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DESIGN AND CONSTRUCTION OF THE INTERIM WASTE MANAGEMENT FACILITY - SWSA 6

S. D. Van Hoesen, Engineering Division,
Martin Marietta Energy Systems, Inc.
P. O. Box 2008, Oak Ridge, TN 37830-6338
(615) 574-7264, FTS 624-7264
J. C. Bauman, Lockwood Greene Engineering, Oak Ridge, TN
R. A. Miller, Engineering Division,
Martin Marietta Energy Systems, Inc.
L. C. Williams, Environmental and Health Protection Division
Oak Ridge National Laboratory, Martin Marietta Energy Systems, Inc.
W. C. Yee, Environmental and Health Protection Division,
Oak Ridge National Laboratory, Martin Marietta Energy Systems, Inc.

I. Introduction

The Interim Waste Management Facility (IWMF) is planned to provide disposal capacity for solid low-level radioactive waste (LLW) generated at Oak Ridge National Laboratory (ORNL). The LLW generation rate is approximately 30,000 ft^3 per year and consists of a variety of technological wastes, primarily contaminated with short-half life radionuclides. IWMF construction was initiated in May 1990 and operation is expected to begin by September of 1991 and continue through 1996.

The performance requirements for the IWMF are established in Department of Energy Order 5820.2a, "Radicactive Waste Management." The IWMF design is based on the concept initially utilized in the Tumulus Disposal Demonstration which has been underway at ORNL since 1986. As indicated in Figure 1 the tumulus disposal technology involves several elements including:

- sealing of LLW in structurally stable steel reinforced concrete disposal vaults,
- stacking of the disposal vaults on grade-level steel reinforced concrete disposal pads,
- collection and monitoring of storm and infiltrating water which contacts the disposal vaults,
- placement of low-permeability multi-layer caps over the waste stack, and
- monitoring of near surface and groundwater.

Details of the IWMF site and design are provided in the following sections.

Based on work performed at Oak Ridge Ridge National Laboratory, operated for the U. S. Department of Energy under contract DE-AC05-840R21400 with Martin Marietta Energy Systems, Inc.

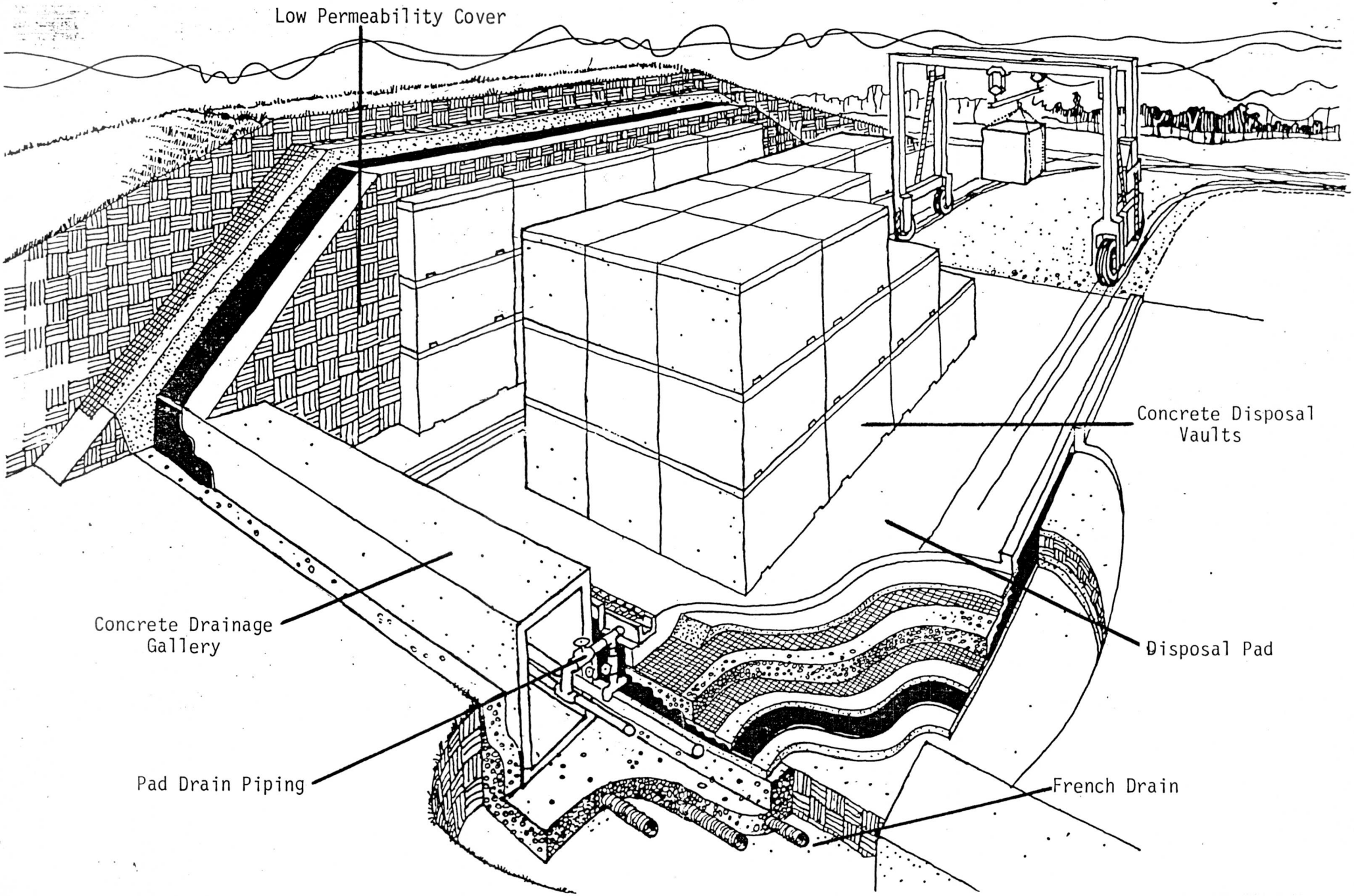

Fig. 1 Tumulus Disposal Technology

II. IWMF Site Description

The IWMF is located in the southwest corner of ORNL Solid Waste Storage Area (SWSA) 6 as indicated in Figure 2. SWSA 6 is an area of approximately 68 acres which slopes to the southwest. The terrain in SWSA 6 consists of elevated ridges and knobs cut by drainage channels, with few level areas except on the tops of ridges and knolls. The IWMF site encompasses and area of approximately 5 acres located at the bottom of a steep knoll. The IWMF area is the only remaining relatively flat area in SWSA 6 which has not been previously used for disposal activities. The site is underlain by weathered shale covered with a thin layer of soil. The groundwater table is relatively high, within a few feet of the surface in some areas. A plan view of the IWMF site is provided in Figure 3 and a cross section of the site is provided in Figure 4.

The hydrologic character of SWSA 6 is highly complex and dominated by stormflow. Most precipitation flows through a shallow near surface zone and enters surface streams within about 200 m. This upper near surface zone, from 0-m to 3-m deep, accounts for about 90% of stormwater flow. The middle zone, ranging in depth from 3 m to 30 m, accounts for approximately 10% of the stormwater flow. The bottom zone, > 30 m in depth, has negligible flow. The hydrologic character of SWSA 6 has resulted in the incorporation of design features in the IWMF to control and monitor surface and subsurface flows, as described in the next section of the paper.

The site geology consists of inclined layers of shale covered with a generally thin layer of soil. The disposal pads will be located on a bench which has been excavated into the native shale material. Geotechnical investigations indicate that the shale has a bearing capacity of approximately 4000 psf.

III. IWMF Design Description

Each of the IWMF design elements is described in the following section.

Surface and groundwater control

Figure 5 shows the surface and groundwater control features that are provided to ensure that the IWMF meets performance requirements. A surface drain is provided on the upslope side of the drainage gallery to intercept any surface flows and drain them to the nearby stream. After closure and construction of the cap this drain will be converted to the outlet for the drainage layer in the cap. The site is graded so that all surface waters are directed for discharge through existing SWSA 6 monitoring station #3.

A french drain is provided along the entire upslope side of the IWMF site under the drainage gallery. The french drain is designed to provide a cutoff for the flow of near surface stormflow during operations, and a means to drain and sample any surface or groundwater which accumulates under the cap. The french drain will be provided with a grab sampling point, and is expected to provide an excellent mechanism to monitor and control groundwater at the same time.

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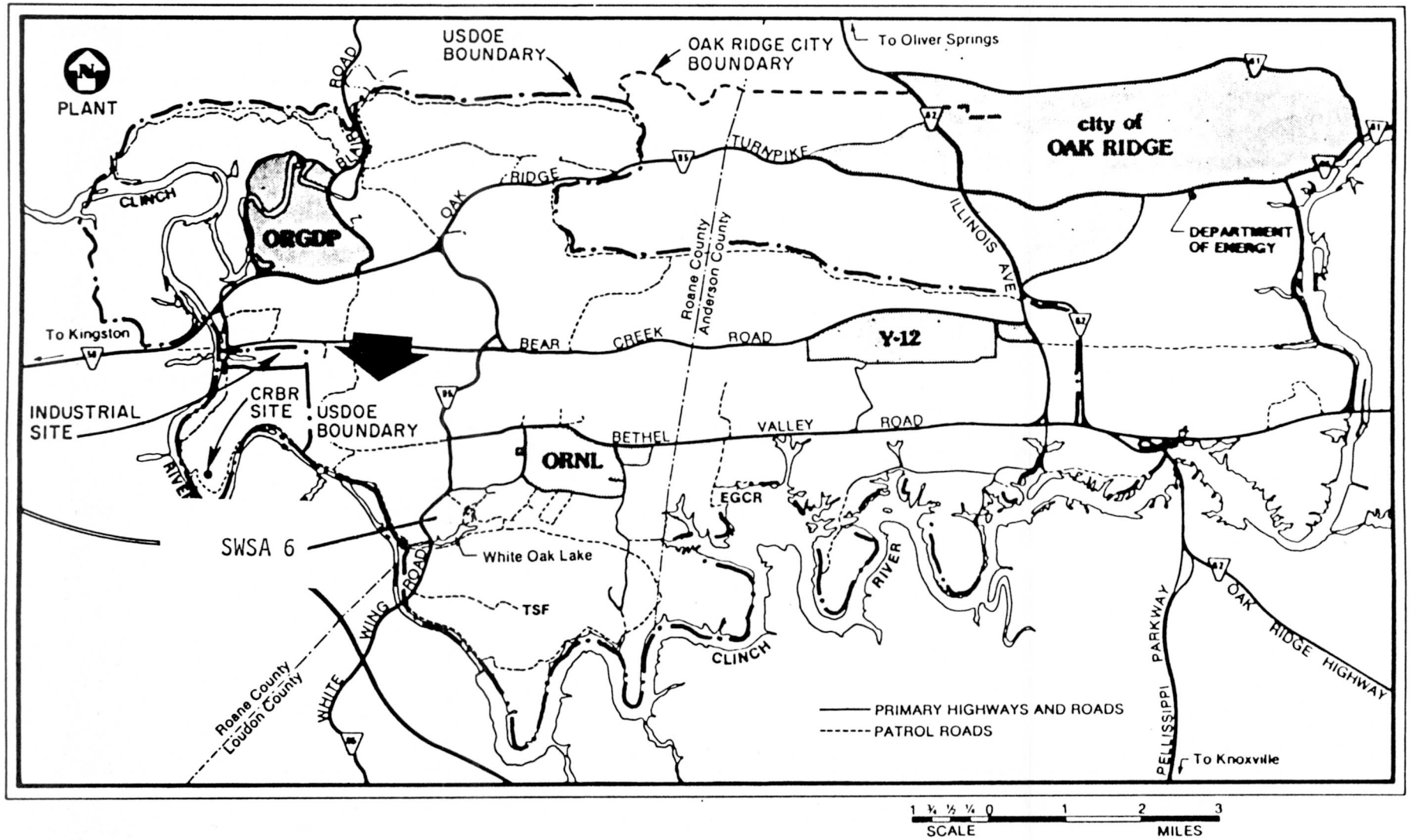

— Fig. 2 Solid Waste Storage Area (SWSA) 6 Location —

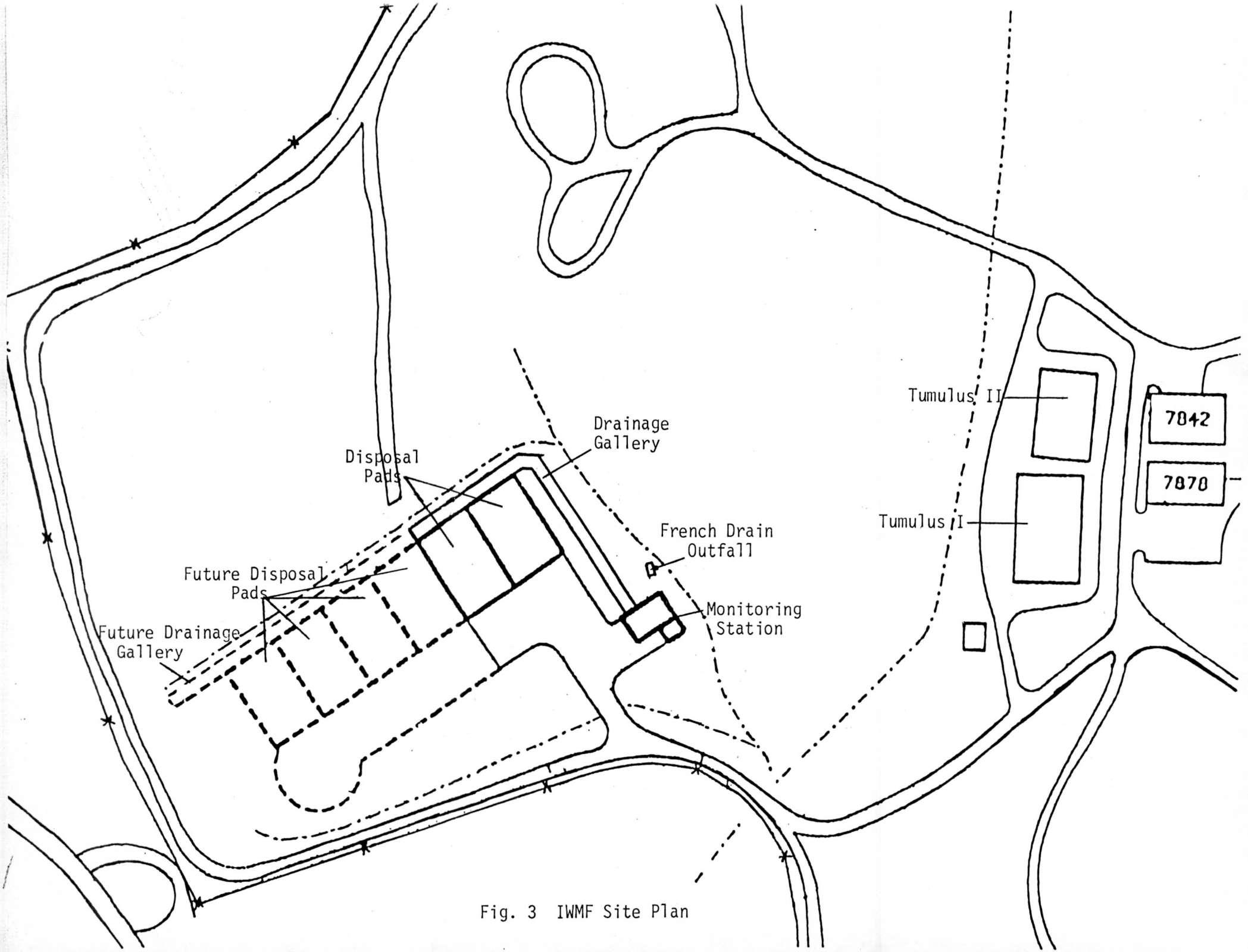

Fig. 3 IWMF Site Plan

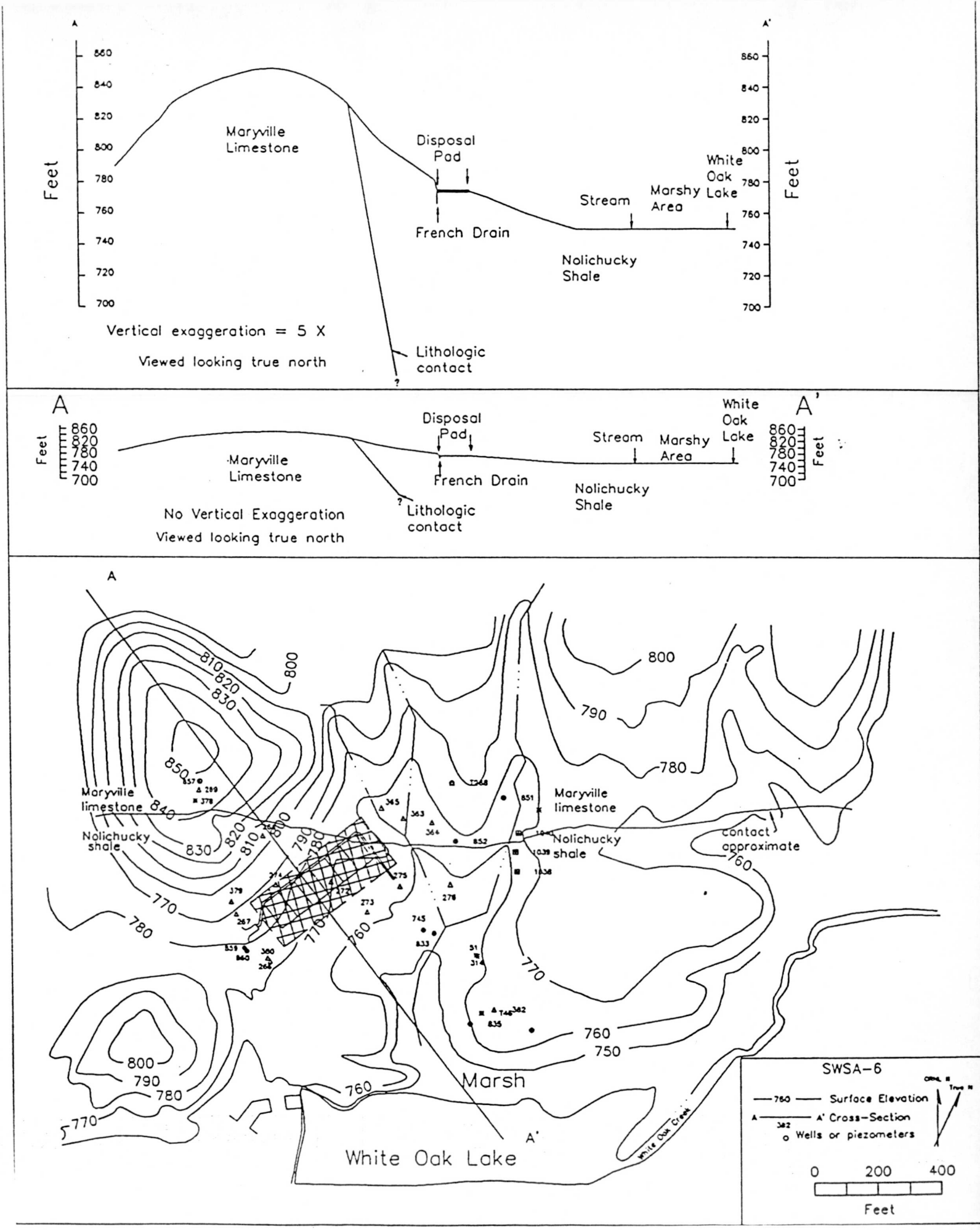

Fig. 4 IWMF Site Cross Section

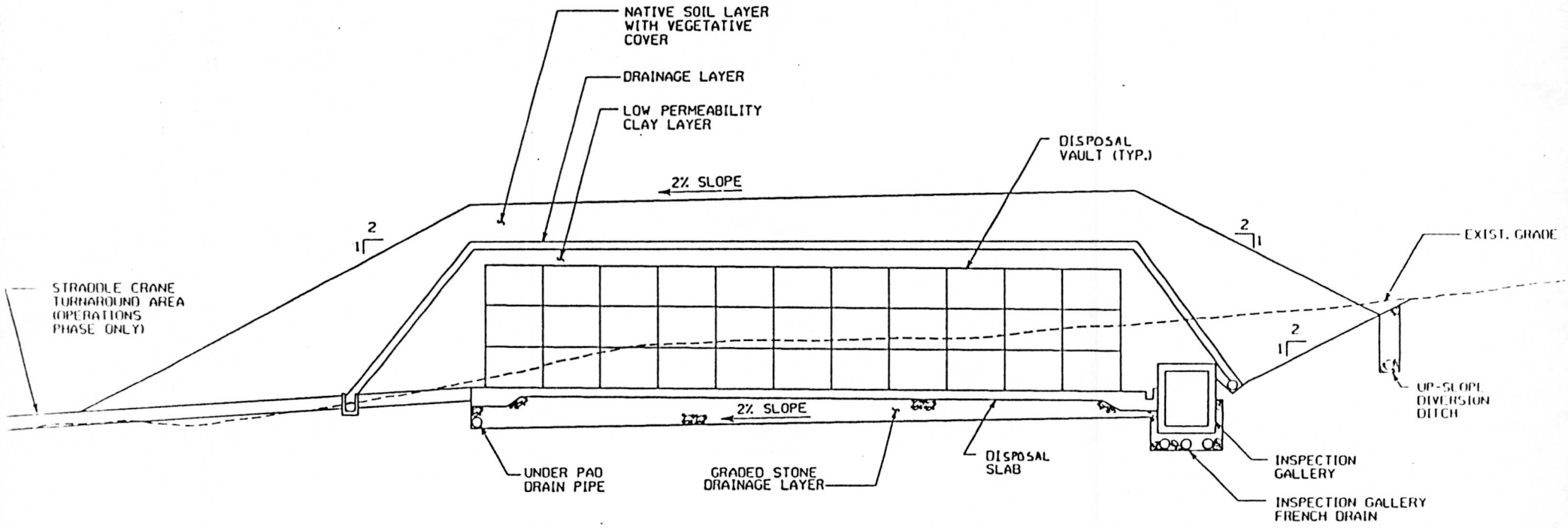

Fig. 5 IWMF Surface and Groundwater Control Features

The french drain consists of two, 12-in. diameter porous concrete pipes bedded in a 4.5-ft thick layer of #4 stone wrapped in filter fabric which drain to the nearby stream. The drainage gallery is placed on top of the gravel.

A second french drain is constructed under the disposal pads. The underpad drain is also designed to provide a means to remove surface infiltration and groundwater which may accumulate under the pads during operation and after closure. The underpad drain empties via a 10-in. diameter porous concrete pipe to a sump in the monitoring station for sampling. The underpad drain is sloped away from the french drain in an attempt to segregate upslope run-on water collected in the french drain from disposal pad area infiltration collected in the underpad drain. The top 6 in. of shale underlying the underpad drain are scarified and compacted to produce a layer with a hydraulic conductivity of approximately 5×10^{-5} cm/sec. This results in a significant difference in hydraulic conductivity compared to the approximately 1×10^{-2} cm/sec conductivity of the #4 stone layer in the underpad drain. A layer of filter fabric is placed on top of the drain layer prior to placement of a 4-in. thick layer of sand which forms the base for the pad concrete pour.

As a part of final cover construction an upslope interceptor ditch is planned to be installed outside the limits of the cover. This ditch is intended to intercept upslope run-on before it goes under the final cover and should reduce the quantity of drainage from the french drain. The ditch will consist of filter wrapped gravel and porous pipe drained to the nearby stream.

A series of standard groundwater monitoring wells will also be placed around the site.

Disposal Pads

The steel reinforced disposal pads are provided for two reasons. First, they form a structurally stable base for the stacked disposal vaults which minimizes the potential for settlement which could degrade final cover performance. The pads also provide a means to collect water which contacts the disposal vaults for monitoring. The pad design is based on requirements for temperature and shrinkage crack control. Epoxy coated reinforcing steel is used to minimize corrosion potential. Concrete design is oriented toward the use of low- water/cement ratio, low-permeability mixes designed to maximize durability.

Each pad is 60-ft wide and 90-ft long. The pads are 15-in. thick except at the end where two 6-in. deep drain channels are located. In this area the pad is 2-ft thick. The pad is sloped to direct any collected water toward the drain channel. A 1-ft wide by 1-ft high curb is located along the perimeter of the pad except for the end opposite the drain channel. The curb is eliminated from the high end of the pad to allow for crane access for disposal vault loading operations. Six pads will eventually be constructed at the IWMF site.

Two concrete mixes are being evaluated for use in the initial IWMF disposal pad construction. The first mix is a cement/fly ash mix which was utilized on the Tumulus II disposal pad. The second mix being considered is a cement/silica fume mix. The silica fume mix is attractive due its very low-permeability and

expected increased durability, although it is approximately 50% higher in material cost. It is planned that a pad will be constructed from each mix to provide comparative information on cost, constructability, and performance.

Pad Drainage and Monitoring Systems

A flow diagram for the systems designed to collect water at the IWMF is provided in Figure 6. The system consists of the storm water collection system, the infiltrating water collection system, the underpad drainage system, two water storage tanks, a truck transfer station, and the monitoring flume and discharge line.

Water is drained from each disposal pad by two floor drains located in the drain channels. The pad flows can be directed to either the storm water collection or infiltrating water collection system. The storm water collection system consists of a 10-in. diameter polyvinyl chloride (PVC) drain line designed to transport water collected from the pad on which disposal vaults are being placed. This line discharges to the stormwater sump in the monitoring station. It is planned that an empty pad will always be in place while loading is occurring on the operating pad. A temporary bypass line will be used to drain the empty pad directly to the creek.

After loading of the operating pad is completed, a temporary cover will be placed over the waste stack to minimize water reaching the pad. As the pads are closed the drains will be valved to discharge to the other drain system, the infiltrating water collection system and the bypass line described previously is then removed. The much lower flows from the closed pads are transported by the 10-in diameter PVC infiltrating water drain line to the infiltrating water sump in the monitoring station.

The stormwater and infiltrating water collection lines and their associated valves and sample ports are located inside of the drainage gallery. The drainage gallery consists of precast epoxy coated reinforced steel concrete utility tunnel sections located along the drain channel end of the disposal pads and connecting to the monitoring station. The drainage gallery entrances are located outside of the projected final cap limits, thus providing access to the gallery for drain system inspection and maintenance after closure. The drainage gallery is provided with heat, ventilation, and lighting.

The underpad drain, stormwater, and infiltrating water sumps are located at the monitoring station. The sumps will normally discharge to the inlet to the monitoring flume. However, each sump is equipped with a valve at its discharge so the sump can be isolated. Sump pumps are provided in each sump which can pump to either of the two 2500 gal storage tanks, or to the truck transfer station. The storage tanks are also equipped with pumps and can be discharged to the truck transfer station or to the flume for final monitoring and discharge.

The flume consists of a calibrated H-flume with water level measurement for flow determination and recording, and a flow proportional sampler. Discharge from the monitoring station is to the surface drainage system leading to discharge from SWSA 6 at monitoring station #3.

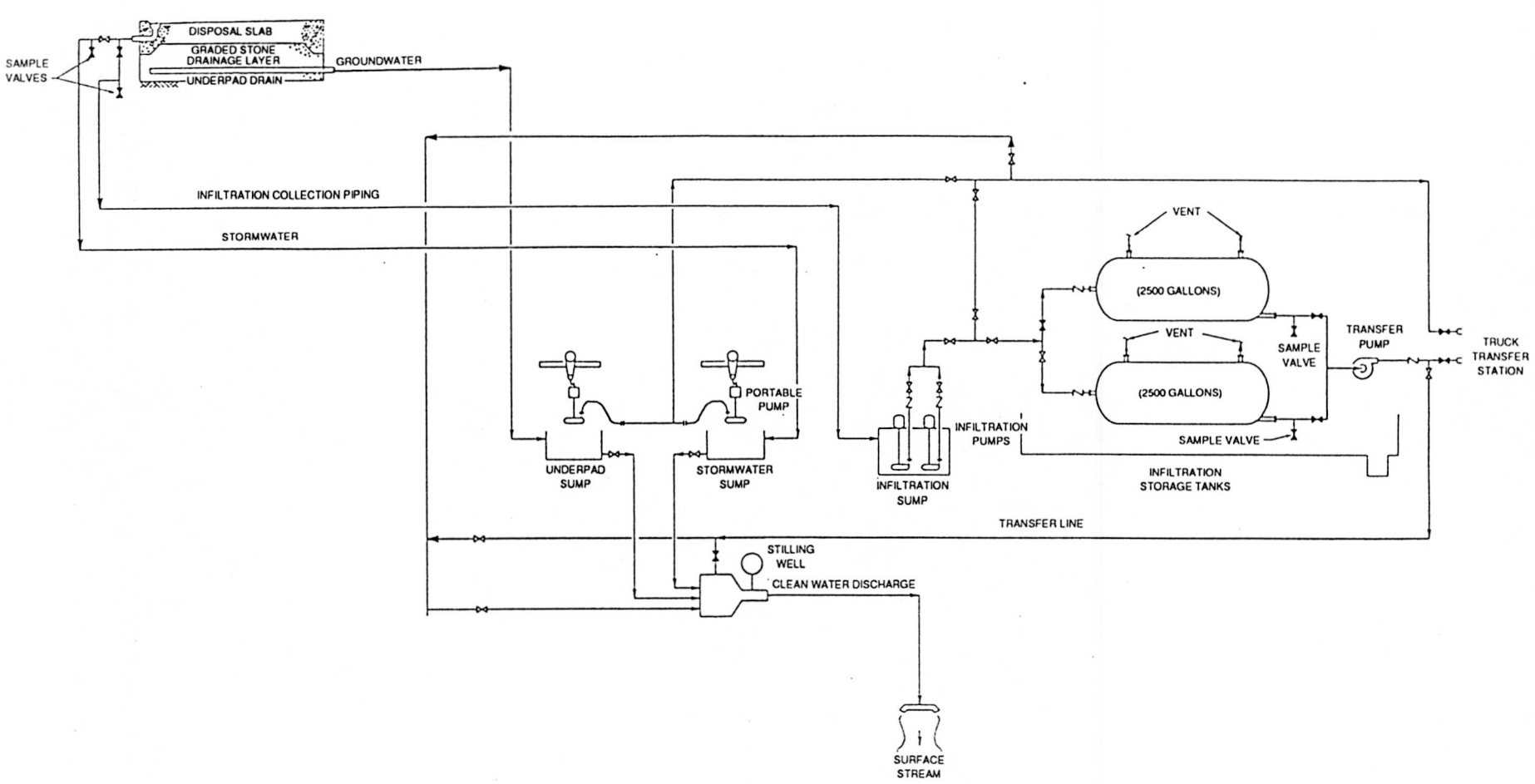

Fig. 6 Interim Waste Management Facility Water Collection Flow Sheet

Disposal Vaults

The LLW to be disposed at the IWMF will have to meet waste acceptance criteria (WAC) established based on DOE and ORNL criteria. For example the waste will have been packaged and certified so that no hazardous wastes, liquids, or transuranic waste (< 100 nci/gm) are present. Limits on radionuclide concentration will be established in conformance with the performance assessment process called for in DOE Order 5820.2a.

The LLW will ordinarily be contained in metal 55 gal drums or B-25 boxes. These contained wastes will be processed at the SWSA 6 Staging Area where the containers will be injected with grout to minimize void space. The stabilized waste will then be sealed in the disposal vault by grouting the annular space between the vault and the waste container. The resulting waste form will have little or no void spaces, and will be structurally stable.

The disposal vault external dimensions are 7-ft 10-in long, 5-ft 7-in wide, and 5-ft high. The internal cavity is 6-ft 8-in. by 4-ft 5-in. by 4-ft 10-in. This results in 7-in. thick walls and a minimum of 2 1/2 in. annular space which is grouted. The vault is equipped with grout injection and vent ports, water drainage channels in the bottom, and lifting fixture attachments at each corner. The vaults weigh 8.5 tons empty, and approximately 13 tons when filled with grouted waste. The vaults are planned to be stacked three high. A total of approximately 300 vaults will be placed on each disposal pad.

Cover

Two cover systems are planned for the IWMF. An interim cover, planned to consist of a low-permeability plastic membrane, will be placed after each disposal pad loading is complete. This system is designed to minimize the quantity of water contacting the disposal vaults prior to construction of the final cover. After all six planned units have been loaded and the interim covers placed, a final low-permeability cover will be placed. The design of the final cover has not yet been determined, but is expected to have an overall permeability of less than 1×10^{-6} cm/sec, and will likely consist of several layers including clay and plastic liners, drainage layers, and vegetative support layers.