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AR0012

Supplemental Remedial Investigation Report

for

Frontier Fertilizer

Davis, California

Volume 2 - Appendices

Submitted to.

U.S. Environmental Protection Agency
Region IX

EPA Contract Number 68-W9-0060
EPA Work Assignment Number 60-28-9L4R

Prepared by
Bechtel Environmental, Inc.

June 1999

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Appendix A

Well Boring Logs

EXPLANATION FOR SES BORING LOGS

SIERRA

GRAVEL

Sandy GRAVEL

Silty GRAVEL

Clayey GRAVEL

SAND

Silty SAND

Sandy SILT

Clayey SAND

SILT

CLAY

Sandy CLAY

Silty CLAY

Clayey SILT

Organics

Base Rock

Asphalt

Concrete

Bentonite

Cement Grout

K = Field estimation of soil hydraulic conductivity

Drive sample interval

Drive sample collected for possible chemical analysis

Contact between sedimentary or lithologic units; solid where definite dashed where approximate, dotted where uncertain; hatched where gradational

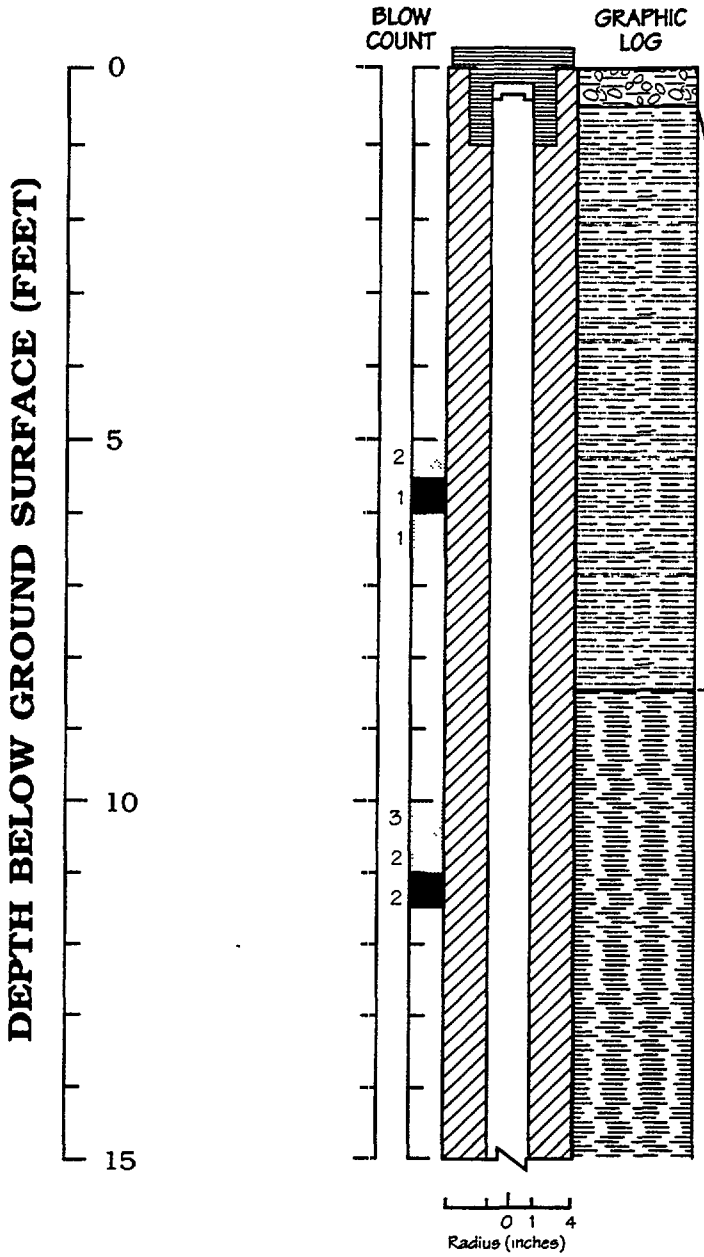
Initial water level measured during drilling (date in italics)

Static water level measured after well development (date in italics)

NOTE: Soils are logged using ASTM D2487 Soil Classification System

BORING OW-5C

SIERRA



DESCRIPTION

Gravelly CLAY with Silt (GC): brown; damp; firm; ~10% sand; ~15% gravel from 0.5-2.0" diameter

Clayey SILT (ML): brown; damp; firm; 20-40% clay; 55-75% silt; ~5% gravel to 1" diameter

dark brown; moist; soft; subangular gravel to 1" diameter at 5'

CLAY with Silt (CL): dark brown; moist; soft to firm

MR-958-00 [OW-5C] 11/11/97

Well Construction and Boring Log - Well OW-5C

Frontier Fertilizer
Davis, California

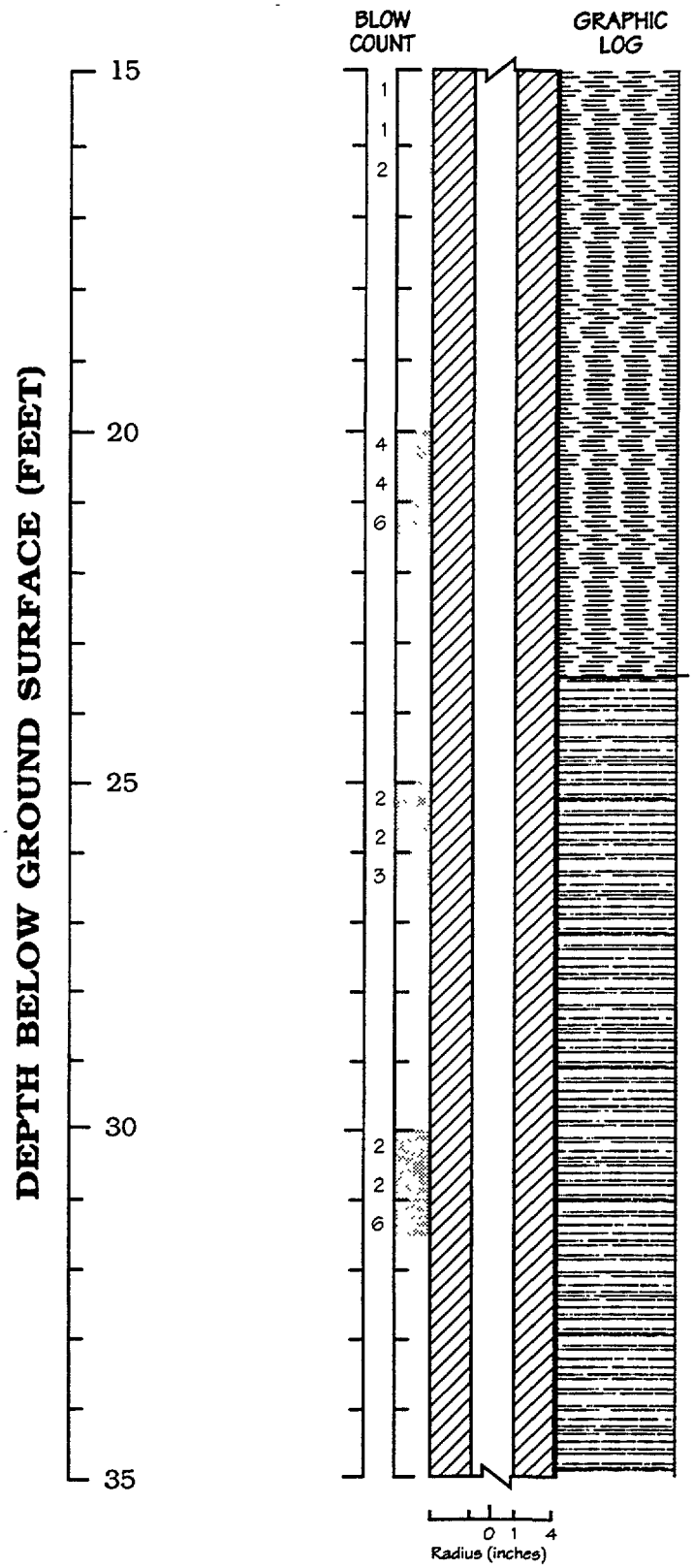
Logged By:	C. Bramer
Supervisor:	D. Leland, P.E. #C46713
Drilling Company:	Soils Exploration Services
C-57#:	582696
Driller:	Dave Ryan
Drilling Method:	Hollow stem auger
Date Drilled:	October 15, 1997
Well Head Completion:	12" traffic-rated vault
Type of Sampler:	Split barrel (2" ID)

Well Details

Concrete Grout:	0-88'
Bentonite Seal:	88-91'
Sand:	91-104'
Screen:	93-103'
Sump:	103-104'

WELL OW-5C
(continued)

SIERRA



DESCRIPTION

CLAY with Silt (CL): continued

grading to firm at 17′

increasing plasticity; stiff at 20′

SILT with Clay (ML): medium brown; stiff; moist; minor very fine sand
soft to firm at 25′

caliche at 30′

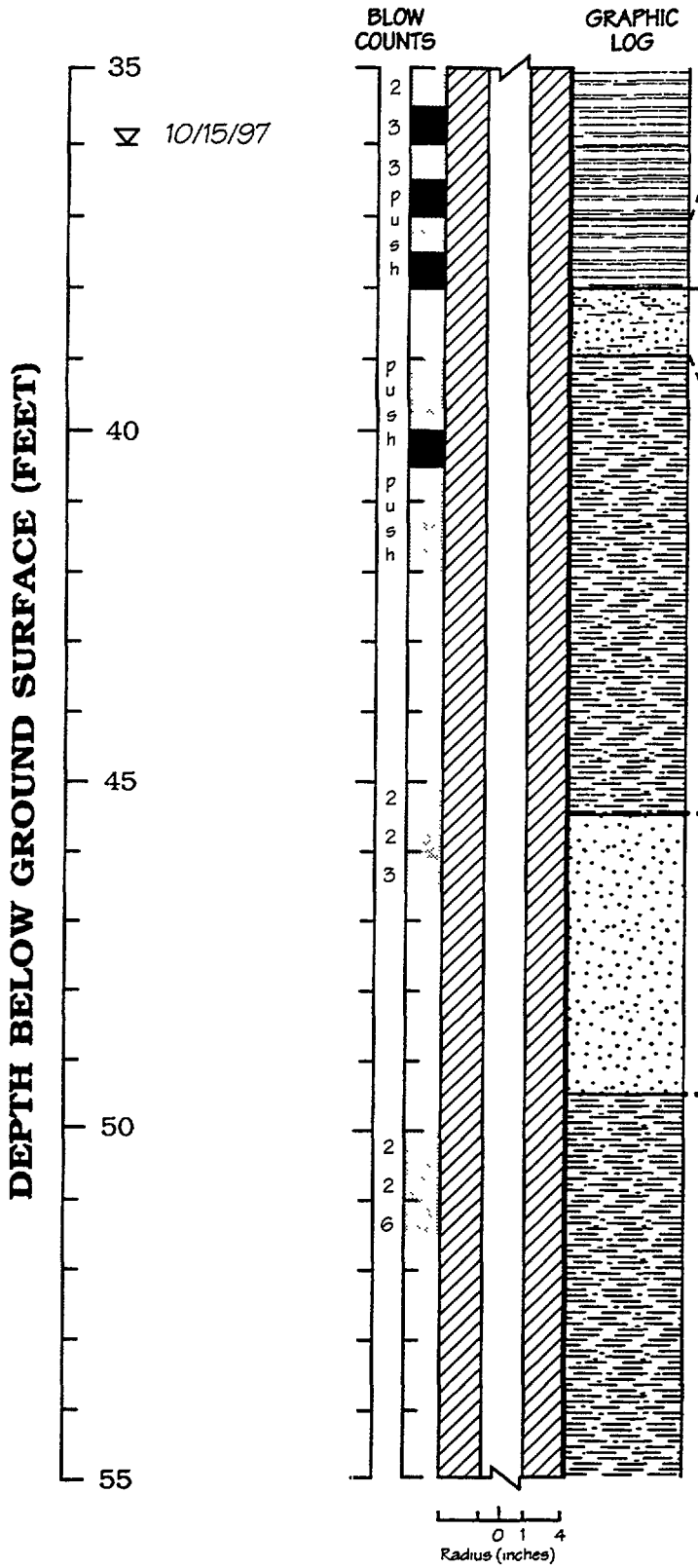
R-958-00 [OW-5C.1] 11/11/97

Well Construction and Boring Log - Well OW-5C (cont.)

Frontier Fertilizer
Davis, California

WELL OW-5C
(continued)

SIERRA



DESCRIPTION

SILT with Clay (ML): continued

SILT with Fine Sand and Clay (ML): olive-brown, mottled yellow; moist to wet; firm; 20-30% fine sand; carbonate spots and streaks

Clayey SAND with Silt (SC): olive; wet; medium dense; 60-70% medium to coarse sand; 5-10% gravel to 1" diameter

Silty CLAY (CL): olive-brown, mottled gray; moist; firm

grades to **SAND (SP):** gray-brown; very wet; medium dense; poorly-graded, clean, fine-grained sand

wet at 49'

grades to **Silty CLAY (CL):** olive-green, mottled brown; moist; firm to stiff

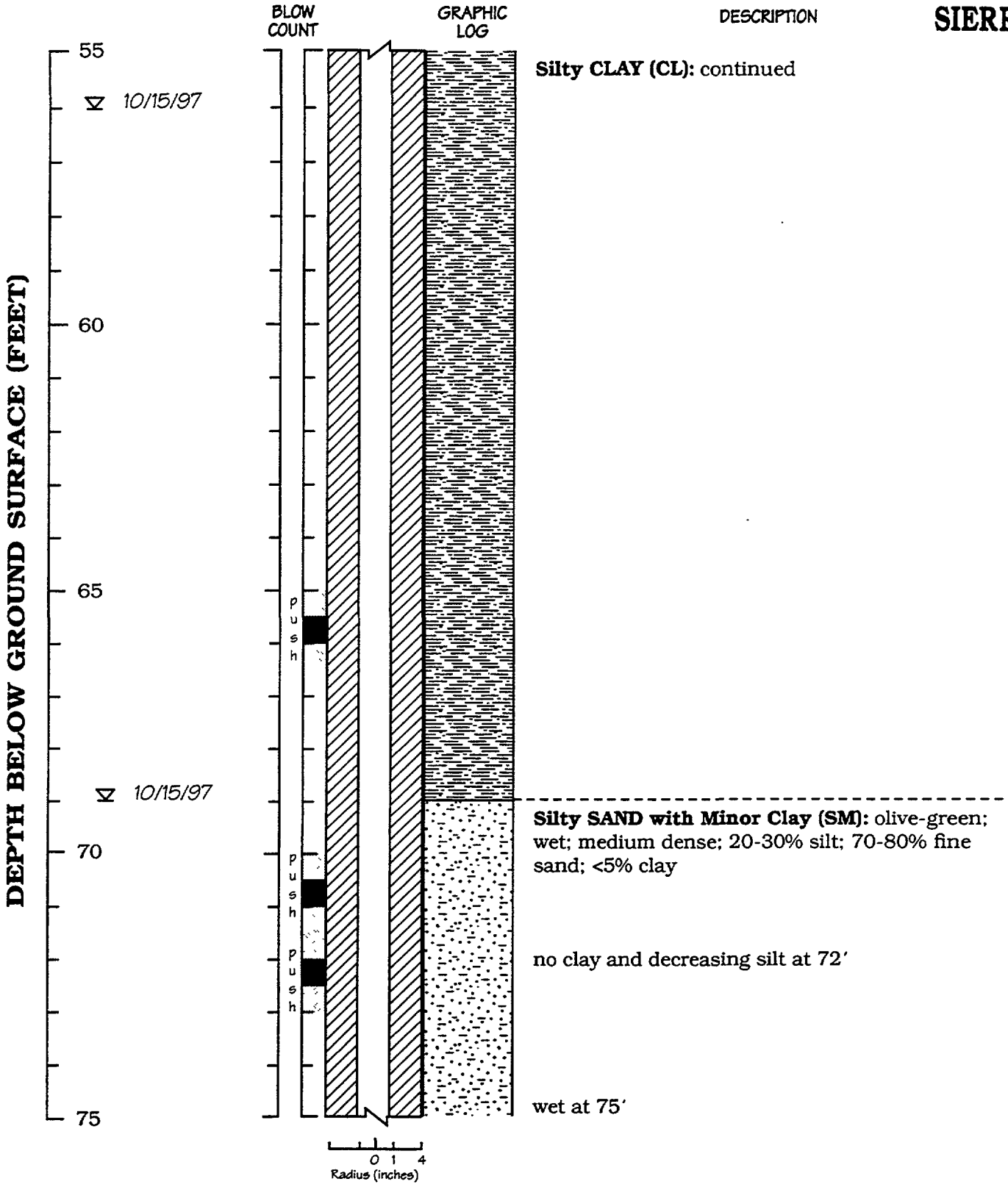
stiff at 53'

Well Construction and Boring Log – Well OW-5C (cont.)

Frontier Fertilizer
Davis, California

WELL OW-5C
(continued)

SIERRA

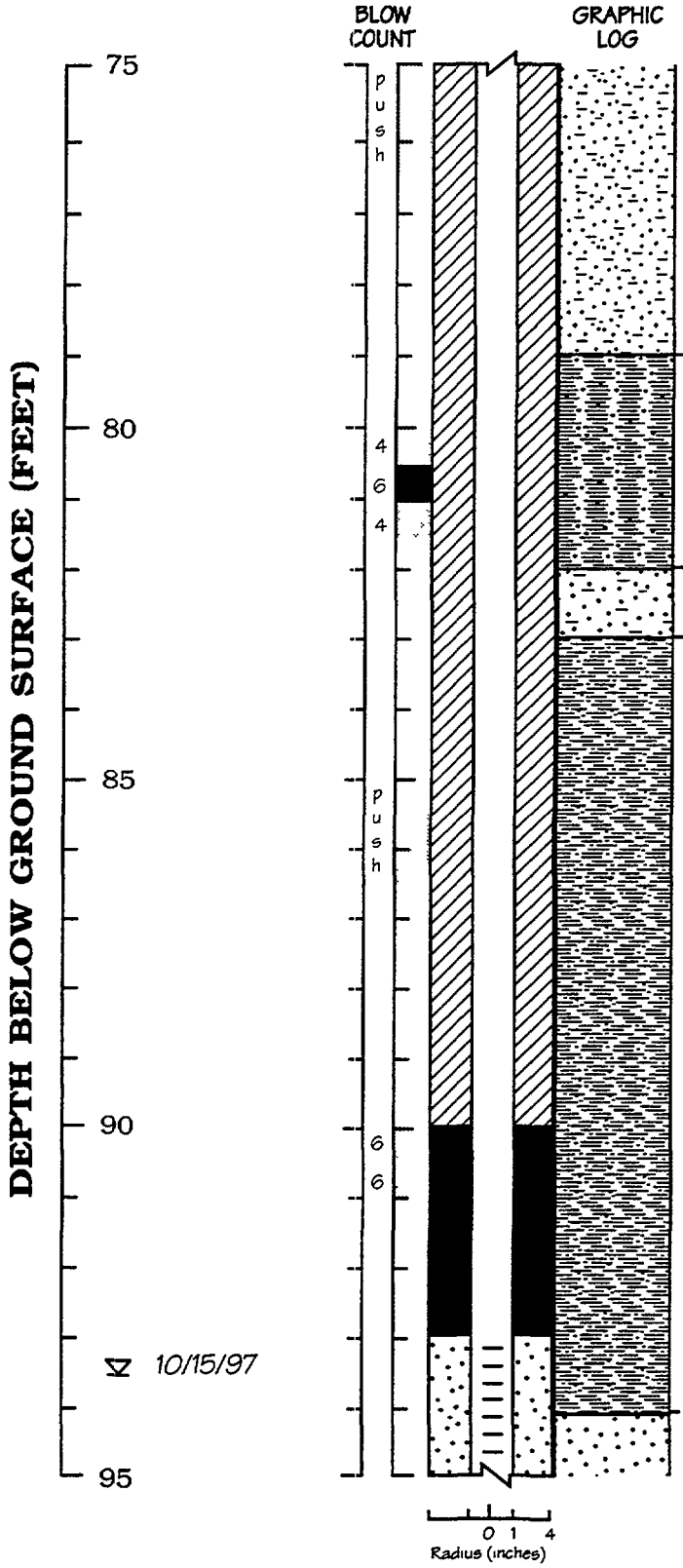


Well Construction and Boring Log – Well OW-5C (cont.)

Frontier Fertilizer
Davis, California

WELL OW-5C
(continued)

SIERRA



DESCRIPTION

Silty SAND with Minor Clay (GM): continued

Sandy CLAY with Silt (CL): medium brown; wet; soft; 30-40% fine sand

driller reports soft layer 1-1.5' thick (SM)?

Silty CLAY with Fine Sand (CL): olive-green; moist; firm to stiff; 60-75% clay; 20-30% silt; 5-10% fine sand

SAND with Gravel and Silt (SW): brown; wet; medium dense; 0-10% silt; 90-100% medium to coarse sand; ~5% subrounded gravel to 1" diameter

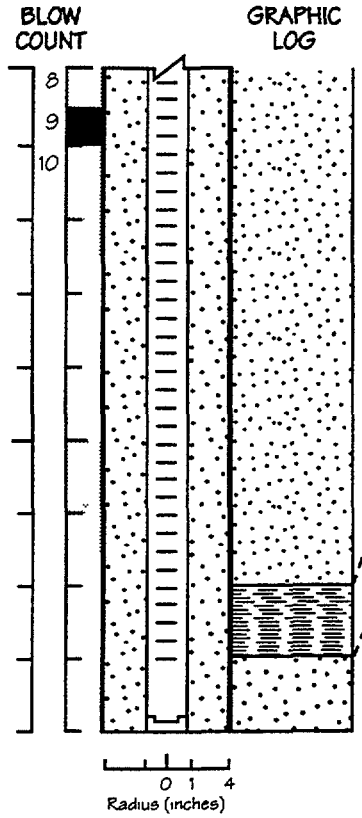
Well Construction and Boring Log - Well OW-5C (cont.)

Frontier Fertilizer
Davis, California

WELL OW-5C
(continued)

SIERRA

DEPTH BELOW GROUND SURFACE (FEET)



DESCRIPTION

SAND with Gravel and Silt (SW): continued

drilling suggests **CLAY**

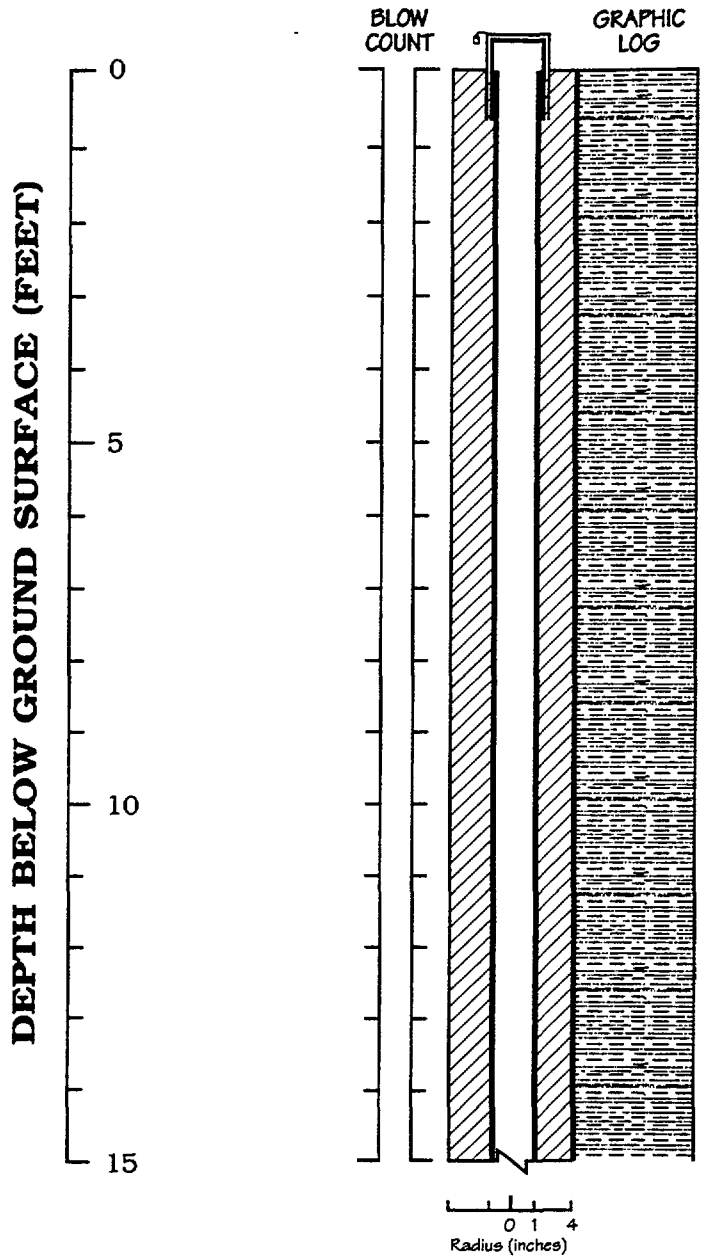
SAND with Gravel and Silt (SW): brown; wet; very dense; 0-10% silt; 90-100% medium to coarse sand; ~5% subrounded gravel to 1" diameter

BOH at 104'

Well Construction and Boring Log - Well OW-5C (cont.)

Frontier Fertilizer
Davis, California

WELL OW-8C



DESCRIPTION

Clayey SILT (ML): gray; damp; soft to firm; 15-30% clay; ~5% fine sand

Darker color with depth

0-5% gravel, from 1/2 to 1" diameter

Color change to olive-brown below 12'

MR-958-00 [OW-8C] 11/11/97

Well Construction and Boring Log - Well OW-8C

Frontier Fertilizer
Davis, California

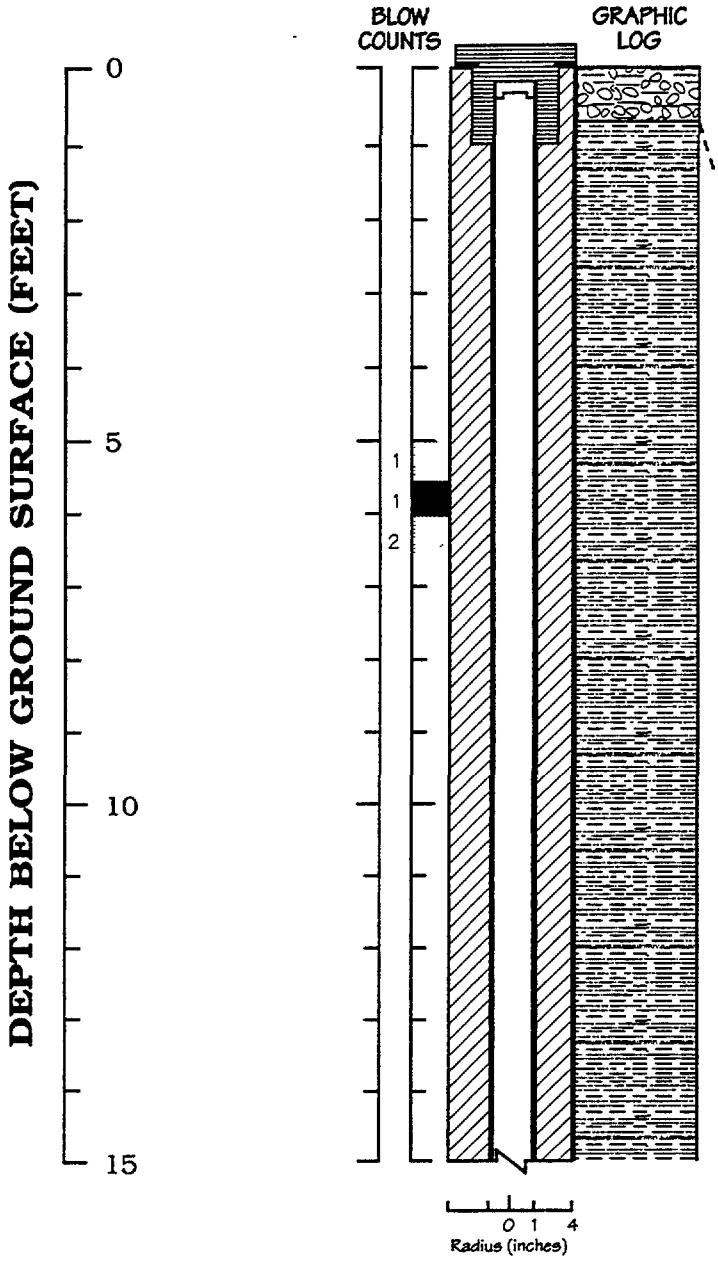
Logged By:	C. Bramer
Supervisor:	D. Leland, P.E. #C46713
Drilling Company:	Soils Exploration Services
C-57#:	582696
Driller:	Mark Nelson
Drilling Method:	8" diameter hollow stem auger
Date Drilled:	October 13, 1997
Well Head Completion:	Locking stovepipe
Type of Sampler:	Split barrel (2" ID) and 5' core barrel

Well Details

Concrete Grout:	0-102'
Bentonite Seal:	102-107'
Sand:	107-120'
Screen:	109-119'
Sump:	119-120'

WELL OW-6C

SIERRA



DESCRIPTION

Gravelly, Lean CLAY with SAND (CL): black; dry to damp; medium dense; ~50% clay, ~10% silt; 20-30% gravel to 1" diameter Af (?)

Clayey SILT with Gravel (ML): brown; damp; soft; 2-50% clay; 50-70% silt; ~10% small gravel

0-5% gravel at 7'

becoming damp to moist at 12'

MR-958-00 [OW-6C] 11/11/97

Well Construction and Boring Log – Well OW-6C

Frontier Fertilizer
Davis, California

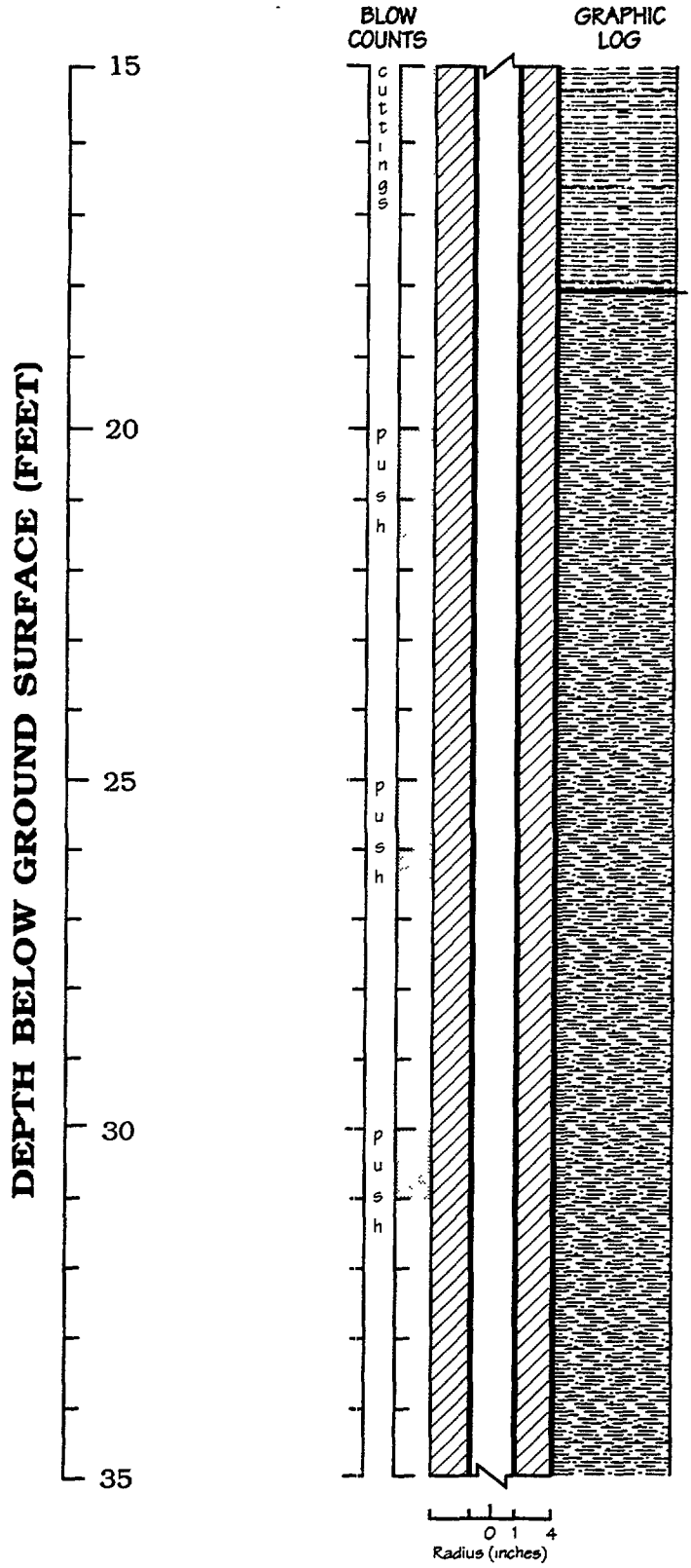
Logged By:	C. Bramer/J. Green
Supervisor:	D. Leland, P.E. #C46713
Drilling Company:	Soils Exploration Services
C-57#:	582696
Driller:	Mark Nelson
Drilling Method:	8" hollow stem auger
Date Drilled:	October 16, 1997
Well Head Completion:	Locking cap & traffic-rated vault
Type of Sampler:	Split barrel (2" ID) and 5' core barrel

Well Details

Concrete Grout:	0-118'
Bentonite Seal:	118-122'
Sand:	122-135'
Screen:	124-134'
Sump:	134-135'

WELL OW-6C
(continued)

SIERRA



DESCRIPTION

Clayey SILT with Gravel (ML): continued

Silty CLAY (CL): dark brown; damp to moist; soft to firm; 50-80% clay; 30-50% silt; root fragments and organic matter

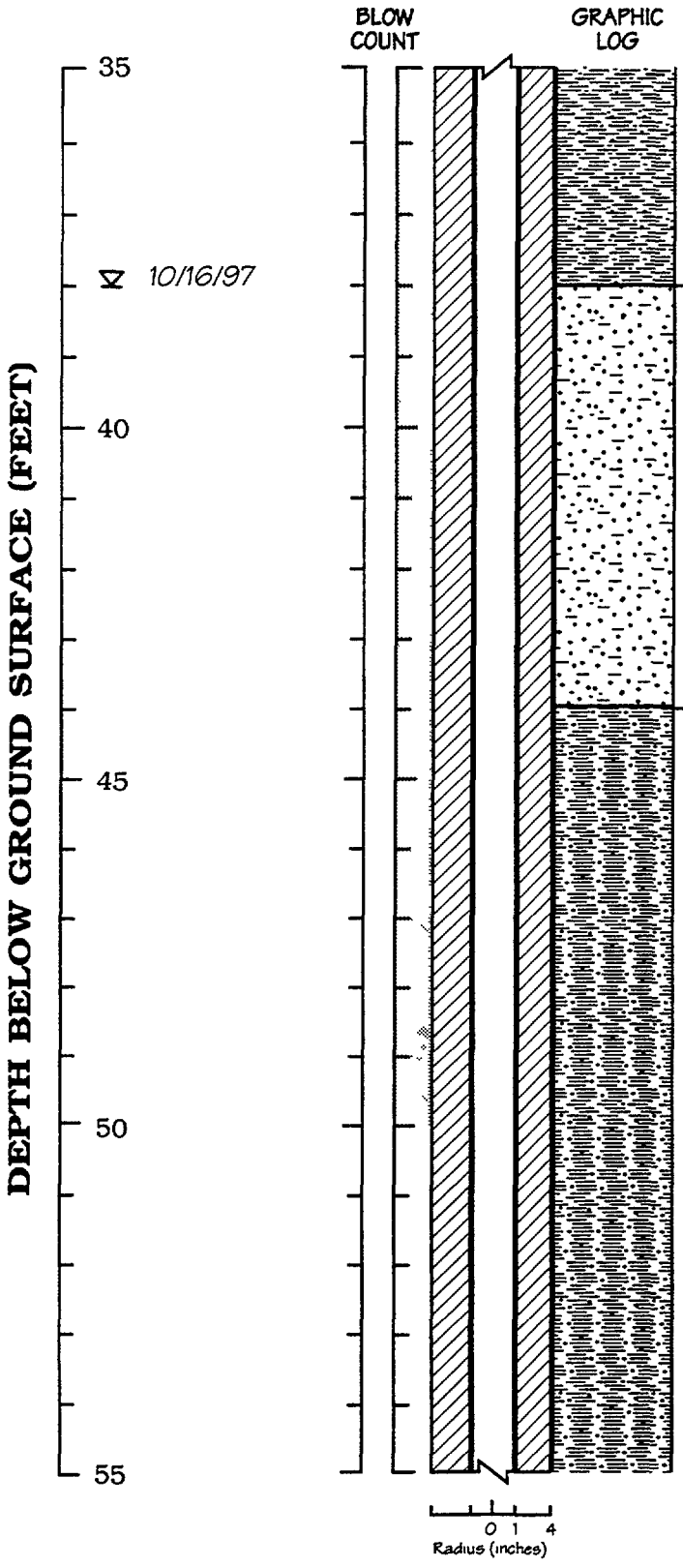
mottled black and gray, ~5% organic matter at 25'

Well Construction and Boring Log – Well OW-6C (cont.)

Frontier Fertilizer
Davis, California

WELL OW-6C
(continued)

SIERRA



DESCRIPTION

Silty CLAY (CL): continued

Silty SAND with Clay (SM): olive-green; moist; loose to medium dense; ~20% clay; 20-30% silt; 50-60% fine sand

increasing fine sand to 50-70% at 40′

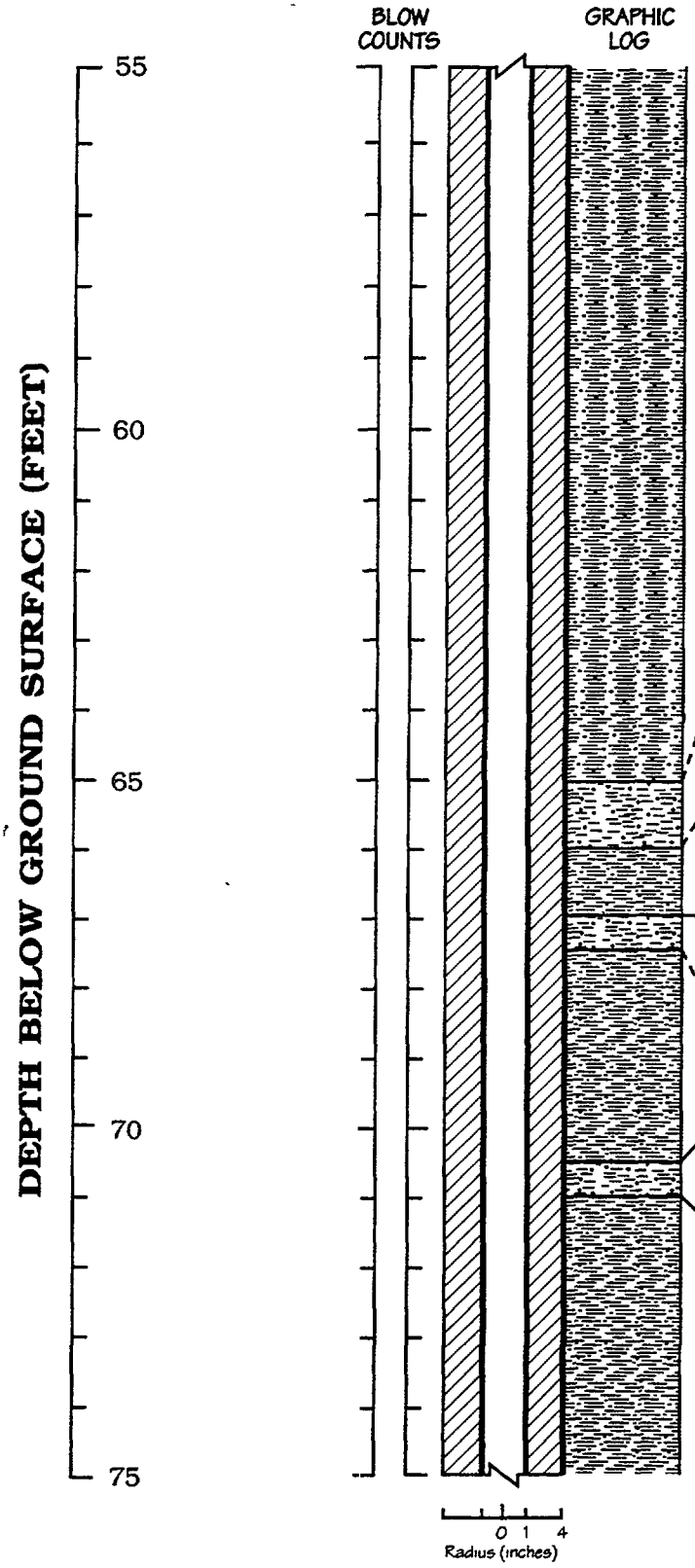
varies to higher clay content in 3-4″ lenses from 40-45′

Sandy CLAY with Sand (CL): yellow-brown, mottled gray and black; moist; firm; 40-60% clay; 20-30% silt; ~10% sand

6″ silt lenses (SM) at 47-47.5′

WELL OW-6C
(continued)

SIERRA



DESCRIPTION

Sandy CLAY with Sand (CL): continued

Sandy SILT (ML): medium brown; slightly moist; 20-30% clay; 30-40% silt; ~40% fine to coarse sand

Silty CLAY with Sand (CL): medium brown; slightly moist to dry; firm to hard; to 20% very fine sand

Sandy SILT (ML): light brown; hard; dry; ~70% silt; ~30% fine sand

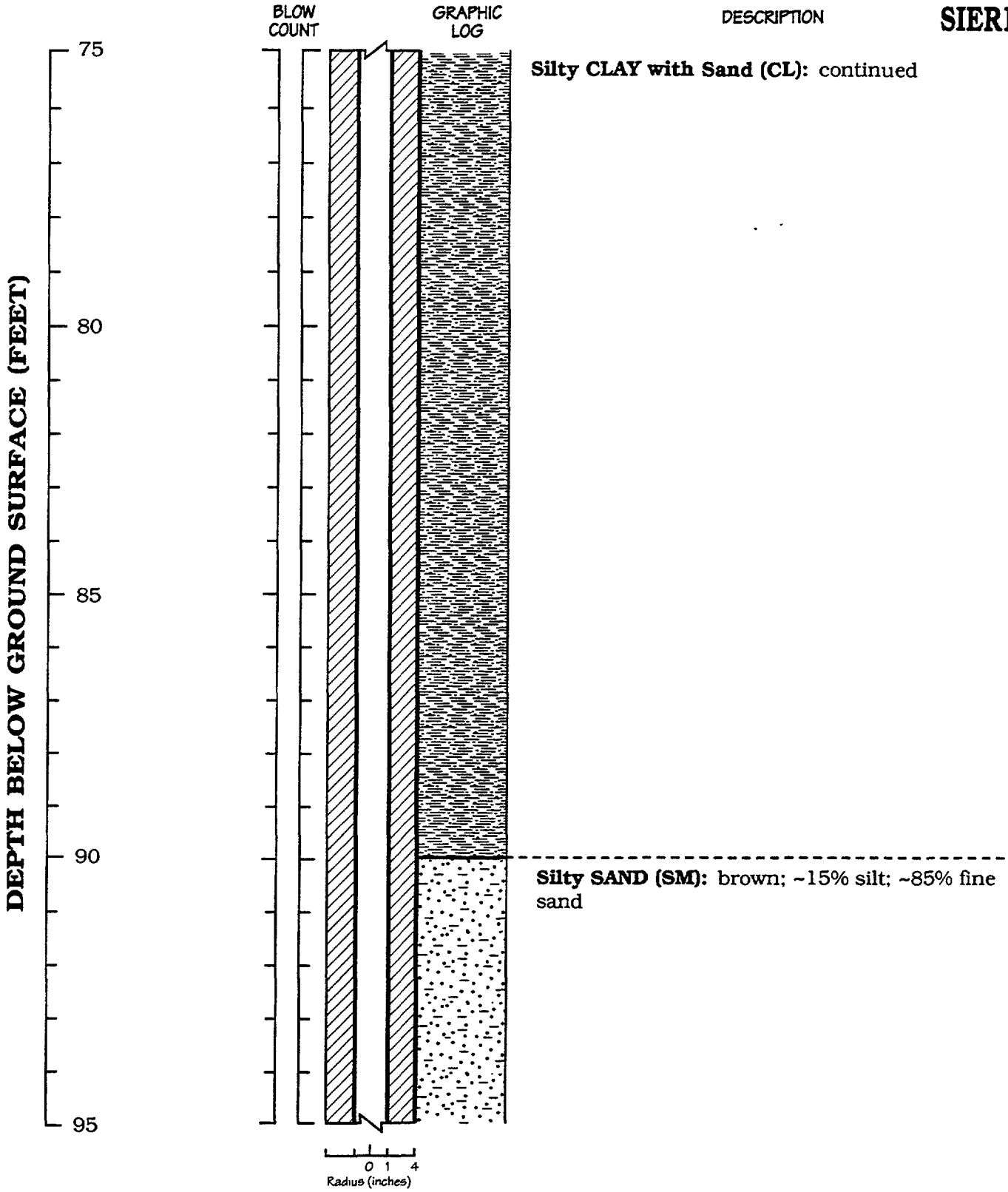
Silty CLAY with Sand (CL): medium brown; slightly moist to dry; firm to hard; to 20% very fine sand

Sandy SILT (ML): light brown; hard; dry; ~70% silt; ~30% fine sand

Silty CLAY with Sand (CL): medium brown; slightly moist to dry; firm to hard; to 20% very fine sand

WELL OW-6C
(continued)

SIERRA



Silty CLAY with Sand (CL): continued

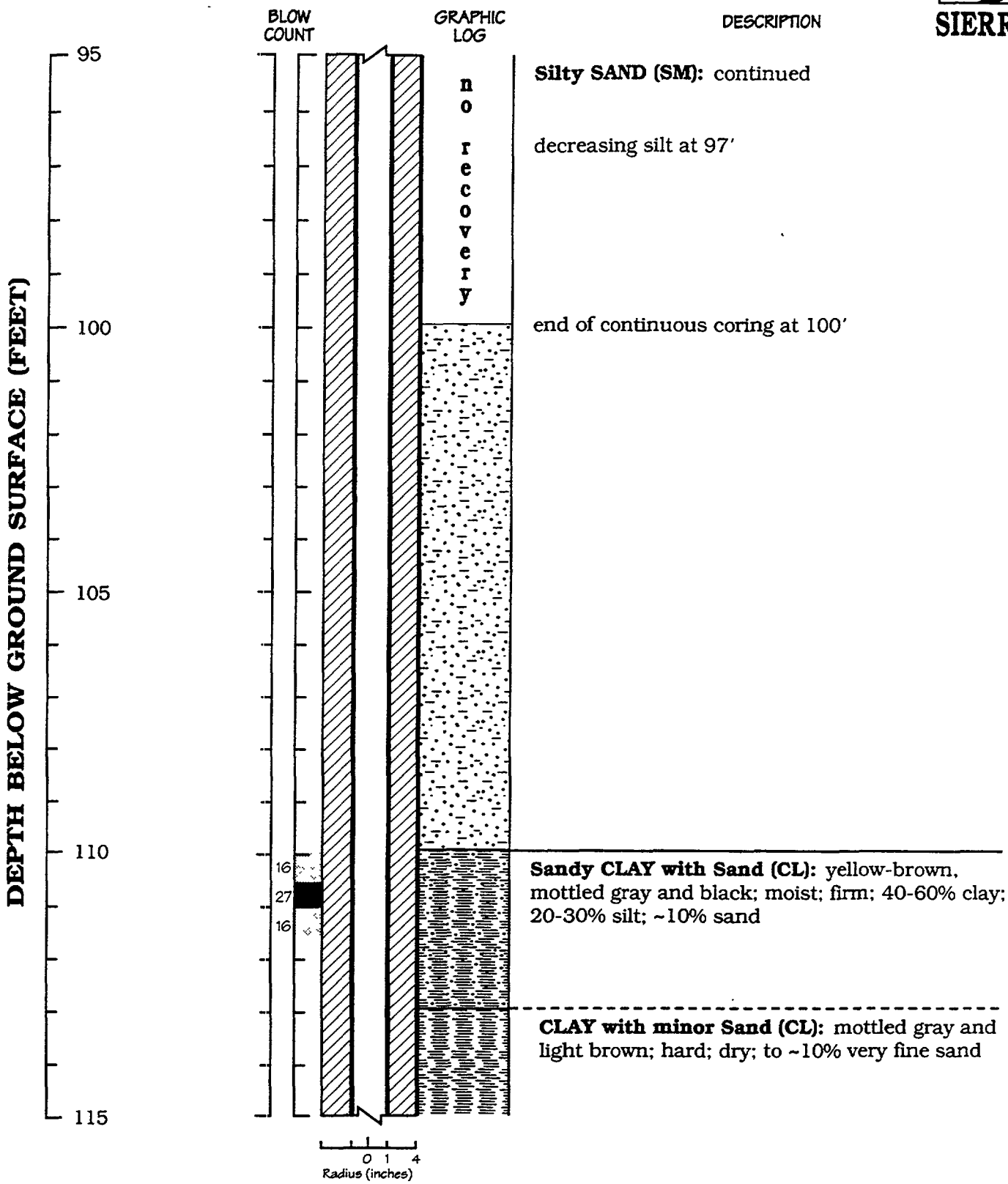
Silty SAND (SM): brown; ~15% silt; ~85% fine sand

Well Construction and Boring Log - Well OW-6C (cont.)

Frontier Fertilizer
Davis, California

WELL OW-6C
(continued)

SIERRA



Silty SAND (SM): continued

decreasing silt at 97'

end of continuous coring at 100'

Sandy CLAY with Sand (CL): yellow-brown, mottled gray and black; moist; firm; 40-60% clay; 20-30% silt; ~10% sand

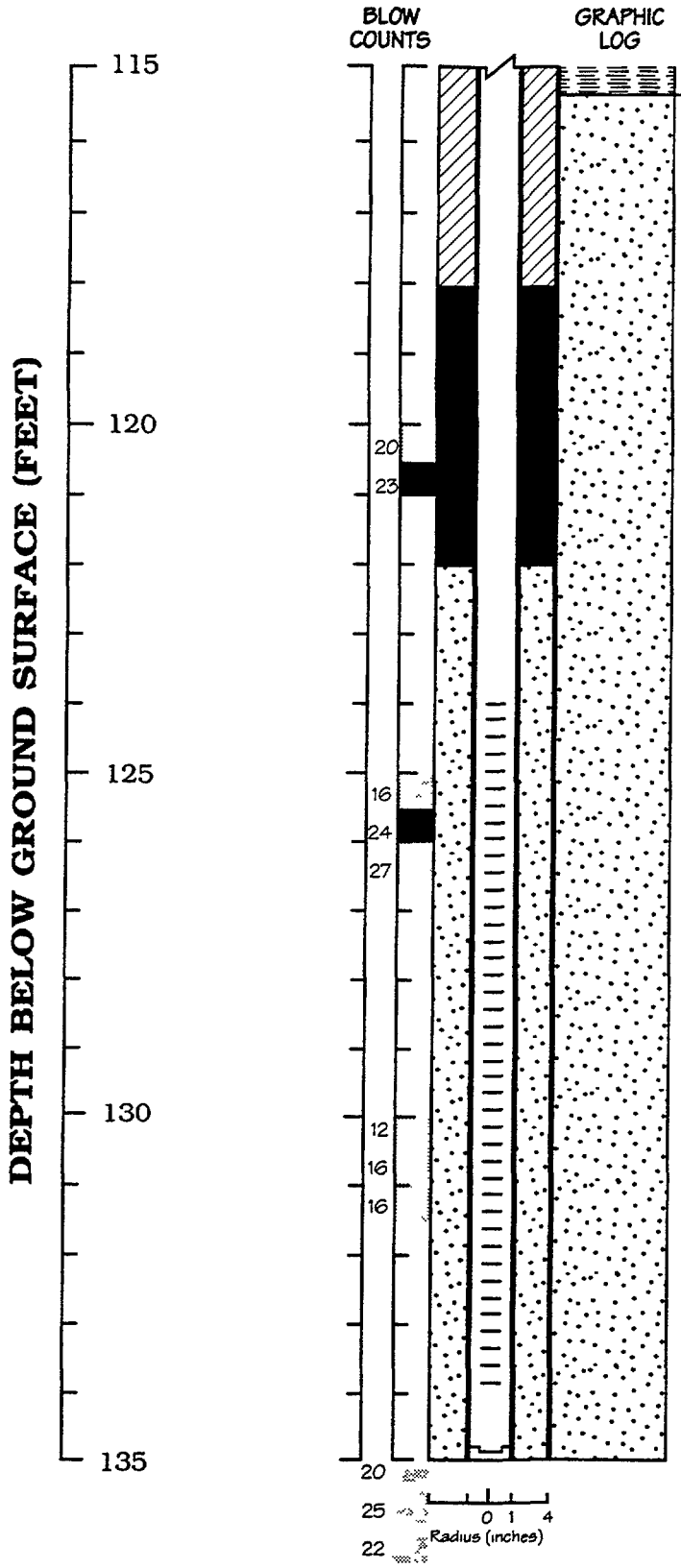
CLAY with minor Sand (CL): mottled gray and light brown; hard; dry; to ~10% very fine sand

Well Construction and Boring Log - Well OW-6C (cont.)

Frontier Fertilizer Davis, California

WELL OW-6C
(continued)

SIERRA



DESCRIPTION

CLAY with minor Sand (CL): continued

SAND (SP): dark brown; wet; dense; predominantly very fine to fine grained

very dense at 126'

dense at 130'

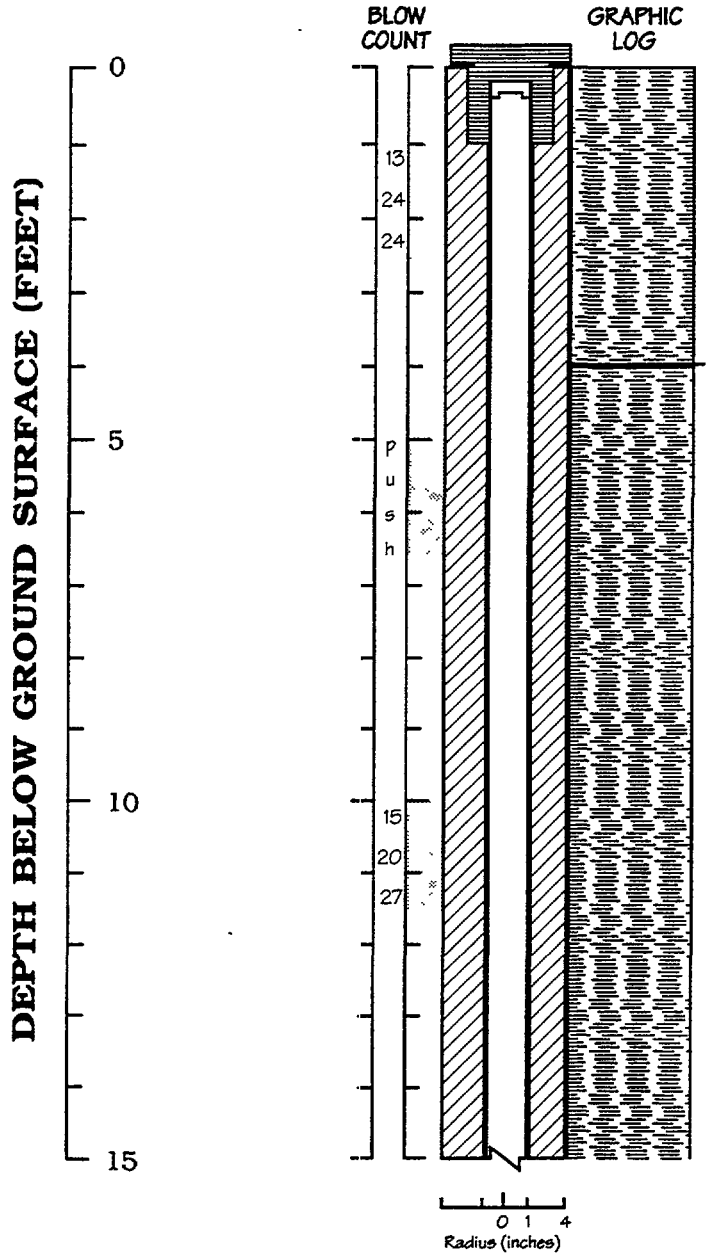
BOH at 135'

Well Construction and Boring Log - Well OW-6C (cont.)

Frontier Fertilizer
Davis, California

WELL OW-7C

SIERRA



DESCRIPTION

Lean CLAY (CL): dark brown; damp; very stiff; ~30% silt; ~20% very fine to fine sand; very low est K; organics

Lean CLAY (CL): olive-brown; damp; stiff; ~30% silt; ~10% very fine to fine sand; very low est K

olive-brown, mottled gray at 11'

MR-958-00 [OW-117] 11/11/97

Well Construction and Boring Log - Well OW-7C

Frontier Fertilizer
Davis, California

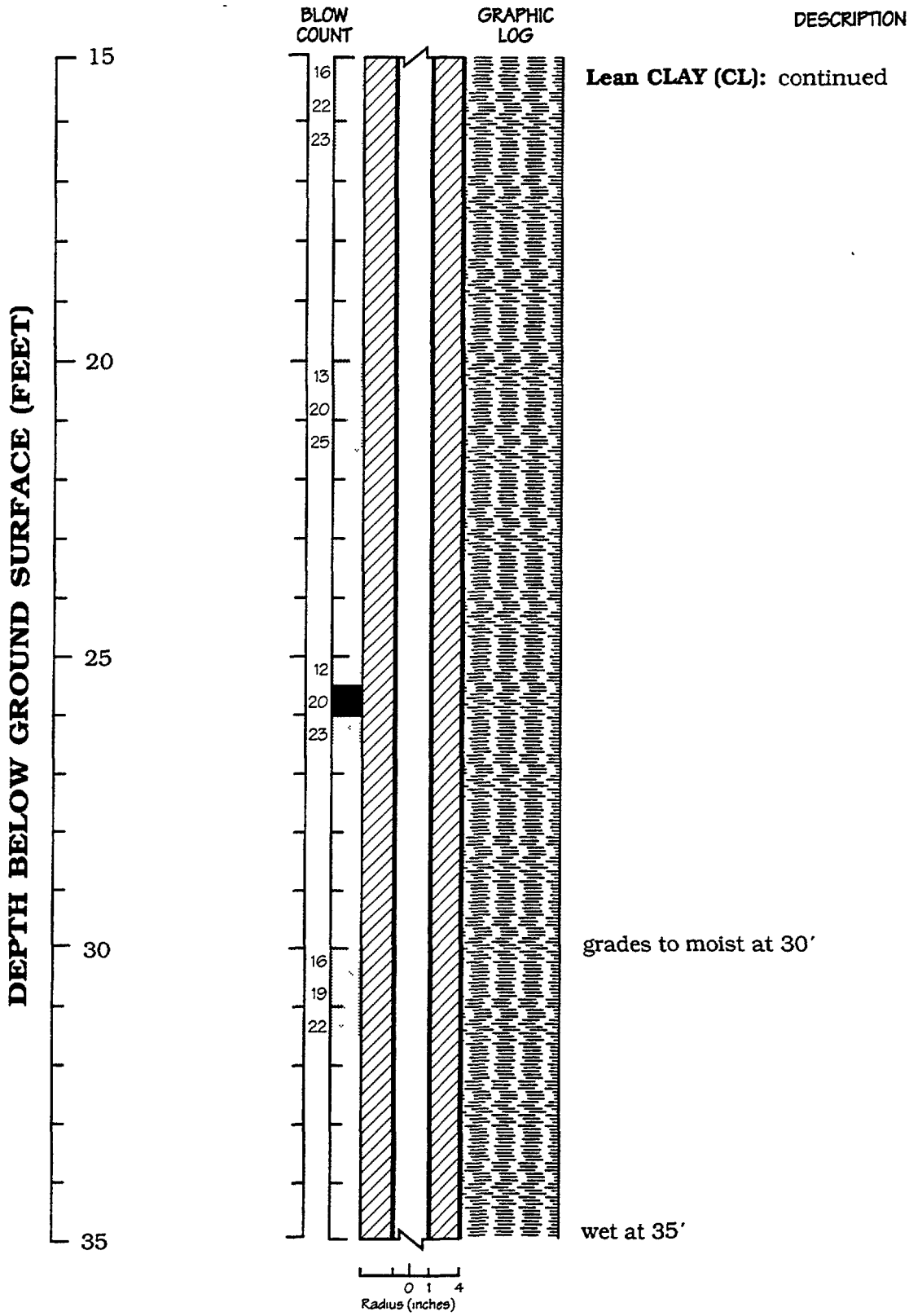
Logged By:	Jim Green
Supervisor:	D. Leland, P.E. #C46713
Drilling Company:	Soils Exploration Services
C-57#:	582696
Driller:	Mark Nelson
Drilling Method:	8" hollow stem auger
Date Drilled:	October 21, 1997
Well Head Completion:	Locking cap & traffic-rated vault
Type of Sampler:	Split barrel (2" ID) and 5' core barrel

Well Details

Concrete Grout:	0-106.5'
Bentonite Seal:	106.5-110.5'
Sand:	110.5-123.5'
Screen:	112.5-122.5'
Sump:	122.5-123.5'

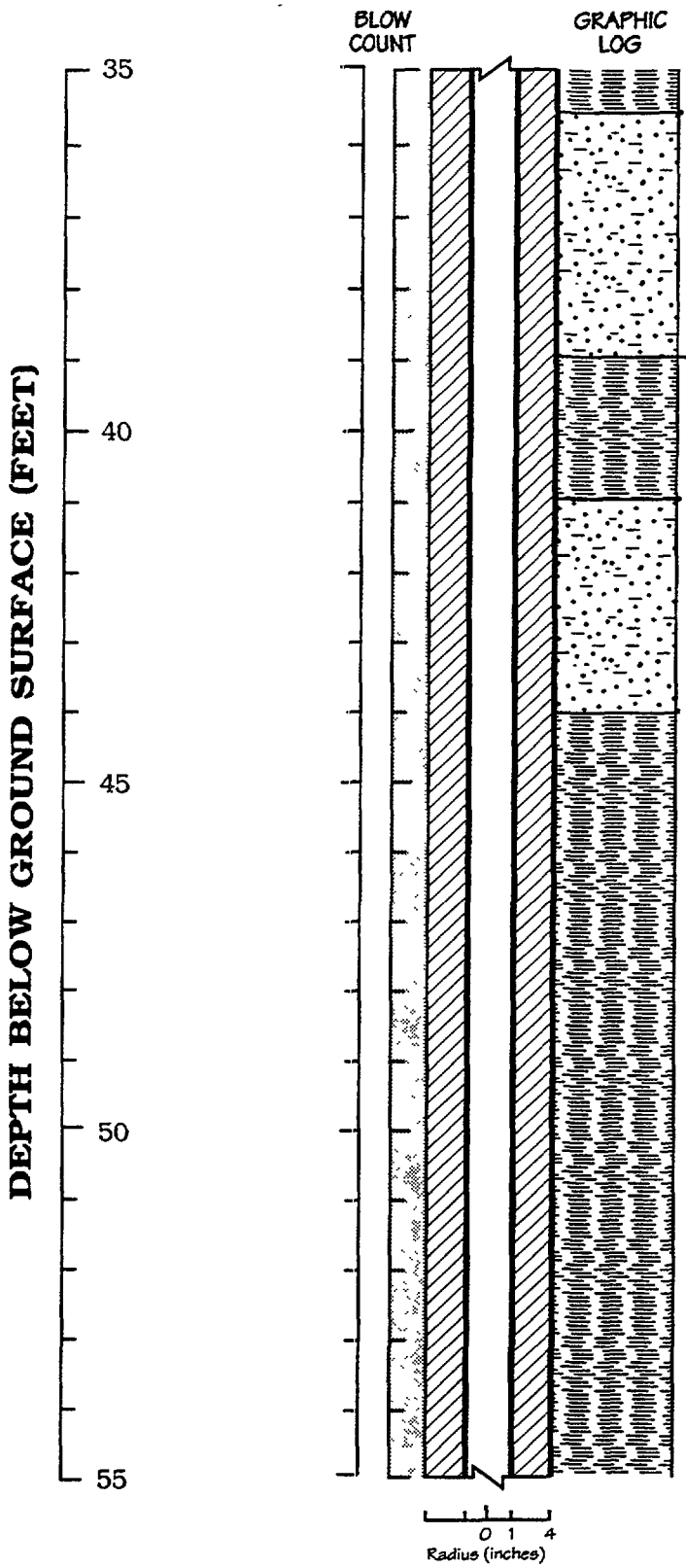
WELL OW-7C
(continued)

SIERRA



WELL OW-7C
(continued)

SIERRA



Lean CLAY (CL): continued

Silty SAND (SM): light brown; wet; medium dense; ~5% clay; ~35% silt; ~60% fine to coarse sand; moderate est K

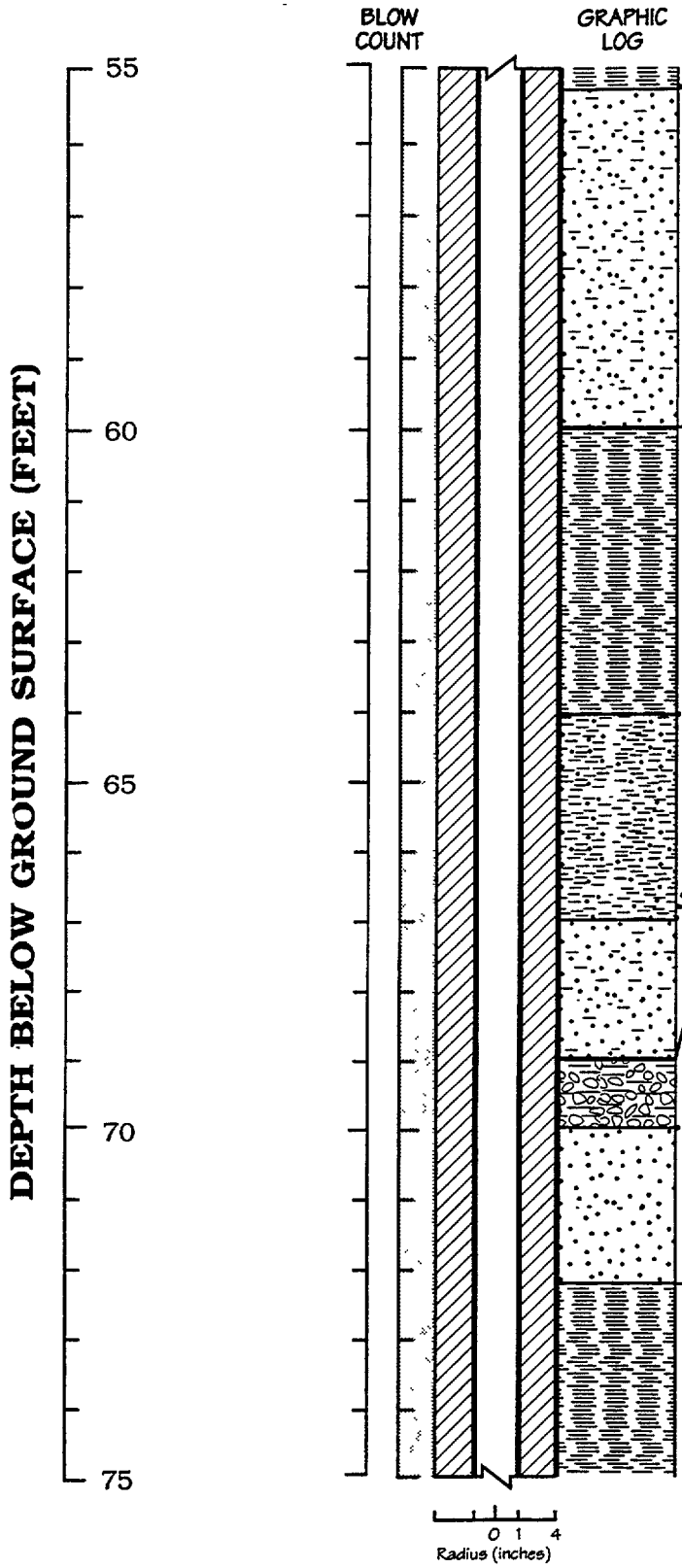
Lean CLAY with Sand (CL): light brown, mottled gray; hard; ~60% clay; ~30% silt; ~10% sand; very low est K

Silty SAND (SM): brown; medium dense; ~15% silt; ~85% poorly sorted, fine to coarse sand; moderate est K

Lean CLAY with Sand (CL): light brown, mottled gray; hard; ~60% clay; ~30% silt; ~10% sand; very low est K

WELL OW-7C
(continued)

SIERRA



DESCRIPTION

Lean CLAY (CL): continued

Silty SAND (SM): brown; medium dense; ~15% silt; ~85% poorly sorted, fine to coarse sand; moderate est K

Lean CLAY with Sand (CL): light brown, mottled gray; hard; ~60% clay; ~30% silt; ~10% sand; very low est K

Sandy SILT (ML): olive-brown, mottled gray; dense; ~25% silt; ~40% silt; ~35% fine to coarse sand; very low est K

Silty SAND (SM): brown; medium dense; ~5% clay; ~30% silt; ~65% fine to coarse sand; moderate est K

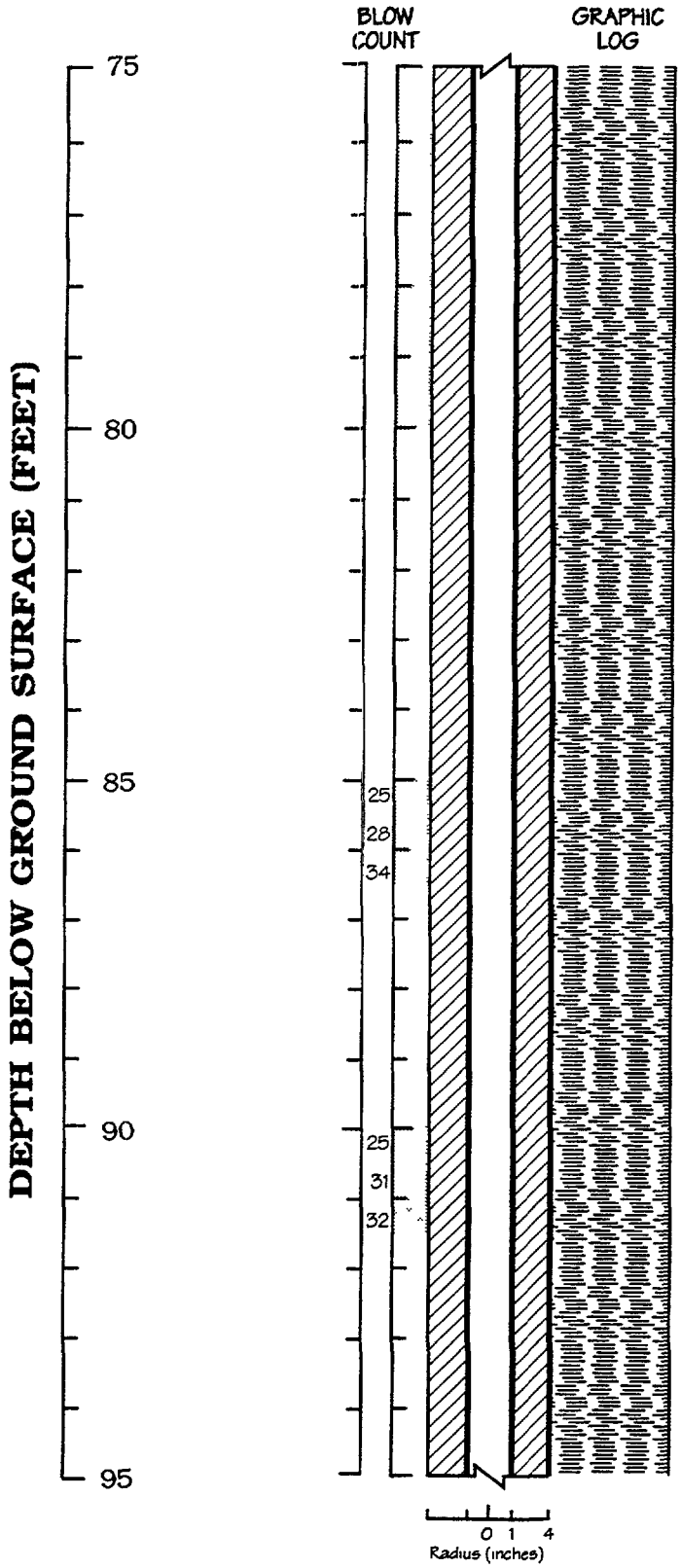
Clayey GRAVEL with Sand (GC): ~25% clay; ~20% silt; ~20% sand; ~35% poorly sorted, subrounded gravel to 1" diameter; low to moderate est K

Moderately graded SAND with Silt (SW/SM): loose; ~10% silt; ~90% moderately graded, fine to medium sand; moderate to high est K

Lean CLAY (CL): ~50% clay; ~40% silt; ~10% very fine to fine sand; very low est K

WELL OW-7C
(continued)

SIERRA



DESCRIPTION

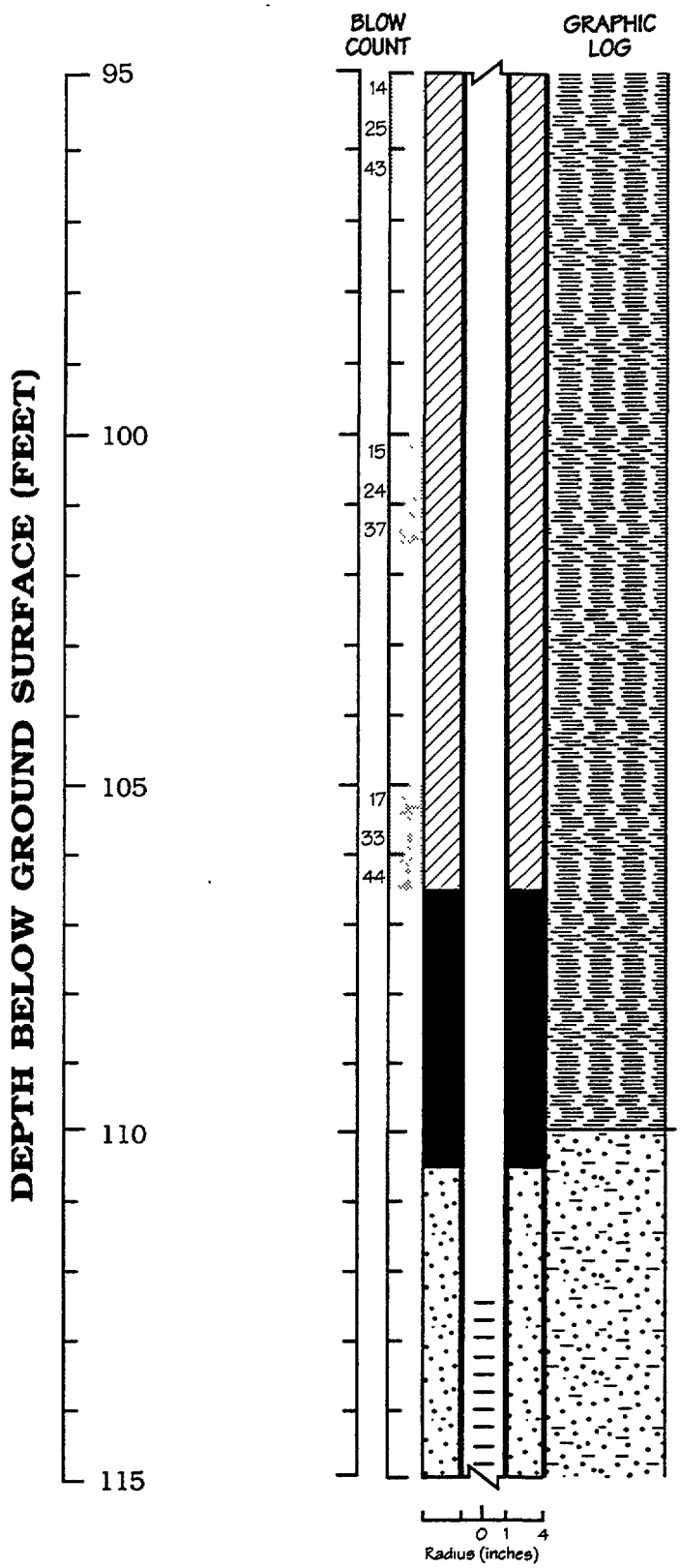
Lean CLAY (CL): ~50% clay; ~40% silt; ~10% very fine to fine sand; very low est K

Well Construction and Boring Log – Well OW-7C

Frontier Fertilizer
Davis, California

WELL OW-7C
(continued)

SIERRA



DESCRIPTION

Lean CLAY (CL): ~50% clay; ~40% silt; ~10% very fine to fine sand; very low est K

Silty SAND (SM/SP): tan; wet; loose; 20-30% silt; 70-80% fine to medium sand; high est K (from cuttings)

Well Construction and Boring Log - Well OW-7C

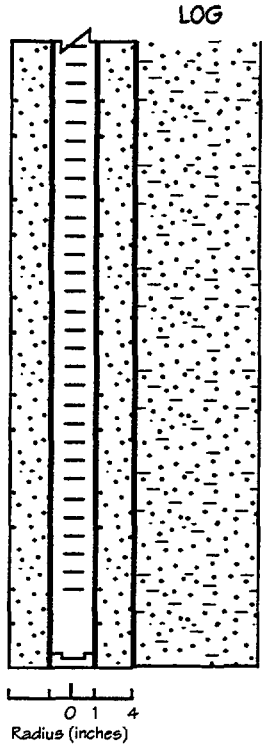
Frontier Fertilizer
Davis, California

WELL OW-7C
(continued)

SIERRA

DEPTH BELOW GROUND SURFACE (FEET)

	BLOW COUNT	GRAPHIC LOG	DESCRIPTION
115			**Silty SAND (SM/SP):** continued
			flowing sand in auger
120			flowing sand in auger
123			**BOH AT 123.5'**

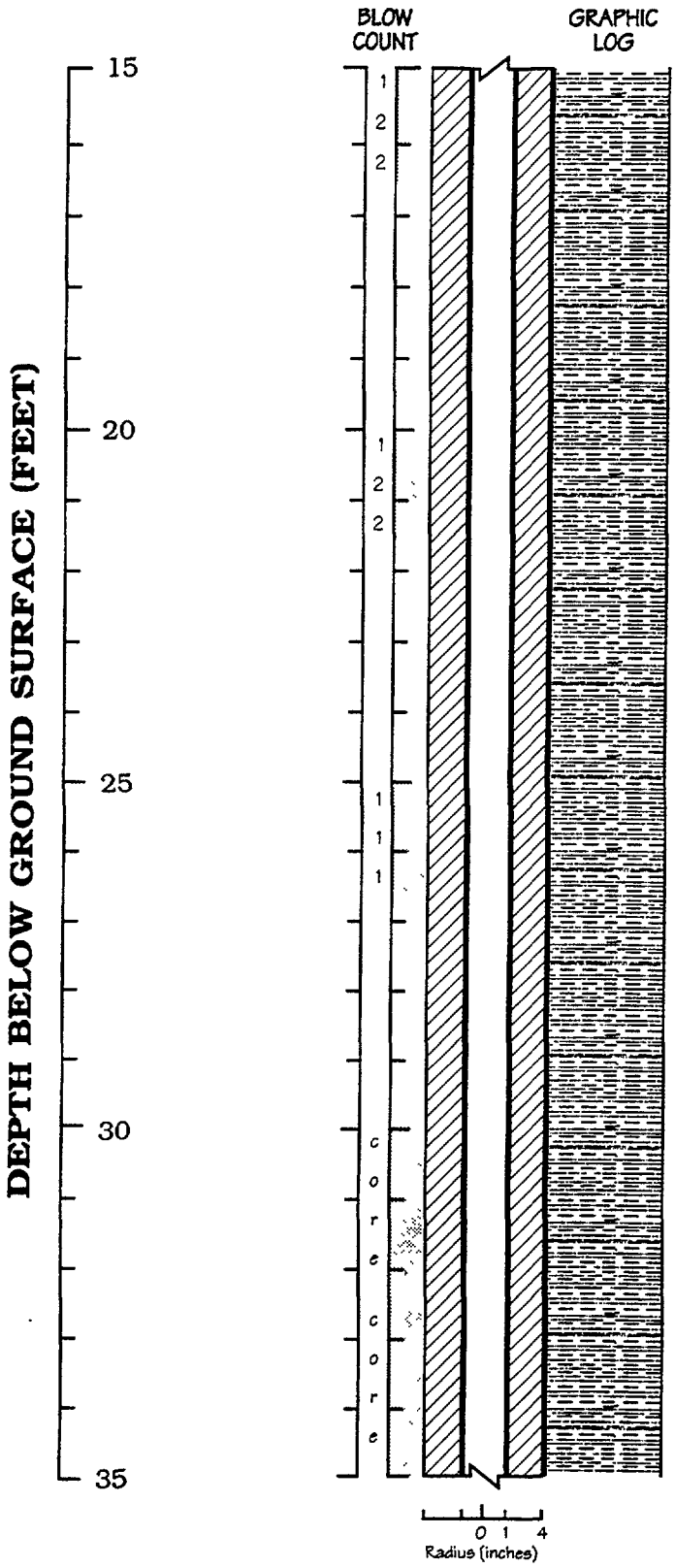


Well Construction and Boring Log – Well OW-7C

Frontier Fertilizer
Davis, California

BORING OW-8C
(continued)

SIERRA



DESCRIPTION

Clayey SILT (ML): black; damp; soft; 15-30% clay; ~5% fine sand; some organics

5-10% clay at 26′

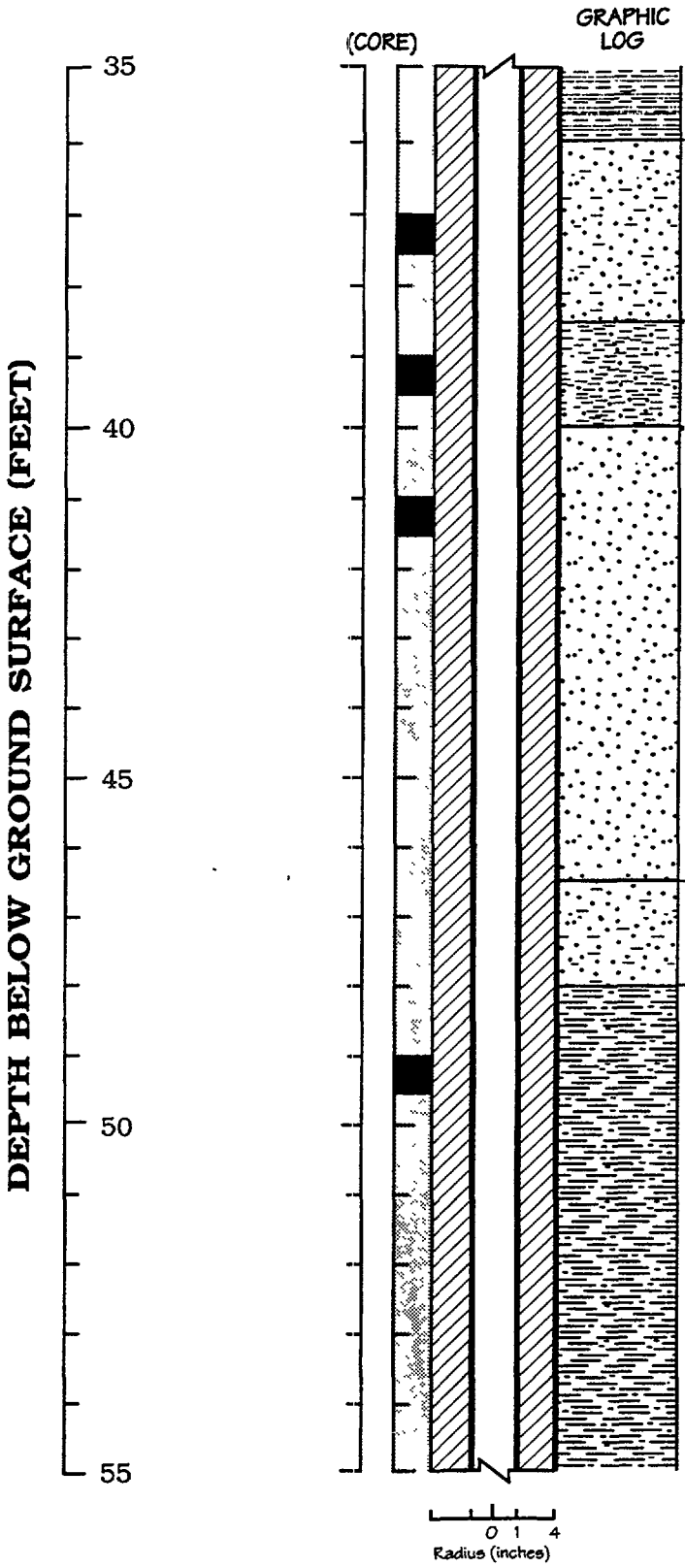
Moist at 33′

Boring Log – Boring OW-8C (cont.)

Frontier Fertilizer
Davis, California

BORING OW-8C
(continued)

SIERRA



DESCRIPTION

Silty SAND (SM): brown, wet; loose; 30-40% silt; 60-70% very fine sand

grades to **Sandy SILT with Clay (ML):** 5-10% clay; 60-70% silt; ~30% fine to medium sand

SAND (SP): brown; wet; loose; ~5% silt; ~95% fine to very fine sand

Silty SAND (SM): brown, wet; medium dense; 20-30% silt; 70-80% fine sand
Contact by driller

Silty CLAY (CL): olive-brown; moist; stiff; 50-65% clay; 30-40% silt; 5-10% fine sand; low est K

very stiff, hard at 51'; very low est K

damp to moist at 52'; very low est K

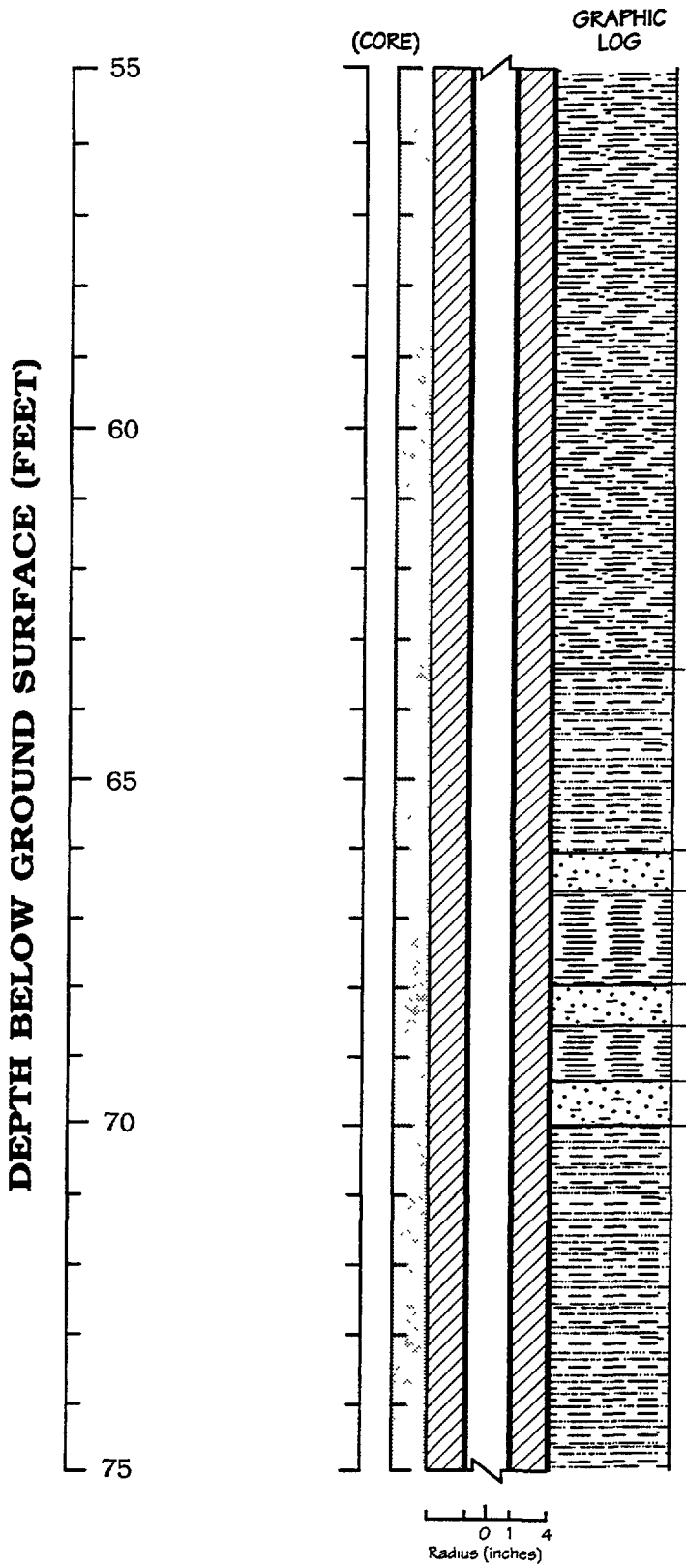
drills harder at 55'

Boring Log – Boring OW-8C (cont.)

Frontier Fertilizer
Davis, California

BORING OW-8C
(continued)

SIERRA



DESCRIPTION

Silty CLAY (CL): continued

Clayey SILT with Gravel (ML): olive, mottled dark gray; moist; stiff; 10-20% clay; ~5% sand; ~5% gravel to 1" diameter

Silty SAND (SM): olive-brown

CLAY (CL): olive-brown

Silty SAND (SM): olive-brown

CLAY (CL): olive-brown

Silty SAND (SM): olive-brown

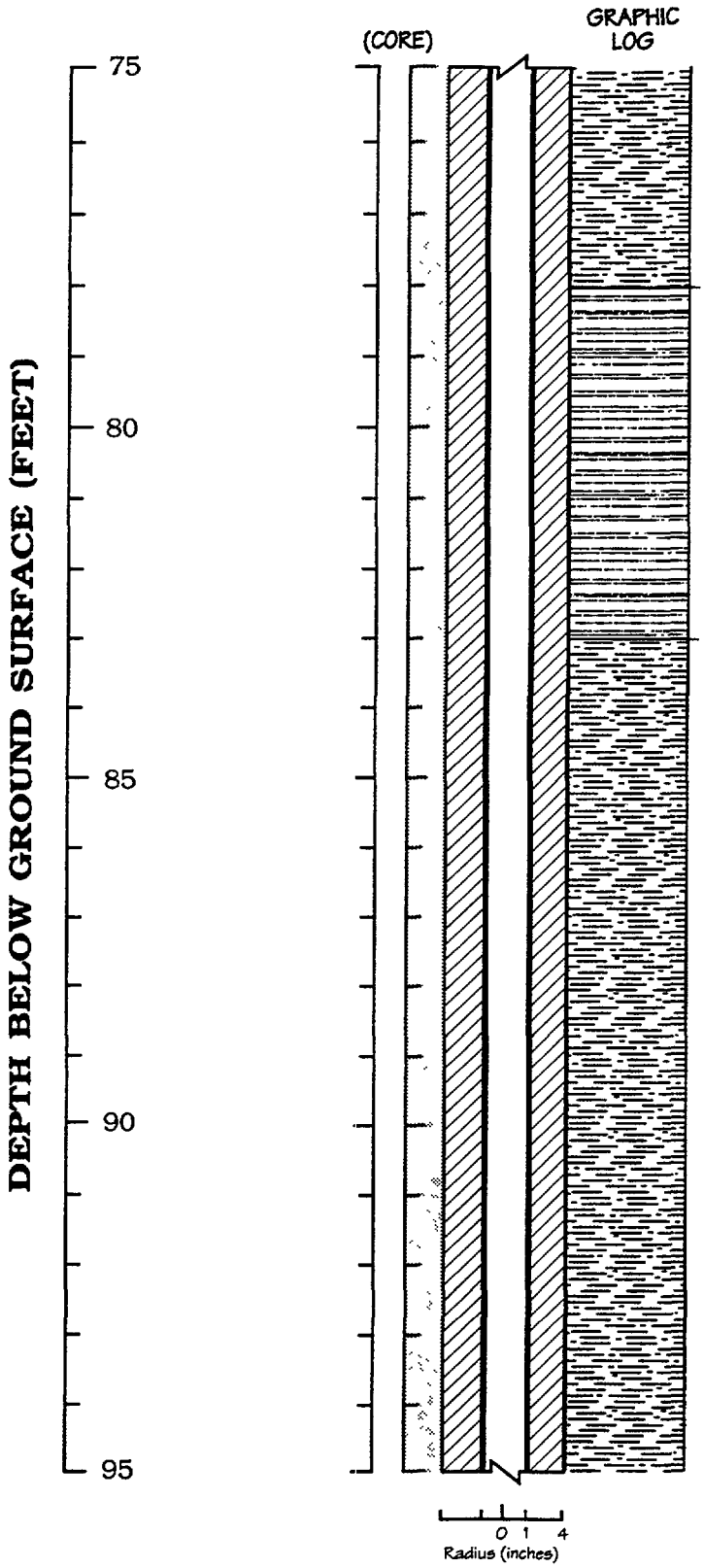
Sandy SILT (ML): olive-brown; wet; 5-10% clay

Boring Log - Boring OW-8C (cont.)

Frontier Fertilizer
Davis, California

BORING OW-8C
(continued)

SIERRA



DESCRIPTION

Silty CLAY (CL): continued
wet at 76′

moist at 77′

SILT (ML): olive; damp to moist; firm; 5-10% fine sand; blocky; low est K

Silty CLAY (CL): olive; moist; firm to stiff; 70-80% clay; 20-30% silt; moderately plastic; low est K

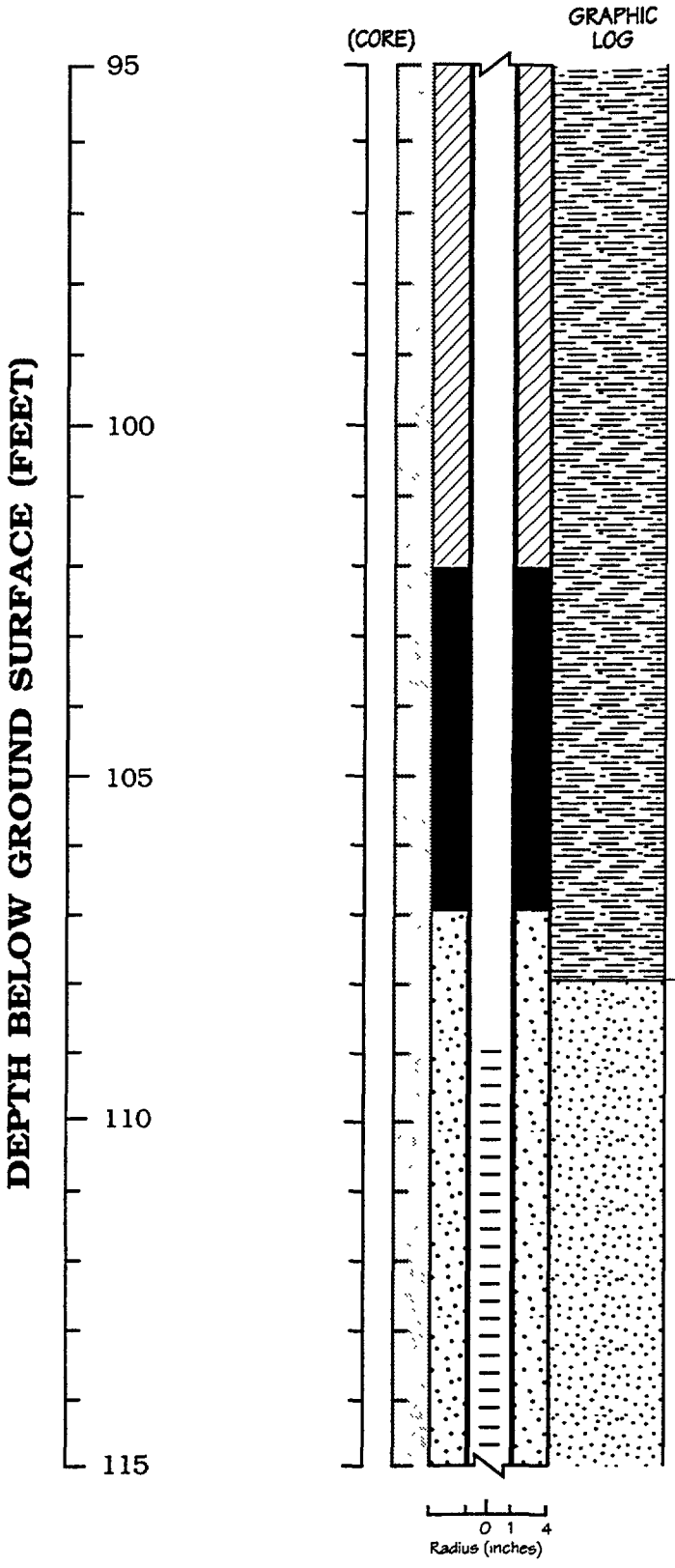
very low est K at 93′

Boring Log – Boring OW-8C (cont.)

Frontier Fertilizer
Davis, California

BORING OW-8C
(continued)

SIERRA



DESCRIPTION

Silty CLAY (CL): continued

Stiff to hard at 97′

Well graded SAND with minor Clay and Gravel (SW): brown; wet; medium dense; ~5% clay; 50-70% fine to coarse sand; 20-40% subrounded gravel from 0.5 to 1″ diameter

70-80% sand; 10-30% gravel at 112′

Boring Log – Boring OW-8C (cont.)

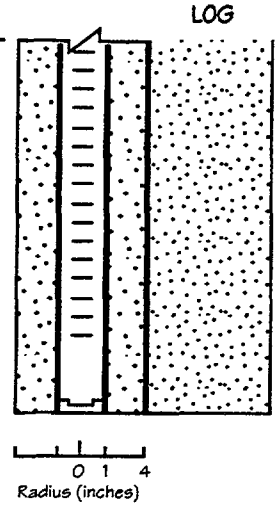
Frontier Fertilizer
Davis, California

BORING OW-8C

(continued)

DEPTH BELOW GROUND SURFACE (FEET)

	BLOW COUNT	GRAPHIC LOG	DESCRIPTION
115			**Well graded SAND with minor Clay and Gravel (SW):** continued
120			**BOH at 120'**

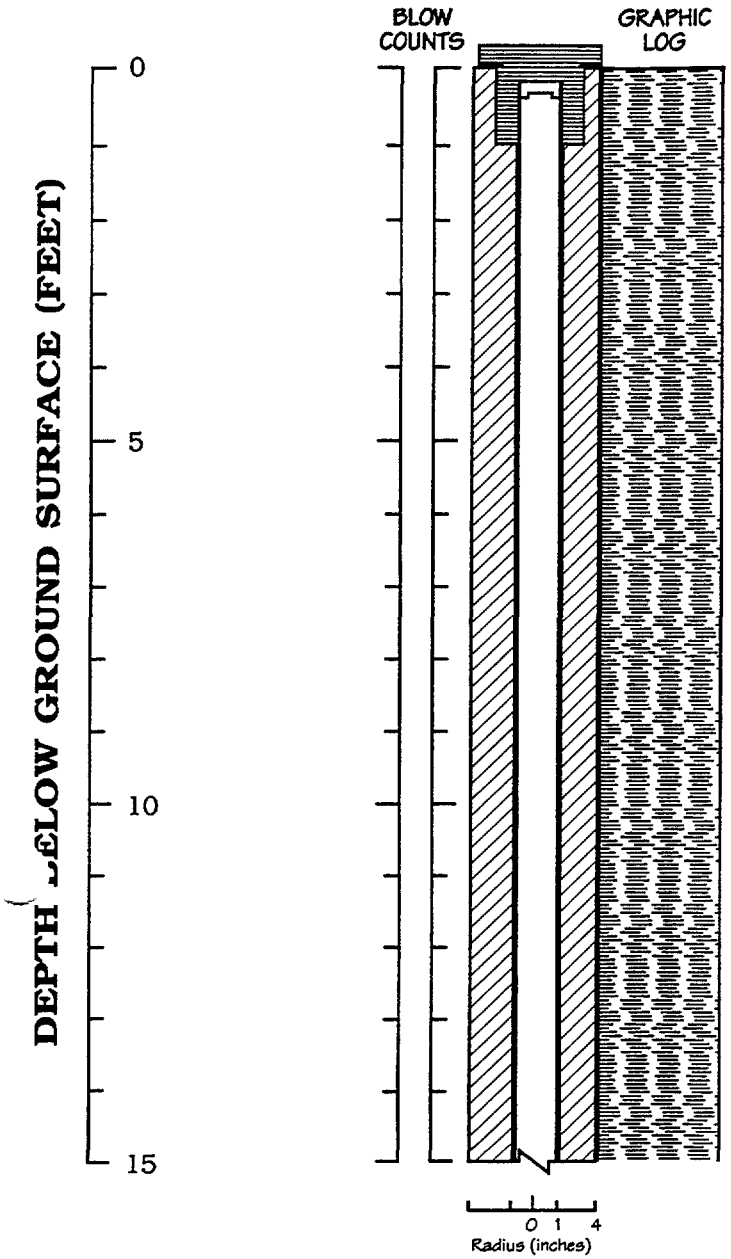


Boring Log – Boring OW-8C (cont.)

Frontier Fertilizer
Davis, California

WELL OW-11C

SIERRA



DESCRIPTION

Lean CLAY (CL): dark brown; damp; stiff; ~55% lean clay, ~40% silt; ~5% sand; very low est K; organics

grades to olive-brown at 13'

MR-958-00 [OW-11C] 11/11/97

Well Construction and Boring Log – Well OW-11C

Frontier Fertilizer
Davis, California

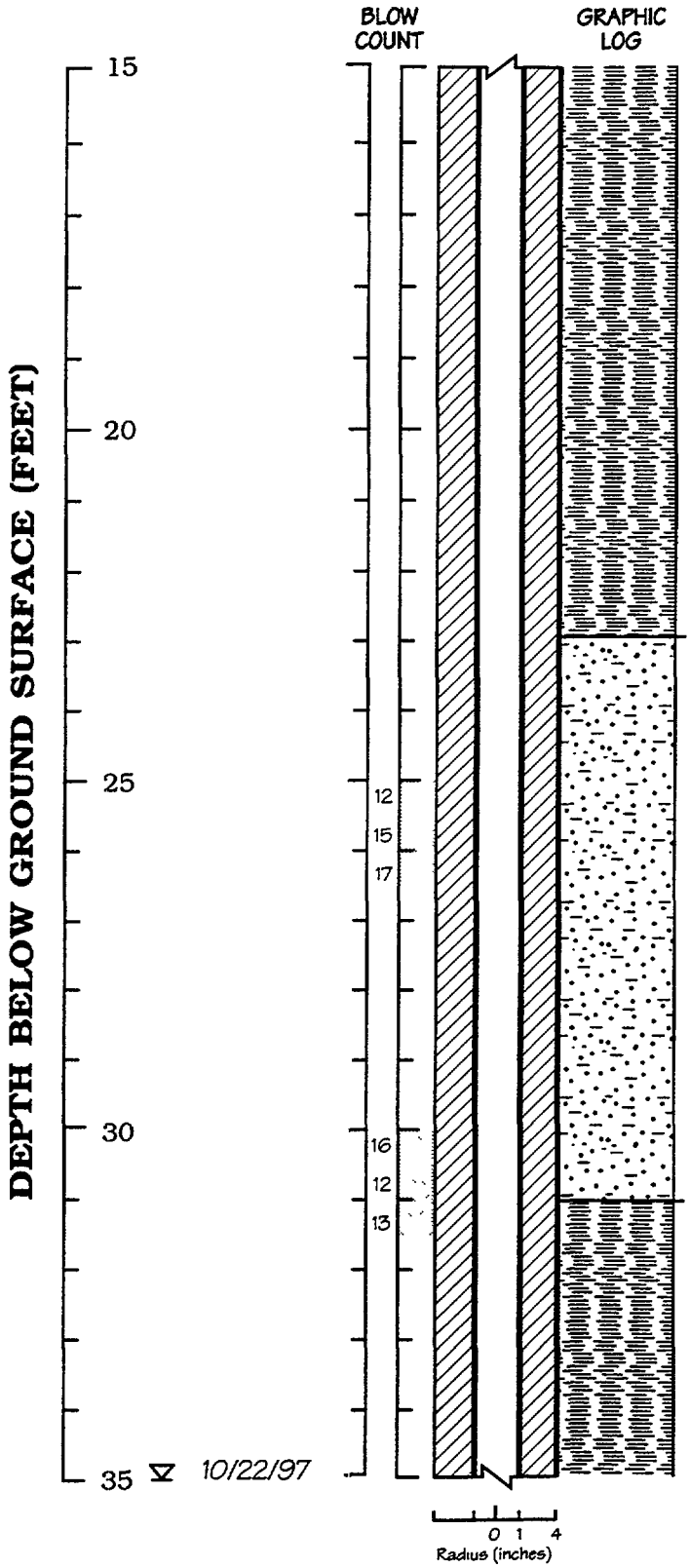
Logged By:	Jim Green
Supervisor:	D. Leland, P.E. #C46713
Drilling Company:	Soils Exploration Services
C-57#:	582696
Driller:	David Ryan
Drilling Method:	8" diameter hollow stem auger
Date Drilled:	October 22, 1997
Well Head Completion:	Locking cap & traffic-rated vault
Type of Sampler:	Split barrel (2" ID and 1-1/2" ID)

Well Details

Concrete Grout:	0-110'
Bentonite Seal:	110-114'
Sand:	114-127'
Screen:	116-126'
Sump:	126-127'

WELL OW-11C
(continued)

SIERRA



DESCRIPTION

Lean CLAY (CL): continued

Silty SAND (SM): light brown; damp; medium dense; ~15% silt; ~85% fine to medium sand; moderate est K

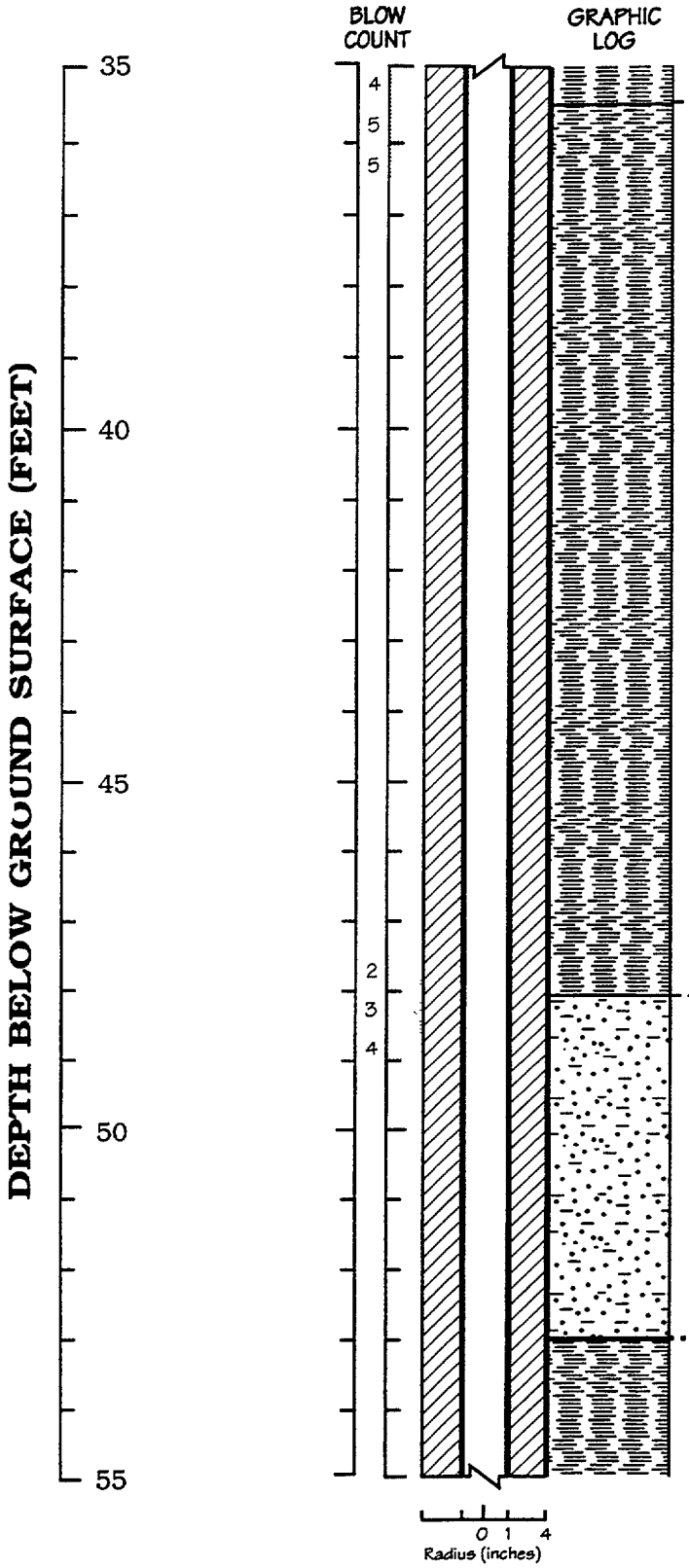
Lean CLAY with Sand (CL): olive-brown, mottled gray; wet; loose; ~50% clay; ~25% silt; ~25% sand; very low est K

Well Construction and Boring Log - Well OW-11C

Frontier Fertilizer Davis, California

WELL OW-11C
(continued)

SIERRA



DESCRIPTION

Lean CLAY (CL): continued

Lean CLAY (CL): ~65% clay; ~30% silt; ~5% sand

flowing sands in auger

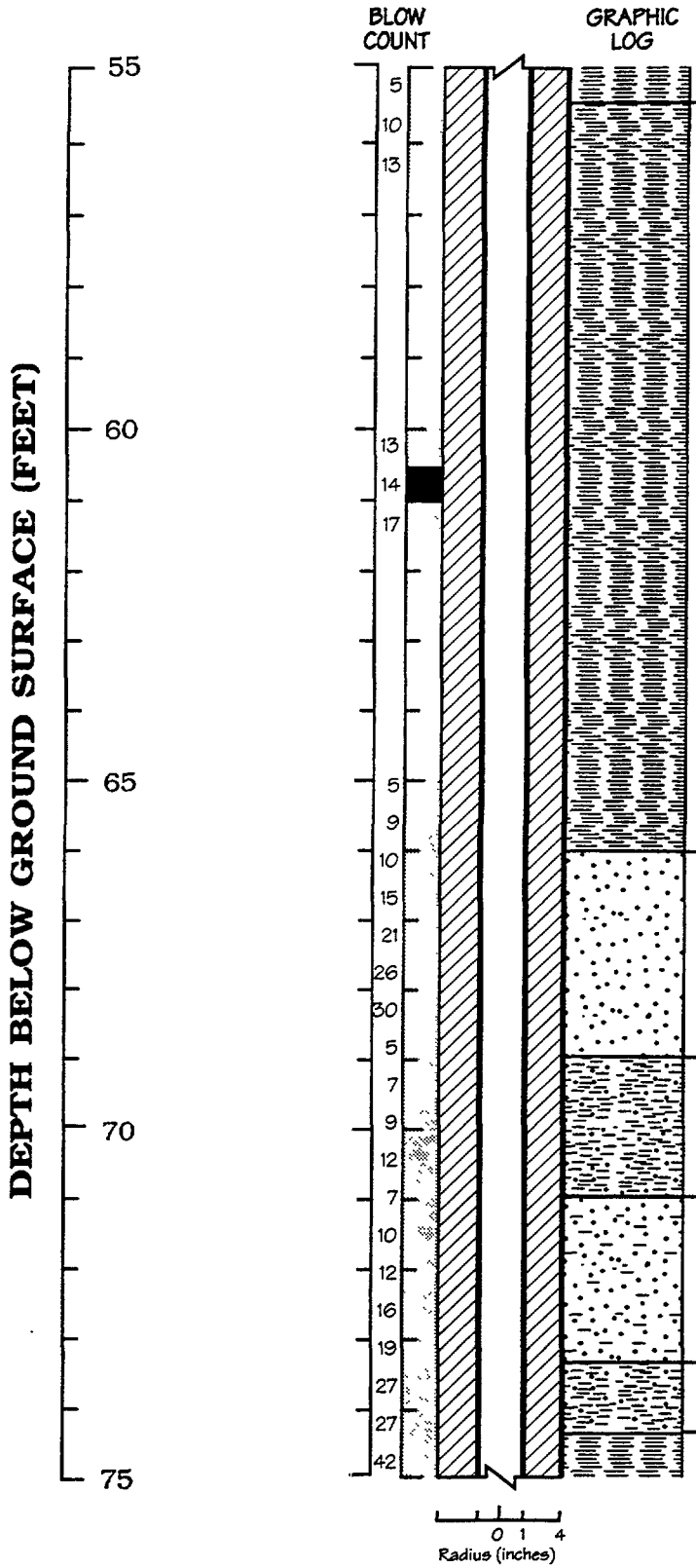
flowing sands in auger

Silty SAND (SM): dark brown; ~25% silt; ~75% moderately graded, medium to course sand; moderate est K

Lean CLAY (CL): olive-brown, mottled gray; hard; ~65% clay; ~25% silt; ~10% sand; very low est K

WELL OW-11C
(continued)

SIERRA



DESCRIPTION

Lean CLAY (CL): continued

Lean CLAY (CL): olive-brown, mottled gray; hard; ~25% clay; ~25% silt; very low est K

Poorly graded SAND with Silt (SP/SM): brown; medium dense; ~10% silt; ~90% medium sand; moderate to high est K

Sandy SILT (ML): olive-brown, mottled gray; ~25% clay; ~40% silt; ~35% fine to coarse sand; low est K

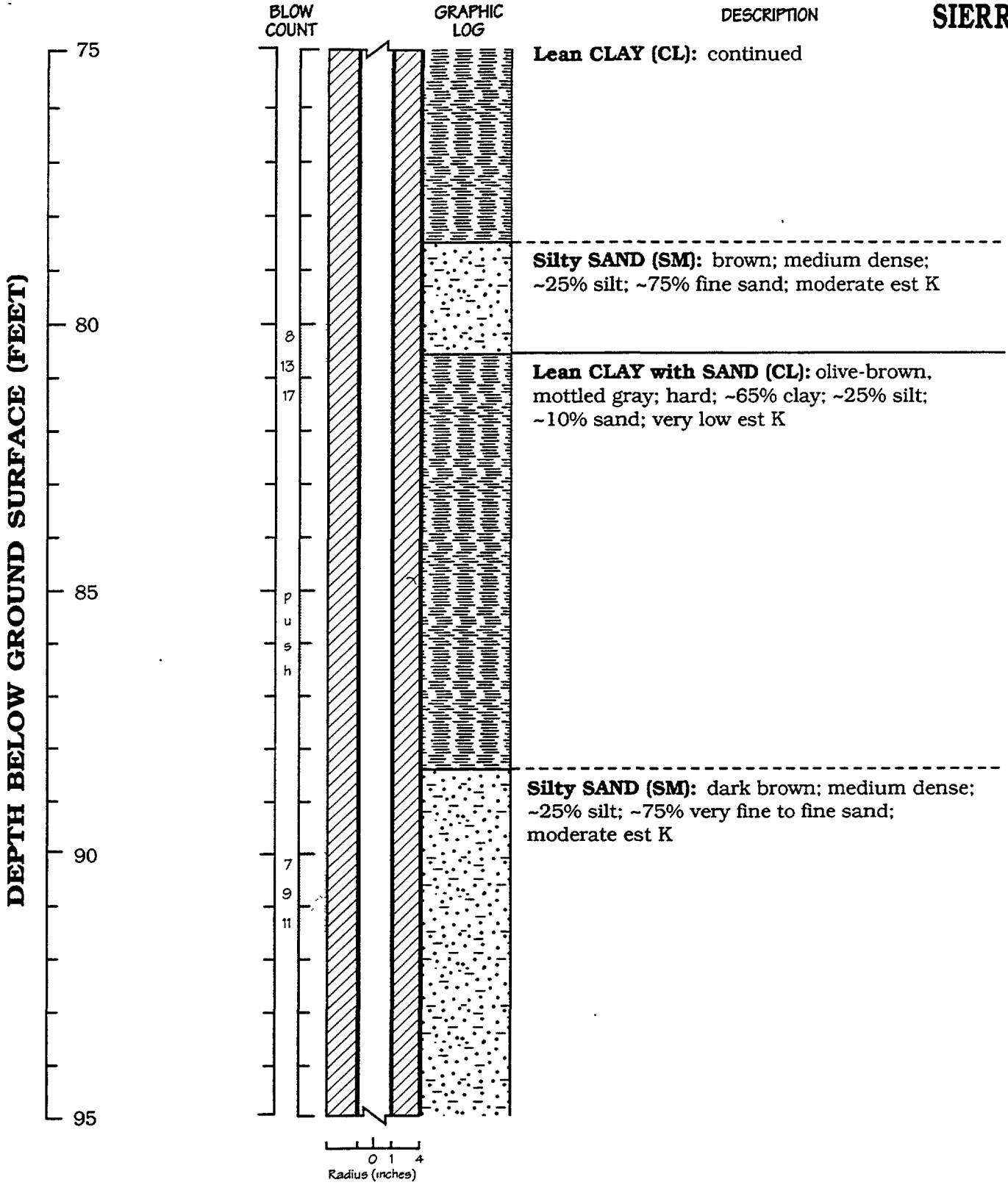
Silty SAND (SM): olive-brown, mottled gray; ~35% silt; ~65% very fine to fine sand; moderate est K

Sandy SILT (ML): ~20% clay; ~40% silt; ~35% very fine to fine sand; very low est K

Lean CLAY with SAND (CL): olive-brown, mottled gray; hard; ~65% clay; ~25% silt; ~10% sand; very low est K

WELL OW-11C
(continued)

SIERRA



Lean CLAY (CL): continued

Silty SAND (SM): brown; medium dense; ~25% silt; ~75% fine sand; moderate est K

Lean CLAY with SAND (CL): olive-brown, mottled gray; hard; ~65% clay; ~25% silt; ~10% sand; very low est K

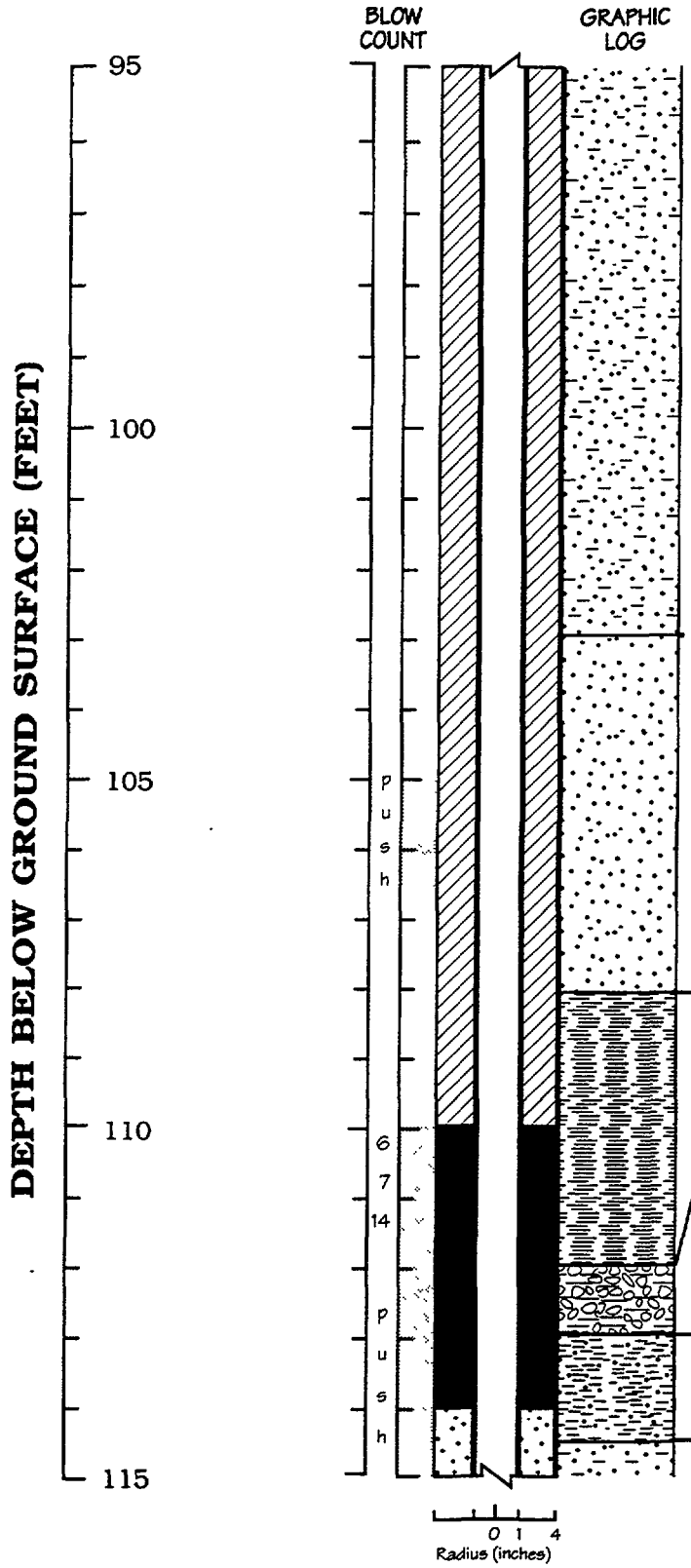
Silty SAND (SM): dark brown; medium dense; ~25% silt; ~75% very fine to fine sand; moderate est K

Well Construction and Boring Log – Well OW-11C

Frontier Fertilizer
Davis, California

WELL OW-11C
(continued)

SIERRA



DESCRIPTION

Silty SAND (SM): continued

flowing sands in auger, unable to sample at 100′

Poorly graded SAND (SP/SM): ~10% silt; ~90% medium sand; moderate to high est K

Lean CLAY with Sand (CL): olive-brown, mottled gray; stiff; ~60% clay; ~30% silt; ~10% sand; very low est K

Clayey GRAVEL with Sand (GC): medium dense; ~10% clay; ~10% silt; ~30% sand; ~50% well graded, subrounded gravel to 2″ diameter; moderate to high est K

Sandy SILT (ML): olive-brown, mottled gray; firm; ~20% clay; ~65% silt; ~15% very fine sand; low est K

Silty SAND (SM): brown, medium dense; ~20% silt; ~80% fine to medium sand; moderate est K

Well Construction and Boring Log – Well OW-11C

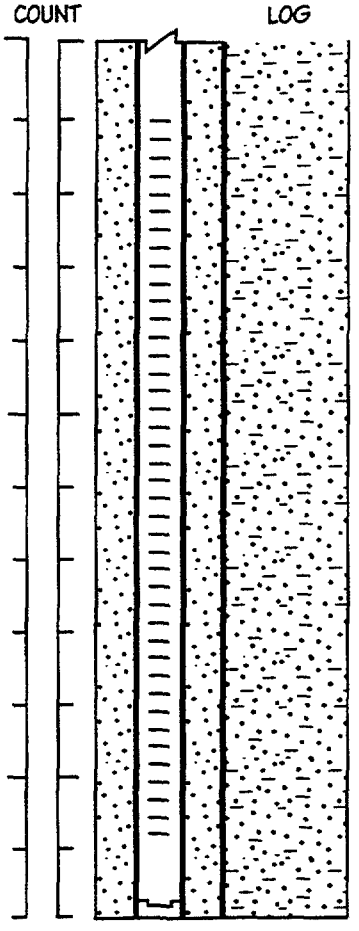
Frontier Fertilizer
Davis, California

WELL OW-11C
(continued)

SIERRA

DEPTH BELOW GROUND SURFACE (FEET)

	BLOW COUNT	GRAPHIC LOG	DESCRIPTION
115			**Silty SAND (SM):** continued
120			flowing sands in auger
			driller reports gravel at 123′
125			flowing sands in auger



Well Construction and Boring Log – Well OW-11C

Frontier Fertilizer
Davis, California

BECHTEL

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FRONTIER FERTILIZER	20376	1 OF 3	B-11

SITE	COORDINATES	ANGLE FROM HORIZ.	BEARING
B-11		90	

BEGUN	COMPLETED	DRILLER	DRILL MAKE AND MODEL	HOLE SIZE	OVERBURDEN (FT.)	ROCK (FT.)	TOTAL DEPTH
6/22/98	6/24/98	WATER DEVELOPMENT	CME-95	8 1/4"	—	N/A	70 ft.

CORE RECOVERY (FT./%)	CORE BOXES	SAMPLES	EL. TOP OF CASING	GROUND EL.	DEPTH/EL. GROUND WATER	DEPTH/EL. TOP OF ROCK
						N/A

SAMPLE HAMMER WEIGHT/FALL	CASING LEFT IN HOLE: DIA./LENGTH	LOGGED BY:
		R. COOK

SAMPLER TYPE AND DIAMETER	SAMPLER ADVANCE / LENGTH CORE RUN	SAMPLE RECOVERY / CORE RECOVERY	SAMPLE BLOWS "N" / PERCENT CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN G.P.M.	PRESSURE P.S.I.	TIME IN MINUTES	ELEVATION	DEPTH	GRAPHIC LOG	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
SS	1.5	1.6	6-7-7					5		X	5.0-6.5: CLAYEY SILT - DARK YELLOWISH BROWN (10YR 4/2), VERY FINE GRAIN, MODERATELY STIFF, SILT ≈ 80%, CLAY ≈ 20%, DRY to MOIST.	
SS	1.5	1.6	6-9-17					10		X	8.5-10.0: CLAYEY SILT: DARK YELLOW BROWN (10YR 4/2), VERY FINE GRAIN, LOW PLASTICITY, MODERATELY STIFF, CLAY ≈ 40%, SILT ≈ 60%, DRY to MOIST	
SS	1.5	1.5	6-17-10					15		X	13.5-15.0: CLAYEY SILT: DARK YELLOW BROWN (10YR 4/2), VERY FINE GRAIN, LOW PLASTICITY, SILT ≈ 60%, CLAY ≈ 40%, DRY to MOIST.	
SS	1.5	1.5	7-10-15					20		X	18.5-20.0: CLAYEY SILT: DARK YELLOW BROWN (10YR 4/2), VERY FINE GRAIN, DRY to MOIST.	
SS	1.5	1.5	5-8-10					25		X	23.5-24.5: CLAYEY SILT: DARK YELLOWISH BROWN (10YR 4/2), VERY FINE GRAIN, LOW PLASTICITY, CLAY ≈ 30%, SILT ≈ 70%, 24.5-25.0: SILTY SAND: DARK YELLOW BROWN (10YR 4/2), VERY FINE GRAIN,	
SS	1.5	1.5	5-7-10					30		X	28.5-30.0: CLAYEY SILT: MODERATE YELLOWISH BROWN (10YR 5/4) DRY to MOIST, VERY FINE GRAIN, CLAY ≈ 50%, SILT ≈ 50% LOW PLASTICITY, MODERATELY STIFF	
SS	1.5	1.1	12-13-17					35		X	33.5-35.0; SILTY CLAY; MOD YELLOWISH BROWN (10YR 5/4); MEDIUM PLASTICITY, VERY FINE GRAIN, STIFF, DRY to MOIST.	

SS = SPLIT SPOON; ST = SHELBY TUBE; D = DENNISON; P = PITCHER; O = OTHER

SITE

HOLE NO. B-11

H&CF 19-1

BECHTEL

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FRONTIER FERTILIZER	20376	2 of 3	B-11

SITE	COORDINATES	ANGLE FROM HORIZ.	BEARING
B-11			

BEGUN	COMPLETED	DRILLER	DRILL MAKE AND MODEL	HOLE SIZE	OVERBURDEN (FT.)	ROCK (FT.)	TOTAL DEPTH
6/22/98	6/24/98	WATER DEVELOPMENT	CME - 95	8 1/4"			70 ft.

CORE RECOVERY (FT./%)	CORE BOXES	SAMPLES	EL TOP OF CASING	GROUND EL.	DEPTH/EL. GROUND WATER	DEPTH/EL. TOP OF ROCK

SAMPLE HAMMER WEIGHT/FALL	CASING LEFT IN HOLE: DIA./LENGTH	LOGGED BY:
		R. Cook

SAMPLER TYPE AND DIAMETER	SAMPLER ADVANCE / LENGTH CORE RUN	SAMPLE RECOVERY / CORE RECOVERY	SAMPLE BLOWS "N" / PERCENT CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN G.P.M.	PRESSURE P.S.I.	TIME IN MINUTES	ELEVATION	DEPTH	GRAPHIC LOG	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
												Attempted to obtain a water sample at 35 ft. BGS. Water was a very high turbidity value greater than 1000 NTU's. 38.5 ft. - No sample. Simulprobe cone stuck in sampler.
								40				
SS	1.5		8-7-27					45			43.5-44.5; Gravelly sand; dark yellowish brown (10YR5/2), poorly sorted; gravel 1/8 to 1/16 in. size to very fine grain, wet, subangular to semi-rounded, 70% sand, 30% silt, loose.	43-44.5 ft. Attempted a simul probe water sample. Unsuccessful, inlet screen obscured by clay.
											44.5-45.0; Clayey silt; moderate yellow brown (10YR5/4), dry to moist, moderately stiff, very fine grain, low plasticity.	
SS	1.5		16-17-20								45.0-45.75; Silty clay; same as above.	
								50			45.75-46.25; Gravelly silty sand; dark yellow brown (10YR 4/2), sand ≈ 50%. Gravel ≈ 20%, silt ≈ 30%. Sand very fine grain, subangular; gravel, subangular, medium, silt - very fine grain, poorly sorted.	
SS	1.5		12-25-27					55			48.5-50.0 Silty clay; (5Y6/1) light olive gray & mod ylw brown (10YR5/4) mottled, stiff to very stiff, medium plasticity, very fine grain, moist to dry.	
SS	1.5		5-6-7					60			53.5-55.0 - Silty clay - mod yellow brown (10YR5/4) with slight banding & mottling of light olive gray (5Y6/1), moist, very stiff, medium plasticity, very fine grain.	
SS	1.5		22-24-27					65			58.5-60.0 Clayey silt, mod ylw brown (10YR5/4), small amount of greenish gray (5GY6/1), mottling ≈ 5%, dry to moist, very fine grain, low plasticity, stiff.	
SS	1.5		11-11-26								63.5-65.0, Clayey silt; same as above. Very stiff, 70% silt, 30% clay, ~~35% sand; gravel~~ RC, ~~(cont.)~~ moist	
SS	1.5		8-12-14					70				

SS = SPLIT SPOON; ST = SHELBY TUBE; D = DENNISON; P = PITCHER; O = OTHER

SITE

HOLE NO. B-11

BECHTEL

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FRONTIER FERTILIZER	20376	3 OF 3	B-11

SITE	COORDINATES	ANGLE FROM HORIZ.	BEARING

BEGUN	COMPLETED	DRILLER	DRILL MAKE AND MODEL	HOLE SIZE	OVERBURDEN (FT.)	ROCK (FT.)	TOTAL DEPTH
6/22/98	6/24/98	WATER DEVELOPMENT	CME-95	8 1/4"			10 ft

CORE RECOVERY (FT./%)	CORE BOXES	SAMPLES	EL TOP OF CASING	GROUND EL.	DEPTH/EL. GROUND WATER	DEPTH/EL. TOP OF ROCK

SAMPLE HAMMER WEIGHT/FALL	CASING LEFT IN HOLE: DIA./LENGTH	LOGGED BY:
		R. COOK

SAMPLER TYPE AND DIAMETER	SAMPLER ADVANCE LENGTH CORE RUN	SAMPLE RECOVERY CORE RECOVERY	SAMPLE BLOWS "N" / PERCENT CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN G.P.M.	PRESSURE P.S.I.	TIME IN MINUTES	ELEVATION	DEPTH	GRAPHIC LOG	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
								10			66.0-67.5; CLAYEY, GRAVELLY SILT, MOD YLW BROWN (10YR 5/4), 70% SILT 25% CLAY, > 5% SAND & GRAVEL, MEDIUM PLASTICITY, MOIST, SAND TO GRAVEL, VERY FINE TO COARSE, ANGULAR TO SUBANGULAR GRAINS; 68.5-69.75; CLAYEY SILT, MOD YLW BROWN (10YR 5/4), SAME AS ABOVE.	SIMUL-PROBE SAMPLE AT 70-71 FEET BGS
								75			69.75-70.0; CLAYEY SILTY SAND, SAND ≈ 52%, SILT ≈ 40%, CLAY ≈ 10%, COLOR CHANGE TO DARK YELLOWISH BROWN (10YR 4/2), VERY FINE GRAIN SAND, WELL SORTED, MOIST, LOW TO ZERO PLASTICITY.	
								80			TOTAL DEPTH = 10 FT.	
								85				
								90				
								95				
								100				

SS = SPLIT SPOON; ST = SHELBY TUBE; D = DENNISON; P = PITCHER; O = OTHER

SITE

HOLE NO. B-11

H&CF 19-1

BECHTEL

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FRONTIER FERTILIZER	20376	1 of 3	B-12

SITE	COORDINATES	ANGLE FROM HORIZ.	BEARING

BEGUN	COMPLETED	DRILLER	DRILL MAKE AND MODEL	HOLE SIZE	OVERBURDEN (FT.)	ROCK (FT.)	TOTAL DEPTH
6/25/98	6/26/98	WATER DEVELOPMENT	CME-95	8 1/4"			93.5 ft.

CORE RECOVERY (FT./%)	CORE BOXES	SAMPLES	EL. TOP OF CASING	GROUND EL.	DEPTH/EL. GROUND WATER	DEPTH/EL. TOP OF ROCK

SAMPLE HAMMER WEIGHT/FALL	CASING LEFT IN HOLE: DIA./LENGTH	LOGGED BY:
		R. Cook

SAMPLER TYPE AND DIAMETER	SAMPLER ADVANCE LENGTH CORE RUN	SAMPLE RECOVERY / CORE RECOVERY	SAMPLE BLOWS "N" / PERCENT CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN G.P.M.	PRESSURE P.S.I.	TIME IN MINUTES	ELEVATION	DEPTH	GRAPHIC LOG	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
SS	1.5	1.3	5-5-7					5			3.5-5.0; CLAYEY SILT; DARK YELLOWISH BROWN, (10YR 4/2), VERY FINE GRAIN, NO PLASTICITY, SLIGHTLY MOTTLED, MODERATELY STIFF, DRY.	
SS	1.5	1.5	7-10-14					10			8.5-10.0; CLAYEY SILT; SAME AS ABOVE. VERY STIFF.	
SS	1.5	1.6	8-12-13					15			13.5-15.0; CLAYEY SILT; DARK YELLOWISH BROWN (10YR 4/2), SILT ≈ 70%, CLAY ≈ 30%, MOIST, MEDIUM PLASTICITY,	
SS	1.5	1.6	5-6-8					20			18.5-20.0; CLAYEY SILT; DK YLW BROWN (10YR 4/2), MEDIUM PLASTICITY, MOIST SAME AS ABOVE.	
SS	1.5	1.4	3-4-7					25			23.5-25.0; CLAYEY SILT; DK YLW BROWN, (10YR 4/2), SILT ≈ 60%, CLAY ≈ 40%, MEDIUM PLASTICITY, MOIST, VERY FINE GRAIN.	
SS	1.5	1.6	5-6-8					30			28.5-30.0 - CLAYEY SILT; COLOR CHANGE TO OLIVE GRAY (5Y 4/1), CLAY ≈ 50%, SILT ≈ 50%, MEDIUM PLASTICITY, MOIST, VERY FINE GRAIN, MODERATELY STIFF.	
SS	1.5	1.6	7-8-10					35			33.5-35.0; SILTY CLAY, MOTTLED ~~CLAY~~ RC OLIVE GRAY (5Y 4/1) & MEDIUM BLUISH GRAY (5B 5/1), HIGH PLASTICITY, VERY FINE GRAIN, MOIST, MODERATELY STIFF.	

SS = SPLIT SPOON; ST = SHELBY TUBE; D = DENNISON; P = PITCHER; O = OTHER

SITE

HOLE NO. B-12

BECHTEL

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FRONTIER FERTILIZER	20376	2 of 3	B-12

SITE	COORDINATES	ANGLE FROM HORIZ.	BEARING

BEGUN	COMPLETED	DRILLER	DRILL MAKE AND MODEL	HOLE SIZE	OVERBURDEN (FT.)	ROCK (FT.)	TOTAL DEPTH
6/25/98	6/26/98	WATER DEVELOPMENT	CME-95	8 1/4"			93.5 ft

CORE RECOVERY (FT./%)	CORE BOXES	SAMPLES	EL. TOP OF CASING	GROUND EL.	DEPTH/EL. GROUND WATER	DEPTH/EL. TOP OF ROCK

SAMPLE HAMMER WEIGHT/FALL	CASING LEFT IN HOLE: DIA./LENGTH	LOGGED BY:
		R. Cook

SAMPLER TYPE AND DIAMETER	SAMPLER ADVANCE LENGTH CORE RUN	SAMPLE RECOVERY CORE RECOVERY	SAMPLE BLOWS "N" / PERCENT CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN G.P.M.	PRESSURE P.S.I.	TIME IN MINUTES	ELEVATION	DEPTH	GRAPHIC LOG	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
								35	35			
											38.5-40.0; SILTY CLAY; SAME AS ABOVE EXCEPT FOR COLOR VARIATION TO 75% OLIVE GRAY (5Y4/1) & ≈ 25% MEDIUM BLUISH GRAY (5B5/1).	
SS	1.5	1.5	5-6-7									
SS	1.5	1.5	4-5-12					40			40.0-41.5; SILTY CLAY, SAME AS ABOVE.	
SS	1.0	1.0	7-8								41.5-42.5; SILTY CLAY, SAME AS ABOVE.	
SS	1.5	1.5	3-4-4									
											42.5-42.9; SANDY SILT; OLIVE GRAY (5Y4/1), SILT ≈ 60%, SAND ≈ 30%, CLAY ≈ 10%, LOW PLASTICITY, VERY FINE GRAIN, MOIST.	
SS	1.5	1.3	4-7-8					45			42.9-43.2; SAND; OLIVE GRAY (5Y4/1), FINE TO VERY FINE GRAIN, ROUNDED TO SUBROUNDED, MOIST TO SATURATED, NO PLASTICITY, GRAINS WELL SORTED, LOOSE.	INSTALLED TEMP WELL BOTTOM OF SCREEN AT ≈ 46 ft.
SS	1.5	1.5	7-8-10									
											43.2-44.0; SILTY CLAY, OLIVE GRAY, (5Y4/1), MODERATELY STIFF, VERY FINE GRAIN, MEDIUM PLASTICITY, MOIST.	
SS	1.5	1.5	6-11-14					50			44.0-45.5; SILTY CLAY; SAME AS ABOVE WITH 1 STRATIFIED LAYER OF FINE TO VERY FINE SAND GRAINS LAYER ≈ 0.1 ft. THICK AT ≈ 45.2 ft. CLAY ≈ 60%, SILT ≈ 40%, HIGH PLASTICITY, SOFT.	
											45.5-47.0; SILTY CLAY, (10YR5/4), SAME AS ABOVE. COLOR CHANGE TO MODERATE YELLOWISH BROWN (10YR5/4) AT 46.1. AT 46.1, VERY FINE GRAIN, MOIST, LOW PLASTICITY, VERY STIFF.	
SS	1.5	1.3	6-15-20					55				
											48.5-50.0; CLAYEY SILT; MODERATE YELLOWISH BROWN (10YR5/4) WITH STREAKS OF GREENISH GRAY (5GY6/1), VERY FINE GRAIN, LOW PLASTICITY, MODERATELY STIFF	
											53.5-55.0; CLAYEY SILT, SAME AS ABOVE. DRY TO MOIST.	
SS	1.5	0.3	10-12-18					60			58.5-60.0; CLAYEY SILT, SAME AS ABOVE. DRY TO MOIST.	
											63.5-65.0; CLAYEY SILT; MODERATE YELLOWISH BROWN (10YR5/4) WITH SOME STREAKS & SPOT MARKINGS OF GRAYISH ORANGE (10YR7/4) VERY STIFF, VERY FINE GRAIN, SILT ≈ 70%, CLAY ≈ 30%, LOW PLASTICITY, DRY TO MOIST.	
SS	1.5	1.5	12-18-20					65				
											68.5-70.0; CLAYEY SILT; MODERATE YELLOWISH BROWN (10YR5/4), SLIGHT GREENISH GRAY SPOTTING (5G6/1), DRY TO MOIST, LOW PLASTICITY, VERY FINE GRAIN, MODERATELY STIFF.	
SS	1.5	1.5	15-17-23					70				

SS = SPLIT SPOON; ST = SHELBY TUBE; D = DENNISON; P = PITCHER; O = OTHER

SITE

HOLE NO. B-12

BECHTEL

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FRONTIER FERTILIZER	20376	3 of 3	B-12

SITE	COORDINATES	ANGLE FROM HORIZ.	BEARING

BEGUN	COMPLETED	DRILLER	DRILL MAKE AND MODEL	HOLE SIZE	OVERBURDEN (FT.)	ROCK (FT.)	TOTAL DEPTH
6/25/98	6/26/98	WATER DEVELOPMENT	CME - 95	8 1/4"			93.5 ft

CORE RECOVERY (FT./%)	CORE BOXES	SAMPLES	EL. TOP OF CASING	GROUND EL.	DEPTH/EL. GROUND WATER	DEPTH/EL. TOP OF ROCK

SAMPLE HAMMER WEIGHT/FALL	CASING LEFT IN HOLE: DIA./LENGTH	LOGGED BY:
		R. COOK

SAMPLER TYPE AND DIAMETER	SAMPLER ADVANCE / LENGTH CORE RUN	SAMPLE RECOVERY / CORE RECOVERY	SAMPLE BLOWS "N" / PERCENT CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN G.P.M.	PRESSURE P.S.I.	TIME IN MINUTES	ELEVATION	DEPTH	GRAPHIC LOG	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
SS	1.5	1.4	10-14-17					70			93.5-95.0, SILTY CLAY; MODERATE YELLOWISH BROWN (10YR 5/4) WITH BRANDED STRIATIONS OF GREENISH GRAY (5GY 6/1) ≈ 85%. SAMPLE MEDIUM PLASTICITY, DRY TO MOIST, VERY FINE GRAIN, MODERATELY STIFF.	
SS	1.5	1.3	?-16-14					75			95.0-96.5; SILTY CLAY; SAME AS ABOVE. COLOR BANDING IS 60%, DARK YELLOWISH BROWN, (10YR 5/4) & 40% GREENISH GRAY (5GY 6/1)	
SS	1.5	1.3	14-18-22								96.5-98.0; SILTY CLAY; SAME AS ABOVE. DARK YELLOWISH BROWN, (10YR 5/4) ≈ 70%, GREENISH GRAY (5GY 6/1) ≈ 30%, STIFF.	
								80				
SS	1.5	1.5	10-15-24								83.5-85.0; SILTY CLAY; DK YELLOWISH BROWN (10YR 5/4), CLAY ≈ 70%, SILT ≈ 30%, SAND ≈ 10%, SAND IS VERY FINE GRAIN, WELL SORTED, MEDIUM to HIGH PLASTICITY, MOIST, MODERATELY STIFF.	
								85				
								90				
SS	1.5	1.5	12-14-17								92.0-93.5; SANDY, CLAYEY SILT, DARK YELLOWISH BROWN, (10YR 4/2), SILT ≈ 60%, SAND ≈ 20%, CLAY ≈ 20%, MEDIUM PLASTICITY, SAND IS VERY FINE to FINE GRAIN, WELL SORTED, MODERATELY STIFF, MOIST.	ATTEMPT A H_2O SAMPLE AT 93.5-95.0 BASED ON 92.0-93.5 SAMPLE. ALLOWED to DRAIN 45 MINUTES. NO H_2O IN SAMPLE. FORMATION TOO CLAYEY & SILTY.
								95			TOTAL DEPTH = 93.5 ft.	
								100				
								105				

SS = SPLIT SPOON; ST = SHELBY TUBE; D = DENNISON; P = PITCHER; O = OTHER

SITE

HOLE NO. B-12

BECHTEL

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FRONTIER FERTILIZER	20376	1 OF 2	B-13

SITE	COORDINATES	ANGLE FROM HORIZ.	BEARING
B-13			

BEGUN	COMPLETED	DRILLER	DRILL MAKE AND MODEL	HOLE SIZE	OVERBURDEN (FT.)	ROCK (FT.)	TOTAL DEPTH
6/29/98	6/29/98	WATER DEVELOPMENT	CME-95	8 1/4"			80.0

CORE RECOVERY (FT./%)	CORE BOXES	SAMPLES	EL. TOP OF CASING	GROUND EL.	DEPTH/EL. GROUND WATER	DEPTH/EL. TOP OF ROCK

SAMPLE HAMMER WEIGHT/FALL	CASING LEFT IN HOLE: DIA./LENGTH	LOGGED BY:
		R. COOK

SAMPLER TYPE AND DIAMETER	SAMPLER ADVANCE LENGTH CORE RUN	SAMPLE RECOVERY CORE RECOVERY	SAMPLE BLOWS "N" / PERCENT CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN G.P.M.	PRESSURE P.S.I.	TIME IN MINUTES	ELEVATION	DEPTH	GRAPHIC LOG	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
											3.5-5.0; CLAYEY SILT - DUSKY YELLOW BROWN (10YR 2/2), MOIST, LOW PLASTICITY, SILT ≈ 70%, CLAY ≈ 25%, SAND < 5%, VERY FINE GRAIN. SOFT TO MODERATELY STIFF.	
SS	1.5	1.5	6-8-12					5			8.5-10.0 CLAYEY SILT; SAME AS ABOVE. STIFF, MOIST.	
SS	1.5	1.7	3-7-9					10			13.5-15.0; CLAYEY SILT; MODERATE YELLOWISH BROWN (10YR 5/4) MOIST, MEDIUM PLASTICITY, CLAY ≈ 30%, SILT ≈ 60%, SAND ≈ 10%, FINE GRAIN, SAND CONTENT INCREASING TO ≈ 30% AT 14.8 ft.	
SS	1.5	1.65	3-5-9					15			18.5-18.9; SILTY SAND, MODERATE YELLOWISH BROWN (10YR 5/4), MEDIUM GRAIN, NO PLASTICITY, SUBROUNDED, WELL SORTED, WET, LOOSE, SAND ≈ 70%, SILT ≈ 25%, TRACE CLAY.	18.5-20; ATTEMPTED A SIMUL-PROBE SAMPLE FOR WATER.
SS	1.5	0.9						20			18.9-19.4; CLAYEY SILT, MODERATE YELLOWISH BROWN, (10YR 5/4) SILT ≈ 60%, CLAY ≈ 20%, SAND ≈ 20%, MEDIUM PLASTICITY, SOFT, MOIST.	
SS	1.5	1.3						25			23.5-25.0; GRAVELLY SAND; OLIVE GRAY (5Y 4/1), POORLY SORTED, SUB-ANGULAR GRAINS, LOOSE, GRAIN SIZE FINE WITH COBBLES UP TO 0.05 ft. OR 1.5 cm, SILT < 10%, NO PLASTICITY, WET.	25.0-26.5 OBTAINED A SIMUL. PROBE WATER SAMPLE.
SS	1.5	1.5	9-25-27					30			25.0-26.5; GRAVELLY SAND, SAME AS ABOVE.	
			5-8-10					35			28.5-30.0; GRAVELLY SAND, GRAVEL ≈ 50%, SAND ≈ 40%, SILT ≈ 10%, VERY COARSE to VERY FINE SAND, GRAVEL UP TO 3 cm, LOOSE, WET.	
SS	1.5	1.3	~~6-8-12~~ 10-16-25					40			33.5-35.0 - GRAVELLY SAND, COLOR CHANGE TO BROWNISH GRAY (5YR 4/1), POORLY SORTED, GRAVEL ≈ 30%, SAND ≈ 70%, TRACE SILT, GRAVEL UP TO 1.8 cm, VERY FINE to VERY COARSE SAND.	
SS	1.5	1.4	4-18-25					45			38.5-40.0; GRAVELLY SAND, OLIVE GRAY (5Y 4/1), GRAVEL CONTENT INCREASES TO ≈ 40%, SAND ≈ 60%	
SS	1.5	1.6	19-25-27					50			43.5-44.5; GRAVELLY SAND, SAME AS ABOVE.	
SS	1.5	1.6	15-17-20					55			44.5-45.0, SILTY CLAY, MODERATE BROWN (5YR 4/4), MOTTLED WITH OLIVE GRAY (5Y 4/1), MEDIUM PLASTICITY, MOIST, VERY FINE GRAIN, VERY STIFF.	
SS	1.5	1.5	8-17-27					60			48.5-50.0; GRAVELLY SAND; OLIVE GRAY, (5Y 4/1) WET, LOOSE POORLY SORTED, VERY FINE to VERY COARSE SAND, GRAVEL ≈ 20%, UP TO 1 cm.; SAND ≈ 70%, SILT < 10%	SET-UP TEMPORARY WELL & SAMPLE. SCREEN FROM 60-70 BGS.
SS	1.5	1.5	9-12-24					65			53.5-55.0; SILTY CLAY, DARK YELLOWISH BROWN (10YR 4/2), HIGH PLASTICITY, MOIST, VERY FINE GRAIN; CLAY ≈ 60%, SILT ≈ 40% MODERATELY STIFF.	
SS	1.5	1.6	12-17-20					70				

SS = SPLIT SPOON; ST = SHELBY TUBE; D = DENNISON; P = PITCHER; O = OTHER

SITE

HOLE NO. B-13

BECHTEL

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FRONTIER FERTILIZER	20376	2 of 2	B-13

SITE	COORDINATES	ANGLE FROM HORIZ.	BEARING
B-13			

BEGUN	COMPLETED	DRILLER	DRILL MAKE AND MODEL	HOLE SIZE	OVERBURDEN (FT.)	ROCK (FT.)	TOTAL DEPTH
6/29/98	6/29/98	WATER DEVELOPMENT	CME-	8 1/4"			80.0 ft

CORE RECOVERY (FT./%)	CORE BOXES	SAMPLES	EL. TOP OF CASING	GROUND EL.	DEPTH/EL. GROUND WATER	DEPTH/EL. TOP OF ROCK

SAMPLE HAMMER WEIGHT/FALL	CASING LEFT IN HOLE: DIA./LENGTH	LOGGED BY:
		R. Cook

SAMPLER TYPE AND DIAMETER	SAMPLER ADVANCE / LENGTH CORE RUN	SAMPLE RECOVERY / CORE RECOVERY	SAMPLE BLOWS "N" / PERCENT CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN G.P.M.	PRESSURE P.S.I.	TIME IN MINUTES	ELEVATION	DEPTH	GRAPHIC LOG	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
SS	1.5	2.0 / ~~1.5~~ RC	12-18-27					75		X	58.5 - 60.0; SILTY CLAY, SAME AS ABOVE; MOTTLED WITH OLIVE GRAY (5Y 4/1) ≈ 10%. 63.5 - 64.5; SANDY, SILTY CLAY; DARK YELLOWISH BROWN (10YR 4/2), WET, SOFT, HIGH PLASTICITY, CLAY ≈ 60%, SILT ≈ 20%, SAND ≈ 20%, SAND IS FINE GRAIN, WELL SORTED.	
SS	1.5	1.2	3					80		X	64.5 - 65.0; SILTY CLAY; MODERATE YELLOWISH BROWN (10YR 5/4); STIFF, VERY FINE GRAIN, CLAY ≈ 70%, SILT ≈ 30%, MOTTLED WITH OLIVE GRAY (5Y 4/1), HIGH PLASTICITY, MOIST. 68.5 - 68.9; SILTY CLAY; SAME AS ABOVE.	
											68.9 - 69.3; SANDY SILT; DARK YELLOWISH BROWN (10YR 4/2), LOOSE, MOIST, MEDIUM SAND, WELL SORTED, ROUNDED, NO PLASTICITY, SILT ≈ 60%, SAND ≈ 20%, CLAY ≈ 20%.	
											69.3 - 70.0; SILTY CLAY; MODERATE YELLOWISH BROWN (10YR 5/4), VERY FINE GRAIN, MEDIUM PLASTICITY, MOIST, MOTTLED WITH OLIVE GRAY <10%, (5Y 4/1), STIFF. 73.5 - 75.0; SILTY CLAY; SAME AS ABOVE, STIFF, MOIST, 2.0 RECOVERY, MOTTLED WITH VERY PALE ORANGE (10YR 8/2) 78.5 - 80.0; SILTY CLAY; SAME AS ABOVE, MOIST, STIFF, NO MOTTLING COLORATIONS.	
											TOTAL DEPTH = 80.0	

SS = SPLIT SPOON; ST = SHELBY TUBE; D = DENNISON; P = PITCHER; O = OTHER

SITE

HOLE NO. B-13

H&CF 19-1

BECHTEL

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FRONTIER FERTILIZER	20376	1 OF 3	B-14

SITE	COORDINATES	ANGLE FROM HORIZ.	BEARING

BEGUN	COMPLETED	DRILLER	DRILL MAKE AND MODEL	HOLE SIZE	OVERBURDEN (FT.)	ROCK (FT.)	TOTAL DEPTH
6/30/98	7/1/98	WATER DEVELOPMENT	CME - 95	8 1/4"			80.0

CORE RECOVERY (FT./%)	CORE BOXES	SAMPLES	EL. TOP OF CASING	GROUND EL.	DEPTH/EL. GROUND WATER	DEPTH/EL. TOP OF ROCK

SAMPLE HAMMER WEIGHT/FALL	CASING LEFT IN HOLE: DIA./LENGTH	LOGGED BY:
		R. COOK

SAMPLER TYPE AND DIAMETER	SAMPLER ADVANCE / LENGTH CORE RUN	SAMPLE RECOVERY / CORE RECOVERY	SAMPLE BLOWS "N" / PERCENT CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN G.P.M.	PRESSURE P.S.I.	TIME IN MINUTES	ELEVATION	DEPTH	GRAPHIC LOG	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
SS	1.5	1.5	5-6-6					0 5		X	3.5-5.0; CLAYEY SILT; DARK YELLOWISH BROWN (10YR 4/2), MODERATELY STIFF, DRY, VERY FINE GRAIN, SILT ≈ 70%, CLAY ≈ 25%, TRACE SAND, NO PLASTICITY, COLOR CHANGE TO DUSKY YELLOWISH BROWN AT 4.4 ft., MOIST, LOW PLASTICITY, SOFT.	
SS	1.5	1.6	6-8-9					10		X	8.5-10.0; CLAYEY SILT; SAME AS ABOVE, STIFF. COLOR CHANGE AT 9.1 ft. TO DARK YELLOWISH BROWN (10YR 4/2), DRY, MOISTURE CONTENT INCREASES TO MOIST AT 9.6, MEDIUM TO HIGH PLASTICITY, VERY FINE SAND CONTENT ≈ 10%.	
SS	1.5	1.6	4-7-11					15		X	13.5-15.0, CLAYEY SILT, DARK YELLOWISH BROWN, (10YR 4/2), MOIST, SILT ≈ 70%, CLAY ≈ 30%, TRACE SAND.	
SS	1.5	1.5	6-5-8					20		X	18.5-20.0; CLAYEY SILT; SAME AS ABOVE, MOIST.	
SS	1.5	1.6	6-9-9					25		X	23.5-25.0; CLAYEY SILT; DARK YELLOWISH BROWN, (10YR 4/2), MOTTLED WITH LIGHT OLIVE GRAY, ( ) ≈ 20-30%, MOIST TO DRY, LOW PLASTICITY, SILT ≈ 70%, CLAY ≈ 30%, SOFT, VERY FINE GRAIN.	
SS	1.5	1.5	6-12-9					30		X	28.5-30.0; CLAYEY SILT; SAME AS ABOVE, VERY STIFF.	
								35		X	33.5-34.1; CLAYEY SILT; SAME AS ABOVE, 34.1-34.3; SAND CONTENT INCREASES TO 30%, VERY FINE GRAIN, WELL SORTED. 34.3-34.9; SAND CONTENT DECREASES TO TRACE.	

SS = SPLIT SPOON; ST = SHELBY TUBE; D = DENNISON; P = PITCHER; O = OTHER

SITE

HOLE NO. B-14

BECHTEL

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FRONTIER FERTILIZER	20376	2 OF 3	B-14

SITE	COORDINATES	ANGLE FROM HORIZ.	BEARING

BEGUN	COMPLETED	DRILLER	DRILL MAKE AND MODEL	HOLE SIZE	OVERBURDEN (FT.)	ROCK (FT.)	TOTAL DEPTH
6/30/98	7/1/98	WATER DEVELOPMENT	CME-95	8 1/4"			80.0

CORE RECOVERY (FT./%)	CORE BOXES	SAMPLES	EL. TOP OF CASING	GROUND EL.	DEPTH/EL. GROUND WATER	DEPTH/EL. TOP OF ROCK

SAMPLE HAMMER WEIGHT/FALL	CASING LEFT IN HOLE: DIA./LENGTH	LOGGED BY:
		R. COOK

SAMPLER TYPE AND DIAMETER	SAMPLER ADVANCE / LENGTH CORE RUN	SAMPLE RECOVERY / CORE RECOVERY	SAMPLE BLOWS "N" / PERCENT CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN G.P.M.	PRESSURE P.S.I.	TIME IN MINUTES	ELEVATION	DEPTH	GRAPHIC LOG	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
								35			34.7-35.0 - SAND CONTENT INCREASES ≈ 40%, WELL SORTED, VERY FINE GRAIN, MOIST, LOW PLASTICITY, SILT ≈ 60%, TRACE, CLAY. 38.5-38.7; CLAYEY SILT. SAME AS ABOVE.	
SS	1.5	1.5	9-5-17								38.7-40.0; SAND; DARK YELLOWISH BROWN, (10YR 4/2), WELL SORTED, MEDIUM GRAIN, SAND ≈ 90%, SILT ≈ 10%, MOIST, TRACE, VERY COARSE GRAIN SAND, LOOSE, GRAINS, SUBROUNDED.	SIMUL-PROBE SAMPLE 38.5-40.0 ft.
SS	1.5	1.5						40			40.0-41.5; SAND; SAME AS ABOVE	
SS	1.5	1.5	5-7-12					45			SAND; COLOR CHANGE TO OLIVE GRAY (5Y 4/1), SAND ≈ 90%, SILT ≈ 10%,	
											48.5-50.0; NO SAMPLE.	SAMPLE LOST IN BOREHOLE, ASSUME TO BE VERY LOOSE SAND.
								50				
SS	1.5	1.5	12-17-23					55			SAND: OLIVE GRAY: FINE TO VERY COARSE SAND; VERY COARSE GRAIN BEGINS AT 54.6 ft.; WELL SORTED ABOVE 54.6; WELL GRADED BELOW.	
											58.5-60.0; NO SAMPLE	SUSPECTED CLAY FROM DARK PRESSURE ON RIG.
								60				
SS	1.5	1.5	7-10-16					65			SILTY CLAY; DARK YELLOW BROWN; (10YR 4/2), MOTTLED WITH LIGHT OLIVE GRAY (5Y 5/2), VERY STIFF, MOIST, VERY FINE GRAIN, MEDIUM PLASTICITY, CLAY ≈ 50%, SILT ≈ 50%.	
SS	1.5	1.5	12-13-18					70			68.5-70.0; SILTY CLAY; DARK YELLOW BROWN (10YR 4/2); MOIST, VERY STIFF, SAND CONTENT INCREASING AT 69.5 ft to ≈ 30%, VERY FINE GRAIN, WELL SORTED. ROUNDED GRAINS.	

SS = SPLIT SPOON; ST = SHELBY TUBE; D = DENNISON; P = PITCHER; O = OTHER

SITE

HOLE NO. B-14

BECHTEL

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FRONTIER FERTILIZER	20376	3 of 3	B-14

SITE	COORDINATES	ANGLE FROM HORIZ.	BEARING

BEGUN	COMPLETED	DRILLER	DRILL MAKE AND MODEL	HOLE SIZE	OVERBURDEN (FT.)	ROCK (FT.)	TOTAL DEPTH
6/30/98	7/1/98	WATER DEVELOPMENT	CME-95	8 1/4"			80.0

CORE RECOVERY (FT./%)	CORE BOXES	SAMPLES	EL. TOP OF CASING	GROUND EL.	DEPTH/EL. GROUND WATER	DEPTH/EL. TOP OF ROCK

SAMPLE HAMMER WEIGHT/FALL	CASING LEFT IN HOLE: DIA./LENGTH	LOGGED BY:
		R. COOK

SAMPLER TYPE AND DIAMETER	SAMPLER ADVANCE LENGTH CORE RUN	SAMPLE RECOVERY / CORE RECOVERY	SAMPLE BLOWS "N" / PERCENT CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN G.P.M.	PRESSURE P.S.I.	TIME IN MINUTES	ELEVATION	DEPTH	GRAPHIC LOG	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
								70				INSTALL TEMP WELL. BOTTOM of SCREEN AT 71.0 ft. TOP of SCREEN AT 66 ft. H_2O SAMPLES TAKEN.
											73.5-75.0; CLAYEY SILT; DARK YELLOWISH BROWN (10YR 4/2), SILT ≈ 60%, CLAY ≈ 40%, MEDIUM PLASTICITY, STIFF, VERY FINE GRAIN, MOIST.	
SS	1.5	1.5	10-12-15					75				
											78.5-80.0; CLAYEY SILT; SAME AS ABOVE,	
SS	1.5	1.6	13-17-22					80				
											TOTAL DEPTH = 80.0 ft.	
								85				
								90				
								95				
								100				
								105				

SS = SPLIT SPOON; ST = SHELBY TUBE; D = DENNISON; P = PITCHER; O = OTHER

SITE	HOLE NO.

BECHTEL

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FRONTIER FERTILIZER	20376	1 OF 3	B-15

SITE	COORDINATES	ANGLE FROM HORIZ.	BEARING

BEGUN	COMPLETED	DRILLER	DRILL MAKE AND MODEL	HOLE SIZE	OVERBURDEN (FT.)	ROCK (FT.)	TOTAL DEPTH
7/7/98	7/9/98	WATER DEVELOPMENT	CME-95	8 1/4"			80.0

CORE RECOVERY (FT./%)	CORE BOXES	SAMPLES	EL. TOP OF CASING	GROUND EL.	DEPTH/EL. GROUND WATER	DEPTH/EL. TOP OF ROCK

SAMPLE HAMMER WEIGHT/FALL	CASING LEFT IN HOLE: DIA./LENGTH	LOGGED BY:
		R. Cook

SAMPLER TYPE AND DIAMETER	SAMPLER ADVANCE / LENGTH CORE RUN	SAMPLE RECOVERY / CORE RECOVERY	SAMPLE BLOWS "N" / PERCENT CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN G.P.M.	PRESSURE P.S.I.	TIME IN MINUTES	ELEVATION	DEPTH	GRAPHIC LOG	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
SS	1.5	1.6	4-6-7					5			3.5-5.0 - CLAYEY SILT; DARK YELLOWISH BROWN (10YR4/2), MOTTLED WITH MODERATE BROWN (5YR4/4), SILT ≈ 70%, CLAY ≈ 20%, SAND ≈ 10%, DRY, VERY FINE TO MEDIUM GRAIN, NO PLASTICITY, SOFT.	
SS	1.5	1.5	6-4-4					10			8.5-10.0; CLAYEY SILT, DARK YELLOWISH BROWN (10YR4/2), NO MOTTLING, MOIST; SAME AS ABOVE FOR REMAINING CHARACTERISTICS.	
SS	1.5	1.6	6-6-7					15			13.5-14.5. SANDY CLAYEY SILT, DARK YELLOWISH BROWN (10YR4/2), SILT ≈ 70%, CLAY ≈ 15%, SAND ≈ 15%, MEDIUM PLASTICITY, MOIST, VERY FINE TO FINE GRAIN, SOFT.	
											14.5-15.0; CLAYEY SILT; DARK YLW BROWN (10YR4/2) SILT ≈ 80%, CLAY ≈ 20%, DRY TO MOIST, NO PLASTICITY, STIFF.	
SS	1.5	1.5	6-6-7					20			18.5-20.0; SILTY CLAY, DARK YELLOWISH BROWN (10YR4/2). CLAY ≈ 70%, SILT ≈ 30%, HIGH PLASTICITY, MOIST.	
SS	1.5	1.5	5-6-6					25			23.5-25.0; SILTY CLAY; SAME AS ABOVE. MOIST, SOFT.	
											28.5-29.2; SILTY CLAY; SAME AS ABOVE.	
SS	1.5	1.5	7-10-12 ~~4-5-9~~ RC					30			29.2-30.0; SANDY CLAYEY SILT; DARK YELLOWISH BROWN (10YR4/2), MEDIUM PLASTICITY, SILT ≈ 60%, SAND ≈ 20%, CLAY ≈ 20%, FINE GRAIN TO VERY FINE GRAIN SAND, MOIST, SOFT.	
SS	1.5	1.5	4-5-7					35			33.5-35.0; CLAYEY SILT; OLIVE GRAY (5Y4/1), MODERATELY STIFF, MOIST, SILT ≈ 60%, CLAY ≈ 40%, MEDIUM PLASTICITY, VERY FINE GRAIN.	

SS = SPLIT SPOON; ST = SHELBY TUBE; D = DENNISON; P = PITCHER; O = OTHER

SITE

HOLE NO. B-15

H&CF 19-1

BECHTEL

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FRONTIER FERTILIZER	20316	2 OF 3	B-15

SITE	COORDINATES	ANGLE FROM HORIZ.	BEARING

BEGUN	COMPLETED	DRILLER	DRILL MAKE AND MODEL	HOLE SIZE	OVERBURDEN (FT.)	ROCK (FT.)	TOTAL DEPTH
7/7/98	7/7/98	WATER DEVELOPMENT	CME-95	8 1/4"			

CORE RECOVERY (FT./%)	CORE BOXES	SAMPLES	EL. TOP OF CASING	GROUND EL.	DEPTH/EL. GROUND WATER	DEPTH/EL. TOP OF ROCK

SAMPLE HAMMER WEIGHT/FALL	CASING LEFT IN HOLE: DIA./LENGTH	LOGGED BY:
		R. Cook

SAMPLER TYPE AND DIAMETER	SAMPLER ADVANCE LENGTH CORE RUN	SAMPLE RECOVERY CORE RECOVERY	SAMPLE BLOWS "N" / PERCENT CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN G.P.M.	PRESSURE P.S.I.	TIME IN MINUTES	ELEVATION	DEPTH	GRAPHIC LOG	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
							35	35				
SS	1.5	1.5	5-7-8								38.5-39.5: CLAYEY SILT: MODERATE YELLOWISH BROWN (10 YR 5/4) SILT ≈ 70%, CLAY ≈ 30%, DRY, NO PLASTICITY, DARK GREENISH GRAY STREAK ≈ 1-2 INCHES IN SAMPLE.	
								40			39.5-40.0; SILTY SAND	
SS	1.5	0.7	12-17-20					45			43.5-45.0: GRAVELLY SAND; OLIVE GRAY (5Y4/1); SAND ≈ 70%, GRAVEL ≈ 20%, SILT ≈ 10%, WET, SUBANGULAR TO ROUNDED, LOOSE.	Attempted SIMUL PROBE SAMPLE 45.0-46.5
~~SS~~	~~1.5~~	~~0.9~~									45.0-46.0 - GRAVELLY SAND; VERY FINE TO COARSE GRAIN, LOOSE, SAND ≈ 80%, GRAVEL ≈ 10%, SILT ≈ 10%.	
SS	1.5	0.9	4-5-5					50			48.5-50.0: GRAVELLY SAND; OLIVE GRAY (5Y4/1), BETTER SORTED THAN ABOVE, FINE TO MEDIUM GRAIN, SUBANGULAR TO ROUNDED GRAINS, LOOSE, WET, SAND ≈ 90%, GRAVEL ≈ 5%, SILT ≈ 5%,	Obtained water sample from temporary well 44-46 ft
SS	1.5	0.5	5-5-6					55			53.5-55.0: GRAVELLY SAND; SAME AS ABOVE.	
SS	1.5	1.6	11-12-18					60			58.5-59.3; SILTY CLAY; MODERATE YELLOWISH BROWN (10YR 5/4); CLAY ≈ 70%, SILT ≈ 30%, MOIST HIGH PLASTICITY, VERY FINE GRAIN, STIFF.	
SS	1.5	0.7	11-12-14					65			59.3-60.0; CLAYEY SILT: MODERATE YELLOW BROWN (10YR 5/4); SILT ≈ 70%, CLAY ≈ 30%, MOISTURE DECREASES WITH DEPTH, NO PLASTICITY, MODERATELY STIFF. 63.5-65.0: CLAYEY, SANDY SILT: SILT ≈ 50%, SAND ≈ 30%, CLAY ≈ 20%, MOIST TO WET, MEDIUM PLASTICITY, VERY FINE TO FINE GRAIN, STIFF.	
SS	1.5	1.2	10-12-19					70			68.5-70.0: SILTY SAND; DARK YELLOWISH BROWN; (10YR 4/2); VERY FINE TO FINE GRAINSAND, WELL SORTED, SUBROUNDED TO ROUNDED GRAINS, STAINS OF	

SS = SPLIT SPOON; ST = SHELBY TUBE; D = DENNISON; P = PITCHER; O = OTHER

SITE

HOLE NO. B-15

H&CF 19-1

BECHTEL

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FRONTIER FERTILIZER	20876	3 of 3	B-15

SITE	COORDINATES	ANGLE FROM HORIZ.	BEARING

BEGUN	COMPLETED	DRILLER	DRILL MAKE AND MODEL	HOLE SIZE	OVERBURDEN (FT.)	ROCK (FT.)	TOTAL DEPTH
7/7/98	7/7/98	WATER DEVELOPMENT	CME-95	8 1/4"			

CORE RECOVERY (FT./%)	CORE BOXES	SAMPLES	EL TOP OF CASING	GROUND EL.	DEPTH/EL. GROUND WATER	DEPTH/EL. TOP OF ROCK

SAMPLE HAMMER WEIGHT/FALL	CASING LEFT IN HOLE: DIA./LENGTH	LOGGED BY:
		R. Cook

SAMPLER TYPE AND DIAMETER	SAMPLER ADVANCE LENGTH CORE RUN	SAMPLE RECOVERY / CORE RECOVERY	SAMPLE BLOWS "N" / PERCENT CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN G.P.M.	PRESSURE P.S.I.	TIME IN MINUTES	ELEVATION	DEPTH	GRAPHIC LOG	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
								70			CONTINUE 68.5-70.0:- OLIVE GRAY (5Y 4/1), LOWER HALF, MODERATELY DENSE, MOIST.	
SS	1.5	1.5	7-10-15					75		X	73.5-75.0: SAND: DARK YELLOWISH BROWN (10YR 4/2): WELL SORTED, MEDIUM GRAIN, MODERATELY DENSE, MOIST.	
SS	1.5	1.5	6-5-10					80		X	78.5-80.0; SANDY SILT; DARK YELLOWISH BROWN (10YR 4/2), SILT ≈ 80%, SAND ≈ 10%, TRACE CLAY, SAND VERY FINE GRAIN, WELL SORTED, MEDIUM PLASTICITY, MOIST.	
											TOTAL DEPTH = 80.0 ft.	Monitoring well OW-12B installed 7/8/98
								85				

SS = SPLIT SPOON; ST = SHELBY TUBE; D = DENNISON; P = PITCHER; O = OTHER

SITE

HOLE NO. B-15

H&CF 19-1

Science, and Technology, Inc.

LOG OF SOIL BORING

Co-ordinates:

Surface Elevation:
Casing Above Surface:
Reference Elevation:
Reference Description:

Job No.	Client: Frontier Fertilizer / Water Development / Bechtel	Location: Davis, CA
Drilling Method: HSA 8" OD 4.25" ID		Boring No. OW-09A
Sampling Method: Cal Modified Split-spoon		Sheet 1 of 3

Water Level				Drilling Start Time	Drilling Finish Time
Time					
Date				Date 7/2/98	Date 7/2/9
Reference					

Surface Conditions:

Sampler Type	Inches Driven / Inches Recovered	Depth of Casing	Sample No. / Sample Depth	Blows/6 in Sampler	Depth in Feet	USCS Log	
					0		
					1		
					2		
					3		3.5-5.0' 5G 6/1 Greenish gray, 3-3.5' clay (mix silt) dry, medium stiff, poorly graded sand (f.11) 3.5-5.0
				4/5/5	4	CL	
					5		
					6		
					7		
					8	CL	Blocky clay cuttings, drill chatter to 9'
				2/4/7	9		
					10		
					11		
					12		
					13	CL	13.5-15' Dk brown 10YR 3/3, soft clay dry
				7/6/6	14		
					15		
					16		
					17		
					18		18.5-20' Same color as above, very soft blocky clay cuttings, moist
				5/4/4	19	CL	
					20		

Drill Co.: W. D.
Drill Contractor: Brian Cook
Lic. No.
Checked By:
By: 1' ABDZKI
Date: 7/2

Science and Technology, Inc.

LOG OF SOIL BORING

Co-ordinates: _____

Surface Elevation: _____
Casing Above Surface: _____
Reference Elevation: _____
Reference Description: _____

Job No.
Client: Frontier Fertilizer / WA / Bechtel
Location: Davis, CA
Drilling Method:
Sampling Method:
Boring No.: OW 09 A
Sheet: 2 of
Drilling: Start Time / Finish Time / Date / Date

Water Level			
Time			
Date			
Reference			

Surface Conditions:

Drilling Contractor: Wi D.
Driller: Brian Cook
Lic.No.

Sampler Type	Inches Driven / Inches Recovered	Depth of Casing	Sample No. / Sample Depth	Blows in Sampler	Depth in Feet	USCS Log	
					20		
					1		
					2		
					23		23.5 - 25.0' blocky cuttings, clay moist very soft
				3/4/7	4	CL	
					5		
					6		
					7		
					8		28.5 - 30.0' blocky cuttings clay moist soft minor clast of rock fragments 0.25' - 1.5 cm in size
				4/4/16	9		
					30	CL	
					1		
					2		
					3		33.5 - 35' blocky cuttings, clay dry/moist, pockets of greenish gray 5G 6/1, lenses of more resistive sediment (calcified?)
				14/16/20	4		
					5		
					6		
					7	CL	
					8		38.5 - 40.0' blocky cuttings, moist clay minor sand/silt, 10YR 5/3 Brown, lense of grey clay w/ some sand/silt
				6/10/12	9		
					40		

By: _____
Date: 7/20/98 Checked By: _____

Science, and Technology, Inc.

LOG OF SOIL BORING

Co-ordinates:

Surface Elevation:

Casing Above Surface:

Reference Elevation:

Reference Description:

Job No.	Client	Location
	W.D. / Bechtel Frontier Fertilizer	Davis, CA

Drilling Method:

Sampling Method:

Boring No. OW 09 A

Sheet 3 of 3

Water Level			
Time			
Date			
Reference			

Drilling	
Start Time	Finish Time
Date	Date

Surface Conditions:

Sampler Type	Inches Driven / Inches Recovered	Depth of Casing	Sample No. / Sample Depth	Blows/6 in Sampler	Depth in Feet	USCS Log	
					40		
					1	CL	
					2		
					3		43.5-45 @ 43.5 very fine sand w/silt, 10YR 5/3, Brown, very soft / soft, moist clay w/ minor silt @ 44 ft
				4/8 / 10	4	SM	
					5	CL	
					6		
					7		
					8	SM	48.5-50' very fine sand w/clay/silt perched water table 10YR 5/3 Brown medium stiff moist, clay w/minor silt (below 50Ft) in shoe
				5/7 / 10	9		
					50	CL	TD = 48.5' 40'-45' screen
					1		
					2		
					3		
					4		
					5		
					6		
					7		
					8		
					9		
					60		

Dr. Contractor: Ben Cook

Dr. W.D.

L.Ho.No.

Checked By:

By:

Date:

Science, and Technology, Inc.

LOG OF SOIL BORING

09B

Co-ordinates:

Surface Elevation:

Casing Above Surface:

Reference Elevation:

Reference Description:

Job No.	Client Frontier Fertilizer Water Devel. / Bechtel	Location Dev 3, CK
Drilling Method: hollow stem auger 8" OD, 4 1/4 ID		Boring No. 09 B
Sampling Method: split spoon		Sheet 1 of 1
Water Level		Drilling Start Time 1300 Date 7/1/98
Time		Finish Time
Date		Date 7/1/98
Reference		
Surface Conditions: soil		

Drill Contractor: Brian Cook

Driller: Water Development Co. Lic. No.

Sampler Type	Inches Driven / Inches Recovered	Depth of Casing	Sample No. / Sample Depth	Blows/6 in Sampler	Depth in Feet	USCS Log	
				4/5/5	0		
					1		
					2	CL	
					3		5 (6/1) Green-ish grey 3-3.5', clay (m.no, silt)
				4/5/5	4		3.5'-5.0' dry, medium stiff, poorly graded sand (F.M) 3.5'-6'
					5		
					6		
					7		blocky
				3/4/7	8		clay balls, drill chatter to 9'
					9		8.5'-10'
					10		
					11		
					12	CL	13.5'-15' Dk brown 10YR 3/3, soft, clay, dry
				7/6/6	13		
					14		
					15		
					16		
					17		
				5/4/4	18		18.5-20' same color as above, very soft blocky clay cuttings, moist
					19		
					20		

Checked By: 7/1/98

Date:

Science, and Technology, Inc.

LOG OF SOIL BORING

Co-ordinates:

Surface Elevation:

Casing Above Surface:

Reference Elevation:

Reference Description:

Job No.

Client Frontier Fertilizer Water Development / Bechtel

Location Davis, CA

Drilling Method:

Sampling Method:

Boring No. OW 09 B

Sheet 2 of 4

Water Level			
Time			
Date			
Reference			

Drilling: Start Time / Finish Time / Date / Date

Surface Conditions:

Drilling Contractor: Brian Cork

Drill Rig No.

Checked By:

By:

Date:

Sampler Type	Inches Driven / Inches Recovered	Depth of Casing	Sample No. / Sample Depth	Blows/6 in Sampler	Depth in Feet	USCS Log	
					20		
					1		
					2	CL	
				3/4/7	23		23.5 - 25.0' blocky cuttings, clay moist, very soft
					4	CL	
					5		
					6		
					7		
				4/4/6	8		28.5 - 30.0' block cuttings, clay, moist, ~~very~~ soft, minor clasts of rock fragments 0.25 - 1.5 cm in size
					9	CL	
					30		
					1		
					2		
				14/18/20	33	CL	33.5 - 35.0' blocky cuttings, clay, dry/moist pockets of greenish grey 5G 6/1 lenses of more resistive sediment, calcified?)
					4		
					5		
					6		
					7		
				6/10/12	38		38.5 - 40' blocky cuttings fine to f. clay, minor sand/silt, 10 YR 5/3 Brown
					9	CL	lense of grey clay w/ some sand/silt
					10		

Science and Technology, Inc.

LOG OF SOIL BORING

Co-ordinates:

Surface Elevation:

Casing Above Surface:

Reference Elevation:

Reference Description:

Job No.

Client: Frontier Fertilizer Water Development / Bechtel

Location: DAVIS, CA

Drilling Method:

Sampling Method:

Boring No. DP 09 B

Sheet 3 of 4

Drilling: Start Time / Finish Time / Date / Date

Water Level / Time / Date / Reference

Surface Conditions:

Drilling Contractor: WD

Driller: Brian

L.Ia.No. 283326

By: NPL

Date: 7/12/2x

Checked By:

Sampler Type	Inches Driven / Inches Recovered	Depth of Casing	Sample No. / Sample Depth	Blows/6 in Sampler	Depth in Feet	USCS Log	
					40		
					1	CL	
					2		
				4/9/10	43	SM	43.5 very fine sand w/silt measured 43.5' 10YR 5/3, Brown, very soft - soft moist clay w/minor silt @ 44ft
					4		43.5 - 45'
					5	CL	
					6		
					7	SM	48.5 - 50' 48.5 very fine sand w/clay/silt Perched water table 10YR5/3, Brown medium stiff, moist, clay w/minor silt @ 50ft (in shoe)
					8		
					9		
				5/7/10	50		
					1		
					2		
					3		
					4		
				10/17/20	55	CL	55.5. 10YR 5/3, Brown clay, medium stiff 55' moist, clay w/silt
					6		
					7		
					8		
					9	CL	58.5 - 60', 10YR 5/3 brown, clay w/silt, moist, soft
				7/10/12	60		

Engineering, Science, and Technology, Inc.

LOG OF SOIL BORING

Co-ordinates:

Surface Elevation:
Casing Above Surface:
Reference Elevation:
Reference Description:

Job No.	Client: Frontier Fertilizer / W.D / Bechtel	Location: Davis, CA
Drilling Method: HSA		Boring No. OW09
Sampling Method: split spoon		Sheet 4 of 4

Water Level			
Time			
Date			
Reference			

Drilling	Start	Finish
Time	1300	1532
Date	7/1/98	7/1/

Surface Conditions:

Drilling Contractor: Boren Cook
Lic. No.
Checked By:
By:
Date:

Sampler Type	Inches Driven / Inches Recovered	Depth of Casing	Sample No. / Sample Depth	Blows in Sampler	Depth in Feet	USCS Log	Description
					60		
					1		
					2		
					3		
				8/10 / 12	4	CL	slury drill cuttings, 10YR 5/3 brown clay w/silt, moist, soft 63.5-65'
	11				5		
					6		
					7		
				7/10 / 12	8		
					9	CL	68.5'-70' 10YR 5/3 brown, soft to very soft, moist/wet greenish grey pockets of clay w/silt
					70		
					1		
					2		
				5/11 / 17	3		
					4	SM	lense of silty sand @ 73.75' to 74.5' ~~" " " @ 74.5~~
					5		brown 10YR, clay w/silt, moist/wet, soft-medium stiff
					6	CL	65-75' screen
					7		
					8		TD 78.5'
					9		
					80		

Science and Technology, Inc.

LOG OF SOIL BORING

Co-ordinates:

Surface Elevation:

Casing Above Surface:

Reference Elevation:

Reference Description:

Job No.

Client: Frontier Fertilizer W.D./Bechtel

Location: Davis, CA

Drilling Method: HSA, 8" OD, 4½" ID

Sampling Method: Split Spoon

Boring No.: 3LOB

Sheet 4 of 4

Water Level			
Time			
Date			
Reference			

Drilling

Start	Finish
Time 1000	Time 1525
Date 7/6/98	Date 7/6/98

Surface Conditions: Soil

Drilling Contractor: W.D.

Driller: Bozan

Lic. No.

By: NIKABEDZIKI

Date: 7/6/98

Checked By:

Sampler Type	Inches Driven / Inches Recovered	Depth of Casing	Sample No. / Sample Depth		Blows/6 in Sampler	Depth in Feet	USCS Log	
						0		
						1		
						2		
					4/6/10	3		DK brown 10YR 3/3, clay, stiff, dry
						4	CL	
						5		
						6		
						7		
					5/6/4	8		DK Brown 10YR 3/2 clay, stiff dry
						9	CL	
						10		
						1		
						2		
					6/7/7	3	CL	Yellowish red 5YR 4/6 clay, medium stiff / soft, dry
						4		
						5		
						6		
						7	CL	
					5/10/13	8		Brown 10YR 5/3 clay w/ sand, stiff, dry very minor fine gravel found of the run
						9		
						10		

Science, and Technology, Inc.

LOG OF SOIL BORING

Co-ordinates:

Surface Elevation:

Casing Above Surface:

Reference Elevation:

Reference Description:

Job No.

Client: Frontier Fertilizer Water Dev. | Bechtel

Location: Davis CA

Drilling Method:

Sampling Method:

Boring No.: OW-13 ~~10~~B

Sheet: 2 of 4

Water Level			
Time			
Date			
Reference			

Drilling: Start Time / Finish Time / Date / Date

Surface Conditions:

Logging Contractor: L.Lo.No.

Checked By:

By: Date:

Sampler Type	Inches Driven / Inches Recovered	Depth of Casing	Sample No. / Sample Depth	Blows/6 in Sampler	Depth in Feet	USCS Log	Description
					20		
					1		
					2		
				4/10/18	3	GW	(5) Olive grey 5Y 4/1, gravel (fine-coarse) subrounded, w/ sands / silts, wet poor sorting ± (±40%)
					4		
					5		
					6		
					7		
				4/5/9	8	GW	(6) Olive grey 5Y 4/1, gravel (fine), subrounded, poor sorting
					9		
					30		
					1		
					2		
				5/12/15	3	GW	(7) little recovery, very coarse sands, poor sorting
					4		
					5		
					6		
					7		
				12/15/18	8	GW	(8) No recovery, gravels
					9		
					40		

Science, and Technology, Inc.

LOG OF SOIL BORING

Co-ordinates:

Surface Elevation:

Casing Above Surface:

Reference Elevation:

Reference Description:

Job No.

Client: WD | Bachtel Frontier Fertilizer

Location: Davis, CA

Drilling Method:

Sampling Method:

Boring No. 13 ~~10~~ B

Sheet 3 of 4

Water Level

Time

Date

Reference

Drilling: Start Time / Finish Time / Date / Date

Surface Conditions:

Sampler Type	Inches Driven / Inches Recovered	Depth of Casing	Sample No. / Sample Depth	Blows in Sampler	Depth in Feet	USCS Log	
					0		
					1		
					2		(9)
				6/10/15	3	GW	56 1/1, greenish gray, gravels, subrounded w/ poorly sorted coarse/fine sand some silt/clay
					4		
					5		
					6		(10)
					7	SW	H2O (@ 47', poorly ~~graded~~ sorted sand w/fine rounded gravels (sluff) 47-48 clay encountered
				32/18/26	8		
					9		
					50		
					1		
					2		Driller (Brian) most likely sluffs from the gravels above
				no blow counts	3		
					4	CL	very stiff clay w/ some silt Brown 10YR 5/3, moist
					5		
					6		
					7		
				10/12/16	8	CL	
					9		very stiff clay w/ calcified layer in lower section Brown 10YR 5/3, moist
					10		

Log No.

Drilling Contractor:

Driller:

Checked By:

By:

Date:

Science, and Technology, Inc.

LOG OF SOIL BORING

Co-ordinates:

Surface Elevation:

Casing Above Surface:

Reference Elevation:

Reference Description:

Job No.

Client: Frontier Fertilizer W.D./Bechtel

Location

Drilling Method: OW

Sampling Method:

Boring No. 13 ~~10~~ B

Sheet 4 of 4

Water Level			
Time			
Date			
Reference			

Drilling	
Start Time	Finish Time
Date 7/6/98	Date 7/6/98

Surface Conditions:

Log No.

Drilling Contractor:

Checked By:

By:

Date:

Sampler Type	Inches Driven / Inches Recovered	Depth of Casing	Sample No. / Sample Depth	Blows/6 in Sampler	Depth in Feet	USCS Log	
					0		
					1		
					2		
				1/2	3		
				1/2		CL	clay w/some silt, brown 10YR 5/3, medium stiff, wet
				1/2	4		
					5		
					6		
					7		
				4/8	8		
				10		CL	silty clay, soft, brown 10YR 5/2 moist/
					9		
					10		sand
					1		
					2		
					3		wet
				8/13	4	SM	sand fine grained w/silt, brown 10YR 5/2
				15			clayey silt, brown, soft, wet
					5		
					6		
					7		
					8		
					9		TD = 83.5'
					10		

83.5 TD

EA Engineering, Science, and Technology, Inc.

LOG OF SOIL BORING

Co-ordinates:

Surface Elevation:

Casing Above Surface:

Reference Elevation:

Reference Description:

Job No.	Client	Location
	Frontier Fert Water Development, Bechtel	Davis, CA

Drilling Method: H

Sampling Method:

Boring No. OW-H-A

Sheet 1 of 3

Water Level			
Time			
Date			
Reference			

Drilling Start Time	Drilling Finish Time
Date 7/9/98	Date 7/9/98

Surface Conditions:

Drilling Contractor: W. D. Lic.No.

Driller: Brian Cook

By: N. L. Aspperl Checked By:

Date: 7/9/98

Sampler Type	Inches Driven / Inches Recovered	Depth of Casing	Sample No. / Sample Depth		Blows in Sampler	Depth in Feet	USCS Log	
						0		
						1		
						2		
						3		block air / cuttings 10YR 3/3, dk brown, clay w/some silt, stiff dry
						4	CL	
						5		
						6		
						7		
						8		
						9	CL	10YR 3/3 dk brown, clay, soft moist
						10		
						11		
						12		
						13		10YR 3/3, dk brown, clay w/minor silt, med stiff, dry
						14		
						15		
						16		
						17		
						18	SM	10YR 3/3 dk brown, med/fine grained silty sand, moderately sorted, moist; clayey silt from 19'4"-19' bgs (lense) med stiff; med/fine grained silty sand mod. sort.
						19	ML	
						20	SM	

EA Engineering, Science, and Technology, Inc.

LOG OF SOIL BORING

Co-ordinates: _____

Surface Elevation: _____
Casing Above Surface: _____
Reference Elevation: _____
Reference Description: _____

Job No.	Client	Location
	Frontier Fert. Water Development, Bechtel	Davis, CA

Drilling Method: HSA 8" OD 4.25" ID
Sampling Method: C-1 Modified Split-Spoon
Boring No. ~~OW~~ ~~1A~~ B4
Sheet 10 of 3

Water Level			
Time			
Date			
Reference			

Drilling	Start	Finish
Time		
Date	7/9	7/9

Surface Conditions:

Drilling Contractor: Brian Cook
Drill: W. D
Lic. No.
By: N. Moedzel
Date: 7/9
Checked By:

Sampler Type	Inches Driven / Inches Recovered	Depth of Casing	Sample No. / Sample Depth	Blows in Sampler	Depth in Feet	USCS Log	Description
					20		
					1		
					2		
					3	SC SP	Olive gray 5Y 4/1, poorly sorted coarse to medium sand w/minor silt, subrounded/subangular
					4		
					25		
					6		
					7		
					8		
					9	SC SP	Same as above; water (muddy) on the split spoon, more H_2O <5% gravels
					30		
					1		
					2		
					3		
					4	SC SP	Missing top 50% of run, same description as above; much more coarser sands w/ <20% gravels poorly sorted, wet
					35		
					6		
					7		
					38	SM SP	Making H_2O @ 38', silt sand (med) <40% recovery, same description as above w/30% silt/clays
					9		
					40		

EA Engineering, Science, and Technology, Inc.

LOG OF SOIL BORING

Co-ordinates: _____

Surface Elevation: _____
Casing Above Surface: _____
Reference Elevation: _____
Reference Description: _____

Job No.	Client	Location
	Frontier Fert. Water Development, Bechtel	Davis, CA

Drilling Method: HSA 8" OD 4.25" ID
Sampling Method: Cal Modified split spoon

Boring No. OW1A
Sheet 3 of 10

Water Level			
Time			
Date			
Reference			

Drilling	Start	Finish
Time	0600	1330
Date	7/9	7/9

Surface Conditions:

Drilling Contractor: [illegible] Lic.No. _____
Driller: _____

Sampler Type	Inches Driven / Inches Recovered	Depth of Casing	Sample No. / Sample Depth		Blows/6 in Sampler	Depth in Feet	USCS Log	
						40		
						1		
						2	SM	
						3		
						4		H_2O coming out of bore hole
						45		No recovery
						6		TD = 46' Screen 42'-32'
						7		2/12 30'
						8		#30 29'
						9		Bent pellets 27'
						50		
						1		
						2		
						3		
						4		
						5		
						6		
						7		
						8		
						9		
						60		

By: N. F.
Date: 7/9/98 Checked By: _____

Science, and Technology, Inc.

LOG OF SOIL BORING

Co-ordinates: _____

Surface Elevation: _____
Casing Above Surface: _____
Reference Elevation: _____
Reference Description: _____

Job No.
Client: Frontier Fertilizer W.D. / Bechtel
Location: Davis, CA

Drilling Method: HSA; 8" OD; 4 1/4" ID
Sampling Method: Split spoon

Boring No.: DW 1/B 1
Sheet 10 of 4

Water Level			
Time			
Date			
Reference			

Drilling: Start Time 1030, Date 7/8/98; Finish Time, Date 7/8/

Surface Conditions:

W.D. Contractor: Brian Cook Lab.No.

Dr. Dr.

LABETZKE

By: 5 Checked By:
Date: 71

Sampler Type	Inches Driven / Inches Recovered	Depth of Casing	Sample No. / Sample Depth	Blows/6 in Sampler	Depth in Feet	USCS Log	
					0		
					1		
					2		
				5h / 13	3		blocky drill cuttings: 10YR 3/3, dk. brown, dry w/some silt, stiff, dry
					4		
					5	CL	
					6		
					7		
				8/8 / 11	8		
					9		10YR 3/3 dk brown, clay, soft, moist
					10	CL	
					11		
					12		
				4/9 / 17	13		Drill chatter
					14		10YR 3/3 dk brown med. stiff dry clay w/minor silt
					15		
					16		
					17		
				7/8 / 6	18	SM	dk brown 10YR 3/3 silty med/fine graded sand, mod sorted, moist
					19	ML	clayey silt from 19'4" – 19' bgs (lense) mod stiff
					20	SM	med/fine graded sand, mod sort w/silty

Science, and Technology, Inc.

LOG OF SOIL BORING

Co-ordinates:

Surface Elevation:
Casing Above Surface:
Reference Elevation:
Reference Description:

Job No.
Client Frontier Fertilizer
WD | Bechtel
Location Davis
Drilling Method:
Sampling Method:
Boring No. OW17B
Sheet 2 of 4
Drilling Start Time Date
Finish Time Date
Water Level
Time
Date
Reference
Surface Conditions:

Sampler Type	Inches Driven / Inches Recovered	Depth of Casing	Sample No. / Sample Depth		Blows/6 in Sampler	Depth in Feet	USCS Log	
						20		
						1		
						2		
					4/11	3	SC	
					27		SP	Olive gray 5Y 4/1, poorly sorted coarse to medium sand w/ minor silt, subrounded / sub angular
						4		
						5		
						6		
						7		
						8		SAME DESCRIPTION AS ABOVE
							SC	Water (mudding) on the split spoon
					17bs	9		Same as above, more H_2O < 5% gravels
					25		SP	
						30		
						1		
						2		
						3		
					7/19		SC	
					26	4	SP	Missing top 50% of run, same as above, but much more coarser sands w/ <20% gravels poorly sorted, wet.
						5		
						6		
						7		
						8		Making H_2O @ 38', silty sand (mud)
					7/14		SM	<40% recovery, same as above
					16	9	SP	30% silt/clays
						40		

Drilling Contractor:
Driller:
Lic. No.
By:
Date:
Checked By:

Science, and Technology, Inc.

LOG OF SOIL BORING

Co-ordinates:

Surface Elevation:

Casing Above Surface:

Reference Elevation:

Reference Description:

Job No.	Client Frontier Fertilizer Water Development	Location Davis
Drilling Method:		Boring No. OW 1 TB BB
Sampling Method:		Sheet 3 of 4
Water Level / Time / Date / Reference		Drilling Start Time Date / Finish Time Date

Surface Conditions:

Sampler Type	Inches Driven / Inches Recovered	Depth of Casing	Sample No. / Sample Depth		Blows/6 in Sampler	Depth in Feet	USCS Log	
						10		
						1		
						2	SM	H_2O coming out of boring hole
					4/7 / 8	3		(9) No recovery
						4		
						5		
						6		
						7		
						8		(10)
						9	SC	Silt, sand, clayey sand
					12/19	50		
					26	1		
						2		
						3	SM	(11)
					8/11 / 19	4		sand w/silt poorly sorted some gravels; @ 54.5' silty clay w/ sandy interbeds, stiff moist
						5	MH	
						6		
						7		
						8		(12)
					8/12 / 20	9		@ 58.5-59.5' silt, coarse sand clayey silt, stiff, moist
						60		

Log No.:

Drilling Contractor:

Checked By:

By:

Date:

Science, and Technology, Inc.

LOG OF SOIL BORING

Co-ordinates:

Surface Elevation:
Casing Above Surface:
Reference Elevation:
Reference Description:

Job No.
Client: Frontier Fertilizer / Water Development / Bechtel
Location: Davis

Drilling Method:
Sampling Method:

Boring No.: DWR B
Sheet 4 of 10

Water Level			
Time			
Date			
Reference			

Drilling: Start Time / Finish Time / Date / Date

Surface Conditions:

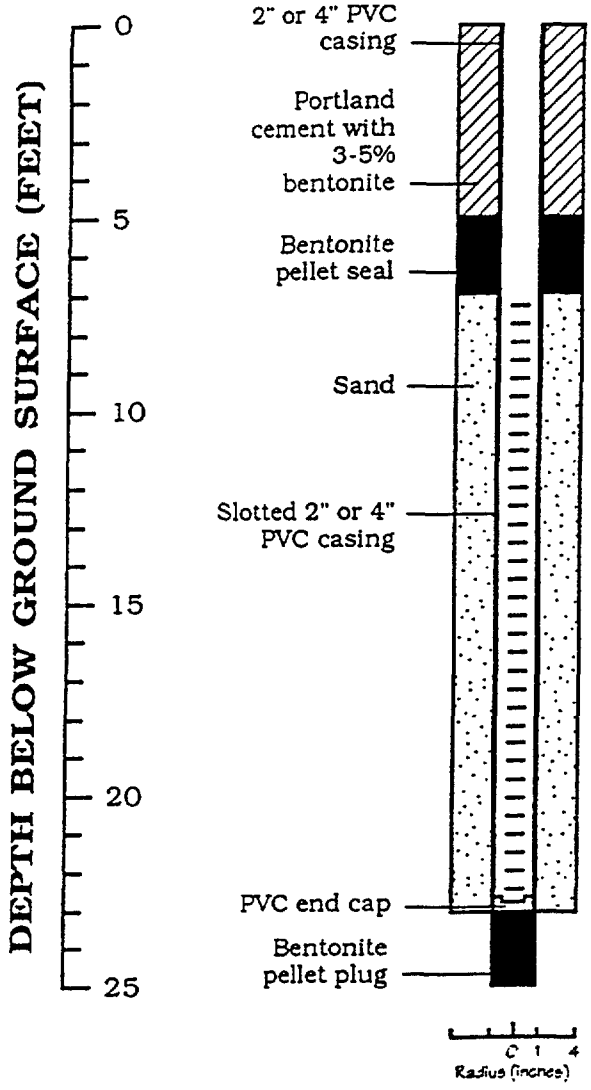
Lab No.
Contractor:
Driller:
Checked By:
By:
Date:

Sampler Type	Inches Driven / Inches Recovered	Depth of Casing	Sample No. / Sample Depth		Blows in Sampler	Depth in Feet	USCS Log	
						60		
						1		
						2		(12) No Recovery
						3		(13)
					10/15 / 13	4		No Recovery
						65		
						6		
						7		
						8	SM	(14)
					10/15 / 30	9		Brown 10YR 5/3, sandy silt (fine grained sand; @ 69' clayey silt w/ some sand, stiff, moist
						70		
						1		
						2	CL	
						3		(15)
					8/16 / 26	4		Brown 10YR 5/3, clayey silt. w/ some sand, stiff, moist
						5		
						6		
						7		TD: 78.5'
						8		TOS 63
								BOS 68
						9		
						80		

Well Construction Logs

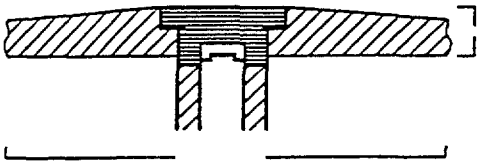
EXPLANATION
TYPICAL WELL CONSTRUCTION

SIERRA

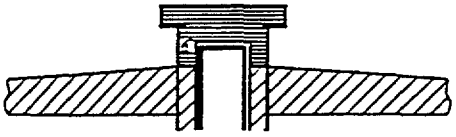


Well Head Completion Schematic
Not to scale

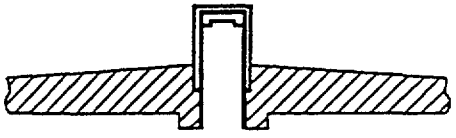
☐ Locking cap & Christy Box



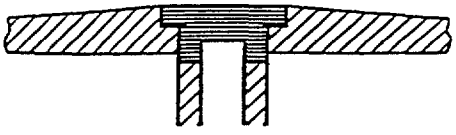
☐ Locking stovepipe & Christy Box



☐ Locking cap & stovepipe



☐ Christy Box



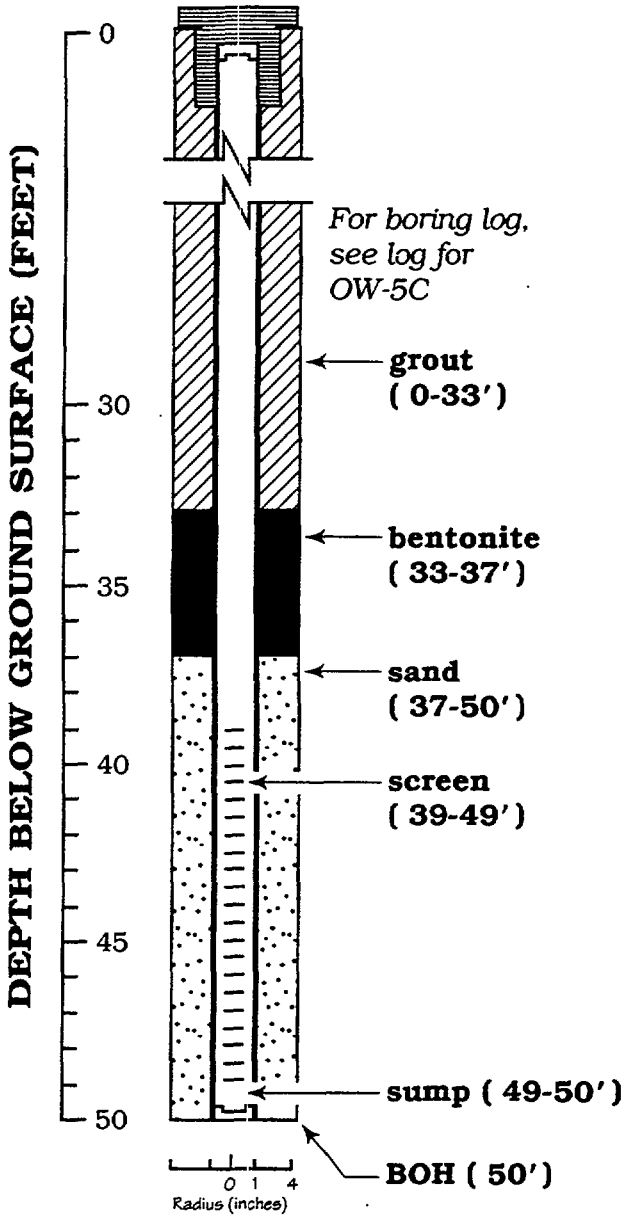
Water level depth and date:

▽ Initial water level

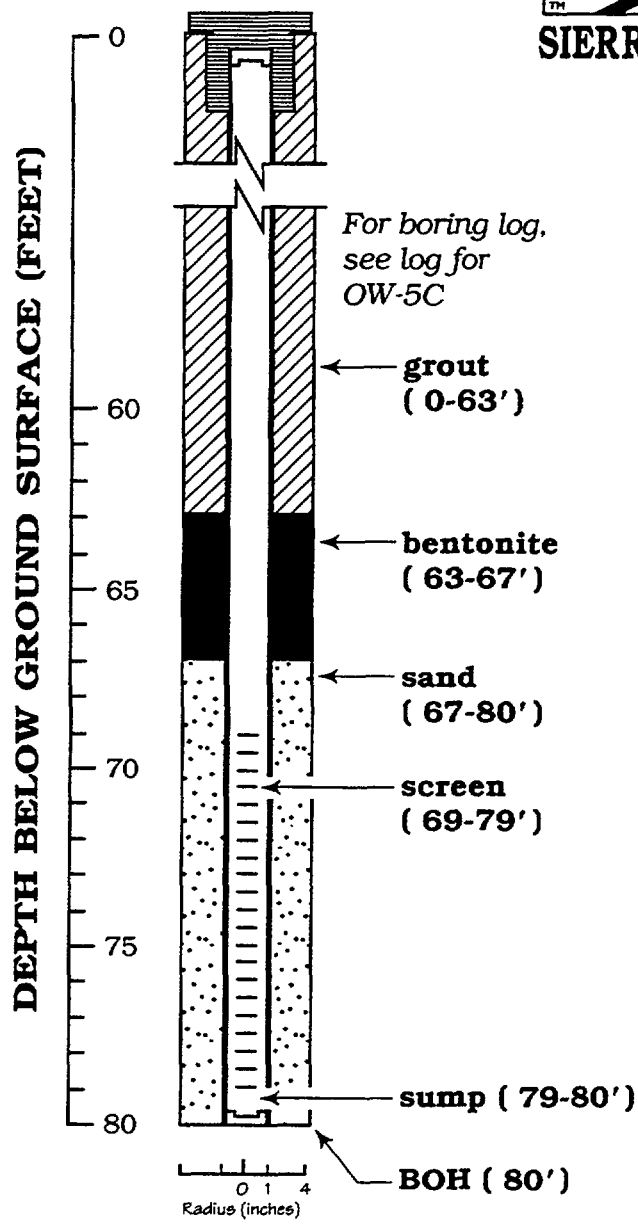
▼ Static water level

NOTE: SES attempts to screen from 5 feet above static water to 10 feet below static water.

WELL OW-5A



WELL OW-5B



SIERRA

Well Construction – Well OW-5A

Frontier Fertilizer
Davis, California

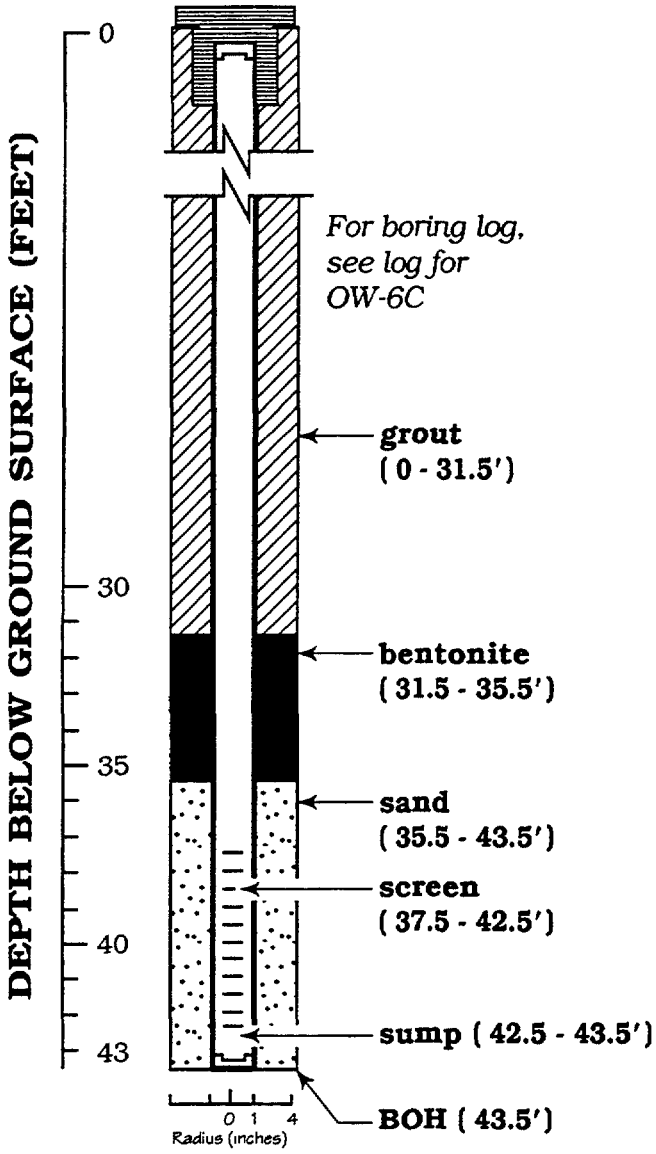
Logged By:	C. Bramer
Supervisor:	D. Leland, P.E. #46713
Drilling Company:	Soils Exploration Services
C-57#:	582696
Driller:	J. Harrison, J. Freitas
Drilling Method:	8" hollow stem auger
Date Drilled:	October 22, 1997
Well Head Completion:	Locking cap & traffic-rated vault
Well Casing:	2" Schedule 40 PVC
Type of Sampler:	N/A

Well Construction – Well OW-5B

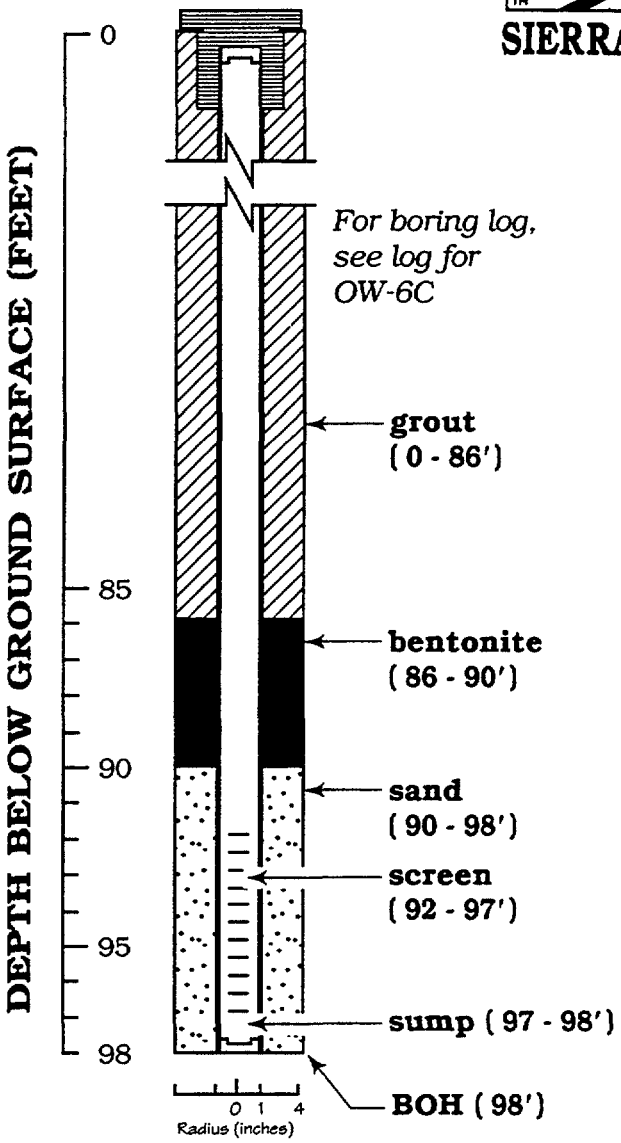
Frontier Fertilizer
Davis, California

Logged By:	C. Bramer
Supervisor:	D. Leland, P.E. #46713
Drilling Company:	Soils Exploration Services
C-57#:	582696
Driller:	D. Ryan, R. Marty
Drilling Method:	8" hollow stem auger
Date Drilled:	October 17-21, 1997
Well Head Completion:	Locking cap & traffic-rated vault
Well Casing:	2" Schedule 40 PVC
Type of Sampler:	N/A

WELL OW-6A



WELL OW-6B



SIERRA

Well Construction – Well OW-6A

Frontier Fertilizer
Davis, California

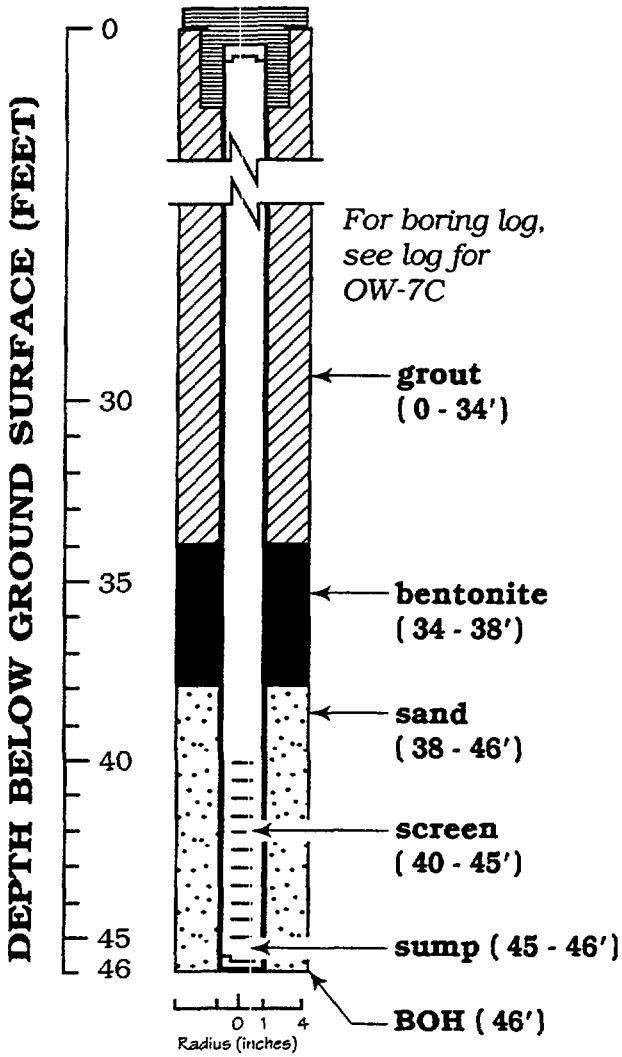
Logged By:	D. Beardsley
Supervisor:	D. Leland, P.E. #C46713
Drilling Company:	Soils Exploration Services
C-57#:	582696
Driller:	J. Harrison, J. Freitas
Drilling Method:	8" hollow stem auger
Date Drilled:	October 29, 1997
Well Head Completion:	Locking cap & traffic-rated vault
Well Casing:	2" Schedule 40 PVC
Type of Sampler:	N/A

Well Construction – Well OW-6B

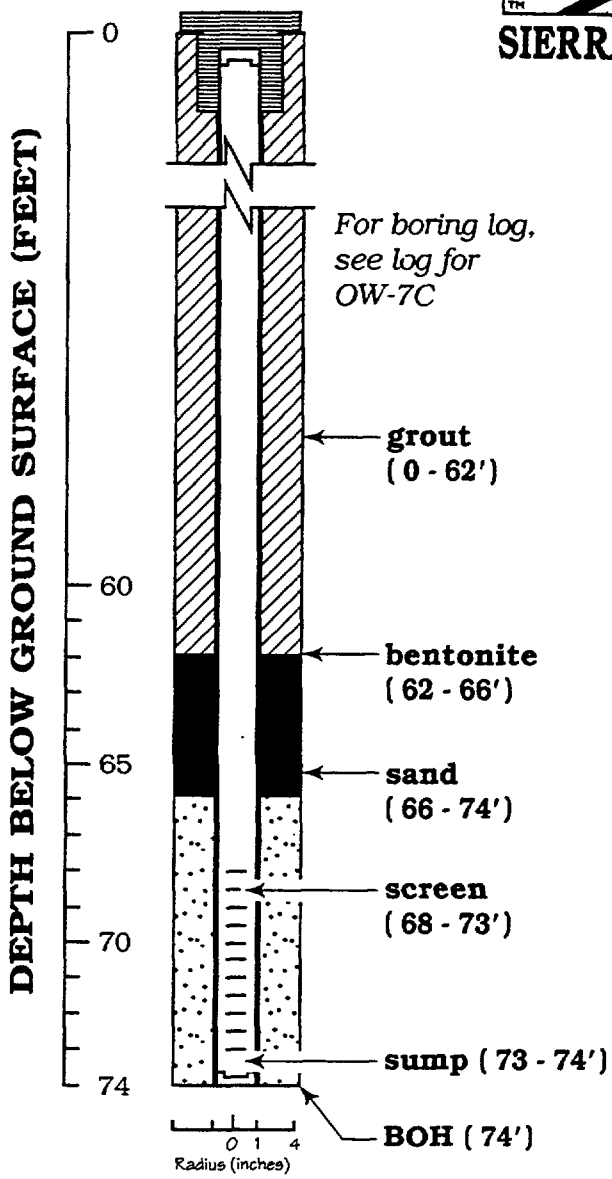
Frontier Fertilizer
Davis, California

Logged By:	D. Beardsley
Supervisor:	D. Leland, P.E. #C46713
Drilling Company:	Soils Exploration Services
C-57#:	582696
Driller:	J. Woodbridge
Drilling Method:	8" hollow stem auger
Date Drilled:	October 28, 1997
Well Head Completion:	Locking cap & traffic-rated vault
Well Casing:	2" Schedule 40 PVC
Type of Sampler:	N/A

WELL OW-7A



WELL OW-7B



Well Construction – Well OW-7A

Frontier Fertilizer
Davis, California

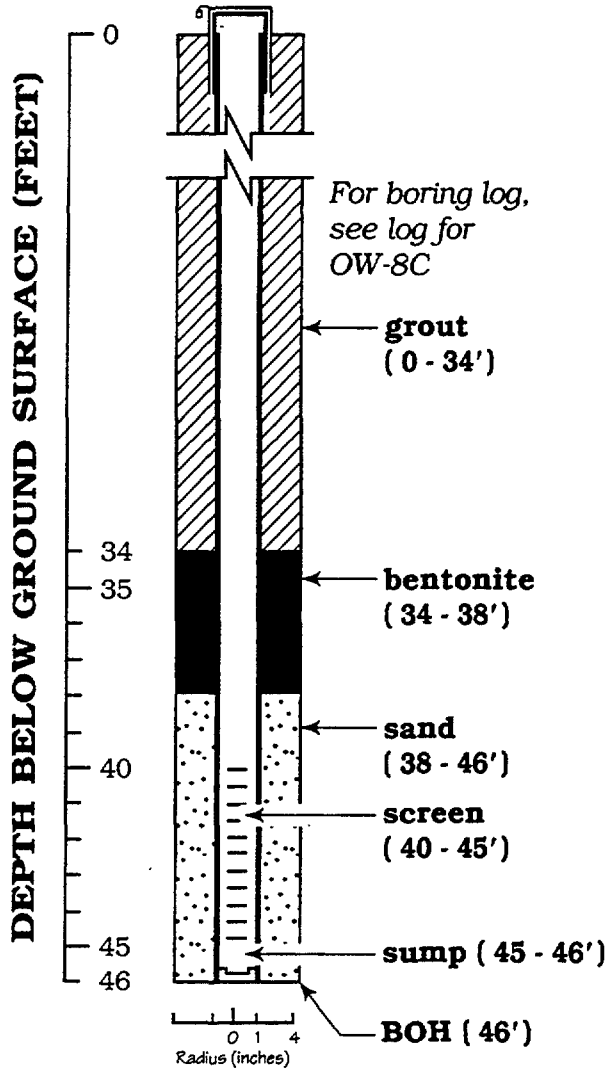
Logged By:	D. Beardsley
Supervisor:	D. Leland, P.E. #C46713
Drilling Company:	Soils Exploration Services
C-57#:	582696
Driller:	R. Ellis
Drilling Method:	8" hollow stem auger
Date Drilled:	October 30, 1997
Well Head Completion:	Locking cap & traffic-rated vault
Well Casing:	2" Schedule 40 PVC
Type of Sampler:	N/A

Well Construction – Well OW-7B

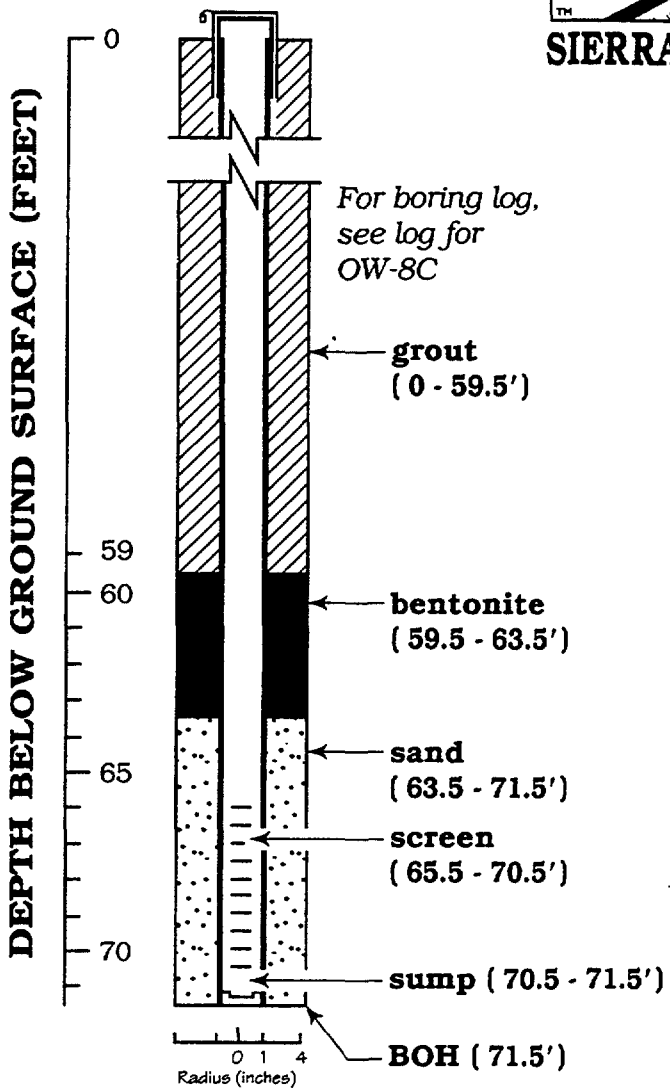
Frontier Fertilizer
Davis, California

Logged By:	D. Beardsley
Supervisor:	D. Leland, P.E. #C46713
Drilling Company:	Soils Exploration Services
C-57#:	582696
Driller:	D. Ryan, R. Marty
Drilling Method:	8" hollow stem auger
Date Drilled:	October 27, 1997
Well Head Completion:	Locking cap & traffic-rated vault
Well Casing:	2" Schedule 40 PVC
Type of Sampler:	N/A

WELL OW-8A



WELL OW-8B



SIERRA

Well Construction – Well OW-8A

Frontier Fertilizer
Davis, California

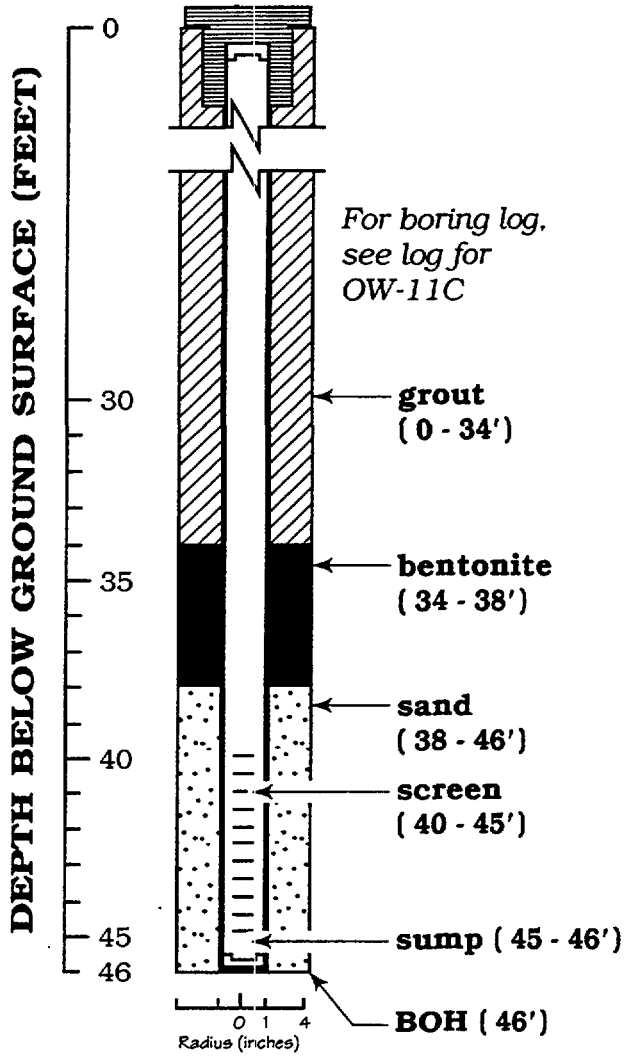
Logged By:	J. Green
Supervisor:	D. Leland, P.E. #C46713
Drilling Company:	Soils Exploration Services
C-57#:	582696
Driller:	J. Harrison, M. Duffy
Drilling Method:	8" hollow stem auger
Date Drilled:	October 16, 1997
Well Head Completion:	Locking stovepipe
Well Casing:	2" Schedule 40 PVC
Type of Sampler:	N/A

Well Construction – Well OW-8B

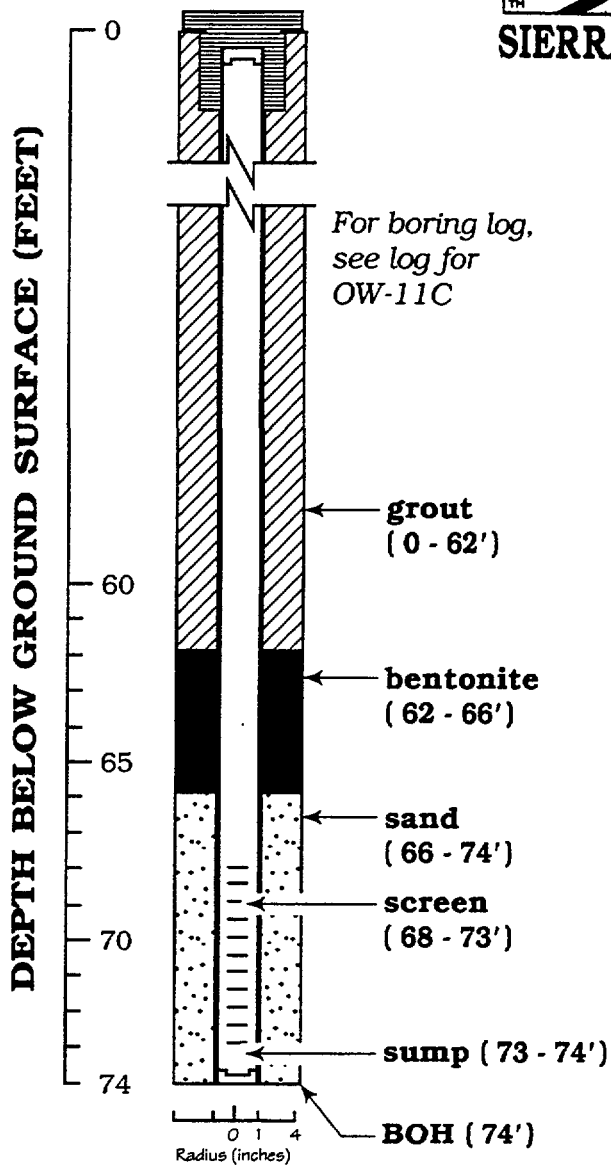
Frontier Fertilizer
Davis, California

Logged By:	J. Green
Supervisor:	D. Leland, P.E. #C46713
Drilling Company:	Soils Exploration Services
C-57#:	582696
Driller:	D. Ryan
Drilling Method:	8" hollow stem auger
Date Drilled:	October 27, 1997
Well Head Completion:	Locking stovepipe
Well Casing:	2" Schedule 40 PVC
Type of Sampler:	N/A

WELL OW-11A



WELL OW-11B



SIERRA

Well Construction – Well OW-11A

Frontier Fertilizer
Davis, California

Logged By:	D. Beardsley
Supervisor:	D. Leland, P.E. #C46713
Drilling Company:	Soils Exploration Services
C-57#:	582696
Driller:	J. Harrison, J. Freitas
Drilling Method:	8" hollow stem auger
Date Drilled:	October 29, 1997
Well Head Completion:	Locking cap & traffic-rated vault
Well Casing:	2" Schedule 40 PVC
Type of Sampler:	N/A

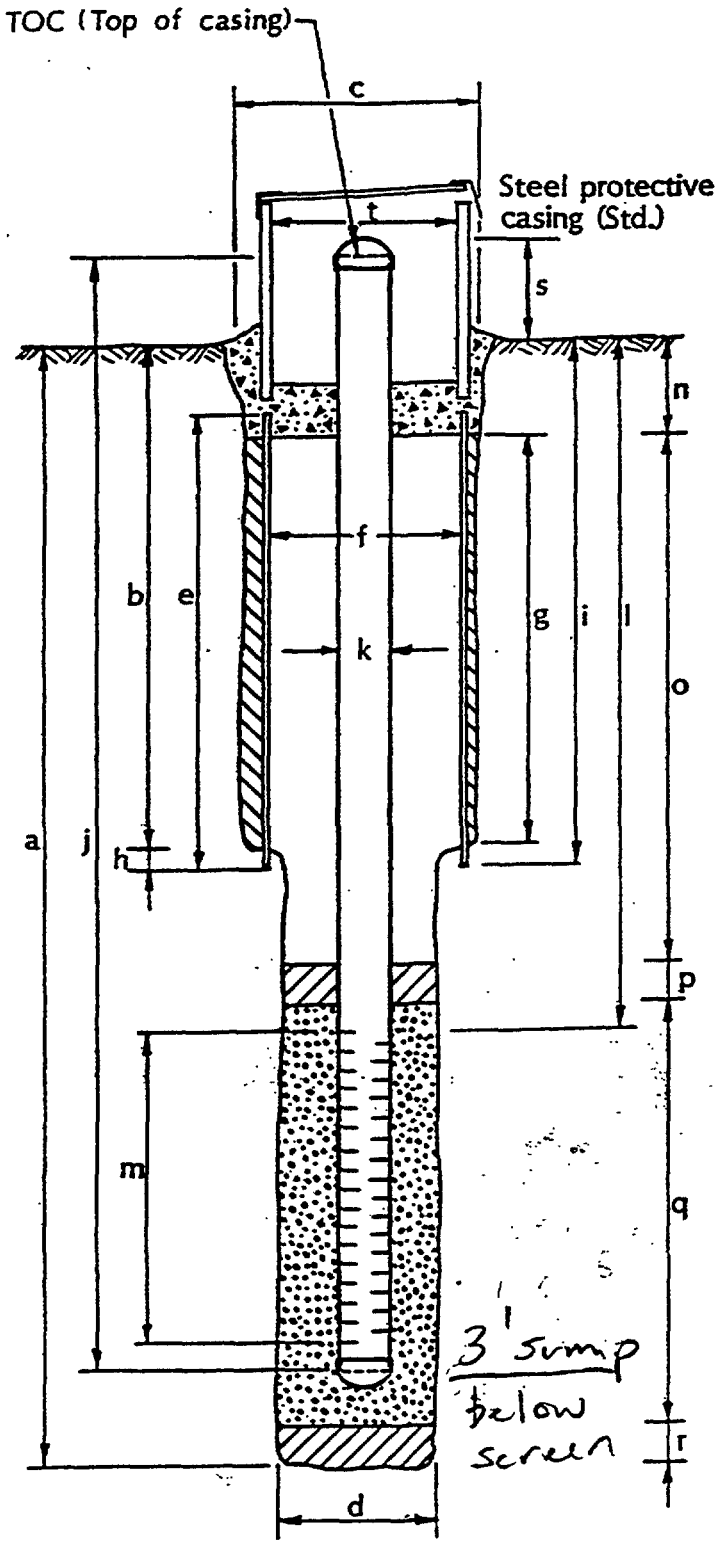
Well Construction – Well OW-11B

Frontier Fertilizer
Davis, California

Logged By:	D. Beardsley
Supervisor:	D. Leland, P.E. #C46713
Drilling Company:	Soils Exploration Services
C-57#:	582696
Driller:	J. Woodbridge
Drilling Method:	8" hollow stem auger
Date Drilled:	October 28, 1997
Well Head Completion:	Locking cap & traffic-rated vault
Well Casing:	2" Schedule 40 PVC
Type of Sampler:	N/A

PROJECT NUMBER _____
PROJECT NAME Frontier Fertilizer
LOCATION Davis
WELL PERMIT NO. _____

BORING/WELL NO. OW U9 A
TOP OF CASING ELEV. _____
GROUND SURFACE ELEV. _____
DATUM _____
INSTALLATION DATE 7/2/92



EXPLORATORY BORING

a. Total depth 48.5 ft.
b. Upper boring depth N/A ft.
c. Upper boring diameter N/A ft.
d. Lower boring diameter 8" ~~14"~~ ~~ft.~~
Drilling method hollow stem auger

CONDUCTOR CASING

e. Casing length N/A ft.
Material N/A
f. Diameter N/A in.
g. Upper (outer) seal N/A ft.
Material N/A
h. Penetration N/A in.
i. Depth N/A ft.

WELL CONSTRUCTION

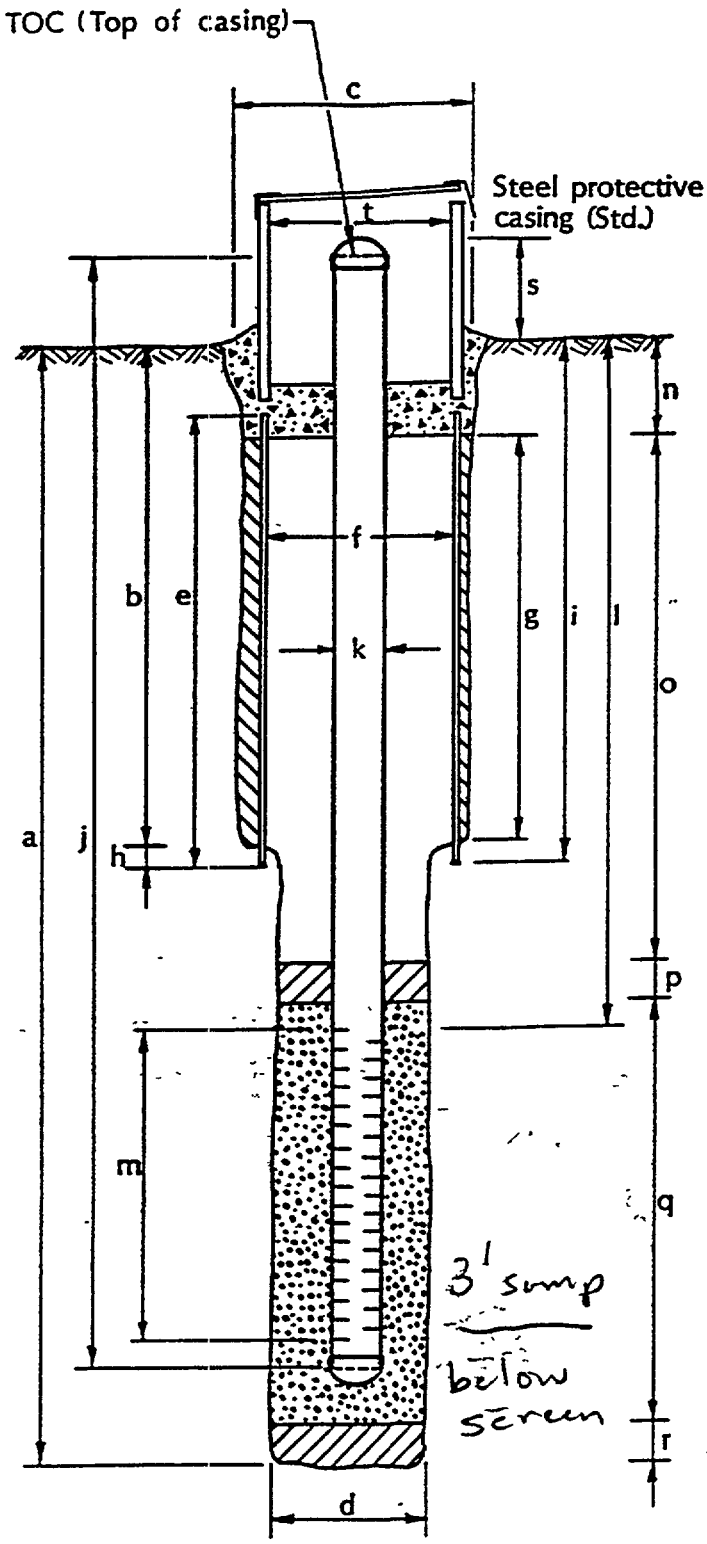
j. Total casing length 48 ft.
Material sch. 40 PVC, 0.020" slot
k. Diameter 2" ~~4"~~ in.
l. Depth to top perforations 40 ft.
m. Perforated length 5 ft.
Perforated interval from 40' to 45 ft.
Perforation type 0.02"
Perforation size slotted
n. Surface seal 3 ft.
Seal material Cement
o. Backfill 33 ft.
Backfill material cement/Bentonite grout
p. Seal 2 ft.
Seal material Bentonite Pellets
q. Gravel pack 10.5 ft.
Material #2/12 med sand
Above filter pack #30 sand 1 ft
r. Bottom seal NA ft.
Material _____
s. Casing stickup N/A ft.
t. Protective casing diameter _____ in.

Prepared by: N. LABEDZKI (EA)
Reviewed by: _____ Date: 9/8/93

Form F-10 Rev. 12/90

PROJECT NUMBER _____
PROJECT NAME Frontier fertilizer
LOCATION Davis, CA
WELL PERMIT NO. _____

BORING/WELL NO. OW 09 ~~A~~ B
TOP OF CASING ELEV. _____
GROUND SURFACE ELEV. _____
DATUM _____
INSTALLATION DATE 7/~~8~~/98



EXPLORATORY BORING

a. Total depth 78.5 ~~ft~~ ft.
b. Upper boring depth N/A ft.
c. Upper boring diameter N/A ft.
d. Lower boring diameter 8" ~~11 inch~~ ft.
Drilling method hollow stem auger

CONDUCTOR CASING

e. Casing length N/A ft.
Material N/A
f. Diameter N/A in.
g. Upper (outer) seal N/A ft.
Material N/A
h. Penetration N/A in.
i. Depth N/A ft.

WELL CONSTRUCTION

j. Total casing length 78 ft.
Material Sch 40 PVC, 0.020" slot
k. Diameter 2" ~~4"~~
l. Depth to top perforations 65 ft.
m. Perforated length 10 ~~5~~ ft.
Perforated interval from 65 to 75 ft.
Perforation type 0.02"
Perforation size slotted
n. Surface seal 3 ft.
Seal material Cement
o. Backfill 58 ft.
Backfill material Cement/Bentonite gro
p. Seal 2 ft.
Seal material Bentonite Pellets
q. Gravel pack 15.5 ft.
Material #2/12 med. sand
* Above filter pack #30 sand 1 ft
r. Bottom seal NA ft.
Material
s. Casing stickup _____ ft.
t. Protective casing diameter _____

Prepared by: N. LABEDZKI (EA)

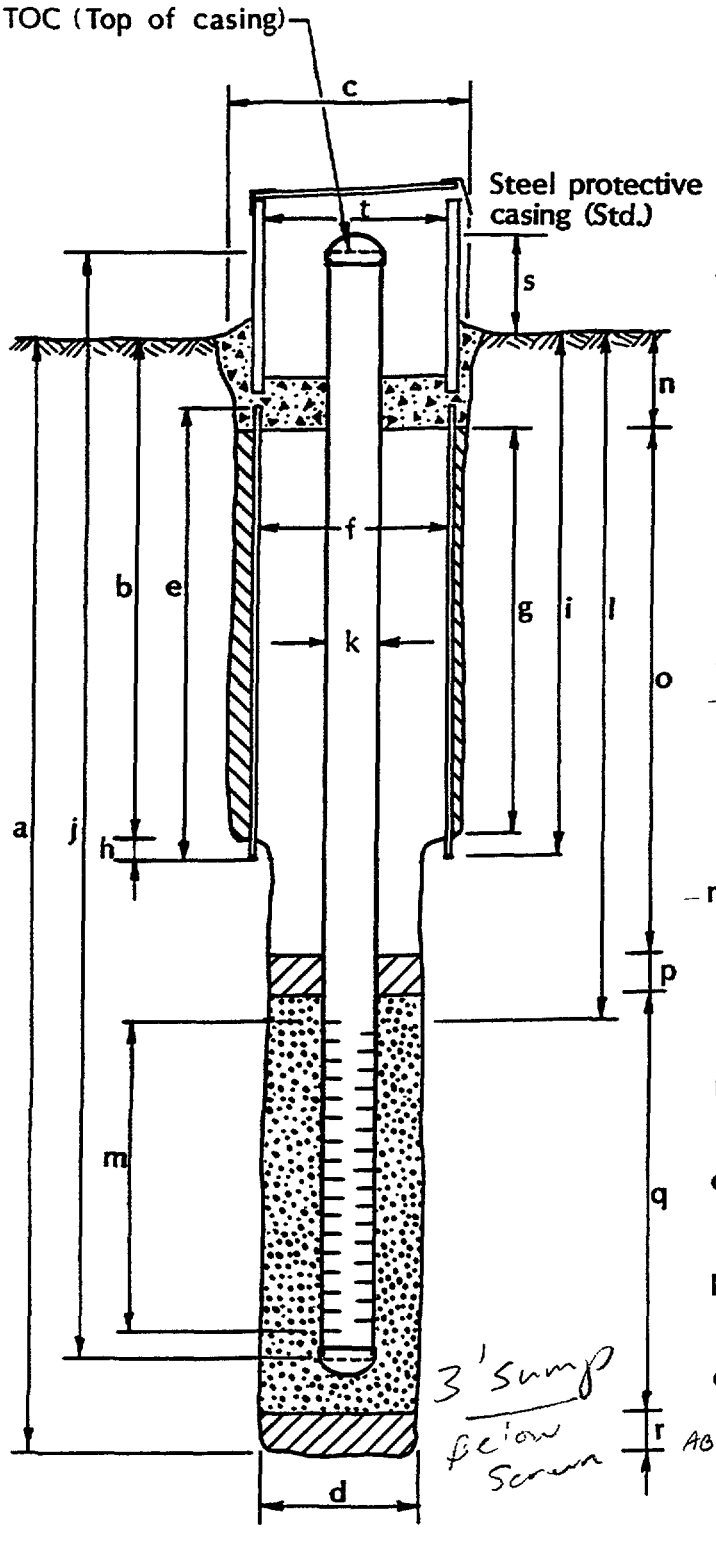
Reviewed by: _____ Date: 8/8/98

Form F-10 Rev. 12/90

WELL DETAILS

PROJECT NUMBER _____
PROJECT NAME Frontier Fertilizer
LOCATION Davis, CA
WELL PERMIT NO. _____

BORING/WELL NO. OW ~~MA~~
TOP OF CASING ELEV. 10
GROUND SURFACE ELEV. _____
DATUM _____
INSTALLATION DATE 7/9/88



EXPLORATORY BORING

a. Total depth 46 ft.
b. Upper boring depth N/A ft.
c. Upper boring diameter N/A ft.
d. Lower boring diameter 8" ~~4"~~ ft.
Drilling method hollow stem auger

CONDUCTOR CASING

e. Casing length N/A ft.
Material N/A
f. Diameter N/A in.
g. Upper (outer) seal N/A ft.
Material N/A
h. Penetration N/A in.
i. Depth N/A ft.

WELL CONSTRUCTION

j. Total casing length ≈ 47 ft.
Material Sch 40 PVC
k. Diameter 2" ~~4~~ in.
l. Depth to top perforations 32 ft.
m. Perforated length 10 ft.
Perforated interval from 32 to 42 ft.
Perforation type Slotted
Perforation size 0.02"
n. Surface seal 3 ft.
Seal material cement / Bentonite grout
o. Backfill 24 ft.
Backfill material cement / Bentonite grout
p. Seal 2 ft.
Seal material Bentonite Pellets
q. Gravel pack 16 ft.
Material #2/12 Med Sand
ABOVE FILTER PACK #30 SAND 1 ft
r. Bottom seal NA ft.
Material NA
s. Casing stickup 2' ft.
t. Protective casing diameter 4 in.

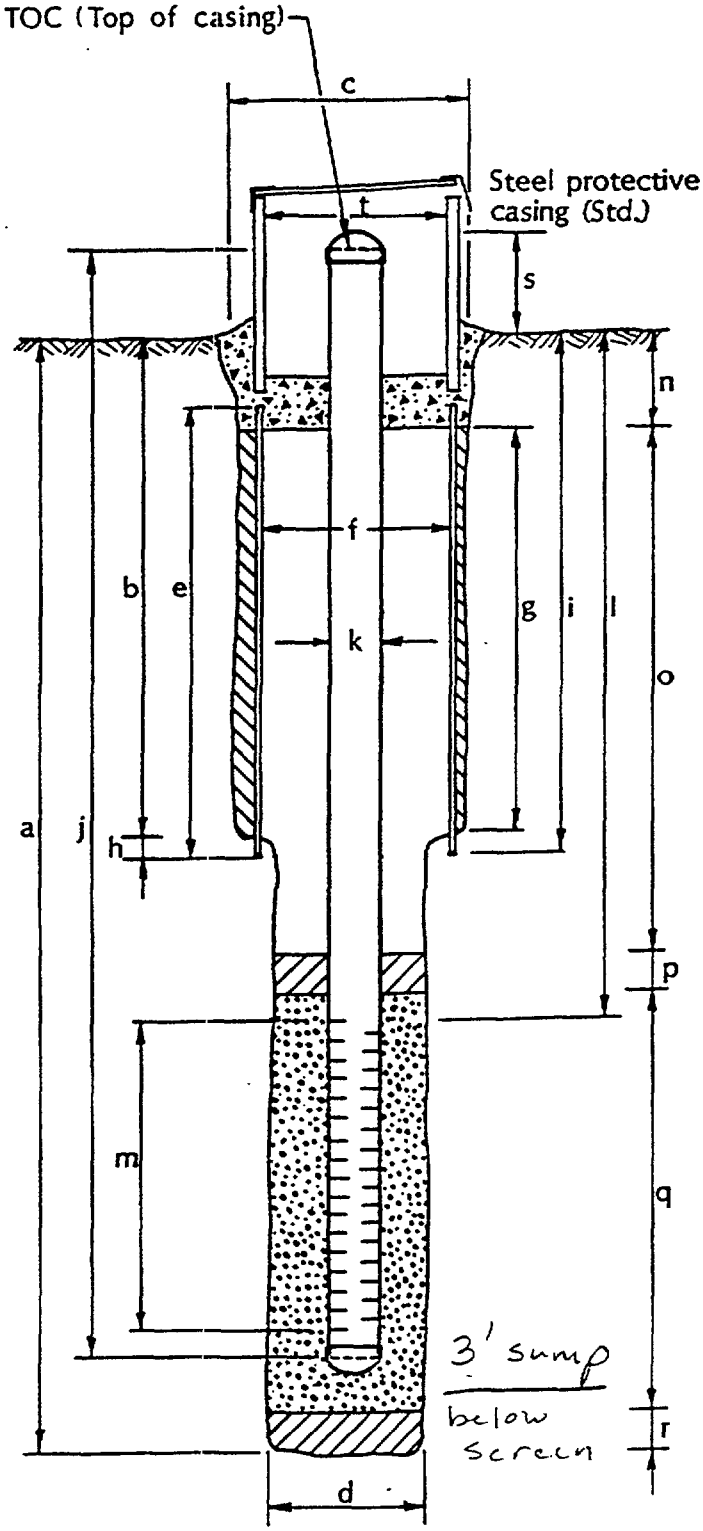
Prepared by: N. LABEDZKI (EA)

Reviewed by: _____ Date: _____

Form F-10 Rev. 12/90

PROJECT NUMBER _____
PROJECT NAME Frontier Fertilizer
LOCATION Davis, CA
WELL PERMIT NO. _____

BORING/WELL NO. OWXB
TOP OF CASING ELEV. 10
GROUND SURFACE ELEV. _____
DATUM _____
INSTALLATION DATE 7/8/98



EXPLORATORY BORING

a. Total depth 78.5 ft.
b. Upper boring depth N/A ft.
c. Upper boring diameter N/A ft.
d. Lower boring diameter 8" ~~4"~~ ~~ft.~~
Drilling method hollow stem auger

CONDUCTOR CASING

e. Casing length N/A ft.
Material N/A
f. Diameter N/A in.
g. Upper (outer) seal N/A ft.
Material N/A
h. Penetration N/A in.
i. Depth N/A ft.

WELL CONSTRUCTION

j. Total casing length ≈ 73 ~~74~~ ft.
Material Schd. 40 PVC, 0.020 slot
k. Diameter 4
l. Depth to top perforations 63 ft.
m. Perforated length 5 ft.
Perforated interval from 63 to 68 ft.
Perforation type 0.02"
Perforation size slotted
n. Surface seal 3 ft.
Seal material Cement/Bentonite grout
o. Backfill 56 ft.
Backfill material cement/Bentonite grout
p. Seal 2 ft.
Seal material Bentonite Pellets
q. Gravel pack 17.5 ft.
Material #2/12 med. sand
Above filter pack #30 SAND 1 ft
r. Bottom seal NA ft.
Material NA
s. Casing stickup 2± ft.
t. Protective casing diameter 4

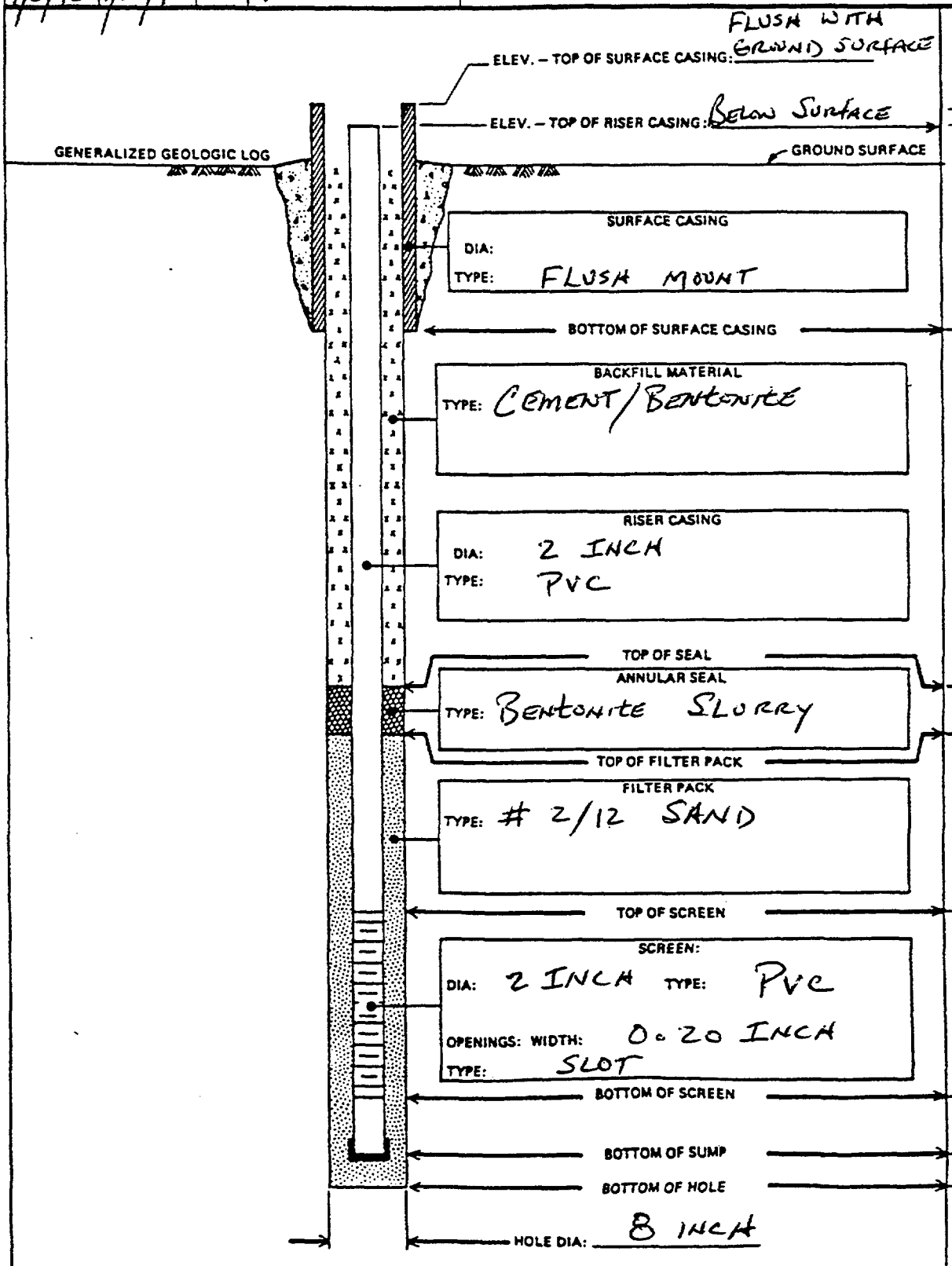
Prepared by: N. LABEDZKI (EA)

Reviewed by: [illegible] Date: 8/13/98

Form F-10 Rev. 12/90

MONITORING WELL

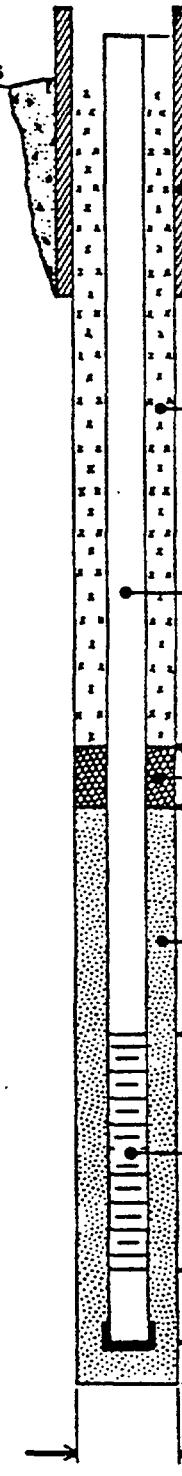
PROJECT: FRONTIER FERTILIZER		WELL NO.: DW-12-B
JOB NO.: 20376	SITE:	COORDINATES:
BEGUN: 7/8/98	COMPLETED: 7/10/98	PREPARED BY: R. COOK
REFERENCE POINT FOR MEASUREMENTS:		



	DEPTH	ELEV.
ELEV. – TOP OF SURFACE CASING: FLUSH WITH GROUND SURFACE		
ELEV. – TOP OF RISER CASING: BELOW SURFACE	-0.21	30.09
GROUND SURFACE	0	30.3
BOTTOM OF SURFACE CASING	N/A	N/A
TOP OF SEAL	60	-29.7
TOP OF FILTER PACK	67	-36.7
TOP OF SCREEN	69	-38.7
BOTTOM OF SCREEN	79	-48.7
BOTTOM OF SUMP	82	-51.7
BOTTOM OF HOLE	83	-52.7

MONITORING WELL

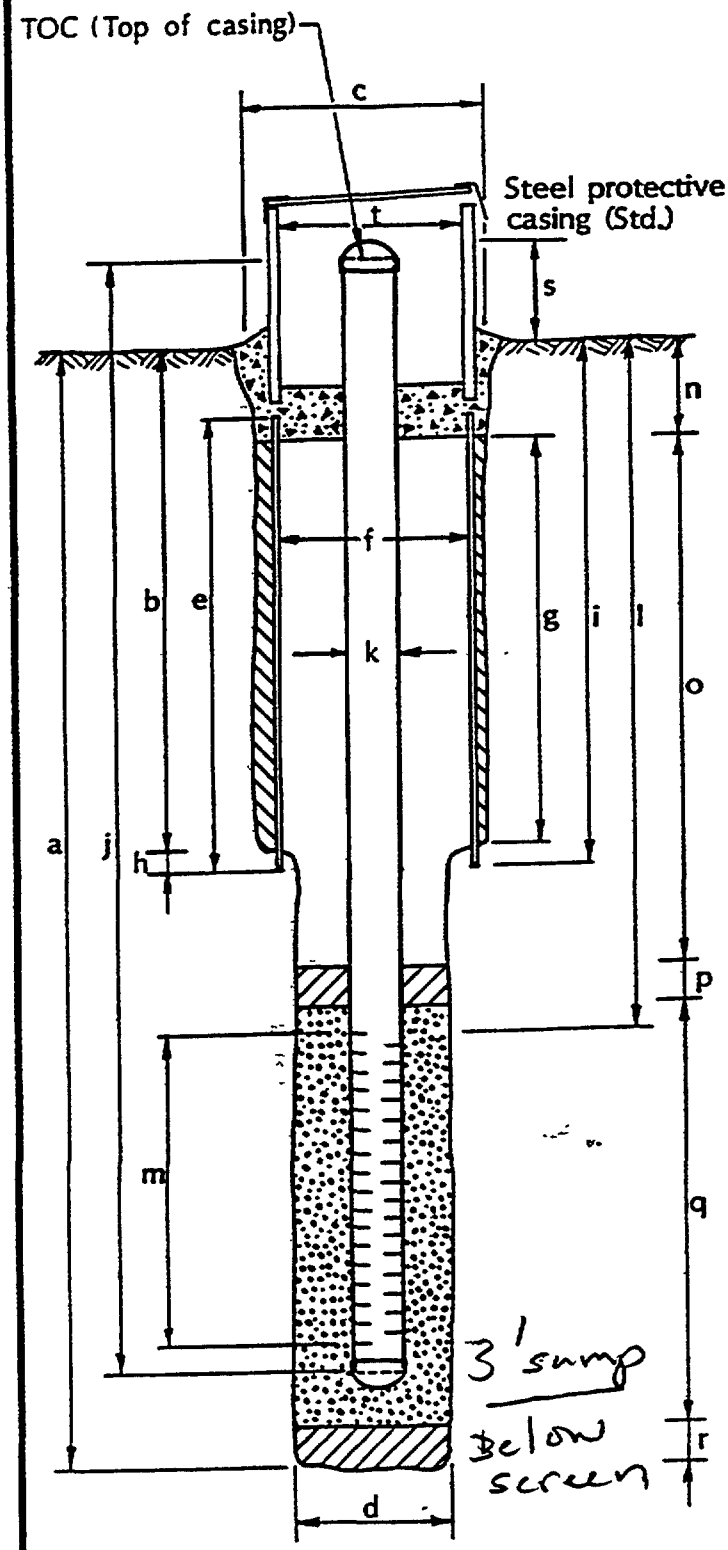
PROJECT: FRONTIER FERTILIZER			WELL NO. OW-12-A
JOB NO: 20376	SITE:	COORDINATES: N 323847.27 E 2085759.45	
BEGUN: 7/10/98	COMPLETED: 7/10/98	PREPARED BY: R. COOK	REFERENCE POINT FOR MEASUREMENTS: Top of Riser casing



	DEPTH	ELEV.
ELEV. – TOP OF SURFACE CASING: FLUSH WITH GROUND		
ELEV. – TOP OF RISER CASING: BELOW SURFACE	-0.19	30.21
GENERALIZED GEOLOGIC LOG — GROUND SURFACE	0.0	30.4
SURFACE CASING — DIA: 2 INCH; TYPE: FLUSH MOUNT		
BOTTOM OF SURFACE CASING	N/A	N/A
BACKFILL MATERIAL — TYPE: CEMENT / BENTONITE		
RISER CASING — DIA: 2 INCH; TYPE: PVC		
TOP OF SEAL	35.0	-4.6
ANNULAR SEAL — TYPE: BENTONITE SLURRY		
TOP OF FILTER PACK	41.0	-10.6
FILTER PACK — TYPE: #2/12 SAND		
TOP OF SCREEN	43	-12.6
SCREEN: DIA: 2 INCH; TYPE: PVC; OPENINGS: WIDTH: 0.20 INCH; TYPE: SLOT		
BOTTOM OF SCREEN	53	-22.6
BOTTOM OF SUMP	56	-25.6
BOTTOM OF HOLE	56	-25.6
HOLE DIA: 8 INCH		

PROJECT NUMBER _____
PROJECT NAME Frontier Fertilizer
LOCATION Davis, CA
WELL PERMIT NO. _____

BORING/WELL NO. OW 10B
TOP OF CASING ELEV. 13
GROUND SURFACE ELEV. _____
DATUM _____
INSTALLATION DATE 7/8/98



EXPLORATORY BORING

a. Total depth 83.5 ft.
b. Upper boring depth N/A ft.
c. Upper boring diameter N/A ft.
d. Lower boring diameter 8" ~~4"~~ ~~ft.~~
Drilling method hollow stem auger

CONDUCTOR CASING

e. Casing length N/A ft.
Material N/A
f. Diameter N/A in.
g. Upper (outer) seal N/A ft.
Material N/A
h. Penetration N/A in.
i. Depth N/A ft.

WELL CONSTRUCTION

j. Total casing length 78 ft.
Material Sch 40 PVC, 0.020" slot
k. Diameter 2" ~~4"~~ in.
l. Depth to top perforations 70 ft.
m. Perforated length 5 ft.
Perforated interval from 70 to 75 ft.
Perforation type 0.02"
Perforation size slotted
n. Surface seal 3 ft.
Seal material cement/Bentonite grout
o. Backfill _____ ft.
Backfill material cement/Bentonite grout
p. Seal 2 ft.
Seal material Bentonite Pellets
q. Gravel pack 15.5 ft.
Material #2/12 mud. sand
Above filter pack #30 sand 1 ft.
r. Bottom seal NA ft.
Material NA
s. Casing stickup NA ft.
t. Protective casing diameter NA in.

Prepared by: N. LABEDZKI (EA)

Reviewed by: _____ Date: _____

Form F-10 Rev. 12/90

Well Development Logs

WELL DEVELOPMENT/ WATER MONITORING DATA

SIERRA

PROJECT NAME & NUMBER: Frontier Fertilizer ; MR-958-00

By: John Harmon, Joe Carter

Well ID: OW-5A

Date: 10/27/97

Time	Depth to Water (ft)	Depth to Product (ft)	Surged	Bailed	Pumped		Gallons removed	Temp. ~~(F)~~ °C	pH	EC (umhos)	Comments: (color, odor, product, est flow rate)
Start: 8:15			X	X			5				Alternately surged and bailed. Removed approx.
Stop: 9:25											5 gallons of extremely silty water
Start: 9:25					X		20				
Stop: 9:31								18	7.49	2000	NTU: 202 x 1000
Start:					X		10				
Stop: 9:39								18	7.68	1725	NTU: 402 x 1000
Start:					X		15				
Stop: 9:43								18	7.49	1700	NTU: 241 x 1000
Start:					X		20				
Stop: 9:47								19	7.46	1725	NTU: 205 x 1000
Start:					X		15				
Stop: 10:17								19	7.57	1700	NTU: 161 x 1000

WELL DEVELOPMENT SUMMARY

Depth to Water Before Development: _____

Depth to Water After Development: _____

Sounded Depth Before Development: _____

Sounded Depth After Development: _____

Development Method: Surge/bail & pump

Total Pumping Time (min): 52

Total Amount Excavated (gals): 85

Average Pumping Rate (gpm): ~1.5

Pumping Rate Range (gpm): ~

Total H20 Injected (gals): Ø

WELL DEVELOPMENT/ WATER MONITORING DATA

SIERRA

PROJECT NAME & NUMBER: Frontier Fertilizer : MR-958-00

By: John Harmon

Well ID: OW-5A

Date: 11/3/97

Time	Depth to Water (ft)	Depth to Product (ft)	Surged	Bailed	Pumped		Gallons removed	Temp. (F)	pH	EC (umhos)	Comments: (color, odor, product, est flow rate)
Start: 12:45											airlift
Stop:											
Start:											
Stop:											
Start:											
Stop:											
Start:											
Stop:											
Start:											
Stop:											
Start:											
Stop:											

WELL DEVELOPMENT SUMMARY

Depth to Water Before ~~Development~~ Airlift: 49.25

Depth to Water After ~~Development~~ Airlift: 50.70

Sounded Depth Before Development: _____

Sounded Depth After Development: _____

Development Method: Airlift.

Total Pumping Time (min): _____

Total Amount Excavated (gals): _____

Average Pumping Rate (gpm): _____

Pumping Rate Range (gpm): _____

Total H20 Injected (gals): _____

WELL DEVELOPMENT/ WATER MONITORING DATA

SIERRA

PROJECT NAME & NUMBER: MR 958-06

By: PMB JAH

Well ID: OW-5A

Date: 11/4/97

Time	Depth to Water (ft)	Depth to Product (ft)	Surged	Bailed	Pumped		Gallons removed	Temp. °C	pH	EC (umhos)	Comments: (color, odor, product, est flow rate)
Start: 0905											WELL SURGE PREVIOUS WEEK PUMP @ 175 ft, 2 GPM
Stop: 0908					X		~~9~~ 6	19°	7.52	1600	NTU 358.0
Start:											
Stop: 0911					X		6	19°	7.50	1525	NTU 76.1
Start:											
Stop: 0914					X		6	18°	7.50	1525	NTU 40.3
Start:											
Stop: 0919					X		10	18°	7.46	1525	NTU ~~37~~ 31.4
Start:											
Stop: 0923					X		8	19°	7.47	1500	NTU 22.3
Start:											
Stop:											

WELL DEVELOPMENT SUMMARY

Depth to Water Before Development: 29.39

Depth to Water After Development:

Sounded Depth Before Development: 49.52

Sounded Depth After Development:

Development Method: PUMP

Total Pumping Time (min): 18

Total Amount Excavated (gals): 36

Average Pumping Rate (gpm): 2.0

Pumping Rate Range (gpm):

Total H20 Injected (gals): Ø

WELL DEVELOPMENT/ WATER MONITORING DATA

SIERRA

PROJECT NAME & NUMBER: Frontier Fertilizer, MR-958-00

By: John Harmon, Joe Carter

Well ID: OW-5B

Date: 10/27/97

Time	Depth to Water (ft)	Depth to Product (ft)	Surged	Bailed	Pumped		Gallons removed	Temp. (°C)	pH	EC (umhos)	Comments: (color, odor, product, est flow rate)
Start: 9:25			X	X			5				Alternately surged and bailed. Removed
Stop: 10:10											approx. 5 gallons of extremely silty water.
Start: 12:05					X		20				
Stop: 12:10								19	7.73	1700	NTU: 983 x 1000
Start: ~~12:15~~					X		20				
Stop: 12:15								19	7.70	1650	NTU: 640 x 1000
Start:					X		20				
Stop: 12:25								19	7.74	1680	NTU: 473 x 1000
Start:					X		20				
Stop: 12:35								19.5	7.81	1680	NTU: 288 x 100
Start:					X		20				
Stop: 12:50								19.5	7.71	1625	NTU: 141 x 100

WELL DEVELOPMENT SUMMARY

Depth to Water Before Development: _____

Depth to Water After Development: _____

Sounded Depth Before Development: _____

Sounded Depth After Development: _____

Development Method: surge/bail & Pump

Total Pumping Time (min): 45

Total Amount Excavated (gals): 105

Average Pumping Rate (gpm): ~2.1

Pumping Rate Range (gpm): _____

Total H20 Injected (gals): _____

WELL DEVELOPMENT/ WATER MONITORING DATA

SIERRA

PROJECT NAME & NUMBER: Frontier Fertilizer : MR-958-00

Well ID: OW-5B

By: John Harman

Date: 11/3/97

Time	Depth to Water (ft)	Depth to Product (ft)	Surged	Bailed	Pumped		Gallons removed	Temp. (F)	pH	EC (umhos)	Comments: (color, odor, product, est flow rate)
Start:	12:15										Airlift
Stop:											
Start:											
Stop:											
Start:											
Stop:											
Start:											
Stop:											
Start:											
Stop:											
Start:											
Stop:											

WELL DEVELOPMENT SUMMARY

Depth to Water Before Development: 77.32

Depth to Water After Development: 78.60

Sounded Depth Before Development: _____

Sounded Depth After Development: _____

Development Method: Airlift

Total Pumping Time (min): _____

Total Amount Excavated (gals): _____

Average Pumping Rate (gpm): _____

Pumping Rate Range (gpm): _____

Total H20 Injected (gals): _____

WELL DEVELOPMENT/ WATER MONITORING DATA

SIERRA

PROJECT NAME & NUMBER: MR-958.00
By: DMB, JAH

Well ID: OW-5B
Date: 11/4/97

Time	Depth to Water (ft)	Depth to Product (ft)	Surged	Bailed	Pumped		Gallons removed	Temp. (°C)	pH	EC (umhos)	Comments: (color, odor, product, est flow rate)
Start: 0830					X						WELL WAS SURGED PREVIOUS WEEK; PUMPED @ 250 Hz, ~3.5 GPM. -3.0GPM
Stop: 0834							15	18°	8.04	1550	NTU 108.0
Start: ~~0835~~					X						NTU
Stop: 0839							17.5 DMB	18°	7.79	1550	32.1
Start:					X						
Stop: 0844							17.5 DMB	18°	7.67	1550	NTU 11.83
Start:					X						
Stop: 0849							17.5 DMB	18°	7.61	1550	NTU ~~18~~ 17.47
Start:					X						
Stop: 0854							17.5 DMB	18°	7.61	1550	NTU 9.68
Start:											
Stop:											

WELL DEVELOPMENT SUMMARY

Depth to Water Before Development: 29.20
Depth to Water After Development: 29.25
Sounded Depth Before Development: 76.71
Sounded Depth After Development: 76.71

Development Method: PUMP
Total Pumping Time (min): 24
Total Amount Excavated (gals): 80

Average Pumping Rate (gpm):
Pumping Rate Range (gpm):
Total H20 Injected (gals): Ø

WELL DEVELOPMENT/ WATER MONITORING DATA

SIERRA

PROJECT NAME & NUMBER: MR-958-00 Frontier Fertilizer

By: John Harmon, Joe Carter

Well ID: OW-5C

Date: 10/27/97

Time	Depth to Water (ft)	Depth to Product (ft)	Surged	Bailed	Pumped		Gallons removed	Temp. ~~(F)~~ C	pH	EC (umhos)	Comments: (color, odor, product, est flow rate)
Start: 8:15			X	X			5				Alternately Surged and bailed. Removed
Stop: 9:25											approx 5 gal. of extremely silty Water.
Start: 10:40					X		40				
Stop: 10:50								19.5	8.28	1800	NTU: 104 x 100
Start:					X		20				
Stop: 10:55								18.5	7.85	1750	NTU: 79 x 100
Start:					X		20				
Stop: 11:05								18	7.74	1800	NTU: 50 x 100
Start:					X		20				
Stop: 11:10								18	7.70	1850	NTU: 45.6 x 100
Start:					X		38				
Stop: 11:20								17.5	7.69	1900	NTU: 34.5 x 100

WELL DEVELOPMENT SUMMARY

Depth to Water Before Development: _____

Depth to Water After Development: _____

Sounded Depth Before Development: _____

Sounded Depth After Development: _____

Development Method: surge/bail & Pump

Total Pumping Time (min): 40

Total Amount Excavated (gals): 143

Average Pumping Rate (gpm): ~3.6

Pumping Rate Range (gpm): _____

Total H20 Injected (gals): _____

WELL DEVELOPMENT / WATER MONITORING DATA

SIERRA

PROJECT NAME & NUMBER: MR 958 00

By: DMB, JAH

Well ID: OW-5C

Date: 11/4/97

Time	Depth to Water (ft)	Depth to Product (ft)	Surged	Bailed	Pumped		Gallons removed	Temp. °C	pH	EC (umhos)	Comments: (color, odor, product, est flow rate)
Start: 0933											WELL SURGED PREVIOUS WEEK
Stop: 0938					X		25	19°	7.69	1500	PUMPED @ 300 Hz, 5.0 GPM NTU 630.0
Start:											
Stop: 0943					X		25	18.5°	7.79	1700	NTU 110.0
Start:											
Stop: 0948					X		25	18°	7.76	1700	NTU 46.2
Start:											
Stop: 0953					X		25	18°	7.70	1700	NTU 167.0
Start:											
Stop: 0958					X		25	18°	7.72	1700	NTU 112.0
Start:											
Stop:											

WELL DEVELOPMENT SUMMARY

Depth to Water Before Development: 31.27

Depth to Water After Development:

Sounded Depth Before Development: 103.21

Sounded Depth After Development:

Development Method: Pump

Total Pumping Time (min): 25

Total Amount Excavated (gals): 125

Average Pumping Rate (gpm):

Pumping Rate Range (gpm): 5.0

Total H20 Injected (gals):

(71.94 x .1663 = 11.73 x 1A - [illegible] ([illegible] (

WELL DEVELOPMENT / WATER MONITORING DATA

SIERRA

PROJECT NAME & NUMBER: MR-958-00 Frontier Fertilizer

By: John Harmon

Well ID: OW-6A

Date: 11/3/97

Time	Depth to Water (ft)	Depth to Product (ft)	Surged	Bailed	Pumped		Gallons removed	Temp. (F)	pH	EC (umhos)	Comments: (color, odor, product, est flow rate)
Start: 10:20											Airlift
Stop:											
Start:											
Stop:											
Start:											
Stop:											
Start:											
Stop:											
Start:											
Stop:											
Start:											
Stop:											

WELL DEVELOPMENT SUMMARY

Depth to Water Before Development: 44.00

Depth to Water After Development: 44.15

Sounded Depth Before Development: _____

Sounded Depth After Development: _____

Development Method: Airlift

Total Pumping Time (min): _____

Total Amount Excavated (gals): _____

Average Pumping Rate (gpm): _____

Pumping Rate Range (gpm): _____

Total H20 Injected (gals): _____

WELL DEVELOPMENT/ WATER MONITORING DATA

SIERRA

PROJECT NAME & NUMBER: Frontier Fertilizer : MR-958-00

Well ID: OW-6B

By: John Harmon

Date: 11/3/97

Time	Depth to Water (ft)	Depth to Product (ft)	Surged	Bailed	Pumped		Gallons removed	Temp. (F)	pH	EC (umhos)	Comments: (color, odor, product, est flow rate)
Start: 10:50											Air lift
Stop:											
Start:											
Stop:											
Start:											
Stop:											
Start:											
Stop:											
Start:											
Stop:											
Start:											
Stop:											

WELL DEVELOPMENT SUMMARY

Depth to Water Before Development: 99.30

Depth to Water After Development: 100.95

Sounded Depth Before Development: _____

Sounded Depth After Development: _____

Development Method: Airlift

Total Pumping Time (min): _____

Total Amount Excavated (gals): _____

Average Pumping Rate (gpm): _____

Pumping Rate Range (gpm): _____

Total H20 Injected (gals): _____

WELL DEVELOPMENT/ WATER MONITORING DATA

SIERRA

PROJECT NAME & NUMBER: MR-958-00 Frontier Fertilizer

Well ID: OW-6A

By: Mike Stinar

Date: 11/4/97

Time	Depth to Water (ft)	Depth to Product (ft)	Surged	Bailed	Pumped		Gallons removed	Temp. (F)	pH	EC (umhos)	Comments: (color, odor, product, est flow rate)
Start: 9:00	28.25		X								
Stop: 9:10											
Start:											
Stop:											
Start:											
Stop:											
Start:											
Stop:											
Start:											
Stop:											
Start:											
Stop:											

WELL DEVELOPMENT SUMMARY

Depth to Water Before Development: 28.25

Depth to Water After Development: 28.35

Sounded Depth Before Development: 42.97

Sounded Depth After Development: 42.95

Development Method: Surge

Total Pumping Time (min):

Total Amount Excavated (gals):

Average Pumping Rate (gpm):

Pumping Rate Range (gpm):

Total H20 Injected (gals):

WELL DEVELOPMENT/ WATER MONITORING DATA

SIERRA

PROJECT NAME & NUMBER: MR-958-00

By: DMB, JAH

Well ID: OW-6A

Date: 11/4/97

Time	Depth to Water (ft)	Depth to Product (ft)	Surged	Bailed	Pumped		Gallons removed	Temp. (°C)	pH	EC (umhos)	Comments: (color, odor, product, est flow rate)
Start: 0900			X								WELL SCREENED ZONE PURGED FOR TEN MINUTES.
Stop:											
Start: 13:17					X		6				PUMP @ 200 Hz; 2.0 GPM
Stop: 13:20								19°	7.70	1600	NTU 1250.0
Start:					X		6				
Stop: 13:23								19°	7.63	1600	NTU 575.0
Start:					X		6				
Stop: 13:26								18.5°	7.57	1600	NTU 515.0
Start:					X		6				
Stop: 13:29								19°	7.52	1600	NTU 440.0
Start:					X		6				
Stop: 13:32								1	7.52	1600	NTU ~~1500~~ DB 136.0

WELL DEVELOPMENT SUMMARY

Depth to Water Before Development: 28.05

Depth to Water After Development: 29.32

Sounded Depth Before Development: 42.95

Sounded Depth After Development: 42.85

Development Method: Pump

Total Pumping Time (min): 15

Total Amount Excavated (gals): 30

Average Pumping Rate (gpm): 2.0

Pumping Rate Range (gpm):

Total H20 Injected (gals):

14.90 x .163 = 2.42 . in

WELL DEVELOPMENT/ WATER MONITORING DATA

SIERRA

PROJECT NAME & NUMBER: MR-958-00: Frontier Fertilizer

Well ID: OW-6B

By: Mike Stiner

Date: 11/4/97

Time	Depth to Water (ft)	Depth to Product (ft)	Surged	Bailed	Pumped		Gallons removed	Temp. (F)	pH	EC (umhos)	Comments: (color, odor, product, est flow rate)
Start: 9:15	32.54		X								
Stop: 9:25											
Start:											
Stop:											
Start:											
Stop:											
Start:											
Stop:											
Start:											
Stop:											
Start:											
Stop:											

WELL DEVELOPMENT SUMMARY

Depth to Water Before Development: 32.54

Depth to Water After Development: 32.64

Sounded Depth Before Development: 99.92

Sounded Depth After Development: 99.58

Development Method: Surge

Total Pumping Time (min): _____

Total Amount Excavated (gals): _____

Average Pumping Rate (gpm): _____

Pumping Rate Range (gpm): _____

Total H20 Injected (gals): _____

WELL DEVELOPMENT/ WATER MONITORING DATA

SIERRA

PROJECT NAME & NUMBER: MR-958-00

By: DMB, JAH

Well ID: OW-6 B

Date: 11/4/97

Time	Depth to Water (ft)	Depth to Product (ft)	Surged	Bailed	Pumped		Gallons removed	Temp. ~~C~~	pH	EC (umhos)	Comments: (color, odor, product, est flow rate)
Start: 0900			X								WELL SCREENED ZONE SURGED FOR TEN MINUTES.
Stop:											
Start: 1230					X		25				PUMPED @ 300 Hz, 5.0 GPM
Stop: ~~1234~~ 1235							~~20~~ PURGE	19.5	7.94	1750	NTU 114.0 | PURGE DRY, FAST RECOVERY
Start: 12:41	49.52	—									RESTARTED PURGE @ 230Hz, 2.5 GPM
Stop: 12:49							20	19.0	7.86	1650	NTU 559.0
Start:											
Stop: 12:57							20	19.0	7.74	1650	NTU 261.0
Start:							20	~~19.0~~			
Stop: 13:04								19.0	7.69	1650	NTU 67.0
Start:							22.5				
Stop: 1313								19.0	7.72	1650	NTU 80.7

WELL DEVELOPMENT SUMMARY

Depth to Water Before Development: 32.60

Depth to Water After Development:

Sounded Depth Before Development: 99.20

Sounded Depth After Development:

Development Method: Pump

Total Pumping Time (min):

Total Amount Excavated (gals):

Average Pumping Rate (gpm):

Pumping Rate Range (gpm):

Total H20 Injected (gals):

66.60 X .163 = 10.69 x 10 = 93 - 6 = (71.28)

WELL DEVELOPMENT/ WATER MONITORING DATA

SIERRA

PROJECT NAME & NUMBER: Frontier Fertilizer; MR-958-00

By: John Harmon, Joe Carter

Well ID: OW-6C (Page 1)

Date: 10/28/97

Time	Depth to Water (ft)	Depth to Product (ft)	Surged	Bailed	Pumped		Gallons removed	Temp. (F)	pH	EC (umhos)	Comments: (color, odor, product, est flow rate)
Start: 8:30			X	X			5				Alternately Surged & Bailed. Approx 5
Stop: 9:15											gallons silty water removed
Start: 9:20											
Stop: 9:30					X		20	18.5	7.31	1650	NTU: 644
Start:											
Stop: 10:00					X		20	19.0	7.72	1600	NTU: 245
Start:											
Stop: 10:15					X		20	19.0	7.85	1600	NTU: 353
Start:											
Stop: 10:25					X		20	20	7.71	1625	NTU: 61
Start:											
Stop: 10:35					X		30	19	7.79	1625	NTU: 34.2

WELL DEVELOPMENT SUMMARY

Depth to Water Before Development: 29.84

Depth to Water After Development: _____

Sounded Depth Before Development: 131.15

Sounded Depth After Development: _____

Development Method: surge/bail & Pump

Total Pumping Time (min): 85

Total Amount Excavated (gals): 185

Average Pumping Rate (gpm): ~2.2

Pumping Rate Range (gpm): _____

Total H20 Injected (gals): _____

WELL DEVELOPMENT/ WATER MONITORING DATA

SIERRA

PROJECT NAME & NUMBER: Frontier Fertilizer : MR-958-00

By: John Harmon, Joe Carter

Well ID: OW-6C (Page 2)

Date: 10/28/97

Time (continued)	Depth to Water (ft)	Depth to Product (ft)	Surged	Bailed	Pumped		Gallons removed	Temp. ~~(F)~~ °C	pH	EC (umhos)	Comments: (color, odor, product, est flow rate)
Start:											
Stop: 10:42					X		30	19	7.78	1650	NTU: 29.2
Start:											
Stop: 10:50					X		20	19	7.75	1625	NTU: 20.7
Start:											
Stop: 10:55					X		20	19	7.77	1625	NTU: 16.4
Start:											
Stop:											
Start:											
Stop:											
Start:											
Stop:											

WELL DEVELOPMENT SUMMARY

Depth to Water Before Development: _____

Depth to Water After Development: _____

Sounded Depth Before Development: _____

Sounded Depth After Development: _____

Development Method: _____

Total Pumping Time (min): _____

Total Amount Excavated (gals): _____

Average Pumping Rate (gpm): _____

Pumping Rate Range (gpm): _____

Total H20 Injected (gals): _____

WELL DEVELOPMENT/ WATER MONITORING DATA

SIERRA

PROJECT NAME & NUMBER: ~~MR-79~~ MR-958-00

By: JMB, JAH

Well ID: OW-6C

Date: 11/4/97

Time	Depth to Water (ft)	Depth to Product (ft)	Surged	Bailed	Pumped		Gallons removed	Temp. (°C)	pH	EC (umhos)	Comments: (color, odor, product, est flow rate)
Start: 11:45											WELL SURGED PREVIOUS WEEK. PUMPED @ 300 Hz, 5.0 GPM
Stop: 11:52					X		35	20°	7.88	1650	NTU 475.0
Start:											
Stop: 11:59					X		35	19°	7.77	1600	NTU 385.0
Start:											
Stop: 12:06					X		35	19°	7.75	1625	NTU 275.0
Start:											
Stop: 12:13					X		35	19°	7.71	1650	NTU 180.0
Start:											
Stop: 12:20					X		35	19°	7.72	1600	NTU 135.0
Start:											
Stop:											

WELL DEVELOPMENT SUMMARY

Depth to Water Before Development: 29.91

Depth to Water After Development:

Sounded Depth Before Development: 135.20

Sounded Depth After Development:

Development Method: Pump

Total Pumping Time (min): 35

Total Amount Excavated (gals): 175

Average Pumping Rate (gpm):

Pumping Rate Range (gpm): 5.0

Total H20 Injected (gals):

WELL DEVELOPMENT/ WATER MONITORING DATA

SIERRA

PROJECT NAME & NUMBER: MR-958-00 Frontier Fertilizer

Well ID: OW-7A

By: John Harmon

Date: 11/4/97

Time	Depth to Water (ft)	Depth to Product (ft)	Surged	Bailed	Pumped		Gallons removed	Temp. (F)	pH	EC (umhos)	Comments: (color, odor, product, est flow rate)
Start: 9:25											Airlift
Stop:											
Start:											
Stop:											
Start:											
Stop:											
Start:											
Stop:											
Start:											
Stop:											
Start:											
Stop:											

WELL DEVELOPMENT SUMMARY

Depth to Water Before Development: 47.00

Depth to Water After Development: 47.00

Sounded Depth Before Development: _____

Sounded Depth After Development: _____

Development Method: Airlift

Total Pumping Time (min): _____

Total Amount Excavated (gals): _____

Average Pumping Rate (gpm): _____

Pumping Rate Range (gpm): _____

Total H20 Injected (gals): _____

WELL DEVELOPMENT/ WATER MONITORING DATA

SIERRA

PROJECT NAME & NUMBER: MR-958-00 : Frontier Fertilizer

Well ID: OW-7A

By: Mike Stinar

Date: 11/4/97

Time	Depth to Water (ft)	Depth to Product (ft)	Surged	Bailed	Pumped		Gallons removed	Temp. (F)	pH	EC (umhos)	Comments: (color, odor, product, est flow rate)
Start: 10:00	27.48		X								
Stop: 10:10											
Start:											
Stop:											
Start:											
Stop:											
Start:											
Stop:											
Start:											
Stop:											
Start:											
Stop:											

WELL DEVELOPMENT SUMMARY

Depth to Water Before Development: 27.48

Depth to Water After Development: 27.96

Sounded Depth Before Development: 45.97

Sounded Depth After Development: 45.98

Development Method: Surge

Total Pumping Time (min): _____

Total Amount Excavated (gals): _____

Average Pumping Rate (gpm): _____

Pumping Rate Range (gpm): _____

Total H20 Injected (gals): _____

WELL DEVELOPMENT/ WATER MONITORING DATA

SIERRA

PROJECT NAME & NUMBER: MR-958-00

By: DMB JAH

Well ID: OW-7A

Date: ~~11/4~~ 11/5/97

Time	Depth to Water (ft)	Depth to Product (ft)	Surged	Bailed	Pumped		Gallons removed	Temp. °C	pH	EC (umhos)	Comments: (color, odor, product, est flow rate)
Start: 1205											WELLS SURGED 11/4/97 BY M.S. PUMPED @ 180 ft, 2.0 GPM
Stop: 1208					X		6	20°	7.41	1200	NTU 180.0
Start:											
Stop: 1211					X		6	19°	7.46	1200	NTU 115.0
Start:											
Stop: 1214					X		6	18.5°	7.44	1200	NTU 68.5
Start:											
Stop: 1217					X		6	18.5	7.37	1200	NTU 41.0
Start:											
Stop: 1220					X		6	18.5	7.35	1200	NTU 25.0
Start:											
Stop:											

WELL DEVELOPMENT SUMMARY

Depth to Water Before Development: 27.48

Depth to Water After Development: 27.52

Sounded Depth Before Development: 45.98

Sounded Depth After Development: 46.00

Development Method: PUMP

Total Pumping Time (min): 15

Total Amount Excavated (gals): 30

Average Pumping Rate (gpm):

Pumping Rate Range (gpm): 2.0

Total H20 Injected (gals): Ø

18.50 x .163 = 2 [illegible]

WELL DEVELOPMENT / WATER MONITORING DATA

SIERRA

PROJECT NAME & NUMBER: Frontier Fertilizer : MR-958-00

Well ID: OW-7B

By: John Harmon

Date: 11/3/97

Time	Depth to Water (ft)	Depth to Product (ft)	Surged	Bailed	Pumped		Gallons removed	Temp. (F)	pH	EC (umhos)	Comments: (color, odor, product, est flow rate)
Start:	9:50										Airlift
Stop:											
Start:											
Stop:											
Start:											
Stop:											
Start:											
Stop:											
Start:											
Stop:											
Start:											
Stop:											

WELL DEVELOPMENT SUMMARY

Depth to Water Before Development: 72.10

Depth to Water After Development: 74.90

Sounded Depth Before Development: _____

Sounded Depth After Development: _____

Development Method: Airlift

Total Pumping Time (min): _____

Total Amount Excavated (gals): _____

Average Pumping Rate (gpm): _____

Pumping Rate Range (gpm): _____

Total H20 Injected (gals): _____

WELL DEVELOPMENT/ WATER MONITORING DATA

SIERRA

PROJECT NAME & NUMBER: MR-958-00 Frontier Fertilizer

Well ID: OW-7B

By: Mike Stinar

Date: 11/4/97

Time	Depth to Water (ft)	Depth to Product (ft)	Surged	Bailed	Pumped		Gallons removed	Temp. (F)	pH	EC (umhos)	Comments: (color, odor, product, est flow rate)
Start: 10:15	27.59		X								Surge
Stop: 10:25											
Start:											
Stop:											
Start:											
Stop:											
Start:											
Stop:											
Start:											
Stop:											
Start:											
Stop:											

WELL DEVELOPMENT SUMMARY

Depth to Water Before Development: 27.59

Depth to Water After Development: 28.11

Sounded Depth Before Development: 71.45

Sounded Depth After Development: 71.75

Development Method: Surge

Total Pumping Time (min): _____

Total Amount Excavated (gals): _____

Average Pumping Rate (gpm): _____

Pumping Rate Range (gpm): _____

Total H20 Injected (gals): _____

WELL DEVELOPMENT/ WATER MONITORING DATA

SIERRA

PROJECT NAME & NUMBER: MR: 958-00

By: DMB, JAH

Well ID: OW-7B

Date: 11/5/97 – 11/6/97

Time	Depth to Water (ft)	Depth to Product (ft)	Surged	Bailed	Pumped		Gallons removed	Temp. (F)	pH	EC (umhos)	Comments: (color, odor, product, est flow rate)
Start: 1227	27.59	–									WELL SURGED 11/4/97 BY M.S. PUMPED @ 200 Hz, 2.0 GPM
Stop: 1233					X		12	20°	7.33	2000	NTU > 2,000.0
Start:											Pump @ 185 Hz, 1.5 GPM
Stop: 1243					X		15	20°	7.35	2000	NTU > 2,000.0 STOP FOR RECHARGE 1243 / PURGE DRY
Start: 13:37	31.37	–									
Stop: 13:42					X		10	20°	7.44	1825	NTU 1233.0 STOP FOR RECHARGE / PURGE DRY
Start: 14:14	35.75	–									
Stop: 14:19					X		7	20°	7.48	1825	NTU 1100.0 PURGE DRY STOP FOR RECHARGE / PURGE DRY
11/6/97 Start: 0721	28.46	–									
Stop: 0726					X		6	19°	7.46 ~~7.94~~	1750	NTU 940.0 PURGED DRY STOP FOR RECHARGE
Start: 11:47	31.79	–						~~19°~~			
Stop: 1150					X		7	19°	7.40 ~~7.98~~	1750	NTU 1017.0 PURGED DRY STOPED FOR RECHARGE

WELL DEVELOPMENT SUMMARY

Depth to Water Before Development: 27.58

Depth to Water After Development: _____

Sounded Depth Before Development: 71.75

Sounded Depth After Development: _____

Development Method: PUMP

Total Pumping Time (min): _____

Total Amount Excavated (gals): _____

Average Pumping Rate (gpm): _____

Pumping Rate Range (gpm): _____

Total H20 Injected (gals): Ø

44.17 x .163 = 7.19 x 12

WELL DEVELOPMENT/ WATER MONITORING DATA

SIERRA

PROJECT NAME & NUMBER: MR-958-00 Frontier Fertilizer

Well ID: OW-7C

By: Mike Stinar

Date: 11/4/97

Time	Depth to Water (ft)	Depth to Product (ft)	Surged	Bailed	Pumped		Gallons removed	Temp. (F)	pH	EC (umhos)	Comments: (color, odor, product, est flow rate)
Start: 10:30	29.40		X								Surge
Stop: 10:40											
Start:											
Stop:											
Start:											
Stop:											
Start:											
Stop:											
Start:											
Stop:											
Start:											
Stop:											

WELL DEVELOPMENT SUMMARY

Depth to Water Before Development: 29.40

Depth to Water After Development: 29.45

Sounded Depth Before Development: 122.88

Sounded Depth After Development: 123.10

Development Method: Surge

Total Pumping Time (min): _____

Total Amount Excavated (gals): _____

Average Pumping Rate (gpm): _____

Pumping Rate Range (gpm): _____

Total H20 Injected (gals): _____

WELL DEVELOPMENT / WATER MONITORING DATA

SIERRA

PROJECT NAME & NUMBER: MR 958 00

By: DMB, JAH

Well ID: OW-7C

Date: 11/5/97

Time	Depth to Water (ft)	Depth to Product (ft)	Surged	Bailed	Pumped		Gallons removed	Temp. (F)	pH	EC (umhos)	Comments: (color, odor, product, est flow rate)
Start: 1254											WELL SURGED 11/4/97 BY M.S. PUMPED 300 Hz, 5.0 GPM
Stop: 1300					X		30	19°	7.51	1650	NTU 695.0
Start:											
Stop: 1306					X		30	18.5°	7.50	~~1650~~ 1600	NTU ~~695.0~~ 147.0
Start:										~~160~~	
Stop: 1312					X		30	18.5°	7.52	1600	NTU 87.0
Start:											
Stop: 1319					X		35	18.5	7.52	1600	NTU 50.0
Start:											
Stop: 1326					X		35	18.5	7.50	1600	NTU 32.2
Start:											
Stop:											

WELL DEVELOPMENT SUMMARY

Depth to Water Before Development: 29.40

Depth to Water After Development: 28.63

Sounded Depth Before Development: 123.10

Sounded Depth After Development: 122.31

Development Method: Pump

Total Pumping Time (min): 30

Total Amount Excavated (gals): 160

Average Pumping Rate (gpm):

Pumping Rate Range (gpm): 5.0

Total H2O Injected (gals): 80

93.70 x .163 = 15.27 x 10 = 152.73 ÷ 5 = 30.54

WELL DEVELOPMENT/ WATER MONITORING DATA

SIERRA

PROJECT NAME & NUMBER: Frontier Fertilizer MR-958:00

By: Dave Beardsley

Well ID: OW-8A

Date: 10/29/97

Time	Depth to Water (ft)	Depth to Product (ft)	Surged	Bailed	Pumped		Gallons removed	Temp. (F)	pH	EC (umhos)	Comments: (color, odor, product, est flow rate)
Start: 7:35	27.41						5				No parameters collected
Stop: 7:45				X							
Start: 7:55			X								
Stop: 8:06											
Start: 8:07				X			10 ~~15~~				
Stop: 8:30											
Start: 8:30			X								
Stop: 9:00	27.90 / 47.61 TD										
Start:											
Stop:											
Start:											
Stop:											

WELL DEVELOPMENT SUMMARY

Depth to Water Before Development: 27.41

Depth to Water After Development:

Sounded Depth Before Development: 47.53

Sounded Depth After Development:

Development Method: Surge / bail

Total Pumping Time (min):

Total Amount Excavated (gals):

Average Pumping Rate (gpm):

Pumping Rate Range (gpm):

Total H20 Injected (gals):

WELL DEVELOPMENT / WATER MONITORING DATA

SIERRA

PROJECT NAME & NUMBER: MR-958-00 Frontier Fertilizer

Well ID: OW-8A

By: John Harmon

Date: 11/3/97

Time	Depth to Water (ft)	Depth to Product (ft)	Surged	Bailed	Pumped		Gallons removed	Temp. (F)	pH	EC (umhos)	Comments: (color, odor, product, est flow rate)
Start: 1350											Airlift
Stop:											
Start:											
Stop:											
Start:											
Stop:											
Start:											
Stop:											
Start:											
Stop:											
Start:											
Stop:											

WELL DEVELOPMENT SUMMARY

Depth to Water Before Development: 47.60

Depth to Water After Development: 49.10

Sounded Depth Before Development: _____

Sounded Depth After Development: _____

Development Method: Airlift

Total Pumping Time (min): _____

Total Amount Excavated (gals): _____

Average Pumping Rate (gpm): _____

Pumping Rate Range (gpm): _____

Total H20 Injected (gals): _____

WELL DEVELOPMENT/ WATER MONITORING DATA

SIERRA

PROJECT NAME & NUMBER: MR958-00

By: DMB, JAH

Well ID: OW-8A

Date: 11/5/97

Time	Depth to Water (ft)	Depth to Product (ft)	Surged	Bailed	Pumped		Gallons removed	Temp. °C	pH	EC (umhos)	Comments: (color, odor, product, est flow rate)
Start: 0930											WELL SURGE PREVIOUS WEEK PUMPED @ 175 Hz, 1.5 GPM
Stop: 0934					X		6	18°	7.36	1800	NTU 102.0
Start: ~~0939~~											
Stop: 0939					X		9	18°	7.36	1800	NTU 21.5
Start:											
Stop: 0946					X		10.5	18°	7.37	1800	NTU 6.6
Start:											
Stop: ~~0940~~ 0950					X		6	18°	7.38	1800	NTU 5.6
Start:											
Stop: ~~0944~~ 0954					X		6	18°	7.36	1800	NTU 4.09
Start:											
Stop:											

WELL DEVELOPMENT SUMMARY

Depth to Water Before Development: 27.53

Depth to Water After Development: 27.94

Sounded Depth Before Development: 47.89

Sounded Depth After Development: 47.85

Development Method: PUMP.

Total Pumping Time (min): 24

Total Amount Excavated (gals): 37.5

Average Pumping Rate (gpm):

Pumping Rate Range (gpm): 1.5

Total H20 Injected (gals): Ø

20.36 x .163 = 3.31 x 108 = 33.18 (.5 = (6.63)

WELL DEVELOPMENT/ WATER MONITORING DATA

SIERRA

PROJECT NAME & NUMBER: MR-958-00 Frontier Fertilizer

Well ID: OW-8B

By: Joe Carter, Dave Beardsley

Date: 10/24/97

Time	Depth to Water (ft)	Depth to Product (ft)	Surged	Bailed	Pumped		Gallons removed	Temp. ~~(F)~~ (C)	pH	EC (umhos)	Comments: (color, odor, product, est flow rate)
Start: 12:00			X	X			5				Alternately bailed and surged. Removed ~
Stop: 13:00											5 gal of extremely silty water
Start: 13:23					X		20				
Stop: 13:33								18	7.46	1950	
Start:					X		10				
Stop: 13:40								18	7.47	2000	NTU: 513 x 1000
Start:					X		10				
Stop: 13:44								18	7.4	2000	NTU: 770 x 1000
Start:					X		10				
Stop: 13:49								18	7.4	2000	NTU: 894 x 1000
Start:											
Stop:											

WELL DEVELOPMENT SUMMARY

Depth to Water Before Development: _____

Depth to Water After Development: _____

Sounded Depth Before Development: _____

Sounded Depth After Development: _____

Development Method: Surge/bail pump

Total Pumping Time (min): 25

Total Amount Excavated (gals): 50

Average Pumping Rate (gpm): 2.

Pumping Rate Range (gpm): _____

Total H20 Injected (gals): _____

WELL DEVELOPMENT/ WATER MONITORING DATA

SIERRA

PROJECT NAME & NUMBER: MR-958-00

By: DMB JAH

Well ID: OW-8B

Date: 11/5/97

Time	Depth to Water (ft)	Depth to Product (ft)	Surged	Bailed	Pumped		Gallons removed	Temp. °C	pH	EC (umhos)	Comments: (color, odor, product, est flow rate)
Start: 1005											WELL SURGED PREVIOUS WEEK PUMPED @ 220 ~~200~~ ml/2, 2.5 GPM
Stop: 1011					X		15	19°	7.28	2000	NTU > 2000.0
Start: ~~1017~~											
Stop: 1017					X		15	19°	7.23	2000	NTU > 2000.0
Start:											
Stop: 1023					X		15	19°	7.15	2000	NTU > 2000.0
Start:											
Stop: 1029					X		15	19°	7.17	2000	NTU 715.0
Start:											
Stop: 1030					X		15	19°	7.17	2000	NTU 820.0
Start:											
Stop:											

WELL DEVELOPMENT SUMMARY

Depth to Water Before Development: 26.88

Depth to Water After Development: 30.45

Sounded Depth Before Development: 71.61

Sounded Depth After Development: 71.57

Development Method: PUMP

Total Pumping Time (min): 31

Total Amount Excavated (gals): 75

Average Pumping Rate (gpm): ~~2.5~~

Pumping Rate Range (gpm): ~~2.5~~ 2.5

Total H20 Injected (gals):

44.73 X .163 = 7.29 X 10 = 72.9 S=14.58

WELL DEVELOPMENT/ WATER MONITORING DATA

SIERRA

PROJECT NAME & NUMBER: MR-958-00 Frontier Fertilizer

By: Joe Carter, David Beardsley

Well ID: OW-8C

Date: 10/29/97

Time	Depth to Water (ft)	Depth to Product (ft)	Surged	Bailed	Pumped		Gallons removed	Temp. (F)	pH	EC (umhos)	Comments: (color, odor, product, est flow rate)
Start: 9:45	31.61		X	X			10				Alternately bailed and Surged.
Stop: 11:00											10 gallons silty water removed
Start:											
Stop:											
Start:											
Stop:											
Start:											
Stop:											
Start:											
Stop:											
Start:											
Stop:											

WELL DEVELOPMENT SUMMARY

Depth to Water Before Development: 31.61

Depth to Water After Development: _____

Sounded Depth Before Development: _____

Sounded Depth After Development: _____

Development Method: Surge/bail

Total Pumping Time (min): _____

Total Amount Excavated (gals): _____

Average Pumping Rate (gpm): _____

Pumping Rate Range (gpm): _____

Total H20 Injected (gals): _____

WELL DEVELOPMENT/ WATER MONITORING DATA

SIERRA

PROJECT NAME & NUMBER: MR-958-00

By: DMB JAH

Well ID: OW-8C

Date: 11/5/97

Time	Depth to Water (ft)	Depth to Product (ft)	Surged	Bailed	Pumped		Gallons removed	Temp. (C)	pH	EC (umhos)	Comments: (color, odor, product, est flow rate)
Start: 0852											WELL WAS SURGED PREVIOUSLY PUMPED @ 300 Hz 5.0GPM
Stop: 0857					X		25	18°	7.09	1400	NTU 840.0
Start: ~~0902~~ 08											
Stop: 0902					X		25	18°	7.36	1425	NTU 840.0
Start:											
Stop: 0907					X		25	18°	7.46	1450	NTU 290.0
Start:											
Stop: 0913 DB					X		30	18°	7.52	1425	NTU 108.0
Start:											
Stop: 0920					X		35	18°	7.57	1425	NTU 108.0
Start:											
Stop:											

WELL DEVELOPMENT SUMMARY

Depth to Water Before Development: 31.24

Depth to Water After Development: DB ~~31.24~~ 31.28

Sounded Depth Before Development: 115.20

Sounded Depth After Development: 117.42

Development Method: Pump

Total Pumping Time (min): 28

Total Amount Excavated (gals): 140

Average Pumping Rate (gpm):

Pumping Rate Range (gpm): 5.0

Total H20 Injected (gals):

(2296 x 11.3 = 12.9 x 10 – 12(5 – 5 – (77.27)

WELL DEVELOPMENT / WATER MONITORING DATA

SIERRA

PROJECT NAME & NUMBER: MR-958-00 Frontier Fertilizer

By: Jim Green

Well ID: OW-11 A

Date: 11/6/97

Time	Depth to Water (ft)	Depth to Product (ft)	Surged	Bailed	Pumped		Gallons removed	Temp. (F)	pH	EC (umhos)	Comments: (color, odor, product, est flow rate)
Start: 16:55			X	X			10				Alternately surged and bailed. Removed
Stop: 17:15											approx 10 gallons of extremely
Start:											silty/sandy water
Stop:											
Start:											
Stop:											
Start:											
Stop:											
Start:											
Stop:											
Start:											
Stop:											

WELL DEVELOPMENT SUMMARY

Depth to Water Before Development: _____

Depth to Water After Development: _____

Sounded Depth Before Development: 45.85

Sounded Depth After Development: 46.00

Development Method: Surge/bail

Total Pumping Time (min): _____

Total Amount Excavated (gals): _____

Average Pumping Rate (gpm): _____

Pumping Rate Range (gpm): _____

Total H20 Injected (gals): _____

WELL DEVELOPMENT / WATER MONITORING DATA

SIERRA

PROJECT NAME & NUMBER: MR-958-00

By: DMB JAH

Well ID: OW-11 A

Date: 11/7/97

Time	Depth to Water (ft)	Depth to Product (ft)	Surged	Bailed	Pumped		Gallons removed	Temp. (F)	pH	EC (umhos)	Comments: (color, odor, product, est flow rate)
Start: 0836											PUMPED @ 180 Hz, 3.0 GPM
Stop: 0844	0844				X		24	19°	7.69	1600	NTU 340.0
Start:											
Stop: 0852	~~0852~~				X		24	19°	7.67	1550	NTU 120.0
Start:											
Stop: ~~0902~~ 0850					X		18	19°	7.66	1550	STOP TO DISCHARGE TANK. ~~0902~~ 0856
Start: 0924											
Stop: 0931					X		21	19°	7.77	1625	NTU 52.0
Start: ~~0939~~											
Stop: 0939					X		24	19°	7.48	1525	NTU. 17.0
Start:											
Stop: 0953					X		42	19°	7.48	1500	NTU 10.75

WELL DEVELOPMENT SUMMARY

Depth to Water Before Development: 28.50

Depth to Water After Development: 28.58

Sounded Depth Before Development: 45.30

Sounded Depth After Development: 45.30

Development Method: PUMP

Total Pumping Time (min): 49.

Total Amount Excavated (gals): 153

Average Pumping Rate (gpm):

Pumping Rate Range (gpm): 3.0

Total H20 Injected (gals):

16.80 x .653 = 10.97 x 10 = 109.70 (.5 = 21.94

WELL DEVELOPMENT/ WATER MONITORING DATA

SIERRA

PROJECT NAME & NUMBER: MR-958-00 Frontier Fertilizer

Well ID: OW-11 B

By: Jim Green

Date: 11/6/97

Time	Depth to Water (ft)	Depth to Product (ft)	Surged	Bailed	Pumped		Gallons removed	Temp. (F)	pH	EC (umhos)	Comments: (color, odor, product, est flow rate)
Start: 17:18			X	X			10				Alternately surged and bailed.
Stop: 17:40											Removed approx. 10 gallons of
Start:											silty/sandy water.
Stop:											
Start:											
Stop:											
Start:											
Stop:											
Start:											
Stop:											
Start:											
Stop:											

WELL DEVELOPMENT SUMMARY

Depth to Water Before Development: _____

Depth to Water After Development: _____

Sounded Depth Before Development: 75.5'

Sounded Depth After Development: 75.9'

Development Method: _____

Total Pumping Time (min): _____

Total Amount Excavated (gals): _____

Average Pumping Rate (gpm): _____

Pumping Rate Range (gpm): _____

Total H20 Injected (gals): _____

WELL DEVELOPMENT/ WATER MONITORING DATA

SIERRA

PROJECT NAME & NUMBER: MR-958-00

By: DMB, JAH

Well ID: OW-11 B

Date: 11/7/97

Time	Depth to Water (ft)	Depth to Product (ft)	Surged	Bailed	Pumped		Gallons removed	Temp. (F)	pH	EC (umhos)	Comments: (color, odor, product, est flow rate)
Start: 0810											WELL SURGED 11/6/97 BY J.G. PUMPED @ 300 Hz, 5.0 GPM
Stop: 0816	65.80	–			X		30				PURGED DRY, STOP FOR RECHARGE
Start: 10:33	61.18	–		GWL		ONLY					10:33 GWL 61.18
Stop:											
Start:											
Stop:											
Start:											
Stop:											
Start:											
Stop:											
Start:											
Stop:											

WELL DEVELOPMENT SUMMARY

Depth to Water Before Development: 35.55

Depth to Water After Development:

Sounded Depth Before Development: 72.80

Sounded Depth After Development:

Development Method:

Total Pumping Time (min):

Total Amount Excavated (gals):

Average Pumping Rate (gpm):

Pumping Rate Range (gpm):

Total H20 Injected (gals):

37.25 x .653 = 24.32 x 10 = 243.2 ÷ ~~48.65~~ 5 = 48.65

WELL DEVELOPMENT/ WATER MONITORING DATA

SIERRA

PROJECT NAME & NUMBER: MR-958-00 : Frontier Fertilizer

By: Jim Green

Well ID: OW-11-C

Date: 11/6/97

Time	Depth to Water (ft)	Depth to Product (ft)	Surged	Bailed	Pumped		Gallons removed	Temp. (F)	pH	EC (umhos)	Comments: (color, odor, product, est flow rate)
Start: 16:05			X	X			10				Alternately surged and bailed using
Stop: 16:47											mechanical development rig to raise and
Start:											lower bailer / surge block. Removed
Stop:											approx 10 gallons of extremely
Start:											sandy/silty water. Total depth
Stop:											at completion slightly higher than
Start:											total depth at beginning due to
Stop:											influx of silt/sand through screen
Start:											
Stop:											
Start:											
Stop:											

WELL DEVELOPMENT SUMMARY

Depth to Water Before Development: _____

Depth to Water After Development: _____

Sounded Depth Before Development: 125.33

Sounded Depth After Development: 125.16

Development Method: Surge/bail

Total Pumping Time (min): _____

Total Amount Excavated (gals): _____

Average Pumping Rate (gpm): _____

Pumping Rate Range (gpm): _____

Total H20 Injected (gals): _____

WELL DEVELOPMENT/ WATER MONITORING DATA

SIERRA

PROJECT NAME & NUMBER: MR-958-00

By: DMB, JAH

Well ID: OW-11 C

Date: 11/7/97

Time	Depth to Water (ft)	Depth to Product (ft)	Surged	Bailed	Pumped		Gallons removed	Temp. ~~(F)~~ C	pH	EC (umhos)	Comments: (color, odor, product, est flow rate)
Start: 0735											WELL SURGED 11/6/97 BY JH. PUMPED @ 300 Hz 5.0 GPM
Stop: 0800					X		125	19°	7.74	1600	NTU 1140.0
Start:											
Stop: 0825					X		125	19°	7.54	1625	NTU 560
Start:								19.5°	7.56	1550	
Stop: 0850					X		125				NTU 139
Start:											
Stop: 0902					X		60	—	—	—	STOP TO DISCHARGE WATER
Start: 0924											
Stop: 0949					X		125	19°	7.54	1600	NTU ~~26.9~~ 97.0
Start:											
Stop: 1002					X		65	19°	7.49	1600	NTU 66.6

WELL DEVELOPMENT SUMMARY

Depth to Water Before Development: 31.00

Depth to Water After Development: 30.87

Sounded Depth Before Development: 124.75

Sounded Depth After Development: 124.93

Development Method: Pump

Total Pumping Time (min): 125

Total Amount Excavated (gals): 625

Average Pumping Rate (gpm):

Pumping Rate Range (gpm): 5.0

Total H20 Injected (gals): Ø

61.22

612.20

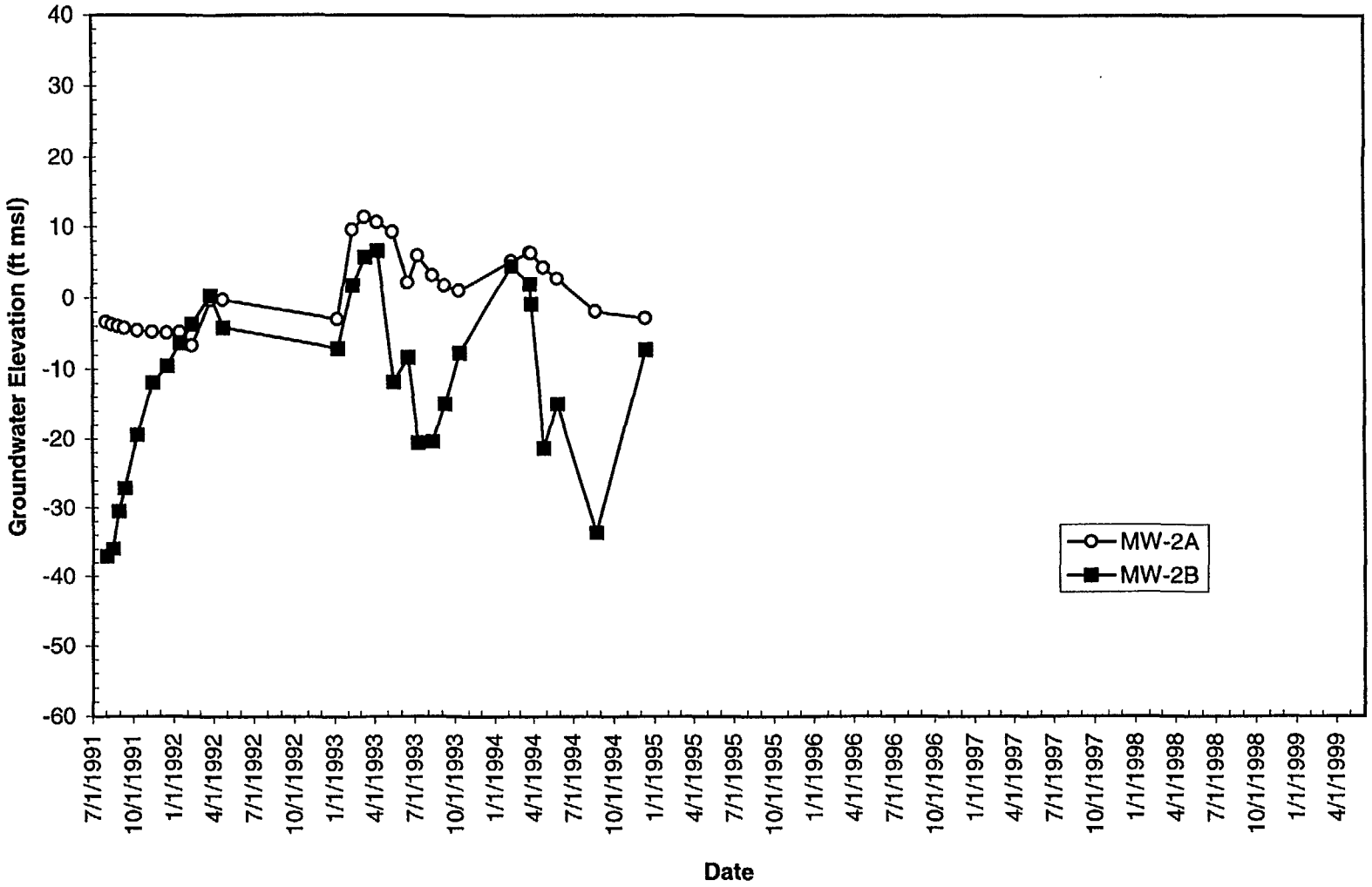
122.44

(93.25 × .653 = ~~60.86~~ × 10 = ~~608 gals~~ ÷ (= ~~121.73 gals~~

Appendix B

Hydrographs

Figure B-1
Hydrograph for MW-2 Wells



6/7/1999
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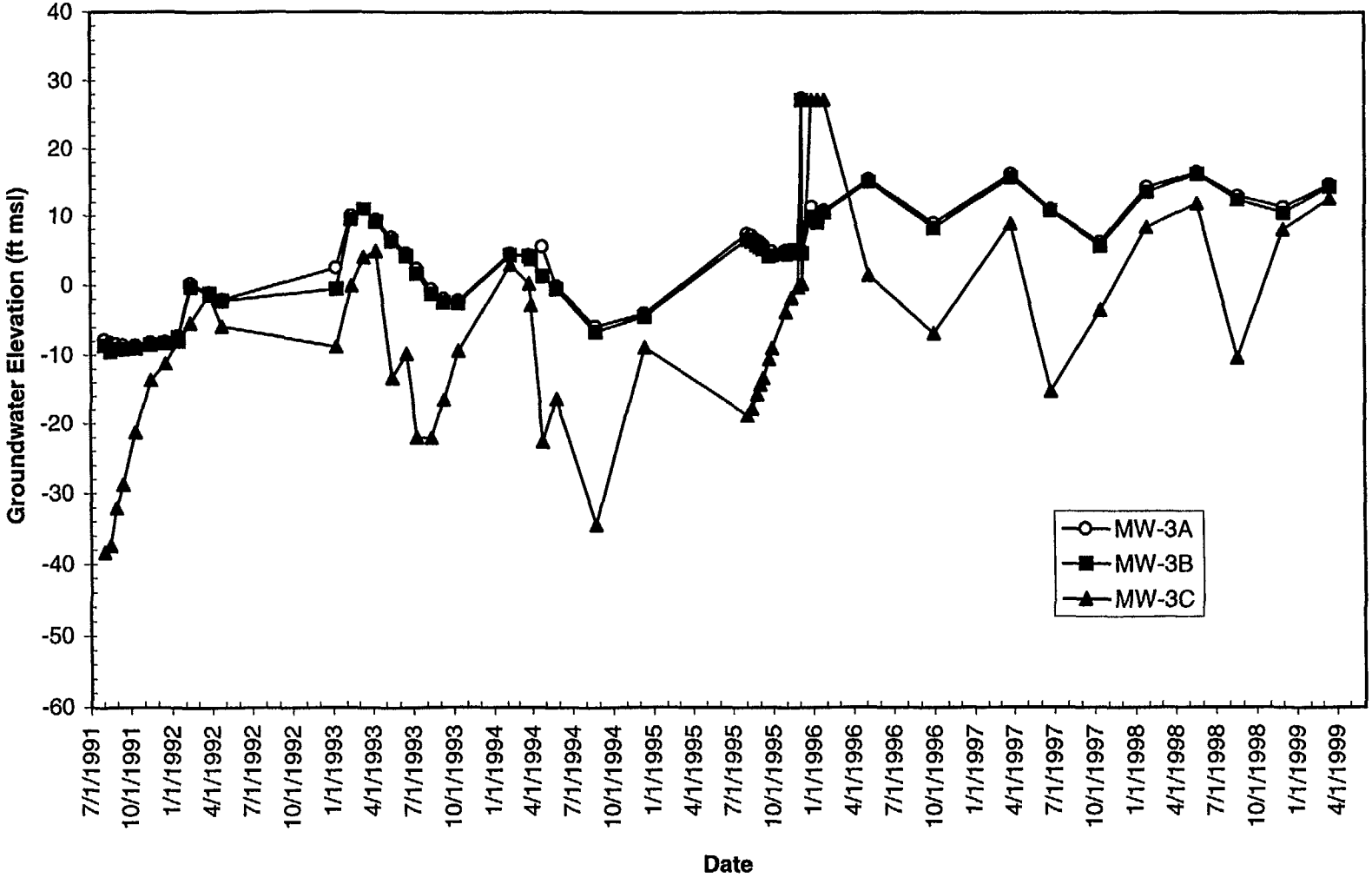
Figure B-2
Hydrograph for MW-3 Wells



6/7/1999
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Figure B-3
Hydrograph for MW-4 Wells

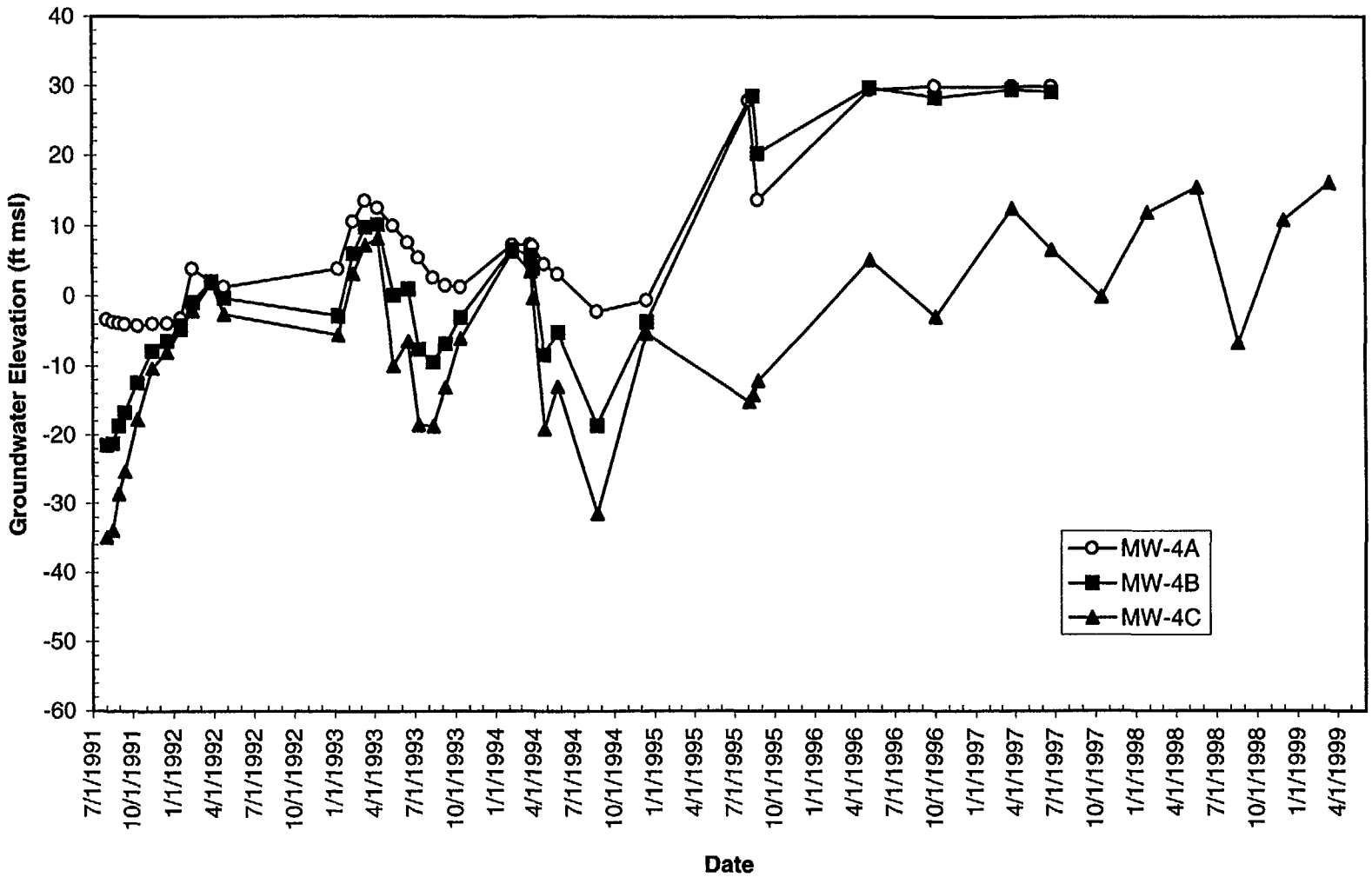

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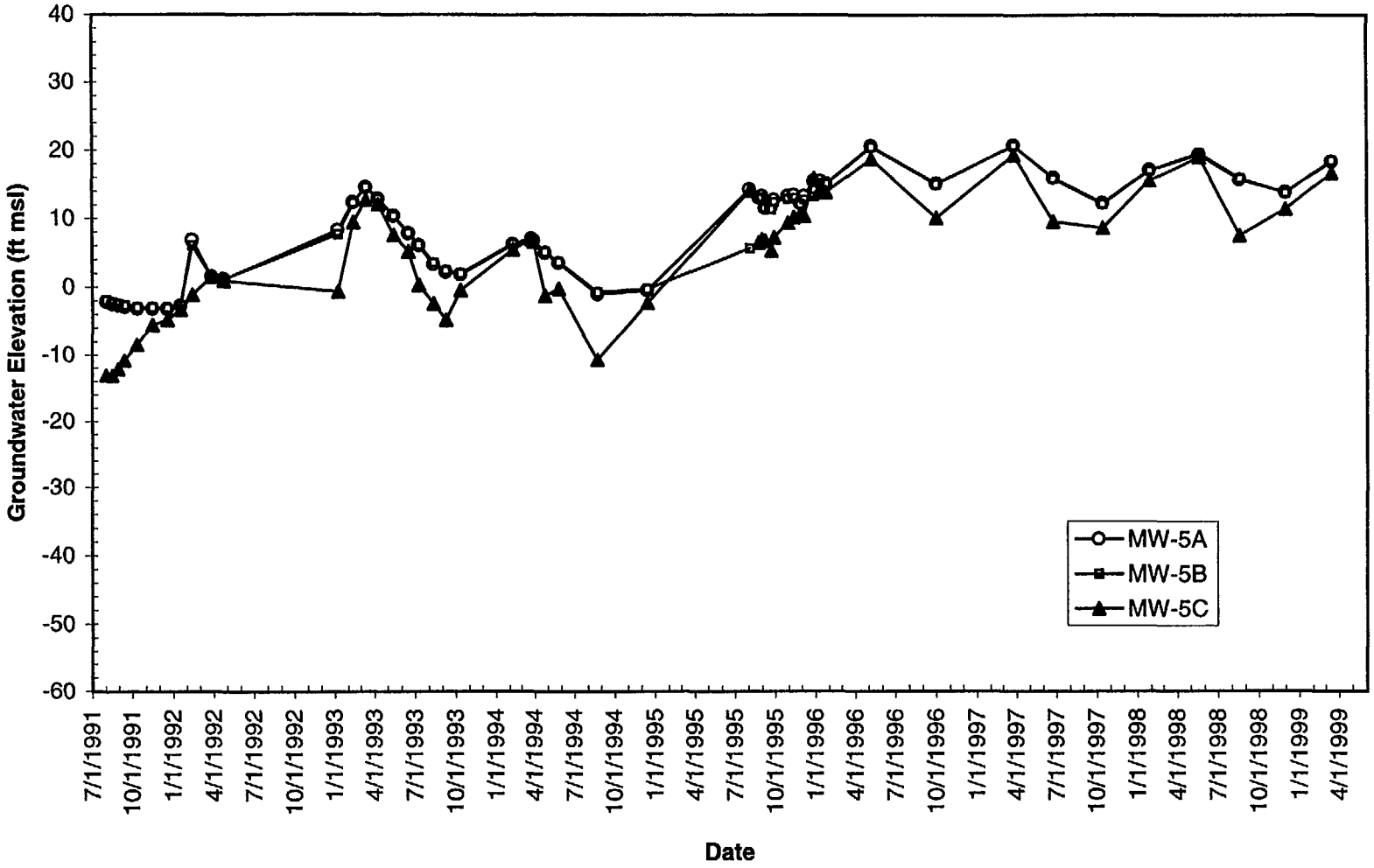
Figure B-4
Hydrograph for MW-5 Wells



6/10/1999
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Figure B-5
Hydrograph for MW-6 Wells

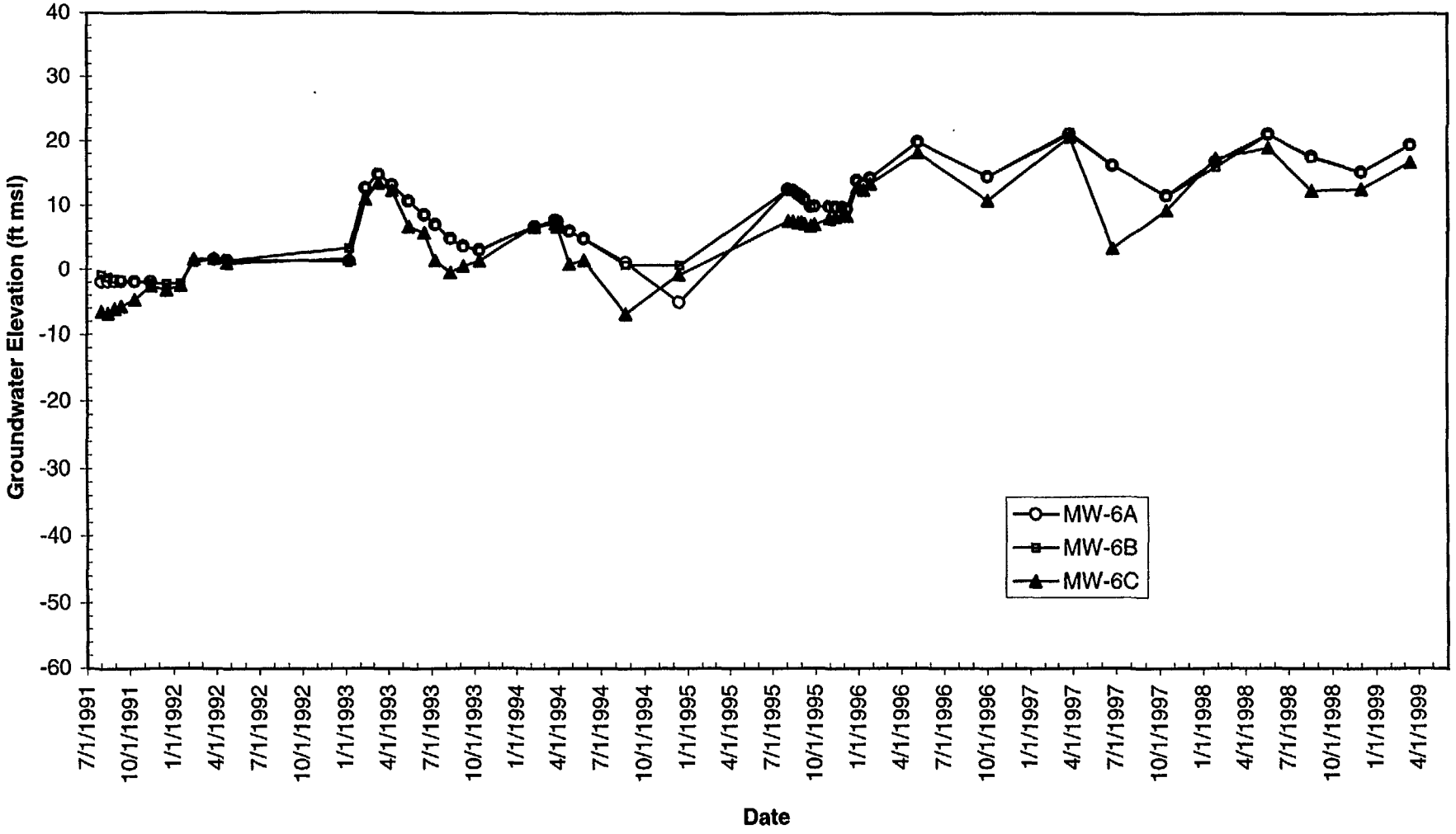

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Figure B-6
Hydrograph for MW-7 Wells

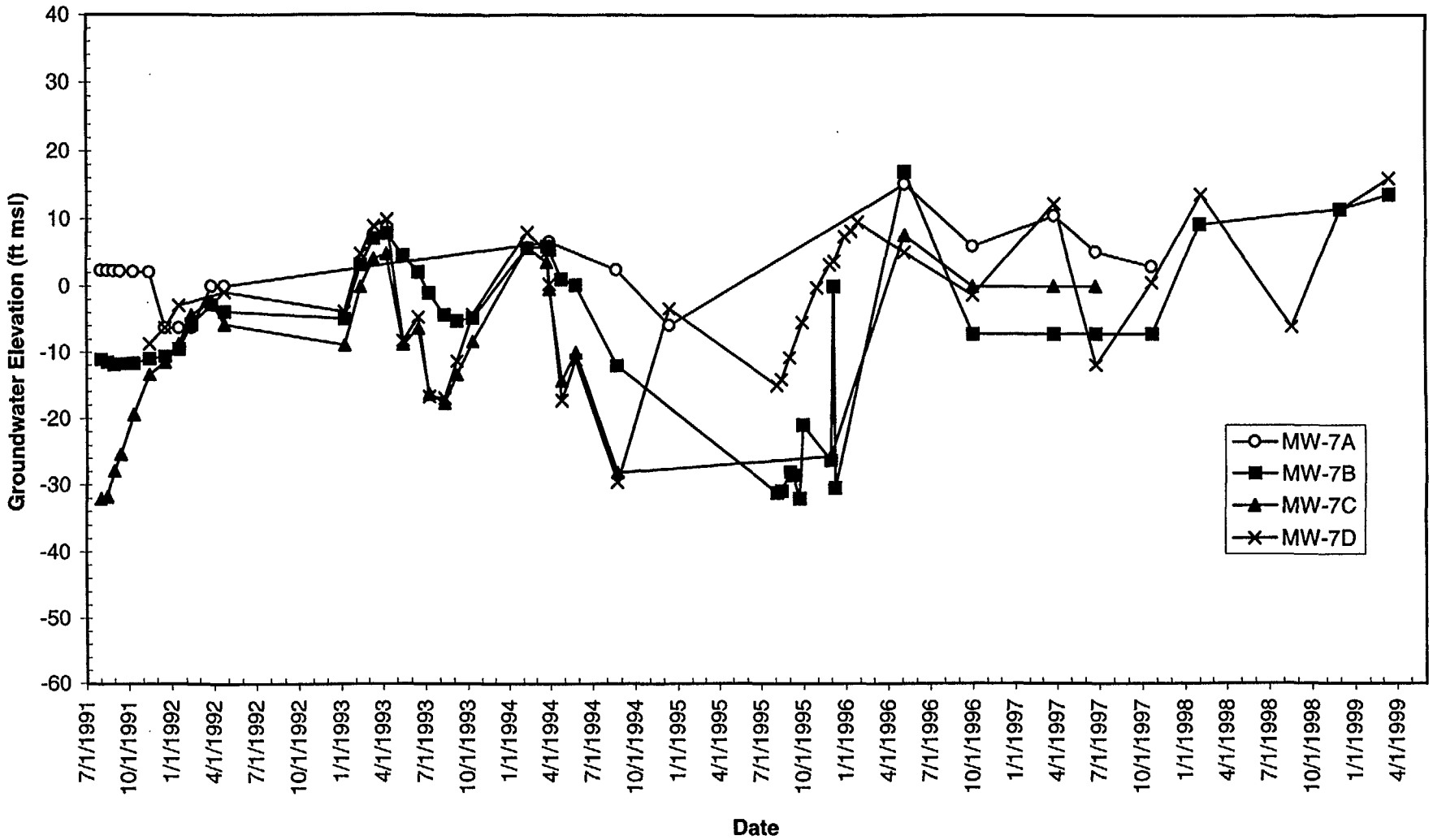

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Figure B-7
Hydrograph for MW-8 Wells

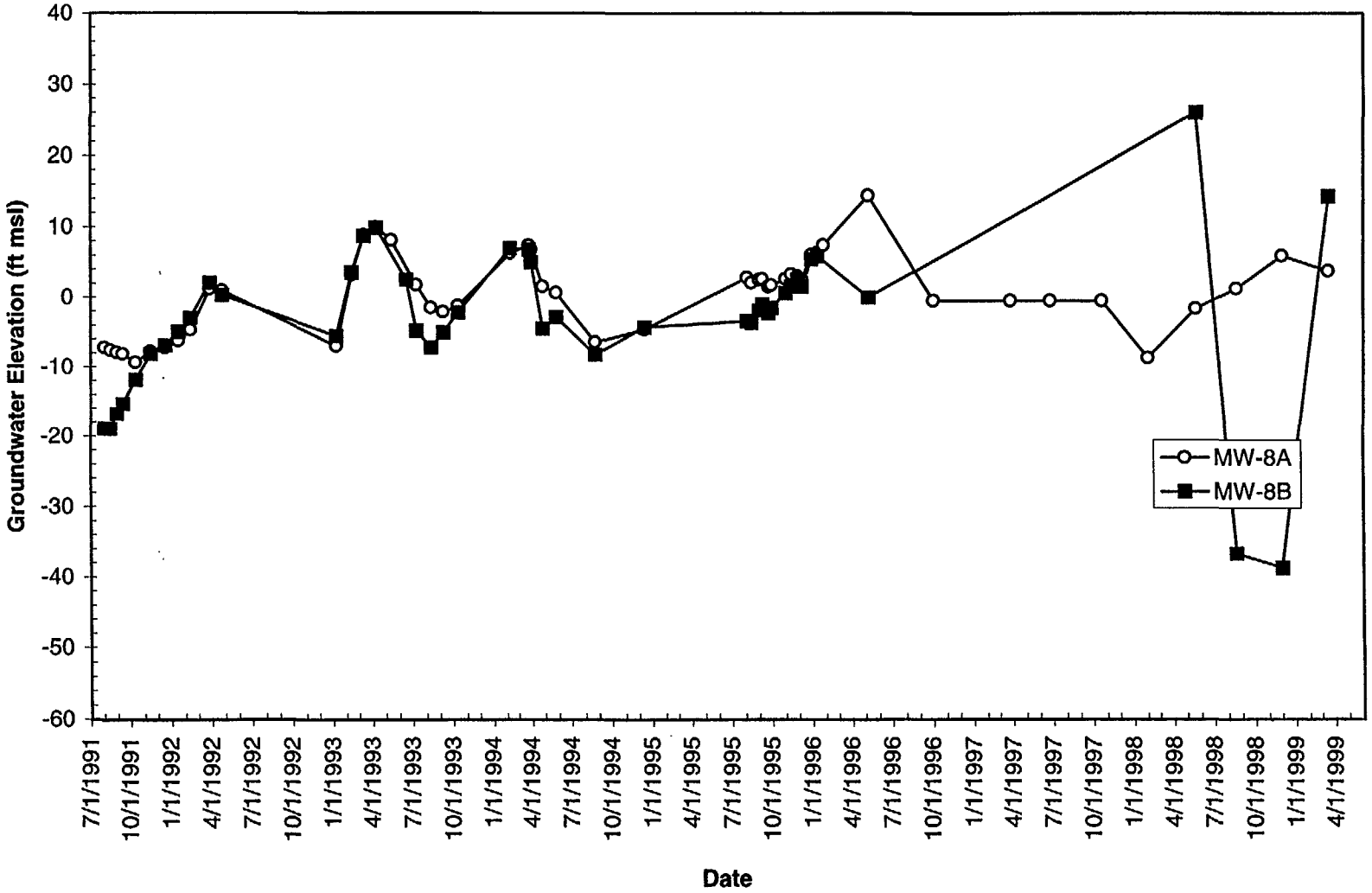

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Figure B-8
Hydrograph for MW-9 Wells

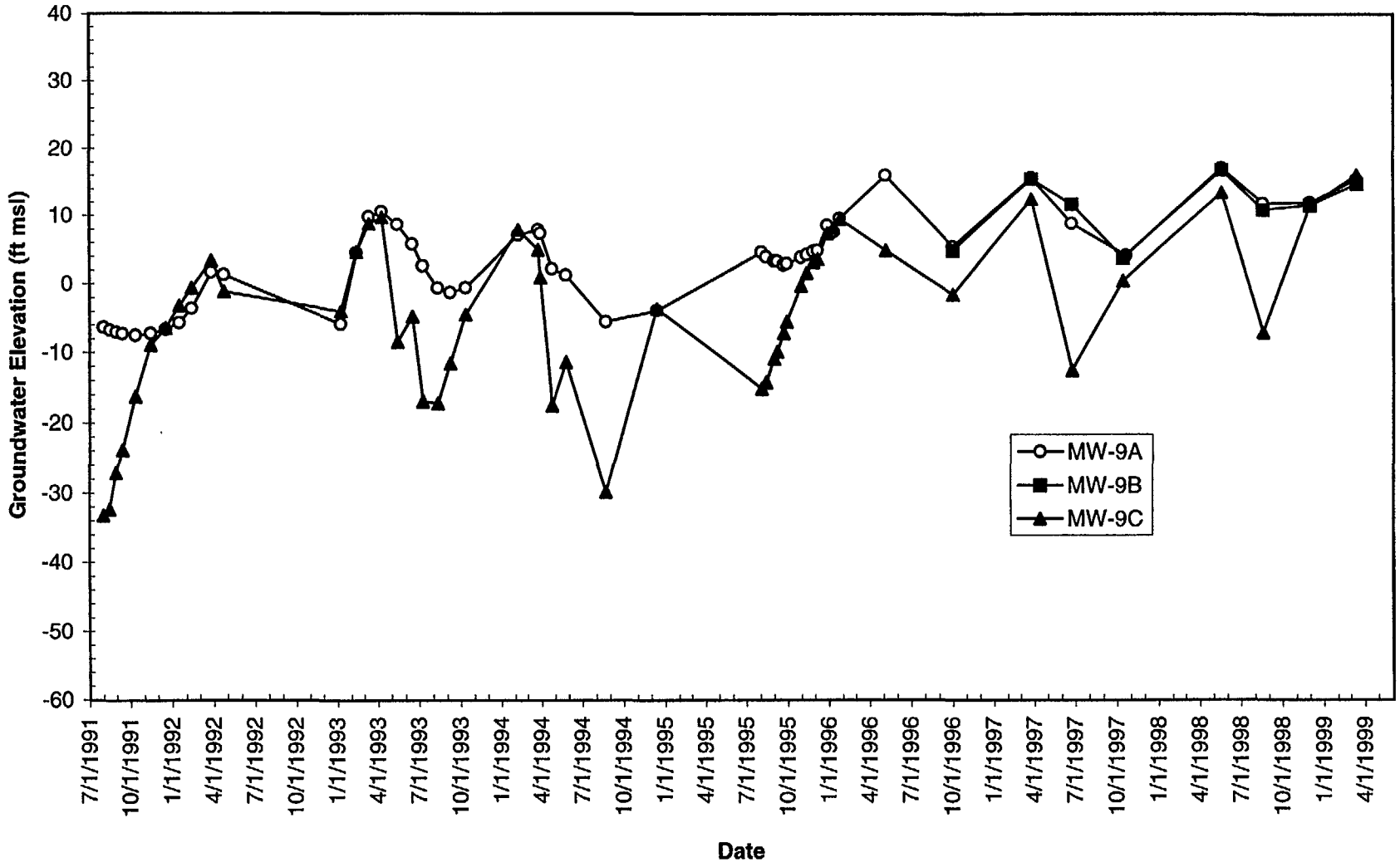

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Figure B-9
Hydrograph for MW-10 Wells

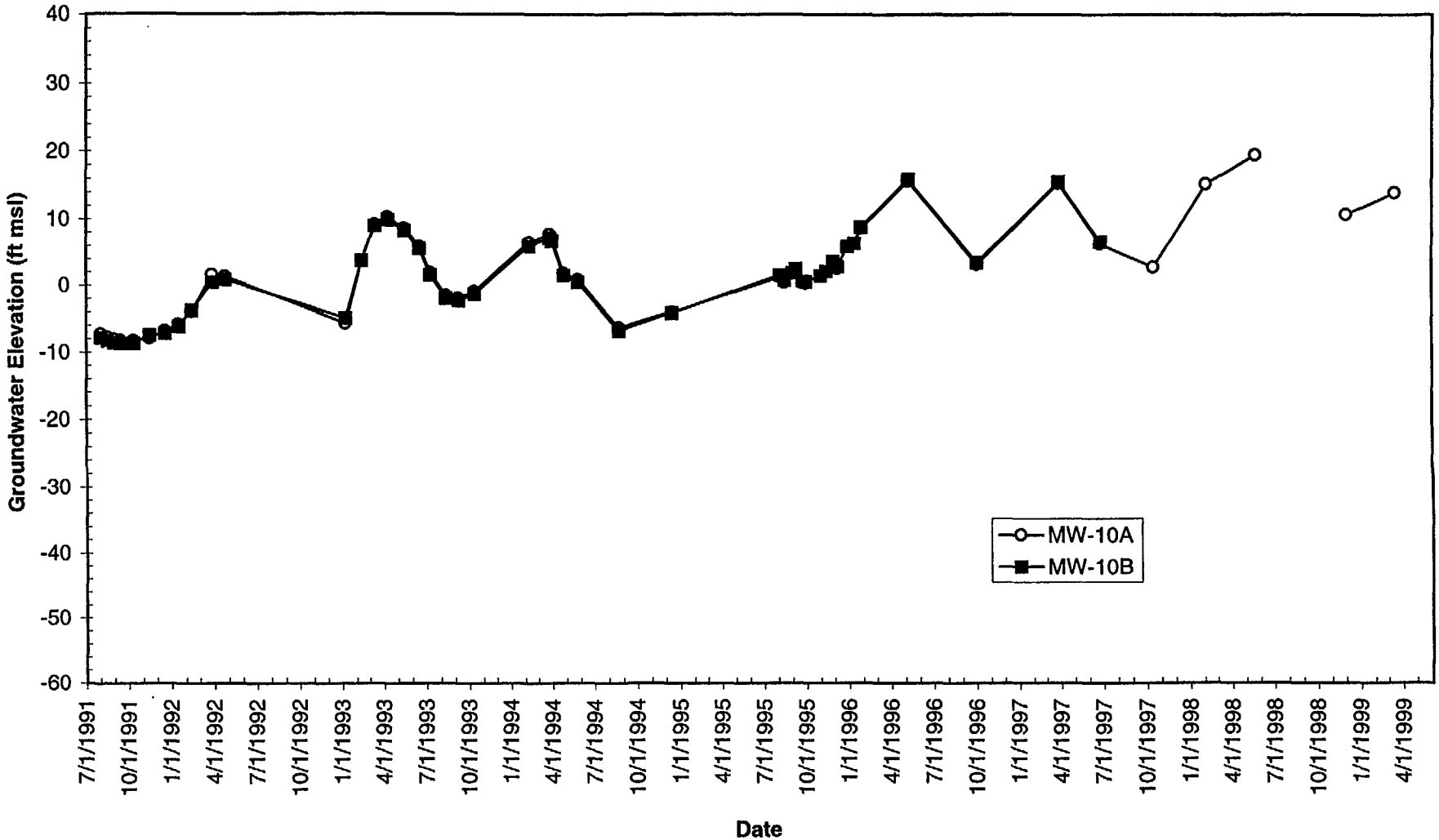

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Figure B-10
Hydrograph for MW-11 Wells

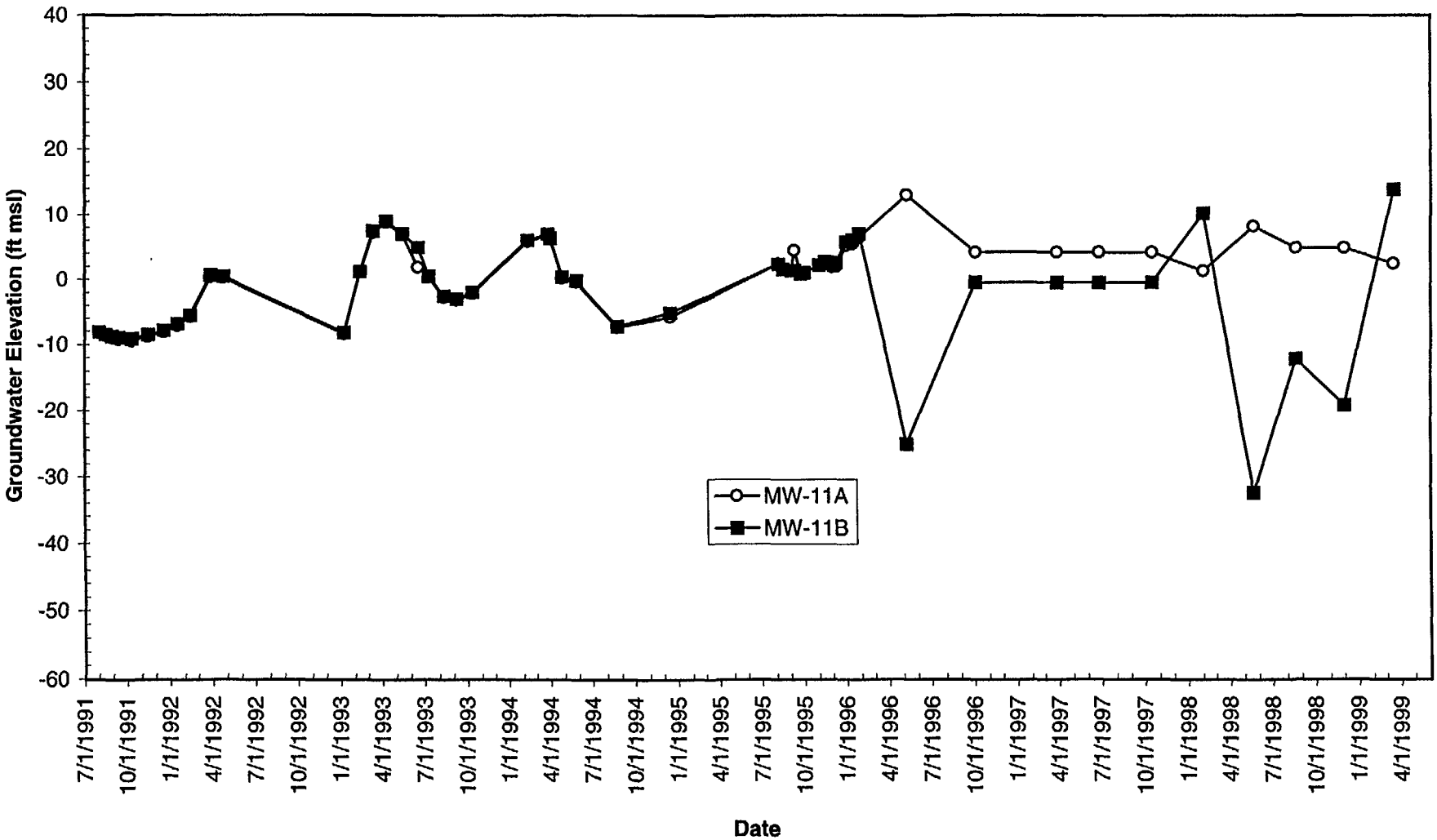

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Figure B-11
Hydrograph for MW-12 Wells

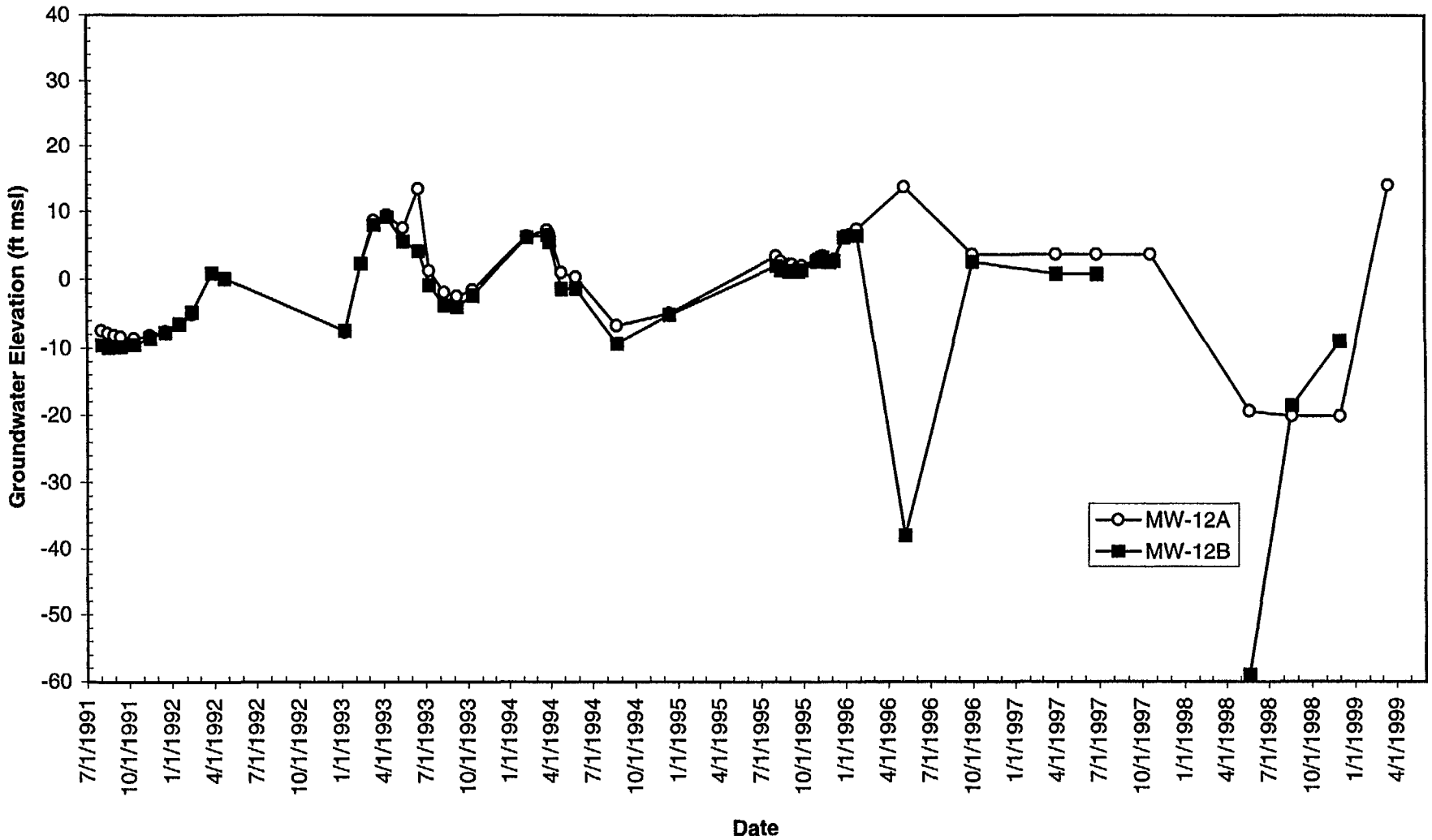

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Figure B-12
Hydrograph for MW-13 Wells

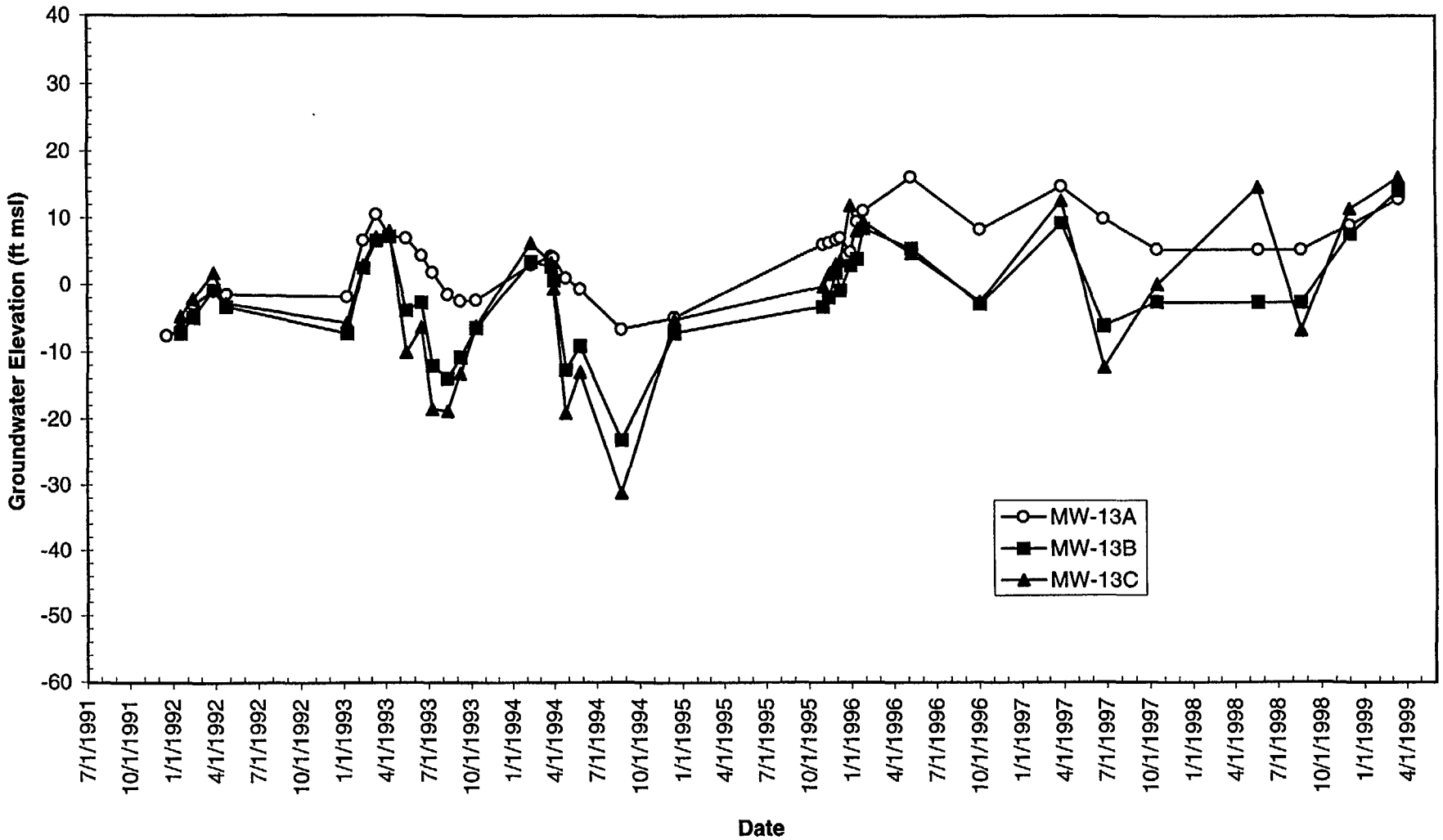

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FIGURE B-13
Hydrograph for OW-1 Wells

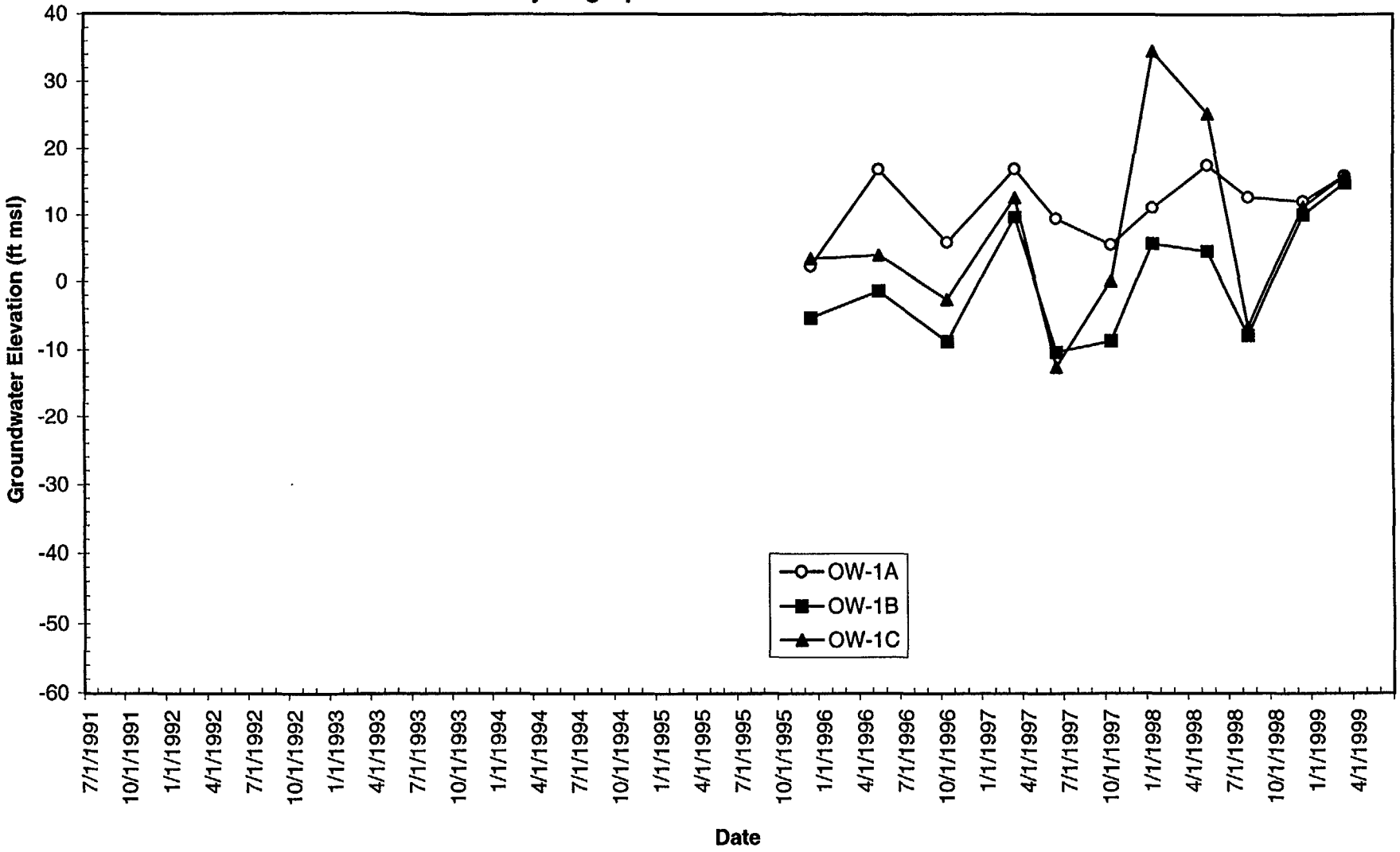

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FIGURE B-14
Hydrograph for OW-2 Wells

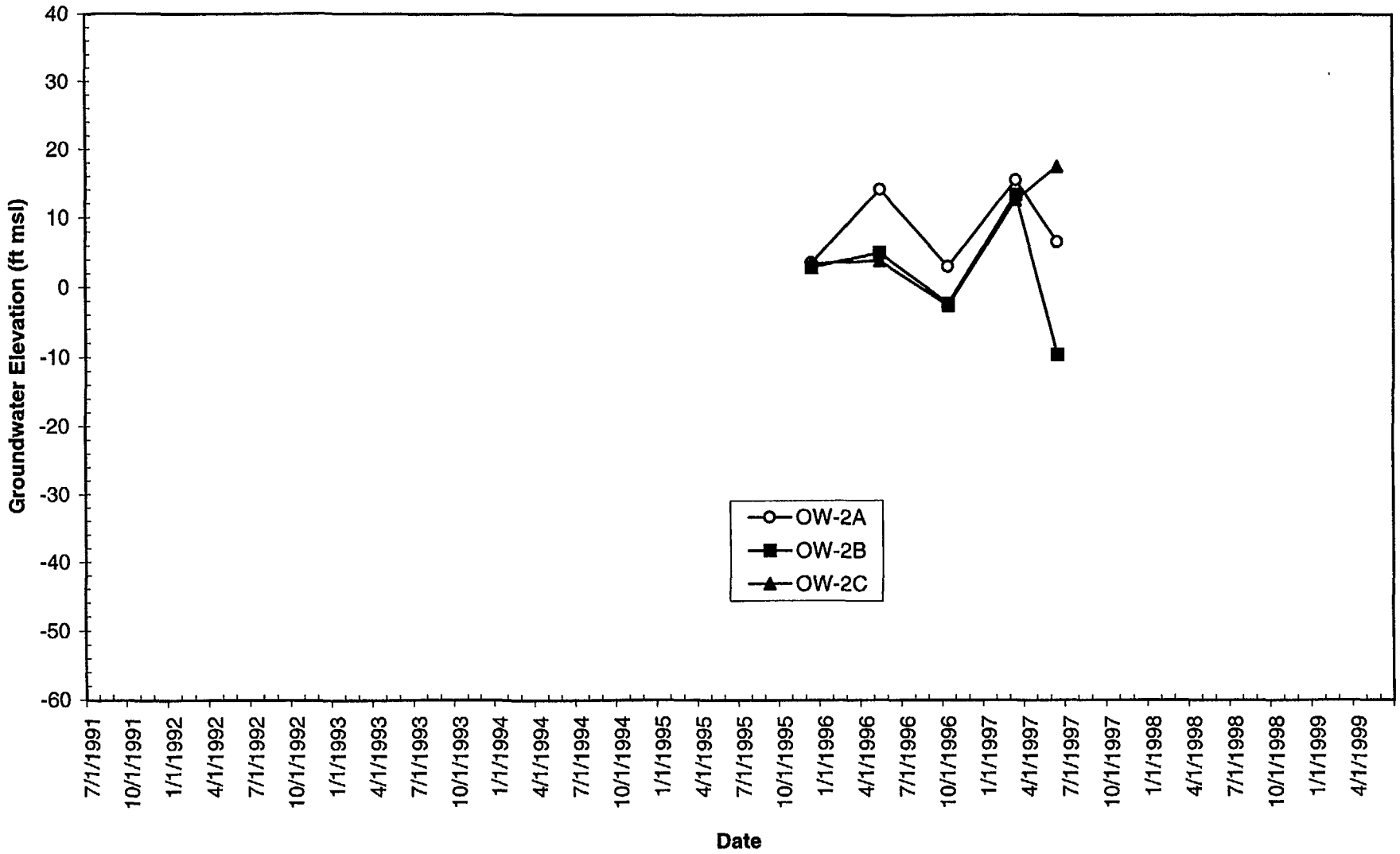

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FIGURE B-15
Hydrograph for OW-3 Wells

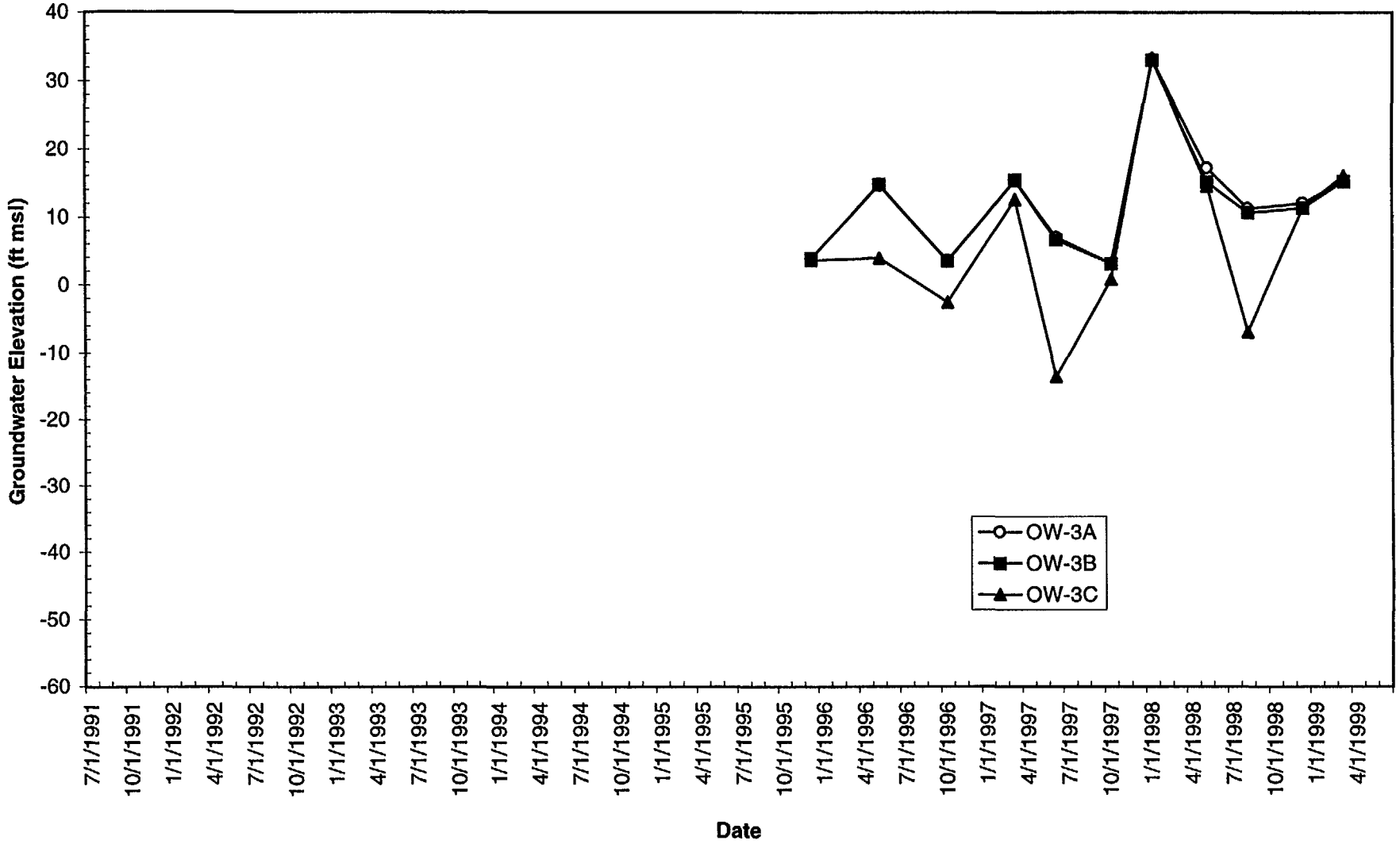

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FIGURE B-16
Hydrograph for OW-4 Wells

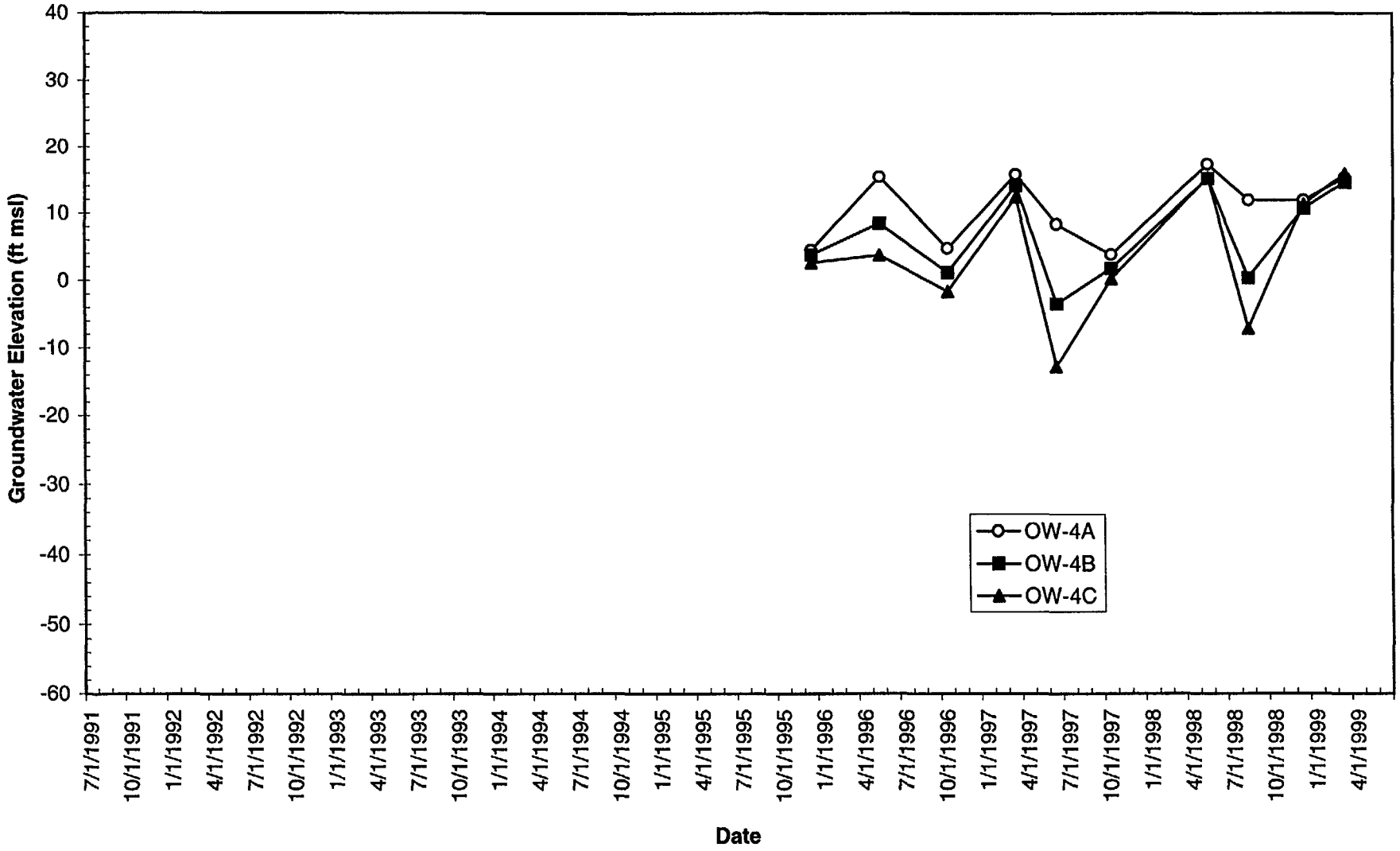

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FIGURE B-17
Hydrograph for OW-5 Wells

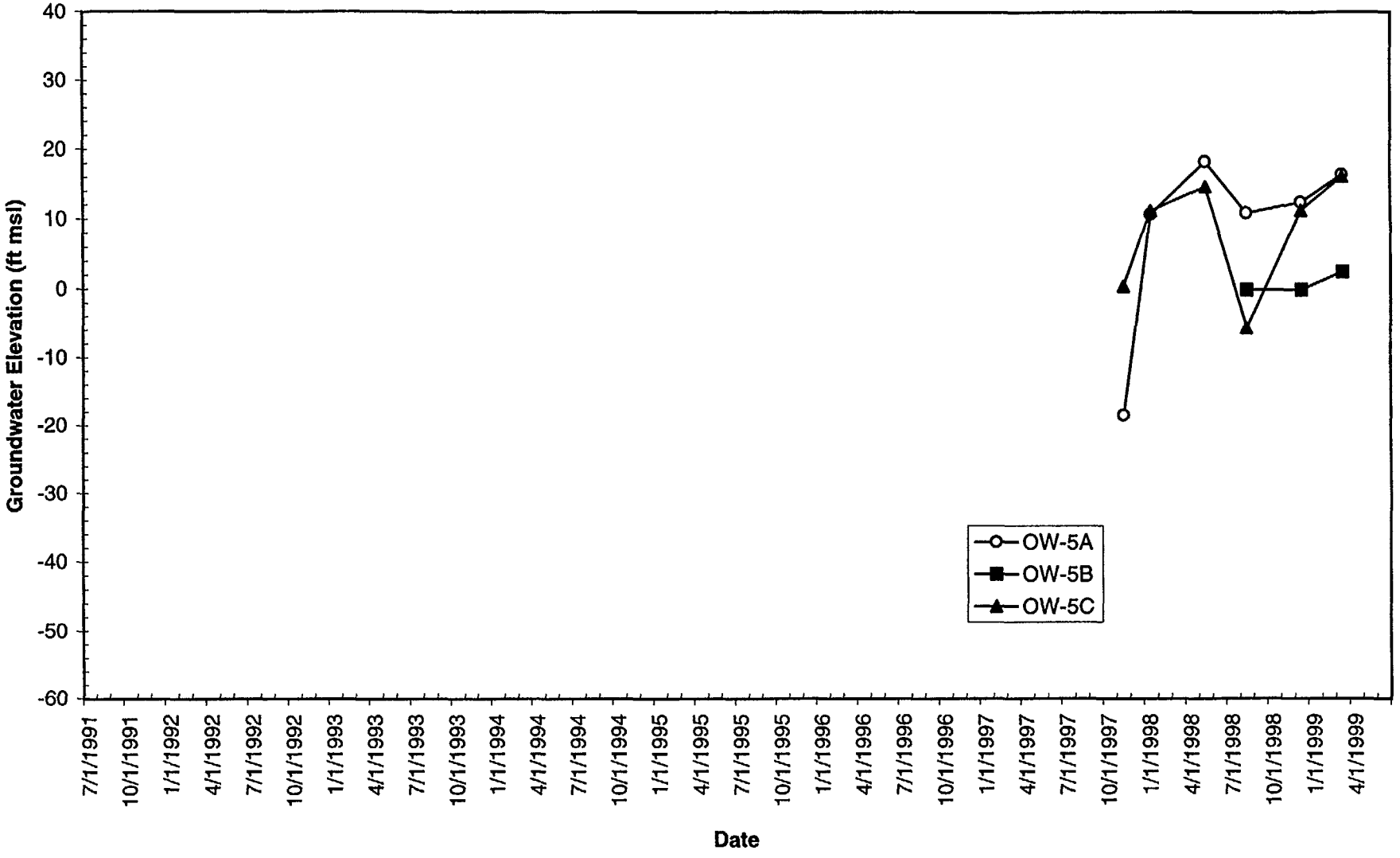

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FIGURE B-18
Hydrograph for OW-6 Wells

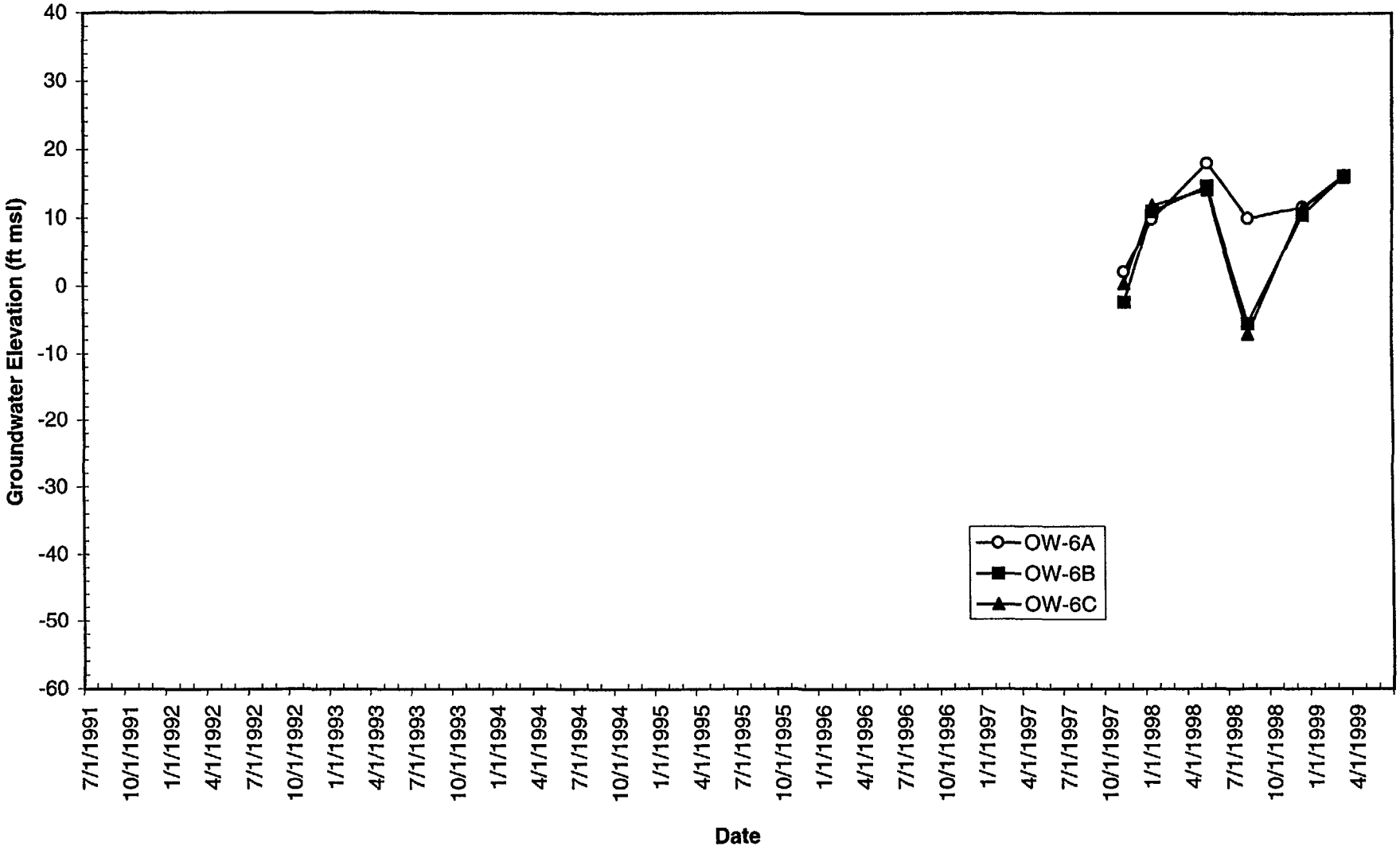

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FIGURE B-19
Hydrograph for OW-7 Wells

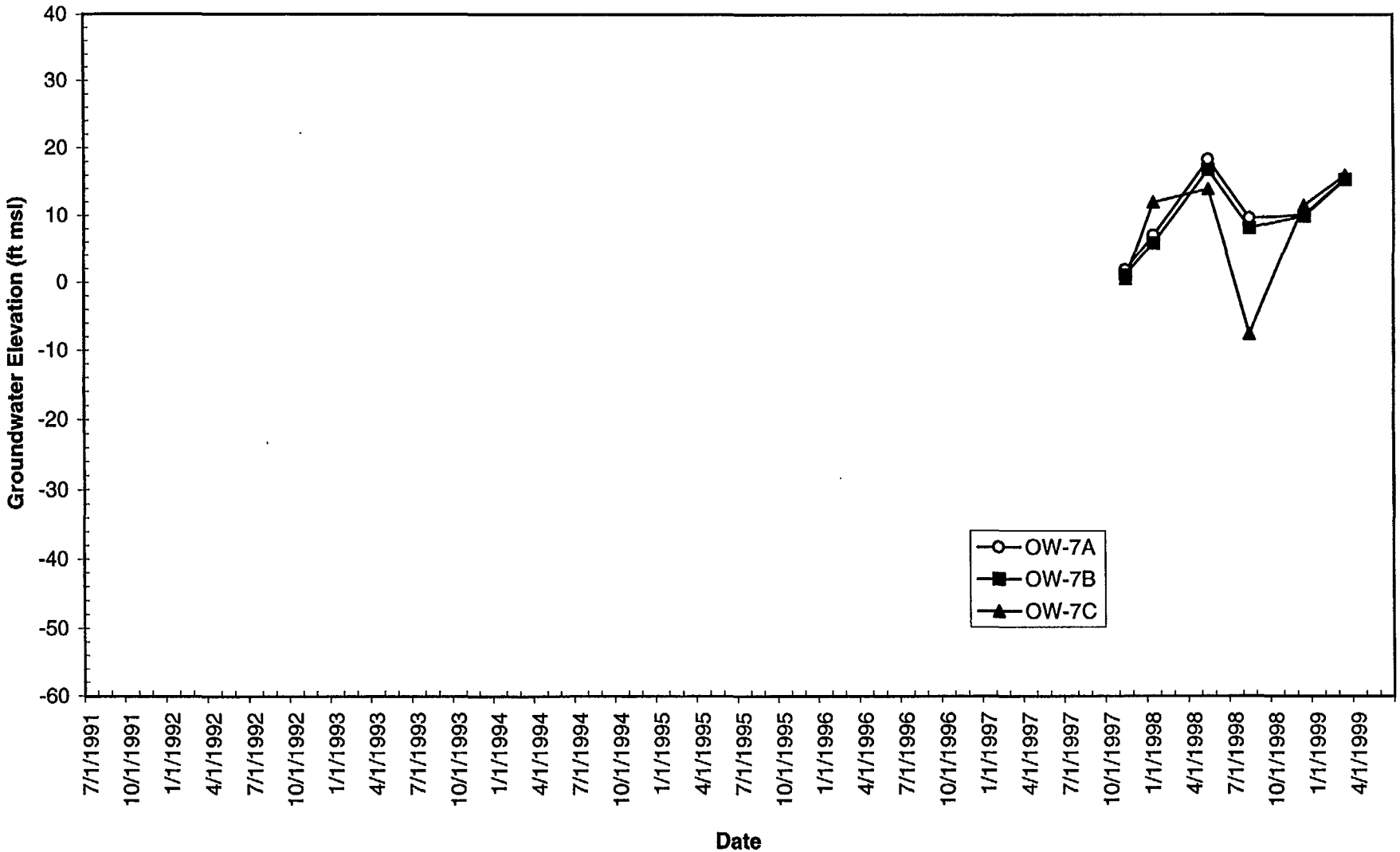

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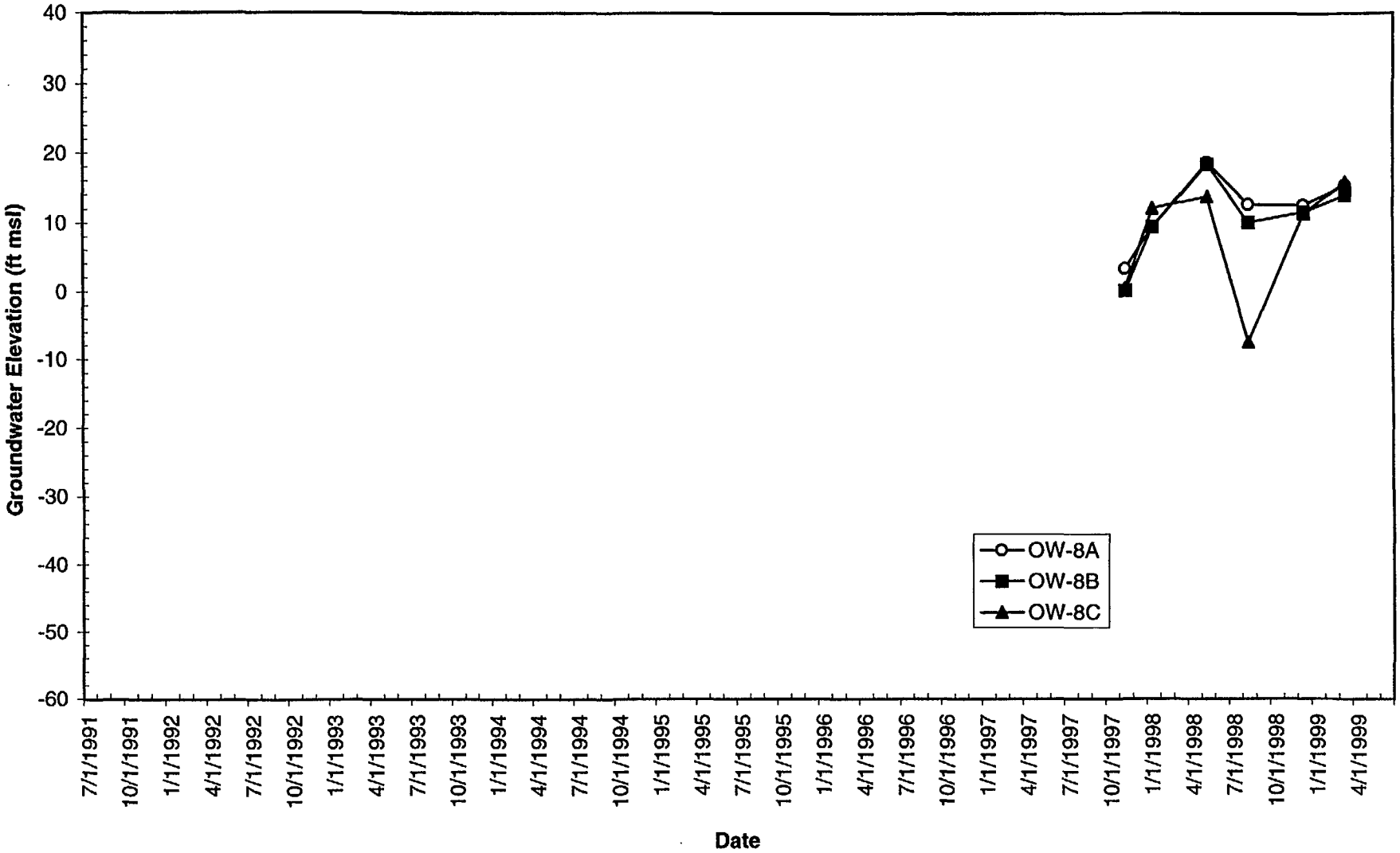
FIGURE B-20
Hydrograph for OW-8 Wells



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Appendix C

Data Quality Assessment

Appendix C

Data Quality Assessment

The purpose of this data quality assessment is to evaluate the usability of analytical data collected at the Frontier Fertilizer site to ensure that the data are of a quality suitable for their intended purpose. The data include groundwater (DMLS) and soil-gas samples collected during remedial investigation activities and groundwater samples collected during routine monitoring.

The Field Sampling Plans and Quality Assurance Project Plan created for the Frontier Fertilizer site investigation were designed to ensure the collection of the type, quantity, and quality of data required. Data quality objectives (DQOs) were established with the express purpose of obtaining the data quality needed.

To assess the quality of data to be used in the Remedial Investigation at the Frontier Fertilizer site, two questions need to be addressed:

- Are the observed sample quantitation limits (SQLs) of each analyte sufficiently low to determine if a specific contaminant is present above or below its preliminary remediation goal (PRG) or MCL?
- Were there quality control (QC) problems encountered during sampling and analysis that could limit data usability?

The quality of analytical results is evaluated by analyzing field and laboratory QC samples and by using laboratory QC checks. Field QC samples collected during the remedial investigation activities and groundwater monitoring included field duplicates and equipment rinsate blanks. Laboratory QC procedures include analyzing matrix spikes, matrix spike duplicates, method blanks, surrogates and standards; instrument calibration and other QC procedures as required by the laboratory methods.

Section C.1 presents an evaluation of the usability of "nondetect" (ND) results. Section C.2 presents an evaluation of data usability based on field QC sample results. Section C.3 discusses data usability based on validation of field and laboratory QC samples.

C.1 Evaluation of the Usability of "Nondetect" Results

The analytical methods for this project were chosen such that have method detection limits or practical quantitation limits below the level of concern for each analyte. The levels of concern for soil gas and flux chamber measurements were defined as the PRG in ambient air for each analyte, and the levels of concern for groundwater were defined as the maximum contaminant level (MCL) for each analyte (or the tap water PRG when an MCL has not been promulgated for the analyte).

A part of the standard analytical procedures, some soil gas and groundwater samples had to be diluted to assure measurements were within the analytical instrument calibration range. In some

cases this dilution increased detection limits above the defined levels of concern (MCL or PRG), which can affect the usability of the results.

To evaluate the impact of elevated method detection limits for groundwater analysis, the laboratory-reported detection limits for groundwater samples collected in May and August 1998 and for the DMLS samples were compared on a compound by compound basis with applicable MCLs or PRGs. For routine groundwater monitoring samples, the results of the comparison indicate that method detection limits were not elevated above levels of concern.

For the DMLS samples, method detection limits were elevated due to the high concentrations present in these samples. This does not impact the usability of the DMLS sample results because they were collected specifically to determine if high concentrations were present, possibly indicating residual DNAPL. That is, the results were not used to determine if chemicals were present at low concentrations, above or below an associated MCL or PRG.

Detection limits elevated above levels of concern were also reported for soil gas and flux chamber samples. As described in Section 2, the results from analysis of soil gas samples were to be used to determine locations for collecting the flux chamber samples. Ultimately, though, flux chamber samples were collected at all of the soil-gas sample locations, so the elevated detection limits did not affect data collection activities.

Elevated detection limits were observed at the soil gas sample locations, and for the four chemicals of concern, with significant concentrations (SG-4, SG-23, and SG-24) and (EDB, DCP, TCP, and CCl_4). Since the baseline risk assessment report focussed on these three sample locations and COCs, the quality of these samples were examined in more detail. The elevated detection limits do not adversely affect the data quality because the risk calculations conservatively assumed one half the reported detection limit.

This evaluation of the analytical results, in the context of the site conditions and other associated results, indicates that the ND results with elevated SQLs can be reliably used, or need not be used since other data are available for the same location, and therefore will not lead to an erroneous (false negative) conclusion.

C.2 Evaluation of Data Usability Based on RI Field QC Results

Two types of field QC samples were collected and analyzed during sampling events at Frontier Fertilizer: equipment rinsate blanks and field duplicates. The purpose of equipment rinsate blanks is to detect cross contamination due to inadequate decontamination of sampling equipment. Analysis of equipment rinsate blanks can also detect problems caused by the shipment of samples contaminated with VOCs, by ambient conditions (wind, rain, etc.), or by faulty sampling techniques. The potential impact of cross contamination (detected in blanks) is false positives, which could result in an overestimation of the extent of contamination.

A review of the equipment rinsate blank results indicated that the data quality is acceptable. That is, there were no detected results that would result in a method detection limit being adjusted above the level of concern (PRG or MCL) for any analyte.

The purpose of field duplicate samples is to evaluate the precision of the sampling and analysis process using the relative percent difference (RPD), a quantitative measure of precision. In some cases, such as the DMLS samples, it is not possible to collect field duplicates. In other cases, where the medium sampled is heterogeneous, such the soil-gas samples collected from the clayey soil at Frontier Fertilizer, field duplicates are not expected to exhibit high precision.

For the routine groundwater monitoring samples, where quality duplicates exhibiting high precision may be expected, the measured precision was found to be acceptable.

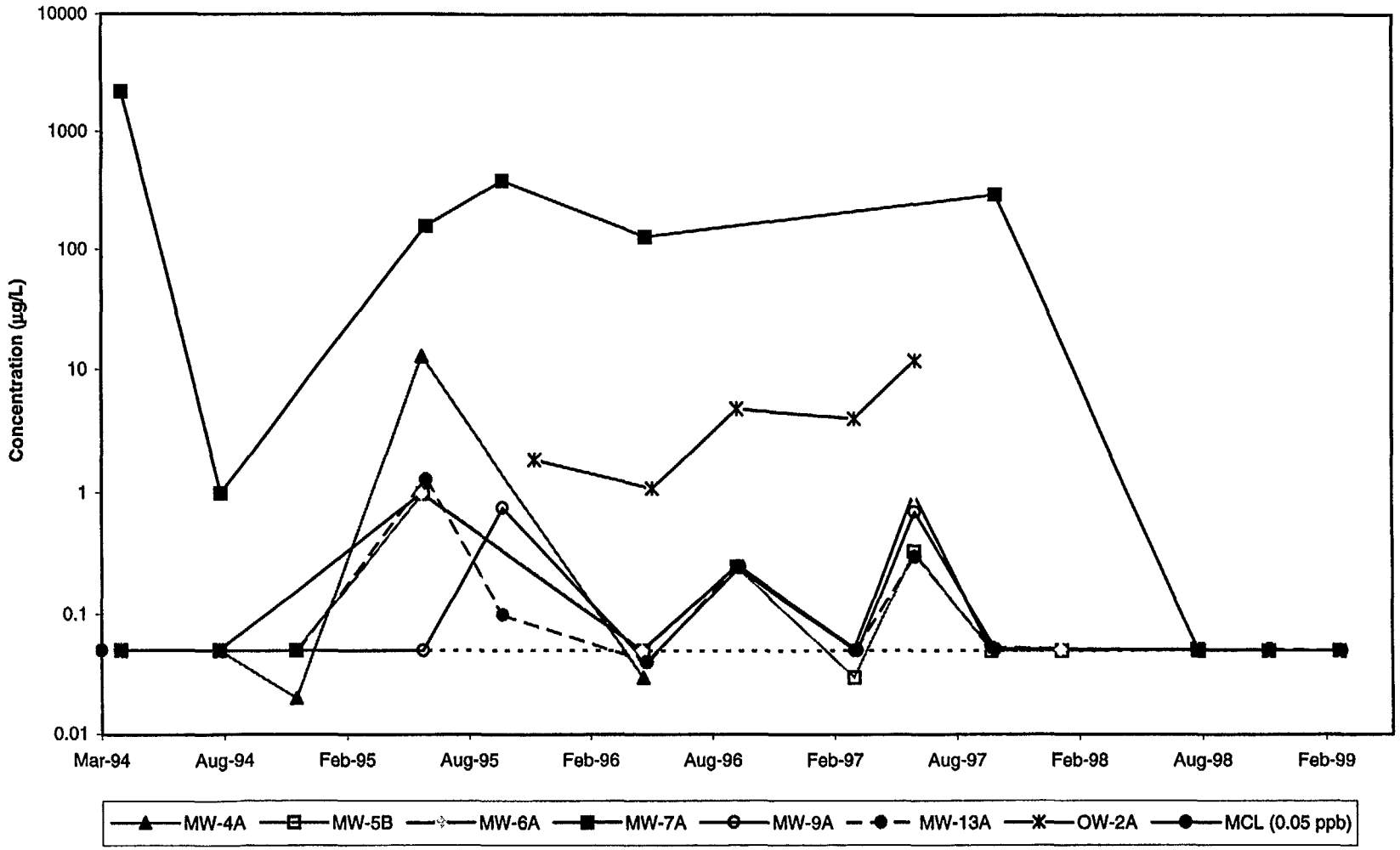
C.3 Evaluation of Data Usability Based on Data Validation Results

As required by the QAPP, a minimum of 10 percent of the quarterly groundwater monitoring data will be validated. This validation is in progress and this report will be updated as necessary to reflect the validation results. Since quarterly sampling has been conducted for several years, the results of data validation are expected to indicate, like previous validation reports, that with rare exceptions the data are usable for the purposes for which they were collected.

Appendix D

Contaminant-Concentration-Versus-Time Plots

FIGURE D-1
EDB Monitoring Well Concentrations Above MCL in Zone S-1



6/14/1999
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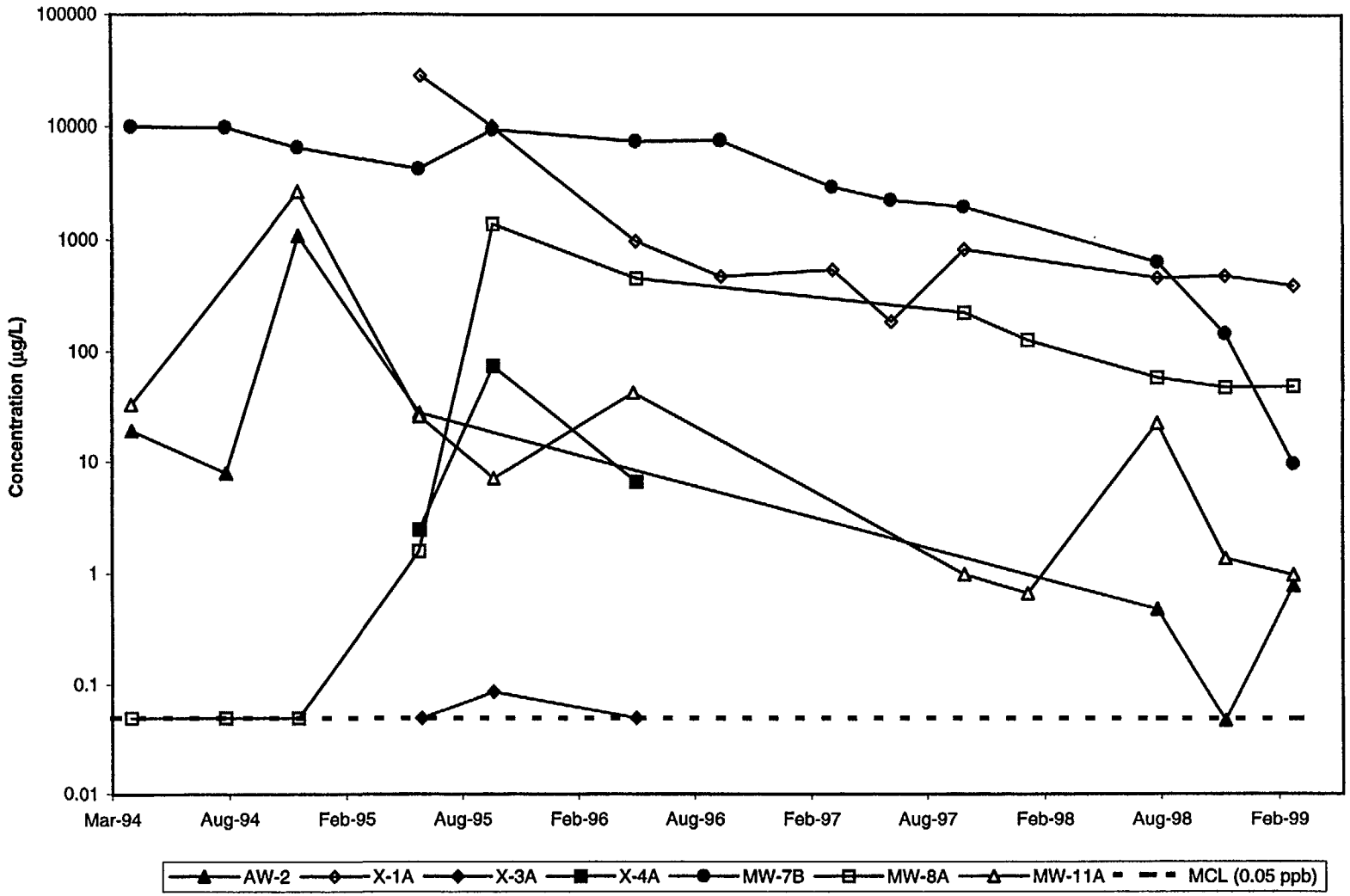
FIGURE D-2
EDB Extraction Well Concentrations Above MCL in Zone S-1



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Arcs_projec\Frontier\98ri\figures\Appendix_D.xls

FIGURE D-3
CCL4 Monitoring Well Concentrations Above MCL in Zone S-1

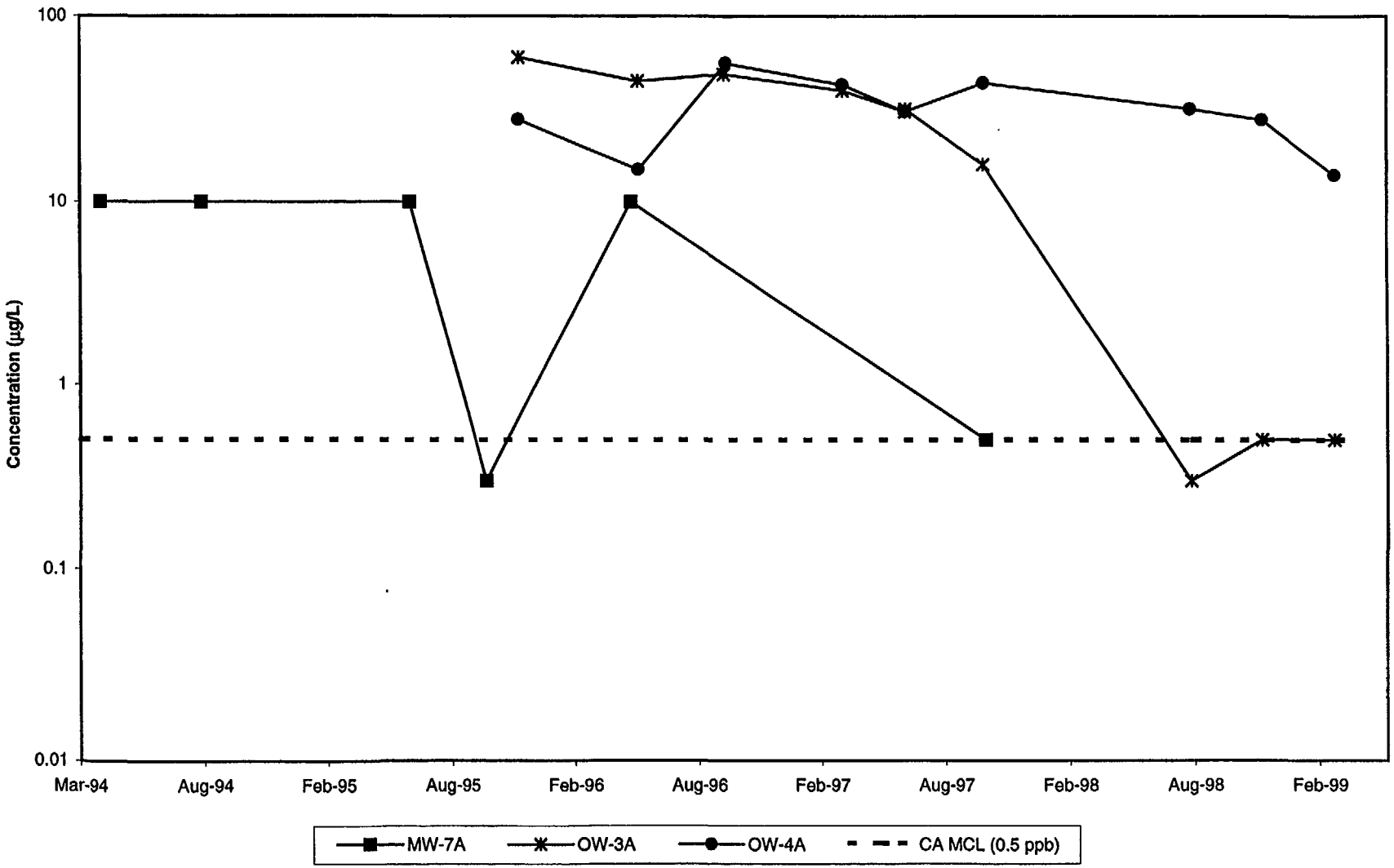

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FIGURE D-4
CCL4 Extraction Well Concentrations Above MCL in Zone S-1

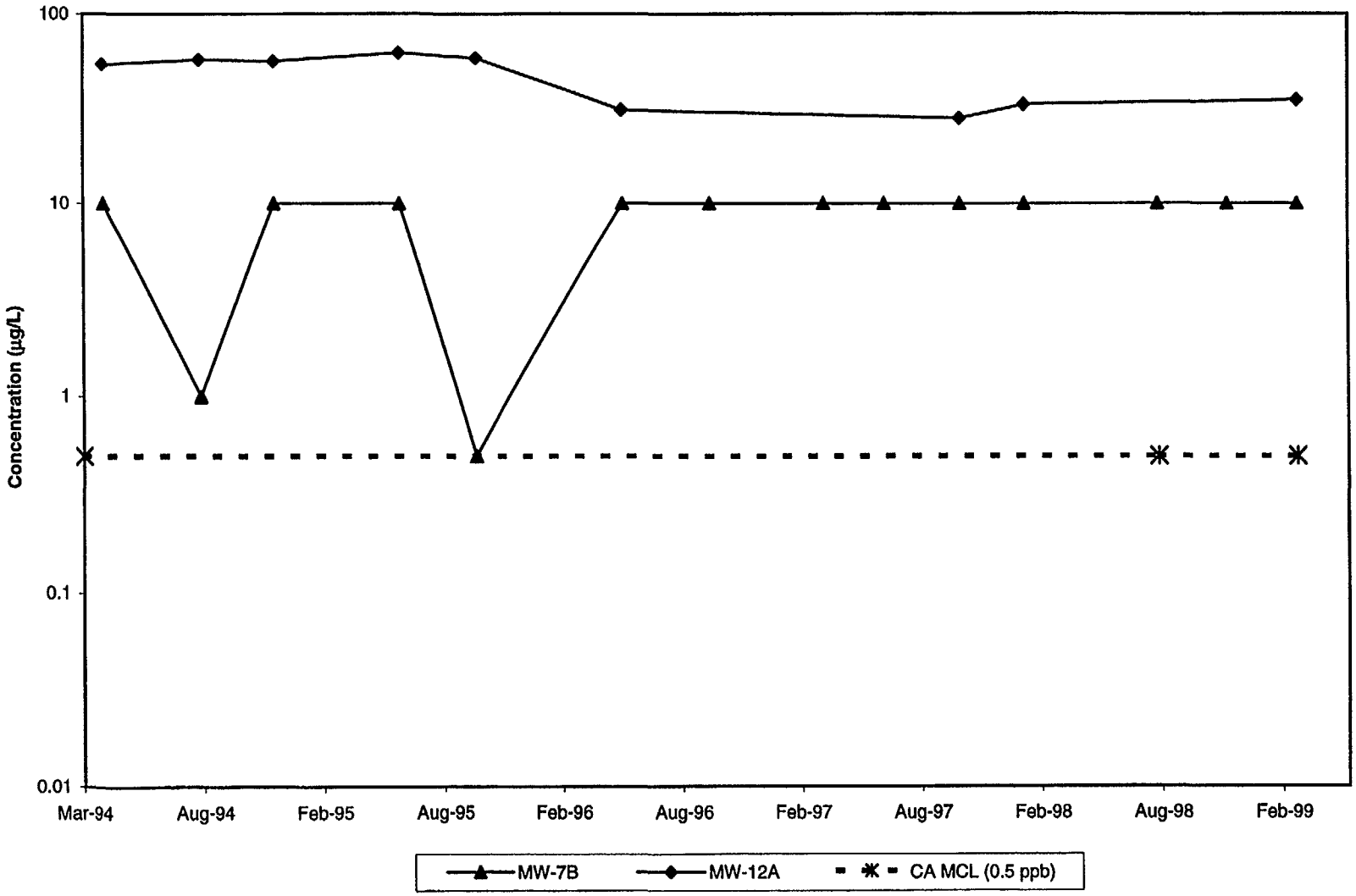

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FIGURE D-5
EDB Monitoring Well Concentrations Above MCL in Zone S-2

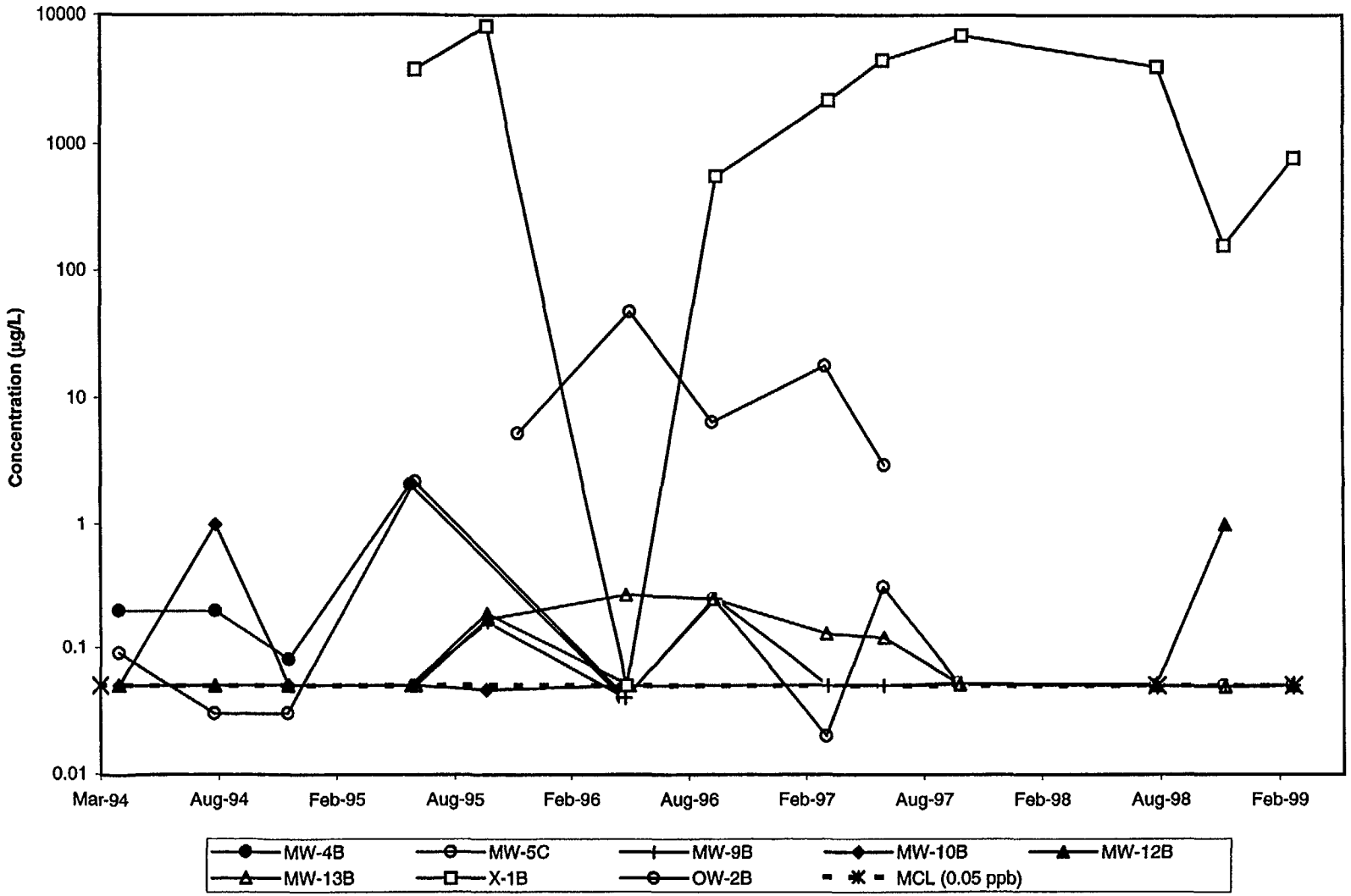

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FIGURE D-6
EDB Extraction Well Concentrations Above MCL in Zone S-2

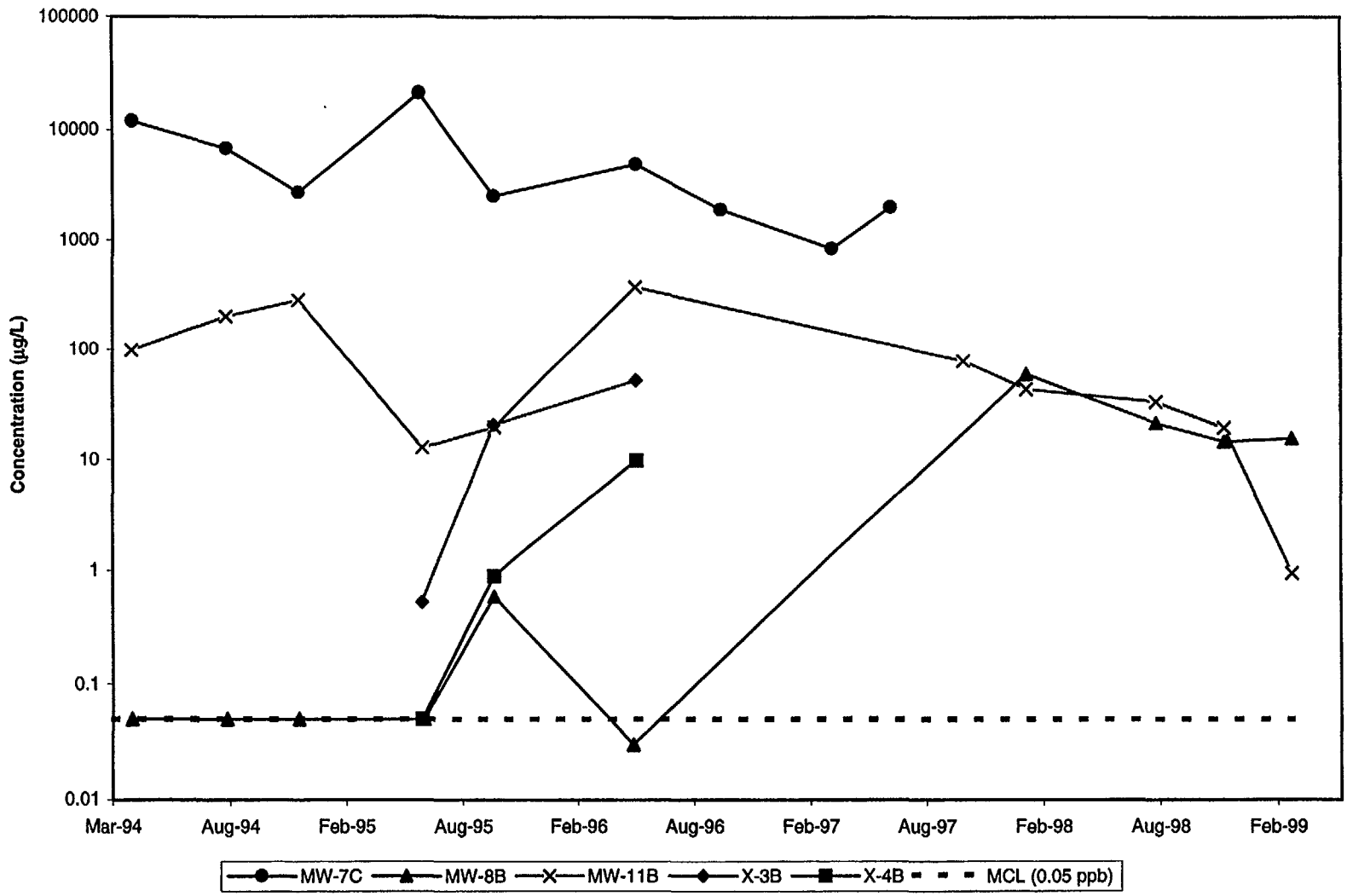

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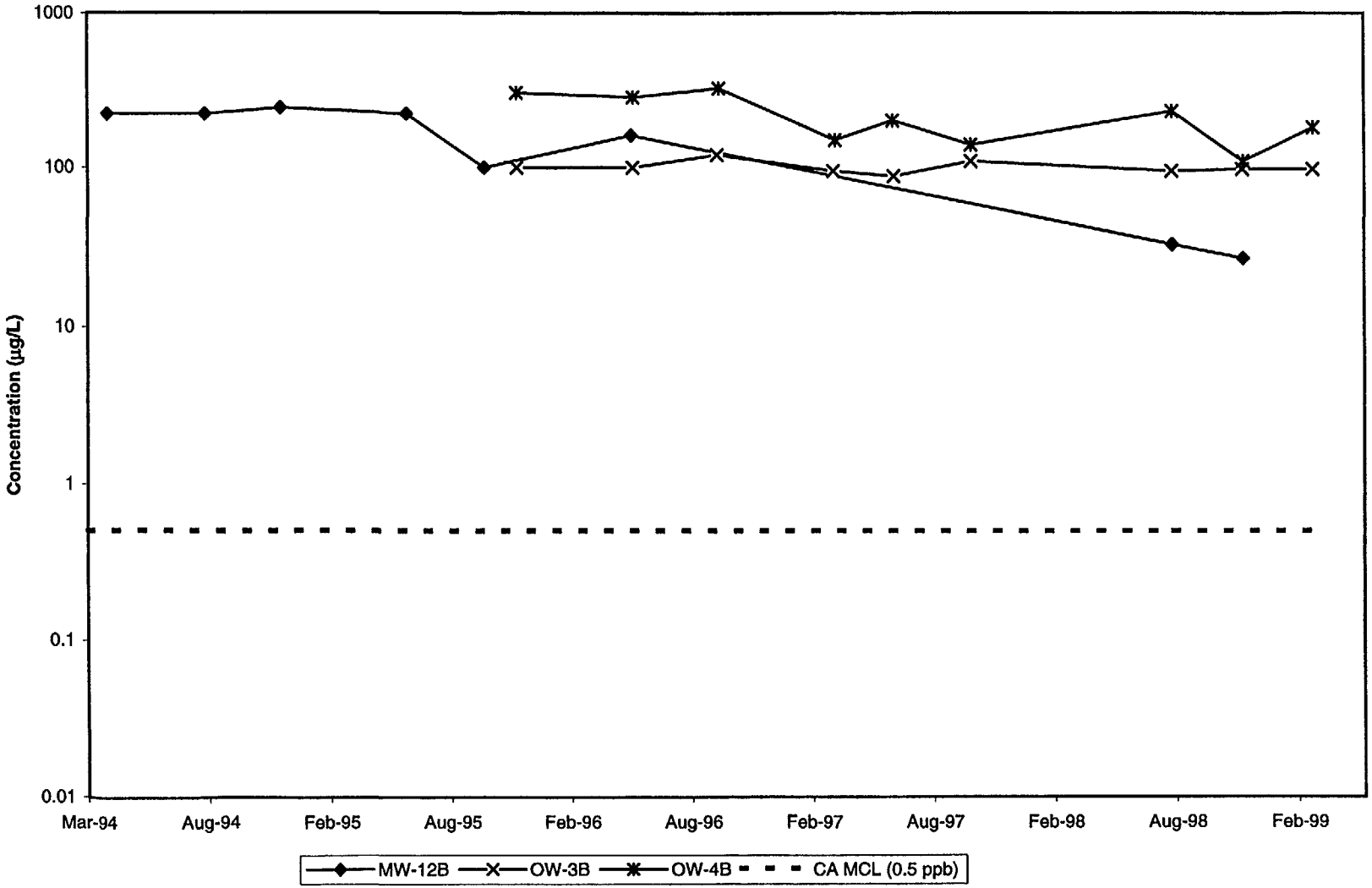
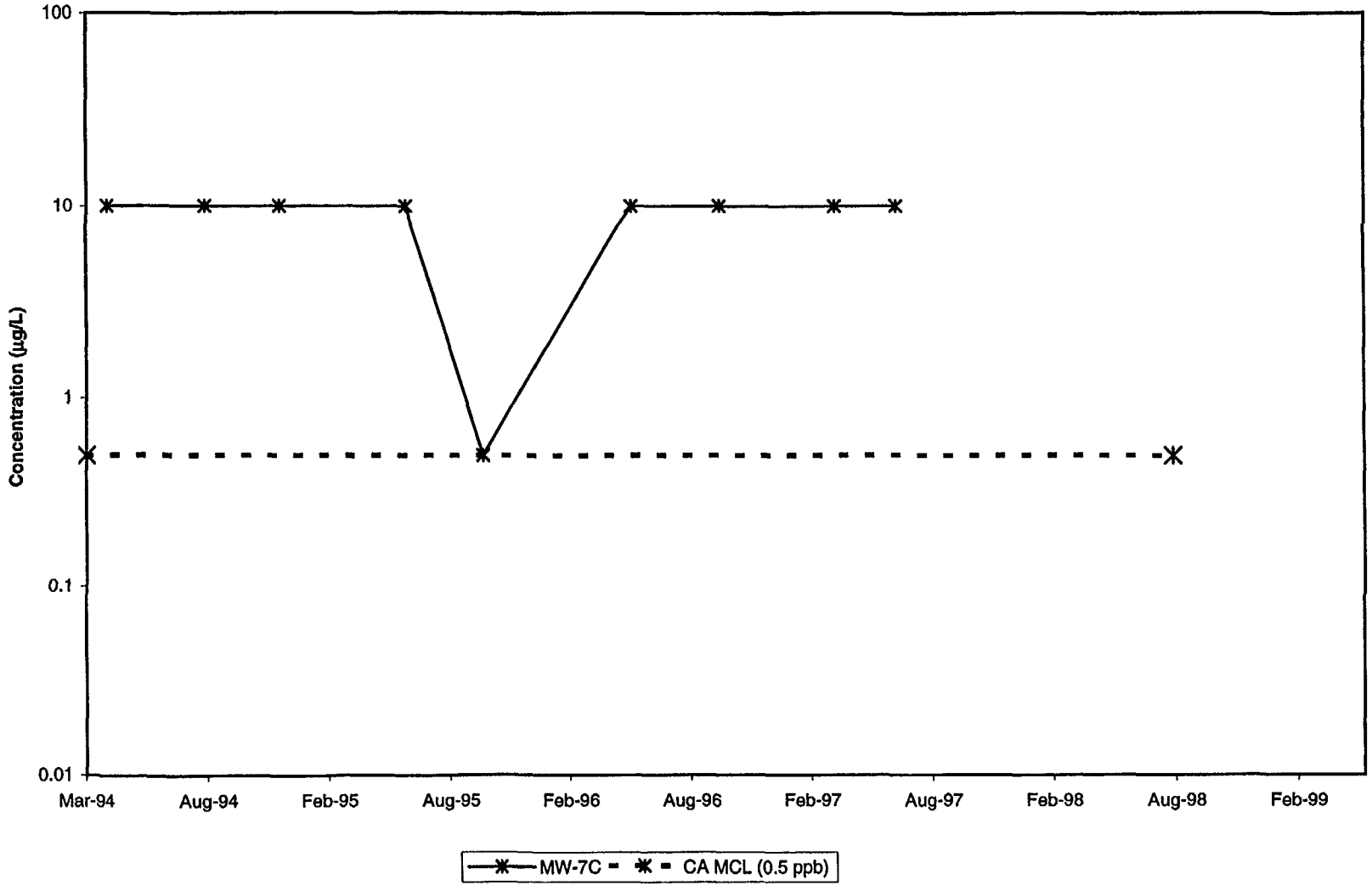
FIGURE D-7
CCL4 Monitoring Well Concentrations Above MCL in Zone S-2



6/14/1999
Arcs_projec\Frontier\98ri\figures\Appendix_D.xls

FIGURE D-8
CCL4 Extraction Well Concentrations Above MCL in Zone S-2



6/14/1999
Arcs_projec\Frontier\98ri\figures\Appendix_D.xls

FIGURE D-9
EDB Monitoring Well Concentrations Above MCL in Zone A-1

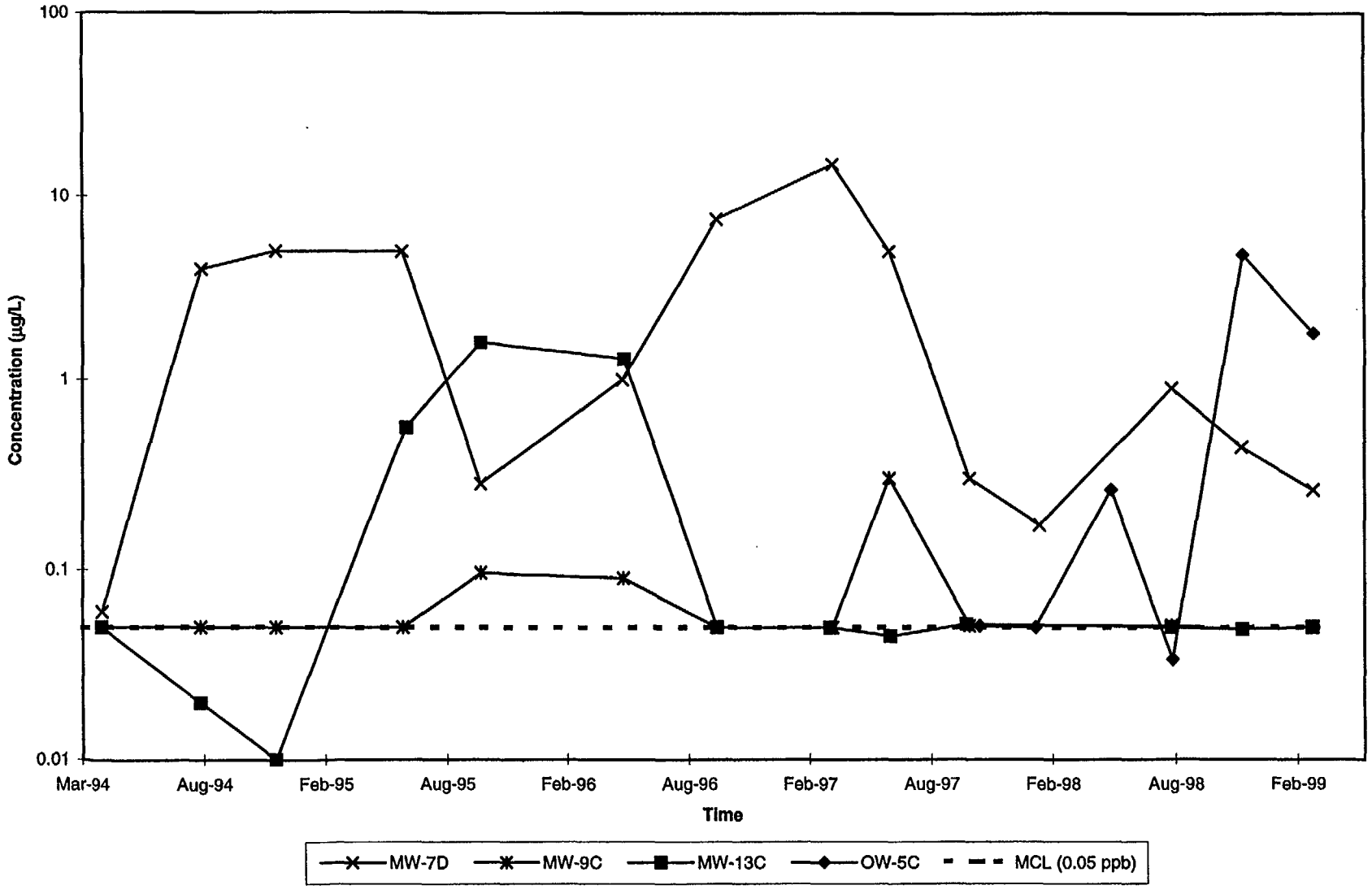


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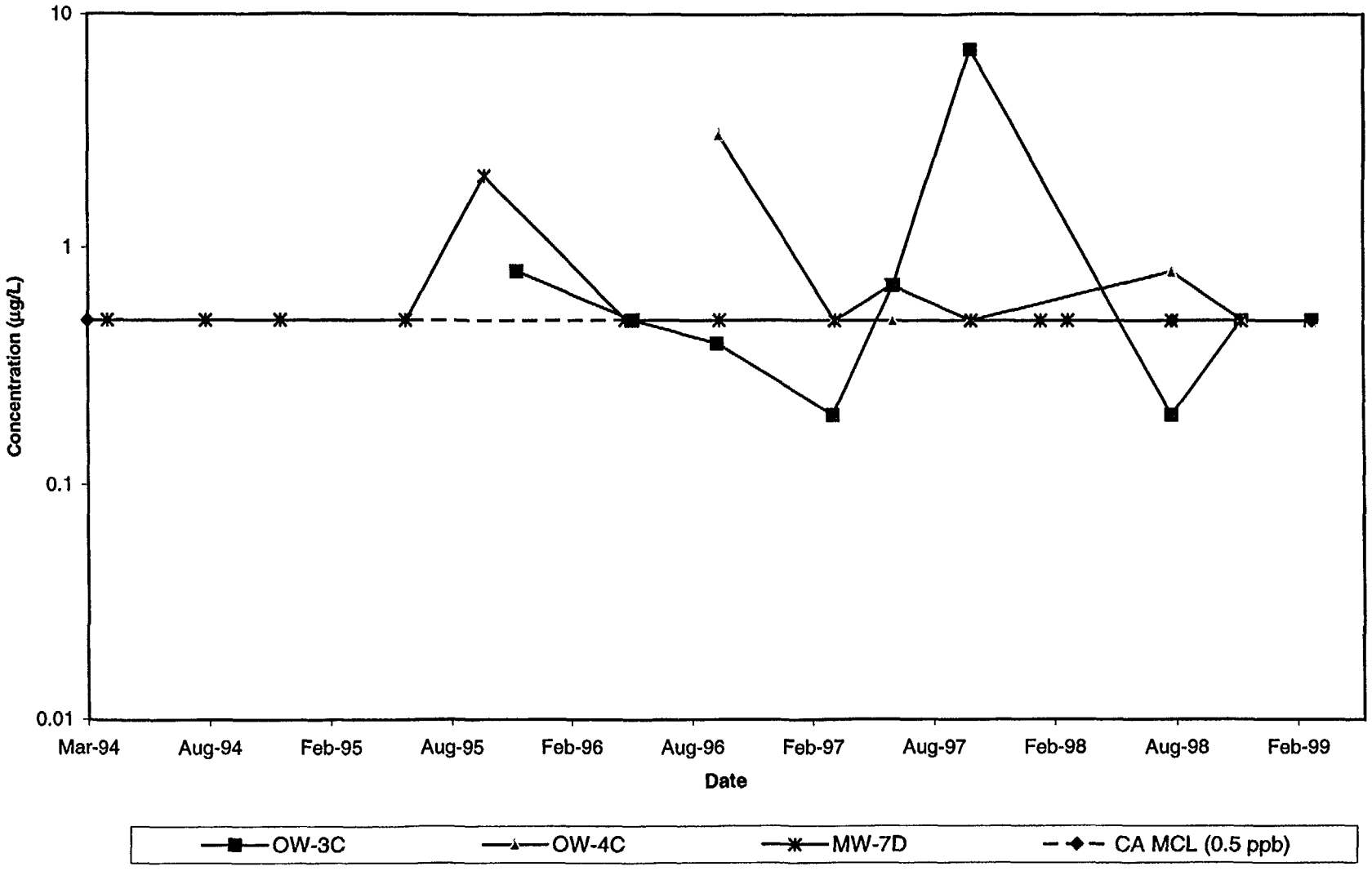
Figure D-10
CCL4 Monitoring Well Concentrations Above MCL in Zone A-1



6/14/1999
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Appendix E

Trend Analysis of Well Chemistry Data

CCN# 028-1685

CALCULATION COVER SHEET

PROJECT	JOB NO.	CALC NO.	SHEET
Frontier Fertilizer	*20376-028-060*	*HY99-1*	*1*
SUBJECT		DISCIPLINE	
Trend Analysis of Well Chemistry Data		*G&HES*	

CALCULATION STATUS DESIGNATION	PRELIMINARY	CONFIRMED	SUPERSEDED	VOIDED
	X			

COMPUTER PROGRAM/TYPE	SCP		MAINFRAME	PC	PROGRAM NO.	VERSION/RELEASE NO.
	x YES	NO		x	*Access 97 & Excel 97*	

A trend analysis of key constituents detected in monitoring and extraction wells at the Frontier Fertilizer Superfund site was performed at the request of the client. The Mann-Kendall non-parametric test for trend was performed as described in Gilbert (1987). For most wells, the constituents showed either a negative trend or no clear trend in concentration. However, positive trend in concentration was observed for DCP at well OW-5C. An apparent positive trend in well MW-8A was observed in the first year of observation, but the trend appears negative since.

Calculation by: Thomas A. Hodge
Checker: Steve Nakasaki
Accepted by: Richard Draper

No.	Reason for Revision	Total No. of Sheets	Last Sheet No.	By	Checked	Approved/ Accepted	Date
0	*Initial calc.*	21		*TAH*	SHN	RBD	6-14-99

Record of Revisions

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1. Introduction

1.1. Purpose

The purpose of this analysis was to determine whether there is any statistically significant trend in the concentration of key constituents detected in the monitoring wells at Frontier Fertilizer.

1.2. Methodology

The method used to detect trends was the non-parameteric Mann-Kendall Test of trend as described in Section 16.4 of Gilbert's "Statistical Methods for Environmental Pollution Monitoring". The method was implemented by converting the key Fortran subroutines provided in Gilbert to Visual Basic and applied to the Microsoft Access database of well chemistry data. The Visual Basic code is atttached. A separate calculation using Excel was performed for DCP at Well MW-8A as an alternate calculation to verify the Visual Basic code. Identical results were obtained.

The database was first screened for the four key indicator constituents, DCP, DBCP, EDB and CCL4. The wells were also screened for sites that had eight or more samples with detected quantities of any of the four constituents. This was intended to assure the reliability of the test results. One well which did not have eight samples with detects, OW-5C, was also included due to special consideration of concern at this site.

The Mann-Kendall Test involves the computation of the Mann-Kendall statistic, S, as follows:

$$S = \sum_{k=1}^{n-1} \sum_{j=k+1}^{n} \text{sign}(x_j - x_k)$$

Where x is the data for concentration for one constituent at one well, listed in the order collected over time and $\text{sign}(x_j - x_k)$ evaluates to +1, or -1 depending on the relative size of x_j and x_k, or 0 if they are equal. The sign of S indicates the direction of the observed trend, positive indicates an upward trend and negative indicates downward. A value of S at or near zero indicates no apparent trend. A high absolute value of S indicates a clear indication of a trend. The variance of S can be computed from

$$\text{Var}(S) = 1/18\ [n\ (n - 1)\ (2n + 5)] - CF$$

where n is the number of samples and CF is a correction factor when ties in the data are present.

$$CF = \sum_{p=1}^{g} t_p\ (t_p - 1)(\ 2t_p + 5)$$

where g is the number of tied groups and t_p is the number of tied data in the group p.

From the computed S and Var(S), the standard normal distribution parameter, Z is:

$$Z = (S + 1) / (\mathrm{Var}(S))^{1/2} \qquad \text{For } S < 0$$

$$Z = 0 \qquad \text{For } S = 0$$

$$Z = (S-1) / \mathrm{Var}(S)^{1/2} \qquad \text{For } S > 0$$

The computed value of Z can be compared to standard cumulative normal distribution tables to obtain the confidence level that the observed trend in the data is not due to a random sequence of numbers.

1.3. Results

At total of 21 separate analyzes were performed for 14 different wells and the 4 key constituents, based on the criteria for selection described above. The results are summarized in Table 1.

The well designation and chemical are listed in columns 1 and 2 of Table 1. The number of samples in column 3. The computed Mann-Kendall S statistic is listed in column 3. For randomly ordered data, the distribution of S approximates a normal distribution, with the variance, in column 5, based solely on the number of samples and ties in the measurements. The computed S and variance are used to compute the normal distribution parameter, Z, in column 6, which determines the confidence level in column 8. The trend direction, column 7, is simply based on the sign of S and does not imply that the trend is significant. The decision as to what confidence level is required to establish the significance of the trend is subjective. However, a confidence level of 95% is commonly used. In Table 1, observed trends with a confidence level of 95% or greater are highlighted in bold type. For these samples there is less than a 5% chance that the observed trend could have randomly occured.

1.4. Conclusions

Of the 21 separate computations, eleven show a clear downward trend in concentration. The wells X-1A, X-1B, MW-7B and MW-11A all show a clear downward trend for both EDB and DCP. The data show a weak indication of a downward trend for DBCP at wells MW-7B and MW-7C. For CCL4, there is a strong indication of downward trend at well OW-4B, and a weak indication of downward trend at MW-12B.

Only Wells MW-8A and OW-5C showed any indication of an upward trend. Both show an upward trend in concentration for DCP. The trend is most apparent for OW-5C. Reviewing the time history plots of EDB concentration in Appendix D-2, the observed concentrations at MW-8A peaked in 1995 and gradually declined since then. The concentration in OW-5C, however shows a gradual increase that may or may not have peaked.

Table 1. Results of Mann-Kendall Trend Analysis

(1) Well Number	(2) Chemical	(3) Number or Samples	(4) Mann-Kendall S	(5) Variance of S	(6) Normal Distribution, Z	(7) Trend Direction	(8) Confidence Level*
AW-2A	1,2-DICHLOROPROPANE	8	-8	65	-0.87	Down	80.7%
MW-11A	1,2-DIBROMOETHANE	12	-47	209	-3.18	Down	**99.9%**
MW-11A	1,2-DICHLOROPROPANE	13	-40	268	-2.38	Down	**99.1%**
MW-11B	1,2-DICHLOROPROPANE	12	-14	213	-0.89	Down	81.4%
MW-12A	CARBON TETRACHLORIDE	11	-3	165	-0.16	Down	56.2%
MW-12B	CARBON TETRACHLORIDE	9	-11	88	-1.06	Down	85.6%
MW-7B	1,2-DIBROMO-3-CHLOROPROPANE	16	-27	492	-1.17	Down	87.9%
MW-7B	1,2-DIBROMOETHANE	17	-115	589	-4.70	Down	**99.9999%**
MW-7B	1,2-DICHLOROPROPANE	18	-62	696	-2.31	Down	**99.0%**
MW-7C	1,2-DIBROMO-3-CHLOROPROPANE	9	-16	92	-1.56	Down	94.1%
MW-7C	1,2-DICHLOROPROPANE	10	-25	125	-2.15	Down	**98.4%**
MW-8A	1,2-DIBROMOETHANE	12	11	209	0.69	Up	75.5%
MW-8A	1,2-DICHLOROPROPANE	13	24	269	1.40	Up	92.0%
OW-3B	CARBON TETRACHLORIDE	10	-7	124	-0.54	Down	70.5%
OW-4A	CARBON TETRACHLORIDE	10	-10	124	-0.81	Down	79.1%
OW-4B	CARBON TETRACHLORIDE	10	-22	124	-1.89	Down	**97.0%**
OW-5C	1,2-DICHLOROPROPANE	6	10	27	1.72	Up	**95.7%**
X-1A	1,2-DIBROMOETHANE	12	-56	213	-3.77	Down	**99.99%**
X-1A	1,2-DICHLOROPROPANE	12	-46	213	-3.09	Down	**99.9%**
X-1B	1,2-DIBROMOETHANE	12	-37	212	-2.47	Down	**99.3%**
X-1B	1,2-DICHLOROPROPANE	12	-33	212	-2.20	Down	**98.6%**

*Bold face indicates greater than 95% confidence level.

1.5. References

Gilbert, Richard O. (1987) Statistical Methods for Environmental Pollution Monitoring,

2. Calculation

2.1. Listing, by well and chemical, of data and computed statistics

Well ID: AW-2A

1,2-DICHLOROPROPANE
Concentration Data:

Date	Concentration, ug/l	Lab Qualifier
10/17/1995	560	
5/24/1996	660	D
10/23/1997	40	
1/29/1998	57	
5/21/1998	150	
8/19/1998	91	
12/2/1998	12	
3/17/1999	120	

Numberof Samples:	8
Mann-Kendall S:	-8
Variance of S:	65
Normal Distribution Value Z:	-0.87

Well ID: MW-11A

1,2-DIBROMOETHANE
Concentration Data:

Date	Concentration, ug/l	Lab Qualifier
3/31/1994	56	
8/24/1994	4600	
12/15/1994	2700	
6/23/1995	110	
10/18/1995	8	
5/24/1996	55	D
10/23/1997	1	
1/29/1998	1	
5/21/1998	1	
8/19/1998	23	
12/2/1998	0.9	J
3/17/1999	0.7	J

Numberof Samples:	12
Mann-Kendall S:	-47
Variance of S:	209
Normal Distribution Value Z:	-3.18

1,2-DICHLOROPROPANE
Concentration Data:

Date	Concentration, ug/l	Lab Qualifier
8/31/1993	6	
3/31/1994	100	
8/24/1994	9900	
12/15/1994	7800	
6/23/1995	290	
10/18/1995	10	
5/24/1996	300	D
10/23/1997	5	
1/29/1998	5	
5/21/1998	3	
8/19/1998	170	
12/2/1998	3	
3/17/1999	2	

Numberof Samples:	13
Mann-Kendall S:	-40
Variance of S:	268
Normal Distribution Value Z:	-2.38

Well ID: MW-11B

1,2-DICHLOROPROPANE
Concentration Data:

Date	Concentration, ug/l	Lab Qualifier
8/30/1993	19	
3/31/1994	510	
8/24/1994	910	
12/15/1994	1000	
10/18/1995	130	
5/28/1996	2200	D
10/23/1997	570	
1/29/1998	880	
5/21/1998	360	
8/19/1998	150	E
12/2/1998	210	
3/17/1999	14	

Numberof Samples:	12
Mann-Kendall S:	-14
Variance of S:	213
Normal Distribution Value Z:	-0.89

Well ID: MW-12A

CARBON TETRACHLORIDE
Concentration Data:

Date	Concentration, ug/l	Lab Qualifier
8/31/1993	6	
3/31/1994	54	
8/24/1994	57	
12/15/1994	56	
6/23/1995	62	
10/18/1995	58	
5/28/1996	31	D
10/23/1997	28	
1/29/1998	33	
5/21/1998	50	
3/17/1999	35	

Numberof Samples:	11
Mann-Kendall S:	-3
Variance of S:	165
Normal Distribution Value Z:	-0.16

Well ID: MW-12B

CARBON TETRACHLORIDE
Concentration Data:

Date	Concentration, ug/l	Lab Qualifier
8/31/1993	6	
3/31/1994	220	
8/24/1994	220	
12/15/1994	240	
6/23/1995	220	
10/18/1995	100	
5/28/1996	160	D
8/19/1998	33	
12/2/1998	27	

Numberof Samples:	9
Mann-Kendall S:	-11
Variance of S:	88
Normal Distribution Value Z:	-1.06

Well ID: MW-7B

1,2-DIBROMO-3-CHLOROPROPANE

Concentration Data:

Date	Concentration, ug/l	Lab Qualifier
4/1/1994	16	
8/25/1994	23	
12/15/1994	24	
6/23/1995	14	
10/17/1995	160	
5/29/1996	38	
10/8/1996	48	
3/31/1997	19	
7/1/1997	290	E
10/23/1997	4	J
1/29/1998	10	
5/21/1998	4	J
8/19/1998	14	
10/14/1998	100	U
12/1/1998	5	U
3/17/1999	5	U

Numberof Samples:	16
Mann-Kendall S:	-27
Variance of S:	492
Normal Distribution Value Z:	-1.17

1,2-DIBROMOETHANE

Concentration Data:

Date	Concentration, ug/l	Lab Qualifier
4/1/1994	10000	
8/25/1994	9800	
12/15/1994	6600	
6/23/1995	4300	
10/17/1995	9400	
5/29/1996	7500	D
10/8/1996	7600	
3/31/1997	3000	
7/1/1997	2300	
10/23/1997	2000	
1/29/1998	1400	
5/21/1998	350	
8/19/1998	650	
10/14/1998	115	J
10/14/1998	100	U
12/1/1998	150	
3/17/1999	5	U

Numberof Samples:	17
Mann-Kendall S:	-115
Variance of S:	589
Normal Distribution Value Z:	-4.70

1,2-DICHLOROPROPANE
Concentration Data:

Date	Concentration, ug/l	Lab Qualifier
8/31/1993	0	
9/1/1993	0	
4/1/1994	8200	
8/25/1994	19000	
12/15/1994	13000	
6/23/1995	7500	
10/17/1995	16000	
5/29/1996	14000	D
10/8/1996	11000	
3/31/1997	7100	
7/1/1997	6100	
10/23/1997	6000	
1/29/1998	4100	
5/21/1998	2100	
8/19/1998	2500	
10/14/1998	2616.66666666667	
12/1/1998	1500	
3/17/1999	160	

Numberof Samples:	18
Mann-Kendall S:	-62
Variance of S:	696
Normal Distribution Value Z:	-2.31

Well ID: MW-7C

1,2-DICHLOROPROPANE
Concentration Data:

Date	Concentration, ug/l	Lab Qualifier
9/1/1993	34000	
4/1/1994	12000	
8/25/1994	17000	
12/15/1994	7500	
6/23/1995	20000	
10/17/1995	5900	
5/29/1996	8000	D
10/8/1996	1500	U
3/31/1997	1700	
7/1/1997	7000	

Numberof Samples:	10
Mann-Kendall S:	-25
Variance of S:	125
Normal Distribution Value Z:	-2.15

1,2-DIBROMO-3-CHLOROPROPANE
Concentration Data:

Date	Concentration, ug/l	Lab Qualifier
4/1/1994	500	
8/25/1994	750	
12/15/1994	630	
6/23/1995	83	
10/17/1995	620	
5/29/1996	190	
10/8/1996	90	U
3/31/1997	29	
7/1/1997	300	

Numberof Samples:	9
Mann-Kendall S:	-16
Variance of S:	92
Normal Distribution Value Z:	-1.56

Well ID: MW-8A

1,2-DICHLOROPROPANE
Concentration Data:

Date	Concentration, ug/l	Lab Qualifier
8/26/1993	0.4	U
3/31/1994	2	
8/24/1994	0.5	U
12/15/1994	1	
6/22/1995	76	
10/17/1995	7100	
5/29/1996	7000	D
10/23/1997	1200	
1/29/1998	950	
5/21/1998	520	
8/19/1998	260	
12/2/1998	280	
3/17/1999	340	

Numberof Samples:	13
Mann-Kendall S:	24
Variance of S:	269
Normal Distribution Value Z:	1.40

1,2-DIBROMOETHANE
Concentration Data:

Date	Concentration, ug/l	Lab Qualifier
3/31/1994	0.5	U
8/24/1994	0.5	U
12/15/1994	0.5	U
6/22/1995	2	
10/17/1995	1400	
5/29/1996	810	D
10/23/1997	230	
1/29/1998	250	
5/21/1998	90	
8/19/1998	60	
12/2/1998	49	
3/17/1999	50	

Numberof Samples:	12
Mann-Kendall S:	11
Variance of S:	209
Normal Distribution Value Z:	0.69

Well ID: OW-3B

CARBON TETRACHLORIDE
Concentration Data:

Date	Concentration, ug/l	Lab Qualifier
12/7/1995	100	
5/30/1996	100	D
10/4/1996	120	
3/28/1997	95	
6/27/1997	88	D
10/20/1997	110	
5/20/1998	110	
8/18/1998	95	
12/1/1998	98	
3/16/1999	98	

Numberof Samples:	10
Mann-Kendall S:	-7
Variance of S:	124
Normal Distribution Value Z:	-0.54

Well ID: OW-4A

CARBON TETRACHLORIDE
Concentration Data:

Date	Concentration, ug/l	Lab Qualifier
12/7/1995	28	
5/31/1996	15	
10/7/1996	56	
3/28/1997	43	
6/27/1997	31	
10/21/1997	44	
5/20/1998	1	
8/19/1998	32	
12/2/1998	28	
3/17/1999	14	

Numberof Samples:	10
Mann-Kendall S:	-10
Variance of S:	124
Normal Distribution Value Z:	-0.81

Well ID: .OW-4B

CARBON TETRACHLORIDE
Concentration Data:

Date	Concentration, ug/l	Lab Qualifier
12/7/1995	300	
5/31/1996	280	D
10/7/1996	320	
3/31/1997	150	
6/26/1997	200	
10/21/1997	140	
5/20/1998	140	
8/19/1998	228	
12/2/1998	110	
3/17/1999	180	

Numberof Samples:	10
Mann-Kendall S:	-22
Variance of S:	124
Normal Distribution Value Z:	-1.89

Well ID: OW-5C

1,2-DICHLOROPROPANE
Concentration Data:

Date	Concentration, ug/l	Lab Qualifier
11/6/1997	0.3	J
1/29/1998	0.3	J
5/21/1998	5	
8/20/1998	2	
12/3/1998	30	
3/18/1999	21	

Numberof Samples:	6
Mann-Kendall S:	10
Variance of S:	27
Normal Distribution Value Z:	1.72

Well ID: X-1A

1,2-DIBROMOETHANE

Concentration Data:

Date	Concentration, ug/l	Lab Qualifier
6/26/1995	14000	
10/17/1995	10000	
5/29/1996	3900	D
10/8/1996	2600	
3/31/1997	1700	
7/1/1997	620	
10/23/1997	840	
1/29/1998	910	
5/21/1998	740	
8/19/1998	470	
12/1/1998	490	
3/17/1999	400	

Numberof Samples:	12
Mann-Kendall S:	-56
Variance of S:	213
Normal Distribution Value Z:	-3.77

1,2-DICHLOROPROPANE

Concentration Data:

Date	Concentration, ug/l	Lab Qualifier
6/26/1995	17000	
10/17/1995	22000	
5/29/1996	9600	D
10/8/1996	4600	
3/31/1997	5600	
7/1/1997	4900	
10/23/1997	6200	
1/29/1998	6400	
5/21/1998	4500	
8/19/1998	4100	
12/1/1998	3500	
3/17/1999	2900	

Numberof Samples:	12
Mann-Kendall S:	-46
Variance of S:	213
Normal Distribution Value Z:	-3.09

Well ID: X-1B

1,2-DIBROMOETHANE

Concentration Data:

Date	Concentration, ug/l	Lab Qualifier
6/30/1995	4500	
10/19/1995	8200	
5/23/1996	8600	D
10/9/1996	19000	
4/1/1997	3000	
6/24/1997	4500	
10/24/1997	7000	
2/4/1998	1700	
5/22/1998	1200	
8/20/1998	4000	
12/1/1998	160	
3/18/1999	800	

Numberof Samples:	12
Mann-Kendall S:	-37
Variance of S:	212
Normal Distribution Value Z:	-2.47

1,2-DICHLOROPROPANE

Concentration Data:

Date	Concentration, ug/l	Lab Qualifier
6/30/1995	6100	
10/19/1995	14000	
5/23/1996	11000	D
10/9/1996	21000	
4/1/1997	6300	
6/24/1997	9300	
10/24/1997	11000	
2/4/1998	6600	
5/22/1998	4600	
8/20/1998	6400	
12/1/1998	3800	
3/18/1999	2700	

Numberof Samples:	12
Mann-Kendall S:	-33
Variance of S:	212
Normal Distribution Value Z:	-2.20

2.2. Visual Basic Source code

```
Option Compare Database
' Visual Basic Code by Thomas Hodge
' Last update 6/8/99
' Functions for computing Mann-Kendall non-parametric trend statistics for data stored in
' an Access database

Function Kend(myrst As Recordset, N As Long) As Long
' Routine to compute the Kendall Statistic S
'X = array of data
'Y= array of dates
' myrst is a recordset with at least two fields "Value" and "Samp_Date"
'S Output Kendall statistic
'N number of data points
'Slope array of slope estimators
' Smed median slope for each call
' number of slope estimators
ReDim X(N), Y(N)
Dim Xd, Yd As Double
Dim S As Long
i = 0
For i = 0 To (N - 1)
myrst.AbsolutePosition = i
X(i + 1) = myrst.Fields("Value")
Y(i + 1) = myrst.Fields("SAMP_DATE")
Next i

S = 0
NS = 0

For i = 1 To (N - 1)
    For j = (i + 1) To N
        Xd = X(j) - X(i)
        Yd = Y(j) - Y(i)
        If (Yd <> 0#) Then ' if dates match, don't change S
            If (Xd > 0#) Then ' increment S if positive change, decrement if negative, lea
ve unchanged if equal
                S = S + 1
            ElseIf (Xd < 0#) Then
                S = S - 1
            End If
'            NS = NS + 1 ' code for computing slope not implemented yet
'            ReDim Preserve Slope(NS)
'            Slope(NS) = Xd / Yd
        End If
    Next j
Next i
Kend = S
End Function

Function ktest(station, chem) As Double
' function to select appropriate records and pass as recordset to function Kend
' requires the existance of a query or Table named 'MKData' with the following
' data fields: Station_ID, CHEM_NAME, Value, Samp_Date

Dim myrst As Recordset
Dim mySQL As String
Dim N As Long

mySQL = "SELECT [MKData].Value, [MKData].SAMP_DATE FROM [MKData]" & _
      "WHERE ((([MKData].STATION_ID) = '" & station & _
      "') And (([MKData].CHEM_NAME) = '" & chem & "'))" & _
      "ORDER BY [MKData].SAMP_DATE;"

Set dbs = CurrentDb
Set myrst = dbs.OpenRecordset(mySQL)
N = myrst.RecordCount
ktest = Kend(myrst, N)
```

```
End Function
 Function VARS(station As String, chem As String, N As Long) As Double
 ' Function to compute the variance of the Mann Kendall S factor, including correction
 ' factor for ties in data
 Dim VAR As Double
 Dim myrst As Recordset
 mySQL = "SELECT MKData.STATION_ID, MKData.CHEM_NAME, MKData.Value, Count(MKData.SAMP_DATE
) AS Tp " & _
     "FROM MKData GROUP BY MKData.STATION_ID, MKData.CHEM_NAME, MKData.Value " & _
     "HAVING (((MKData.STATION_ID)='" & station & "') AND ((MKData.CHEM_NAME)='" & chem & "
') " & _
     "AND ((Count(MKData.SAMP_DATE))>1));"

Set dbs = CurrentDb
Set myrst = dbs.OpenRecordset(mySQL)
g = myrst.RecordCount ' number of sets of ties
CF = 0# ' correction factor
For i = 0 To (g - 1)
    myrst.AbsolutePosition = i
    tp = myrst.Fields("Tp")
    CF = CF + tp * (tp - 1) * (2 * tp + 5)
Next i

VARS = 1 / 18 * (N * (N - 1) * (2 * N + 5) - CF)


 End Function


Function Zvalue(VAR, S) As Double
' function computes the Normal Distribution Z factor for the computed Mann-Kendall S

If (S > 0) Then
    Zvalue = (S - 1) / Sqr(VAR)
ElseIf (S < 0) Then
    Zvalue = (S + 1) / Sqr(VAR)
Else
    Zvalue = 0
End If

End Function
```

2.3. Alternate Calculation using Excel

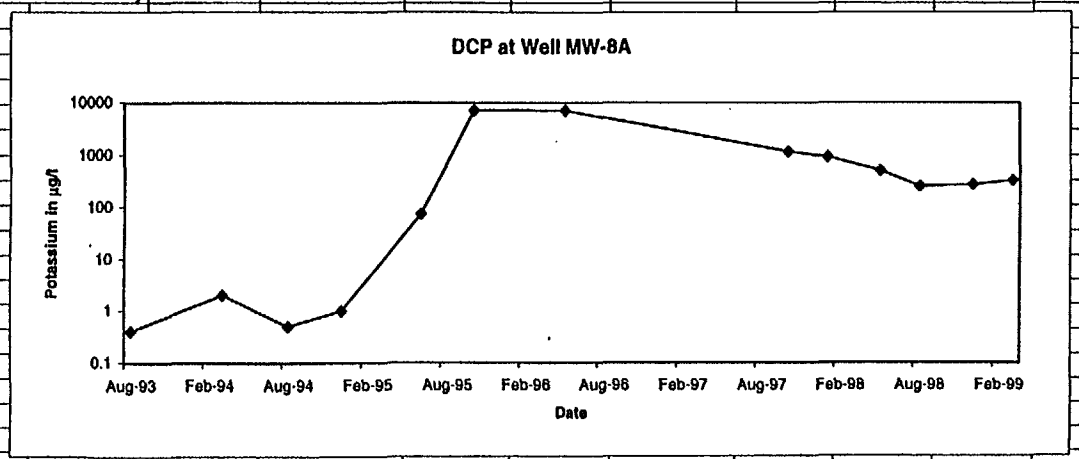
Alternate Calculation of Mann-Kendall S for DCP, well MW-8A

1,2-DICHLOROPROPANE

Date	MW-8A Concentration	Time	1	2	3	4	5	6	7	8	9	10	11	12	13
26-Aug-93	0.4	Value, ug/l	0.40	2.00	0.50	1.00	76.00	7100.00	7000.00	1200.00	950.00	520.00	260.00	280.00	340.00
31-Mar-94	2			1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
24-Aug-94	0.5				-1.00	-1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
15-Dec-94	1					1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
22-Jun-95	76						1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
17-Oct-95	7100							1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
29-May-96	7000								-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00
23-Oct-97	1200									-1.00	-1.00	-1.00	-1.00	-1.00	-1.00
29-Jan-98	950										-1.00	-1.00	-1.00	-1.00	-1.00
21-May-98	520											-1.00	-1.00	-1.00	-1.00
19-Aug-98	260												-1.00	-1.00	-1.00
02-Dec-98	280													1.00	1.00
17-Mar-99	340														1.00

$$S = \Sigma\Sigma \, \mathrm{sign}(X_j - X_k)$$

for k = 1 to n -1 and j = k+1 to n

Mann-Kendall Test Of Trend

	N	13	Ties: #	0
	S	24	Test Statistic	T1
				T2
	Var S	269		
	Z	1.40	Normal Probability Z	
	Trend Probability	92.0%