40-8902

9818

Licensing Documentation

Title: VOLUME XI - GROUND WATER MONITORING PLAN
BLUEWATER MILL TAILINGS FACILITIES NEAR
GRANTS, NEW MEXICO FOR ANACONDA COPPER COMPANY

Prepared for Anaconda Copper Co.

By: DAMES & MOORE
250 EAST BROADWAY, SUITE 200
SALT LAKE CITY, UT 84111

Date: SEPTEMBER 22, 1981

Reviewed by Science Applications, Inc.
505 Marquette Ave. N.W.
Albuquerque, New Mexico 87102

Date: SEPTEMBER 25, 1981

Anaconda Copper Company
P.O. Box 638
Grants, New Mexico 87020

93-0347

40-8902

9318

RETURN ORIGINAL TO PDR, HQ.

GROUND WATER MONITORING PLAN
BLUEWATER MILL TAILINGS FACILITIES
NEAR GRANTS, NEW MEXICO
FOR ANACONDA COPPER COMPANY

September 22, 1981

Job No. 4010-078-06

Dames & Moore

IGNATED ORIGINAL

y Mary C. Hood

93-0347

TABLE OF CONTENTS

LIST OF TABLES, ATTACHMENTS AND PLATES

GROUND WATER MONITORING PLAN
BLUEWATER MILL TAILINGS FACILITIES
NEAR GRANTS, NEW MEXICO
FOR ANACONDA COPPER COMPANY

INTRODUCTION

This report outlines our proposed plan for ground water monitoring for the tailings disposal facilities at the Bluewater Uranium Mill near Grants, New Mexico. The major facilities to be monitored are the existing tailings disposal area, the evaporation ponds, and the proposed below-grade trench disposal area. The locations of major facilities are shown on Plate 1, Site Plan Showing Monitoring Locations.

The proposed monitoring plan provided herein is designed to follow the intent of the New Mexico Water Quality Control Commission Regulations and U. S. Nuclear Regulatory Commission Guideline 4.14, "Radiological Effluent and Environmental Monitoring at Uranium Mills." The objectives of the monitoring program are as follows:

1. To establish "baseline" ground water quality conditions in newly completed wells for comparison with subsequent operational monitoring results.
2. To provide an early warning system for the prevention of large-scale excursions of contaminants.
3. To ascertain whether regulatory requirements of the State of New Mexico are being achieved.
4. To compare actual field conditions with predictions made from mathematical modeling.
5. To evaluate the performance of seepage control measures and to differentiate the effects of the three major facilities.

TAILINGS DISPOSAL FACILITIES

The Anaconda uranium mill has been in operation since the early 1950's. Tailings have been deposited in the existing above-grade tailings disposal area using conventional slurry disposal methods since 1953. Roughly 20,000,000 cubic yards of tailings are presently stored in the existing facility. The tailings impoundment was situated directly upon natural formations at the site which include alluvium, basalt and the San Andres Formation. Deep well injection of tailings effluent was practiced from 1960 through 1978. The disposal well was located near Monitor Well (Well #15) northeast of the evaporation ponds. Injection was into the Yeso Formation at depths of 950 to 1,423 feet. Evaporation ponds were constructed from 1978 through 1980 and are presently used to store and evaporate tailings liquid effluent from the milling operations. The evaporation ponds are lined with synthetic liner and clay materials. It is proposed to dispose of future tailings in a below-grade cut and cover trench disposal system to be located east of the evaporation ponds as shown on Plate 1. Tailings will be slurried into the unlined pits which will subsequently be covered with materials excavated from the adjacent pit, after decant of all free water from the pit. Discussion of disposal operations and tailings management is provided in Volume 9. Detailed seepage evaluations of the trench disposal system are presented in Volume 10.

HYDROGEOLOGY, WATER QUALITY AND GROUND WATER USE

The principal aquifers in the area are the basalt-alluvial aquifer and the San Andres-Glorieta aquifer. The Chinle Formation and the Yeso Formation are utilized to a minor extent several miles from the site but not within the potential impact area of the mill.

The San Andres Limestone and the Glorieta Sandstone form a single aquifer composed of massive limestone, sandy limestone and sandstone. The development of cavernous zones and solution channels in the upper part of the aquifer has resulted in high transmissivities and high well yields in most places. Geologic conditions are quite complex in the mill vicinity due to faulting. Ground water flow is generally eastward. Water quality is generally fair to good in areas of use and decreases in quality to the northeast where the formation increases in depth.

Quaternary basalt and alluvium form the second most utilized aquifer in the area. The aquifer primarily underlies the valley of the Rio San Jose and its tributaries south of the tailings pond. Ground water flow is generally southeasterly reflecting topographic and surface drainage conditions. A mantle of alluvium covers much of the area of the disposal sites, but is generally thin, of low permeability and does not constitute an aquifer in that area. Alluvium is essentially unsaturated at the evaporation ponds and subgrade disposal area. Natural ground water quality is quite variable, but is fair to good in areas of active recharge and moderately to highly permeable.

The Chinle Formation is composed primarily of mudstone and siltstone with interbedded silty sandstone and some coarse-grained sandstone. It generally acts as an aquiclude for the underlying San Andres Formation, but does yield small quantities of water to wells located several miles southeast of the Anaconda property boundary. The formation commonly contains gypsum and water quality is generally poor.

The Chinle Formation has been subject to erosion over the entire site and has been completely removed in some areas. The Chinle is mostly unsaturated over the site. It contains a few perched saturated layers and is saturated in its lower part along the northern portions of the Anaconda property. Detailed information on the geology and ground water hydrology of the site is presented in Volumes 2, 3 and 4.

PAST GROUND WATER MONITORING

Monitoring of ground water quality has been conducted since 1952. This information has been evaluated in several reports and summarized in Volume 3.

Water quality samples have been obtained from existing monitoring and water wells. The locations of existing wells in the mill vicinity are shown on Plate 1. Selected existing well data are presented on Table 1. A complete regional well inventory and map showing location of all wells in the region are provided in Volume 3.

PROPOSED PLAN

DISCUSSION

Ground water monitoring in this report has been divided into two parts: (1) monitoring of the saturated zone (ground water), that is, in aquifers present at the site; and (2) monitoring of the unsaturated zone. Unsaturated zone monitoring has as its purpose the detection of seepage prior to seepage reaching the water table, and is recommended for the below-grade tailing disposal area.

State of New Mexico Regulations do not provide specific guidance on design of monitoring systems. USNRC Regulatory Guide 4.14 (Revision 1) "Radiological Effluent and Environmental Monitoring at Uranium Mills" recommends that samples be obtained from at least one well located hydrologically upgradient and three wells downgradient of tailings disposal facilities; and that samples be obtained quaterly for one year prior to operation, monthly during the first year of operation and quarterly thereafter. In addition, NRC recommends samples be collected quarterly from each well within two kilometers of the tailings area that is or could be used for drinking water, livestock water, or crop irrigation. The below-grade disposal system is the only new facility and will be located far above the water table. It is, therefore, unwarranted to require monthly sampling during the first year of operation. However, since it appears that a full year of baseline sampling data will not be available in new wells installed to monitor the below-grade tailings facility, we have scheduled monthly sampling for the first year following their installation and quarterly thereafter as discussed later in the text.

Guide 4.14 suggests that samples be analyzed for dissolved natural uranium, thorium-230, radium-226, lead-210, and polonium-210. Uranium-natural is generally below MPC for unrestricted areas in the tailings pond and has been found to be far below MPC in wells in the vicinity. Therefore, we propose that uranium-natural not be routinely analyzed. We propose herein that thorium-230, lead-210 and polonium-210 not be routinely analyzed because these constituents are known to be extremely immobile at pH levels above pH 5.5.

The extensive calcareous materials at the site which provide buffering capacity, the long monitoring history at the site showing negligible effects on pH, and the ongoing monitoring for better indicator parameters obviate the need for routine analysis of these radionuclides.

In the proposed plan we have emphasized monitoring and analysis of key parameters indicative of contaminant migration, with less frequent analysis of other contaminants of low mobility. The key parameters were selected on the basis of high concentration in the tailings solution, high mobility, or their indicativeness of pollution from the tailings facility.

GROUND WATER MONITORING

WELLS

A monitoring well system has been laid out to specifically monitor each major facility (tailings pond, evaporation pond, and below-grade trench disposal area) and each aquifer which might possibly be affected. Proposed wells and their purpose are outlined on Table 2. The proposed system would require monitoring of 17 existing wells and 10 new wells which will have to be installed. New monitoring wells should be installed prior to tailings deposition in the first trench, except Well D which may be installed later but prior to tailings deposition in Trench 5.

In addition to the above wells, there are 17 wells within 2 kilometers which are or could be utilized as water monitoring sources. These wells are tabulated on Table 3. It is recommended that these wells also be monitored.

SAMPLING FREQUENCY AND PARAMETERS

We recommend that wells for the tailings facilities ground water monitoring system (Table 2) be sampled quarterly, except newly installed wells. We recommend that samples be analyzed for key parameters (Table 4) on the above schedule and that annually the detailed list of parameters (Table 5) be analyzed.

Newly installed wells should be sampled and analyzed more frequently during their first year to establish baseline conditions at the well. We recommend that newly installed wells be sampled monthly for their first year and analyzed for the detailed list of parameters (Table 5) quarterly and for key parameters (Table 4) in the months between. After one year of sampling, newly installed wells should be monitored as recommended in the previous paragraph.

We recommend that other wells within two kilometers of the tailings facilities (Table 3) be sampled quarterly and analyzed for key parameters (Table 4). Since many of these wells are inaccessible for measurement of water levels, water levels should be made only if feasible.

Each well that is sampled should be pumped until the electrical conductivity of the water produced is essentially constant. At least two casing volumes of water should be extracted prior to sample collection. Pumping provides the best means of obtaining the samples from the wells. Pumping rate, pumping time, volume of water pumped prior to sample collection, descriptions of the procedures used for sample collection and preservation and other pertinent information should be recorded at the site. To aid in the recording of this information, a ground water quality sampling form should be filled out (an example of such a form is included as Attachment 1). Important information should be recorded on the water sample tag (see Attachment 2) and secured to the sample bottle. Water samples should be collected and preserved in accordance with EPA standard procedures. These require that samples to be analyzed for certain dissolved ions be field-filtered with a 0.45 micron membrane filter and/or stabilized by the addition of preservatives (see EPA Standard Procedures). Several different bottles with different preservatives are required for each sample. Samples should be transmitted to the analytical laboratory within the hold times specified by EPA. Attachment 3 summarizes preservative techniques and hold times as specified by the EPA. Several parameters must be measured immediately in the field. These include water level (prior to sampling), pH, conductivity and temperature.

ANALYTICAL METHODS

Ground water samples analyzed for radionuclides, from sources that are not expected to be used as drinking water, should be field-filtered, properly preserved and analyzed for dissolved radionuclides. Ground water samples from sources that could be used as drinking water for humans or livestock should be analyzed separately for dissolved and suspended radionuclides. Lower limits of detection, as recommended in USNRC Regulatory Guide 4.14, should be as follows:

U-natural, Th-230, Ra-226	$- 2 \times 10^{-10}$	µCi/ml
Po-210, Pb-210	$- 1 \times 10^{-9}$	µCi/ml

The standard deviation of the random error associated with the analysis of samples should always be calculated and should be no greater than 10 percent of the measured value.

Sampling and chemical analysis should be performed in accordance with the following references unless otherwise specified by the director of the New Mexico Environmental Improvement Division.

Standard Methods for the Examination of Water and Wastewater, latest edition, American Public Health Association; or

Methods for Chemical Analysis of Water and Waste and other publications of the Analytical Quality Laboratory, EPA; or

Techniques of Water Resource Investigations of the U.S. Geological Survey.

REPORTING

The results of the monitoring program should be evaluated annually and submitted to the New Mexico Environmental Improvement Division. Sampling and water level measurement frequency and analytical parameter list should be reviewed annually and modified to reflect monitoring needs.

UNSATURATED ZONE MONITORING

GENERAL

The purpose of this monitoring is to evaluate water content changes and water quality in the unsaturated zone. Depending upon site-specific conditions, seepage can move downward as either a saturated front or under unsaturated moisture conditions until downward movement is inhibited by layers of low permeability. Ground water mounding then occurs, causing lateral spreading of the mound.

From the results of detailed evaluation of seepage movement from the below-grade trench disposal system (Volume 10), seepage movement would be primarily lateral with little or no vertical migration due to perching, mounding and lateral spreading. Perched saturated conditions are expected to occur near the disposal pit in alluvium and in sandstone of the Chinle Formation intercepted by the trench seepage. Movement in alluvial sediments would be expected to be downgradient along the alluvium-bedrock contact. This contact surface is irregular, but slopes overall to the south (Volume 10, Plate 18, "Bedrock Contour Map"). General seepage movement in the sandstones of the Chinle Formation would be downdip to the northeast.

Two types of monitoring facilities are planned: (1) detection wells situated upon perching stratums and (2) neutron logging of permanent holes to determine moisture content changes.

DETECTION WELLS

Shallow detection wells drilled to the base of alluvium and into sandstone of the Chinle Formation intercepted by the trench excavation would be completed at locations to monitor fluids moving into or out of the below-grade disposal area and to evaluate performance of the trenches. Ground water or seepage conditions in materials intercepted by the trench would be noted at the time of excavation of adjacent trenches.

A series of 12 locations (herein designated SD-1 through SD-12) would be completed around the perimeter and within the below-grade disposal area and along the north side of the evaporation ponds, as shown on Plate 1. At each location a minimum of two detection wells would be installed. Typically, one well at each location should be drilled and completed to the base of permeable alluvium. The second detection well at each location should be completed entirely within the Chinle Formation within sandstones or the most permeable stratum at a depth equivalent to approximately the bottom of the disposal trenches (50 to 70 feet). Well locations have been selected to provide coverage around the areas and also on the basis of low points in the bedrock surface.

Each well should be at least 4 inches in diameter with not less than 7 feet of gravel pack and 5 feet of screen at the base of the hole. The annulus above the gravel pack should be grouted to prevent infiltration of surface water and vertical ground water movement in the subsurface. The well should be tightly capped. We recommend that the wells be drilled with air rotary equipment insofar as possible to prevent introduction of water into the holes.

Detection wells should be installed in two phases. Detection wells SD-3 through SD-8 should be installed prior to tailings deposition in the first trench. Detection wells SD-1, SD-2, and SD-9 through SD-12 should be installed later but prior to tailings deposition in Trench 5. Most wells should be initially dry. We propose that the seepage detection wells be checked monthly for the first year and sampled if they contain water. Samples should be analyzed for key parameters (Table 4) monthly and the detailed parameter list (Table 5) annually.

After the first year, the detection wells should be checked quarterly for the presence of water. If water is present, it should be sampled and analyzed for key parameters quarterly and the detailed parameter list annually. Sampling procedures and analytical methods should be in accordance with those specified previously for ground water monitoring.

MOISTURE CONTENT LOGGING

Neutron logging of permanent holes is proposed to monitor moisture content changes and thus vertical seepage movement. Neutron logging measures the volumetric moisture content of water in soil and rock strata by using the principle of neutron moderation or thermalization. High energy neutrons, emitted from a radioactive source in the logger, are slowed down, or thermalized, by collisions with atomic nuclei. Hydrogen has a greater thermalizing effect on fast neutrons than occurs with many elements commonly found in soils. This forms the basis for detecting concentrations of water in a soil. A second factor, energy release during capture of slow neutrons by elements in the soil, is utilized to detect concentrations of slow neutrons. Log calibration and quantification of the moisture content in a hole is greatly aided by the direct measurement of the moisture content of undisturbed soil or rock samples. However, with repeated logging of the same hole, moisture content changes can readily be observed. Thus, it is not required to directly measure the initial moisture content and porosity of the soil or rock at all locations.

We propose that four neutron logging holes (herein designated NL-1 through NL-4) be installed in the northern part of the trench disposal area as shown on Plate 1 prior to tailings deposition in the trenches. A more extensive network is not deemed necessary due to the very low potential for vertical seepage migration through the claystones of the Chinle Formation. Holes NL-1, NL-2, and NL-3, located along the first trench to be operated, would aid evaluation of the performance of the first disposal trench for comparison with predicted results, and would be in a position to monitor any deeper, downdip seepage movement in Chinle sandstones derived from disposal in trenches to the south. Location NL-4 would be in a position to measure background moisture content changes during the first few years of disposal and to monitor later trench performance. Results of the neutron logging should be evaluated annually and the need for additional holes assessed based upon performance of the disposal trenches and monitoring devices.

Neutron logging holes should be cored and completed to depths of about 150 feet. It is recommended that casing be constructed of seamless steel or aluminum. Polyvinylchloride (PVC) casing can cause difficulty due to the hydrogen and chlorine atoms in the pipe that may cause interference. The inside diameter of the casing should be as close as possible to the outside diameter of the neutron probe. Also, the drilled hole should be as close in diameter to the outside diameter of the casing as possible. It is proposed that the casing be cement grouted to minimize the potential for water movement down the annulus. The casing should be closed at the bottom and unperforated.

The entire hole should be cored, and selected undisturbed samples of soil or rock should be tested to measure in situ bulk density, moisture content and specific gravity of the solid particles. A caliper log should be run before installing the casing. These data will aid in calibrating the neutron logs and establishing the baseline degree of saturation. Electrical and radiometric logging is also recommended for additional correlation and stratigraphic information. We propose that the neutron holes be logged quarterly. Additional study will be required to specify and select instrumentation and to define hole size which depends upon instrumentation size.

REPORTING

The results of the seepage monitoring should be evaluated annually and submitted to the New Mexico Environmental Improvement Division. Modifications to the monitoring program should be considered annually based upon the previous monitoring results.

SUMMARY

A brief summary of the ground water and seepage monitoring program is presented on Table 6.

Respectfully submitted,

DAMES & MOORE

Larry T Murdock

Larry T. Murdock
Partner

George W. Condrat

George W. Condrat
Geological Engineer

LTM/GWC:si

T[illegible] 1

SELECTED WELL DATA

Well Name	Well Inventory Number	Well Depth (Ft)	Minimum Well Diameter (Inches)	Open Interval *	Aquifer(s) **	Length of Time Previously Monitored
H(C)	-	70	4	49 - 70 GP	Trc	2 Years
Engineers Well	2					
B(M)	5	161	4	117 - 150 GP	Qal-Qb	3 Years
C(M)	6	165	4	125 - 150 GP	Qal-Qb	3 Years
OW-5	7	71	2	68 - 71 OH	Qal-Qb	13 Years
E(M)	8	100	4	69 - 90 GP	Qal-Qb	< 1 Year
F(M)	9	135	4	94 - 115 GP	Qal-Qb	< 1 Year
J(M)	35	57			Qal-Qb	< 1 Year
K(M)	36	67			Qal-Qb	< 1 Year
T(M)	39	135	6	128 - 133 GP	Qal-Qb	< 1 Year
U(M)	41	144	4	126 - 141 GP	Qal-Qb	< 1 Year
V(M)	-	82	4	71 - 80 GP	Qal-Qb	< 1 Year
X(M)	43	134			Qal-Qb	< 1 Year
North Well	14	250			Psg	24 Years
Monitor Well	15	628			Psg	20 Years
C(SG)	17	423	4.5	365 - 425 GP	Psg	3 Years
D(SG)	18	259	2.0	150 - 250 GP	Psg	3 Years
G(SG)	19	278	4	173 - 278 GP	Psg	3 Years
Anaconda #1	21	356			Psg	< 24 Years
Anaconda #2	22	386			Psg	24 Years
Anaconda #3	25	200			Psg	24 Years
Anaconda #4	26	211			Psg	20 Years
Anaconda #5	AN-5	440.5	14.75	285 - 440 OH	Psg	1 Year

(Continued)

TABLE I (Continued)

SELECTED WELL DATA

Well Name	Well Inventory Number	Well Depth (Ft)	Minimum Well Diameter (Inches)	Open Interval *	Aquifer(s) **	Length of Time Previously Monitored
Anaconda Pilot Hole					Psg	1 Year
I(SG)	34	330	5	235 - 330 OH	Psg	1 Year
L(SG)	37	610			Psg	1 Year
M(SG)	47	575	5		Psg	1 Year
S(SG)	40	337			Psg-Py	1 Year
Obs-2	45	319	7 7/8	10 - 319 OH	Psg-Py	1 Year
Obs-3	46	355	7 7/8	10 - 355 OH	Psg-Py	1 Year
W(SG)	42	355	5	251 - 355 OH	Psg	1 Year

* GP - Gravel Packed Zone
OH - Open Hole

** Qal-Qb- Basalt-alluvial aquifer
Trc - Chinle Formation
Psg - San Andres - Glorieta Aquifer
Py - Yeso Formation

TABLE 2

RECOMMENDED WELLS FOR TAILINGS MONITORING SYSTEM

Well Name	Well Inventory Number	Aquifer	Purpose
Engineer's Well	2	Qal - Qb	Upgradient of tailings pond
B(M)	5	Qal - Qb	Downgradient of tailings pond
C(M)	6	Qal - Qb	Downgradient of tailings pond
I(M)	39	Qal - Qb	Downgradient of tailings pond
K(M)	36	Qal - Qb	Downgradient of tailings pond
U(M)	41	Qal - Qb	Downgradient of tailings pond
X(M)	43	Qal - Qb	Downgradient of tailings pond
L(SG)	37	Psg	Upgradient of tailings pond
S(SG)	40	Psg - Py	Downgradient of tailings pond
Obs-3	46	Psg - Py	Downgradient of tailings pond
W(SG)	42	Psg	Downgradient of tailings pond
A *	-	Psg	Downgradient of tailings pond and lateral to evaporation ponds
C(SG)	17	Psg	Lateral to tailings pond and across fault
H(C)	-	Trc	Downgradient of evaporation ponds and upgradient of subgrade disposal area
G *	-	Trc	Upgradient of evaporation ponds
H *	-	Trc	Downgradient of evaporation ponds and upgradient of subgrade disposal area
M(SG)	47	Psg	Upgradient of evaporation pond and subgrade disposal area
North Well	14	Psg	Upgradient of subgrade disposal area and lateral to evaporation ponds
Monitor Well	15	Psg	Lateral to subgrade disposal area; possible downgradient of evaporation ponds
B *	-	Psg	Upgradient of trench disposal area and downgradient of evaporation ponds
C *	-	Psg	Downgradient of subgrade disposal area
I(SG)	34	Psg	Downgradient of subgrade disposal area
D *	-	Psg	Downgradient of subgrade disposal area
E *	-	Trc	Lateral to subgrade disposal area
F *	-	Trc	Downgradient of disposal area
I *	-	Psg	Downgradient of disposal area
J *	-	Psg	Upgradient of trench disposal area

---

* New Well to be Installed

Key: Qal - Alluvium
Qb - Basalt
Trc - Chinle Formation
Psg - San Andres-Glorieta Formations
Py - Yeso Formation

TABLE 3

OTHER WELLS WITHIN 2 KM OF TAILINGS FACILITIES

Well Name	Well Inventory Number	Aquifer
Berryhill House	1	Qal - Qb
Aragon	3	Qal - Qb
Roundy-Up	4	Qal - Qb
OW-S	7	Qal - Qb
E(M)	8	Qal - Qb
F(M)	9	Qal - Qb
Berryhill Sec. 5	12	Psg
Bowlins	16	Psg
Payne	20	Psg
Anaconda #1	21	Psg
Anaconda #2	22	Psg
Anaconda #3	25	Psg
Anaconda #5	AN-5	Psg
Mexican Camp	27	Psg
Sabre-Pinon	28	Psg
Bluewater (Auro's) Motel	S-70	Psg
Roundy (Harmon) House	S-74	Psg

Key:

Qal - Alluvium
Qb - Basalt
Psg - San Andres-Glorieta Formations

TABLE 4

KEY PARAMETER LIST

Field Measurements

- Water Level (prior to sampling)
- pH
- Specific Conductance
- Temperature

Laboratory Measurements

- Total Dissolved Solids
- Sulfate
- Chloride
- Nitrate
- Total Alpha
- Radium-226

TABLE 5

DETAILED GROUND WATER PARAMETER LIST

Field Measurements

- Water Level (prior to sampling)
- pH
- Specific Conductance

Laboratory Measurements

Common Ions

Ammonia (NH_3)

Bicarbonate (HCO_3)

Carbonate (CO_3)

Calcium (Ca)

Chloride (Cl)

Boron (B)

Fluoride (F)

Magnesium (Mg)

Nitrate (NO_3)

Nitrite (NO_2)

Potassium (K)

Sodium (Na)

Sulfate (SO_4)

Total Dissolved Solids (TDS)

Trace Metals

Aluminum (Al)
Arsenic (As)
Barium (Ba)
Cadmium (Cd)
Chromium (Cr)
Copper (Cu)
Iron (Fe)

Lead (Pb)
Manganese (Mn)
Mercury (Hg)
Molybdenum (Mo)
Nickel (Ni)
Selenium (Se)
Vanadium (V)
Zinc (Zn)

Radionuclides

Total Alpha

Natural Uranium (U-Natural)

Radium (Ra_{226})

Polonium (Po_{210})

Lead (Pb_{210})

Thorium (Th_{230})

TABLE 6

SUMMARY OF RECOMMENDED MONITORING

	Number	Frequency	Parameters
Facilities Ground Water Monitoring Wells (Table 2)	17 existing wells	Quarterly	Key parameters (Table 4) quarterly Detailed list (Table 5) annually
	10 proposed new wells	Monthly for first year	During first year, detailed list (Table 5), quarterly and key parameters (Table 4) monthly.
		Quarterly after first year	After first year, detailed list (Table 5), quarterly and key parameters (Table 4) annually.
Other Wells Within 2 Km (Table 3)	17 existing wells	Quarterly	Key parameters (Table 4)
Seepage Detection Wells	24 proposed wells	Monthly for first year	If water present during first year, key parameters (Table 4) monthly and detailed list (Table 5) annually.
Moisture Content Logging	4 cased borings	Quarterly	Neutron logging for moisture content

ATTACHMENT 1

GROUND WATER QUALITY SAMPLING FORM

Well No.: ____________________

Owner: ____________________

Date/Time ______ / ______ Sampled By: ____________________

Appearance: ____________________
(clear, colored, turbid, sediment, etc.)

Remarks: ____________________

Field Measurements and Sample Collection[a]

Static Water Level: ____________________ (in feet below land surface)

Pumping Rate: ____________________ (in gallons per minute)

Duration of Pumping: from ______ to ______, Total Time = ______ (in minutes)

Volume of Water Pumped Prior to Sampling[b]: ____________________ (in gallons)

Method of Pumping: ____________________

Electrical Conductivity (E.C.) Measurements

Meter No.: ____________________

Time Sampled: ________ (E.C.) ________ (in micromhos/cm, corrected to 25°C)

Time Sampled: ________ (E.C.) ________ (in micromhos/cm, corrected to 25°C)

Time Sampled: ________ (E.C.) ________ (in micromhos/cm, corrected to 25°C)

Time Sampled: ________ (E.C.) ________ (in micromhos/cm, corrected to 25°C)

pH: ____________________ (to the nearest .1 pH unit)

Meter No.: ____________________

Temperature: ________ °C

(a) Field measurements and sample collection made in accordance with Dames & Moore Technical Memorandum for the pre-operational ground water.

(b) A minimum of two (2) casing volumes of water shall be pumped from the well prior to sample collection.

SAMPLE LOCATION________________________

SAMPLE NUMBER__________________________

DATE COLLECTED____________ TIME__________

JOB NUMBER_____________________________

OWNER__________________________________

Reverse Side

Specify Sample Preservation Used:

____

____

field-filtered with H_2SO_4

field-filtered with no preservative

field-filtered with HNO_3

no field-filtering-no preservative

ATTACHMENT 2 - SAMPLE TAG

RECOMMENDATION FOR SAMPLING AND PRESERVATION OF SAMPLES ACCORDING TO MEASUREMENT (1)

Measurement	Vol. Req. (ml)	Container	Preservative	Holding Time(6)
Acidity	100	P, G(2)	Cool, 4°C	24 Hrs.
Alkalinity	100	P, G	Cool, 4°C	24 Hrs.
Arsenic	100	P, G	HNO_3 to pH <2	6 Mos.
BOD	1000	P, G	Cool, 4°C	6 Hrs.(3)
Bromide	100	P, G	Cool, 4°C	24 Hrs.
COD	50	P, G	H_2SO_4 to pH <2	7 Days
Chloride	50	P, G	None Req.	7 Days
Chlorine Req.	50	P, G	Cool, 4°C	24 Hrs.
Color	50	P, G	Cool, 4°C	24 Hrs.
Cyanides	500	P, G	Cool, 4°C NaOH to pH 12	24 Hrs.
Dissolved Oxygen				
Probe	300	G only	Det. on site	No Holding
Winkler	300	G only	Fix on site	No Holding

Measurement	Vol. Req. (ml)	Container	Preservative	Holding Time(6)
Fluoride	300	P, G	Cool, 4°C	7 Days
Hardness	100	P, G	Cool, 4°C	7 Days
Iodide	100	P, G	Cool, 4°C	24 Hrs.
MBAS	250	P, G	Cool, 4°C	24 Hrs.
Metals				
Dissolved	200	P, G	Filter on site HNO_3 to pH <2	6 Mos.
Suspended			Filter on site	6 Mos.
Total	100		HNO_3 to pH <2	6 Mos.
Mercury				
Dissolved	100	P, G	Filter HNO_3 to pH <2	38 Days (Glass) 13 Days (Hard Plastic)
Total	100	P, G	HNO_3 to pH <2	38 Days (Glass) 13 Days (Hard Plastic)

Measurement	Vol. Req. (ml)	Container	Preservative	Holding Time(6)
Nitrogen				
Ammonia	400	P, G	Cool, 4°C H_2SO_4 to pH <2	24 Hrs.(4)
Kjeldahl, Total	500	P, G	Cool, 4°C H_2SO_4 to pH <2	7 Days
Nitrate	100	P, G	Cool, 4°C H_2SO_4 to pH <2	24 Hrs.(4)
Nitrite	50	P, G	Cool, 4°C	24 Hrs. (4)
NTA	50	P, G	Cool, 4°C	24 Hrs.
Oil & Grease	1000	G only	Cool, 4°C H_2SO_4 to pH <2	24 Hrs.
Organic Carbon	25	P, G	Cool, 4°C H_2SO_4 to pH <2	24 Hrs.
pH	25	P, G	Cool, 4°C Det. on site	6 Hrs.(3)
Phenolics	500	G only	Cool, 4°C H_3PO_4 to pH <4 1.0 g $CuSO_4$/l	24 Hrs.
Phosphorus				
Ortho-phosphate, Dissolved	50	P, G	Filter on site Cool, 4°C	24 Hrs.(4)

Measurement	Vol. Req. (ml)	Container	Preservative	Holding Time(6)
Hydrolyzable	50	P, G	Cool, 4°C H_2SO_4 to pH <2	24 Hrs.(4)
Total	50	P, G	Cool, 4°C	24 Hrs. (4)
Total, Dissolved	50	P, G	Filter on site Cool, 4°C	24 Hrs.(4)
Residue				
Filterable	100	P, G	Cool, 4°C	7 Days
Non-Filterable	100	P, G	Cool, 4°C	7 Days
Total	100	P, G	Cool, 4°C	7Days
Volatile	100	P, G	Cool, 4°C	7 Days
Settleable Matter	1000	P, G	None Req.	24 Hrs.
Selenium	50	P, G	HNO_3 to pH <2	6 Mos.
Silica	50	P only	Cool, 4°C	7 Days
Specific Conductance	100	P, G	Cool, 4°C	24 Hrs. (5)
Sulfate	50	P, G	Cool, 4°C	7 Days

Measurement	Vol. Req. (ml)	Container	Preservative	Holding Time(6)
Sulfide	50	P, G	2 ml zinc acetate	24 Hrs.
Sulfite	50	P, G	Cool, 4°C	24 Hrs.
Temperature	1000	P, G	Det. on site	No Holding
Threshold Odor	200	G only	Cool, 4°C	24 Hrs.
Turbidity	100	P, G	Cool, 4°C	7 Days

1. More specific instructions for preservation and sampling are found with each procedure as detailed in this manual. A general discussion on sampling water and industrial wastewater may be found in ASTM, Part 23, p. 72-91 (1973).

2. Plastic or Glass

3. If samples cannot be returned to the laboratory in less than 6 hours and holding time exceeds this limit, the final reported data should indicate the actual holding time.

4. Mercuric chloride may be used as an alternate preservative at a concentration of 40 mg/1, especially if a longer holding time is required. However, the use of mercuric chloride is discouraged whenever possible.

5. If the sample is stabilized by cooling, it should be warmed to 25°C for reading, or temperature correction made and results reported at 25°C.

6. It has been shown that samples properly preserved may be held for extended periods beyond the recommended holding time.

OVERSIZE DOCUMENT PAGE PULLED

SEE APERTURE CARDS

NUMBER OF OVERSIZE PAGES FILMED ON APERTURE CARDS 1

9304280175-01

APERTURE CARD/HARD COPY AVAILABLE FROM

RECORDS AND REPORTS MANAGEMENT BRANCH