KERR-McGEE CORPORATION

FORMER BURIAL AREA #1 GROUNDWATER ASSESSMENT WORKPLAN

for
Cimarron Corporation's Former
Nuclear Fuel Fabrication Facility
Crescent, Oklahoma

April, 2002

License Number: SNM-928
Docket No. 70-0925

CIMARRON CORPORATION
CRESCENT, OKLAHOMA

CIMARRON CORPORATION

P.O. BOX 315 • CRESCENT, OK 73028

April 17, 2002

Mr. Kenneth Kalman
Low-Level Waste & Decommissioning Projects Branch
Division of Waste Management
Office of Nuclear Materials Safety & Safeguards
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Re: Docket No. 70-925; License No. SNM-928
Former Burial Area #1 Groundwater Assessment Workplan

Dear Mr. Kalman:
Cimarron Corporation (Cimarron) submits herein two copies of Former Burial Area #1 Groundwater Assessment Workplan. As we have discussed, Cimarron will implement this plan after allowing at least four weeks for NRC review and comment. The schedule provided NRC in a separate submittal does not include time to prepare and resubmit a revised work plan for NRC approval prior to initiating field work.

Our decommissioning schedule shows Cimarron performing this work during the summer of 2002, and reporting the results by the end of January, 2003. The assessment report submittal date may be delayed if a second round of groundwater sampling in Burial Area #1 is needed.

If you have questions or comments, please call me at 405-282-2935 (Cimarron) or 918-225-7753 (Cushing).

Sincerely,

Jeff Lux
Manager, Planning and Regulatory Compliance

xc: D. Blair Spitzberg, NRC Region IV

NMSS01 Public

Cimarron Corporation
Former Burial Area #1 Groundwater Assessment Workplan

April 2002

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Introduction

The following Workplan provides details for a proposed assessment at the Cimarron Corporation Facility, a wholly owned subsidiary of Kerr-McGee Corporation. The area of interest is known as Former Burial Area #1, located in Sub-Area F in the northeast part of the facility.

Historical Information

Cimarron Corporation operated the Cimarron Facility in Logan County, Oklahoma from 1966 to 1975 under licenses from the Nuclear Regulatory Commission (NRC). The principal operation at the plant involved the fabrication of fuel elements from enriched uranium. Cimarron began decommissioning operations in 1975.

From information provided in the Cimarron Radiological Characterization Report, October 1994, and the Cimarron Decommissioning Plan, April 1995, the Final Status Survey Plan for the entire 840-acre site was divided into three phases, which involve the survey of both affected and unaffected areas. These three phases were designated as Phases I, II, and III. Areas surveyed during each Phase were further subdivided into smaller "Sub-Areas" (i.e. Sub-Areas A through E, F through J, and K through O).

This Workplan will focus on a portion of the site referred to as Burial Area Number 1 (BG-1) located in Sub-Area F. BG-1 was constructed in 1965 and was used to bury both radioactive and non-radioactive waste in a series of trenches. BG-1 was closed in 1970.

Soil settlement in the trenches resulted in the initiation of an investigation in 1984 to establish an appropriate remedial action. In February 1985, several monitoring wells were installed in the vicinity of BG-1 (i.e. monitoring wells 1314 through 1317). In May 1985, soil samples were collected from nine boreholes along the perimeter of this area. Down-hole gamma scans were also performed in the borings.

Based on the survey data and the continued settling of the trenches, the decision was made to exhume the waste materials contained within BG-1 in 1986. By 1988, all waste materials was removed. Approximately 65,000 cubic yards of material was shipped off-site to a licensed low-level radioactive waste disposal facility near Beatty, Nevada.

The excavation remained open from 1988 until 1993. During the time the excavation was open, NRC had their contractor (ORISE) conduct an initial confirmatory survey. This confirmatory survey resulted in the identification of several elevated areas containing contaminated soils which were subsequently excavated and shipped off-site for disposal. In 1991, ORISE conducted a second confirmatory survey and provided a report to the NRC that documented BG-1 was decommissioned in accordance with the release criteria. NRC subsequently released this area for backfill in late 1992.

During the period March through July 1993, clean soil was placed in the excavated area. Final grading of BG-1 was completed in July 1993.

Regional Geology

The Cimarron Facility lies in the Central Lowlands portion of the Great Plains physiographic province. The local and regional topography is characterized by low, rolling hills and incised rivers, streams, and floodplains. A principal geomorphic feature at the site is the Cimarron River floodplain, which is approximately one-half mile in width and trends east-west. The river and floodplain are bordered by a system of low-lying cliffs and bluffs that overlook the river.

The facility is located in an upland area immediately south of the Cimarron River. The property includes portions of the floodplain and the adjoining cliffs and bluffs. The upland elevation of the former operations areas is approximately 980 to 1,000 feet above mean sea level. The elevation of the floodplain is approximately 930 feet above mean sea level. Total relief across the site is approximately 70 feet. Local drainage is toward the Cimarron River and its floodplain.

The regional geologic structure is a gentle, west-southwest dipping homocline of Permian bedrock. Sediments forming the Permian bedrock were deposited in shallow marine and non-marine deltaic environments. Quaternary-age alluvial and terrace deposits unconformably overlie the erosional surface of the bedrock.

Permian bedrock in the area includes (from younger to older) the Hennessey Shale Formation, the Garber Sandstone, and the Wellington Formation. Regional dip of the Permian beds at the surface is about 20 to 40 feet per mile to the west. The Hennessey Formation is absent beneath the site, but is present about four miles west (downdip) of the facility. Figure 1 is a cross-section extending from north to south through the subject area.

The Garber Sandstone and underlying Wellington Formation include lenticular sandstones interbedded within shales and mudstones. The combined thickness of the Garber Sandstone and the Wellington Formation is about 800 to 1,000 feet.

The lithology of both units is similar, consisting of interbedded sandstones, shales and mudstones with an absence of fossils. The water-bearing characteristics of each formation (e.g., hydraulic conductivity and water quality) are similar. Since the two formations are reportedly not readily distinguishable, they often are considered as a single hydrostratigraphic unit, the Garber-Wellington Aquifer (Wood and Burton, 1968).

The Quaternary deposits overlying the Garber Sandstone include terrace deposits from earlier river channels and alluvium in the modern river channels. The terrace deposits are located on the northern side of the Cimarron River. The alluvium in the river channel floodplain on the south side is unconformably deposited on the Garber Sandstone (Engineering Enterprises, 1973).

Site Geology

A soil veneer one to eight feet thick covers most of the "upland" Cimarron Facility. Shallow bedrock at the site consists of sandstones and siltstones of the Garber Formation (Garber Sandstone). The Garber Sandstone is relatively thick; drilling conducted during recent investigations has penetrated no other formations. A deep well drilled in 1969 near the former Uranium Plant encountered the base of the Garber sandstone at approximately 200 feet below ground surface. The Garber–Wellington Formation directly underlies the entire Cimarron Facility.

The Quaternary alluvium in the Cimarron River channel consists of sand, silt, clay, and lenticular gravel beds. The alluvium is estimated to range between 30 and 100 feet in thickness with an average thickness of about 50 feet.

Three Garber Formation sandstone units and two mudstone units have been identified in borings drilled at the site (see Figure 1). These sandstones have been informally classified (from shallow to deep) as the A, B, and C sandstones (in some site reports as the 1, 2, and 3 sandstones respectively). Thicknesses range from 30 to 55 feet for each of the sandstones.

The two predominant mudstones (the A and B mudstones) are each approximately six to 14 feet thick, and separate the A sandstone from the B sandstone, and the B sandstone from the C sandstone, respectively. The mudstones generally are massive, with some zones of thin laminations in the upper portions. The mudstones are less permeable than the sandstones, and retard the vertical movement of groundwater.

Sandstone A is the first water bearing sandstone encountered at the Cimarron Facility. This sandstone consists of up to 25 feet of red-to-tan colored sandstone and silty sandstone on the western half of the site, and is up to 10 feet thick in the subject area.

Sandstone A may be either well or poorly cemented, and is locally cross-bedded. Water level data collected from monitor wells show that the sandstone is fully saturated at the southern boundary (upgradient side) of the site. The saturated thickness decreases to the north where groundwater discharges as base flow into small, northflowing tributaries to the Cimarron River, and at seeps where the sandstone outcrops along the bluff. In the area of BG-1, Sandstone A appears to thin in the immediate area where the trenches previously existed and is entirely eroded at the northern end of the former trenched areas.

Mudstone A is a 10-foot thick sequence of mudstone and silty mudstone between Sandstone A and the underlying Sandstone B. Water level data from monitor wells show that this mudstone unit hydrologically separates the two sandstones.

Sandstone B is the second, or intermediate, water-bearing sandstone encountered at the site. This sandstone, which is similar in lithology to Sandstone A, can be up to 30 feet in thickness across the site. In the subject area, the sandstone is up to 25 feet thick and is the uppermost water-bearing aquifer.

Water level data collected from monitor wells in the B sandstone located at the central and western parts of the site show that the saturated thickness decreases to the north where groundwater discharges to both the alluvium of the Cimarron River and to seeps in cliffs overlooking the river flood plain. In the BG-1 area, Sandstone B discharges to the north into the alluvium as shown in the Figure 2 cross-section. Figure 3 is a map of the subject area showing the line of cross-section in Figure 2.

Well yield data collected during a short-term aquifer test and well development work on a Sandstone B monitor well TMW-21 indicates that Sandstone B will not support a sustained pumping rate greater than approximately one to two gallons per minute.

Mudstone B is a sequence of mudstones ranging in thickness from 6 to 14 feet between Sandstone B and Sandstone C outside of the subject area. Locally, Mudstone B ranges in thickness from 0 to 10 feet. Water level and water quality data from site monitor wells show that this unit hydraulically separates Sandstone B from Sandstone C.

Sandstone C underlies the Mudstone B confining layer and is a sequence of interlayered sandstones and mudstones at least 100 feet in thickness beneath the entire Cimarron site. The base of the fresh water zone as defined by the USGS, is found within the shallow-most strata of Sandstone C (Carr, 1977).

Water-level data collected from monitor wells constructed at various depths in Sandstone C show that the sandstone is fully saturated, with pressure heads that increase with depth. The potentiometric surface is above the elevation of the Cimarron River, demonstrating that Sandstone C is discharging into the Cimarron

River as base flow. The base of the high salinity interface was observed on-site in the deeper strata of Sandstone C at approximately 190 feet below grade.

Previous Characterizations of BG-1

As previously mentioned, limited groundwater characterization was performed in 1984 and 1985 with the completion of wells 1314, 1315, 1316, and 1317. Uranium concentrations in groundwater from well 1315, downgradient from BG-1 fluctuated over the years but has shown a continual downward trend. After several years of groundwater monitoring, NRC expressed concern that a possible uranium source may still remain in the former BG-1 area.

In response, Cimarron conducted a magnetometer survey in July 1998. Four small anomalies were located. To further characterize the area, Cimarron proposed an assessment in March 1999, which included soil sampling, deeper bedrock borings and groundwater sampling. Also, the anomalous areas encountered during the magnetometer survey were inspected with excavated backhoe pits. None of the miscellaneous debris encountered was associated with the materials originally buried in the former BG-1 area. Also, the soil assessment performed in 1999 did not identify any potential sources.

However, the 1999 groundwater characterization efforts did identify an expanded uranium plume possibly extending downgradient of the former BG-1 area and into Sub-Area C. Sub-Area C lies approximately 230 feet north of the former BG-1 trenches and was released from license in 1996.

Based upon the initial 1999 characterization, additional assessment efforts were performed in 2000 to investigate the possible migration of the uranium into the alluvium of Sub-Area C and the bedrock of Sub-Area F. Wells were installed in the alluvium as well as both Sandstone B and Sandstone C. In addition, a "screening" assessment of the floodplain alluvium was performed with the installation of a series of temporary well points using direct push technology. A total of 57 "one-time" groundwater samples were collected.

The screening assessment utilized a Geo-Probe unit to hydraulically push a steel probe to refusal, assumed to be at or near bedrock. Following removal of the probe, a 10-foot section of 1-inch PVC screen with 1-inch PVC riser was pushed to the bottom of the boring. No filter pack was installed around the screen. The upper few inches of the annulus were filled with bentonite to prevent surface fluids from entering the borehole.

Tubing was inserted inside the PVC casing string to total depth. Pressurized air was used to lift both formation water and sediment. This encouraged some limited development of the zone. A "one-time" groundwater sample was then collected from each 1-inch "well". The samples were filtered with a 0.45 micron filter prior to analysis in the on-site laboratory. The samples were analyzed for gross alpha and gross beta using the on-site Tennelec in order to have rapid qualitative information (24-hours or less versus 30 day plus for off-site labs). Limited off-site lab analyses was performed for quantitative results. The gross alpha values from the Tennelec were converted to total uranium measured in pico- Curies per Liter (pCi/L).

On-site Lab groundwater sample results for temporary monitor wells and direct push sampling points provided the majority of the data from which a preliminary uranium plume was drawn. Due to project constraints at that time, existing wells were not sampled at the same time as the assessment sampling points, and sample preparation and analytical methodology were not consistent for all sample locations (i.e. some samples were analyzed on-site and some were analyzed off-site).

The results of this assessment indicated that uranium had migrated into the alluvium in Sub-Area C, and may be present in the unconfined shallow groundwater at concentrations exceeding the site-specific groundwater criteria of 180 pCi/l (the "Criteria"). To provide sufficient data to both define the extent of the plume, and to develop a remedial action plan (as requested by NRC), additional monitor wells, appropriately screened and completed, should be installed. Cimarron Corporation proposes the following work plan to provide that information.

Proposed Scope of Work

Monitor wells will be installed in the floodplain alluvium and in Sandstone "B" in the vicinity of BG-1. The exact location and number of wells may change, as the final extent of the assessment will be based on analytical screening of groundwater samples by an off-site laboratory. The final well network will provide adequate data to completely delineate that portion of the plume that exceeds the Criteria. Preliminary locations are shown in Figure 4.

<u>Well Installation - Alluvium</u>

Approximately 34 alluvial borings are proposed to advance into the top of bedrock. Total depth will range from 15 to 20 feet near the northern edges of the former trenches. As the alluvium thickens to the north approaching the Cimarron River, total depth may reach 30 feet.

Completed monitor wells will be constructed of 2-inch PVC and will be screened across the full-saturated thickness of the aquifer. Screen lengths will range from 10 to 15 feet in the vicinity of the former trenches. In the direction of the river, the thicker alluvial material will require screen lengths ranging from 20 to 25 feet.

Soil samples from select borings will be sampled in one-foot increments for analysis of total uranium using the soil counter in the on-site laboratory. This sampling is intended to demonstrate that soils in the subject area do not exceed the decommissioning criteria for soils.

Soil samples from at least two borings will be collected for off site analysis to determine distribution coefficient and geotechnical properties of the soils. The samples submitted for the distribution coefficient tests will be chosen from those exhibiting significant uranium concentrations. Additional geotechnical soil testing may be conducted in relation to potential remedial measures.

Well 1317 will be plugged and abandoned due to possible screen plugging. Redevelopment efforts have failed to improve its water bearing capabilities and will be replaced by the nearby existing well TMW-13, installed in 1999.

Procedures for monitor well installation and development, groundwater sampling, groundwater sample preservation and analysis, monitor well abandonment are included in Appendix A of the work plan.

Well Installation - Bedrock

A total of five bedrock wells are proposed. Three locations will be used to better define the limits of the bedrock uranium plume while two others will be replacement wells for Wells 1315 and 1316 which are older wells installed prior to the 1989 site investigation by James L. Grant. The two replacement wells will be installed in core holes drilled through the B sandstone into the upper section of Mudstone B. The sandstone will be sampled by continuous coring. Monitor wells will be completed with 2-inch PVC riser and screen.

This proposed bedrock assessment will provide a total of 12 Sandstone B monitor wells along with the two existing Sandstone C wells. To provide groundwater flow direction and gradient, a third Sandstone C well will be installed to the north near TMW-24 in a non-impacted area.

Monitor wells will be thoroughly developed to remove sediment and flush fines from the sand pack and the portion of the formation adjacent to the well screen. Each monitor well location and top-of-casing elevation will be surveyed using survey-grade GPS equipment. X and Y state-plane coordinates will be located and top of casing elevations will be recorded to within 0.1 foot.

Procedures for monitor well installation and development, groundwater sampling, groundwater sample preservation and analysis, monitor well abandonment are included in Appendix A of the work plan.

Aquifer Test – Alluvium

A pump test may be performed in a well installed during this assessment, or in one of the existing wells screened to fully penetrate the alluvium. Initial testing (measuring drawdown while pumping at various rates) will be conducted to determine an appropriate discharge rate for the test. A three-day pumping test will then be conducted to determine the hydraulic conductivity of the alluvial materials

Groundwater Sampling and Analysis – Additional Borings

Groundwater samples from newly installed wells will be shipped overnight to an off-site laboratory for analysis of total uranium. These analytical results will be used exclusively for the determination of locating additional wells and step-out locations and will not be part of the final submittal. For monitor wells located near the edge of the plume, analytical results (after adjusting for analytical error) will indicate if the edge of the plume has been identified. If results from such wells indicate that a monitor well may be located in the interior of the 180+ pCi/l plume, an offset well will be drilled to ensure the entire plume is delineated.

Confirmatory groundwater samples will be collected from all existing and newly installed area monitoring wells (i.e., Sub-Area F and C) at the conclusion of the field work. This round of analyses for total uranium will provide confirmation that the limits of the plume have been identified. As in previous groundwater sampling events, Cimarron personnel will perform validation of analytical results.

Documentation

Appendix A contains procedures related to drilling activities, soil and groundwater sampling, and piezometer and monitor well installation. These procedures identify necessary documentation such as soil boring log diagrams, monitor well installation diagrams and field note books.

Deliverables

A groundwater assessment report will describe field activities conducted, and provide boring logs, monitor well installation diagrams, and laboratory results. It will present the hydrogeology of the subject area, the extent of the uranium plume that exceeds the 180 pCi/l criteria, and the projected rate and direction of groundwater flow toward the Cimarron river. The report will form the basis for the development of a remedial action plan for the groundwater plume.

Schedule

Kerr-McGee will submit a report on the assessment project within 90 days of validation of the final laboratory report.

References

Carr, J.E., and Marcher, M.V., 1977. "A Preliminary Appraisal of the Garber-Wellington Aquifer Southern Logan and Northern Oklahoma Counties, Oklahoma," USGS Open file Report 77-278.

Engineering Enterprises, 1973. Hydrological Information in the Vicinity of the Kerr-McGee Facility, Logan County, OK.

Grant, James L., 1989. Site Investigation Report for the Cimarron Corporation Facility, Logan County, Oklahoma, September 12, 1989.

Wood and Burton, 1968. Groundwater Resources in Cleveland and Oklahoma Counties, Oklahoma: Oklahoma Geological Survey Circular, 71.
Groundwater Evaluation Report

APPENDIX A

Drilling- Subsurface Soil and Bedrock Sampling

KERR-MCGEE CORPORATION
CIMARRON FACILITY
SAMPLING AND ANALYSIS PROCEDURE

Drilling- Subsurface Soil and Bedrock Sampling

Objective: To establish a method for screening and sampling subsurface soil and bedrock.

Scope: To establish a method of drilling as a means of subsurface field sampling:

- Subsurface soil screening and sampling using drilling methods,
- Bedrock core collection and logging,
- Bedrock screening and sampling using drilling methods, and
- Core hole abandonment.

Subsurface Soil Sampling Using Drilling Methods

Sampling equipment may include the following:

Sample containers as per the Sampling and Analysis Plan

Sample labels

Munsell color chart

Soil boring logs

Field log book

Chain of custody form

Indelible marking pen

Hand sprayer or wash bottle

Hand lens

Paper towels

Vinyl, nitrile, or latex gloves

Aluminum foil

Utility knife

Mixing bowl(s) and spoon(s)

Real-time monitoring instruments

Garbage bags

Decontamination equipment

Sample Collection

If shelby tube samples are collected without extruding the sample, place caps over the ends of the tubes, tape them securely, label the shelby tube, and place the sample in the cooler for transfer.

Open the split spoon or split barrel sampler or extrude the soil core from a shelby tube sampler. Do not allow the sample to contact other potentially contaminated material. This can be accomplished by extruding or placing the sample on clean aluminum foil, plastic garbage bags, or visqueen.

Describe the lithology of the sample, including soil classification, soil sample location, field screening measurement, and other observations made. Record this information on the soil boring log (form KM-5655-A) as described on the form. Remove rocks and/or debris as appropriate.

If samples are collected for radiological analysis, scan the length of the soil sample to identify possible zones of radiological contamination. Record readings on the soil boring log.
Ensure that samples collected for radiological analysis are compacted and fill at least 90% of the sample bottle.

Samples collected for radiological analysis only do not need to be placed on ice
When compositing soil samples, collect and homogenize each aliquot in separate mixing bowls.
Combine the aliquots in a larger bowl and thoroughly homogenize the total sample.
Decontaminate sampling equipment between samples as specified in the field work plan.
Sampling equipment must be decontaminated between composite samples but not between aliquots.

Subsurface Bedrock Sampling

Sampling equipment may include:

Sample containers

Munsell color chart

Soil boring logs

Field log book

Chain of custody form

Appropriate gloves

Garbage bags

Indelible marking pen

Hand sprayer or wash bottle

Hand lens

Paper towels

Aluminum foil

Utility knife

Mixing bowl(s) and spoon(s)

Real-time monitoring instruments

Laths, stakes, and or flags for marking boring locations

Decontamination equipment

Bedrock Core Collection

Remove core from the core barrel. Describe the lithology of the core, including rock classification, sample location, field screening measurements, and other observations made. Record this information on the soil boring log (form KM-5655-A) as described on the form. If the core is to be retained, wrap it in plastic (if possible), and place it in a core box. Label the plastic wrap surrounding the core. If the core is fragmented and cannot be wrapped, simply place it in the correct interval of the core box.

Record the top and bottom depth, position of core loss zones (if known), and identification of fractures on the boring log. Fractures caused by coring or by removing core from the core barrel should be distinguished from fractures interpreted as in-situ.

Label the top and end of the core boxes. Record the core hole number, depth interval of the core, and other appropriate information. Wooden blocks may be used as spacers inside core boxes to mark the ends of core runs and positions of core loss zones. If used, label the wooden blocks with the depth intervals they represent.

Bedrock Sample Collection

When removing the rock core from the barrel, do not allow the sample to contact other potentially contaminated material. This can be accomplished by placing the sample on clean aluminum foil or plastic garbage bags. If samples are collected for radiological analysis, scan the length of the core to identify possible zones of radiological contamination. Record readings on the boring log. Samples collected for radiological analysis only do not need to be placed on ice. Decontaminate sampling equipment between samples as specified in the field work plan.

Borehole Abandonment

Plug each core hole not converted into a monitoring well or piezometer by filling the hole from total depth to within four feet below ground surface with a cement/bentonite grout composed of Portland Type I cement with 5 percent bentonite.

If the borehole is greater than 20 feet deep, grout must be placed by extending a tremie pipe to within a few feet of the bottom of the hole, and then pumping the grout through the tremie pipe upward in the core hole. Fill the remainder of the core hole with uncontaminated soil.

SOIL BORING LOG KM—5655-A

KERR-McGEE CORPORATION Hydrology Dept. Engineering Services	KM SUBSIDIARY	LOCATION	BORING NUMBER

DEPTH IN FEET	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	UNIFIED SOIL FIELD CLASS.	BLOWS PER FOOT	PID (ppm)	SOIL SAMPLE				REMARKS OR FIELD OBSERVATIONS
						NO.	TYPE	DEPTH	REC.	

EXPLANATION

Water Table (24 Hour)

Water Table (Time of Boring)

PID Photoionization Detection (ppm)

NO. Identifies Sample by Number

TYPE Sample Collection Method

SPLIT-BARREL | AUGER | ROCK CORE

THIN-WALLED TUBE | CONTINUOUS SAMPLER | NO RECOVERY

DEPTH. Depth Top and Bottom of Sample

REC. Actual Length of Recovered Sample in Feet

GRAPHIC LOG LEGEND

CLAY	DEBRIS FILL
SILT	HIGHLY ORGANIC (PEAT)
SAND	SANDY CLAY
GRAVEL	CLAYEY SAND
SILTY CLAY	______
CLAYEY SILT	______

DATE DRILLED	PAGE of
DRILLING METHOD	
DRILLED BY	
LOGGED BY	
EXISTING GRADE ELEVATION (FT. AMSL)	
LOCATION OR GRID COORDINATES	

MAJOR DIVISIONS			GROUP SYMBOLS	TYPICAL NAMES
COARSE-GRAINED SOILS	GRAVELS	CLEAN GRAVELS	GW	Well-Graded Gravels and Gravel-Sand Mixtures, Little or No Fines
			GP	Poorly Graded Gravels and Gravel-Sand Mixtures, Little or No Fines
		GRAVELS WITH FINES	GM	Silty Gravels, Gravel-Sand-Silt Mixtures
			GC	Clayey Gravels, Gravel-Sand-Clay Mixtures
	SANDS	CLEAN SANDS	SW	Well-Graded Sands and Gravelly Sands, Little or No Fines
			SP	Poorly Graded Sands and Gravelly Sands, Little or No Fines
		SANDS WITH FINES	SM	Silty Sands, Sand-Silt Mixtures
			SC	Clayey Sands, Sand-Clay Mixtures
FINE-GRAINED SOILS	SILTS AND CLAYS LIQUID LIMIT >50%		ML	Inorganic Silts, Very Fine Sands, Rock Flour, Silty or Clayey Fine Sands
			CL	Inorganic Clays of Low to Medium Plasticity, Gravelly Clay, Sandy Clays, Silty Clays, Lean Clays
			OL	Organic Silts and Organic Silty Clays of Low Plasticity
	SILTS AND CLAYS LIQUID LIMIT <50%		MH	Inorganic Silts, Micaceous or Diatomaceous Fine Sands or Silts, Elastic Silts
			CH	Inorganic Clays of High Plasticity, Fat Clays
			OH	Organic Clays of Medium to High Plasticity
HIGHLY ORGANIC SOILS			PT	Peat, Muck and Other Highly Organic Soils

ASTM GEOLOGICAL DESCRIPTION CHECKLIST FOR FINE-GRAINED AND PARTLY ORGANIC SOILS

1. **TYPICAL NAME:** Sandy Silt, Silt, Silty Clay, Clay, Clayey Silt, Sandy Clay, Organic Silt, Organic Clay
2. **MAXIMUM PARTICLE SIZE**
3. **SIZE DISTRIBUTION**
4. **DRY STRENGTH:** None, Very Low, Low, Medium, High, Very High
5. **DILATENCY:** None, Slow, Rapid
6. **PLASTIC THREAD:** Weak and Soft, Medium, Stiff, Very Stiff
7. **PLASTICITY OF FINES:** None, Low, Medium, High
8. **COLOR:** Use Munsell Notation, If Possible
9. **ODOR:** None, Earthy, Organic
10. **MOISTURE CONTENT:** Dry, Moist, Wet, Saturated
11. **CONSISTENCY:** Soft, Firm (Medium), Stiff, Very Stiff, Hard
12. **STRUCTURE:** Stratified, Laminated, Fissured, Slickensided, Blocky, Lensed, Homogeneous
13. **CEMENTATION:** Weak, Strong
14. **LOCAL OR GEOLOGIC NAME**

ASTM GEOLOGICAL DESCRIPTION CHECKLIST FOR COARSE GRAINED SOILS

1. **TYPICAL NAME:** Boulders, Cobbles, Gravel, Sand (Add Descriptive Adjectives For Minor Constituents)
2. **GRADUATION:** Well Graded, Poorly Graded
3. **MAXIMUM PARTICLE SIZE**
4. **SIZE DISTRIBUTION:** Percent Gravel, Sand and Fines
5. **GRAIN SHAPE:** Angular, Subangular, Subrounded, Rounded
6. **MINERALOGY:** Rock Type For Gravel, Predominant Minerals in Sand
7. **COLOR:** Use Munsell Notation, if Possible
8. **ODOR:** None, Earthy, Organic
9. **MOISTURE CONTENT:** Dry, Moist, Wet, Saturated
10. **NATURAL DENSITY:** Loose Dense
11. **STRUCTURE:** Stratified, Lensed, Nonstratified
12. **CEMENTATION:** Weak, Strong
13. **LOCAL OR GEOLOGIC NAME**

NOTES

Groundwater Sampling

KERR-MCGEE CORPORATION
CIMARRON FACILITY
SAMPLING AND ANALYSIS PROCEDURE

Groundwater Sampling

Objective: To establish a procedure for sampling groundwater.

Scope: This procedure covers:

- Monitor well purging,
- Groundwater sample collection, and
- Disposition of investigation derived waste.

Groundwater Purging

Groundwater purging equipment may include:

Field log book

Chain of custody form

Indelible marking pen

Field parameter forms

Samples as per the Sampling and Analysis Plan

Sample labels

Disposable bailers

Polypropylene rope

Electronic water level indicator

Specific conductivity meter with standard solutions

pH meter and calibration buffer solutions

Thermometer

Plastic sheeting

Five gallon bucket

Disposable gloves

Calculator

Decontamination equipment

Container for collection of purge water (e.g., 55-gallon drum or plastic tank)

Garbage bags

Monitoring Well Purging

Make sure the pH meter and conductivity meters are calibrated and test the water level indicator before going to the field to collect samples. Record the instrument and confirmation of calibration in the field log book.

Unlock the casing protector and remove the well cap. Record these readings in the field log Book. Test the electric water level indicator to ensure operability. Measure the depth to water and total well depth to within 0.01 feet relative to the measuring point at the top of the well casing (TOC).

If needed, place a clean sheet of plastic or a 30 gallon trash can lined with clean plastic adjacent to the monitoring well to prevent equipment from contacting the ground. Remove a minimum of three casing volumes of water from the well.

A Bladder pump,submersible pump, peristaltic pump, or bailer may be used. Table 1 shows the amount of fluid to be evacuated from various common sized monitoring wells.

If using a pump to purge the well, submerge the pump no more than 5 feet below the top of the water surface to ensure that water entering the screen flows up and no "stagnant" water is left in the well casing.

While purging the well, collect a sample of the purge water in a plastic beaker after removing each well casing volume. Record observations about the purge water on the field parameter form (e.g., , turbid, cloudy, clear, colored).

Using this sample, measure temperature to the nearest 0.1°C, pH to one decimal place, and conductivity to three significant figures. Record the results in the field log book. Pour the sample into the container into which purge water is being placed. Decontaminate the probes with distilled water.

The well may be sampled when three casing volumes have been purged if three consecutive temperature and conductivity measurements are within 10% of each other and pH is within 0.1 unit. The well must be then be sampled within 24 hours of purging.

Record these values as well as the total volume of purged water on the field parameter form. If a well does not yield sufficient water to remove three casing volumes, record the temperature, conductivity, and pH of the last water to be removed from the well. The well must then be sampled within 24 hours of the time it was bailed dry. Place purge water into a storage container and dispose of in the storm water retention pond.

Sample Collection

Sample collection equipment may include:

Sample containers and preservative

Field log book

Indelible marking pen

Disposable bailers

Polypropylene rope

Plastic sheeting

Five gallon bucket

Disposable gloves

Decontamination equipment

Preservative

Groundwater Sample Collection for Unfiltered Samples

Lower the bailer into the well, being careful not to "plunge" the bailer into the water. Retrieve the bailer from the well and pour the sample directly from the bailer into the sample container. If using a pump to sample, discharge from the pump directly into the sample bottles.

Record the sample number on the chain of custody form.

If dedicated bailers are not used, decontaminate sampling equipment between monitoring wells.

If sampling for other than radionuclides, sample containers will be filled in the following sequence: volatile organics (VOC), purgeable organic carbon, purgeable organic halogens, total organic halogens (TOX), total organic carbon (TOC), extractable metals, total metals (TAL), dissolved filtered metals, phenols, cyanide, sulfate/chloride, turbidity, nitrate/ammonia, radionuclides. Visually check the VOC sample bottle to ensure no bubbles are present.

Groundwater Sample Collection for Filtered Samples

Lower the bailer into the well, being careful not to "plunge" the bailer into the water. Retrieve bailer from well and attach a filter (typically 5.0 micron) and pressure filtration unit to bailer. Pressure filter the water in the bailer directly into the sample container. If using a pump to sample, attach an in-line, high capacity filter on the pump discharge and fill sample bottles directly.

Record the sample number on the chain of custody form. If dedicated bailers or pumps are not used, decontaminate sampling equipment between monitoring wells. Filters should be changed when filtration times become inordinately long. Generally, filtered samples are obtained and filled in the following order for these parameters only: dissolved metals, radionuclides.

TABLE 1. VOLUME OF WATER TO BE PURGED FROM VARIOUS SITED MONITORING WELLS

Feet of Water	Number of Gallons To Evacuate One Casing Volume					Number of Gallons To Evacuate Two Casing Volume					Number of Gallons To Evacuate Three Casing Volume				
	2"	3"	4"	5"	6"	2"	3"	4"	5"	6"	2"	3"	4"	5"	6"
1.0	0.16	0.37	0.65	1.02	1.47	0.32	0.74	1.30	2.04	2.94	0.48	1.11	1.95	3.06	4.41
2.0	0.32	0.74	1.30	2.04	2.94	0.64	1.48	2.60	4.08	5.88	0.96	2.22	3.90	6.12	8.82
3.0	0.48	1.11	1.95	3.06	4.41	0.96	2.22	3.90	6.12	8.82	1.44	3.33	5.85	9.18	13.23
4.0	0.64	1.48	2.60	4.08	5.88	1.28	2.96	5.20	8.16	11.76	1.92	4.44	7.80	12.24	17.64
5.0	0.80	1.85	3.25	5.10	7.35	1.60	3.70	6.50	10.20	14.70	2.40	5.55	9.75	15.30	22.05
6.0	0.96	2.22	3.90	6.12	8.82	1.92	4.44	7.80	12.24	17.64	2.88	6.66	11.70	18.36	26.46
7.0	1.12	2.59	4.55	7.14	10.29	2.24	5.18	9.10	14.28	20.58	3.36	7.77	13.65	21.42	30.87
8.0	1.28	2.96	5.20	8.16	11.76	2.56	5.92	10.40	16.32	23.52	3.84	8.88	15.60	24.48	35.28
9.0	1.44	3.33	5.85	9.18	13.23	2.88	6.66	11.70	18.36	26.46	4.32	9.99	17.55	27.54	39.69
10.0	1.60	3.70	6.50	10.20	14.70	3.20	7.40	13.00	20.40	29.40	4.80	11.10	19.50	30.60	44.10
15.0	2.40	5.55	9.75	15.30	22.05	4.80	11.10	19.50	30.60	44.10	7.20	16.65	29.25	45.90	66.15
20.0	3.20	7.40	13.00	20.40	29.40	6.40	14.80	26.00	40.80	58.80	9.60	22.20	39.00	61.20	88.20
25.0	4.00	9.25	16.25	25.50	36.75	8.00	18.50	32.50	51.00	73.50	12.0	27.75	48.75	76.50	110.25
30.0	4.80	11.10	19.50	30.60	44.10	9.60	22.20	39.00	61.20	88.20	14.40	33.30	58.50	91.80	132.3

Monitor Well Installation

KERR-MCGEE CORPORATION
CIMARRON FACILITY
SAMPLING AND ANALYSIS PROCEDURE

Piezometer and Monitoring Well Installation and Abandonment

Objective: To establish a method for the installation of monitoring wells and piezometers.

Scope: This procedure covers:

- Installation equipment,
- Specifications,
- Monitoring well installation,
- Shallow water table completions,
- Surveying requirements, and
- Piezometer and monitoring well abandonment

Installation Equipment

Piezometer and monitoring well installation equipment may include the following:

Well completion diagram forms

Well casing

Well screen

Centralizers (if needed)

Bentonite powder and pellets

Type I Portland cement

Concrete

Outer protective casing w/ lock

Boring logs

Field log book

Indelible marking pen

Locks keyed to other site monitoring wells

Fiberglass tape

Electronic water level indicator

Decontamination equipment

Specifications – All Piezometers and Monitoring Wells

All monitoring wells will be installed in accordance with Oklahoma Water Resources Board (OWRB) rules OAC 785:35. Boreholes or core holes in which piezometers or monitoring wells are installed must provide at least three inches of annular space around the well screen and riser pipe.

A qualified hydrogeologist must specify piezometer and monitoring well size and materials, screened interval, well screen specifications, filter pack material, seal and grout intervals, and completion details.

PVC wells and piezometers will be constructed of screw-coupled casings. No cement, glue, or tape can be used in monitoring well installation. Centralizers must be used in all piezometers and monitoring wells greater than 20 feet in depth, unless drilled with hollow stem auger. When used, centralizers will be spaced at intervals specified by a qualified hydrogeologist.

Monitor wells will include a sump at least six inches in length below the bottom of the well screen. Filter pack material will extend at least two feet above the top of the well screen unless this distance would create a pathway for vertical migration of contamination into the well.

A bentonite pellet seal at least two feet thick will be placed on top of the filter pack. If bentonite slurry is used in lieu of bentonite pellets, the slurry will be at least five feet thick. A thick cement/bentonite grout consisting of at least 5 pounds of bentonite per sack of cement will be placed on top of the bentonite seal to within one foot of the ground surface. Cement grout placed to depths exceeding twenty feet must be pumped from the bottom of the annular space upward through a tremie pipe.

A vented cap must be placed on the top of the riser pipe unless the well is in a flood-prone area, which will require a non-vented cap.

Specifications –Extending Above Grade

A locking steel well protector at least two inches larger in dimension than the well materials will extend at least twelve inches into the ground and must extend at least two feet above grade. A concrete pad at least four feet square and at least four inches thick will be poured around the protector pipe. The outside of the pad should be at grade elevation. The concrete will extend down the annulus to the top of the cement/bentonite grout. The concrete will slope away from the well protector. A surveying pin or bolt will be placed in the concrete protector pad to serve as a "ground elevation" survey point. A 1/8 to ¼ inch hole will be drilled through the well protector at the top of the concrete pad.

Specifications – Flush Mounting

A waterproof locking cap must be installed in the top of the riser pipe. A steel protective casing must be placed as a protector around the top of the riser pipe. Concrete must extend at least two inches around the outside of the meter box and at least one foot below the bottom of the protective casing. Concrete should slope gently away from the meter box so the area does not drain into the meter box. A surveyor's pin or bolt must be placed in the concrete to serve as a "ground elevation" survey point.

Specifications - Shallow Water Table

Variance from the above specifications may be necessary if the water table is within five feet of the surface. In such cases, completion details must be specified by a qualified hydrogeologist. In no case will the distance from the top of the screen to the top of the filter pack may be less than 0.5 feet, or the bentonite pellet seal thickness be less than one foot.

Piezometer and Monitoring Well Installation

Inspect well material to ensure it meets specifications and is clean and free of foreign matter prior to use. Wash screens and casings with Alconox or equivalent and deionized water rinse. Store washed materials in clean plastic sheeting until installation. Washing is not necessary if well material is in the manufacturer's original packaging and the packaging is intact.

Record all well completion information on the monitoring well installation diagram, using the appropriate form for above-grade or flush-mounted completions. Lower well screen and casing (with centralizers as specified) into the borehole, recording the depth of the top and bottom of the well screen to within 0.1 feet below grade. If the terrain is very uneven, drive a bolt or spike in the ground to serve as a reference until the well is completed.

With the casing string suspended near the bottom of the boring, pour the filter pack material slowly into the annulus to prevent bridging. Calculate the estimated amount of sand needed to help determine if bridging is occurring. Use a fiberglass tape with a weight attached to the end to determine the top of the filter pack. Measure the depth to the top of the filter pack to within 0.1 foot.

Unless the hydrogeologist specifies another method, swab the well screen with a weighted surge block and remove the water from the well. Allow the filter sand pack to settle, and measure the depth to the top of the filter pack again. Add additional filter material if necessary. If over one foot of filter pack was added, wash the filter again.

Pour bentonite pellets slowly down the annulus to prevent bridging. Measure the depth to the top of the bentonite seal to within 0.1 feet with the weighted tape. Ensure that the bentonite seal is at least two feet thick. If the seal is above the water table, pour several gallons of clean (potable) water down the annulus to hydrate the bentonite seal.

Mix a thick cement/bentonite grout consisting of at least 5 pounds of bentonite powder per sack of concrete, and fill the annulus to within two feet of the ground surface. Allow the grout to settle before installing the concrete pad. Cut a notch or place a mark on the top of the well casing as a reference point for Top of Casing (TOC) elevation and depth to water measurements.

Shallow Water Table Completions

Variance from the above specifications may be necessary if the water table is within seven feet of the surface. In such cases, completion details must be specified by a qualified hydrogeologist.

In no case will the distance from the top of the screen to the top of the filter pack may be less than 0.5 feet, or the bentonite pellet seal thickness be less than one foot.

Surveying Requirements

Piezometers and monitoring wells must be surveyed to within 1.0 feet horizontally, and the top of casing and ground elevations must be surveyed to within 0.1 feet MSL

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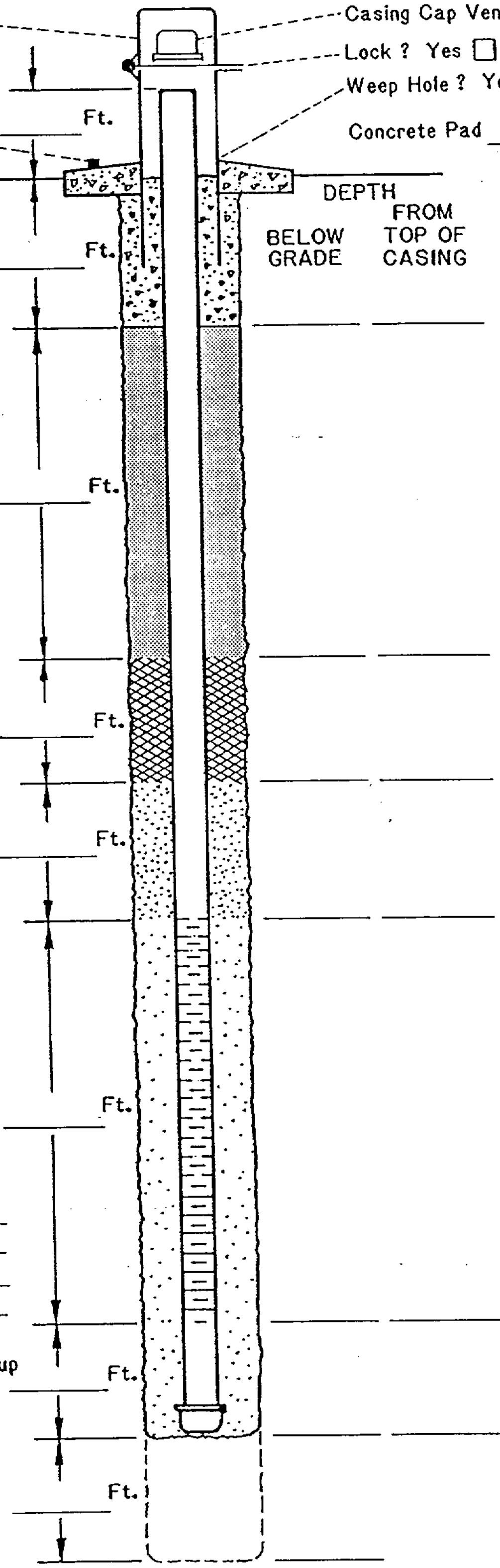
Piezometer and Monitoring Well Abandonment

Either pull or overdrill the casing. If the casing is pulled, drill out the borehole to make sure it is open to the original boring depth if required by OWRB rules. Backfill the borehole with cement/bentonite grout from total depth to less than four feet below grade through a tremie pipe. Backfill the uppermost four feet with clean soil. If it is not practical to remove the well casing, fill the well casing with a cement/bentonite grout from total depth to grade level. In accordance with Oklahoma Water Resources Board regulations, a licensed driller must notify the appropriate regulatory agency prior to monitor well or piezometer abandonment, and fill out and submit the appropriate well abandonment report.

KERR-McGEE CORPORATION
HYDROLOGY DEPARTMENT
MONITORING WELL INSTALLATION DIAGRAM



Protective Pipe
Yes ☐ No ☐
Steel ☐ PVC ☐
Surveying Pin ? Yes ☐ No ☐ ______ Ft.

Concrete ______ Ft.

Cement/Bentonite Grout Mix
Yes ☐ No ☐
5.5 Gallons Water to 94Lb. Bag Cement & 3-5 Lb. Bentonite Powder
Other: ______________ ______ Ft.

Bentonite Seal
Pellets ☐ Slurry ☐ ______ Ft.

Filter Pack Above Screen ______ Ft.

FILTER PACK MATERIAL
Silica Sand ☐
Washed Sand ☐ ______ Ft.
Pea Gravel ☐
Other: ______________
Sand Size ______________

Dense Phase Sampling Cup ______ Ft.
Bottom Plug
Yes ☐ No ☐

Overdrilled Material Backfill ______ Ft.
Grout ☐ Sand ☐
Caved Material ☐
Other: ______________

Casing Cap Vent ? Yes ☐ No ☐
Lock ? Yes ☐ No ☐
Weep Hole ? Yes ☐ No ☐
Concrete Pad ______ Ft. x ______ Ft. x ______ Inches

DRILLING INFORMATION:

1. Borehole Diameter= ______ Inches.
2. Were Drilling Additives Used ? Yes ☐ No ☐
   Revert ☐ Bentonite ☐ Water ☐
   Solid Auger ☐ Hollow Stem Auger ☐
3. Was Outer Steel Casing Used ? Yes ☐ No ☐
   Depth= ______ to ______ Feet.
4. Borehole Diameter for Outer Casing ______ Inches.

WELL CONSTRUCTION INFORMATION:

1. Type of Casing: PVC ☐ Galvanized ☐ Teflon ☐
   Stainless ☐ Other ______________
2. Type of Casing Joints: Screw-Couple ☐ Glue-Couple ☐ Other ______________
3. Type of Well Screen: PVC ☐ Galvanized ☐
   Stainless ☐ Teflon ☐ Other ______________
4. Diameter of Casing and Well Screen:
   Casing ______ Inches, Screen ______ Inches.
5. Slot Size of Screen:
6. Type of Screen Perforation: Factory Slotted ☐
   Hacksaw ☐ Drilled ☐ Other ______________
7. Installed Protector Pipe w/Lock: Yes ☐ No ☐

WELL DEVELOPMENT INFORMATION:

1. How was Well Developed ? Bailing ☐ Pumping ☐
   Air Surging (Air or Nitrogen) ☐ Other ______________
2. Time Spent on Well Development ?
   ______ / ______ Minutes/Hours
3. Approximate Water Volume Removed ? ______ Gallons
4. Water Clarity Before Development ? Clear ☐
   Turbid ☐ Opaque ☐
5. Water Clarity After Development ? Clear ☐
   Turbid ☐ Opaque ☐
6. Did Water have Odor ? Yes ☐ No ☐
   If Yes, Describe ______________
7. Did Water have any Color ? Yes ☐ No ☐
   If Yes, Describe ______________

WATER LEVEL INFORMATION:

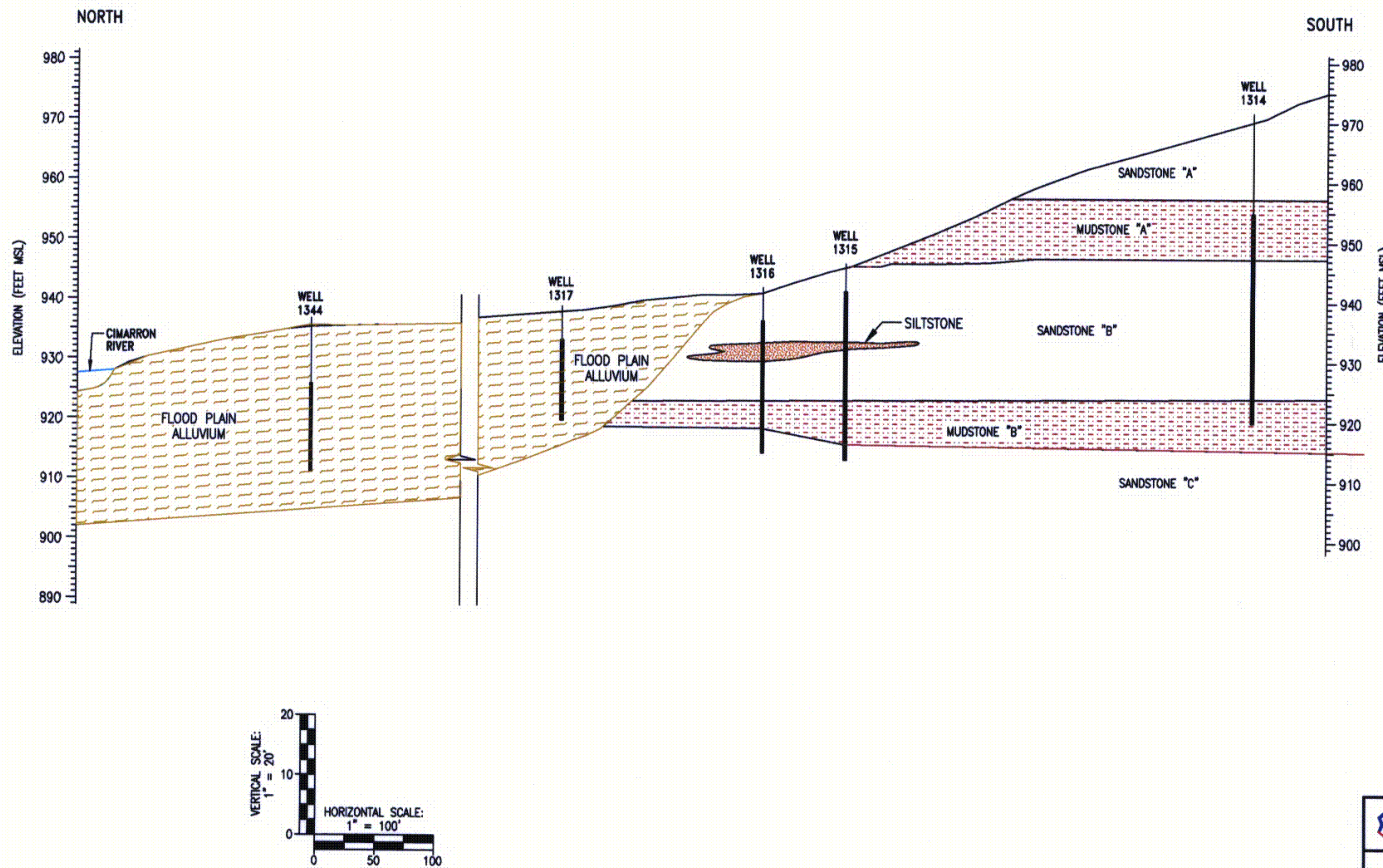
Water Level Summary (From Top of Casing)

During Drilling ______ Ft. Date ______
Before Development ______ Ft. Date ______
After Development ______ Ft. Date ______

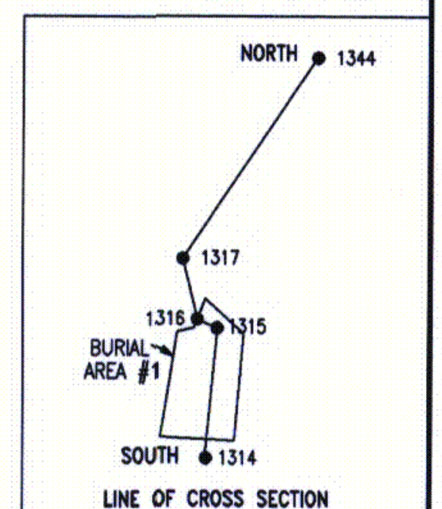
Driller/Firm ______________ Drill Rig Type ______________ Date Installed ______________

Drill Crew ______________ Well No. ______________ Kerr-McGee Hydrologist ______________

ILLUSTRATIONS



C01



CIMARRON CORPORATION

Figure 1
CIMARRON FACILITY
NORTH-SOUTH CROSS SECTION THROUGH
WELLS 1314, 1315, 1316, 1317 & 1344

REV.	DESCRIPTION	DRWN BY:	CK'D BY:	APP'D BY:	DATE
1	WELL 1344 ADDED.	JE	RS	JL	6/18/98
0	DRAWING ISSUED.	JE	SL	JK	4/18/97

DRWN. BY JE	DATE 4/17/97	SCALE AS SHOWN
JOB NO.	DRAWING NO. 98-XSEC-2	REV. 1

...\CIMARRON\GND-WTR\98_XSEC2

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THAT CAN BE VIEWED AT THE RECORD TITLED:

DWG. NO. 99BG1-XSEC-EE'

REV. A

FIGURE 2

"CIMMARRON FACILITY BURIAL AREA #1

CROSS SECTION E - E'"

WITHIN THIS PACKAGE...OR, BY SEARCHING USING THE DOCUMENT/REPORT NUMBER

99BG1-XSEC-EE' REV. A

NOTE: Because of this page's large file size, it may be more convenient to copy the file to a local drive and use the Imaging (Wang) viewer, which can be accessed from the Programs/Accessories menu.

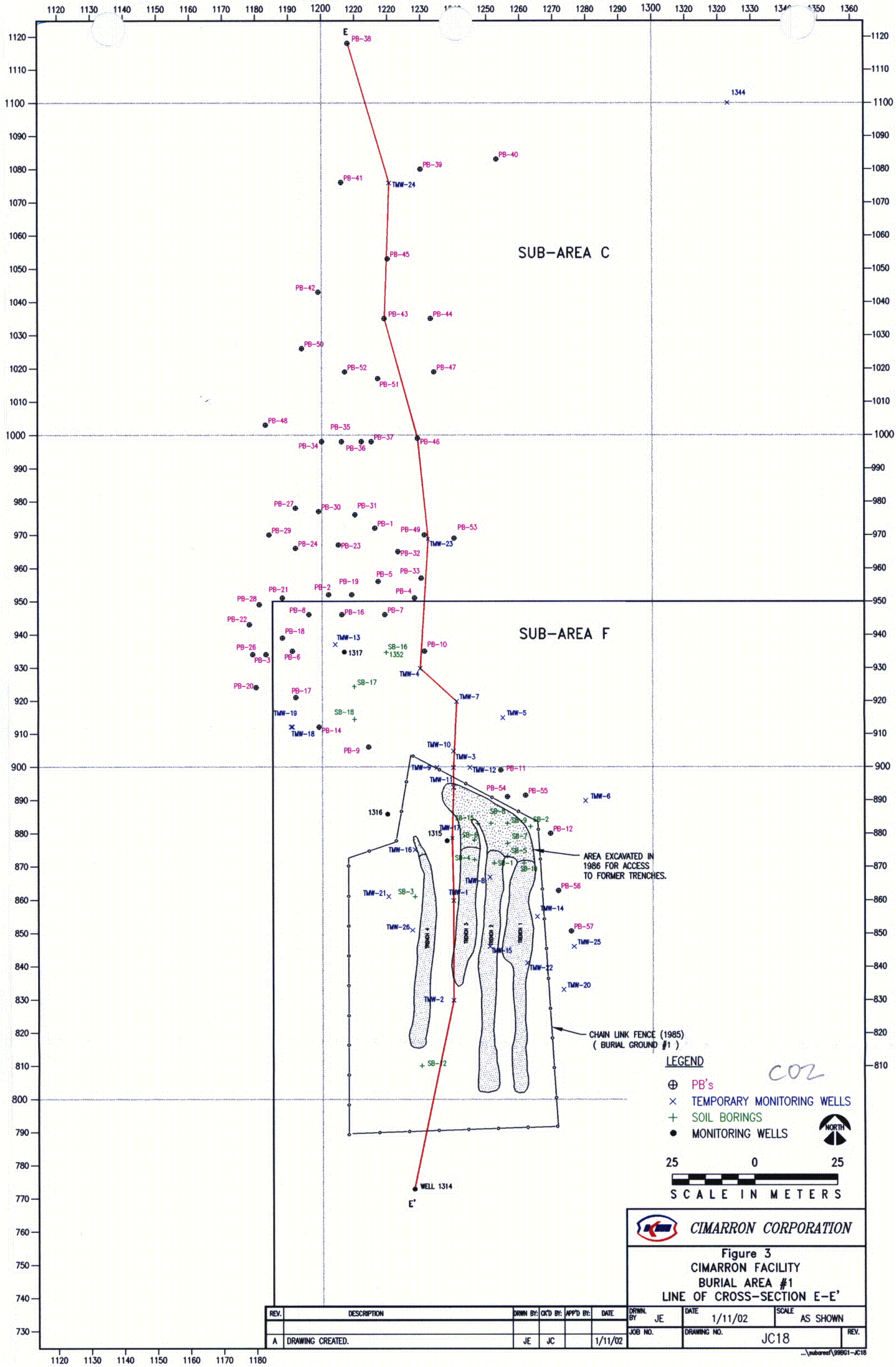

Figure 3
CIMARRON FACILITY
BURIAL AREA #1
LINE OF CROSS-SECTION E-E'

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THAT CAN BE VIEWED AT THE RECORD TITLED:

FIGURE 4

"CIMMARRON FACILITY BURIAL AREA #1 PROPOSED ASSESSMENT LOCATIONS"

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FIGURE 4

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