TENNESSEE VALLEY AUTHORITY

JOHNSONVILLE FOSSIL PLANT

OPERATIONS MANUAL
DREDGED ASH DISPOSAL AREA

APRIL 2001

TVA

Prepared By

Tennessee Valley Authority
Fossil Engineering Services

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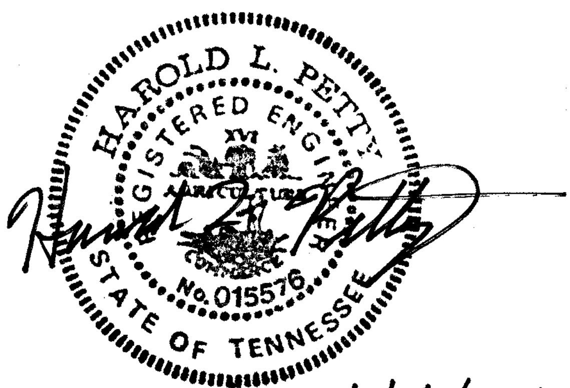
Title: OPERATIONS MANUAL DREDGED ASH DISPOSAL AREA	PCN # JOF271
	Plant/Unit: JOHNSONVILLE FOSSIL PLANT

Vendor	Contract No.	Key Nouns: Permit, Closure/Post-Closure Plan, Dredge Cell

Applicable Design Documents	REV	RIMS NUMBER	DESCRIPTION
	R0		Original - May, 1991 Tribble & Richardson & Law Engineering
References	R1		Revised - January, 1992 Tribble & Richardson & Law Engineering
	R2	**B65 010323 250**	Revised - April, 2001 Tennessee Valley Authority Site & Environmental Engineering (see revision log on next page)

TENNESSEE VALLEY AUTHORITY
FOSSIL POWER GROUP
FOSSIL ENGINEERING SERVICES
SITE AND ENVIRONMENTAL ENGINEERING



4/4/01

	Revision 2	R2
Date	April 04, 2001	
Prepared	Chris Hensley	CWH
Checked	Joel Paris	
Supervised	Harold L. Petty	HLP

Johnsonville Fossil Plant
Operations Manual
Dredged Ash Disposal Area
Revision Log - Revision 2 - April, 2001

Revision 2 items are indicated throughout the Operations Manual by a vertical line in the margin.

The following items were revised as a part of Revision 2:

The entire manual was scanned and converted to an electronic MS Word file.

The names, addresses, phone numbers of the responsible officials listed in Section I were updated.

Figure 1 was revised to a color map.

The cap for closure (Sections III and iX) was revised to match the Tennessee DSWM Variance Agreement for Fossil Fuel Ash disposal.

Appendix B was revised. Drawing 10W218-5(R2) was electronically restored and revised. The cap was revised to match the Tennessee DSWM Variance, the seeding mix was changed to specify Native Grasses, and miscellaneous minor changes made.

Appendix D was revised. Section 580 - Seeding was replaced with Section 583 - Native Grasses - Seeding and Mulching.

Appendix E was revised. DSWM policy memo SW-91-2 dated February 19th, 1991 was replaced with DSWM policy memo SW-91-2 revised February 27th, 1991.

Appendix I was deleted. TVA is not require to provide probable closure costs.

The font, page numbers and minor edits made for production of this revision are not marked but acknowledged here as a component of the revision.

OPERATIONS MANUAL

DREDGED ASH DISPOSAL AREA

TENNESSEE VALLEY AUTHORITY

JOHNSONVILLE FOSSIL PLANT

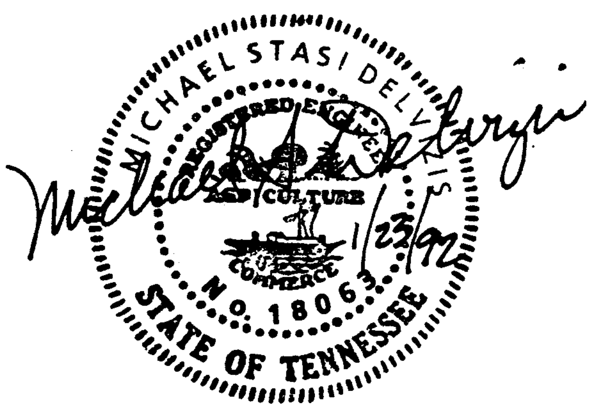
May, 1991

Revised January 23, 1992

(Revisions are shown in bold typeface)

Prepared For:

Tennessee Valley Authority



Prepared By:

Tribble & Richardson, Inc. and

Law Engineering, Inc.

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OPERATIONS MANUAL
DREDGED ASH DISPOSAL FACILITY
TENNESSEE VALLEY AUTHORITY
JOHNSONVILLE FOSSIL PLANT

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I. SITE INFORMATION

A. Responsible Officials

The following is a list of entities involved with the permitting, design, operation, maintenance, quality control/assurance of the new Dredged Disposal Area at the Tennessee Valley Authority Johnsonville Fossil Plant.

1. Owner: Tennessee Valley Authority (TVA)
   Contact: Plant Manager
   Tennessee Valley Authority Johnsonville Fossil Plant
   P.O. Box 259 - Hwy 70 New Johnsonville, Tennessee 37134
   (931) 535-8212

   As of the date of this report the plant manager is Mr. Michael Moseley

2. State: Tennessee Department of Conservation
   Division of Solid Waste Management
   Nashville Environmental Assistance Center
   711 Gass Blvd.
   Nashville, Tennessee 37243
   (615) 687-7000

   The contact as of the date of this report is Mr. Al Majors, EAC Solid Waste Manager

   Tennessee Department of Conservation
   Division of Solid Waste Management
   5th Floor L&C Tower
   401 Church Street
   Nashville, Tennessee 37423-1535
   (615) 532-0780

   The contact as of the date of this report is Mr. Mike Apple, P. E. State Director.

B. Site Location

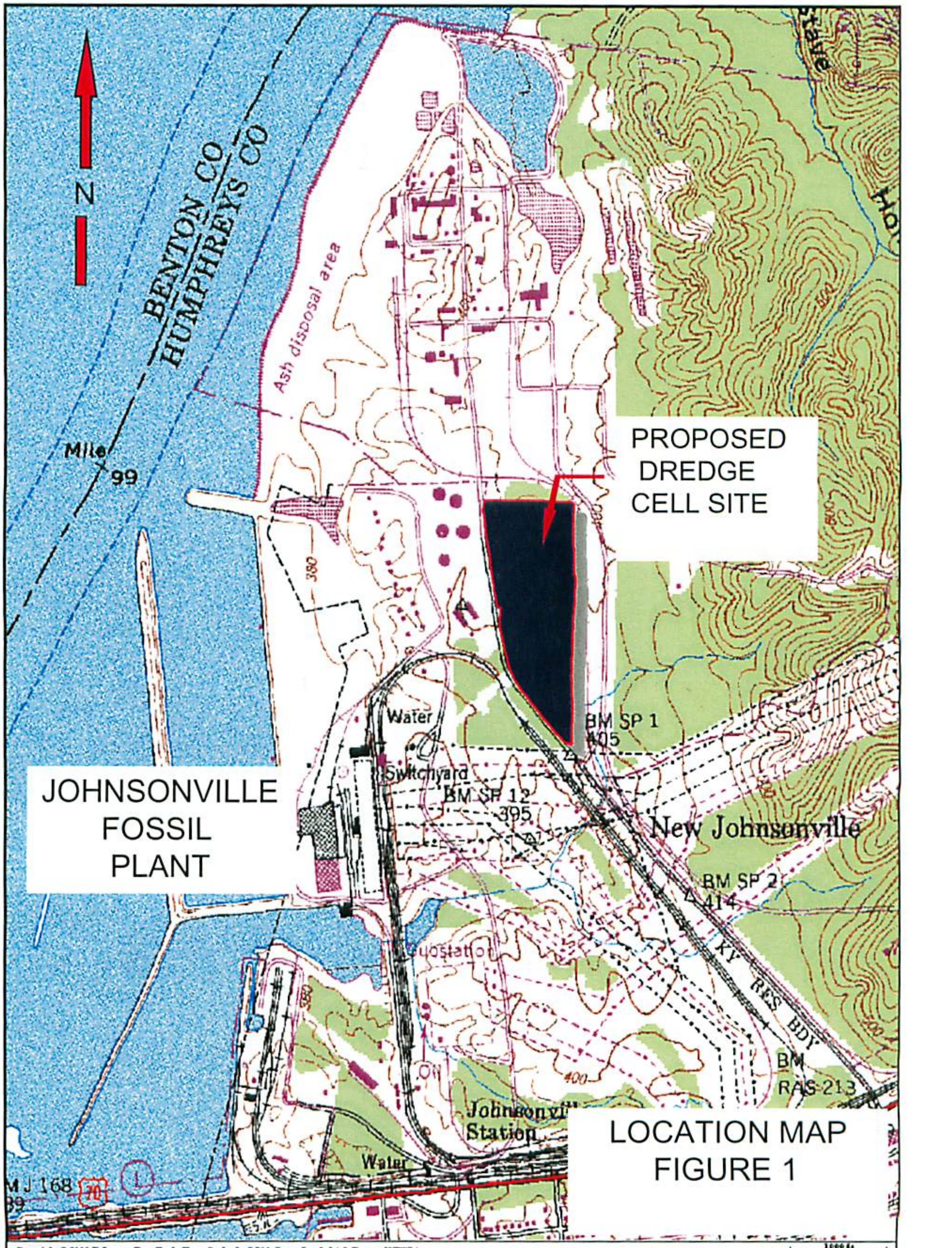
The TVA Johnsonville Fossil Plant (JOF) is located in Humphreys County, Tennessee on the eastern shore of Kentucky Lake. The JOF is approximately twelve miles west of the Town of Waverly. Access to the site is by Tennessee Route 70. Reference is made to Figure 1 which is an excerpt of the USGS Johnsonville, Tennessee Quad Map.

C. Site Description

The site selected for the new dredge pond is a 35 acre tract of land owned by TVA in Humphreys County, Tennessee, adjacent to the Johnsonville Fossil Plant and east of the gas turbines. The site is located approximately 0.75 mile north of U.S. Route 70/State Route 1, between an access road and a county road that is used primarily for construction access to the DuPont plant. The site is approximately 0.5 miles east of the eastern shore of Kentucky Lake.

Before being cut for timber, the site was forested with an oak-flatwoods association. There is no prime farmland on the site, and no productive use currently is made of the site.

The site is completely enclosed by the access road, the county road, and a railroad spur for the DuPont plant. Beyond these immediate boundaries are the DuPont plant facilities to the north, an oil tank farm for the Johnsonville Plant to the west, the rail loop area for the Johnsonville Plant to the south, and unused forested land to the east. The closest residence is apparently in the town of New Johnsonville and across Hwy 70, approximately 0.9 mile to the south. Because the site is a relatively narrow tract (about 1,000 feet wide at its widest point), enclosed by roads



LOCATION MAP
FIGURE 1

1000 ft

and railroad tracks, and surrounded by industrial land uses in three directions, its potential for commercial or residential development is limited.

The site was relatively flat, with elevations ranging from about 396 to about 402 feet AMSL. It lies within the alluvial plains of Kentucky Lake. Soil testing data provided by TVA in its initial application for a solid waste disposal permit, (Reference 1: Sargent & Lundy, January 1990) indicated permeability's of 1 X 10^{-6} to 1 X 10^{-7} cm/sec for a depth of approximately 10 feet below the soil surface existing at the time of drilling. Further hydrogeological testing conducted by Law Engineering (Reference 2) indicated that in some areas on the site the native soils in the geologic buffer zone do not meet the required hydraulic conductivity values and will require recompaction and/or replacement to achieve 1 X 10^{-6} cm/sec permeabilities. The groundwater table was at approximately 25 feet below existing grade. Review of the reports provided by TVA (Reference 1) indicate the direction of groundwater movement could not be estimated from the available data, but topography indicates that general movement would be west toward Kentucky Lake. A piezometric surface map has been prepared with new data collected since the January 3, 1990, report which confirms this. The piezometric map and data used to construct it are presented in Appendix A.

U.S. Geological Survey topographic maps do not show any perennial or intermittent streams on the site. Site visits confirm no water features are present on the site. The natural drainage of the site appears to flow in two directions, with most of the site draining to the west, toward the Johnsonville Plant, and the northwest corner draining to the north, towards the DuPont Plant.

D. Buffer Zone Compliance

The JOF new dredged ash disposal area (east of gas turbines) will be in compliance with all applicable buffer zone standards listed in the Solid Waste Regulations paragraph 1200-1-7.04(3). Reference is made to design drawings furnished by TVA, drawing # 1OW218-2 with general title Main Plant - Ash Dredge Cell - East of Gas Turbines (3/29/90) with revision 1 (Appendix B- Revised design drawings) and the January 1990 Sargent & Lundy report (Reference 1), the January 1992 Law Engineering Report (Reference 2) for review of compliance with buffer zone requirements (Reference 1). Specifically: The fill area is 100 feet from the nearest TVA reservation boundary line. There are no residences located within 500 feet of the fill area. There are no wells used as a source of drinking water by humans or livestock located within 500 feet of the fill area. Information regarding locations of drinking water wells is based on investigations by Sargent & Lundy and is included in their January 1990 report. The fill area is over 200 feet from the nearest stream. No constructed appurtenances for the fill area are located within 50 feet of the TVA reservation boundary.

E. Access Control

The JOF dredged ash disposal site is located within the JOF property. This site is not to be fenced but will be posted with warning and no trespassing signs. TVA security personnel periodically patrol the JOF grounds and will include this site in their rounds. The new dredged ash disposal site will be utilized only for coal combustion ash from the JOF.

II. DESCRIPTION OF SOLID WASTES

A. Types of Waste

The JOF began commercial operation with the first unit in 1951 and the last in 1959 and consists of ten coal-fired units with a maximum capacity of 1485 MW. The only waste that will be disposed of in the new dredge ash disposal site is ash from coal combustion at the JOF Plant. This ash will be dredged from the existing active ash pond at the Johnsonville site. The ash received by the active ash pond consists of about 20% bottom ash (coarse, granular material removed from the bottom of the furnaces) and 80% fly ash (fine particles removed from the flue gases). However, most of the bottom ash is draglined out of the active ash pond and dry stacked. Therefore, the ash that is sent to the new dredge ash disposal site will consist primarily of fly ash. This fly ash will be sluiced to the new dredged ash disposal site as a slurry. After settling to the bottom, it will have a consistency similar to mud. When the pond is drained the fly ash will dry into a relatively inert, structurally stable material. The combustion of coal for the purpose of generating electricity results in the production of by-products that include fly ash and bottom ash. Fly ash is completely composed of the noncombustible mined components incorporated in the coal during its formation. Fly ash is relatively inert, noncombustible, nonputrescible, and will not decompose to produce gases.

Additional data regarding the typical characteristics of fly ash and testing of JOF ash pond samples are included in Appendix C- Ash Testing.

B. Anticipated Volumes

The JOF facility produces approximately 315,000 cubic yards of ash per year. The objective to be attained by implementing this new dredged ash disposal facility is to provide additional storage capacity in the active ash pond. This is to be accomplished by dredging the active ash pond and then disposing of this material in the new dredged ash disposal site. Based on the TVA drawings and report (Sargent & Lundy, January 1990) furnished by TVA it is anticipated that the new dredged ash disposal site will provide approximately 830,000 cubic yards of ash storage.

C. Solid Waste Sources and Service Area

The waste source will exclusively be the ash generated by the JOF facility.

D. Special Wastes

The only waste to be disposed of in the new dredged ash disposal facility is ash from the JOF.

III. DAILY OPERATIONS

A. Waste Handling Operation

The 35-acre site will be developed with an oblong dredge pond contained by earthen dikes (Appendix B). The dredge pond will have an area of approximately 21 acres; most of the remaining site acreage will be occupied by the dikes. A buffer zone approximately 50-feet wide will be provided around the toe of the dikes.

The new dredged ash pond will be developed and filled in two phases. During the first phase, most of the site will be cleared and grubbed, and the new dredged ash pond area will be excavated to an elevation no lower than 393 feet above sea level (AMSL). Excavated topsoil will be stockpiled for later use. The 393-foot bottom-of-pond elevation is intended to provide at least 3 feet of geologic buffer, with maximum permeability of 1×10^{-6} cm/sec, in place under the new dredged ash pond. For information about the geologic buffer refer to the Geologic Buffer System section included in Section V and the Quality Assurance/Quality Control section included in Section XI of this manual. The top layer of the clayey soil will be compacted to reduce its permeability. Corings and permeability tests will be conducted to ensure that the maximum permeability of the pond bottom is equivalent to 3 feet of 1×10^{-6} cm/sec (lab) permeability material. The bottom of the pond will be equipped with an underdrain system consisting of three lines of fabric-filtered perforated pipe that drain to a sump.

The Phase I new dredge ash pond dikes will be constructed of clayey soil excavated from the pond area. If additional soil is needed, it will be purchased from an off-site source. The dikes will be constructed in layers and compacted to 95% Standard Proctor compaction to ensure their integrity. The dikes will then be hydroseeded with the standard TVA seed mixture, fertilizer, and mulch to prevent erosion (see TVA seeding specification in Appendix D of this report). The dikes will be refertilized and reseeded as necessary to establish and maintain a good vegetative cover. The top of the Phase 1 dikes will be at elevation 413.5 feet AMSL, which is 20.5 feet above the bottom of the pond and approximately 11 to 17 feet above the existing ground elevation. The dikes have an inner slope of 2H:lV and an outer slope of 3H:lV.

After completion of Phase I construction, a portable floating dredge will be placed in the active ash pond at the JOF site, and piping assembled to the new dredge pond. Approximately 550,000 cubic yards of ash will be dredged from the active ash pond and sluiced to the new dredge ash disposal site through temporary above ground piping. The ash/water slurry will be pumped to the dredge pond at a rate ranging from 200 to 500 cubic yards per hour. The slurry will enter the dredge pond at the northerly end and flow throughout the pond. The ash will then settle out, and excess water will be returned to an existing stilling pool on the JOF site. Dredging and sluicing will be conducted 5 days per week, 10 to 24 hours a day, with periodic down time for maintenance as required.

The water level in the dredge pond will be controlled by means of a weir box located at the southerly end of the pond. Water that spills into the weir box will flow by gravity through underground piping and ditches to an existing stilling pool on the JOF site. This stilling pool is an NPDES permitted facility that provides surface water quality control and discharge of all ash dredge pond water used at the JOF Plant (NPDES Permit No. TN0005444 DSN 001).

The water level in the dredge pond will be maintained at an elevation of at least two (2) feet below the top of the dikes at all times. This two (2) feet of freeboard will ensure that rainfall and wave action can be contained. The 25-year, 24-hour rainfall is estimated to raise the water elevation only 5.75 inches, even with no discharge from the pond. The assumption of no discharge is very conservative, since the weir box and piping to the stilling pool is a passive discharge system.

Phase I construction is expected to take approximately 6 months; setup of dredging and sluicing equipment will then take approximately 1 month, and operation is expected to take an additional 6 months.

After completion of Phase I dredging and sluicing, the dredge pond will be drained to the extent practical by pumping water from the underdrain system sump to an existing stilling pool on the JOF Plant site. A layer of bottom ash from the active ash pond at the JOF site will be placed on the surface of the dredge pond ash to form a base for construction of Phase II dikes. Phase II dikes will then be constructed on top of the ash, inside of the Phase I dikes. The Phase II dikes will be constructed of compacted layers of ash draglined from inside the dredge pond. TVA has used this type of ash to construct many other dredge pond dikes, and it has been found to have adequate strength and stability. Any water that permeates through the ash dikes will be contained by the Phase I earthen dikes. The Phase II dikes have a top elevation of 428.5 feet AMSL, and 4H:IV slopes on both sides. Because of the stable nature of the ash material, no erosion protection will be required for the Phase II dikes. During final closure of the pond the Phase II dikes will be covered with a final cap, as described hereinafter.

The Phase II dikes will enclose an area of approximately 11 acres; this will allow an additional 282,200 cubic yards of ash to be sluiced to the dredge pond. Phase II construction activities are expected to take approximately 3 months, and Phase II sluicing is expected to take approximately 4 months. The total amount of ash removed from the active ash pond during Phase I and Phase II, approximately 830,000 cubic yards, will provide at least 2.6 years of additional ash storage in the active ash pond.

B. Covering Program

1. Daily and Intermediate Cover

No daily or intermediate cover will be required for the new dredged ash disposal site. The fly ash is physically stable, nonputrescible, and is not an attractant for disease or animal vectors.

2. Final Cover

As has been discussed previously, the new dredged ash pond Phase II will be an embankment constructed of soil placed in vertical lifts with interior side slopes at 2H:IV and exterior side slopes at 3H:IV. The final dike cover will be placed on the exterior side slopes and vegetated upon completion of the Phase I dikes. This placement of final cover will facilitate erosion control and will help maintain the integrity of the dike.

The final grade at the completion of the Phase II operation is to be constructed to an approximate final elevation of 438 feet

AMSL (Refer to TVA drawing 1OW218-5, Revision 2). This final grading will facilitate controlling run-off of precipitation and further minimize the generation of leachate or accumulation of moisture within the disposal area.

Upon completion of the dredging operations the final cap, 24" thick, to be utilized on the ash will be as follows (from top layer downward):

- Soil suitable for support of vegetation six inches (6")
- Compacted soil totaling eighteen inches (18").

Vegetative cover shall be established on the final cover. The conditioning, fertilizing and seeding of the final cover, in order to establish an adequate vegetative cover, shall begin immediately upon placement of the final cover. The applicable seeding methods and types to be used for vegetation will be selected in consideration of seasonal and other factors. TVA specifications for seed mixture applications are included in Appendix D.

3. Cover Material

The cover material will consist of stockpiled topsoil and from off site sources. It is estimated that the following volumes of material will be required for final cover:

- Soil suitable for vegetative support 23,000 CY.
- Compacted soil 65,000 CY.

C. Operating Equipment

TVA currently conducts dredging with in-house forces or contracts with a private construction company for dredging operations. The equipment to be used during in-house dredging is a hydraulic dredge made by AMMCO. The dredge is 20' wide x 45' long. It has 2 engines, one 625 hp diesel for the dredge pump and one 190 hp diesel for hydraulic and auxiliary power. The dredge pump is a 10,000 gpm, 12-inch discharge trash pump. The dredge employs a rotary cutter forward of the suction that is capable of digging 32 feet deep over a 97 foot swath if swung 90^0 either side of centerline. The dredge will be used with a 10,000 gpm, 650 hp diesel booster pump that also has a 12-inch discharge. The disposal pond will be constructed and closure will be made using common bulldozers and pan-scrapers. TVA owns two dredges similar to the one just described and many dozers and pan-scrapers. If private construction companies are used, they are required to provide equipment and personnel that is adequate in both size and quantity for transport and placement of the ash. The construction contractor must also be able to rent or lease back-up equipment within 24 hours of primary equipment breakdown. However, even if dredging is interrupted for more than 24 hours no adverse effects should occur as a result at this facility.

D. Dust and Litter Control

Litter control is not applicable to this disposal facility. Ash will not generate litter. Dust control measures are provided at the JOF to help prevent a nuisance to adjacent landowners and TVA employees/operations. No oils or chemicals shall be used for dust suppression without written approval from the Tennessee Department of Conservation. Water shall be used for providing dust suppression. Minimum dust control measures shall include the utilization of a water tank truck with appropriate equipment for spraying and/or hosing.

E. Safety Precautions

1. <u>Access Control</u>: As discussed previously, the JOF dredged ash disposal site is located within the JOF property. TVA security personnel regularly patrol the JOF grounds to control unauthorized access. Also the ash disposal site will be utilized only for waste from the JOF.

2. <u>Fire Protection</u>: Ash from the JOF is a by-product produced by the combustion of coal and therefore poses no threat as a potential fire hazard. However, properly maintained fire suppression equipment shall be provided for all ash disposal equipment and vehicles. As a minimum, this equipment shall include fire extinguishers of the size and type required to extinguish the type of fire that may potentially occur in said vehicles and equipment.

3. <u>Security</u>: TVA security personnel are on-duty 24 hours per day at the JOF. Established security procedures will be utilized for the disposal facility.

4. <u>Safety Training</u>: The JOF has TVA safety training procedures in place for periodic job and first aid training. These procedures will continue to be utilized.

5. <u>First Aid</u>: The JOF facility currently has in place a staffed and functional clinic that will be available for ash disposal site personnel.

F. Personnel Facilities

The following personnel facilities shall be made available at the JOF:

(1) A building or shelter which is accessible by any facility personnel and has adequate screening, heating facilities and lighting.
(2) Safe drinking water.
(3) Sanitary hand-washing facilities.
(4) Toilet facilities.

(5) A two way radio and/or telephone for communications.
(6) A first aid kit.

All of the above services and facilities are readily available for operating personnel at the TVA plants.

G. Random Inspection Program

A random inspection program for coal combustion ash disposal facilities is not required. This is due in part to the fact that the disposal facility will only utilize ash from JOF and the access control/security provided at the JOF. Therefore, a random inspection program for unauthorized wastes is not necessary (DSWM Policy Memorandum SW-91-2 Item 5, Appendix E).

IV. SURFACE WATER MANAGEMENT SYSTEM

The surface water management system for the new dredged ash disposal site will consist of two basic concepts. These two basic concepts are to (1) control run-on from surrounding areas and (2) control run-off from the new disposal site.

The potential run-on from surrounding areas should be managed with little difficulty. This is due in part to existing drainage network, which include some existing ditches and the existing surface drainage patterns. Also the construction of the dikes for the new dredged ash disposal will preclude run-on from flow onto the disposal site. Adequate precautions will need to be taken during construction of the dikes to preclude extraneous water from having detrimental effects on construction. In addition, the capping and vegetation of the exterior dike slopes and other disturbed areas will facilitate erosion control and surface water management.

Run-off from precipitation that falls onto the new dredged ash disposal facility will be controlled within the pond dikes and will ultimately be discharged through the existing NPDES permitted pond at the JOF site.

Additional erosion control measures may include

1. Only disturbing as much area as necessary at any one time to maintain stacking operations.
2. Seeding/Mulching of all disturbed areas shall commence as soon as practically possible.
3. Use of hay bales, silt fences, or equivalent devices down-gradient of disturbed areas and stockpiles, around drainage pipes inlets/outlets and at intervals along grassed waterways, until such time as permanent vegetation is established.

V. GEOLOGIC BUFFER SYSTEM

A. Disposal Area Base

The geologic buffer system to be utilized in the new dredged ash disposal site is intended to meet or exceed the requirements of the DSWM for coal combustion ash disposal facilities. The current policy adapted by the DSWM for coal combustion ash does not require a liner but does require three (3) feet in total thickness of material with a maximum hydraulic conductivity of 1 X 10^{-6} cm/sec. The thickness will be measured from the base of the new dredged ash disposal site after excavation to the top of the seasonal high water table elevation. Information regarding the thickness and permeability of the in-situ material is based on investigations included in the Sargent & Lundy report dated January, 1990, the Law Engineering report dated January, 1992, and the TVA drawings previously referenced.

Law Engineering's on site investigation was conducted to determine the existing elevations and the quality of the material existing at the proposed site. Law Engineering obtained a representative number of undisturbed soil samples for laboratory permeability testing to confirm the buffer met the buffer thickness and hydraulic conductivity requirements. Law Engineering's investigation determined that the in-situ soil permeability in some areas of the geologic buffer system exceeded the maximum permissible level of 1 X 10^{-6} cm/sec. Based on Law Engineering's investigation it is proposed to remove the existing materials from the dredge cell's base between elevation 390 feet and 393 feet and replace with compacted clayey soil. Law Engineering's testing indicates that the native material removed during undercutting can be recompacted to achieve the specified hydraulic conductivity value. Reference is made to the Quality Assurance/Quality Control Section XI for procedures to be followed during the construction of the geologic buffer.

VI. LEACHATE CONTROL AND MANAGEMENT SYSTEM

The requirements for the leachate control and management system for coal combustion ash disposal facilities shall be met by providing a geologic buffer system as indicated in the previous section, Section V. Geologic Buffer System. This will meet the current policy adapted by the DSWM for coal combustion ash disposal facilities.

VII. GAS CONTROL SYSTEM

Gas collection for coal combustion ash disposal facilities is not applicable as so stated in DSWM Policy Memorandum SW-91-2 (Appendix H). Ash produced from the combustion of coal is the only waste material which will be deposited in this facility. Coal combustion ash is completely composed of the noncombustible mineral components incorporated in the coal during its formation. Fly ash is relatively inert, noncombustible, nonputrescible, and will not decompose to produce gases.

VIII. GROUNDWATER MONITORING

A. Compliance Monitoring Boundary

The compliance monitoring boundary of the new dredged ash disposal site should be the area within the location of the existing monitoring wells.

These well designations are:

Up-gradient Wells	Well B10, B13
Down-gradient Wells	Well B11, B12

The location of these wells are shown on the TVA drawings (Appendix B).

B. Monitoring System for the Existing Facility

As mentioned above, a groundwater monitoring system is in place and was installed to support permitting of the JOF ash disposal facilities. Monitoring well logs are included in Appendix F. Background monitoring of wells has been conducted and this monitoring data is included in Appendix G - Background Groundwater Monitoring Program. This data is excerpted from the TVA Final Environmental Assessment previously referenced and from preoperational data collected over the past year.

C. Detection Monitoring Program

1. Sampling and Analysis Plan: The operator must determine the concentration or value of the following parameters in groundwater samples in accordance with List I and List II which follow.

List I

Indicator parameters used for characterizing and tracking the ground water chemistry and changes therein:

I. Ammonia
II. Calcium
III. Chloride
IV. Iron

V. Magnesium
VI. Manganese
VII. Nitrate (as N)
VIII. Potassium
IX. Sodium
X. Sulfate
XI. Chemical Oxygen Demand (COD)
XII. Total Dissolved Solids (TDS)
XIII. Total Organic Carbon (TOC)
XIV. pH

List II

Parameters establishing the ground water quality:

I. Arsenic
II. Barium
III. Cadmium
IV. Chromium
V. Cyanide
VI. Lead
VII. Mercury
VIII. Selenium
IX. Silver

However, ammonia, total organic carbon and cyanide are not expected to be present in coal combustion by-products and therefore monitoring of these is unnecessary for this monitoring program. The operator has established background concentrations based on a sampling program dating back to 1982 and analysis for all List I and List II parameters with the exception of ammonia, total organic carbon and cyanide. Refer to Appendix G for this data.

Beginning with the next routine sampling date following approval of this permit plan, the operator will begin sampling for the 20 groundwater contamination indicator parameters specified below at least once every six months until final closure of the facility. Following closure, sampling will be conducted on an annual basis for two (2) years after which sampling may be discontinued.

Calcium	Arsenic
Chloride	Barium
Iron	Cadmium
Magnesium	Chromium
Manganese	Lead
Nitrate (as N)	Mercury
Potassium	Selenium
Sodium	Silver
Sulfate	
Chemical Oxygen Demand (COD)	
Total Dissolved Solids (TDS)	
pH	

Monitoring for volatile organic compounds (VOC's) (listed in Appendix I of the DSWM Solid Waste Regulations) will not be necessary for this facility since these VOC's are not known or suspected to be constituents of coal fly ash. If any of these constituents were present in the coal, which is unlikely, the high temperatures of the combustion process (greater than 2,000°F) would be expected to decompose or drive off all volatile constituents. TVA has conducted tests of fly ash from other facilities for the presence of VOC's and the results indicated the VOC's were "nondetectible". A summary of testing results is included in Appendix C of this Operations Manual.

If new wells are installed at this site an initial monitoring schedule must be followed to establish reliable background concentrations or values against which future comparisons can be made. TVA will sample each new well quarterly for the first year and analyze each such sample for the parameters listed in List I and List II. After the first year these wells will be monitored at least once every six months following the same guidelines as for the existing monitoring wells.

Additional procedures to be followed for the Detection Monitoring Program are in TVA's Quality Assurance Procedure - Groundwater Sample Collection Techniques which is included in Appendix H.

2. Record Keeping and Reporting

Record Keeping: Records of all groundwater sampling of Wells B10, B11, B12 and B13 are kept at the facility. Information includes groundwater sampling activities conducted, the sample analysis results and the groundwater surface elevation.

Reporting: All results of ground water sampling and analysis results and groundwater surface elevations of Wells B10, B11, BI2, and B13 are submitted to the Tennessee Department of Conservation within thirty days after completing the analysis.

3. Monitoring Well Design and Construction

All monitoring wells shall be certified as being constructed according to this plan by a registered Tennessee engineer or registered Tennessee geologist.

Monitoring wells shall to be constructed as described below:

A. Drilling Methods: A variety of well drilling methods are available for the purpose of installing groundwater monitoring wells. The drilling method shall minimize the disturbance of subsurface materials and shall not cause contamination of the groundwater. Regardless of the drilling method selected, drilling equipment shall be steam cleaned before use and between borehole locations to prevent cross contamination of wells. This site will employ hollow stem continuous auger drilling or air rotary method. Other methods will be used should conditions require it.

B. Monitoring Well Construction Materials: Well construction materials shall be sufficiently durable to resist chemical and physical degradation and yet not interfere with the quality of groundwater samples. Materials to be used for well casings, well screens, filter packs, and annular seals are covered below. Figure II is a typical detail for a groundwater monitoring well.

1. Well Casings and Screens: ASTM, NSR rated, Schedule 40, 4 inch PVC shall be used for the casing pipe and well screens at this site. It should be understood that since PVC pipe is being selected for casing and screening material there may be the possibility that after installation, PVC deteriorating compounds could be present in the groundwater. If these compounds are detected, then the DSWM must assume that the contaminants are from the landfill and not from the well casing or screen unless identical compounds are found in the up gradient wells and can not be attributed to wastes placed in the site.

The owner accepts the responsibility of the casing and screen material selected. Plastic pipe sections must be flush threaded or be amenable to connection by another mechanical method such as stainless steel screws. No solvents or glues should be allowed in well construction. These compounds readily leach organic contaminants into the ground water. All well casings and screens should be steam cleaned prior to emplacement to ensure that all oils, greases and waxes have been removed.

C. Filter Pack and Annular Sealant: The materials used to construct the filter pack shall be chemically inert clean quartz sand. Fabric filters shall not be used as filter pack materials. Natural gravel packs are acceptable provided an appropriate well screen slot size is used.

The materials used to seal the annular space must prevent cross contamination between strata. The materials shall be chemically resistant to ensure seal integrity during the life of the monitoring well and chemically inert so they do not affect the quality of the groundwater samples. A minimum of two feet of certified coarse grit sodium bentonite shall immediately overlie the filter pack. A cement and bentonite mixture, bentonite chips/pellets, or anti-shrink cement mixtures shall be used as the annular sealant in the unsaturated zone above the certified coarse grit sodium bentonite seal and below the frost line. Extending from a little below the frost line to the surface, the cap shall be composed of concrete blending into a mounded cement apron (to direct rainwater runoff away from the well) extending outward three feet from the edge of the bore hole.

The untreated sodium bentonite seal shall be placed around the casing either by dropping it directly down the borehole or, if a hollow stem auger is used, putting the bentonite between the casing and the inside of the auger stem. Both of these methods present a potential for bridging. In shallow monitoring wells, a tamping device shall be used to reduce this potential. In deeper wells, it may be necessary to pour a small amount of formation water down the casing to wash the bentonite down the hole.

The cement-bentonite mixture shall be prepared using formation water or potable water and placed in the borehole using a tremie pipe. The tremie method ensures good sealing of the borehole from the bottom.

The remaining annular space shall be sealed with expanding cement to provide for security and an adequate surface seal. Locating the interface between the cement and bentonite-cement mixture 1/2 to 1 foot below the frost line, serves to protect the well from damage due to frost heaving. The cement shall be placed in the borehole using the tremie method.

A one-quarter inch vent hole provides an avenue for the escape of gas. The protective cap guards the casing from damage and the locking cap serves as a security device to prevent well tampering.

As with drilling machinery, the well casing and screen shall be steam cleaned before use. Filter sands, well sealant materials, and anything else that may influence sample quality shall be free of contamination.

D. Well Intake Design: The design and construction of the intake of the monitoring wells shall:

1. allow sufficient groundwater flow to the well for sampling;
2. minimize the passage of formation materials (turbidity) into the well; and
3. ensure sufficient structural integrity to prevent the collapse of the intake structure.

For wells completed in unconsolidated materials, the intake of a monitoring well shall consist of a screen or slotted casing with openings sized to ensure that formation material is prohibited from passing through the well during development. Screen size shall be selected to retain 90% of the filter pack and 40% of the formation material. Extraneous fine grained material (clays and silts) that have been dislodged during drilling may be left on the screen, in the filter pack, and in the well water. These fines shall be removed from the screen and surrounding area during development. For quality-control purposes, only commercially manufactured screens or slotted casings shall be used. Field slotting of screens is unacceptable.

Screening with 0.010 inch slots shall be used unless geologic conditions discovered at the time of installation dictate a different size. The annular space between the face of the formation and the screen or slotted casing shall be filled to minimize passage of formation materials into the well. A filter pack of clean, well rounded, quartz sand or glass beads in each monitoring well that is constructed on site is recommend. In order to ensure discrete sample horizons, the filter pack shall extend no more than two feet above the well screen. A different filter pack material may have to be considered should geologic conditions at the time of drilling dictate the need for a different size.

E. Well Development: After the construction of monitoring wells is completed, natural hydraulic conductivity of the formation shall be restored and all foreign sediment removed to ensure turbidity-free groundwater samples. A variety of techniques are available for developing a well. To be effective, they require reversals or surges in flow to avoid bridging by particles, which is common when flow is continuous in one direction. These reversals or surges can be created by using surge blocks, bailers, or pumps. Formation water shall be used for surging the well. Should a well be constructed in low yielding water bearing formations, an outside source of water may be introduced into the well to facilitate development. In these cases, the water shall be chemically analyzed to ensure that it cannot contaminate the aquifer. If compressed air is used in the development of wells there is the possibility that trace contaminants may be introduced.

Therefore, sufficient precaution shall be taken to prevent introduction of contaminants which may be cause for concern. All equipment used to develop a well shall be steam cleaned prior to its introduction into the well.

F. Documentation of Well Design and Construction: The following information shall be required in the design and construction of wells:

- name of driller, identification of drill rig;
- date of construction;
- drilling method and drilling fluid * (primarily drilling mud) used;
- well location (+/- 0.5 ft.);
- bore hole diameter and well casing diameter;
- well depth (+/- 0.1 ft.);
- drilling and logs
- casing materials *;
- screen materials and design;
- casing and screen joint type;
- screen slot size/length;
- filter pack material */size;
- filter pack volume;
- filter pack placement method;
- sealant materials *;
- sealant volume;
- sealant placement method;
- surface seal design/construction;
- well development procedure;
- type of protective well cap;
- ground surface elevation (+/- .01 ft.);
- well cap elevation (+/- .01 ft.);
- top of casing elevation (+/- .01 ft.); and
- detailed drawing of well (include dimensions).

*Samples of materials, adequate for leaching/sorption tests should be retained.

4. Well Plugging

Procedure: If it becomes necessary to abandon a monitoring well, the following plugging procedures shall be used to ensure the well will not become an avenue of aquifer contamination. Plugging can also serve to inhibit water loss from artisan aquifers and to eliminate the physical hazard of an open hole. Proper plugging materials and techniques will vary according to the original well construction and the hydrographics of the site.

The general procedure for plugging shallow monitoring wells completed in water table aquifers includes three steps.

i. Removal of obstructions in the well that could interfere with the plugging operation and thorough flushing of the well to purge residual drilling fluids and other fine detritus,

ii. Removal of the well casing (where practical) to ensure placement of an effective seal-as a minimum when the casing is not properly grouted, the upper 20 feet of casing must be removed,

iii. Sealing of the well with an impermeable filler such as neat cement.

Sealant Materials: Well sealants shall be chemically inert and impermeable. Neat portland cement (with or without bentonite clay additives) and bentonite clay are an acceptable sealant. General purpose (Type 1) neat portland cement is acceptable. The cement slurry is to be mixed with five to six gallons of water for each 94 pound sack of cement. The water of the cement slurry should have a low sulfate content and a total dissolved solids content less than 2,000 parts per million. No aggregate materials are to be included in the slurry. The neat cement slurry shall be piped to the point of application so that the well is filled upward from the bottom. Free falling of the slurry into the well is unacceptable.

Recommended quantities of neat portland cement needed for plugging various diameter wells are shown in Table 1.

TABLE 1

CAPACITIES OF WELL CASINGS			
Diameter of Hole	Gallons per Lineal Foot	Sacks Cement Per Lin. Foot	Cement Set Volume
2"	0.1632	0.0199	50.2
3"	0.3672	0.0311	32.1
4"	0.6528	0.0791	12.6
5"	1.0200	0.1240	8.0
6"	1.4688	0.1785	5.6
7"	1.9992	0.2430	4.1
8"	2.6112	0.3373	3.2
10"	4.0800	0.4958	2.0
12"	5.8752	0.7140	1.4

Recommended quantities of neat portland cement needed for plugging various diameter wells are shown in the above Table. Quantities are based on the set volume, which is somewhat less than the slurry volume.

(Taken from "Plugging Abandoned Wells" by Donald K. Keech, Ground Water Age, January 1973)

Bentonite clay additives reduce shrinking (and cracking) of the cement while the slurry is setting. Three to five pounds of additive and 6-1/2 gallons of water are to be mixed with each 94 pound sack of cement (the clay and water are to be mixed together before cement is added to form the slurry).

Bentonite clay can be used separately as a well sealant. The clay can be dropped into the well in the form of granules, chunks, pellets, or balls. Where the potentiometric head of an aquifer causes water to rise in the well high above the level of the plug, consideration must be given to the physical form of the bentonite to be used. Adding the bentonite in chunk or pellet form will prolong the effective period of wetting prior to hydration and allow proper placement of the plug. Bentonite clay can not be used as a sealant where organic contaminants are present in the groundwater unless the bentonite is treated and documentation is presented to show that it is capable of containing organic contaminants.

Shallow monitoring wells installed in unconsolidated sediments or consolidated rocks without fractures or dissolution voids are to be filled with a sealant. Backfilling of the screened or uncased section of the well (up to several feet below the casing) with clean, disinfected sand is permissible. Sand with a diameter of 0.025 inches or less (plaster sand or mortar sand) reduces cement penetration/loss. As a minimum, the upper 50 feet of deep monitoring wells shall be plugged with neat cement or bentonite clay.

Consolidated rocks with a high density of fractures or dissolution voids shall be filled completely with neat cement. Sand and clay fill materials are not suitable. The use of bridging materials, such as pea gravel or larger rocks (the diameter of the bridging material should be less than 1/3 of the diameter of the well) below the casing or the placement of a plug at the base of the casing, may be necessary to retain the neat portland cement slurry in the well.

Where several confined aquifers are present in an abandoned monitoring well, impermeable seals between water bearing sections are required. Flow from artisan wells can cause problems with the installation of neat portland cement. Packers or heavy plugs shall be required to inhibit water flow.

IX. ENVIRONMENTAL PROTECTION STATEMENTS

A. Flood Protection: No solid waste in this facility is proposed to be disposed of within the 100 year flood plain. Based upon review of flood plain boundary data distributed by the Federal Emergency Management Agency this site is not located in the 100 year flood plain. F.E.M.A. Panel No. 470266 Map 01 shows the nearest flood plain boundary to be approximately 1,100 feet from the ash disposal site. The approximate 100 year flood elevation at the JOF is elevation 375. The bottom of the proposed dredged ash pond is elevation 393.

B. Environmental Impact: This facility should not cause or contribute to the taking of any endangered species of plants, fish, or wildlife or to the destruction of their habitat. No 34 negative impacts are expected to occur as a result of the 35 acre site for dredged ash disposal. Also refer to the TVA report titled Final Environmental Assessment TVA/RDG/EOS-89-2, (Reference 3).

X. CLOSURE AND POST CLOSURE

A. Expected Year of Closure

On a yearly basis, approximately 315,000 cubic yards of ash are produced at the JOF. Based upon the TVA drawings, it is estimated that approximately 830,000 cubic yards of volume are available for ash disposal.

The projected date of closure will be affected by TVA's implementation of construction of the new dredged ash disposal area. As previously discussed it is anticipated that Phase I operations will take approximately 13 months and Phase II will take 7 months. However, for the purposes of estimating the expected closure date, it is assumed that operations will begin in September, 1991. Intermittent operation of the dredging could take place over a period of ten years or more, depending on disposal needs of the plant. The latest anticipated closure date including allowing 4 months for closure activities, is September, 2001.

B. Facility Contact

The names, addresses, and telephone numbers of the TVA personnel that may be contacted during the Closure/Post-Closure care period are listed as follows:

Plant Manager
Tennessee Valley Authority
Johnsonville Fossil Plant
P.O. Box 259 - Hwy 70
New Johnsonville, Tennessee 37134
(931) 535-8212

As of the date of this report the plant manager is Mr. Michael Moseley

C. Facility Closure

1. Partial Closure Steps

This section is for the purpose of explaining the steps that will need to be followed should the dredged ash disposal facility be closed prior to the projected closure date discussed previously. A basic premise for partial closure of the facility is that this facility, if closed before the projected closure date, will result in final grades that are less than the proposed final grades shown on the TVA plans. If such a partial closure is implemented TVA will be required to submit revisions to the Permit Plans (to include drawings and narrative).

2. Closure Schedule

Upon determination that the closure of the facility is forthcoming a notification of TVA's intent to close the Dredged Ash Disposal facility must be sent to DSWM sixty (60) days prior to the closure date.

After the final grade of ash has been reached, closure activities, to include final grading and vegetative cover must be complete as soon as practical but are not to exceed 180 days.

TVA must notify DSWM in writing of completion of closure of the disposal facility. Such notification must include a certification by TVA that the disposal facility has been closed in accordance with the approved permit plans. Within 21 days of the receipt of such notice DSWM is supposed to inspect the facility to verify that closure has been completed and is in accordance with the approved plan. Within 10 days of such verification, DSWM is supposed to approve the closure in writing to TVA. Closure shall not be considered final and complete until such approval has been made by DSWM.

3. Notice in Deed to Property

TVA is required to ensure that within 90 days of completion of final closure of the facility and prior to sale or lease of the property on which the facility is located, there is recorded, in accordance with State law, a notation on the deed to the property or on some other instrument which is normally examined during title search that will in perpetuity notify any person conducting a title search that the land has been used as a disposal facility.

4. Post Closure Care Activities

During the post closure care period, the operator must, at a minimum, perform the following activities on closed portions of his facility:

a. Maintain the approved final contours and drainage system of the site such that precipitation run-on is minimized, erosion of the cover/cap is minimized, precipitation on the stack is controlled and directed off the stack, and ponding is eliminated.
b. Ensure that a healthy vegetative cover is established and maintained over the site.
c. Maintain the drainage facilities, sediment ponds, and other erosion/sedimentation control measures (if such are present), at least until the vegetative cover is established sufficiently enough to render such maintenance unnecessary.
d. Maintain and monitor the ground water monitoring system. The monitoring system and sampling and analysis program established in the previous sections shall be continued during the post-closure care period, unless the Closure/Post Closure plan is modified to establish a different system or program . Monitoring data must be reported in writing to the DSWM within 30 days after the completion of the analysis.

5. Cost Estimate/Financial Assurance

TVA is an agency and instrumentality of the United States created by the TVA Act of 1933, 16 U.S.C. 831-83ldd (1988) .

TVA is not required to provide financial assurance in accordance with DSWM solid waste regulations rule 1200-1-7-.03 (1)(b)(3) page.03-1.

XI. QUALITY ASSURANCE/QUALITY CONTROL

A. General

The purpose of this plan is to establish standards that must be followed by the registered professional engineer or geologist in order to insure that the construction, of the facility meets the specifications given in the design documents. The professional engineer or geologist shall use sound judgment when determining what additional procedures may be required in order to further assure the construction quality.

The Quality Assurance/Quality Control shall be performed by a party independent of all other Construction Contractors involved in construction for the new dredged ash disposal site. The plan will be performed in addition to any Construction Quality Control Programs implemented by Construction Contractors.

Detailed in this plan are the minimum standards for soil selection, minimum testing programs, minimum construction standards, and the minimum documentation required to assure that the requirements of the plans and specifications are met.

Throughout this document, the word "clay" is used to mean material of low permeability. This may include soil classified as clay or mixtures of soil with additives as required to meet the specifications.

B. Subbase

1. Material Construction: Prior to construction of the geologic buffer system, the existing grades will be verified to ensure they are in accordance with the grades shown on the plans.

   The base material will be in good condition with no excess water or stability problems.

2. Geologic Buffer Construction: The bottom three feet of the new dredged ash pond will consist of material with a maximum permeability of 1 X 10^{-6} cm/sec. The bottom includes an underdrain system for draining of the dredged ash. The bottom of the pond will consist of earthen material, free of roots, vegetation and other organic materials.

If the new dredged ash pond bottom has areas determined to be not acceptable by the registered professional engineer or geologist remedial actions shall be taken. As a minimum, additional tests may be required to locate the extent of the unacceptable area. It shall be remedied based on the engineer's or geologist's sound professional judgment. Actions may include re-compaction or removal and replacement of unsatisfactory material with new material, compaction and re-testing.

Documentation of these procedures shall be provided by the engineer or geologist.

C. Geologic Buffer

1. Construction Specifications: As previously discussed, the geologic buffer requirement adopted by the DSWM requires three feet of soil with a hydraulic conductivity of 1 X 10^{-6} cm/sec. The three feet of soil in the bottom of the new dredged ash pond, will meet the following requirements:

- A saturated, vertically oriented hydraulic conductivity no greater than 1 X 10^{-6} cm/sec for the pond, after compaction within the density and moisture content range specified for construction as determined during laboratory testing.

• A classification of CH or CL, as determined by the Unified Soil Classification System, ASTM standard D-2487-69, unless the DSWM approves another classification.

• Any alternative soil proposed to DSWM will include documentation that the soil can be compacted to achieve the hydraulic conductivity and engineering properties of the soil specified above.

2. Clay Source Verification: The clay source will be tested and verified by a registered professional engineer or geologist as meeting the standards specified. Random samples of the source material will be obtained every 3000 cubic yards excavated and whenever the texture, color or location of the source of the 'soil changes significantly. Samples will be tested for the following such that a correlation to permeability may be made:

a. Moisture-density relationship of the soil by the Standard Proctor Test, (ASTM D698);
b. Grain size analysis (ASTM D422);
c. Atterberg Limits (ASTM D4318).

If material is required to be placed for the geologic buffer, random samples will be obtained and tested at a rate of one sample for every 5 acres per each one foot thickness, for the purpose of verifying hydraulic conductivity. Samples will be tested for hydraulic conductivity as specified by ASTM D5084.

3. Clay Dike or Buffer Construction: The geologic buffer will be constructed as outlined below:

a. Lift thickness of no more than 8 inches, loose lift (prior to compaction).

b. Each lift is thoroughly and uniformly compacted to that density and within that moisture content range determined necessary to achieve a hydraulic conductivity less than 1 X 10^{-6} cm/sec.

c. Soil <u>will not</u> be compacted at moisture contents less than optimum, nor to less than 95% of the maximum dry density, as determined by the Standard Proctor Test, ASTM D698.

d. Compaction of the lifts immediately above the underdrain collection system, or other sensitive system components shall be placed with care in order not to damage those components.

e. The bottom and sidewall of the geologic buffer or dike will be continuous and completely keyed together at all construction joints. Where required the previous lift or area of construction shall be scarified to facilitate bonding between lifts.

f. During construction, the clay will be protected from detrimental climatic effects by:

- Protecting construction from extraneous surface water, sloped to facilitate drainage
- Removing all ice and snow prior to placing a lift, and not using frozen soil in any part of the geologic buffer;
- Recompacting any soil that has been subjected to a freeze and thaw cycle;
- Insuring that geologic buffers are not subject to desiccation cracking by sprinkling the liner with water not less than twice per day, covering or tarping the soil, or other preventative measures;
- By removing soil which has experienced desiccation cracking before compacting the next lift or installing the next geologic buffer system component.
- By removing excessively wet soil or areas determined to be not acceptable by the registered professional engineer or geologist.

g. If the construction has areas determined to be not acceptable by the registered professional engineer or geologist remedial actions shall be taken. As a minimum, additional tests may be required to locate the extent of the unacceptable area. It shall be remedied based on the engineer's or geologist's sound professional judgment. Actions may include re-compaction or removal and replacement of unsatisfactory material with new material, compaction and re-testing. Documentation of these procedures shall be provided by the engineer or geologist.

4. Clay Construction Certification: A registered professional engineer or geologist will verify that a compacted geologic buffer is constructed in accordance with these criteria by performing all of the following quality control tests.

a. Field density-moisture measurements of the geologic buffer immediately after compaction, as specified by ASTM D2922 (nuclear methods), for each 1000 cubic yards placed, with a minimum of 1 test per day of construction of lift of soil. The location of the soil samples will be rotated with each lift to maximize the coverage of the tests. Field in place density/moisture content tests will be conducted using a nuclear density gauge, sand cone or drive cylinder. If nuclear density methods are used sufficient numbers of the sand cone or drive cylinder tests will be performed to correlate and verify the nuclear gauges results. The moisture content of the fill materials will be kept within a range which allows the earthwork contractor to achieve the required density and permeability. When, in the opinion of the certifying Engineer or Geologist the moisture content of the fill material is too high or too low, the material will be alternately dried or moistened to facilitate compaction to the specified density.

b. The undisturbed hydraulic conductivity of a soil sample will be conducted at a minimum once per 5 acres per foot of thickness of constructed geologic buffer. Samples will be tested for hydraulic conductivity as specified by ASTM D5084. Permeability samples will be obtained by extracting a Shelby Tube sample from the in-place compacted material and returning this sample to the laboratory for testing. The hole left by the Shelby Tube will be carefully backfilled with nonshrink grout, hand tamped, and compacted into place.

c. Upon completion of the clay construction, elevations will be taken to verify construction.

d. Provide documentation of the quality control measures performed with field notes and certifications.

D. Cap

1. The final cover shall be 24 inches of compacted soil with a minimum of 6 inches of which shall support vegetative cover per the DSWM variance agreement stated in policy memorandum: SW-91-2 Revised (Appendix E).
2. Cap Construction Certification: A technician in the field under the direction of a Professional Engineer or Professional Geologist will verify that the cap is constructed in accordance with these criteria If the construction of the cap has areas that are determined to be not acceptable by the registered professional engineer or geologist remedial actions shall be taken. Actions may include adding additional soil to meet the 24" minimum requirement.

3. The registered professional engineer or geologist will provide documentation of the measures performed with field notes and certification.
4. Once the soil has been applied, the area shall be seeded as soon as practical in accordance with the requirements shown on the drawing and in accordance with the TVA specifications shown in Appendix D.
5. Upon completion of the cap construction, elevations will be taken to verify construction.

E. DOCUMENTATION

1. Daily Logs
   a. The registered professional engineer or geologist performing Quality Assurance/Quality Control shall prepare a daily log giving the detailed descriptions of the construction operations.
   b. The daily log shall include but not be limited to: construction operations and their locations, operations and locations of other QA/QC engineers or geologists, all tests performed and their designation and location, all the locations and designations of samples taken, locations and findings of core sampling, meteorological conditions, and general comments and observations.
   c. A copy of the daily logs shall be kept on site and made available to TVA, the QA/QC personnel, and Construction Contractor.

Test Data

All field and laboratory test data shall be accompanied by test/sampling data, location, reasons for the location, personnel and any comments.

2. Approval Documentation

   a. All corrective measures taken to bring unsuitable work into conformance with the design specifications must be documented. This document must describe what is at fault and the exact location and test designation(s) that shows the work to be unsuitable, the corrective measures agreed upon to bring it into conformance with design specifications, the dates that corrective work was accepted, and the test designation that shows the work to be acceptable. All work shall be documented as to quality and verified by the engineer or geologist.

   b. The documentation will be organized and indexed to enable easy access and retrieval of original inspection and testing data sheets and reports. During the construction period, originals of the documents will be maintained by the engineer or geologist of and copies will be kept by the TVA. Once the construction quality assurance has been certified by an independent, registered engineer and has been accepted by the owner, originals of the documentation will be maintained by TVA through the closure and post closure period of the site.

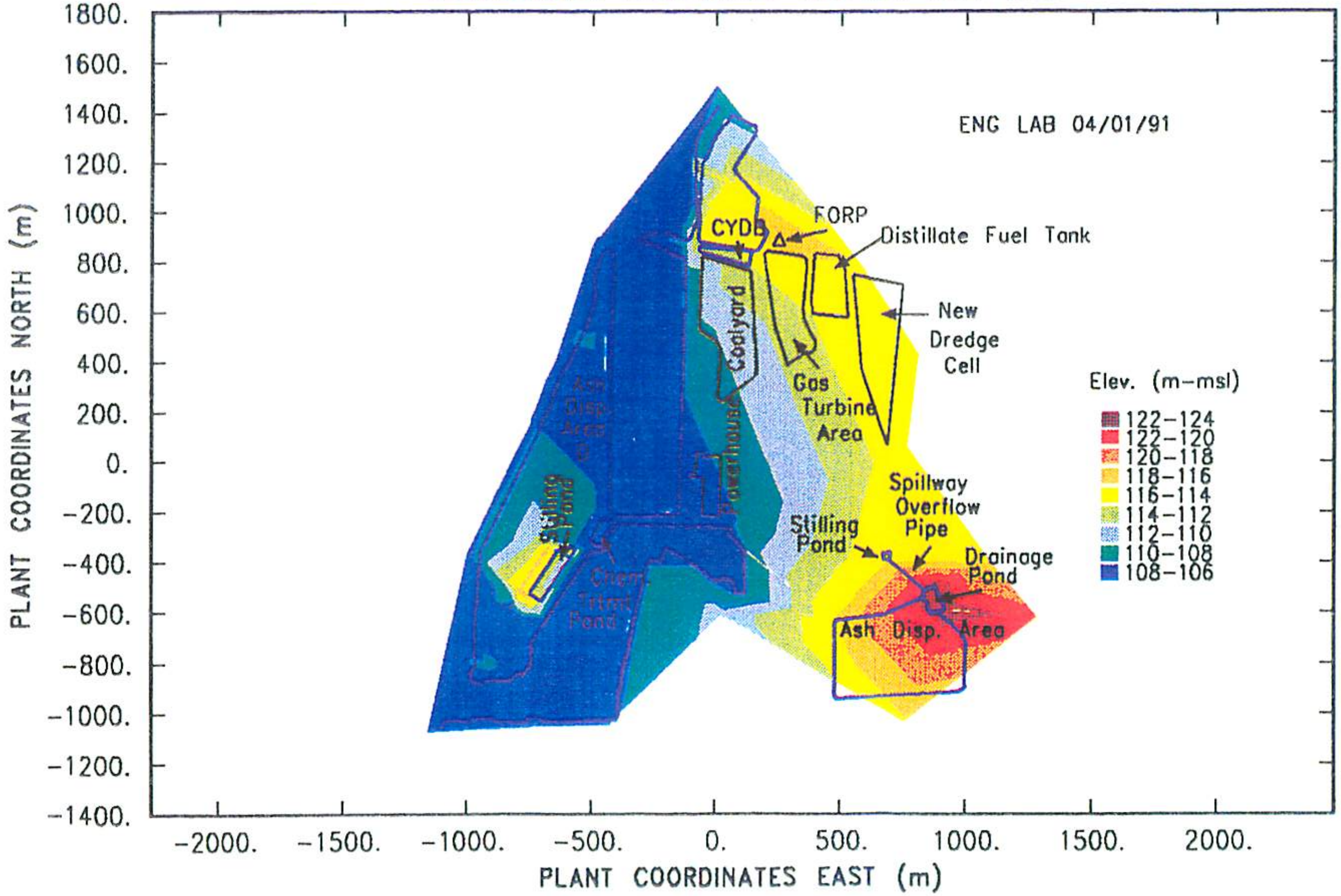
XII. REFERENCES

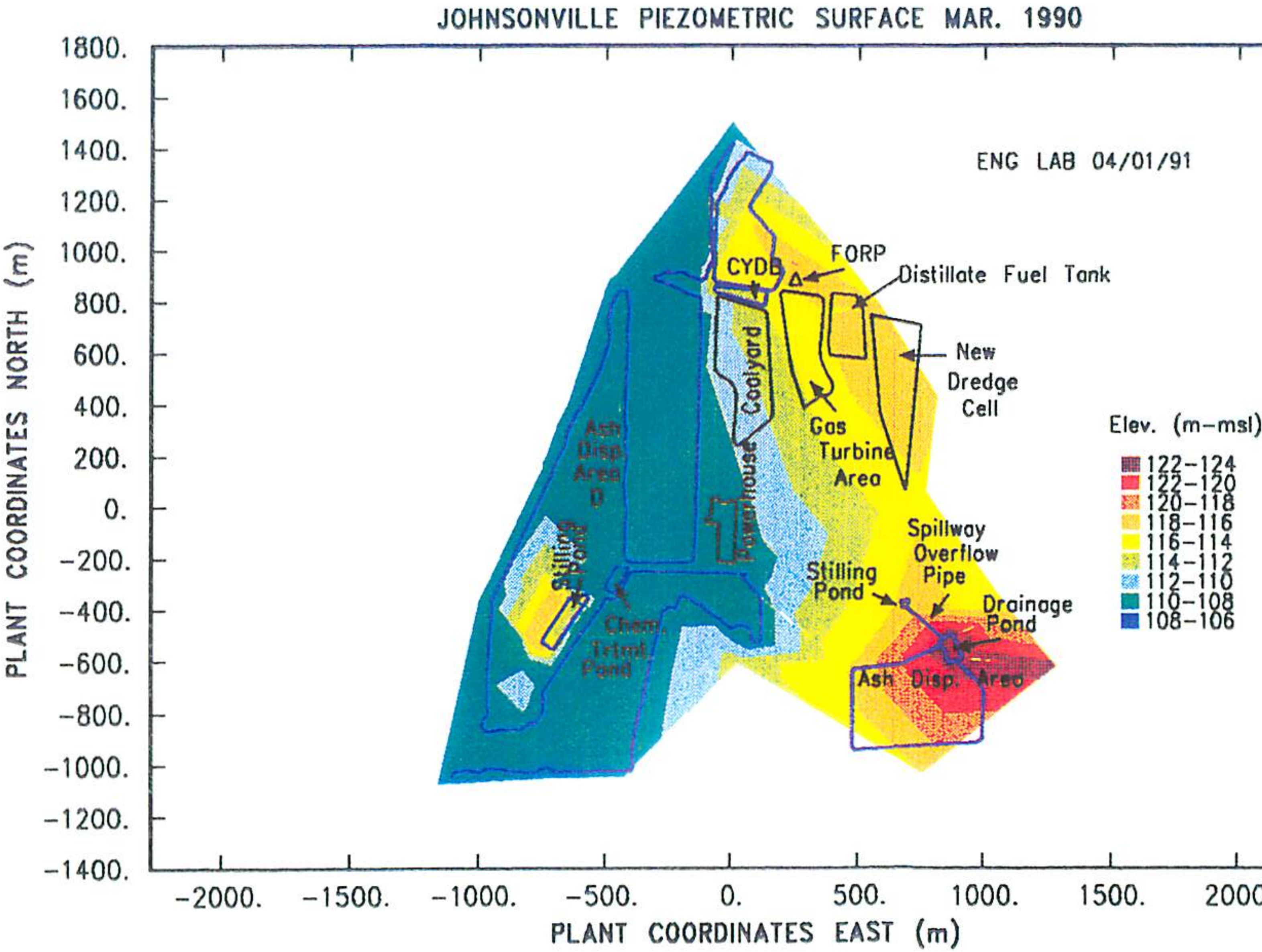
1. Application for Solid Waste Disposal Permit for Dredged Ash Disposal Area, January 1990, By Sargent and Lundy
2. Report of Supplemental Hydrogeological Activities-, Proposed Dredged Ash Disposal Cell, Tennessee Valley Authority - New Johnsonville Steam Plant, January, 1992, by Law Engineering
3. TVA Final Environmental Assessment Report #TVA2/RDG/EQS89-2

APPENDIX A

PIEZOMETRIC SURFACE MAP AND DATA

JOHNSONVILLE PIEZOMETRIC SURFACE DEC. 1990




JOHNSONVILLE PIEZOMETRIC SURFACE MAR. 1990
ENG LAB 04/01/91
PLANT COORDINATES NORTH (m)
PLANT COORDINATES EAST (m)
1800.
1600.
1400.
1200.
1000.
800.
600.
400.
200.
0.
-200.
-400.
-600.
-800.
-1000.
-1200.
-1400.
-2000.
-1500.
-1000.
-500.
0.
500.
1000.
1500.
2000.
CYDB
FORP
Distillate Fuel Tank
New
Dredge
Cell
Coalyard
Gas
Turbine
Area
Powerhouse
Ash
Disp.
Area
D
Stilling
Pond
Chem.
Trtmt.
Pond
Spillway
Overflow
Pipe
Stilling
Pond
Drainage
Pond
Ash Disp. Area
Elev. (m-msl)
122-124
122-120
120-118
118-116
116-114
114-112
112-110
110-108
108-106

! Johnsonville Piezometric Contours
! Water Elevation in mmsl
! by JSL 3-20-91 sun/home/tennessee/jsl/jvmaps/SImaps/welev.dat

! Plant Coordinates		Water Elevation(mmsl)		
E-Coords(m)	N-Coords(m)	Dec. 90	Mar. 91	Well
-118.3	515.5	108.8	109.6	B1
-135.6	869.5	109.5	110.2	B2
350.5	761.7	115.4	115.8	B3
32.1	-608.2	110.6	112.7	B5
459.3	-629.4	115.4	115.7	B6
681.8	-400.4	115.8	116.4	B7
532.8	-783.9	115.8	116.3	B8
1283.5	-622.4	121.2	122.8	B9
763.7	57.0	115.4	115.8	B10
553.3	590.7	115.6	117.5	B11
584.6	780.5	115.7	116.1	B12
808.1	429.4	115.7	116.2	B13
-77.9	1047.4	112.5	112.7	C1
-8.9	1021.0	115.2	114.1	C2
48.3	1004.4	114.2	114.4	C3
-89.6	1183.3	113.5	113.6	C4
55.5	1114.6	114.6	114.5	C5
102.3	1082.4	115.2	116.4	C6
1103.9	-409.6	115.9	115.5	A1
457.7	-632.5	115.2	116.0	A2
755.9	-1035.8	115.7	116.1	A3
-637.7	-350.5	107.6	108.4	SS13
-810.1	-731.5	107.6	111.7	SS15
-734.6	-289.6	111.1	114.6	SS16
252.621	943.323	117.9	118.1	FORP
-76.613	920.124	114.4	114.3	CYDB
-78.503	912.208	114.4	114.3	CYDB
-77.180	903.299	114.4	114.3	CYDB
-72.266	897.956	114.4	114.3	CYDB
-71.888	898.352	114.4	114.3	CYDB
121.094	838.377	114.4	114.3	CYDB
128.654	839.562	114.4	114.3	CYDB
130.166	842.531	114.4	114.3	CYDB
136.782	892.217	114.4	114.3	CYDB
132.624	897.362	114.4	114.3	CYDB
126.953	898.748	114.4	114.3	CYDB
-57.523	918.740	114.4	114.3	CYDB
-71.321	919.728	114.4	114.3	CYDB
-74.912	919.335	114.4	114.3	CYDB
-788.099	-524.768	116.4	117.4	Stilling Pond
-750.907	-549.792	116.4	117.4	St. Pond
-739.580	-550.380	116.4	117.4	St. Pond
-600.253	-345.085	116.4	117.4	St. Pond
-602.896	-334.445	116.4	117.4	St. Pond
-611.203	-330.309	116.4	117.4	St. Pond
-672.371	-347.646	116.4	117.4	St. Pond
-679.356	-356.512	116.4	117.4	St. Pond
-785.645	-514.917	116.4	117.4	St. Pond
-787.721	-523.704	116.4	117.4	St. Pond

854.080	-540.682	123.0	123.4	Drainage Pond
860.129	-537.125	123.0	123.4	Drainage Pond
855.593	-524.472	123.0	123.4	Drainage Pond

858.239	-517.157	123.0	123.4	Drainage Pond
902.474	-495.608	123.0	123.4	Drainage Pond
909.279	-499.759	123.0	123.4	Drainage Pond
947.465	-582.198	123.0	123.4	Drainage Pond
945.008	-591.885	123.0	123.4	Drainage Pond
929.507	-598.804	123.0	123.4	Drainage Pond
-832.612	-521.631	108.1	108.1	Ash Pond D
-683.151	-279.652	108.1	108.1	Ash Pond D
-590.634	-322.357	108.1	108.1	Ash Pond D
-498.109	-172.895	108.1	108.1	Ash Pond D
-505.225	474.764	108.1	108.1	Ash Pond D
-519.457	503.228	108.1	108.1	Ash Pond D
-555.045	496.112	108.1	108.1	Ash Pond D
-732.971	76.2075	108.1	108.1	Ash Pond D
-953.602	-365.053	108.1	108.1	Ash Pond D
-967.842	-792.081	108.1	108.1	Ash Pond D
-896.665	-806.322	108.1	108.1	Ash Pond D
-761.444	-614.156	108.1	108.1	Ash Pond D
-1155.227	-1072.000	107.7	108.8	Ky. Lake
-1147.859	-1056.000	107.7	108.8	Ky. Lake
-1130.856	-1048.000	107.7	108.8	Ky. Lake
-1096.661	-1046.000	107.7	108.8	Ky. Lake
-1040.929	-1054.000	107.7	108.8	Ky. Lake
-1026.759	-1048.000	107.7	108.8	Ky. Lake
-1017.691	-1038.000	107.7	108.8	Ky. Lake
-941.300	-1039.000	107.7	108.8	Ky. Lake
-921.500	-1049.000	107.7	108.8	Ky. Lake
-800.600	-1053.000	107.7	108.8	Ky. Lake
-792.600	-1048.000	107.7	108.8	Ky. Lake
-791.100	-1037.000	107.7	108.8	Ky. Lake
-762.400	-1034.000	107.7	108.8	Ky. Lake
-724.800	-1048.000	107.7	108.8	Ky. Lake
-689.500	-1048.000	107.7	108.8	Ky. Lake
-432.500	-1045.000	107.7	108.8	Ky. Lake
-423.500	-1045.000	107.7	108.8	Ky. Lake
-411.600	-1025.000	107.7	108.8	Ky. Lake
-415.700	-979.000	107.7	108.8	Ky. Lake
-413.800	-966.000	107.7	108.8	Ky. Lake
-414.400	-944.000	107.7	108.8	Ky. Lake
-408.200	-922.000	107.7	108.8	Ky. Lake
-396.800	-840.000	107.7	108.8	Ky. Lake
-363.800	-742.000	107.7	108.8	Ky. Lake
-366.400	-735.000	107.7	108.8	Ky. Lake
-353.200	-676.000	107.7	108.8	Ky. Lake
-349.200	-647.000	107.7	108.8	Ky. Lake
-290.300	-404.000	107.7	108.8	Ky. Lake
-285.600	-398.000	107.7	108.8	Ky. Lake
-277.600	-399.000	107.7	108.8	Ky. Lake
-266.300	-385.000	107.7	108.8	Ky. Lake
-263.100	-385.000	107.7	108.8	Ky. Lake
-235.700	-392.000	107.7	108.8	Ky. Lake
-208.300	-337.000	107.7	108.8	Ky. Lake
-178.400	-351.000	107.7	108.8	Ky. Lake
-143.500	-374.000	107.7	108.8	Ky. Lake
-125.200	-377.000	107.7	108.8	Ky. Lake
-116.100	-388.000	107.7	108.8	Ky. Lake
-101.600	-403.000	107.7	108.8	Ky. Lake
-75.300	-419.000	107.7	108.8	Ky. Lake
-65.100	-430.000	107.7	108.8	Ky. Lake
-43.400	-436.000	107.7	108.8	Ky. Lake
-36.400	-450.000	107.7	108.8	Ky. Lake
-4.600	-471.000	107.7	108.8	Ky. Lake
-9.400	-478.000	107.7	108.8	Ky. Lake

34.600	-461.000	107.7	108.8	Ky. Lake
43.300	-462.000	107.7	108.8	Ky. Lake
70.500	-469.000	107.7	108.8	Ky. Lake

74.400	-485.000	107.7	108.8	Ky. Lake
83.900	-509.000	107.7	108.8	Ky. Lake
82.000	-522.000	107.7	108.8	Ky. Lake
85.400	-530.000	107.7	108.8	Ky. Lake
99.400	-527.000	107.7	108.8	Ky. Lake
112.600	-531.000	107.7	108.8	Ky. Lake
120.000	-526.000	107.7	108.8	Ky. Lake
119.000	-358.000	107.7	108.8	Ky. Lake
109.400	-333.000	107.7	108.8	Ky. Lake
91.400	-317.000	107.7	108.8	Ky. Lake
50.800	-272.000	107.7	108.8	Ky. Lake
42.700	-267.000	107.7	108.8	Ky. Lake
51.500	-269.000	107.7	108.8	Ky. Lake
65.700	-249.000	107.7	108.8	Ky. Lake
-401.400	-239.000	107.7	108.8	Ky. Lake
-411.400	-238.000	107.7	108.8	Ky. Lake
-425.000	-250.000	107.7	108.8	Ky. Lake
-453.500	-308.000	107.7	108.8	Ky. Lake
-475.600	-348.000	107.7	108.8	Ky. Lake
-482.000	-351.000	107.7	108.8	Ky. Lake
-502.600	-352.000	107.7	108.8	Ky. Lake
-516.400	-349.000	107.7	108.8	Ky. Lake
-530.800	-355.000	107.7	108.8	Ky. Lake
-549.900	-398.000	107.7	108.8	Ky. Lake
-556.700	-398.000	107.7	108.8	Ky. Lake
-614.900	-480.000	107.7	108.8	Ky. Lake
-783.900	-735.000	107.7	108.8	Ky. Lake
-779.600	-745.000	107.7	108.8	Ky. Lake
-776.600	-754.000	107.7	108.8	Ky. Lake
-781.700	-769.000	107.7	108.8	Ky. Lake
-780.900	-774.000	107.7	108.8	Ky. Lake
-777.000	-791.000	107.7	108.8	Ky. Lake
-780.500	-808.000	107.7	108.8	Ky. Lake
-792.100	-830.000	107.7	108.8	Ky. Lake
-815.900	-856.000	107.7	108.8	Ky. Lake
-822.300	-852.000	107.7	108.8	Ky. Lake
-829.500	-848.000	107.7	108.8	Ky. Lake
-835.100	-854.000	107.7	108.8	Ky. Lake
-868.600	-878.000	107.7	108.8	Ky. Lake
-891.600	-877.000	107.7	108.8	Ky. Lake
-937.500	-878.000	107.7	108.8	Ky. Lake
-1001.822	-889.000	107.7	108.8	Ky. Lake
-1020.714	-882.000	107.7	108.8	Ky. Lake
-1031.860	-866.000	107.7	108.8	Ky. Lake
-1033.183	-855.000	107.7	108.8	Ky. Lake
-1018.258	-829.000	107.7	108.8	Ky. Lake
-1009.000	-819.000	107.7	108.8	Ky. Lake
-1013.913	-775.000	107.7	108.8	Ky. Lake
-1014.101	-660.000	107.7	108.8	Ky. Lake
-1004.655	-545.000	107.7	108.8	Ky. Lake
-1003.333	-515.000	107.7	108.8	Ky. Lake
-999.300	-465.000	107.7	108.8	Ky. Lake
-989.700	-383.000	107.7	108.8	Ky. Lake
-995.300	-364.000	107.7	108.8	Ky. Lake
-946.800	-266.000	107.7	108.8	Ky. Lake
-744.300	159.000	107.7	108.8	Ky. Lake
-743.700	176.000	107.7	108.8	Ky. Lake
-725.400	219.000	107.7	108.8	Ky. Lake
-694.000	279.000	107.7	108.8	Ky. Lake
-686.600	325.000	107.7	108.8	Ky. Lake
-642.100	416.000	107.7	108.8	Ky. Lake
-629.200	429.000	107.7	108.8	Ky. Lake

-535.300	632.000	107.7	108.8	Ky. Lake
-517.400	686.000	107.7	108.8	Ky. Lake
-512.300	725.000	107.7	108.8	Ky. Lake

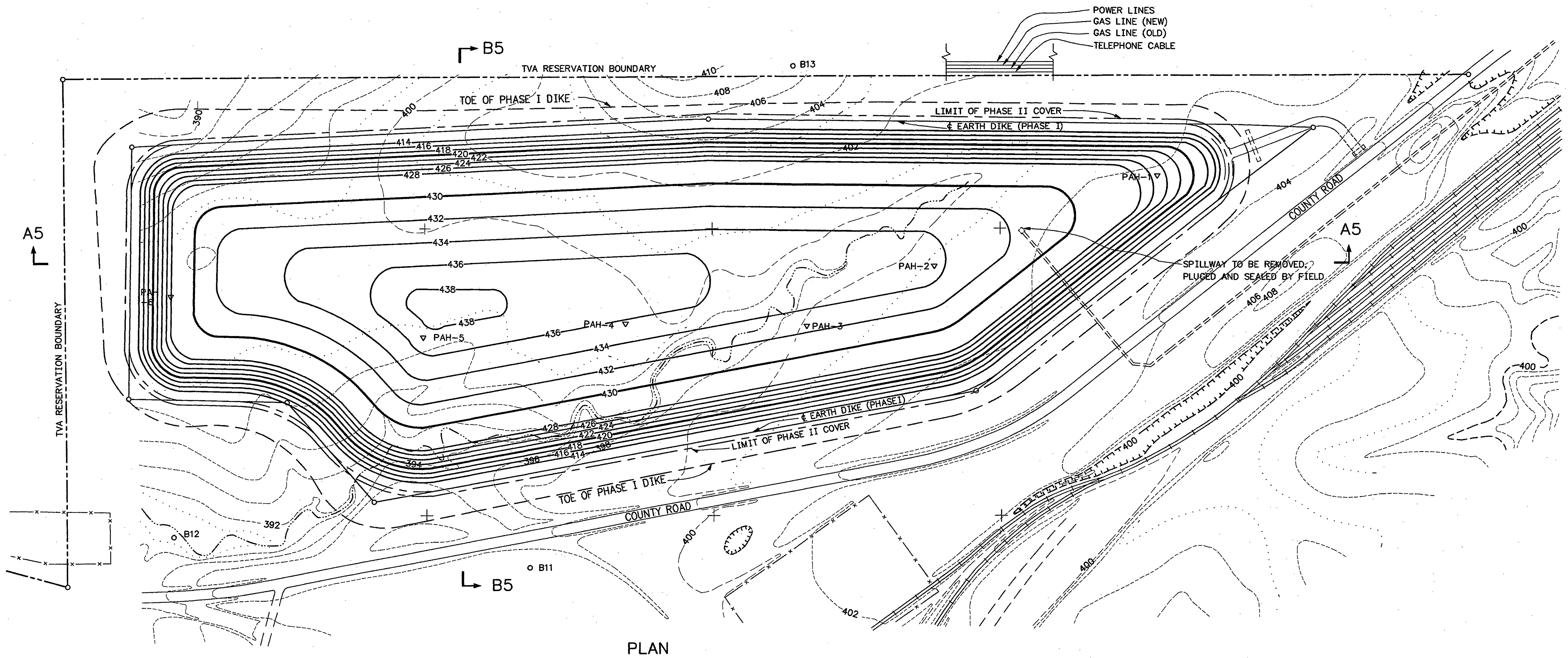
-522.100	784.000	107.7	108.8	Ky. Lake
-513.400	808.000	107.7	108.8	Ky. Lake
-503.200	851.000	107.7	108.8	Ky. Lake
-491.300	875.000	107.7	108.8	Ky. Lake
-480.000	893.000	107.7	108.8	Ky. Lake
-465.600	902.000	107.7	108.8	Ky. Lake
-450.700	901.000	107.7	108.8	Ky. Lake
-441.800	892.000	107.7	108.8	Ky. Lake
-439.500	880.000	107.7	108.8	Ky. Lake
-436.100	866.000	107.7	108.8	Ky. Lake
-436.300	853.000	107.7	108.8	Ky. Lake
-432.900	830.000	107.7	108.8	Ky. Lake
-438.800	736.000	107.7	108.8	Ky. Lake
-438.400	693.000	107.7	108.8	Ky. Lake
-441.800	629.000	107.7	108.8	Ky. Lake
-450.300	381.000	107.7	108.8	Ky. Lake
-442.400	338.000	107.7	108.8	Ky. Lake
-447.700	285.000	107.7	108.8	Ky. Lake
-440.100	221.000	107.7	108.8	Ky. Lake
-448.800	180.000	107.7	108.8	Ky. Lake
-455.200	112.000	107.7	108.8	Ky. Lake
-443.500	15.000	107.7	108.8	Ky. Lake
-448.000	-56.000	107.7	108.8	Ky. Lake
-448.600	-115.000	107.7	108.8	Ky. Lake
-449.400	-143.000	107.7	108.8	Ky. Lake
-448.200	-178.000	107.7	108.8	Ky. Lake
-444.400	-193.000	107.7	108.8	Ky. Lake
-433.900	-199.000	107.7	108.8	Ky. Lake
-420.300	-202.000	107.7	108.8	Ky. Lake
-165.600	-201.000	107.7	108.8	Ky. Lake
-155.800	-192.000	107.7	108.8	Ky. Lake
-132.300	725.000	107.7	108.8	Ky. Lake
-133.700	822.000	107.7	108.8	Ky. Lake
-135.900	861.000	107.7	108.8	Ky. Lake
-135.000	872.000	107.7	108.8	Ky. Lake
-192.000	891.000	107.7	108.8	Ky. Lake
-214.700	900.000	107.7	108.8	Ky. Lake
-233.600	911.000	107.7	108.8	Ky. Lake
-279.500	931.000	107.7	108.8	Ky. Lake
-323.000	944.000	107.7	108.8	Ky. Lake
-327.700	957.000	107.7	108.8	Ky. Lake
-323.200	963.000	107.7	108.8	Ky. Lake
-304.800	963.000	107.7	108.8	Ky. Lake
-283.100	978.000	107.7	108.8	Ky. Lake
-255.100	974.000	107.7	108.8	Ky. Lake
-205.600	976.000	107.7	108.8	Ky. Lake
-190.700	969.000	107.7	108.8	Ky. Lake
-176.700	958.000	107.7	108.8	Ky. Lake
-133.700	943.000	107.7	108.8	Ky. Lake
-116.100	953.000	107.7	108.8	Ky. Lake
-98.700	1003.000	107.7	108.8	Ky. Lake
-86.200	1032.000	107.7	108.8	Ky. Lake
-91.500	1111.000	107.7	108.8	Ky. Lake
-92.900	1201.000	107.7	108.8	Ky. Lake
-92.300	1256.000	107.7	108.8	Ky. Lake
-94.800	1318.000	107.7	108.8	Ky. Lake
-89.500	1364.000	107.7	108.8	Ky. Lake
-76.600	1396.000	107.7	108.8	Ky. Lake
2.600	1507.000	107.7	108.8	Ky. Lake
-600.000	-700.000	107.7	108.8	Ky. Lake
-800.000	-600.000	107.7	108.8	Ky. Lake
-700.000	-625.000	107.7	108.8	Ky. Lake

-720.000	-625.000	107.7	108.8	Ky. Lake
-662.800	-750.000	107.7	108.8	Ky. Lake
-775.000	-620.000	107.7	108.8	Ky. Lake

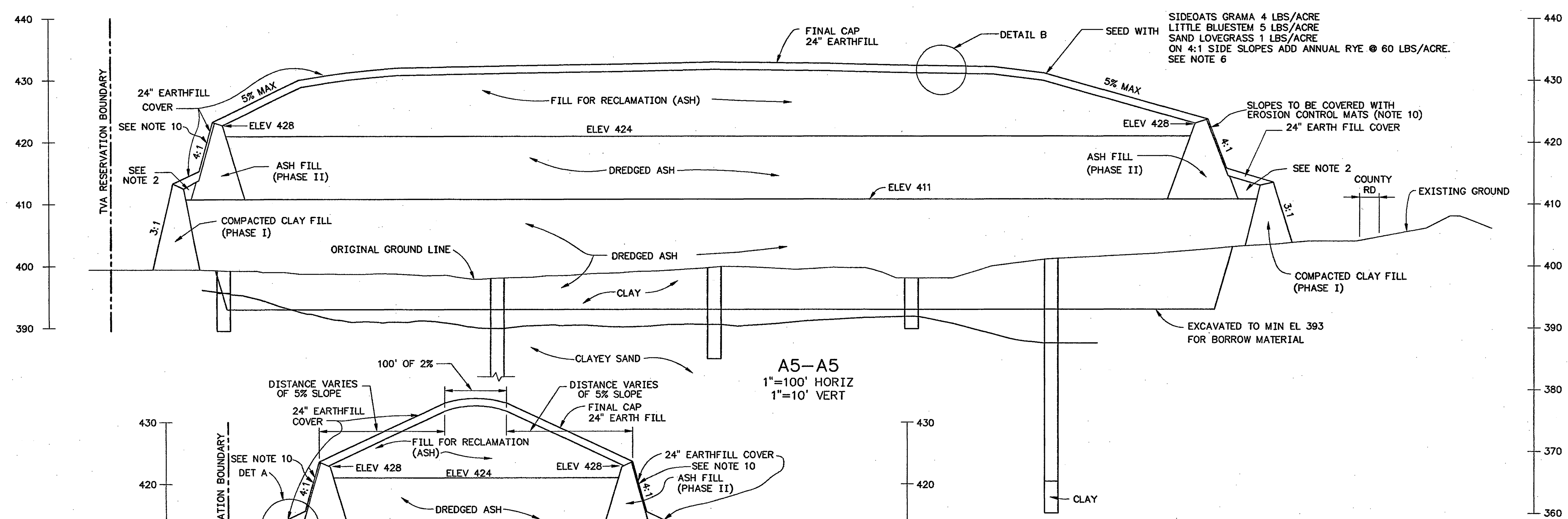
-132.300	200.000	107.7	108.8	Ky. Lake
-132.300	400.000	107.7	108.8	Ky. Lake
-132.300	600.000	107.7	108.8	Ky. Lake

APPENDIX B

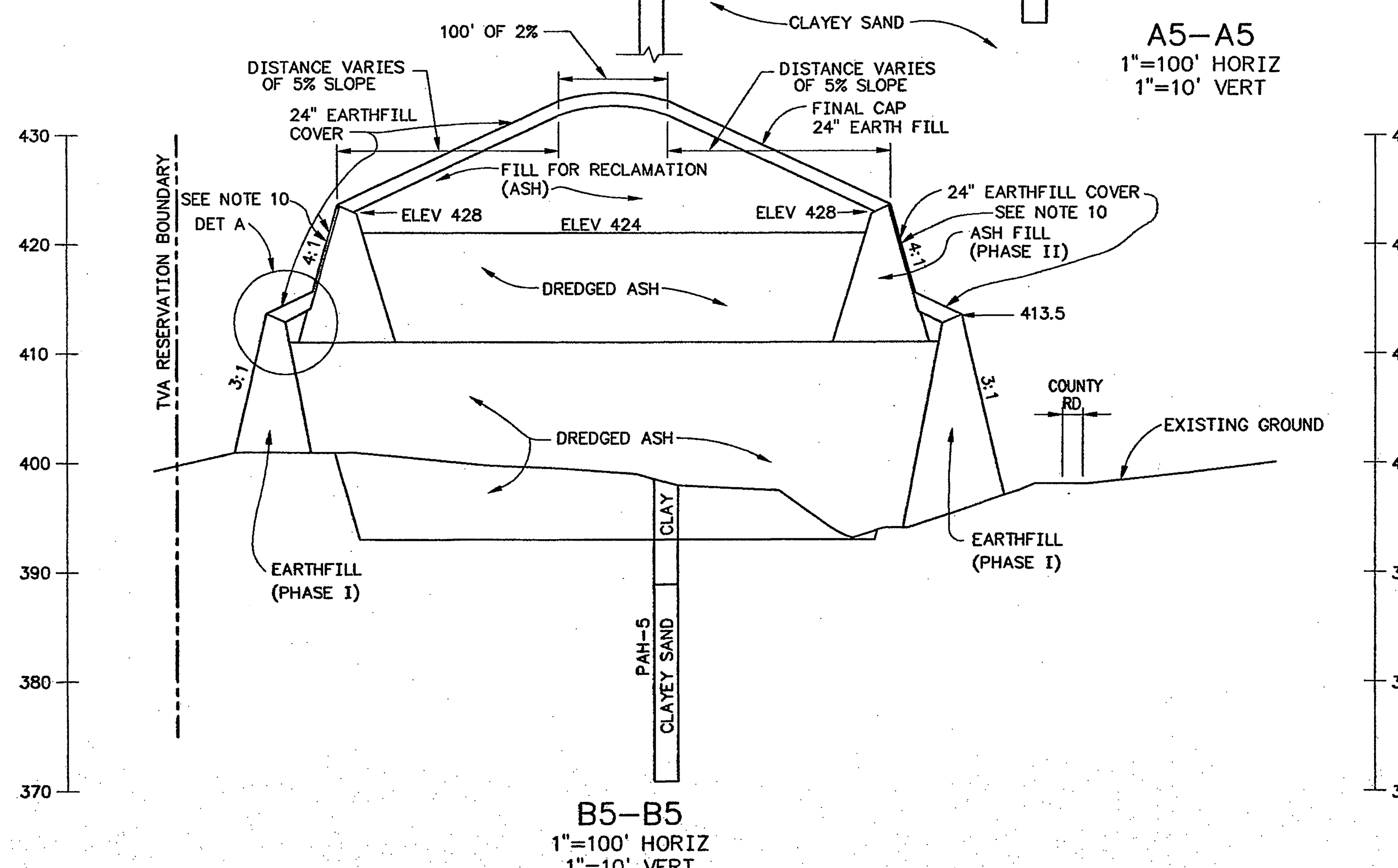
REVISED DESIGN DRAWINGS



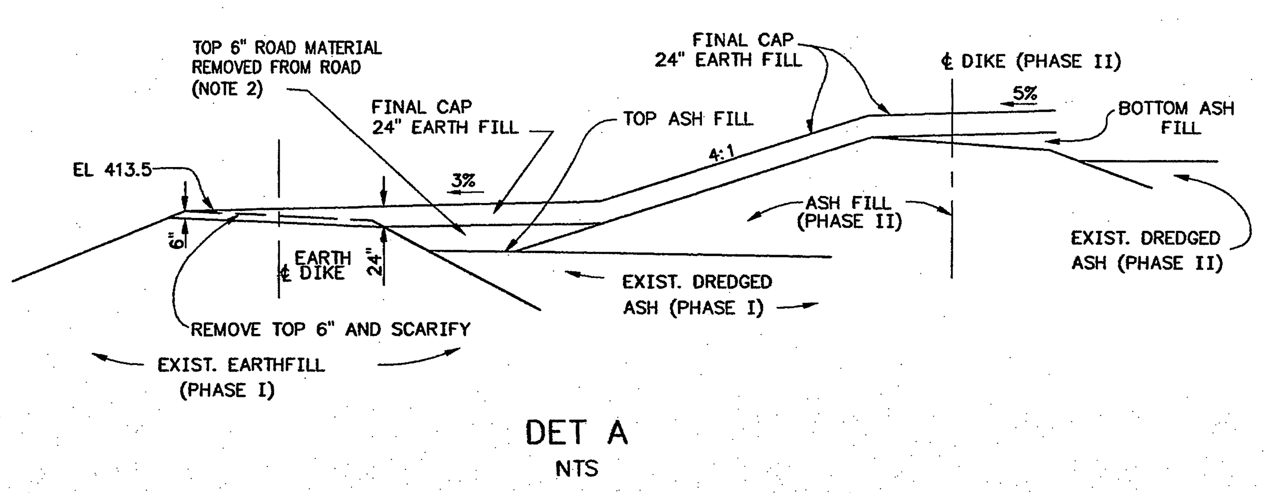
PLAN



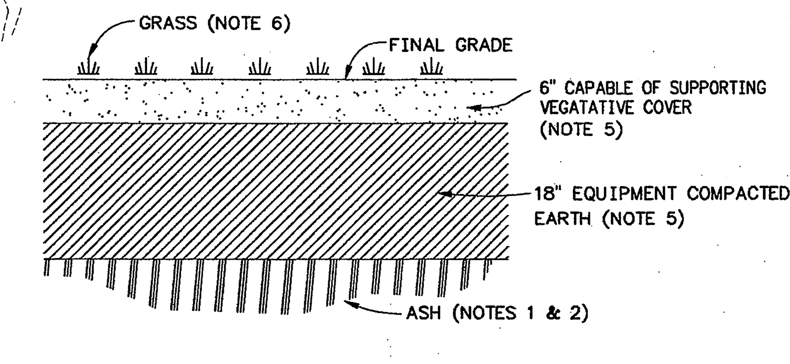
A5–A5
1"=100' HORIZ
1"=10' VERT



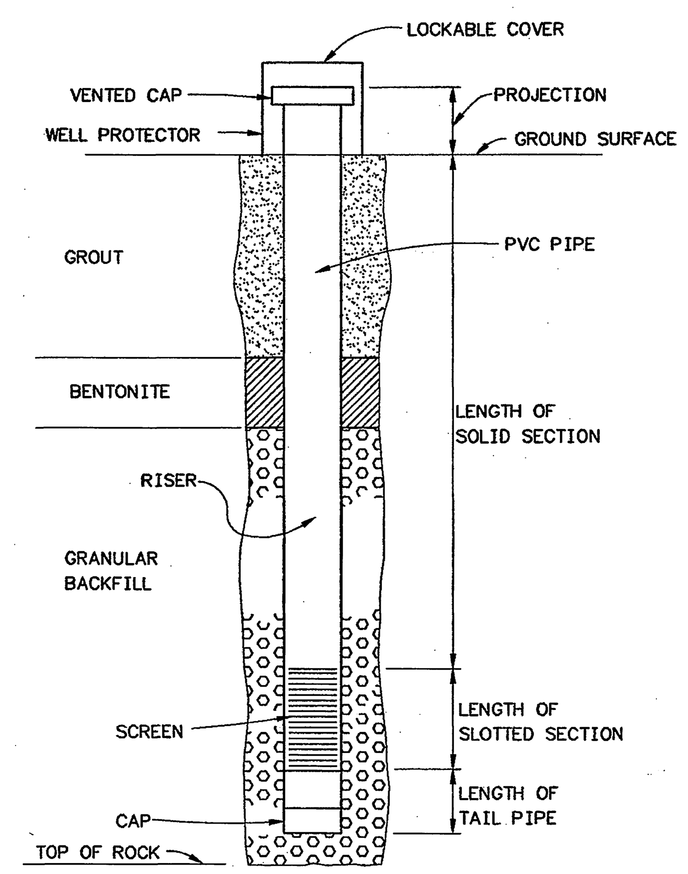
B5–B5
1"=100' HORIZ
1"=10' VERT



DET A
NTS



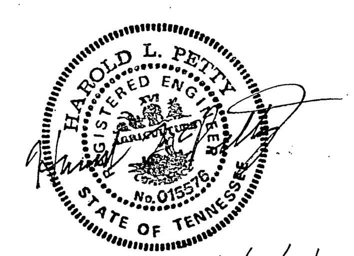
TYPICAL FINAL CAP SECTION
DETAIL B
NTS



TYPICAL MONITOR WELL
NTS

NOTES:

1. ALL ASH FILL TO BE HAULED FROM EXISTING PONDS AND SPREAD AND COMPACTED. THE INITIAL ASH FILL SHALL BE BOTTOM ASH. THIS BOTTOM ASH SHALL BE PLACED BY END DUMPING FROM THE TOP OF DIKE AND WORKED INTO THE POND TO FORM A STABLE BASE FOR THE HAULING AND COMPACTING EQUIPMENT TO WORK ON. ONCE THE BASE HAS BEEN STABILIZED THE REMAINDER OF THE ASH CAN BE EITHER BOTTOM ASH OR FLY ASH OR A MIXTURE OF BOTTOM ASH AND FLY ASH.
2. BEFORE FILLING THE AREA BETWEEN THE TOP OF THE PHASE 1 DIKE AND THE TOE OF THE PHASE 2 DIKE, THE EXISTING CRUSHED SURFACING ON THE TOP OF THE PHASE 1 DIKE SHALL BE GRADED FROM THE DIKE TO THE AREA BETWEEN THE DIKES FOR DISPOSAL.
3. ASH FILL PLACED ON THE STABILIZED BASE AND IN THE AREA BETWEEN THE TOP OF THE PHASE 1 DIKE AND THE TOE OF THE PHASE 2 DIKE FOR THE CLOSURE OF THIS DISPOSAL AREA SHALL BE PLACED AND SPREAD IN HORIZONTAL LAYERS OF 8 TO 12 INCHES WITH A 12 INCH MAXIMUM LOOSE THICKNESS AND SHALL BE TRACKED WITH A DOZER OR SUITABLE HAULING EQUIPMENT TO ALLOW THE COMPACTOR TO OPERATE MORE EFFICIENTY. THE ASH FILL SHALL BE ROLLED WITH A MINIMUM OF 4 PASSES, IMMEDIATELY AFTER SPREADING BY SMOOTH SURFACE STEEL WHEEL VIBRATORY ROLLERS (6 –10 TONS) FOR COMPACTION AND DUST CONTROL.
4. TRAVEL OF ASH MOVING EQUIPMENT (PANS, TRUCKS, DOZERS, ETC.), EITHER LOADED OR UNLOADED, ON THE DIKES OF THIS DISPOSAL AREA SHALL NOT BE PERMITTED IF THERE ARE OTHER REASONABLE ALTERNATIVES.
5. THE FINAL CAP SHALL BE A MINIMUM 24 INCHES OF EQUIPMENT COMPACTED SOIL, THAT IN THE OPINION OF THE ENGINEER, IS REASONABLY FREE OF ROOTS, LARGE STONES, AND SUITABLE FOR THE INTENDED PURPOSE. THE TOP SIX INCHES (MINIMUM) SHALL BE SOIL THAT WILL SUPPORT VEGETATION.
6. SEEDING SHALL MEET THE REQUIREMENTS OF T–1 SECTION 583.
7. MULCHING SHALL BE PER T–1 SECTION 582.
8. ALL AREAS SHALL BE COVERED WITH CURLEX 1 EROSING CONTROL MAT, ALL NATURE ASPEN EXCELSOR, QUICK GRASS (Green) WITH GREEN STANDARD NETTING TYPE OR ACCEPTED INDURSTRY EQUAL.
9. SEEDED AREAS SHALL BE MAINTAINED UNTIL A SATISFACTORY COVER OF PLANT MATERIAL IS SECURED. ALL AREAS SHALL BE PRESERVED AND PROTECTED AND REPAIRED AS SPECIFIED FOR THIS PURPOSE. AREAS HAVING A POOR STAND OF PLANTS SHALL BE RESEEDED AND FERTILIZED AT THE PROPER RATES.
10. BORROW AREA CUT AND FILL SLOPES AND OTHER DISTURED AREAS SHALL BE SEEDED (TYPE 8 MIXTURE 1, FOR FALL SEEDING OR TYPE 6 MIXTURE 1, FOR SPRING SEEDING), FERTILIZED, AND MULCHED IN ACCORDANCE WITH SECTION 580 AND 582 OF GENERAL CONSTRUCTION SPECIFICATION T–1.



4/4/01

SUMMARY OF QUANTITIES (FINAL CLOSURE)

ITEM NO.	DESCRIPTION	QUANTITY	UNIT
	ASH FILL	150,000	CY
123	EARTH COVER	71,500	CY
583	SEEDING	106,500	SY
582	MULCHING	106,500	SY

COMPANION DWGS:
10W218–2, THRU–4 & 10W219

PROJECT REVISION HISTORY

REV. NO.	DATE	DSGN	DRWN	CHKD	SUPV	RVWD	APPD	ISSD	PROJECT ID	AS CONST	REV CD
R1	10–25–99	MGH	MGH	HLP	HLP	REP	LAN	RLK			
REVISED TO RELEASE FOR PHASE 2 CONSTRUCTION											
R0	10–9–91	EJR	MGH	JLG	JLG	KWB		JHC			
INITIAL ISSUE											
R											
R 2		JDP	CWH	JDP	HLP	REP	LAN	JGA			D
ELECTRONICALLY RESTORED DRAWING; REVISED CAP TO DSWM VARIANCE											

DISCIPLINE INTERFACE

SCALE: 1"=100' EXCEPT AS NOTED

MAIN PLANT
ASH DREDGE CELL–EAST OF GAS TURBINES

CLOSURE
PLAN & SECTIONS

DESIGNED BY:	DRAWN BY:	CHECKED BY:	SUPERVISED BY:	REVIEWED BY:	APPROVED BY:	ISSUED BY:
E.J. REED	M.G. HRANEK	J.L. GLOVER	J.L. GLOVER	K.W. BURNETT		J.H. COULSON

JOHNSONVILLE FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

AUTOCAD R14 | DATE | 30 | C | 10W218–5 | R 2

TASK COMPLETED BY: | REV NO.

ELECTRONICALLY RESTORED DRAWING
THIS DRAWING HAS BEEN COMPLETELY REDRAWN AND SUPERSEDES :(10W218–5 R1)

PLOT FACTOR:1200
W_TVA

C.A.D. DRAWING
DO NOT ALTER MANUALLY

30 C 10W218–5

APPENDIX C

ASH TESTING

JOHNSONVILLE FOSSIL PLANT
TCLP RESULTS *

SAMPLE #	SAMPLE TYPE	As	Ba	Cd	Cr	Pb	Hg	Se	Ag
J-2 12/17	BOTTOM ASH	BDL	0.58	BDL	BDL	BDL	BDL	BDL	BDL
J-5 12/18	BOTTOM ASH	0.06	0.53	BDL	BDL	BDL	BDL	BDL	BDL
J-8 12/19	BOTTOM ASH	BDL	0.37	BDL	BDL	BDL	BDL	BDL	BDL
J-12 12/20	BOTTOM ASH	BDL	0.40	BDL	BDL	BDL	BDL	BDL	BDL
J-22 12/21	BOTTOM ASH	BDL	0.37	BDL	BDL	BDL	BDL	BDL	BDL
J-1 12/17	FLY ASH	0.10	0.93	0.02	0.07	BDL	BDL	BDL	BDL
J-4 12/18	FLY ASH	BDL	0.61	0.01	0.17	BDL	BDL	BDL	BDL
J-7 12/19	FLY ASH	BDL	0.31	BDL	0.29	BDL	BDL	BDL	BDL
J-11 12/20	FLY ASH	BDL	0.34	BDL	0.17	BDL	BDL	BDL	BDL
J-21 12/21	FLY ASH	BDL	0.45	BDL	0.12	BDL	BDL	BDL	BDL
J-15 12/20	POND ASH	BDL	0.74	BDL	BDL	BDL	BDL	BDL	BDL
J-25 12/20	POND ASH	BDL	2.19	BDL	BDL	BDL	BDL	BDL	0.02
DETECTION LIMIT		0.05	0.01	0.01	0.01	0.05	0.0005	0.01	0.01

* ALL UNITS mg/l

BDL - BELOW DETECTION LIMITS

Table 4.7

JOHNSONVILLE ASH COMPOSITION

Element	Mass (µg/kg)
Al =	159000.000
Ba =	980.000
Ca =	10500.000
Cr =	130.000
Mo =	5.000
Si =	243000.000
Sr =	440.000
S =	900.000
As =	128.000
B =	265.000
Cd =	5.000
Cu =	115.000
Fe =	103000.000
Mg =	5100.000
Na =	3600.000
Ni =	120.000
Se =	5.000
Zn =	230.000

Composite of three samples taken
from ash pond in July 1988

The following table titled Analytical Summary Results is a summary of testing of ash samples from TVA's Allen Fossil Plant in Memphis, Tennessee. The analysis of the samples was in accordance with TCLP testing requirements which included TCLP Extraction, TCLP 2HE Extraction, TCLP 2HE Extraction 8240 and TCLP Extraction 8270.

[illegible] RESULTS

PROJECT: PLANT ALLEN CTVR
WORK ORDER NO.: 1008

PARAMETER	POND #1	POND #2	POND #3	ASP-001	ASP-002	ASP-003	REPORTING LIMIT (ug/L)
Benzene	ND	ND	ND	ND	ND	ND	5
Carbon tetrachloride	ND	ND	ND	ND	ND	ND	5
Chlordane	ND	ND	ND	ND	ND	ND	0.5
Chlorobenzene	ND	ND	ND	ND	ND	ND	5
Chloroform	ND	ND	ND	ND	ND	ND	5
m-Cresol	ND	ND	ND	ND	ND	ND	20
o-Cresol	ND	ND	ND	ND	ND	ND	20
p-Cresol	ND	ND	ND	ND	ND	ND	20
1,4-Dichlorobenzene	ND	ND	ND	ND	ND	ND	20
1,2-Dichlorobenzene	ND	ND	ND	ND	ND	ND	20
1,1-Dichloroethylene	ND	ND	ND	ND	ND	ND	5
2,4-Dinitrotoluene	ND	ND	ND	ND	ND	ND	100
Heptachlor	ND	ND	ND	ND	ND	ND	0.05
Hexachlorobenzene	ND	ND	ND	ND	ND	ND	20
Hexachloroethane	ND	ND	ND	ND	ND	ND	20
Nitrobenzene	ND	ND	ND	ND	ND	ND	20
Pyridine	ND	ND	ND	ND	ND	ND	5
Pentachlorophenol	ND	ND	ND	ND	ND	ND	100
Trichloroethylene	ND	ND	ND	ND	ND	ND	5
Tetrachloroethylene	ND	ND	ND	ND	ND	ND	5
2,4,5-Trichlorophenol	ND	ND	ND	ND	ND	ND	100
2,4,6-Trichlorophenol	ND	ND	ND	ND	ND	ND	20
Vinyl chloride	ND	ND	ND	ND	ND	ND	10
Endrin	ND	ND	ND	ND	ND	ND	0.1
Lindane	ND	ND	ND	ND	ND	ND	0.05
Methoxychlor	ND	ND	ND	ND	ND	ND	0.5
Toxaphene	ND	ND	ND	ND	ND	ND	1
2,4-D	ND	ND	ND	ND	ND	ND	10
2,4,5-TP	ND	ND	ND	ND	ND	ND	1
Methyl ethyl ketone	ND	ND	ND	ND	ND	ND	100
Hexachlorobutadiene	ND	ND	ND	ND	ND	ND	20

ND = Not Detected

APPROVED BY: Richard L Merrell

05-29-90 09:55AM

APPENDIX D

TVA SEEDING SPÈCIFICATIONS

VEGETATION SPECIFICATIONS

NATIVE GRASSESS - SEEDING AND MULCHING

(SPECIAL FOR WASTE AREAS)

SECTION 582 - <u>Mulching</u>

Refer to FP-96 Section 625. FP-96 Standard Specification for Construction of Roads and Bridges on Federal Highway Projects (US DOT - FHWA)

SECTION 583 - <u>Native Grasses Seeding</u>

<u>583.1 – Description</u>

This specification consists of furnishing and placing native warm season grass seed on waste disposal areas when specified by the plans or the Engineer. The use of these grasses for landfill cover crops is being encouraged by the Tennessee Department of Environment and Conservation Division of Solid Waste Management.

<u>583.2 – Materials</u>

1. <u>Seeds</u>

Seeds shall meet the requirements of applicable seed laws and shall be tested in accordance with the most current edition of the U.S. Department of Agriculture Handbook No. 30, <u>Testing Agricultural and Vegetable Seed</u>. Seeds shall be from the last preceding crop and comply with the requirements outlined below for purity and germination. Each variety of seed shall be furnished in separate, strong bags with each bag being fully tagged or labeled to show the variety, weight, purity, germination, and test data prescribed by law. All test results shall be fully certified by the vendor or by a recognized seed testing agency. TVA reserves the right to require that samples be furnished, and to inspect and test the seeds after delivery. Seeds found not to comply with specification requirements shall be subject to rejection.

When mixing or forming seed mixtures, the seeds shall be carefully and uniformly mixed. Seeds shall not be mixed until each variety of seed to be used in the mix has been inspected and/or tested separately and approved.

583.2 – Materials (Continued)

Seed Varieties	Purity, Minimum %	Germination Minimum %
Sideoasts Gramma (*Bouteloua curtipendula*)	95	85
Little Bluestem (Schizachyrium scoparium)	95	85
Sand Lovegrass (*Eragrostis trichodes*)	95	85
Annual Rye (lolium multiflorum)	90	90

Seeding materials shall be free from seeds or bulbets of Wild Onion (Allium vineale), Canada Thistle (Cirsium arvense), and Johnson Grass (Sorghum halepense).

Continued next page......

Seed species shall not contain more than six seeds per ounce of the seed of any of the following noxious weeds or the seeds of any other weed specifically listed as noxious:

Bindweed (Convolvulus arvensis)
Buckthorn (Plantago lanceolata)
Corncockle (Agrostemmo githago)
Dodder (Cuscuta species)
Oxeyedaisy (Chrysanthemum leucantheumum)
Quackgrass (Agropyron repens)
Sorrel (Rumex acetosella)

Seed species shall not contain an excess of 2 percent by weight of weed seeds, noxious or otherwise.

2. <u>Seed or seed mixtures, rates, and seasons</u>

Seeding mixtures, rates, and seasons shall be those specified herein. The types to be used for each area or project will be specified by the drawing or by memorandum. Mixtures or rates of application other than those specified shall be used only when specified by the plans or the Engineer. Seeding shall be planted during the season and between the dates specified. Note that the pound rates are PLS (pure live seed).

Type 1: Winter seeding ((Plant between November 1 and December 31)

(1) Sideoats Grama	4 pounds per acre
(2) Little Bluestem	5 pounds per acre
(3) Sand Lovegrass	1 pounds per acre
(4) Annual Rye	60 pounds per acre
	70 pounds per acre

Type 2: Spring seeding (Plant between April 15 and July 1).

Mixture:

(1) Sideoats Grama	4 pounds per acre
(2) Little Bluestem	5 pounds per acre
(3) Sand Lovegrass	1 pounds per acre
	10 pounds per acres

Note: All slopes 3:1 or greater shall be seeded with the winter mixture

e. Temporary Cover

Type 3: Temporary winter seeding (Plant between October 15 and March 15).

Annual Ryegrass	80 pounds per acre

583.3– Soil Chemistry Requirements

Soil pH range: 5.0 - 7.8 S.U.

Soil Fertility: Low-Medium for phosphorous and potassium.

583.4 -- Soil Preparation

Areas to be seeded shall have approved cross sections and grades. Objects such as large roots, stones, stumps, coarse vegetation, debris, or any other items that might impede mechanical mowing shall be removed and disposed of satisfactorily.

Seedbeds shall be plowed, disked, harrowed, scarified, or cultivated to the approved depth. In areas where it is practical, this work shall be done with farm-type equipment. On steep slopes, preparation of seedbeds shall be done with the tools and methods specified by the Engineer. It is strongly recommended that scarifying and preparation on cut and fill slopes be accomplished with tools or equipment specially designed for this purpose. Small furrows or grooves formed in the slopes shall be horizontal or as nearly horizontal as practical. The work shall be performed only when the ground is in a workable and tillable condition as determined by good farming practices.

583.5 -- Special Hydroseeding Equipment

Equipment to be used for the hydraulic application of planting materials shall be a Finn Hydro-Seeder, Bowie Hydro Mulcher, Toro Environmental Control Unit, or an approved equal. The equipment shall have mixing tanks with built-in agitators having operating capacities sufficient to agitate, suspend, and homogeneously mix slurries of water and planting materials. The slurry distribution lines shall be large enough to prevent clogging or stoppage. Discharge lines shall be equipped with sets of different sized hydraulic spray nozzles capable of providing for even distribution of varying slurry mixtures on areas to be seeded.

583.6 -- Seeding Methods

Seeds shall be sown with approved hydroseeding equipment. Rates specified in Section 583.2 shall be maintained in a manner that will guarantee uniform coverage. Seeding operations shall not be performed when drought, high winds, and excessive moisture or other factors may defer satisfactory results. The carrier mix shall be 0-13-13. The area shall be cultipacked immediately after seeding.

583.7 -- Maintenance

Seeded areas shall be maintained until a satisfactory cover of plant material is secured, unless stipulated otherwise. All areas shall be preserved, repaired, and protected as specified for this purpose. Areas having poor stands of plant material shall be seeded again and fertilized at the proper rates.

Watering shall be accomplished during the maintenance period to the extent necessary.

583.8 -- Method of Measurement

Seeded areas will be measured in square yard units and include the seeded areas along slopes.

APPENDIX E

POLICY MEMORANDUM SW-91-2

TENNESSEE DEPARTMENT OF HEALTH AND ENVIRONMENT

FROM	TO	DATE

-ICE CORRESPONDENCE

POLICY MEMORANDUM: SW-91-2 Revised

DATE: February 27, 1991

TO: SWM Staff

FROM: Tom Tiesler

SUBJECT: Variance Agreement for Fossil Fuel Fly Ash and Bottom Ash Disposal Within a Class II Facility

The purpose of this memorandum is to establish the criteria by which a fossil fuel fly and bottom ash disposal facility will be permitted. Fossil fuel fly and bottom ash disposal will be permitted as a Class II Facility with the following variances:

1. The geologic buffer required will be 3 feet in total thickness with a maximum hydraulic conductivity of 1×10^{-6} cm/sec. The thickness will be measured from the base of the fill to the seasonal high water table of the uppermost unconfined aquifer, or the top of the formation aquifer;

2. No leachate migration control system will be required;

3. No gas migration control system will be required;

4. The final cover shall be 24 inches of compacted soil with a minimum of 6 inches which shall support vegetative cover; and

5. No random inspection program will be required.

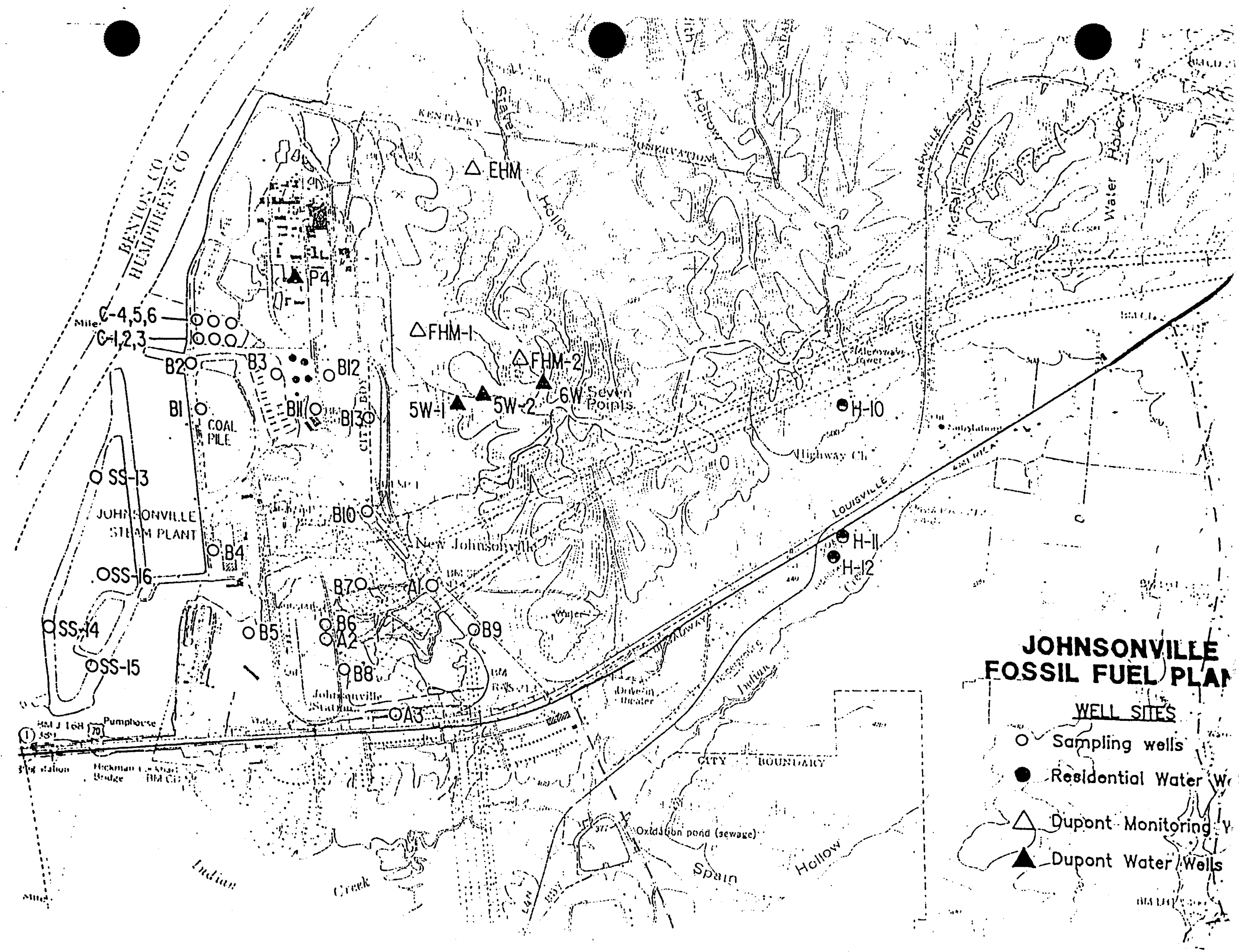
Any other variances to the Class II Facility permit criteria will require the Commissioner's approval.

TT/TQ/F5111046

ROM	DATE

APPENDIX F

MONITORING WELL INSTALLATION RECORDS



JOHNSONVILLE
FOSSIL FUEL PLAN
WELL SITES
Sampling wells
Residential Water W
Dupont Monitoring
Dupont Water Wells
BENTON CO
HUMPHREYS CO
C-4,5,6
C-1,2,3
B1
B2
B3
B4
B5
B6
B7
B8
B9
B10
B11
B12
B13
A1
A2
A3
P4
COAL PILE
JOHNSONVILLE STEAM PLANT
SS-13
SS-14
SS-15
SS-16
EHM
FHM-1
FHM-2
5W-1
5W-2
6W
Seven Points
H-10
H-11
H-12
New Johnsonville
LOUISVILLE
Highway Ch
Johnsonville Station
Pumphouse
70
CITY BOUNDARY
Oxidation pond (sewage)
Indian Creek
Spain Hollow
McCall Hollow
Water Hollow
NASHVILLE
KENTUCKY
Hollow
Drive-in theater

MONITORING WELL INSTALLATION RECORD

PROJECT: JOHNSONVILLE

WELL NUMBER: B10

INSTALLATION DATE: 8-16-89

PLANT COORDINATES EAST: 2505.62'

NORTH: 187.07'

GROUND SURFACE ELEVATION: 401.51 ftmsl

TOP OF INNER CASING: 404.51 ftmsl

GRANULAR BACKFILL MATERIAL: SAND

SLOT SIZE: 0.0010"

CASING MATERIAL: PVC

CASING DIAMETER: 2"

DRILLING TECHNIQUE: HOLLOW STEM AUGER

DRILLING CONTRACTOR: LAW

BOREHOLE DIAMETER: 8"

FIELD REPRESENTATIVE: TILLERY

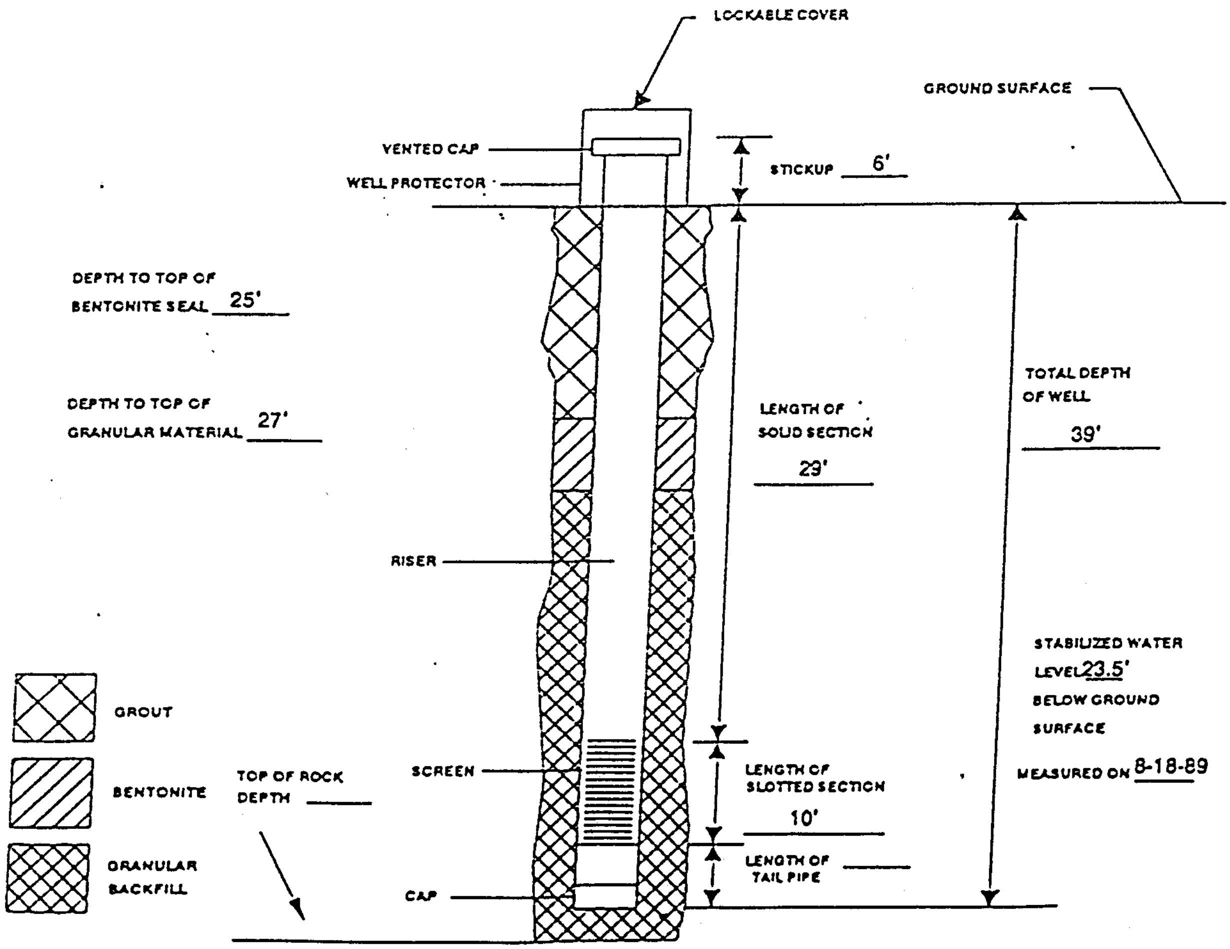
LOCKABLE COVER ? YES

FILTER CLOTH AROUND SCREEN ? NO

DRILLING FLUID: NO

COMMENTS:

(NOT TO SCALE)



MONITORING WELL INSTALLATION RECORD

PROJECT: JOHNSONVILLE

WELL NUMBER: B11

INSTALLATION DATE: 8-15-89

PLANT COORDINATES EAST: 1815.36'

NORTH: 1938.16'

GROUND SURFACE ELEVATION: 398.51 ftmsl

TOP OF INNER CASING: 401.51 ftmsl

GRANULAR BACKFILL MATERIAL: SAND

SLOT SIZE: 0.0010"

CASING MATERIAL: PVC

CASING DIAMETER: 2"

DRILLING TECHNIQUE: HOLLOW STEM AUGER

DRILLING CONTRACTOR: LAW

BOREHOLE DIAMETER: 8"

FIELD REPRESENTATIVE: TILLERY

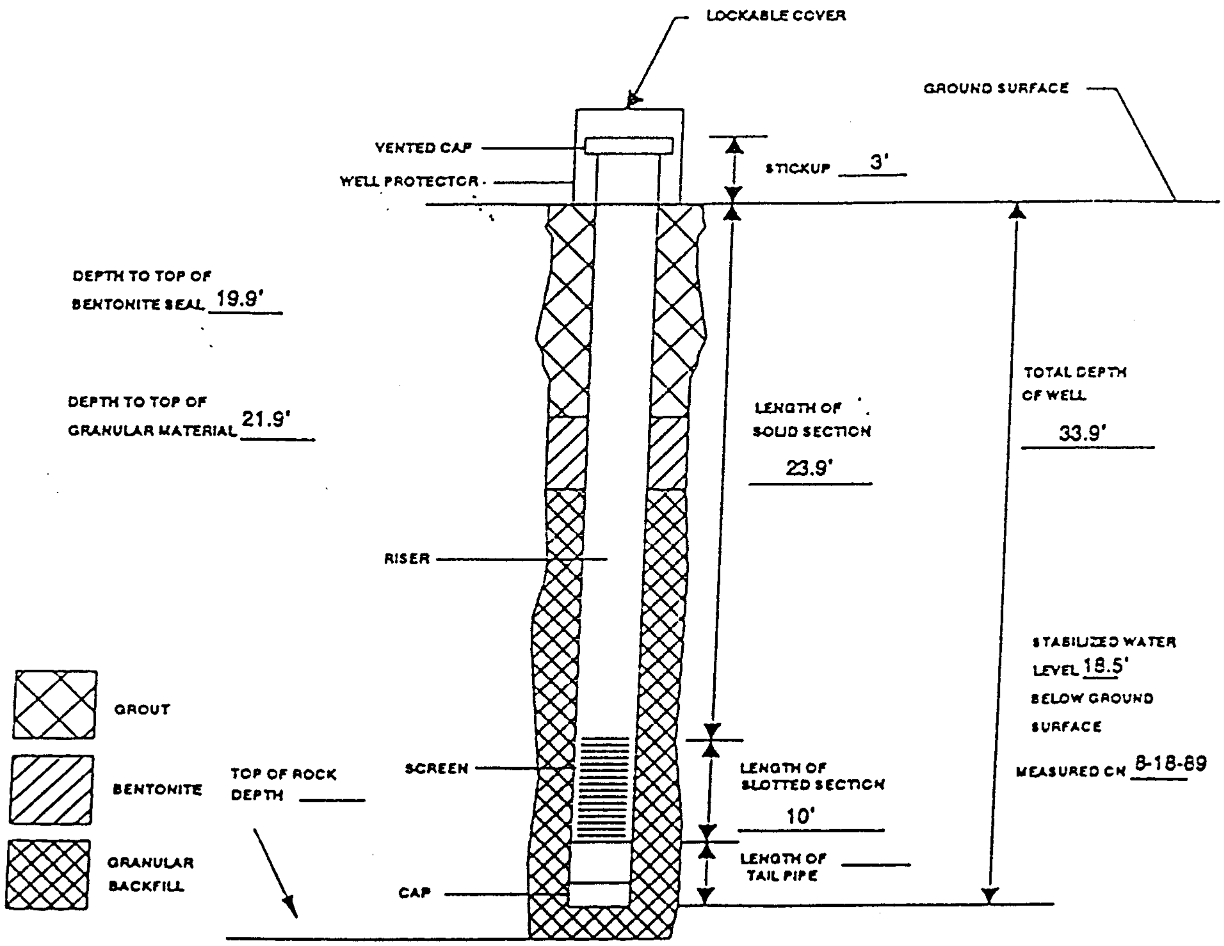
LOCKABLE COVER ?: YES

FILTER CLOTH AROUND SCREEN ?: NO

DRILLING FLUID: NO

COMMENTS:

(NOT TO SCALE)



DWG LAB 6/90

MONITORING WELL INSTALLATION RECORD

PROJECT: JOHNSONVILLE

WELL NUMBER: B12 — INSTALLATION DATE: 8-17-89

PLANT COORDINATES EAST: 1918.18' — NORTH: 2560.70'

GROUND SURFACE ELEVATION: 390.63 ftmsl — TOP OF INNER CASING: 393.63 ftmsl

GRANULAR BACKFILL MATERIAL: SAND — SLOT SIZE: 0.0010"

CASING MATERIAL: PVC — CASING DIAMETER: 2"

DRILLING TECHNIQUE: HOLLOW STEM AUGER — DRILLING CONTRACTOR: LAW

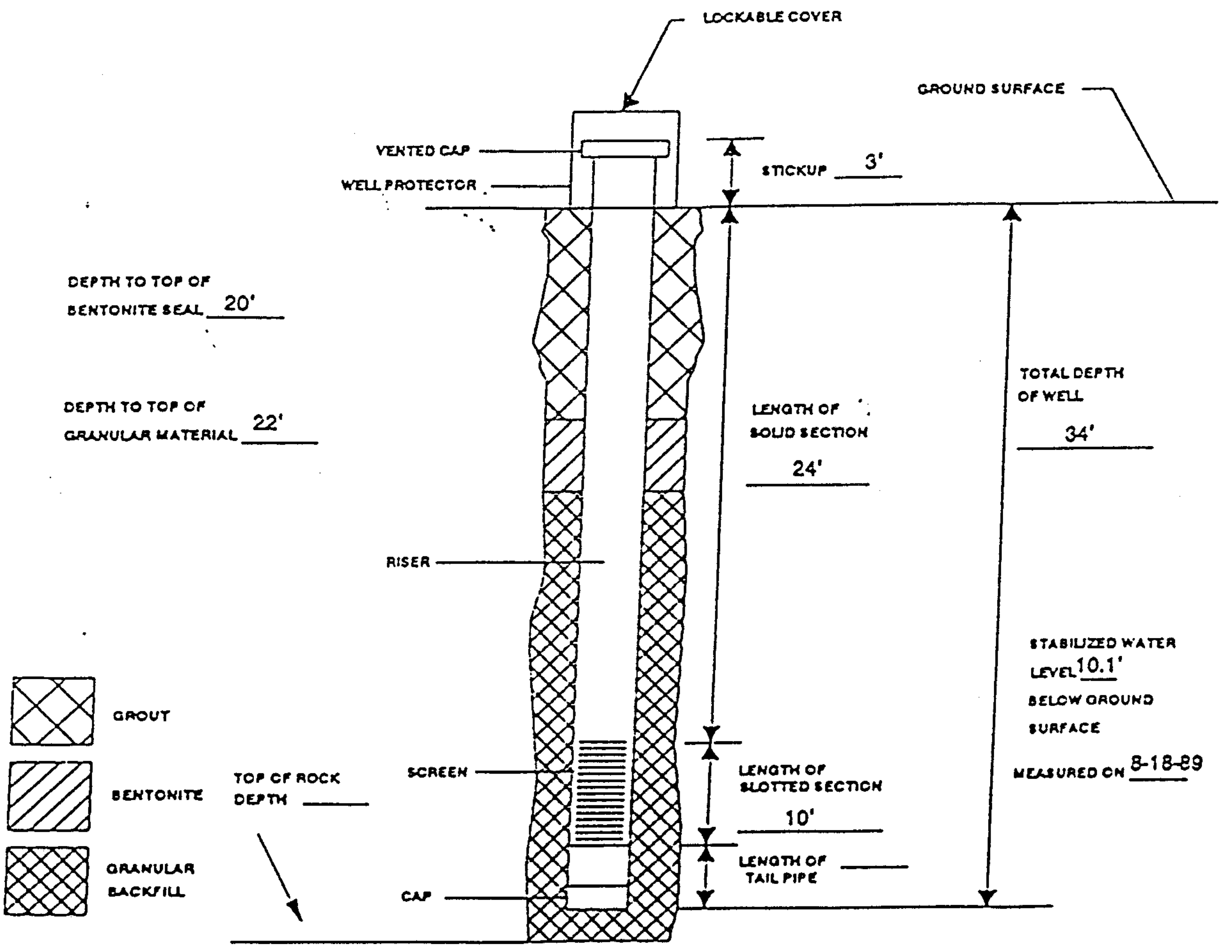
BOREHOLE DIAMETER: 8" — FIELD REPRESENTATIVE: TILLERY

LOCKABLE COVER ? YES — FILTER CLOTH AROUND SCREEN ? NO

DRILLING FLUID: NO

COMMENTS: ______

(NOT TO SCALE)



EHO LAB 6/9/90

MONITORING WELL INSTALLATION RECORD

PROJECT JOHNSONVILLE

WELL NUMBER B13

INSTALLATION DATE 8-16-89

PLANT COORDINATES EAST 2651.33'

NORTH 1408.70'

GROUND SURFACE ELEVATION 407.49 ftmsl

TOP OF INNER CASING 410.49 ftmsl

GRANULAR BACKFILL MATERIAL SAND

SLOT SIZE 0.0010"

CASING MATERIAL PVC

CASING DIAMETER 2"

DRILLING TECHNIQUE HOLLOW STEM AUGER

DRILLING CONTRACTOR LAW

BOREHOLE DIAMETER 8"

FIELD REPRESENTATIVE TILLERY

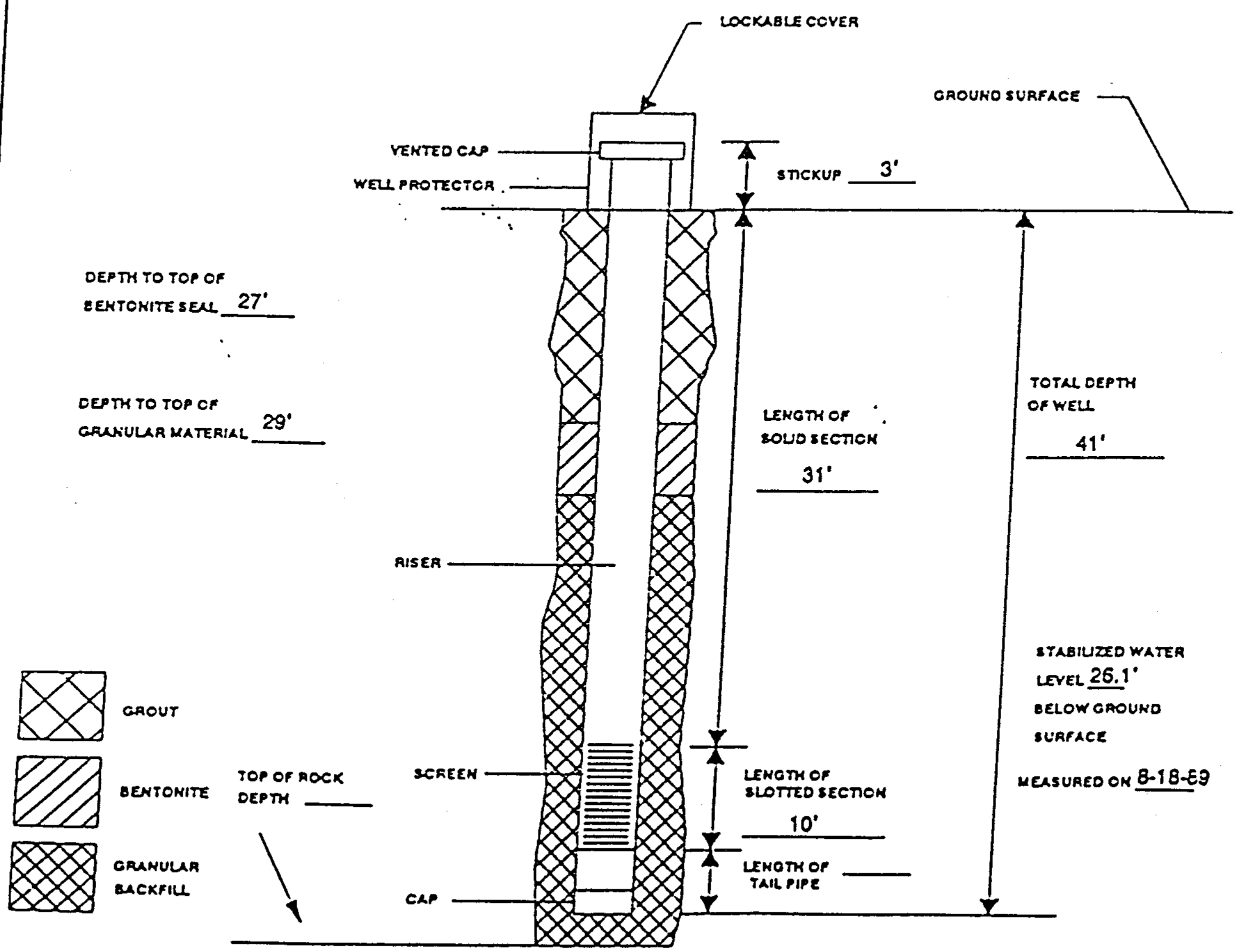
LOCKABLE COVER ? YES

FILTER CLOTH AROUND SCREEN ? NO

DRILLING FLUID NO

COMMENTS

(NOT TO SCALE)



APPENDIX G

BACKGROUND GROUNDWATER MONITORING PROGRAM

Table 4.3

JOHNSONVILLE SITE AND OFFSITE
GROUNDWATER QUALITY

Parameter	1982 Means Values					
	Onsite Wells			Offsite Wells		
	A1	A2	A3	H10	H11	H12
Conductivity, µmhos/cm	115	117	120	42	62	66
pH, std. units	6.7	6.7	6.6	6.1	5.6	5.9
Alkalinity, mg/L, as $CaCO_3$	46	57	59	18	14	18
Calcium, mg/L	17	21	10	4	4	4.6
Magnesium, mg/L	1.3	1.5	1.3	1.5	2.1	0.4
Sodium, mg/L	2.1	2.1	2.2	2.5	4.4	2.6
Chloride, mg/L	2	1	2	1.9	8.4	2.7
Sulfate, mg/L	12	10	2	1	3	7
Arsenic, µg/L	1	1	2	1	1	3
Barium, µg/L	76	77	76	-	-	-
Beryllium, µg/L	<0.5	<0.5	<0.5	-	-	-
Boron, µg/L	14	2	7	-	-	-
Cadmium, µg/L	0.1	0.1	0.1	2	2	<1
Chromium, µg/L	1.5	2.8	1.3	-	-	-
Copper, µg/L	25	32	29	-	-	-
Iron, µg/L	230	1,425	14,500	500	530	1,900
Lead, µg/L	2.8	4.8	3.8	4	4	3
Manganese, µg/L	31	293	1,175	53	95	140
Nickel, µg/L	5	16	15	-	-	-
Zinc, µg/L	18	17	16	830	42	3,300
Antimony, µg/L	2	2	<2	<1	<1	<1
Aluminum, µg/L	<50	<50	<50	<10	20	30
Selenium, µg/L	1	<1	<1	<1	<1	1
Bicarbonate, mg/L	56	70	72	22	17	22
Residue, mg/L	65	73	68	37	48	56

Table 4.4

RESULTS OF GROUNDWATER QUALITY ANALYSES
AUGUST 1988

Parameter	DWS	A1 1982	A1 8/88	A2 1982	A2 8/88
Conductivity, µmhos/cm		115	120	117	161
pH, std. units	6.5-8.5	6.7	6.3	6.7	6.7
Alkalinity, mg/L, as $CaCo_3$		46	46	57	70
Calcium, mg/L		17	20	21	30
Magnesium, mg/L		1.3	1.8	1.5	2.1
Sodium, mg/L		2.1	2.1	2.1	2
Chloride, mg/L		2	1	1	1
Sulfate, mg/L	250	12	8	10	10
Arsenic, µg/L	50	1	<1	1	8
Barium,µg/L	1,000	76	<10	77	20
Beryllium, µg/L		<0.5		<0.5	
Bqron, µg/L		14	<50	2	60
Cadmium, µg/L	10	0.1	<.1	0.1	<.1
Chromium, µg/L	50	1.5	<1	2.8	10
Copper, µg/L	1,000	25	40	32	90
Iron, µg/L	300	230	3,900	1,425	25,000
Lead, µg/L	50	2.8	9	4.8	490
Manganese, µg/L	50	31	100	293	410
Nickel, µg/L		5	7	16	12
Zinc, µg/L	5,000	18	40	17	960
Antimony, µg/L		2		2	
Aluminum, µg/L		<50	160	<50	2,100
Selenium, µg/L	10	1	<1	<1	<1
Bicarbonate, mg/L		56	56	70	84
Residue, mg/L	500	65	70	73	90
Colbalt, µg/L			<1		13
Tin, µg/L	<50		<50		<50
Lithium, µg/L	25		<10		<10
Potassium, mg/L	4.8		2.8		4.6
Molybdenum, µg/L	<20		<20		<20
Strontium, µg/L	190		<50		70
Vanadium, µg/L	20		<10		10

Table 4.5

JOHNSONVILLE ASH POND WELLS AND FLOW LEACHATE ESTIMATES

Parameter	DWS	Monitor Wells SS13 4/86	SS13 8/88	SS15 4/86	SS16 4/86	FOWL pH=5	FOWL pH=6.5
Alkalinity, total, mg/L		150	107	117	71		
Conductivity, µmhos/cm (lab analyses)		350	319	500	500		
Calcium, mg/L		60.2	86	34.3	294	396	394
Magnesium, mg/L		7.45	8.8	8.2	32.1	4.9	2
Sodium, mg/L		18.0	14	84.0	29.0	10	12
Potassium, mg/L		1.4	4.8	1.1	4.5		
Silica, mg/L		13.9	-	18	19	26	26
Nitrate and nitrate (N), mg/L	10	0.12	-	0.33	0.04		
Chloride, mg/L		9	4	16	12		
Sulfate, mg/L	250	85	60	160	820	951	945
Total dissolved solids, mg/L	500	280	210	390	1300	762	758
Color, PCU		35	-	35	25		
Turbidity, NTU		50	-	80	33		
Copper, µg/L	1000	<10	30	100	10	24	4
Zinc, µg/L	5000	30	3500	90	130	85	10
Arsenic, µg/L	50	27	7	<1	9.6	100	100
Barium, µg/L	1000	70	260	60	30	256	253
C[illegible]ium, µg/L	10	1.8	86	5.8	6.3	8.9	2
C[illegible]mium, µg/L	50	2.4	18	8.4	3.1	2	2
Lead, µg/L	50	4.6	27	0.4	4.4		
Mercury, µg/L	0.2	0.3	-	0.8	0.5		
Nickel, µg/L		39	41	260	260	50	10
Selenium, µg/L	10	<1	<1	<1	<1	<1	52
Silver, µg/L	50	<0.2	-	<0.2	<0.2		
Iron, µg/L	300	8770	33000	6660	2250	104	9.7
Manganese, µg/L	50	9000	7200	3110	9040		
pH, std. units	6.8-8.5	6.3	6.0	6.3	6.3		
Bicarbonate, mg/L		183	130	143	87		
Aluminum, µg/L						524	109
Colbalt, µg/L			28				
Tin, µg/L			<50				
Lithium, µg/L			25				
Molybdenum, µg/L			<20			748	674
Stontium, µg/L			190			1631	1616
Vanadium, µg/L			20				
Boron, µg/L						3340	4225

APPENDIX H

TVA QUALITY ASSURANCE PROCEDURE

GROUNDWATER SAMPLE COLLECTION TECHNIQUES

Copy No. 20

TENNESSEE VALLEY AUTHORITY
SYSTEM ENGINEERING
DATA SYSTEMS

QUALITY ASSURANCE PROCEDURE

No. DS-41.6

Title: GROUNDWATER SAMPLE COLLECTION TECHNIQUES

Revision:	0
Date:	12/7/89
Prepared by:	D. L. Meinert 9-13-89
Recommended by: Manager, Field Engineering	A. H. Smalley 9-15-89
Technical Reviewer Data Systems	T. M. Wilson
Technical Reviewer Data Systems	K. H. Winters 9-18-89
Concurred by: QAC, Field Engineering	L. E. Scroggie 12/1/89
Approved by: Manager, Data Systems	R. T. Joyce 12/7/89
Concurred by: Manager, Engineering Lab.	E. E. Driver
Concurred by: Manager, Environ. Chemistry	C. W. Holley 9/22/89
Concurred by: Manager, Water Quality	R. D. Urban 10/6/89

TVA 30025 (S&F OPS-3-89)

1.0 **OBJECTIVE**

To prescribe specific, detailed instructions for Field Engineering (FENG) personnel involved in the collection of water samples in accordance with standard practices generally accepted by the U.S. Environmental Protection Agency (EPA), U.S. Geological Survey (USGS), and TVA.

2.0 **SCOPE**

The techniques described herein are limited to those to be used by FENG personnel for routine studies. They do not apply to special studies that may require special apparatus and/or handling or specially trained personnel. For example, the collection of groundwater samples at Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) sites (i.e., "Superfund" sites), certain Resource Conservation and Recovery Act (RCRA) sites, and those activities which fall under the scope of the Superfund Amendments and Reauthorization Act (SARA) of 1986 are not within the scope of this procedure. This procedure applies to collection of routine groundwater samples in connection with TVA's regional water management program activities and assessment of groundwater quality in the vicinity of TVA power facilities.

3.0 **REFERENCES**

3.1 National Handbook of Recommended Methods for Water Data Acquisition, Chapter 2, "Groundwater" (January 1980), U.S. Geological Survey, Reston, VA, 1977.

3.2 Handbook--Groundwater, Environmental Protection Agency, EPA/625/6-87/016, Cincinnati, OH, 1987.

3.3 A Guide to Groundwater Sampling-Technical Bulletin No. 362, National Council of the Paper Industry for Air and Stream Improvement, Inc., New York, NY, 1982.

3.4 Practical Guide for Groundwater Sampling, Environmental Protection Agency, EPA/600/2-85/104, Ada, Oklahoma, 1985.

3.5 Macrodispersion Experiment Management Policies and Requirements (EPRI RP 2485-05), TVA Engineering Laboratory Report No. WR28-2-520-136, Chapters 4.2.6, "Field Tracer Sampling," and 4.2.7, "Field Monitoring and Sampling," 1987.

3.6 Fletcher G. Driscoll, Groundwater and Wells, Johnson Division, St. Paul, Minnesota, Second Ed., 1982.

ALH 92

3.7 40 CFR 136, "Guidelines Establishing Test Procedures for the Analysis of Pollution," Table II - Required Containers, Preservation Techniques, and Holding Times.

3.8 Methods for Chemical Analysis of Water and Wastes, Environmental Protection Agency, EPA-600/4-79-020, Cincinnati, OH, 1979.

3.9 Standard Methods for the Examination of Water and Wastewater, 16th Ed., American Public Health Association, Washington, D.C., 1985.

3.10 Handbook for Sampling and Sample Preservation of Water and Wastewater, Environmental Protection Agency, EPA-600/4-82-029, Cincinnati, OH, 1982.

3.11 Sampling Guidelines for Groundwater Quality, Electric Power Research Institute, EA-4952, Research Project 2485-1, Palo Alto, CA, 1987.

3.12 Groundwater Manual for the Electric Utility Industry, Electric Power Research Institute, CS-3901, Research Project 2301-1 (volumes 1, 2, and 3), Palo Alto, CA, 1985.

3.12.1 Volume 1: Geological Formations and Groundwater Aquifers.

3.12.2 Volume 2: Groundwater Related Problems.

3.12.3 Volume 3: Groundwater Investigations and Mitigation Techniques.

3.13 Resource Conservation and Recovery Act (RCRA) Groundwater Monitoring Technical Enforcement Guidance Document, Environmental Protection Agency, PB87-107751, OSWER-9950.1, Washington, D.C., 1986.

3.14 DS-41.1, "Collection and Handling of Samples."

3.15 DS-41.2, "Water Sample Collection Techniques."

3.16 DS-41.4, "Trace Organics Sample Collection Techniques."

3.17 DS-42.1, 42.3, 42.4, 42.7, 42.8, and 42.11, "Water Quality Field Analyses."

3.18 DS-43.1, 43.2, 43.3, 43.7, and 43.8, "Standardization of Field Instruments."

3.19 DS-5.20, "STORET - Water Quality Data Management."

4.0 ABBREVIATIONS AND DEFINITIONS

4.1 Definitions

4.1.1 Definitions of job titles and general responsibilities of managerial and supervisory personnel in FENG are given in section 4.1 of reference 3.14.

4.2 Abbreviations

4.2.1 DO--Dissolved oxygen

4.2.2 DMGT--Data Management, Data Systems

4.2.3 ECHE--Environmental Chemistry, Water Quality Department

4.2.4 EPA--United States Environmental Protection Agency

4.2.5 FENG--Field Engineering, Data Systems

4.2.6 MLS--Multilevel sampling well

4.2.7 NPDES--National Pollutant Discharge Elimination System

4.2.8 ORP-Oxidation-reduction potential

4.2.9 pH--Measure of hydrogen ion concentration

4.2.10 USGS--United States Geological Survey

4.2.11 WQ--Water Quality Department

4.2.12 WQU--Water Quality Unit (Chattanooga), DMGT

5.0 RESPONSIBILITIES

5.1 The projects engineers (eastern or western geographic areas) have overall responsibility for sample collection activities and are responsible for assuring that employees are qualified for their assignments and that all requirements are met. The projects engineers are responsible for approval of all work and budget estimates before field activities begin and are responsible for designating qualified senior project engineers.

5.2 The unit supervisors and senior project engineers are responsible for the technical adequacy of the particular functional work being performed. They are responsible for coordinating sampling schedles and technical workplans with the laboratory, Data Management, and the client organization. Unit supervisors and senior project engineers are responsible to ensure that data are collected and reported on schedule and in a valid manner according to the procedures of this manual.

The unit supervisors and senior project engineers are responsible for reviewing all data collected by FENG personnel for reasonableness and accuracy prior to the data being released to the client organization.

All quality control problems are reported to the appropriate unit supervisor or senior project engineer.

5.3 Survey leaders are responsible for the quality of the field work done by his or her party or crew. It is the responsibility of the field survey leader to notify his or her unit supervisor or senior project engineer of any deviations from procedures and workplans or problems or difficulties encountered in the field, particularly as they may affect the quality of the data being collected.

5.4 All FENG personnel assigned to a project or involved in sample collection are responsible for following all instructions in this procedure manual. This includes ensuring that manuals are up-to-date and that procedures are strictly followed. If errors in procedures are observed, the error must be brought to the immediate attention of the QAC. Notes in the procedures manuals or alteration, in the field, to procedures are prohibited. FENG personnel are responsible for working in a safe manner, for notifying unit supervisors and project engineers of any deviation from the workplan, and for submitting records to their unit supervisor.

5.5 The ECHE laboratory, Water Quality Department, performs bacteriological, chemical, and physical analyses.

5.6 The WQU is responsible for coding, keypunching, processing, reviewing, validating, retrieving, and reporting field and laboratory data related to ambient groundwater quality.

6.0 PROCEDURES/REQUIREMENTS

6.1 Workplans

6.1.1 A written workplan is usually prepared in advance of the sampling activities. This written workplan must be coordinated with the client organization and other service organizations. The workplan must receive concurrence by all affected organizations and will address, at a minimum, the purpose of the monitoring activities, the choice of water characteristics to be measured, the method or methods to be employed in collection of the samples, the locations and frequency of sampling, project deadlines and schedules, budget requirements, and collection of auxiliary data.

6.1.2 If special sample collection requirements, handling techniques, or analyses are required (other than the standard procedures contained in this manual), they will be spelled out in detail in the workplan or in supplemental procedures. All items which will affect the quality of the data to be collected must be addressed in the written workplan and/or referenced to the appropriate FENG procedures. The written workplan must be approved by the appropriate senior project engineer prior to any fieldwork.

6.2 Requirements and Instructions for Groundwater Sampling

6.2.1 "Collection and Handling of Samples" (reference 3.14) will be followed as appropriate. In addition, particular attention must be given to the following requirements.

6.2.2 The FENG survey leader will review the workplan in detail and consult with his or her unit supervisor and project engineer prior to the first survey to ensure that no misunderstanding exists about how, when, where, and what samples are to be collected.

6.2.3 Before starting a new work activity at a TVA facility (i.e., nuclear, steam, hydro, etc.), the FENG project engineer or unit supervisor will contact the facility manager or his/her designee (usually the Results Section supervisor at a steam plant) and inform them of the work to be performed and on what schedule it will be done. To ensure recognition of any situations which may require special safety awareness, the field survey leader will meet with the plant manager or his/her designee and complete a safety notification record which identifies safety procedures which need to be observed, unusual conditions to be aware of, and names of FENG personnel working at the TVA facility.

6.2.4 The survey leader will select and assemble the needed equipment (pumps, meters, Hydrolabs, filtration apparatus, tapes/plunkers, compressor, generators, titration equipment, pH/conductance/ORP standards, buckets, etc), sample containers, workplan, maps, well driller logs, and forms and field worksheets. The survey leader will ensure that all equipment and supplies are appropriately cleaned, in good working order and within their laboratory calibration interval as specified in DS-43.1, attachment 1 (reference 3.18). It is recommended that an equipment checklist be prepared on the initial field survey and that it be referred to and updated on each subsequent survey.

6.2.5 The survey leader will obtain a summary of the last four sets of field data for use to validate and compare information at the time it is being collected. A computer printout can be obtained from the WQU to facilitate this data validation process.

6.3 Groundwater Sample Collection Techniques

6.3.1 Quality Control of Sampling Operations

6.3.1.1 Every effort will be made to collect a representative and uncontaminated sample. After each sample is collected, it will be visually examined for any foreign material that is not representative. If any foreign material is observed, or suspected, the sample will be discarded and new sample recollected in a fresh sample container. Do not immerse anything--even a thermometer--in the sample. Always pour the sample directly into the specified containers one at a time. Transferral to another container will greatly increase the opportunity for contamination and cross contamination.

6.3.1.2 Many sample containers contain chemical preservatives. These preservatives may be a source of contamination to other samples, may be ineffective if diluted, or may be harmful if allowed to contact skin or eyes. Use care when handling sample containers with chemical preservatives. Fill sample containers individually, one at a time, to prevent cross contamination of preservatives: uncap the container, fill it directly from the sampler, and recap the container. Do not place flexible sample tubing inside the containers unless specifically instructed to do so. Do not lay caps on surfaces that might contaminate them. Do not overfill containers. If any of these potential sources of contamination occur, discard the affected portion of the sample, and collect another portion in a fresh container.

6.3.1.3 Sample collection methods for groundwater may include the use of a pneumatic bladder pump, submersible centrifugal pump, single or 10-channel peristaltic pump, check valve bailer, Kemmerer sampler, lysimeter, or perhaps a gas lift pump. The method used to collect a groundwater sample must be compatible with the water quality characteristics of interest. All of these methods, in one or more ways, alter the quality of the sample while it is being collected. In most instances, the pneumatic bladder pump or check valve bailer, when used properly, will collect the most representative (least altered) sample for a variety of constituents (particularly volatile organics and reduced/dissolved species). The use of gas lift devices for collection of groundwater quality samples is not recommended. Chapter 6 of reference 3.2 provides additional details.

6.3.1.4 When collecting groundwater samples, the sample should be obtained as close to the discharge at the source or wellhead as possible to reduce the potential for contamination, precipitation of solute, and loss of dissolved gasses. Treated (chlorinated or filtered) or stored groundwater samples, such as from some private or domestic wells are of limited value. Care must be taken to limit sample contact with air and agitation that would interfere with the field determination of pH, ORP, dissolved gasses, and alkalinity, or the laboratory determination of volatile organics and reduced species.

6.3.1.5 On occasion it may be desirable to determine concentrations of dissolved inorganic constituents (i.e., dissolved minerals or dissolved metals) in groundwater. In such cases, by definition, the sample is filtered through a 0.45μm average pore diameter cellulose ester membrane filter (Millipore Cat. No. HAWP04700 or equivalent) during (pressure filtration) or immediately after (vacuum filtration) sample collection. Techniques used to filter groundwater samples should be discussed in detail in the project's workplan. In most cases, the preferred method for filtration of groundwater is an "in-line" pressure filtration technique which eliminates sample contact with the atmosphere and utilizes the sampling pump's pressure for filtration. The field worksheets and request for laboratory analysis forms must clearly indicate when samples are filtered in the field. Samples for field analysis (temperature, DO, pH, conductance, ORP, alkalinity, etc.) and certain laboratory analyses (ferrous and manganous ions, sulfide, organics, turbidity, suspended solids, etc.) are never filtered. Additional details in regard to sample filtration procedures are given in section 6.2.2 of reference 3.15.

6.3.1.6 Samples collected for extremely low levels (i.e., less than one part per billion) of trace organics and/or trace elements may easily be contaminated by contact with foreign materials. Motor oil, gasoline, soft plastics, etc., may be potential sources of contamination for trace organic/pesticide sampling, while soil and dust, which is ubiquitous at fossil plants, may be potential sources of contamination for many trace elements. Reference 3.16 and section 6.3.3.5 below discuss routine precautions which are taken to minimize potential sources of contamination. The permanent installation of a groundwater sampling device in each monitoring well has many advantages. It will eliminate the possibility of the introduction of foreign material during the lowering of sampling equipment into the well and the potential for cross contamination between wells caused by the possible carryover of contaminants on the sampling equipment from one well to another. In those cases where special attention must be paid to extremely low levels of organics or trace elements, permanent installation of sampling equipment/pumps in each groundwater monitoring well is a necessity.

6.3.1.7 Unless otherwise specified in the project's workplan, duplicate groundwater samples will be collected at every 20th well (i.e., five percent of the samples). Further details in regard to collection of duplicate samples are given in section 6.15.3 of reference 3.14.

6.3.2 <u>Standardization of Field Equipment and Field Measurements</u>

6.3.2.1 FENG procedures for standardization of field instruments (reference 3.18) must be followed, as appropriate, with particular attention given to the following instruments which are commonly used by FENG in the collection of groundwater quality samples.

6.3.2.1.1 Field Instruments (reference 3.18) FBNG Procedure

Hydrolabs	DS-43.2
YSI Conductivity Meters	DS-43.3
Orion pH Instruments	DS-43.7
Thermometers	DS-43.8

6.3.2.1.2 Field instruments will be standardized as specified in the above referenced procedures. At a minimum, instruments will be standardized before and after field measurements are made and whenever the accuracy of the instrument is questioned. Form TVA 30035, "Instrument Standardization, Field Standardization of Instruments," will be completed to document all field standardizations of instruments.

6.3.2.2 FBNG procedures for water quality field analyses (reference 3.17) must be followed, as appropriate, with particular attention given to the following analyses which are commonly used by FBNG in the collection of groundwater quality samples.

6.3.2.2.1 Water Quality Field Analyses (reference 3.17) FBNG Procedure

Alkalinity and Acidity	DS-42.1
Conductance	DS-42.3
Dissolved Oxygen (DO)	DS-42.4
Oxidation-Reduction Potential (ORP)	DS-42.7
pH	DS-42.8
Temperature	DS-42.11

6.3.3 <u>Collection of Well Samples Using a Submersible Pump</u>

6.3.3.1 To obtain a representative sample of groundwater, it must be understood that the composition of the water within the well casing and in close proximity to the well is probably not representative of the overall groundwater quality at the sampling site. This is due to the possible presence of drilling contaminants near the well, introduction of foreign material from the surface, casing corrosion, and/or because environmental conditions such as the oxidation-reduction potential may differ drastically near the well from the conditions in the surrounding water-bearing materials. Consequently, each well must be flushed (purged) of standing (i.e., stagnant) water until it contains fresh water from the surrounding aquifer. The recommended length of time required to pump a well and the rate at which a well can be pumped before sampling are dependent on many factors including the physical characteristics of the well, the hydrogeological nature of the aquifer (i.e., hydraulic conductivity), the type of sampling equipment being used, and the water quality parameters of interest.

6.3.3.2 Prior to any sampling or pumping of a well, measure and record the distance to the water surface (Dws) with a tape and plunker or electric tape. Measure and record the depth of the well (Dw) with a tape and plunker. Depth measurements are usually referenced to the top of the well casing and not the outer protective casing. All data, measurements, observations, and computations are to be recorded on form TVA 30066A, "Groundwater Quality Data Field Worksheet (Chemical Data)," attachment 1. In addition, if the well to be sampled is a new well or has never been sampled, form TVA 30066B, "Groundwater Quality Data Field Worksheet (Physical Data)," attachment 2, which documents information about type of well, owner of well, location of well, well drillers log/information, etc., must also be completed.

6.3.3.3 Calculate the volume of water in the well as shown below:

Well Casing ID (inches)	Gallons Per Foot	Liters Per Foot
2.0	0.1632	0.6178
3.0	0.3672	1.390
4.0	0.6528	2.471

$$Vw \text{ (in gallons)} = (Dw - Dws) \times \text{gallons/ft}$$

or

$$Vw \text{ (in liters)} = (Dw - Dws) \times \text{liters/ft}$$

where:

Vw = Volume of well, in gallons or liters;
Dw = Depth of well, in feet; and
Dws = Depth to water surface, in feet.

6.3.3.4 If a submersible pump is not already permanently installed, such as might be the case at a private or domestic well, the preferred method of purging and sampling a well is to use a pneumatic bladder pump. However, in situations where large volumes of water must be purged from a well, resulting in long pumping times (i.e., greater than one hour), a centrifugal pump with a higher pumping capacity (1-4 gallons per minute) can usually be used instead of the lower capacity bladder pump (1-3 liters per minute). All such cases should be specifically addressed in each project's workplan. Domestic wells with a submersible pump already permanently installed can be sampled from a convenient tap or faucet after letting the water run for several minutes.

6.3.3.5 Prior to lowering the pump into the well, a large tarpaulin or heavy sheet of plastic should be spread on the ground to cover the work area. This "good housekeeping" practice will help minimize the potential for contamination caused by contact of the soil with the pump and/or pump tubing. Immediately prior to placing the pump into the well, rinse the outside of the pump and the first two feet of pump tubing with distilled water.

6.3.3.6 Carefully lower the pump to two feet below the water surface. The pump should not be lowered below the top of the well screen or to the bottom of the well unless specific instructions to do so are given in the workplan. Studies have shown that lowering the pump to the bottom of a well (below the well screen) may result in a poor flushing of the column of water above the pump if the transmissivity of the aquifer is high. In such cases the pump would be primarily removing inflowing water from the lower portion of the well casing and not effectively removing the water in the upper water column. Pumping from near the surface (and lowering the pump with the drop in the water surface) ensures that inflowing water moves up through the water column and that no stagnant water will remain in the well after purging. If the well's recharge rate is slow, the pumping rate will need to be reduced to minimize the drawdown of the water level in the well. At no time should the water level be drawn below the top of the well screen.

6.3.3.7 While purging the well, continuously monitor the time, pumping rate, and distance to water surface. The pumping rate should be adjusted to minimize the drawdown of the water surface in the well. Using a Hydrolab flow-through cell system to avoid groundwater-air contact, also monitor the groundwater's temperature, pH, DO, conductance, and ORP. Record all the stabilization test data on form TVA 30066A, "Groundwater Quality Data Field Worksheet," attachment 1, approximately every five minutes. At each well, while recording and monitoring the field stabilization test data (i.e., pumping rate, water surface, temperature, pH, DO, conductivity, and ORP), the survey leader will compare the data being collected with previously collected field data. A computer printout of the last four sets of field results, obtained from the WQU in Chattanooga, will facilitate this comparison and ensure, on the spot, that valid and comparable data are being obtained.

6.3.3.8 When at least two well volumes of water have been purged from the well and the Hydrolab readings (temperature, pH, DO, conductivity, and ORP) have stabilized, (i.e., do not change by more than 10 percent), samples may be collected. If the water quality readings have not stabilized after removal of two well volumes, remove a third well volume, then begin sampling. When filling the various sample bottles/containers, care must be taken to minimize sample aeration, and to gently fill each bottle. This will often necessitate the lowering of the pumping rate to less than one liter per minute to avoid the turbulence caused by the high velocity of the water as it is discharged from the pump tubing. Be sure to record the pumping rate, temperature, pH, DO, conductivity, ORP, etc., at the time of sample collection and record the distance to the water surface immediately upon completion of sampling.

6.3.3.9 If the well's recharge is slow, the pumping rate will need to be reduced to minimize the drawdown of the water surface level in the well. If a well becomes dry during the purging, it must be allowed to recover before sampling to avoid taking a nonrepresentative sample. It may be necessary to allow 24 hours or longer for recovery. If circumstances are encountered which are not addressed in this procedure or in the project's workplan, notify the FENG project engineer immediately for instructions.

6.3.3.10 After purging and sampling, water should be removed from the pump and tubing before sampling another well. A centrifugal pump should have the check valve removed so that water will drain back into the well when the pump is turned off. If using a bladder pump, remove the pump from the well, connect the air line to the sample line, and blow out any remaining water left in the sample line before proceeding to the next well.

6.3.4 Collection of Samples Using a Bailer or Kemmerer Sampler

6.3.4.1 Prior to sampling a well with a bailer or Kemmerer sampler, measure and record the distance to the water surface and the depth of the well as given in section 6.3.3.2.

6.3.4.2 Calculate the volume of water in the well as shown in 6.3.3.3.

6.3.4.3 Prior to sampling a well with a bailer or Kemmerer sampler, thoroughly flush the sampler with distilled water. Carefully lower the sampler to the water surface. Do not drop the sampler or let it free fall to the water surface, as this will cause aeration of the sample. Gently lower the sampler into the water. Trigger the Kemmerer sampler. Retrieve the bailer or sampler. Repeat this process until two well volumes of water have been removed or as specified in the project's workplan.

6.3.4.4 Collect the samples by carefully lowering the sampler to the well screen or the perforated section of the well casing or to the depth specified in the workplan. Care should be taken to avoid striking the bottom of the well with the sampler.

6.3.4.5 Fill the specified bottles/containers directly from the sampler. Slow and careful transfer is important to minimize sample aeration. Measure and record temperature, pH, DO, conductivity, ORP, and the distance to the water surface immediately after collection of the sample.

6.3.5 Collection of Samples From Multilevel Sampling (MLS) Wells

6.3.5.1 A typical MLS well, see attachment 3, will consist of several (often 20 to 30) small diameter, flexible sampling tubes. Each tube will have a filter, usually a nylon mesh, on the intake end of the tube with the intake ends of these tubes spaced at known distances below the ground surface. These flexible sampling tubes are housed and extend to the surface inside a PVC pipe as shown in attachment 3.

6.3.5.2 Groundwater samples will be collected from MLS wells using peristaltic 10-channel pumps (i.e., two 10-channel pumps for 20 flexible sampling tubes, three 10-channel pumps for 30 flexible sampling tubes, etc.). In all sample collections from MLS wells, the 10-channel peristaltic pumps will be used in parallel to purge all tubes and collect all samples simultaneously. Every effort will be made to collect representative and uncontaminated samples. An important consideration in obtaining a valid, representative sample is first the removal of the standing water which has been trapped in the multilevel flexible sample tubing since the last sample collection. However, to avoid stressing the aquifer and perhaps altering its natural movement, this purging of the trapped water in the tubing will be minimized. One of the reasons for using the small diameter flexible tubing is that it minimizes the amount of water which is purged. For example, one foot of 3/16-inch ID tubing contains approximately 5-1/2 mL of water. Therefore, the purging of two tubing volumes would result in the purging of approximately one liter of water from each sample tube (assuming 100-foot lengths of 3/16-inch ID tubing) prior to collection of the samples. Specific purging instructions for individual MLS wells will be detailed in each project's workplan.

6.3.5.3 To collect samples at MLS wells, connect the MLS flexible sampling tubes to the 10-channel peristaltic pump tubes by mating like numbered (colored) tubes number 1 through 30 (assuming there are 30 flexible sample tubes and that three 10-channel pumps are used).

6.3.5.4 Place waste containers beneath each sampling tube, turn on the 10-channel peristaltic pumps, and simultaneously purge all the sample tubes of stagnant water by pumping approximately two volumes of water from each sample tube. (One foot of 3/16-inch ID tubing contains approximately 5-1/2 mL of water.) Discard the purge water. Record on the field worksheets any tubes which do not produce water or produce only small quantities of water.

6.3.5.5 After purging the MLS sample tubes, place sample bottles/containers marked with sample identification numbers and in proper numerical order under each correspondingly numbered sample tube. Fill the bottles/containers to the required volume and repeat this step until all types of sample bottles (i.e., metals, minerals, nutrients, sulfide, etc.) have been collected.

6.3.5.6 During the collection of the MLS groundwater samples, it is important to keep track of the fluid volume in each of bottle/container, because each sampling tube will not discharge at the same rate. As a bottle or container reaches the proper volume of sample, the sample collector will clamp off the appropriate peristaltic pump tube while allowing the remaining bottles/containers to continue to fill. Finally, after the last bottle or container has filled and the pump tube has been clamped off, the 10-channel peristaltic pumps can be shut off.

6.3.5.7 Immediately after collection of MLS well samples, make field measurements for those water quality characteristics specified in the project's workplan (e.g., temperature, pH, DO, conductivity, ORP, alkalinity, etc.).

6.3.6 Collection of Samples Using a Peristaltic Pump

6.3.6.1 A peristaltic pump can be used to collect a sample from a shallow well (water surface less than 25 feet below ground surface), spring or seep.

6.3.6.2 Prior to sampling a shallow well, measure and record the distance to the water surface and the depth of the well as given section 6.3.3.2.

6.3.6.3 Calculate the volume of water in the well as shown in 6.3.3.3.

6.3.6.4 Lower the tygon or teflon tubing connected to the peristaltic pump into the water. Remove at least two volumes of water before collection of samples from a shallow well. No purging of water is necessary if collecting a sample from a spring or seep, since the water is naturally flowing.

6.3.6.4 Fill the specified containers, process the samples, and make the water quality field measurements as specified in the project's workplan. Measure (or estimate) and record the spring or seep discharge rate (or the pumping rate if sampling a shallow well) on form TVA 30066A, "Groundwater Quality Data Field Worksheet," attachment 1.

6.3.7 Collection of Samples Using a Lysimeter (Pressure-Vacuum Soil Water Sampler)

6.3.7.1 General Instructions--Lysimeter (pressure/vacuum soil water samplers) can generally be installed and used at any depth up to approximately 50 feet. The access tubes (i.e., pressure/vacuum tube and sample discharge tube) from the lysimeter can extend above the ground surface directly above the lysimeter, or if conditions require, the access tubes can be laid in a trench, terminating above the ground surface at some distance from the lysimeter. The ends of the access tubes should be installed so that they will be protected from damage by mechanical equipment, livestock, etc. The tube ends should be covered or plugged to prevent debris from entering the tubes and later contaminating the samples. The ground surface directly above the lysimeter should not be covered in any manner that would interfere with the normal percolation of soil moisture down to the depth of the lysimeter. Attachment 4 shows a typical lysimeter installation.

6.3.7.2 Access Tubes--The "pressure/vacuum" access tube and the "sample discharge" access tube are usually small diameter polyethylene tubes (e.g., 3/16" I.D.) that extend from the porous ceramic collection device to the ground surface. Typically the tubes are inserted through a cap or plug at the open end of the porous collection cup as shown in attachment 4. One end of the "sample discharge" tube extends nearly to the bottom of the porous ceramic collection cup with the other (discharge) end extending to the ground surface. The discharge end of this tube must be marked and identified as the tube from which the samples are collected. The "pressure/vacuum" access tube is installed slightly differently. One end of the "pressure/vacuum" tube is inserted only about an inch past the cap or plug with the other end also extending to the ground surface. The fit of the tubing through the cap or plug and the fit of the cap or plug at the open end of the porous collection cup must be tight and well seated so as to be able to maintain a pressure-vacuum seal.

6.3.7.3 Installing a Soil Water Sampler--Installation of a lysimeter can be performed in several ways. Methods for installation of a lysimeter must be specified in the project's workplan. Typically a 4-inch-diameter hole is cored using a T-handle bucket auger. The augered soil should be sifted through a 1/4-inch mesh screen to remove any larger rocks and pebbles. This sifted soil will provide a reasonably uniform backfill for filling in around the inplaced lysimeter. The following discussion details some of the more common methods for installation of a lysimeter. The primary concern in all the methods is that the porous ceramic cup of the lysimeter be in tight, intimate contact with the soil so that soil moisture can move readily from the soil through the pores of the ceramic cup where it can then be withdrawn through the sample discharge tube.

6.3.7.3.1 Native Soil Backfill Method--After the hole has been cored to the desired depth, insert the lysimeter and backfill the hole with native screened (sifted) soil, tamping continuously with a small-diameter rod to ensure good soil contact with the porous ceramic cup and to prevent surface water from channeling down the cored hole.

6.3.7.3.2 Soil Slurry Method- After the hole has been cored, mix a substantial quantity of the sifted soil from the bottom of the hole with water to make a slurry which has a consistency of cement mortar. This slurry is then poured into the bottom of the cored hole. Immediately after the slurry has been poured, push the lysimeter into the hole so that approximately the bottom third of the lysimeter is completely embedded in the soil slurry. Backfill the remaining voids around the lysimeter with sifted soil, tamping lightly with a small-diameter rod to ensure good soil contact with the lysimeter. Backfill the remainder of the hole, tamping firmly, to prevent surface water from running down the cored hole. The first set(s) of soil water samples collected after installing a lysimeter by this soil slurry method may need to be discarded to avoid differences in water chemistry between the water used to prepare the slurry and the natural soil water.

6.3.7.3.3 Sand and Soil Method--Core hole to the desired depth. Pour into the hole, to a depth of about two inches, crushed 200 mesh pure silica sand of almost talcum powder consistency (commercially available under trade names of Super-Sil and Silica Flour). Insert the lysimeter and pour in additional sand until at least the bottom third of the lysimeter is covered. Backfill the remainder of the hole with sifted native soil, tamping to ensure good soil contact with the lysimeter and to prevent surface water from channeling down between the lysimeter and the soil.

6.3.7.3.4 Bentonite-Sand-Soil Method--Core hole to the desired depth. Pour into the hole, to a depth of about two inches, a small quantity of wet bentonite clay. This will isolate the lysimeter from soil below. Next, pour in a small quantity of 200 mesh silica-sand and insert the lysimeter. Pour in additional sand until at least the bottom third of the lysimeter is covered. Backfill with sifted native soil to a level about two inches above the lysimeter, tamping lightly. Again add about two inches of wet bentonite clay as a plug to further isolate the lysimeter and guard against possible channeling of water down the hole. Finally, backfill the remainder of the hole slowly with sifted native soil, tamping continuously. Allow sufficient time for the wet bentonite clay to harden before using the lysimeter to collect soil water samples.

6.3.7.4 Collecting a Soil Water Sample--After the lysimeter has been installed, a pinch clamp is securely tightened on the sample discharge tube, and a vacuum is applied to the pressure/vacuum tube. A vacuum of approximately 60 centibars (18" of mercury) is applied. A pinch clamp is then securely tightened on the pressure/vacuum tube. The lysimeter is then left undisturbed for a predetermined period of time, determined by experience and/or trial and error.

6.3.7.4.1 The vacuum within the lysimeter causes the soil moisture to move from the soil through and into the porous ceramic cup. The rate at which the soil water will collect in the lysimeter depends on the capillary conductivity of the soil and the amount of vacuum that has been created within the lysimeter. In most soils of good conductivity, substantial soil water samples can be collected within a few hours. Under more difficult conditions it may require several days to collect an adequate volume of sample.

6.3.7.2 Access Tubes--The "pressure/vacuum" access tube and the "sample discharge" access tube are usually small diameter polyethylene tubes (e.g., 3/16" I.D.) that extend from the porous ceramic collection device to the ground surface. Typically the tubes are inserted through a cap or plug at the open end of the porous collection cup as shown in attachment 4. One end of the "sample discharge" tube extends nearly to the bottom of the porous ceramic collection cup with the other (discharge) end extending to the ground surface. The discharge end of this tube must be marked and identified as the tube from which the samples are collected. The "pressure/vacuum" access tube is installed slightly differently. One end of the "pressure/vacuum" tube is inserted only about an inch past the cap or plug with the other end also extending to the ground surface. The fit of the tubing through the cap or plug and the fit of the cap or plug at the open end of the porous collection cup must be tight and well seated so as to be able to maintain a pressure-vacuum seal.

6.3.7.3 Installing a Soil Water Sampler--Installation of a lysimeter can be performed in several ways. Methods for installation of a lysimeter must be specified in the project's workplan. Typically a 4-inch-diameter hole is cored using a T-handle bucket auger. The augered soil should be sifted through a 1/4-inch mesh screen to remove any larger rocks and pebbles. This sifted soil will provide a reasonably uniform backfill for filling in around the inplaced lysimeter. The following discussion details some of the more common methods for installation of a lysimeter. The primary concern in all the methods is that the porous ceramic cup of the lysimeter be in tight, intimate contact with the soil so that soil moisture can move readily from the soil through the pores of the ceramic cup where it can then be withdrawn through the sample discharge tube.

6.3.7.3.1 Native Soil Backfill Method--After the hole has been cored to the desired depth, insert the lysimeter and backfill the hole with native screened (sifted) soil, tamping continuously with a small-diameter rod to ensure good soil contact with the porous ceramic cup and to prevent surface water from channeling down the cored hole.

6.3.7.3.2 Soil Slurry Method- After the hole has been cored, mix a substantial quantity of the sifted soil from the bottom of the hole with water to make a slurry which has a consistency of cement mortar. This slurry is then poured into the bottom of the cored hole. Immediately after the slurry has been poured, push the lysimeter into the hole so that approximately the bottom third of the lysimeter is completely embedded in the soil slurry. Backfill the remaining voids around the lysimeter with sifted soil, tamping lightly with a small-diameter rod to ensure good soil contact with the lysimeter. Backfill the remainder of the hole, tamping firmly, to prevent surface water from running down the cored hole. The first set(s) of soil water samples collected after water damage. All shipping containers shall be clearly addressed and shall be sealed and closed with strapping tape.

7.3 Holding Times--The time which elapses between sample collection and sample analysis is critical for many constituents (e.g., BOD, ortho-phosphorus, turbidity, nitrite, etc.). So that the laboratory can complete the analyses within the appropriate holding times, samples must be shipped or transported so as to arrive within the time limits given in attachment 1, reference 3.15. Any time samples are to be collected with holding times less than 48 hours, the laboratory must be notified in advance. All collections of samples should be coordinated with the laboratory.

7.4 Chain-of-Custody--The sample collector is responsible for the care and custody of the samples until they are properly dispatched to the receiving laboratory. The sample collector will ensure that each sample is under his/her control at all times. When samples are dispatched to the laboratory for analyses, the sample collector will retain a copy to the completed sample custody record(s) and request for laboratory analysis form(s), the originals of which accompany the samples. All samples shipped to the laboratory will be listed on the sample custody form, cross referenced with their unique sample tag (identification) number. The sample custody form will record the name and telephone number of the sample collector/shipper and the date of shipment. Shipping record receipts for shipments (UPS, Greyhound bus, etc.) will be retained by the sample collector/shipper as part of the permanent chain-of-custody documentation. Upon receipt, the laboratory will inspect for the shipping container for broken seals and will inspect the samples for breakage, missing samples, tampering, etc. The laboratory will verify all samples by cross referencing tag numbers between the sample custody record and the sample bottles received to ensure that all samples which were shipped have been received complete and intact. The laboratory will immediately notify the sample collector/shipper of any discrepancies.

7.5 Field Data Worksheets--Copies of all field data worksheets will be sent to the WQU in Chattanooga. Section 8.3 gives additional details.

8.0 RECORDKEEPING

8.1 Project Notebooks

8.1.1 A project field notebook and/or file shall be maintained by the FENG survey leader to record pertinent information and observations. The project field notebook accompanies the survey leader to the field. The survey leader shall record and/or file all physical measurements and field analyses performed in the project notebook/file. In addition, auxiliary data often prove very useful in the interpretation of the results. Thus, water surface elevations of nearby ash ponds, basins, lakes, streams, etc., gas bubbles in the sample line, rapid development of turbidity or color in the sample, equipment problems, clogged sampling ports at MLS wells, weather conditions, deviations from workplans or this procedure, or any number of other observations could prove very helpful and should be recorded. Project field notebooks, should there be a change in personnel, should include all information necessary to properly conduct the field survey. At a minimum this would include: the original project workplan with all revisions; sample identification (tag) numbers and descriptions of the well locations; copies of past survey field worksheets and groundwater level observations; computer printouts of prior field data; a survey equipment checklist; and all field instrument calibration records. Also included in the field notebook might be maps, sample collection and handling instructions, bus schedules, names and telephone number of project personnel, and any miscellaneous notes to aid in conducting the survey.

8.1.2 A project office notebook and/or file are maintained by the FENG project engineer. The project office notebooks remain in the office at all times and are available for reference by FENG, client, and other project organizations. In addition to containing the original project workplan and all revisions, it should contain information relating to the project such as memoranda, budget estimates, progress reports, data reports, correspondence with client organizations, etc.

8.2 Survey Reports--Following completion of each groundwater field survey, the FENG survey leader will prepare a brief (usually handwritten) report to the FENG project engineer which will be filed in the project office notebook. The report shall contain:

a. Copies of all field worksheets;
b. Survey dates and personnel participating in the survey;
c. A statement certifying that all samples were collected as specified in the workplan or, if such was not the case, a detailed listing of any omissions or deviations from the workplan;
d. Identification of equipment failures or malfunctions and recommendations for additional equipment needed to complete the survey more efficiently;
e. A brief discussion of observations made during the survey, any problems encountered, and recommendations for improving data quality;
f. All observations made (i.e., environmental, photographs, physical, etc.) that could in any way affect the interpretation of the data that were not specifically recorded on the field forms and which need to be brought to the project leader's attention; and
g. A detailed explanation of any overtime incurred.

8.3 <u>Disposition of Forms</u>

8.3.1 Forms TVA 30066A and B, Groundwater Quality Data Field Worksheets, attachments 1 and 2, are used any time physical and/or chemical groundwater measurements are made. The original is sent to and is filed by the WQU in Chattanooga. Copies are retained by FENG and the client organization(s).

8.3.2 Form TVA 11552, Groundwater Level Measurements (Field), attachment 5, is used any time groundwater elevations are observed or recorded on ash ponds, coal pile runoff ponds, metal cleaning waste ponds, rivers, lakes, etc. The original is sent and is filed by the WQU in Chattanooga. Copies are retained by FENG and the client organization(s).

8.3.3 Form TVA 991, Request for Analysis, is used for samples requiring laboratory analyses. It specifies which analyses are to be performed or which workplan is to be followed for sample analyses. The original is sent with the samples to the laboratory, one copy is retained by FENG, and one copy is sent to WQU. Reference 3.15 contains an example of form TVA 991.

8.3.4 Form TVA 11064, Sample Custody Record, is used any time samples are shipped or delivered to the laboratory to ensure that the proper number and types of samples, as specified in the project workplan, are in fact received by the laboratory. The original is sent with the samples to the laboratory, and one copy is retained by FENG. Reference 3.15 contains an example of form TVA 11064.

8.3.5 Retention periods and file locations for these forms are given in attachment 6.

LIST OF ATTACHMENTS

1. Groundwater Quality Data Field Worksheet (Chemical Data), form TVA 30066A.
2. Groundwater Quality Data Field Worksheet (Physical Data), form TVA 30066B.
3. Schematic Drawing of a Multilevel Sampling (MLS) well.
4. Typical Lysimeter Installation.
5. Groundwater Level Measurements (Field), form TVA 11552.
6. Records (Use, Distribution, and Retention).

Attachment 1

Ground Water Quality Data Field Worksheet
(Chemical Data)

Collected By: ______ Project Name: ______
Collection Date: ______ Acct. No.: ______
Sample Tag No.: ______ Well ID: ______
Collection Method: Bladder Pump ______ Centrifugal Pump ______ Bailer ______ Kemmerer ______
Stabilization Test: Start Time: ______ End Time: ______
W.S. Elevation: ______ W.S. Elevation: ______
Description of RP: ______

Time (min)	Pump Rate	Water Surface (ft)	Temperature (°C)	pH	DO (mg/L)	Conductivity (μmhos/cm)	ORP (mV)

Sample Field Measuremments (at time of sample collection):

Time: ______
Temperature (°C) ______ Phenol Alkalinity (mg/l) ______
pH ______ Total Alkalinity (mg/l) ______
ORP (mV) ______ Conductivity (μmhos/cm) ______
DO (mg/l) ______ Odor ______
Total Acidity (mg/l) ______ Sample Color ______
Sample Turbidity: Clear ______ Slightly Turbid ______ Turbid ______ Highly Turbid ______

Remarks: ______

Volume of water in well casing: ______
Volume of purged well water: ______

Reviewed by ______ Date ______

Attachment 2

Ground Water Quality Data Field Worksheet (Physical Data)

Project ______________________________

Well Name/Number ______________ Spring Name/Number ______________

Owner's Name ______________________________

Address ______________________________

Phone Number ______________________________

Well/Spring Information

Lat ____________ Long ____________ State ____________

Location ______________________________

Well Depth (ft.) ______________________________

Depth of Well Screen (ft.) ______________________________

Approximate Water Surface Depth (ft.) ______________________________

Description of Reference Point Used to Make Depth Measurement ______________________________

____

Elevation of Reference Point (MSL-ft.) ______________________________

Water Use ______________________________

Volume of Water Use (GPD) ______________________________

Type Casing ______________________________

Casing Dimensions ID ________ (in) OD ________ (in) Length ________ (ft)

Does well have permanently installed pump? ________ If so, type of pump ________

capacity (gpm) ________ discharge flow rate (gpm) ________

Well Drillers Log Data

(Attach sketch and/or provide written detailed description)

Remarks: ______________________________

____

____

____

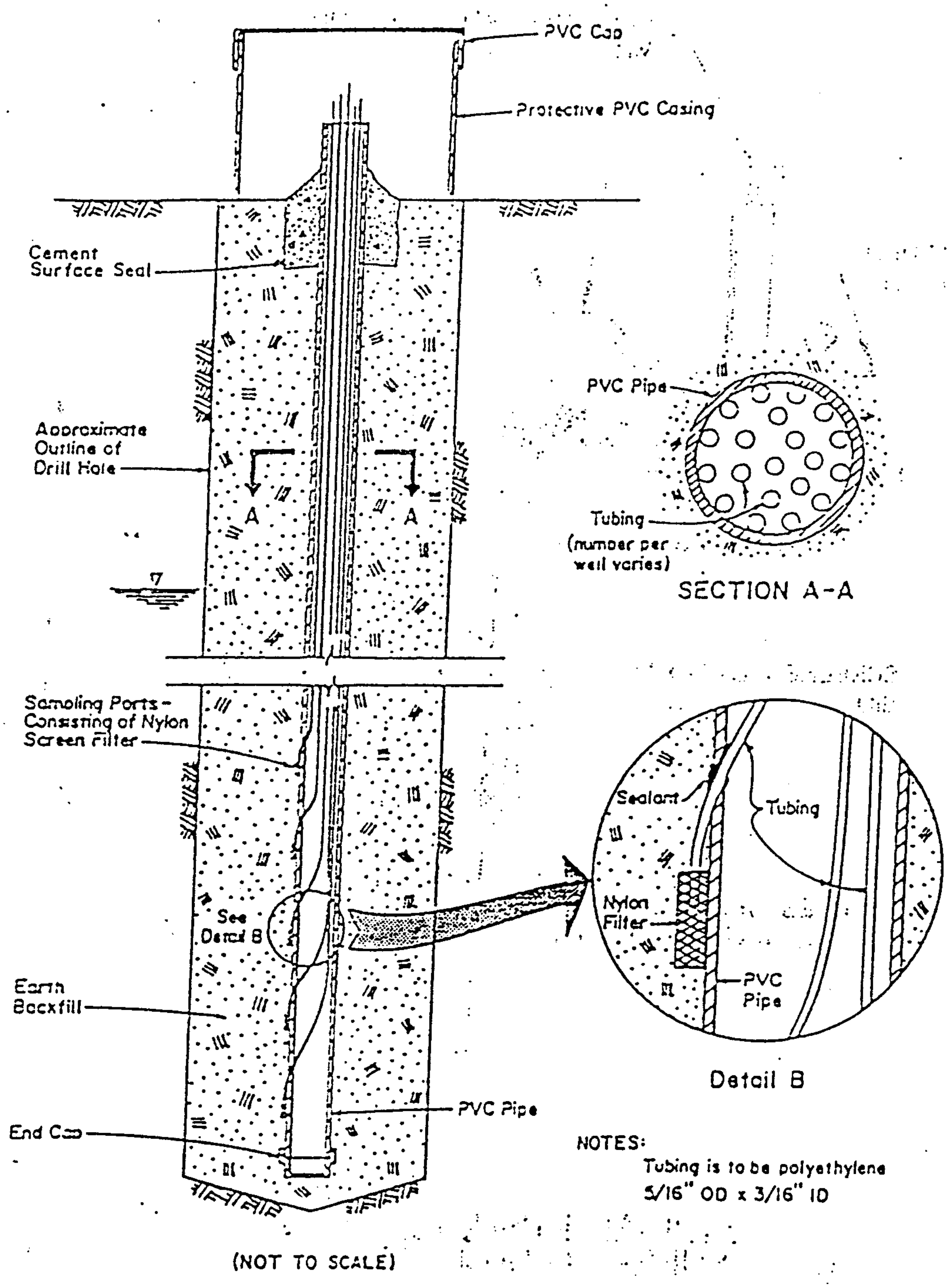
____

TVA 300448 (INROPS-1-88)

Reviewed by ______________ Date ______________

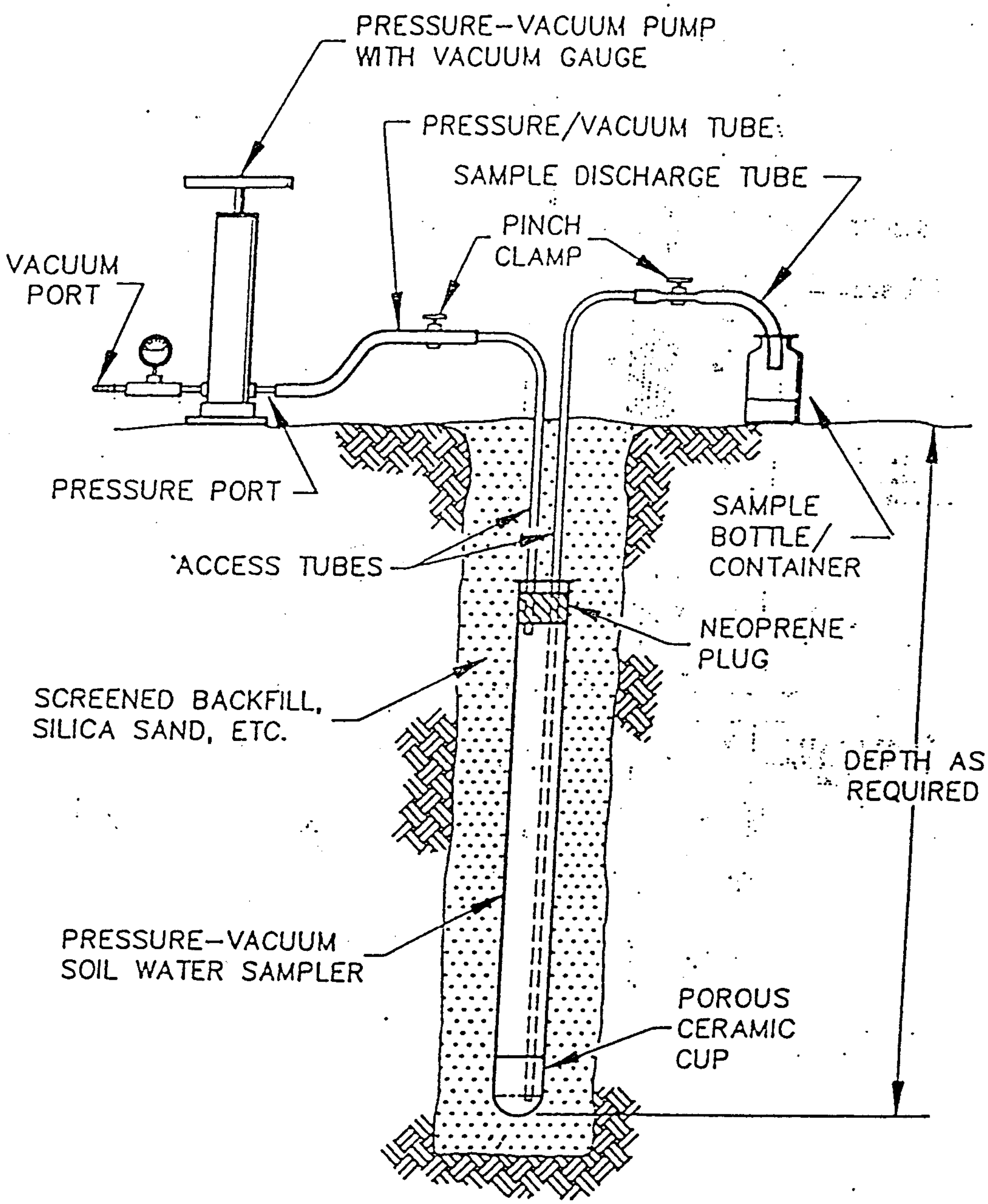
Attachment 3

Schematic Drawing of a Multilevel Sampling (MLS) Well



NOTES:
Tubing is to be polyethylene 5/16" OD x 3/16" ID

Attachment 4



TYPICAL LYSIMETER INSTALLATION
(PRESSURE–VACUUM SOIL WATER SAMPLER)

Attachment 5

Tennessee Valley Authority
Division of Natural Resources Services
Ground-Water Level Measurements (Field)

Date
Location
Measured by

Well No.	Elev. of M.P.	W.L. Below M.P.	W.L. Elev. M.S.L.	Remarks:

Abbreviations: M.P.: Measuring Point (top of casing, etc.)
W.L.: Water Level
M.S.L.: Mean Sea Level

TVA 11552 (NRS-5-79)

Attachment 6

Records (Use, Distribution, and Retention)

Record	Use	Distribution	Retention Location	Retention Time[a,b]
TVA 30066A/B	GW Quality Data Field Worksheet (Chemical/Physical Data)	. Original forwarded to WQU . Copy 1 retained by FENG . Copy 2 forwarded to client	. WQU files (STORET) . FENG project notebook . Client files	. 20 years . 1 year . As needed
TVA 11552	Groundwater Elevations (piezometers, well, water bodies, etc.)	. Original data forwarded to to DMGT and/or WQU . Copy 1 retained by FENG . Copy 2 forwarded to client	. DMGT/WQU files . FENG project notebook . Client files	. 20 years . 1 year . As needed
TVA 991	Request for Analysis	. Original forwarded with samples to laboratory . Copy 1 retained by FENG . Copy 2 forwarded to WQU	. Laboratory files . FENG project notebook . WQU files	. 1 year . 1 year . 2 years
TVA 11064	Sample Custody Record	. Original forwarded with samples to laboratory . Copy retained by FENG	. Laboratory files . FENG project notebook	. 1 year . 1 year
Various	Laboratory Results	. Original results forwarded to WQU by laboratory . Copy 1 forwarded to FENG by WQU . Copy 2 forwarded to client by FENG/WQU (after review)	. WQU files (STORET) . FENG project notebook . Client files	. 2 years . 1 year . As needed

a. Retention time for STORET-related data and field worksheets is 20 years.

b. Retention time for STORET-related laboratory results report forms is 2 years beyond project completion.

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