GPU NUCLEAR

GPU Nuclear, Inc.
Route 441 South
Post Office Box 480
Middletown, PA 17057-0480
Tel 717-944-7621

E910-00-0016
September 18, 2000

U.S. Nuclear Regulatory Commission
Attention: Document Control Desk
Washington, DC 20555

Gentlemen,

Subject: Saxton Nuclear Experimental Corporation (SNEC)
SNEC License Termination Plan (LTP), Response to NRC Request for Additional Information
Operating License No. DPR-4
Docket No. 50-146

Attached to this letter is GPU Nuclear's response to the NRC Request for Additional Information, dated August 18, 2000, concerning the License Termination Plan (LTP) for the Saxton Nuclear Experimental Corporation (SNEC) facility license: DPR-4, which was submitted on February 2, 2000.

If you have any questions or require additional information regarding this submittal please contact Mr. James Byrne at (717) 948-8461.

Sincerely,

G. A. Kuehn, Jr.
Director, SNEC Facility

Attachment

cc: NRC Project Manager NRC
NRC Project Scientist, Region 1

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RESPONSE TO THE NRC REQUEST FOR ADDITIONAL INFORMATION
GPU NUCLEAR – SAXTON NUCLEAR EXPERIMENTAL CORPORATION (SNEC) FACILITY
DOCKET NO. 50-146

Question 1 - Section 2.1.1, page 2-1: States that "Information on systems, components and structures, which have been removed are not provided in this plan." For completeness, reference the documents from which this information may be obtained. Confirm that decommissioning records are being maintained in a 10 CFR 50.75(g) file.

Response:

The radiological characterization information on systems, components and structures, which have been removed, can be found in SNEC LTP Section 2 reference 2-6; "SNEC Facility Site Characterization Report" previously submitted to the NRC. A minor revision to section 2.1.1 of the LTP will be made to clarify this, as indicated below.

GPU Nuclear confirms that decommissioning records required by 10 CFR 50.75(g) are being maintained.

2.1.1 Purpose

In accordance with the requirements of 10 CFR 50.82(a)(9)(ii)(A), (Reference 2-1) and guidance contained in USNRC Regulatory Guide 1.179 (Reference 2-2), this chapter of the SNEC License Termination Plan (LTP) provides a description of the radiological conditions at the SNEC Facility site and its immediate surroundings. The main goal of SNEC Facility characterization activities has been to determine the nature and extent of radiological contamination of the site and where appropriate the immediate surroundings. Extensive soil characterization efforts were undertaken in 1994 in support of the SNEC Soil Remediation Project. These results were provided to the NRC in the "1994 Saxton Soil Remediation Project Report" (Reference 2-3). Characterization of the remaining SNEC Facility structure, the Containment Vessel (CV), which housed the reactor pressure vessel (RPV) and associated Nuclear Steam Supply System (NSSS) components, was completed in 1996 and documented in the report, "SNEC Facility Site Characterization Report" (Reference 2-6). This report was provided to the NRC in July 1996. The environmental radiological status of the site and surrounding environment was provided to the NRC in the SNEC Decommissioning Environmental Report, April 1996 (Reference 2-29).

Supplemental characterization has taken place from 1996 to present and will continue through remediation and during final status survey activities. The characterization information provided in the LTP is intended to show the current radiological status of the SNEC Facility. As such, information on areas that have been remediated is current. Information on systems, components and structures, which have been removed, is provided in Reference 2-6.

Question 2 - Section 2.1.2, page 2-1: Verify that SNEC procedure 6575-QAP-4220.01 also includes QA practices for the National Institute of Standards and Technology-traceable calibration of both field and laboratory instruments used in support of surveys and sampling for decommissioning activities. (Section 2.5 refers only to operation and source checks for portable radiological instruments using SNEC procedure 6575-QAP-4220.01.)

Response:

The referenced procedure, 6575-QAP-4220.01, has been renumbered as E900-QAP-4220.01 and revised. This procedure governs all radiological instruments used at the SNEC Facility, both field and laboratory. Section 4.4.1 of this procedure states that: "Sources used in the calibration of radiological instruments shall be traceable to the National Institute of Standards and Technology (NIST) directly or by calibration via NIST traceable methods." Therefore, this procedure includes QA practices for the National Institute of Standards and Technology-traceable calibration of both field and laboratory instruments used in support of surveys and sampling for decommissioning activities.

A minor revision to sections 2.5 and 2.7 of the LTP will be made to clarify this, as indicated below.

2.5 QA/PROCEDURES

The SNEC facility has been in a decommissioning mode for some time. These efforts, including the majority of the characterization process, predate the MARSSIM process. Previous characterization efforts used NUREG/CR-2082 (Reference 2-9) and NUREG/CR-5849 (Reference 2-23) to direct the characterization effort. These references do not employ the "Data Quality Objective" process when planning characterization activities. Under these guidance documents, characterization surveys and sampling is performed on an "as needed" basis, considering site conditions and operational history. The overall purpose of such a program is to establish the nature and extent of radioactive contamination. However, a retrospective review of the SNEC Facility site characterization process shows that the intent of the Data Quality Objective (DQO) process has been met.

The characterization program has been conducted using the SNEC procedure No. 6575-PLN-5420.06, "SNEC Site Characterization Plan" (Reference 2-4). This comprehensive plan provided an organized approach to specifying survey and sample locations and lower tier implementing procedures specified sampling and survey technique as well as laboratory analyses.

In concert with the DQO process, criteria or goals for characterization were established and survey and sampling plans developed to achieve these goals. Those goals closely follow those established by MARSSIM to provide the quality data needed to support the final status survey. Some of those goals are:

1. To collect information from locations where little is known about radiological conditions.

2. Sample those areas indicated in the HSA as suspect.

3. Provide information on the relative concentrations of radionuclides of concern and provide input to initial DCGL development.

4. Provide sufficient repeat and duplicate analysis to ensure confidence in sample results.

5. To provide information to support timely and adequate remediation.

6. To provide accurate and timely information about site conditions to stakeholders during the decommissioning process (the public, regulators, licensee management, etc.)

The principal study questions for all SNEC Facility site characterization work have been:

1. Are contaminants present at the site as a result of licensed activities?, and if present,

2. Are contaminant concentrations above background levels and to what degree do they approach postulated DCGL values?

The SNEC Facility Decommissioning Quality Assurance Plan (Reference 2-25) ensures that all survey activities are performed in a manner that assures the results are accurate and that uncertainties have been adequately considered. All sampling, analysis and surveys have been performed under written procedures, which are reviewed and approved in a rigorous fashion. These activities are carried out by trained and qualified individuals. Radiological survey instrumentation and laboratory equipment is operated in accordance with SNEC procedure E900-QAP-4220.01, "Quality Assurance Program for Radiological Instruments", (Reference 2-24). Characterization data, as well as calibration and source check records are maintained in accordance with approved procedures that comply with NRC and industry requirements. All characterization activities have been and continue to be conducted under the auspices of a comprehensive quality assurance program, specifically 1000-PLN-3000.05, "SNEC Facility Decommissioning Quality Assurance Plan" (Reference 2-25).

2.7 REFERENCES

2-1 Code of Federal Regulations, Title 10 Part 50.82, "Application for Termination of License."

2-2 USNRC Regulatory Guide 1.179, "Standard Format and Content of License Termination Plans for nuclear Power Reactors," January 1999.

2-3 GPU Nuclear, "1994 Saxton Soil Remediation Project Report".

2-4 SNEC procedure No. 6575-PLN-5420.06, "SNEC Site Characterization Plan".

2-5 Station Work Instructions:

2-5.1 SWI-94-001, "Remove Core Bore Samples from Saxton Containment Vessel Bldg. Structures", Rev 2.

2-5.2 SWI-94-002, "Bulk Sample Collection from SNEC Site Facilities in Preparation for Offsite Analysis".

2-5.3 SWI-94-003, "System Sampling at SNEC Facilities".

2-5.4 SWI-99-065, "Collecting Samples of Scabbled Concrete in the SNEC CV.

2-5.5 SWI-99-068, "Characterization of the Remaining On-Site Structures"

2-5.6 SWI-99-069, "Saxton Coal Fired Steam Plant Discharge Tunnel Area".

2-5.7 SWI-99-070, "SNEC Site Sub-surface Soil Gamma Logging and Sampling".

2-5.8 SWI-99-071, "Saxton Out-falls and Other Remote Areas".

2-6 "SNEC Facility Site Characterization Report", May 1996.

2-7 NUREG-1575, "Multi-Agency Radiation Survey and Site investigation Manual (MARSSIM)," December 1997.

2-8 SNEC Report, "Decommissioned Status of the SNEC Reactor Facility" dated February 20, 1975.

2-9 NUREG/CR-2082, "Monitoring for Compliance With Decommissioning Termination Survey Criteria"

2-10 "Saxton Nuclear Power Plant Final Release Survey of Reactor Support Buildings", GPU Nuclear Corporation report, Revision 3, March 1992.

2-11 "Confirmatory Radiological Survey for Portions of the Saxton Nuclear Experimental Facility, Saxton, Pa.", June 1991, Oak Ridge Associated Universities.

2-12 USNRC Regulatory Guide 1.86, "Termination of Operating Licenses for Nuclear reactors," June 1974.

2-13 "SNEC Facility Offsite Dose Calculation Manual", "6575-PLN-4542.08"

2-14 GPU Nuclear Report, "SNEC Facility Historical Site Assessment", Draft January 2000.

2-15 GEO Engineering "Phase I Report of Findings – Groundwater Investigation." November 18, 1992.

2-16 GEO Engineering "Summary of Field Work." June 7, 1994.

2-17 Haley and Aldrich "Summary of Field Work." July 24, 1998.

2-18 United States Environmental Protection Agency, Primary Drinking Water Standard, 40CFR141.

2-19 CoPhysics Corp. report, "Review of the Final Release Survey of the Reactor Support Buildings at the Saxton Nuclear Experimental Facility", 12/14/99

2-20 Minutes of the February 2, 1987 SNEC briefing to NRC Region 1.

2-21 TLG Services, Inc. report, "The Saxton Facility Reactor Vessel, internals, Ex-Vessel Lead, Structural Steel and Reactor Compartment Concrete Shield Wall Radionuclide Inventory", December, 1995 (TLG Document No. G01-1192-003).

2-22 RESRAD, Version 5.82, United States Department of Energy and Argonne National Laboratory, April 1998.

2-23 NUREG/CR-5849, "Manual for Conducting Radiological Surveys in support of License Termination", draft of June 1992.

2-24 SNEC procedure E900-QAP-4220.01, "Quality Assurance Program for Radiological Instruments".

2-25 GPU Nuclear Plan, 1000-PLN-3000.05, "SNEC Facility Decommissioning Quality Assurance Plan".

2-26 United States Nuclear Regulatory Commission Branch Technical Position. "An Acceptable Radiological Environmental Monitoring Program." Revision 1, November 1979.

2-27 June 1988 "*In-situ* Survey General Public Utilities Facility and Surrounding Area", conducted by EG&G Energy Measurements for the DOE/NRC, report number DOE/ONS-8806 dated September 1990.

2-28 July 1989 "Aerial Radiological Survey of the Saxton Nuclear Experimental Corporation Facility" conducted by EG&E Energy Measurements for the DOE/NRC, report number EGG-10617-1132 dated October 1991.

2-29 "Saxton Nuclear Experimental Corporation Facility Decommissioning Environmental Report," GPU Nuclear, April 1996.

Question 3 - Section 2.2.1, page 2-4: Since decommissioning activities are ongoing and because recent radiologically contaminated areas were identified, confirm whether the estimates and projections given in Table 2-1, "Radionuclide Inventory for the SNEC Facility (2000)"; Table 3.1, "SNEC Facility Decommissioning Person-Rem Estimate"; and Table 3.2, "SNEC Facility Low Level Radioactive Waste Projection" need to be updated, and if so, revise the tables.

Response:

As noted in NRC questions numbered 4, 5, 6, 8, and 13, additional characterization of the SNEC Facility site and surrounding area is required. The results of this ongoing characterization work may dictate a revision to Table 2-1; however, the projection of total site activity provided in Table 2-1 is quite conservative. Given the expected additional characterization results and the findings to date, a substantive revision is not expected. A definitive estimate cannot be performed until the additional characterization is complete, at that time NRC will be notified as to whether a revised table is required. If a revision is required, GPU Nuclear will forward it as soon as it is available.

Table 3.1 is a table of "SNEC Facility Person-Rem Estimate". The ongoing decommissioning activities have not impacted this estimate. Also, the recently identified radiologically contaminated areas have not impacted this estimate as they are contaminated to low levels that do not contribute to measurable, direct personnel radiation exposure. There is however, an error in the table that will require its revision. The revised table is provided below.

Table 3.2 is a projection of "SNEC facility Low level Radioactive Waste". The on going work and impact of the recently identified radiologically contaminated areas will require revision of this projection. The revised table is provided below.

Table 3.1 SNEC Facility Decommissioning Person-Rem Estimate

TASK	PERSON-REM
Asbestos Remediation (Actual)	2.97
System Dismantlement (Actual)	12.83
Large Component Removal (Actual)	7.38
Structure D&D	2.75
Waste Management	1.75
Miscellaneous Support Activities	2.75
Scaffolds and Shielding	5.75
Characterization	.75
Totals	36.93

Table 3.2 SNEC Facility Low Level Radioactive Waste Projection

TYPE	QUANTITY
Metal	125,000 lbs.
Soil	3,000 ft^3
Water	700 gal
Sediment	2,000 ft^3
Concrete	40,000 lbs.
Dry Active Waste (DAW)	2,000 ft^3

Question 4 - <u>Section 2.2.4.1.2, page 2-10</u>: **The Decommissioning Support Facility (DSF) consists of a prefabricated building that is currently used to support decommissioning operations and contains radioactive material (RAM). The DSF and soil beneath the DSF has not been characterized. Please provide your plans to address this issue.**

<u>Note</u>: Detailed information on the radiological characterization, remediation plan, FSS design, sampling methodology, and remediation of the DSF, and soil beneath the DSF will be required for the NRC to release these areas for unrestricted use.

<u>Response:</u>

The Decommissioning Support Facility (DSF) was erected in August of 1996, some twenty-four (24) years after the cessation of operation of the SNEC Facility. The DSF was constructed on top of the old SNEC Control and Auxiliary Building. This on-grade structure was demolished in 1992 following NRC approval of the termination survey (SNEC LTP Section 2 reference 2-10 and 2-11). In 1994, extensive on and near site soil sampling was conducted as part of the "Saxton Soil Remediation Project" (SNEC LTP Section 2 reference 2-3). The area now occupied by the DSF was included in this program and the surface soil in the DSF footprint was sampled and reported in SNEC LTP Section 2 reference 2-3, previously submitted to the NRC.

Immediately prior to construction of the DSF, additional soil sampling of the DSF footprint was conducted. LTP Table 2-6 will be revised as follows to report those results in summary form.

During the operation of the DSF, no liquid or solid spills of radioactive material have occurred and the control of loose surface contamination and airborne radioactivity has been maintained to prevent inadvertent contamination of building surfaces. Additionally, all operations involving the DSF are governed by a written procedure designed to minimize the likelihood of such contamination. There is no reason to suspect subsurface contamination involving this facility which would require remediation. To directly access such areas at this time could prevent the use of the facility for its intended purpose.

As the DSF is in continuous use as the prime decommissioning support facility, radiological characterization would not be meaningful or useful at this time. When characterization is complete, the results will be provided as a revision to the LTP.

GPU Nuclear is aware that detailed information on the radiological characterization, remediation plan, FSS design, sampling methodology, and remediation of the DSF, and soil beneath the DSF will be required for the NRC to release these areas for unrestricted use. GPU Nuclear will provide this information to the NRC when it is available.

Table 2-6

Summary Results of Characterization for Near Site Structures

		Exposure rate survey data	Direct Frisk Data	Beta Gamma Smear Data	Alpha Smear Data
Structure	**Location**	**GA urem/hr**	**Net cpm Direct Frisk**	**dpm/100 cm^2**	**dpm/100 cm^2**
Penelec Garage (Fig. 2-19)	Interior	6.3	70	< 227	< 8.6
Penelec Garage (Fig. 2-19)	Roof	5.1	60	< 227	< 8.6
Penelec Line Shack (Fig. 2-21)	Interior	4.8	20	< 231	< 10.9
Penelec Line Shack (Fig. 2-21)	Roof	5.3	20	< 231	< 10.9
Penelec Switch Yard Bldg. (Fig. 2-22)	Interior	4	10	< 231	< 10.9
Penelec Switch Yard Bldg. (Fig. 2-22)	Roof	Not Done	0	< 231	< 10.9
Penelec Warehouse (Fig. 2-20)	Interior	8	40	< 231	< 9.9
Penelec Warehouse (Fig. 2-20)	Roof	5.3	50	< 231	< 9.9
MHB (DSF)	Interior	18	20	< 236	< 11.6
DSB (DSF)	Interior	28	60	< 236	< 11.6
PAF (DSF)	Interior	6	10	< 227	< 9.9
SSGS Discharge Tunnel (Fig. 2-18)	Interior	4	30	< 229	< 12.3
DSF soil in construction footprint prior to construction	**Location**	**Average of 7 Soil samples (pCi/gm)**	**Range of seven samples (pCi/gm)**		
Average of seven samples	Soil beneath slab	0.27	<0.06 – 1.3		

Note: These are the average results of the characterization surveys performed.

Question 5 - Section 2.2.4.1.4, page 2-11: Several piping sections in the Discharge Tunnel and a pipe believed to be the facility's original radioactive liquid effluent discharge line require further characterization due to the presence of ground water and silt below grade in the tunnel. Due to limited characterization data available (at the time of the LTP submittal) on the soil and ground water beneath the tunnel floor, the NRC staff believes that SNEC should treat these inaccessible areas initially as Class I and work toward rejecting the null hypothesis in accordance with the Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM). Table 5-2 does not provide initial classifications for the tunnel. Revise this section and table accordingly.

Note: Detailed information on the radiological characterization, remediation plan, FSS design, sampling methodology, and remediation of the Discharge Tunnel to include the concrete structure, discharge line/pipes, and soil beneath the tunnel will be required for the NRC to release these areas for unrestricted use.

Response:

Detailed characterization of the Saxton Steam Generating Station (SSGS) discharge tunnel is awaiting removal of water and sediment from the tunnel to allow access and survey. Section 2.2.4.1.4 and Table 5-2 of the LTP will be revised to classify the SSGS Discharge Tunnel floor and walls as "Impacted Class 1", the ceiling will remain as "TBD" pending characterization results as

GPU Nuclear staff are confident the results will support a lower classification. See proposed revision to section 2.2.4.1.4 below and the response to NRC question 18 for the proposed revision to Table 5-2.

It should be noted that preliminary results of an investigation of the ground water behavior in this area indicate that ground water levels are such that only in-leakage of water into the tunnel would have occurred.

GPU Nuclear is aware that detailed information on the radiological characterization, remediation plan, FSS design, sampling methodology, and remediation of the SSGS Discharge Tunnel, and soil beneath the SSGS Discharge Tunnel will be required for the NRC to release these areas for unrestricted use. GPU Nuclear will provide this information to the NRC when it is available.

2.2.4.1.4 Saxton Steam Generating Station (SSGS) Discharge Tunnel

The Saxton Steam Generating Station (SSGS) Discharge Tunnel is contaminated as a result of radioactive liquid effluent discharges from the SNEC facility. This tunnel was the routine discharge point for liquid radioactive effluents. The presence of ground water and several inches of silt in this below grade structure have precluded complete characterization. The water and silt require removal to adequately survey this area for final release. Characterization results to date of this structure indicate that extensive remediation will not be needed to meet final release criteria. However, several piping sections will require removal as they are significantly above initial DCGLs. Figure 2-18 shows this tunnel in detail and contains the general area exposure rate results. Table 2-3 lists some of the sediment and water sample results. Table 2-6 shows the average values for the surveys taken during characterization. One pipe in the east seal chamber was found to contain elevated readings. Specifically, a pipe, believed to be the original SNEC facility liquid effluent discharge line was sampled and had 3668 pCi/g Cs-137 and 50 pCi/g Co-60 inside. Several areas in the western most seal chamber have elevated exposure rate measurements and will require further characterization. Chapter 5.0 provides the preliminary survey classifications that result from the characterization data. Table 5-2 lists the initial classifications for the tunnel.

Question 6 - Section 2.2.4.2, page 2-12: Surface and subsurface soil characterization was limited to the facility property and immediately adjoining area because of the need for removal of certain structures (CV and support tunnel). Due to prevailing soil conditions and ground water near the surface of the CV and the surrounding support tunnel, subsurface soil has not been completely characterized. Please provide your plans to address this issue.

Note: Detailed information on the radiological characterization, remediation plan, FSS design, sampling methodology, and remediation of subsurface soil near the CV and surrounding support tunnel will be required for the NRC to release these areas for unrestricted use.

Response:

In part, see the response to question 12 and 13 in support of this question. The CV Pipe Tunnel will be removed (except the section under the MHB as described in section 3.2.5 of the LTP), as part of remaining remediation activities. Following removal, the underlying soil will be sampled/surveyed and remediated as necessary. Ground water removal efforts are underway in the affected areas and when complete will permit remediation and survey of the soil surrounding the CV. Plans are to remove all contaminated surface and subsurface soil to a level less than the default surface DCGL. Because of the depth of this structure (CV), characterization activities must be performed in concert with the remediation effort being conducted adjacent to the CV. To characterize soil/rock formations below the CV from grade level using drilling equipment would be difficult and could jeopardize the CV steel liner since the angle of entry would necessarily be severe. Therefore, the appropriate time to characterize this area is during remediation of known volumes of contaminated soil adjacent to the CV. It should be noted however, that if all of the resident contaminated materials are excavated before reaching the CV concrete base, then there is no known method by which contamination could have gotten below the CV base concrete. The base area would then be assumed to be non-impacted.

GPU Nuclear is aware that detailed information on the radiological characterization, remediation plan, FSS design, sampling methodology, and remediation of the CV, and soil beneath the CV will be required for the NRC to release these areas for unrestricted use. GPU Nuclear will provide this information to the NRC when it is available.

Question 7 - Sections 2.2.4.2, page 2-12; and 2.2.4.3, page 2-12: Gamma logging was conducted to compliment analyses of 42 core samples of subsurface soil. Results of the sampling indicated that subsurface soil at depths of at least 10 feet on the north side of the CV require remediation. Although soil samples were collected in the same locations as count rate measurements, NRC staff generally considers the use of gamma logging for screening purposes only. That is, the direct correlation of count rate measurements to isotopic concentrations using gamma logging must be adequately demonstrated. Clarify the intent of gamma logging for subsurface soil and whether this method is proposed for soil remediation to demonstrate compliance. Provide the approved and referenced site procedure for gamma logging. In addition to Holes #10 and #13, given in Table 2-16, elevated concentrations of Cs-137 in subsurface soil are also indicated for Hole #11. Revise this sentence.

Response:

The exclusive use of gamma logging is **not** being proposed for soil remediation to demonstrate compliance without additional supporting survey work. Gamma logging is a valuable investigative characterization and scoping tool used to supplement and compliment other methods such as direct sampling.

Comparisons of sampling and gamma-logging data are at times inconsistent. This is not because gamma logging is inaccurate, but because of the non-representative nature of sampling and the type of contamination found around industrial facilities. GPU Nuclear's consultant has observed this problem at several sites including the SNEC Facility site.

Gamma logging is useful in both screening surveys (to determine depth and average concentration of contamination) and in final status surveys (to provide an upper limit of the average radionuclide concentration). If no significant counts are obtained from the gamma logging detector in a hole, then a "less than" value, or minimum detectable concentration (MDC), can be quoted for the soil around the hole at a given confidence level (95%). By ensuring that the MDC is less than the release criteria, the surveyor can designate the soil to be "clean". It technically is not necessary to collect soil samples if gamma logging detects no significant activity.

However, GPU Nuclear will continue a joint sampling and selective gamma-logging program as supplements to one another for subsurface measurements. But, in areas where sampling is impossible or obviously inaccurate (i.e., in rubble, gravel, or muck), gamma logging must be relied upon.

The approved and referenced site procedure for gamma logging is provided with this submittal.

The sentence referenced from section 2.2.4.2 on gamma logging results will be revised to reflect that borehole number eleven (11), also showed elevated activity.

2.2.4.2 Soil

In addition to the CV, contaminated soil in and around the SNEC Facility site will require remediation. As described in Section 2.2.1, the SNEC Soil Remediation Project, completed in 1994, removed contaminated soil from the site in an effort to reduce Cs-137 levels to <1pCi/g average. While this project achieved its goal, contaminated soil near the CV and the surrounding support tunnel could not be removed until these structures were removed. Additionally, soil conditions and pervasive ground water near the surface prevented an assessment of soil contamination below about three feet deep in these areas. Also, this project was limited to the SNEC Facility property and the immediately adjoining area.

In order to survey the areas not covered by the 1994 soil project and to investigate potentially impacted areas identified by the HSA (Reference 2-14) a major surface and subsurface soil sampling program was completed in 1999. In addition to random points, biased sample locations were selected based on the HSA and previous survey results. Cs-137 was the only nuclide attributed to licensed operations detected. The surface findings are reported in Table 2-14, while the sample locations are shown on Figures 2-13 and 2-14. Given the site history and previous survey data, the results are unremarkable. The information has been used to classify the survey units as described in Chapter 5.0. The data has resulted in some areas off the SNEC Facility site but within the surrounding Penelec property being classified as "impacted".

In addition to the 55 surface sample locations, 42 subsurface locations were sampled. These were generally biased locations, located in areas where below grade tanks, piping, ducts, spills, and structures were once present. The results of subsurface sampling are presented in Table 2-15. Subsurface sample locations are shown on Figures 2-15 and 2-16. As a compliment to the subsurface sampling, gamma bore logging was performed at these same locations. The use of two different techniques allows for the differentiation of possible soil contamination at a location from the presence of buried radioactive components. The results of the gamma bore logging are presented in Table 2-16. Subsurface gamma bore logging locations are shown on Figures 2-15 and 2-16. Results of the subsurface sampling and gamma logging indicate the need to remediate soil to a depth at least ten (10) feet deep on the north side of the CV. The gamma bore logging results show that some radioactive components are still present at this depth in this location (hole #10, 11 & 13). These are believed to be piping exiting the CV below grade in the area north of the CV. These areas will be remediated prior to the final status survey. Chapter 5.0 provides the survey classifications that result from the characterization data.

Question 8 - Section 2.2.4.3, page 2-12: Pavement areas (and soil beneath the pavement) in the facility and surrounding areas have not been completely characterized. The NRC staff recognizes that characterization in some areas may be precluded due to the influence of elevated ambient radiation levels from locations storing RAM and other ongoing decommissioning activities. Please provide your plans to address this issue.

Note: Detailed information on the radiological characterization, remediation plan, FSS design, sampling methodology, and remediation of pavement areas, and soil beneath the pavement will be required for the NRC to release these areas for unrestricted use.

Response:

Additional characterization of remaining pavement (and soil beneath the pavement) in the facility and surrounding areas is underway. The results will be forwarded to NRC when available.

It is important to note that no paving has taken place at the site since initial operation began in 1962. This has been verified by reviewing aerial photographs, physical survey of the site, personnel interviews and the Historical Site Assessment process. This means that it is likely that surface contamination would be detected on pavement in concert with coincident subsurface contamination.

GPU Nuclear is aware that detailed information on the radiological characterization, remediation plan, FSS design, sampling methodology, and remediation of pavement areas, and soil beneath the pavement will be required for the NRC to release these areas for unrestricted use. GPU Nuclear will provide this information to the NRC when it is available.

Question 9 - Section 2.2.4.5, page 2-14: Explain how the data from the monitoring wells are representative and appropriate for measuring contaminated ground water onsite, i.e., provide the basis and information for well locations, well depths, ground water elevations, ground water contours, direction of ground water flows (Figure 2-17), hydraulic gradients, hydraulic conductivity, ground water velocity, sampling method, and the isotopic analyses conducted. The basis should include: 1) a discussion on the potential that radionuclides resulting from licensed activities will reach the ground water (water bearing units) and surface water in the surrounding area; 2) the isotopic concentrations and uncertainties for each radionuclide identified in the ground water (providing that the analysis indicates the radionuclides have the potential to contaminate the ground water); and 3) a determination as to whether the potentially contaminated ground water moves beyond the SNEC property.

Response:

The response is divided in three sections; Section I provides background information and objectives for site investigations and Section II provides specific information regarding aquifer properties, measurements, and groundwater monitoring and characterization. Section III is in response to the question 9, section 2), based on teleconferences with NRC on September 11 and 15, 2000.

Section I

Groundwater Technology's, Inc. investigation (1981) provided the basic hydrogeologic framework, serving as a guide for future groundwater monitoring. Monitoring well installations have occurred, since the initial investigation in 1981, in a staged approach, first by GEO Engineering (1992, and 1994) and by Haley and Aldrich (1998). Depending on the purpose for monitoring, wells were installed at several locations typically adjacent to site structures of interest. Monitoring wells were installed in both soil and bedrock.

The Preliminary Hydrological Investigation, Saxton Nuclear Station, Saxton, Pennsylvania. 1981 by GROUNDWATER TECHNOLOGY, INC. reviewed information obtained from the Pennsylvania State Geologist and the United States Geological Survey (Water Resource Branch). In conjunction with geologic reconnaissance, this provided the initial geologic interpretation for the Saxton site. Test borings located near the Containment Vessel (CV) and the Radioactive Waste Disposal Facility (RWDF) were installed to characterize the soils and bedrock and the groundwater in each media.

Results of investigation lead to following conclusions:

- The investigation identified three distinct subsurface materials: fill, a boulder layer with silty clay matrix and bedrock (occurring in this order from ground surface when present).
- Field permeability tests were conducted in boreholes and soil laboratory mechanical analysis was performed on construction fill materials. Based on the field permeability testing, the highest permeability is at the boulder layer/bedrock interface.
- The boulder layer appears to act as a barrier to the flow of groundwater between the construction fill and the bedrock.
- Preliminary groundwater level observations in test borings indicate a hydraulic gradient of 10 to 15 feet over a distance of 600-800 feet from the site to the river.
- The combination of hydraulic gradient, bedrock permeability, and bedrock structure (bedding and fracture patterns) indicates that the groundwater has a potential to flow from the site to the river.

The main objective of the Phase I Report of Findings-Groundwater Investigation Saxton Nuclear Experimental Station, Saxton, Pennsylvania, 1992 GEO Engineering was the installation of 8 monitoring wells at locations near the CV and RWDF. The wells were screened (and sanded) across the top bedrock and boulder layer contact. This was an area identified in the 1981 investigation as an area of high permeability compared to its immediate surroundings. Other pertinent information follows:

- A relative elevation survey of each well using an arbitrary datum of 100.00 feet at GEO-1 was completed. Water level information from these eight wells was used to produce computer-generated contour maps of the groundwater surface. The resultant direction of groundwater flow (groundwater flowing perpendicular from locations with higher contour to those with lower elevations) is in a westerly direction towards the Raystown Branch of Juniata River.
- For the purpose of monitoring radionuclide contamination in groundwater, several wells were installed hydraulically downgradient of the CV and several other upgradient of this structure.
- The investigation confirmed the orientation of potential groundwater pathways in the bedrock (fractures and bedding).
- A recommendation was proposed for the installation of 2 groundwater-monitoring wells in bedrock adjacent to the CV.

In 1994, two gas-actuated monitoring wells devices were installed into the bedrock near the CV as reported in GEO Engineering's, Summary of Field Work, 1994. These two devices were installed into the bedrock to a depth similar to the base of the CV. The devices were installed west and northwest of the CV, at approximately 25-degree angles, to facilitate the interception of groundwater flowing in the bedrock.

During this field activity, a 50-foot observation well (GEO-9) was installed in bedrock making it possible to obtain water level elevation data from the bedrock unit. As part of this field activity, monitoring wells GEO-1 to GEO-8 were retrofitted with gas actuated samplers.

In The Report of Field Work by Haley and Aldrich (1998) two additional gas actuated groundwater monitoring devices were installed adjacent to the RWDF (to the depth of the sump) to investigate the potential presence of tritium in groundwater. Also, GEO-10 was installed at the bedrock /soil interface to supplement the existing monitoring wells. It was situated downgradient of GEO-5 to evaluate trace amounts of tritium detected in the groundwater at GEO-5.

Section II

Monitoring Well Locations and Depths

Regarding the inquiry for well locations and depths, a phased approach was used for monitoring well installations. In general, monitoring wells are situated to detect potentially contaminated groundwater flowing in bedrock and at the soil/ bedrock interface associated with site decommissioning activities and at specific site structures previously noted.

Groundwater Elevations

Groundwater elevations are based on the measurement of depth to water in the monitoring well relative to the top of casing elevation. Depth to water was measured using an electronic water level meter, capable of measurement to 0.01 ft. As mentioned above, elevations for the top of casing were determined from a relative elevation survey of each well using an arbitrary datum of 100.00 feet at GEO-1. Groundwater elevation contours were computer generated from the software application Surfer. Relative groundwater elevations along with horizontal coordinates are used to create a grid from which the program uses kriging, or triangulation between points to generate contours at user-specified intervals.

Direction of Groundwater Flow

Direction of groundwater flow is by definition, perpendicular to groundwater elevation contours. Groundwater flow direction was based on groundwater elevation contours as derived from water levels collected on 10/25/92 and 11/5/92.

Hydraulic Gradient

The hydraulic gradient was based on the relative difference in groundwater elevations divided by the linear distance between monitoring wells, respectively, within the same geologic unit. While groundwater elevations varied slightly over several monitoring events, the hydraulic gradient in the overburden materials remained relatively stable, ranging from 0.02 to 0.04. This gradient is based on data from monitoring wells collected as part of the 18 November 1992 report entitled Phase I Report of Findings - Groundwater Investigation. Water levels used in the calculation of hydraulic gradient were collected on 10/25/92 and 11/5/92.

Hydraulic Conductivity

Hydraulic conductivity values are based on field permeability testing, soil characterization, empirical relationships, published values and the experience of GPU Nuclear's expert consultant. Packer tests (rock pressure tests) were performed during the 1981 Preliminary Hydrogeologic Investigation in order to estimate the apparent permeability of the bedrock below the site. The packer test involves pumping water under pressure into selected sections of an open borehole isolated using pneumatic packers. In addition to packer testing for the 1981 report, sieve analyses were conducted on samples of the silty sand and ash fill. Initial estimates of hydraulic conductivity suggested a high of 1×10^{-6} cm/s for the fill. Packer tests indicated hydraulic conductivity of the bedrock to range between 1×10^{-3} cm/s to negligible flow.

Based on recent analyses for the purpose of the RESRAD modeling, data from the grain size distributions of the fill collected from the 1981 investigation were entered into several empirical relationships in order to refine the estimates of hydraulic conductivity. These empirical relationships relate median effective grain diameter (typically, the grain diameter which represents the 10% finer by weight on a grain size distribution) as well as other properties including sorting and porosity to hydraulic conductivity. The empirical relationships used have been shown to correspond well with field measured hydraulic conductivity (in comparison with data yielded from pump tests or slug testing of monitoring wells, for example). Hydraulic conductivity values for the fill generated through the empirical relationships using grain size data were somewhat higher than the estimates initially suggested in the 1981 Preliminary Hydrogeologic Investigation report, ranging from 1×10^{-5} to 1×10^{-6} cm/s (3.15 to 31.5 m/yr).

In addition to methods described above, hydraulic conductivity was qualitatively assessed given the experience of our expert consultant and based on their visual observation during installation of the soil borings and soil sample characterization. The values given above also correspond with published values for silts, sandy silts, and clayey sands (Applied Hydrogeology, Fetter, C.W.).

Groundwater Velocity

Groundwater velocity is defined as the product of the hydraulic conductivity and hydraulic gradient divided by the porosity of the aquifer. The hydraulic conductivity and hydraulic gradient values were obtained as discussed above. Porosity of the soil was assessed in a similar manner as hydraulic conductivity, and was based on analysis of the grain size distributions, soil characterization, empirical relationships, published values and the experience of our expert consultant. Porosity was estimated to range from 0.3 to 0.4 (unitless value). This range also corresponds with published values for silt with fractions of clay and sand (Physical and Chemical Hydrogeology, Domenico and Schwartz).

Discussion on the potential that radionuclides resulting from licensed activities will reach the groundwater and surface water in the surrounding area.

As reported, tritium was the only positively identified radionuclide resulting from licensed operations. Tritium has not been detected above the USEPAs Primary Drinking Water Standard of 20,000 pCi/L. Radionuclide testing in the monitoring wells have not detected other radioactive contaminates. While specific studies have not been performed to evaluate the connection of groundwater to the River, it is likely there is hydraulic connection between the two and groundwater discharges to surface water. Given this, and the overall flow direction toward the River, there is a mechanism for potentially contaminated groundwater to reach the River. However, the present monitoring well network provides sufficient coverage to detect potential contamination in groundwater flowing away from the CV and RWDF. Based on the information as presented here, groundwater flow direction and average groundwater flow velocity indicate that groundwater originating from the CV and RWDF would have already moved into the area of the downgradient monitoring well network and therefore potential contamination, if present, would have been detected.

As requested during the September 11, 2000 teleconference with the NRC, the references cited in the response and the LTP dealing with the various ground water reports and studies are provided.

Section III

Response

The key concern for this question was whether measurements (e.g. gross alpha analyses) had been performed on SNEC groundwater monitoring wells with the analytical sensitivity required to meet the LTP and EPA dose criteria of 4 mrem/yr. The SNEC LTP did not provide specific information relative to gross alpha and hard to detect (HTD) nuclide measurements in SNEC well water samples. In addition, the SNEC Radiological Environmental Monitoring Program (REMP) Report did not provide these measurement results. Historically, transuranic (TRU) and HTD nuclide measurements in soils in and surrounding the SNEC site have not indicated significant activity with the exception of natural background (e.g. U-234/238, Ra-226, & Th-232). This assessment is based on samples taken from the 1994 Soil Remediation Project and samples obtained to date. Since there is no significant evidence of TRU and HTD nuclide activity in SNEC soil samples, there is minimal potential to expect these types of radioactivity in the site groundwater wells.

To validate these soil analyses and potential migration into the site groundwater, composite samples of all the SNEC groundwater wells were taken in July, 1999. This composite sample consisted of all the GEO wells (1-10) and all the MW wells (1-4). The following table lists the results:

TRU Radionuclide	Concentration (pCi/L)
Am-241	< 0.03
Cm-242	< 0.04
Cm-243/244	< 0.03
Pu-238	< 0.006
Pu-239	< 0.03
U-234	0.43
U-235	0.024
U-238	0.42
Total	0.874

HTD Nuclides	Concentration (uCi/ml)
C-14	< 2E-8
Fe-55	< 4E-7
I-129	< 1E-9

Ni-63	< 2E-7
Tc-99	< 8E-8

The positive uranium activity in the above table is considered background radioactivity. The table activities were summed to determine the total gross alpha activity. The total gross alpha activity equals 0.874 pCi/L. This activity is well below the 15 pCi/L gross alpha MCL listed in 40 CFR 141 to meet the EPA dose criteria of 4 mrem/yr. The HTD nuclides were all less than minimum detectable concentration (MDC).

In addition to the above results, groundwater composite samples, obtained on 7/13/200, were analyzed for gross alpha. This composite sample consisted of wells GEO1-5, 8, 10 and MW 2-4. GEO 6, 7, 9 and MW 1 have been removed due to excavation/decommissioning activities in these respective areas. The gross alpha activity measurement for this sample was <5 pCi/L, well below the EPA gross alpha MCL of 15 pCi/L.

Question 10 - Section 2.6, page 2-19: Because of the recent discovery of other radiologically contaminated areas (i.e., Saxton Steam Generating Station sumps), the information supplied in the LTP is insufficient to indicate that the facility or site has been comprehensively characterized. The NRC requests that SNEC justify why the site characterization conducted is adequate to demonstrate that it is unlikely that significant quantities of residual radioactivity have gone undetected.

Note: Detailed information on the radiological characterization, remediation plan, FSS design, sampling methodology, and remediation of the sumps to include the concrete structures, and soil beneath the sumps will be required for the NRC to release these areas for unrestricted use.

Response:

GPU Nuclear is confident that the facility or site has been comprehensively characterized. The "recent discovery of other radiologically contaminated areas (i.e., Saxton Steam Generating Station sumps)" is not reflective of inadequate radiological characterization. Indeed the findings support the quality of the SNEC Facility characterization process. This process includes the Historical Site Assessment (HSA) among other projects, to gather information important to the classification of the site. It was through the HSA that these structures (Saxton Steam Generating Station) were determined to have been potentially impacted. The HSA, in concert with other surveys, data and record reviews, intimate knowledge of the site and comprehensive characterization surveys, demonstrate that the site characterization conducted is adequate to prove that it is unlikely that significant quantities of residual radioactivity have gone undetected. In addition to the work of GPU Nuclear in the site characterization field, the on-going Radiological and Environmental Monitoring Program (REMP) which includes on and near site measurements contributes to this conclusion. Lastly, the USDOE aerial radiological survey results (LTP references 2-27 and 2-28) lend further credence to this conclusion.

As with most decommissioning projects conducted to date, radiological characterization continues through the remediation phase and frequently up to the Final Status Survey phase. That will likely be the case with the SNEC Facility as well. However, GPU Nuclear is confident that it is unlikely that significant quantities of residual radioactivity have gone undetected.

Question 11 - Tables 2-2 through 2-5, page 2-25: From Table 2-1, page 2-24, the predominant radionuclide inventory includes: Am-241, Co-60, Cs-137, Ni-63, H-3, Pu-241, and Sr-90. However, in Tables 2-2 through 2-5, Co-60 and Cs-137 are almost exclusively reported. Clarify the radionuclides of concern for each survey area. Revise the section accordingly or provide the basis for excluding these radionuclides not listed in Tables 2-2 through 2-5.

Response:

Table 2-1 reflects the radionuclide inventory of the entire SNEC Facility site and includes the more contaminated Containment Vessel (CV). A broad range of nuclides is present in the CV as shown in the table. Tables 2-2 through 2-5 on page 2-25 on the other hand, report radioactive contamination levels in the environment; relatively non-impacted areas or building surfaces that were minimally contaminated. These tables report all analysis results greater than the lower limit of detection or if listed as "Not Reported" (NR), the laboratory did not report or list a value. All positive values from the analysis performed have been reported in these tables. As detailed elsewhere in the LTP, Cs-137 is by far the predominant radionuclide present at the SNEC Facility. This is frequently the only radionuclide detected in the environment or in the area and structures surrounding the CV. On rare occasions, Co-60 is detected at a fraction of the Cs-137 present in these areas.

GPU Nuclear is aware that detailed information on the radiological characterization, remediation plan, FSS design, sampling methodology, and remediation of the sumps, concrete structures, and soil beneath the sumps will be required for the NRC to release these areas for unrestricted use. GPU Nuclear will provide this information to the NRC when it is available.

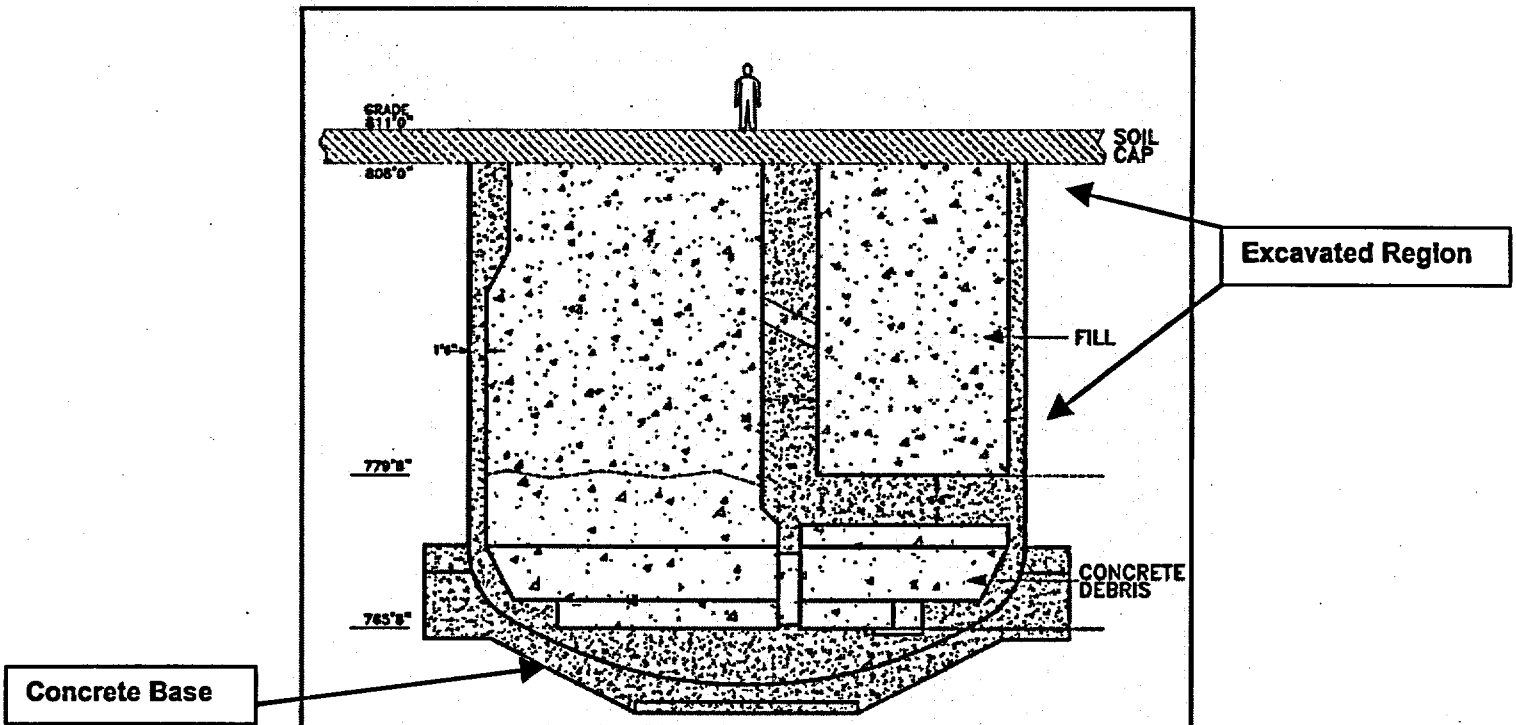
Question 12 - Section 4.3.4, page 4-3: This section states: "Because of the difficulty in excavating beneath an existing structure, remediation of the sub-floor soil may take place after the structure has been demolished." Under this scenario, the CV cannot be released for unrestricted use until the soil beneath the floor has been determined to meet the release criteria. Please provide your plans to address this issue.

NOTE: Detailed information on the radiological characterization, remediation plan, FSS design, sampling methodology, and remediation of soil beneath the CV's sub-floor will be required for the NRC to release these areas for unrestricted use.

Response:

The SNEC CV has a concrete base outside and below the outer steel shell (see diagram below). This concrete base was originally poured into an excavation dug ~70 feet deep and ~60 feet in diameter into bedrock. Thus, there is no soil or fill material immediately below the outer CV steel envelope. The flow through any potential leak in the envelope will always be from the exterior to the interior of the CV due to the existing ground water pressures. Therefore, GPU Nuclear is confident that no leakage from the CV to the environment below the foundation has occurred. The only source of contamination outside of the CV was the leakage of piping, tanks and components in the soil adjacent to the CV. Contaminated soil in this area is currently being remediated. As remediation progresses in the vicinity of the CV, it will be determined to what depth and extent it is needed. Remediation activities will continue until the area is suitable for release.

Because of the depth of this structure, characterization activities must be performed in concert with the remediation effort being conducted adjacent to the CV. To characterize soil/rock formations below the CV from grade level using drilling equipment would be difficult and could jeopardize the CV steel liner since the angle of entry would necessarily be severe. Therefore, the appropriate time to characterize this area is during remediation of known volumes of contaminated soil adjacent to the CV. It should be noted however, that if all of the resident contaminated materials are excavated before reaching the CV concrete base, then there is no known method by which contamination could have gotten below the CV base concrete. The base area would then be assumed to be non-impacted.



Containment Vessel, Sectional View
Post Demolition

The Final Status Survey (FSS) of the subsurface materials next to the CV will be performed when the first clean layer of soil is exposed through remediation activities. The area will be surveyed as if the final exposed layer is surface soil. A surface and subsurface survey will be performed at this point to ensure that the lowest level of contamination has been removed. After the survey, the area will be back-filled with clean fill. A record of all sample analyses of fill materials will be maintained.

The subsurface survey and sampling program around or surrounding the CV will employ a statistically based layered sampling and measurement approach. In this methodology, each layer of soil is assumed to represent a sample population. The number of layers would extend below the depth of any nearby or formerly buried components, or to bedrock. Each survey level must then pass statistical testing criteria in order to be acceptably below the appropriate DCGL value. A $DCGL_{EMC}$ would also be applied for elevated concentrations above the $DCGL_{W}$, in the same manner it is applied to surface activities. Subsurface measurements would be made in bore-holes with a Sodium Iodide detector and sampling would be used as confirmation of the results. If the in-situ measurement and sampling results are less than the DCGL, this would be acceptable evidence that the subsurface radionuclide concentrations are also below acceptable levels.

Question 13 - Section 4.4, page 4-3: The recent discovery of radiological contamination in the Saxton Steam Generating Station sumps should be included and discussed in detail.

Response:

The four Saxton Steam Generating Station (SSGS) sumps are located in the basement of the demolished "Turbine Room" section of the SSGS. This sub-grade building extends some twenty-one (21) feet below grade and is filled with the construction debris from the demolished SSGS. The results of the Historical Site Assessment (HSA) led GPU Nuclear to characterize this facility to determine if it was impacted or not by the operation of the SNEC Facility.

The SSGS Turbine Room cannot presently be accessed for conventional survey due to the construction debris present. Additionally, the recent discovery of extensive asbestos contamination of the SSGS debris field has hindered characterization efforts in this area.

The work performed to date is best classified as "scoping surveys" as the situation precludes conventional characterization efforts. The operational scheme for the facility and its layout were reviewed using drawings and interviews with operating personnel. Areas of likely contamination were selected based on the information gathered. These were the four sumps, the floor area under several tanks associated with system interfaces from the SNEC Facility and the intake tunnel located below the SSGS Turbine Room. A drilling rig has been used to drill eight (8) inch diameter boreholes into these locations from the surface. Some holes could not be bored to the desired depth due to interfering debris/structure. In those holes that were successfully drilled, sediment sampling from the floor/sump was performed and gamma logging conducted of the entire depth profile. Sediment samples have been analyzed on-site for gamma emitting radionuclides. Off-site analysis for "hard to detect nuclides" (HTDN) is underway. The attached sketch and associated table provide the results to date.

A recent decision to excavate the SSGS footprint will allow complete characterization of this structure and surrounding area. When that work is complete and the results known, the data will be reported to the NRC.

Table of SSGS footprint sample well results:

SSGS Footprint Sample Well Designations/Locations		
Well No.	**Location**	**Cs-137/Co-60 Results (On-Site Analysis)**
1	East Sump	**121 pCi/g, 0.4 pCi/g, (0.09 pCi/gm Am-241)**
2	West Sump	**6 pCi/g, <LLD**
3	Collection Tank Area	**6 pCi/g, <LLD**
4	Trash Rake-Plant Intake	**0.7 pCi/g, <LLD**
5	Intake Recirc. Pump South	Sampling in progress
6	Northwest Sump	**10 pCi/g**
7	Northeast Sump	**129 pCi/g, 2.4 pCi/g**
8	Steam Plant Misc.	Sampling in progress
9	Intake Recirc. Pump North - Abandoned	No sample - insufficient drill depth
10	Intake Recirc. Pump North	Sampling in progress
11	Intake Recirc. Pump South	Sampling in progress
12	Intake Tunnel Clean Out	Sampling in progress

Question 14 - Section 5.2.1, page 5-2: Ni-63 and H-3 were also identified in Table 2-1 as predominant radionuclides, however, these radionuclides were not mentioned in this section. Revise the section accordingly or provide the basis why Ni-63 and H-3 should be omitted as predominant radionuclides.

Response:

Section 5.2.1 will be revised as follows:

5.2.1 Identity of Radiological Contaminants

The radionuclide inventory at the SNEC Facility was estimated during the site characterization process, which was conducted in 1995 through 1996. The data are compiled in the SNEC Facility Site

Characterization Report (Reference 5-7) and summarized in Chapter 2 of this plan. Additional data continues to be gathered on radionuclide concentrations from routine operational and decommissioning survey work supporting dismantlement activities in response to questions from the Historical Site Assessment (HSA), and from supplemental site characterization work performed since 1996. The predominant radionuclide present on structural surfaces and in facility systems is Cesium-137. Cobalt-60 is also present, but at much lower concentrations than Cesium-137. Ni-63, Eu-152 and H-3 are present in activated concrete volumes in the SNEC CV. Ni-63 and H-3 are also present in low concentrations in some remaining piping system sediments. H-3 has also been identified in sediment from the Saxton Steam Generating Station Discharge Tunnel. Additionally, there is some low level transuranic radionuclides, such as Americium-241 and Plutonium-238 and 239, present in the SNEC Facility CV, and in the former effluent pathway piping leading to the Saxton Steam Generating Station Discharge Tunnel. However, Cs-137 is the dominant isotope present in soils and sediments remaining at the site outside of site structures.

Question 15 - Table 5-9, page 5-36, and Table 5-10, page 5-39: Characteristics and detection sensitivities for the pressurized ion chamber (for exposure rate measurements) and Bicron Micro-Rem meter (for dose equivalent rate measurements) described in "Background Level Determinations," page 5-70, should also be listed in the radiological instrument tables.

Response:

Tables 5-9 and 5-10 will be revised as follows:

Table 5-9
Typical Survey Instrumentation Characteristics

Measurement Type	Detector Type	Effective Detector Area and Window Density	Instrument and Model	Detector Model
Alpha Scan	Gas-flow proportional	126 cm^2 0.8 mg/cm2 Aluminized Mylar	Ludlum 2350-1	Ludlum 43-68
Beta-Gamma Scan	Gas-flow proportional	126 cm^2 0.8 mg/cm2 Aluminized Mylar	Ludlum 2350-1	Ludlum 43-68
Gamma Scan	NaI Scintillator	1" D x 1" L, also 2" D x 2" L	Ludlum 2350-1	Ludlum 44-2, or 44-10 (or eq.)
Dose Equivalent Instrument	Plastic Scintillator	1" D x 1" Length	Bicron Micro-Rem Meter	N/A
Static Surface Contamination	Gas-flow proportional	126 cm^2 0.8 mg/cm2 Aluminized Mylar	Ludlum 2350-1	Ludlum 43-68
Soil and Bulk Material	High-purity Germanium	1.60" x 1.94", 2.16" x 2.32"	Ortec/Canberra	N/A
Exposure Rate Instrument	Pressurized Ion Chamber (PIC)	~8 Liter Sphere	Reuter-Stokes RSS-131 (or eq.)	N/A

Table 5-10
Typical Detection Sensitivities

Instrument and Detector	Radiation	BKGND Count Time (min)	BKGND (cpm)	Instrument Efficiency[a] (cpm/dpm)	Count Time (min)	MDC dpm/100 cm^2	Scan[b] MDC dpm/100 cm^2
Ludlum Model 2350-1, 43-68 Probe	Alpha	5	2	0.155	1	49	500[c]
Ludlum Model 2350-1, 43-68 Probe	Beta-Gamma	5	243	0.275	1	220	511
2"x2" NaI	Gamma	1	~10k-20k	900 cpm/uR/h (weighted)	1 sec (scan)	N/A	~6.4 pCi/g (Cs-137)
Bicron Micro-Rem Meter	Gamma	N/A	μrem/h (varies)	Read Out in μrem/h	N/A	N/A	N/A
Reuter-Stokes[d] Pressurized Ion Chamber	Gamma	N/A	μR/h (varies)	Read Out in μR/h	N/A	N/A	N/A

[a] Actual calibration sources may be Cs-137, Tc-99, Am-241 or Pu-239. The efficiency is determined by counting the source with the detector in a fixed position from the source (reproducible geometry).
[b] MDC_{scan} is calculated by assuming a scan rate of 5 cm/sec (unless otherwise marked), which is equivalent to a count time of 0.03 min, assuming an 8.9 cm detector width.
[c] The alpha scan MDC is determined by the approach described in Section 6.7.2.2 of NUREG-1575 (Reference 5-5). It assumes ≥ 1 cpm is necessary for the surveyor to pause.
[d] The pressurized Ion Chamber (PIC) is used for comparison only. No release survey data are collected using this instrument.

Question 16 - <u>Sections 5.2.3.2.1, 5.2.3.2.3, and 5.2.3.2.4, pages 5-5 to 5-8</u>: Because there are several references to developing site-specific DCGLs, it is not clear how the screening values are intended to be used in the design of the FSS. Clarify if screening values will be used for planning surveys and demonstrating compliance with the release criteria. Also, clarify how the unity rule or the use of surrogates will be implemented. Provide information as to when the surrogate and gross activity DCGLs will be determined and under what conditions site-specific DCGLs will be used.

<u>Response:</u>

The site specific and augmented NRC screening DCGL values (Table 5-1) are intended for use in all areas where surface contamination exists such as in the upper six inches of soil (pCi/g) or for structural surfaces like steel and surface contaminated concrete (dpm/100 cm^2). Additionally, the surface soil DCGL values listed in Table 5-1 will be used as subsurface soil DCGL values in all cases where specific site modeling was not used to create additional DCGL values. Areas where site-specific modeling is currently being considered are the Saxton Steam Generating Station area subsurface volume contamination and the volume contaminated concrete of the SNEC CV. These additional DCGL values would be presented to NRC staff for review before use.

Review of remaining radionuclide concentrations associated with the SNEC Facility shows that Cs-137 is the appropriate radionuclide for use as a surrogate. Therefore, there are no current plans for using other radionuclides in the initial planning process. An example of how a surrogate radionuclide is used follows. This example <u>does not</u> reflect an actual concentration encountered at the SNEC Facility. However, it does show the use of a fractional limit imposed on the mix of 75%. This limit will ensure that no individual DCGL will be exceeded when used with an appropriately defined and conservative mix from any area. Using the most conservative mix from an area based on sample data adds an additional safety factor. Actual radionuclide concentrations will be developed post-remediation to ensure an appropriate mix is considered in the Final Status Survey planning stage.

Radionuclide	Concentration (pCi/g)	% of Total	DCGL (pCi/g)	Fraction of DCGL	Allowable Fraction	Allowable pCi/g	75% of Limit
Cs-137	10.5	74.84%	8.5	1.235	0.851	7.229	5.422
Co-60	0.5	3.56%	2.5	0.200	0.138	0.344	0.258
Am-241	0.01	0.07%	1.5	0.007	0.005	0.007	0.005
Ni-63	2	14.26%	1700	0.001	0.001	1.377	1.033
H-3	1	7.13%	260	0.004	0.003	0.689	0.516
C-14	0.02	0.14%	3.7	0.005	0.004	0.014	0.010
SUM=>	**14.03**	**100%**		**1.452**	**1.000**	**9.660**	**7.245**

Using the example provided, detection equipment would be optimized for Cs-137 with a limit of 5.4 pCi/g. This same approach can be used to produce effective DCGLs for surface activities (dpm/100 cm^2). An additional amount of conservatism is introduced for structural surface contamination, since all gross beta response is assumed to be as a result of Cs-137 contamination.

Site-specific DCGL values may be used in a similar fashion to calculate effective DCGL values, by simply substituting the appropriate values in the above Table and then doing the math. To date no additional site-specific DCGL values have been developed for surface or volume contamination other than those already provided in the SNEC LTP.

Question 17 - Section 5.2.3.2.4, pages 5-8: Describe the DQOs for the exposure rate measurements performed over open land survey units and explain their utilization in the FSS design. Clarify whether there will be a separate release criterion for exposure rate measurements.

Response:

Open land areas will be scanned by semi-automated contractor supplied measurement equipment and/or by hand-held NaI detector instrumentation. Samples will also be taken from open land areas. Sampling locations will be selected using MARSSIM methodology and scans will meet the intent of scan methodology as described in the MARSSIM manual.

Exposure rates will be measured as an adjunct to the Final Status Survey measurement and sampling program to ensure that there is no unexplained above background exposure rate values present on site. Exposure rate measurements will be performed at 1 meter above the surface at each sampling location as well as in any additional area selected. These measurements have no specified DCGL limits associated with them. Instead, they will be compared with background measurements performed in non-impacted areas of similar geological composition. All measurements that are outside of two sigma of the mean background level identified in the non-impacted area will be further examined to determine if they contain previously unidentified contaminants relating to SNEC operation. If areas of concern are found, these areas could then be re-scanned, re-sampled or a nuclide specific spectroscopy measurement may be performed to further identify radionuclide composition.

Exposure rate measurements will be performed to assist in identifying problem areas but will not be performed to meet final site release requirements. Therefore, there is no set or predefined limits for this measurement type other than those discussed above.

Question 18 - Table 5-2, page 5-11, and Section 5.2.4.2, page 5-11: Provide justification to support classification of the Northeast Dumpsite as a Class 3 area. For clarity, the NRC staff suggests that Table 5-2 also summarize the survey areas along with the radionuclide concentrations and variability for each survey unit. Explain how a non-impacted area illustrated in Figure 5-1 can be surrounded by an impacted area.

Response:

The Northeast dumpsite is discussed in the Historical Site Assessment (HSA) report, page 30 (attached). Reasons for this classification level are presented in the HSA. Sampling results and HSA information support this classification.

A proposed revision of Table 5-2 has been included as indicated below.

Table 5-2
INITIAL CLASSIFICATIONS OF SITE AREAS

Survey Unit Designations of the SNEC Facility and Surrounding Impacted Areas									
Description	Classification			Survey Unit Area (m^2)*				No. of Survey Units*	Type of DCGL Applied*
	1	2	3	Floor	Walls	Ceiling	Other		
MISCELLANEOUS SNEC FACILITY AREAS & ITEMS									
Off-site Airborne Monitoring Stations		X					<10	1	1
Intake Tunnel Opening			X				600	1	2
SSGS Discharge Tunnel Outfall			X				600	1	2
Weir Outfall	X						400	1	2
Weir Outfall Buffer		X					1200	1	2
Northeast Dump Site			X				7000	1	2
Remaining Weir Line to River	X						122	1	2
Spillway (Shunt Line Outfall)			X				400	1	2
Embedded Piping in CV	X						TBD	1	1
Northwest Open Land Area			X				4100	1	2
Northwest Open Land Area		X					10	1	2
Other Embedments in CV	X						TBD	1	1
CONTAINMENT VESSEL (CV) AREA 1, BASEMENT 765' TO 779'-8"									
Ceiling	X					50.3		1	1, 3
Main Floor	X			40.1				1	1, 3
Haunch Wall	X			24.1	14.0			1	1, 3
Sloped Wall South	X				84.3			1	1, 3
South Wall 777-8" to 779'-8"	X				6.5			1	1, 3
North Wall (Excluding M/U Filter Cubicle)	X				41.6			1	1, 3
Sump	X			1.5	5.9			1	1, 3
M/U Filter Cubicle Exterior Walls	X				29.5			1	1, 3
M/U Filter Cubicle Mezzanine	X			8.7				1	1, 3
M/U Filter Cubicle	X			4.2	28.3	4.2		1	1, 3
CONTAINMENT VESSEL (CV) AREA 1, ROD ROOM									
Main Floor	X			8.8				1	1, 3
Haunch Wall	X			7.7	4.2			1	1, 3
North Wall (Sloped)	X				17.3			1	1, 3
South Wall	X				14.9			1	1, 3
East Wall	X				14.3			1	1, 3
Ceiling	X					22.7		1	1, 3
Reactor Vessel Port	X					9.3		1	1, 3
CONTAINMENT VESSEL (CV) AREA 2, PRIMARY COMPARTMENT 779'-8" TO 818'									
North Wall 779'-8" to 795'	X				32.6			1	1, 3
North Wall 795' to Ceiling	X				40.2			1	1, 3
West/South Curved Wall 779'-8" to Ceiling	X				122.2			2	1, 3
East Wall 779'-8" to 795'	X				35.3			1	1, 3
East Wall 795' to Ceiling	X				41.9			1	1, 3
Floor	X			41.9				1	1, 3
Ceiling	X					32.5		1	1, 3

*NRC Default Surface DCGLs=1, Site Specific Surface Soil DCGLs=2, Volumetric Concrete DCGLs=3
TBD = To Be Determined. These items may be removed before the FSS begins.
*Estimated with best available information
NOTE: These areas are impacted. Characterization is ongoing, in order to properly classify them.

Table 5-2 (continued)
INITIAL CLASSIFICATIONS OF SITE AREAS

Survey Unit Designations of the SNEC Facility and Surrounding Impacted Areas									
Description	Classification			Survey Unit Area (m^2)*				No. of Survey Units*	Type of DCGL Applied*
	1	2	3	Floor	Walls	Ceiling	Other		
CONTAINMENT VESSEL (CV) AREA 3, AUXILIARY COMPARTMENT 779'-8" TO 812'									
North Wall 779'-8" to 795'	X				31.9			1	1, 3
North Wall 795' to Ceiling	X				31.4			1	1, 3
West Wall 779'-8" to 795'	X				35.3			1	1, 3
West Wall 795' to Ceiling	X				34.3			1	1, 3
South & East Curved Wall 779'-8" to 795'	X				52.7			1	1, 3
South & East Curved Wall 795' to Ceiling	X				51.8			1	1, 3
Ceiling	X					30.4		1	1, 3
CONTAINMENT VESSEL (CV) AREA 4, OPERATING COMPARTMENT 812' TO 818'									
812' Floor Above Storage Well	X			38.3				1	1, 3
812' Floor Above Aux. Compartment	X			37.1				1	1, 3
812' to 818' Center Wall	X				31.3			1	1, 3
812' Stairway Hatch	X				13.6			1	1, 3
812' Aux. Compartment Equipment Hatch	X				14.9			1	1
818' Primary Compartment Equipment Hatch	X				13.4			1	1
818' Floor	X			56.7				1	1, 3
CONTAINMENT VESSEL (CV) AREA 6, STORAGE WELL 765' TO 812'									
Deep End South Wall 765' to 779'-8"	X				25.2			1	1, 3
Deep End South Wall 779'-8" to 795'	X				29.7			1	1, 3
Deep End South Wall 795' to Ceiling	X				23.4			1	1, 3
Shallow End South Wall 779'-8" to 795'	X				40.3			1	1, 3
Shallow End South Wall 795' to Ceiling	X				29.0			1	1, 3
Deep End West Wall 765' to 779'-8"	X				21.9			1	1, 3
Shallow End 779'-8" Floor	X			29.3				1	1, 3
Deep End 765' Floor	X			9.0				1	1, 3
Deep End 765' El., Haunch Wall	X			7.9	4.3			1	1, 3
768'-3" El. Top of Haunch Wall to 779'-8"	X				30.4			1	1, 3
Deep End 795' to Ceiling Curved Wall	X				31.4			1	1, 3
Deep End 779'-8" to 795' Curved Wall	X				39.9			1	1, 3
Shallow End 779'-8" to 795' N-NW Curved Wall	X				47.0			1	1, 3
Shallow End 795' to Ceiling Curved Wall	X				37.0			1	1, 3
Storage Well Shield Block Walls	X				36.6			1	1, 3
Ceiling	X					22.5		1	1, 3
CONTAINMENT VESSEL (CV), INTERIOR & EXTERIOR DOME									
Interior Walls of CV Dome	X				466.1			10	1
Interior Top of CV Dome	X					335.7		10	1
Exterior Walls From Grade Down ~2.4 Meters	X				117.1			2	1
Exterior Walls From Grade to 2 Meters	X				71.5			1	1
Exterior Walls > 2 Meters to Dome Top		X			420.1			4	1
Exterior Top of CV Dome		X				335.7		3	1

*NRC Default Surface DCGLs=1, Site Specific Surface Soil DCGLs=2, Volumetric Concrete DCGLs=3
*Estimated with best available information

Table 5-2 (continued)
INITIAL CLASSIFICATIONS OF SITE AREAS

Survey Unit Designations of the SNEC Facility and Surrounding Impacted Areas									
Description	Classification			Survey Unit Area (m^2)*				No. of Survey Units*	Type of DCGL Applied*
	1	2	3	Floor	Walls	Ceiling	Other		
MATERIAL HANDLING BAY (MHB) – SNEC AREA									
Floors & Walls Up to 2 Meters (Interior)	X			21.7	19.9			1	1
Upper Walls & Ceiling (Interior)		X			63.0	21.7		1	1
Roof			X			23.9		1	1
Exterior Walls			X		55.5			1	1
PERSONNEL ACCESS FACILITY (PAF) – SNEC AREA									
Floors & Walls Up to 2 Meters (Interior)	X			36.1	48.9			1	1
Upper Walls & Ceiling (Interior)		X			115.7	36.1		1	1
Roof			X			39.8		1	1
Exterior Walls			X		132.5			1	1
DECOMMISSIONING SUPPORT BUILDING (DSB) – SNEC AREA									
Floors & Walls Up to 2 Meters (Interior)	X			212.4	120.7			5	1
Upper Walls & Ceiling (Interior)		X			289.5	212.4		1	1
DSB Carport			X	61.6		61.6		1	1
Roof			X			224.6		1	1
Exterior Walls			X		325.4			1	1
WAREHOUSE (LARGE GARAGE-South) – PENELEC AREA									
Floors & Walls Up to 2 Meters (Interior)		X		450.2	290.3			2	1
Upper Walls & Ceiling (Interior)			X		292.3	450.2		1	1
Exterior Walls			X		373.5			1	1
Roof		X				418.1		1	1
Drains, Septic System & Misc. Piping		X					<10	1	1
GARAGE (SMALL GARAGE-Southwest) – PENELEC AREA									
Floors & Walls Up to 2 Meters (Interior)	X			109.3	122.1			4	1
Upper Walls & Ceiling (Interior)			X		296.7	109.3		2	1
Exterior Walls			X		179.5			1	1
Roof		X			116.1			1	1
Drains & Misc. Piping	X						<10	1	1
LINE SHACK - PENELEC AREA									
Floors & Walls Up to 2 Meters (Interior)	X			289.9	177.3			5	1
Upper Walls & Ceiling (Interior)	X				190.9	412		7	1
Exterior Walls	X				342.6			4	1
Roof	X					323.7		4	1
Roof Drainage System	X						<10	1	1
Old Septic System	X						<10	1	1
Floor Drains & Associated Piping	X						<10	1	1
PENELEC SWITCHYARD BUILDING									
Interior			X	54.6	89.0	54.6		1	1
Exterior Walls and Roof			X		151.1	68.0		1	1

*NRC Default Surface DCGLs=1, Site Specific Surface Soil DCGLs=2, Volumetric Concrete DCGLs=3
*Estimated with best available information

Table 5-2 (continued)
INITIAL CLASSIFICATIONS OF SITE AREAS

Survey Unit Designations of the SNEC Facility and Surrounding Impacted Areas									
Description	Classification			Survey Unit Area (m^2)*				No. of Survey Units*	Type of DCGL Applied*
	1	2	3	Floor	Walls	Ceiling	Other		
SAXTON STEAM GENERATING STATION (SSGS)									
Interior of Discharge Tunnel	X			6265	12530	6265		See Note	1, 3
Footprint of SSGS – Open Land Area	X						3200	See Note	1, 2, 3
Impacted Section of SSGS Intake Tunnel		X					1930	See Note	1, 2, 3
SAXTON STEAM GENERATING STATION (SSGS) SPRAY POND AREA									
Open Land Area		X					12300	2	2
SNEC FACILITY SITE OPEN LAND AREA									
SNEC Facility Site & Near Site Area	X						10800	11	2
GPU ENERGY (PENELEC) SITE OPEN LAND AREA									
Westinghouse and Adjacent Areas**	X						5700	6	2
Warehouse Burn Area	X						20	1	2
Buffer Zones		X					8300	4	2
REMAINING IMPACTED OPEN LAND AREA									
Site Road Access Areas		X					20900	9	1, 2
Stack Release Area (NNE)		X					14000	3	2
Stack Release Area (SSW)		X					8600	2	2
Buffer Zones			X				43400	4	2

*NRC Default Surface DCGLs=1, Site Specific Surface Soil DCGLs=2, Volumetric Concrete DCGLs=3
NOTE: These areas are impacted and probably are Class 1. Characterization is ongoing. Ceiling of Discharge Tunnel may be Class 2 after proper characterization is complete. SSGS & SSGS Intake Tunnel has yet to be properly characterized and no structural surface area has been calculated. Values in table are ground elevation profiles of the suspected subsurface area.
*Estimated with best available information.
**Includes substation yard drainage area.

The non-impacted area in Figure 5-1 will be re-classified as an Impacted Class 3 Area. Figure 5-1 will be revised appropriately.

Question 19 - Section 5.2.4.4, page 5-14: This section discusses making changes to classification based on "a high degree of confidence." Elaborate as to what constitutes a high degree of confidence.

Response:

Section 5.2.4.4 was included in the SNEC LTP to provide a method for changing classifications when a change was warranted without adding undue restrictions. Section 5.2.4.4 will be revised as indicated below.

5.2.4.4 CHANGES IN CLASSIFICATION

Changes in classification are based on survey data and other available information that indicates another classification is more appropriate. All changes of area classifications (after LTP approval) where a higher classification is lowered (e.g., Class 1 to Class 2), will be performed in accordance with 10 CFR 50.59. However, lower classifications may be raised as deemed appropriate to GPU management, any time new information warrants such a change. To justify changing an area classification from Class 1 to Class 2, the existing information (from the HSA, scoping surveys, or characterization surveys) should provide a high degree of confidence that no individual measurement would exceed the $DCGL_W$. However, these reasons for change will not of themselves be used without valid measurement and/or sample results as a justification for reducing an areas classification (Class 1 to 2 or 2 to 3). The justification for lowering a Class 2 to a Class 3-survey classification will require a high degree of confidence that no individual measurement would be above a small fraction of the $DCGL_W$ (i.e., 10%). A high degree of confidence is established when a scan of an impacted area indicates that the above values have not been exceeded, and existing sample analysis results from these areas also support these measurement results.

Question 20 - Section 5.4, Table 5-5, page 5-24: The footnote designations used in the table are labeled with numbers, but within the table the footnotes are shown as letters. For clarity, one type of designation should be used consistently. In addition, the scan coverage for a Class 3 area should be revised to reflect minimum recommended scan coverage of "Judgmental, up to 10% other than "0 to 10%" as indicated. Also, if preliminary information suggests that there may be locations above the DCGL, the survey unit should not be designated a Class 2 area. This survey unit would be more appropriately considered Class 1 and surveyed accordingly. Justify your approach or revise this section.

Response:

Table 5-5 will be revised as shown below. GPU Nuclear agrees that if preliminary information suggests that there may be locations above the DCGL, the survey unit should not be designated a Class 2 area. This is consistent with MARSSIM methodology and the SNEC LTP (see Sections 5.2.4.2.1 through 5.2.4.2.3 of the SNEC LTP).

Table 5-5
Survey Design Summary

Specification	Class 1		Class 2		Class 3		Plant Systems
	Structures	Land Areas	Structures	Land Areas	Structures	Land Areas	
SURVEY UNITS							
Size Range=>	10 to 100 m^2	100 to 2000 m^2	10 to 1,000 m^2	100 to 10,000 m^2	No Limit	No Limit	N/A
Reference Coordinate Grid[a]=>	1 to 2 m	10 to 20 m	1 to 2 m	10 to 20 m	5 to 10 m	20 to 50 m	N/A
SCAN MEASUREMENTS							
Scan Coverage=>	100%		10 to 100%[b]		Judgmental, up to 10%		Variable[c]
Scan Area Selection=>	Accessible surface areas		Judgmental; systematic along transects or of randomly selected grids		Judgmental; random		Judgmental; accessible[d] surface area
STATIC MEASUREMENTS							
Number of Measurements>	Calculated using the methodology of Appendix 5-2 (Default Value is 30[e])						30[f]
Location Selection=>	Random starting point, systematic spacing[g]				Random		Accessible Points
Spacing (L)=>	$L = (A/n)^{1/2}$ for square grid (see Section 5.4.3.2), A = total survey unit area; n = # of measurements				N/A		N/A
Type of Survey[h]=>	SC	SO[i]	SC	SO[i]	SC	SO[i]	SC[j]

a) A square grid system pattern is used and multiple grid patterns are employed as necessary unless survey needs dictate otherwise.

b) Where scanning coverage greater than 50% is judged appropriate, the survey unit may be reclassified as a Class 1 survey unit.

c) Performed according to the scan coverage for the class of survey unit (where possible). The amount of accessible surface area dictates the percentage of surface area scanned

d) Includes health and safety considerations.
e) This number is sufficient for survey units less than 10 square meters in area, and may be used for embedments such as brackets, unistrut or sections of piping.
f) As allowed by plant system size and accessibility to system interior surfaces.
g) Except when statistical tests are not applied (i.e., post remediation survey data for a survey unit are all less than DCGL).
h) SC represents surface contamination measurements; SO, represents soil measurements.
i) Subsurface samples will be obtained from randomly selected locations as well as biased locations.
j) Scale and sediment samples will be collected from embedments (e.g., piping, unistrut) as appropriate.

Question 21 - Section 5.4.3, page 5-27: Clarify the statement: "When instrumentation and techniques used for scan measurements are capable of providing data of sufficient quality as static measurements, they may be used in place of a static measurements." Explain under what conditions will the use of scan measurements be applicable over static measurements. Provide justification as to the applicability of this technique and how the data will be evaluated to demonstrate compliance with the release criteria.

Response:

See proposed revision of Section 5.4.3 below.

5.4.3 STATIC MEASUREMENTS

Static measurements provide a quantitative measure of the radioactivity present at the location measured. Static measurements are performed at a frequency and location throughout each survey unit, such that a statistically sound conclusion can be developed. Static measurements may be performed at locations of elevated residual radioactivity identified by scan measurements. These types of static measurements may include direct surface contamination measurements, and soil and bulk material measurements.

There are several vendors that can supply semi-automated, large area, position sensitive, and radiation measurement equipment. The use of this type of instrumentation is applicable in areas where relatively flat surfaces exist (either for structures or for surface soils). Scanning results using this equipment could be acceptably substituted for static measurements when the scan MDC is well below the requirements for releasing the area (e.g., 10% of the applicable DCGL). This type of equipment can provide greater confidence in the survey results in that surveyor error is greatly reduced and typical detection sensitivities are usually higher than hand held survey equipment. In addition, an entire area is more appropriately scanned at 100% coverage making statistical testing of survey areas unnecessary.

GPU Nuclear is currently evaluating these types of equipment and their capabilities in an effort to expedite and possibly improve overall scanning capabilities. If instrumentation of this type is used for scan measurements and the measurements are capable of providing data of sufficient quality as that provided by static measurements, they could be used in place of static measurements. The same logic may be applied for using *in-situ* gamma spectrometry in place of sampling and analysis for soil and other volume contaminated materials in concert with appropriate surrogate radionuclides. However, GPU Nuclear has agreed that soil samples will still be collected in open land areas additional to these semi-automated scan survey techniques.

Question 22 - Section 5.4.4, Tables 5-7 and 5-8, pages 5-31 and 5-32: Clarify how Class 2 and Class 3 survey units will be reclassified. Explain how a determination will be made if all or a portion of a survey unit is reclassified, and if remediation of the elevated activity will be considered prior to reclassifying a survey unit. Clarify the method that will be used if an area must be upgraded to a higher classification.

Response:

In, general Figure 5-2 and Section 5.4.4.1 serve as the initial data review process. Tables 5-7 and 5-8 attempt to clarify when reclassification is appropriate. However, there is no substitute for professional judgment since, elevated measurements can be caused by events other than contaminated survey units.

Section 5.4.4.4 and 5.4.4.5 will be revised as follows.

5.4.4.4 Reclassification

If survey measurements in a Class 2 or Class 3-survey unit exceeds the DCGL, the survey unit is reclassified as a Class 1-survey unit. A Class 2 or Class 3-survey unit that is remediated is reclassified as a Class 1 survey unit. If survey measurements in a Class 3-survey unit exceed 0.10 x the DCGL, the survey unit is reclassified as a Class 2 survey unit. If a Class 2 survey unit exhibits, measurements exceeding 0.5 x the DCGL it may be further investigated or re-classified as a Class 1 survey unit.

Due to size restrictions and other considerations, a reclassified survey unit may be need to be divided into two or more smaller survey units e.g., when a larger Class 2 survey unit is divided into two Class 1 survey units. When this type of subdivision is necessary because of the discovery of measurements or samples above release limits, GPU Nuclear will discuss the proposed re-classification and subdivision of the subject areas with regulatory personnel prior to planning and performing any additional final status survey in these areas.

5.4.4.5 Resurvey

If a survey unit is reclassified or if remediation activities are performed, then a re-survey using the methods and frequency applicable to the new survey unit classification is performed. Other than increasing scan coverage to 100% of the surface area, a complete resurvey of a Class 2 survey unit determined to be a Class 1 survey unit is not necessary provided remediation is not performed.

In the case where a new survey unit is separated out from an existing survey unit or an existing survey unit is subdivided, Class 3 survey units need only additional randomly located measurements to complete the survey data set. Class 1 and Class 2 survey units require a new survey design based on random-start systematic measurement locations.

Where only a small fraction of the area (< 10%) of a Class 1-survey unit is remediated, replacement measurements area collected within the remediated areas. Their locations are determined using the random selection process.

Question 23 - Section 5.5.2.4.1, page 5-37: Explain how the anticipated site radionuclide mixture ratios and various energies will be accounted for during instrument calibrations. Note that in the MDC_{SCAN} equation, as referenced from MARSSIM and defined in NUREG-1507, instrument efficiency, ε_i, is the net count rate per 2π surface emission, and the source efficiency, ε_s, is the 2π surface emission rate per the surface activity.

Response:

See proposed revision of Section 5.5.2.2 below.

5.5.2.2 Calibration and Maintenance

Instruments and detectors are calibrated for the radiation types and energies of interest. Anticipated radionuclide mixture ratios and varying energies are accounted for during calibration by using a calibration source with a conservative and/or representative average energy as compared to the weighted average energy of the anticipated nuclide mixture. For calibration of beta detectors, detector efficiencies are determined with calibration sources consisting of Tc-99, which emits an average energy of approximately 0.085 keV. This average energy is conservative when compared to the expected weighted average beta emission energy of 157 keV (the predominant detectable beta emitter is Cs-137). Similarly, the use of Th-230 or Pu-239 calibration sources having weighted average alpha energies of 4.654 MeV and 5.128 MeV, respectively, is representative as compared to the alpha emission energies (approximately 5.1 MeV to 6.1 MeV) of the expected surface nuclide mix for alpha emitters (Pu-238, Pu-239 & Am-241).

Calibration source efficiency variations resulting from source backscatter is small compared with efficiency loss due to uneven survey surfaces encountered during the survey process. The distance between the source and the detector is the primary contributor to detection efficiency variations. To account for survey surface to detector variations in the field such as surveys over scabbled concrete, the average variation in distance from the concrete to the detector is determined based on the unevenness of the survey surface. A correction or distance factor is then applied to the calibration factor of the instrument. The distance factor will be determined empirically at the SNEC Facility using an appropriate large area (150-cm2) calibration source and an approved procedure.

Instrument calibration and maintenance are performed in accordance with approved procedures. If vendor services are used, these services are conducted in accordance with approved procedures and a vendor QA program that is subject to approval in accordance with the Quality Assurance Program For Radiological Instruments and the SNEC Decommissioning Quality Assurance Plan (DQAP). Radioactive sources used for calibration purposes are traceable to the National Institute of Standards and Technology (NIST) or equivalent standards.

NUREG-1507 and MARSSIM survey methodology and efficiency calculation equations will be used (as appropriate) for fixed point and scan survey-planning input. All structural surfaces surveyed will be evaluated to determine the effect of surface unevenness, dust loading and moisture that could impact detector efficiency. If these survey area characteristics are shown to have an impact on detection efficiency, appropriate compensatory corrections will be made in the survey design, as well as the resulting calculated survey results.

Question 24 - Section 5.5.2.4.2 and 5.5.2.5, page 5-38: Provide the basis (e.g., site-specific relative ratios) for using a beta (β)-gamma surrogate for the purpose of detecting alpha (α) activity. In Table 5-10, explain what calibration sources and variables were used to determine the α- and β-particle efficiencies given (i.e., β-particle total efficiency for Tc-99 would be approximately 12%).

Response:

The highest gross alpha to Cs-137 ratio (to date) from any area outside of SNEC CV has been the material found in the SSGS Discharge Tunnel (see Table on following page). As can be seen from the results, Cs-137 is the major contributor and would provide greater than 90% of the beta response from this material for a surface deposited activity. Note that by assuming all instrument response is as a result of Cs-137, the final levels of all calculated activities will be overestimated since all calculated concentrations will be ratioed from the measured Cs-137 value.

For survey areas outside the CV, GPU Nuclear personnel will be using a post remediation-sampling program to verify final state concentrations and ratios of relevant radionuclides in all remediated areas. That is, the Discharge Tunnel radionuclide distribution will not be applied to all areas – most areas will have their own specific distribution determined.

In the SNEC CV, the same approach is being applied. Remediation efforts are being directed to decontaminate or remove embedments, residual piping and ductwork as well as surface and subsurface structural contamination. A post remediation sampling program will be employed to determine the final state radionuclide concentrations and ratios present in the SNEC CV before planning any Final Status Survey.

The values provided in Table 5-10 are "Typical" values for the instrumentation listed. Table 5-10 contains detection efficiencies that were determined using Cs-137 (beta) and Pu-239 (alpha) as the calibration sources for instrumentation used during previous survey efforts. Since instrument efficiencies vary slightly from instrument to instrument, the exact instrument efficiency is not appropriate for a table of this type that was intended to provide non-specific data (typical values). Table 4.2 of NUREG-1507 provides typical detection efficiencies for various energy beta and alpha emitters. It would appear that the SNEC LTP values are reasonably reported as "Typical" values based on NUREG-1507. Note that each instrument has its own set of efficiencies determined during calibration that are used to calculate activity results from raw count rates. "Typical" efficiencies are not used for final calculations.

	SNEC SAMPLE RESULTS	
	LAB or LAB No.	Location/Description
	Teledyne	Tunnel 6" Drain Line Scraping
	SNEC Sample No.	Comments:
	SX10SD990033	
		SAXTON STEAM GENERATING STATION *Discharge Tunnel - Pipe Sediment*
	Isotope	pCi/g
1	Am-241	5.4
2	C-14	< 6
3	Cm-243	No Analysis
4	Cm-244	< 0.4
5	Co-60	30
6	Cs-134	< 2
7	Cs-137	4800
8	Eu-152	< 20
9	Eu-154	< 5
10	Eu-155	< 9
11	Fe-55	No Analysis
12	H-3	< 100
13	N-94	< 2
14	Ni-59	< 100
15	Ni-63	55
16	Pu-238	1.6
17	Pu-239	2.5
18	Pu-240	No Analysis
19	Pu-241	< 60
20	Pu-242	< 0.4
21	Sb-125	< 20
22	Sr-90	< 8
23	Tc-99	< 10
24	U-234	0.45
25	U-235	< 0.2
26	U-238	0.57
	Other Isotopes	pCi/g or pCi/l (if water)
	I-129	< 5
	Gross Beta	No Analysis
	K-40	< 50 (39.8)
	Ra-226	< 70
	Th-232	No Analysis
	Cm-242	< 0.4
	Th-228	< 7

Question 25 - Section 5.5.3.4.7, page 5-43: Site characterization identified subsurface soil contamination in several areas. Describe how survey units in these areas will be surveyed in the FSS. Clarify whether these areas will be remediated prior to the FSS.

Response:

See answer to question No. 12 for FSS planning in remediated subsurface areas.

In general, subsurface characterization measurements and sampling may indicate remediation is necessary prior to planning subsurface surveys. This is the case in the area adjacent to the SNEC CV where remediation efforts are currently underway. There are no plans for remediation in other areas at the present time. However, the Saxton Steam Generating Station footprint characterization program is still underway.

A description of an applicable remediation and Final Status Survey (FSS) scenario is included below for subsurface soils where contamination is suspected. This response should be considered an enhancement and clarification of Sections 4.3.4 and 5.5.3.4.7 of the SNEC LTP.

- Characterization and Historical Site Assessment (HSA) information was reviewed and used to determine the appropriate area classification. The area classification chosen considers subsurface volumes below structures as well as previous remediation and survey efforts.
- A review of any existing measurement and/or sample results in the subsurface volume is then performed to determine if sufficient analysis results are available for Final Status Survey planning purposes. Review of results may indicate remediation is necessary.
- If additional characterization surveys or samples from various depths are needed, these are then planned and executed.
- If these additional sample results suggest or necessitate additional remediation, then additional remediation is performed before any further work proceeds.
- Impacted subsurface areas are then made accessible; i.e. obstacles to sampling and survey work are removed (where possible), including any contaminated materials or structures.
- When it is determined that there is a low probability of subsurface contamination above an applicable action level in any subsurface volume, or where sampling below structures is prohibitively difficult or expensive; sampling through floor/slab structures or road coverings may be the appropriate choice rather than removing the entire structure to access the subsurface volume.
- Surface soil DCGL values are used as applicable subsurface contamination limits for all subsurface areas where no specific modeling work has been performed.
- For areas such as the Saxton Steam Generating Station footprint, surface soil DCGL limits may not be applicable to subsurface volumes because of the modeling methodology employed. In these special cases, surface soil DCGL values may be replaced with more model specific values.

Question 26 - Table 5-16, page 5-64: Clarify the intent of the table. Decision errors are an essential part of the DQO process. Specifically, the Type I (α) error is established by the NRC with the default value being 0.05. The decision errors and the relative shift, Δ/σ, are used to determine the number of measurements necessary to satisfy the selected statistical test. Based upon the selection of the appropriate statistical test, this number can be optimized if Δ/σ is > 1. Changes in α will require NRC approval for modification in those instances where sample numbers are unreasonable.

Response:

GPU Nuclear agrees to an initial 0.05 α (Type I error) value. Any changes necessary to the 0.05 α (Type I error) limit will be discussed with and approved by the NRC prior to implementation. The data table in this section was included as an aid to understanding error determinations.

Question 27 - "Selecting a Minimum Number of Samples", page 5-67: It is not the intent of MARSSIM to design the survey to match a predetermined sample size. The formal process of establishing DQOs is to develop a survey design that optimizes the power of the statistical test for each individual survey unit. The number of samples required to demonstrate that a survey unit passes the release criteria needs to be determined and provided for each survey unit.

Response:

From MARSSIM, page 4-15, last paragraph, "Special considerations may be necessary for survey units with structure surface areas less than 10 m^2 or land areas less than 100 m^2. In this case, the number of data points obtained from the statistical tests is unnecessarily large and not appropriate for smaller survey unit areas. Instead, some specified level of survey effort should be determined based on the DQO process and with the concurrence of the responsible regulatory agency. The data generated from these smaller survey units should be obtained based on judgment, rather than on systematic or random design, and compared individually to the DCGLs."

GPU Nuclear would apply this paragraph when the survey unit was small (i.e., < 10 m^2). This includes such things as embedments, ducts and other structures that had limited surface areas. Note that the data from these small survey areas is to be obtained based on judgment rather than systematic or random design. Thirty samples and/or measurements in this size area would be sufficient.

Question 7 Attachment

SWI-00-015 “SNEC Site Bore Hole Gamma Logging and Sampling”

SNEC Facility SWI Cover Sheet

SNEC SWI	Saxton Nuclear Experimental Corporation Station Work Instruction	Number SWI-00-015
Title SNEC Site Bore Hole Gamma Logging and Sampling		Revision Number 0
Applicability/Scope This SWI is applicable to SNEC Site personnel involved in characterization activities		Effective Date 7-31-00
In QA Plan Scope Yes ☒ No ☐ Safety Reviews Required Yes ☒ No ☐		Specific SWI ☒ Generic SWI ☐

Document Control Stamps

DOCUMENT CONTROL

INFORMATION ONLY

Title	Signature	Date
Originator	B. Brosey/ B. Brosey	7/31/00
Responsible Technical Review	MSWilliams/ MSWilliams	7/31/00
Independent Safety Review	N/A	
Radiation Safety Officer	For A. Paynter/ W. Stoner/	7/31/00
SNEC Facility Site Supervisor	P. Carmel/ Perry G Carmel	7/31/00
Program Director, SNEC Facility	G.A. Kuehn/ Perry G Carmel for	7/31/00

Closed Out By	
Signature	Date
Reason	

1.0 TASK DESCRIPTION

1.1 This SWI provides guidance on obtaining radiological and/or environmental data for the purpose of characterizing additional areas and facilities more recently identified and determined to be impacted as a result of the operation of the Saxton Nuclear Experimental Corporation (SNEC) Facility.

1.2 This SWI is an extension of the original Saxton Site Characterization Plan (**Reference No. 6.6**), and encompasses additional areas and facilities more recently identified as being potentially impacted.

1.3 Information collected under this SWI will be used for planning remediation activities and/or additional characterization activities (as appropriate), supporting the SNEC Facility remediation and Final Status Survey program.

1.4 This SWI contains no minimum number of survey/sample locations. D&D Engineering and/or SNEC Management will decide the number and location of all bore holes/wells needed based on concerns. requests for information and the need for scoping/characterization information.

2.0 EQUIPMENT/MATERIALS/TRAINING

2.1 Equipment and Materials Needed (Typical Listing)

2.1.1 E-140N Portable Count Rate Meter with a HP-210/260 or Equivalent GM Probe
2.1.2 Bicron Micro-Rem Dose Rate Instrument or Equivalent
2.1.3 Sodium Iodide Detector (NaI) and Count Rate Instrumentation
2.1.4 Calibration or check sources (as necessary)
2.1.5 Survey Map for the Areas
2.1.6 Sample Collection Containers (various sizes as needed)
2.1.7 Clipboard, Paper, Pencils/Pens, Permanent Marking Pen, etc.
2.1.8 Special Measurement Equipment e.g., Gamma-ray Spectrometer, etc. (as necessary)
2.1.9 Electrical Power Source (portable generator, etc., as needed)
2.1.10 Scraping Tool, Scoops, Spatulas, Shovels
2.1.11 Plastic Bags and Tie Wraps
2.1.12 Video and/or Photographic Equipment
2.1.13 Site Map Supplied by L. Robert Kimball & Associates Inc.
2.1.14 Bore Hole Drilling Equipment, Pipe Casing, PCV Piping, etc.
2.1.15 Portable Lighting, etc.
2.1.16 Cutting knife and Other Hand Tools
2.1.17 Other Equipment and Materials as Deemed Appropriate

2.2 Training

SNEC site personnel performing characterization work shall be qualified, and approved by the SNEC Site Supervisor and RSO to perform the functions described. Some training may be performed in the field prior to starting the work. Documented training is required for the following:

- Soil Sampling (**Reference 6.5**).
- Radiological measurements.
- All other tasks as necessary to perform work described in this SWI where SNEC Management requires documented training.

3.0 PREREQUISITES, LIMITS AND PRECAUTIONS

3.1 Review work objectives and requirements during a pre-job briefing.

3.2 Inspect the survey areas to ensure accessibility.

3.2.1 If accessibility is a problem (trees, tall grass, shrubs etc.), obtain site support for removing obstructions on an as needed basis.

3.2.2 Inspect each work site (review drawings etc.) to ensure that there are no obstructions, cable crossings and underground piping or electrical conduits in the area to be drilled.

3.2.3 The initial list of bore holes/wells to be gamma-logged includes wells 1 through 4 previously drilled by PA Drilling Company. Other bore hole/well gamma-logging and sampling points will be added, as directed by SNEC Management.

3.3 Assemble all necessary equipment, materials and support services prior to starting work.

3.4 Review safety-related issues as required by the SNEC site safety representative.

3.5 Sample tracking shall be performed in accordance with **Reference 6.1.**

3.6 Radiological Controls instrumentation used to perform radiological surveys or analyze samples on-site shall meet the requirements of **Reference 6.2.**

3.7 Radiological Controls Technicians shall perform and document radiological surveys in accordance with **Reference 6.3.**

3.8 On-site count-room gamma spectroscopy of samples shall be performed in accordance with **Reference 6.4.**

3.9 Review applicable Sections of **Reference 6.5** prior to performing sampling operations.

3.10 Qualified and experienced personnel shall operate portable gamma-ray spectroscopy equipment IAW this SWI or an approved SNEC Facility procedure.

3.10.1 CoPhysics Portable gamma-ray spectroscopy equipment shall be operated in accordance with the CoPhysics procedure attached to this SWI **(Attachment 3)**..

3.11 All samples collected shall be retained until verification surveys are complete and NRC approves site license termination.

3.12 At a minimum, all samples shall be gamma scanned. Off-site laboratory sample analysis requirements shall be determined after review of initial on-site sample analysis results. The initial off-site laboratory location is the AmerGen ERL. Other off-site laboratory services may also be assigned as determined by D & D Engineering.

3.13 Personnel involved with sampling operations shall take the necessary precautions to prevent sample cross contamination (i.e., change gloves between samples, use only clean/new containers to collect samples).

3.14 All sample containers shall be marked with the following information:

1) Date and time sample was taken.
2) The assigned Sample Identification Number from the Chain of Custody Log.
3) Person's initials who collected the sample.
4) Sample location and sampling depth (as appropriate).

3.15 Show all sampling and survey locations on survey maps or site diagrams. A copy of **Attachment 2** (or equivalent, survey form, etc.) should be used for each gridded area based on the L. R. Kimball & Associates site grid map. Mark all corner pin numbers as found in the field for each grid area (if available). Survey areas without marker pins may be approximately located using a copied section of the L. R. Kimball & Associates SNEC site grid maps or other representative diagrams/maps.

3.16 Because of unforeseen circumstance e.g., unfavorable field conditions or safety concerns, a sampling point may not be accessible. If this happens, discuss the problem with SNEC site supervision to determine if an alternate location is viable. Relocate sampling points as approved by SNEC management. Record any comments on **Attachment 1** (list any added **Attachment 1** sheets as an Enclosure).

3.17 Radioactive check source and calibration sources shall be controlled as directed by the Radiological Controls department IAW current SNEC site procedures. Radioactive check or calibration sources that are stored at the site shall be stored in a secure location when not in use.

4.0 WORK INSTRUCTIONS

4.1 Review the areas to be drilled/sampled/gamma-logged on the SNEC site area grid map provided by L. Robert Kimball & Associates Incorporated.

4.2 Locate and mark the drill sites prior to performing drilling operations.

4.2.1 Locate the first sampling/measurement point on a grid diagram (copy of **Attachment 2**). Show land marks as appropriate. (a Radiological Controls survey form may be used as a substitute for **Attachment 2** providing the grid pins at each corner of the gridded sampling area are placed on the survey map).

4.2.2 Lay out and mark the drilling sites using a tape measure or other measuring device IAW existing drawings and/or as directed by SNEC Management.

4.3 The contractor performing the drilling operation shall provide a bore hole for sampling and gamma logging as required by SNEC management. A typical bore hole of six- (6) feet in depth will provide two- (2) samples (one- (1) sample for every three- (3) foot of hole depth).

NOTE

Depending on the type of drilling equipment used, samples may be taken more frequently e.g., every foot (as determined by SNEC Management). However, at a minimum one (1) sample should be collected for every three-(3) foot of drill depth. In some locations, because of the type of material encountered (building debris, stone, etc.), and the drilling method used, this may not be possible and the actual sample depth may be poorly identified. When this is the case, the best estimated depth of the sample materials should be recorded with the words "**ESTIMATED DEPTH**" added to the sample identification tag/label of the sample container.

4.4 Obtain bore hole samples from drilling contractor and process IAW **Reference 6.5**. Some samples may be in plastic sleeves depending on the method used by the contractor to obtain the samples or drill the holes. Cut as necessary to obtain sample materials.

NOTE

Previously drilled holes may have been sampled under other implementing documents.

4.5 Perform a gamma logging sequence IAW **Attachment 3** (or an approved SNEC procedure).

4.6 Perform bore hole/well water volume sediment sampling IAW **Attachment 4**. Treat any sample materials collected IAW this SWI.

4.7 Use a copy of **Attachment 1** to record ground water level and hole depth for each bore hole/well as this information becomes available, or record this information on a Radiological Survey form. Include all complete **Attachment 1** sheets as an Enclosure.

4.8 When a measurement sequence is complete (as determined by CoPhysics and/or SNEC Management), the bore holes/wells may be back filled or removed as required by SNEC management.

4.9 All bore hole sampling and gamma-logging equipment shall be surveyed IAW SNEC site Radiological Controls procedures prior to release from the site property. Equipment clean up shall be controlled IAW good radiological controls practices as directed by Radiological Controls personnel.

4.10 Radiological Controls personnel shall submit all grid maps and/or Radiological Survey Form(s) and on-site HP(Ge) Gamma Spectroscopy Sample Analysis Reports to the Group Radiological Controls Supervisor (GRCS) for review.

4.11 The GRCS shall review all survey forms and sample grid maps for completeness and adequacy (as appropriate) and submit copies to D&D Engineering for each measurement/sample location.

5.0 ACCEPTANCE CRITERIA

5.1 All surveys shall be documented.

5.2 All samples shall be labeled appropriately and logged into the SNEC facility sample logbook.

5.3 All samples shall have a SNEC sample number assigned.

5.4 All additional samples or surveys (outside those required by this SWI) shall be documented IAW this SWI.

5.5 All survey forms shall be reviewed and approved by a SNEC site GRCS.

5.6 All survey and sample results shall be (eventually) copied and attached to this SWI for close out.

5.7 All samples shall be gamma scanned on-site (at a minimum).

5.8 All survey and sample results (including survey and sampling maps) shall be copied and forwarded to D&D Engineering.

5.9 A copy of the gamma scanning data report or a Technical Evaluation calculation used to document gamma scan results shall be attached to this SWI for close-out.

5.10 All bore hole/well locations will be clearly marked on a survey form or a copy of **Attachment 2**, to include coordinates (measurements) from the lower left grid pin.

5.11 All acceptance criteria have been satisfied: ______________________ Date/Time: ____________
Site Supervisor (or designee)

6.0 REFERENCES

6.1 E900-ADM-4500.39 - Chain of Custody for Samples

6.2 E900-QAP-4220.01 - Quality Assurance Program for Radiological Instruments

6.3 E900-ADM-4500.12 - Radiological Surveys: Requirements & Documentation

6.4 E900-OPS-4524.33 - Acquisition & Data Analysis of High Resolution Gamma Spectra using the

Inspector Portable Gamma Spectroscopy System

6.5 E900-IMP-4520.01 – Final Status Survey Sampling Methodology

6.6 6575-PLN-4520.06 – SNEC Site Characterization Plan

7.0 ATTACHMENTS

7.1 Attachment 1 - Additional Sampling Information or Comments

7.2 Attachment 2 - Above Background Grid Locations

7.3 Attachment 3 - CoPhysics Procedure for the Gamma-logging of Radioactivity in Soil/Debris Using a Multichannel Gamma Spectrometer

7.4 Attachment 4 - Sampling Sediment From Water Volume In Bore Holes/Wells

Attachment 1

Additional Measurement and Sampling Information or Comments

(Use as many copies of this form as necessary to describe actions taken)

ENCLOSURE No.____________

Site Supervisor (or Designee) Sign & Date Each Page Added.

Attachment 2

GRID LOCATIONS*

(As applicable, complete one form (or equivalent) for each grid location)

Pin No. ____________ Pin No. ____________

Pin No. ____________ Pin No. ____________

Use additional copies of this form as needed.

*As determined by this SWI.

Attachment 3

CoPhysics Procedure for the Gamma-logging of Radioactivity in Soil/Debris Using a Multichannel Gamma Spectrometer

10/99
Revised 7/00

1.0 Purpose

The purpose of this procedure is to specify a method to estimate the vertical extent and magnitude of gamma-emitting radionuclides (cesium-137 and cobalt-60) in soil/debris via down-hole gamma logging of holes punched with a Geoprobe or other acceptable drilling rigs.

2.0 Applicability/Scope

The scope of this procedure includes the punching or drilling of 2" diameter holes (or larger) into soft soils with subsequent measurement of subsurface gamma radiation spectra using a gamma scintillation detector. The procedure also may be applied to the assessment of harder soils or concrete rubble using heavier drilling rigs.

While gamma logging does not assess an exact amount of soil or debris, it is useful in final status surveys to provide an upper limit of the radionuclide concentrations in the approximately 2-foot diameter column of soil or sample materials around the hole. If no significant counts are obtained from the radionuclides of interest around the hole, then a "less than" value, or minimum detectable concentration (MDC), can be quoted for the soil/debris around the hole at a given confidence level (usually 95%). By ensuring that the MDC is less than the release criteria, the surveyor can designate the soil/debris to be "clean" at the given confidence level.

If significant counts are obtained from the radionuclides of interest, then the average concentration in the approximately 1-foot radius around the hole can be estimated from the gamma logging data and additional soil/debris sampling can then be performed with subsequent laboratory analysis to more specifically quantify the concentrations.

3.0 Definitions

3.1 Geoprobe – A truck-mounted, hydraulic ram that punches holes into soil for various types of geophysical testing. Some units have rotary drilling capability.

3.2 Drilling rig – A large, truck mounted rotary drill, used to drill 4" to 12" diameter holes into soil, rock and building materials.

3.3 Count rate to concentration conversion factor (cpm per pCi/g) – A factor used to convert detector counts per minute in a specific photopeak to a radionuclide concentration around the bore hole. It may be determined from a calibration of the

Attachment 3 (cont'd)

detector at a test hole in radionuclide-bearing soil of known concentration or with a calibration source at varying source to detector distances.

3.4 ROI – Region of Interest.

4.0 *Procedure*

4.1 Equipment Listing

4.1.1 Portable multichannel analyzer, power supply and electronics

4.1.2 NaI gamma radiation detector with cable(s) of sufficient length to reach the expected depth of the holes to be dug.

4.1.3 Radioactive check and/or calibration source(s)

4.1.4 PVC bore hole sleeves (in 10- or 20-foot lengths) with watertight plugs to be installed as needed on site. Diameter of sleeves may vary depending on the size of detector to be used.

4.2 Hole Preparation

Bore holes are to be punched, augured or cored. Punching or coring are the preferred methods, as they tend not to disturb the vertical soil distribution as does drilling. An approximately 2-1/2" diameter hole is necessary to allow installation of a Schedule 40 PVC sleeve, or equivalent. The only critical sleeve specification is the inside diameter which must be at least 2.0" for a 1" x 4" NaI detector or larger for larger detector types. In addition, the bottom of the sleeve must be water tight (using a plug or cap) to prevent groundwater entry.

4.2.1 When holes have been drilled and a PVC sleeve is in place (previously drilled holes may have PVC sleeves already installed), ensure that there is no significant water present in the PVC sleeve. Remove water as per Radiological Controls direction before inserting the radiation detector.

4.3 Sampling

Soil sampling may be necessary to further assess areas in which elevated gamma-ray activity is detected. Typical split-tube samplers can be used to extract soil cores. The remaining hole then would be sleeved and gamma-logged. Specific sample handling procedure is provided in the Saxton Facility Policy and Procedure Manual, Final Status Survey Sampling Methodology.

Attachment 3 (cont'd)

4.4 *Equipment Decontamination*

Soil sampling split tubes and other tools must be decontaminated to prevent sample cross contamination. A bucket wash and rinse with air or towel drying is to be used.

4.5 *Gamma Logging*

The NaI gamma scintillation detector is to be lowered into each sleeve at 12" intervals, starting at one half interval (i.e., 6") from the surface. Perform a count at each interval for a sufficiently long period to achieve the desired Minimum Detectable Concentration (normally 3 to 10 minutes). Print the results or store the spectra in the computer for later report printing. Backup all data onto floppy disk every day as a loss prevention measure. Also manually record the Cs-137 and Co-60 region net count rates on a data sheet (see Appendix) for purposes of rapid field review of the data so that additional hole location planning can be performed.

4.6 *Quality Assurance*

4.6.1 Daily Checks

At the beginning of each day, the instrument must be checked as follows:

1. Check cable and connectors for wear or looseness;
2. Perform a background count in a non-contaminated area; visually check the spectrum for unusual peaks or noise;
3. Perform a check-source count in a predetermined geometry; visually check the spectrum including photopeak resolution and shape; record the count rate..

4.6.2 Duplicates

At least 1 of every 20 measurements must be repeated as a duplicate.

4.6.3 Performance

The system must comply with the following criteria for each type of quality control check:

a.) Duplicates: 90% of the results must fall within 2 standard deviations of each other; all results must fall within 3 standard deviations of each other.

Attachment 3 (cont'd)

b.) Standardization check: the source check result must be within +/- 15% of the initial reference value.

c.) Background check: normally, the gross count rate in the ROI's must be within +/- 25% of the initial reference value. However, this is not applicable for field surveys where a fixed geometry is not available.

If any of the QA tests fail, inform the instrumentation consultant and correct the problem before proceeding with measurements.

4.7 Calculation of Soil Radionuclide Concentration

After spectra are collected, the following procedure will be used to analyze the data:

4.7.1 A background spectrum will be subtracted from each field spectrum. The background spectrum will be obtained in known clean soils on site. Before subtraction, the background spectrum will be scaled to match the Ra-226 concentration in the field spectrum using the 352 keV Pb-214 photopeak. This will reduce or eliminate the 609 keV Bi-214 photopeak's contribution to the 662 Cs-137 photopeak.

4.7.2 The net photopeak count rate and uncertainty will be determined for the 662, 1172, and 1332 keV photopeak.

4.7.3 The count rate to concentration conversion factors (cpm per pCi/g) for each radionuclide and a geometry correction factor will be used to calculate the estimated radionuclide concentration from the net count rates.

4.7.4 The data will be analyzed and presented in spreadsheet form.

5.0 REFERENCES

5.1 2ANSI N42.12 - "Calibration and Usage of Sodium Iodide Detector Systems", American National Standards Institute, 1980, 1985.

5.2 Saxton Nuclear, Final Status Survey Sampling Methodology, E900-IMP-4520.01, Rev 0.

5.3 Aptec Corp., MCArd Manual, 1992.

Attachment 3 (cont'd)

EXAMPLE OF BOREHOLE GAMMA-LOGGING DATA SUMMARY SHEET

Project: Date:

Hole ID: Spectrum File Name:

Depth		662 keV ROI			1332 keV ROI		
(feet)	Range (ft)	net CPS	% err	Visible peak?	net CPS	% err	Visible peak?
Surface							
0.5	0 - 1						
1.5	1 - 2						
2.5	2 - 3						
3.5	3 - 4						
4.5	4 - 5						
5.5	5 - 6						
6.5	6 - 7						
7.5	7 - 8						
8.5	8 - 9						
9.5	9 - 10						
10.5	10 - 11						
11.5	11 - 12						
12.5	12 - 13						
13.5	13 - 14						
14.5	14 - 15						
15.5	15 - 16						
16.5	16 - 17						
17.5	17 - 18						
18.5	18 - 19						
19.5	19 - 20						
20.5	20 - 21						
21.5	21 - 22						
Duplicate:							
Duplicate:							

NOTES: ____

____

Attachment 4

SAMPLING SEDIMENT FROM WATER VOLUMES IN BORE HOLES/WELLS

(To be performed at the conclusion of the Gamma-Logging effort unless otherwise determined by SNEC Management)

The purpose of this sampling operation is to collect representative sediment samples from bore holes (wells) drilled by Pennsylvania Drilling or other contracted drilling services, at locations chosen by SNEC Management. These sample materials are made up of sub-surface soils, sediments and construction debris materials that will provide additional scoping/characterization analysis results.

One composite and representative sample should be collected from each bore hole/well. The composite sample may be complied from various particle size collection filters (as necessary) that will ultimately be combined into a single composite sample from each well site. Other additional samples may be taken as deemed appropriate to answer other questions about particle size as necessary, but the initial composite sample should be a sampling of various particle sizes.

General Work Guidelines

1. Review applicable requirements of this SWI regarding sample handling, etc.
2. Assemble and test submersible pump and filter assembly.
3. Acquire 110v electrical power from GFI protected circuit.
4. Prepare sampling areas IAW Radiological Controls instructions.
5. Remove well caps and PVC gamma-logging well liners (as necessary).
6. Assemble the pump/motor /filter assembly.
7. Collect samples by lowering the sampling pump/filter assembly down well holes. Apply power to the pump motor and move pump/filter assembly as necessary to collect representative samples within the well. Remove the assembly as necessary to check for sample volumes. If necessary, allow the pump/motor/filter assembly to re-circulate for an extended period to expedite adequate sample collection.
8. Remove pump assembly from bore hole/well; open filter housing and remove sample. Use appropriate precautions for handling potentially contaminated materials.
9. Flush the sample collection pump and sampling filter unit with (at least) two-(2) fresh water flushes between well locations and install a clean filter in the filter housing.
10. Radiological Controls personnel shall retain custody of the samples as they are collected for purposes of monitoring radiation and contamination levels and assigning sample log numbers, as well a preparing them for on-site and off-site analysis.
11. After on-site analysis these samples may be sent to an off-site vendor laboratory for additional analysis requirements (to be determined after review of on-site sample results).
12. Re-insert PVC sleeves, cap and/or cover wells as appropriate.
13. Ensure appropriate documentation of samples and sample locations has been performed IAW this SWI.

SCHEDULE OF ENCLOSURES		SWI NUMBER SWI-00-003	
NO.	ENCLOSURE DESCRIPTION		
1			
RTR REVIEW	DATE	ISR REVIEW	DATE
IMPLEMENTING APPROVER			DATE
NO.	ENCLOSURE DESCRIPTION		
2			
RTR REVIEW	DATE	ISR REVIEW	DATE
IMPLEMENTING APPROVER			DATE
NO.	ENCLOSURE DESCRIPTION		
3			
RTR REVIEW	DATE	ISR REVIEW	DATE
IMPLEMENTING APPROVER			DATE
NO.	ENCLOSURE DESCRIPTION		
4			
RTR REVIEW	DATE	ISR REVIEW	DATE
IMPLEMENTING APPROVER			DATE
NO.	ENCLOSURE DESCRIPTION		
5			
RTR REVIEW	DATE	ISR REVIEW	DATE
IMPLEMENTING APPROVER			DATE

Question 9 Attachment

Ground/water Technology Inc. "Preliminary Hydrological Investigation, Saxton Nuclear Experimental Station, Saxton, Pennsylvania." 1981

GEO Engineering "Summary of Field Work." June 7, 1994

GEO Engineering "Phase 1 Report of Findings – Groundwater Investigation." November 18,1992

Hayley & Aldrich "Summary of Field Work." July 24, 1998

Hayley & Aldrich "Data Report for Soil Friction Evaluation." May 5, 1999

Hayley & Aldrich "Report on Lateral Stresses for Structural Evaluations, Containment Vessel." May 13, 1999

Hayley & Aldrich "Report on Lateral Stresses for Structural Stability Evaluations, Containment Vessel." July 21, 1999

Hayley & Aldrich "Report on Soil Friction Evaluation." July 21, 1999

2412.6.4

10

PRELIMINARY HYDROGEOLOGICAL INVESTIGATION
SAXTON NUCLEAR EXPERIMENTAL STATION
SAXTON, PENNSYLVANIA

GROUND/WATER TECHNOLOGY, INC.
40 Ford Road, P.O. Box 99 • Denville, New Jersey 07834

PRELIMINARY HYDROGEOLOGICAL INVESTIGATION

SAXTON NUCLEAR EXPERIMENTAL STATION

SAXTON, PENNSYLVANIA

Prepared for

GPU Nuclear Environmental Controls Group - TMI
P.O. Box 480
Middletown, Pennsylvania 17057

Prepared by

GROUND/WATER TECHNOLOGY, INC.
P.O. Box 99
Denville, New Jersey 07834

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PROJECT AUTHORIZATION

A proposal requested by GPU's Nuclear Environmental Controls Group-TMI was submitted by Ground/Water Technology, Inc. on April 7, 1981 for a hydrologic and geologic investigation at the Saxton Nuclear Experimental Station, Saxton, Pennsylvania. This proposal included the following scope of services:

1. Assemble available technical literature and well logs.

2. Conduct a detailed geological reconnaissance of the site and its immediate vicinity.

3. Review environmental reports, construction drawings and interview former employees to aid in the evaluation of the influences of plant construction on the subsurface soils, rock and water environment.

4. Drill test borings, collect samples and install permanent devices which would allow for procurement of high quality groundwater samples and the determination of groundwater levels.

5. Prepare a written report summarizing our activities and giving a synopsis of the hydrogeological environment of the site. This report would also present our assessment of the probability of off-site migration of groundwater based upon the geologic research and field work included in this program.

During a telephone communication with Dr. Martin McBride, (Project Lead, Nuclear Environmental Controls Group) the above scope of work was authorized, with the exception of the detailed geologic reconnaisance and the installation of groundwater samplers/piezometers. Subsequently, after the completion of the drilling program, the geological reconnaissance was authorized.

PROJECT DESCRIPTION

On May 7, 1981 Environmental Controls Group, and Ground/Water Technology personnel visited the site with personnel previously assigned to the Saxton site in order to select drilling locations. On the following day, Ground/Water Technology personnel visited the offices of the Pennsylvania State Geologist and the United States Geological Survey offices (Water Resource

Branch) located in Harrisburg, Pennsylvania. Both offices were able to provide geologic and hydrologic materials describing the Saxton site region. During the period of May 12 to May 22, 1981 drilling, sampling and rock pressure tests were conducted at the Saxton site. During subsequent weeks, geologic research and laboratory testing of selected samples were completed.

SITE LOCATION AND DESCRIPTION

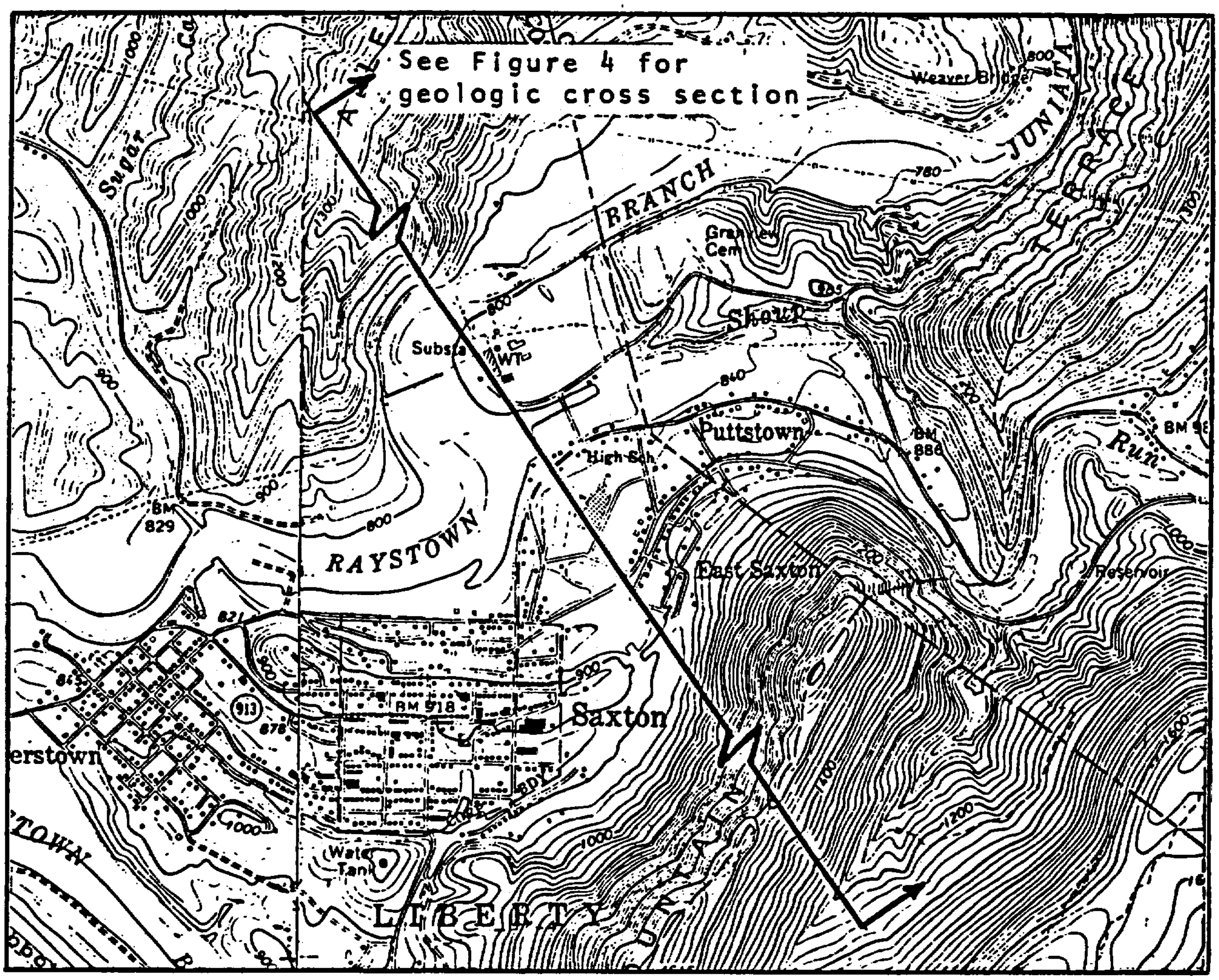
The Saxton Nuclear Experimental Station, located in Bedford County, is situated in the valley of the Rayston Branch of the Juniata River (Figure 1). The river meanders along its watercourse while the overall flow direction is to the northeast. This river valley is bordered on the northwest by Allegrippis Ridge and to the southeast by Terrace Mountain. The relief from the river to the ridge tops exceeds 500 feet.

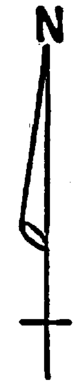
The Saxton Nuclear Experimental Station was built adjacent to an existing coal-fired generating station (Figure 2). The nuclear reactor had produced energy which ran the steam plant's generator. At present the coal-fired plant has been demolished and Saxton Nuclear Experimental Station has been deactivated, and most of its structures remain.

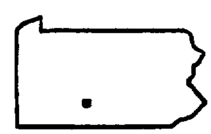
TEST BORING LOCATIONS

Of primary interest in siting of test borings were the containment structure and the radwaste treatment plant. The foundation of the containment structure was excavated into the bedrock to about 50 feet below ground surface. The radwaste treatment plant facility was also founded in the bedrock with its deepest point being about 25 feet below ground surface.

Two test borings were drilled into rock near each of the above structures (Figure 2) to radiologically survey and test extracted soil and rock materials (B-2 through B-5). Test boring (B-1) on the east side of the site was also drilled into rock







LOCATION PLAN

SAXTON NUCLEAR EXPERIMENTAL STATION

SAXTON **PENNSYLVANIA**

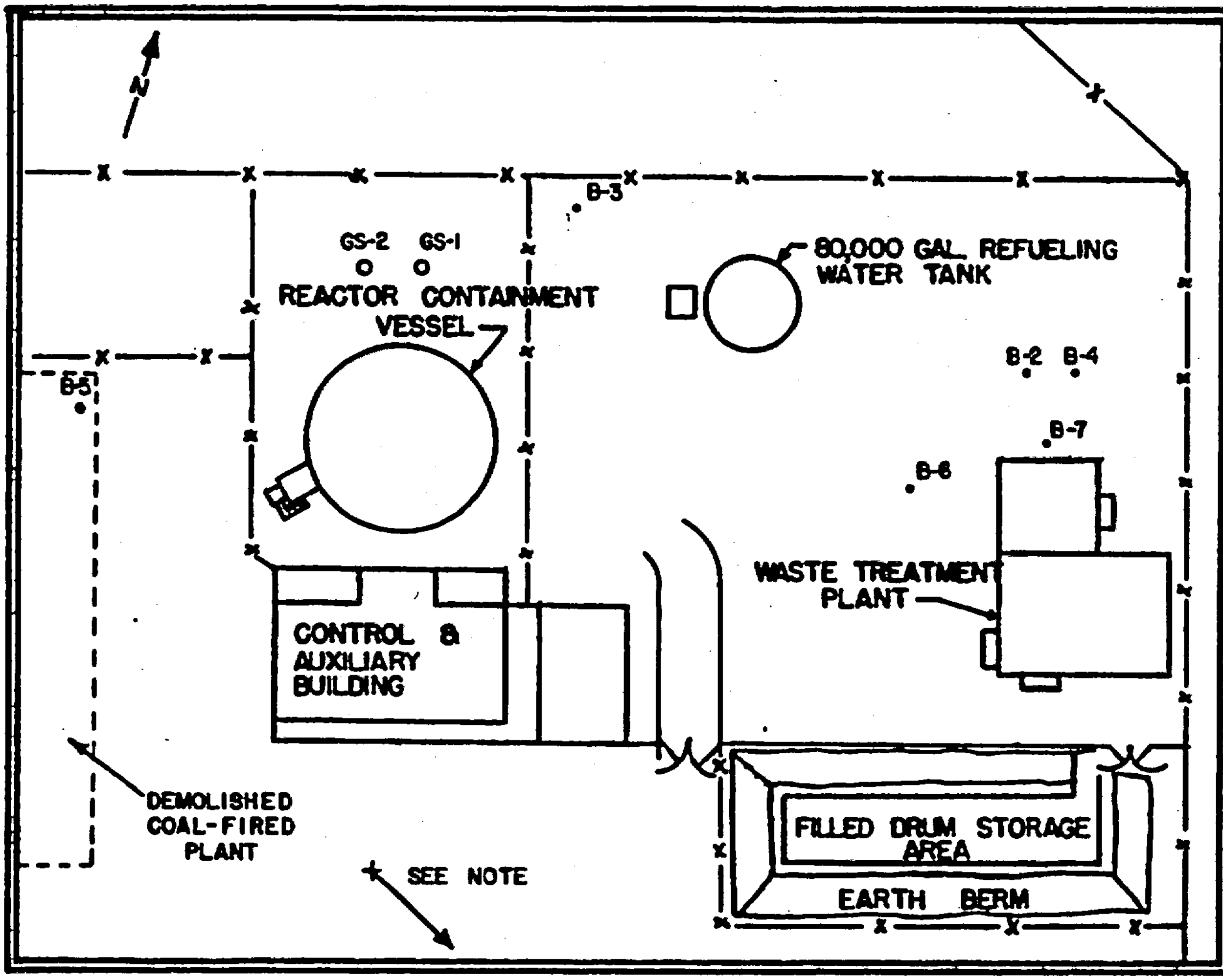
SOURCE:

USGS 7.5 min. Quad

Saxton, Pa. 1960
Photo Revised 1973

Hopewell, Pa. 1968
Photo Revised 1973

FIGURE 1
GROUNDWATER TECHNOLOGY, INC.



NOTE:
TEST BORING B-1 IS LOCATED APPROXIMATELY 430' IN DIRECTION SHOWN BY ARROW.

LEGEND
- •B-2 TEST BORING (MAY, 1981)
- o GS-2 HAND DUG TEST PIT (MAY, 1981)

LOCATION PLAN OF TEST BORINGS AND TEST PITS AT SAXTON NUCLEAR EXPERIMENTAL STATION SAXTON, PENNSYLVANIA

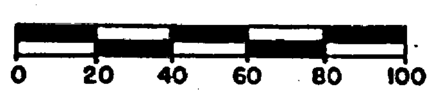


FIGURE 2
GROUNDWATER TECHNOLOGY, INC.

to provide "background" information about subsurface conditions away from any disturbance that might have been produced during construction.

Soil borings were also completed to supplement the above test borings. Borings B-6 and B-7 were drilled to the top of rock in the vicinity of the radwaste treatment plant. B-6 was located approximately 25 feet west of the plant. B-7 was located as close as possible to the north side of the plant.

Two hand-dug pits were located just north of the reactor (GS-1 and GS-2). The pits were dug to a depth of 4 and 6 feet respectively. Soil samples were collected for both radiological testing and grain size gradation tests (see Appendix B).

SOIL, ROCK AND GROUNDWATER SAMPLE ACQUISITION

A CME-55 test boring rig was used to obtain split-spoon samples and to core the bedrock (NWX core). Generally, soils and rock were sampled continuously over the full depth of borings B-1 and B-7. To prevent the possibility of any form of cross-contamination, samples were placed in separate plastic bags. The split-spoon sample barrel used to sample soils was washed with tap water, cleaned with a detergent, and rinsed with tap water after each sample was removed. The rock core barrel was also rinsed with tap water after each rock core was removed from the bore hole.

When the rock core sampling portion was completed, the bore hole was pumped (generally about a half hour) to remove recirculating water and to obtain a groundwater sample. On selected borings packer tests (rock pressure testing) were then undertaken. Upon completion of each boring, the hole was sealed with cement grout.

SOIL DESCRIPTION

Split-spoon samples collected during the drilling program and samples from hand-dug pits near the reactor indicate that the surficial soil near the buildings is comprised of two types of construction backfill: (1) well graded reddish silty fine to coarse sand with some fine to medium gravel and (2) a well graded mixture of ash and cinders. Boring logs are presented in Appendix A. Both of these fill materials were reported placed during station construction. Laboratory mechanical analyses were performed on both the silty sands and the ash. The gradation curves of these materials are presented in Appendix B. The thickness of the fill generally ranges from 3 to 6 feet, although the fill may be thicker at locations where building construction excavation took place (e.g. waste treatment facility - see boring B-6).

Underlying the fill materials is a boulder layer which was encountered in the majority of the borings. This layer is generally 4 to 6 feet thick and separates the fill material from the top of the bedrock. To sample the boulder layer NWX coring was attempted. Although samples of the boulders could be recovered by this technique, the drilling fluid tended to wash away the fine materials in the interstices between the boulders. However, in a few of the core samples, some silty clay remained between the boulders and is therefore assumed to be the material making up the boulder matrix. The core samples indicate that the silt and clay was localized in the boulder layer and did not appear to be present in the fractured bedrock below that zone.

BEDROCK GEOLOGY

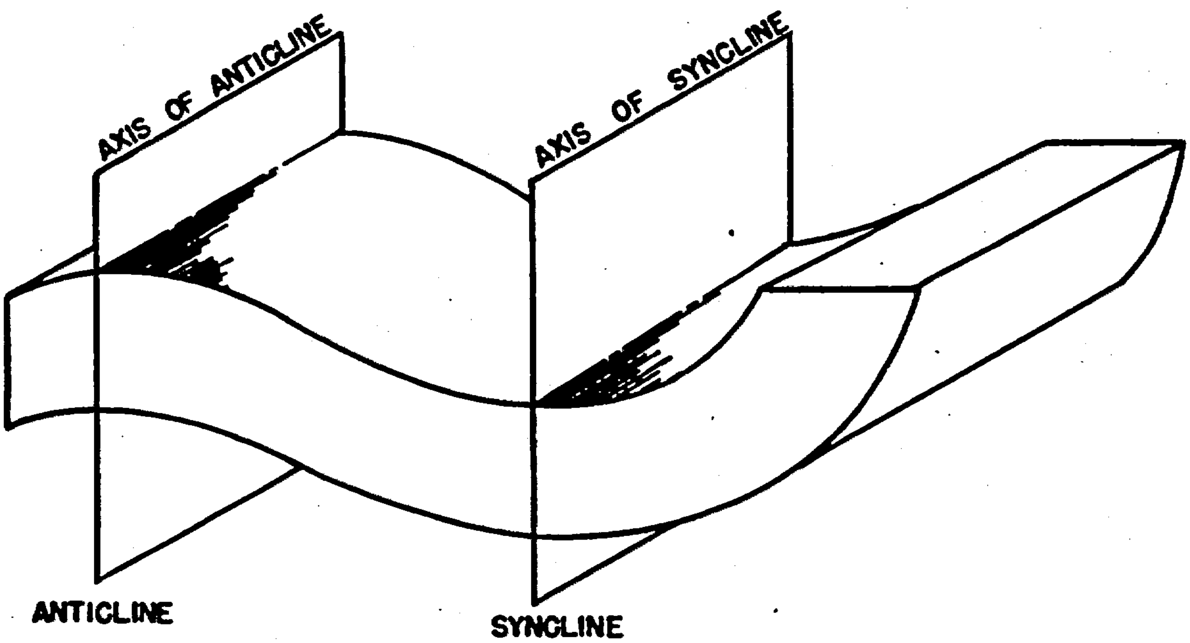
The geologic map of Pennsylvania (1:250,000 scale) compiled by the Pennsylvania Geologic Survey, Fourth Series (1960) identifies the bedrock material underlying the Saxton Experimental Nuclear Station as "marine beds" of upper Devonian age. These rocks are described as gray to olive brown shales, graywackes and sandstones. Geologic worksheets, which will be the product of a future detailed state geologic map, were reviewed at the Pennsylvania State Geologist's office. These worksheets indicate that the area in the vicinity of the Saxton site will be identified as the "Foreknobs Formation", upper Devonian age, mapped by J.M. Dennison in 1970. He describes this formation as gray alternating sandstone and siltstone with red beds.

Observations of the geology at road cuts in the area between Breezewood and Saxton, Pennsylvania indicate that the Paleozoic rocks of this area are folded, being a product of a mountain building event occurring probably during the late Devonian and continuing to the end of the Permian period. These road cuts show alternating layers of siltstone and sandstone beds with red beds.

Typical cross sections through the Appalachian Mountains of Pennsylvania depicted on the geologic map of Pennsylvania indicate that the geology of this region is typically a series of major folds referred to as anticlines and synclines. Figure 3 is a sketch showing an idealized anticline and syncline.

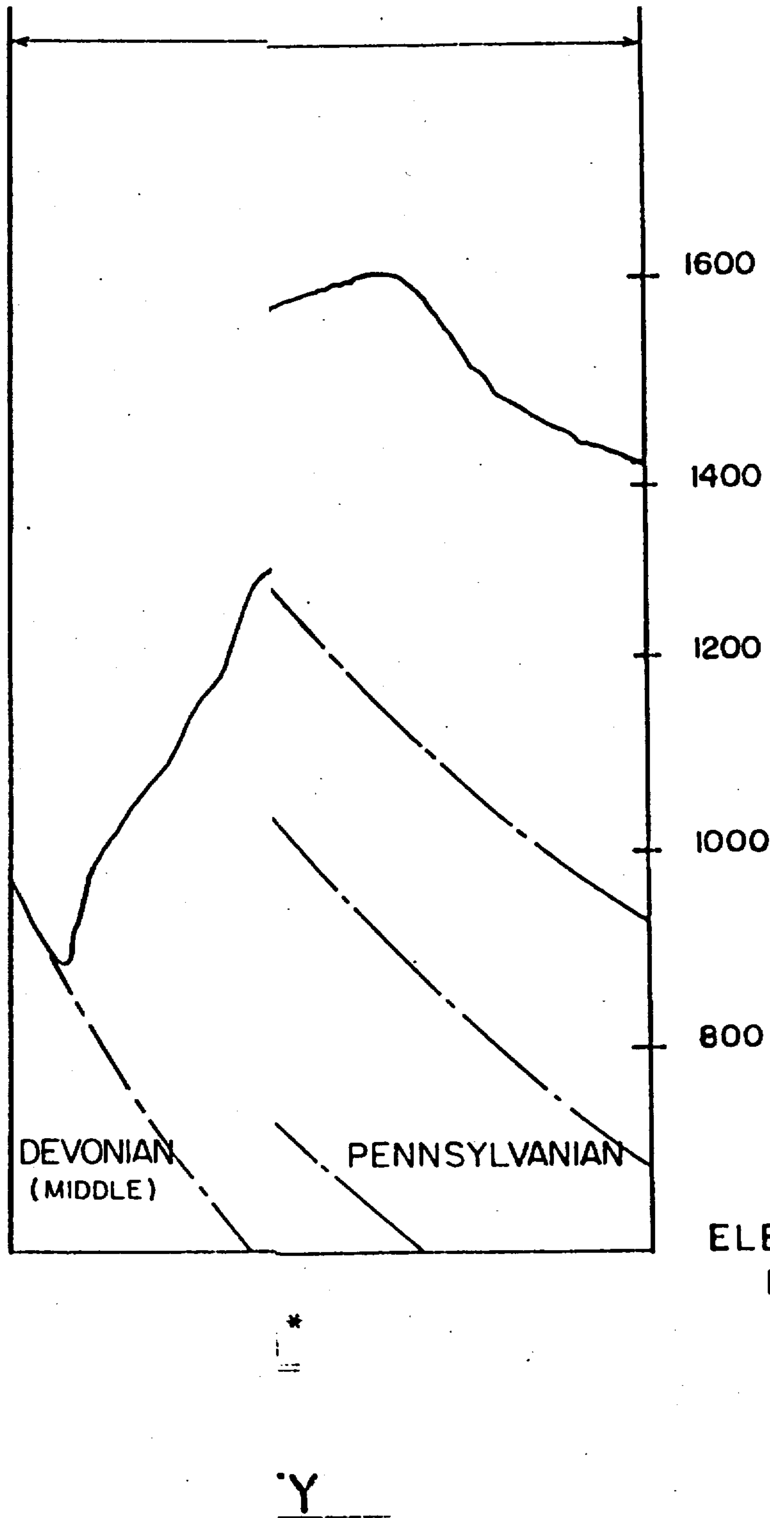
Since the geologic map of Pennsylvania does not specifically draw a cross section through the plant site, a geologic cross section was constructed through this region (Figure 4). This geologic cross section is drawn at a northwest-southeast orientation (Figure 1) and indicates that the Saxton Nuclear Experimental Station is constructed on the limb of a major syncline that dips generally towards the east.

A review of Pennsylvania geologic literature indicates that the nearest location to the plant site where a published geologic study has been conducted is the Broad-Top Coal Fields, approximately five miles to the east. This report entitled, "The Broad-Top Coal Fields," by James H. Garner was published in 1913 as Topographic and Geologic Survey of Pennsylvania Report #10. In this report, the Broad-Top Coal Field is identified as the general axis of the syncline.



SKETCH OF IDEALIZED ANTICLINE AND SYNCLINE

FIGURE 3
GROUNDWATER TECHNOLOGY, INC.



* INTERPRETED CROS
PENNSYLVANIA – C
GEOLOGICAL SURVE

FIGURE 4

GROUND/WATER TECHNOLOGY, INC.

G/WT FILE NO. 81513

During the geologic reconnaissance many bedrock outcrops were examined throughout the region. These outcrops substantiate the premise that the plant site is located on the western limb of a major syncline which strikes generally N 25° - 42°E and dips approximately 15° - 45°E. Some minor internal folding is present within various bedding members though the overall dip of the major structure is to the east.

The fracture fabric of these Devonian rocks was also examined throughout the area. A well developed major fracture pattern occurs in most of the outcrops which strikes from N 50° - 75°W and dips nearly vertical. A second poorly developed fracture set trends along the approximate line of the strike of the bedding and typically dips 45° - 60° to the west.

GROUNDWATER IN THE PIPE TUNNEL AND THE RADWASTE BUILDING

During the initial site visit we observed the presence of water both in the pipe tunnel and the radwaste treatment plant. The site representative informed us that, during certain times while the station was operational, water would bubble up through the joint between the pipe tunnel and the containment shell and would drain through the tunnel into the radwaste treatment plant. At that time, water in that facility was reportedly controlled by pumping from the basement sump.

Construction drawings indicate that the surface grade at the pipe tunnel is approximately 811 feet above msl and that the floor of the pipe tunnel is approximately 803 feet above msl. If we assume a groundwater elevation of about 807 feet (the average groundwater level observed during this boring program was 3 to 5 feet below grade), then approximately 4 feet of water should be present in the pipe tunnel. Since the radwaste treatment plant is constructed predominantly below grade, ground water will drain from the pipe tunnel towards this "sink" during periods when water is entering this constructed system. It would be expected that, during periods of high groundwater levels, water will enter the tunnel and recharge the "sink" at the radwaste treatment plant. Since the groundwater level fluctuates, during the drier portions of the hydrologic year water in the tunnel may actually re-enter the groundwater regime. The higher water level in the pipe tunnel and the radwaste treatment plant could, during the dry season, force water from the structures back out through zones which may not be water tight, such as the observed joint at the containment-tunnel junction.

HYDROGEOLOGIC SETTING

One of the objectives of this investigation was to characterize the subsurface stratigraphy as an aid in assessing the hydrogeology of the site. There are three distinct subsurface zones which have different waterbearing and transmitting properties. These zones are as follows:

1. A construction fill material, comprised of well graded silty fine to coarse sand with some gravel ash or cinders.
2. A boulder layer with silty clay in the interstices.
3. The bedrock of grey siltstones, sandstones and red beds.

During the drilling of the test borings, the groundwater level was measured at depths of about 3 to 5 feet. These measurements probably represent an average of the piezometric levels in the three subsurface zones.

TESTING RESULTS

In order to obtain a relative indication of the ability of the various subsurface zones to transport groundwater, field permeability tests were conducted in selected bore holes and laboratory mechanical analyses were performed on construction fill materials. Due to the nature of the rock coring technique, it was difficult to recover a good representative sample in the boulder-clay deposit. It is presumed that the clay retards groundwater flow, probably making the stratum relatively impervious.

Mechanical (sieve) analyses were performed on two samples of the red silty sand fill and on a sample of ash fill (refer to Appendix B for results). A large portion of the red silty sand fill material was finer than the #200 sieve. Hydrometer tests were performed on these two samples to obtain the gradation of the fine-grained materials. Both samples were well-graded, containing about 45 percent passing the #200 sieve. The well-graded nature of the fill suggests a very low permeability probably ranging between 10^{-6} cm/sec to 10^{-8} cm/sec.

Although it was possible to perform a mechanical analysis on the ash fill material, the validity of the results is questionable since the friable particles may have been altered by the sieving action. However, visual examination in the field suggests that this material has substantially greater permeability than the red silty sand fill.

Packer tests (rock pressure tests) were conducted in bedrock at borings B-3, B-4, and B-5 to determine the apparent permeability of the bedrock. This field test entails pumping water under pressure into selected sections of the bore hole isolated by pneumatic packers. The packer test apparatus used had a test section of 6 feet between the upper and lower packer. The test results (Appendix C) indicate a substantial range in rock permeability, ranging from moderate values (about 1.06 x 10^{-3} cm/sec) to negligible values (no flow recorded in the test section). The test results were compared with the RQD (rock quality designation) values obtained during the coring of each test section to determine if RQD could be used as a reliable indicator for zones of high permeability. It appears that a reasonably good correlation does exist between higher permeability and low RQD.

The different bore holes show some similarities with respect to RQD values. A zone of very low RQD values exists near the top of the "natural" bedrock surface and is considered to be a weathered erosional plane (Table 1). This premise is also supported by the packer test results, indicating higher

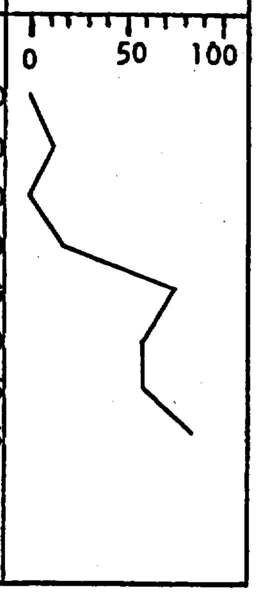
TABLE I

SUMMARY OF ROCK QUALITY DESIGNATION (RQD) VALUES FOR SAXTON NUCLEAR EXPERIMENTAL STATION SAXTON, PENNSYLVANIA

BORING B-1

DEPTH IN FEET*
10.0-12.0
12.0-17.0
17.0-20.0
20.0-24.0
24.0-29.0
29.0-34.0
34.0-42.5
42.5-49.5

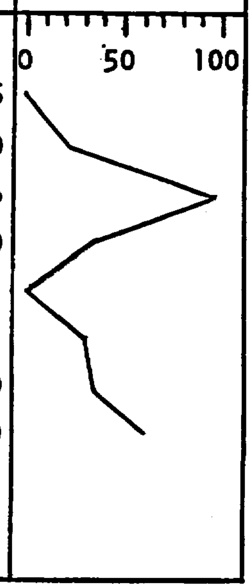
RQD (AS %)



BORING B-2

DEPTH IN FEET*
9.5-11.5
11.5-15.0
15.0-16.6
16.6-18.0
18.0-19.7
19.7-21.0
21.0-24.0
24.0-25.0

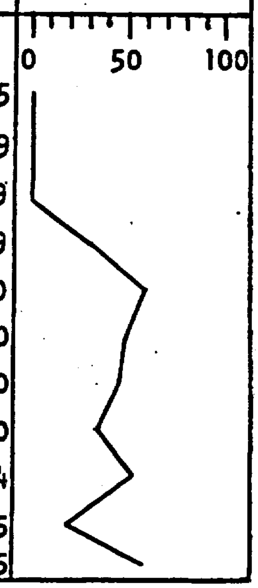
RQD (AS %)



BORING B-3

DEPTH IN FEET*
10.5-11.5
11.5-13.9
13.9-18.9
18.9-23.9
23.9-29.0
29.0-34.0
34.0-39.0
39.0-44.0
44.0-46.4
46.4-48.5
48.5-50.5

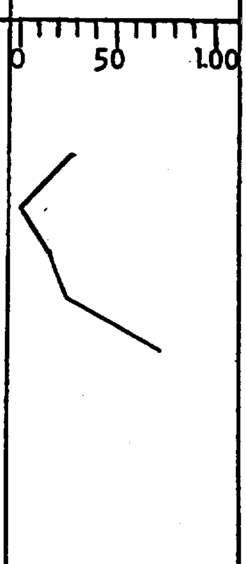
RQD (AS %)



BORING B-4

DEPTH IN FEET*
8.5-10.0
10.0-14.7
14.7-16.5
16.5-21.5
21.5-23.5
23.5-26.5

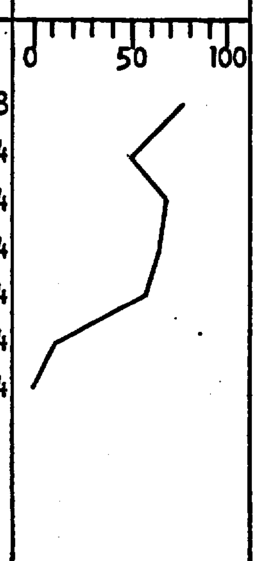
RQD (AS %)



BORING B-5

DEPTH IN FEET*
22.1-23.8
23.8-25.4
25.4-30.4
30.4-35.4
35.4-40.4
40.4-45.4
45.4-50.4

RQD (AS %)



*Depth in feet from ground-surface

permeability values in this zone. Another zone of low RQD values occured at a depth between 40 and 50 feet below ground surface in borings B-3 and B-5. These low RQD values may be accounted for in two ways; (1) the zone may have been created during the construction of the reactor or (2) the zone may be a naturally occurring more permeable layer. Since there is no evidence of construction excavation to depths of 40 or 50 feet at these locations, the low RQD values are attributed to a naturally occurring zone of higher permeability. Continuity of this zone in the bedrock is inferred, since B-3 and B-5 were drilled along the strike of the bedding and since these zones are at approximately the same structural elevation in each boring.

CONCLUSIONS

Field and laboratory testing, visual classification of rock and soil samples, and geologic reconnaissance lead to the following preliminary conclusions:

1. The site is located on the western limb of a major syncline, the bedding of which dips from the river toward the site. A major fracture pattern within the bedrock strikes generally to the northwest and has a near vertical dip.

2. The subsurface profile at the site is made up of three basic strata, encountered as follows:

   a. A construction fill, generally consisting of silt, sand and gravel or ash and cinders.

   b. A layer of boulders in a silty clay matrix.

   c. Bedrock, consisting of siltstone, sandstone and red beds.

3. The relative permeability of the rock and soil are as follows:

   a. In general, the construction fill and boulder layers are less permeable than the bedrock.

   b. The boulder layer appears to act as a barrier to flow of groundwater between the construction fill and bedrock.

c. The permeability of the bedrock varies with depth. The highest permeability is at the boulder layer-bedrock interface. This is probably a function of the weathered nature of the top of the bedrock, which is quite fractured resulting in this higher permeability. Other zones of comparatively high permeability may be present in the bedrock such as has been identified at borings B-3 and B-5.

4. Groundwater level observations in test borings indicate a groundwater gradient of 10 to 15 feet over a distance of 600 to 800 feet from the site to the river.

5. The combination of groundwater gradient, bedrock permeability, and bedrock structure (bedding and fracture patterns) indicates that the groundwater has a potential to migrate from the site toward the river.

6. Groundwater entering the pipe tunnel through the joint between the pipe tunnel and the containment shell has the potential to drain into the radwaste treatment plant. As the groundwater levels decrease through the hydrologic year this process can reverse, causing water to drain back through the joint and out into the groundwater regime.

RECOMMENDATIONS

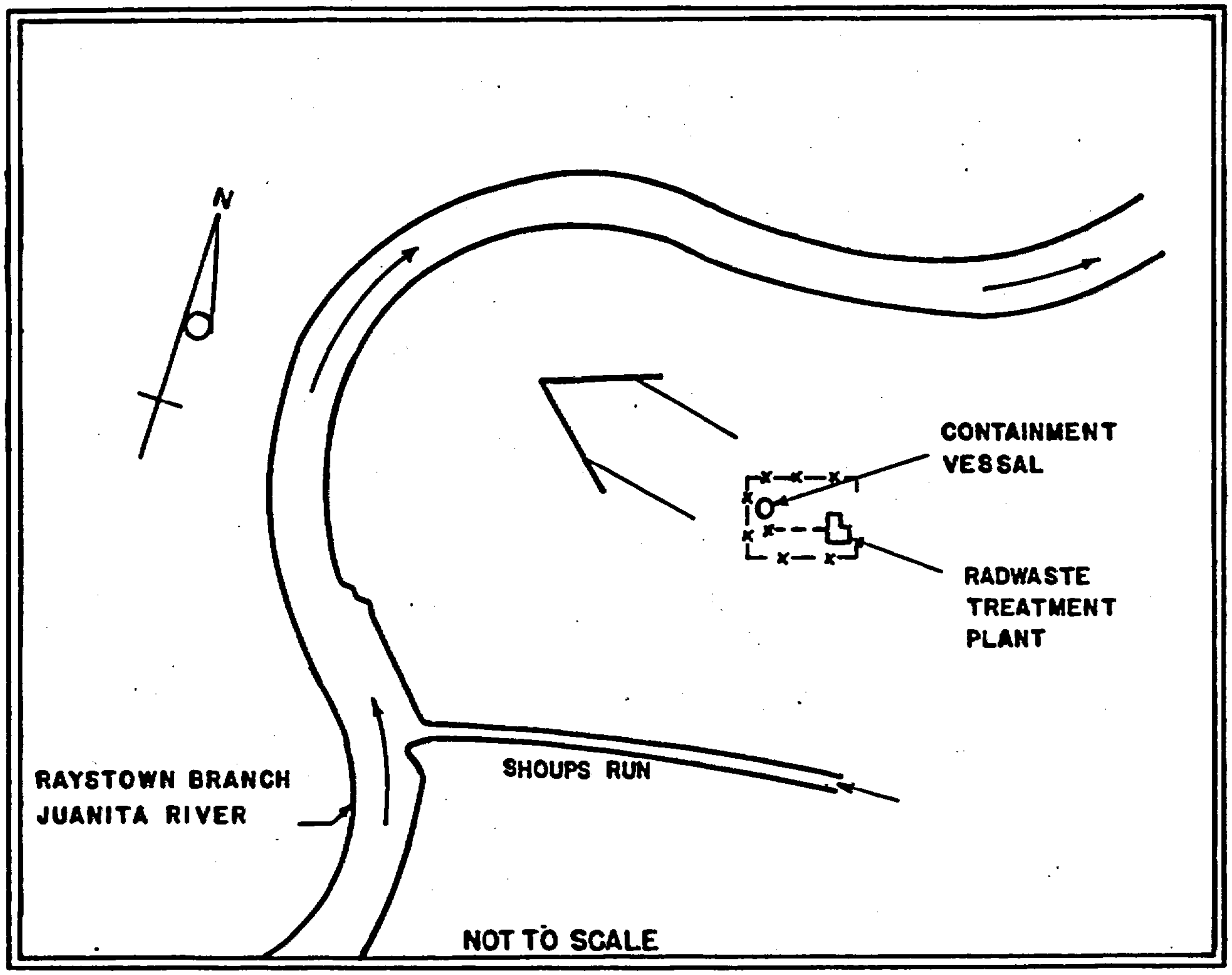
If the results of the recently conducted radiological tests of the soil, rock and groundwater at the Saxton site warrant the implementation of a groundwater monitoring program for the more definitive determination of the groundwater flow regime, the strategy for locating the monitoring points should consider the following recommendations:

1. The field and laboratory tests conducted on both the soils and the bedrock at the Saxton site indicate that the bedrock is the predominant water bearing zone and consequently more emphasis should be placed on groundwater monitoring in the bedrock.

2. Geological information strongly supports the premise that groundwater traveling from a deep source (e.g. the containment, seated approximately 50 feet into the bedrock will travel generally northwest, following the structural orientation of bedding and the major fracture set. Therefore, any future monitoring points addressing contamination from structures

founded in the bedrock should favor a northwest-southeast orientation (Figure 5).

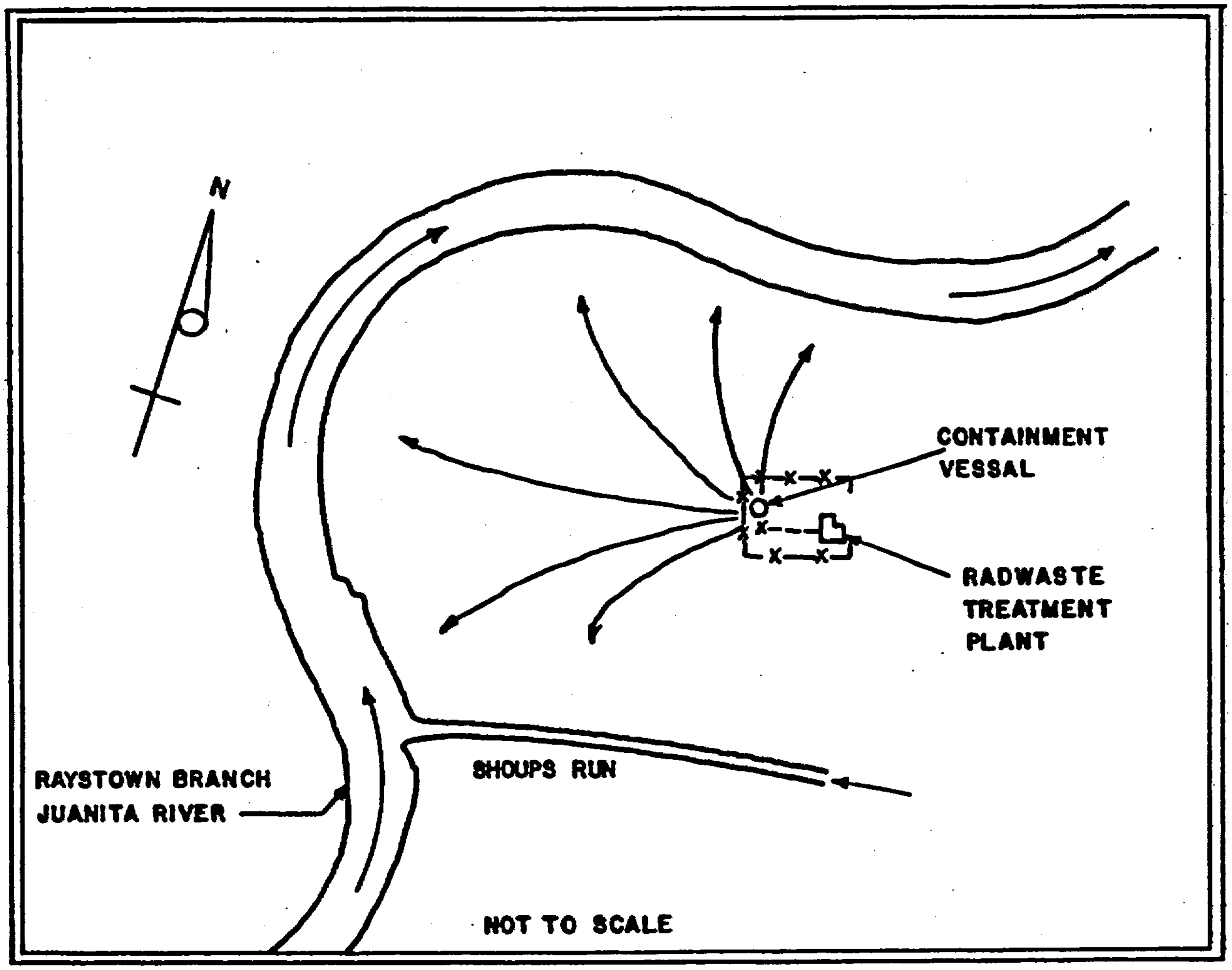
3. In the absence of precise groundwater elevation information at the site, it is difficult to predict the groundwater flow paths which are not directly influenced by the structural controls of the bedrock. The flow patterns at the top of rock are probably affected more by the geomorphological conditions and properties of the soil zones. The site is surrounded on three sides by surface waters which could act as discharge points for groundwater flow (Shoups Run to the east and Raystown Branch of the Juniata River on the west and north). Topographically, the most likely direction of shallow groundwater flow from the site appears to range from the southwest to the north (Figure 6). Therefore, baseline piezometry should be acquired in this area.



THE EXPECTED STRUCTURAL CONTROLLED GROUNDWATER FLOW DIRECTION IN THE BEDROCK SAXTON NUCLEAR EXPERIMENTAL STATION SAXTON, PENNSYLVANIA

BASED ON GEOLOGIC RECONNAISANCE
AND TEST BORINGS

FIGURE 5
GROUNDWATER TECHNOLOGY, INC.



THE EXPECTED GENERALIZED GROUNDWATER FLOW PATTERN AT THE SOIL/ROCK INTERFACE SAXTON NUCLEAR EXPERIMENTAL STATION SAXTON, PENNSYLVANIA

BASED ON GEOLOGIC RECONNAISANCE, TEST BORING AND INTERPRETATION OF GEOMORPHOLOGY

FIGURE 6

GROUNDWATER TECHNOLOGY, INC.

GLOSSARY

Anticline - The fold that is convex upward or had such an attitude at some stage of development.

Axis of a fold - The line following the apex of an anticline or the lowest part of a syncline.

Bedding - Collective term signifying existence of beds or laminae. Planes dividing sedimentary rocks of the same or different lithology.

Bedrock - Any solid rock exposed at the surface of the earth or overlain by unconsolidated material.

Devonian Age - In the ordinarily excepted classification, the fourth in the order of age of the periods comprised in the Paleozoic era, following the Silurian and succeeded by the Mississippian. Also the system of strata deposited at that time. Sometimes called the age of fishes.

Dip - The angle at which a stratum or any planar feature is inclined from the horizontal. The dip is at a right angle to the strike.

Fold - A bend in strata or any planar structure.

Fracture - Breaks in rocks due to intense folding or faulting.

Friable - Easily crumbled, as would be the case with rock that is poorly cemented.

Graywacke - A type of sandstone marked by: (1) large detrital quartz and feldspars (phenocysts) set in a (2) prominent to dominant "clay" matrix (and hence absence of infiltration or mineral cement) which may on low-grade metamorphism (diagenesis) be converted to chlorite and sericite and partially be replaced by carbonate, (3) a dark color, (4) generally tough and well indurated, (5) extreme angularity of the detrital components (microbreccia), (6) presence in smaller or larger quantities of rock fragments, mainly chert, quartzite, slate or phyllite, and (7) certain macroscopic structures (graded bedding, intraformational conglomerates of shale or slate chips, slip bedding, etc.) and (8) certain rock associations.

<u>Interstices</u> - The area where fine grain materials occur between coarser grain materials.

<u>Limb of fold</u> - One of the two parts of an anticline or syncline on either side of the axis.

<u>Paleozoic</u> - One of the eras of geologic time that, between the Late Precambrian and Mesozoic eras, comprises the Cambrian, Ordovician, Silurian, Devonian, Mississippian, Pennsylvanian, and Permian systems. The beginning of the Paleozoic was formerly supposed to mark the appearance of life on the earth, but that is now known to be incorrect. Also, The group of rocks deposited during the Palezoic era.

<u>Permian period</u> - Last period of the Paleozoic era, also system of same age. Formerly considered by the U.S. Geological Survey to be last epoch of the Carboniferous, and its strata.

<u>Red beds</u> - Term applied to red sedimentary rocks, which usually are sandstones and shales, though in exceptional cases red limestones have been reported. The coloring of the red beds is ferric anhydride.

<u>Sandstone</u> - A cemented or otherwise compacted detrital sediment composed predominantly of quartz grains, the grades of the latter being those of sand. Mineralogical varieties such as feldspathic and glauconitic sandstones are recognized, and also argillaceous, siliceous, calcareous, ferruginous, and other varieties according to the nature of the binding or cementing material.

<u>Shale</u> - A laminated sediment in which the constituent particles are predominantly of the clay grade. Shale includes the indurated, laminated, or fissile claystones and siltstones. The cleavage is that of bedding and such other secondary cleavage or fissility that is approximately parallel to bedding. The secondary cleavage has been produced by the pressure of overlying sediments and plastic flow.

<u>Siltstone</u> - A very fine-grained consolidated clastic rock composed predominantly of particles of silt grade.

<u>Strike</u> - The course or bearing of the outcrop of an inclined bed or structure on a level surface; the direction or bearing of a horizontal line in the plane of an inclined stratum, joint, fault, cleavage plane, or other structural plane. It is perpendicular to the direction of the dip.

<u>Syncline</u> - A fold in rocks in which the strata dips inward from both sides toward the axis.

APPENDIX A

GROUNDWATER TECHNOLOGY, INC.

BORING NO. B-1

CONTRACTED WITH GPU NUCLEAR — JOB NO. 81513

PROJECT NAME SAXTON BORING & CORING PROGRAM — SHEET 1 OF 3

LOCATION SAXTON, Pa.

SAMPLER:

DATUM Ground Surface — HAMMER WT. 140 LBS. — HOLE DIAMETER 2" — ENGINEER CRB

SURF. ELEV. 812± FT. — HAMMER DROP 30 IN.

DATE STARTED 5/12/81 — PIPE SIZE 2 IN. — BORING METHOD DC — DATE COMPLETED 5/13/81

ELEV.	SOIL DESCRIPTION	STRA. DEPTH	DEPTH SCALE	NO.	TYPE	REC	BLOWS/6"	BORING & SAMPLING NOTES
			0.0					
	Reddish Brown, silty sand and clay, 6" coal-fly ash			S-1	DS	1.2	7/13/31/36	
			2.0					
	Top 2" coal-fly ash 1' red, sandy silt and clay 1" light grey silty sandstone			S-2	DS	1.4	8/12/24/39	
			4.0					
	Sandstone - boulder			S-3	DS	1.0	>100	
			5.0					
	Refer to sheet 2 and 3 for coring logs							

SAMPLER TYPE

DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER

GROUNDWATER DEPTH

AT COMPLETION ______ FT.
AFTER ____ HRS. ______ FT.
AFTER 24 HRS. ______ FT.

BORING METHOD

HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT
DC - DRIVING CASING
MD - MUD DRILLING

CLIENT: GPU NUCLEAR

PROJECT: SAXTON BORING & CORING PROGRAM

LOCATION: SAXTON, Pa.

DATE: 5/12/81

FILE NO.: 81513

BORING NO.: B-1

SHEET 2 of 3

Ground Surface Elev.: 810-815 Ft.

Datum: Ground Surface

Type of Drill Rig: CME

Core Barrel: NX

Core Bit: NWG Diamond

Type of Feed During Coring: Hydraulic

CORE NO.	DEPTH	REC/RQD	ROCK TYPE	WEATHERING	REMARKS
	5.0				
R-1	10.0	0.6/5.0	Tan Sandstone (2"-3") with silty-clay between boulders		Top of Rock 9.5' - 10.0'
R-2	12.0	0.0/0.0	Red siltstone		Core barrel blocked 10.0' - 12.0'
R-3	15.0 17.0	5.0/13.4	Gray siltstone		Bedding ~40° dip Fossils present 12.0' - 15.0'
R-4	20.0	3.0/0.0	Reddish-gray siltstone		Failure along bedding planes
R-5	24.0	3.8/20.8	Reddish-gray siltstone		
R-6	25.0 29.0	4.8/78.0	Greenish-red silstone (blocky)		Rock much less fractured than above runs
R-7	30.0 34.0	4.9/62.0	Greenish-red (blocky) siltstone		

COMMENTS:

INSPECTOR: CRB

CLIENT: GPU NUCLEAR

PROJECT: SAXTON BORING & CORING PROGRAM

LOCATION: SAXTON, PA.

DATE: 5/13/81

FILE NO.: 81513

BORING NO.: B-1

SHEET 3 of 3

Ground Surface Elev.: 810-815 Ft.

Datum: Ground Surface

Type of Drill Rig: CME

Core Barrel: NX

Core Bit: NWG Diamond

Type of Feed During Coring: Hydraulic

CORE					
NO.	DEPTH	REC/RQD	ROCK TYPE	WEATHERING	REMARKS
	35.0				
R-8	40.0	8.3/62.0	Red and Gray siltstone		
	42.5				
R-9	45.0	6.9/84.0	Red siltstone with some gray siltstone		
	49.5				Terminated drilling at 49.5'
	50.0				

COMMENTS:

INSPECTOR: CRB

GROUNDWATER TECHNOLOGY, INC.

BORING NO. B-2

CONTRACTED WITH GPU NUCLEAR — JOB NO. 81513

PROJECT NAME SAXTON BORING & CORING PROGRAM — SHEET 1 OF 2

LOCATION SAXTON, Pa.

SAMPLER:

DATUM Ground Surface — HAMMER WT. 140 LBS. — HOLE DIAMETER 2" — ENGINEER CRB

SURF. ELEV. 812± FT. — HAMMER DROP 30 IN.

DATE STARTED 5/13/81 — PIPE SIZE 2 IN. — BORING METHOD DC — DATE COMPLETED 5/13/81

ELEV.	SOIL DESCRIPTION	STRA. DEPTH	DEPTH SCALE	NO.	TYPE	REC	BLOWS/6"	BORING & SAMPLING NOTES
			0.0					
	Black Top Soil		0.5	S-1	DS	1.0'	8/27	1' DS samples
	Reddish brown silty sand		1.0					
	8" of reddish brown silty sand 1" white sandstone, gravel, fractured		2.0	S-2	DS	0.67'	19/34	
	Reddish brown silty sand with some angular gravel		3.0	S-3	DS	0.63'	38/65	
	Reddish brown silty sand with some angular gravel		4.0	S-4	DS	0.5'	48/73	Casing driven to 4'
	Reddish brown silty sand with some angular gravel		5.0	S-5	DS	0.63'	25/55	Set-up mud pan at 5'
	Reddish brown silty sand with some angular gravel		5.3	S-6	DS	0.25'	68/3"	
	Boulder		6.0		DS			
	Red silt, angular gravel		6.5	S-7	DS	0.5'	95/6"	Roller bit to 6' through boulder
	Refer to sheet 2 for coring logs							

SAMPLER TYPE

DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER

GROUNDWATER DEPTH

AT COMPLETION ______ FT.
AFTER ____ HRS. ______ FT.
AFTER 24 HRS. ______ FT.

BORING METHOD

HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT
DC - DRIVING CASING
MD - MUD DRILLING

CLIENT: GPU NUCLEAR
PROJECT: SAXTON BORING & CORING PROGRAM
LOCATION: SAXTON, PA.

DATE: 5/13/81
FILE NO.: 81513
BORING NO.: B-2
SHEET 2 of 2

Ground Surface Elev.: 810-815 Ft.
Datum: Ground Surface
Type of Drill Rig: CME

Core Barrel: NX
Core Bit: NWG Diamond
Type of Feed During Coring: Hydraulic

CORE NO.	DEPTH	REC/RQD	ROCK TYPE	WEATHERING	REMARKS
	5.0				
	6.5				
R-1	8.5	1.4/2.0	Sandstone boulders		Difficult coring
R-2	10.0 9.5	0.4/1.0	White sandstone boulders		Core barrel blocked
R-3	11.5	~/0.0	Highly weathered siltstone		Top of rock ~ 11.0' - 11.5'
R-4	15.0 15.0	3.5/23			
R-5	16.6	~/99	Blocky red siltstone		Less fractured rock (Bit blocked)
R-6	18.0	1.4/36	Red fine sandstone		(Bit blocked)
R-7	19.67	1.3/0	Red siltstone		(Bit blocked)
R-8	20.0 21.0	1.0/32	Red siltstone		(Bit blocked)
R-9	24.0	2.4/37	Red-black fine sandstone		
R-10	25.0 25.0	1.2/60	Red fine sandstone		Iron stained fractures Highly weathered fractures Terminated drilling at 25.0' Hole grouted
	30.0				

COMMENTS:

INSPECTOR: CRB

GROUNDWATER TECHNOLOGY, INC.

CONTRACTED WITH GPU NUCLEAR	BORING NO. B-3
PROJECT NAME SAXTON BORING & CORING PROGRAM	JOB NO. 81513
LOCATION SAXTON, Pa.	SHEET 1 OF 3

SAMPLER:

DATUM Ground Surface	HAMMER WT. 140 LBS.	HOLE DIAMETER 2"	ENGINEER GJC
SURF. ELEV. 812± FT.	HAMMER DROP 30 IN.		
DATE STARTED 5/14/81	PIPE SIZE 2 IN.	BORING METHOD DC	DATE COMPLETED 5/18/

ELEV.	SOIL DESCRIPTION	STRA. DEPTH	DEPTH SCALE	NO.	TYPE	REC	BLOWS/6"	BORING & SAMPLING NOTES
			0.0					
	Fly ash, cinders, fill, melted slag (dry), fine-coarse sand with gravel sized coal-pieces		1.0	S-1	DS	1.0'	4/13	
	Brown yellow clay (dry) with sand bottom 1" brown medium sand		2.0	S-2	DS	0.65'	23/35	
	Brownish tan medium-fine sand 1" coal on top. Yellow clay with gravel grades to tan med-fine sand		3.0	S-3	DS	0.67'	29/47	
	½" coal sand sized then tan medium-fine silty sand		3.5	S-4	DS	0.5'	48/6	Boulder at 3.5'
	2" yellow clay with gravel							
	Refer to sheet 2 and 3 for coring logs							

SAMPLER TYPE	GROUNDWATER DEPTH	BORING METHOD
DS - DRIVEN SPLIT SPOON	AT COMPLETION ______ FT.	HSA - HOLLOW STEM AUGERS
PT - PRESSED SHELBY TUBE	AFTER ____ HRS. ______ FT.	CFA - CONTINUOUS FLIGHT
CA - CONTINUOUS FLIGHT AUGER	AFTER 24 HRS. ______ FT.	DC - DRIVING CASING
		MD - MUD DRILLING

CLIENT: GPU NUCLEAR

PROJECT: SAXTON BORING & CORING PROGRAM

LOCATION: SAXTON, PA.

DATE: 5/14/81

FILE NO.: 81513

BORING NO.: B-3

SHEET 2 of 3

Ground Surface Elev.: 810-815 Ft.

Datum: Ground Surface

Type of Drill Rig: CME

Core Barrel: NX

Core Bit: NWG Diamond

Type of Feed During Coring: Hydraulic

CORE NO.	CORE DEPTH	CORE REC/RQD	ROCK TYPE	WEATHERING	REMARKS
	3.5				
R-1	5.0 – 5.5		White sandstone boulder		
R-2	7.5		White sandstone granite boulder		
R-3	9.5 – 10.0		White-pink sandstone granite boulder		
R-4	11.5	0.8/0	Red Siltstone		Very fractured rock-top of rock at about 10.5'
R-5	13.92	~/0	Red pebbly siltstone then green siltstone		
R-6	15.0 – 18.92	4.8/0	Greenish siltstone		Many iron stained fractures
R-7	20.0 – 23.92	5.0/33	Grey silstone with shaley zones		Iron stained, highly fractured
R-8	25.0 – 29.0	5.0/60	Grey-blue siltstone and red siltstone		Iron staining at 2.0', 3.2' shaley 3.5'-4.3'
R-9	30.0 – 34.0 – 35.0	5.0/50	Red siltstone blue sandy siltstone reddish white sandstone		

COMMENTS:

INSPECTOR: GJC

CLIENT: GPU NUCLEAR
PROJECT: SAXTON BORING & CORING PROGRAM
LOCATION: SAXTON, PA.

DATE: 5/18/81
FILE NO.: 81513
BORING NO.: B-3
SHEET 3 of 3

Ground Surface Elev.: 810-815 Ft.
Datum: Ground Surface
Type of Drill Rig: CME

Core Barrel: NX
Core Bit: NWG Diamond
Type of Feed During Coring: Hydraulic

CORE NO.	CORE DEPTH	CORE REC/RQD	ROCK TYPE	WEATHERING	REMARKS
R-10	39.0	4.7/47.0	Reddish sandstone blueish shaley siltstone		Upper 1.0' vertical fractures
R-11	40.0 – 44.0	5.0/37.0	Tan sandstone reddish grey siltstone, red shaley siltstone grey siltstone		
R-12	45.0 – 46.4	2.4/52.0	Brown sandstone grey siltstone red siltstone		
R-13	48.5	1.65/19.0	Red and grey alternating beds of siltstone		
R-14	50.0 – 50.5	2.5/60.0	Red siltstone grading into red sandstone		Terminated drilling at 50.5'

COMMENTS:

INSPECTOR: GJC

GROUND/WATER TECHNOLOGY, INC.

BORING NO. B-4

CONTRACTED WITH GPU NUCLEAR — JOB NO. 81513

PROJECT NAME SAXTON BORING & CORING PROGRAM — SHEET 1 OF 2

LOCATION SAXTON, Pa.

SAMPLER:

DATUM Ground Surface — HAMMER WT. 140 LBS. — HOLE DIAMETER 2" — ENGINEER CRB

SURF. ELEV. 812± FT. — HAMMER DROP 30 IN.

DATE STARTED 5/19/81 — PIPE SIZE 2 IN. — BORING METHOD DC — DATE COMPLETED 5/19/8

ELEV.	SOIL DESCRIPTION	STRA. DEPTH	DEPTH SCALE	NO.	TYPE	REC	BLOWS/6"	BORING & SAMPLING NOTES
			0.0					
	Black organic soil and fly ash			S-1	DS	0.83'	4/17	
			1.0					
	Red silty fine sand			S-2	DS	0.75'	19/19	
			2.0					
	Red fine sand-some silt			S-3	DS	0.79'	19/30	
			3.0					
	Brown fine-medium sand 1.5"		3.1	S-4	DS	0.125'	80 blow	refusal due to probable boulder. Boulder 3'-1" to 4'-0"
	Boulder at 4' with sandstone (no sample)		4.0		DS			
			5.0		DS			
	Refer to sheet 2 for coring logs							

SAMPLER TYPE

DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER

GROUNDWATER DEPTH

AT COMPLETION ______ FT.
AFTER ____ HRS. ______ FT.
AFTER 24 HRS. ______ FT.

BORING METHOD

HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT
DC - DRIVING CASING
MD - MUD DRILLING

CLIENT: GPU NUCLEAR

PROJECT: SAXTON BORING & CORING PROGRAM

LOCATION: SAXTON, PA.

DATE: 5/19/81

FILE NO.: 81513

BORING NO.: B-4

SHEET 2 of 2

Ground Surface Elev.: 810-815 Ft.

Datum: Ground Surface

Type of Drill Rig: CME

Core Barrel: NX

Core Bit: NWG Diamond

Type of Feed During Coring: Hydraulic

CORE NO.	CORE DEPTH	CORE REC/RQD	ROCK TYPE	WEATHERING	REMARKS
	5.0				
R-1	10.0 10.0	N/D	Clay 6" White-tan Sandstone Boulder Red clayey silt weathered siltstone		Clayey silt-red weathered siltstone. top of rock at 8.5' vertical fractures and fractures along bedding plane
R-2	14.65	4.4/29	Red fractured siltstone		
R-3	15.0 16.5	1.5/0	Red, fractured and decomposed, siltstone		Red siltstone at bottom (1') light grey sandstone 0.5'
R-4	20.0 21.5	4.8/16	Red fractured siltstone		Occasional green siltstone ¼" - ½" (4 sections)
R-5	23.5	1.8/25	Red fractured siltstone		Decomposed zone 1" at 23.4 - 23.5
R-6	25.0 26.5	2.9/73	Red siltstone		Silt in some fractures. less fractured than above run. Terminated drilling at 26.5'

COMMENTS:

INSPECTOR: CRB

GROUND/WATER TECHNOLOGY, INC.

BORING NO. B-5

CONTRACTED WITH GPU NUCLEAR — JOB NO. 81513

PROJECT NAME SAXTON BORING & CORING PROGRAM — SHEET 1 OF 3

LOCATION SAXTON, Pa.

SAMPLER:

DATUM Ground Surface — HAMMER WT. 140 LBS. — HOLE DIAMETER 2" — ENGINEER CRB

SURF. ELEV. 812± FT. — HAMMER DROP 30 IN.

DATE STARTED 5/20/81 — PIPE SIZE 2 IN. — BORING METHOD DC — DATE COMPLETED 5/21/8

ELEV.	SOIL DESCRIPTION	STRA. DEPTH	DEPTH SCALE	NO.	TYPE	REC	BLOWS/6"	BORING & SAMPLING NOTES
			0.0					
	Concrete slab 1' thick		1.0					Roller bit through
	Fly ash and little ½" gravel		2.0	S-1	DS	0.4'	6/3	
	Red silty sand with some ½" gravel		3.0	S-2	DS	0.6'	6/4	
	Tan and red fine-medium sand some angular gravel		4.0	S-3	DS	0.4'	3/4	
	Tan fine sand & gray gravel		5.0	S-4	DS	0.4'	5/3	
	Orange sand-gravel Boulder at 6'		6.0	S-5	DS	0.5'	6/53	
	Orange fine sand-fine, angular gravel		6.5	S-6	DS	0.45'	56	Roller bit was usec to drill through boulders from 7.5' to 8.5'
	Orange, fine sand-fine angular gravel		7.0 7.5	S-7	DS	0.5'	62	
	Refer to sheet 2 and 3 for coring logs							

SAMPLER TYPE

DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER

GROUNDWATER DEPTH

AT COMPLETION ______ FT.
AFTER ____ HRS. ______ FT.
AFTER 24 HRS. ______ FT.

BORING METHOD

HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT
DC - DRIVING CASING
MD - MUD DRILLING

CLIENT: GPU NUCLEAR

PROJECT: SAXTON BORING & CORING PROGRAM

LOCATION: SAXTON, PA.

DATE: 5/20/81

FILE NO.: 81513

BORING NO.: B-5

SHEET 2 of 3

Ground Surface Elev.: 810-815 Ft.

Datum: Ground Surface

Type of Drill Rig: CME

Core Barrel: NX

Core Bit: NWG Diamond

Type of Feed During Coring: Hydraulic

CORE					
NO.	DEPTH	REC/RQD	ROCK TYPE	WEATHERING	REMARKS
	5.0				
	8.5				
R-1	10.0 13.0		Boulders		Clayey sand layer between boulders
R-2	15.0 15.7		Grey silty sandstone boulders		
R-3	20.0 20.7		Grey sandstone boulders		Core lifter split and part of core may remain in hole Bottom of fill for foundation of demolished coal fired plant Approximately 22 feet.
R-4	22.1		Grey sandstone, boulders		Apparent top of bedrock
R-5	23.8	1.7/76	Grey sandstone		At R-5, rock core improves Most breaks in rock occur along bedding planes although some vertical fracturing
R-6	25.0 25.4	1.6/47	Grey sandstone		
R-7	30.0 30.4	4.9/68	Grey siltstone and sandstone		Siltstone highly folded
R-8	35.0	4.9/64	Grey siltstone and sandstone		

COMMENTS:

INSPECTOR: CRB

CLIENT: GPU NUCLEAR

PROJECT: SAXTON BORING & CORING PROGRAM

LOCATION: SAXTON, PA.

DATE: 5/21/81

FILE NO.: 81513

BORING NO.: B-5

SHEET 3 of 3

Ground Surface Elev.: 810-815 Ft.

Datum: Ground Surface

Type of Drill Rig: CME

Core Barrel: NX

Core Bit: NWG Diamond

Type of Feed During Coring: Hydraulic

CORE NO.	DEPTH	REC/RQD	ROCK TYPE	WEATHERING	REMARKS
	35.4				
R-9	40.0 – 40.4	4.8/58.0	Grey siltstone		more fractured than above run
R-10	45.0 – 45.4	4.6/12.0	Grey siltstone		Iron staining along 45° bedding planes, approximately every 6"
R-11	50.0 – 50.4	3.8/0.0	Grey siltstone		At 47.0', loss of drilling fluid. Very fractured with iron staining. Terminated drilling at 50.4'

COMMENTS:

INSPECTOR: CRB

GROUND/WATER TECHNOLOGY, INC.

BORING NO. B-6

CONTRACTED WITH GPU NUCLEAR JOB NO. 81513

PROJECT NAME SAXTON BORING & CORING PROGRAM SHEET 1 OF 1

LOCATION SAXTON, Pa.

SAMPLER:

DATUM Ground Surface HAMMER WT. 140 LBS. HOLE DIAMETER 2" ENGINEER CRB

SURF. ELEV. 812± FT. HAMMER DROP 30 IN.

DATE STARTED 5/22/81 PIPE SIZE 2 IN. BORING METHOD DC DATE COMPLETED 5/22/8

ELEV.	SOIL DESCRIPTION	STRA. DEPTH	DEPTH SCALE	NO.	TYPE	REC	BLOWS/6"	BORING & SAMPLING NOTES
			0.0					
	Black fly ash		2.0	S-1	DS	0.9	3/6/7/7	
	Black fly Ash		4.0	S-2	DS	0.9	3/4/3/2	
	Black fly ash (wet)		6.0	S-3	DS	0.3	3/3/6/4	
	Black fly ash (wet)		8.0	S-4	DS	0.2	2/1/1/1	
	Red sandy silt		10.0	S-5	DS	0.3	2/1/3/2	
	Red silt with some sand and gravel		12.0	S-6	DS	1.0	2/3/8/15	
	Red, silt and sand some fine gravel		13.0	S-7	DS	0.8	22/55	Top of rock surface ~ 13.0'

SAMPLER TYPE

DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER

GROUNDWATER DEPTH

AT COMPLETION ______ FT.
AFTER ____ HRS. ______ FT.
AFTER 24 HRS. ______ FT.

BORING METHOD

HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT
DC - DRIVING CASING
MD - MUD DRILLING

GROUNDWATER TECHNOLOGY, INC.

BORING NO. B-7

CONTRACTED WITH GPU NUCLEAR — JOB NO. 81513

PROJECT NAME SAXTON BORING & CORING PROGRAM — SHEET 1 OF 2

LOCATION SAXTON, Pa.

SAMPLER:

DATUM Ground Surface — HAMMER WT. 140 LBS. — HOLE DIAMETER 2" — ENGINEER CRB

SURF. ELEV. 812± FT. — HAMMER DROP 30 IN.

DATE STARTED 5/22/81 — PIPE SIZE 2 IN. — BORING METHOD DC — DATE COMPLETED 5/22/81

ELEV.	SOIL DESCRIPTION	STRA. DEPTH	DEPTH SCALE	NO.	TYPE	REC	BLOWS/6"	BORING & SAMPLING NOTES
			0.0					
	Fly ash, red fill, concrete pieces red siltstone boulder concrete piece, fly ash		2.0	S-1	DS	1.4	3/5/31/20	
	Red fill, silt and clay fine and medium sand occasional fine gravel		4.0	S-2	DS	1.2'	17/25/22/26	
	Fill, sand and decomposed shale		4.5	S-3	DS	0.6'	80	
	Refer to sheet 2 for coring logs							

SAMPLER TYPE

DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER

GROUNDWATER DEPTH

AT COMPLETION ______ FT.
AFTER ____ HRS. ______ FT.
AFTER 24 HRS. ______ FT.

BORING METHOD

HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT
DC - DRIVING CASING
MD - MUD DRILLING

CLIENT: GPU NUCLEAR

PROJECT: SAXTON BORING & CORING PROGRAM

LOCATION: SAXTON, PA.

DATE: 5/22/81

FILE NO.: 81513

BORING NO.: B-7

Ground Surface Elev.: 810-815 Ft.

Datum: Ground Surface

Type of Drill Rig: CME

Core Barrel: NX

Core Bit: NWG Diamond

Type of Feed During Coring: Hydraulic

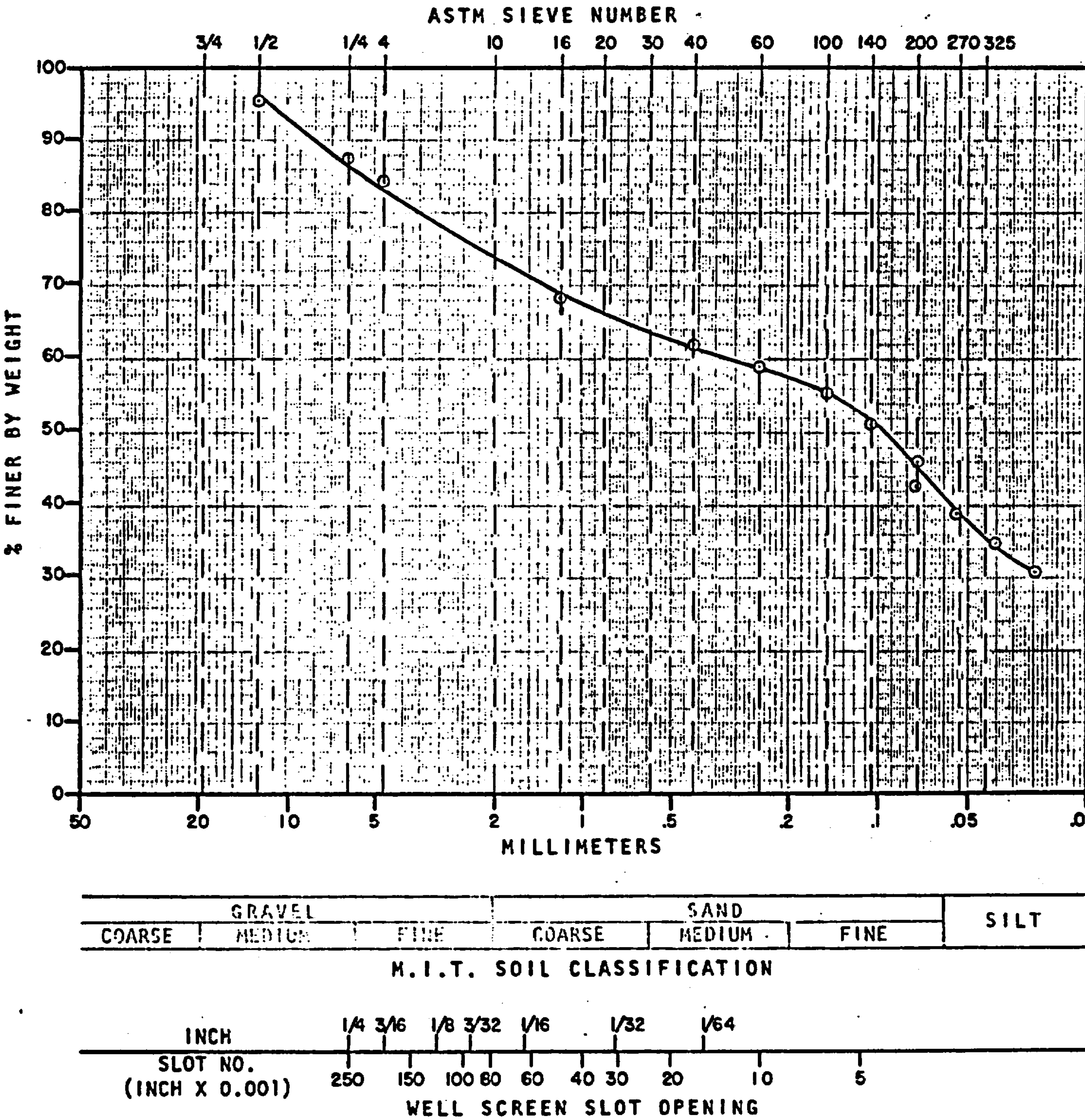
CORE NO.	CORE DEPTH	CORE REC/RQD	ROCK TYPE	WEATHERING	REMARKS
	4.5				
	5.0		Sandstone boulders 2"-6" with clay in interstial space		Apparent rock surface at 8.5'
R-1	9.4	2.0/			
	10.0				
	15.0				

COMMENTS:

INSPECTOR: CRB

APPENDIX B

GRAIN SIZE DISTRIBUTION



Hole Number: GS#2
Sample Nubmer: S-1 (Random fill)
Depth of Sample: 0.0-1.5'

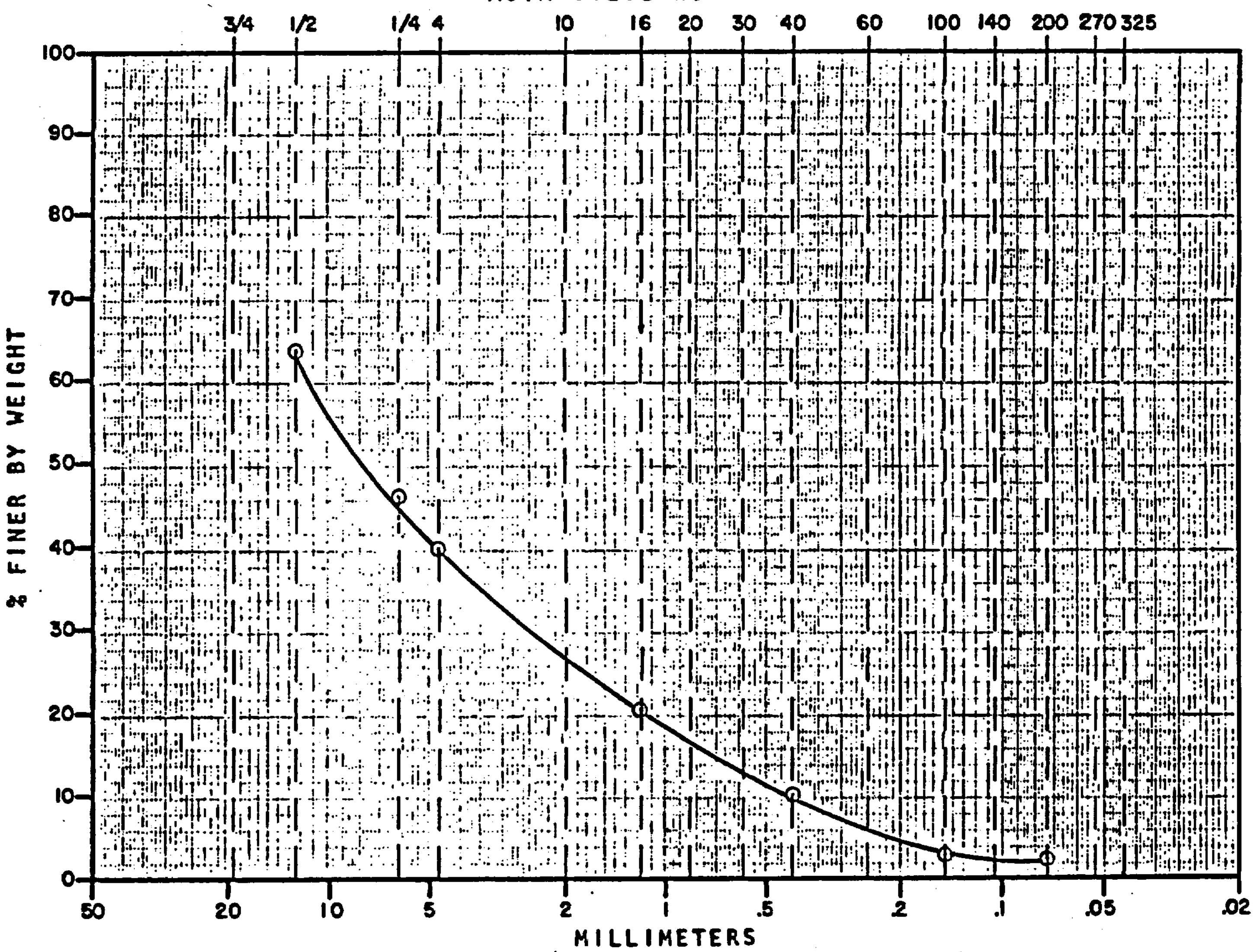
NOTE: Sample obtained from a hand-dug hole located approximately 20 ft. north of containment

CLIENT: GPU NUCLEAR
LOCATION: SAXTON, PA.

FILE NO.: 81513
DATE: 6/02/81 | BY: MEC

GROUNDWATER TECHNOLOGY, INC.

GRAIN SIZE DISTRIBUTION



GRAVEL			SAND			SILT
COARSE	MEDIUM	FINE	COARSE	MEDIUM	FINE	

M.I.T. SOIL CLASSIFICATION

INCH: 1/4 3/16 1/8 3/32 1/16 1/32 1/64

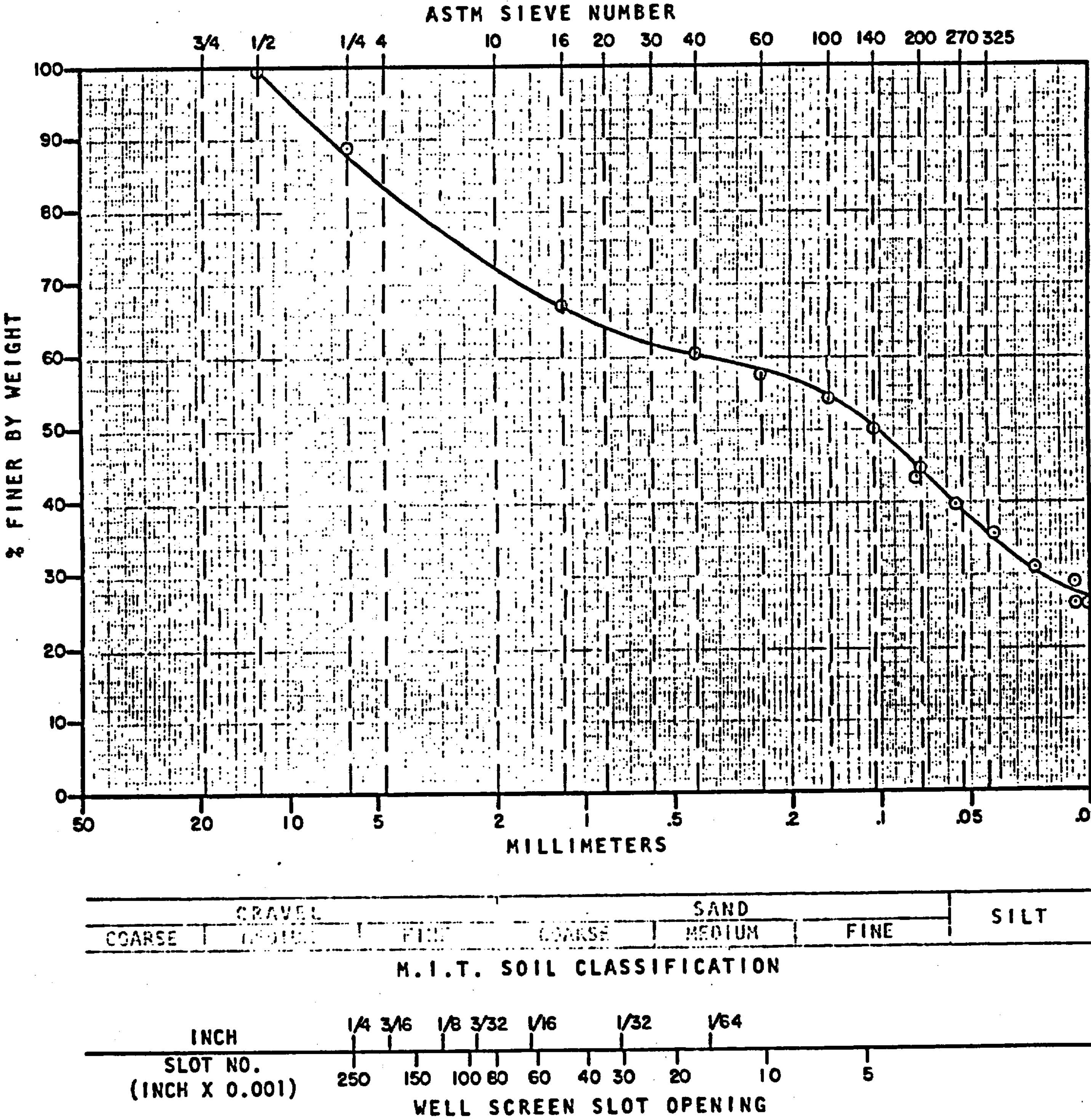
SLOT NO. (INCH X 0.001): 250 150 100 80 60 40 30 20 10 5

WELL SCREEN SLOT OPENING

Hole eumber: GS#2	CLIENT: GPU NUCLEAR
Sample Number: S-2 (Fill - fly ash)	LOCATION: SAXTON, PA.
Depth of Sample: 1.5-3.0'	
	FILE NO.: 81513
NOTE: Sample obtained from a hand-dug hole located approximately 20 ft. north of containment	DATE: 6/02/81 BY: RGK

GROUNDWATER TECHNOLOGY, INC.

GRAIN SIZE DISTRIBUTION



Hole Number: GS#2
Sample Number: S-3 (Random fill)
Depth of Sample: 3.0-4.0'

NOTE: Sample obtained from a hand-dug hole located approximately 20 ft. north of containment

CLIENT: GPU NUCLEAR
LOCATION: SAXTON, PA.

FILE NO.: 81513
DATE: 6/02/81 BY: RGK

GROUNDWATER TECHNOLOGY, INC.

APPENDIX C

<u>SUMMARY AND RESULTS OF THE PACKER TESTS IN THE ROCK</u>

BORING NO	DEPTH OF TEST SECTION FROM GROUND SURFACE	TESTING PRESSURE	PERMEABILITY
	(FT)	(PSI)	(CM/SEC)
B-3	16.8 - 22.8	1	4.93×10^{-3} 4.93×10^{-3}
		2-3	4.02×10^{-3} 4.02×10^{-3}
		5	3.05×10^{-3} 2.65×10^{-3}
B-3	21.8 - 27.8		NO FLOW
B-3	31.8 - 37.8	4	1.24×10^{-3}
		11	8.46×10^{-3} 8.46×10^{-3} 8.02×10^{-3}
		15	6.06×10^{-4}
B-3	41.8 - 47.8	5	1.1×10^{-4} 1.1×10^{-4}
		15	1.5×10^{-4}
		20	1.9×10^{-4}
B-4	12.0 - 18.0	3	3.12×10^{-4} 3.09×10^{-4}
		8	2.91×10^{-4} 2.91×10^{-4}
		12	2.94×10^{-4} 2.82×10^{-4}
		6	3.01×10^{-4}
B-4	18.0 - 24.0	4	1.58×10^{-5} 1.58×10^{-5}
		10	3.98×10^{-5} 3.54×10^{-5}

SUMMARY AND RESULTS OF THE PACKER TESTS IN THE ROCK

BORING NO	DEPTH OF TEST SECTION FROM GROUND SURFACE	TESTING PRESSURE	PERMEABILITY
	(FT)	(PSI)	(SM/SEC)
B-4	18.0 - 24.0	18	3.08×10^{-5}
B-5	24.0 - 30.0	7	NO FLOW
		15	6.82×10^{-5} 6.48×10^{-5}
		22	6.19×10^{-5} 6.85×10^{-5}
B-5	30.0 - 36.0	7	NO FLOW
		7	NO FLOW
		14	2.52×10^{-5}
		30	LOST FLOW 5.72×10^{-5}
B-5	36.0 - 42.0	9	1.87×10^{-3} 1.87×10^{-3} 1.79×10^{-3}
		18	1.29×10^{-3} 1.33×10^{-3}
		31	1.06×10^{-3} 1.05×10^{-3}
B-5	42.0 - 48.0	10	2.98×10^{-3} 2.96×10^{-3} 2.80×10^{-3}
		20	2.07×10^{-3} 2.04×10^{-3}
		30	1.68×10^{-3} 1.68×10^{-3}

GEO Engineering

150 Mineral Spring Drive
Dover, New Jersey 07801
201 361-3600 FAX 361-3800

COPY

In since re well.

June 7, 1994

Beverly A. Good
General Public Utilities Nuclear Corporation
1 Upper Pond Road
Parsippany, NJ 07054

SUBJ: **Summary of Field Work**
Saxton Nuclear Experimental Station
Saxton, Pennsylvania

Dear Ms. Good:

This letter summarizes the field work for the installation of two gas displacement samplers (Geomons) and one piezometer in the bedrock at the Saxton site. Additionally, our services included retrofitting the existing eight overburden monitor wells with Geomons. We performed this field work in accordance with the scope of work outlined in our December 17, 1993 letter to you.

Bedrock Ground Water Monitoring

Ground water movement within the bedrock occurs predominantly in the fractures and bedding planes (spaces between the individual rock layers) of the bedrock. Therefore, the direction of ground water flow will be controlled by the orientations of these fractures and bedding planes, and our understanding of these orientations was fundamental to designing a bedrock ground water monitoring system.

Specific bedrock information collected during our October 1992 investigation included the orientations of the two dominant fracture patterns and of the bedding planes. One fracture pattern trended northeast-southwest, and dipped (tilted) moderately toward the northwest. The second fracture pattern trended northwest-southeast, and dipped steeply toward the southwest. The bedding planes trended northeast-southwest, and dipped moderately toward the southeast.

Two boreholes were drilled into bedrock at an angle to maximize the interception of the fractures and bedding planes. Geomon samplers were installed into these boreholes (MW-1 and MW-2) for the bedrock ground water detection system (refer to Figure 1 in Attachment 1 for a site plan). MW-1 was installed along a northeast-southwest trend (from the northeast toward the southwest), whereas MW-2 was installed along a southwest-northeast trend (from the southwest toward the northeast). Additionally, we installed a vertical piezometer (GEO-9) to monitor bedrock ground water elevation.

Geomon Retrofitting of Overburden Wells

During this investigation, a representative of Aquifer Systems, Inc. of Succasunna, New Jersey retrofitted the eight overburden monitor wells (GEO-1 through GEO-8) with Geomons. Each Geomon was secured to an existing overburden well using a watertight wellhead fitting.

We provided a Geomon sampling tutorial to representatives of GPU (Mr. Louis Toke and Mr. Joseph Melnic) during our retrofitting work. For this tutorial, we utilized a portable container of nitrogen gas (No. 20 size) and a high pressure regulator for sample collection. This regulator is GPU property and was left on-site after the retrofitting, which was in accordance with our December 1993 scope of work letter. Nitrogen gas in portable containers is generally readily available at welding supply stores.

Monitor Well Installation

GPU Nuclear retained Pennsylvania Drilling Co., Inc., of McKees Rocks, Pennsylvania, to install the bedrock angle boreholes and the vertical piezometer during the week of March 14, 1994. GEO Engineering observed the drilling and piezometer installation and installed Geomon samplers in the two angle boreholes. Refer to Attachment 2 for the boring logs for the bedrock wells and piezometer.

The borehole for each angle well (MW-1 and MW-2) was advanced at an angle of approximately 25 degrees from vertical. Each borehole was drilled through the overburden soil and approximately four (MW-1) to five (MW-2) feet into bedrock using a ten-inch diameter air hammer. Steel pipe was temporarily installed into these boreholes to prevent soil from collapsing into these boreholes. Each borehole was then advanced to completion using an eight-inch diameter air hammer. Refer to Figure 2 in Attachment 1 for the construction details of MW-1 and MW-2.

Once the boreholes for MW-1 and MW-2 were completed, we installed Geomons in each borehole. Each Geomon was installed to monitor bedrock ground water only. The annular space between the Geomon solid riser pipe and the borehole was filled with a sand filter pack, a bentonite pellet seal and cement grout. Each well was completed by removing the steel pipe and installing a flush-mounted manhole to provide surface protection.

The borehole for the vertical piezometer (GEO-9) was completed in a similar manner as those for MW-1 and MW-2. Upon completion, Pennsylvania Drilling installed

PVC well screen and solid riser pipe into the borehole. The annular space between the PVC pipe and the borehole was filled with a sand filter pack, a bentonite pellet seal, and cement grout. The piezometer was completed by installing a flush-mounted manhole to provide surface protection. Refer to Figure 3 in Attachment 1 for the construction details of GEO-9.

GEO Engineering performed a relative elevation survey of GEO-9 following its installation. This survey was performed relative to an arbitrary datum of 100.00 feet at the top of the PVC casing of GEO-1. This information can be utilized to assess the relative elevation of the bedrock ground water.

We trust the foregoing fulfills your requirements. If you would like to discuss this matter further, please call.

Sincerely,

GEO ENGINEERING, INC.

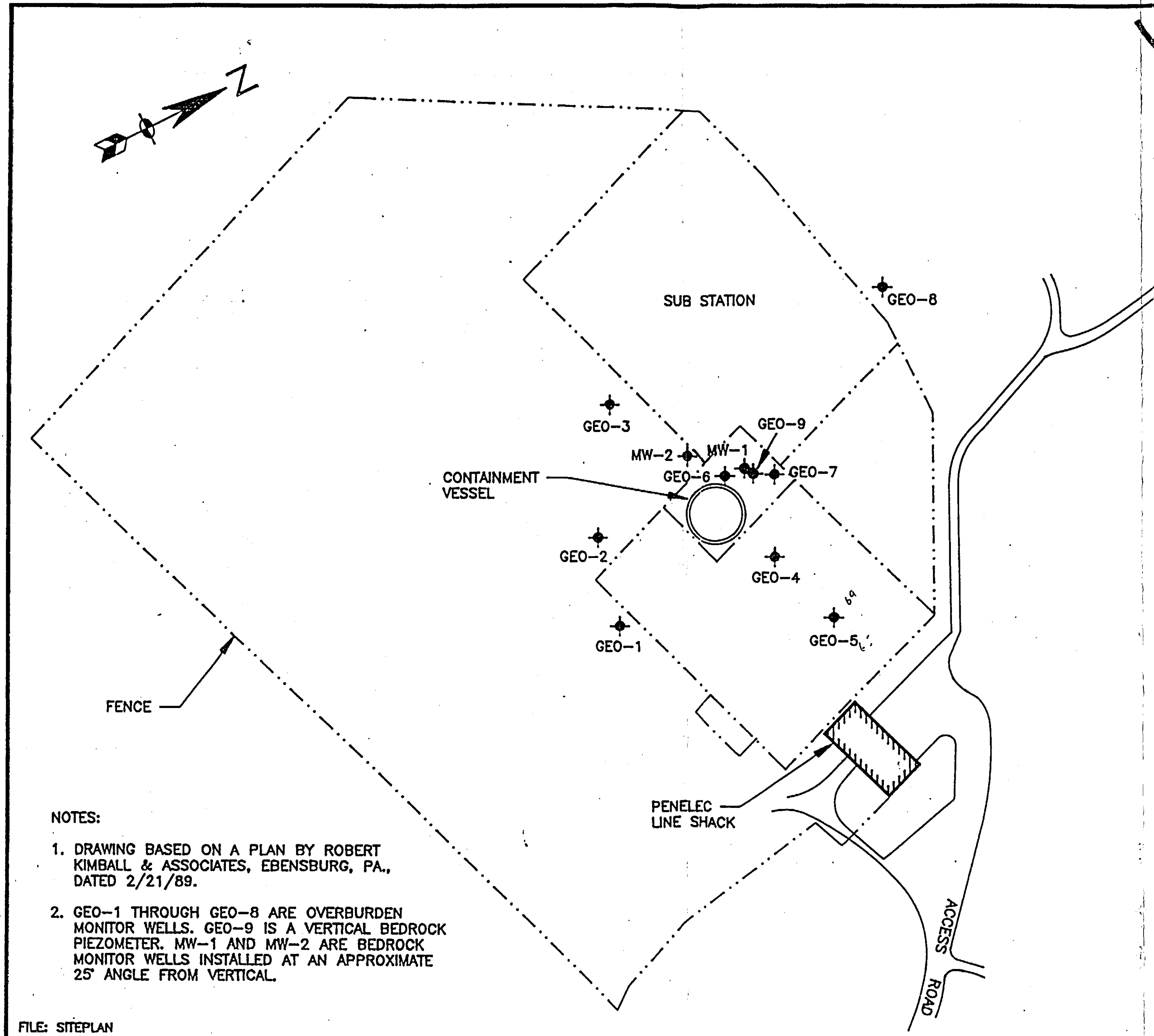
Kenneth J. Luperi
Project Geologist

Charles R. Butts
Associate

KJL/CRB/avm
attachments

Attachment 1

Figure 1: Site Plan
Figure 2: Bedrock Monitor Well Construction Details - MW-1 and MW-2
Figure 3: Bedrock Piezometer Construction Details - GEO-9



NOTES:

1. DRAWING BASED ON A PLAN BY ROBERT KIMBALL & ASSOCIATES, EBENSBURG, PA., DATED 2/21/89.

2. GEO-1 THROUGH GEO-8 ARE OVERBURDEN MONITOR WELLS. GEO-9 IS A VERTICAL BEDROCK PIEZOMETER. MW-1 AND MW-2 ARE BEDROCK MONITOR WELLS INSTALLED AT AN APPROXIMATE 25° ANGLE FROM VERTICAL.

FILE: SITEPLAN

SAXTON NUCLEAR EXPERIMENTAL CORP.
SAXTON, PENNSYLVANIA

GPUN CORPORATION
PARSIPPANY, NEW JERSEY

SITE PLAN

FIGURE No.	GEO FILE No.	DATE	REV.
1	93129	MAY 1994	Ø

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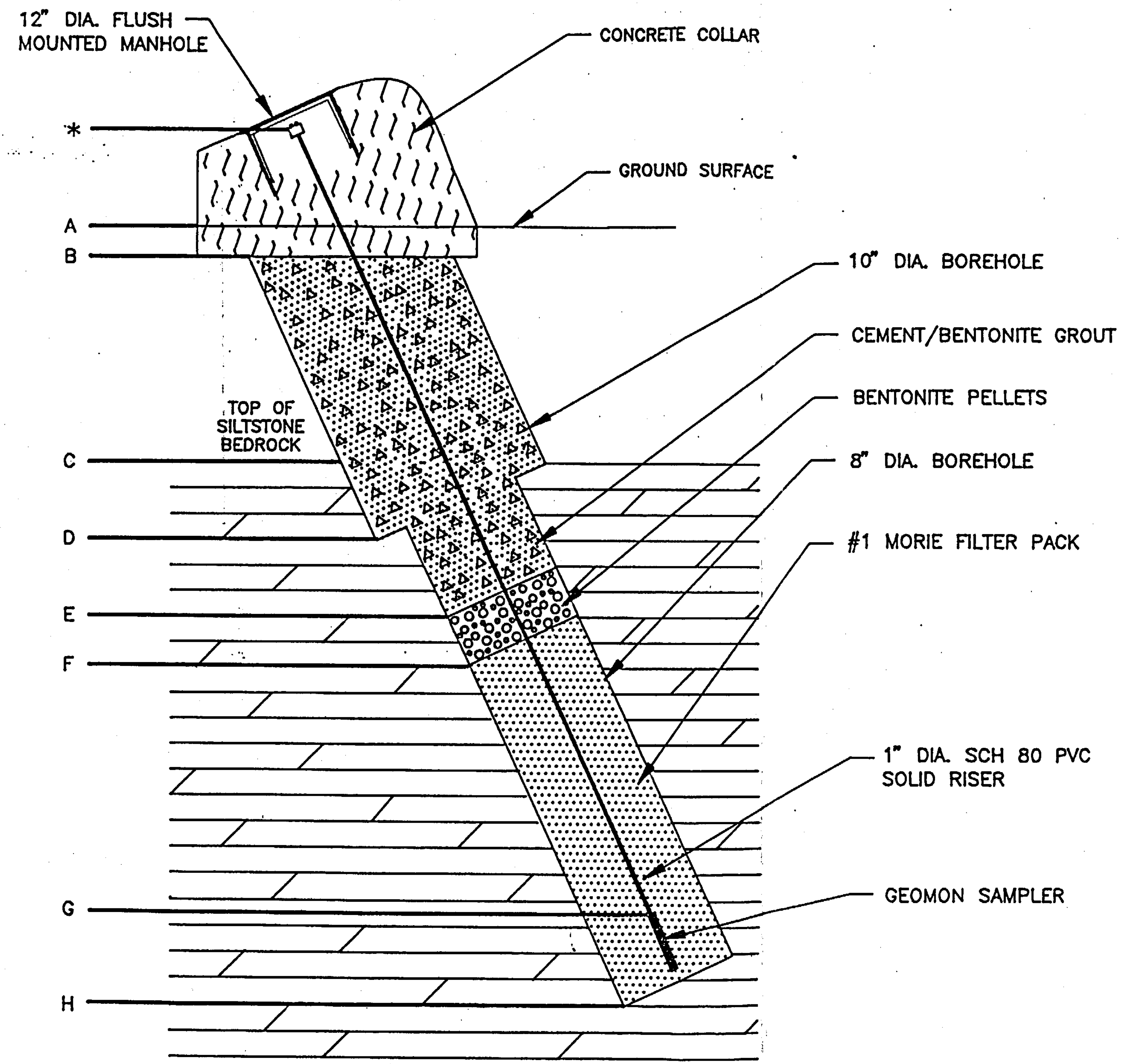

TYPICAL BEDROCK MONITOR WELL DETAILS

NOT TO SCALE

FILE: ANGLEWEL

DEPTH BELOW GROUND SURFACE (LINEAR FEET)		
	GEO–1	GEO–2
A	0	0
B	1	1
C	19	13
D	23	20
E	25	25
F	30	30
G	54	54
H	55	55

* TOP OF SOLID RISER AND MANHOLE ARE APPROXIMATELY 1 FOOT ABOVE GROUND SURFACE.

NOTE: GEO–1 DRILLED AT AN APPROXIMATE ANGLE OF 25° FROM VERTICAL TO THE SOUTHWEST. GEO–2 DRILLED AT AN APPROXIMATE ANGLE OF 25° FROM VERTICAL TO THE NORTHEAST.

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BEDROCK MONITOR WELL CONSTRUCTION DETAILS

FIGURE No.	GEO FILE No.	DATE	REV.
2	93129	MAY 1994	Ø

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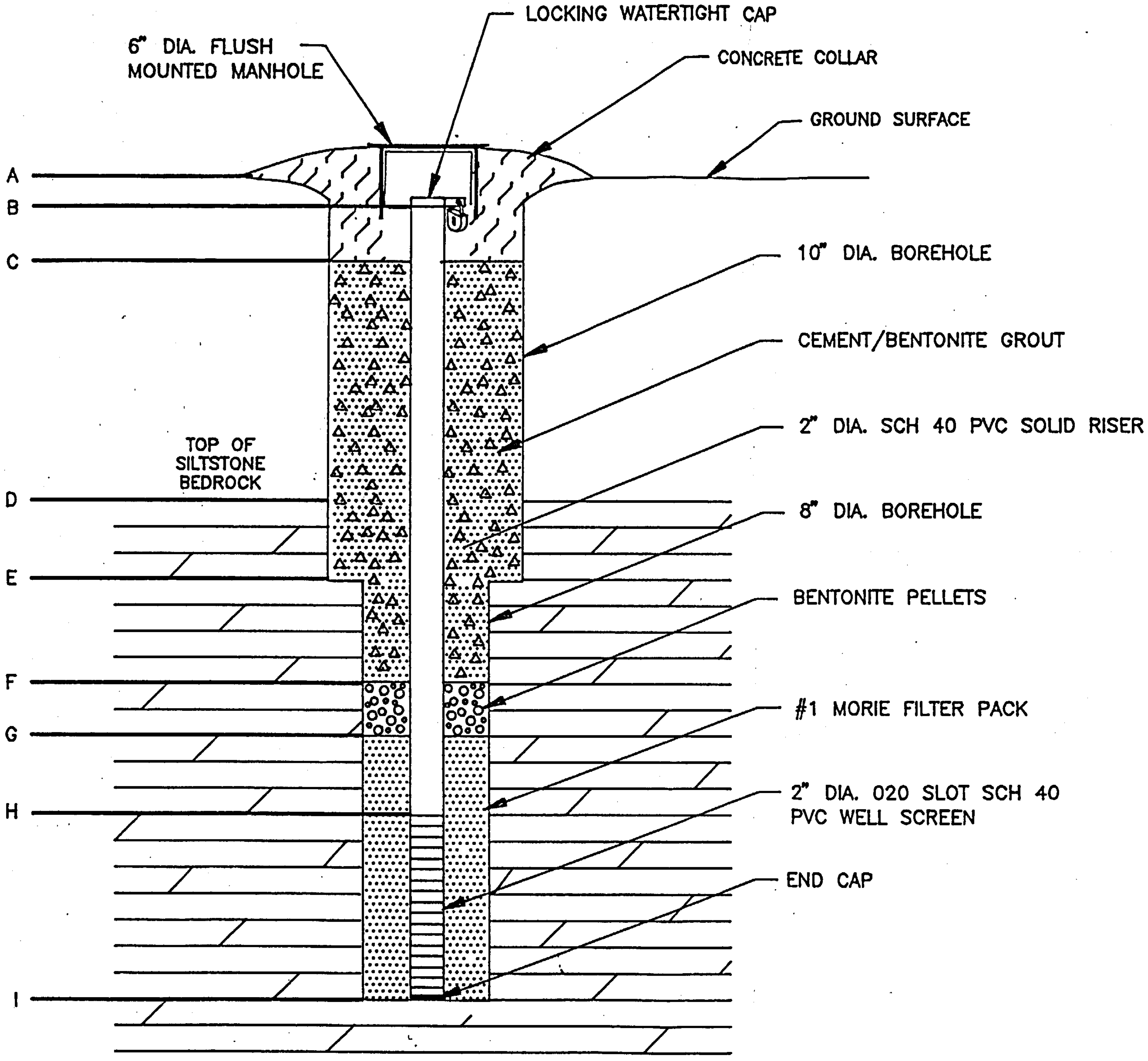

TYPICAL BEDROCK PIEZOMETER DETAILS

NOT TO SCALE

FILE: MWELL

*RELATIVE ELEVATION**

	GEO-9
A	98.45
B	97.95
C	97.45
D	79.45
E	75.45
F	75.45
G	68.45
H	63.45
I	48.45

* ELEVATIONS OBTAINED BY A RELATIVE SURVEY PERFORMED BY GEO ENGINEERING, INC., ON 3/18/94 AND ARE BASED ON AN ARBITRARY DATUM OF 100.00 FT. AT TOP OF PVC CASING OF GEO-1.

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GPUN CORPORATION
PARSIPPANY, NEW JERSEY

BEDROCK PIEZOMETER
CONSTRUCTION DETAILS

FIGURE No.	GEO FILE No.	DATE	REV.
3	93129	MAY 1994	Ø

GEO Engineering DOVER, N.J. (201) 361-3600

Attachment 2

Boring Logs - MW-1, MW-2 and GEO-9

Client: GPUN
Project: Saxton Nuclear Station
Location: Saxton, Pa.
Drilling Contractor: Penna. Drilling Co.
Inspector: KJL

File No.: 93129

Date Started: 3/14/94
Date Completed: 3/15/94

Sample No.	Sample Recover	Blows /12"	Depth (Feet)	Soil Type	Soil Description
			0		Dark brown, coarse to fine SAND, some Silt; dry.
					Boulders; dry.
			10	Fill ?	As above; moist.
					Brown, coarse to fine GRAVEL, and (-) Sand; wet.
					Boulders; moist.
			20		Dark brown-dark red weathered siltstone; dry.
				Siltst.	
			30		As above; moist.

Sample: ⊠ Drill cuttings

Boring Method: Air rotary.

GEO Engineering

Project: Saxton Nuclear Station
Location: Saxton, Pa.

Sample No.	Sample Recover	Blows /12"	Depth (Feet)	Soil Type	Soil Description
			30		Dark brown-dark red weathered siltstone; moist.
			40	Siltst.	As above; wet.
			50		As above; wet.
					Boring terminated at 55 linear feet depth from ground surface. Boring completed at an angle of 25 degrees from vertical.
			60		
			70		

Sample: ☒ Drill cutttings.

Boring Method: Air rotary.

GEO Engineering

Client: GPUN
Project: Saxton Nuclear Station
Location: Saxton, Pa.
Drilling Contractor: Penna. Drilling Co.
Inspector: KJL

Boring No.: MW-2

File No.: 93129

Date Started: 3/17/94
Date Completed: 3/18/94

Sample No.	Sample Recover	Blows /12"	Depth (Feet)	Soil Type	Soil Description
			0	Asph.	Asphalt.
					Black CINDERS, and(-) coarse to fine Sand; dry.
					As above; dry.
					Boulders; dry.
				Fill ?	
			10		As above; moist.
					Olive green, weathered siltstone; dry.
					Dark gray, weathered siltstone; dry.
					Olive green, weathered siltstone; dry.
					Brown-red, weathered siltstone; dry.
					As above; moist.
			20	Sltst.	
			30		As above; moist.

Sample: ☒ Drill cuttings

Boring Method: Air rotary.

GEO Engineering

Project: Saxton Nuclear Station
Location: Saxton, Pa.

Sample No.	Sample Recover	Blows /12"	Depth (Feet)	Soil Type	Soil Description
			30		Brown-red, weathered siltstone; moist.
			40		As above; wet.
				Sltst.	
			50		As above; wet.
					Boring terminated at 55 linear feet depth from ground surface. Boring completed at an angle of 25 degrees from vertical.
			60		
			70		

Sample: ☒ Drill cutttings.

Boring Method: Air rotary.

GEO Engineering

Client: GPUN
Project: Saxton Nuclear Station
Location: Saxton, Pa.
Drilling Contractor: Penna. Drilling Co.
Inspector: KJL

Boring No.: GEO-9

File No.: 93129

Date Started: 3/16/94
Date Completed: 3/16/94

Sample No.	Sample Recover	Blows /12"	Depth (Feet)	Soil Type	Soil Description
			0		Dark brown, coarse to fine SAND, some Silt; dry.
					Boulders; dry.
			10	Fill ?	As above; dry.
					Brown, coarse to fine GRAVEL, and (-) Sand; wet.
					Boulders; moist.
					Dark brown-dark red weathered siltstone; dry.
			20		
				Siltst.	As above; dry.
			30		As above; moist.

Sample: ☒ Drill cuttings

Boring Method: Air rotary.

GEO Engineering

Sample No.	Sample Recover	Blows /12"	Depth (Feet)	Soil Type	Soil Description
			30		Dark brown-dark red weathered siltstone; moist.
			40	Siltst.	As above; wet.
					As above; moist.
			50		Boring terminated at 50 feet depth.
			60		
			70		

Sample: ☒ Drill cutttings.

Boring Method: Air rotary.

GEO Engineering

GEO Engineering

150 Mount Spring Drive
Dover, New Jersey 07801
201 361 3600 FAX 361 3800

November 18, 1992

COPY

Beverly A. Good
GPU Nuclear
Three Mile Island
P.O. Box 480
Middletown, PA 17057

SUBJ: Phase I Report of Findings - Groundwater Investigation
Saxton Nuclear Experimental Station
Saxton, Pennsylvania

Dear Ms. Good:

This letter reports the findings of our Phase I Groundwater Investigation at the Saxton site. We performed this investigation in accordance with the scope of work outlined in our August 21, 1992, letter to you.

This investigation focused on installing eight shallow groundwater monitor wells in the overburden soil. We performed a location survey of these overburden wells and prepared groundwater elevation contour maps showing groundwater flow direction, based on water level measurements provided to us by a GPU representative. Additionally, we collected valuable information regarding the depth to the bedrock surface and the orientation of the bedrock groundwater flow pathways. This information will minimize the number of sampling points (i.e. bedrock monitor wells) needed during a Phase II investigation to produce a reliable detection system for the bedrock ground water.

Groundwater Occurrence and Flow Direction in the Overburden

The results of this investigation indicate the overburden ground water occurs at depths ranging from approximately 4 to 16 feet, based on water level data collected on October 29 and November 5 , 1992. Groundwater elevation contour maps of these data indicate ground water within the overburden soil flows west, toward the Raystown Branch of the Juniata River. Refer to Figures 1 and 2 in Attachment 1 for monitor well locations and for groundwater elevation contour maps of the October 29 (Figure 1) and November 5 (Figure 2) water level data.

Site Geology

GEO Engineering classified the subsurface soil at each monitor well location during installation. Our soil classifications were based solely on the drill cuttings from each well borehole. We did not collect soil samples at discrete depths since this method of soil sampling was performed by Ground/Water Technology, Inc., of Denville, New Jersey during their May 1981 subsurface investigation.

Generally, our findings confirm the findings of Ground/Water Technology, Inc. The site is immediately underlain by a fill layer comprised of flyash, cinders and/or silt and sand-size sediment. This fill layer is underlain by a layer of boulders in a silty clay matrix. Bedrock lies beneath this boulder layer.

The depth to the bedrock surface varies between approximately 7.5 and 18 feet. The bedrock is either red, red-gray or olive green-gray siltstone.

Bedrock Groundwater Pathways

Groundwater movement within the bedrock beneath the site is predominantly controlled by fractures in the bedrock. Ground water also moves within the spaces (bedding planes) between the individual layers of the siltstone bedrock at Saxton. There are two major fracture patterns; one which is trending nearly parallel to the bedding, while the other is nearly perpendicular to the bedding. Hence, groundwater flow direction in the bedrock will be controlled by the orientations of the fractures and the bedding planes. Accordingly, our understanding of these orientations is necessary to design a reliable bedrock groundwater detection system with a minimal number of bedrock monitor wells.

GEO Engineering investigated the orientations of two dominant fracture patterns and of the bedding planes at three separate bedrock exposures (outcrops). The orientations of the two fracture patterns and of the bedding planes were similar at each bedrock outcrop. One fracture pattern generally trended N 21° E and dipped (tilted) approximately 51° (below horizontal) towards the northwest, while the second fracture pattern generally trended N 62° W and dipped approximately 77° towards the southwest. The bedding planes generally trended N 23° E and dipped approximately 40° towards the southeast.

Monitor Well Installation

GPU Nuclear retained Pennsylvania Drilling Co., Inc. of McKees Rocks, Pennsylvania to install the overburden monitor wells. GEO Engineering observed the installation of these wells and provided guidance regarding their construction.

The borehole of each monitor well was drilled through the overburden soil to bedrock, except at GEO-2 and GEO-6, where the borehole was terminated prior to encountering bedrock. Each borehole was drilled using a 6-inch diameter pneumatic (air) hammer. After completing each borehole, the drillers installed PVC well screen and solid riser pipe in the borehole. The annular space between the well pipe and the borehole was filled with a sand filter pack to extend several feet above the top of the well screen. The remaining annular space was filled with a bentonite pellet seal and a cement grout. Each well was completed by installing a flush-mounted valve box set in a concrete support pad. Refer to Figure 3 in Attachment 2 for the construction details of the overburden wells.

After monitor well installation, GEO Engineering performed a relative elevation survey of each well. This survey was performed relative to an arbitrary datum of 100.00 feet at the top of the PVC casing of GEO-1. We utilized this information to produce the overburden groundwater elevation contour maps (Figures 1 and 2). Refer to Table 1 in Attachment 3 for a summary of the water level measurements and the monitor well elevations.

Recommendations - Phase I

The results of this investigation indicate ground water flow within the overburden soil is toward the west. Therefore, any future detection monitoring of the overburden ground water could be accomplished by sampling wells hydraulically downgradient of the containment vessel (GEO-3, GEO-6, GEO-7 and/or GEO-8). Additionally, wells GEO-1, GEO-4 and GEO-5 could serve as background monitoring points, since these wells are located hydraulically upgradient of the containment vessel.

Recommendations - Phase II

Based on the findings of this investigation, future detection monitoring within the bedrock could be accomplished by installing two bedrock monitor wells adjacent to the containment vessel. During the Phase I investigation, sufficient information was produced to proceed with the design details of a bedrock monitoring system. Therefore, the remaining scope of Phase II will be the design of the monitor wells and their installation.

We trust the above fulfills your current requirements. If you have any questions or require additional information, please call us.

Sincerely,

GEO ENGINEERING, INC.

Kenneth J. Luperi
Project Geologist

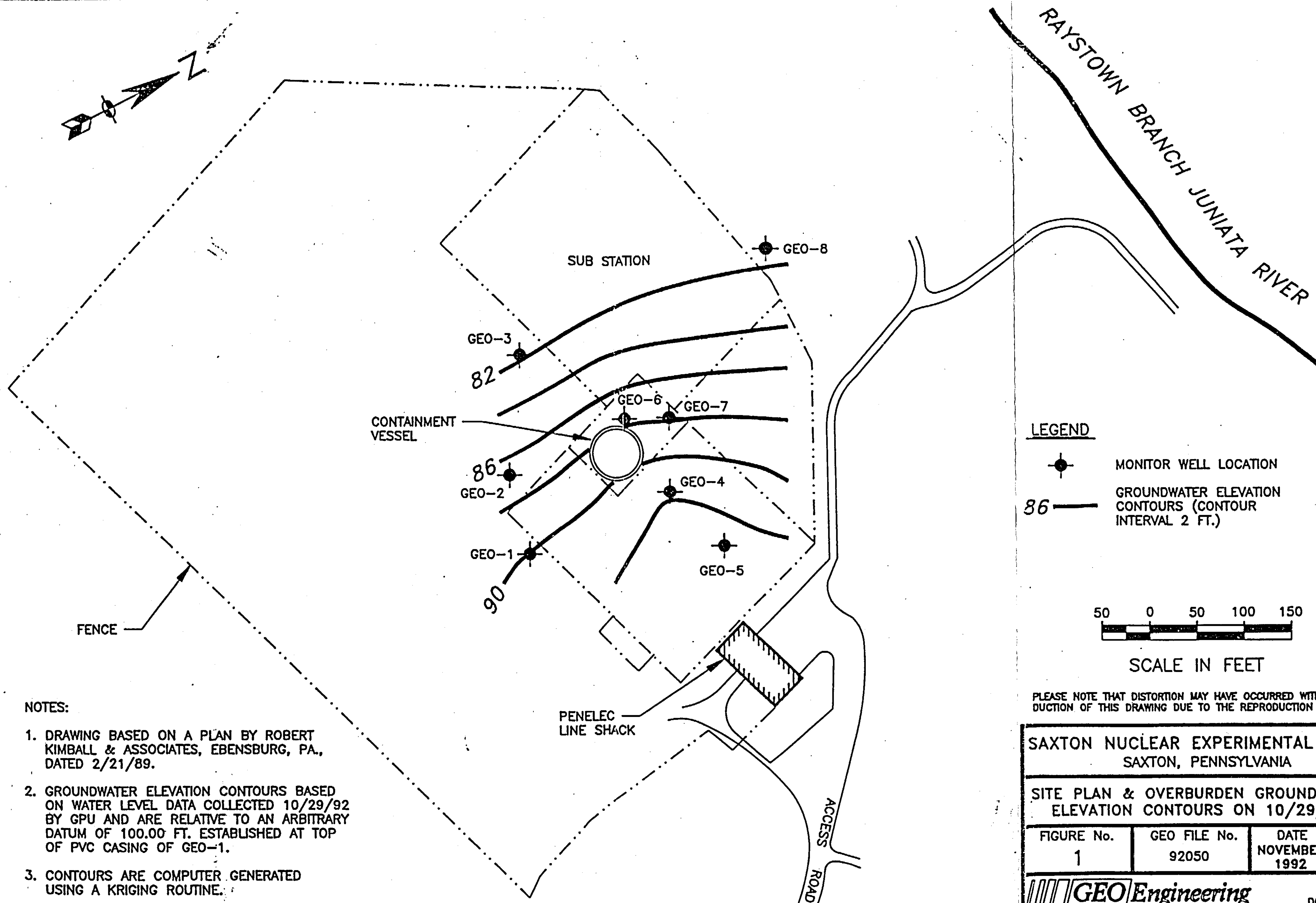
Charles R. Butts
am.

Charles R. Butts
Associate

KJL/CRB/lll

Attachment 1

Figure 1:	Site Plan and Overburden Groundwater Elevation Contours on October 29, 1992.
Figure 2:	Site Plan and Overburden Groundwater Elevation Contours on November 5, 1992.



LEGEND

- MONITOR WELL LOCATION
- 86 GROUNDWATER ELEVATION CONTOURS (CONTOUR INTERVAL 2 FT.)

NOTES:

1. DRAWING BASED ON A PLAN BY ROBERT KIMBALL & ASSOCIATES, EBENSBURG, PA., DATED 2/21/89.
2. GROUNDWATER ELEVATION CONTOURS BASED ON WATER LEVEL DATA COLLECTED 10/29/92 BY GPU AND ARE RELATIVE TO AN ARBITRARY DATUM OF 100.00 FT. ESTABLISHED AT TOP OF PVC CASING OF GEO-1.
3. CONTOURS ARE COMPUTER GENERATED USING A KRIGING ROUTINE.

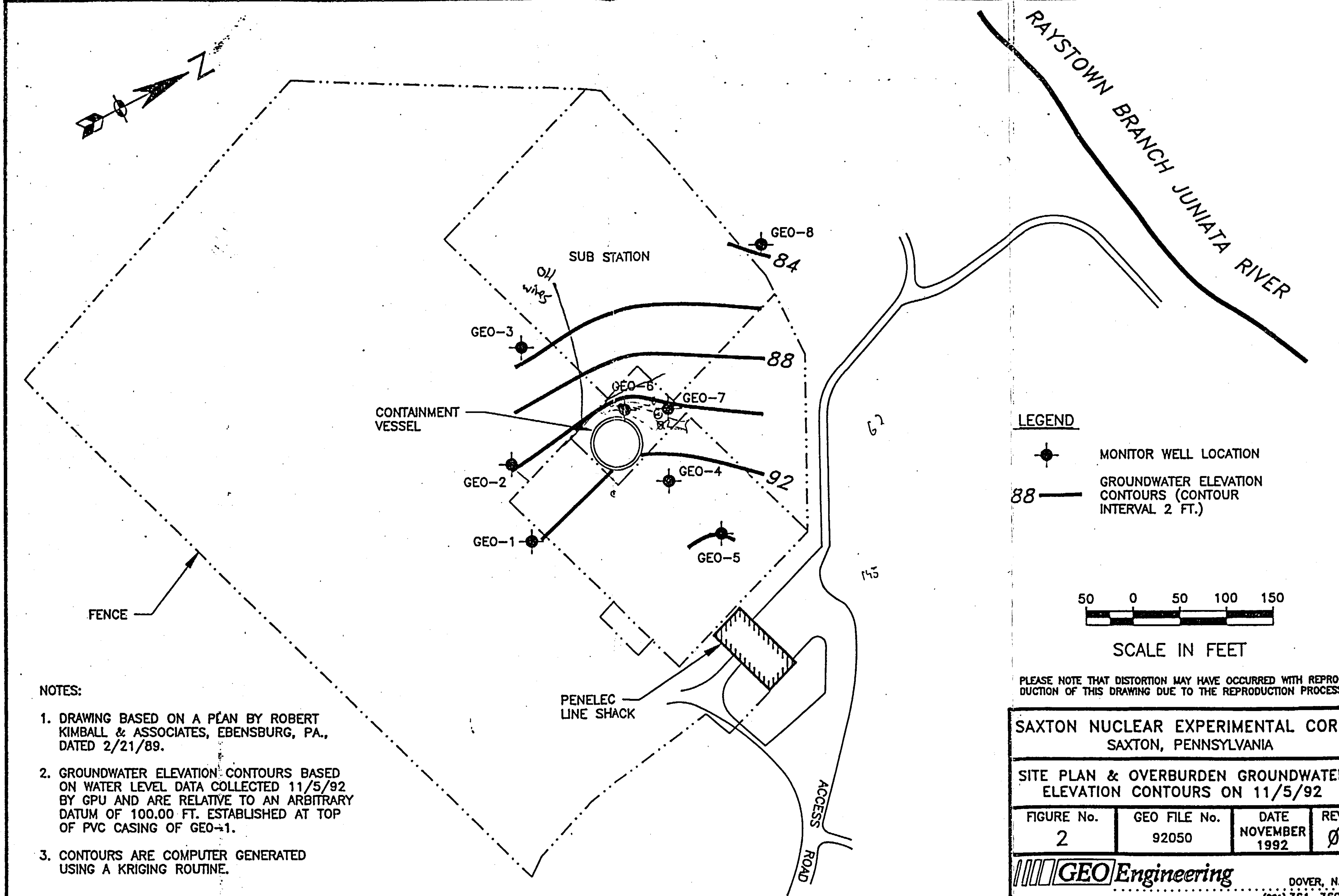
PLEASE NOTE THAT DISTORTION MAY HAVE OCCURRED WITH REPRODUCTION OF THIS DRAWING DUE TO THE REPRODUCTION PROCESS.

SAXTON NUCLEAR EXPERIMENTAL CORP.
SAXTON, PENNSYLVANIA

SITE PLAN & OVERBURDEN GROUNDWATER ELEVATION CONTOURS ON 10/29/92

FIGURE No.	GEO FILE No.	DATE	REV.
1	92050	NOVEMBER 1992	Ø

GEO Engineering DOVER, N.J. (201) 361-3600



NOTES:

1. DRAWING BASED ON A PLAN BY ROBERT KIMBALL & ASSOCIATES, EBENSBURG, PA., DATED 2/21/89.
2. GROUNDWATER ELEVATION CONTOURS BASED ON WATER LEVEL DATA COLLECTED 11/5/92 BY GPU AND ARE RELATIVE TO AN ARBITRARY DATUM OF 100.00 FT. ESTABLISHED AT TOP OF PVC CASING OF GEO-1.
3. CONTOURS ARE COMPUTER GENERATED USING A KRIGING ROUTINE.

PLEASE NOTE THAT DISTORTION MAY HAVE OCCURRED WITH REPRODUCTION OF THIS DRAWING DUE TO THE REPRODUCTION PROCESS.

SAXTON NUCLEAR EXPERIMENTAL CORP.
SAXTON, PENNSYLVANIA

SITE PLAN & OVERBURDEN GROUNDWATER ELEVATION CONTOURS ON 11/5/92

FIGURE No.	GEO FILE No.	DATE	REV.
2	92050	NOVEMBER 1992	Ø

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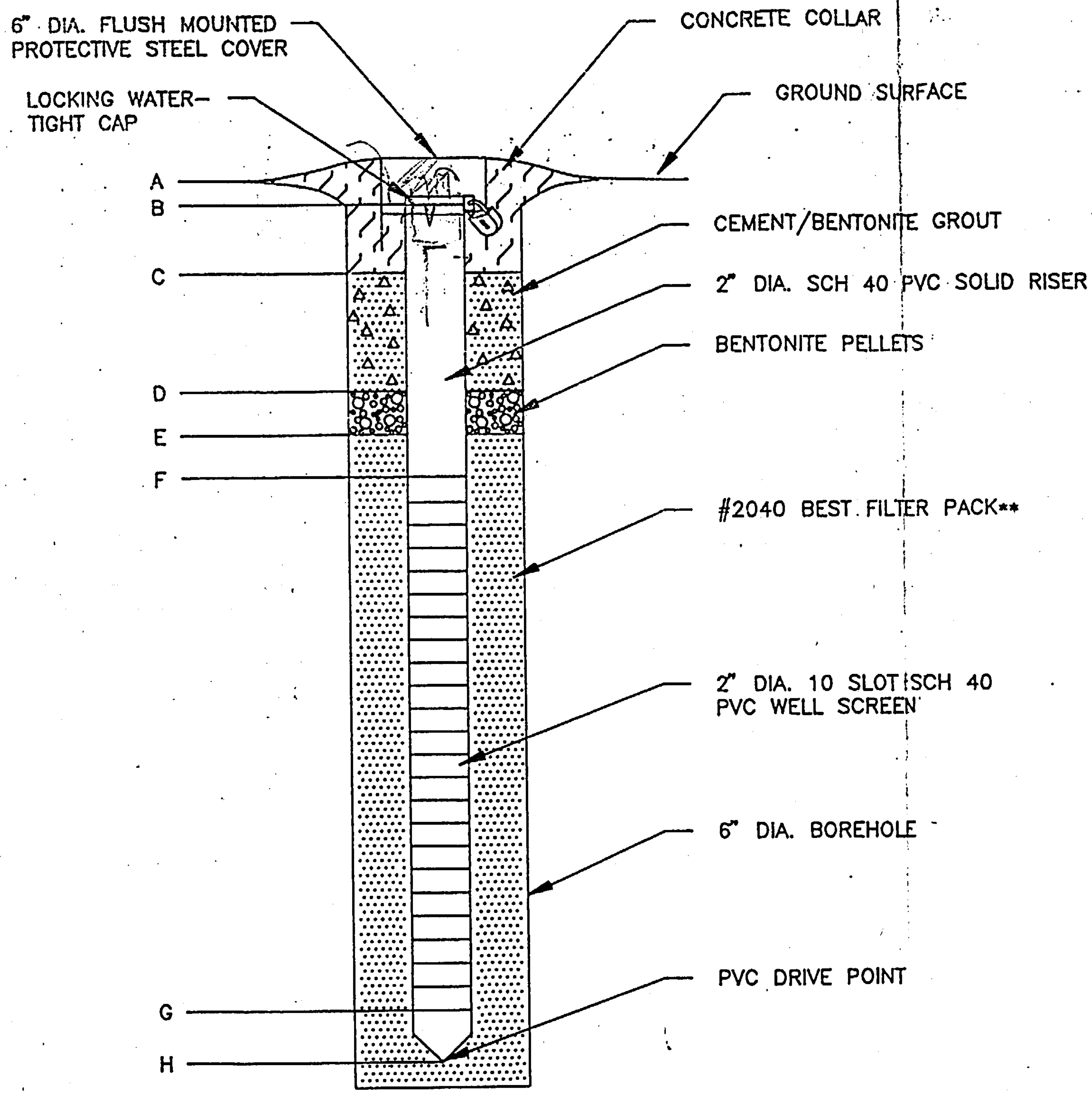
DOVER, N.J.
(201) 361-3600

Attachment 2

Figure 3: Overburden Well (Piezometer) Construction Details



TYPICAL OVERBURDEN WELL DETAILS

NOT TO SCALE

RELATIVE ELEVATION*

	GEO-1	GEO-2	GEO-3	GEO-4	GEO-5	GEO-6	GEO-7	GEO-8
A	100.31	98.35	98.05	97.64	98.55	97.70	98.36	96.80
B	100.00	98.00	97.71	97.24	98.15	97.63	98.08	96.15
C	99.31	97.85	97.05	96.64	97.55	96.70	97.36	95.80
D	98.31	97.35	94.55	95.64	96.55	95.70	94.36	94.80
E	97.31	96.35	92.05	93.64	94.55	93.70	91.36	92.80
F	96.31	94.68	90.05	92.64	93.55	92.70	89.36	91.80
G	86.89	85.26	80.63	83.22	84.13	83.28	79.94	82.38
H	86.31	84.68	80.05	82.64	83.55	82.70	79.36	81.80

* ELEVATIONS OBTAINED BY A RELATIVE SURVEY PERFORMED BY GEO ENGINEERING, INC. ON 10/16/92 AND ARE BASED ON AN ARBITRARY DATUM OF 100.00 FT. AT TOP OF PVC CASING OF GEO-1.

** THIS FILTER PACK IS EQUIVALENT TO THE MORIE TYPE FILTER PACK THAT RANGES BETWEEN 00 AND 00N.

SAXTON NUCLEAR EXPERIMENTAL CORP.
SAXTON, PENNSYLVANIA

OVERBURDEN WELL (PIEZOMETER) CONSTRUCTION DETAILS

FIGURE No.	GEO FILE No.	DATE	REV.
3	92050	NOVEMBER 1992	Ø

GEO Engineering DOVER, N.J. (201) 361-3600

Attachment 3

Table 1: Summary of Water Level Measurements and Monitor Well Elevations

Table 1: Summary of Water Level Measurements and Monitor Well Survey Information

GEO Engineering, Inc.
November 1992
Filename: 92050TB1.WK1
Checked by: KJL
Date: 11/17/92

MONITOR WELL ID	RELATIVE WELL ELEVATION (TOC)	DEPTH TO GROUND WATER (FT) October 29, 1992	RELATIVE GROUNDWATER ELEVATION (FT. MSL) October 29, 1992	DEPTH TO GROUND WATER (FT) November 5, 1992	RELATIVE GROUNDWATER ELEVATION (FT. MSL) November 5, 1992
GEO-1	100.00	9.78	90.22	8.12	91.88
GEO-2	98.00	11.28	86.72	8.22	89.78
GEO-3	97.71	16.19	81.52	12.48	85.23
GEO-4	97.24	5.20	92.04	4.38	92.86
GEO-5	98.15	5.34	92.81	4.10	94.05
GEO-6	97.63	9.80	87.83	6.63	91.00
GEO-7	98.08	10.27	87.81	8.05	90.03
GEO-8	96.15	ND	--	12.44	83.71

NOTES: TOC – Top of PVC casing.
ND – No ground water detected.
-- – Not applicable.

Footnote: All water level measurements collected by GPUN.

HALEY & ALDRICH

Summary of Field Work
Saxton Nuclear Experimental Station
Saxton, Pennsylvania

UNDERGROUND ENGINEERING & ENVIRONMENTAL SOLUTIONS

Summary of Field Work
Saxton Nuclear Experimental Station
Saxton, Pennsylvania

by

Haley & Aldrich, Inc.
Dover, New Jersey

for

GPU Nuclear, Inc.
Harrisburg, Pennsylvania

July 1998

HALEY & ALDRICH

UNDERGROUND
ENGINEERING &
ENVIRONMENTAL
SOLUTIONS

Haley & Aldrich, Inc.
150 Mineral Spring Drive
Dover, NJ 07801-1635
Tel: 973.361.3600
Fax: 973.361.3800
E-mail: NEW@HaleyAldrich.com

HALEY & ALDRICH

24 July 1998
File No. 74526-000

J. Patrick Donnachie
GPU Nuclear, Inc.
2574 Interstate Drive
Harrisburg, PA 17110

Subject: Summary of Field Work
Saxton Nuclear Experimental Station
Saxton, Pennsylvania

Dear Mr. Donnachie:

This letter summarizes the field work for the installation of three gas displacement groundwater samplers (Geomons) for supplemental monitoring at the Saxton site. We performed this work in accordance with the proposal as outlined in our 8 January 1998 letter to you.

We recommend that GPU Nuclear, Inc. (GPU) continue to sample the monitoring wells at the site on a quarterly basis. The sampling results of testing two newly installed Geomons in the vicinity of the former Waste Treatment Building indicate that only trace levels of tritium exist in the groundwater in this area. Trace levels of tritium detected in GEO-5 was not detected in groundwater at GEO-10.

Between 26 May and 28 May 1998, three Geomons were installed at the Saxton site. Two Geomons were installed in bedrock (MW-3 and MW-4) and one Geomon was installed in the overburden material (GEO-10). The locations of these Geomons are shown on Figure 1 in Appendix A. MW-3 and MW-4 were installed to investigate whether elevated levels of tritium are present in the groundwater near a sump that was located in the former waste treatment building. GEO-10 was installed to supplement the existing monitoring wells during the decommissioning activities of the power station and to monitor for the possible migration of trace amounts of tritium detected in the groundwater at GEO-5.

GEOMON LOCATIONS

MW-3 and MW-4 were installed to investigate whether elevated levels of tritium are present in the groundwater near a sump that was located in the former waste treatment building. According to the drawing titled Saxton Reactor Project, General Layout of R.W.D.F.-Waste Treatment Plant (D-37802-1) dated 4 January 1961 by Westinghouse Electric Corporation, the sump was located in the southern portion of the Waste Treatment Building (Figure 1) at a depth of approximately 25.5 feet below ground surface. Review of GEO Engineering's letter

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report dated 18 November 1992, indicate that groundwater in the bedrock flows along two major fracture patterns and bedding planes. Based on these fracture patterns and bedding planes, MW-3 and MW-4 were located generally east and west, respectively, of the former Waste Treatment Building (Figure 1).

The location of GEO-10 was selected to supplement the existing groundwater monitoring wells during the decommissioning activities of the power station. Additionally, GEO-10 was also located to monitor for possible migration of trace amounts of tritium in groundwater detected in GEO-5.

GEOMON INSTALLATION

Three Geomons, two in bedrock and one in the overburden, were installed between the dates of 26 May and 28 May 1998 at the Saxton site. Pennsylvania Drilling Co., Inc. of McKees Rocks, Pennsylvania was retained by Haley & Aldrich to install the Geomons. The borehole if each Geomon was drilled with a combination of a 6-inch diameter solid stem auger and air rotary bit. After completing each borehole, the drillers installed the Geomon and solid riser pipe in the borehole. The remaining annular space between the Geomon and riser pipe was filled with sand filter pack followed by a bentonite pellet seal and cement grout. Flush mount well protection covers were installed at MW-4 and GEO-10. A stick-up well protection cover was installed at MW-3. Refer to Appendix B for the construction details of the Geomons.

After Geomon installation, Haley & Aldrich performed a relative elevation survey of the newly installed Geomons. This survey was performed utilizing past survey information and is relative an arbitrary datum of 100.00 feet at the top of PVC of GEO-1. A table summarizing the elevation survey for MW-3, MW-4 and GEO-10 is shown on Figure 1.

REVIEW OF GROUNDWATER SAMPLING DATA

The results of groundwater sampling data were reviewed by Haley & Aldrich after Geomon installation and a round of sampling. A set of groundwater sampling data collected on 28 May 1998 from MW-3, MW-4, GEO-5 and GEO-10 (Table 1) and historical data for GEO-5 from Table 6 in GPU's 1997 Radiological Environmental Monitoring Report were reviewed (Appendix C).

TABLE I: 28 May 1998 Sampling Results

Sampling Location	Tritium Result (pCi/L)
MW-3	150±80
MW-4	140±80
GEO-5	190±80
GEO-10	<120

CONCLUSIONS AND RECOMMENDATIONS

Based upon the review of the above data, the groundwater in the vicinity of the sump that was located in the former Waste Treatment Building only contains trace levels of tritium. Furthermore, it appears that the trace levels of tritium detected in groundwater at GEO-5 has not been detected in the groundwater at GEO-10. Therefore, we recommend that GPU Nuclear, Inc. (GPU) continue to sample the monitoring wells at the site on a quarterly basis.

Sincerely yours,
HALEY & ALDRICH, INC.

Robert M. Shusko
Staff Engineer

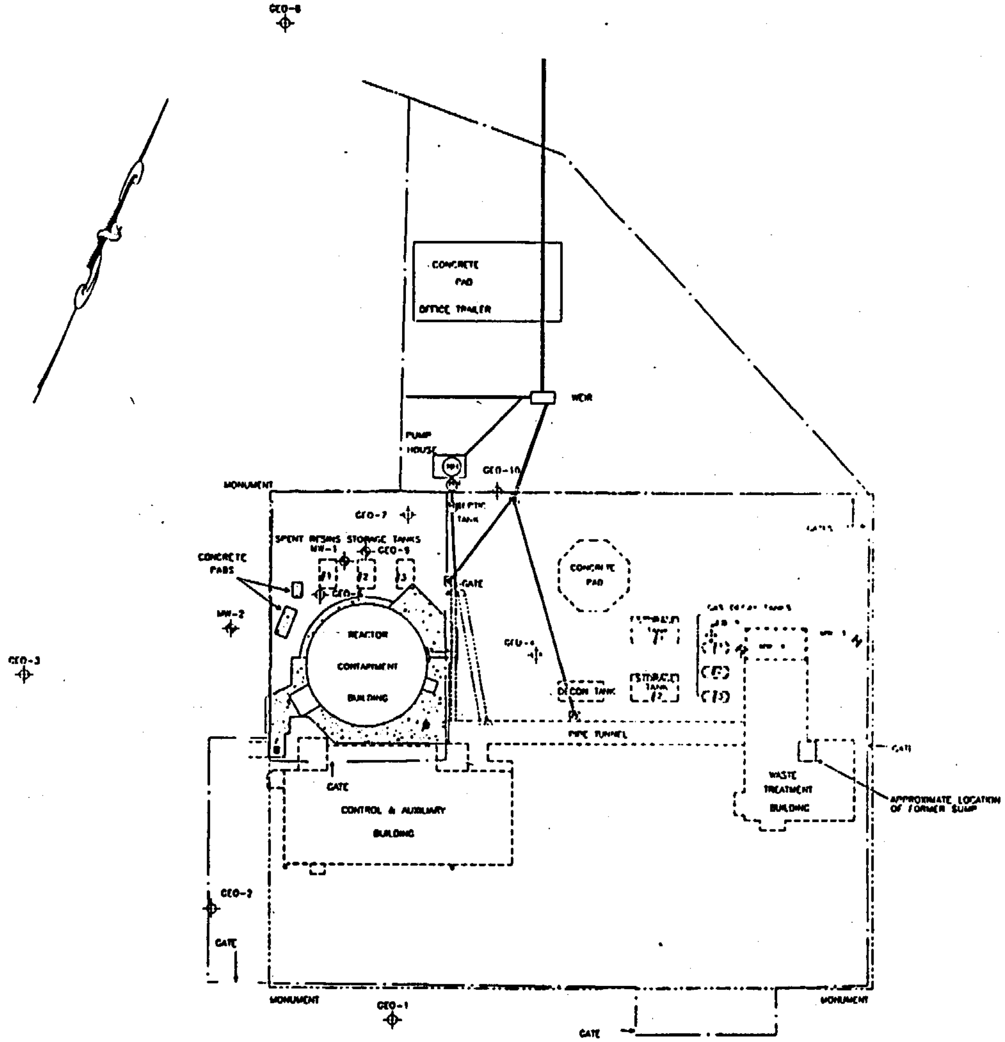
Charles R. Butts
Vice President

CRB/RMS:avm/74526h01

Appendix A

Appendix A

Figure 1: Monitor Well Location Plan



[illegible]	RELATIVE ELEVATION OF TOP OF CASING (CAP OFF)*
MW-3	103.70
MW-4	96.57
GEO-10	96.97

* ELEVATIONS OBTAINED BY RELATIVE SURVEYS PERFORMED BY GEO ENGINEERING AND HALEY & ALDRICH AND ARE BASED ON AN ARBITRARY DATUM OF 100.00 FT. OF PVC CASING OF GEO-1.

LEGEND

- OUTLINE OF REMAINING STRUCTURES
- OUTLINE OF REMOVED STRUCTURES
- FENCE
- PROPERTY LINE
- OVERBURDEN WELL LOCATION
- BEDROCK WELL LOCATION

NOTES:

1) BASE PLAN PROVIDED BY GPU NUCLEAR, INC.

2) GEO-9 IS A VERTICAL BEDROCK PIEZOMETER. MW-1 AND MW-2 ARE BEDROCK MONITOR WELLS INSTALLED AT AN APPROXIMATE 25° ANGLE FROM VERTICAL.

0 25 50
SCALE IN FEET

HALEY & ALDRICH

UNDERGROUND ENGINEERING & ENVIRONMENTAL SOLUTIONS

SAXTON NUCLEAR FACILITY
LIBERTY TOWNSHIP, PENNSYLVANIA

MONITOR WELL LOCATION PLAN

SCALE: AS SHOWN

JULY 1998

FIGURE 1

FILE: SITEPLAN 74526-000

Appendix B

Appendix B

Geomon Construction Details
For MW-3, MW-4 and GEO-10

HALEY & ALDRICH

HALEY& ALDRICH

Boring Log & Geomon Construction

Client: GPU Nuclear, Inc.
Project: Geomon Installation
Location: Saxton, PA
Drilling Contractor: Pennsylvania Drilling Co.
H&A Representative: RMS
Surface Elevation: NA
Well Permit No.:

Boring No: MW-3
Page 1of 2
File No.: 74526-000

Date Started: 5/26/98
Date Completed: 5/27/98

Sample No.	Sample Recovery	Blows /12"	Depth (Feet)	Well Info	Soil Type	Soil Description
			0		FILL	0' to 3': Orange-brown fine to coarse SAND, some fine Gravel, trace Silt.
						3' to 5': Black medium to coarse SAND; cinders.
			5			5' to 6': Black-brown medium to coarse SAND, little Silt; cinders with the orange-brown fill mixed in.
						6' to 7': Apparent boulder layer.
						Bedrock surface at 7'.
			10		BED ROCK	7' to 15': Red-brown Siltstone and Sandstone.
			15			

Sampler Type: NA

Sample Recovered
No Recovery
Waterlevel
Nx Bc
Drill Cuttings

Boring Method: 0-7' Solid Stem Auger
7-29' Air Rotary

HALEY& ALDRICH

Boring Log & Geomon Construction

Project: Geomon Installation
Location: Saxton, PA

Boring No.: MW-3

File No.: 74526-000

Sample No.	Sample Recovery	Blows /12"	Depth (Feet)	Soil Type	Soil Description
			15		15' to 29': Red-brown and olive-gray siltstone and sand stone.
			20	BED ROCK	
			25		
					Boring terminated at 29'.
			30		
			35		

Geomon Construction Details:

Depth: 27.5'

Geomon Diameter: 1.25" dia.	Borehole Diameter: 6"
Solid Riser Length: 26.67'	Solid Riser Type: 3/4" Sch 80 PVC
Screen Length: 10"	Screen Type: 10 micron filter media
Gravel Pack Depth: 22.5-27.5'	Gravel Pack Type: Moric #00
Grout Depth: 20.5-22.5'	Grout Type: Bentonite Pellets
Grout Depth: 0-20.5'	Grout Type: Cement

HALEY& ALDRICH

Boring Log & Geomon Construction

Client: GPU Nuclear, Inc.
Project: Geomon Installation
Location: Saxton, PA
Drilling Contractor: Pennsylvania Drilling Co.
H&A Representative: RMS
Surface Elevation: NA
Well Permit No.:

Boring No: MW-4
Page 1of 2
File No.: 74526-000

Date Started: 5/27/98
Date Completed: 5/27/98

Sample No.	Sample Recovery	Blows /12"	Depth (Feet)	Well Info	Soil Type	Soil Description
			0		FILL	0' to 10': Red-brown fine to coarse SAND, some fine to coarse Gravel, trace Silt.
			5			
			10			Bedrock surface at 10'.
					BED ROCK	10' to 15': Red-brown and olive-gray Siltstone and Sandstone.
			15			

Sampler Type: NA

Sample Recovered
Nx Be
No Recovery
Drill Cuttings
Waterlevel

Boring Method: 0-20' Solid Stem Auger
20-28.5' Air Rotary

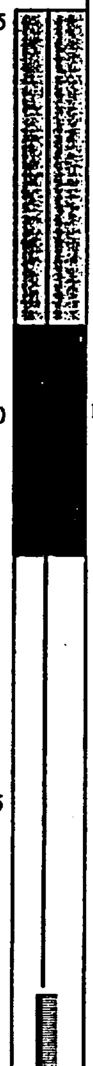
Boring Log & Geomon Construction

Project: Geomon Installation
Location: Saxton, PA

Boring No.: MW-4

File No.: 74526-000

Sample No.	Sample Recovery	Blows /12"	Depth (Feet)	Soil Type	Soil Description
			15		15' to 28.5': Red-brown and olive-gray siltstone and sand stone.
			20	BED ROCK	
			25		
					Boring terminated at 28.5'.
			30		
			35		



Geomon Construction Details:

Depth: 28.5'
Geomon Diameter: 1.25" dia. — Borehole Diameter: 6"
Solid Riser Length: 27.67' — Solid Riser Type: 3/4" Sch 80 PVC
Screen Length: 10" — Screen Type:10 micron filter media
Gravel Pack Depth: 22-28.5' — Gravel Pack Type: Morie #00
Grout Depth: 19-22' — Grout Type: Bentonite Pellets
Grout Depth: 0-19' — Grout Type: Cement

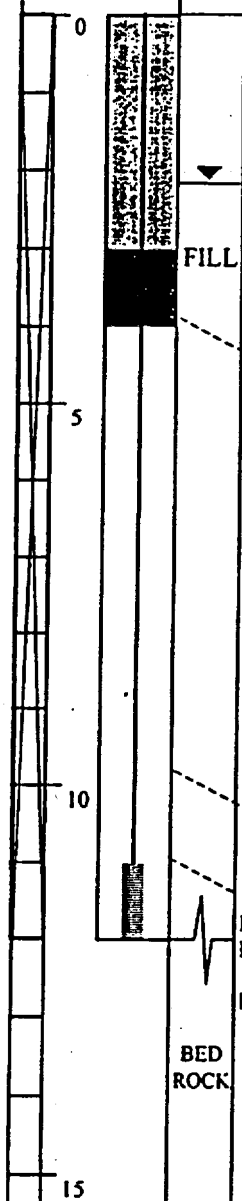
Boring Log & Geomon Construction

Client: GPU Nuclear, Inc.
Project: Geomon Installation
Location: Saxton, PA
Drilling Contractor: Pennsylvania Drilling Co.
H&A Representative: RMS
Surface Elevation: NA
Well Permit No.:

Boring No: GEO-10
Page 1of 1
File No.: 74526-000

Date Started: 5/27/98
Date Completed: 5/27/98

Sample No.	Sample Recovery	Blows /12"	Depth (Feet) / Well Info	Soil Type	Soil Description
				FILL	0'-4': Red-brown fine to coarse SAND, some fine to coarese Gravel, trace Silt.
					Apparent boulder encountered at 4'.
					4' to 10': Apparent boulder.
					10' to 11': Red-orange SAND, some Silt
				BED ROCK	Bedrock at 12' Boring terminated at 12'.
					Red-brown Siltstone and gray Siltstone.



Geomon Construction Details:

Depth: 12.0'
Geomon Diameter: 1.25" dia. **Borehole Diameter:** 6"
Solid Riser Length: 11.17' **Solid Riser Type:** 3/4" Sch 80 PVC
Screen Length: 10" **Screen Type:** 10 micron filter media
Gravel Pack Depth: 12-4' **Gravel Pack Type:** Morie #00
Grout Depth: 4-3' **Grout Type:** Bentonite Pellets
Grout Depth: 3-0' **Grout Type:** Cement

Sampler Type: NA

Sample Recovered
No Recovery
Waterlevel
Nx Be
Drill Cuttings

Boring Method: 0-4' Solid Stem Auger
4-12' Air Rotary

Appendix C

Appendix C

GEO-5 Historical Tritium Results

TABLE 6
SX-GW-GEO-5
TRITIUM RESULTS
(pCi/L)

DATE	RESULTS
7/13/94	L.T. 170
10/06/94	560 ± 130
10/27/94	310 ± 120
1/12/95	L.T. 190
4/05/95	L.T. 180
5/30/95	270 ± 120
6/13/95	370 ± 130
7/13/95	370 ± 110
8/17/95	390 ± 130
9/15/95	410 ± 130
10/18/95	760 ± 140
11/17/95	L.T. 200
1/25/96	L.T. 190
4/03/96	L.T. 150
7/10/96	L.T. 140
10/03/96	L.T. 140
1/08/97	L.T. 140
4/16/97	L.T. 150
7/09/97	L.T. 150
10/01/97	180 ± 100
1/08/98	L.T. 150

UNDERGROUND
ENGINEERING &
ENVIRONMENTAL
SOLUTIONS

Haley & Aldrich, Inc.
150 Mineral Spring Drive
Dover, NJ 07801-1635
Tel: 973.361.3600
Fax: 973.361.3800
E-mail: NEW@HaleyAldrich.com

HALEY & ALDRICH

05 May 1999
File No. 74596-000

GPU Nuclear, Inc.
2574 Interstate Drive
Harrisburg, PA 17110

Attention: Mr. James J. Byrne

Subject: Data Summary Report for
Soil Friction Evaluation
Former Saxton Nuclear Experimental Station
Saxton, Pennsylvania

Gentlemen:

Haley & Aldrich, Inc. has been retained by GPU Nuclear, Inc. to conduct a geotechnical engineering evaluation of the available frictional resistance which can be mobilized between the steel containment vessel and the below ground backfill soils which were placed around the vessel during original construction. It is understood that you desire to use available soil friction resistance to aid in resisting ground water induced hydrostatic uplift forces during decommissioning operations.

Our work has been divided into two broad tasks:

1. Data collection to define the backfill soils present and to aid in establishing their engineering properties.

2. Geotechnical engineering analyses and recommendations based on the data obtained.

This report summarizes the data collection aspects of the work. Included herein is a description of the field exploration program, test boring logs, observation well installation records and data, and laboratory soil test results. Our engineering studies will be summarized in a separate report entitled "Report of Soil Friction Evaluation", which will follow shortly.

Field Investigation of the Backfill

The field work involved conducting test borings within the backfill soils, the concrete saddle, and the underlying bedrock for the purpose of backfill identification and installation of groundwater observation wells. The work occurred during the period 24 to 30 March 1999.

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Our Mr. Charles Butts provided technical monitoring in the field throughout the work. Our Dr. Edward B. Kinner visited the site on 26 March to observe site conditions, field operations and backfill soils encountered.

The field program included drilling four test borings (TB-1 through TB-4; see Figure 1). Logs of the test borings are included in Appendix A. An area accessible for drilling was identified by GPU Nuclear on the northwestern side of the containment structure away from the pipe tunnel, adjacent to the containment shield. Pennsylvania Drilling Company, Inc. was subcontracted to actually drill the borings and install the observation wells.

Test borings TB-1 and TB-2 were not drilled the full planned depth. At TB-1 bedrock was encountered at a depth of about 16 ft. and it was necessary to move the drilling location closer to the containment vessel in order to penetrate the full depth of the backfill. This was attempted at TB-2, but an obstruction was encountered at approximately 4-ft. depth. Boring TB-3 was subsequently located at a position that allowed full depth penetration of the backfill soils.

The first five-foot depth interval in TB-3 was advanced with an auger (without discrete sampling) to facilitate setting a surface casing. Thereafter, the soil backfill was sampled continuously to a depth of 38 feet 9 inches. The boring was then cored through the concrete saddle beneath the containment vessel and approximately five feet into the bedrock. While the casing was temporarily seated in the concrete saddle, a measurement indicated that the groundwater level in the bedrock was approximately ten feet below the ground surface. This water level was approximately seven feet lower than that observed initially in the backfill materials during drilling. An observation well was thus installed in the rock at this boring.

In general, the backfill soils were observed to be very soft, well graded, predominately a silty sand or a sandy silt with 10-20% clay and varying amounts of gravel.

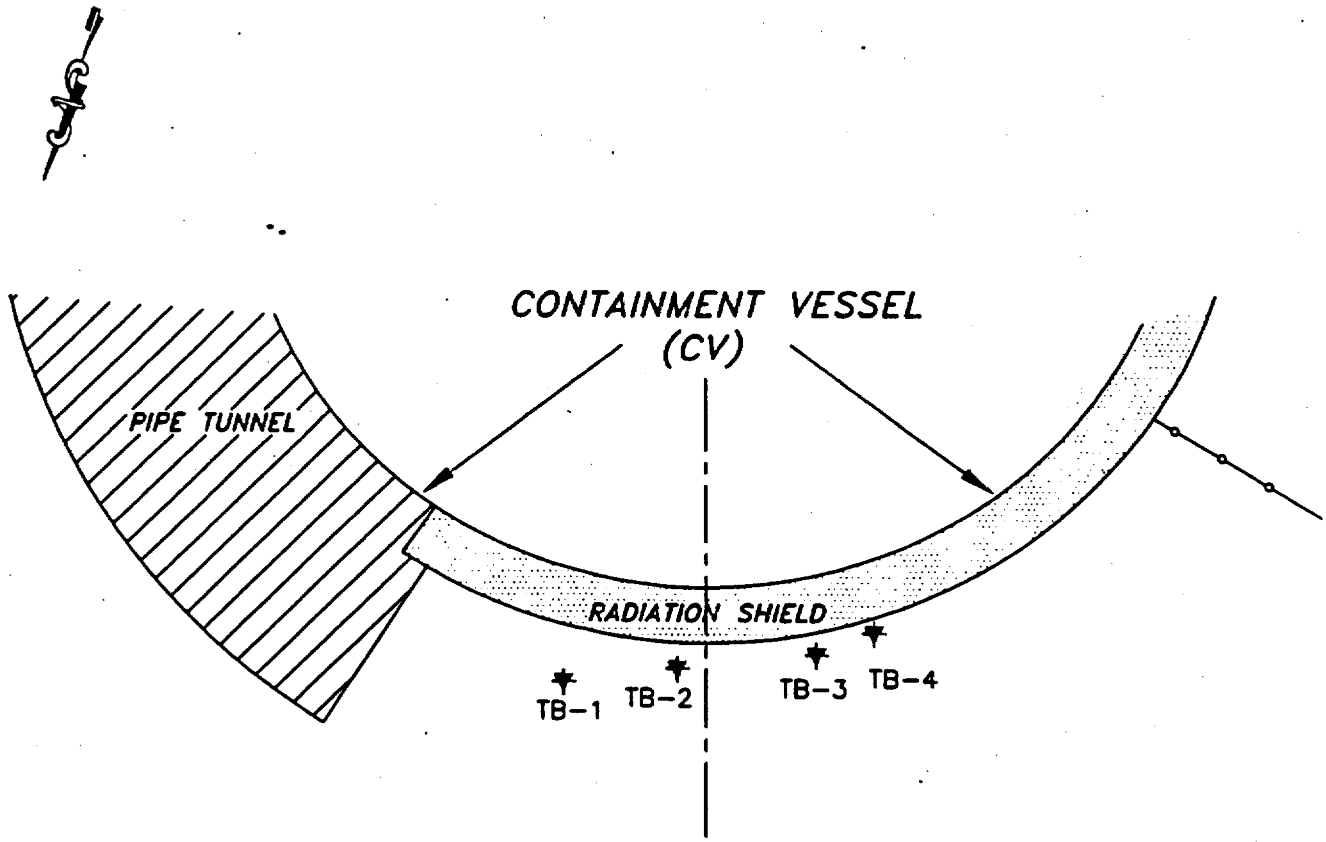
The final boring, TB-4, was drilled to a depth of 25 feet without sampling. The purpose of this boring was to install a ground water observation well screened in the soil backfill.

Data on monitoring well installation details are included on the logs of TB-3 and TB-4.

Groundwater Levels

Measured groundwater level data are included in Appendix B. GPU Nuclear staff obtained groundwater level data following the field program as noted on the data sheets.

It is to be noted that the groundwater level in the bedrock (TB-3) is several feet lower than that measured in the soil backfill (TB-4).



LEGEND

TEST BORING LOCATION

FENCE

APPROXIMATE CENTER LINE OF CONTAINMENT VESSEL

NOTES:

1.) END OF PIPE TUNNEL, EDGE OF RADIATION SHIELD, AND CENTER LINE OF CONTAINMENT VESSEL WERE USED TO REFERENCE TEST BORING LOCATIONS.

2.) RADIATION SHIELD IS APPROXIMATELY 3 FEET THICK.

0 5 10
SCALE IN FEET

FILE: REACTION 74596-000

HALEY & ALDRICH
UNDERGROUND ENGINEERING & ENVIRONMENTAL SOLUTIONS

GPU NUCLEAR, INC.
SOIL FRICTION EVALUATION
SAXTON, PENNSYLVANIA

TEST BORING LOCATIONS

SCALE: AS SHOWN

APRIL 1999

FIGURE 1

Laboratory Testing of Soil Backfill

The backfill samples were forwarded to Haley and Aldrich's soil testing laboratory in sealed plastic bags. All samples were visually examined. Thereafter, samples from TB-3 were combined as necessary to provide adequate volumes for testing. The testing, included sieve and hydrometer for grain size distribution, Atterberg Limits, water content and electrical resistivity. Test results are presented in Appendix C.

In addition to the testing conducted at the Haley & Aldrich laboratory, samples of the backfill material were delivered to another laboratory for analytical testing for determination of soil corrosion potential as requested by GPU Nuclear. The results of these tests are also reported in Appendix C.

Please do not hesitate to contact us if you have any questions.

Sincerely yours,
HALEY & ALDRICH, INC.

Charles R. Butts
Vice President

Charles R. Butts for
Cetin Soydemir, Ph.D., P.E.
Vice President

Charles R. Butts for
Edward B. Kinner, Sc.D., P.E.
Principal

Enclosures:

Figure 1:	Boring Location Plan
Appendix A:	Test Borings Logs, including Groundwater Observation Well Installation Details
Appendix B:	Groundwater Level Data
Appendix C:	Laboratory Test Results

\\NEW\common\documents\74\74596\74596a02

Appendix-A

HALEY& ALDRICH

Boring Log

Client: GPU Nuclear, Inc.
Project: Soil Friction Evaluation
Location: Saxton, PA
Drilling Contractor: Pennsylvania Drilling Company, Inc.
Inspector: C.R. Butts
Surface Elev.: 811 feet (approx.)

Boring No.: TB-1
Page 1 of 2
File No.: 74596-000

Date Started: 3/24/99
Date Completed: 3/24/99

Sample No.	Sample Recovery	Blows /12"	Depth (Feet)	Soil Description
			0	Augered to 5 feet and set a 5 foot length of 6 inch diameter temporary surface casing in the augered hole. Observed a 6-12 inch thick layer of angular crushed stone at the ground surface which was underlain by approximately 4 feet of material similar to samples S-1 to S-7 below. Initial water level observed during drilling was approximately 2 feet 6 inches below the ground surface.
S-1	4"	2	5	Red brown sandy SILT, little gravel, little clay. (A 4 inch piece of gravel in the sampler tip)
S-2	0	2	7	No recovery with the 2 inch sampler. Resampled with a 3 inch sampler. Recovered 1 1/2 inches of black gray fine GRAVEL, little coarse sand (fly ash)
S-3	12"	5	9	Red brown clayey SILT, trace rounded gravel, trace sand. (3 inch sampler, 140 lb hammer)
S-4	12"	4	11	As above. (2 inch sampler)
S-5	12"	5	13	Red brown sandy silty CLAY, trace fine gravel. (1 1/2 inch piece of siltstone in sampler tip)
			15	See page 2 of 2.

Sampler Type: Standard Split Spoon

Boring Method: Cased hole using a CME-35 drill rig

Sample Driven

No Recovery

Nx Bedrock Core

Drill Cuttings

HALEY& ALDRICH

Boring Log

Client: GPU Nuclear, Inc.
Project: Soil Friction Evaluation

Boring No.: TB-1

File No.: 74596-000

Sample No.	Sample Recovery	Blows /12"	Depth (Feet)	Soil Description
S-6	14	83	15	As above 1inch. Then 13 inches of gray green SILTSTONE. (bedrock)
S-7	6	50	17	Gray green SILTSTONE. (bedrock refusal)
				Boring terminated at 17 feet 7inches and backfilled with bentonite.
			20	
			25	
			30	
			35	

HALEY& ALDRICH

Boring Log

Client: GPU Nuclear, Inc.
Project: Soil Friction Evaluation
Location: Saxton, PA
Drilling Contractor: Pennsylvania Drilling Company, Inc.
Inspector: C.R. Butts
Surface Elev.: 811 feet (approx.)

Boring No.: TB-2
Page 1 of 1
File No.: 74596-000

Date Started: 3/24/99
Date Completed: 3/24/99

Sample No.	Sample Recovery	Blows /12"	Depth (Feet)	Soil Description
			0	Augered to 5 feet. Attempted to set a 5 foot length of surface casing but the hole was caving at a depth of approximately 4 feet (an apparent obstruction was encountered). This hole was abandoned and backfilled with bentonite. The material observed to this depth was similar to that described at similar depth in TB-1.
			5	Boring terminated at 5 feet, backfilled with bentonite.
			10	
			15	

Sampler Type: Standard Split Spoon

Boring Method: Cased hole using a CME-35 drill rig

Sample Driven
No Recovery
Nx Bedrock Core
Drill Cuttings

Boring Log & Monitor Well Construction

Client: GPU Nuclear, Inc.
Project: Soil Friction Evaluation
Location: Saxton, PA
Drilling Contractor: Pennsylvania Drilling Company, Inc.
Inspector: C.R. Butts
Surface Elevation: 811 feet (approx.)

Boring No: TB-3

File No.:74596-000

Date Started: 3/25/99
Date Completed: 3/26/99

Sample No.	Sample Recovery	Blows /12"	Depth (Feet)	Well Info	Soil Description
			0		Augered through 6 inches of crushed stone. The material observed during augering was similar to that observed to a depth of 5 feet described in TB-1. A 5 foot length of temporary surface casing was set in the augered hole. Initial water level approximately 2 feet 6 inches below the ground surface.
S-1	2"	3	5		Black gray sandy fine GRAVEL. (Coal plant waste material)
S-2	3"	3	7		As above. (one piece of 1" sandstone)
S-3	9"	3	9		Red brown silty coarse to fine SAND, trace gravel, little clay.
S-4	7"	3	11		As above (except some gravel)
S-5	6"	3	13		As above (except trace gravel)
			15		See page 2 of 3

Sampler Type: Standard Split Spoon

Boring Method: Cased hole using a CME-35 drill rig

Sample Recovered
Nx Bedrock Core
No Recovery
Drill Cuttings
Waterlevel

HALEY& ALDRICH

Boring Log & Monitor Well Construction

Project: Soil Friction Evaluation
Location: Saxton, PA

Boring No.:TB-3

File No.:74596

Sample No.	Sample Recovery	Blows /12"	Depth (Feet)	Well Info	Soil Description
S-6	8"	wt rds	15		Red brown silty coarse to fine SAND. little clay, little gravel (very loose. no hammer needed to sample, only weight of rods)
S-7	12"	wt rds	17		As above (lost a 1/4 of a tub of fluid while advancing the casing to 19 feet, added fluid)
S-8	11"	wt rds	19		As above
S-9	5"	wt rds	21		Red brown sandy SILT, little clay, trace fine gravel
S-10	0	wt rds	23		No recovery (also attempted to sample with a 3 inch sampler; no recovery). Cleaned the hole since 6 inches had accumulated in the bottom of the casing. Lost fluid, mixed additional drilling fluid.
S-11	14"	wt rds	25		Same as 21-23 feet. (Lost fluid while advancing the casing to 27 feet. Mixed additional fluid. 2-3 inches of sediment in the bottom of the casing prior to sampling)
S-12	6"	wt rds	27		Same as 21-23 feet
S-13	4"	wt rds	29		Red brown silty medium to fine SAND, little fine gravel, trace coarse sand. (Last sample of the day: advance the casing to 31 feet in the a.m.)
S-14	6"	wt rds	31		As above. (6 blow counts noted in the last 6" while driving the sample)
S-15	4"	4	33		As above. (blow counts increasing)
			35		See page 3 of 3.

HALEY& ALDRICH

Boring Log & Monitor Well Construction

Project: Soil Friction Evaluation
Location: Saxton, PA

Boring No.:TB-3

File No.:74596

Sample No.	Sample Recovery	Blows /12"	Depth (Feet)	Well Info	Soil Description
S-16	14"	20	35		As above.
S-17	6"	7	37		As above (but less dense: for 12 inches weight of rods and 7 blow counts in the next 6") Top of saddle at 38 feet 9 inches. Cored 6 feet 3 inches through the concrete: five breaks in the concrete. Bedrock a red gray SILTSTONE beneath the concrete (upper 1 foot 6 inches very fractured with pieces mostly smaller than 4 inches. The remaining 3 feet 6 inches of the core run much more competent and less fractured. Bottom of the hole at 50 feet.
			39		
			41		
			43		
			45		
			47		
			49		
			50		Coring terminated at 50 feet. Hole completed with an observation well.

Monitor Well Construction Details:

Well Depth: 50'	
Well Diameter: 1" dia.	**Borehole Diameter:** 4"
Solid Riser Length: 45'	**Solid Riser Type:** Sch 40 PVC
Screen Length: 5'	**Screen Type:** 10 Slot Sch 40 PVC
Gravel Pack Depth: 43 - 50'	**Gravel Pack Type:** Morey #00
Grout Depth: 41-43'pellets	**Grout Type:** BentonPowder
Grout Depth: 0-41'	**Grout Type:** Cement

Monitor well construction completed with a flushmount manhole.

Boring Method: Cased hole using a CME-35 drill rig

Boring Log & Monitor Well Construction

Client: GPU Nuclear, Inc.
Project: Soil Friction Evaluation
Location: Saxton, PA
Drilling Contractor: Pennsylvania Drilling Company, Inc.
Inspector: C.R. Butts
Surface Elevation: 811 feet (approx.)

Boring No:TB-4

File No.:74596-000

Date Started: 3/29/99
Date Completed: 3/29/99

Sample No.	Sample Recovery	Blows /12"	Depth (Feet)	Well Info	Soil Description
			0		Augered through 6 inches of crushed stone. The material observed during augering was similar to that observed to a depth of 5 feet described in TB-1. A 5 foot length of temporary surface casing was set in the augered hole. Initial water level approximately 2 feet 6 inches below the ground surface. No sampling, straight drilled to 25 feet and constructed an observation well to that depth (refer to construction details).
			5		
			10		
			15		See page 2 of 2

Sampler Type: Standard Split Spoon

Boring Method: Cased hole using a CME-35 drill rig

Sample Recovered
Nx Bedrock Core
No Recovery
Drill Cuttings
Waterlevel

HALEY& ALDRICH

Boring Log & Monitor Well Construction

Project: Soil Friction Evaluation
Location: Saxton, PA

Boring No.:TB-4

File No.: 74596-000

Sample No.	Sample Recovery	Blows /12"	Depth (Feet)	Well Info	Soil Description
			15		
			20		**Monitor Well Construction Details:** **Well Depth:** 25' **Well Diameter:** 1" dia. **Borehole Diameter:** 1" **Solid Riser Length:** 15' **Solid Riser Type:** Sch 40 PVC **Screen Length:** 10' **Screen Type:** 10 Slot Sch 40 PVC **Gravel Pack Depth:** 13 -25' **Gravel Pack Type:** Morey #00 **Grout Depth:** 11-13' **Grout Type:** Bentonite Pellets **Grout Depth:** 0-11' **Grout Type:** Cement Monitor well construction completed with flushmount manhole cover.
			25		Boring terminated at 25 feet. Hole completed with an observation well.
			30		
			35		

Appendix-B

HALEY & ALDRICH

OBSERVATION WELL MONITORING REPORT

Observation Well: TB-3
Test Boring: as above
Installation Date: 3/26/99
File No.: 74596-000
Ground El.: 811' approx.
El. Datum: * (see note below)

Project: Soil Friction Evaluation
City/State: Saxton, PA
Client: GPU Nuclear, Inc.

Water Level Measurements: ☐ From Rim ☒ From Riser ☐ From GS Elevation: 811' approx.

Depths to water are measured from ground surface, which is at El. .

Date	Time (Day)	Elapsed Time (days)	Depth to Water (ft)	Elevation of Water	Remarks	** Read By
3/30/99	Tues.	4	10'1"	NA	initial reading	CRB
4/8/99	Thurs.	13	9'10 3/4"	NA	75°F	D.C.
4/12/99	Mon.	17	9'1¼"	NA	rain Friday and Saturday	D.C.
4/14/99	Wed.	19	9'4½"	NA	55°F	D.C.
4/19/99	Mon.	24	9'10¼"	NA	55°F	D.C.
4/22/99	Thurs.	27	9'4½"	NA	rain Wednesday night	D.C.

* note: top of riser and ground surface are at similar elevations, approx. 811' MSL.

** (CRB) Charles R. Butts of Haley & Aldrich, Inc.

(D.C.) Dilip Chokshi of Raytheon Engineers & Constructors

OWM02GF2 FRP 1 August 1994

HALEY & ALDRICH

OBSERVATION WELL MONITORING REPORT

Observation Well: TB-4
Test Boring: as above
Installation Date: 3/29/99
File No. 74596-000
Ground El. 811' approx.
El. Datum: *(see note below)

Project: Soil Friction Analysis
City/State: Saxton, PA
Client: GPU Nuclear, Inc.

Water Level Measurements: ☐ From Rim ☒ From Riser ☐ From GS Elevation: 811'approx

Depths to water are measured from ground surface, which is at El. .

Date	Time (Day)	Elapsed Time (days)	Depth to Water (ft)	Elevation of Water	Remarks	** Read By
3/30/99	Tues.	1	3'1"	NA	initial reading	CRB
4/8/99	Thurs.	10	4'5"	NA	75°	D.C.
4/12/99	Mon.	14	3'-11 3/4"	NA	rain Friday and Saturday	D.C.
4/14/99	Wed.	16	4'3¼"	NA	55°F	D.C.
4/19/99	Mon.	21	4'-10¼"	NA	55°F	D.C.
4/22/99	Thurs.	24	4'-4½"	NA	rain Wednesday night	D.C.

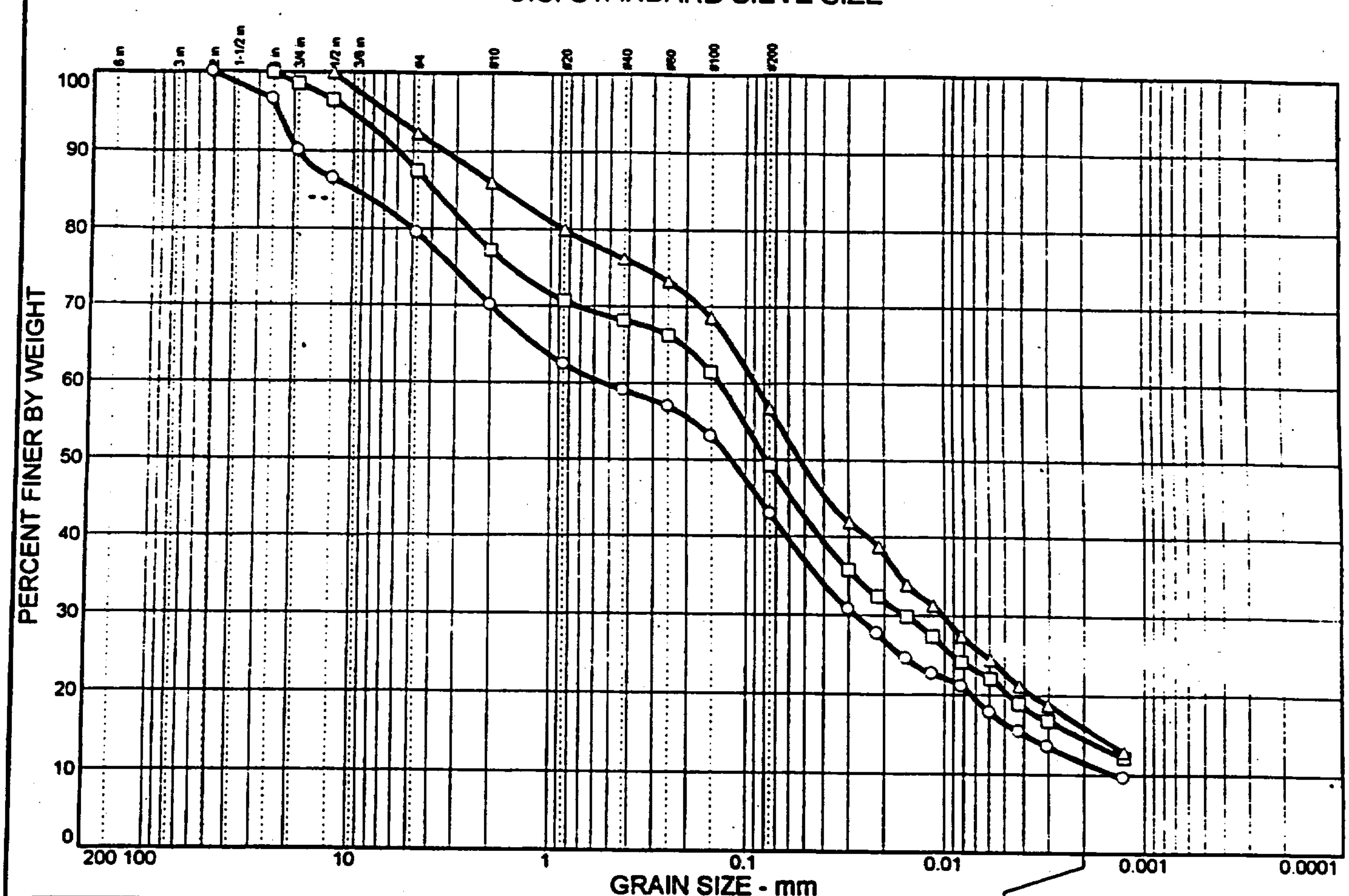
* note: top of riser and ground surface are at similar elevations, approx. 811' MSL.

** (CRB) Charles R. Butts of Haley & Aldrich, Inc.
(D.C.) Dilip Chokshi of Raytheon Engineers & Constructors

OWM02GF2 FRP 1 August 1994

Appendix-C

U.S. STANDARD SIEVE SIZE



	% + 3"	% GRAVEL		% SAND			% FINES	
		CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
○	0.0	9.8	10.7	9.4	11.1	16.0	31.5	11.5
□	0.0	1.3	11.1	10.3	9.1	18.8	34.7	14.7
△	0.0	0.0	7.6	6.3	10.0	19.3	40.7	16.1

	Expl. No.	Sample No.	Depth (ft)	Atterberg Limits % W_L	W_P	I_P	Water Content (%)	C_u	C_c	USCS
○	TB-3	C01	9.0-15.0	25.7	16.3	9.4	19.7	388.54	1.03	SC
□	TB-3	C02	15.0-21.0				25.1			SM
△	TB-3	C03	21.0-29.0	26.1	16.8	9.3	22.1			CL

	Sample Description
○	Red brown silty coarse to fine SAND, some gravel, little clay
□	Red brown silty coarse to fine SAND, little clay, little gravel
△	Red brown sandy SILT, little clay, trace fine gravel

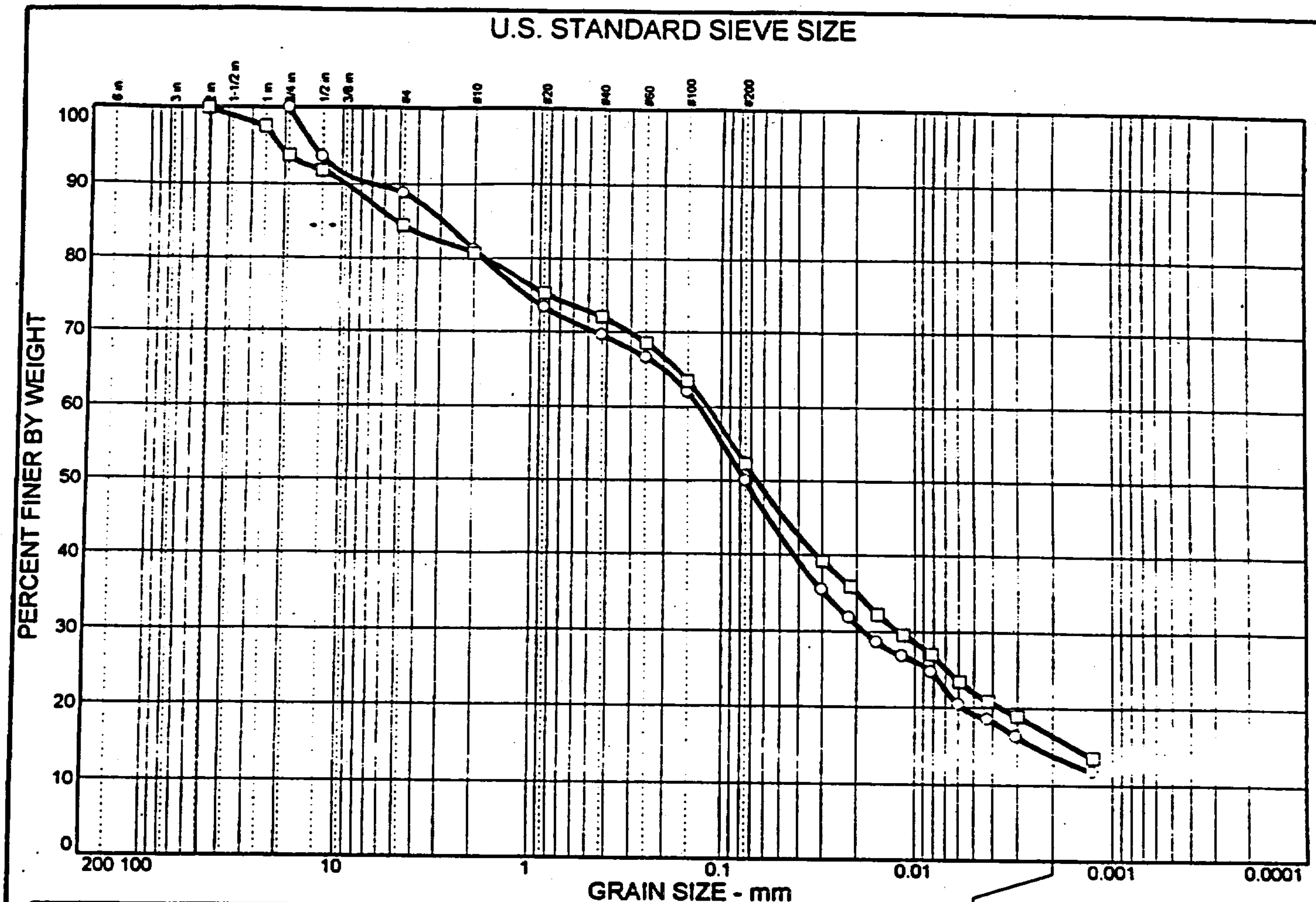
Remarks:
○
□
△

Soil Friction Evaluation
Former Saxton Nuclear Experimental Station
Saxton, Pennsylvania

GRAIN SIZE DISTRIBUTION

DATE: 4/23/99

FILE NO: 74596-000



	% + 3"	% GRAVEL		% SAND			% FINES	
		CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
○	0.0	0.0	11.2	7.6	11.6	19.6	36.2	13.8
□	0.0	6.1	9.5	3.7	8.7	19.7	35.9	16.4

	Expl. No.	Sample No.	Depth (ft)	Atterberg Limits % W_L	W_P	I_p	Water Content (%)	C_u	C_c	USCS
○	TB-3	C04	29.0-35.0				22.5			ML
□	TB-3	C05	35.0-39.0	28.0	17.5	10.5	24.3			CL

	Sample Description
○	Red brown silty medium to fine SAND, little clay, little fine gravel, trace coarse sand
□	Red brown sandy SILT, little clay, little gravel

Remarks:

○

□

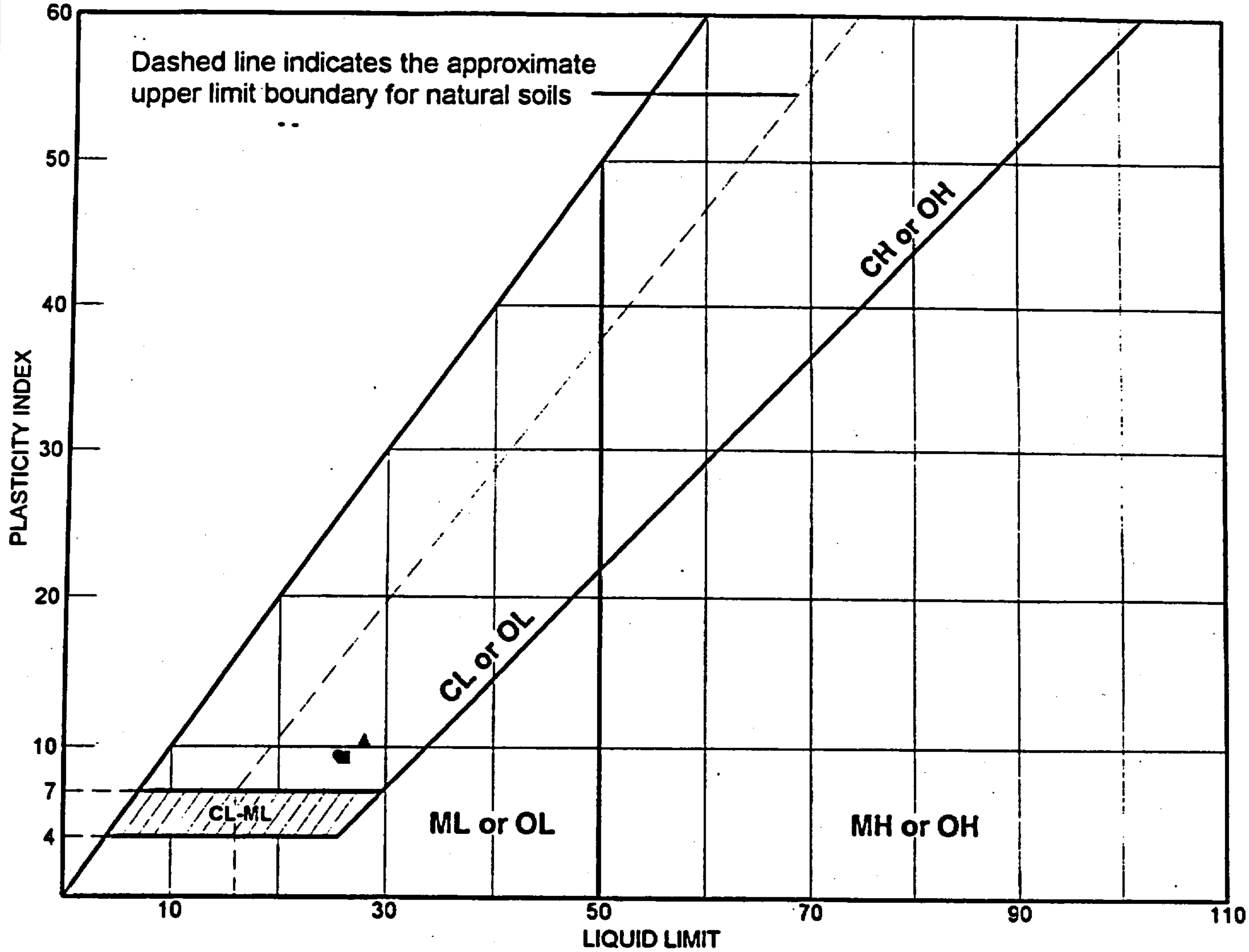
Soil Friction Evaluation
Former Saxton Nuclear Experimental Station
Saxton, Pennsylvania

GRAIN SIZE DISTRIBUTION

DATE: 4/23/99

FILE NO: 74596-000

LIQUID AND PLASTIC LIMITS TEST REPORT



SOIL DATA								
SYMBOL	SOURCE	SAMPLE NO.	DEPTH (ft.)	NATURAL WATER CONTENT (%)	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	USCS
●	TB-3	C01	9.0-15.0	19.7	16.3	25.7	9.4	SC
■	TB-3	C03	21.0-29.0	22.1	16.8	26.1	9.3	CL
▲	TB-3	C05	35.0-39.0	24.3	17.5	28.0	10.5	CL

LIQUID AND PLASTIC LIMITS TEST REPORT

HALEY AND ALDRICH, INC.

Client: GPU Nuclear, Inc.

Project: Soil Friction Evaluation
Former Saxton Nuclear Experimental Station
Saxton, Pennsylvania

Project No.: 74596-000

H&A FORM No. 527 NOV. 1992

HALEY & ALDRICH, INC.

SOIL RESISTIVITY TEST RESULTS

FILE No. 74596-000
DATE 23-Apr-99

PROJECT: Soil Friction Evaluation
Former Saxton Nuclear Experimental Station
Saxton, Pennsylvania

EXPL. No.: TB-1
SAMPLE No.: S03
DEPTH (ft.) 9.0-11.0

Note: The test was performed in general compliance with ASTM G 57-78 (1984)

CHECKED BY: D.Crawford

TEST AT NATURAL WATER CONTENT

SOIL TEMPERATURE t (degrees C)	VOLTAGE DROP V (volts)	CURRENT I (amps)	RESISTANCE R (ohms)
23.6	14.040	0.004380	R = V/I
	13.910	0.004350	Rt = 3204
	14.050	0.004370	TEMPERATURE CORRECTION REQUIRED (t > 21.0 degrees)
	13.820	0.004320	(Y/N) Y Rc = 3853
AVERAGE:	13.955	0.004355	Rc = Rt[(24.5 + t)/40]

NATURAL WATER CONTENT		SOIL UNIT WEIGHT	
CONTAINER No.		WT. BOX(g)	233.81
WT. WET SOIL + CONTAINER (g)	24.1096	WT. BOX + SOIL(g)	811.25
WT. DRY SOIL + CONTAINER (g)	21.4919	VOL. BOX	0.0095
WT. CONTAINER (g)	6.666	WET UNIT WEIGHT(pcf)	134.03
WATER CONTENT (%)	17.66	DRY UNIT WEIGHT(pcf)	113.91

RESISTIVITY (ohm - cm) = 21.0 (Rc)
= 80918

TEST ON SATURATED SAMPLE

SOIL TEMPERATURE t (degrees C)	VOLTAGE DROP V (volts)	CURRENT I (amps)	RESISTANCE R (ohms)
23.4	13.560	0.005110	R = V/I
	13.520	0.005120	Rt = 2647
	13.550	0.005110	TEMPERATURE CORRECTION REQUIRED (t > 21.0 degrees)
	13.520	0.005120	(Y/N) Y Rc = 3169
AVERAGE:	13.538	0.005115	Rc = Rt[(24.5 + t)/40]

NATURAL WATER CONTENT		SOIL UNIT WEIGHT	
CONTAINER No.		WT. BOX(g)	233.83
WT. WET SOIL + CONTAINER (g)	40.3903	WT. BOX + SOIL(g)	774.16
WT. DRY SOIL + CONTAINER (g)	32.2742	VOL. BOX	0.0095
WT. CONTAINER (g)	6.8996	WET UNIT WEIGHT(pcf)	125.41
WATER CONTENT (%)	31.99	DRY UNIT WEIGHT(pcf)	95.02

RESISTIVITY (ohm - cm) = 21.0 (Rc)
= 66556

GROUNDWATER ANALYTICAL

Groundwater Analytical, Inc
P.O. Box 1200
228 Main Street
Buzzards Bay, MA 02532

Telephone (508) 759-4441
FAX (508) 759-4475

April 23, 1999

Mr. Steven Provencal
Haley & Aldrich, Inc.
465 Medford Street
Boston, MA 02129-1400

Project: **Saxton Geotechnical/74596-000**
Lab ID: **26187**
Sampled: **03-24-99**

Dear Steve:

Enclosed are the Metals, Ammonia, Chloride, Sulfate, Sulfide, pH and Specific Conductance Analyses performed for the above referenced project. The Sulfide Analysis was subcontracted. This project was processed for Standard Two Week turnaround.

This letter authorizes the release of the analytical results, and should be considered a part of this report. This report contains a project narrative indicating project changes and non-conformances, a brief description of the Quality Assurance/Quality Control procedures employed by our laboratory, and a statement of our state certifications.

I attest under the pains and penalties of perjury that, based upon my inquiry of those individuals immediately responsible for obtaining the information, the material contained in this report is, to the best of my knowledge and belief, accurate and complete.

Should you have any questions concerning this report, please do not hesitate to contact me.

Sincerely,

Jonathan R. Sanford
President

JRS/myr
Enclosures

GROUNDWATER ANALYTICAL

Inorganic Chemistry

Field ID:	TB-1, S-4	Matrix:	Soil
Project:	Saxton Geotechnical/74596-000	Sampled:	03-24-99
Client:	Haley & Aldrich	Received:	04-09-99

Lab ID:	26187-01	Container:	500 mL Glass	Preservation:	Cool

Analyte	Result	Units	Reporting Limit	Analyzed	QC Batch	Method
Chloride	BRL	mg/Kg	560	04-20-99	CL-0306-S	EPA 325.2-Mod
Ammonia (as Nitrogen)	14	mg/Kg	7	04-21-99	AM-0344-S	EPA 350.1-Mod
pH	5.5	pH	2	04-13-99	PH-0569-S	EPA 9045
Specific Conductance	150	umhos/ cm at 25 °C	2	04-13-99	SC-0333-S	EPA 120.1-Mod
Sulfate	BRL	mg/Kg	1,400	04-20-99	SU-0306-S	EPA 375.2-Mod

Method References: Methods for Chemical Analysis of Water and Wastes, US EPA, EPA-600/4-790-020, Revised (1983), and Methods for the Determination of Inorganic Substances in Environmental Samples, US EPA, EPA/600/R-93/100, (1993), Standard Methods for the Examination of Water and Wastewater, APHA Eighteenth Edition (1992).Test Methods for Evaluating Solid Waste, US EPA, SW-846, Third Edition, Update III (19
Results are reported on a dry weight basis.

Report Notations: BRL Indicates result, if any, is below reporting limit for analyte. Reporting limit is the lowest value that can be reliably quantified under routine laboratory operating conditions. Reporting limits are adjusted for sample dilution and sample size.

GROUNDWATER
ANALYTICAL

Trace Metals by ICP-AES

Field ID:	TB 1, S-4	Laboratory ID:	26187-01
Project:	Saxton Geotechnical/75496-000	Sampled:	03-24-99
Client:	Haley & Aldrich	Received:	04-09-99
Container:	500 mL Glass	% Solids	85
Preservation:	Cool		
Matrix:	Soil		

CAS Number	Analyte	Concentration	Units	Reporting Limit	Analyzed	QC Batch	Method
7440-70-2	Calcium, Total	300	mg/Kg	120	04-22-99	MM-0766-S	6010B
7439-95-4	Magnesium, Total	1,200	mg/Kg	12	04-22-99	MM-0766-S	6010B

Method Reference: Test Methods for Evaluating Solid Waste, US EPA, SW-846, Third Edition, Update III (1996).
Results are reported on a dry weight basis.

Report Notations: BRL Indicates concentration, if any, is below reporting limit for analyte. Reporting limit is the lowest concentration that can be reliably quantified under routine laboratory operating conditions. Reporting limits are adjusted for sample dilution and sample size.

GROUNDWATER ANALYTICAL

Project Narrative

Project:	**Saxton Geotechnical/74596-000**	Lab ID:	**26187**
Client:	**Haley & Aldrich**	Received:	**04-09-99**

A. Physical Condition of Sample(s)

This project was received by the laboratory in satisfactory condition, and the sample(s) were received undamaged in appropriate containers with the correct preservation, except for the following non-conformance(s):

1. Samples 26187-01 was not received within 3 days of sampling, as recommended by the laboratory.

B. Project Documentation

This project was accompanied by satisfactory Chain of Custody documentation, with the following amendment(s) or correction(s):

1. Sample 26487-01 was received in one 500mL glass container.

C. Analysis of Sample(s)

No analytical anomalies or non-conformances were noted by the laboratory during the processing of these sample(s). All data contained within this report are released without qualification.

CHAIN OF CUSTODY RECORD

Haley & Aldrich, Inc.

PAGE 1 OF 1

H&A FILE NO. 74596-000
PROJECT Sexton Geotechnical
H&A CONTACT Steve Provencal

LABORATORY Groundwater Analytical Lab
ADDRESS Buzzards Bay
CONTACT Eric Jensen

DELIVERY DATE April 9, 1999
TURNAROUND TIME Normal Turnaround Time
PROJECT MANAGER Mark Dobday

H&A SAMPLE NUMBER	DATE	TIME	SAMPLE DEPTH	SAMPLE TYPE	VOA	ABN	METALS	PEST/PCB	PET ID	TPH	O&G	TCLP	1				NUMBER OF CONTAINERS	COMMENTS (Special Instructions, Precautions, etc.)
B-1, S-4	3/24/99	1600	11-13 ft.	SOIL									X					1. Calcium Magnesium Ammonia Chloride Sulphate Sulfide pH Conductivity

[redacted] Relinquished by	Received by
Sign Freddie Farrar	Sign K. [illegible]
Print Freddie Farrar	Print Karl [illegible] Jr.
Firm Haley + Aldrich Inc.	Firm H&A Inc.
Date 4-9-99 Time 13:15	Date 4/9/99 Time 13:15

Relinquished by	Received by
Sign K. [illegible]	Sign Alan Maddigan
Print Karl [illegible] Jr.	Print Alan Maddigan
Firm H&A Inc.	Firm Groundwater A.
Date 4/9/99 Time 14:00	Date 4/9/99 Time 1400

Relinquished by	Received by
Sign Alan Maddigan	Sign [illegible]
Print Alan Maddigan	Print Eric Jensen
Firm Groundwater A	Firm GWA
Date 4/9/99 Time 7:00PM	Date 4/9/99 Time 7pm

Relinquished by	Received by
Sign	Sign
Print	Print
Firm	Firm
Date Time	Date Time

LIQUID: VOA Vial / Glass Bottle / Plastic Bottle / Preservative / Container / Volume

SOLID: VOA Vial / Glass Bottle / Plastic Bottle / Preservative / Container / Volume

PRESERVATION KEY:
A - Sample chilled B - Sample filtered C - NaOH D - HNO3 E - H2SO4
F - HCl G - NaThiosulfate H - Acidified with

Evidence samples tampered with? Yes No If yes, please explain in comments.

November 1990

GROUNDWATER ANALYTICAL

Quality Assurance/Quality Control

A. Program Overview

Groundwater Analytical conducts an active Quality Assurance program to ensure the production of high quality, valid data. This program closely follows the guidance provided by *Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans*, US EPA QAMS-005/80 (1980), and *Test Methods for Evaluating Solid Waste*, US EPA, SW-846, Update III (1996).

Quality Control protocols include written Standard Operating Procedures (SOPs) developed for each analytical method. SOPs are derived from US EPA methodologies and other established references. Standards are prepared from commercially obtained reference materials of certified purity, and documented for traceability.

Quality Assessment protocols for most organic analyses include a minimum of one laboratory control sample, one method blank, one matrix spike sample, and one sample duplicate for each sample preparation batch. All samples, standards, blanks, laboratory control samples, matrix spikes and sample duplicates are spiked with internal standards and surrogate compounds. All instrument sequences begin with an initial calibration verification standard and a blank; and excepting GC/MS sequences, all sequences close with a continuing calibration standard. GC/MS systems are tuned to appropriate ion abundance criteria daily, or for each 12 hour operating period, whichever is more frequent.

Quality Assessment protocols for most inorganic analyses include a minimum of one laboratory control sample, one method blank, one matrix spike sample, and one sample duplicate for each sample preparation batch. Standard curves are derived from one reagent blank and four concentration levels. Curve validity is verified by standard recoveries within plus or minus ten percent of the curve.

B. Definitions

Batches are used as the basic unit for Quality Assessment. A Batch is defined as twenty or fewer samples of the same matrix which are prepared together for the same analysis, using the same lots of reagents and the same techniques or manipulations, all within the same continuum of time, up to but not exceeding 24 hours.

Laboratory Control Samples are used to assess the accuracy of the analytical method. A Laboratory Control Sample consists of reagent water or sodium sulfate spiked with a group of target analytes representative of the method analytes. Accuracy is defined as the degree of agreement of the measured value with the true or expected value. Percent Recoveries for the Laboratory Control Samples are calculated to assess accuracy.

Method Blanks are used to assess the level of contamination present in the analytical system. Method Blanks consist of reagent water or an aliquot of sodium sulfate. Method Blanks are taken through all the appropriate steps of an analytical method. Sample data reported is not corrected for blank contamination.

Surrogate Compounds are used to assess the effectiveness of an analytical method in dealing with each sample matrix. Surrogate Compounds are organic compounds which are similar to the target analytes of interest in chemical behavior, but which are not normally found in environmental samples. Percent Recoveries are calculated for each Surrogate Compound.

GROUNDWATER
ANALYTICAL

QUALITY ASSURANCE
Laboratory Control Sample Recovery

Category: Trace Metals
Matrix: Solid
Units: mg/Kg

Laboratory Control Sample

ANALYTE	BATCH ID	SPIKE ADDED	SPIKED RESULT	PERCENT RECOVERY	QC LIMITS
Calcium	MM-0766-SLI	500	507	101 %	75-125
Magnesium	MM-0766-SLI	500	440	88 %	75-125

Quality Control Limits are defined by the methodology, or alternatively based upon the historical average recovery plus or minus three standard deviation units.

GROUNDWATER ANALYTICAL

QUALITY ASSURANCE
Method Blank

Category: Trace Metals
Matrix: Soil

PARAMETER	CONCENTRATION (mg/Kg)	REPORTING LIMIT (mg/Kg)	BATCH	EPA METHOD
Calcium	BRL	100	MM-0766-SB	6010
Magnesium	BRL	10	MM-0766-SB	6010

BRL = Below Reporting Limit. Calculations based on dry sample weight. Method References: Test Methods for Evaluating Solid Waste, US EPA SW-846, Third Edition (1986). Graphite Furnace analyses performed with Zeeman background correction and Lvov platform technique.

GROUNDWATER
ANALYTICAL

Quality Control Report
Laboratory Control Sample

Category: **Inorganic Chemistry**
Matrix: **Soil**

Analyte	Method	QC Batch	Units	Spiked	Measured	Recovery	QC Limits
Chloride	EPA 325.2-Mod	CL-0306-S	mg/Kg	250	253	**101 %**	80 - 120 %
Ammonia (as Nitrogen)	EPA 350.1	AM-0344-S	mg/Kg	50.0	41.0	**81 %**	80 - 120 %
Specific Conductance	EPA 120.1-Mod	SC-0333-S	umhos / cm at 25 °C	1,413	1,390	**98 %**	80 - 120 %
Sulfate	EPA 375.2-Mod	SU-0306-S	mg/Kg	500	523	**105 %**	80 - 120 %

Method References: Methods for Chemical Analysis of Water and Wastes, US EPA, EPA-600/4-790-020, Revised (1983), and Methods for the Determination of Inorganic Substances in Environmental Samples, US EPA, EPA/600/R-93/100, (1993), Standard Methods for the Examination of Water and Wastewater, APHA Eighteenth Edition (1992).Test Methods for Evaluating Solid Waste, US EPA, SW-846, Third Edition, Update III (19
Results are reported on a dry weight basis.

Report Notations: All calculations performed prior to rounding. Quality Control Limits are defined by the methodology, or alternatively based upon the historical average recovery plus or minus three standard deviation units.

GROUNDWATER
ANALYTICAL

Quality Control Report
Method Blank

Category: **Inorganic Chemistry**
Matrix: **Soil**

Analyte	Result	Units	Reporting Limit	QC Batch	Method
Ammonia (as Nitrogen)	BRL	mg/Kg	20	AM-0306-S	EPA 350.1-Mod
Chloride	BRL	mg/Kg	2	CL-0344-S	EPA 325.2-Mod
Specific Conductance	BRL	umhos / cm at 25 °C	2	SC-0333-S	EPA 120.1-Mod
Sulfate	BRL	mg/Kg	50	SU-0306-S	EPA 375.2-Mod

Method References: Methods for Chemical Analysis of Water and Wastes, US EPA, EPA-600/4-790-020, Revised (1983), and Methods for the Determination of Inorganic Substances in Environmental Samples, US EPA, EPA/600/R-93/100, (1993), Standard Methods for the Examination of Water and Wastewater, APHA, Eighteenth Edition (1992).Test Methods for Evaluating Solid Waste, US EPA, SW-846, Third Edition, Update III (1996). Results are reported on a dry weight basis.

Report Notations: BRL Indicates result, if any, is below reporting limit for analyte. Reporting limit is the lowest value that can be reliably quantified under routine laboratory operating conditions. Reporting limits are adjusted for sample dilution and sample size.

GROUNDWATER ANALYTICAL

Certifications and Approvals

CONNECTICUT, Department of Health Services, PH-0586

Potable Water, Wastewater/Trade Waste, Sewage/Effluent, and Soil

pH, Conductivity, Acidity, Alkalinity, Hardness, Chloride, Fluoride, Ammonia, Kjeldahl Nitrogen, Nitrate, Nitrite, Orthophosphate, Total Dissolved Solids, Cyanide, Aluminum, Antimony, Arsenic, Barium, Beryllium, Cadmium, Total Chromium, Hexavalent Chromium, Cobalt, Copper, Iron, Lead, Magnesium, Manganese, Mercury, Molybdenum, Nickel, Potassium, Selenium, Silver, Sodium, Thallium, Tin, Titanium, Vanadium, Zinc, Purgeable Halocarbons Purgeable Aromatics, Pesticides, PCBs, PCBs in Oil, Ethylene Dibromide, Phenols, Oil and Grease.

MAINE, Department of Human Services, MA103

Drinking Water

Reciprocal certification in accordance with Massachusetts certification for drinking water analytes.

Waste Water

Reciprocal certification in accordance with Massachusetts certification for waste water analytes.

MASSACHUSETTS, Department of Environmental Protection, M-MA-103

Potable Water

Antimony, Arsenic, Barium, Beryllium, Cadmium, Chromium, Copper, Lead, Mercury, Nickel, Selenium, Thallium, Nitrate-N, Nitrite-N, Fluoride, Sodium, Sulfate, Cyanide, Turbidity, Residual Free Chlorine, Calcium, Total Alkalinity, Total Dissolved Solids, pH, Trihalomethanes, Volatile Organic Compounds, 1,2-Dibromoethane, 1,2-Dibromo-3-chloropropane, Total Coliform, Fecal Coliform, Heterotrophic Plate Count, E-Coli

Non-Potable Water

Aluminum, Antimony, Arsenic, Beryllium, Cadmium, Chromium, Cobalt, Copper, Iron, Lead, Manganese, Mercury, Molybdenum, Nickel, Selenium, Silver, Strontium, Thallium, Titanium, Vanadium, Zinc, pH, Specific Conductance, Total Dissolved Solids, Total Hardness, Calcium, Magnesium, Sodium, Potassium, Total Alkalinity, Chloride, Fluoride, Sulfate, Ammonia-N, Nitrate-N, Kjeldahl-N, Orthophosphate, Total Phosphorus, Chemical Oxygen Demand, Biochemical Oxygen Demand, Total Cyanide, Non-Filterable Residue, Total Residual Chlorine, Oil and Grease, Total Phenolics, Volatile Halocarbons, Volatile Aromatics, Chlordane, Aldrin, Dieldrin, DDD, DDE, DDT, Heptachlor, Heptachlor Epoxide, Polychlorinated Biphenyls (water), Polychlorinated Biphenyls (oil)

MICHIGAN, Department of Environmental Quality

Drinking Water

Trihalomethanes, Regulated and Unregulated Volatile Organic Compounds by EPA Method 524.2; 1,2-Dibromoethane, 1,2-Dibromo-3-chloropropane by EPA Method 504.1

NEW HAMPSHIRE, Department of Environmental Services, 202798

Drinking Water

Metals by Graphite Furnace, Metals by ICP, Mercury, Nitrite-N, Orthophosphate, Residual Free Chlorine, Turbidity, Total Filterable Residue, Calcium Hardness, pH, Alkalinity, Sodium, Sulfate, Total Cyanide, Insecticides, Herbicides, Base/Neutrals, Trihalomethanes, Volatile Organics, Vinyl Chloride, DBCP, EDB, Nitrate-N.

Wastewater

Metals by Graphite Furnace, Metals by ICP, Mercury, pH, Specific Conductivity, TDS, Total Hardness, Calcium, Magnesium, Sodium, Potassium, Total Alkalinity, Chloride, Fluoride, Sulfate, Ammonia-N, Nitrate-N, Orthophosphate, TKN, Total Phosphorus, COD, BOD, Non-Filterable Residue, Oil & Grease, Total Phenolics, Total Residual Chlorine, PCBs in Water, PCBs in Oil, Pesticides, Volatile Organics, Total Cyanide

RHODE ISLAND, Department of Health, 54

Surface Water, Air, Wastewater, Potable Water, Sewage

Chemistry: Organic and Inorganic

eas LABORATORIES

May 4, 1999

Client: GROUNDWATER ANALYTICAL
P.O. Box 1200
228 Main Street
Buzzards Bay, MA 02532

Attention: Mr. Eric Jensen

EAS Project Number: 0890-99

Sample Number(s): 9904134

Copies of this report and the supporting computer stored data are retained in our files in the event they are required for future reference.

Any sample submitted to our laboratory will be retained for a maximum of thirty (30) days from receipt of the sample.

All analytical data, unless otherwise specified, is reported on a wet weight (as received) basis.

Our laboratory is a multi-state Certified Public Health Laboratory, offering a full range of analytical services which include:

Drinking Water Analysis
Water and Wastewater Analysis
Hazardous Waste Analysis (RCRA)
Full Priority Pollutant Analysis
Field Sampling

Gregory C. Lawrence

Gregory C. Lawrence
Laboratory Director

encl.

105 COMMERCIAL STREET WATERTOWN CT 06795 PHONE (860) 274-5461 FAX (860) 945-0449

GROUNDWATER ANALYTICAL
P O.Box 1200
8 Main Street
Buzzards Bay, MA 02532-

I ·cation Collected:
L_te Sample Collected: 03/24/1999
Sample Description: TB-1
F S Project Number: 0890-99
I S Sample Number: 9904134
Date Sample Received: 04/13/1999

Parameter	Data	Quantitation Limit	Units	Analysis Date
Sulfide, Total	BQL	10.	mg/kg	04/29/99

E L = Below Quantitation Limit

* Certification *

C_nnecticut Certified Laboratory Number: PH 0558

N w York Certified Laboratory Number: 10916

Massachusetts Certified Laboratory Number: CT 020

The above analyses were conducted in accordance with:

1. APHA Standard Methods for the Examination of Water and Wastewater, 18th Edition, 1992.

2. Clean Water Act, List of Approved Test Procedures, 40 CFR.

3. EPA Test Methods for the Evaluation of Solid Waste, SW-846, 3rd Edition, December, 1987.

Chain of Custody Record

Project Name: SAXTON GEOTECHNICAL

Sampled By:

Lab subcontracted to: EAS

Date	Time	Sample Identification	Number of Containers	Container Volume (ml)	Glass or Plastic (G/P)	Matrix (Water/Soil/Other)	Grab / Composite	Preservative (Type)	Filtered (Yes/No)	Total / Fecal Coliform	COD	MBAS	Sulfide	(Tex)		Remarks	Lab ID Number
3/24	16^00	TB-1	1	125ml vial	G	Soil		4°C					X				990413

Reporting and Billing Information

GROUNDWATER ANALYTICAL

228 Main Street, Buzzards Bay MA 02532

Telephone: 508-759-4441 Fax: 508-759-4475

Contact Person: Eric Jensen

Purchase Order Number:

Please Fax Report ☒ Yes ☐ No

Turnaround and Special Instructions

Results Due: STD: 4/26

Special Instructions:

☐ MA DEP Form Required

Custody Record

Signature	Time	Date
Relinquished By: Bethany Clemmy	15^00	4/12/99
Received By:		
Received By:		
Received at Lab By: [signature]	1529	4/13/99

Method of Shipment: ☒ USPO Express Mail ☐ Federal Express ☐ Hand ☐ Other ☐ GWA Courier

Shipping Label / Airbill

UNDERGROUND
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Haley & Aldrich, Inc.
465 Medford Street
Suite 2200
Boston, MA 02129-1400
Tel 617.886.7400
Fax 617.886.7600
Email: BOS@HaleyAldrich.com

HALEY &
ALDRICH

13 May 1999
File No. 74596-000

Raytheon Nuclear, Inc.
508 Carnegie Center
CN 5287
Princeton, NJ 08543-5287

Attention: Mr. S.J. Chen

Subject: Report on Lateral Stresses for Structural Evaluations
Containment Vessel
Former Saxton Nuclear Experimental Station
Saxton, Pennsylvania

Gentlemen:

This letter and its attachments present the results of our analyses on the lateral stresses acting on the steel containment vessel, the pipe tunnels and the radiation shield (band) needed in your analyses of the structural aspects of the Containment Vessel. We have previously issued two reports on the subject matter, including the " Data Summary Report for Soil Friction Evaluation", dated 5 May 1999, and the " Report on Soil Friction Evaluation", dated 12 May 1999. The analyses presented herein were undertaken in accordance with the telephone communication between Mr. S. J. Chen and the undersigned on 10 May 1999.

GROUNDWATER ELEVATIONS

At your request, two groundwater elevations were considered in the analyses:

1. Flood Groundwater Level of El. 811 (MSL Datum)
2. Normal Groundwater Level of El. 807, based on the observation well data collected at the site during April-May 1999.

GEOTECHNICAL PARAMETERS

The following geotechnical parameters were assumed in the analyses representing the BACKFILL material, following "a reasonably conservative approach" as discussed in our telecommunication of 10 May 1999. The assumptions were made for the BACKFILL soils based on the data obtained through test borings, laboratory soil index test data, and engineering judgement.

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California

San Francisco
California

Washington
District of Columbia

It is understood for structural purposes, that you require "high side" estimates of lateral stress for analysis. To accomplish this requirement, we selected:

1. A saturated soil unit weight believed to be somewhat greater than in-situ.
2. An effective soil friction angle somewhat less than we believe actually exists. This yields a "high side" estimate of the at rest earth pressure coefficient.

Parameters selected are as follows:

Saturated Unit Weight	=	0.120 kcf
Submerged Unit Weight	=	0.058 kcf
Moisted Unit Weight	=	0.115 kcf
Angle of Internal Friction	=	23 degrees
Coeffic. of Earth Pressure at Rest	=	0.609

For the unit weight of water 0.0624 kcf was used in the analyses.

RESULTS OF ANALYSES

The lateral stress distributions determined are graphically displayed in Figures 1 through 4 as follows:

Figure 1: At Tunnel Section; Groundwater Level at El. 811 (Flood Condition)

Figure 2: At Tunnel Section; Groundwater Level at El. 807 (Normal Condition)

Figure 3: At Radiation Shield Section; Groundwater Level at El. 811 (Flood Condition)

Figure 4: At Radiation Shield Section; Groundwater Level at El. 807 (Normal Condition)

The lateral stress distributions were presented in components of "effective (soil skeleton) stresses" and "neutral (hydrostatic) stresses". The Total Lateral Stresses for your analyses are the sum of the two components.

Please do not hesitate to contact us, if you have any questions or need additional information.

Sincerely yours,
HALEY & ALDRICH, INC.

Cetin Soydemir
Vice President

Edward B. Kinner
Principal

Attachments:
Figure 1
Figure 2
Figure 3
Figure 4

C: GPN Nuclear, Inc.; Attn: Mr. James J. Byrne
GPU Nuclear, Inc.; Attn: Mr. Kenneth Whitmore

\\BOS\DATA\PROJECTS\74596\Latst.doc

HALEY & ALDRICH, INC.

CALCULATIONS

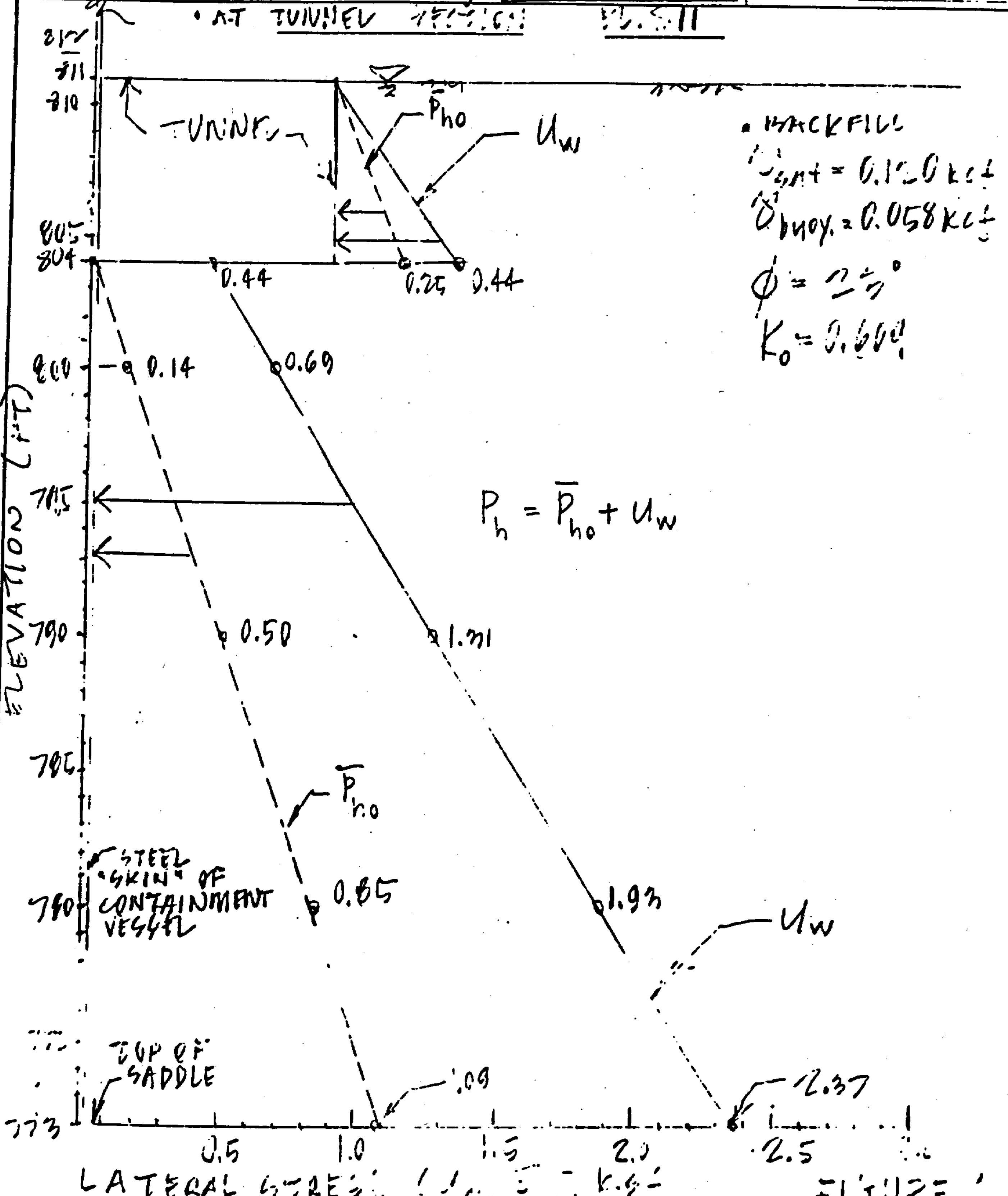
File No.	745[illegible]
Sheet	1 of 4
Date	[illegible]
Computed By	[illegible]
Checked By	[illegible]

Client [illegible]

Project [illegible]

Subject [illegible] STRESSES, [illegible] LEVEL

• AT TUNNEL [illegible]



HALEY & ALDRICH, INC.

CALCULATIONS

File No.	74596-003
Sheet	2 of 4
Date	5/11/99
Computed By	CCC
Checked By	EBK

Client: GPU

Project: Saxton, PA

Subject: • Horizontal stresses: GW at El. 807

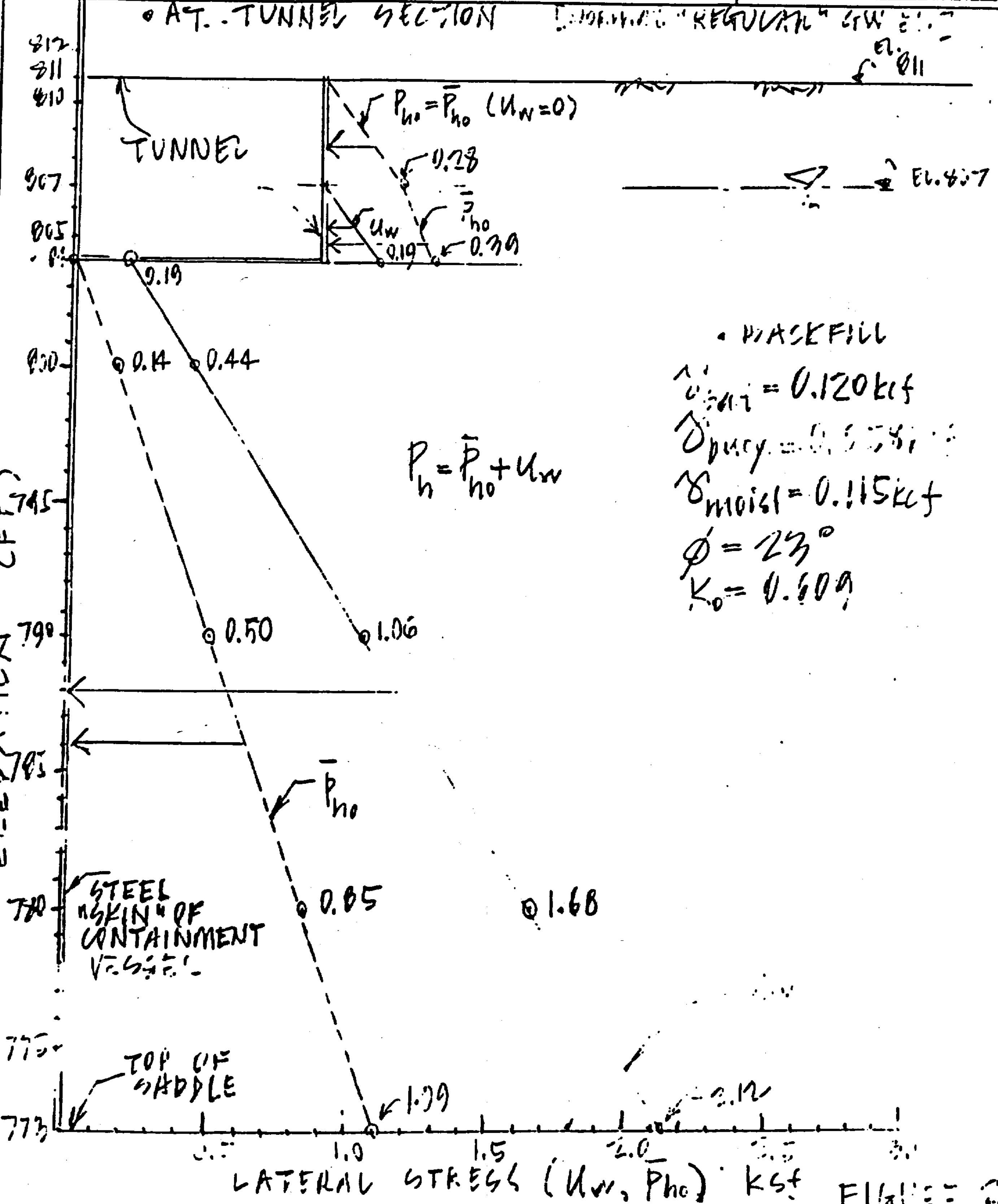


FIGURE 2

HALEY & ALDRICH, INC.

CALCULATIONS

File No.	74596-0??
Sheet	3 of 4
Date	5/11/9?
Computed By	
Checked By	EBK
Client	GPU
Project	SAXTON, PA
Subject	• HORIZONTAL STRESSES

• AT RADIATION SHIELD SECTION EL.811

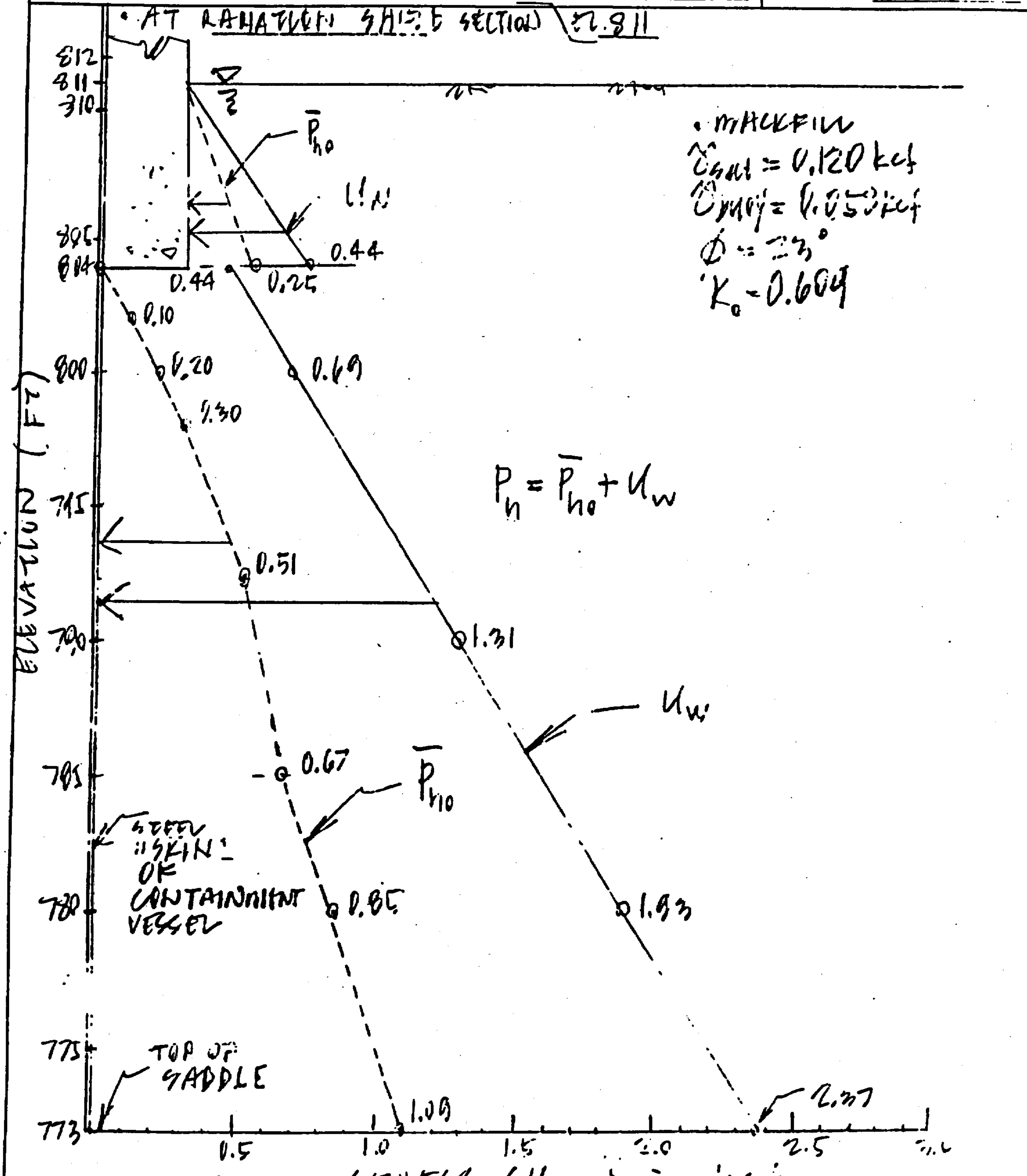


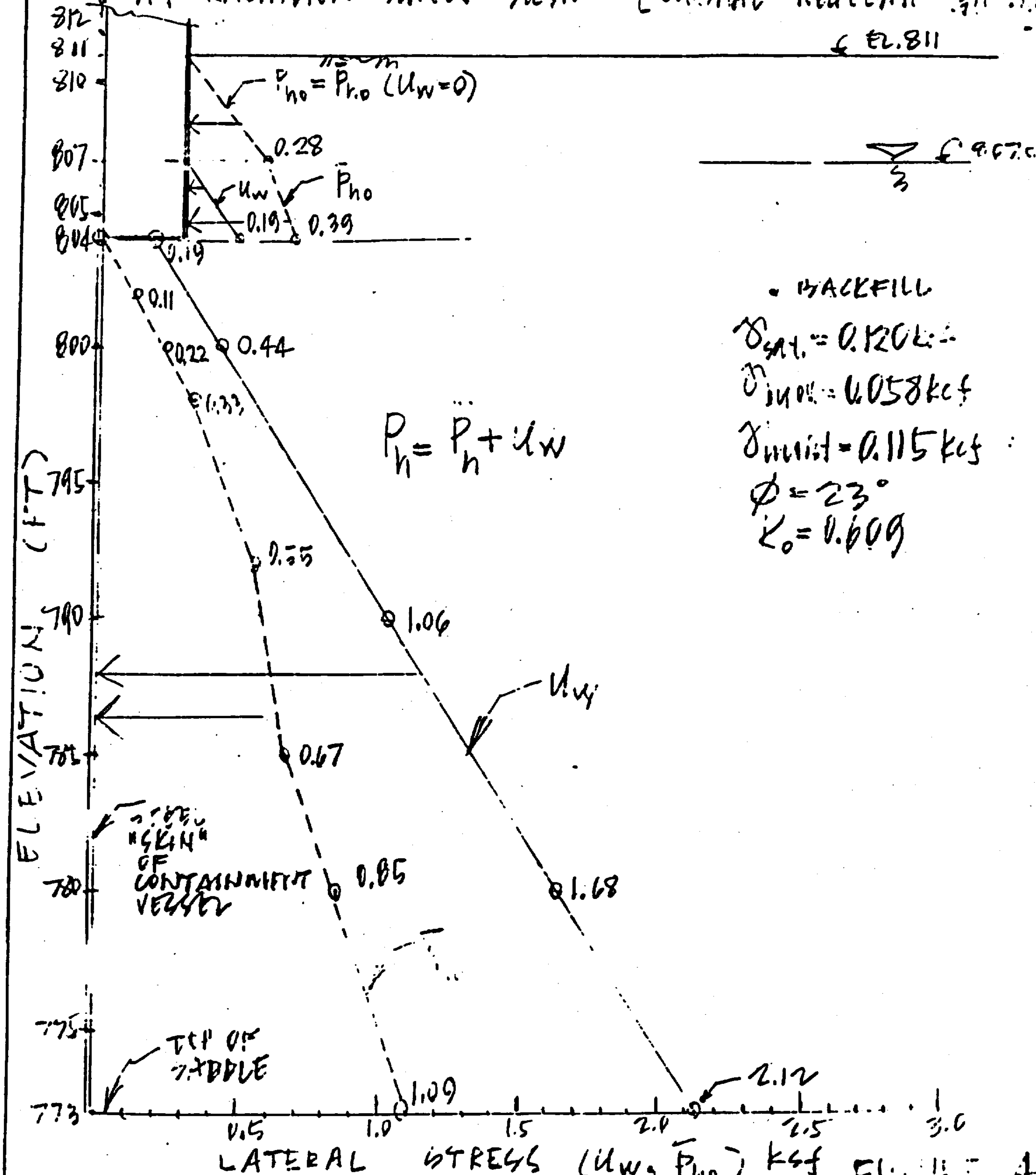
FIGURE 3

HALEY & ALDRICH

CALCULATIONS

Client	GPU	File No.	74586-00?
Project	SAXTON, PA	Sheet	4 of 4
Subject	HORIZONTAL ST... : GW at EL. 807	Date	5/11/99
		Computed By	[illegible]
		Checked By	EBK

AT RADIATION SHIELD SECTION [NORMAL "REGULAR" ...]



$P_h = \bar{P}_h + u_w$

• BACKFILL

$\gamma_{SAT} = 0.120$ kcf

$\gamma_{sub} = 0.058$ kcf

$\gamma_{moist} = 0.115$ kcf

$\phi = 23°$

$K_o = 0.609$

FIGURE 4

CAL02AFH FRP 20 November 1997

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465 Medford Street
Suite 2200
Boston, MA 02129-1400
Tel: 617.886.7400
Fax: 617.886.7600
Email: BOS@HaleyAldrich.con

HALEY & ALDRICH

Updated 21 July 1999
13 May 1999
File No. 74596-000

Raytheon Nuclear, Inc.
508 Carnegie Center
CN 5287
Princeton, NJ 08543-5287

Attention: Mr. S.J. Chen

Subject: Report on Lateral Stresses for Structural Stability Evaluations
Containment Vessel
Former Saxton Nuclear Experimental Station
Saxton, Pennsylvania

Gentlemen:

With our letter of 13 May 1999, we presented the results of our analyses on the lateral stresses acting on the steel containment vessel, the pipe tunnels and the radiation shield needed in your structural stability analyses of the Containment Vessel during the decommissioning phase. Our analyses were conducted in a framework established with Mr. S.J. Chen, Raytheon Nuclear, Inc. (RNI), and the undersigned in a telephone communication on 10 May 1999. Earlier we had issued two reports including, "Data Summary Report for Soil Friction Evaluation", dated 5 May 1999, and draft "Report on Soil Friction Evaluation", dated 12 May 1999. We have subsequently interacted with GPU Nuclear Inc. (GPU) relative to review comments on our 12 May 1999 and 13 May 1999 reports. This report incorporates those review items pertinent to your work. The new material does not change the results of our previous analyses presented in Figures 1 through 4 of our 13 May 1999 report, which are also included herein.

GROUNDWATER ELEVATIONS

At your request, two groundwater elevations were considered in the analyses:

1. Flood Groundwater Level of El. 811 (MSL Datum)
2. Normal Groundwater Level of El. 807, based on the observation well data collected at the site during April-May 1999.

GEOTECHNICAL PARAMETERS

The following geotechnical parameters were used in the analyses representing the BACKFILL material following "a reasonably conservative approach" as discussed in

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New York

San Diego
California

San Francisco
California

Washington
District of Columbia

our telecommunication of 10 May 1999. The BACKFILL soil parameters were assigned based on the data obtained through test borings, laboratory soil index test data, and engineering judgement.

It is understood that for structural stability analyses you require "high side" estimates of lateral stresses. To accomplish this requirement, we assigned:

1. A saturated soil unit weight believed to be somewhat greater than in-situ.
2. An effective soil friction angle somewhat less than we believe actually exists. This yields a "high side" estimate of the at rest earth pressure coefficient.

Assigned parameters are as follows:

Saturated Unit Weight	=	0.120 kcf
Submerged Unit Weight	=	0.058 kcf
Moist Unit Weight	=	0.115 kcf

(Please note that in Appendix C of our "Data Summary Report", dated 5 May 1999, under "Soil Resistivity Test Results-Test on Saturated Sample" reference is made to a sample which was prepared and saturated in the laboratory following the ASTM standard for the particular test. The sample was subsequently placed in a testing box of known volume, weighed, and the saturated unit weight of 125.4 pcf was determined. The fabric (structural arrangement of the soil matrix) as created during the test would be different than that of the backfill soil in-situ, and hence the saturated unit weight of 125.4 pcf would not be representative for use in the lateral stress analyses.)

Angle of Internal Friction	=	23 degrees
Coeffic. of Earth Pressure at Rest	=	0.609

For the unit weight of water 0.0624 kcf was used in the analyses.

RESULTS OF ANALYSES

The lateral stress distributions determined are graphically displayed in Figures 1 through 4 as follows:

Figure 1: At Tunnel Section; Groundwater Level at El. 811 (Flood Condition)

Figure 2: At Tunnel Section; Groundwater Level at El. 807 (Normal Condition)

Figure 3: At Radiation Shield Section; Groundwater Level at El. 811 (Flood Condition)

Figure 4: At Radiation Shield Section; Groundwater Level at El. 807 (Normal Condition)

The lateral stress distributions were presented in components of "effective (soil skeleton) stresses" and "neutral (hydrostatic) stresses". The Total Lateral Stresses for your analyses are the sum of the two components.

CONCLUSION

We recommend that lateral stress diagrams presented in Figures 1 through 4 be used in structural stability analyses for the respective groundwater level being considered. These lateral stresses acting on the Containment Vessel represent reasonably conservative upper-bound values, and we recommend that no further increase in these values be considered in structural stability analyses for the purpose of providing additional factor of safety.

Please do not hesitate to contact us, if you have any questions or need additional information.

Sincerely yours,
HALEY & ALDRICH, INC.

Cetin Soydemir/sh
Cetin Soydemir
Vice President, Ph.D., P.E.

Edward B. Kinner
Edward B. Kinner, Sc.D., P.E.
Principal

Attachments:
- Figure 1
- Figure 2
- Figure 3
- Figure 4

C: ✓GPN Nuclear, Inc.; Attn: Mr. James J. Byrne
GPU Nuclear, Inc.; Attn: Mr. Kenneth Whitmore

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HALEY & ALDRICH, INC.

CALCULATIONS

File No.	74594-000
Sheet	1 of 4
Date	5/11/99
Computed By	CCS
Checked By	EBK
Client	GPU
Project	SAXTON, PA
Subject	• HORIZONTAL STRESSES; GW at FLOOD LEVEL

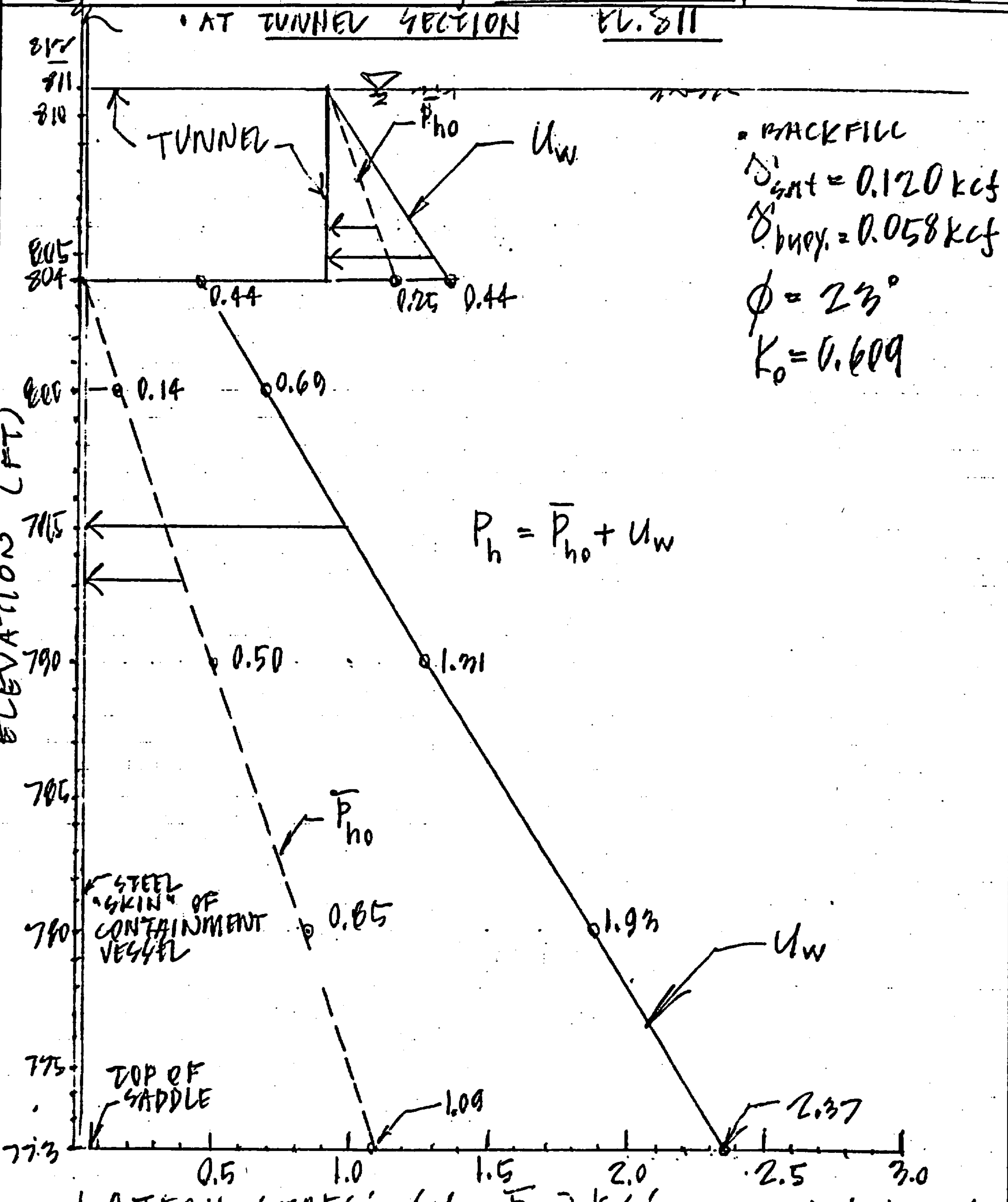
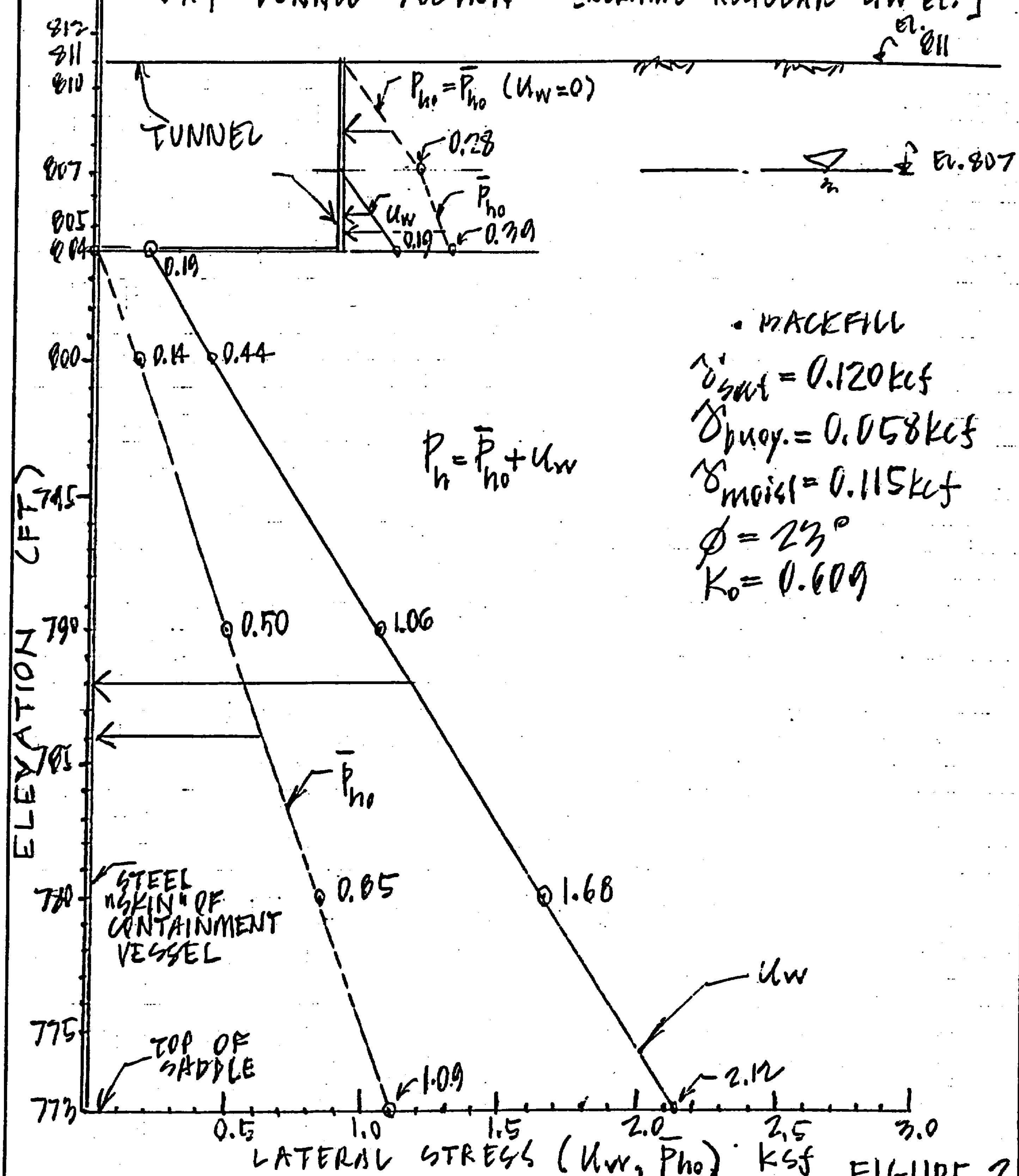


FIGURE 1

HALEY & ALDRICH, INC.	CALCULATIONS	File No.	74596-00(
		Sheet	2 of 4
Client	GPU	Date	5/11/99
Project	Saxton, PA	Computed By	CCS
Subject	• Horizontal Stresses: GW at El. 807	Checked By	EBK

• AT TUNNEL SECTION [NORMAL "REGULAR" GW EL.]



• BACKFILL

$\gamma_{sat} = 0.120$ kcf

$\gamma_{buoy.} = 0.058$ kcf

$\gamma_{moist} = 0.115$ kcf

$\phi = 23°$

$K_o = 0.609$

FIGURE 2

CAL1AFH.FRP 3 June 1993

HALEY & ALDRICH, INC.

CALCULATIONS

File No.	74596-006
Sheet	3 of 4
Date	5/11/99
Computed By	LLS
Checked By	EBK
Client	GPU
Project	SAXTON, PA
Subject	• HORIZONTAL STRESSES; GW @ FLOOD LEVEL

• AT RADIATION SHIELD SECTION \ EL. 811

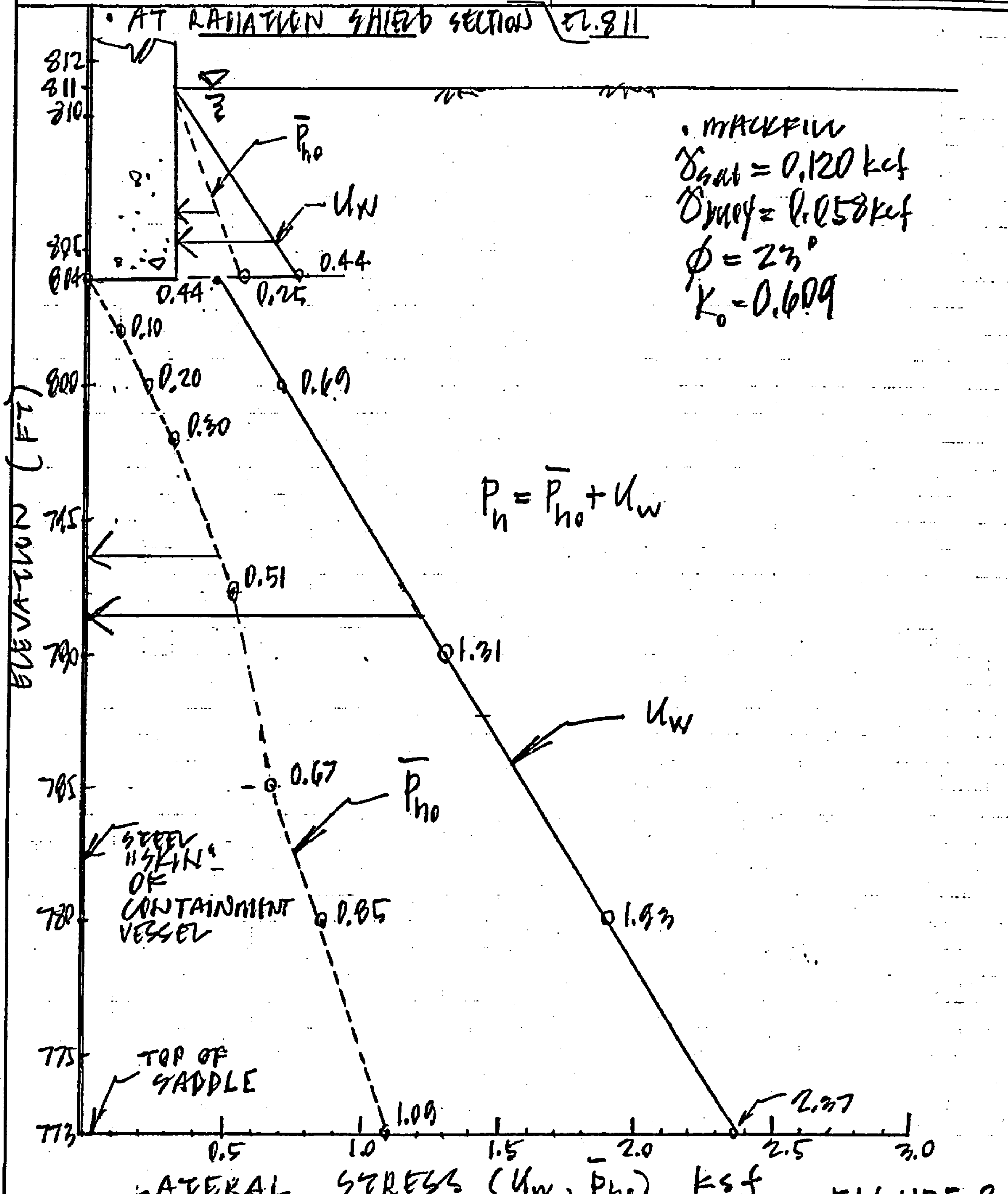


FIGURE 3

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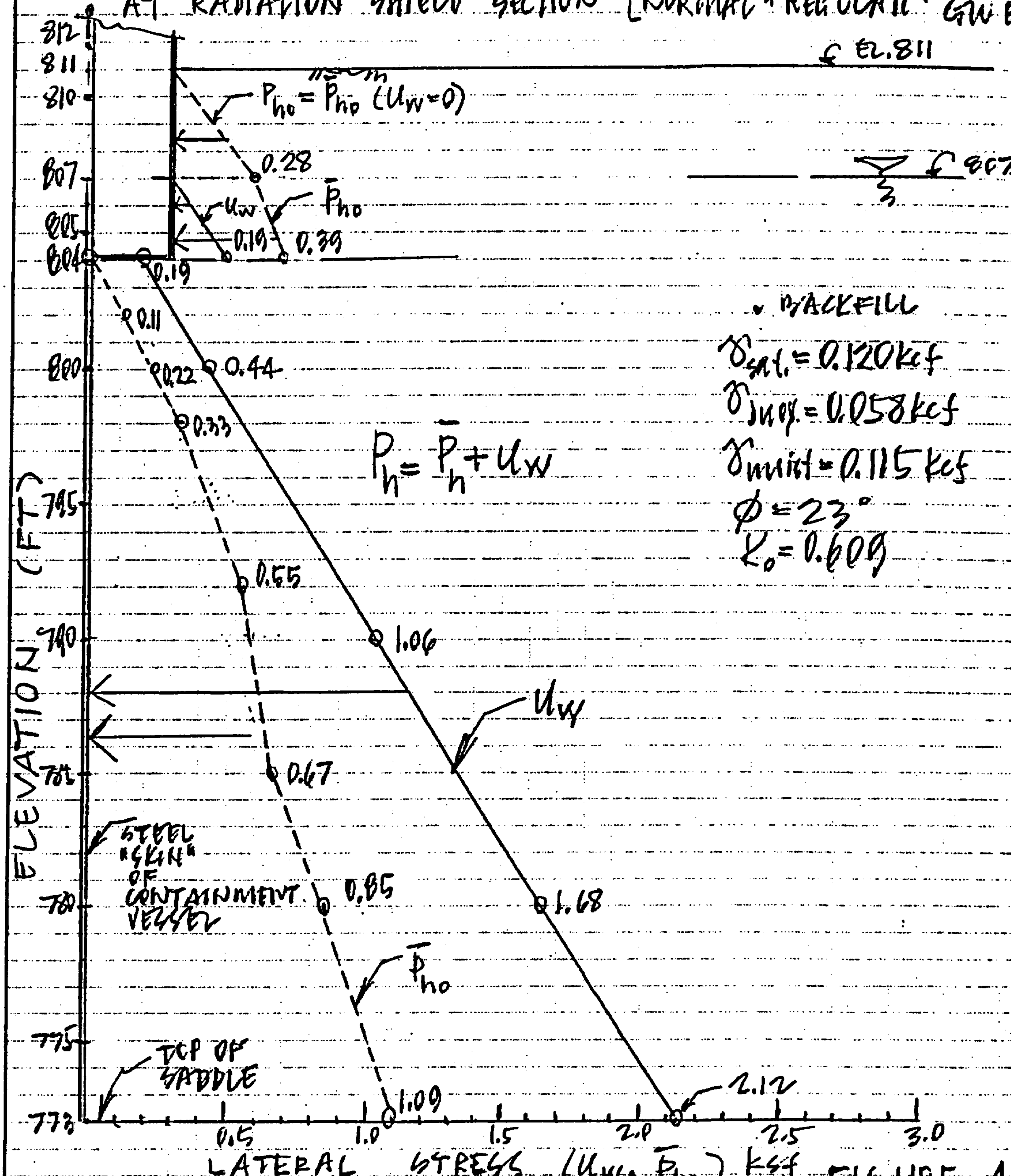
CALCULATIONS

File No. 74584-006
Sheet 4 of 4
Date 5/11/99
Computed By LCS
Checked By EBK

Client GPU
Project SAXTON, PA
Subject Horizontal Stresses : GW at El. 807

AT RADIATION SHIELD SECTION [NORMAL "REGULATE" GW El.



• BACKFILL

$\gamma_{sat.} = 0.120$ kcf

$\gamma_{sub.} = 0.058$ kcf

$\gamma_{moist} = 0.115$ kcf

$\phi = 23°$

$K_o = 0.609$

FIGURE 4

CAL02AFH.FRP 20 November 1997

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Haley & Aldrich, Inc.
465 Medford Street
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Fax: 617.886.7600
Email: BOS@HaleyAldrich.com

HALEY & ALDRICH

21 July 1999
File No. 74596-000

GPU Nuclear, Inc.
2574 Interstate Drive
Harrisburg, PA 17110

Attention: Mr. James J. Byrne

Subject: Report on Soil Friction Evaluation
Former Saxton Nuclear Experimental Station
Saxton, Pennsylvania

Gentlemen:

Haley & Aldrich, Inc. has been retained by GPU Nuclear, Inc. to conduct a geotechnical engineering evaluation of the available frictional resistance which can be mobilized between the steel containment vessel and the below ground backfill soils which were placed around the vessel during original construction. It is understood that you desire to use at least some of the available soil frictional resistance to aid in resisting ground water induced hydrostatic uplift forces as weight is removed from the structure during decommissioning.

Our work has been divided into two broad tasks:

1. Data collection to define the backfill soils present and to aid in establishing their engineering properties.

2. Geotechnical engineering analyses and recommendations related to frictional resistance based on the data obtained.

Our report entitled "Data Summary Report for Soil Friction Evaluation" dated 5 May 1999 summarized the work for Item 1. This report summarizes the work related to the engineering analyses and the recommended soil friction resistance value (Item 2). This report incorporates appropriate comments relating to the GPU Nuclear review of our 12 May 1999 draft report.

SOIL FRICTION VALUE

Based on the analyses described herein and our discussions with you, it is our opinion that frictional resistance can be mobilized between the backfill soils and the steel containment vessel. This frictional resistance can be used in your planning to resist hydrostatic uplift forces from ground water during decommissioning. In our opinion up to 191 tons of soil frictional resistance can be considered in stability analyses against uplift.

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Los Angeles California
Manchester New Hampshire
Newark New Jersey
Portland Maine
Rochester New York
San Diego California
San Francisco California
Washington District of Columbia

Our comments follow.

PHYSICAL DIMENSIONS AND SOIL PARAMETERS USED IN ANALYSES

Physical Dimensions and Related Comments

The required 100-year flood level and applicable physical dimensions for use in the analyses are summarized in Table I.

Photographs provided by GPU Nuclear that were taken during construction establish that the containment vessel was constructed within a deep excavation made into bedrock. The photographs indicate that the sides of the rock excavation were approximately vertical, with the excavation radius several feet greater than that of the vessel. While the specific excavation radius is not known, the probable relationship to the containment vessel is shown in Figure 1, for illustrative purposes, based on the photographs.

In summary the vessel is surrounded by a relatively thin annulus of backfill soils below the surface of the rock. Above the bedrock surface, the backfill width is greater because of the sloped excavation that was made within the overburden soils.

Tunnels "ring" the containment vessel around approximately 2/3s of its circumference. In general these tunnels extend in an outward radial direction from the vessel wall to distances greater than the annulus width within the bedrock portion of the former excavation. Additionally the tunnels are shown on construction drawings to be supported by both steel columns, which bear on the saddle, and by footings, which bear on the bedrock outside the excavation limits. In summary the tunnels are not supported by the backfill soils. Thus, neither the weight of the tunnels nor the weight of soil backfill placed adjacent to the outer tunnel walls (see Zone A Figure 1) contributes to vertical stress (and hence frictional resistance) within the backfill annulus. Accordingly the vertical effective stress is zero within the backfill soils (immediately adjacent to the vessel) at El. 804, the assumed bottom of the tunnel slab.

The radiation shield is present over the remaining 1/3 of the vessel circumference. As noted in Figure 1 the shield is narrower than the tunnels. It is supported by short diagonal columns bearing on the rock. The weight of the shield similarly does not contribute to vertical stress within the backfill annulus. However, because of its narrow radial width, elastic stress distribution theory has been used to estimate the contribution to horizontal stress within the annulus (and hence frictional resistance) from the backfill soils placed against the radiation shield (i.e., similar to surcharge loading acting at El. 804). The backfill soils in Zone B, Figure 1, have been determined to provide a small increment of horizontal stress (and hence frictional resistance) within the upper portions of the backfill below El. 804 (please see attachments to Table III, including Sheets 1, 1A and 1B). Once again, at the skin of the vessel, the vertical and thus horizontal effective stress below the bottom of the radiation shield at El. 804 is zero.

Discussions were held with GPU Nuclear staff on whether or not frictional resistance could be assumed between the vessel skin and the tunnels and between the vessel skin and the radiation shield. In both cases uncertainties exist concerning the present capacity of any interface or connections. Consequently, at present it has been agreed to ignore all tunnel and shield weight from the uplift resistance calculations and to also ignore any frictional forces that might be mobilized between the vessel skin and these units.

Thus the maximum recommended frictional force noted earlier is derived from frictional stresses calculated within the backfill soils at the soil-vessel interface from El. 804 downward to the top of the saddle.

Soil Parameters

The soil parameters used in the friction analyses are summarized in Table II. These parameters are based on observations made from the test borings, laboratory test results summarized in our 5 May 1999 Data Summary Report, and engineering judgement based on experience and the literature.

Based on visual classifications, the laboratory grain size distribution test results and Atterberg Limit test results, the backfill material was classified as "Silty Coarse to Fine Sand with some gravel and little clay" between the depths of 9 ft to 21 ft; "Sandy Silt with little clay and trace fine gravel" from 21 ft to 29 ft; and "Silty Medium to Fine Sand with little clay, gravel and trace of coarse sand" from 29 ft to 35 ft. The saturated unit weight and the corresponding buoyant weight for the in-place backfill material were assigned as 110 pcf and 47.6 pcf, respectively. It is our judgement that the backfill material was not systematically compacted in lifts. This is indicated by the very low Standard Penetration Test (SPT) blow count (N) values obtained in the test boring.

The angle of internal friction for the backfill soil was assigned as 26 degrees. This is primarily based on the low SPT-N data. In relating SPT-N values to the angle of internal friction value, we made use of the empirical correlations published by Terzaghi and Peck (1967); Peck, Hansen and Thornburn (1974), and Schmertmann (1975), which are reproduced in Appendix A.

Finally, the value of 13 degrees was assigned for the friction angle which could be mobilized at the interface of the backfill and the steel vessel wall. This value is based on the Department of the Navy, Design Manual 7.1, Table 1 (page 7.2-63), which is also reproduced in Appendix A.

The above soil parameters were assigned as "average" values representing the respective physical properties. Because of the expected spatial variation in the properties as well as the uncertainties inherent in such empirical correlations, it is our opinion that the assigned values may vary within a plus or minus 20 percent band (i.e., the "average" values being enveloped between upper bound (plus 20 percent) and lower bound (minus 20 percent) values).

ANALYSES

Calculated hydrostatic stresses, vertical effective stresses and horizontal effective stresses are shown in Figures 2 and 3 for the circumferential portions of the vessel underlying the tunnels and the radiation shield, respectively.

In the case of the Tunnel Section (Figure 2), geostatic vertical effective stresses have been used commencing at El. 804, the bottom of tunnel slab. At the Shield Section (Figure 3), geostatic stresses are similarly used below about El. 785. Above El. 785 the vertical and horizontal effective stress distributions are somewhat larger than geostatic, owing the contribution to vertical stress (or surcharge) from the backfill above El. 804 (Zone B, Figure 1).

Numerical results of the calculations are shown in Table III, and its attachments Sheet 1, 1A and 1B. Relevant equations used are noted.

CONCLUSION

The calculated frictional force in Table III is 239 tons. It is recommended that in uplift stability analyses, only 80 percent of 239 tons, that is 191 tons, be considered as the frictional force resisting uplift. That is, in our opinion, the 20 percent reduction represents a "true lower bound value" consistent with the explanation provided under the section, "Soil Parameters".

Please do not hesitate to contact us if you have any questions.

Sincerely yours,
HALEY & ALDRICH, INC.

Cetin Soydemir/ebh

Cetin Soydemir, Ph.D., P.E.
Vice President

Edward B. Kinner

Edward B. Kinner, Sc.D., P.E.
Principal

Enclosures:
Tables I, II and III (attach. Sheet 1, 1A, and 1B)
Figures 1, 2 and 3
Appendix A

C: Mr. Kenneth Whitmore

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Tables

TABLE I
GEOMETERY AND OTHER DETAILS
SOIL FRICTION EVALUATION
FORMER SAXTON NUCLEAR EXPERIMENT STATION
SAXTON, PENNSYLVANIA

Item	Value Used	Source	Comment
Groundwater Elevation	El. 811	Provided to Haley & Aldrich, Inc. by GPU Nuclear Corp.	100-year flood level
Ground Surface Elevation	El. 811	Drawing D-37794-7	-
Top of Saddle Elevation	El. 773	Drawing D-37757-VI, shows El. 773.17	Test Boring TB-3, top of concrete El. 772.25
Vessel Diameter	50 ft	Drawing D-37757-VI	-
Elevation of Bottom of Tunnel	El. 804	Drawing D-37794-7 (scaled as El. 803.5)	Drawings D37786-II and D-37787-I indicate minor variations in elevation with location; El. 804 used as typical
Elevation of Bottom of Radiation Shield	El. 804	Drawing D-37794-7 (scaled as El. 804)	-
Circumferential Arc Distances Tunnels Radiation Shield	 240 degrees 120 degrees	Drawing D-37780	Drawing indicates: Tunnels = 237.5 degrees Radiation Shield = 122.5 degrees Rounded values were used.

Notes:
1. Elevations are in feet and reference Mean Sea Level Datum (MSL).

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TABLE II
ASSIGNED BACKFILL PHYSICAL AND STRENGTH PARAMETERS
SOIL FRICTION EVALUATION
FORMER SAXTON NUCLEAR EXPERIMENT STATION
SAXTON, PENNSYLVANIA

Item	Assigned Value
Saturated Unit Weight, γ_{sat}	110 pcf
Bouyant Unit Weight, γ'	47.6 pcf
Internal Friction Angle, ϕ'	26 degrees
At-rest Lateral Earth Pressure Coefficient $K_o = 1 - \sin\phi'$	0.56
Interface Friction Angle between Backfill Soil and Steel Vessel $\delta = \phi/2$	13 degrees

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TABLE III
CALCULATION OF SIDE RESISTANCE (FRICTION) AGAINST UPLIFT
FORMER SAXTON NUCLEAR EXPERIMENT STATION
SAXTON, PENNSYLVANIA

				UNDER TUNNEL AREA		UNDER RADIATION SHIELD AREA			
Depth Below Ground Surface z (ft)	Depth Below Tunnel or Radiation Shield z* (ft)	Elevation (ft, MSL)	Hydrostatic Water Pressure[2] u_w (ksf)	Vertical Effective Stress[3] σ_{vo}' (ksf)	Lateral Effective Stress[4] σ_{ho}' (ksf)	Lateral Effective Stress due to Surcharge[5] $\Delta\sigma_{ho}'$ (ksf)	Lateral Effective Stress[6] σ_{ho}' (ksf)	Vertical Segment Δz (ft)	Frictional Force at the Vessel-Backfill Interface[7] ΔP_f (kips)
0	-	811	0.00	-	-	-	-		
7	0	804	0.44	0.00	0.00	0.00	0.00	-	-
11	4	800	0.69	0.19	0.11	0.12	0.23	4	11
17	10	794	1.06	0.48	0.27	0.06	0.33	6	47
23	16	788	1.44	0.76	0.43	0.02	0.45	6	79
29	22	782	1.81	1.05	0.59	-	0.59	6	111
35	28	776	2.18	1.33	0.75	-	0.75	6	145
38	31	773	2.37	1.48	0.83	-	0.83	3	86
									239 tons

Notes:

1. Values for material parameters selected for the analysis are as follows:

Backfill
- o Total Unit Weight (saturated): γ_t = 110 pcf
- o Submerged Unit Weight (bouyant): γ' = 47.6 pcf
- o Angle of Internal Friction: ϕ = 26 degrees
- o Coefficient of Earth Pressure at rest: $K_o = 1 - \sin\phi$ = 0.56
- o Interface Friction Angle between Vessel and Fill: $\tan\delta$ = 0.231 where δ = 13 degrees
- o Vessel Diameter: D = 50 ft

2. Hydrostatic water pressure calculated as follows: $u_w = (\gamma_{water})(z)$, where γ_{water} = 62.4 pcf. Groundwater level is at ground surface; El. 811.
3. Vertical effective stress under tunnel area calculated as follows: $\sigma_{vo}' = (\gamma')(z^*)$, where $\gamma' = \gamma_t - 62.4$ pcf.
4. Lateral effective stress under tunnel area calculated as follows: $\sigma_{ho}' = (\sigma_{vo}')(K_o)$.
5. See sheets 1 and 1A for determination of lateral stress due to surcharge ($\Delta\sigma_{ho}'$) under radiation shield area.
6. Lateral effective stress under radiation shield area calculated as follows: σ_{ho}' = lateral effective stress under tunnel area + $\Delta\sigma_{ho}'$.
7. Friction force at the vessel-backfill interface calculated as follows: ΔP_f = [(Average of σ_{ho}' over Δz under tunnel area)(⅔)(π)(D) + (Average of σ_{ho}' over Δz under radiation shield area)(⅓)(π)(D)](tanδ)(Δz).
   Note: per Table I - Selected arc length for tunnel = 240°; 240°/360° = ⅔ circumference. Selected arc length for radiation shield = 120°; 120°/360° = ⅓ circumference.

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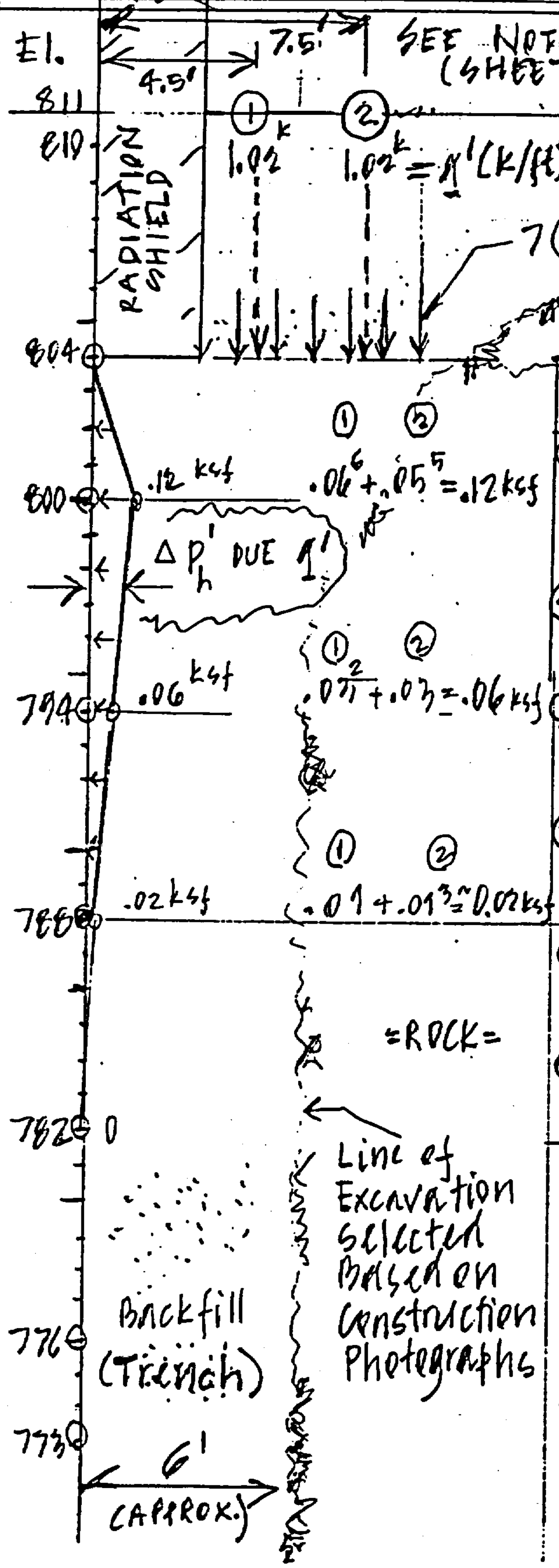
CALCULATIONS

Client	GPU
Project	SAXTON NUCLEAR EXP. STA.
Subject	SIDE FRICTION RESISTANCE
File No.	74596-000
Sheet	1 of Table III
Date	6/07/99
Computed By	CS
Checked By	EBK



H = 16' (SEE NOTE 2) (SHEET 1A) 804 – 788

① $n = (4/16) = 0.25$ — $m = (4.5/16) = 0.28$

$\frac{H}{q'}\,p = 1.0$ — $p = \frac{(1.03)(1.02)}{16} = 0.06^{6}$

② $n = 0.25$ — $m = (7.5/16) = 0.47$

$p = \frac{(0.86)(1.02)}{16} = 0.05^{5}$

① $n = (10/16) = 0.63$ — $m = 0.28$

$p = \frac{(0.45)(1.02)}{16} = .02^{9}$

② $n = 0.63$ — $m = 0.47$

$p = \frac{(.46)(1.02)}{16} = .03$

① $n = (16/16) = 1.0$ — $m = 0.28$

$p = \frac{(.16)(1.02)}{16} = .01^{6}$

② $n = 1.0$ — $m = 0.47$

$p = \frac{(0.2)(1.02)}{16} = .01^{3}$

Reference: For the solution of lateral stress on the vessel load due to "surcharge"

- Peck, R.B., Hanson, W.E. and Thornburn, T.H. Foundation Engineering, Second ed., John Wiley & Sons, 1974, Figure 26.8 (page 424). (See Sheet 1B)

CAL02AFH.FRP 20 November 1997

HALEY & ALDRICH	**CALCULATIONS**	File No.	74596-ODC
		Sheet	1A of Table III
Client	GPU	Date	6/02/99
Project	SAXTON NUCLEAR EXP. STATION	Computed By	CS
Subject	SIDE FRICTION RESISTANCE	Checked By	EJK

NOTES (FOR SHEET 1)

1. The soil overburden which acts as surcharge at El. 804 was idealized in two line loads ① and ②. The line load idealization was made (instead of the uniform distribution) since elastic solution for the line load condition is readily available (as shown on Sheet 1B).

2. The "effective" wall height relative to surcharge loading was considered as 16 ft. since the rock line (boundary) is only at 6 ft. (approximately) from the vessel wall (i.e., the backfill is contained in the trench; Sheet 1). The effect of surcharge loading dissipates with depth faster due to the limited extent of the backfill.

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Sheet 1B of Table III

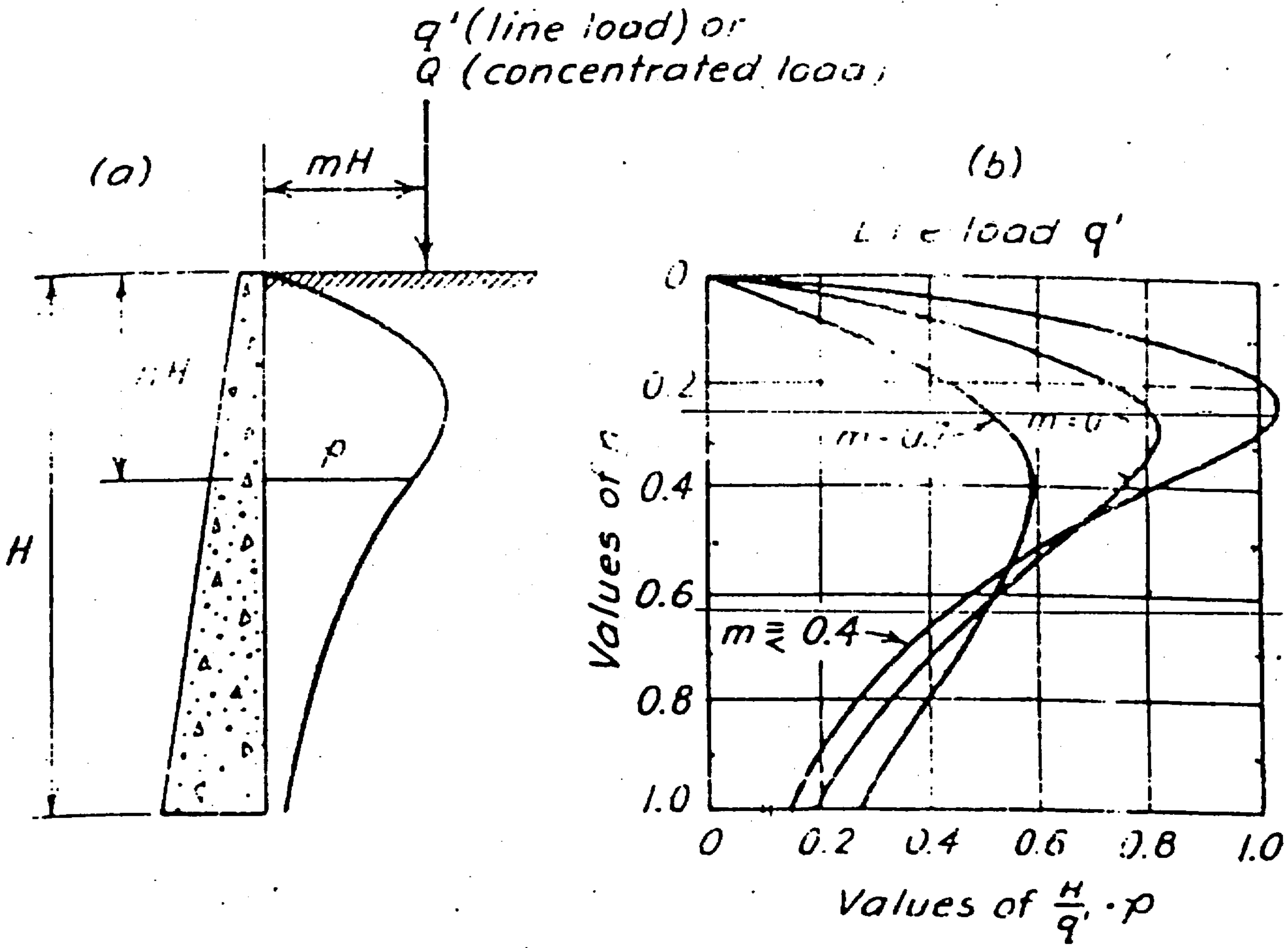
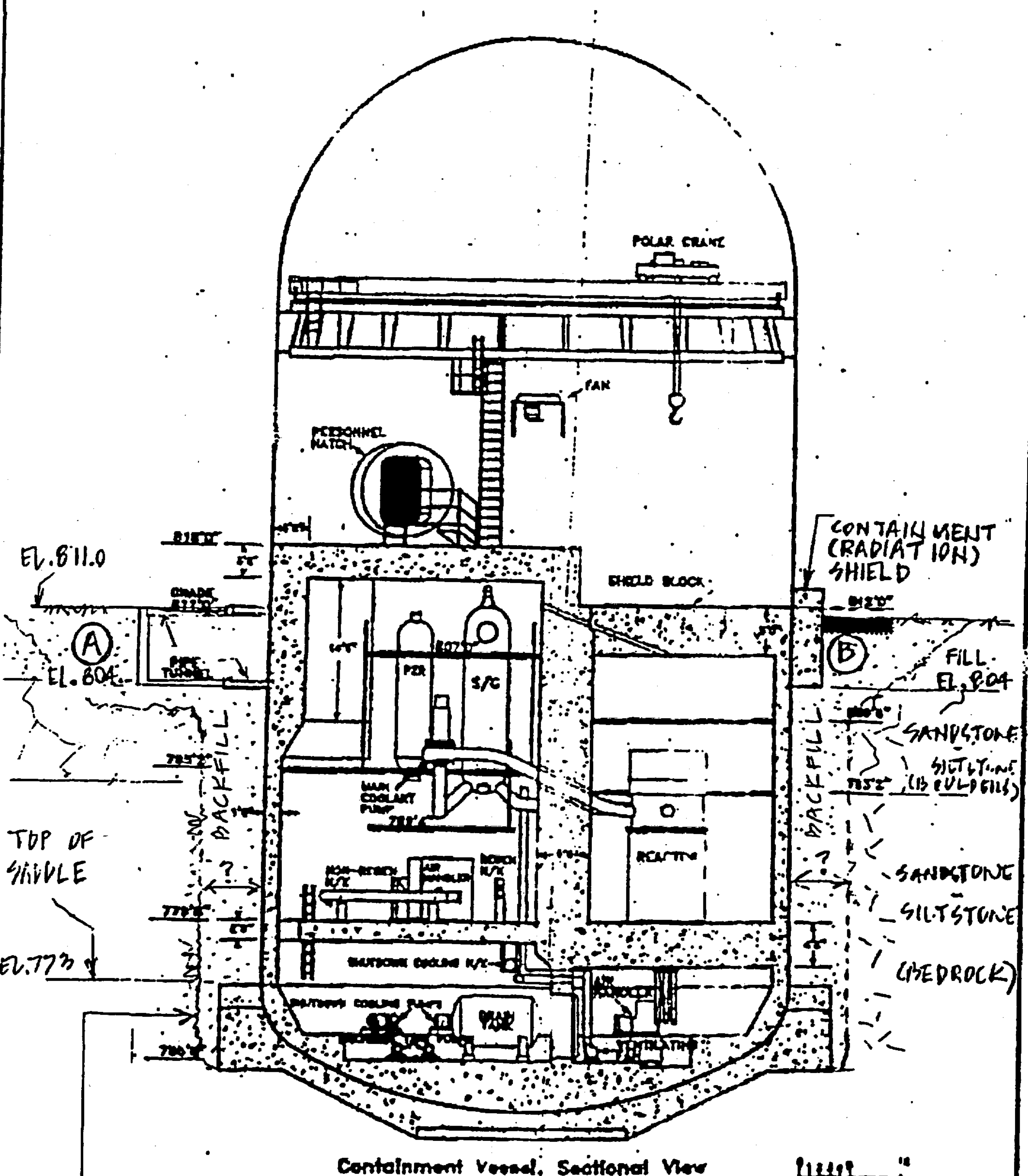


FIGURE 26.8. Earth pressure against vertical wall
centrated load on surface of horizontal backfill. (a) I
(b) Pressures due to live load q per unit of length
(c) Pressures along vertical line on back of wall
application of concentrated load Q.

Charts for Estimating Backfill Pressure. The wedge theories, including the trial wedge method, can be modified with little difficulty

26.5b, if
taken as ⅔
For the

Figures



Containment Vessel, Sectional View (looking West)

SCALE (FEET)

LINE OF EXCAVATION (ASSUMED) FOR CONSTRUCTION

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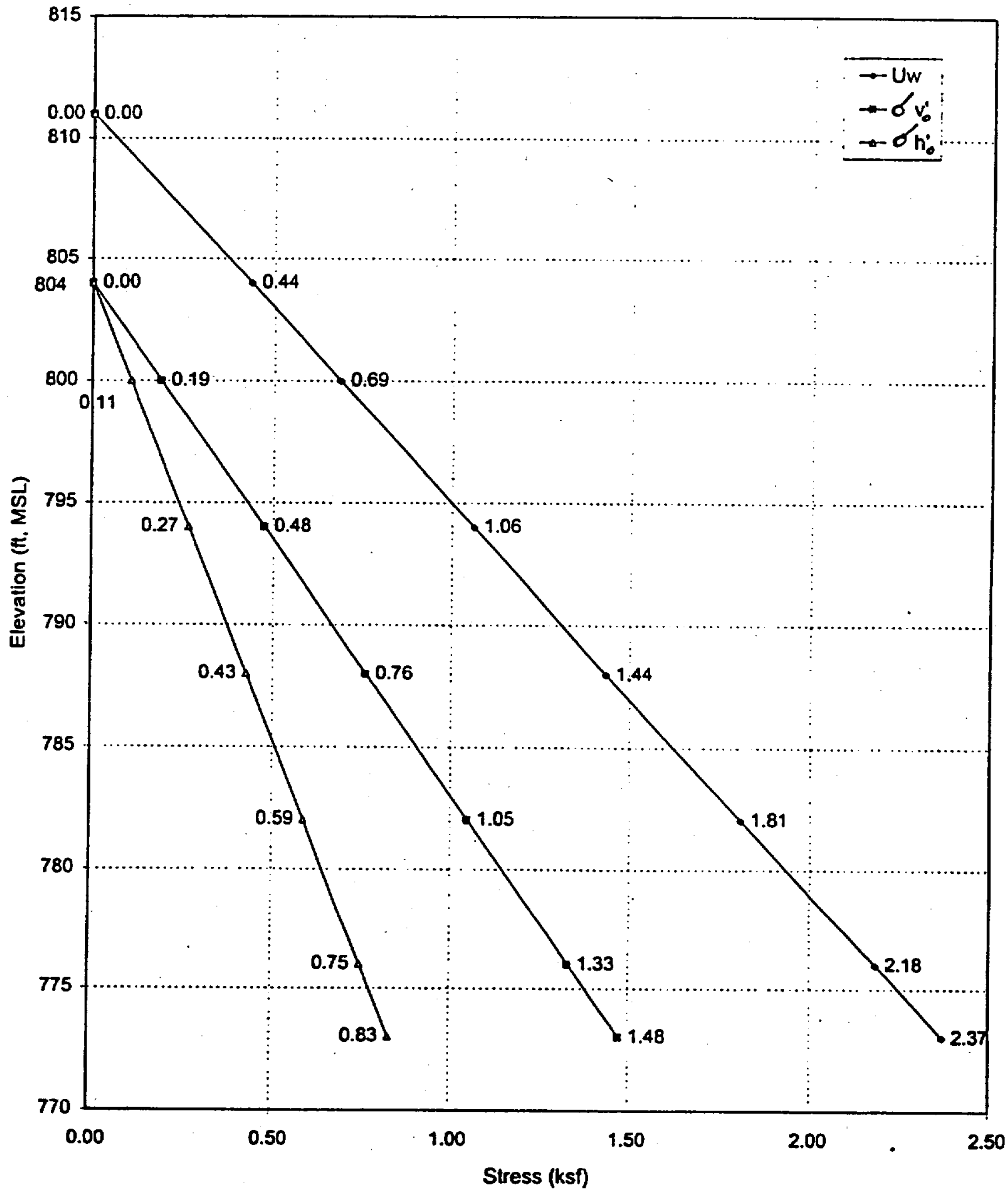
FIGURE 1



Notes:

1. Elevation is in feet and is referenced to Mean Sea Level Datum (MSL).
2. Refer to Table III for definitions of terminology.

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HALEY & ALDRICH

UNDERGROUND ENGINEERING & ENVIRONMENTAL SOLUTIONS

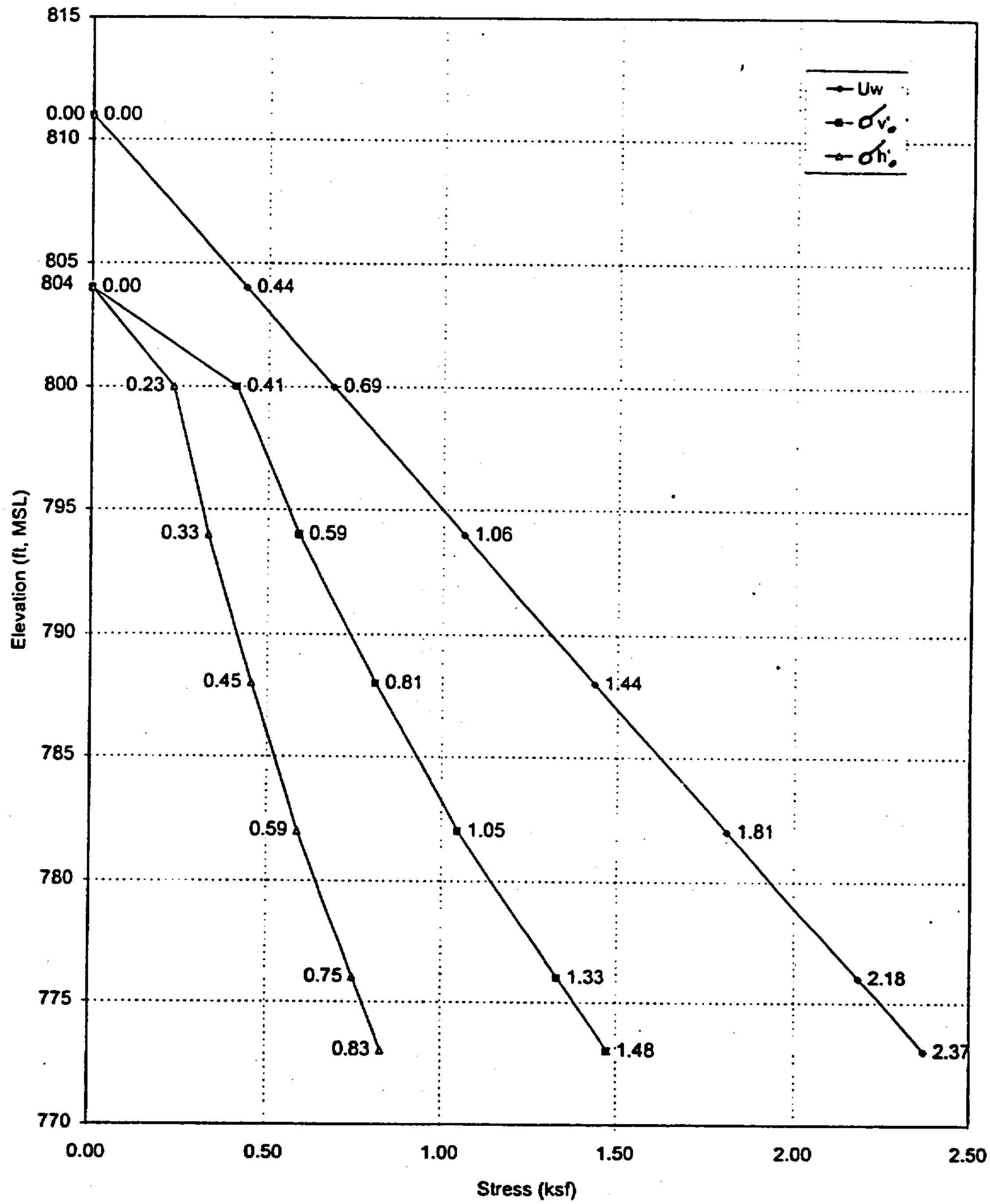
SOIL FRICTION EVALUATION
FORMER SAXTON NUCLEAR EXPERIMENT STATION
SAXTON, PENNSYLVANIA

STRESS DISTRIBUTION ALONG CONTAINMENT VESSEL - TUNNEL SECTION

File No. 74596-000

JULY 1999

FIGURE 2



Notes:

1. Elevation is in feet and is referenced to Mean Sea Level Datum (MSL).
2. Refer to Table III for definitions of terminology.

F:\74596\[LATEP2.XLS]table

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UNDERGROUND ENGINEERING & ENVIRONMENTAL SOLUTIONS

SOIL FRICTION EVALUATION
FORMER SAXTON NUCLEAR EXPERIMENT STATION
SAXTON, PENNSYLVANIA

STRESS DISTRIBUTION ALONG CONTAINMENT VESSEL - SHIELDING BAND

File No. 74596-000

JULY 1999

FIGURE 3

Appendix A

Table

REPRESENTATIVE VALUES OF $\bar{\phi}_{tc}$

$\bar{\phi}_{tc}$: Obtained from Triaxial Compression Tests

Soil Material	$\bar{\phi}_{tc}$ (degrees) Loose	Dense
Sand, round grains, uniform	27.5	34
Sand, angular grains, well-graded	33	45
Sandy gravels	35	50
Silty sand →	27 to 33	30 to 34
Inorganic silt →	27 to 30	30 to 35

Source: Terzaghi and Peck (4), p. 107.

$\phi \cong 26^\circ$ "assigned"

Ref. Terzaghi, K. and Peck, R.B. (1967), Soil Mechanics in Engineering Practice, John Wiley & Sons, Inc., New York, Second Edition.

SHEET A-1

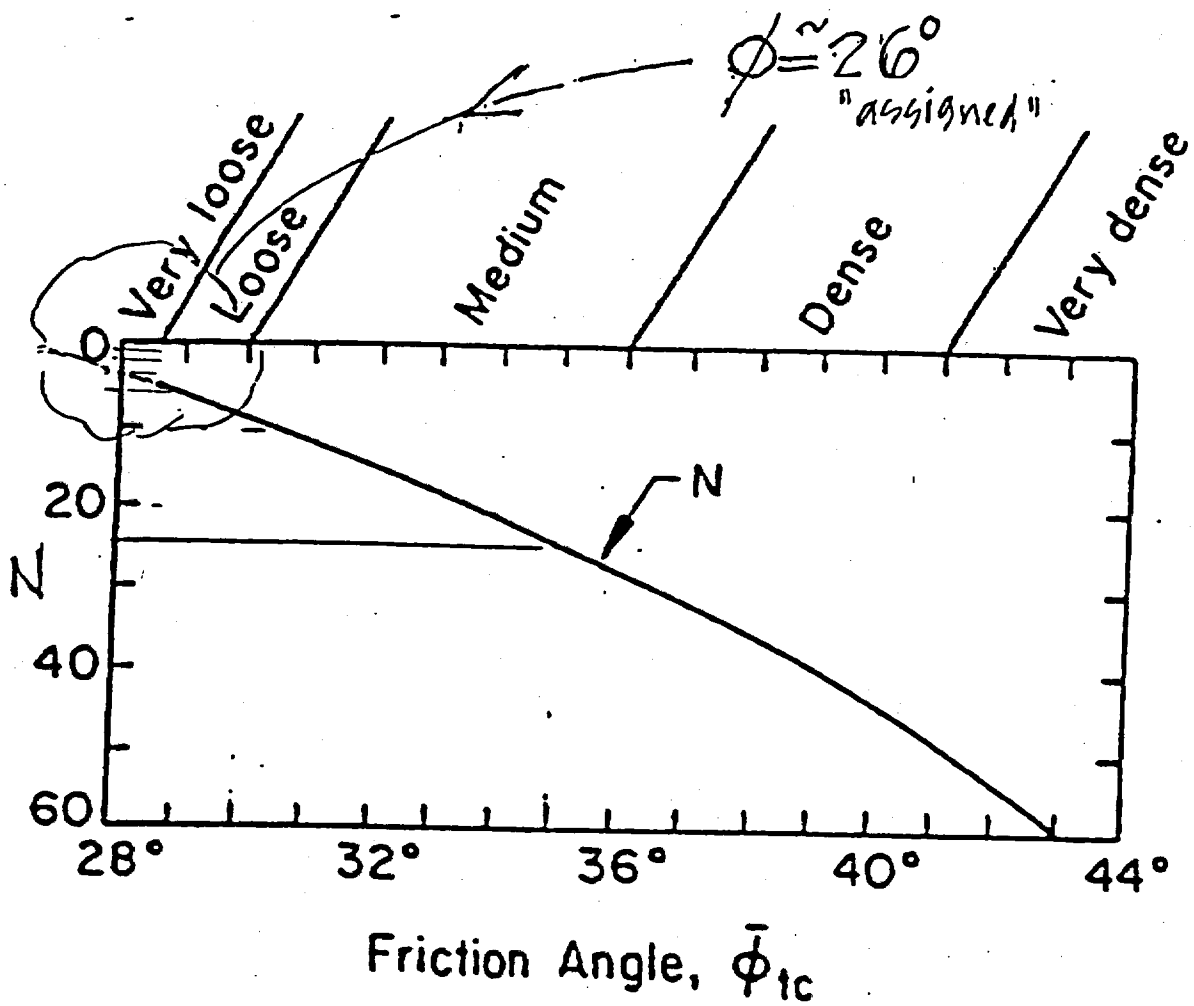

Figure. N versus $\bar{\phi}_{tc}$

Ref. Peck, R.B., Hanson, W.E and Thornburn, T.H., Foundation Engineering, John Wiley & Sons, New York, Second Edition, 1974.

SHEET A-2

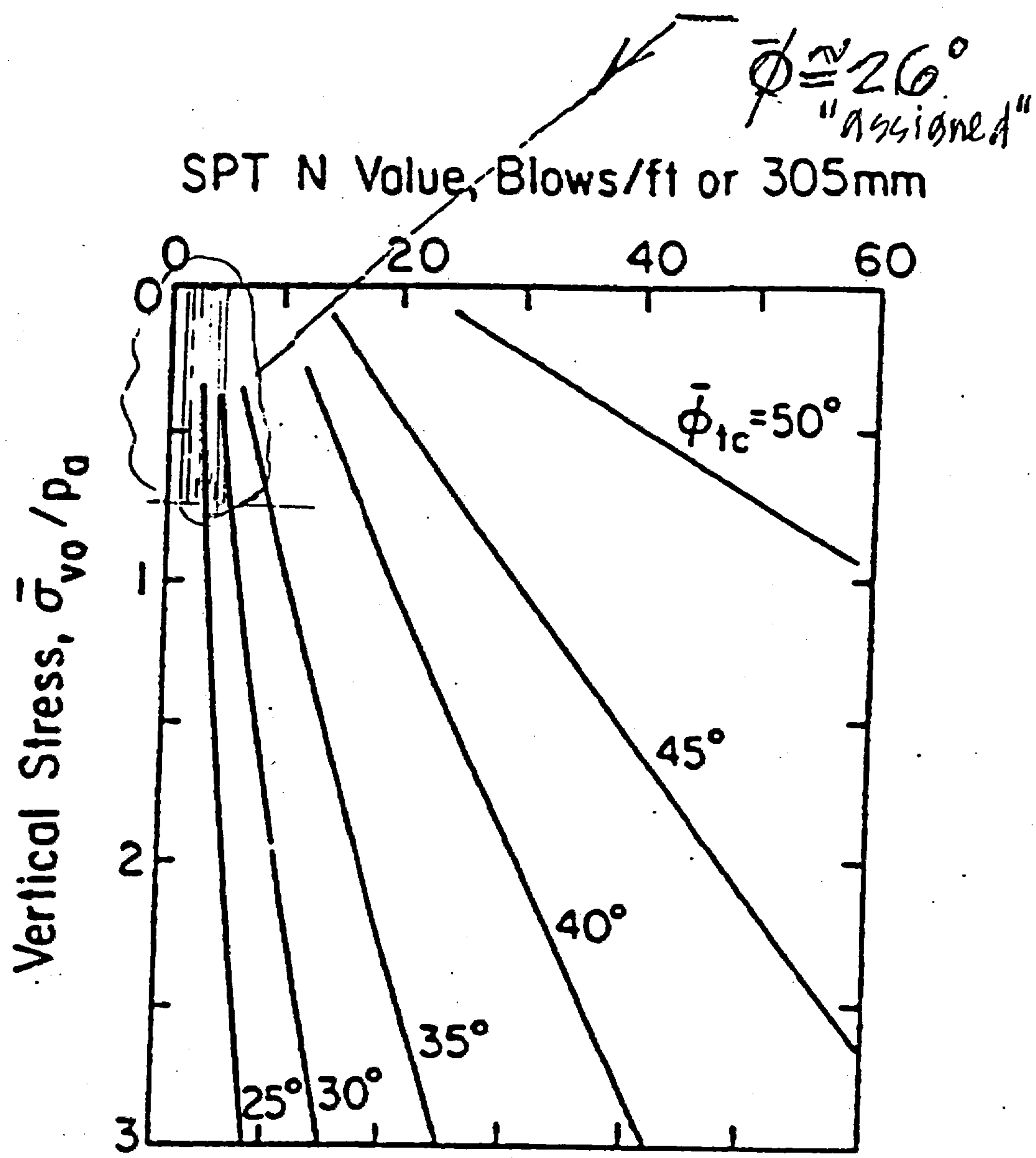

Figure. N versus $\bar{\phi}_{tc}$ and Overburden Stress

Ref. Schmertmann, J.H. (1975), "Measurement of In-situ Shear Strength", Proceedings, ASCE Specialty Conference on In-situ Measurement of Soil Properties, Vol. 2, Raleigh, pp. 57-138.

SHEET A-3

TABLE
Ultimate Friction Factors and Adhesion for Dissimilar Materials

Interface Materials	Friction factor, tan δ	Friction angle, δ degrees
Mass concrete on the following foundation materials:		
Clean sound rock	0.70	35
Clean gravel, gravel-sand mixtures, coarse sand	0.55 to 0.60	29 to 31
Clean fine to medium sand, silty medium to coarse sand, silty or clayey gravel	0.45 to 0.55	24 to 29
Clean fine sand, silty or clayey fine to medium sand	0.35 to 0.45	19 to 24
Fine sandy silt, nonplastic silt	0.30 to 0.35	17 to 19
Very stiff and hard residual or preconsolidated clay	0.40 to 0.50	22 to 26
Medium stiff and stiff clay and silty clay	0.30 to 0.35	17 to 19
(Masonry on foundation materials has same friction factors.)		
Steel sheet piles against the following soils:		
Clean gravel, gravel-sand mixtures, well-graded rock fill with spalls	0.40	22
Clean sand, silty sand-gravel mixture, single size hard rock fill	0.30	17
Silty sand, gravel or sand mixed with silt or clay	0.25	14
Fine sandy silt, nonplastic silt	0.20	11
Formed concrete or concrete sheet piling against the following soils:		
Clean gravel, gravel-sand mixture, well-graded rock fill with spalls	0.40 to 0.50	22 to 26
Clean sand, silty sand-gravel mixture, single size hard rock fill	0.30 to 0.40	17 to 22
Silty sand, gravel or sand mixed with silt or clay	0.30	17
Fine sandy silt, nonplastic silt	0.25	14
Various structural materials:		
Masonry on masonry, igneous and metamorphic rocks:		
Dressed soft rock on dressed soft rock	0.70	35
Dressed hard rock on dressed soft rock	0.65	33
Dressed hard rock on dressed hard rock	0.55	29
Masonry on wood (cross grain)	0.50	26
Steel on steel at sheet pile interlocks	0.30	17

Interface Materials (Cohesion)	Adhesion C_a (psf)
Very soft cohesive soil (0 - 250 psf)	0 - 250
Soft cohesive soil (250 - 500 psf)	250 - 500
Medium stiff cohesive soil (500 - 1000 psf)	500 - 750
Stiff cohesive soil (1000 - 2000 psf)	750 - 950
Very stiff cohesive soil (2000 - 4000 psf)	950 - 1,300

Ref. Dept. of the Navy, "Foundations and Earth Structures - Design Manual 7.2", NAVFAC, 1982.

SHEET A-4

Question 13 Attachment

Saxton Steam Generating Station (SSGS) Footprint Area Sketch

SSGS FOOTPRINT AREA