CLOSURE/POST CLOSURE PLAN
DREDGED ASH DISPOSAL
(RAIL LOOP AREA)
TENNESSEE VALLEY AUTHORITY
JOHNSONVILLE FOSSIL PLANT

Prepared by Site and Environmental Engineering
Tennessee Valley Authority
January, 1998

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I. INTRODUCTION

A. Facility Description

Johnsonville Fossil Plant (JOF) is located on the east shore of Kentucky Lake, approximately 12 miles west of the town of Waverly in Humphreys County, Tennessee (see Figure I). The plant has 10 coal-fired units with a total generating capacity of 1,485 megawatts. The first unit began operation in late 1951 and the last in 1959.

B. Operational History

The combustion of coal for the purpose of generating electricity results in the production of by-products that include fly ash and bottom ash. JOF produces approximately 315,000 cubic yards of ash per year. The present coal ash disposal method at JOF is sluicing fly ash and bottom ash to the active ash pond, the "west pond," which is 91 acres in size and is located west of the generating facility. This pond requires periodic hydraulic dredging to maintain compliance with the NPDES permit free-water volume requirement. The ash dredged from this pond has been hydraulically conveyed to settling ponds constructed in the railroad loop area on the JOF site. **In 1992, an** ash disposal area **was** developed **(see Figure 1, Dredge Cell Site)** on a 35-acre tract of land owned by TVA adjacent to the JOF railroad loop (Division of Solid Waste Management Permit No. IDL 43-102-0082).

TVA has been dredging ash to the railroad loop area (RLA) since 1982. Working in the RLA has resulted in three separate stacks with temporary/final cover. This Closure/Post Closure Plan is for an area of approximately 69 acres in the southern half of the railroad loop area. **TVA will fill the low areas between the three stacks creating one uniform stack with final cover over the entire stack. Ash placed in the low areas will not increase the footprint of the RLA. This closure plan will**

improve the aesthetics of the RLA, improve storm drainage in the area, reduce the area of exterior slopes to be maintained, and prevent the disturbance of a new area for four years.

C. Expected Year of Closure

The dredged ash disposal facility in the railroad loop area receives ash dredged from the active ash pond. **In past years, approximately 350, 000 cubic yards of dredged material was removed from the active pond during each dredging cycle. In 1995/1996, about 700,000 cubic yards of material was removed from the active pond.** On a yearly basis, approximately **250,000** cubic yards of **fly** ash are produced at JOF. It is estimated that approximately **900,000** cubic yards of volume is available for ash disposal in the railroad loop area. This estimate is based on July 31, 1990, aerial photography and recent **(1996)** survey data.

The projected date of closure for the railroad loop facility will be affected by TVA's schedule for completing dredging to the **existing** dredged ash disposal area and by both ash production and ash utilization. However, in accordance with the DSWM solid waste regulations (March 18, 1990), TVA proposes to close this area in accordance with plans contained in this document. **The current schedule for the stack is dredging approximately 900,000 cubic yards in calendar year 1998/1999 and final closure in the spring and summer of 2000.**

D. Facility **Contact**

The names, addresses, and telephone numbers of the TVA personnel that may be contacted during the 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
(615) 535-2501

As of the date of this report, the plant manager is Mr. **James "Ricky" Jett.**

II. FACILITY CLOSURE

A. Partial Closure Steps

This section is for the purpose of explaining the steps that will need to be followed should the Railroad Loop Area (RLA) Dredged Ash Disposal Facility be closed prior to the projected closure date discussed in Section 1, Subsection C, Expected Year of Closure. A basic premise for partial closure of the (RLA) disposal 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 plans submitted as part of this Closure/Post-Closure Plan. If such a partial closure is implemented, TVA will be required to submit revisions to the Closure/Post-Closure Plan (to include drawings and narrative). The specific items that may need to be modified are listed in Section II, Subsection B, Complete Closure Steps. Each item in Section II, Subsection B, Complete Closure Steps should be addressed even if the response would be that no change is necessary.

B. Complete Closure Steps

1. **Stack Operation**

During normal operation, **two methods may be used to place the ash in the disposal area.** Material dredged from the active west ash pond will be hydraulically deposited in the dredge ash disposal facility and dewatered so that the ash can be removed and stacked to achieve final contours.

a. The **first** ash stacking **method** consists of:

(1) Dewatering the dredged ash if necessary to facilitate handling and stacking operations.

(2) Transporting the ash by pans, backhoe/loaders, front-end loaders and dump trucks to areas for stacking.

(3) Spreading the ash **in horizontal layers** with bulldozers to a maximum thickness of 1 - 2 feet.

(4) Compacting the ash with a vibratory roller compactor to achieve an in-place density of ninety percent (90%) of its maximum compaction density, as determined by the STANDARD PROCTOR COMPACTION TEST (ASTM D-698).

(5) The ash will be graded to provide approximately a 1-percent minimum slope at the end of each working day to provide drainage sufficient to prevent ponding and excess surface infiltration. The disposal process is an essentially continuous incremental stacking procedure. No daily earth cover will be required. Intermediate cover may be placed in areas that do not achieve final contours and vegetated during inactive

phases of operation. The ash is physically stable, nonputrescible, and is not an attractant for disease or animal vectors.

(6) The stack side-slopes will continue at 3:1 with intermediate benches for erosion control and surface water drainage.

(7) Dust **will be** controlled by utilizing a water tank truck as required on the haul road and stack.

b. The second ash stacking method consists of:

(1) Using dewatered ash to construct a raised dike inside the previous containment dike.

(2) Dredging the raised dikes full.

(3) Decanting the ash and using the water to compact the settled ash.

(4) No daily earth cover will be required. Intermediate cover may be placed in areas that do not achieve final contours and vegetated during inactive phases of operation. The ash is physically stable, nonputrescible, and is not an attractant for disease or animal vectors.

(5) Repeating steps one through four until the site reaches final grade.

(6) The stack side-slopes will continue at 3:1 with intermediate benches for stability, erosion control and surface water drainage.

(7) Dust will be controlled by utilizing a water tank truck as required on the haul road.

(8) Final grading is accomplished with a dozer after the dredged ash has dewatered for a period of time.

2. Drainage System

The surface water drainage system will be operated with the same concepts as have proven to be historically successful during the operation of other TVA ash stacking facilities.

The potential run-on from surrounding areas will continue to be intercepted in the existing diversion ditching network. These interception ditches direct the surface flow around the stack area to preclude this water from mixing with runoff from the ash stack. The handling of this extraneous water assists in stormwater management and erosion control within the stack area.

The run-off from the stack area will utilize the following method of controlling water. The run-off collection system will consist of maintaining a minimum **two**-percent **(2%)** **, maximum five-percent** slope on top of the stack and utilizing side slope benches to control run-off by directing the water downslope along circuitous ditches on approximately **two** -percent **(2%)** slopes. These slopes and circuitous path aid in controlling velocities and erosive forces while facilitating the deposition of ash that may accumulate in the run-off. The ditching from the ash stacking area flows to a settling pond for additional sediment control. Discharge from the stack settling pond is to an existing stilling pool on the 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 JOF (NPDES Permit No. TN0005444 DSN001).

Collection of any accumulated fly ash that settles in the ditches, settling pond or other areas will periodically be removed and placed on the stack for disposal. As the height of the stack is raised on the 3 to 1 side slopes, the placement of **intermediate** cover material **(see section II.B.6.)** and establishment of vegetative cover will be accomplished as soon as possible. This helps control erosion and maintains an effective drainage system. Past operations have maintained good attention to detail in this regard. This attention to detail will continue in order to keep erodible ash under erosion control.

In areas where final contours are not achieved but will be reserved for later stacking, intermediate cover will be placed and seeded to establish vegetation. This material may be removed at a later date when stacking resumes. As with the areas receiving final cover, this material will be placed as soon as possible to aid in erosion and dust control.

Several steel **500 kV (3-conductor bundle)** power line support towers are located within the **RLA** . Some of these towers are located in small depressions which do not allow adequate drainage. These depressions are to be filled **with dredged ash and then brought to final grade with construction equipment** prior to closure to facilitate proper drainage.

Care must be taken at all times to ensure that proper clearances are maintained from power lines while heavy equipment is in use at the site. A copy of the documents providing guidance on these clearances is provided in Appendix G.

3. Leachate Collection

This facility currently does not have a leachate collection system. **Modeling studies indicate implementing this proposed closure plan reduces leachate by 96%, compared to the current conditions, in the older ash underlying the site.**

Therefore, in accordance with the March 18, 1990, regulations (1200-1-7-.04) (1) (b)3, (page .04-1) leachate collection is not required for this facility since the facility currently does not have a leachate collection system and there is no indication **that** leachate contamination **will be problematic**.

4. Gas Collection

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

5. Final Cover

The footprint of the dredged ash stacking area is shown on the drawings submitted as part of this Closure/Post-Closure Plan. The continued use of the stack, until its closure, will result in an increase in the vertical dimensions but no increase in the footprint. The embankment of ash is proposed to be constructed to an approximate maximum final elevation of 465 msl. The closure of the dredged ash facility to this grade, as shown on the drawings, will allow the area of 3 to 1 side slopes to be maximized while minimizing the amount of relatively flat surface area that will be the final top of the stack. This final grading will facilitate controlling run-off of precipitation and further minimize the generation of leachate or accumulation of moisture within the stack.

Due to the unique characteristics of fly ash to evaporate and store water, the use of the HELP model consistently over predicts leachate generation. Studies conducted to support permitting of the dredged ash facility **constructed in 1992** at JOF explain this in more detail.

Given the unique characteristics of ash and the results of the modeling studies conducted by TVA, the final cap to be utilized on top of the ash will be as follows (from top layer downward):

- Soil suitable for support of vegetation, twelve inches (12")
- Soil compacted to achieve a maximum hydraulic conductivity of 1×10^{-7} cm/sec, twelve inches (12") **or a synthetic membrane or geosynthetic layer that is at least equal in permeability to 12 inches of 1×10^{-7} cm/sec compacted soil.**

Appendix A is a printout of the HELP model that provides the justification for using this final cap. In summary, the printout is to be used to evaluate the cap design only in regards to the anticipated average annual percolation through the cap. The results indicate that for the 30 years modeled, the average annual percolation through the cap is predicted to be **0.27** inches/year **at the end of the 30 year closure period**. **This represents a 96-precent reduction when compared to existing conditions.** The proposed cap design will provide sufficient protection from the percolation of water into fly ash stack. This is further supported by the field experiments and analyses conducted by TVA that indicate that the fly ash exhibits strong capillary forces and an ability to store water. Reference is also made to the report "Design, Construction, and Maintenance of Cover Systems for Hazardous Waste - An Engineering Guidance Document" prepared by the Army Engineer Waterways Experiment Station for EPA, May 1987. Reference is also made to **10W532-10 and -17 of** the plans submitted as part of this Closure/Post-Closure Plan for additional details regarding the final cap.

6. Intermediate Cover

Intermediate cover consisting of at least 6 inches of soil suitable for the support of vegetative cover is to be placed on areas that have not achieved final grades and will not receive ash for extended periods. During subsequent stages in the development of the area, this cover may be removed and used elsewhere if practical.

7. Vegetative Cover

The conditioning, fertilizing, and seeding of the intermediate and/or final cover in order to establish an adequate vegetative cover shall begin immediately upon placement of the intermediate and/or final cover. **The cover will be seeded using a mixture of grasses listed in Section 580 and mulched according to Section 582 of TVA's T-1 Construction Specifications for the season the work is done.** TVA specifications for seeding **and mulching** are included in Appendix B.

8. Groundwater Monitoring

(1) Compliance Monitoring Boundary

The compliance monitoring boundary of the RLA dredged ash stacking facility should be the area within the location of the existing monitoring wells.

These wells designation are:

Upgradient Well	Well B9**, A1**
Downgradient Wells	Well B5, B6, B7, B8**, A2**

The location of these wells are shown on the drawings submitted as part of this Closure/Post-Closure Plan.

(2) Monitoring System for the Existing Facility

As mentioned above, the RLA dredged ash disposal area has a groundwater monitoring system in place which was installed **to** support closure of the facility. Quarterly monitoring of these wells has been conducted since their installation. Quarterly monitoring data is included in Appendix F.

(3) Detection Monitoring Program

a. **Sampling Parameters**

The samples will be analyzed for the samples listed below:

I. Fluoride

II. Ag

III. Ba

IV. Be

V. Cu

VI. V

VII. Zn

VIII. As

IX. Sb

X. Cd

XI. Co

XII. Cr

XIII. Pb

XIV. Se

XV. Tl

XVI. Ni

XVII. Hg

Beginning with the next routine sampling date following approval of this closure plan, the operator will begin sampling for the groundwater contamination parameters specified **in paragraph (3) a. above** at least once every six months.

Monitoring for volatile organic compounds (VOCs) (listed in DSWM Solid Waste Regulations Appendix I) will not be necessary for this facility since these VOCs are not known or suspected to be constituents of coal fly ash. If any of these consisutents were present in the coal, which is unlikely, the high temperatures of the combustion process (greater than 2,500°F) would be expected to decompose or drive off all volatile constituents. TVA has conducted tests of fly ash for the presence of VOCs and the results indicated the VOCs were "nondetectible." A summary of testing results is included in Appendix C of this Closure/Post-Closure Plan. 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 D.

b. Recordkeeping and Reporting:

Recordkeeping: Records of all groundwater sampling of Wells B5, B6, B7, B8, and B9 are kept at the facility. Information includes groundwater sampling activities conducted, the sample: analysis results and the groundwater surface evaluation.

Reporting: All results of groundwater sampling and analysis results and groundwater surface elevations of Wells B5, B6, B7, B8, and B9 are submitted to the Tennessee Department of Solid Waste Management within thirty days after completing the analysis.

c. 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 **artesian** 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 geohydrology 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 sealant shall be chemically inert and impermeable. Neat portland cement (with or without bentonite clay additives) and bentonite clay are acceptable sealants. 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 next 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. 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, chucks, 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 cannot 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.

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)

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 **artesian** wells can cause problems with the installation of neat portland cement. Packers or heavy plugs shall be required to inhibit water flow.

9. Closure Schedule

Upon determination that the closure of the facility is forthcoming, a notification of TVA's intent to close the 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 possible but are not to exceed 180 days.

TVA must notify DSWM in writing of completion of closure of the RLA disposal facility. Such notification must include a certification by TVA that the RLA disposal facility has been closed in accordance with the approved Closure/Post-Closure care plan. 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.

10. 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.

11. Post-Closure Care Activities

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:

(1) 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.

(2) Ensure that a healthy vegetative cover is established and maintained over the site.

(3) Maintain the drainage facilities, sediment ponds, and other erosion/sedimentation control measures (if such are present at the disposal site), at least until the vegetative cover is established sufficiently enough to render such maintenance unnecessary.

(4) Maintain and monitor the groundwater monitoring system. The monitoring system and sampling and analysis program established in the previous sections will 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.

12. 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. 831-831dd (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.

A summary estimate of probable closure costs is included in Appendix E for information purposes only.

III. QUALITY ASSURANCE/QUALITY CONTROL **(QA/QC)**

A. General

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

The **QA/QC** shall be performed by a party independent of all other construction contractors involved in construction for the 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 ensure 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. **Cap Construction**

1. Construction specifications: **If the impermeable layer of the cap is constructed from** one foot of **clay, it** will meet the following requirements.

   - A saturated, vertically oriented hydraulic conductivity no greater than 1 x 10^{-7} cm/sec, 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 3,000 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:

(1) Moisture-density relationship of the soil by the Standard Proctor Test, (ASTM D698);

(2) Grain size analysis (ASTM D422);

(3) Atterberg Limits (ASTM D4318).

Random samples of the material placed will be obtained a minimum of once every 5 acres to verify the correlations which are made from the previously stated sample testing. Samples will be tested for hydraulic conductivity as specified by the EPA Method 9100 in Test Methods for Evaluating Solid Waste SW-846 or other method approved by the DSWM.3. Cap Construction: The cap will be constructed as outlined below:

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

(2) 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^{-7} cm/sec.

(3) Soil will not 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.

(4) The cap 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.

(5) During construction, the clay will be protected from detrimental climatic effects by:

- Protect 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 cap;
- Recompacting any soil that has been subjected to a freeze and thaw cycle.
- Ensuring that the cap is not subject to desiccation cracking by sprinkling the soil 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 this next lift or installing the next cap system component.
- By removing excessively wet soil or areas determined to be not acceptable by the **PE or PG**

(6) 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 judgment. Actions may include recompaction or removal and replacement of unsatisfactory material with new material, compaction, and retesting. Documentation of these procedures shall be provided by the engineer or geologist.

4. Clay Construction Certification: A **PE or PG** will verify that a compacted cap is constructed in accordance with these criteria by performing all of the following quality control tests.

(1) Field density-moisture measurements of the cap immediately after compaction, as specified by ASTM D2922 (nuclear methods), for each 3000 cubic yards placed, with a minimum of 1 test per day of **soil placement**. The location of the soil samples will be rotated with each lift to maximize the coverage of the tests. ~~Filed~~ **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 test will be performed to correlate and verify the nuclear gauge 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.

(2) The undisturbed hydraulic conductivity of a soil sample will be conducted at a minimum once per 5 acres of the cap, by the EPA Method 9100 in Test methods for Evaluating Solid Waste SW-846 or by another method per DSWM approval. 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 bentonite, hand tamped, and compacted into place.

(3) Upon completion of the clay construction, elevations will be taken to verify construction.

(4) Provide documentation of the quality control measures performed with field notes and certifications.

(5) The soil to be utilized for establishing the intermediate and/or the vegetative cover shall have an organic composition capable of sustaining a healthy stand of vegetation. Once this soil has been applied and tamped, the area shall be seeded **and mulched** as soon as practical in order to minimize soil erosion. The soil for vegetation shall not be compacted such that vegetative growth is hindered. The top surface of the soil for vegetation may need to be roughened to create a favorable environment for vegetation to grow in. The seeding, **mulching** and fertilization schedule can be found in Appendix B of this manual. **The thickness (12-inch minimum) of the final vegetative cover shall be verified.**

The TVA specifications shown in Appendix B shall be modified to change the following: (1) reference to topsoil to read soil suitable for vegetative growth, (23) Section 580.3 shall be modified to provide 12" of soil suitable for vegetative growth to match the cap section detail shown on the plans, (3) Section 580.4 - seedbeds to be roughened or scarified shall be done in such a manner that will not damage the portion of the cap that consists of the 12" of soil with a maximum hydraulic conductivity of 1×10^{-7} cm/sec.

5. <u>Synthetic or Geosynthetic Cap</u>

As an alternative to a foot of 1×10^{-7} compacted clay, a seam-welded membrane of at least 30 mil PVC, polypropylene, or HDPE or a geosynthetic clay liner (GCL), CLAYMAX 500SP or equal may be used as a cap at final closure. A fabric covered geonet such as Gundle Fabri-Net, or its equal, will be placed on top of the synthetic membrane or GCL for drainage. Finally, a foot of soil suitable for vegetative cover meeting the specification in section III. B. 4.(5) above will cover the synthetic cap and support vegetation.

(1) All QA/QC and documentation requirements in section III with regard to the soil for vegetative cover shall be applied to the soil covering the synthetic membrane or GCL.

(2) QA/QC for the synthetic cap shall be in accordance with the manufacturer's instructions. The PE or PG shall inspect the synthetic cap during installation to ensure it complies with the QA/QC requirements and document its installation according to section III-C.

C. <u>DOCUMENTATION</u>

1. <u>Daily Logs</u>

(1) The registered **PE or PG** performing **QA/QC** shall prepare a daily log giving the detailed descriptions of the construction operations.

(2) 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 designations of samples taken, locations and findings of core sampling, meteorological conditions, and general comments and observations.

(3) A copy of the daily logs shall be kept on site and made available to TVA, the QA/QC personnel, and Construction Contractor.

(4) 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

(1) 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 the 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.

(2) The documentation will be organized and indexed inspection 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 and copies will be kept by the TVA. **Originals** of the documentation will be maintained by TVA through the closure and post closure period of the site.

APPENDICES

Appendix A

HELP Model Printout

The HELP Model output is included on a 3 ½" floppy in the hydrogeologic report, "Hydrogeology of Rail Loop Dredged Ash Stacking Area, TVA New Johnsonville Fossil Plant," document number WR97-2-30-113. This document will be transmitted under separate cover.

APPENDIX B

TVA Vegetation Specification

SECTION 580 - Seeding (Pay Item 580)

580.1 -- Description

This specification consists of furnishing and placing seed, commercial fertilizer, and agricultural limestone on roadway slopes, shoulders, borrow pits, channel banks, waste areas, lawns, meadows, beaches, open play areas, and other areas specified by the plans or the Engineer and in accordance with the methods outlined by these specifications.

580.2 -- Materials

1. Seeds

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, Testing Agricultural and Vegetable Seed. 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.

Seed Varieties	Purity, Minimum %	Germination, Minimum %	
Korean Lespedeza (Lespedeza stipulacea), scarified . . .	90	85	
Sericea Lespedeza (Lespedeza cuneata), scarified	95	85	
Interstate Sericea Lespedeza (Lespedeza cuneata, variety Interstate), scarified	95	85	1
White Clover (Trifolium repens)	95	85	
Alsike Clover (Trifolium repens hybridum)	95	85	

580.2 -- Materials (Continued)

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

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. Seed or seed mixtures, rates, and seasons

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 drawings 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. Temporary cover shall be planted when it is required during seasons not suitable for planting the seed specified by the plans.

a. Lawns

Type 1: Spring or fall seeding (Plant between March 15 and May 1, or between August 15 and October 15).

(1) Kentucky 31 Fescue . . . 120 pounds per acre
(2) Rebel Fescue . . . . . . 120 pounds per acre | 1
(3) Creeping Red Fescue . . 80 pounds per acre

Type 2: Fall seeding (Plant between August 15 and October 15).

(1) Perennial Ryegrass . . . 120 pounds per acre
(2) Kentucky Bluegrass . . . 80 pounds per acre

Type 3: Spring seeding (Plant between March 15 and May 1).

Bermuda Grass . . . . 40 pounds per acre

580.2 -- Materials (Continued)

c. Channel Banks, Cuts, Fill Slopes, Waste Areas, and Other Disturbed Areas

Type 6: Spring seeding only (Plant between March 15 and May 15).

Mixture:

(1) Kentucky 31 Fescue . . . 60 pounds per acre

(2) Bermuda Grass (hulled) . 40 pounds per acre

(3) Creeping Red Fescue . . 80 pounds per acre
(Shaded slopes only)

(4) Weeping Lovegrass . . . 15 pounds per acre
Korean Lespedeza
(scarified) . . . . . . 10 pounds per acre
Total mixture . . . 25 pounds per acre

(5) Sericea Lespedeza
(scarified) . . . . . . 30 pounds per acre
Kentucky 31 Fescue . . . 30 pounds per acre
Total mixture . . . 60 pounds per acre

(6) Interstate Sericea
Lespedeza (scarified) . 30 pounds per acre
Rebel Fescue . . . . . . 30 pounds per acre 1
Total mixture . . . 60 pounds per acre

(7) Crownvetch (scarified
and inoculated) . . . . 30 pounds per acre
Kentucky 31 Fescue . . . 30 pounds per acre
Total mixture . . . 60 pounds per acre

(8) Bahia Grass . . . . . . 40 pounds per acre
Bermuda Grass . . . . . 20 pounds per acre
Switch Grass . . . . . . 10 pounds per acre
Total mixture . . . 70 pounds per acre 1

(9) Rebel Fescue . . . . . . 40 pounds per acre
Hard Fescue . . . . . . 10 pounds per acre
White Clover . . . . . . 5 pounds per acre
Total mixture . . . 55 pounds per acre

580.2 -- Materials (Continued)

e. Temporary Cover

Type 9: Temporary winter seeding (Plant between October 15 and March 15).

Annual Ryegrass	80 pounds per acre
White Clover	10 pounds per acre
Total mixture . . .	90 pounds per acre

Type 10: Temporary summer seeding (Plant between May 1 and August 15).

Mixture:

(1)	Korean Lespedeza (scarified)	20 pounds per acre
	Foxtail Millet	20 pounds per acre
	Total mixture . . .	40 pounds per acre
(2)	Red Clover	20 pounds per acre
	Weeping Lovegrass . . .	10 pounds per acre
	Total mixture . . .	30 pounds per acre

3. Fertilizer

Fertilizers shall be those readily available commercially. The application of fertilizer shall be at a rate of 200 pounds Ureaform (38-0-0) per acre with either 400 pounds of 15-15-15 per acre or 600 pounds of 6-12-12, unless specified otherwise by the drawings or memorandum.

Ammonium nitrate (NH_4NO_3) may be used for supplemental fertilization when specified by the Engineer.

4. Agricultural Limestone

Limestone shall contain no less than 85 percent calcium carbonate by weight. It shall be crushed so that at least 85 percent will pass a No. 10 sieve. The application of limestone shall be at the rate of 2 tons per acre unless specified otherwise by the drawings or memorandum. Hydrated lime may be substituted at a rate of 1 ton per acre.

580.3 -- Topsoil

All lawn areas to be seeded shall have a 2-inch minimum depth of topsoil immediately below finish grade. Topsoil requirements for other areas, if any, will be determined by field inspection and shall comply with Section 581.3.

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580.6 -- Seeding Methods (Continued)

Care shall be taken to ensure that seed and fertilizer remain uniformly and thoroughly mixed in the seeding equipment. Additional mixing shall be performed if necessary to avoid segregation of the seed or seed and fertilizer.

Hydroseeding is the method of applying lime, fertilizer, seed, and mulch combined with water in a single operation. Using the equipment described in Section 580.5, mixing tanks shall be filled with water to the level indicated inside of the tanks. With the engines turned on and the agitators running, the following materials shall be added: (1) limestone at the specified rate of 1/5 per acre (finely ground); (2) fertilizer; (3) seed (Section 580.2); and (4) wood fiber mulch (Section 582.2), for each 1000 gallons of water. The resulting slurries shall be applied to seedbeds at a rate of 5000 gallons per acre.

When hydroseeding slopes are 2:1 or steeper, a vinyl or plastic mulch (Section 582.2) shall be added to the slurries at the rate specified by the manufacturer.

Discharge lines are activated by opening bypass valves with hand levers that allow the slurries to spray through the nozzles. Slurries shall be sprayed on the seedbeds as the spraying vehicles move slowly across the area. Care shall be taken to ensure that all areas are evenly covered. If wind or rough terrain causes skips to occur, additional applications shall be made before moving to other areas. To provide for the even distribution of a slurry, hydroseeding should be performed with the wind or preferably with no wind at all.

For steep slopes, even coverage is best obtained when an application is begun at the top and worked down a slope with successive overlapping passes. When a hydroseeder is located on top of a slope, the reverse is true.

Seed not sown by drills or hydroseeders shall be covered to a depth of approximately 1/4-inch by lightly harrowing or raking. Raking or harrowing shall follow contours as closely as practical.

Where mulching is to be done, the mulch shall be applied immediately after the seeding is completed to avoid the loss of soil moisture or possible erosion. Mulching shall comply with Section 182. 582

When specified by the Engineer, one or more applications of fertilizer shall be made after a stand of grass has been obtained and allowed to grow for a period of from 3 to 6 weeks. The grade and rate of application of the fertilizer will be specified by the Engineer. When ammonium nitrate or a similar soluble fertilizer is used alone, areas shall be thoroughly soaked as soon as an application is completed.

SECTION 582 - Mulching (Pay Item 582)

582.1 -- Description

This item consists of mulching roadway slopes, shoulders, or other areas by covering them with straw, hay, hydro mulch, or similar materials in accordance with these specifications and at the locations specified by the plans or the Engineer.

582.2 -- Materials

The materials used for mulching shall conform to the following requirements and must be approved by the Engineer before being used. The stems or stalks of straw, hydro mulch, and hay should be as long as is feasible to obtain an overlapping or shingling effect when these materials are applied. Materials containing large amounts of chaff, leaves, short fragments of straw, or stems will not generally be approved.

Straw shall consist of stalks of oats, rye, or wheat; straw is preferred.

Hay shall be obtained from any grasses or legumes that are reasonably free of noxious weeds.

Hydro mulch shall be a product manufactured from wood fiber, vinyl, or plastic materials designed specifically for use as a hydro mulch and for application by the hydro jet method.

Wood fiber mulch, such as Conwed "Hydro Mulch," Weyhauser "Silvafiber," or the equivalent, shall consist of a natural wood cellulose fiber which is readily dispersable in water, nontoxic to plant germination and growth, and does not react with other materials. The mulch shall be dyed, preferably green, to allow for visual metering during application. The moisture content shall be no greater than 12 percent, ash content no greater than 1 percent, and the pH no less than 4.5. The waterholding capacity measured in grams of water per 100 grams of fiber shall be a minimum of 1150 percent. The mulch shall be packaged in moisture-resistant bags.

Vinyl or plastic mulch, such as "Aerospray 70," "Terratack," or the equivalent, shall consist of a natural gelatinous material in a synthetic plastic, vinyl, or latex base that does not react with any other material. The mulch shall be readily dispersible in water, nontoxic to plant germination and growth, not hazardous to wildlife or the environment, and comply with Federal health standards. The material shall be acceptable in solid or liquid forms and packaged in measured containers.

Emulsified asphalt for adhesive shall conform to type SS-1 (Section 1115) except that the residue penetration at 25°C shall be 150 to 200. If type SS-1 is unavailable, emulsified asphalt type AE-3 may be used. Asphalt emulsions shall be prepared so that their specified characteristics will not change during transportation or normal storage. They shall be nontoxic to plants. Vinyl or plastic hydro mulch described previously may be used in place of asphalt where costs and availability permit.

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APPENDIX C

TCLP and VOC Testing of JOF Ash

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 summery 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.

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 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	S. 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 12/7/89
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 Collection of Well Samples Using a Submersible Pump

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 <u>Collection of Samples Using a Bailer or Kemmerer Sampler</u>

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 <u>Collection of Samples From Multilevel Sampling (MLS) Wells</u>

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 <u>Collection of Samples Using a Peristaltic Pump</u>

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 <u>Collection of Samples Using a Lysimeter</u> (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.

6.3.7.4.2 In general, vacuums of 50-85 centibars (15"-25" of mercury) are normally applied to the lysimeter. However, in very sandy soils it has been shown that high vacuums may result in a slow rate of sample collection. In coarse, sandy soils, the high vacuums may deplete the soil moisture in the immediate vicinity of the porous ceramic cup and, hence, reduce the capillary conductivity, which results in lower sample collection rates. In loam and gravelly clay loam, collection rates of 300-500 mL/day at 50 centibars (15" of mercury) are common. On waste water disposal sites, collection rates of up to 1500 mL/day have been observed.

6.3.7.4.3 To recover the soil water from the lysimeter, attach the pressure/vacuum access tube to the pressure port on a pump. Place the sample discharge tube into the sample bottle or container. Open both pinch clamps (one on the pressure/vacuum tube and one on the sample discharge tube) and gently apply pressure to develop enough pressure within the lysimeter to force the collected soil water out of the lysimeter and into the sample bottle or container.

6.3.7.4.4 Subsequent samples are collected by again creating a vacuum within the lysimeter and repeating the above steps, sections 6.3.7.4 through 6.3.7.4.3

7.0 <u>HANDLING OF SAMPLES</u>

7.1 <u>Sample Identification</u>--All sample bottles and sample containers shall be labeled with a permanent sample identification number. This sample identification number or tag number must be unique for each sample collected and must be cross referenced on all field sheets (forms TVA 30066A and 30066B), chain-of-custody forms (form TVA 11064), and laboratory analysis requests (form TVA 991). Prior to packaging and shipping of samples, all containers and bottles shall be inspected for tag numbers and cross checked against all field sheets, chain-of-custody forms, and laboratory analysis requests. Additional explanation of sample identification requirements are given in section 6.11, reference 3.14 .

7.2 <u>Packing and Shipping of Samples</u>--Sample containers should be closely protected against contamination while transporting them to the survey site, during sampling, field handling and analysis processes, and while transporting them back to the laboratory. Detailed instructions for packing and shipping the various kinds of samples are given in reference 3.7. These requirements are summarized in attachment 1 of reference 3.15. As soon as practicable, samples that are to be stored at 4°C must be packed on ice. To avoid breakage, care must be taken when packing bottles and containers in shipping chests. Copies of field sheets, sample custody records, and request for laboratory analyses must be sent to the laboratory with the samples. Check to make sure all paperwork has been accurately completed and sealed in a plastic bag to prevent 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 Disposition of Forms

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 Measurements (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 ____________

TVA 30066A (S&F OPS-11-87)

TVA 30038 (S&F OPS 5-88)

Attachment 2

Ground Water Quality Data Field Worksheet
(Physical Data)

Project ______ Spring Name/Number ______
Well 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) ______

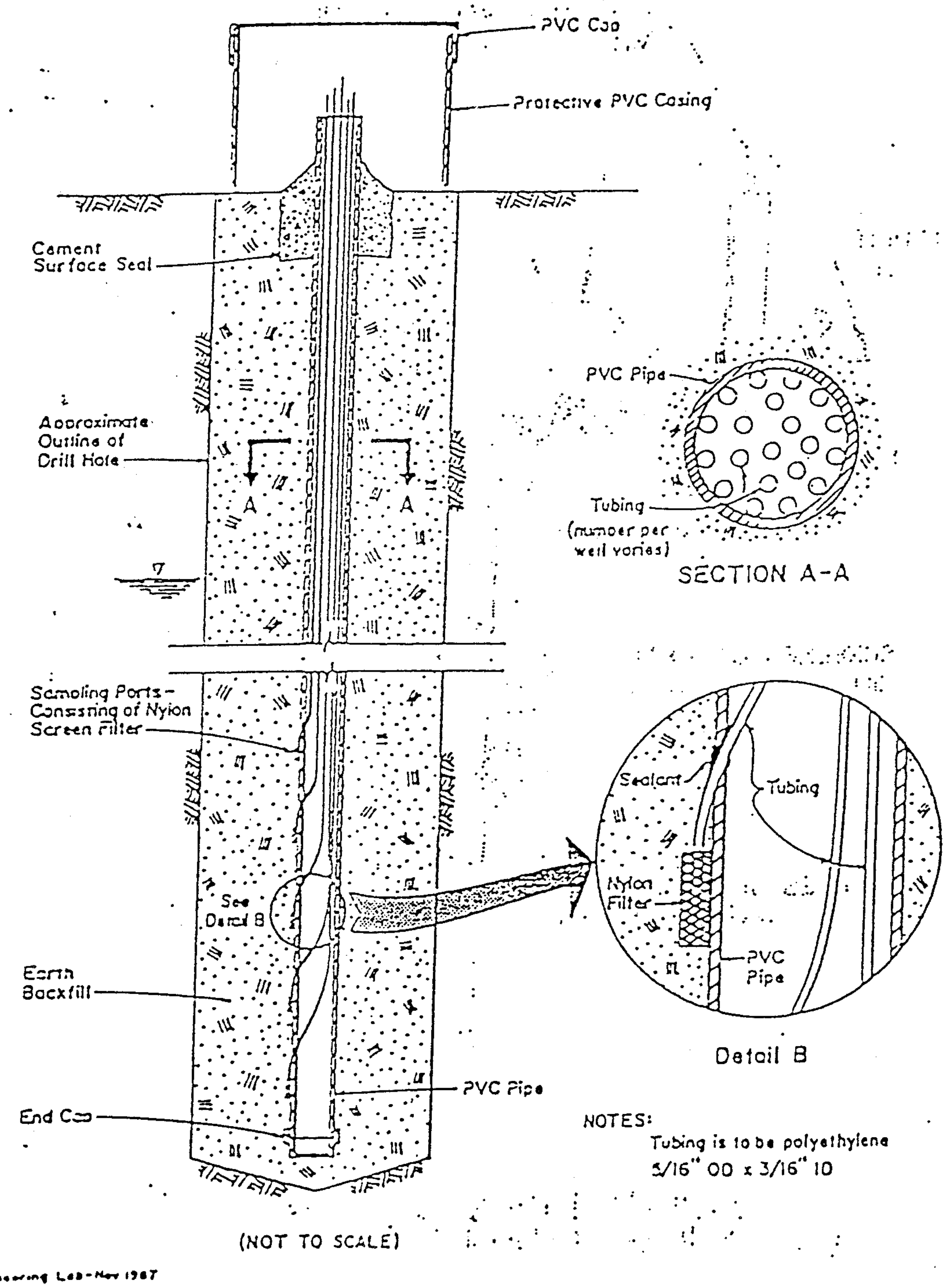
Well Drillers Log Data
(Attach sketch and/or provide written detailed description)

Remarks: ______

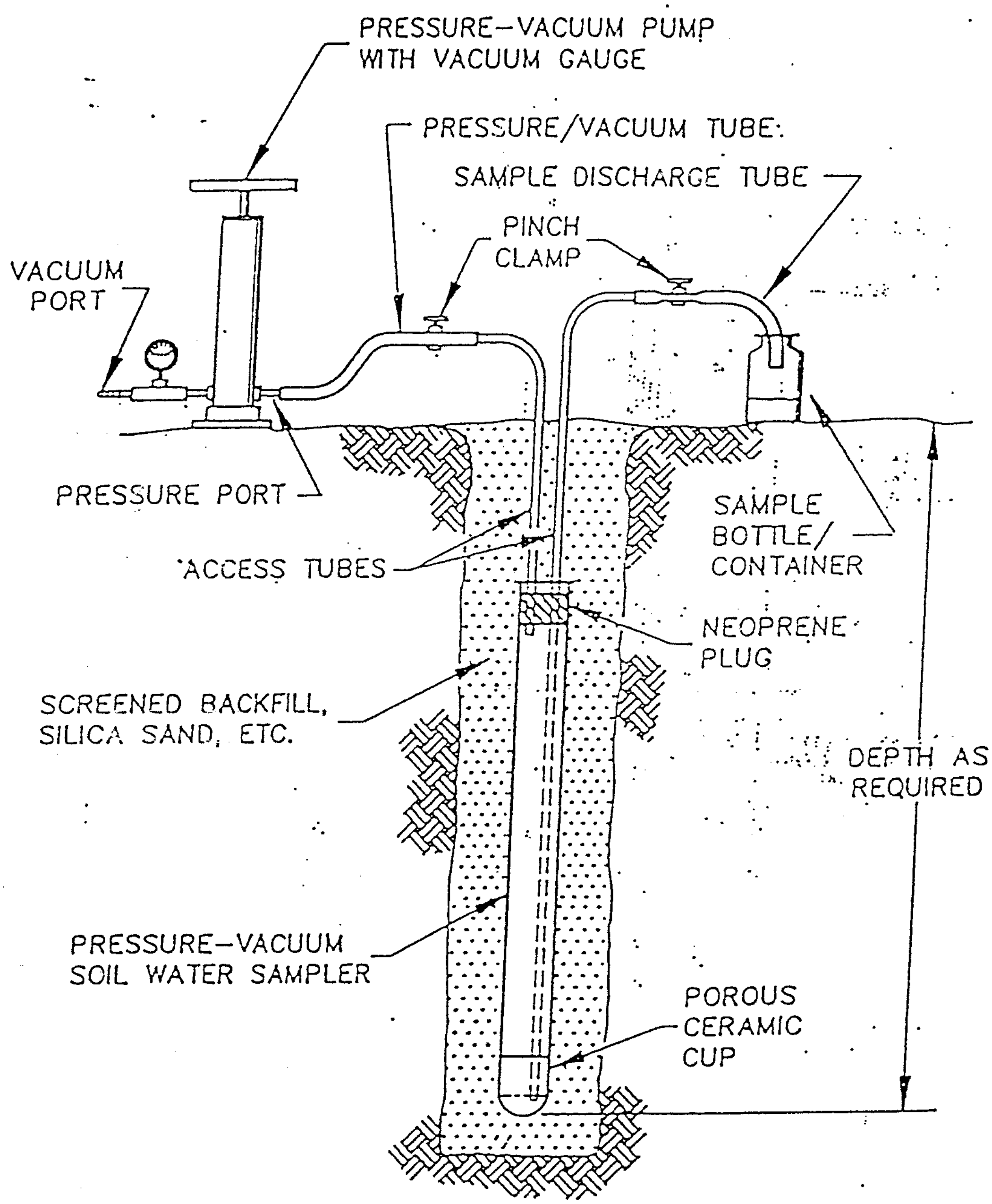
Reviewed by ______ Date ______

Attachment 3

Schematic Drawing of a Multilevel Sampling (MLS) Well



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 DHGT and/or WQU . Copy 1 retained by FENG . Copy 2 forwarded to client	. DHGT/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.

ALH 70

APPENDIX E

Probable Closure Costs

COST ESTIMATE

WORK SHEET A:

CLOSURE ACTIVITIES

NOTES:
1) This worksheet is to be submitted as part of the C/PC Plan.
2) Provide a cost for all activities which apply.
3) Additional cost information may be attched as needed.

1. Establishing final cover:

A. Top soil

1.	Quantity needed (cu. yd.)	62,500
2.	Excavation unit cost ($/cu. yd.)	$3
3.	Excavation cost (1. x 2.)	$187,500
4.	Placement and spreading unit cost ($/cu. yd.)	$7
5.	Placement cost (1. x 4.)	$437,500
*TOTAL:	Top soil (3. + 5.)	$625,000

B. Landfill cap

1. On–site Clay

a.	Quantity needed (cu. yd.)	
b.	Excavation unit cost ($/cu. yd.)	
c.	Excavation cost (a. x b.)	
d.	Placement/ spreading unit cost ($/cu. yd.)	
e.	Placement cost (a. x d.)	
f.	Compaction unit cost ($/cu. yd.)	
g.	Compaction cost (a. x f.)	
*TOTAL:	On–site clay (c. + e. + g.)	N/A

2. Off–site clay

a.	Quantity needed (cu. yd.)	62,500
b.	Purchase unit cost ($/cu. yd.)	$1
c.	Purchase cost (a. x b.)	$62,500
d.	Delivery unit cost ($/cu. yd.)	$4
e.	Delivery cost (a. x d.)	$250,000
f.	Placement/ spreading unit cost ($/cu. yd.)	$2
g.	Placement cost (a. x f.)	$125,000
h.	Compaction unit cost ($/cu. yd.)	$1
i.	Compaction cost (a. x h.)	$62,500
*TOTAL:	Off–site clay (c. + e. + g. + i.)	$500,000

3. Quality control/testing of clay

a.		
b.		
c.		
*TOTAL:	Clay testing (c.) (L.S.)	$20,000

C.	Synthetic membrane	
1.	Quantity needed (sq. yd.)	
2.	Purchase unit cost ($/sq. yd.)	
3.	Purchase cost (1. x 2.)	
4.	Installation unit cost ($/sq. yd.)	
5.	Installation cost (1. x 4.)	
*TOTAL:	Synthetic membrane (3. + 5.)	N/A
D.	Geotextile filter fabric	
1.	Quantity needed (sq. yd.)	
2.	Purchase unit cost ($/sq. yd.)	
3.	Purchase cost (1. x 2.)	
4.	Installation unit cost ($/sq. yd.)	
5.	Installation cost (1. x 4.)	
*TOTAL:	Geotextile filter fabric (3. + 5.)	N/A
TOTAL for establishing final cover (*): (A. + B. + C. + D.)		$1,145,000

2. Establishing vegetation cover:

A.	Labor ($/acre)	$350.00
B.	Seeding ($/acre)	$350.00
C.	Fertilizing ($/acre)	$250.00
D.	Mulching ($/acre)	$50.00
E.	Number of acres	69
TOTAL for establishing vegetation cover: E. x (A. + B. + C. + D.)		$69,000

3. Establishing or completing a system to minimize and control erosion/sedimentation:

A.	Sediment pond	
1.	Excavation/construction ($)	
2.	Materials (e.g. pipe, riprap) ($)	
*TOTAL:	(1. + 2.)	N/A
B.	Diversion ditch	
1.	Construction ($)	
2.	Materials ($)	
*TOTAL:	(1. + 2.)	N/A
C.	Temporary structures (e.g. silt fence, swales)	
1.	Construction ($)	
2.	Materials ($)	
*TOTAL:	(1. + 2.)	N/A
TOTAL for establishing or completing a system to minimize and control erosion and sedimentation (*): (A. + B. + C.)		N/A

4. Establishing or completing leachate collection removal, and treatment system:

A. Installation

1.	Number of feet	______
2.	Piping system unit cost ($/ft)	______
3.	Piping system cost (1. x 2.)	______
4.	Storage tanks ($)	______
5.	Pumps ($)	______

TOTAL for establishing or completing leachate system: (3. + 4. + 5.) — N/A

5. Establishing or completing a system to collect or vent gases:

A. Installation

1.	Materials (e.g. piping)	______
2.	Equipment (e.g. pumps)	______
3.	Labor (e.g. drilling)	______

TOTAL for establishing or completing a system to collect or vent gases: (1. + 2. + 3.) — N/A

6 Establishing or completing groundwater/surface water monitoring system:

A. Installation

1.	Number of wells	______
2.	Drilling unit cost ($/well)	______
3.	Drilling Cost (1. x 2.)	______
4.	Materials unit cost (e.g. casing) ($/well)	______
5.	Materials (1. x 4.)	______
6.	Equipment (e.g. pumps)	______
7.	Labor	______

TOTAL for establishing or completing groundwater monitoring system: (3. + 5. + 6. + 7.) — N/A

TOTAL CLOSURE COSTS: (Sum of TOTALS for Sections 1. thru 6.) — $1,214,000

COST ESTIMATE

WORK SHEET B:

POST CLOSURE ACTIVITIES

Notes:

1) This worksheet is to be submitted as part of the C/CP Plan.

2) The facility will be maintained and monitored for 30 years after final closure fo Class I and II landfills and 2 years after final closure of Class III and IV landfills.

3) Fill in blanks for all activities which apply.

4) All costs are to be calculated on an ANNUAL BASIS.

1. Survey inspections to confirm final grade and drainage are maintained:

A.	Transportation	INCLUSIVE
B.	Labor	INCLUSIVE
	TOTAL for Surveying inspections: (A. + B.)	$12,000

2. Maintain healthy vegetation:

A.	Transportation	INCLUSIVE
B.	Labor	$3,000
C.	Seeding	$3,000
D.	Fertilizing	$2,100
E.	Mulching	$500
F.	Rodent Control	N/A
G.	Mowing	$12,000
	TOTAL for Maintaining healthy vegetation: (A. + B. + C. + D. + E. + F. + G.)	$20,600

3. Maintain the drainage facilities, sediment ponds and other erosion/sedimentation control measures:

A.	Transportation	N/A
B.	Labor	6,000
C.	Cleaning out of systems	6,000
D.	Repair of gullies or rills	
1.	Soil aquistion	
a.	Quantity	1,200
b.	Purchase unit cost ($/cu. yd.)	$1
c.	Purchase cost (a. x b.)	$1,200
d.	Delivery unit cost ($/cu. yd.)	$4
e.	Delivery cost (a. x d.)	$4,800
	Total 1: (c. + e.)	$6,000
2.	Placement/spreading/compaction	$2,500
3.	Revegetation	$4,000
	Total D: (1. + 2. + 3.)	$12,500
	TOTAL for Maintaining drainage: (A. + B. + C. + D.)	$24,500

4. Maintain and monitor the leachate collection, removal and treatment system:

A. Treatment of leachate

1. On–site	
a. Quantity (cu. yd.)	
b. Treatment unit cost ($/cu. yd.)	
c. Treatment costs (a. x b.)	
d. Sewer discharge unit cost	
e. Discharge cost (a. x d.)	
Total 1: On–site (c. + e.)	N/A
2. Off–site	
a. Quantity (cu. yd.)	
b. Hauling unit cost ($/cu. yd.)	
c. Hauling cost (a. x b.)	
d. Treatment unit cost ($/cu. yd.)	
e. Treatment cost (a. x d.)	
Total 2: Off–site (c. + e.)	N/A
*TOTAL: (1. or 2. Total)	N/A

B. Maintenance of leachate collection system:

1. Transportation	
2. Labor	
3. Repairs/Materials (e.g. below)	
a. Pumps	
b. Cleaning out system	
c. Leak detection	
d. Other	
Total 3: (a. + b. + c. + d.)	
*TOTAL: (1. + 2. + 3.)	N/A

TOTAL for Monitoring and maintaining leachate system (*): (A. + B.)	N/A

5. Maintain and monitor the gas collection or venting system:

A. Transportation	
B. Labor	
C. Repairs/Materials (e.g. below)	
1. Cleaning	
2. Caps	
3. Other	
Total: (1. + 2. + 3.)	

TOTAL for Maintaining and monitoring gas control system: (A. + B. + C.)	N/A

6. Maintain and monitor the groundwater and/or surface water monitoring system:

A.	Monitoring of groundwater systems:		
	1.	Number of wells/springs	5
	2.	Number of samples/well	2
	3.	Unit cost of analysis	$1,000
	4.	Cost of sampling + analysis (1. x 2. x 3.)	$10,000
	5.	Labor cost per well	INCLUSIVE
	6.	Labor costs (1. x 5.)	INCLUSIVE
	*TOTAL A:	(4. + 6.)	$10,000
B.	Inspection and maintenance of system:		
	1.	Transportation	N/A
	2.	Labor	$4,000
	3.	Repairs/Materials	
		a. Caps	$400
		b. Tubing	$400
		c. Pumps	$400
		d. Well replacement	$400
		e. Other	$400
		Total 3: (a. + b. + c. + d. + e.)	$2,000
	*TOTAL B:	(1. + 2. + 3.)	$6,000

TOTAL for Maintaining and monitoring groundwater systems (*): (A. + B.) — $16,000

TOTAL POST CLOSURE COSTS:

Annual Basis: (Sum of Sections 1. thru 6.) — $73,100

Inflation Rate Utilized: — 5.00%

30 Year Basis: (Annual cost) (Inflation rate) (30 yrs.) — 4,856,680

NOTE: If desired because of anticipated cost or inflation fluctuations, we recommend submitting a separate sheet with the year–by–year annual costs (30 year breakdown) for maintaining and monitoring facility.

APPENDIX F

BACKGROUND GROUNDWATER MONITORING REPORT

STORET RETRIEVAL DATE 93/07/09 PGM=ALLPARM
W47313
36 01 25.0 087 59 07.0 2
JOHNSONVILLE STEAM PLANT GROUNDWATER
47085 TENNESSEE HUMPHREYS
TENNESSEE RIVER BASIN 040803
WELL NO. B5
131TVAC 900331 06040005
0000 METERS DEPTH

/TYPA/AMBNT/WELL

			INITIAL DATE	90/03/13	90/03/13	90/12/11	91/03/05	91/06/24	91/09/23	91/09/23	91/12/03	91/12/03
			INITIAL TIME	0705	0706	0945	0953	1025	0823	0835	0910	0911
			MEDIUM	WATER	WATER	WATER	WATER	WATER	WATER	WATER	WATER	WATER
00008	LAB	IDENT.	NUMBER	2980	2981	18919	4395	12343	18479	18443	20603	20604
00010	WATER	TEMP	CENT	14.0		13.5	13.3	16.2		15.3	14.1	
00090	REDOX	ORP	MV	637		208	382	401		381	568	
00094	CNDUCTVY	FIELD	MICROMHO	254		408	199	264		249	261	
00300	DO		MG/L	3.2		1.9	4.2	264.0		2.6	3.5	
00400	PH		SU	5.70		5.40	4.80	5.20		5.20	5.40	
00431	T ALK	FIELD	MG/L	56		19	19	10		2	14	
00435	T ACDITY	CACO3	MG/L								105	
00530	RESIDUE	TOT NFLT	MG/L	12000	2400	1000	820	120	6000		1000	2000
00680	T ORG C	C	MG/L	1.4	1.3	1.6	3.5	1.1	1.4		.8	.8
00685	T. INORG	C	MG/L								19.0	20.0
00915	CALCIUM	CA,DISS	MG/L					20.0		19.0		
00916	CALCIUM	CA-TOT	MG/L	37.0	17.0	15.0	14.0	20.0	46.0		28.0	29.0
00925	MGNSIUM	MG,DISS	MG/L					4.7		4.1		
00927	MGNSIUM	MG,TOT	MG/L	10.0	4.6	4.2	3.4	5.5	14.0		9.2	9.4
00929	SODIUM	NA,TOT	MG/L	28.00	24.00	22.00	19.00	20.00	20.00		19.00	19.00
00937	PTSSIUM	K,TOT	MG/L	4.70	2.30	1.90	1.50	7.20	2.30		1.50	1.50
00940	CHLORIDE	TOTAL	MG/L	19	20	20	16	26	23		29	29
00945	SULFATE	SO4-TOT	MG/L	50	51	88	42	53	58		62	58
00946	SULFATE	SO4-DISS	MG/L					45.0		52.0		
01000	ARSENIC	AS,DISS	UG/L					1K		5		
01002	ARSENIC	AS,TOT	UG/L	42	6	1K	4	1K	3		5	5
01005	BARIUM	BA,DISS	UG/L					50		60		
01007	BARIUM	BA,TOT	UG/L	2600	360	290	140	140	760		250	270
01022	BORON	B,TOT	UG/L	530	50K	100	70	50K	50K		50K	50K
01027	CADMIUM	CD,TOT	UG/L	13	12	10	5	2	6		2	2
01034	CHROMIUM	CR,TOT	UG/L	260	23	12	15	8	26		31	28
01040	COPPER	CU,DISS	UG/L					10K		50		
01042	COPPER	CU,TOT	UG/L	370	30	30	200	20	210		130	130
01045	IRON	FE,TOT	UG/L	91000	12000	8200	6400	5900	36000		16000	14000
01046	IRON	FE,DISS	UG/L					30		610		
01051	LEAD	PB,TOT	UG/L	190	9	10	18	5	22		14	15
01055	MANGNESE	MN	UG/L	18000.0	8100.0	3500.0	3200.0	1600.0	6000.0		2800.0	2700.0
01056	MANGNESE	MN,DISS	UG/L					1500.0		1700.0		
01062	MOLY	MO,TOT	UG/L	20K	20K	20K	20K	20K	30			

(SAMPLE CONTINUED ON NEXT PAGE)

STORET RETRIEVAL DATE 93/07/09 PGM=ALLPARM
W47313
36 01 25.0 087 59 07.0 2
JOHNSONVILLE STEAM PLANT GROUNDWATER
47085 TENNESSEE HUMPHREYS
TENNESSEE RIVER BASIN 040803
WELL NO. B5 /TYPA/AMBNT/WELL
131TVAC 900331 06040005
0000 METERS DEPTH

(SAMPLE CONTINUED FROM PREVIOUS PAGE)

INITIAL DATE		90/03/13	90/03/13	90/12/11	91/03/05	91/06/24	91/09/23	91/09/23	91/12/03	91/12/03
INITIAL TIME		0705	0706	0945	0953	1025	0823	0835	0910	0911
MEDIUM		WATER	WATER	WATER	WATER	WATER	WATER	WATER	WATER	WATER
01067 NICKEL	NI,TOTAL UG/L	480	120	110	87	130	240		170	170
01082 STRONTUM	SR,TOT UG/L	1000	130	120	50K	50K	240		310	880
01085 VANADIUM	V,DISS UG/L					10K				
01087 VANADIUM	V,TOT UG/L	110	10	10K	20K	10K	30		30	10
01090 ZINC	ZN,DISS UG/L					260		250		
01092 ZINC	ZN,TOT UG/L	1100	210	230	230	260	710		430	440
01097 ANTIMONY	SB,TOT UG/L	1K	1K	1K	3	1K	1K			
01105 ALUMINUM	AL,TOT UG/L		9800	6800	5200	8100	37000		20000	20000
01106 ALUMINUM	AL,DISS UG/L					240		780		
01132 LITHIUM	LI,TOT UG/L	30	20	10K	10K	20	20		10K	10K
01142 SILICON	SI,TOT UG/L	54000	17000	15000	16000	18000	60000		19000	20000
01147 SELENIUM	SE,TOT UG/L	1K	1K	1K	1K	1K	2		1K	1K
46570 CAL HARD	CA MG MG/L	134	61	55	49	73	172		108	111
70300 RESIDUE	DISS-180 C MG/L	270	260	220	210	200	300		270	430
72004 PPG/FLOW	PRIOR TO SMP-MINS	20.0	20.0	10.0	8.0	10.0		15.0	10.0	
72008 TOT DPTH	OF WELL FT	36.2	36.2	36.2	36.2	36.2		36.2	36.2	
72015 TOP DPTH	OF SMPLE FT				35.0	35.0		25.0	30.0	
72037 PUMPING	RATE GPM			.53	.79	.66		.66	.66	
72109 DEPTH TO	WATER FR MPFT	15.30	15.30	21.70	14.60	15.90		20.20	21.50	
74041 WQF	SAMPLE UPDATED	900531	900531	910222	910503	911011	920229	920229	920724	920724
84002 CODE	GENERAL REMARKS	D1	D2						D1	D2
84068 SERIES	CODE ALPHA	B5	B5	B5	B5	B5		B5	B5	B5

INITIAL DATE		92/03/17	92/06/09	92/09/02	92/12/14	93/03/15	93/06/08
INITIAL TIME		0700	0630	1015	1510		1500
MEDIUM		WATER	WATER	WATER	WATER	WATER	WATER
00008 LAB	IDENT. NUMBER	2765	6932	12553	17404		
00010 WATER	TEMP CENT	14.4	16.1	15.4	15.3		15.8
00090 REDOX	ORP MV	346	568	334	577		401
00094 CNDUCTVY	FIELD MICROMHO	252	272	270	255		250
00300 DO	MG/L	3.4	3.9	3.5	3.2		3.6
00400 PH	SU	5.20	5.14	5.20	5.40		5.09
00431 T ALK	FIELD MG/L	10	10	10	21		6
00435 T ACDITY	CACO3 MG/L	100	45				
00437 ACIDITY	FROM CO2 MG/L			81	65		92
00530 RESIDUE	TOT NFLT MG/L	1900	3200	300	150		
00680 T ORG C	C MG/L	.8	1.4	4.4	.8		
00685 T. INORG	C MG/L	24.0	25.0	37.0	23.0		

(SAMPLE CONTINUED ON NEXT PAGE)

STORET RETRIEVAL DATE 93/07/09 PGM=ALLPARM

W47313
36 01 25.0 087 59 07.0 2
JOHNSONVILLE STEAM PLANT GROUNDWATER
47085 TENNESSEE HUMPHREYS
TENNESSEE RIVER BASIN 040803 /TYPA/AMBNT/WELL
WELL NO. B5
131TVAC 900331 06040005
0000 METERS DEPTH

(SAMPLE CONTINUED FROM PREVIOUS PAGE)

INITIAL DATE			92/03/17	92/06/09	92/09/02	92/12/14	93/03/15	93/06/08
INITIAL TIME			0700	0630	1015	1510		1500
MEDIUM			WATER	WATER	WATER	WATER	WATER	WATER
00916 CALCIUM	CA-TOT	MG/L	25.0	26.0	19.0	22.0		
00927 MGNSIUM	MG,TOT	MG/L	3.0	7.5	5.0	4.6		
00929 SODIUM	NA,TOT	MG/L	18.00	21.00	21.00	21.00		
00937 PTSSIUM	K,TOT	MG/L	1.40	3.40	1.60	1.40		
00940 CHLORIDE	TOTAL	MG/L	28	32	33	34		
00945 SULFATE	SO4-TOT	MG/L	68	440	20	47		
01002 ARSENIC	AS,TOT	UG/L	7	4	1	1		
01007 BARIUM	BA,TOT	UG/L	440	410	110	20		
01022 BORON	B,TOT	UG/L	230	50K	50K	500K		
01027 CADMIUM	CD,TOT	UG/L	3	2	2	1		
01034 CHROMIUM	CR,TOT	UG/L	45	34	5	4		
01042 COPPER	CU,TOT	UG/L	100	60	20	10K		
01045 IRON	FE,TOT	UG/L	33000	16000	4200	1300		
01051 LEAD	PB,TOT	UG/L	37	20	5	2		
01055 MANGNESE	MN	UG/L	1900.0	1400.0	770.0	460.0		
01062 MOLY	MO,TOT	UG/L	20K			20K		
01067 NICKEL	NI,TOTAL	UG/L	180	140	95	86		
01082 STRONTUM	SR,TOT	UG/L	160	130	50K	50K		
01087 VANADIUM	V,TOT	UG/L	60			10K		
01092 ZINC	ZN,TOT	UG/L	450	350	260	250		
01097 ANTIMONY	SB,TOT	UG/L				1K		
01105 ALUMINUM	AL,TOT	UG/L	98000	22000	7500	2600		
01132 LITHIUM	LI,TOT	UG/L	10K	20	10K	10K		
01142 SILICON	SI,TOT	UG/L	170000	37000	19000			
01147 SELENIUM	SE,TOT	UG/L	7			2		
01350 TURBID		SEVERITY						2
04186 WELL WTR	PURGVOLM	LITER						30.000
04187 WELL WTR	INTLVOLM	LITER						11.770
04188 WELLCSNG	INSIDE	DIMTR MM						51.0
04189 ELEVATIN	ABOVE SL	GRDWTR M					112.270	
04190 SCREEN	BOTTOM	FR MP M						11.030
04191 SCREEN	TOP	FR MP M						8.070
04192 TOT DPTH	OF SAMPL	FR MP M						10.060
04193 PUMPING	RATE	LPM						2.000
04194 DEPTHTOT	FR BELOW	MP M						11.030
04195 DEPTH	WTR LEV	FR MP M					4.950	5.220
46570 CAL HARD	CA MG	MG/L	75	96	68	74		
70300 RESIDUE	DISS-180 C	MG/L	110	240	230	200		

(SAMPLE CONTINUED ON NEXT PAGE)

STORET RETRIEVAL DATE 93/07/09 PGM=ALLPARM
W47313
36 01 25.0 087 59 07.0 2
JOHNSONVILLE STEAM PLANT GROUNDWATER
47085 TENNESSEE HUMPHREYS
TENNESSEE RIVER BASIN 040803
WELL NO. B5 /TYPA/AMBNT/WELL
131TVAC 900331 06040005
0000 METERS DEPTH

(SAMPLE CONTINUED FROM PREVIOUS PAGE)

INITIAL DATE			92/03/17	92/06/09	92/09/02	92/12/14	93/03/15	93/06/08
INITIAL TIME			0700	0630	1015	1510		1500
MEDIUM			WATER	WATER	WATER	WATER	WATER	WATER
72004 PPG/FLOW	PRIOR TO	SMP-MINS	15.0	15.0	20.0	20.0		15.0
72008 TOT DPTH	OF WELL	FT	36.2	36.2	36.2	36.2		
72015 TOP DPTH	OF SMPLE	FT		26.3				
72037 PUMPING	RATE	GPM	2.50	2.50	2.00	2.00		
72109 DEPTH TO	WATER	FR MPFT	17.60	18.54	21.03	22.47		
74041 WQF	SAMPLE	UPDATED	920724	920724	930115	930219	930414	930622
84068 SERIES	CODE	ALPHA	B5	B5	B5	B5	B5	B5

STORET RETRIEVAL DATE 93/07/09 PGM=ALLPARM
W47362
36 01 27.0 087 58 50.0 2
JOHNSONVILLE STEAM PLANT GROUNDWATER
47085 TENNESSEE HUMPHREYS
TENNESSEE RIVER BASIN 040803
WELL NO. B6 /TYPA/AMBNT/WELL
131TVAC 911221 06040005
0000 METERS DEPTH

INITIAL DATE			92/03/18	92/06/09	92/09/01	92/12/14	93/03/16	93/06/09
INITIAL TIME			1125	1540	1705	1720	0830	0902
MEDIUM			WATER	WATER	WATER	WATER	WATER	WATER
00008 LAB	IDENT.	NUMBER	2766	6942	12554	17405	2015	
00010 WATER	TEMP	CENT	14.8	20.1	21.6	19.5	14.4	16.5
00090 REDOX	ORP	MV	149	430	361	332	325	292
00094 CNDUCTVY	FIELD	MICROMHO	861	571	594	719	567	700
00300 DO		MG/L	.6	1.8	1.4	.7	.8	.6
00400 PH		SU	5.46	5.49	5.70	5.40	5.60	5.51
00431 T ALK	FIELD	MG/L	10	17	14	14	32	7
00435 T ACDITY	CACO3	MG/L	58	21				
00437 ACIDITY	FROM CO2	MG/L			35	55	38	47
00530 RESIDUE	TOT NFLT	MG/L	4000	13000	4500	2900	2600	
00680 T ORG C	C	MG/L	1.8	8.1	7.3	2.7	1.0	
00685 T. INORG	C	MG/L	16.0	10.0	12.0	10.0	15.0	
00916 CALCIUM	CA-TOT	MG/L	140.0	50.0	80.0	96.0	74.0	
00927 MGNSIUM	MG,TOT	MG/L	4.9	26.0	16.0	13.0	10.0	
00929 SODIUM	NA,TOT	MG/L	11.00	4.20	7.40	7.50	6.00	
00937 PTSSIUM	K,TOT	MG/L	6.90	30.00	29.00	8.30	6.70	
00940 CHLORIDE	TOTAL	MG/L	6	3	3	5	4	
00945 SULFATE	SO4-TOT	MG/L	280	100	170	400	190	
01002 ARSENIC	AS,TOT	UG/L	530	1300	390	250	210	
01007 BARIUM	BA,TOT	UG/L	270	840	340	170	110	
01022 BORON	B,TOT	UG/L	5100	1200	2400	2900	1600	
01027 CADMIUM	CD,TOT	UG/L	5	21	5	2	1	
01034 CHROMIUM	CR,TOT	UG/L	9	240	96	59	28	
01042 COPPER	CU,TOT	UG/L	370	130	390	210	140	
01045 IRON	FE,TOT	UG/L	270000	980000	290000	170000	110000	
01051 LEAD	PB,TOT	UG/L	113	250	11	77	33	
01055 MANGNESE	MN	UG/L	2500.0	2000.0	1600.0	1600.0	1500.0	
01062 MOLY	MO,TOT	UG/L	20K			330	250	
01067 NICKEL	NI,TOTAL	UG/L	720	2000	58	370	110	
01082 STRONTUM	SR,TOT	UG/L	590	80K	400	420	190	
01087 VANADIUM	V,TOT	UG/L	490			310	210	
01092 ZINC	ZN,TOT	UG/L	750	2200	820	360	280	
01097 ANTIMONY	SB,TOT	UG/L				1K	2	
01105 ALUMINUM	AL,TOT	UG/L	73000	230000	81000	36000	20000	
01132 LITHIUM	LI,TOT	UG/L	10K	90	90	10K	10K	

(SAMPLE CONTINUED ON NEXT PAGE)

STORET RETRIEVAL DATE 93/07/09 PGM=ALLPARM
W47362
36 01 27.0 087 58 50.0 2
JOHNSONVILLE STEAM PLANT GROUNDWATER
47085 TENNESSEE HUMPHREYS
TENNESSEE RIVER BASIN 040803 /TYPA/AMBNT/WELL
WELL NO. B6
131TVAC 911221 06040005
0000 METERS DEPTH

(SAMPLE CONTINUED FROM PREVIOUS PAGE)

INITIAL DATE			92/03/18	92/06/09	92/09/01	92/12/14	93/03/16	93/06/09
INITIAL TIME			1125	1540	1705	1720	0830	0902
MEDIUM			WATER	WATER	WATER	WATER	WATER	WATER
01142 SILICON	SI,TOT	UG/L	21000	9000	2300			
01147 SELENIUM	SE,TOT	UG/L	24			16	1K	
01350 TURBID		SEVERITY					4	4
04186 WELL WTR	PURGVOLM	LITER					26.000	28.000
04187 WELL WTR	INTLVOLM	LITER					9.750	9.970
04188 WELLCSNG	INSIDE	DIMTR MM					51.0	51.0
04190 SCREEN	BOTTOM	FR MP M					8.530	8.530
04191 SCREEN	TOP	FR MP M					5.480	5.480
04192 TOT DPTH	OF SAMPL	FR MP M					6.000	7.000
04193 PUMPING	RATE	LPM					1.500	1.000
04194 DEPTHTOT	FR BELOW	MP M					8.530	8.530
04195 DEPTH	WTR LEV	FR MP M					3.700	3.610
46570 CAL HARD	CA MG	MG/L	370	232	266	293	226	
70300 RESIDUE	DISS-180	C MG/L	460	100	230	470	330	
72004 PPG/FLOW	PRIOR TO	SMP-MINS	25.0	20.0	10.0	20.0	15.0	32.0
72008 TOT DPTH	OF WELL	FT	27.6	27.6	27.6	28.0		
72015 TOP DPTH	OF SMPLE	FT		19.7				
72037 PUMPING	RATE	GPM	2.50	2.50	2.00	2.00		
72109 DEPTH TO	WATER	FR MPFT	11.70	11.75	12.47	12.53		
74041 WQF	SAMPLE	UPDATED	920724	920724	930115	930219	930506	930622
84068 SERIES	CODE	ALPHA	B6	B6	B6	B6	B6	B6

STORET RETRIEVAL DATE 93/07/09 PGM=ALLPARM
W47363
36 01 34.0 087 58 43.0 2
JOHNSONVILLE STEAM PLANT GROUNDWATER
47085 TENNESSEE HUMPHREYS
TENNESSEE RIVER BASIN 040803
WELL NO. B7 /TYPA/AMBNT/WELL
131TVAC 911221 06040005
0000 METERS DEPTH

	INITIAL DATE			92/09/02	92/12/15	93/03/16	93/06/08
	INITIAL TIME				0705	0715	1700
	MEDIUM			WATER	WATER	WATER	WATER
00008	LAB	IDENT.	NUMBER		17406	2016	
00010	WATER	TEMP	CENT		15.9	14.8	20.7
00090	REDOX	ORP	MV		523	275	258
00094	CNDUCTVY	FIELD	MICROMHO		242	233	246
00300	DO		MG/L		1.6	.9	.6
00400	PH		SU		7.10	6.90	6.86
00431	T ALK	FIELD	MG/L		112	112	114
00437	ACIDITY	FROM CO2	MG/L		7	7	24
00530	RESIDUE	TOT NFLT	MG/L		72	2300	
00680	T ORG C	C	MG/L		1.1	.6	
00685	T. INORG	C	MG/L		30.0	34.0	
00916	CALCIUM	CA-TOT	MG/L		43.0	47.0	
00927	MGNSIUM	MG,TOT	MG/L		4.4	6.2	
00929	SODIUM	NA,TOT	MG/L		3.70	3.60	
00937	PTSSIUM	K,TOT	MG/L		2.90	4.60	
00940	CHLORIDE	TOTAL	MG/L		3	4	
00945	SULFATE	SO4-TOT	MG/L		14	15	
01002	ARSENIC	AS,TOT	UG/L		10	23	
01007	BARIUM	BA,TOT	UG/L		10	140	
01022	BORON	B,TOT	UG/L		500K	500K	
01027	CADMIUM	CD,TOT	UG/L		.4	4	
01034	CHROMIUM	CR,TOT	UG/L		6	94	
01042	COPPER	CU,TOT	UG/L		10K	250	
01045	IRON	FE,TOT	UG/L		7100	79000	
01051	LEAD	PB,TOT	UG/L		10	30	
01055	MANGNESE	MN	UG/L		900.0	780.0	
01062	MOLY	MO,TOT	UG/L		20K	100	
01067	NICKEL	NI,TOTAL	UG/L		23	99	
01082	STRONTUM	SR,TOT	UG/L		50K	130	
01087	VANADIUM	V,TOT	UG/L		10K	160	
01092	ZINC	ZN,TOT	UG/L		40	770	
01097	ANTIMONY	SB,TOT	UG/L		1K	1K	
01105	ALUMINUM	AL,TOT	UG/L		2900	28000	
01132	LITHIUM	LI,TOT	UG/L		10K	10K	
01147	SELENIUM	SE,TOT	UG/L		2	1K	

(SAMPLE CONTINUED ON NEXT PAGE)

STORET RETRIEVAL DATE 93/07/09 PGM=ALLPARM
W47363
36 01 34.0 087 58 43.0 2
JOHNSONVILLE STEAM PLANT GROUNDWATER
47085 TENNESSEE HUMPHREYS
TENNESSEE RIVER BASIN 040803
WELL NO. B7 /TYPA/AMBNT/WELL
131TVAC 911221 06040005
0000 METERS DEPTH

(SAMPLE CONTINUED FROM PREVIOUS PAGE)

INITIAL DATE				92/09/02	92/12/15	93/03/16	93/06/08
INITIAL TIME					0705	0715	1700
MEDIUM				WATER	WATER	WATER	WATER
01350	TURBID		SEVERITY			3	4
04186	WELL WTR	PURGVOLM	LITER			35.000	40.000
04187	WELL WTR	INTLVOLM	LITER			17.200	17.050
04188	WELLCSNG	INSIDE	DIMTR MM			51.0	51.0
04189	ELEVATIN	ABOVE SL	GRDWTR M	115.670			
04190	SCREEN	BOTTOM	FR MP M			11.220	11.220
04191	SCREEN	TOP	FR MP M			8.380	8.380
04192	TOT DPTH	OF SAMPL	FR MP M			10.000	11.000
04193	PUMPING	RATE	LPM			1.500	1.000
04194	DEPTHTOT	FR BELOW	MP M			11.220	11.220
04195	DEPTH	WTR LEV	FR MP M	3.400		2.720	2.810
46570	CAL HARD	CA MG	MG/L		126	143	
70300	RESIDUE	DISS-180	C MG/L		90	270	
72004	PPG/FLOW	PRIOR TO	SMP-MINS		25.0	25.0	40.0
72008	TOT DPTH	OF WELL	FT		36.8		
72037	PUMPING	RATE	GPM		2.00		
72109	DEPTH TO	WATER	FR MPFT		11.58		
74041	WQF	SAMPLE	UPDATED	930305	930203	930506	930622
84068	SERIES	CODE	ALPHA	B7	B7	B7	B7

STORET RETRIEVAL DATE 93/07/09 PGM=ALLPARM
W47364
36 01 20.0 087 58 46.0 2
JOHNSONVILLE STEAM PLANT GROUNDWATER
47085 TENNESSEE HUMPHREYS
TENNESSEE RIVER BASIN 040803 /TYPA/AMBNT/WELL
WELL NO. B8
131TVAC 911221 06040005
0000 METERS DEPTH

INITIAL DATE			92/03/18	92/06/10	92/09/02	92/12/14	93/03/16	93/06/09
INITIAL TIME			1155	0645	0657	1740	0900	0800
MEDIUM			WATER	WATER	WATER	WATER	WATER	WATER
00008 LAB	IDENT.	NUMBER	2767	6943	12555	17407	2017	
00010 WATER	TEMP	CENT	17.1	17.0	17.6	17.5	14.4	19.1
00090 REDOX	ORP	MV	312	481	497	570	373	377
00094 CNDUCTVY	FIELD	MICROMHO	1370	1534	1442	1480	1475	1306
00300 DO		MG/L	.5	3.0	1.2	.6	2.0	1.1
00400 PH		SU	5.27	4.93	4.30	5.00	4.90	4.87
00431 T ALK	FIELD	MG/L	20	12	3	17	.5	.2
00435 T ACDITY	CACO3	MG/L	80	131				
00437 ACIDITY	FROM CO2	MG/L			142	184	60	57
00530 RESIDUE	TOT NFLT	MG/L	45000	47000	40000	20000	42000	
00680 T ORG C	C	MG/L	3.3	17.0	8.0	6.4	1.1	
00685 T. INORG	C	MG/L	10.0	9.0	10.0	10.0	15.0	
00916 CALCIUM	CA-TOT	MG/L	270.0	410.0	370.0	380.0	320.0	
00927 MGNSIUM	MG,TOT	MG/L	9.6	110.0	70.0	51.0	45.0	
00929 SODIUM	NA,TOT	MG/L	24.00	25.00	22.00	24.00	1.90	
00937 PTSSIUM	K,TOT	MG/L	9.40	48.00	130.00	19.00	14.00	
00940 CHLORIDE	TOTAL	MG/L	9	8	8	8	12	
00945 SULFATE	SO4-TOT	MG/L	560	900	965	110	790	
01002 ARSENIC	AS,TOT	UG/L	640	940	1100	900	480	
01007 BARIUM	BA,TOT	UG/L	1300	3500	2600	1400	1200	
01022 BORON	B,TOT	UG/L	6000	8700	7500	7100	5300	
01027 CADMIUM	CD,TOT	UG/L	1	61	35	43	26	
01034 CHROMIUM	CR,TOT	UG/L	830	870	1200	630	400	
01042 COPPER	CU,TOT	UG/L	1400	3300	2300	2000	1100	
01045 IRON	FE,TOT	UG/L	590000	180000	1500000	1200000	650000	
01051 LEAD	PB,TOT	UG/L	21	430	540	450	220	
01055 MANGNESE	MN	UG/L	4000.0	6500.0	4600.0	7000.0	4800.0	
01062 MOLY	MO,TOT	UG/L	1300			1700	910	
01067 NICKEL	NI,TOTAL	UG/L	60	2800	3200	2600	1400	
01082 STRONTUM	SR,TOT	UG/L	1200	2700	2100	2800	1200	
01087 VANADIUM	V,TOT	UG/L	1500			2000	1100	
01092 ZINC	ZN,TOT	UG/L	3200	7400	5500	5800	3000	
01097 ANTIMONY	SB,TOT	UG/L				1K	1K	
01105 ALUMINUM	AL,TOT	UG/L	240000	810000	590000	330000	160000	
01132 LITHIUM	LI,TOT	UG/L	10K	160	520	30	20	

(SAMPLE CONTINUED ON NEXT PAGE)

STORET RETRIEVAL DATE 93/07/09 PGM=ALLPARM
W47364
36 01 20.0 087 58 46.0 2
JOHNSONVILLE STEAM PLANT GROUNDWATER
47085 TENNESSEE HUMPHREYS
TENNESSEE RIVER BASIN 040803 /TYPA/AMBNT/WELL
WELL NO. B8
131TVAC 911221 06040005
0000 METERS DEPTH

(SAMPLE CONTINUED FROM PREVIOUS PAGE)

INITIAL DATE			92/03/18	92/06/10	92/09/02	92/12/14	93/03/16	93/06/09
INITIAL TIME			1155	0645	0657	1740	0900	0800
MEDIUM			WATER	WATER	WATER	WATER	WATER	WATER
01142 SILICON	SI,TOT	UG/L	8600	19000	5200			
01147 SELENIUM	SE,TOT	UG/L	11			20	12	
01350 TURBID		SEVERITY					4	4
04186 WELL WTR	PURGVOLM	LITER					18.000	16.000
04187 WELL WTR	INTLVOLM	LITER					5.870	5.890
04188 WELLCSNG	INSIDE	DIMTR MM					51.0	51.0
04190 SCREEN	BOTTOM	FR MP M					11.580	11.580
04191 SCREEN	TOP	FR MP M					8.530	8.530
04192 TOT DPTH	OF SAMPL	FR MP M					10.000	10.500
04193 PUMPING	RATE	LPM					1.500	.800
04194 DEPTHTOT	FR BELOW	MP M					11.580	11.580
04195 DEPTH	WTR LEV	FR MP M					8.670	8.680
46570 CAL HARD	CA MG	MG/L	714	1477	1212	1159	984	
70300 RESIDUE	DISS-180	C MG/L	720	1300	1300	1200	1300	
72004 PPG/FLOW	PRIOR TO	SMP-MINS	15.0	10.0	5.0	15.0	15.0	23.0
72008 TOT DPTH	OF WELL	FT	36.9	36.9	36.9	38.0		
72015 TOP DPTH	OF SMPLE	FT		32.8				
72037 PUMPING	RATE	GPM	2.50	2.50	2.00	2.00		
72109 DEPTH TO	WATER	FR MPFT	27.88	28.61	29.43	29.36		
74041 WQF	SAMPLE	UPDATED	920724	920724	930115	930219	930506	930622
84068 SERIES	CODE	ALPHA	B8	B8	B8	B8	B8	B8

STORET RETRIEVAL DATE 93/07/09 PGM=ALLPARM
W47302
36 01 27.0 087 58 18.0 2
JOHNSONVILLE STEAM PLANT GROUNDWATER
47085 TENNESSEE HUMPHREYS
TENNESSEE RIVER BASIN 040803 /TYPA/AMBNT/WELL
WELL NO. B9
131TVAC 900317 06040005
0000 METERS DEPTH

INITIAL DATE			90/03/12	90/06/19	90/06/19	90/09/04	90/12/11	91/03/05	91/06/25	91/06/25	91/09/24
INITIAL TIME			1250	1025	1026	1335	1045	1030	1310	1311	1120
MEDIUM			WATER	WATER	WATER	WATER	WATER	WATER	WATER	WATER	WATER
00008 LAB	IDENT.	NUMBER	2973	7783	7784	13730	18920	4396	12344	12345	18480
00010 WATER	TEMP	CENT	16.0	17.9		20.0	14.9	14.1	17.2		15.9
00090 REDOX	ORP	MV	388	377		209	407	390	400		454
00094 CNDUCTVY	FIELD	MICROMHO	98	76		74	67	56	110		90
00300 DO		MG/L	6.4	6.5		6.1	7.5	7.8	7.2		6.5
00400 PH		SU	6.10	5.80		5.70	5.70	5.80	6.10		5.80
00431 T ALK	FIELD	MG/L	51	47	49	39	30	61	55		38
00530 RESIDUE	TOT NFLT	MG/L	3700	860	790	31	150	54	250	220	39
00680 T ORG C	C	MG/L	2.3	1.3	1.3	1.0	.5	.5	1.0	1.2	.6
00915 CALCIUM	CA,DISS	MG/L							15.0	15.0	11.0
00916 CALCIUM	CA-TOT	MG/L	23.0	16.0	18.0	11.0	8.7	51.0	20.0	16.0	9.9
00925 MGNSIUM	MG,DISS	MG/L							3.4	3.3	3.2
00927 MGNSIUM	MG,TOT	MG/L	6.8	6.4	4.7	3.4	3.7	3.5	5.6	4.9	3.3
00929 SODIUM	NA,TOT	MG/L	2.80	2.90	2.90	2.50	2.60	2.70	2.60	2.70	2.30
00937 PTSSIUM	K,TOT	MG/L	1.00	.64	.62	.25	.30	.41	8.10	8.70	.23
00940 CHLORIDE	TOTAL	MG/L	2	2	2	2	2	4	2	2	2
00945 SULFATE	SO4-TOT	MG/L	1K	1K	1K	1K	950	1K	2	2	1K
00946 SULFATE	SO4-DISS	MG/L							1.0K	1.0K	13.0
01002 ARSENIC	AS,TOT	UG/L	2	1K	1	1K	1K	1K	1	1	1K
01005 BARIUM	BA,DISS	UG/L							10K	10K	10K
01007 BARIUM	BA,TOT	UG/L	1400	600	450	70	70	150	160	340	110
01022 BORON	B,TOT	UG/L	250	640	540	50K	50K	50K	50K	50K	50K
01027 CADMIUM	CD,TOT	UG/L	.1K	6	22	.1	.5	.9	.3	.4	.1
01034 CHROMIUM	CR,TOT	UG/L	40	14	13	2	3	3	10	8	5
01040 COPPER	CU,DISS	UG/L							10K	10K	30
01042 COPPER	CU,TOT	UG/L	40	20	10	10	10K	10K	10K	10K	18
01045 IRON	FE,TOT	UG/L	110000	44000	30000	2800	6400	480	6100	24000	6000
01046 IRON	FE,DISS	UG/L							10K	10K	50
01051 LEAD	PB,TOT	UG/L	24	54	45	2	3	4	13	14	4
01055 MANGNESE	MN	UG/L	2200.0	930.0	660.0	82.0	140.0	43.0	1500.0	380.0	150.0
01056 MANGNESE	MN,DISS	UG/L							39.0	27.0	26.0
01062 MOLY	MO,TOT	UG/L	20K	20K	20K	20K	20K	20K	20K	20K	20K
01067 NICKEL	NI,TOTAL	UG/L	34	19	12	5	8	10	15	15	7
01082 STRONTUM	SR,TOT	UG/L	560	340	250	70	50	210	50K	140	50K
01085 VANADIUM	V,DISS	UG/L							10K	10K	

(SAMPLE CONTINUED ON NEXT PAGE)

STORET RETRIEVAL DATE 93/07/09 PGM=ALLPARM
W47302
36 01 27.0 087 58 18.0 2
JOHNSONVILLE STEAM PLANT GROUNDWATER
47085 TENNESSEE HUMPHREYS
TENNESSEE RIVER BASIN 040803 /TYPA/AMBNT/WELL
WELL NO. B9
131TVAC 900317 06040005
0000 METERS DEPTH

(SAMPLE CONTINUED FROM PREVIOUS PAGE)

INITIAL DATE			90/03/12	90/06/19	90/06/19	90/09/04	90/12/11	91/03/05	91/06/25	91/06/25	91/09/24
INITIAL TIME			1250	1025	1026	1335	1045	1030	1310	1311	1120
MEDIUM			WATER	WATER	WATER	WATER	WATER	WATER	WATER	WATER	WATER
01087 VANADIUM	V,TOT	UG/L	140	90	50	10K	10K	10K	10K	20	10
01090 ZINC	ZN,DISS	UG/L							10	10	10K
01092 ZINC	ZN,TOT	UG/L	180	140	100	40	60	10	280	60	17
01097 ANTIMONY	SB,TOT	UG/L	1K	1K	1K	1K	1K	4	1K	1K	1K
01105 ALUMINUM	AL,TOT	UG/L	53000	49000	24000	3300	5900	740	10000	24000	5800
01106 ALUMINUM	AL,DISS	UG/L							50K	60	60
01132 LITHIUM	LI,TOT	UG/L	20	10K	10K	10K	10K	10K	40	40	10K
01140 SILICON	SI,DISS	UG/L							5500	5700	5400
01142 SILICON	SI,TOT	UG/L	29000	24000	12000	5400	11000	5200	18000	33000	6700
01147 SELENIUM	SE,TOT	UG/L	1K	1	1K	1K	1K	1K	1	1K	1K
46570 CAL HARD	CA MG	MG/L	85	66	64	41	37	142	73	60	38
70300 RESIDUE	DISS-180	C MG/L	240	160	150	70	40	110	250	250	150
72004 PPG/FLOW	PRIOR TO	SMP-MINS	25.0	25.0	25.0	15.0	15.0	15.0	15.0	15.0	15.0
72008 TOT DPTH	OF WELL	FT	50.1	50.1	50.1	50.1	50.1	50.1	50.1	50.1	50.1
72015 TOP DPTH	OF SMPLE	FT		25.0	25.0	30.0	30.0	30.0	25.0	25.0	28.0
72037 PUMPING	RATE	GPM		.66	.66	.66	.66	.79	.66	.66	.66
72109 DEPTH TO	WATER	FR MPFT	18.40	21.70	21.70	26.90	25.60	20.60	17.40	17.40	21.80
74041 WQF	SAMPLE	UPDATED	900531	900824	900824	901024	910222	910503	911011	911011	920229
84002 CODE	GENERAL	REMARKS		D1	D2				D1	D2	
84068 SERIES	CODE	ALPHA	B9	B9	B9	B9	B9	B9	B9	B9	B9

INITIAL DATE			91/12/04	92/03/17	92/06/08	92/09/02	92/12/14	93/03/15	93/06/07
INITIAL TIME			1320	1150	1555	1045			1550
MEDIUM			WATER	WATER	WATER	WATER	WATER	WATER	WATER
00008 LAB	IDENT.	NUMBER	20605	2768	6933	12556			
00010 WATER	TEMP	CENT	14.4	17.1	17.5	16.1			16.3
00090 REDOX	ORP	MV	400	340	549	319			309
00094 CNDUCTVY	FIELD	MICROMHO	89	77	71	68			59
00300 DO		MG/L	7.1	6.2	6.0	6.8			6.0
00400 PH		SU	5.90	6.00	6.43	5.90			5.90
00431 T ALK	FIELD	MG/L	38	45	33	29			38
00435 T ACDITY	CACO3	MG/L	20	26	28				
00437 ACIDITY	FROM CO2	MG/L				40			71
00530 RESIDUE	TOT NFLT	MG/L	100	90	28	130			
00680 T ORG C	C	MG/L	.6	.4	.7	3.9			
00685 T. INORG	C	MG/L	17.0	18.0	21.0	21.0			
00916 CALCIUM	CA-TOT	MG/L	11.0	7.3	8.4	5.8			
00927 MGNSIUM	MG,TOT	MG/L	4.0	.5	3.3	2.8			

(SAMPLE CONTINUED ON NEXT PAGE)

STORET RETRIEVAL DATE 93/07/09 PGM=ALLPARM
W47302
36 01 27.0 087 58 18.0 2
JOHNSONVILLE STEAM PLANT GROUNDWATER
47085 TENNESSEE HUMPHREYS
TENNESSEE RIVER BASIN 040803
/TYPA/AMBNT/WELL
WELL NO. B9
131TVAC 900317 06040005
0000 METERS DEPTH

(SAMPLE CONTINUED FROM PREVIOUS PAGE)

INITIAL DATE			91/12/04	92/03/17	92/06/08	92/09/02	92/12/14	93/03/15	93/06/07
INITIAL TIME			1320	1150	1555	1045			1550
MEDIUM			WATER	WATER	WATER	WATER	WATER	WATER	WATER
00929 SODIUM	NA,TOT	MG/L	2.60	2.80	2.90	3.00			
00937 PTSSIUM	K,TOT	MG/L	.23	.20	.90	.40			
00940 CHLORIDE	TOTAL	MG/L	2	2	2	2			
00945 SULFATE	SO4-TOT	MG/L	1K	1	5	1K			
01002 ARSENIC	AS,TOT	UG/L	1K	1	1	9			
01007 BARIUM	BA,TOT	UG/L	130	50	100	100			
01022 BORON	B,TOT	UG/L	50K	50K	50K	50K			
01027 CADMIUM	CD,TOT	UG/L	.1K	1K	.1	5			
01034 CHROMIUM	CR,TOT	UG/L	16	1K	7	26			
01042 COPPER	CU,TOT	UG/L	90	10K	10K	10K			
01045 IRON	FE,TOT	UG/L	9100	2600	7300	7600			
01051 LEAD	PB,TOT	UG/L	4	4	6	5			
01055 MANGNESE	MN	UG/L	260.0	76.0	100.0	140.0			
01062 MOLY	MO,TOT	UG/L		20K					
01067 NICKEL	NI,TOTAL	UG/L	12	2	8	18			
01082 STRONTUM	SR,TOT	UG/L	80	80K	80K	50K			
01087 VANADIUM	V,TOT	UG/L	10K	10K					
01092 ZINC	ZN,TOT	UG/L	80	20	10K	20			
01105 ALUMINUM	AL,TOT	UG/L	7300	2700	6000	7400			
01132 LITHIUM	LI,TOT	UG/L	10K	10K	10	10K			
01142 SILICON	SI,TOT	UG/L	7200	9200	12000	15000			
01147 SELENIUM	SE,TOT	UG/L	1K	3					
01350 TURBID		SEVERITY							2
04186 WELL WTR	PURGVOLM	LITER							45.000
04187 WELL WTR	INTLVOLM	LITER							17.900
04188 WELLCSNG	INSIDE	DIMTR MM							51.0
04189 ELEVATIN	ABOVE SL	GRDWTR M					120.910	124.760	
04190 SCREEN	BOTTOM	FR MP M							15.300
04191 SCREEN	TOP	FR MP M							12.190
04192 TOT DPTH	OF SAMPL	FR MP M							14.320
04193 PUMPING	RATE	LPM							1.000
04194 DEPTHTOT	FR BELOW	MP M							15.300
04195 DEPTH	WTR LEV	FR MP M					8.150	4.300	6.440
46570 CAL HARD	CA MG	MG/L	44	20	35	26			
70300 RESIDUE	DISS-180	C MG/L	110	100	140	70			
72004 PPG/FLOW	PRIOR TO	SMP-MINS	15.0	20.0	20.0	15.0			30.0
72008 TOT DPTH	OF WELL	FT	50.2	50.2	50.2	50.2			
72015 TOP DPTH	OF SMPLE	FT	30.0		26.3				

(SAMPLE CONTINUED ON NEXT PAGE)

STORET RETRIEVAL DATE 93/07/09 PGM=ALLPARM
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WELL NO. B9
131TVAC 900317 06040005
0000 METERS DEPTH

(SAMPLE CONTINUED FROM PREVIOUS PAGE)

INITIAL DATE			91/12/04	92/03/17	92/06/08	92/09/02	92/12/14	93/03/15	93/06/07
INITIAL TIME			1320	1150	1555	1045			1550
MEDIUM			WATER	WATER	WATER	WATER	WATER	WATER	WATER
72037 PUMPING	RATE	GPM	.66	2.50	2.50	2.00			
72109 DEPTH TO	WATER	FR MPFT	22.60	19.64	21.23	25.70			
74041 WQF	SAMPLE	UPDATED	920724	920724	920724	930115	930305	930414	930622
84068 SERIES	CODE	ALPHA	B9	B9	B9	B9	B9	B9	B9

APPENDIX G

GUIDANCE ON CLEARANCES FROM ELECTRICAL TRANSMISSION LINES

Johnsv. Ach

G03 880525 001

TO : Richard L. Tallent, Chief, Technical Support Branch, LP 2S 37F-C

FROM : Cecil W. Thomas, Head Civil Engineer, TSEP, LP 1N 55A-C

DATE : May 24, 1988

SUBJECT: REVIEW OF CODE REGULATIONS DEALING WITH ELECTRICAL CLEARANCES FOR OVERSIZED TRUCKS

The NESC does not specifically address the clearance requirements for oversized trucks; however, due to an interpretation request (IR282) received by the NESC Secretariat on October 17, 1980, an interpretation was prepared. In this opinion they note that the clearances in Table 232-1 for roads, streets, etc., subject to truck traffic are based upon an equipment or vehicle height of 14 ft. Furthermore, they state that "a reasonable procedure would be to increase the road crossing clearances of Table 232-1 by the difference between the height of the tallest truck in the operating condition and 14 ft." Consequently, the clearances above an oversized truck for the TVA system are as follows:

Nominal Voltage	Clearance above an Oversized Truck
46 kV	7 ft.
69 kV	7 ft.
161 kV	8.7 ft.
500 kV	12.7 ft.

Clearances for other voltages are readily available. If you have further questions please contact Don Lockard at extension 3222-C.

Cecil W. Thomas

CLC:EL
cc: RIMS, MR 4N 72A-C

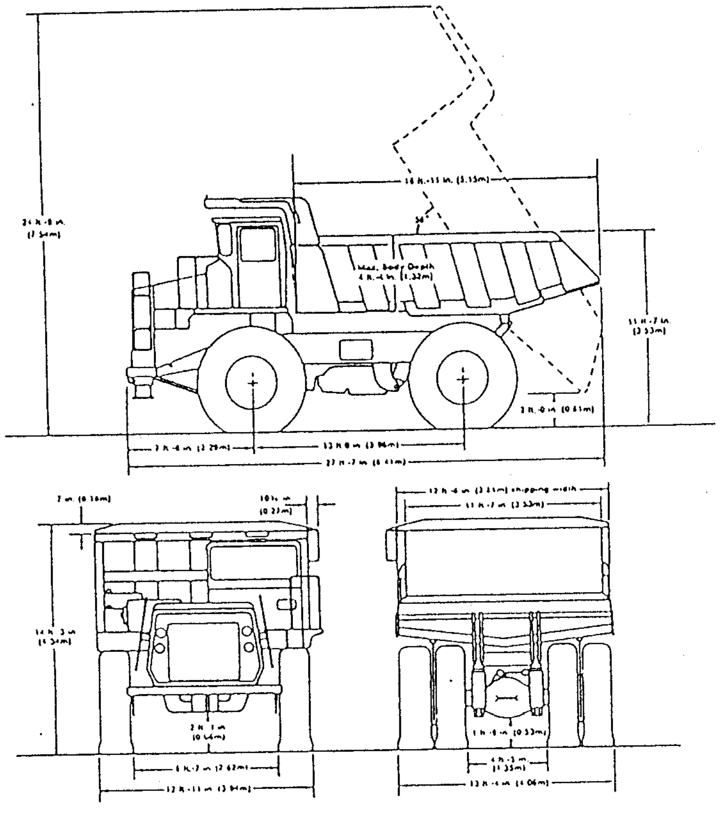

Fig IR 282-2

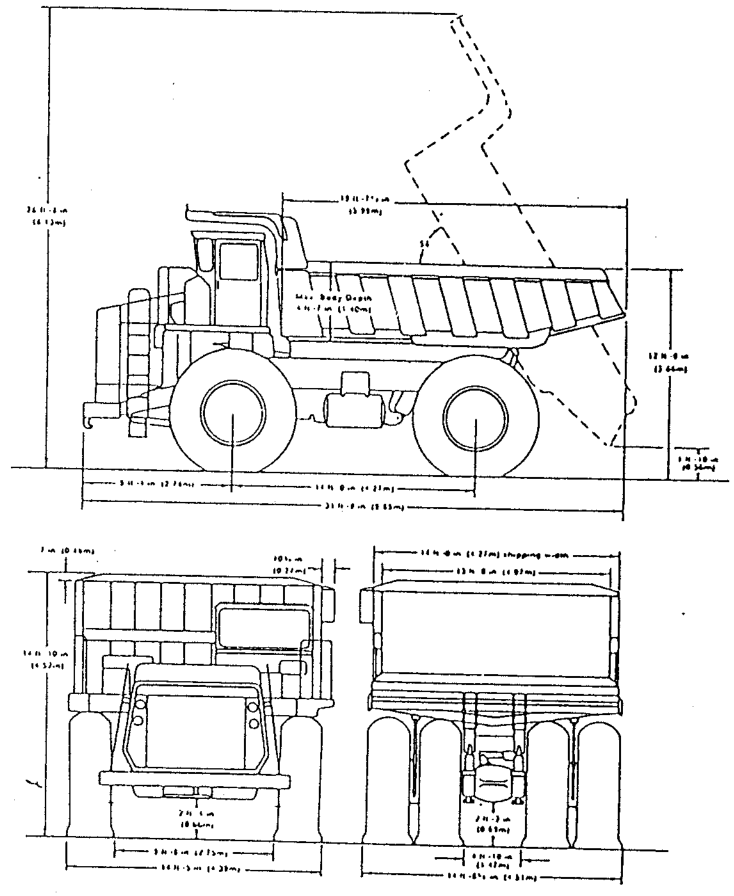

Fig IR 282-3

In areas where truck beds will be raised, the minimum wire clearances are measured from the uppermost portion of the truck.

May 24, 1993

CONDUCTOR CLEARANCE REQUIREMENTS - GENERAL USE & NESC CODE

Vertical Clearance to ground in Feet based on standard truck height of 14'

	General Use[c]			NESC Code - ANSI C2-1990					
	46-& 69-kV	161-kV	500-kV	13-kV	46-kV	69-kV	161-kV	230-kV	500-kV[e].
General: Ground, roads, pasture highways[a].	23	25	30	19	19	20	22	23	27
		TVA						NESC	
Areas subject to pedestrians and restricted[a]. traffic only	18	20	25	15	15	16	18	19	23
Railroads[a].	32	35	40	27	27	28	30	31	35
Communication conductors and messengers[b].	7	10	16	6	7	7	9	10	16
Service drops, guys, neutral conds., cables[b].	6	10	15	4	5	5	7	8	14
Lower level conductor voltage[6]. up to and including:									
13-kV[d].	6	10	15	2	3	3	5	6	12
46-kV[d].	6	10	15	--	5	5	7	8	14
69-kV[d].	6	10	15	--	--	5	7	8	14
161-kV[d].	--	15	20	--	--	--	9	10	16
230-kV[d].	--	--	22	--	--	--	--	11	17
500-kV[d.e].	--	--	25	--	--	--	--	--	18

WS:MAM
5493