TEXAS MUNICIPAL POWER AGENCY
GIBBONS CREEK STEAM ELECTRIC STATION

COMBUSTION WASTE LANDFILL FACILITY

OPERATIONS MANUAL
VOLUME I

B&V PROJECT 15027
B&V FILE 95.0000

I hereby certify that this report was prepared by me or under my direct supervision and that I am a duly Registered Professional Engineer under the laws of the State of Texas.

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ISSUE DATE AND REVISION NO.
091490-1

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1.0 INTRODUCTION

The Texas Municipal Power Agency (TMPA) Gibbons Creek Steam Electric Station (GCSES) Unit 1 is located along Big Branch of Gibbons Creek in Grimes County, Texas. The station will require the development and operation of a new landfill to replace the original combustion waste disposal facility for the disposal of combustion wastes generated by the remaining operating life of the station. The combustion wastes consist of bottom ash, economizer ash, pyrites, fly ash and stabilized flue gas desulfurization (FGD) sludge.

This document describes the development and operation of the new landfill facility that will be used for the permanent disposal of GCSES combustion wastes in accordance with the Texas Water Commission solid waste landfill guidelines. Included in this manual is a description of the following: physical characteristics of the site; combustion waste properties; transportation and placement requirements, landfill stage development; fugitive dust control techniques; and operation and closure procedures.

2.0 SITE DESCRIPTION

2.1 GENERAL SITE LOCATION

The GCSES plant site is located in Grimes County along the Big Branch of Gibbons Creek. The power island is bounded on the east by the Gibbons Creek Reservoir used as the generating station cooling water pond and on the west by Texas Route FM244. The landfill site is located approximately one mile north of the GCSES power island, north and west of the reservoir. The combustion wastes and FGD stabilization facility is located approximately 500 feet east of the generating unit.

The landfill site is connected to the GCSES power island by a haul road adjacent to the GCSES railroad spur. The portion of the haul road on the levee across the Gibbons Creek Reservoir is paved to minimize future maintenance. A new bridge has been constructed across the GCSES cooling water discharge canal.

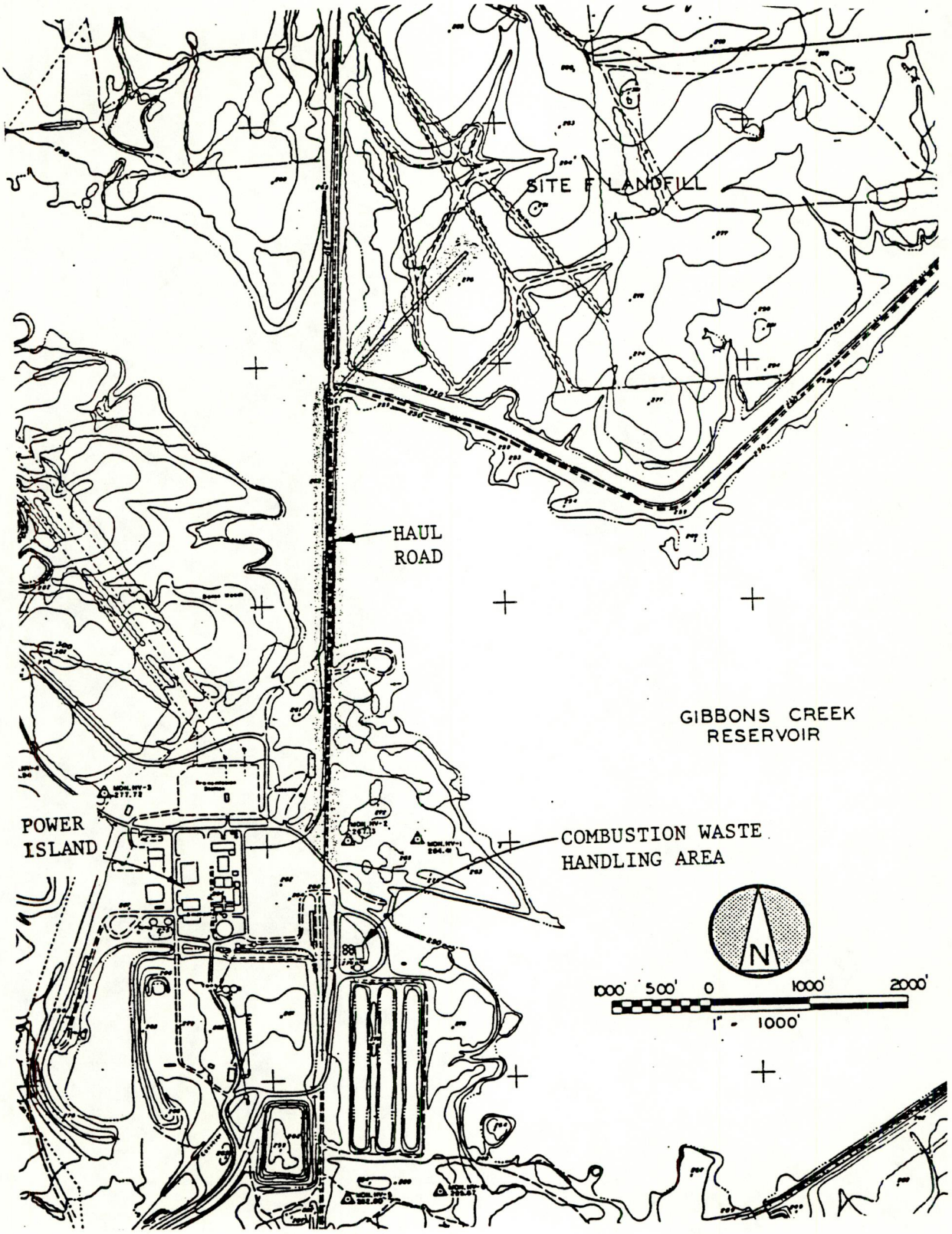
Figure 2-1 provides a general GCSES facility plan location.

2.2 EXISTING COMBUSTION WASTE HANDLING FACILITIES

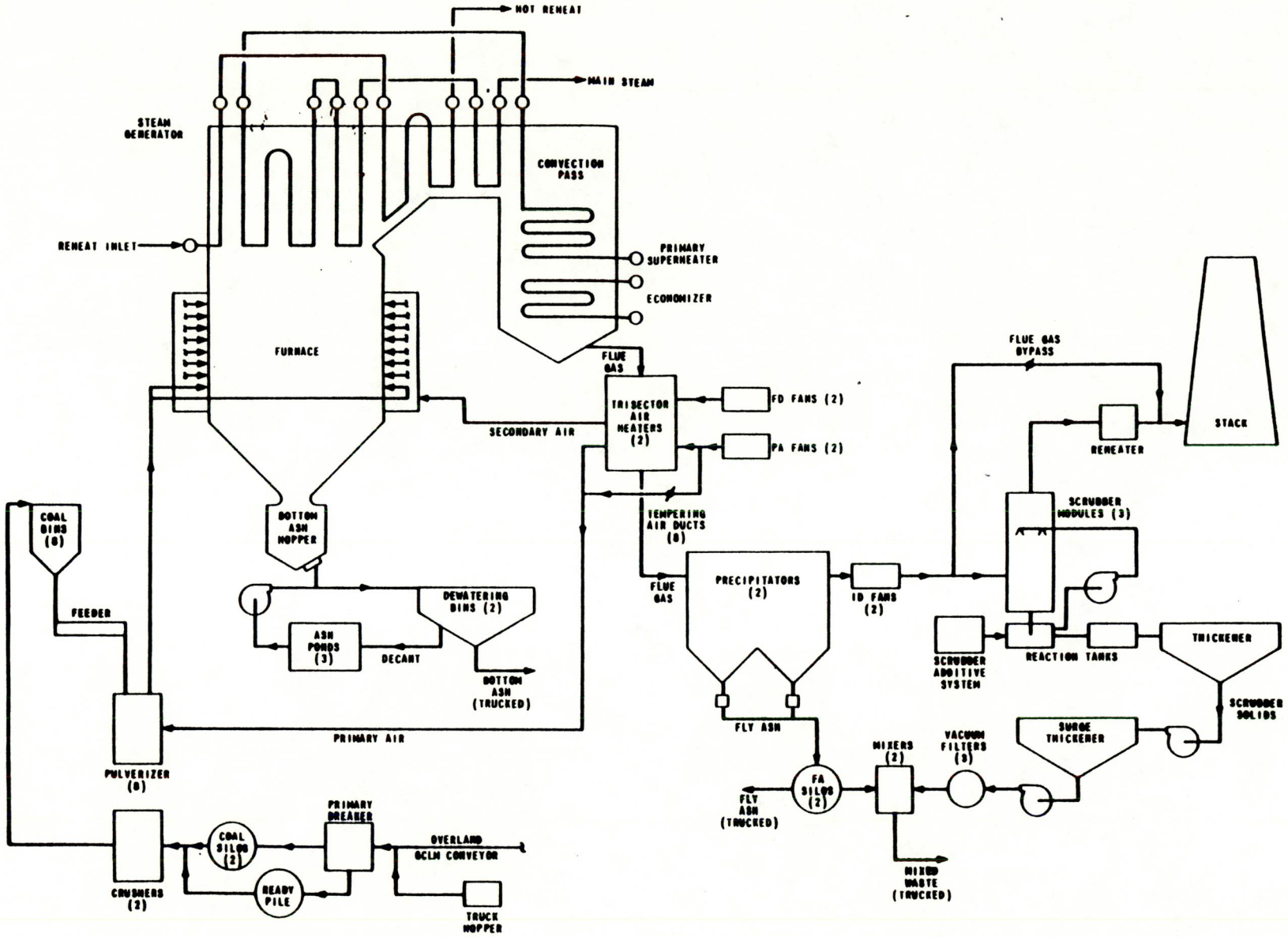
The combustion solids storage and FGD waste stabilization facility of GCSES is designed for truck loading and transport of combustion solids. Bottom ash, economizer ash, and pyrites are pumped to two parallel hydrobins for dewatering. The hydrobins are elevated for truck loading. Fly ash is pneumatically conveyed to two elevated silos adjacent to the hydrobins. The fly ash is either discharged through a hydromixer for truck loading or to the FGD stabilization facility.

FGD sludge is discharged from the scrubber system to thickeners. The thickened solids are pumped to the stabilization facility for further dewatering by vacuum filter as required. The dewatered FGD sludge is mixed with fly ash and conveyed to a radial stacker. The radial stacker has one day of storage capacity at full plant load.

Figure 2-2 provides a simplified flow diagram of GCSES.



GCSES FACILITY PLAN
FIGURE 2-1



SIMPLIFIED FLOW
DIAGRAM OF GCSES
FIGURE 2-2

2.3 LANDFILL SITE DESCRIPTION

2.3.1 Topography

The landfill site is located approximately 1 mile north of GCSES with the Gibbons Creek Reservoir located on the south and east sides and surrounded by private property on the west and north sides. The west side is bounded by the GCSES railroad spur. Approximately half of the area is heavily wooded with the remaining area used as pasture land. Topography is flat to gently undulating and generally slopes south to southwest. The site drains to the Gibbons Creek Reservoir.

2.3.2 Landfill Subsurface Stratigraphy

Fifteen borings were performed in the planned landfill area. Boring depths ranged from 10 feet to 50 feet below ground surface. The overburden subsurface stratigraphy consisted of stratified, heterogeneous layers of clays, silts, and sands of varying thicknesses. The clays and silts consisted of fat clays with very high plasticity and high plastic silts with liquid limits ranging from 55 to 95 percent, plasticity indexes from 35 to 62, and natural moisture contents ranging from 12 to 44 percent. These materials are generally classified as CH, CH-MH, and MH according to the Unified Classification System. The silty sand layers were comprised of very fine grained, poorly graded dense sands with occasional high plasticity clay and silt lenses.

Some occasional sandstone layers were encountered in Borings B-7 and B-12. These layers were 2-3 feet thick and generally occurred between 20 and 30 feet below ground surface. Sandstone bedrock was encountered in Borings B-1 through B-6, B-8, B-10, B-11, B-15, and B-16 at depths ranging from 5 feet to 48 feet from ground surface. The bedrock consisted of two layers, the upper layer being an argillaceous yellowish-tan, fine to medium grained sandstone and the lower layer being an argillaceous, greenish-grey sandstone with lignitic seams and partings. The boring logs and laboratory test results are provided in Appendix C.

2.3.3 Ground Water Conditions

Observation wells were installed in Borings B-7, B-11, B-15, B-16, B-17, and B-18. Water level readings have been recorded by TMPA personnel. Ground water elevations are listed in Table 2-1.

No permanent connected ground water table was apparent from the monitoring of the wells. The water level in Well B-7 appears influenced by the close proximity of Gibbons Creek Reservoir. Piezometer Logs are provided in Appendix C.

2.3.4 Flood Level

The 100-year flood level for the landfill site is controlled by the adjacent Gibbons Creek Reservoir at Elevation 247.0 feet. The emergency spillway crest elevation is at 254.5 feet. All landfill facilities will be constructed above this flood elevation.

TABLE 2-1. GROUND WATER LEVEL SUMMARY

Ground Water Observation Well Number	Ground Elevation feet	Ground Water Elevation				
		March 28, 1988	July 27, 1988	March 10, 1989	June 5, 1989	October 17, 1989
B-7	252.2	245.9	244.28	245.8	246.3	245.5
B-11	266.8	229.8	242.0	Dry	246.6	242.9
B-15	261.5	249.2	248.0	248.7	249.3	249.1
B-16	261.7	249.8	247.14	248.9	249.4	248.5
B-17	292.3	252.4	Dry	Dry	Dry	245.0
B-18	269.1	231.5	253.83	256.6	Dry	255.6

3.0 COMBUSTION WASTES CHARACTERISTICS

A laboratory testing program was undertaken to determine the engineering properties of the various combustion waste materials produced at GCSES. The four general combustion waste materials streams produced at GCSES consist of the following.

- o Fly ash.
- o Bottom ash, pulverizer rejects and economizer ash.
- o Pozzatek cake consisting of a mixture of fly ash and vacuum filter dewatered scrubber thickener cake.
- o Pozzatek bypass consisting of a mixture of fly ash and scrubber thickener underflow. The thickener underflow is not additionally dewatered by the vacuum filter prior to mixing with fly ash and landfill disposal.

3.1 SAMPLING PROGRAM

Three sampling periods were used to achieve variability in the samples of each combustion waste material collected for tests. A sample of each of the four materials was collected on each sampling date. Samples of each material were approximately 150 pounds in weight. Samples of each material type were recovered on each of the following dates by Buchanan/Soil Mechanics, Inc. under the supervision of TMPA.

- o March 21, 1988
- o April 5, 1988
- o April 13, 1988

A total of three samples were obtained for each material, and a total of 12 samples were taken during this program.

3.2 LABORATORY TESTING PROGRAM

The laboratory tests were assigned to determine the compaction, shear strength, consolidation and permeability properties of the combustion

wastes. All tests were performed by Buchanan/Soil Mechanics, Inc. The laboratory tests assigned included the following.

Test Description	Test Designation	Number of Tests Performed
Moisture Content	ASTM D2216	12
Sieve Analysis	ASTM D2217	12
Maximum Density	ASTM D698	12
Consolidation	ASTM D2435	2
Drained Direct Shear	ASTM D3080	24
Permeability	EM-1110-1906 (Falling Head)	4
Permeability	EM-1110-1906 (Constant Head)	3

Natural moisture content, sieve analysis and compaction tests were performed on all samples collected at GCSES. Direct shear tests were performed on each material. Fly ash and pozzatek samples were tested at densities equivalent to 85 to 95 percent of maximum density as determined by ASTM D698 to determine the variability of shear strength with compaction. Permeability tests were performed on selected remolded samples of Pozzatek and bottom ash samples. All testing was performed at the moisture content present at sampling except for the fly ash. The natural moisture content of the collected fly ash was very low because it was sampled dry from the precipitator. Therefore, additional water was added to the compacted samples of fly ash to approximate field moisture content after conditioning.

The results of the laboratory testing program are provided in Appendix D.

4.0 COMBUSTION WASTES DISPOSAL SYSTEM

4.1 GENERAL

The new landfill site is shown on Drawing 15027-1STU-S1007. The landfill will be developed in stages to minimize the active landfill areas. The landfill site will provide a permanent disposal of combustion wastes for GCSES Unit 1 for the remaining plant life which will extend through the year 2012. Combustion waste landfill phase development will include site grading, base liner construction, haul road construction, sedimentation pond construction, and initial containment dike construction. Landfill operation will include combustion waste loading, transportation, placement, compaction and grading, sequential containment dike construction, and run-off and erosion control. The landfilled combustion wastes will be sealed by the final closure operations. Figures B-1 through B-7 in Appendix B show the progressive development of the landfill.

4.2 SITE DEVELOPMENT

The landfill area will be developed in four general phases. Phase I will be developed in two stages of approximately five-year life. The initial Phase I stage will consist of approximately 85 acres of development with an initial 24-foot high containment dike, base and slope liners, and two sedimentation ponds. The subsequent landfill development will be contiguous to the previous development. The landfill development specifications are provided in Appendix A.

4.2.1 Site Preparation

The site will be cleared of all trees, brush, grass, debris, and topsoil to provide a stable surface for further development. The topsoil will be stockpiled in future landfill areas for use as containment erosion protection and for landfill closure operations. Clearing, grubbing, and razing will be performed as provided in Section 2A of the attached specifications. The clay liner, containment dike, haul road, sedimentation ponds and drainage ditch subgrades will be cleared and grubbed.

4.2.2 Site Grading

The landfill site will be graded to conform with the natural site drainage and as shown on the drawings. Borrow areas for earth fill material, developed within the limits of the landfill, will start from the high point in each phase. All site grading and earthworks will be performed in accordance with Section 2B of the attached specifications. The site grading plans are provided on Drawing 15027-1STU-S1007.

4.2.3 Site Drainage

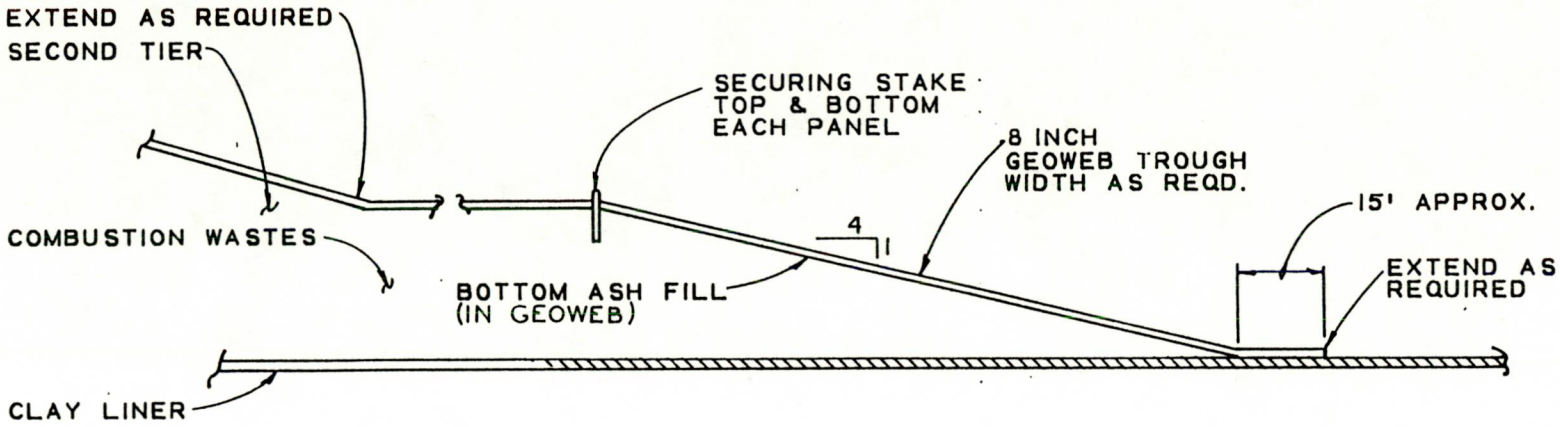
The drainage system of the site development is designed to confine the surface water runoff from each active phase and convey it to the appropriate sedimentation pond. Runoff from completed and closed phases will be diverted to natural drainage. On active landfill slopes where runoff is concentrated from the landfill crest and high velocities exist, temporary geoweb and bottom ash flumes will be used to convey runoff across the active face as shown on Figure 4-1.

The landfill drainage system plan for the entire landfill development is provided on Drawing 15027-1STU-S1007. Sedimentation ponds details and drainage structure sections and details are provided on Drawing 15027-1STU-S1008.

4.2.4 Containment Dikes

Containment dikes will be constructed of excavated earth materials and bottom ash. The bottom ash will be excavated and hauled from temporary bottom ash stockpiles or trucked from the GCSES plant site hydrobins. The earth fills will be constructed from earth materials excavated from the sedimentation pond areas or borrow areas developed in the landfill site. Borrow areas developed within the landfill will be graded to conform with natural site drainage. No borrow area will be excavated more than 2 feet below the natural grade unless approved by the Owner.

Typical containment dike cross sections are provided on Drawing 15027-1STU-S1008. The containment dike alignments are provided on Drawing 15027-1STU-S1007. Drainage pipes may be deleted where bottom ash is not used in



TEMPORARY ACTIVE FACE
DRAINAGE CONTROL DETAILS
FIGURE 4-1

dike construction. Containment dike construction will be performed in accordance with Section 2B of the attached specifications. First tier containment dikes for each phase will be constructed under each phase development contract. Second and third tier dikes will be constructed under the operations contract for each phase. Erosion control will be placed on the exterior dike slopes in accordance with Section 2D.

In locations where containment dikes are constructed over a previously constructed sedimentation pond, the former pond area will be overexcavated a minimum of 12 inches below the existing clay liner. The pond subgrade will be prepared and the pond area filled in accordance with Section 2B of the attached specifications.

4.2.5 Landfill Liners

The entire landfill will be sealed with a clay liner. Liner construction will be sequenced with landfill phase development. The clay liner material will be in accordance with the Texas Water Commission requirements as specified in Section 2B of the attached specifications. The clay liner will be placed and compacted on the prepared subgrade in accordance with Section 2B of the attached specifications. Drawing 15027-1STU-S1008 provides typical liner details. Drawing 15027-1STU-S1007 provides site grading for liner placement. The liner thicknesses noted are minimums. In locations where liners will be constructed over previously constructed sedimentation ponds, the area will be overexcavated and backfilled as described in Subsection 4.2.4.

4.3 LANDFILL OPERATION

The combustion wastes will be transported by truck from the hydrobins, fly ash silos and the conditioned FGD solids stackout to permanent disposal in the landfill. The landfill operation will consist of the following tasks.

- Loading.
- Transportation.

- Placement and compaction.
- Landfill site and haul road maintenance.
- Dust control.

4.3.1 Material Quantities

Table 4-1 provides the anticipated production of combustion wastes for GCSES through 2012. The combustion wastes properties are provided in Section 3.0.

4.3.2 Transportation

Combustion wastes generated at GCSES are temporarily stored approximately 500 feet east of the generating unit. The storage area consists of two hydrobins for bottom ash, economizer ash and pulverizer rejects, two silos for fly ash, and a radial stacker for conditioned FGD sludge. The hydrobins and fly ash silos are elevated for direct truck loading. The conditioned FGD sludge is excavated from the radial stacker stockpiles and loaded into trucks by front end loader.

Combustion wastes will be transported by truck from the temporary combustion waste storage and FGD preparation area to the landfill. Figure 4-2 provides the haul road location. Drawing 15027-1STU-S1003 provides typical haul road sections. The leeve haul road is surfaced with roller compacted concrete for additional durability and to reduce maintenance requirements.

The bridge spanning the cooling water discharge canal is designed for a 200 ton gross weight truck with a maximum axle load of 238,000 pounds and a dual wheel load of 119,000 pounds. Only one-way traffic will be allowed on the bridge and levee. The maximum allowed speed of the haul trucks on the bridge and all levee haul road curves is 30 miles per hour. The maximum truck speed is 30 miles per hour. The maximum allowed speed of the haul trucks on the power island area and FGD preparation area is 20 miles per hour.

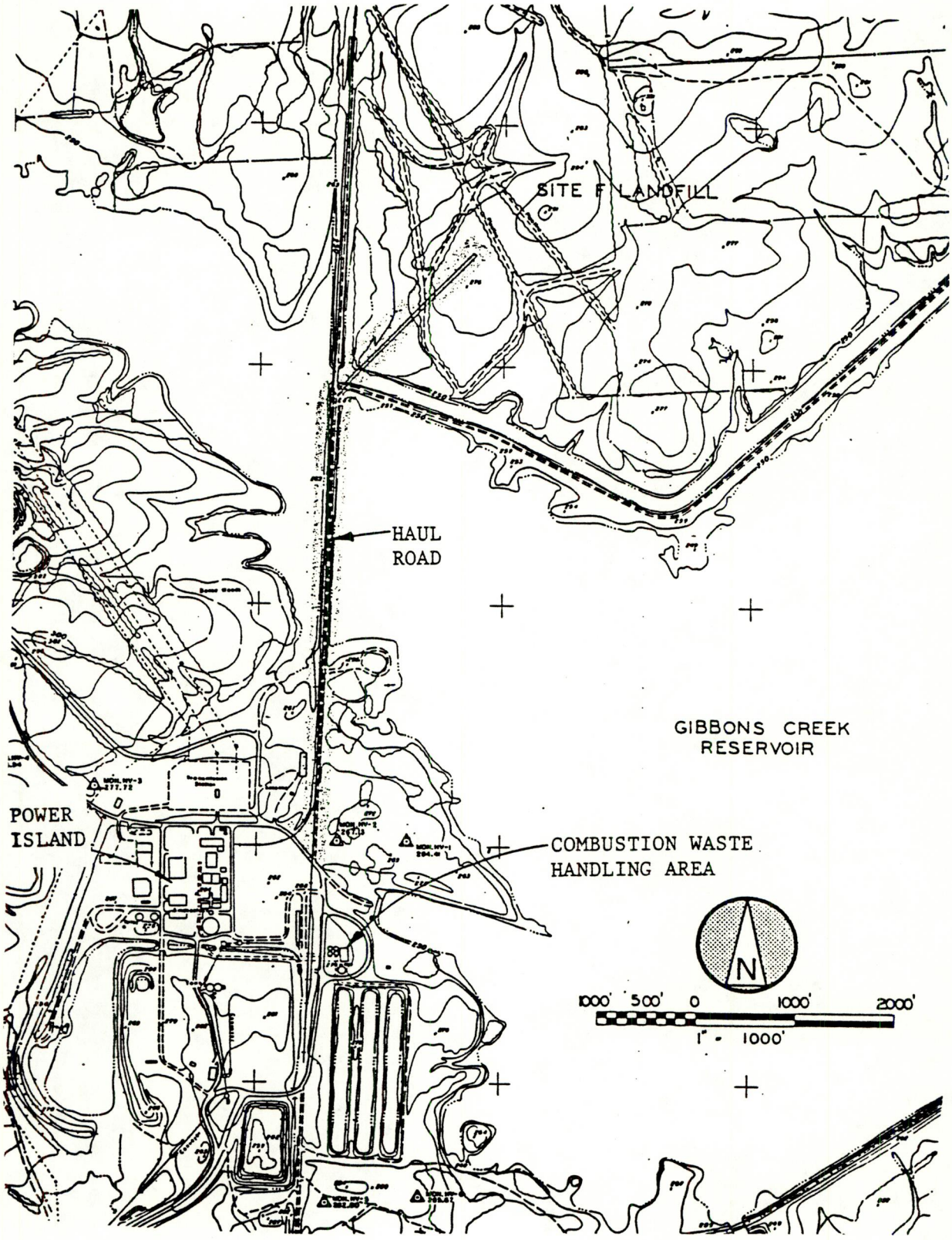
All trucks shall limit their load to prevent spillage over the sides of the beds. The tailgates of all trucks shall be equipped with suitable seals to prevent loss of material through tailgates. All trucks shall be

TABLE 4-1. COMBUSTION WASTE LANDFILL QUANTITIES

Period	Landfill Quantities, 1,000 tpy				
	Bottom Ash	Fly Ash	Scrubber Solids	Pulverizer Rejects	Total
5/90-12/90	161	299	96	10	566
1/91-12/92	254	471	186	16	927
1/93-12/93	278	517	184	17	996
1/94-12/96	204	378	172	15	769
1/97-7/99	236	439	181	16	872
7/99-12/06	194	361	188	16	759
1/07-9/08	227	421	197	16	861
9/08-12/10	211	391	193	16	811
1/11-12/12	162	300	179	15	656
Average Annual Requirements					
1/91-12/12	220	410	185	16	831
Beyond 12/12	162	300	179	15	656

Average Daily Requirement

Period	Landfill Quantities tons/day
1/91-12/92	3,552
1/93-12/93	3,816
1/94-12/96	2,946
1/97-7/99	3,341
7/99-12/06	2,908
1/02-9/08	3,299
9/08-12/10	3,107
1/11-12/12	2,513
Average 1/91-12/12	3,185



LANDFILL HAUL ROAD LAYOUT
FIGURE 4-2

TMPA 080989-0

washed as required to minimize tracking of material from combustion waste handling areas to the remainder of the site.

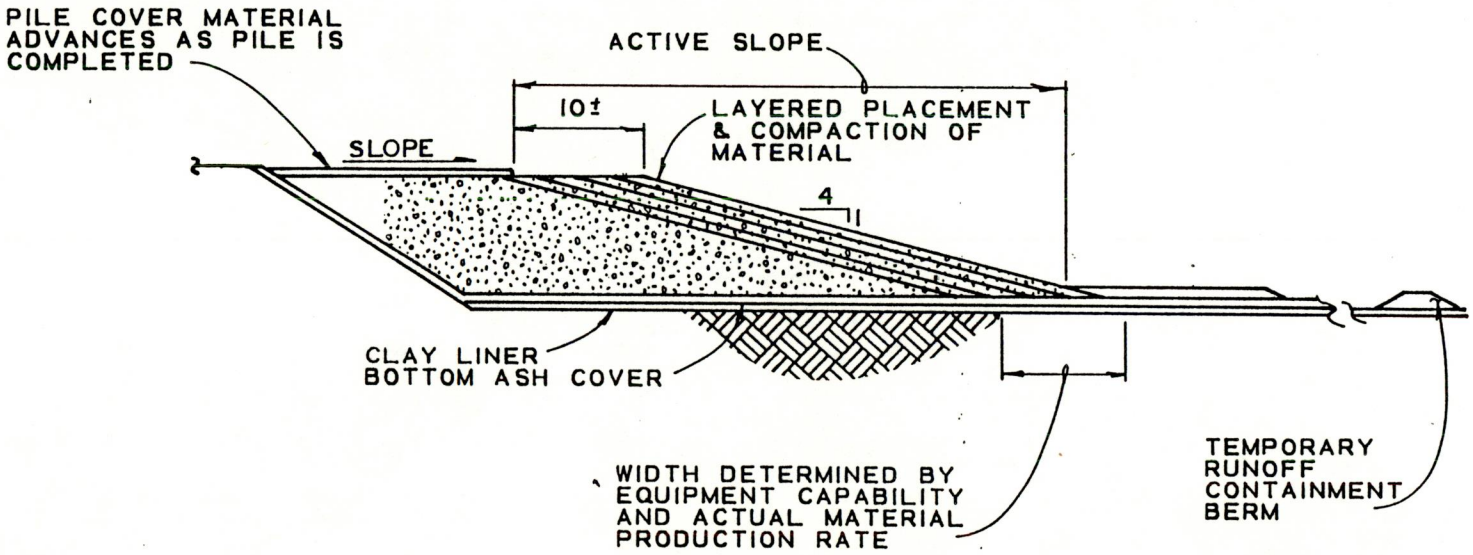
Combustion wastes transported from the plant site will be delivered to the material handling area at the base of the active landfill face. The trucks will travel only on haul roads or previously placed combustion wastes. At no time will they traverse or disturb landfill clay liners or drainage structures. Temporary landfill haul roads will be constructed of earth fills or bottom ash placed and compacted over the clay liners as the landfill is developed. Bottom ash may be stored separately in areas selected by the Owner.

4.3.3 Placement and Compaction

Placement operations will be sequenced to fit the overall staged development of the landfill, the plant solids production rate, and the combustion waste properties. The landfill operation plan is based on placing and compacting the solids to maintain stability and drainage, and to minimize dust generation and truck access problems. The active area of combustion waste placement is minimized.

To provide maximum compaction while minimizing the area of the active face to reduce fugitive dust development, the overall development of the fill will be based on progressive placement of solids in 6- to 24-inch thick lifts to maximum fill height of 20 feet on a four horizontal to one vertical slope. To minimize the possibility of standing water and erosion of the combustion wastes, completed portions of the fill will be covered and sloped. Figure 4-3 shows the general plan of waste placement on the active landfill area.

To provide a protective cover for the landfill clay liners and to provide drainage for the combustion wastes, a minimum 24-inch thick layer of bottom ash shall be placed over the clay liner in areas of active combustion waste placement. The first lift of combustion wastes will be started against the initial perimeter dike over the bottom ash liner cover. The initial lift will be constructed by unloading solids at the farthest



LANDFILL SOLIDS PLACEMENT OPERATION
FIGURE 4-3

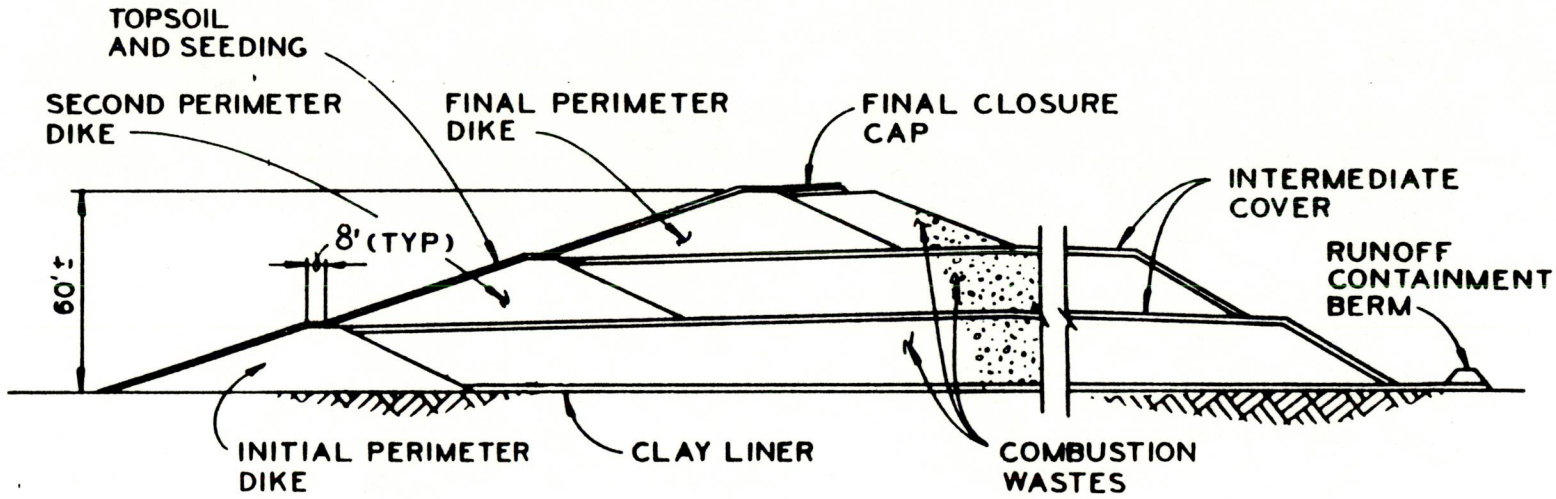
edge of lift development. Solids will then be spread and compacted to extend the lift area.

Once the initial lift is completed, trucks will travel to where the solids are deposited at the active area slope. Bulldozers will spread the solids into lifts ranging from 6 inches to a maximum of 24 inches depending on weather conditions. Placement of the solids will be in thin layers of approximately 6 inches during inclement weather to allow for rapid compaction of the material. Other methods used to place combustion wastes must be approved by the Owner. Following placement, the solids will be compacted to 90 percent of maximum density as determined by ASTM D698. In-place density tests shall be performed twice monthly or as requested by TMPA. Laboratory moisture-density tests in accordance with ASTM D698 shall be performed quarterly or as requested by TMPA on selected combustion wastes. TMPA will be notified 24 hours before in-place density tests are performed. The type of compaction equipment can be determined by testing the effectiveness of different equipment at the proposed grades in the existing landfill. Water trucks will be supplied to control dust generated by winds or by mobile equipment traffic on haul roads and active landfill areas.

Assuming a seven-day landfilling operation per week, the average daily solids placement quantity for Gibbons Creek Lignite Mine (GCLM) lignite derived combustion wastes is approximately 2,275 tons. With a lift thickness of 12 inches, the average daily landfill area used will be approximately 1.8 acres.

The total thickness of the combustion wastes will be uniform and graded to conform with the natural site grades and drainage. The drainage from the active landfill area will follow the natural site grading to the sedimentation ponds and drainage ditches constructed for each stage.

As the landfill active face progresses towards the boundary of the stage development, an intermediate cover of bottom ash or earth will be



FINAL LANDFILL CONFIGURATION
FIGURE 4-4

placed over completed fill areas as shown on Figure 4-3. The intermediate cover is used to minimize fugitive dust and erosion of the landfilled wastes. The area of exposed combustion solids will be between 3 to 5 acres.

When the landfill active face approaches the layer boundary, a new tier of 20-foot high perimeter dikes with the same cross section as the initial dikes will be constructed on top of the initial 20-foot thick landfill to provide additional usable storage volume. The landfilling operation will continue in this new storage area in the same manner as the preceding 20-foot high tier. At the completion of this tier, a third and last 20-foot high tier will be constructed in the same manner. The construction sequence is shown on Figure 4-4. Room will be left between tiers for truck haul roads. Final closure operations of this stage of the landfill will be performed as noted in Section 5.0 as the top tier progresses.

As the landfill area approaches its nominal 60-foot high completed volume, the next stage of the landfill area will be prepared. The construction of base liners, perimeter dikes, and runoff containment berms, ditches, and ponds will be completed prior to filling of the previously developed area. The landfill development will continue with the same operations as Stage I. Additional landfill phase developments will be added as they are required by the volume of combustion wastes generated.

4.4 FUGITIVE DUST CONTROL

The landfill transportation and placement operations will be performed to minimize the generation of fugitive dust. This will be accomplished by the following techniques during combustion solids transportation and landfill operations.

- Transportation
  - -- Moisture conditioning of the solids prior to loading of transport trucks.
  - -- Watering of haul roads.
  - -- Washing of trucks to minimize carry-over of solids.

-- Requiring truck gate seals to minimize spillage of solids on haul roads.

- Landfill Operations
  - -- A program of watering of all active exposed faces of fly ash or pozzatek combustion solids. This shall include water trucks or portable irrigation systems.
  - -- Intermediate and final covers of soil or granular bottom ash materials.
  - -- Development of the landfill in tiers to minimize the length of active landfill area.

4.4.1 Transportation

All combustion solids prior to truck loading will be moisture conditioned to minimize dusting of solids during transport from the combustion solids handling facility to the active landfill face. The transport truck tailgates will be equipped with a fluidic seal to minimize loss of materials during the hauling operation. Periodic washing of the trucks will be performed to prevent buildup of solids on tires and other running gear. These operations will minimize the deposition of combustion solids on haul roads. The haul roads will be periodically watered or broomed as required to suppress dust generation.

4.4.2 Landfill Operation

The landfill will be performed to minimize the size of the active face. The maximum area of exposed combustion wastes will be approximately 5 acres. The combustion solids will be deposited in a moisture conditioned state. Fugitive dust control at the active face will consist of a watering program to maintain the surface of the landfilled solids in a moist state. Since the daily landfill quantity will cover on the order of 1.8 acres, older combustion solids will not be left exposed for an extended period.

The landfill will be developed in approximately 24-foot high tiers to limit the length of the active face. As the tier progresses, the surface of the tier will be covered with granular bottom ash or earth to prevent exposure of the fine grained fly ash and scrubber solids to wind action.

This will limit the active area requiring watering, allowing the watering program to concentrate on the active landfill areas and haul roads. When the landfill active face progresses to the landfill stage boundary, the sloped face of the tier will be covered, thereby encapsulating the fine grained material deposited. The same operation will be performed for each successive tier development.

5.0 LANDFILL CLOSURE/POST CLOSURE

5.1 GENERAL

The filled combustion waste landfill stage will be sealed and reclaimed to a natural state to minimize infiltration of rainfall into the combustion wastes, and to prevent erosion of the landfill. The closure operations will be performed progressively as the final tier of each landfill stage is filled.

5.2 CLOSURE DESCRIPTION

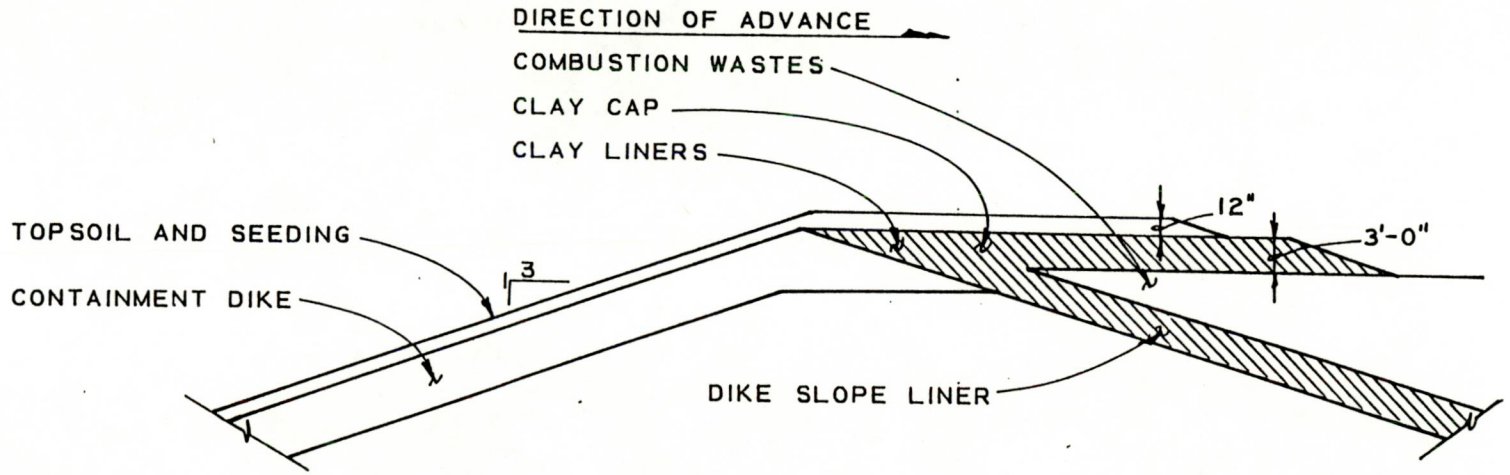
Three major steps occur in the landfill closure.

- The combustion wastes disposed of in the landfill will be graded to direct runoff to the natural drainage pattern that surrounds the landfill. Proper drainage patterns will also minimize the chance for erosion of the reclaimed landfill.
- The landfill will then be sealed to restrict the amount of water that can seep into the landfill.
- The landfill will be reclaimed, in which the landfill area will be covered with topsoil and seeded.

Closure of the landfill will begin when the landfill reaches its final elevation along the boundary of the landfill stage and will continue progressively as the landfill stage is filled. The landfill will be fine graded to conform with the original site drainage patterns. The landfill will be covered with a minimum of 3 feet of compacted clay-rich soil conforming to the Industrial Solid Waste Technical Guideline Number 3 prior to reclaiming the landfill area with topsoil and seeding. Side slopes will have a maximum slope of three horizontal to one vertical to minimize erosion.

The final step in closure of the landfill is reclamation. After the site is appropriately graded and the clay rich cap layer is in place, a 12-inch layer of earth and topsoil will be spread over the clay. Following placement of the topsoil, the landfill area will be seeded with shallow rooted grass in accordance with Section 2D of the attached specifications.

Figure 5-1 presents typical details of the various landfill closure features. Drainage and erosion control systems will be installed in areas of runoff concentration on slopes of the landfill.



LANDFILL CLOSURE DETAIL
FIGURE 5-1

APPENDIX A

SITE DEVELOPMENT SPECIFICATION

Section 2A - CLEARING AND GRUBBING

2A.1 GENERAL. This section covers clearing and grubbing for the access road and construction areas.

All excavations made by grubbing or removal of existing structures which are below indicated final grade shall be backfilled and compacted in accordance with the section titled EARTHWORK.

The Contractor shall obtain all applicable permits prior to the start of work.

Fugitive dust control shall be in accordance with the section titled EARTHWORK. Before clearing work is accepted, any regrowth of vegetation or tree shoots which have grown after initial cutting shall be cut and removed as specified hereinafter. Tree shoots shall be removed to the level specified for tree removal in that area. All regrowth of vegetation shall be mowed and raked. The cleared area at the time of final acceptance shall be completely cleared and grubbed as specified herein and as indicated on the drawings.

2A.2 CLEARING AND GRUBBING. Clearing shall include clearing and removing all trees and stumps within the construction area limits; the cutting and removal of all brush, shrubs, debris, and all vegetation to approximately flush with the ground surface; and the disposal of all cuttings and debris.

Grubbing shall include the removal and disposal of all stumps and roots larger than 2 inches in diameter, including matted roots regardless of size. Grubbing shall extend to a depth of 12 inches below the natural surrounding ground surface.

The Contractor shall not remove or damage trees outside the construction area limits specified to be cleared or grubbed. The Owner may wish to preserve certain trees or groups of trees within the limits of the work outside the clay liner and containment dike area. The Owner will designate the trees which are to be preserved within the clearing limits, and the Contractor shall mark such trees by clearly visible means which will not damage the tree.

Trees left standing shall be adequately protected from permanent damage by construction operations. Equipment utilized in the clearing and grubbing work shall be kept within the specified construction area limits.

2A.2.1 Limits of Work. The limits of the clearing and grubbing under this section shall include all areas of cut or fill within the limits of construction including, but not limited to, the following.

Clearing and grubbing of the areas to be occupied by road construction and combustion waste storage area development

2A.2.2 Site Preparation. All subgrades for permanent construction, including subgrades for fills and embankments, shall be stripped of surface vegetation, sod, debris, and organic topsoil. Surface vegetation shall be removed complete with roots to a depth of 12 inches below the ground surface. Suitable stripped material shall be stockpiled for later use as specified in the section titled EROSION CONTROL.

2A.2.3 Disposal of Waste. Logs, trees, stumps, roots, brush, tree trimmings, and other materials resulting from clearing and grubbing operations shall become the property of the Contractor and shall be entirely removed from the site and disposed of by and at the expense of the Contractor or disposed of in a location acceptable to the Owner. Upon completion of the disposal, the area shall be entirely void of all loose stumps, trimmings, brush, vegetation, and other debris. Open burning is not permitted at the site.

2A.3 EXISTING ROADS. Designated roads which are within the Owner's property limits shall be used as construction roads.

2A.4 EXISTING FENCES. All existing fences within the limit of new construction shall be removed. Removal shall include the complete removal of posts and wire. Metal and wood posts and wire shall be disposed of as specified in the article titled Disposal of Waste unless noted otherwise on the drawings. Post holes shall be filled with tamped earth.

All existing fences outside the limits of construction which are altered during construction shall be restored to their original alignment. Fences which are damaged shall be replaced.

Section 2B - EARTHWORK

2B.1 GENERAL. This section covers general earthwork and shall include the necessary preparation of the construction areas; removal and disposal of all debris; excavation and trenching as required; the handling, storage, transportation, and disposal of all excavated material; preparation of subgrades; pumping and dewatering as necessary or required; protection of adjacent construction; backfilling; pipe embedment; construction of fills and embankments; surfacing and grading; and other appurtenant work.

2B.2 REMOVAL OF WATER. The Contractor shall provide and maintain adequate dewatering equipment to remove and dispose of all surface water entering excavations and other parts of the work. Each excavation shall be kept dry during subgrade preparation and continually thereafter until the construction to be provided therein is completed to the extent that no damage will result.

2B.3 CLASSIFICATION OF EXCAVATED MATERIALS. No classification of excavated materials will be made except for identification purposes. Excavation work shall include the removal and subsequent handling of all materials excavated or otherwise removed in performance of the contract work, regardless of the type, character, composition, or condition thereof.

All rock which cannot be handled and compacted as earth shall be kept separate from other excavated materials and shall not be mixed with backfill, fill, or embankment materials except as specified or directed.

Soil identification shall be in accordance with Table 3 of the Unified Soil Classification System which is bound at the end of this section. Identification and classification shall be based upon visual examination and simple manual tests performed by qualified personnel furnished by the Contractor.

2B.4 FREEZING WEATHER RESTRICTIONS. Backfilling and construction of fills and embankments during freezing weather shall not be done except by permission of the Owner. No earth material shall be placed on frozen surfaces, nor shall frozen materials, snow, or ice be placed in any backfill, fill, or embankment.

2B.5 MAINTENANCE OF TRAFFIC. The Contractor shall conduct his work with as little interference as possible with the Owner's operations and the work of other contractors. Whenever it is necessary to cross, obstruct, or close roads, driveways, parking areas, and walks, the Contractor shall provide and maintain suitable and safe bridges, detours, or other temporary expedients at his own expense. In making open cut road crossings, the Contractor shall not block more than one half of the road at any time.

2B.6 PROTECTION OF UNDERGROUND CONSTRUCTION. The Contractor shall locate, protect, shore, brace, support, and maintain all existing underground pipes, conduits, drains, and other underground construction which may be uncovered or otherwise affected by the work.

2B.7 TESTING. All field and laboratory testing required to determine compliance with the requirements of this section shall be provided by the Contractor. All laboratory testing shall be done by an independent testing laboratory acceptable to the Owner and retained and paid by the Contractor. Field sampling shall be done by the testing laboratory or by a qualified employee of the Contractor.

At least one field density determination shall be performed for each 500 cubic yards of compacted material. Field samples shall be taken at locations selected by the Owner. If additional field control tests are necessary, in the opinion of the Owner, such tests shall be made. If the additional tests show the material does not meet the requirements of this specification, the tests shall be at the Contractor's expense. If the material does meet the requirements of this specification, the costs of the additional tests shall be paid by the Owner.

Maximum density for cohesive compacted materials shall be determined in accordance with ASTM D698. The terms "maximum density" and "optimum moisture content" shall be as defined in ASTM D698. If the material does not meet the requirements of this specification, the material shall be reworked, recompacted, and retested. All retests shall be at the Contractor's expense.

A copy of each test result shall be promptly furnished to the Construction Manager and the Engineer.

2B.8 BLASTING. Blasting or other use of explosives for excavation will not be permitted.

2B.9 FUGITIVE DUST CONTROL. The Contractor shall provide the Owner with the measures that shall be used to minimize the generation of fugitive dust during construction operations. This shall include, but not be limited to, the use of sufficient watering vehicles to maintain the surface of all construction roads and disturbed areas in a moist condition. Chemical dust palliatives may be used with the written approval of the Owner.

2B.10 SITE PREPARATION. Major clearing and grubbing work shall be performed as described in the section titled CLEARING AND GRUBBING. In addition, all subgrades for permanent construction, including subgrades for fills and embankments, shall be stripped of surface vegetation, sod, debris, and organic topsoil. Surface vegetation shall be removed complete with roots to a depth of 12 inches below the ground surface.

All combustible and other waste materials shall be removed from the construction areas and disposed of by and at the expense of the Contractor as specified in the section titled CLEARING AND GRUBBING. Fire regulations and other safety precautions shall be observed when waste materials are burned offsite. Open burning is not permitted at the site.

Organic topsoil which is free of trash, vegetation, rocks, and roots shall be stockpiled at locations selected by the Owner.

2B.11 FILLS AND EMBANKMENTS. Fills and embankments shall be constructed to lines and grades indicated on the drawings and as herein specified.

2B.11.1 Materials. To the maximum extent available, suitable earth materials obtained from excavation shall be used for the construction of fills and embankments. Additional material shall be obtained from borrow areas as required.

All material placed in fills and embankments shall be free from rocks or stones larger than 6 inches in their greatest dimension, brush, stumps, logs, roots, debris, and organic or other deleterious materials.

2B.11.2 Subgrade Preparation. After preparation of the fill or embankment site, the subgrade shall be leveled, rolled, and moisture conditioned so surface materials of the subgrade will be as compact and well bonded with the first layer of the fill or embankment as specified for subsequent layers. The top 12 inches of the subgrade shall be compacted to 95 percent of maximum density.

2B.11.3 Placement and Compaction. All fill and embankment materials shall be placed in approximately horizontal layers not to exceed 12 inches in uncompacted thickness. Material deposited in piles or windrows by excavating and hauling equipment shall be spread and leveled before compaction.

Each layer of material being compacted shall have the best practicable uniform moisture content to ensure satisfactory compaction. The Contractor shall add water and harrow, disk, blade, or otherwise work the material in each layer as required to ensure uniform moisture content and adequate compaction. Each layer shall be thoroughly compacted to 95 percent of maximum density at ±3 percent of optimum moisture content unless otherwise specified. If the material fails to meet the density or moisture content specified, compaction methods shall be altered.

In locations where trenching through embankment will be required for the installation of piping the fill material will be placed and compacted to an elevation a minimum of two pipe diameters above the required trench bottom elevation before the commencement of trenching operations.

2B.11.4 Borrow Areas. Material necessary to complete fills and embankments shall be excavated from borrow areas and hauled to the fill or embankment site. Borrow material will be available on the Owner's property.

Borrow areas shall be shaped to conform with the natural drainage and not form areas to pond water. No borrow area in the landfill development shall exceed 2 feet in depth unless authorized by the Owner. The location, size, shape, depth, drainage, and surfacing of all borrow areas shall be acceptable to the Owner. Borrow areas shall be regular in shape, with finish graded surfaces when completed. Side slopes shall not be steeper than five horizontal to one vertical and shall be uniform for the entire length of any one side.

All areas disturbed by borrowing operations shall be seeded and maintained as indicated in the section titled EROSION CONTROL upon completion of the earthmoving in the area.

2B.12 CLAY LINER CONSTRUCTION. The liners include ditch clay liners and landfill clay slope and base liners. The operation of the clay borrow pit shall be in conformance with all local, state, and federal regulations. All necessary permits for operating the borrow pit shall be secured by the Contractor. The borrow pit shall be seeded and maintained as described in the section titled EROSION CONTROL, and as required by the appropriate agencies.

2B.12.1 Subgrade Preparation. Prior to placement of the clay liners, the subgrade, fill or natural ground, shall be thoroughly compacted and proof rolled. The subgrade shall be shaped to the lines, grades, and cross sections indicated on the drawings and compacted to a depth of at least 12 inches to 95 percent of maximum density. The subgrades shall not be higher than as indicated on the drawings. This operation shall include scarifying, reshaping, and wetting required to obtain proper compaction. After compaction, the area shall be proof rolled to test for uniformity and any loose soils detected shall be recompacted as specified.

No clay liner material shall be placed until the subgrade for that portion has been properly prepared and accepted by the Owner.

2B.12.2 Construction. The clay liners shall be constructed to the lines and grades indicated on the drawings. General requirements, the order of excavation, and the sources of materials shall be as specified herein.

2B.12.3 Materials. All materials placed in the clay liners shall be free from brush, stumps, logs, roots, rocks greater than 3 inches in maximum dimension, and other deleterious material. All material for the clay liner construction required shall be obtained from the clay borrow area.

The clay liner material shall be classified by the Contractor by testing and visual inspection and in accordance with Table 3 of the Unified Soil Classification System bound at the end of this section and the following additional requirements.

Unified soil classification	SC, CL, CH, MH
Percent passing No. 200 sieve	Greater than 30
Liquid limit	Greater than 30
Plastic index	Greater than 15

The drawings indicate the detailed limitations for the placement of clay liner material.

2B.12.4 General Requirements. The suitability of each part of the subgrade for placing clay liner materials thereon and of all materials for use in clay liner construction shall be acceptable to the Owner.

Dimensions indicated on the drawings for thickness of clay liner material are minimum dimensions. No intermingling of materials will be permitted within these dimensions.

2B.12.5 Equipment. Maximum compaction of the natural ground or embankment slope as prepared, and of each layer or lift of the liners, shall be obtained through the use of equipment so operated that the finished liners shall be uniformly stable and compacted. Isolated operations shall be provided with sufficient equipment to permit the work to be carried to completion in a continuous and efficient manner. Prime movers used for pulling equipment shall have sufficient power to pull the equipment satisfactorily when fully loaded. The loading and operation of equipment shall be subject to adjustment as required to produce the specified compaction. Equipment movement over the liner shall not damage previously placed liner material.

2B.12.6 Placing and Compacting Liner Material. The Contractor will be required to break up the earthfill materials, either at the place of excavation or on the embankment, to such maximum size as is determined necessary by the Owner to secure specified density of the material. Equipment shall spread out and not track each other to such an extent as to make ruts. The compacted surface of each lift shall be roughened or loosened by scarifying to a minimum depth of 2 inches, before the succeeding layer is placed thereon, in order to provide the necessary bond between each lift.

Prior to and during the compacting operations, the material in each layer of the clay liners shall have the best practicable moisture content, and the moisture content shall be uniform throughout the layer. To obtain

the best practicable moisture content, the Contractor will be required to perform such operations as are necessary. Supplementary water, as required, shall be added to the materials on the earthfill. If the fill material in borrow areas or other excavations contains an excess of moisture prior to excavation, the Contractor will be required to excavate drainage channels or perform such work as may be necessary to reduce the moisture content of the material. Working of the material on the embankment may be required to produce the required uniformity of water content.

Water required to bring the material to the specified moisture content shall be evenly applied and it shall be the Contractor's responsibility to secure a uniform moisture content throughout the layer by such methods as may be necessary. Compaction shall commence immediately after the layer has been brought to the uniform moisture content required, and shall continue, with or without additional water, until each layer has been uniformly compacted to not less than the specified density. Moisture content and density tests will be made as necessary. If the material fails to meet the moisture content or density specified, the compaction methods shall be altered, if necessary, to obtain the specified moisture and density.

Joints between segments of the clay liners placed in the same lift shall be staggered such that no joint is continuous between lifts. Movement of equipment from the prepared subgrade directly onto the clay liner will not be permitted.

In restricted areas, successive passes of the compaction equipment need not overlap, but uniform compaction is required. Where new material abuts old material, the old materials shall be cut or broken by machine or hand methods until they show the characteristic color of undried materials. The compaction equipment shall then work on both materials, bonding them together.

2B.12.7 Compaction and Moisture Requirements. Compacted clay materials shall meet the following compaction and moisture requirements.

All parts of the clay liners shall be compacted to 95 percent of maximum density at the specified moisture content. During compaction, the moisture content of each of these materials shall be maintained above +3 percent of optimum. The clay liner materials shall be placed in layers not to exceed 12 inches in uncompacted thickness over the prepared subgrade.

2B.13 BOTTOM ASH FILLS. The bottom ash fills shall be constructed to the lines and grades indicated on the drawings.

2B.13.1 Materials. Materials for the bottom ash cover shall be excavated from the existing bottom ash stockpile adjacent to the site or from the GCSES hydrobins.

Prior to transportation to the dike for placement, the bottom ash material from the hydrobins shall be stockpiled, drained, and blended within the confines of the existing bottom ash stockpile as required. The material shall be blended, as required, to achieve the specified density.

If the Owner determines that sufficient bottom ash material is not available, earth fill material may be substituted for the bottom ash material. The bottom ash or earth material shall be compacted in accordance with FILLS AND EMBANKMENTS.

2B.13.2 Placement and Compaction. All cover material shall be placed in approximately horizontal layers not to exceed 12 inches in uncompacted thickness, unless otherwise directed by the Owner based on the adequacy of the Contractor's equipment and obtaining passing test results. Material deposited in piles or windrows by excavating and hauling equipment shall be spread and leveled before compaction.

Each layer of material being compacted shall have the best practicable uniform moisture content to ensure satisfactory compaction. The Contractor shall add water, harrow, disk blade, or otherwise work the material in each layer to achieve satisfactory compaction to 95 percent of maximum density.

Density tests shall be made as necessary by the Contractor's testing laboratory. If the material fails to meet the specified density, the compaction methods shall be altered to obtain the specified density.

2B.14 GEOTEXTILE FABRIC. The geotextile fabric shall consist of a nonwoven fabric consisting only of continuous chain polymeric filaments or yarns of polyester, or polypropylene formed into a stable network by needle punching.

The fabric shall be inert to commonly encountered chemicals and hydrocarbons. It shall also be resistant to mildew and rot, ultraviolet radiation, insects, and rodents. The engineering fabric shall conform to the properties in the following table. The average roll minimum value (weakest principle direction) for strength properties of any individual roll tested, from the manufacturing lot or lots of a particular shipment, shall be in excess of the average roll minimum value (weakest principle direction) stipulated below. The average roll minimum value is defined as the sampling average (weakest principal direction) of the physical properties for any individual roll tested within a lot designated first quality.

Physical Properties	Average Roll Minimum Value
Grab Tensile Strength* ASTM D1682 (lb)	190

Physical Properties	Average Roll Minimum Value
Elongation at Failure* ASTM D1682 (percent)	60
Mullen Burst Strength ASTM D3786 (psi)	300
Thickness ASTM D-1777 (mils)	90
Trapezoid Tear Strength* ASTM 1117 (lb)	60
Puncture Strength ASTM D751 (modified) (lb)	80

*Weakest Principle Direction

The geotextile fabric shall be provided in rolls wrapped with protective covering to protect the fabric from mud, dirt, dust, and debris. The fabric shall be free of defects or flaws which significantly affect its physical properties. Each roll of fabric in the shipment shall be labeled with a number or symbol to identify that production run.

2B.15 GEOWEB DITCH PROTECTION. GEOWEB 8-4 Confining System as manufactured by Presto Products, Inc., Appleton, WI, or acceptable equivalent shall be installed in locations indicated on the drawings.

Physical Property	
Expanded dimension	8 ft x 20 ft x 8 in. or 8 ft x 20 ft x 4 in.
Material	HDPE
Carbon black content	2 percent

The GEOWEB shall be placed and anchored in accordance with the manufacturer's recommendations and backfilled with sand or gravel as specified on the drawings. The GEOWEB shall be underlain by geotextile fabric.

2B.16 PIPE TRENCH EXCAVATION. No more trench shall be opened in advance of pipe laying than is necessary to expedite the work.

2B.16.1 Alignment and Grade. The alignment and grade or elevation of each pipeline shall be fixed and determined by means of batter boards and offset stakes, laser beam equipment, or surveying instruments unless otherwise accepted. Vertical and horizontal alignment of pipes, and the

maximum joint deflection used in connection therewith, shall be in conformity with requirements of the specification section covering installation of pipe.

2B.16.2 Limiting Trench Widths. Trenches shall be excavated to a width which will provide adequate working space and pipe clearance for proper pipe installation, jointing, and embedment. The width of trench below an elevation 12 inches above the top of the pipe shall not be more than 18 inches greater than the outside diameter of the pipe unless otherwise indicated on the drawings.

Where necessary to reduce earth load on trench banks to prevent sliding and caving, banks may be cut back on slopes which shall not extend lower than 1 foot above the top of the pipe.

2B.16.3 Unauthorized Trench Widths. Where, for any reason, the width of the lower portion of the excavated trench exceeds the maximum specified, pipe of adequate strength, special pipe embedment, or arch concrete encasement, as required by loading conditions and with the concurrence of the Engineer, shall be furnished and installed by and at the expense of the Contractor.

2B.16.4 Mechanical Excavation. The use of mechanical equipment will not be permitted in locations where its operation would cause damage to trees, buildings, culverts, or other existing property, utilities, or structures above or below ground. In all such locations, hand excavating methods shall be used.

2B.16.5 Trench Depth. Pipe trenches shall be excavated to the depth required for the installation of embedment pipe foundation material below the underside of the pipe as indicated on the drawing bound at the end of this section.

2B.16.6 Bell Holes. Bell holes shall provide adequate clearance for tools and methods used in installing pipe. No part of any bell or coupling shall be in contact with the trench bottom, trench walls, or embedment when the pipe is jointed.

2B.17 PIPE EMBEDMENT. Embedment materials both below and above the bottom of the pipe, classes of embedment to be used, and placement and compaction of embedment materials shall conform to the requirements indicated on the drawing included at the end of this section and to the following supplementary requirements.

2B.17.1 Embedment Classes. All pipe embedment shall be second class as indicated on the drawing included at the end of this section and as specified herein.

Sand embedment material shall be clean sand which shall have a gradation such that 95 percent of the material shall pass a No. 4 sieve and not more than 5 percent shall pass a No. 100 sieve.

2B.17.2 Placement and Compaction. Embedment material shall be spread on the trench bottom and the surface graded to provide a uniform and continuous support beneath the pipe at all points between pipe joints. The material shall be compacted with vibrating platform type compactors. Compactive effort and moisture content shall be adjusted to provide a firm but slightly yielding support for the pipe. It will be permissible to slightly disturb the finished subgrade surface by withdrawal of pipe slings or other lifting tackle.

After each pipe has been graded, aligned, and placed in final position on the bedding material, sufficient pipe embedment material shall be deposited and compacted under and around each side of the pipe and end thereof to hold the pipe in proper position and alignment during subsequent pipe jointing and embedment operations.

Embedment material shall be deposited and compacted uniformly and simultaneously on each side of the pipe to prevent lateral displacement. Embedment material shall be placed in layers of 8 inches or less and each layer shall be uniformly compacted to 90 percent of maximum density.

Embedment materials shall be placed in uniform layers and shall have a moisture content which will ensure that maximum density will be obtained with the compaction method used. Vibrating compactors shall be used to compact sand.

All tools used in the placement and compaction of the embedment of coated pipe shall be selected and used so the pipe coating will not be damaged.

2B.18 TRENCH BACKFILL. All trench backfill above pipe embedment shall conform to the following requirements.

Compacted backfill will be required for the full depth of the trench above the embedment.

Compacted backfill material shall meet the requirements specified hereinafter. Compacted backfill material shall be either suitable job excavated material or suitable material furnished by the Contractor from his own sources.

Compacted backfill material shall be finely divided and free from debris, organic material, and stones larger than 3 inches in greatest dimension. Compacted backfill material shall be placed in uniform layers not exceeding 8 inches in uncompacted thickness. Increased layer thickness may be permitted if the Contractor demonstrates to the satisfaction of the Owner

that the specified compacted density will be obtained. The method of compaction and the equipment used shall be appropriate for the material to be compacted and shall not transmit damaging shocks to the pipe. Trench backfill shall be compacted to not less than 90 percent of maximum density.

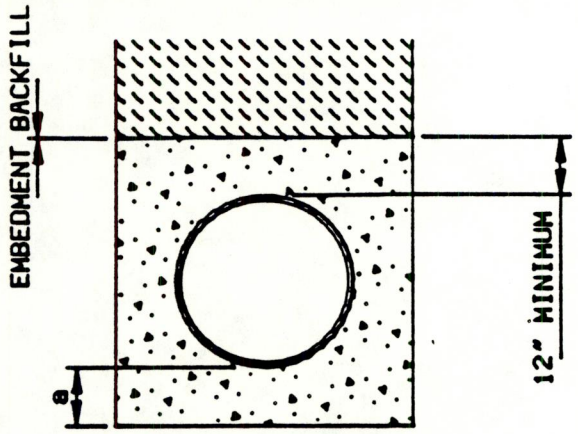
2B.19 MAINTENANCE AND RESTORATION OF FILLS, EMBANKMENTS, AND BACKFILLS. Fills, embankments, and backfills that settle or erode before final acceptance of the work, and pavement, structures, and other facilities damaged by such settlement or erosion, shall be repaired. The settled or eroded areas shall be refilled, compacted, and graded to conform to the elevation indicated on the drawings or to the elevation of the adjacent ground surface. Damaged facilities shall be repaired in a manner acceptable to the Owner.

2B.20 STRAW BALES/GEOTEXTILE SEDIMENTATION BARRIER. Rows of straw bales or geotextile sedimentation barriers shall be constructed across the sedimentation pond inlet channels as indicated on the drawings to control sedimentation from runoff. The straw bales shall be set into a shallow trench and anchored with wood posts. The geotextile sedimentation barrier shall be constructed with posts and a fabric filter media. The media shall be firmly attached to the posts and anchored into the soil. The Contractor shall install the straw bales or geotextile sedimentation barrier at the start of construction and maintain them until work is accepted by the Owner.

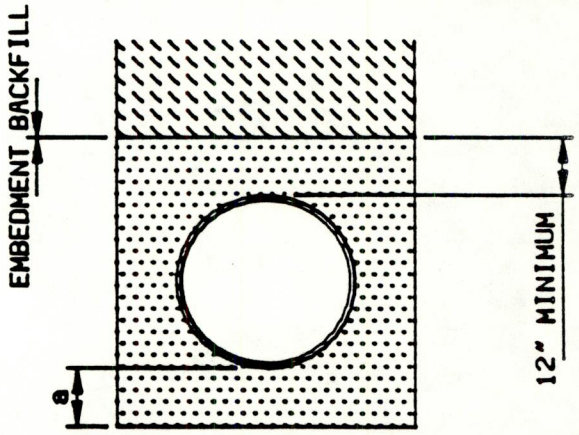
2B.21 FINAL GRADING. After all construction work has been completed, all ground surface areas disturbed by this construction or construction plant and operations shall be graded. The grading shall be finished to the contours and elevations indicated on the drawings or, if not indicated, to the matching contours and elevations of the original, undisturbed ground surface. The final grading shall provide smooth uniform surfacing and effective drainage of the ground areas.

2B.22 DISPOSITION OF MATERIALS. Excavated earth material shall be used to construct fills, embankments, and backfills to the extent required. Surplus earth, if any, and materials which are not suitable for fills, embankments, and backfills shall be spoiled on the site in a manner and location as directed by the Owner.

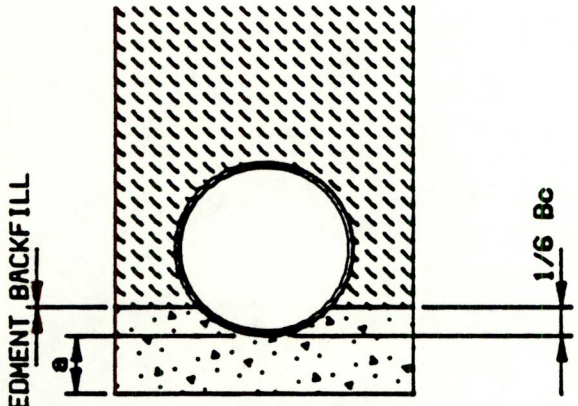
Materials shall be deposited in the disposal areas and leveled and compacted in 24 inch maximum layers. Compaction shall be by not less than three passes of a bulldozer.



FIRST CLASS BEDDING



SECOND CLASS BEDDING



THIRD CLASS BEDDING

LEGEND

D	NOMINAL PIPE SIZE
Bc	OUTSIDE DIAMETER OF PIPE
H	COVER ABOVE TOP OF PIPE
a	FOUNDATION DEPTH BELOW PIPE SEE TABLE
	GRANULAR EMBEDMENT
	COMPACTED BACKFILL
	SAND EMBEDMENT

NOTES

FOR FIRST CLASS BEDDING BENEATH RAILROADS, ROADS, AND PARKING AREAS, EXTEND GRANULAR EMBEDMENT TO TOP OF SUBGRADE OR 5 FEET ABOVE TOP OF PIPE.

SEE SPECIFIED REQUIREMENTS FOR MATERIALS, COMPACTION, AND TRENCH WIDTHS.

PIPE FOUNDATION DEPTH

D	a MIN. SOIL	a MIN. ROCK
60" & SMALLER	4"	9"
66" TO 90"	6"	12"
96" & LARGER	12"	12"

BLACK & VEATCH
ENGINEERS-ARCHITECTS

ENGINEER	VHS	DRAWN	AGG
CHECKED	DRN	DATE	10/06/82

NO	DATE	REVISIONS AND RECORD OF ISSUE	BY	CHK	APP	FLM
1	10/01/87	PROJECT NUMBER CHANGE	JC	DRN	VHS	
0	10/06/82	INITIAL ISSUE	JC	DRN	VHS	

PROJECT DRAWING NUMBER: 81112-DS-0053
REV: 1

PIPE EMBEDMENT

CODE
AREA

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TABLE 3
Unified Soil Classification System

Primary Divisions for Field and Laboratory Identification			Group Symbol	Typical Names	Laboratory Classification Criteria		Supplementary Criteria For Visual Identification
Coarse-grained soils. (More than half of material finer than 3-inch sieve is larger than No. 200 sieve size.)	Gravel. (More than half of the coarse fraction is larger than No. 4 sieve size about 1/4 inch.)	Clean gravels. (Less than 5% of material smaller than No. 200 sieve size.)	GW	Well graded gravels, gravel-sand mixtures, little or no fines.*	$C_u = \frac{D_{60}}{D_{10}}$ greater than 4. $C_z = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ between 1 and 3.		Wide range in grain size and substantial amounts of all intermediate particle size
			GP	Poorly graded gravels, gravel-sand mixtures, little or no fines.*	Not meeting both criteria for GW.		Predominantly one siz (uniformly graded) or a range of sizes with some intermediate sizes missing (gap graded).
.....do....	.....do....	Gravels with fines. (More than 12% of material smaller than No. 200 sieve size.)*	GM	Silty gravels, and gravel-sand-silt mixtures.	Atterberg limits below "A" line, or PI less than 4.	Atterberg limits above "A" line with PI between 4 & 7 is borderline case GM-GC	Nonplastic fines or fines of low plasticity.
			GC	Clayey gravels, and gravel-sand-clay mixtures.	Atterberg limits above "A" line, and PI greater than 7.		Plastic fines.
....do.....	Sands. (More than half of the coarse fraction is smaller than No. 4 sieve size.)	Clean sands. (Less than 5% of material smaller than No. 200 sieve size.)	SW	Well graded sands, gravelly sands, little or no fines.*	$C_u = \frac{D_{60}}{D_{10}}$ greater than 6. $C_z = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ between 1 and 3.		Wide range in grain sizes and substantial amounts of all intermediate particle sizes.
			SP	Poorly graded sands and gravelly sands, little or no fines.*	Not meeting both criteria for SW.		Predominately one siz (uniformly graded) or a range of sizes with some intermediate sizes missing (gap graded).
.....do....	.....do....	Sands with fines. (More than 12% of material smaller than No. 200 sieve size.)*	SM	Silty sands, sand-silt mixtures.	Atterberg limits below "A" line, or PI less than 4.	Atterberg limits above "A" line with PI between 4 and 7 is borderline case SM-SC.	Nonplastic fines or fines of low plasticity.
			SC	Clayey sands, sand-clay mixtures.	Atterberg limits above "A" line with PI greater than 7.		Plastic fines.

* Materials with 5 to 12 percent smaller than No. 200 sieve are borderline cases, designated: GW-GM, SW-SC, etc.

TABLE 3 (continued)
Unified Soil Classification System

Primary Divisions for Field and Laboratory Identification		Group Symbol	Typical Names	Laboratory Classification Criteria		Supplementary Criteria For Visual Identification		
						Dry Strength	Reaction to Shaking	Toughness Near Plastic Limit
Fine-grained soils. (More than half of material is smaller than No. 200 sieve size.) (Visual: more than half of particles are so fine that they cannot be seen by naked eye.)	Silts and clays. (Liquid limit less than 50.)	ML	Inorganic silts, very fine sands, rock flour, silty or clayey fine sands.	Atterberg limits below "A" line, or PI less than 4.	Atterberg limits above "A" line with PI between 4 and 7 is borderline case ML-CL.	None to slight	Quick to slow	None
	.....do.....	CL	Inorganic clays of low to medium plasticity; gravelly clays, silty clays, sandy clays, lean clays.	Atterberg limits above "A" line, with PI greater than 7.		Medium to high	None to very slow	Medium
	.....do.....	OL	Organic silts and organic silt-clays of low plasticity.	Atterberg limits below "A" line.		Slight to medium	Slow	Slight
Primary Divisions for Field and Laboratory Identification		Group Symbol	Typical Names	Laboratory Classification Criteria		Supplementary Criteria For Visual Identification		
						Dry Strength	Reaction to Shaking	Toughness Near Plastic Limit
...do....	Silts and clays. (Liquid limit greater than 50.)	MH	Inorganic silts, micaceous or diatomaceous fine sands or silts, elastic silts.	Atterberg limits below "A" line.		Slight to medium	Slow to none	Slight to medium
	.....do.....	CH	Inorganic clays of high plasticity, fat clays.	Atterberg limits above "A" line.		High to very high	None	High
	.....do.....	OH	Organic clays of medium to high plasticity.	Atterberg limit below "A" line		Medium to high	None to very slow	Slight to medium
...do....	Highly organic soils.....	Pt	Peat, muck and other highly organic soils.	High ignition loss, LL and PI decrease after drying.		Organic color and odor, spongy feel, frequently fibrous texture.		

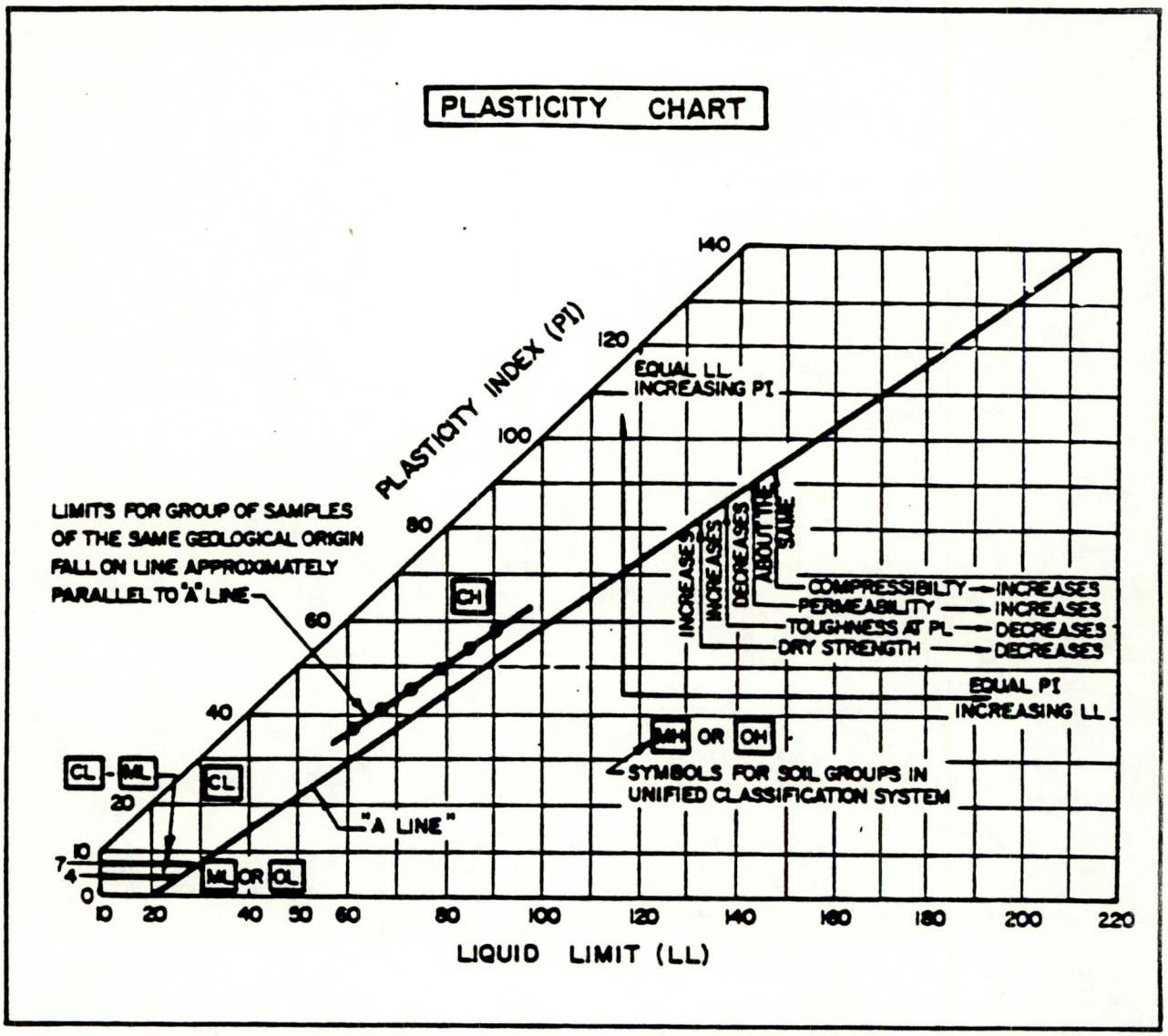

FIGURE 2
Utilization of Atterberg Plasticity Limits

Section 2C - DRAINAGE PIPING

2C.1 GENERAL. This section covers materials, manufacture, and installation for containment dike drain piping.

Earthwork and trenching shall be as specified in the section titled EARTHWORK unless noted otherwise in this section.

2C.2 MATERIALS. Underdrain pipe shall conform to the following requirements.

Corrugated plastic tubing, designated Containment Dike Drain Pipe on the drawings:

Pipe and fittings	ADS heavy-duty slotted pipe with sock filter material as manufactured by Advanced Drainage Systems, Inc. conforming to ASTM D1248, ASTM F405, AASHTO M-252 or acceptable equal

Reinforced concrete pipe, designated RCP on the drawings:

Fine aggregate	Clean natural sand, ASTM C33. Artificial or manufactured sand will not be acceptable.
Cement	ASTM C150 Type 5, containing not more than 5 percent tricalcium aluminate
Reinforced concrete pipe, fittings, and specials	ASTM C76 Class III as modified hereinafter. Wall thickness not less than Wall B. Minimum length 6 feet except fittings and closure pieces
Gaskets (O-ring)	ASTM C361, Section 6.9.1, except minimum tensile strength shall be 1,500 psi, hardness shall be 40 plus or minus 5, maximum water absorption shall be 10 percent. Polymer shall be neoprene or other synthetic rubber; natural rubber will not be acceptable.

2C.3 HANDLING. Pipe, fittings, and accessories shall be handled in a manner that will ensure installation in sound, undamaged condition. Equipment, tools, and methods used in loading, unloading, reloading, and hauling pipe and fittings shall not damage the pipe and end sections. Hooks inserted in the ends of pipe shall have broad, well padded contact surfaces and shall not come in contact with joint surfaces. Damaged pipe shall be removed from the site.

Filter socks which have been damaged shall be replaced or repaired by the Contractor before installing the pipe.

Plastic pipe shall be shaded as required to prevent curvature and deterioration due to thermal expansion and exposure to sunlight.

2C.4 GENERAL INSTALLATION REQUIREMENTS. Drain piping shall be accurately installed in accordance with lines and grades indicated on the drawings or as required by connections to other piping. Pipe grades between designated invert elevations shall be uniform to ensure unrestricted flow and eliminate low spots or traps that would retain water. Pipe shall not be laid in water or in unsuitable weather or trench conditions. Unless otherwise accepted, pipe laying shall begin at the lowest point and pipe shall be laid so that the spigot ends point in the direction of flow. Pipe shall be laid in a manner to provide uniform support throughout its length.

Pipelines intended to be straight shall be laid straight.

2C.4.1 Cutting. Cutting shall be done in a neat manner, without damage to the pipe. Cuts shall be smooth, straight, and at right angles to the pipe axis. Pipe shall be cut with mechanical pipe cutters. Where the use of mechanical cutters would be difficult or impracticable, the proposed method of pipe cutting shall be acceptable to the Owner.

2C.4.2 Cleaning. Foreign matter shall be thoroughly cleaned from the interior of all pipe and fittings before installing. Pipe shall be kept clean until the work has been accepted. Surfaces shall be wire brushed, if necessary, and wiped clean, dry, and free from oil and grease before the joints are assembled. Joint contact surfaces shall be kept clean until the jointing is completed.

Every precaution shall be taken to prevent foreign material from entering the pipe while it is being installed. No debris, tools, clothing, or other materials shall be placed in the pipe.

Whenever pipe laying is stopped, the open end of the pipe shall be closed with an end board closely fitting the end of the pipe to keep sand and earth out of the pipe. The end board shall have several small holes near the center to permit water to enter the pipe and prevent flotation in the event of flooding of the trench.

2C.4.3 Inspection. Pipe and fittings shall be carefully examined for cracks and other defects immediately before installation. Spigot ends shall be examined with particular care since they are vulnerable to damage from handling. Defective pipe and fittings shall be removed from the site of the work.

2C.5 ALIGNMENT. Piping shall be laid to the lines and grades indicated on the drawings. Substantial batter boards shall be erected at intervals of not more than 25 feet. Batter boards shall be used to determine and check pipe subgrades. Not less than three batter boards shall be maintained in proper position at all times when trench grading is in progress.

Other methods of maintaining alignment and grade, such as use of laser beam equipment or surveying instruments, will be considered, provided complete information describing the proposed method is submitted to the Owner for review before pipe laying is started.

2C.6 LAYING PIPE. Lateral displacement of the pipe shall be prevented during embedment operations. Pipe shall not be laid in water, nor under unsuitable weather or trench conditions.

Pipe laying shall begin at the lowest elevation with bell ends facing the direction of laying except when reverse laying is permitted by the Owner.

When jointed in the trench, the pipe shall form a true and smooth line. Pipe shall not be trimmed except for closures. Pipe not making a good fit shall be removed. Permissible defects shall be placed in the top of the line.

Trenches shall be graded to the required slopes. Trenches shall be shaped and tamped to receive and fit the lower part of the pipe. If rock is encountered in the excavation, it shall be removed and replaced with suitable earth or granular fill material to a minimum depth of 6 inches below the bottom of the pipe. Pipe shall be laid on the prepared bed starting at the outlet end with sections firmly joined. Outside laps of circumferential joints shall point upstream. Longitudinal seams of corrugated metal culverts shall be placed at the side of the trench.

2C.7 JOINTING. Joint preparation and jointing operations shall comply with the written instructions and recommendations of the pipe manufacturer.

2C.7.1 Corrugated Plastic Tubing. Joints and fittings shall be installed in accordance with the instructions furnished by the manufacturers and

ASTM F449. All coupling, joints, tees, elbows, and other fittings shall be wrapped with drain sock material. All drain ends of drain sock material shall be securely taped to plastic tubing or adjacent sock material prior to backfilling.

2C.7.2 Concrete Pipe Joints. Rubber gaskets for concrete pipe shall be installed in accordance with the pipe manufacturer's recommendations. Immediately before jointing the pipe, the outside of the spigot and gasket and the inside of the receiving bell shall be thoroughly cleaned and coated with a suitable lubricant. The position and condition of the rubber gasket shall be checked with a feeler gauge after the piping unit is installed.

2C.8 ACCEPTANCE TESTS. Each reach of buried drainage piping shall meet the requirements of the following acceptance tests. All defects shall be repaired to the satisfaction of the Owner.

Wherever both ends of a section of drainline are accessible, the section will be lamped by the Owner. The Contractor shall furnish all necessary equipment and suitable assistants to help the Owner.

Section 2D - MANHOLES

2D.1 GENERAL. This section covers materials and construction for drainage manholes. Manholes shall be constructed complete with fittings, trashrack, and other appurtenances, in accordance with the details indicated on the drawings.

Excavation and backfill shall be as specified in the section titled EARTHWORK.

Manholes which are so designated shall be reinforced concrete as detailed with no substitutions allowed. At the option of the Contractor, other manholes shall be constructed of cast-in-place concrete or precast concrete sections.

2D.2 MATERIALS. Materials shall be furnished in accordance with the following.

Concrete	Materials, placing, forming, finishing, curing, and other appurtenant work as specified in CAST-IN-PLACE CONCRETE section
Precast sections	Circular precast concrete, ASTM C76, except as modified
Minimum wall thickness	5 inches
Openings	Circular or horseshoe shaped boxout for each connecting pipe, with surfaces grooved or roughened to improve mortar bond
Gaskets	
Mastic	Fed Spec SS-S-210; K. T. Snyder "Ram-Nek," Hamilton-Kent "Kent-Seal No. 2," or acceptable equal
Rubber	Neoprene or other synthetic, 40 plus or minus 5 hardness when measured by ASTM D2240, Type A durometer

Concrete block	Solid, curved, segmental units, ASTM C139, except as modified
Compressive strength	3,500 psi minimum
Curing	Steam cured for at least 8 hours
Minimum thickness	As indicated on the drawings
Nonshrinking grout	Master Builders "Masterflow 713 Grout," Sauereisen Cements "F-100 Level Fill Grout," Gifford Hill "Supreme Grout," or acceptable equal

2D.3 CONSTRUCTION. A rubber or mastic gasket shall be provided to seal joints between precast sections. The space between connecting pipes and the wall of precast sections shall be completely filled with nonshrinking grout.

Reinforcing steel bars shall be grouted to the top of all manholes to form a trashrack, as specified on the drawings.

Section 2E - GROUT-FILLED SYNTHETIC FABRIC FORMS

2E.1 GENERAL. This section covers materials and procedures for the installation of grout-filled synthetic fabric forms.

Grout-filled synthetic fabric forms will be required at the locations indicated on the drawings. The work shall consist of installing unreinforced grout-filled synthetic fabric form, panels, and bags as indicated on the drawing. Forms shall be placed as indicated on the contract drawings by positioning a specially woven fabric envelope at locations indicated on the drawings and injecting the forms with grout.

The Contractor shall furnish evidence, satisfactory to the Owner, of successful performance in this type of work. The Contractor shall provide, throughout the progress of installation of the work of this section, one person who shall be thoroughly familiar with the specified requirements, completely trained and experienced in the necessary skills, and who shall be present at the site and shall direct all work performed under this section.

Material sources of the grout and the synthetic fabric forms shall be submitted with the proposal data and shall not be changed without prior approval of the Owner.

2E.2 MATERIALS.

2E.2.1 Grout. The grout shall be furnished by the Contractor and shall consist of a mixture of portland cement, fine aggregate, and water so proportioned and mixed as to provide a pumpable slurry. The mix shall obtain the required compressive strength of 2,000 psi at 28 days when made and tested in accordance with ASTM C-31 and C-39. Portland cement shall conform to ASTM C-150, Type II, Modified. Aggregate shall meet the requirements of ASTM C-33, except as to grading. Aggregate grading shall be consistent and shall be well graded from the maximum size which can be conveniently handled with available pumping equipment. Mixing water shall be clean, potable, and free from injurious amounts of foreign matter. Admixtures, if utilized, shall contribute to the nature of the specifications. Pozzolith, or an equal water reducer conforming to ASTM C-494, may be used to reduce segregation, increase workability and pumpability, improve strength, and increase watertightness. If an air entrainment agent is used, it shall improve resistance to freezing and thawing, and shall reduce both bleeding and permeability. Other admixtures shall not be used.

2E.2.2 Synthetic Fabric Forms. The fabric forming material shall consist of multiple panels of double-layer or bags, open-selvage fabric joined in a mat configuration. The two fabric layers shall each be no lighter than 20 by 20 count/inch, 840 denier, or an equivalent weight fabric.

Suitability of the fabric design shall be demonstrated by injecting the proposed grout into 6 inch diameter sleeves under a pressure of 10 to 15 psi which shall be maintained by means of air pressure or a standpipe for 10 minutes. The sleeves shall be constructed of the same fabric used in the individual layers of fabric. Six inch by 12 inch test cylinders shall be cut from each specimen and tested in accordance with ASTM C-39. The average compressive strength of the test cylinders shall be at least 20 percent higher at 7 days than that of companion test cylinders made in accordance with ASTM C-31, and not less than 2,500 psi at 28 days.

2E.3 REFERENCE SAMPLES. One set of three test cylinders shall be taken by the Contractor each day that grout is injected into the forms; one cylinder shall be tested at 7 days and two cylinders at 28 days. Copies of the test results will be furnished to the Owner. The grout for the test cylinder shall be taken from the injection hose after the grout has passed through the pump.

2E.4 PRELIMINARY REVIEW. The Owner's acceptance of the source and quality of the grout and synthetic fabric forms shall be obtained before the grout-filled synthetic fabric formwork is started. For such acceptance, certified reports shall be submitted to the Owner. The report shall include, but not be limited to, a description of the materials to be used, the proposed method of installation, and a list of material suppliers. Complete shop drawings showing the individual fabric panels in relation to the site location plan shall be furnished.

2E.5 PLACEMENT. Placement of grout-filled synthetic fabric forms shall not start until acceptance of materials as specified in the article titled PRELIMINARY REVIEW. Grout-filled synthetic fabric forms shall be placed on the areas indicated on the drawings.

Prior to grout injection, the fabric panels or bags shall be loosely positioned at their design locations. Panels shall be continuous or monolithic units for their full width, including the anchor trench portion. Each panel shall measure approximately 3 percent more in each direction than the mat after injection to allow for proper filling out of the cross section. Adjacent fabric panels shall be joined, before grout injection, by field sewing the two layers of fabric separately, edge to edge, except that with the approval of the Owner or where called for by the plans, adjacent panels may be lapped a minimum of 2 feet. In no case will simple butt joints be permitted.

Small cuts shall be made in the fabric to allow for the insertion of the injection hose or nozzle. The sequence of injecting the panels shall ensure that no cold joint exists in any one panel and that the panels are filled to an adequate cross section.

Grout shall be injected in such a way that excessive pressure on the fabric formwork is avoided. Holes in the fabric left by the removal of the injection hose shall be temporarily closed by inserting a piece of burlap or similar material. The burlap shall be removed when the concrete is no longer fluid and the surface is firm to hand pressure. Foot pressure on the filled mat shall be restricted to an absolute minimum for 1 hour after pumping. Upon completion of the grouting operation, all the anchor trenches shall be backfilled.

Section 2F - EROSION CONTROL

2F.1 GENERAL. This section covers the furnishing of materials and equipment, and the performance of all operations in connection with establishing turf as indicated on the drawings or in these specifications.

Soil erosion control work shall include preparation of the soil surface, fertilizing, planting of seed, compacting, mulching, watering, and maintenance.

All soil erosion control work shall be performed by a contractor who is experienced and regularly engaged in the type of work specified and whose work is acceptable to the Owner.

The ground preparation, seeding, mulching, and other erosion control activities shall be in conformance with Item 164 of the Texas State Department of Highways and Public Transportation Standard Specifications for Construction of Highways, Streets, and Bridges (Texas SSCHSB).

The work shall be performed using acceptable equipment manufactured expressly for its intended purpose.

Mulch, seed, and fertilizer may be applied simultaneously with a hydraulic applicator manufactured specifically for this purpose, provided all other requirements of the specifications are met. The hydraulic applicator shall be capable of applying the mulch, seed, and fertilizer slurry in the proper proportions under its own power to slopes at least as steep as 2 feet horizontal to 1 foot vertical.

The Contractor shall not start erosion protection or preparatory work until excavation, backfill, embankments, rough grading, surfacing, and paving are completed in the vicinity of the erosion protection work.

2F.2 MATERIALS. Materials for soil erosion protection shall include topsoil, fertilizer, seed, and mulch.

2F.2.1 Topsoil. Topsoil for planting operations shall be fertile, friable, natural loam containing a liberal amount of humus or native topsoil and shall be capable of sustaining vigorous plant growth. Topsoil shall be free of subsoil and shall be reasonably free of stone, lumps, clods of hard earth, plants or their roots, stalks, and other extraneous matter.

2F.2.2 Commercial Fertilizer. Fertilizer shall be a commercial mixture in accordance with Item 166 of the Texas SSCHSB. Fertilizer requirements shall be determined by the Contractor from a soil analysis.

Fertilizer shall be uniform in composition, free flowing, and suitable for application with acceptable equipment. Fertilizer shall be delivered to the site in standard size bags or in bulk indicating weight, analysis, and name of manufacturer. Fertilizer shall be stored in a weatherproof place in such a manner that it will be kept dry and its effectiveness will not be impaired.

2F.2.3 Seed. All seed shall meet the requirements of the seed laws of the State of Texas and the requirements of Item 164 of the Texas SSCHSB.

Seed shall be furnished in sealed, standard containers unless written exception is granted. Seed that is wet or moldy or that has been otherwise damaged in transit or storage will not be acceptable.

2F.2.4 Mulch. Mulching materials shall conform to Item 164 of the Texas SSCHSB and to the following requirements.

2F.2.4.1 Vegetative Mulch. Vegetative mulch shall consist of straw or hay free from rot or mold and shall be in a good state of preservation when used. Vegetative mulch shall be primarily long, heavy stemmed material delivered in dry bales and shall be kept dry until applied. Vegetative mulch shall be as free as practicable from weed seed and other deleterious substances.

2F.2.4.2 Wood Cellulose or Paper Fiber Mulch. Wood cellulose or paper fiber mulch, for use with the hydraulic application of grass seed and fertilizer, shall consist of specially prepared wood cellulose or paper fiber, processed to contain no germination prohibiting factors, and dyed an appropriate color to facilitate visual metering of application of the materials. The mulch materials shall be delivered in packages not to exceed 100 pounds in gross weight. Mulch shall contain not in excess of 10 per cent moisture, air dry weight basis. Mulch shall be manufactured so that after addition and agitation in slurry tanks with fertilizers, grass seeds, water, and any other acceptable additives, the fibers in the material will become uniformly suspended to form a homogenous slurry. Mulch shall be of such a consistency that when hydraulically sprayed on the ground, the material will form a blotter like ground cover impregnated uniformly with grass seed, which, after application, will allow the absorption of moisture and allow water to reach the underlying soil.

2F.3 PREPARATION AND APPLICATION. The preparation of the soil, the application of seed and mulch shall conform to the requirements of Item 164 of the Texas SSCHSB.

2F.3.1 Preparation of Soil. The area to be planted shall be thoroughly tilled to a depth of at least 4 inches by discing, harrowing, or other acceptable methods until the soil is well pulverized.

After completion of the tilling operation the surface shall be cleared of all stones, stumps, or other objects larger than 1-1/2 inches in thickness or diameter, and of roots, wire, grade stakes, and other objects that might be a hindrance to maintenance operations.

The spreading of topsoil shall be completed over the entire area indicated on the drawings before the beginning of soil preparation.

Any objectionable undulations or irregularities in the surface resulting from tillage or other operations shall be removed before planting operations are begun. Soil preparation shall be performed only during periods when satisfactory results are likely to be obtained. When results are not satisfactory because of drought, excessive moisture, or other causes, the work shall be stopped until such conditions have been corrected to the satisfaction of the Construction Manager.

2F.3.2 Fertilizing. Commercial fertilizer of the type specified shall be distributed uniformly over the entire planting area at the rate of 800 pounds per acre for areas to be seeded. The fertilizer shall be applied with a fertilizer drill before the beginning of the mulching operation as a part of the soil preparation or if a seed drill with a fertilizer attachment is used, fertilizer may be applied with the seeding operation following the mulching.

If seed is to be applied by hydraulic application, the fertilizer may be mixed with the seed and mulch and applied as a slurry as specified in the article titled Wood Cellulose or Paper Fiber Mulch.

2F.3.3 Seeding. Seed shall be applied uniformly at rates specified in Item 164 of the Texas SSCHSB.

On slopes too steep for the practical operation of power drawn equipment, grass seed shall be broadcast uniformly by hand methods and raked into the surface.

Seeding and fertilizing shall be performed between the dates specified in Item 164 of the Texas SSCHSB unless otherwise acceptable to the Owner. Seeding and fertilizing shall not be done during periods of such severe drought, high winds, or excessive moisture, as determined by the Owner, that satisfactory results are not likely to be obtained. The Contractor may be required to place temporary cover to meet the requirements of Item 164.

2F.3.4 Compacting. Immediately after the seeding operations have been completed, the entire area shall be compacted by means of a cultipacker, roller, or other acceptable equipment weighing 60 to 90 pounds per linear foot of roller. If the soil is of such type that a smooth or corrugated roller cannot be operated satisfactorily, a pneumatic roller (not wobble-wheel) shall be used. The pneumatic roller shall have tires of sufficient size so complete coverage of the soil surface is obtained. When a

cultipacker or similar equipment is used, the final rolling shall be at right angles to the existing slopes to prevent water erosion or at right angles to the prevailing wind to prevent wind erosion.

The areas that have been seeded by hand and areas where the use of mechanical equipment is impractical shall be compacted by hand immediately after seeding by using a commercial hand tamper, roller, or other method acceptable to the Owner.

2F.3.5 Mulching. Mulching shall be performed within 24 hours after seeding, but shall not be done during windy or rainy weather or when such weather is imminent. If the seedbed has become crusty, eroded, or disturbed by the Contractor's operations before mulching, the Contractor shall rework the soil and reseed in these areas. Mulching shall be started at the windward side of relatively flat areas or at the upper part of steep slopes and shall continue uniformly until each area is covered.

2F.3.5.1 Vegetative Mulch. Vegetative mulch shall be placed as specified in Item 164 of the TSDHPT specifications.

Vegetative mulch of straw or hay may be applied with an asphalt tack in a mixture of 1-1/2 to 2 tons of mulch per acre with 75 to 150 gallons of emulsified asphalt per ton of mulch.

The mulch and asphalt mixture shall be placed with conventional mechanical equipment which will distribute the mulch uniformly by blowing it onto the area.

Baled straw or hay shall be broken up and loosened sufficiently before being fed into the blower hopper to avoid the placing of matted or unbroken clumps. The use of wet straw or hay is prohibited.

The equipment shall be provided with jet nozzles spaced in the muzzle of the blower through which the asphalt is ejected simultaneously with the mulch, coating the mulch uniformly with a spray of asphalt. Small areas may be mulched by hand by spreading the mulch in a loose, fluffy condition and sprayed with emulsified asphalt over the surface of the mulch.

Vegetative mulching material without emulsified asphalt may also be used provided that it is disced or punched into the soil so it is partially covered. Several passes may be required, if a straight disc is used, in order to mix the mulching material with the topsoil sufficiently to ensure protection from erosion by either wind or water. The mulch tilling operation shall be performed parallel to the ground contours.

Under some circumstances, it may become desirable to apply straw or hay mulch and anchor it into the soil on steep slopes to prevent erosion as

soon as construction of the slopes is completed as determined by the Owner.

Even though it is not the proper season to plant grass seed, vegetative mulch may be applied first and the seed may then be drilled in on top of the mulch at the proper seeding time. By applying mulch immediately following construction, and anchoring it into the soil, the normal seedbed preparation procedure may not be required, depending on the tilth of the soil, as determined by the Owner. In such cases, the fertilizer shall be applied at the time of seeding.

2F.3.5.2 Wood Cellulose or Paper Fiber Mulch. Wood cellulose or paper fiber mulch, for use with the hydraulic application of grass seed and fertilizer, shall be applied uniformly at the rate of 2,500 pounds per acre. The fiber mulch, fertilizer, and seed mixture shall be mixed with water to form a slurry to be applied under pressure. Hydraulic equipment used for the application of the slurry shall have a built-in agitation system. The slurry distribution lines shall be large enough to prevent stoppage and shall be equipped with a set of hydraulic spray nozzles that will provide even distribution of the slurry on the slopes to be mulched.

Wood cellulose or paper fiber mulch shall be placed as specified in Item 164 of the Texas SSCHSB.

2F.4 WATERING. Watering will be required to promote the establishment of healthy turf. Areas which have been seeded shall be watered such that water will penetrate 2 inches into the soil.

Additional applications of water will be required until the grass is well established after planting.

Water shall be supplied by the Contractor. All pipes, pumps, hoses, sprinklers, and other materials necessary to apply water shall be furnished by the Contractor.

2F.5 MAINTENANCE AND PROTECTION. The Contractor shall maintain and protect all planted areas until final acceptance of the work. Final acceptance will not be made until an acceptable uniform stand of grass is obtained, except portions of the seeding may be accepted at various times. Upon acceptance by the Owner of a planted area, the Owner will assume responsibility for maintenance of that portion.

Any portions of the areas of planting which fail to show a uniform stand of grass shall be replanted as before, except commercial fertilizer shall be applied at one-half the original rate. Planting shall be repeated until an acceptable stand of grass is provided.

Care shall be taken to avoid overwatering on the sloped areas to prevent erosion. Any areas which have become eroded shall be regraded and replanted. Topsoil shall be added if required.

Maintenance shall include mowing until new grass areas are accepted by the Owner.

2F.6 GUARANTEE. The Contractor shall guarantee all work and materials for a period of one year after completion of the seeding work. During the guarantee period, turf which dies shall be replaced by and at the expense of the Contractor. Replacement made under the Contractor's guarantee shall be covered by a like guarantee for a period of one year after completion of the replacement.

Section 2G - CAST-IN-PLACE CONCRETE

2G.1 GENERAL. This section covers cast-in-place concrete and includes reinforcing steel, forms, finishing, curing, grouting, and other appurtenant work.

Cast-in-place concrete shall be in accordance with the latest applicable requirements of the Federal Specifications, ACI, ASTM, and CRSI, except as modified by these specifications.

2G.2 MATERIALS. Materials shall be in accordance with these requirements.

Cement	ASTM C150, Type I, II, or III
Fine aggregate	Clean natural sand, ASTM C33
Coarse aggregate	Crushed stone, washed gravel, or other acceptable inert granular material conforming to ASTM C33
Water	Clean and free from deleterious substances
Air-entraining agent	ASTM C260
Plasticizing retarder	ASTM C494, Type B or D
Plasticizer	ASTM C494, Type A
Reinforcing steel bars	ASTM A615-85 Grade 60
Epoxy bonding compound	Sika Chemical "Sikadur Hi-Mod," U.S. Grout "Five Star Epoxy," or acceptable equal
Membrane curing compound	Styrene-acrylate or styrene-butadiene; minimum 18 percent solids, nonyellowing, unit moisture loss 0.039 g/sq cm maximum, Gifford-Hill "Sealco 800," ProSoCo "Kure and Seal," Protex "Acryseal," Sonneborn "Kure-N-Seal," or L&M "Dress & Seal"

2G.3 PRELIMINARY REVIEW. The source and quality of concrete materials and the concrete proportions proposed for the work shall be submitted to the Engineer for review before the concrete work is started. Such review will be for general acceptability only; continued compliance with all contract provisions will be required.

2G.4 LIMITING REQUIREMENTS. The quantity of portland cement, expressed in pounds per cubic yard, shall be not less than that indicated in the following table. These minimum cement factors shall apply only to concrete containing either the specified plasticizer or plasticizing retarder. If, for any reason, both the plasticizer and plasticizing retarder are omitted, the cement factor shall be increased by 10 percent.

	Coarse Aggregate Size From No. 4 Sieve to		
Concrete slump	1/2"	3/4"	1"
3 inches	592	564	536
4 inches	611	583	555
5 inches	630	602	573

Total water content	Not more than 6.4 gallons per 100 pounds of cement
Coarse aggregate size	One inch to No. 4
Total air content	5 percent plus or minus 1 percent
Consistency	Workable, without segregation, with slump not more than 4 inches when concrete is placed
Mixing	Thoroughly in a mechanical mixer for not less than 1-1/2 minutes
Compressive strength at age 28 days	Not less than 3,500 psi

2G.5 BATCHING AND MIXING. Batching and mixing shall conform to ASTM C94, except as otherwise specified herein.

Truck mixers shall be revolving drum type and shall be equipped with a mixing water tank. Only the prescribed amount of mixing water shall be

placed in the tank for any one batch, unless the tank is equipped with a device by which the amount of water added to each batch can be readily verified by the Owner.

A delivery ticket shall be prepared for each load of ready-mixed concrete delivered and handed to the Owner by the truck operator at the time of delivery. Tickets shall show the number of yards delivered, the quantities of each material in the batch, the outdoor temperature in the shade, the time at which the cement was added, and the numerical sequence of the delivery.

When a truck mixer or agitator is used for transporting concrete, the concrete shall be delivered to the site of the work and discharge shall be completed within 1-1/2 hours, or before the drum has been revolved 300 revolutions, whichever comes first, after the introduction of the mixing water to the cement and aggregates, or the introduction of the cement to the aggregates, unless a longer time is specifically accepted by the Engineer. In hot weather, or under conditions contributing to quick stiffening of the concrete, a time less than 1-1/2 hours may be required by the Owner. When a truck mixer is used for the complete mixing of the concrete, the mixing operation shall begin within 30 minutes after the cement has been intermingled with the aggregates.

2G.6 REINFORCEMENT. Reinforcements shall be accurately formed and positioned and shall be maintained in proper position while the concrete is being placed and compacted. Details of fabrication shall conform to ACI 318-83.

2G.6.1 Splices. Unless otherwise required by the specifications or drawings, splices shall conform to ACI 318-83. Splices shall be Class C tension-lapped splices unless a different class is indicated on the drawings. Splices in horizontal reinforcement placed in vertical wall sections shall be detailed in accordance with the top reinforcement requirements of ACI 318-83.

2G.7 FORMS. Forms shall be designed to produce hardened concrete having the shape, lines, and dimensions indicated on the drawings. Forms shall be substantial and sufficiently tight to prevent leakage of mortar and shall be maintained in proper position and accurate alignment. Forms shall be thoroughly cleaned and oiled before concrete is placed and shall not be removed until the concrete has hardened sufficiently to support all loads without damage.

Vertical surfaces of footings extended above grade shall be formed.

Form ties shall be of the removable end, permanently embedded body type. Outer ends of the permanently embedded portions of form ties shall be at least 1 inch back from adjacent outer concrete faces.

Chamfer strips shall be placed in forms to bevel all salient edges and corners except where otherwise noted. Bevel dimensions shall be 3/4 by 3/4 inch unless otherwise indicated on the drawings.

2G.8 EMBEDMENTS. Materials that are to be embedded in the concrete shall be accurately positioned and securely anchored. Embedments shall be clean when they are installed. After installation, surfaces not in contact with concrete shall be cleaned of all concrete spatter and other foreign substances.

2G.9 PLACEMENT. Where concrete is placed against dry or porous surfaces, such surfaces shall be covered with polyethylene film to protect the concrete from loss of water. Joints in the film shall be sealed with waterproof sealing tape. Unless otherwise accepted by the Owner, all concrete in contact with earth or granular fill shall be placed against polyethylene film.

Concrete shall be conveyed to the point of final deposit and placed by methods which will prevent the separation or loss of the ingredients. During and immediately after depositing, all concrete shall be thoroughly compacted, worked around all reinforcements and embedments, and worked into the corners of the forms. Unless otherwise required, immersion type vibrators shall be used for compaction.

Concrete shall be placed within 1 hour and 30 minutes after introduction of the cement to the aggregates.

Concrete shall not be pumped through aluminum pipe or aluminum alloy pipe.

2G.9.1 Hot Weather Concreting. Except as modified herein, hot weather concreting shall comply with ACI 305. At air temperatures of 90 F or above, special procedures shall be adopted to keep the concrete as cool as possible during placement and curing. The temperature of the concrete when it is placed in the work shall not exceed 95 F.

Whenever the air temperature exceeds 95 F, membrane cured slabs shall be kept wet to promote cooling of the concrete during the curing period.

2G.9.2 Cold Weather Concreting. Except as modified herein, cold weather concreting shall comply with ACI 306. The temperature of concrete at the time of mixing shall be not less than that indicated in the following table for corresponding outdoor temperature (in shade) existing at the time of placement.

Outdoor Temperature	Concrete Temperature
Below 30 F	70 F
Between 30 F and 45 F	60 F
Above 45 F	45 F

When deposited, the temperature of heated concrete shall be not over 80 F.

When freezing temperatures may be expected during the curing periods, suitable means shall be provided for maintaining the concrete at temperatures of not less than 50 F for 5 days or 70 F for 3 days after the concrete is placed. Concrete and adjacent form surfaces shall be kept moist at all times. Sudden cooling of concrete shall not be permitted.

The use of calcium chloride will not be permitted.

2G.10 FINISHING FORMED SURFACES. All fins and other surface projections shall be removed from all formed surfaces from which the forms are stripped except exterior surfaces that will be in contact with earth backfill. In addition, surfaces which will be exposed above grade shall be cleaned and rubbed to produce a smooth, uniform surface free of marks, voids, surface glaze, and discolorations.

The removable ends of all form ties shall be removed and the recesses resulting from such removal shall be filled with mortar and rubbed smooth.

2G.11 FINISHING UNFORMED SURFACES. The unformed surfaces of concrete shall be screeded and given an initial float finish followed by additional floating and troweling where required.

Unformed surfaces which are specified to be steel trowel finished shall be finished to provide a flat profile within 1/8 inch deviation as measured from a 10 foot straightedge. The deviation for other surfaces shall not exceed 1/4 inch in 10 feet.

Surfaces designated on the drawings and the exposed top surfaces of equipment bases shall be steel trowel finished. Troweling shall be performed after the second floating when the surface has hardened sufficiently to prevent an excess of cement being drawn to the surface. Troweling shall produce a dense, smooth, uniform surface free from blemishes and trowel marks.

2G.12 CURING. Concrete shall be protected from loss of moisture for at least 7 days by polyethylene film or membrane curing compound. Membrane curing compound shall be applied as recommended by the manufacturer. Concrete shall not be permitted to freeze for at least 7 days following placement. Membrane curing shall not be used on cast-in-place concrete bases for field erected tanks and on surfaces which will be covered at a later date with mortar, concrete, dampproofing, or any coating.

2G.13 REPAIRING DEFECTIVE CONCRETE. Defects in formed concrete surfaces shall be repaired to the satisfaction of the Owner within 24 hours, and defective concrete shall be replaced within 48 hours after the adjacent

forms have been removed. All concrete which is porous, honeycombed, and otherwise defective to a depth in excess of 1 inch shall be cut out and removed.

Concrete repair work shall be performed in a manner that will not interfere with thorough curing of surrounding concrete. Mortar and concrete used in repair work shall be adequately cured and shall be finished to match adjacent surfaces.

2G.14 LEAN CONCRETE. Where lean concrete is indicated on the drawings, it shall be composed of the same materials and meet the same requirements as the concrete hereinbefore specified, except that its 28 day compressive strength shall not be less than 2,000 psi and it shall not contain less than 375 pounds of cement per cubic yard.

APPENDIX B

LANDFILL STAGE DEVELOPMENT PLANS