'Hazardous Materials Emergency Response Plan' (HMER)

Devon Energy Corp. Company Call List

Artesia (505)	Cellular	Office	Home
Foreman – BJ Cathey	390-5893	748-0176	887-6026
Asst. Foreman – Bobby Jones	748-7447	748-0176	746-3194
Don Mayberry	748-7180	748-5235	746-4945
Mike Myers	(505) 513-0782	(505) 748-0187	(505) 395-3020
Engineer – Wyatt Abbitt	(405) 245-3471	(405) 552-8137	(405) 245-3471

Agency Call List

Eddy County (505)

Artesia

State Police 746-2703
City Police 746-2703
Sheriff's Office 746-9888
Ambulance 911
Fire Department 746-2701
LEPC (Local Emergency Planning Committee) 746-2122
NMOCD 748-1283

Carlsbad

State Police 885-3137
City Police 885-2111
Sheriff's Office 887-7551
Ambulance 911
Fire Department 885-2111
LEPC (Local Emergency Planning Committee) 887-3798
US Bureau of Land Management 887-6544
New Mexico Emergency Response Commission (Santa Fe) ... (505)476-9600
24 HR .... (505) 827-9126
National Emergency Response Center (Washington, DC) (800) 424-8802

Emergency Services

Boots & Coots IWC .... 1-800-256-9688 or (281) 931-8884
Cudd Pressure Control .... (915) 699-0139 or (915) 563-3356
Halliburton .... (505) 746-2757
B. J. Services .... (505) 746-3569

Give GPS position:

Flight For Life - Lubbock, TX .... (806) 743-9911
Aerocare - Lubbock, TX .... (806) 747-8923
Med Flight Air Amb - Albuquerque, NM .... (505) 842-4433
Lifeguard Air Med Svc. Albuquerque, NM .... (505) 272-3115

Prepared in conjunction with
Wade Rohloff of;

Compliance Services
PO Box 2734 Hobbs NM 88240 (505) 63-1561

Permit Conditions of Approval

Operator: DEVON ENERGY PRODUCTION COMPANY, LP , 6137
Well: HACKBERRY 31 STATE #002
API: 30-015-34782

OCD Reviewer	Condition
BArrant	Pit construction and closure must satisfy all requirements of your approved plan, O.C.D. Rule 19.15.2.50, and the Pit and Below-Grade Tank Guidelines
BArrant	Operator to tie back production casing to intermediate casing and verify by CBL or temperature survey.
BArrant	As noted operator to drill surface hole with 'fresh water' mud. Operator to drill intermediate hole with 'fresh water mud' as hole conditions of well bore dictate conditions.
BArrant	*Operator is to catch mud samples from the flow line out from the setting of surface casing and down to the* setting of intermediate casing every 100'. A record of chloride samples are to be taken and submitted to the Oil Conservation Artesia office.
BArrant	Please notify OCD time of spud and time to witness the circulation of cement to surface, the surface and intermediate casing.

Proposal No: 215852875A

Devon Energy Corporation

Ocotillo 6 #1

STATE

Sheep Draw Field
Sec. 6-23S-26E
Eddy County, New Mexico
May 30, 2006

Well Recommendation

Prepared for:
Elizabeth Larson
Drilling Engineer
Oklahoma City, Oklahoma
Bus Phone: (405) 552-8121

Prepared by:
John Parks
Region Technical Rep.
Oklahoma City, Oklahoma
Bus Phone: (405) 228-4302

THE BLUE WELLBORE[SM]
Makes better wells

Service Point:
Artesia
Bus Phone: (505) 746-3140
Fax: (505) 746-2293

Service Representatives:
Mark Malone
Manager, Region Technical
Bus Phone: (432) 683-2781

Operator Name: Devon Energy Corporation
Well Name: Ocotillo 6 F #1
Job Description: Surface Casing
Date: May 30, 2006

Proposal No: 215852875A

JOB AT A GLANCE

Depth (TVD)	700 ft
Depth (MD)	700 ft
Hole Size	17.5 in
Casing Size/Weight :	13 3/8 in, 48 lbs/ft
Pump Via	13 3/8" O.D. (12.715" .I.D) 48
Total Mix Water Required	5,159 gals
Spacer	
Fresh Water	20 bbls
Density	8.3 ppg
Lead Slurry	
35:65:6 Poz:Class C	366 sacks
Density	12.8 ppg
Yield	1.83 cf/sack
Tail Slurry	
Class C	250 sacks
Density	14.8 ppg
Yield	1.35 cf/sack
Displacement	
Mud	104 bbls
Density	8.5 ppg

Operator Name: Devon Energy Corporation
Well Name: Ocotillo 6 F[illegible] #1
Job Description: Surface Casing
Date: May 30, 2006

Proposal No: 215852875A

WELL DATA

ANNULAR GEOMETRY

ANNULAR I.D. (in)	DEPTH(ft)	
	MEASURED	TRUE VERTICAL
17.500 HOLE	700	700

SUSPENDED PIPES

DIAMETER (in)		WEIGHT (lbs/ft)	DEPTH(ft)	
O.D.	I.D.		MEASURED	TRUE VERTICAL
13.375	12.715	48	700	700

Float Collar set @	660 ft
Mud Density	8.50 ppg
Est. Static Temp.	80 ° F
Est. Circ. Temp.	80 ° F

VOLUME CALCULATIONS

483 ft	x	0.6946 cf/ft	with	100 % excess	=	671.2 cf
217 ft	x	0.6946 cf/ft	with	100 % excess	=	301.3 cf
40 ft	x	0.8818 cf/ft	with	0 % excess	=	35.3 cf (inside pipe)
				TOTAL SLURRY VOLUME	=	1007.8 cf
					=	180 bbls

Operator Name: Devon Energy Corporation
Well Name: Ocotillo 6 I [illegible] #1
Job Description: Surface Casing
Date: May 30, 2006

Proposal No: 215852875A

FLUID SPECIFICATIONS

Spacer — 20.0 bbls Fresh Water @ 8.34 ppg

FLUID	VOLUME CU-FT	VOLUME FACTOR	AMOUNT AND TYPE OF CEMENT
Lead Slurry	671	/ 1.83	= 366 sacks (35:65) Poz (Fly Ash):Class C Cement + 2% bwoc Calcium Chloride + 0.25 lbs/sack Cello Flake + 6% bwoc Bentonite + 93.6% Fresh Water
Tail Slurry	337	/ 1.35	= 250 sacks Class C Cement + 2% bwoc Calcium Chloride + 0.25 lbs/sack Cello Flake + 56.3% Fresh Water

Displacement — 103.7 bbls Mud @ 8.5 ppg

CEMENT PROPERTIES

	SLURRY NO. 1	SLURRY NO. 2
Slurry Weight (ppg)	12.80	14.80
Slurry Yield (cf/sack)	1.83	1.35
Amount of Mix Water (gps)	9.76	6.35
Estimated Pumping Time - 70 BC (HH:MM)	4:45	2:30
COMPRESSIVE STRENGTH		
8 hrs @ 80 ° F (psi)		500
12 hrs @ 80 ° F (psi)	200	1150
24 hrs @ 80 ° F (psi)	350	2100
72 hrs @ 80 ° F (psi)	500	2700

Operator Name: Devon Energy Corporation
Well Name: Ocotillo 6 [illegible] #1
Job Description: Surface Casing
Date: May 30, 2006

Proposal No: 215852875A

PRICE ESTIMATE

Product Material

QTY	UNIT	PRODUCT DESCRIPTION	NET AMOUNT
488	94lbs	Class C Cement	4,691.53
1107	lbs	Calcium Chloride	427.74
1911	lbs	Bentonite	288.94
154	lbs	Cello Flake	236.73
129	74lbs	Poz (Fly Ash)	500.08
1	ea	Cement Plug, Wooden, Top 13-3/8 in	220.50
		Product Material Subtotal:	$6,365.52

Service Charges

QTY	UNIT	PRODUCT DESCRIPTION	NET AMOUNT
1	ea	Personnel Surcharge - Cement Svc	53.97
681	cu ft	Bulk Materials Service Charge	818.02
		Service Charges Subtotal:	$871.99

Equipment

QTY	UNIT	PRODUCT DESCRIPTION	NET AMOUNT
1	4hrs	Cement Pump Casing, 0 - 1000 ft	735.00
1	job	Cement Head	189.84
1	job	Data Acquisition, Cement, Standard	493.50
90	miles	Mileage, Heavy Vehicle	234.36
90	miles	Mileage, Auto, Pick-Up or Treating Van	133.43
		Equipment Subtotal:	$1,786.13

Customer will be charged for all 'SPECIAL PROPPANTS' delivered to location, whether they are pumped or not. All proppants other than standard grade frac sand are considered 'SPECIAL PROPPANTS'.
The technical data contained in this proposal is based on the best information available at the time of writing and is subject to further analysis and testing. The pricing data contained in this proposal are estimates only and may vary depending on the work actually performed. Pricing does not include federal, state and local taxes or royalties.
This quotation is based on BJ Services Company being awarded the work on a first call basis and within thirty (30) days of the proposal date. These prices will be subject to review if the work is done after thirty (30) days from the proposal date, or on a second or third call basis.

Operator Name: Devon Energy Corporation
Well Name: Ocotillo 6 [illegible] #1
Job Description: Surface Casing
Date: May 30, 2006

Proposal No: 215852875A

PRICE ESTIMATE

Freight/Delivery Charges

QTY	UNIT	PRODUCT DESCRIPTION	NET AMOUNT
1317	tonmi	Bulk Delivery, Dry Products	1,150.53
		Freight/Delivery Charges Subtotal:	$1,150.53
		TOTAL:	**$10,174.17**

Customer will be charged for all 'SPECIAL PROPPANTS' delivered to location, whether they are pumped or not. All proppants other than standard grade frac sand are considered 'SPECIAL PROPPANTS'.
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Operator Name: Devon Energy Corporation
Well Name: Ocotillo 3 F[illegible]al #1
Job Description: Intermediate Casing
Date: May 30, 2006

Proposal No: 215852875A

JOB AT A GLANCE

Depth (TVD)	1,700 ft
Depth (MD)	1,700 ft
Hole Size	12.25 in
Casing Size/Weight :	9 5/8 in, 36 lbs/ft
Pump Via	9 5/8" O.D. (8.921" .I.D) 36
Total Mix Water Required	4,534 gals
Spacer	
Fresh Water	20 bbls
Density	8.3 ppg
Lead Slurry	
35:65:6 Poz:Class C	295 sacks
Density	12.7 ppg
Yield	1.95 cf/sack
Tail Slurry	
Class C	250 sacks
Density	14.8 ppg
Yield	1.34 cf/sack
Displacement	
Mud	128 bbls
Density	8.5 ppg

Operator Name: Devon Energy Corporation
Well Name: Ocotillo 6 F[illegible] #1
Job Description: Intermediate Casing
Date: May 30, 2006

Proposal No: 215852875A

WELL DATA

ANNULAR GEOMETRY

ANNULAR I.D. (in)	DEPTH(ft)	
	MEASURED	TRUE VERTICAL
12.715 CASING	700	700
12.250 HOLE	1,700	1,700

SUSPENDED PIPES

DIAMETER (in)		WEIGHT (lbs/ft)	DEPTH(ft)	
O.D.	I.D.		MEASURED	TRUE VERTICAL
9.625	8.921	36	1,700	1,700

Float Collar set @	1,660 ft
Mud Density	8.50 ppg
Est. Static Temp.	89 ° F
Est. Circ. Temp.	86 ° F

VOLUME CALCULATIONS

700 ft	x	0.3765 cf/ft	with	0 % excess	=	263.6 cf
495 ft	x	0.3132 cf/ft	with	100 % excess	=	309.9 cf
505 ft	x	0.3132 cf/ft	with	100 % excess	=	316.4 cf
40 ft	x	0.4341 cf/ft	with	0 % excess	=	17.4 cf (inside pipe)
				TOTAL SLURRY VOLUME	=	907.3 cf
					=	162 bbls

Operator Name: Devon Energy Corporation
Well Name: Ocotillo 6 I _ #1
Job Description: Intermediate Casing
Date: May 30, 2006

Proposal No: 215852875A

FLUID SPECIFICATIONS

Spacer 20.0 bbls Fresh Water @ 8.34 ppg

FLUID	VOLUME CU-FT	VOLUME FACTOR	AMOUNT AND TYPE OF CEMENT
Lead Slurry	573	/ 1.95	= 295 sacks (35:65) Poz (Fly Ash):Class C Cement + 5% bwow Sodium Chloride + 0.25 lbs/sack Cello Flake + 5 lbs/sack LCM-1 + 6% bwoc Bentonite + 95.8% Fresh Water
Tail Slurry	334	/ 1.34	= 250 sacks Class C Cement + 1% bwoc Calcium Chloride + 56.3% Fresh Water

Displacement 128.3 bbls Mud @ 8.5 ppg

CEMENT PROPERTIES

	SLURRY NO. 1	SLURRY NO. 2
Slurry Weight (ppg)	12.70	14.80
Slurry Yield (cf/sack)	1.95	1.34
Amount of Mix Water (gps)	9.99	6.34
Estimated Pumping Time - 70 BC (HH:MM)	4:00	2:15
COMPRESSIVE STRENGTH		
8 hrs @ 89 ° F (psi)		500
12 hrs @ 89 ° F (psi)	150	1450
24 hrs @ 89 ° F (psi)	350	2400
72 hrs @ 89 ° F (psi)	800	3200

Operator Name: Devon Energy Corporation
Well Name: Ocotillo 6 F I #1
Job Description: Intermediate Casing
Date: May 30, 2006

Proposal No: 215852875A

PRICE ESTIMATE

Product Material

QTY	UNIT	PRODUCT DESCRIPTION	NET AMOUNT
442	94lbs	Class C Cement	4,249.30
235	lbs	Calcium Chloride	90.80
1540	lbs	Bentonite	232.85
1475	lbs	LCM-1	532.77
74	lbs	Cello Flake	113.75
104	74lbs	Poz (Fly Ash)	403.17
1228	lbs	Sodium Chloride	180.52
1	ea	Cement Plug, Rubber, Top 9-5/8 in	121.80
		Product Material Subtotal:	$5,924.96

Service Charges

QTY	UNIT	PRODUCT DESCRIPTION	NET AMOUNT
1	ea	Personnel Surcharge - Cement Svc	53.97
627	cu ft	Bulk Materials Service Charge	753.15
		Service Charges Subtotal:	$807.12

Equipment

QTY	UNIT	PRODUCT DESCRIPTION	NET AMOUNT
1	4hrs	Cement Pump Casing, 1001 - 2000 ft	1,092.00
1	job	Cement Head	189.84
1	job	Data Acquisition, Cement, Standard	493.50
90	miles	Mileage, Heavy Vehicle	234.36
90	miles	Mileage, Auto, Pick-Up or Treating Van	133.43
		Equipment Subtotal:	$2,143.13

Customer will be charged for all 'SPECIAL PROPPANTS' delivered to location, whether they are pumped or not. All proppants other than standard grade frac sand are considered 'SPECIAL PROPPANTS'.
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This quotation is based on BJ Services Company being awarded the work on a first call basis and within thirty (30) days of the proposal date. These prices will be subject to review if the work is done after thirty (30) days from the proposal date, or on a second or third call basis.

Operator Name: Devon Energy Corporation
Well Name: Ocotillo [illegible] #1
Job Description: 3 Stage Long String
Date: May 30, 2006

Proposal No: 215852875A

JOB AT A GLANCE

Depth (TVD)	11,750 ft
Depth (MD)	11,750 ft
Hole Size	8.75 in
Casing Size/Weight :	5 1/2 in, 26 lbs/ft
Pump Via	5 1/2" O.D. (4.548" .I.D) 26
Total Mix Water Required	23,499 gals
Stage No: 1	**Float Collar set @** 11,670 ft
Spacer	
Turbo Flow III	40 bbls
Density	11.5 ppg
Spacer	
Fresh Water	5 bbls
Density	8.3 ppg
Spacer	
Surebond III	1,000 gals
Density	9.4 ppg
Spacer	
Fresh Water	10 bbls
Density	8.3 ppg
Cement Slurry	
Super C Modified	902 sacks
Density	13.3 ppg
Yield	1.59 cf/sack
Displacement	
Displacement Fluid	234 bbls

JOB AT A GLANCE (Continued)

Stage No: 2	**Stage Collar set @** 8,000 ft
Spacer	
Mud Clean II	1,000 gals
Density	8.5 ppg
Cement Slurry	
60:40 Poz:Class H (MPA)	1,117 sacks
Density	13.8 ppg
Yield	1.35 cf/sack
Displacement	
Displacement Fluid	161 bbls
Stage No: 3	**Stage Collar set @** 4,500 ft
Spacer	
Fresh Water	10 bbls
Density	8.3 ppg
Lead Slurry	
35:65:6 Poz:Class C	817 sacks
Density	12.5 ppg
Yield	2.04 cf/sack
Tail Slurry	
60:40 Poz:Class C (MPA)	150 sacks
Density	13.8 ppg
Yield	1.37 cf/sack
Displacement	
Displacement Fluid	90 bbls

Operator Name: Devon Energy Corporation
Well Name: Ocotillo E [illegible] #1
Job Description: 3 Stage Long String
Date: May 30, 2006

Proposal No: 215852875A

WELL DATA

ANNULAR GEOMETRY

ANNULAR I.D. (in)	DEPTH(ft)	
	MEASURED	TRUE VERTICAL
8.921 CASING	1,700	1,700
8.750 HOLE	11,750	11,750

SUSPENDED PIPES

DIAMETER (in)		WEIGHT (lbs/ft)	DEPTH(ft)	
O.D.	I.D.		MEASURED	TRUE VERTICAL
5.500	4.548	26	11,750	11,750

STAGE: 1

Float Collar set @	11,670 ft
Mud Density	9.50 ppg
Est. Static Temp.	174 ° F
Est. Circ. Temp.	139 ° F

VOLUME CALCULATIONS

3,750 ft	x	0.2526 cf/ft	with	50 % excess	=	1420.8 cf
80 ft	x	0.1128 cf/ft	with	0 % excess	=	9.0 cf (inside pipe)
			TOTAL SLURRY VOLUME		=	1429.8 cf
					=	255 bbls

STAGE: 2

Stage Collar set @	8,000 ft
Mud Density	9.50 ppg
Est. Static Temp.	142 ° F
Est. Circ. Temp.	124 ° F

VOLUME CALCULATIONS

3,500 ft	x	0.2526 cf/ft	with	70 % excess	=	1503.3 cf
			TOTAL SLURRY VOLUME		=	1503.3 cf
					=	268 bbls

WELL DATA (Continued)

STAGE: 3

Stage Collar set @	4,500 ft
Mud Density	9.50 ppg
Est. Static Temp.	112 ° F
Est. Circ. Temp.	101 ° F

VOLUME CALCULATIONS

1,700 ft	x	0.2691 cf/ft	with	0 % excess	=	457.4 cf
2,393 ft	x	0.2526 cf/ft	with	100 % excess	=	1208.8 cf
407 ft	x	0.2526 cf/ft	with	100 % excess	=	205.7 cf
				TOTAL SLURRY VOLUME	=	1872.0 cf
					=	334 bbls

Operator Name: Devon Energy Corporation
Well Name: Ocotillo 6 F [illegible] #1
Job Description: 3 Stage Long String
Date: May 30, 2006

Proposal No: 215852875A

FLUID SPECIFICATIONS

STAGE NO.: 1

Spacer	40.0 bbls Turbo Flow III @ 11.5 ppg
Spacer	5.0 bbls Fresh Water @ 8.34 ppg
Spacer	1,000.0 gals Surebond III @ 9.35 ppg
Spacer	10.0 bbls Fresh Water @ 8.34 ppg

FLUID	VOLUME CU-FT	VOLUME FACTOR	AMOUNT AND TYPE OF CEMENT
Cement Slurry	1430	/ 1.59	= 902 sacks (15:61:11) Poz (Fly Ash):Class C Cement:CSE-2 + 0.5% bwoc BA-10 + 0.15% bwoc R-3 + 2% bwow Potassium Chloride + 0.75% bwoc EC-1 + 0.25 lbs/sack Cello Flake + 0.7% bwoc CD-32 + 5 lbs/sack LCM-1 + 0.6% bwoc FL-25 + 0.6% bwoc FL-52A + 70.6% Fresh Water
Displacement			234.5 bbls Displacement Fluid

CEMENT PROPERTIES

	SLURRY NO. 1
Slurry Weight (ppg)	13.30
Slurry Yield (cf/sack)	1.59
Amount of Mix Water (gps)	7.36
Estimated Pumping Time - 70 BC (HH:MM)	3:45
Free Water (mls) @ 139 ° F @ 90 ° angle	0.0
Fluid Loss (cc/30min) at 1000 psi and 139 ° F	50.0
COMPRESSIVE STRENGTH	
12 hrs @ 173 ° F (psi)	1400
24 hrs @ 173 ° F (psi)	2000
72 hrs @ 173 ° F (psi)	2500

Operator Name: Devon Energy Corporation
Well Name: Ocotillo 6 #1
Job Description: 3 Stage Long String
Date: May 30, 2006

Proposal No: 215852875A

FLUID SPECIFICATIONS (Continued)

STAGE NO.: 2

Spacer		1,000.0 gals Mud Clean II @ 8.45 ppg
Cement Slurry	1503 / 1.35	= 1117 sacks (60:40) Poz (Fly Ash):Premium Plus H Cement + 1% bwow Sodium Chloride + 0.75% bwoc BA-10 + 0.15% bwoc R-3 + 0.25 lbs/sack Cello Flake + 2 lbs/sack Kol Seal + 4% bwoc MPA-1 + 61.2% Fresh Water
Displacement		160.7 bbls Displacement Fluid

CEMENT PROPERTIES

	SLURRY NO. 1
Slurry Weight (ppg)	13.80
Slurry Yield (cf/sack)	1.35
Amount of Mix Water (gps)	6.02
Estimated Pumping Time - 70 BC (HH:MM)	3:30
Free Water (mls) @ 124 ° F @ 90 ° angle	0.0
Fluid Loss (cc/30min) at 1000 psi and 124 ° F	300.0
COMPRESSIVE STRENGTH	
12 hrs @ 142 ° F (psi)	1200
24 hrs @ 142 ° F (psi)	2000
72 hrs @ 142 ° F (psi)	3000

Operator Name: Devon Energy Corporation
Well Name: Ocotillo 6 F ' I #1
Job Description: 3 Stage Long String
Date: May 30, 2006

Proposal No: 215852875A

FLUID SPECIFICATIONS (Continued)

STAGE NO.: 3

Spacer			10.0 bbls Fresh Water @ 8.34 ppg
Lead Slurry	1666	/ 2.04	= 817 sacks (35:65) Poz (Fly Ash):Class C Cement + 5% bwow Sodium Chloride + 0.25 lbs/sack Cello Flake + 6% bwoc Bentonite + 107.8% Fresh Water
Tail Slurry	206	/ 1.37	= 150 sacks (60:40) Poz (Fly Ash):Class C Cement + 5% bwow Sodium Chloride + 0.25 lbs/sack Cello Flake + 0.4% bwoc Sodium Metasilicate + 4% bwoc MPA-1 + 64.7% Fresh Water
Displacement			90.4 bbls Displacement Fluid

CEMENT PROPERTIES

	SLURRY NO. 1	SLURRY NO. 2
Slurry Weight (ppg)	12.50	13.80
Slurry Yield (cf/sack)	2.04	1.37
Amount of Mix Water (gps)	11.24	6.36
Estimated Pumping Time - 70 BC (HH:MM)	3:30	2:30
Free Water (mls) @ ° F @ 90 ° angle		
Fluid Loss (cc/30min) at 1000 psi and ° F		
COMPRESSIVE STRENGTH		
12 hrs @ 112 ° F (psi)	250	800
24 hrs @ 112 ° F (psi)	400	2000
72 hrs @ 112 ° F (psi)	800	3000

ACTUAL CEMENT VOLUMES MAY VARY BASED ON CALIPER.

BATCH MIX THE FIRST STAGE SUPER C MODIFIED CEMENT SLURRY.

ALLIANCE
DRILLING FLUIDS, LLC

Devon Energy Corporation

20 North Broadway
Oklahoma City, Oklahoma 73102

Ocotillo 6 F [illegible] #1

Section 6, T-23-S, R-26-E
Eddy County, New Mexico
Prepared For:
Ms Elizabeth Larson

Prepared by:
Paul Webb

Alliance Drilling Fluids, LLC
415 W. Wall Street, Suite 1818
Midland, Texas 79701
Office: 432-684-0911

May 31, 2006

ALLIANCE
DRILLING FLUIDS, LLC

May 31, 2006

Ms Elizabeth Larson
Devon Energy Corporation
20 North Broadway
Oklahoma City, Oklahoma 73102

Dear Ms Larson:

Alliance Drilling Fluids LLC would like to thank you for the opportunity to present our recommendations for your **Ocotillo 6 #1 Well** to be drilled in Section 6, T-23-S, R-26-E, Eddy County, New Mexico.

The following suggested drilling fluids program is based on data supplied by Devon Energy Corporation and our experience in the area

We suggest a **Bentonite/Lime** spud mud to drill the surface hole. Drill out below 13-3/8" surface casing with **Fresh Water**, circulating through the reserve pit. There is the possibility of encountering loss returns in all intervals to be drilled.

Drill out below 9-5/8" intermediate casing with **Fresh Water**. Circulate through the reserve pit.

At 9,800', or prior to the top of the Strawn, we recommend mudding up with an **ALL Zan/ALL Pac** type drilling fluid. Prior to drilling the Morrow, reduce the fluid loss to 6-8 cc

Included in this program are recommended properties, estimated costs and offset wells. Should you have any questions or require additional information, please let me know.

Very truly yours,

Alliance Drilling Fluids LLC

Paul Webb
Technical Sales & Service

Overview

- **Bentonite/Lime** spud mud with a 34 - 38 sec/qt viscosity, converting to a **Fresh/Native** mud to drill the surface hole.
- Drill out below 13-3/8" surface casing with **Fresh Water**. Circulate through the reserve pit.
- Drill out below 9-5/8" intermediate casing with 8.4-8.6 lb/gal **Fresh Water** . Circulate through the reserve pit.
- At 9,700', or prior to the top of the Strawn, return circulation to the steel pits and displace the hole with 9.5 lb/gal **Cut Brine Water** and mud up with an **ALL Zan/ALL CMS** type drilling fluid.
- Maintain a 9.5 - 10.5 lb/gal mud weight, 34 - 40 sec/qt viscosity and 8-10 cc's fluid loss after mud up.
- If mud weights in excess of 10.5 lb/gal are required to control the pressures in the Strawn, then consideration should be made to setting a liner prior to drilling to TD.
- At 10,700', or top of the Morrow Section, lower fluid loss to 6-8 cc's with ALL **CMS** and increase viscosity to 38 - 42 sec/qt.
- Pressures may be encountered in the Strawn, Atoka and Morrow Sections,that may require

- **Total mud related costs are estimated at $71,500 to $75,000. This estimate is based on the Alliance Drilling Fluids *LLC* pricing to Devon Energy Corporation.**

- **The total estimated drilling time is forty to forty-five (40-45) days.**

Key concerns include the following:

- Seepage losses to total lost returns in all intervals to be drilled.
- Hole cleaning.
- Pressures in the Strawn, Atoka and Morrow Sections.
- Sensitive shales in the Strawn, Atoka and Morrow Sections.

- **This well will be serviced from Alliance Drilling Fluids facility in Hobbs, New Mexico.**

Drilling Issues

Seepage Losses

- Seepage losses can be expected in all intervals to be drilled.
- **Drilling Paper** additions should be sufficient to control any minor seepage losses.

Lost Returns

- Lost returns can be expected in all intervals to be drilled.
- Severe losses in the Capitan Reef (if there is good development) may be encountered from 750to 1,600' and while drilling the Bone Springs series from 4,800' to 8,050'
- Use **Bulky Fibrous LCM** pills with **Fiber Seal, Fiber Plug** and **Cotton Fiber** to control losses.
- **ALL Zone Seal, ALL Seal** and **Calcium Carbonate** (medium and coarse) are acid soluble **LCM** products and consideration should be given to using only these products in the production interval.
- Maintain fluid density as low as possible to minimize the problems of

Hole Cleaning

- Use high viscosity **Bentonite** pill sweeps to aid in hole cleaning if dry drilling becomes necessary while drilling the surface hole.
- Use **Poly Plus** sweeps to ensure a clean hole while drilling with a **Clear Water** type fluid.

Abnormal Pressures

- Pressures may be expected in the Strawn, Atoka and Morrow Sections.
- Adjust drilling fluid weight as needed for well control with 10 lb/ gal **Brine Water** or **Barite**
- There is a possibility of encountering pressures that may require drilling fluid weights in the 11.0 lb/gal range to control.

Sensitive Shales

- Sensitive shales can be expected in the Strawn and Morrow Sections lower filtrate to 6-8 cc's.

Geology/Drilling Problems

ESTIMATED GEOLOGICAL FORMATION TOPS AND POTENTIAL DRILLING PROLEMS

FORMATION	TOP (Ft)	POTENTIAL DRILLING PROBLEMS
Yates/ 7 Rivers	428	Losses
Capitan	570	Seepage
Delaware	1,625	Seepage
Bone Springs	4,830	Lost Circulation, Corrosion
1st Bone Springs	5,750	Seepage Losses, Lost Returns, Wash-Outs
2nd Bone Springs	6,230	Seepage Losses, Lost Returns, Wash-Outs
3rd Bone Springs	8,050	Seepage Losses, Lost Returns, Wash-Outs
Wolfcamp	8,450	Gas, Seepage
Penn	9,415	
Strawn	10,000	Water sensitive, Gas
Atoka	10,360	Sloughing, Gas
Morrow	10,800	Water sensitive, Gas
Middle Morrow	10,990	Water sensitive, Gas
Lower Morrow	11,335	Water sensitive, Gas
Barnett	11,600	Water sensitive, Hole stability
TD	11,750	

DEVON ENERGY CORPORATION
OCOTILLO 6 FED 1
SECTION 6, T-23-S, R-26-E
EDDY COUNTY, NEW MEXICO

ALLIANCE DRILLING FLUIDS, LLC

Interval 1 Summary

17-1/2" Open Hole - (0'- 700') - 13-3/8" Casing	
Drilling Fluid System	Bentonite/Lime Spud Mud, Fresh/Native
Key Products	Bentonite, Lime, Paper, Soda Ash, Caustic Soda, LCM
Solids Control	Adjustable Linear Shaker
Potential Problems	Seepage Losses, Lost Returns, Hole Cleaning

Interval Drilling Fluid Properties					
Depth Interval (ft)	Mud Weight (lb/gal)	Plastic Viscosity (cp)	Yield Point ($lb/100ft^2$)	API Fluid Loss (ml/30min)	Drill Solids (%)
0 - 700	8.5 - 8.7	3 - 5	5 - 7	NC	<3.0

- Spud with a **Bentonite/Lime** type drilling fluid with a 30 - 36 sec/qt viscosity. Add 5 - 7 sacks of **Drilling Paper** to spud mud.
- **Drilling Paper** additions should be sufficient to control minor seepage losses.
- Jet and clean, shale and settling pits as needed to control mud properties.
- Lost circulation may be encountered while drilling the surface hole. Should losses be encountered, add up to 20 lb/bbl LCM. Mix **Bulky Fibrous LCM (ALL Seal, Cotton Fibers, ALL Case, Fiber Seal)** pills in conjunction with **ALL Poly Seal** to control mild losses to lost returns.
- Should dry drilling become necessary, mix and pump high viscosity pre-hydrated **Bentonite** pills to aid in hole cleaning.
- For corrosion control, slug the drill pipe every 4 hours with 2-1/2 gallons of **ALL Hib FA 30** with 2-1/2 gallons of **Diesel**. Slug the drill pipe before and after trips with the same 5 gallon mixture. Add 10 gallons per day of **ALL Hib 370** to minimize the effects of oxygen. Install corrosion ring in the Kelly saver sub, remove after 80-100 hours for analysis.

Interval 2 Summary

12-1/4" Open Hole - (700'- 1,700') - 9-5/8" Casing	
Drilling Fluid System	Fresh Water
Key Products	MF-55, Lime, Fibrous LCM, Poly Plus
Solids Control	Reserve Pit, Adjustable Linear Shaker
Potential Problems	Seepage Losses, Lost Returns, Hole Cleaning

Interval Drilling Fluid Properties					
Depth Interval (ft)	Mud Weight (lb/gal)	Plastic Viscosity (cp)	Yield Point ($lb/100ft^2$)	API Fluid Loss (ml/30min)	Drill Solids (%)
700 - 1,700	8.4 - 8.5	1	1	NC	<1.0

- Drill out below the 13-3/8" casing with **Fresh Water**. Circulate through the reserve pit.
- Maintain a 9.5 - 10.0 pH with **Lime**.
- Add **MF-55** at the flow line to flocculate drill solids while drilling with a **Clear Water** type fluid.
- **Drilling Paper** additions should be sufficient to control minor seepage losses.
- Lost circulation may be encountered while drilling the intermediate hole. Should losses be encountered, add up to 20 lb/bbl LCM. Mix **Bulky Fibrous LCM (ALL Seal, Cotton Fibers, ALL Case, Fiber Seal)** pills in conjunction with **ALL Poly Seal** to control mild losses to lost returns.
- Add 0.5-1.0 gallons of **Poly Plus** down the drill pipe every 100'-150' or as needed to aid in hole cleaning when drilling with a **Clear Water** type fluid
- Should dry drilling become necessary, mix and pump high viscosity pre-hydrated **Bentonite** pills to aid in hole cleaning.
- For corrosion control, slug the drill pipe every 4 hours with 2-1/2 gallons of **ALL Hib FA 30** with 2-1/2 gallons of **Diesel**. Slug the drill pipe before and after trips with the same 5 gallon mixture. Add 10 gallons per day of **ALL Hib 370** to minimize the effects of oxygen. Install corrosion ring in the Kelly saver sub, remove after 80-100 hours for analysis. Have **ALL H_2S 320** on location to treat any H_2S that may be present.
- We suggest returning to the steel pits and mudding up with an **ALL Pac** type drilling fluid for any unanticipated hole problems. Control viscosity at 40 - 44 sec/qt and fluid loss at12 - 15 cc's after mud up.

Interval 3 Summary

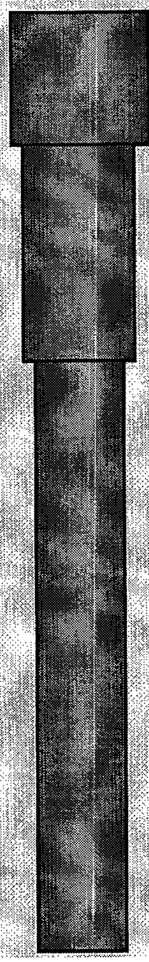
8-3/4" Open Hole - (1,700'- 11,750') - 5-1/2" Casing	
Drilling Fluid System	Cut Brine/Polymer
Key Products	ALL Zan, ALL CMS LCM, Lime, Caustic Soda
Solids Control	Reserve Pit, Adjustable Linear Shaker
Potential Problems	Seepage Losses, Lost Returns, Hole Cleaning

Interval Drilling Fluid Properties

Depth Interval (ft)	Mud Weight (lb/gal)	Plastic Viscosity (cp)	Yield Point ($lb/100ft^2$)	API Fluid Loss (ml/30min)	Drill Solids (%)
1,700 - 4,300	8.4 - 8.5	1	1	NC	<2.0
4,300 - 9,700	8.7 - 9.5	1	1	NC	<2.0
9,700 - 10,700	9.5 - 9.8	6 - 9	8 - 12	8 - 10	<5.0
10,700 - 11,750	9.8 - 10.5	9 - 12	12 - 20	6 - 8	<5.0

- Drill out below the 9-5/8" casing with **Fresh Water**. Circulate through the reserve pit.
- Maintain a 10.0 - 10.5 pH with **Lime**.
- Add **MF-55** at the flow line to flocculate drill solids while drilling with a **Clear Water** type fluid.
- Add 0.5-1.0 gallons of **Poly Plus** down the drill pipe every 100'-150' or as needed to aid in hole cleaning when drilling with a **Clear Water** type fluid.
- Adjust drilling fluid weight with 10.0 lb/gal **Brine Water** as needed for well control.
- Use acid soluble **LCM (ALL Zone Seal, ALL Case, Calcium Carbonate)** pills to control any mud losses to hole.
- At 9,700', or prior to the top of the Strawn, we recommend displacing with 9.5 lb/gal **Cut Brine Wate** and returning circulation to the steel pits. Maintain a 9.5-10.0 pH with **Caustic Soda,** reduce total hardness to 200 mg/l with **Soda Ash**, and mud up with an **ALL Zan/ALL CMS** type drilling fluid.
- Maintain a 9.5 - 9.8 lb/gal mud weight, 36 - 40 sec/qt viscosity and 8-10 cc's fluid loss after mud up.
- At 10,700', or top of the Morrow Section, lower fluid loss to 6-8 cc's using **ALL CMS** and increase viscosity to 38 - 42 sec/qt range with **ALL Zan.**
- If mud weights in excess of 10.2 lb/gal are required in the Strawn, Atoka and Morrow Sections, adjust drilling fluid weight with **Barite.**
- For corrosion control, slug the drill pipe every 4 hours with 2-1/2 gallons of **ALL Hib FA 30** with 2-1/2 gallons of **Diesel.** Slug the drill pipe before and after trips with the same 5 gallon mixture. Add 10 gallons per day of **ALL Hib 370** to minimize the effects of oxygen. Install corrosion ring in the Kelly saver sub, remove after 80-100 hours for analysis. Have **ALL H_2S 320** on location to treat any H_2S that may be present

Well Summary

Casing Size (in)	Hole Size (in)	Casing Program	Depth MD (ft)	Estimated Formation Tops	Mud System	Mud Weight (lb/gal)	Inter-val Days	Interval Mud Cost
13-3/8	17-1/2		428 570 **700**	Yates, 7 Rivers Capitan **Casing Point**	Bentonite/Lime Spud Mud	8.8 - 9.2	2	$3,500
9-5/8	12-1/4		1,625 **1,700**	Delaware **Casing Point**	Brine Water/Native	10.0-10.2	6	$6,000
7 5-1/2	8-3/4		4,830 5,750 6,630 8,050 8,450 9,415 **9,700** 10,000 10,360 **10,700** 10,990 11,335 **11,750**	**Possible losses** Bone Springs 1st Bone Springs 2nd Bone Springs 3rd Bone Springs Woflcamp Penn Mud Up sensitive shale Strawn possible pressure Atoka Middle Morrow Lower Morrow **Casing Point**	Fresh Water Cut Brine Cut Brine/ALL Zan	8.4-8.5 8.7-9.5 9.5-9..8 9.8-10.5	32	$62,000

CUMMULATIVE DAYS: 40 CUMMULATIVE COST: $71,500

- **This estimate does not include extensive lost circulation or major problem incidents**

DEVON ENERGY CORPORATION
OCOTILLO 6 FED 1
SECTION 6, T-23-S, R-26-E
EDDY COUNTY, NEW MEXICO

ALLIANCE DRILLING FLUIDS, LLC

Reference Map

EDDY COUNTY, NEW MEXICO

PREPOSED WELL: RED

REFERENCE WELLS: BLUE

BIT RECORDS: GREEN

	6	5	4	3	2	1	6	5	4	3	2	1	6	5	4	3	2	1
	7	8	9	10	11	12	7	8	9	**10**	11	12	7	8	9	10	11	12
	18	17	16	15	14	**13**	18	17	16	15	14	13	18	17	16	15	14	13
T-22-S	19	20	21	22	23	24	19	20	21	22	23	24	19	20	21	22	23	24
	30	29	28	27	26	25	30	29	28	27	26	25	30	29	28	27	26	25
	31	32	33	34	35	36	**31**	**32**	33	34	35	36	31	32	33	34	35	36
	6	5	4	3	2	**1**	**6**	5	4	3	2	1	6	5	4	3	2	1
	7	8	9	10	11	12	7	8	9	10	11	12	7	8	9	10	11	12
	18	17	16	15	14	13	18	17	16	15	14	13	18	17	16	15	14	13
T-23-S	19	20	21	22	23	24	19	20	21	22	23	24	19	20	21	22	23	24
	30	29	28	27	26	25	30	29	28	**27**	26	25	30	29	28	27	26	25
	31	32	33	34	35	36	31	32	33	34	35	36	31	32	33	34	35	36
	6	5	4	3	2	1	6	5	4	3	2	1	6	5	4	3	2	1
	7	8	9	10	11	12	7	8	9	10	11	12	7	8	9	10	11	12
	18	17	16	15	14	13	18	17	16	15	14	13	18	17	16	15	14	13
T-24-S	19	20	21	22	23	24	19	20	21	22	23	24	19	20	21	22	23	24
	30	29	28	27	26	25	30	29	28	27	26	25	30	29	28	27	26	25
	31	32	33	34	35	36	31	32	33	34	35	36	31	32	33	34	35	36
			R-25-E						R-26-E						R-27-E			

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OCOTILLO 6 J 1
SECTION 6, T-23-S, R-26-E
EDDY COUNTY, NEW MEXICO

ALLIANCE DRILLING FLUIDS, LLC

Reference Wells

DRILLING FLUID RECAPS

NADEL & GUSSMAN
CARLSBAD S-27 STATE COM #7
SEC. 27, T-23-S, R-26-E
EDDY COUNTY, NEW MEXIC0

NEWFIELD EXPLORATION CO.
CARLSBAD #6
SEC. 27, T-23-S, R-26-E
EDDY COUNTY, NEW MEXIC0

LOUIS DREYFUS
McGRUDER 13 COM #1
SEC. 13, T-22-S, R-25-E
EDDY COUNTY, NEW MEXIC0

NADEL & GUSSMAN
BENNETT #1
SEC. 10, T-22-S, R-26-E
EDDY COUNTY, NEW MEXIC0

BIT RECORD & SCOUT TICKET

EXXON
SQUAW FED #3
SEC. 1, T-23-S, R-25-E
EDDY COUNTY, NEW MEXIC0

LOUIS DREYFUS
EV ST #2
SEC. 32, T-22-S, R-26-E
EDDY COUNTY, NEW MEXIC0

PENWELL
HACKBERRY 31 ST #1
SEC. 31, T-22-S, R-26-E
EDDY COUNTY, NEW MEXIC0

EXXON
NM EV ST COM #1
SEC. 32, T-22-S, R-26-E
EDDY COUNTY, NEW MEXIC0

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OCOTILLO 6 J 1
SECTION 6, T-23-S, R-26-E
EDDY COUNTY, NEW MEXICO

ALLIANCE
DRILLING FLUIDS, LLC

Solids Control Requirements

API SHAKER SCREEN DESIGNATION

Mesh Size	Opening (Microns)	% Open Area	Opening (Inches)	Classification Of Particles
10	2,000	56.3	0.0787	Gravel
20	840	43.6	0.0331	Sand
30	590	40.8	0.0232	Sand
40	420	36.0	0.0165	Sand
50	297	30.3	0.0117	Sand
60	250	30.5	0.0098	Sand
80	177	34.0	0.0070	Sand
100	149	30.3	0.0059	Sand
120	125	30.9	0.0049	Sand
150	105	37.4	0.0041	Sand
200	74	33.6	0.0029	Sand
250	63	36.0	0.0025	Silt
325	44	30.0	0.0017	Sit
400	37	36.0	0.0015	Silt

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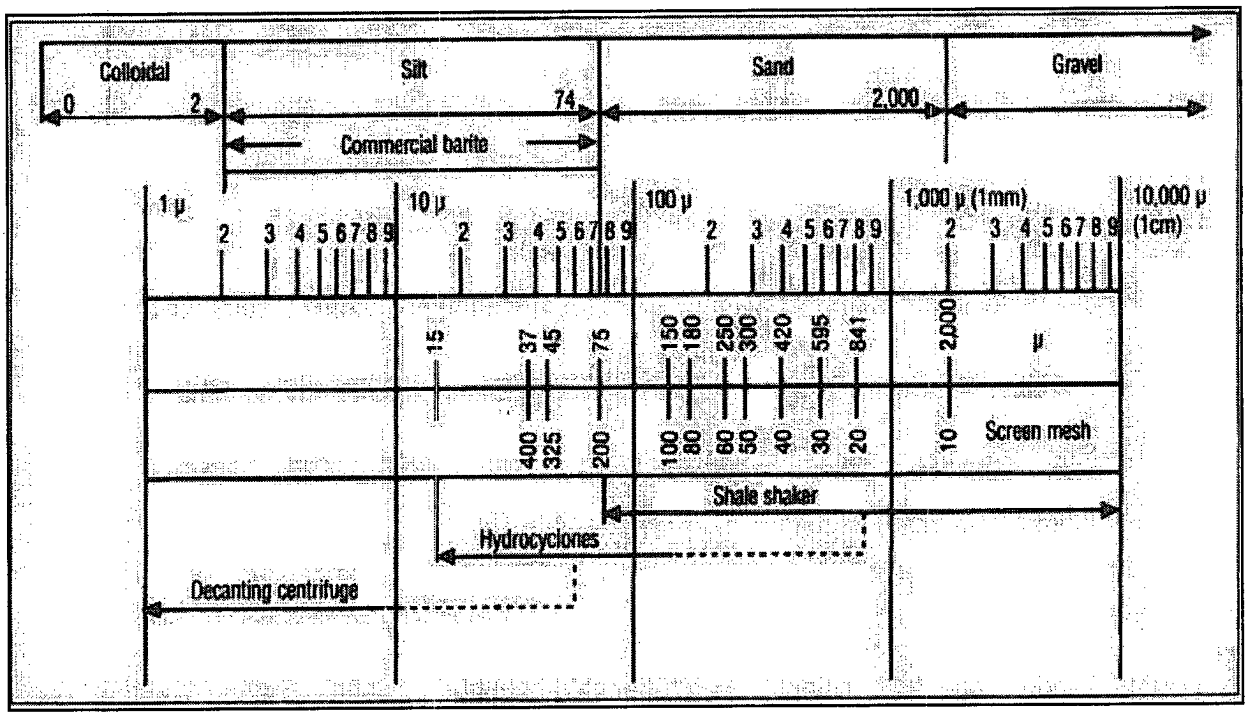
SECTION 6, T-23-S, R-26-E
EDDY COUNTY, NEW MEXICO

ALLIANCE DRILLING FLUIDS, LLC

Solids Control Requirements

API SHAKER SCREEN AND SOLIDS DESIGNATION



Category	Size	Example	Mechanical Equipment
Colloidal	Less than 2μ	Bentonite, Clays, and Ultra-Fine Drill Solids	(Chemical Flocculation)
Silt	2-74μ (<200 mesh)	Barite, Silt, and Fine Drill Solids	Decanting Centrifuge, Hydroclones and Shale Shakers
Sand	74-2,000μ (200-10 mesh)	Sand and Drill Solids	Shale Shakers and Hydroclones
Gravel	Larger than 2,000μ (>10 mesh)	Drill Solids, Gravel and Cobble	Shale Shakers

DEVON ENERGY CORPORATION
OCOTILLO 6 1
SECTION 6, T-23-S, R-26-E
EDDY COUNTY, NEW MEXICO

ALLIANCE DRILLING FLUIDS, LLC

Lost Circulation Plan

Seepage losses

Losses up to approximately 10 bbl/hr are normally considered as seepage losses. Seepage type losses are frequently cured by the simple action of reducing or stopping the pump rate and allowing the formation to heal and become sealed off by the development of a filter cake. The pump rate can be gradually increased after the losses have been stopped.

If losses do not heal by themselves and the amount of loss cannot be tolerated for economical or other reasons, add **Drilling Paper** to the circulating system or pump **Drilling Paper** pills if the reserve pit is being circulated. If there is no reduction in the loss rate sweep the hole with the following pill:

When drilling with clear water mix and pump Bentonite or Salt Gel LCM pills as follows:

Bentonite or **Salt Gel**	15 lb/bbs
ALL Seal	4-6 lb/bbl
ALL Sure Seal	6-8 lb/bbl
ALL Case	6-8 lb/bbl

Partial losses

Losses from 10 bbl/hr to 100 bbl/hr are referred in this particular case as partial losses. This situation will usually require treatment. The following pill is recommended:

ALL Case	8-10 lb/bbl
ALL Sure Seal	8-10 lb/bbl
ALL Walnut Beads	4-6 lb/bbl
ALL Seal	6-8 lb/bbl
Calcium Carbonate (C)	6-8 lb/bbl

Lost Circulation Plan - Continued

<u>**Total loss of returns**</u>

The priority will usually be well control, so the annulus must be filled from the top with either drilling fluid or other light weight liquid. Unless the fracture is induced, losses can normally be stopped by pumping conventional LCM pills. The alternative then is a soft plug or reinforcing plug (gunk).

However, a pill of LCM is often the first choice since it gives quick response if it works and is easy to do. Recommended pill to pump should contain as much LCM as possible, **but not more than 100 lb/bbl total LCM concentration**. A standard formulation would be:

ALL Case	12-15 lb/bbl
ALL Sure Seal	10-15 lb/bbl
Fiber Seal	10-12 lb/bbl
ALL Walnut Beads	6-8 lb/bbl
ALL Seal	8-10 lb/bbl
Calcium Carbonate (C)	8-10 lb/bbl

These recommendations are for use after mud up. The product selection and quantity will depend on drilling assemblies, tools and nozzle sizes at the time of losses.

Lost Circulation

LOST CIRCULATION OR LOST RETURNS

Lost circulation or **lost returns** are the partial or total loss of whole drilling fluid to subsurface formations. Lost circulation occurs when the openings in the formation allow the passage of whole fluid into the formation resulting in losses ranging from 1 bbl/hr to complete loss of returns. Besides the economical aspects of lost returns, lost circulation adversely affects the overall drilling operation by:

1. The loss of hydrostatic head that may result in a well-control situation.
2. The reduction in the pressure gradient may lead to well bore instability which could result in hole collapse and/or stuck pipe.
3. Side tracks or complete loss of the well.
4. Failure to achieve adequate annular cement coverage.
5. Good quality formation evaluation may not be possible.

CAUSES AND POTIENTAL LOST-CIRCULATION ZONES

Lost circulation is caused by one of the two following mechanisms:

1. **Natural losses**-where invasion of whole fluid is lost to formations that are highly permeable, unconsolidated, fractured, cavernous or vugular.
2. **Induced losses**-where the drilling fluid is lost due to excessively induced pressures that hydraulically fracture the formations.

NATURAL LOSSES

Unconsolidated Formations

Although these formations are mainly shallow and normally consist of sands or gravel, they can occur in shell beds or reef deposits. Coarse unconsolidated formation can have a sufficiently high permeability for whole drilling fluid to invade the formation matrix (10-100 Darcies). For whole fluid to be lost, the average particle found in the system must be 1/3 or less of the formation opening. These losses are normally confined to shallow wells or surface hole. The rate of loss can vary from seepage to total losses. In the event of total losses, it is sometimes common practice to **Drill Blind** if a sufficient supply of water is available and environmental or well control consideration are not an issue. One reason to prevent shallow losses is the risk of washing out these unconsolidated formations, forming a large cavity that is less stable and difficulty in obtaining an adequate cement job on the surface casing. In some areas, it may be more applicable to drill with **Air, Mist, Foam** or **Aerated Drilling Fluids** to prevent losses.

Lost Circulation

Highly Permeable/Low-Pressure Formations (Depleted Zones)
These are mainly depleted sand reservoirs and can occur at any depth. The extraction of formation fluids in producing formations in the same field or general vicinity may cause subnormal (depleted) formation pressures. The loss of drilling fluid to theses formations requires passages of sufficient size and intergranular connectivity to allow entry of whole fluid. Moreover, the hydrostatic pressure must exceed formation pressure. This type of loss can range from seepage to severe and can often lead to differentially stuck pipe.

Natural Fractures
This type of loss occurs mainly in shales where fractures or fissures naturally exist. These fractures require only that the drilling fluid pressure exceed the fluid pressure within the rock. This can happen at overbalances as low as 50 psi. Initial loss rates can vary from seepage, but are more likely to be severe in nature. This type of loss rate can be troublesome to cure as it tends not to be localized but exists throughout the interval being drilled.

Cavernous And Vugular Formations
Cavernous or vugular formations usually are associated with low-pressure carbonate (limestone and dolomite) or volcanic formations. In limestone, vugs are created by the previous continuous flow of water that dissolved part of the rock matrix (leaching), creating a void space that is often later filled with oil or gas. When these formations are drilled, the drill string may freely fall through the void zone with an accompanying sudden loss of returns. The volume of the losses will depend on the degree to which the vugs are interconnected. In areas with a drilling history these losses are usually predictable.

INDUCED LOSSES

Induced fractures occur when some critical pressure exceeds the fracture gradient of the rock, causing the formation to break down. Once a fracture is created or opened by an imposed pressure, it may be difficult to heal, and may never regain the original formation strength. In invert-emulsions (Oil Based) fluids these losses are much harder to cure than in water-based fluids. It has been suggested that induced losses account for up to 90% of all recorded lost circulation incidents. Accordingly, it is better to pre-plan or pre-treat to avoid lost circulation than permit it to occur. These losses often occur from intermediate casing being set in the wrong place or by excessive down hole circulating and surge pressures. Conditions that result from excessive pressures are:

Mechanical Forces

1. **Improper hydraulics.** Excessive flow rates and fluid rheological properties resulting in high Equivalent Circulating Density (ECD).
2. **Drilling practices.**
   A) Pump surging caused by increasing the pump rate too rapidly after connections and trips. This is extremely important when drilling with invert-emulsions. Failure to bring the pumps up to speed slowly can result in much higher circulating pressures on the formation, because of the tendencies of inverts to have higher viscosities when cooled.
   B) Raising and lowering the pipe too quickly on connections or during trips (surge/swab)
3. **Excessive Rate of Penetration.**
   Excessive cuttings in the annular flow stream will result in a higher ECD.

Lost Circulation

Hole Conditions

1. Sloughing or caving shales will increase solids loading in the annulus, resulting in high ECD. This condition may also result in a packing-off. Packing-off, if even temporary, can cause extremely high pressures to be imparted to the formation.
2. Washouts can lead to cuttings accumulations in the enlarged hole section. These accumulations can fall back into the hole, leading to packing-off or the creation of bridges in the absence of drill pipe.
3. Cuttings beds or barite sag in deviated wells may result in localized density increase.
4. Kicks and well-control procedures.

Drilling Fluid Properties That Will Affect Pressure Loss In The Annulus

1. Excessive viscosities and gel strengths.
2. A build-up of drilled solids.
3. Thick filter cakes that reduce the hydraulic diameter of the well bore.
4. Excessive drilling fluid weight or increasing the density too rapidly.
5. Unbalanced drilling fluid columns.
6. Barite sag.
7. Excessive low gravity solids (LGS)

CLASSIFICATION OF THE SEVERITY OF LOSSES

Seepage Losses (1-10 bbl/hr)

This takes the form of very slow losses, sometimes in the form of filtration to a highly permeable formation. Seepage losses also can be confused with cuttings removal at the surface. It is important not to confuse these two different occurrences.

If seepage losses are suspected, the bit must be pulled off-bottom and the drilling fluid volumes checked with and without circulation. All mixing equipment and non-essential solids removal equipment should be turned off and base line values recorded.

Once it is established that fluid is being lost, a decision must be made on whether to tolerate or cure this situation. Depending on the economics of the drilling fluid and/or rig time, it might be more prudent to continue drilling with seepage losses.

If pressure constraints are tight, a good cement job is required. If formation damage or stuck pipe are the primary concerns, attempts should be made to cure the losses before proceeding with drilling.

Partial Losses (10-100 bbl/hr)

Partial losses are more than seepage losses with the cost of the fluid becoming the overriding criteria in the decision to drill ahead or combat the losses. Once again, all the above factors will determine if drilling with losses is to be tolerated. Drilling with partial losses can be considered if the fluid is relative inexpensive and the pressures are within operating limits.

Lost Circulation

Severe Losses (>100 bbl/hr)

In almost all cases when losses of this type are encountered, regaining full circulation is required. Begin by pumping a lighter weight fluid down the annulus (drilling fluid, water or other light weight fluid) while monitoring the volumes required to fill the hole.

If the well becomes stable, calculate the hydrostatic head required to fill the well. If losses persist, began by spotting conventional LCM pills, moving to plugs if conventional treatments are unsuccessful. Due to the reduction of hydrostatic head the well must be monitored closely at all times for an influx of fluids. In some areas it may be possible to continue drilling if the fluid cost is low and pressures are manageable.

CLASSIFICATION OF LOST CIRCUALTION MATERIALS

Lost Circulation Materials can be classified into six types:

1. Fibrous
2. Granular
3. Flaked or platelet
4. Mixed
5. High fluid loss squeezes
6. Reinforcing plugs

The first four conventional lost circulation materials tend to be supplied in three grades— Fine, Medium, and Coarse.

- **Fine materials** under most circumstances will pass through the shaker screens and stay in the system.
- **Medium materials** tend to be screened out, but most likely will not plug jets or MWD tools.
- **Coarse materials** can plug off everything except open-ended drill pipe.
  Other specialty materials are graded according to particle size or the mesh opening through which they will pass. It is important to consult the product literature prior to using any lost circulation material.
  The two other materials available are **high fluid loss squeezes** and **reinforcing plugs**.
- **Reinforcing plugs** are mixed either in the slugging pit or re-circulating mixer and spotted in the hole either through the bit or open-ended drill pipe. Reinforcing plugs are classified as either soft or hard plugs.
- **Soft plugs** have a solid mass, but tend to have little, if any, compressive strength and form a rubbery consistency.
- **Hard plugs** have a much higher compressive strength.

Lost Circulation

Material Types

Fibrous: Materials with relatively little degree of rigidity and are thought to mat or entangle on the surface or within a formation that is taking fluid.

Examples: ALL Seal, Cedar Fiber, Fiber Plug and **Drilling Paper**. Most of these materials are supplied in fine medium and coarse grades.

Granular: Particulate materials of various degrees of rigidity and size. These materials are able to bridge and wedge either at the face of or within formations capable of taking fluid.

Examples: **Calcium Carbonate, Sized Salt**, **Pecan** or **Walnut Hulls** and **Graphite**.

- **Calcium Carbonate**: Different grades of ground limestone or marble used to prevent seepage/partial losses. **Calcium Carbonate** is acid soluble and is often used to reduce seepage losses in production zones.
- **Sized Salt**: Various grades of salt, suspended in saturated salt solutions. Sized salt is used in pill form or as a whole system particularly when drilling or working over producing zones. The blocking effect can be removed by dissolving the pill with fresh water and acid.
- **Pecan** or **Walnut Hulls**: Hulls are available in three grades: fine, medium and coarse.
- **Graphite**: Graphite is supplied in coarse grind size and may be used in both waster base and oil base drilling fluids. This material has been applied successfully in curing both natural and induced losses. Normally 10 lb/bbl is carried in the active drilling fluid system to limit losses to induced fractures. Graphite has also proven beneficial for blocking permeable formations and reducing the differential sticking potential of the fluid.

Flaked or Platelet: Materials with a flat, layer like appearance that may have limited rigidity.

Examples: **Mica, Pheno Seal** and **Cellophane**.

- **Mica**: Can be one of several silicates of varying chemical composition, but with similar physical characteristics. All micas tend to cleave into thin sheets that are flexible and elastic. Mica comes in three grades: fine, medium and coarse.
- **Pheno Seal**: Is a thermoset, laminated, flaked material. It is provided in three grades: fine, medium and coarse. This is a very rigid material and will not degrade as fast as mica.
- **Mixed:** Materials that are mixes of fibrous, granular and flaked material in one sack. These materials offer the benefits of mixing all three materials with regards to proper sizing.
  Examples: **All Case** and **Kwikseal®** (medium and coarse)
- **High Fluid-Loss Squeezes**: When squeezed into the loss zone this type of slurry readily dehydrates, allowing solids to pack the fractures forming a seal. A typical high-fluid loss slurry contains a mixture of diatomaceous earth, bridging agents, and barite suspended in either water or oil. These slurries are good for induced fractures where external bridging is not paramount and it is important to get a high-pressure drop into the fracture. Drilling fluid solids should provide the necessary fines for bridging. In low-porosity, fractured formations, 10 lb/bbl of fine fibrous LCM is usually added. Course or granular LCM should not be added as they may prevent the diatomaceous earth from entering the fracture or, if invasion occurs, may act as a proppant. Hydrostatic pressure is often enough to seal the loss zone. A light squeeze pressure (100-300 psi) may be applied to open up and then seal the fractures. The basic slurry or slurry containing low concentrations of fiber can be pumped through bit jets. Example: **Diaseal® M.**

Lost Circulation

- **Soft Plugs:** There are basically three types of soft plugs: **Polymeric, Bentonitic** and **Chemical Treatment.**
  Polymeric: The polymeric plugs include cross-linked polymers and sometimes contains sized particles to help Reduce invasion into the thief zone. These plugs are designed with a retarder for formation temperatures above 80^0F. The plugs can be weighted up to 18 lb/gal. Care should be taken when placing the plugs near the producing interval, as they may not degrade and may damage the producing zone.
  Bentonitic: Gunk squeeze and Reverse Gunk squeeze are examples of Bentonitic squeezes. This method uses materials normally available at the rig site. The conventional Gunk Squeeze can be used with water base drilling fluids while the Reverse Gunk Squeeze is used with oil base fluids.
  Gunk Squeeze: A treatment consists of pumping a mixture of un-hydrated clay material (**bentonite**) and **diesel**, which rapidly gels/thickens when intermixed with the drilling fluid. **Cement** is occasionally added to the mixture to provide additional strength to the squeeze.
  Reverse Gunk Squeeze: A mixture of **organophilic clay** and **water** which rapidly gels when inter-mixed with an oil-based fluid down hole. The clay/water mixture is squeezed into the formation at the same time as oil-based fluid is pumped down the annulus so the two fluids will mix and cause the clay to swell and form an Impermeable zone.
  Sodium Silicate: An example of a chemical plug where **calcium chloride** is pumped first pumped to wet the formation, followed by **sodium silicate** and **cement** with a **fresh water** spacer between the components. When the sodium silicate comes in contact the calcium chloride brine it forms a gelatinous mass, leaving a pad for the cement to set up against.
- **Hard Pugs: Cement, Oil/Bentonite/Cement and Barite Plugs.**
  Cement is an inexpensive lost circulation material and can be very effective in sealing lost circulation zones. It is critical that the treatment be applied properly so the cement slurry is not contaminated. The composition of the cement can be neat or with different additives to vary properties such as density, setting time, filtration loss, bridging capabilities, gel strength and compressive strength.
  Oil/Bentonite/Cement (OBC) is a hydration type plug with a high concentration of bentonite and cement mixed into diesel that hydrates when mixed with water or brine to form a hard plug. The cement allows the pill to develop compressive strength over time.
  The final strength of OBC is determined by the pumping ratio of OBC down the drillstring, drilling fluid Pumped concurrently down the annulus and the bentonite to cement ratio. The starting ratio of fluid to OBC is usually 4:1 and produces progressively firmer plugs as the ratio of fluid to OBC decreases to 1:3. The 4:1 ratio mix will produce a highly viscous fluid, while the 1:3 ratio mixes into a semi-soft to hard plug.
  Barite/Hematite Plugs are an effective means of sealing off active borehole sections in extreme or emergency situations. They can be placed to provide an immovable sealing column through either settling or dehydration, thereby preventing further formation fluid intrusion into the wellbore. The plug slurry can be either **water, diesel oil, mineral oil** or **synthetic oil**. The slurry is designed for rapid settling of weight material to form a hard pack.
  The primary application of a wellbore plug is in a well control situation where the well is kicking from a lower formation and simultaneously losing circulation to an upper zone.
  The settling rate of a weight material water slurry is inversely proportional to the density of the slurry. The high concentration of solids and gel strengths means high density slurries settle more slowly than low density slurries. The optimum barite slurry is between 14.0-16.0 lb/gal, however a **barite** slurry can be weighted to 22.0 lb/gal. The optimum weight for a **hematite** slurry is 16.0-18.0 lb/gal.

Lost Circulation

PLANNING AND PREPARATION

For all drilling operations, lost circulation contingencies and prevention procedures should be considered. Remedy of lost circulation will be most effective when it is planned before the well is spudded. Some industry estimates indicate that up to 50% off all lost circulation incidents can be prevented.

The casing plan exerts the single greatest influence in avoiding lost circulation. In many cases induced fractures occur because the intermediate casing string was set too high and the drilling fluid weight needed to control deeper, high-pressure zones fractured an exposed low-pressure formation. As a general rule, there should be a minimum of open hole between the casing shoe and the expected loss zone. Good casing design using all available tools and information to identify potential problem zones is critical, as is knowledge of fracture gradients and the existence of depleted zones. The fracture gradient of depleted zones is often unknown. If cavernous formations are expected close to the surface (common in some land locations), every effort must me made to set the conductor pipe as close to the top of the loss zone as possible. Plans may also be needed for contingency casing strings. If the loss zone is hydrocarbon bearing, consideration needs to be given to possible bullheading operations.

It is also important to plan ahead for LCM stock levels, water or diesel and barite supply, mixing facilities and storage. It is suggested that a minimum stock list should include 300-400 sacks of fine, medium and coarse LCM. This should be a mixture of granular, flake and fibrous materials. There should also be sufficient material for at least four reinforcing plugs. If there is a potential for severe losses, specialized pills (reactive and non-reactive) should be included in inventory. A detailed list will depend on the location and the type of drilling fluid and well to be drilled.

Drilling Fluid Design

Drilling fluid programs usually are determined from an analysis of the formations that will be encountered during a drilling operation. This planning will include the **type** (water, oil or synthetic) as well as the **fluid density, chemistry** and **rheology** required for adequate hole cleaning and maximized penetration rate. If fluid weight is close to the fracture gradient, thereby increasing the risk of lost circulation, the rheological properties of the fluid (plastic viscosity, yield point and gel strengths) and the pump rate should be controlled to minimize ECD while maintaining solids suspension and good hole cleaning.

An important aspect of drilling fluid maintenance is **control of solids**. As drilling progresses, drill solids will be incorporated into the fluid. A high concentration of low-gravity drilled solids will affect the rheology of the fluid. High rheology values cause excessive annular pressure losses that can promote induced fracturing. Every effort should be made to control low-gravity drilled solids to a maximum of five percent (5%) by volume. **Proper pill placement** is a key to correcting lost circulation problems. An out-of-gauge hole can seriously affect accurate placement of lost circulation pills. Placement of such pills usually depends on measured pumping volumes. Unless logs have been run and an accurate knowledge of the hole volume is available, the hole generally is assumed to be in-gauge. This can lead to large errors in the placement of lost-circulation pills, squeezes and plugs. Proper drilling fluid selection can help maintain a stable and gauge wellbore, thus giving the lost circulation material the best chance to remedy the problem.

Oil or synthetic fluids (OBM or SBM) are much more expensive than water base fluids, nevertheless, the OBM/SBM fluids generally provide the best overall drilling results.

It may be necessary to plan on displacing one system with another during the course of drilling the well. An inhibitive system can be used to drill sensitive formations. Once these formations are behind casing, the system can be changed for one less expensive for drilling zones of potential lost returns. Proper planning and a good knowledge of the geology are necessary to drill economically in troublesome areas.

Lost Circulation

PREVENTION AND CONTROL OF LOST CIRCULATION

Minimize Annular Loading

An increase in annular drilling fluid weight due to drilled cuttings can break down the formation, particularly in surface holes. The effective increase in annular drilling fluid weight must be calculated and taken into account. Controlled drilling may be required.

Running LCM In The Drilling Fluid

With partial losses expected or ongoing, adding approximately 15 to 20 lb/bbl LCM (ALL Case or Mica (F) is recommended) to the drilling fluid can possibly prevent losses. This will require bypassing the shakers for prolonged periods. Such action can negatively impact cuttings evaluation if drilling is continued. If a critical formation pick is needed, this technique will have limited value. Before bypassing the solids control equipment to keep LCM in the drilling fluid system, careful consideration should be given to the fact that the major effect of bypassing the equipment will be on the drilling properties. Bypassing the equipment will lead to:

a) increased drilled solids content
b) increased drilling fluid density
c) increased drilling fluid rheological properties, including plastic viscosity, yield point and gel strengths.
d) increased filter cake thickness
e) increased filter cake quality

All of these effects will worsen the lost circulation problem it is intended to combat. These changes in fluid properties will not only increase hydrostatic pressure downhole, but also ECD, the pressure required to break circulation, surge pressures and in pipe sticking. The question to be asked is whether the value of the LCM to be saved is worth the possibility of worsening the problem and losing the hole.

Careful consideration should be given to the addition of LCM if any kicks are to be circulated out as this could easily plug the choke. Kicks associated with losses may be bullheaded.

Maintaining Good Drilling Fluid Properties

- Efficient solids control packages allow the drilling fluid properties to be closely controlled.
- The density should be kept as low as possible to give a satisfactory overbalance.
- Maintain gel strengths, yield point and viscosity at the lowest levels that will effectively clean the hole. High viscosities can increase the ECD to a level that will break sown the formation while circulating.
- Keep fluid loss low to prevent excessive filter cake buildup.

Keeping ECD To A Minimum

- Use a hydraulics program for estimating equivalent circulating density.
- Reduce restrictions in the annulus (filter cake buildup)
- Keep hydraulics at the minimum level required to clean the hole.
- Control the ROP to avoid over loading the annulus.
- Reduce the length of the exposed loss zone and reduce the influx size.

Lost Circulation

Minimizing Surge And Swab Pressures

- Use a hydraulics program for determining trip velocity and acceleration schedule.
- While tripping in, break circulation at the shoe and approximately every 1000 ft. in the open hole.
- Circulate at least 5 minutes.
- Bring the pumps up slowly after connections.
- Rotate the pipe before turning on the pumps.
- While tripping out, pump out for the first few stands/singles off bottom.
- Keep tripping speeds slow across areas of potential lost circulation.
- Surge pressure calculations should be made and the driller instructed as to the maximum allowable speed for running pipe.
- Consider the use of lubricants to reduce drag.
- Consider the use of sweeps to clear the cuttings from the wellbore prior to tripping to run casing. This will minimize cuttings bridges when running casing and cementing.

Surface Equipment

- Remove pump strainers.
- Line up surface piping so a least one mud pump can be rapidly switched to water.
- Pressure test all surface equipment in advance. The normal procedure would be to check for leaks in the surface equipment before assuming losses were downhole.
- Ensure that no drilling fluid transfers, additions, or dilutions are made while drilling proceeds toward or in a loss zone.

Downhole Equipment

- Remove bit nozzles if large losses are expected.
- Minimize the BHA. No stabilizers and only the minimum number of collars and heavy weight drill pipe should be run. Restrict angle build by maintaining high RPM and low weight.
- Avoid running tools with limited flow paths or restriction where possible. This includes core barrels, MWDs, mud motors, floats and survey rings.
- Avoid running drill pipe casing protectors that can swell and act like a packer.

Pulling Back To Safety

- The string can be pumped out of the hole, thereby displacing the treatment while pulling out. Continue pulling to the shoe, keeping the pipe moving at all times.
- Cement should not be pumped if there are doubts about whether the string can be safely pulled back to the shoe.

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Lost Circulation

Warning Signs

- There is a possibility that seepage losses may occur prior to major losses.
- It is still essential to monitor for signs of increasing overpressure.

Attacking Immediately

- Losses should be dealt with as soon as they occur. It is possible to drill ahead with losses, but if the open hole section it too large, it is difficult to direct the treatment to the place where it is needed. Additionally, if a higher pressure zone is penetrated, an underground blowout may result.
- To permit a treatment as soon as the loss zone is encountered, the slug pit should be filled with an LCM pill. A minimum of 100 barrels pumpable volume should be available. This should be mixed at the highest concentration the agitators can handle.
- Prepare a large volume of reserve drilling fluid.

Identify Where The Loss Zone Is

- If losses first occur while drilling ahead, or are accompanied by a change in torque or a drilling break (including the bit dropping), the losses are likely to be on bottom.
- If losses occur while tripping or increasing drilling fluid weight, the losses may be off bottom. If necessary, a temperature or spinner survey can be run.

Avoiding Stuck Pipe

- When losses occur, cuttings will settle out around the BHA and may mechanically stick the pipe. The cuttings will act as a packer and worsen losses below them. Always keep the pipe moving. Where possible, pull to the shoe before attempting a treatment.
- Reactive clays overlying the loss zone are likely to become unstable if exposed to uninhibited fluids.
- As loss zones may be low pressure, beware of differential sticking.

Well Control

- When losses occur in a highly permeable gas bearing zone with the annulus closed, there is a high likelihood of gas invasion. This effect will cause the gas to migrate up the wellbore, displacing the drilling fluid in the well. If bullheading is used, bullheading rates must never be less than 600 gal/min. If it is necessary to pump fresh water, brine water or any fluid of varying density to the well, ensure that the number of strokes pumped is recorded. It is essential to be able to calculate the height of water/brine, and therefore the hydrostatic pressure in the well at all times.

Lost Circulation

DETECTION AND ANALYSIS OF LOSSES

Effective treatment of lost circulation consists of a series of steps that include:

1. Assessing the possible causes of lost circulation.
2. Identification of the type of loss zone.
3. Establishing the location of the zone.
4. Selection of the proper treatment.

Knowing the type of loss zone helps identify the best lost circulation materials to use, the probable location of the loss, and the changes in drilling fluid properties and drilling practices that may be required to control the loss.

Establishing the location of the loss zone in necessary to place the LCM in the area where it will have the best opportunity to sea the zone. Choosing the right treatment requires knowing the type of zone to be sealed.

Before attempting to cure a lost circulation problem, it is important to confirm that losses are occurring downhole and not at the surface or around the casing. The following procedure is recommended:

- Establish the loss rate.
- Check the solids control equipment to ensure that no new equipment has been placed on line and the discharge rates are normal.
- Check to ensure no drilling fluid has been dumped, transferred or otherwise removed from the system.
- Check all joints, pipe connections and valves for leaks.
- Assess casing ware potential.

Possible Causes Of Lost Circulation

Imagined

When a drop in the drilling fluid volume is noted, it frequently is assumed the losses are occurring downhnole. This may not always be the case. The first line of action should be to pick the bit up off bottom and observe the well for fluid movement. Then establish a rate of loss. Once the rate of loss is established, check the solids control equipment for excess discharge rates.

Check with appropriate personnel that no drilling fluid has been dumped or transferred.

Drilling Unconsolidated or Highly Permeable Formations

Extremely permeable formations with high inter-granular porosity usually are found at shallow depths and are rarely over-pressured. In these zones, the pores usually are too large for the formation of a competent filter cake. Consequently, when hydrostatic pressure exceeds the formation pore pressure, drilling fluid will be forced into the rock. Lost circulation may be initiated while drilling, tripping or circulating to condition the hole prior to running casing.

The loss usually starts with a gradual reduction in the pit level and may exceed rig pumping capacity if no remedial action is taken. This type of loss can range from seepage to severe losses and often dead to differentially stuck pipe.

Natural Fissures Or Fractures

This type of lost circulation can occur in many rock types and only requires that the mud hydrostatic pressure exceed the fluid pressure within the rock. This can happen at overbalances as low as 50 psi. Older, harder and more consolidated formations are the more likely locations for natural fractures.

Lost Circulation

They are created by geological movements after sedimentation and compaction and have a higher frequency of occurrence near faults and areas that have been subjected to tectonic forces and stresses, such as movement of salt domes or diapirs.

Initial loss rate can be seepage, but can quickly approach the severe category if drilling proceeds. This type of loss can cause some of the most troublesome lost circulation incidents recorded.

Cavernous Or Vugular Formations

These are normally found in limestone formations and when drilled, are characterized by sudden, complete losses with the bit often dropping several feet. The loss rates often will exceed rig pumping capabilities. The caverns are caused by water percolating through the limestone formations over geological periods of time creating channels.

Caverns can be localized or form part of a more extensive system where the voids may range in size from pinholes to tunnels. Pressures in these formations usually are sub-normal, meaning they are below that of a freshwater gradient. Caverns are the most difficult lost circulation zones in which to re-establish returns and in many cases the well must be drilled "blind" or with no returns.

Air, foam or aerated fluid drilling may be effective in these circumstances. If the caverns occur close to the surface, location collapse is possible.

Induced Fractures

Induced fractures occur when some critical pressure exceeds the fracture gradient of the rock, causing the formation to break down. Conditions that can lead to excessive pressures include:

Drilling Fluid Weight

Drilling fluid weight is the major source of pressure in the well. The density of the fluid should be maintained at a safe minimum to: 1) hold back formation pressure, 2) allow tripping (trip margin), 3) stabilize the wellbore (note that weak formations require an effective fluid overbalance for stability, which is dependent on well inclination and direction with respect to the in-situ stresses).

While drilling, a transition from an abnormally pressured zone to a normal or sub-pressured zone may be encountered. This pressure differential may be sufficient to cause induced losses. These induced losses occur in the form of hydraulically fracturing the shales or the pressure may be sufficient to cause whole drilling fluid invasion into the permeable sandstone.

f hydraulic fracturing of the formation is suspected, the most probable point of loss is just below the casing shoe.

During well control situations lost circulation can occur when the well is shut-in. The shut-in pressure is transmitted down the wellbore, breaking the formation at its weakest point, this not only results in lost circulation, but losing control of the well.

Proper planning and execution will minimize the possibility and severity of the kick. Personnel responsible for the operation at the well site should be aware of the maximum allowable casing shut-in pressure and volume. The volume of the intruding fluid or gas is directly related to the shut-in pressure and should be minimized.

If a well has been shut-in, proper kill procedures should be used to maintain a sufficient and constant bottom-hole pressure to kill the well. If proper procedures are not followed, an underground blowout can occur.

Proper planning and execution is the key to avoiding mud losses caused by excessive drilling fluid density. Always maintain as low a drilling fluid weight as practical.

Lost Circulation

Equivalent Circulating Density (ECD)

The pressure losses associated with circulation result in an increase in effective drilling fluid weight know n as the Equivalent Circulating Density (ECD). This increase may be sufficient to induce losses. Where conditions allow, these losses may be cured by reducing the base drilling fluid weight and rheology, slowing down the pump rate or a combination of both. Proper attention, however, should be given to hole cleaning and wellbore stability when these remedies are considered.

ECD is calculated by the following equation: $ECD\ (lb/gal) = \frac{\rho\ (lb/gal) + P_a(psi)}{[0.052 \times TVD\ (ft)]}$

Where:

ρ = fluid density in lb/gal

P_a = pressure loss in the annulus in psi

If high drilling fluid weight is required to control abnormal formation pressures in another part of the hole, this may result in losses to a weak zone. If the density cannot be reduced without destabilizing the well or inducing a kick, consideration should be given to reducing the ECD through alternating either the pump rates or the flow properties of the fluid.

If alteration of the low rate or rheology is considered, close attention to hole cleaning must be observed so as not to stick the pipe or overload the annulus with cuttings. A possible solution would be to pump high viscosity sweeps containing lost circulation material.

Pump Rate/Drilling Fluid Rheology

Flow properties and circulation rate should be balanced to give the minimum pressure losses consistent with cuttings removal. High rates of circulation, while improving hole cleaning, may expose the formation to excessive pressure.

Conversely, high yield point and high gel strengths may also subject the formation to high pressures for a given pump rate. When these types of losses are seepage in nature, simply reducing the pump rate for a given period may actually cure the losses.

Once the losses are cured, the pump strokes may be brought up gradually until the desired pump rate is achieved.

Filtration Control

A high fluid loss generally equates to a thick filter cake building against the formation. This reduces the annular clearance. A half-inch filter cake reduces an 8-1/2 inch hole to 7-1/2 inches or a 6-1/2 inch hole to a 5-1/2 inch hole.

Smaller diameter annuli lead to higher velocities for a given flow rate and hence, a higher ECD. In severe cases, the drilling fluid cake can reach a level where the hole pack off around the drillstring.

Cuttings Related

Cuttings can affect lost circulation in several ways. When hole cleaning is inadequate, cuttings may accumulate in the annulus, loading up the drilling fluid locally until losses are induced.

Hole washouts can reduce the fluid velocity to the point where cuttings are no longer transported out of the well. When that occurs, they may accumulate, slough downwards and bridge off where hole size is normal, resulting in pressure surges.

In deviated wells, cutting beds not properly eroded and left to build up may slump in the hole, packing off and pressurizing the formation to the point of breakdown.

Disturbing Cuttings Beds

One common practice when drilling deviated wells is to pump pills of significantly differing viscosities to assist with hole cleaning. It is possible when disturbing these beds to have a slumping situation where these cuttings actually pack-off and pressure up the formation to the breakdown point.

Lost Circulation

Pressure Surges

Pressure surges that derive from pump surging while breaking circulation or rapid lowering of the drill pipe or casing can result in a pressure peak high enough to break down the formation. The induced fracture(s) may propagate rapidly at the fracture propagation pressure, which is significantly lower than the formation breakdown pressure, resulting in losses.

A number of drilling practices are capable of inducing downhole losses by creating surge pressures that will increase the pressure on the formation:

- Running in with the drillstring or casing will inevitably create a piston effect and a surge pressure. This problem will be made worse by packed-hole assemblies and when the drilling fluid is cold and has high gel strengths. It may be necessary to break circulation at several stages while tripping in the hole. Maximum allowable pipe handling speeds should be set and followed.
- Pump surge. If the pump speed is increased rapidly, surge pressure will be generated. It is essential to bring the pump on line slowly and with care.
- Excessive penetration rate. It is always necessary to control penetration rates to ensure the annulus is being cleaned. Controlled drilling will be required if a formation with a low-fracture gradient is exposed in the open-hole section.

Hole Enlargement

Hole enlargement will lead to a resulting drop in fluid velocity in the portion of the wellbore where it has occurred. Increased wellbore size allows depositional buildup of the cuttings in this section.

Once enough cuttings accumulate in the washout section they may begin to slump in and bridge the wellbore, resulting in a packed-off situation. Pack-offs will then increase the pressure resulting in a breakdown of the formation.

Hole In The Casing

A hole in the casing can lead to lost circulation by subjecting the formation, previously protected by the casing, to drilling fluid weight that exceeds it fracture gradient.

Circulating Casing

Because of the higher pressures resulting from smaller annular clearances, losses often occur while circulating the casing. During this stage of the operation the fluid often is in a cooled down state. The increased rheologies associated with this cooled state lead to higher circulating pressures.

Locating The Thief Zone

It is very important to establish the location of the losses. If not, the chances are treatments will not be successful. Knowing what type losses are occurring make it possible to determine the type of lost circulation material, the probable position of the loss zone and whether any changes to the drilling fluid weight, fluid properties or drilling practices are necessary.

CHARACTERISTICS OF LOSS ZONE

Losses Through Pores

- Occur in unconsolidated or high matrix permeability formations.
- Occur when solids content of mud is low.
- Losses start gradually, building up to a maximum rate with additional penetration.
- Loss rate not appreciably higher while tripping in.

Lost Circulation

- Loss rate not very sensitive to pump rate.
- Drilling fluid weight substantially below fracture gradient.

Losses Through Natural Fractures

- Drilling fluid weight substantially below fracture gradient.
- Formation is not of high matrix permeability.
- Losses start suddenly.
- Loss rate increases exponentially.
- Loss rate while tripping is similar to circulating.
- Loss rate is somewhat sensitive to pump rate.
- With additional penetration, loss rate is highly variable at constant overbalance.
- Losses may be associated with a drilling break.

Losses Through Caverns

- Drilling fluid weight below fracture gradient.
- Losses are instantaneous.
- Losses may be associated with a drilling break or the bit may drop form a few inches to a few feet just preceding the loss.
- Excessive torque may be experienced before loss.
- Rock may have been subjected to dolomitization or karstification.
- Loss rate while tripping is similar to circulating.
- With additional penetration, loss rate is highly variable at constant overbalance.

Losses Through Induced Fractures

- Drilling fluid weight approximately equal to or greater than fracture gradient.
- Formation may be impermeable (shale) and not have high matrix permeability.
- Likely to occur when a change in lithology is encountered from shale to sandstone.
- Losses start suddenly, initial rate is maximum rate.
- Loss rate is considerably higher when tripping pipe.
- Loss rate is very sensitive to pump rate.
- Loss rate is not associated with a drilling break.

POSITION OF THE LOSS ZONE

Locating the loss zone position is paramount to rectifying lost circulation problems. Correct identification of the position of the thief zone allows for proper placement of the lost circulation material. The thief zone can be located from previous drilling records, drilling rates, drilling breaks, formation changers and from various logging techniques.

- If the losses are experienced while **drilling**, the zone likely is on bottom and caused by natural fractures, caverns or highly permeable formations
- If losses are experienced while **tripping** or while **increasing mud weight**, the loss zone probably is not on bottom and is a result on induced fractures. Recognizing a loss while tripping back into the hole requires attention to the volume of fluid being displaced by the pipe. This volume can be determined by either visual observation or from regular examination of the pit level record.

Lost Circulation

- **Drilling** into a sub-normally pressured, **naturally fractured formation** usually is indicated by a sudden high loss of returns accompanied by an increase in rotary torque. This is a reliable indication that the loss circulation zone is at bit depth when no previous problems have been encountered.

Losses are normally "on-bottom" if:

- They first occur while drilling ahead.
- The loss is accompanied by a notable change in ROP, torque, or drilling roughness.
- Induced fractures on-bottom can be caused by balled-up BHA or bit restricting the annulus.
- The loss is due obviously to natural fractures, faults, caverns, vugs or highly-permeable sands and gravels, drilling break with increase in torque and Kelly free falls while drilling coupled with an instant loss in circulation.

Losses are normally "off-bottom" if:

- They first occur while tripping, drilling fast or increasing drilling fluid weight.
- They are obviously the result of an induced fracture.
- They are the result of shutting the well in and killing the well.
- Annular loading increases and the apparent mud weight is higher than the last casing shoe fracture gradient.

Logging Methods

- **Spinner Survey**. A spinner survey tool acts as a down hole flow meter so the fluid flow into the loss zone can be identified. The spinner survey is made by running a small spinner attachment into the well on a single conductor cable in such a manner that the rotor would spin or turn if there is any horizontal movement in the fluid. There are two limitations of this method: 1. It requires deliberate loss of large volumes of mud and 2. It is not effective where sealing particles are already present in the mud.
- **Radioactive Tracer Survey**. Radioactive surveys for the point of loss consist of making two gamma ray surveys. A base log is run before the introduction a radioactive material. A slug of drilling fluid containing radioactive material is pumped down the hole. A new log is then run and high concentrations of radioactive material will be noted as the point of loss. This method provides accurate data for locating the loss zone but requires expensive equipment and additional deliberate loss of fluid to obtain the desired results.
- **Hot Wire Survey.** The hot wire essentially is a calibrated resistance wire sensitive to temperature changes. It is run to a desired depth in the well and the resistance is noted. Drilling fluid is then pumped into the hole. If the tool is above the loss zone, fluid will flow, changing its resistance. If the resistance does not change, the tool is below the point of loss. The tool can be used in any type of drilling fluid, but large a volume of drilling fluid is required while making the survey.
- **Pressure Transducer Survey**. This type of survey involves using a short cylinder that is open at the tip and swaged at the bottom to restrict the flow of drilling fluid through the tube. There is a window fitted with a neoprene diaphragm on one side of the tube. On the diaphragm there is an electrode that moves back and forth between two fixed electrodes. As the pressure differential varies across the diaphragm, the potential varies in the electric circuit indicating the rate of flow and where the mud becomes static.

This method appears to have certain advantages:

1. It is simple in construction and operation.
2. It is not easily clogged by lost circulation material.
3. It is workable in almost any type of mud.
4. It can be used to locate a hole in the casing.

The disadvantages are: 1. Considerable fluid flow is required and 2. The equipment may not be readily available.

Lost Circulation

Open Hole Logs

- Open hole logs can be used to indicate zones of high drilling fluid invasion which may be linked to induced fractures. Logs can also supply information regarding the mechanical properties of the formation in the wellbore and the directions of the minimum and maximum stresses. They do not give exact formation strength, but offer a comparison among the various formations. Thus, a formation-properties log can be qualitatively used to quickly identify weak zones.

Sonic Logs.

- The **Ultrasonic Borehole Imager (UBI)** tool provides a high resolution image of the borehole and identifies the orientation of any breakouts (washouts) and clearly shows any fractures that may be present. Breakouts usually appear in the direction of the minimum stress, whereas induced fractures are perpendicular to the minimum stress direction.
- The **Dipole Shear Sonic Imager (DSI)** tool uses shear wave anisotropy in the rock to determine the stress orientation. Therefore, it is more reliable as it does not rely of wellbore failure. Fluid invasion also can be inferred from differences in the transit time between **LWD** and **wireline sonic logs.** If invasion occurs, the sonic slowness is seen to increase (wireline logs will indicate a slower formation than the LWD log)

Compensated Dual Resistivity (CDR) tool can also be used for fracture detection if **OBM** or **SBM** is used, but not water-based drilling fluids as there is insufficient resistivity contrast. This log can be run as part of the LWD tool. A comparison with logs run later on wireline can then identify post-drilling fracturing or fracture healing.

Though it is a good practice to locate the thief zone, there are several reason why surveys are not run more often.

- Considerable time is spent getting the necessary equipment to the rig and a deliberate loss of mud is required for the surveys.
- The results of the surveys are sometimes difficult to interpret.
- Conditions may not allow these tool to be run because of abnormal subsurface pressure.

Mud Loggers Chart

- This data can provide an accurate record of how and when losses occurred. Offset well log data is also very useful in this identification process. The rig site geologists often has offset log data of the formation from adjacent wells which can help identify the cause and potential location of the loss. The drilling fluid engineer can help in deciding whether any changes in the mud properties are warranted.

Lost Circulation

RECOMMENDED TREATMENT

When lost circulation is initially experienced, the drilling fluid weight should be reduced, if possible. An estimate of the maximum drilling fluid weight the formation can withstand can be obtained by the method described below:

- If the fluid level in the annulus is falling when the pumps are off, fill the annulus from the top with water or base fluid, depending on the drilling fluid system, and calculate the new gradient.

If there are no returns when pumping:

- Fill the annulus from the top with water or base fluid.
- Compare the circulating pressure (in psi) prior to the losses occurring (pressure $\mathbf{P_1}$) with the pressure at the same circulating rate after the losses have occurred (pressure $\mathbf{P_2}$). Length of the empty hole in feet is calculated:

$$\frac{P_1 - P_2}{0.052 \times MW}$$

Where P_1 and P_2 are standpipe pressure in psi, and MW is the drilling fluid density in lb/gal.

- If the position of the loss zone is known, a new drilling fluid gradient can be calculated to balance the weakened formation.
- Reduce the ECD by lowering pumping rate or conditioning the fluid to lower gel strength and plastic viscosity.

The following charts and procedures are designed to provide the responses to the first actions that should be taken when encountering losses and when reducing drilling fluid density can not be achieved or failed to work. While these should be adhered to initially, specific conditions and the experience gained from previous treatments may dictate change with time.

Formula to calculate annular mud weight due to cuttings loading:

$$\text{Annular Mud Weight lb/gal} = \frac{[Q]\,[W_1] + [0.00567]\,[D_h]^2\,[ROP]\,[SG\ Drill\ Solids]}{Q + [0.00068]\,D_h]^2\ [ROP]}$$

Q= circulation rate, gal/min
W_1= mud weight in suction pit
D_h =hole diameter in inches
ROP= drill rate in ft/hr
SG= specific gravity of drill solids

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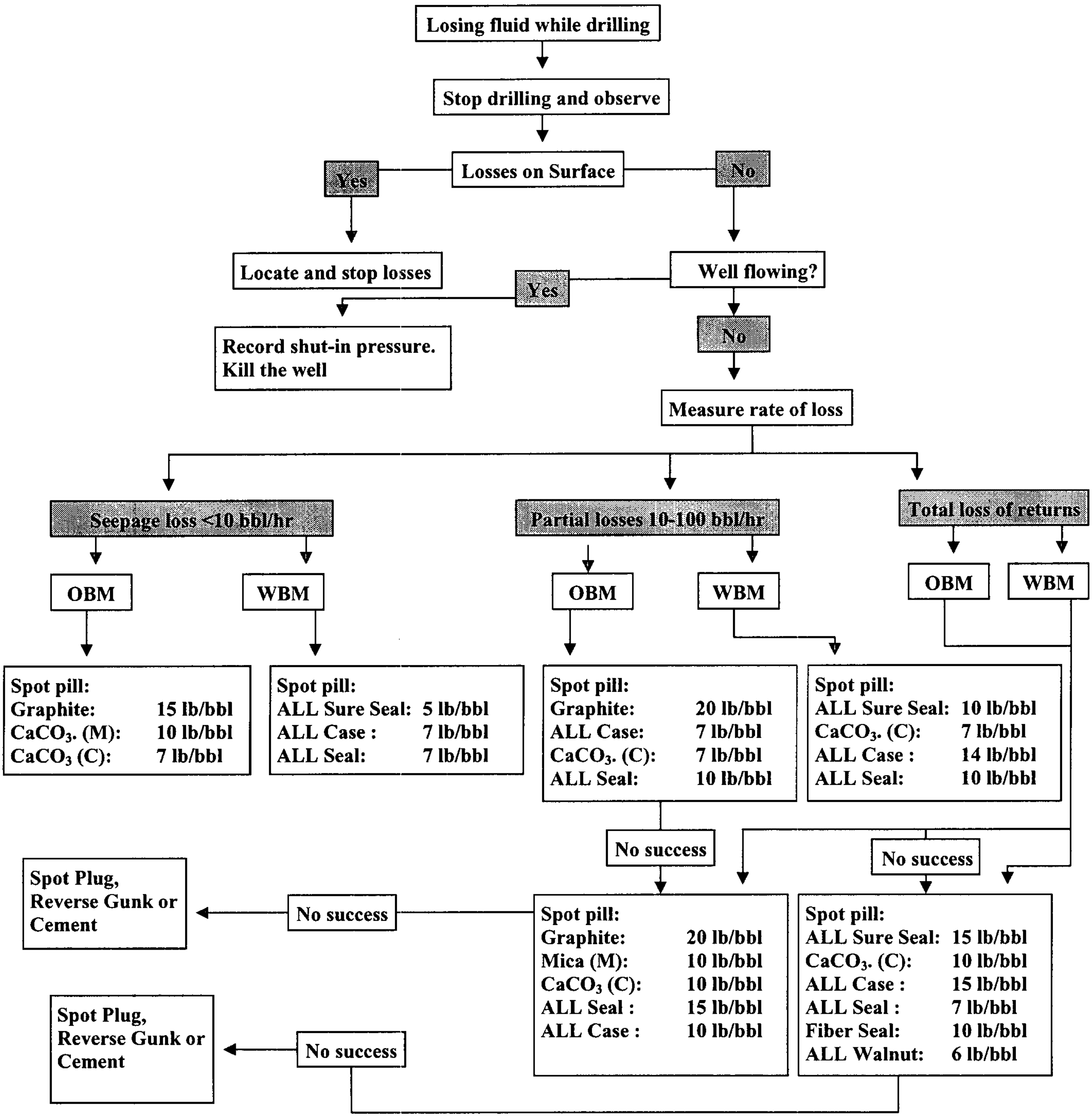
Lost Circulation Plan - Continued



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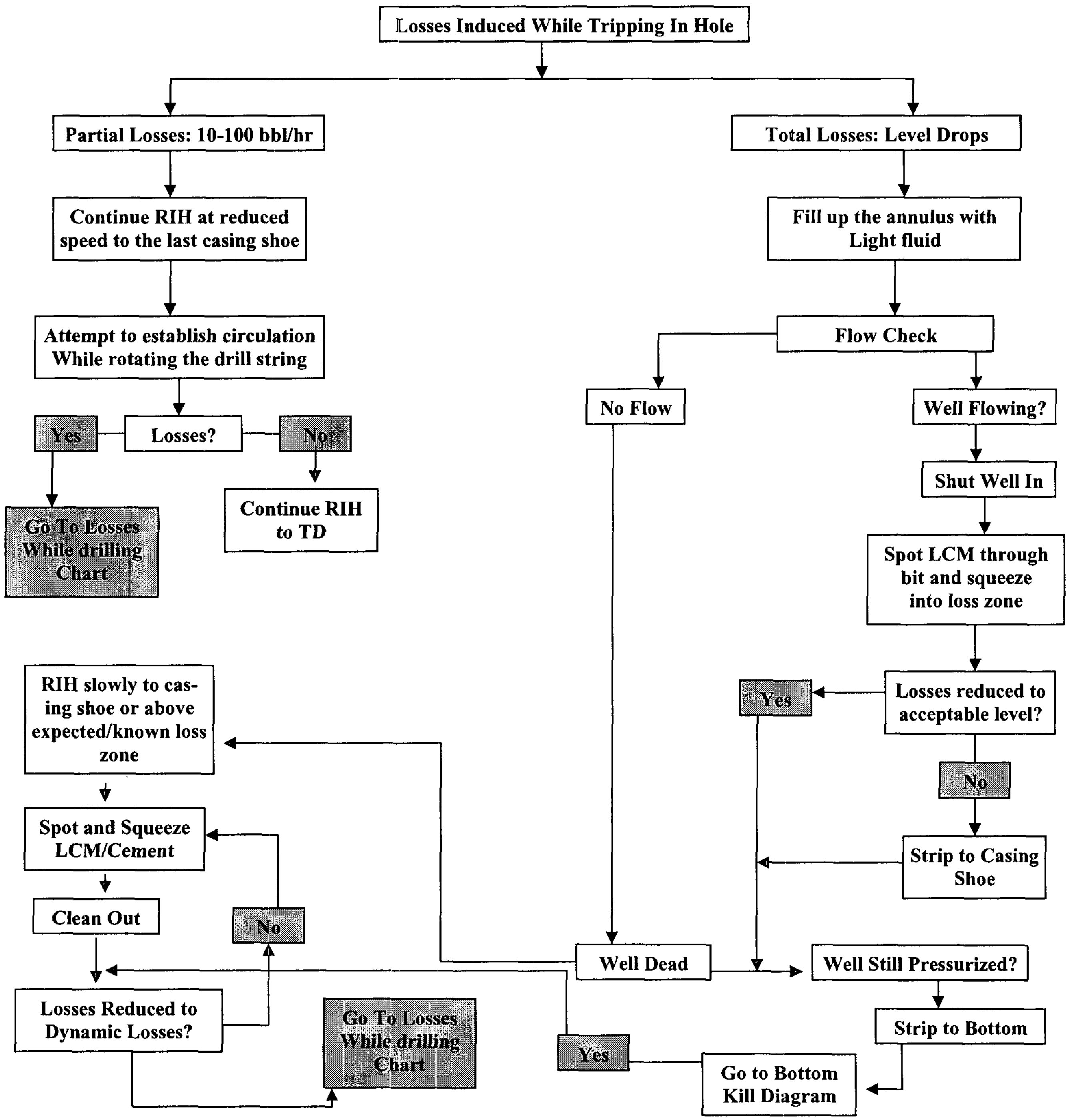
Lost Circulation Plan - Continued



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