

CLOSURE AND POST CLOSURE PLAN

PREPARED FOR

THE CITY OF TORRINGTON
HAZARDOUS WASTE DISPOSAL FACILITY
INDUSTRIAL SLUDGE LANDFILL

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PREPARED BY

YWC, INC.

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1.0 GENERAL

This Closure Plan identifies and describes all activities that will be necessary to complete the final closure of the Torrington Metal Hydroxide Industrial Waste Landfill in accordance with 40 CFR, Part 264, Sub-Part 6. This Plan is an amended version of the previously prepared Closure/Post-Closure Plan prepared for the City of Torrington by YWC, submitted to the Connecticut Department of Environmental Protection (DEP) on April 8, 1985, and revised as per comments from DEP personnel dated January 9, 1987 (CTD000845263). The Plan addresses only final closure, as the facility has ceased to accept industrial sludge. A copy of the approved Closure Plan (and any revisions) will be kept on file by the City of Torrington until certification of closure, prepared by an independent registered professional engineer, indicating that the facility has been closed in accordance with the specifications in the approved Closure Plan, and has been submitted to the Connecticut DEP, and to the Regional Administration (U.S. EPA, Region I). Engineering Design Plans and Construction Specifications for final site closure are appended to this Closure Plan.

Updates for the Closure and Post-Closure Plans will be the responsibility of the City of Torrington's Director of Public Works, Mr. Robert Good.

This Closure Plan ensures that the final closure of the Torrington Industrial Waste Landfill will be completed in a manner that minimizes the need for further maintenance. In addition, the Plan was developed to control, minimize, or eliminate risks to human health and the environment while limiting the possible release of the RCRA-regulated wastes (metal hydroxide sludges), leachate, or contaminated surface run-off or decomposition products to the atmosphere, surface, or groundwaters.

The Closure Plan provides such protection through the use of EPA recommended cover design, including provisions for:

- a 2 foot thick soil layer having a permeability of 10^{-7} cm/sec. or less;
- a 20 mil or thicker synthetic liner;
- a 12 inch thick drainage (sand) layer;
- a 2 foot thick vegetative soil layer;
- a shallow rooted vegetative crop.

Also included are provisions for site security to prevent unauthorized access, periodic monitoring of appropriately designated groundwaters, and scheduled facility inspections to confirm the condition and performance of the closure system.

2.0 SITE DESCRIPTION

The City of Torrington Metal Hydroxide Industrial Waste Landfill is a small portion of the total Municipal Landfill and is physically located on top of a closed out portion of the Refuse Landfill. The entire Municipal Landfill is located within the City limits, just off Old Dump Road. The City of Torrington Landfill Site Plan and Topography which also shows the Metal Hydroxide Landfill is included as Figure 2-1. The total area of the Metal Hydroxide Industrial Waste Landfill is approximately 2.63 acres. Metal hydroxide sludge has been placed in cells at the landfill to a depth of 7 feet.

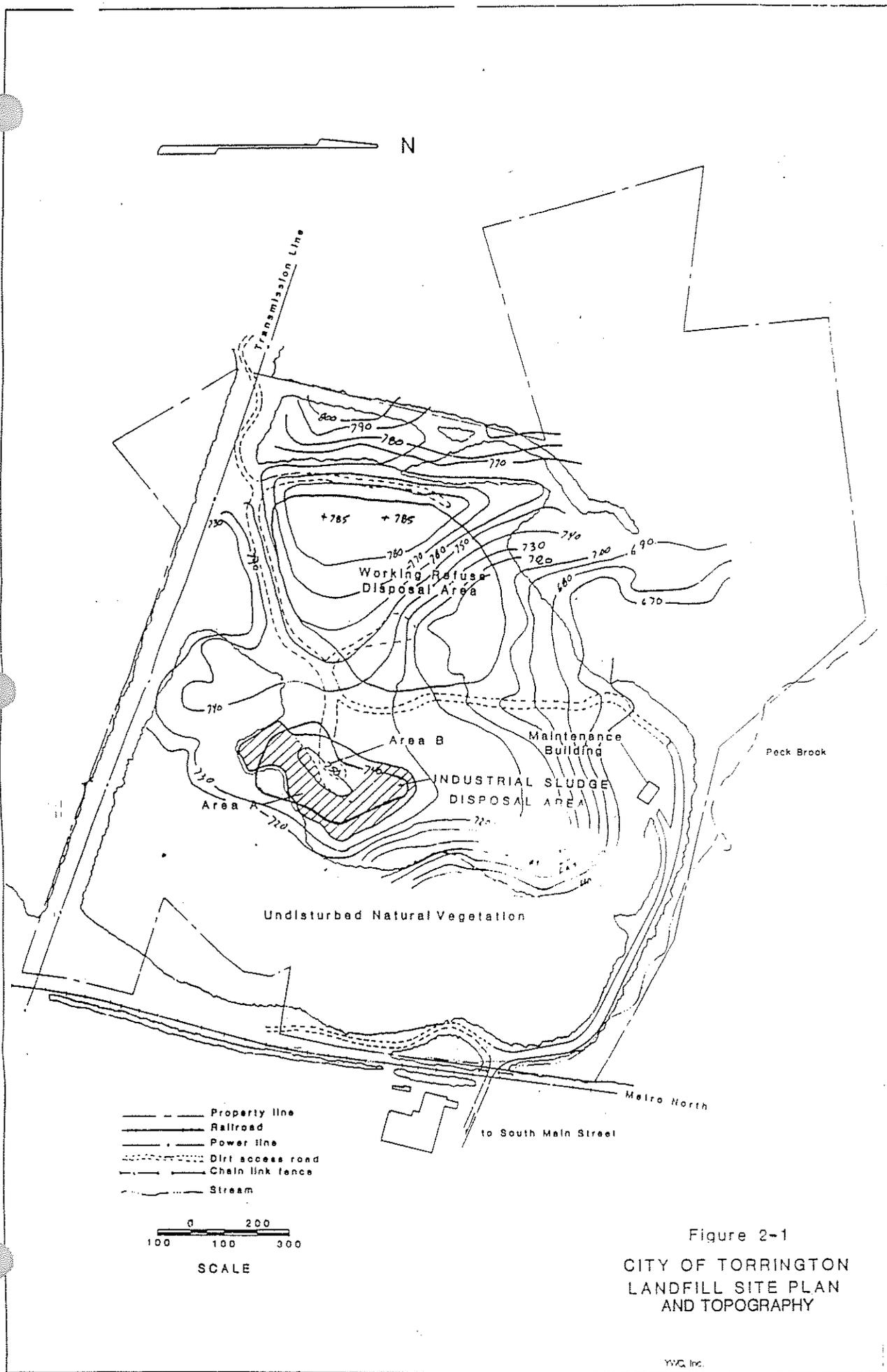


Figure 2-1
 CITY OF TORRINGTON
 LANDFILL SITE PLAN
 AND TOPOGRAPHY

3.0 PARTIAL CLOSURE

The Torrington Landfill has ceased to accept industrial (metal hydroxide) sludge as of August 30, 1986, and it is therefore inappropriate to discuss partial Closure Plans. The final material disposed of was the metal hydroxide sludge and sand from the drying beds of the City of Torrington Water Pollution Control Plant.

4.0 WASTE INVENTORY

The maximum waste inventory includes the total volume of metal hydroxide sludge placed in the landfill cells, as well as an estimate of the total amount of soils and groundwater affected by this waste.

Groundwater monitoring of the Metal Hydroxide Industrial Waste Landfill has been extensive and covers the time from April 1982 to date. This information is included in Appendix D. This information indicates a groundwater generally of poor quality, exhibiting conditions typically associated with a municipal refuse landfill leachate.

Because of the location of the Metal Hydroxide Sludge Landfill within the Torrington Municipal Landfill, it is difficult to characterize the source of the observed poor quality of groundwater. The only metal detected at elevated levels (with the exception of iron and manganese) is barium, and this was found at its highest concentrations upgradient of the Metal Hydroxide Sludge Landfill. The majority of parameters detected in elevated concentrations are those normally associated with refuse leachate rather than metal hydroxide leachate. Hence, at this time, no soils or groundwater contamination can be quantified. Because of the lack of detection of metals down gradient, the qualitative estimate is that little or no soil and groundwater has been affected to date by the metal sludge portion of the landfill.

Therefore, the maximum volume of contaminated soil and groundwater is the maximum volume of the Hydroxide Sludge Landfill. Based upon the surface area of the Industrial Sludge Landfill of 114,500 square feet, an average depth of 7 feet, and a working volume of 79%, the total volume (considering volumes lost to berm construction) is 23,450 cubic yards of dewatered hydroxide sludge. The total volume of the landfill, including berm material, is approximately 29,700 cubic yards. The Waste Analysis Plan of the materials deposited at the facility during its regulated period (taken from the Part B Application) is presented in Appendix B.

As per the final ruling published in the July 9, 1987 Federal Register, the landfilled sludges must be sampled for Appendix IX compounds. To comply with this requirement in a cost-effective manner, the sludge will be sampled via split-spoon sampler in nine locations (Drawing TP-1), with samples taken at 2 foot intervals (but not less than four samples per hole). The sludge samples will then be composited into three general groups (S1, S2, and S3 on TP-1) and analyzed for the Appendix IX compounds. This sampling procedure will allow an appropriate verification of the composition of the sludge.

5.0 EQUIPMENT DECONTAMINATION

There are no structures or facilities on the Metal Sludge Landfill which need to be dismantled. The landfill was a materials disposal facility, and no containers, tanks, or waste piles exist or existed at the site. All shovels, rakes, and other portable equipment used at the Industrial Sludge Landfill have either been cleaned prior to leaving the site or disposed of in the landfill prior to closure. All cleaning materials have been disposed of in the landfill.

During the regrading of the landform for final closure and the placement of the various cap materials, a dozer, along with other equipment, will be utilized. There is the potential for the dozer blade to come into contact with metal hydroxide sludge during the regrading of the landform and the placement of the first lift of the clay layer. Therefore, at the end of each day that the dozer blade comes into contact with the metal hydroxide sludge, the dozer blade will be decontaminated. All decontamination materials will be disposed of within the landfill.

Decontamination of equipment will utilize steam-cleaning, and little washwater is anticipated. That washwater (i.e., condensed steam) that is produced will be collected in secure drums or water tanks, sampled and analyzed, manifested, and sent to an appropriate treatment facility.

6.0 CLOSURE PLAN

This Closure Plan addresses the specifics of the cover construction, the structures necessary to control surface run-on and run-off, and the modified groundwater monitoring program. Construction Specifications and Engineering Design Plans are appended and provide additional information regarding cover preparation and construction techniques (Appendix C).

A licensed contractor, experienced in closure activities associated with hazardous waste disposal, will be retained by the City to complete all construction activities. Closure efforts will be monitored by qualified engineering personnel to ensure compliance with the approved Closure Plan. When complete, the City of Torrington and its registered professional engineer, will certify that the Industrial Sludge Landfill closure has been completed as specified in the plans and specifications of the approved Closure Plan.

6.1 Site Preparation

Closure activities will include construction of a landfill closure cover consisting of five soil layers, an impermeable synthetic membrane, and geotextile erosion control membranes. In order to prevent differential settling of the cap, several procedures have been or will be followed to stabilize the waste and prepare the surface for cap placement.

Waste stabilization involves the solidification of the waste sludges to prevent settlement as fluids are slowly forced out. Early sludges (1970's) added to the landfill were insufficiently dewatered, and were later stabilized by extensive sand addition. The approximate ratio of sand to sludge utilized during the entire landfilling procedure was 4:1 (sand/dewatered sludge). This resulted in a solid, stable material which was covered with 6 to 24 inches of local soil and compacted by a track-mounted bucket loader used at the landfill. With a stabilized sludge solids content of approximately 50% prior to initial compaction, little further settlement is expected.

However, to verify such a conclusion, at least three core samples of bulked sludge from the last completed cell will be removed, taken to an accredited materials (soils) testing laboratory, and subjected to a one-dimensional consolidation test (odometer test), a permeability analysis, and determination of the coefficient of consolidation. From the coefficient of consolidation, the estimated weight and surface pressure of cover material, and the percent of consolidation achieved at this loading, the initial percent consolidation will be compared with the ultimate

compression. If such analysis indicates a greater than 6 inch further compaction can be expected for this material, then additional compression of the sludge material (by appropriate construction equipment) is to be performed in order to achieve the more consolidated material (primary consolidation). With this procedure, settlement from initial and primary consolidation can be essentially eliminated.

Secondary compression, usually associated with clays and organic materials, is not expected to be important with this material, due to the high percentage of sand (bulking agent) and the relatively low compressibility of the material following the initial compaction. No organic solids are present in the sludge, no biological oxidation of solids is anticipated, no liquification of solids is expected and, with the sand bulking agent, the shrinkage as dewatering proceeds is not expected to be significant.

Following the determination of adequate compressive preparation of the sludge, the actual cover emplacement can begin. Because of the present fill overburden, no wind dispersal of materials is anticipated during cover placement. When necessary, slight wetting of the surface can be employed to preclude dust formation. Surface water and groundwaters are to be protected during cap placement by diversion of all surface waters from the cell(s) being covered, via swales, ditches, and other run-on/run-off structures addressed below.

To further address the problem of settlement of the cap or underlying landfill material, three permanent benchmarks are to be emplaced on the cap. These are to be surveyed as to their initial elevations with respect to the benchmark noted on Drawing TP-1 (railroad spike in boulder, elevation 769.09 feet). The emplaced benchmarks will be 2 foot square concrete blocks, and will be placed as shown on Drawing TP-1.

6.2 Cap Design

The cap design is in accordance with EPA Guidelines, Section 265.310. Detailed Specifications for this design are present in Appendix C to this document, and can be summarized (from bottom to top):

- A 2 foot thick soil layer having a permeability of 1×10^{-7} cm/sec. or less.
- A 20 mil synthetic membrane liner.
- A 12 inch thick drainage (sand) layer.

- o Geotextile filter fabric material designed to prevent the passage of fine material into the drainage layer from above.
- o 24 inches of vegetative soils (subsoil and topsoil).
- o A vegetative crop.

A typical section of this cover is presented in Figure 6-1. The specific types of soils and synthetic materials along with proper construction techniques (e.g., compaction methods) to ensure cover integrity, and the types and characteristics of vegetation to be used and proper testing methods, are all outlined in detail in the Construction Specifications appended to this Closure Plan. However, the procurement of all of the soil materials and testing to ensure conformance with cover material specifications will be the responsibility of the selected contractor, which in turn will be verified and certified by the City's engineer.

The final cover system is designed to minimize the possible effects as a result of freezing. Estimated depth of frost penetration for the Central Connecticut (Torrington) region is approximately 25 inches. The depth of soil materials above the synthetic liner and soil cap material is a least 3 feet. As a result, frost penetration should not adversely impact the final cover system.

6.3 Drainage and Erosion Control

Surface run-on and run-off controls to be implemented during closure of the landfill will include the limiting of top crown surface slopes to between 3% and 5% (Figure 6-1), with side slopes of up to 1:2 (Figures 6-2 and 6-3). Maximum slopes near drainage channels will be of no more than 1:2, but actual site conditions may result in side slopes slightly greater than 1:2. While this will result in excellent run-on/run-off diversion, such slopes may warrant additional erosion controls to limit soil loss. The previously described soil vegetative cover will assist in this effort, but further measures, especially during construction, may be warranted. In order to deal with these slopes, a suitable surface erosion synthetic soil cover will be emplaced (Armatex Geomatrix, or equal). These erosion control materials will be placed wherever slopes greater than 1:2 are found (Figure 6-3). These materials will prevent excessive erosion of the soil and vegetative materials on these slopes.

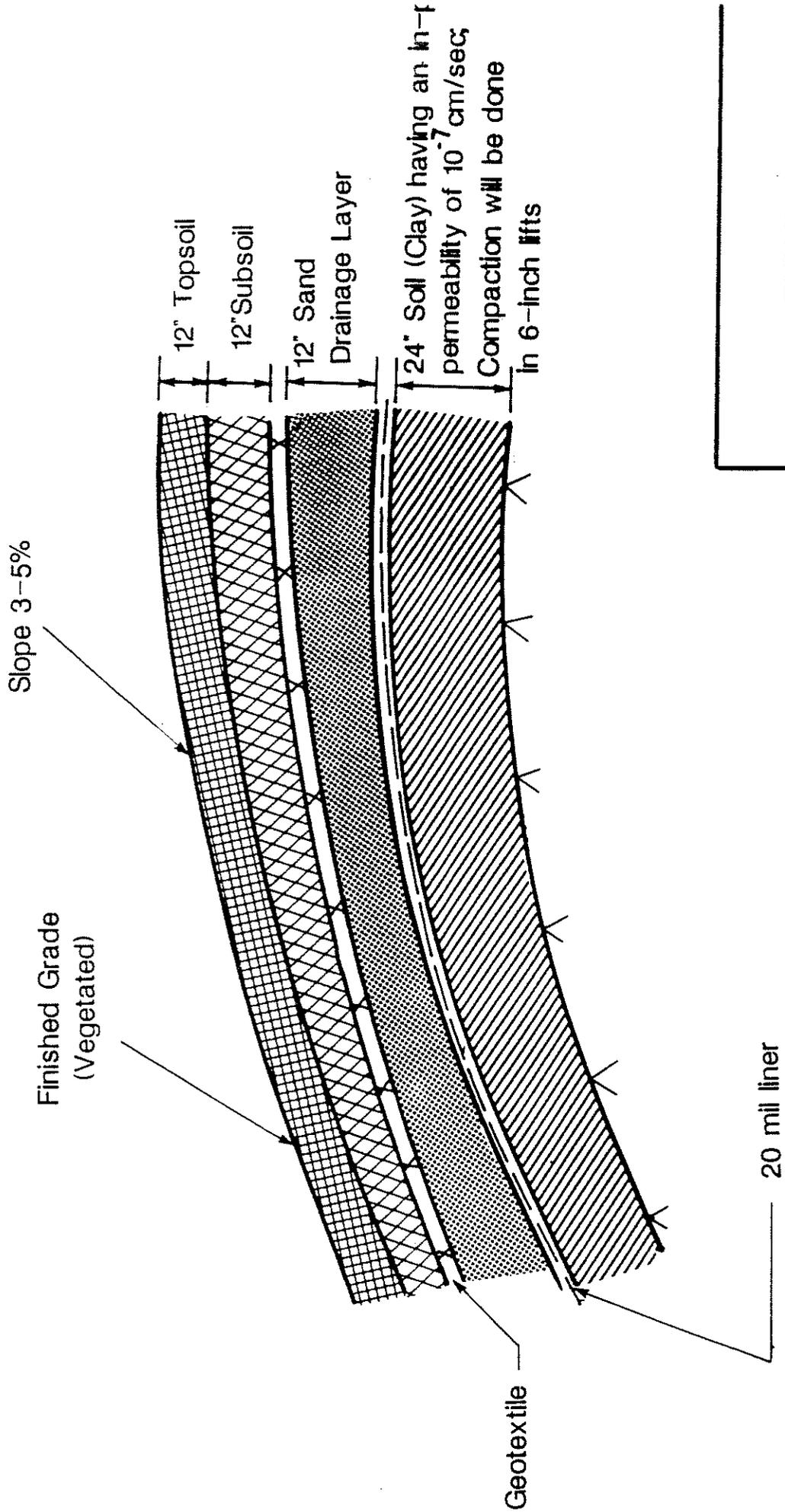


FIGURE 6-1

**Typical Cap
Crown Section**

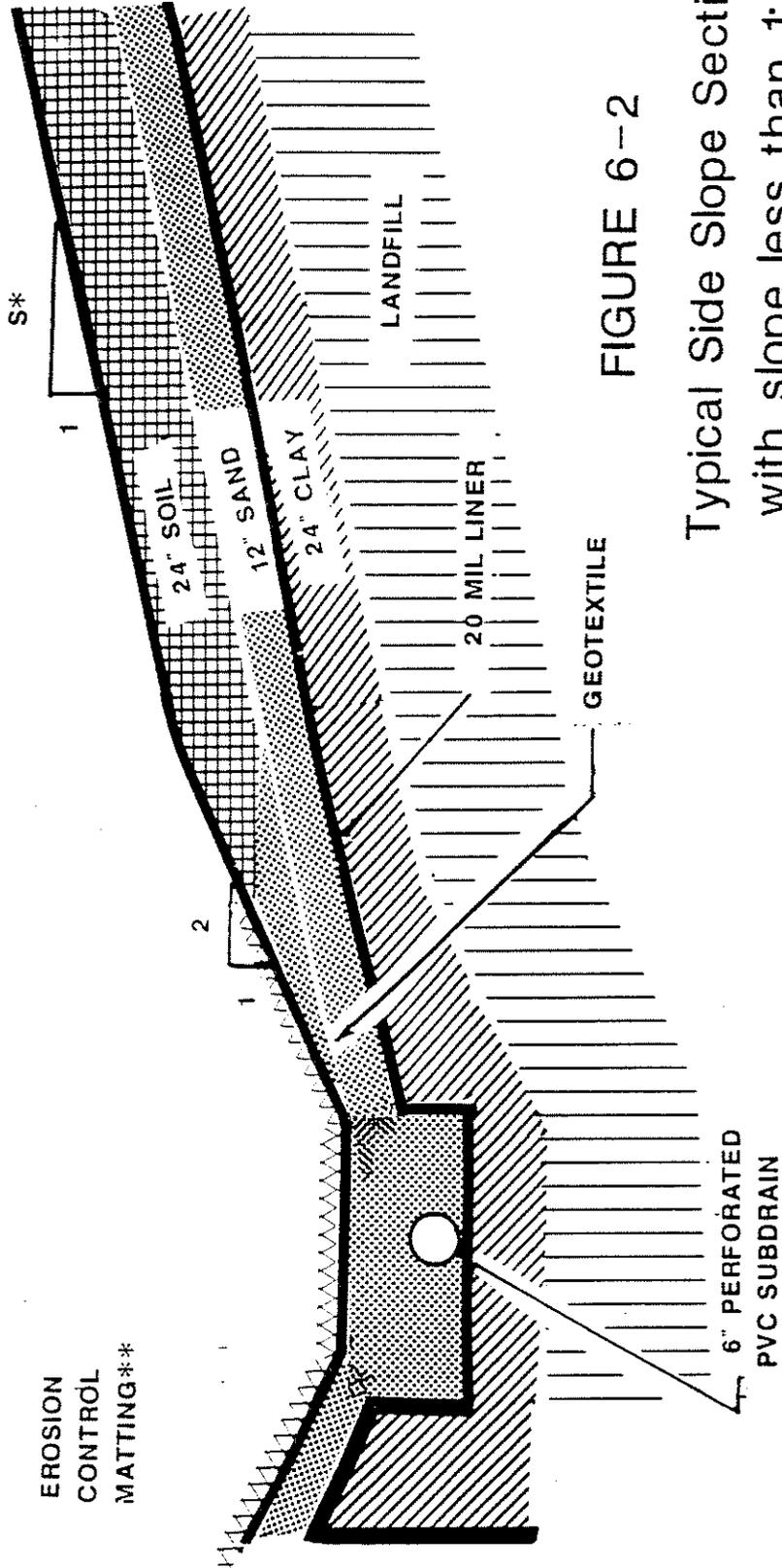


FIGURE 6-2

Typical Side Slope Section
with slope less than 1:2

*--Slope variable; less than 1:2
 **--Grass will be grown on the matting for additional erosion control

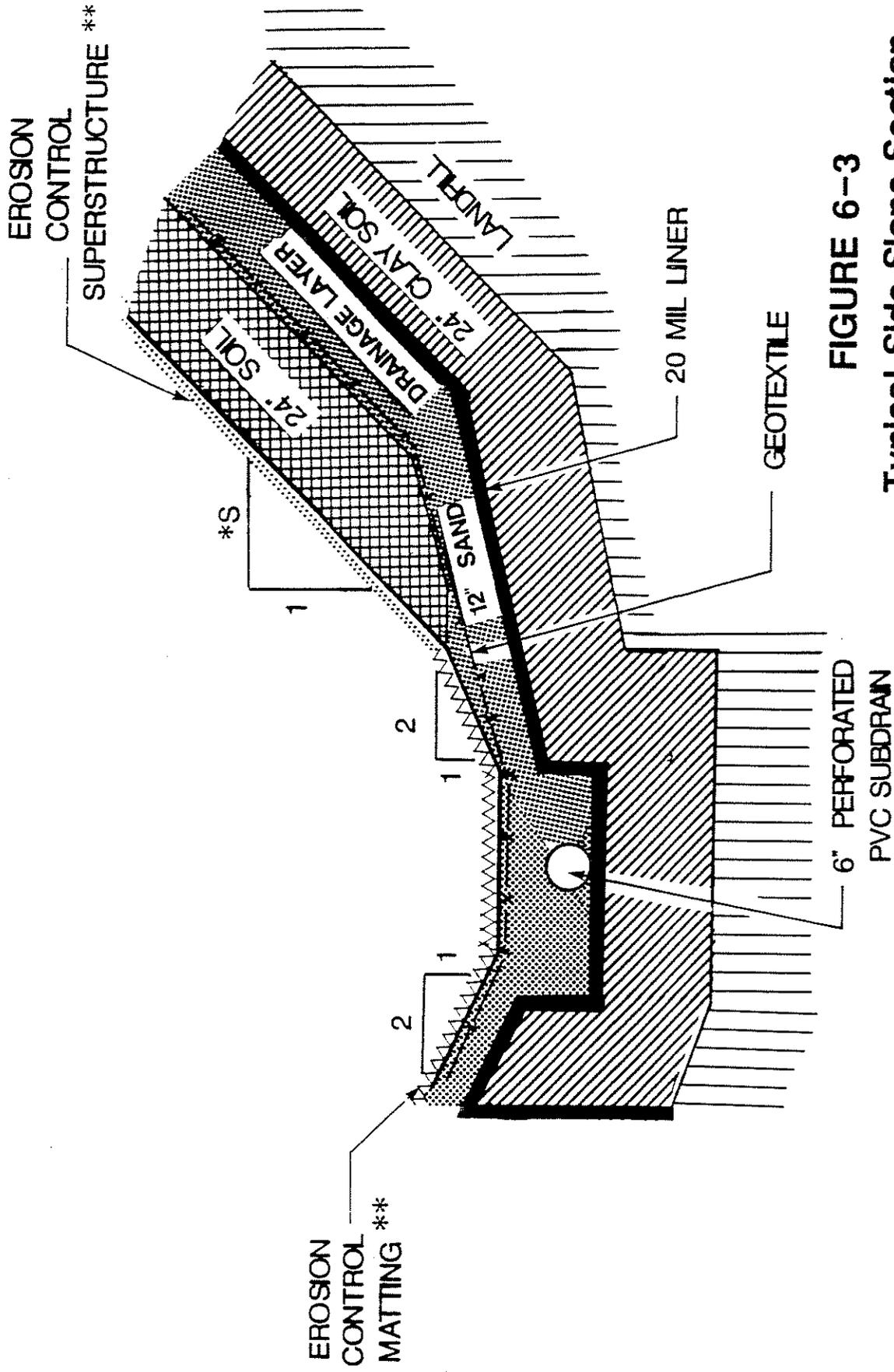


FIGURE 6-3
Typical Side Slope Section
with drainage channel slope
greater than 1:2

*: Slope variable; greater than 1:2 up to 1:1 maximum

** - Grass will be grown on both the matting and superstructure for additional erosion control

This landfill is located on the eastern slope of a hill (refuse landfill), with its northern, eastern, and south/southeastern slopes sloping onto a down sloping surface falling away from the metal hydroxide landfill. The metal hydroxide landfill's western edge slopes into a wide area that drains to the north. This wide drainage area divides the refuse landfill from the metal hydroxide landfill. Except for limited sections of the south/southwestern portion of the metal hydroxide landfill, the topography of the metal hydroxide landfill and surrounding land form areas lends itself to natural sheet flow without the need for drainage channels for surface run-off and run-on control throughout the majority of the circumference of the landfill. Drainage channels will be provided in those areas where the topography is such that sheet flow will not be totally sufficient, and where run-on could be potentially anticipated.

The drainage ditches, where required, have been evaluated to ensure available capacity to convey run-off that would be expected from a 25 year (return period) precipitation event. It has been determined (calculations in Appendix A) that the drainage ditches have the capacity to convey more than twice that quantity of run-off. To protect against erosion of these channels during periods of extreme run-off, synthetic "matting" (Miramat, Curex Blanket, or equal) or bituminous pavement will be placed throughout the run-off channel system.

The Armater Geomatrix product has been used successfully at a number of embankment sites to stabilize slopes of 1:1 and greater. Some of these projects have included:

- Industrial waste lagoon sidewalls in Coolomb, France;
- Railway embankments in Gabon, West Africa;
- Highway embankments in Argeles, France; and
- Irrigation canal sidewalls of the Elephant Butte Irrigation District in Las Cruces, New Mexico.

With proper installation procedures followed, appropriate slope stability should be obtained with this material for slopes greater than 1:2, but less than or equal to 1:1.

The Miramat synthetic "matting" has been successfully employed at several locations, including:

- Storm water channel erosion control at the Dalton, Georgia By-Pass between Routes 3 and 71;

- Erosion control at privately owned (BFI) landfill in Morristown, New Jersey;
- Waste Management's private landfill in Bordentown, New Jersey; and
- Erosion control at the SCI hazardous waste landfill in Niagara Falls, New York.

As can be seen, these materials have been successfully employed at other landfill and drainage facilities. Their employment here is considered appropriate.

The drainage layer of sand is protected against clogging by fine materials (silt and clay) by a geotextile membrane (Specifications appended). With this preventive measure against clogging, and with a minimum top slope of between 3% to 5% (much higher on sides), effective removal of precipitation which has infiltrated the vegetative topsoil layer will be maintained.

Revegetation of the final cover is an important aspect of final site closure because the vegetative mass increases soil stability and helps control erosion by water (run-on and run-off) and wind. For the Torrington Industrial Landfill closure, it is planned that grasses (which can provide a quick ground cover and dense root structure of limited depth) will be provided. Information regarding the type of vegetation to be planted at the landfill, following closure, is provided in the Construction Specifications (appended).

Because this cap design equals or exceeds EPA Guidelines, the long-term minimization of water flow through the landfill has been achieved.

6.3.1 Potential Municipal Landfill Expansion Impacts

The City of Torrington has an Application pending with the Connecticut DEP Solid Waste Management Unit to expand its Municipal Refuse Landfill vertically an average of 40 feet. This vertical expansion has the potential to increase dramatically the volume and velocity of surface drainage that will be directed towards the toe of the east and northeast slopes of the Hazardous Waste Cell. Therefore, the drainage swale located between the Hazardous Waste Cell and the proposed expanded Municipal Refuse Landfill must be designed, sized, and constructed to intercept the increased flow and direct it away from the Hazardous Waste Cell to prevent erosion of the Hazardous Waste Cell.

It is ~~inappropriate~~ at this stage of the Hazardous Waste Cell Closure Design to re-design the existing drainage swale between the western edge of the metal hydroxide landfill and the refuse landfill. This existing drainage swale, as is, is more than adequate for the existing refuse landfill and the proposed improvements to the metal hydroxide landfill. It is not known at this time if the requested vertical expansion of the Municipal Refuse Landfill will be granted, denied, or modified. Therefore, as part of the final design of the Municipal Refuse Landfill expansion, once a Landfill expansion is granted, if granted, the drainage swale between the Municipal Refuse Landfill and Hazardous Waste Cell will have to be re-designed, if necessary, and constructed to intercept and direct the run-off from the Municipal Refuse Landfill away from the Hazardous Waste Cell.

6.4 Site Security

To ensure that the closed facility remains in satisfactory physical condition, certain security measures and inspection routines will be instituted upon completion of closure activities.

To prevent unauthorized entrance to the landfill, the entrance gate just east of the railroad tracks will remain closed and locked during non-operating hours. This will prevent any unauthorized motor vehicles from gaining access to the closed landfill areas. The physical location of the landfill, the side of a mountain with rugged, steep forested slopes, provides a natural barrier to both vehicular and pedestrian access. During normal operating hours, the landfill is patrolled, thereby controlling and limiting access to the Refuse Landfill and preventing access to the Hazardous Waste Landfill, except by authorized personnel. In addition, warning signs with the legend "Danger - Unauthorized Personnel Keep Out - Hazardous Waste Area" will be posted around the perimeter of the Industrial Sludge Landfill and also at the gate. In addition, the signs to be located around the perimeter of the Industrial Sludge Landfill site will be located on 50 foot centers, and will be maintained or replaced as necessary to ensure that any unauthorized persons gaining access to the facility by foot will be alerted to the potential dangers associated with the hazardous waste disposal site. All signs are to be legible from a minimum distance of 25 feet. The entire site is to be surrounded by fencing to ensure the prevention of unauthorized entry. In addition, the wells at the citizen's drop-off area will be fenced and covered to avoid the likelihood of vandalism.

6.5 Groundwater Monitoring

The groundwater monitoring program for the Industrial Waste Landfill was submitted to the Connecticut DEP in June 1986. Since approval for this Plan is pending, the Draft Plan has been appended (Appendix D) to this Closure Plan as a description of the proposed groundwater monitoring program. If required by the appropriate Regulatory Agencies, the Final (amended) Plan will be substituted for the Draft Plan.

Drawing TP-1, Sections AA and BB, show the maximum estimated groundwater elevation. This information is based upon an evaluation of best available information and, at best, is only an approximation of actual conditions.

7.0 SCHEDULE FOR CLOSURE

Because the Torrington Industrial Landfill ceased disposal operations in August 1986, the 180 day notification of closure will not be met. However, upon formal approval of the Closure Plan, notification of closure will be given. Within 80 days of Closure Plan approval, Torrington Industrial Landfill Closure activities will be initiated. Completion of final closure at the Metal Hydroxide Sludge Landfill will occur within 180 days after approval of the Closure Plan. A licensed contractor, selected through standard City of Torrington bidding procedures, and experienced in construction activities associated with hazardous waste disposal options, will be retained by the City of Torrington to complete the closure. The planned closure schedule is presented in Table 7-1.

An inspector representing the City of Torrington will be present at the site during all construction activities to supervise the entire construction process. Construction inspection will be performed by engineers experienced in the closure of landfills to ensure conformance to the Specifications for all work as found appended.

TABLE 7-1
TORRINGTON INDUSTRIAL LANDFILL
 CLOSURE SCHEDULE

<u>Closure Activity</u>	<u>Activity Completion Date (Days)</u>
Closure Plan Approval	0
Solicitation of Closure Construction Bids	30
Submittal of Closure Construction Bids	45
Selection of Closure Construction Contractor	55
Commence Closure Construction	100
Stabilize Present Cells	110
Place, Grade, and Compact Low Permeability Layer	120
Construct Drainage Controls	125
Install Synthetic Membrane	135
Place, Grade, and Compact Soil Drainage Layer	140
Install Filter Fabric	145
Place, Grade, and Prepare Topsoil and Sandy Loam Layer	150
Apply Lime, Fertilizer, Seed, and Mulch	155
Install Warning Signs and Fencing	160
Final Site Clean-Up	160
Certification of Closure Submittal to Connecticut DEP	180

8.0 CLOSURE COST ESTIMATE

Closure activities associated with final closure of the Torrington Industrial Landfill are estimated to cost \$438,700 (February 1987 dollars). Table 8-1 presents a summary of the estimated costs. The activities associated with this cost estimate include construction of the cover system, construction of drainage control structures, earth work, and grading. These estimates include transportation and installation of all materials.

It should be noted that this estimated cost is significantly higher than previous estimates because of the radical redesign required by the EPA Guidelines established since the initial (April 8, 1985) submittal. This is due primarily to the increased requirements for sludge stabilization, the low permeability layer, and site security requirements.

TABLE 8-1
 TORRINGTON INDUSTRIAL LANDFILL
 CLOSURE COST ESTIMATES

Initial Sampling			\$ 29,500
Stabilization	\$ 1.68/Cu. Yd.	30,000 Cu. Yd.	\$ 50,400
Low Permeability Soil Layer	\$ 13.94/Cu. Yd.	8,500 Cu. Yd.	\$118,200
PVC Liner (20 mil)	\$ 0.30/Sq. Ft.	114,500 Sq. Ft.	\$ 34,400
Sand Drainage Layer	\$ 10.15/Cu. Yd.	4,250 Cu. Yd.	\$ 43,100
Geotextile Matting	\$ 0.14/SF	114,500 SF	\$ 16,100
Subsoil	\$ 7.03/Cu. Yd.	6,375 Cu. Yd.	\$ 44,800
Topsoil	\$ 12.00/Cu. Yd.	2,125 Cu. Yd.	\$ 25,500
Seeding/Landscaping	\$171.94/1000 SF	114,500 SF	\$ 19,700
Erosion Control	\$ 10.50/SY	2,430 SY	\$ 25,600
Drainage Swale Construction	\$ 0.78/SF	12,600 SF	\$ 9,800
Fencing and Security	\$ 12.00/LF	1,800 LF	\$ 21,600
Construction Sub-Total			<u>\$438,700</u>
ESTIMATED CLOSURE COST			<u>\$438,700</u>

9.0 POST-CLOSURE PLAN

9.1 General

Once the Industrial Waste Landfill is closed in accordance with this Plan, it must still be adequately maintained to minimize the possibility of environmental damage by either natural causes or through human contact. Federal and Connecticut Regulations require that a Post-Closure (maintenance) Plan be prepared for the 30 years following final closure of the landfill. The primary areas to be addressed for post-closure maintenance are inspections for physical damage to the landfill cover, and groundwater monitoring to detect any groundwater contamination. In both instances, these post-closure activities are extensive of programs instituted during the active life of the facility.

The intensity and length of the post-closure care program may be modified before the end of the 30-year period. This may be accomplished if evidence is produced which demonstrates that the secure nature of the facility makes continuing the specified intensity of post-closure requirements unnecessary. To obtain a waiver of certain portions of the Post-Closure Plan, a written request with satisfactory background data must be submitted to the Commissioner of the Department of Environmental Protection and the Regional Administrator of Region I, EPA for review.

9.2 Inspection and Maintenance

A post-closure inspection regime will be instituted immediately upon final closure of the facility. The purpose of the post-closure inspection is to reveal any deterioration in the final cover over landfill cells which could lead to the uncovering of the landfilled waste or lead to infiltration of rainwater through the waste, thus increasing the possibility of leachate contamination of the groundwater. The groundwater monitoring wells, surveyed benchmarks, security fencing and warning signs will also be checked as part of routine inspections.

The inspections during the post-closure period are depicted below:

Post-Closure Inspections

<u>Item</u>	<u>Frequency</u>
Gates and Fencing	Monthly
Signs	Monthly
Cover*	Monthly
Groundwater Monitoring Wells	Monthly
Surveyed Benchmarks	Monthly

*Monthly and after Severe Storms.

These inspections are to be followed to ensure that any problems are discovered early enough to correct the situation before any harm comes to human health or the environment. For the first year, the inspections are to be held on a monthly basis. If the site shows no sign of deterioration during this year, the inspections may be performed on a quarterly basis thereafter. If any repair work is necessary, monthly inspections will be required for a minimum six-month period following completion of repairs. In the event of a severe storm, the site is to be inspected as soon as reasonably possible after the storm to check the integrity of the cover.

In the event that any problems are discovered, the City must take adequate remedial action on a schedule which prevents any damage to human health or the environment. If a discovered problem presents an imminent health hazard or a hazard has already occurred, remedial action to remove or eliminate the hazard must be taken immediately.

The City of Torrington is required to keep a record of all inspections performed in an inspection log book. The inspection log must indicate the date an inspection was made and who made the inspection. All observations must be indicated, as well as the time of the observation. Any actions taken regarding the observation should be included on this log. Actions taken at a later date must be cross-referenced to the original log to indicate when a particular problem is solved. A sample inspection log sheet can be found as Figure 9-1. The inspection logs will be kept in the files of the Director of Public Works.

All groundwater monitoring wells must be inspected monthly to ensure:

- a) That the caps are in place.
- b) That the caps are locked and secure.
- c) That the casing is vertical and secure, and that the concrete collar is intact and secure.

The purpose of inspecting the condition of the groundwater monitoring wells is to ensure that they have not been successfully tampered with, nor that their integrity, nor the integrity of the groundwater sampling, has not been breached. Any deficiencies must be corrected as soon as possible following their discovery.

FIGURE 9-1
TORRINGTON HAZARDOUS WASTE LANDFILL
INSPECTION LOG

Date: _____

Inspector: _____

Item/Location Inspection: _____

Time of Inspection: _____

Weather Conditions: _____

OBSERVATIONS:

REMEDIAL ACTION OR REPAIRS:

All surveyed benchmarks must be inspected monthly to ensure that they are still in place. If one or more are discovered missing, they must be surveyed in as soon as possible following their discovery.

All gates and fences must be inspected on a monthly basis. The purpose of these inspections will be to discover:

- a) Discontinuities in the fencing material or any intruder deterrence device such as barbed wire.
- b) Weakness in posts or foundations which may cause a section of fence to topple.
- c) Malfunctions in the gates which may result in a gate's failure to close and lock properly.

The purpose of inspecting the condition of fencing and gates is to ensure that the possibility of unauthorized entry to the facility is minimized. Any abnormalities in the fencing must be adequately repaired as soon as possible following their discovery.

All signs shall be inspected monthly to ensure:

- a) They are securely in place.
- b) They remain legible from a distance of 25 feet.

Any sign which has fallen from its mounting or which is found to be loose shall be returned to its intended position and firmly attached to its mounting. In the event where trees, shrubs, or any other item has obstructed adequate view of a sign, one of the following remedial actions must be implemented.

- a) Relocate the sign.
- b) Put up additional signs as required.
- c) Trim the trees or shrubs, or remove the obstacle.

The landfill cover is to be inspected on a monthly basis for:

- a) Healthy growth of ground cover (during growing season).
- b) Any evidence of surface erosion, storm water puddling.

- c) Any other damage to cover material, including outcroppings of waste material and settling resulting from improper compaction or other causes.

If any of the above abnormalities are discovered, the cause shall be determined, and any necessary remedial or corrective measures are to be taken as soon as possible. Remedial measures that might be expected could include refertilization and reseedling of vegetative cover; regrading of cover to control run-off and puddling; construction of swales or other drainage devices to redirect storm water away from areas damaged in the past.

Other maintenance procedures for cover maintenance, settlement correction, frequency of mowing, erosion control, run-on/run-off control structure repair, and site security items are described completely in the amended Specifications.

9.3 Cost Estimates

Annual post-closure costs are summarized below. A total of \$9,550 per year is anticipated for the identified items. Also included is the estimated 30 year (present day) allotment cost for the full post-closure program. It should be noted that these costs do not include the initial 24 well sampling program.

<u>Item</u>	<u>Annual Cost*</u> <u>(February 1987)</u>
Laboratory Analyses	\$ 9,800
Labor	\$ 2,400
Quarterly and Annual Reports	\$ 3,600
Post-Closure Inspection	\$ 3,000
Contingency for Landscaping	<u>\$ 1,500</u>
	<u>\$ 20,300</u>
TOTAL 30 YEAR ALLOTMENT	\$609,000

*Based upon six monitoring wells sampled quarterly.

It should be noted that these estimated costs do not include the preliminary Appendix IX determinations for the sludge and groundwater samples. Based upon a unit price of \$3,000 for sludge samples and \$2,750 for water samples, a total of \$25,500 (three composited and six groundwater samples) will be required for this initial testing. These costs are included in the Closure Cost Estimates under Initial Sampling.

10.0 FINANCIAL REQUIREMENTS

The City of Torrington is required to submit a financial statement indicating that sufficient liability insurance (an aggregate of \$8 million) is available for sudden and non-sudden accidental occurrences until the time when the metal hydroxide cells are certified closed. Such a financial test letter is to be prepared by the City's Chief Financial Officer and submitted to the Department of Environmental Protection and the Regional Administrator of the EPA, Region I.

11.0 CLOSURE AND POST-CLOSURE ADMINISTRATIVE PROCEDURES

The Closure and Post-Closure Plans will be kept at the Department of Public Works, and all correspondence concerning the Closure and Post-Closure Plans will be done through that office. Amendment of the Plans will be authorized and approved by the Mayor of Torrington and the City Council.

As specified in 40 CFR Part 264.119, within 90 days after closure is completed, the City of Torrington will submit to the Planning and Zoning Authority a survey plat indicating the location and dimension of the industrial sludge disposal area with respect to permanently surveyed benchmarks. The plat will be prepared and certified by a certified professional land surveyor. The plat will contain a note, prominently displayed, which states the City of Torrington's obligation to restrict disturbance of the site. In addition, a record will be included indicating the type, location, and quantity of industrial sludge disposed in the industrial sludge disposal area. The Planning and Zoning Board will officially approve the document at its monthly meeting by incorporating the document into the official meeting minutes. The document will subsequently be made part of the Planning and Zoning file. Figure 11-1 presents the note format that will be used to accompany the survey plat.

In addition to the notification of the Planning and Zoning Authority, the City of Torrington will record a notation on the property deed that will perpetually notify any purchaser that the land has been used to manage hazardous waste, and its use is restricted. Also, the notation will include the survey plat and record of the type, location, and quantity of hazardous wastes disposed in the industrial sludge area. It will be filed with the Planning and Zoning Authority. The notation will, thereby, be made part of the deed and subsequently the file. Figure 11-2 presents the form of the written deed notice.

Within 60 days of the completion of closure activities, i.e., construction of the cap, the City of Torrington will submit to the Department of Environmental Protection and the Environmental Protection Agency by registered mail, return receipt requested, a letter certifying that the sludge landfill has been closed in accordance with the Specifications of the approved Closure Plan. The Certification will be signed by both the facility owner/operator and an independent registered professional engineer. A sample Closure Certification is provided in Figure 11-3.

FIGURE 11-1
SAMPLE NOTE TO ACCOMPANY SURVEY PLAT

This plat describes real property in which hazardous wastes have been disposed and buried in accordance with requirements of 40 CFR, Part 265. Although the hazardous waste disposal facility is now closed, public health, environmental safety, and regulations issued by the United States Environmental Protection Agency of 40 CFR, Part 265.117(c) require that post-closure use of the property never be allowed to disturb the integrity of the final cover, liner(s) or any attached containment system unless it can be demonstrated that any proposed disturbance will not increase any risk to the public or the environment as determined by the Connecticut Department of Environmental Protection and the Region I Administrator of the United States Environmental Protection Agency.

Your attention is directed to the accompanying list of wastes, described by type and location, buried at the above-described facility.

OWNER'S OR OPERATOR'S SIGNATURE

DATE

FIGURE 11-2
SAMPLE DEED NOTICE

The minimum requirements of notice under Part 265.120 are as follows:

TO WHOM IT MAY CONCERN:

_____, the undersigned, of _____
_____, City of _____,
County of _____, State of _____,
hereby gives the following notice as required by 40 CFR, Part 265.120:

- 1) I am, and since _____, 19____, have been in possession
in fee simple of the following described lands _____

(Legal Description)

- 2) Since _____, 19____, I have disposed of
hazardous chemical wastes under the terms of regulations promulgated by
the United States Environmental Protection Agency on/in the above
described land.

FIGURE 11-3
SAMPLE CERTIFICATION OF CLOSURE

To Whom It May Concern:

This letter certifies that the Torrington Industrial Sludge Landfill has been closed in accordance with the Specifications of the approved Closure Plan and, as such, satisfies the requirements of 40 CFR, Section 265.115.

Public Works Director
City of Torrington

Registered Professional Engineer
P.E. License No. _____

APPENDIX A
RUN-OFF CALCULATIONS

TORRINGTON, CONNECTICUT
METAL HYDROXIDE SLUDGE LANDFILL
CLOSURE PLAN
DRAINAGE DITCH DESIGN

- 1) The Rational Formula (1) was used to estimate the peak run-off rate from the landfill area.

Rational Formula: $Q_p = CiA$

Where:

Q_p = Peak Run-Off (cfs)

C = Run-Off Coefficient (cfs Hr./Acre In.)

i = Average Rainfall Intensity (In./Hr.) Lasting for a Critical Period of Time

A = Site of Drainage Area (Acres)

For the Torrington Site:

$C = 0.70$

$A = 2.623$ Acres

$L^1 = 2.5$ In./Hr. for 25 Year Storm, 1 Hr. Storm

$Q_p = 4.59$ cfs

- 2) The flow capacity of the drainage channels was based upon the design shown in Figures 6-2 and 6-3. The Manning Equation was employed to determine the open channel flow (1):

$$Q = \frac{1.49}{n} AR^{2/3} S^{1/2}$$

Where:

Q = Flow Rate (cfs)

n = Roughness Coefficient

A = Cross-Sectional Area of Channel

P = Wetted Perimeter

R = A/P , the Hydraulic Radius

S = Slope of Channel

For the Torrington Landfill:

$n = 0.05$ (Channels with Vegetation)

$A = 9$ ft²

$P = 9.7082^1$

$R = 0.9271$

$S = 0.007$

$Q = 21.3$ cfs

APPENDIX B
WASTE ANALYSIS PLAN
(FROM PART B PERMIT APPLICATION)

3.0 WASTE CHARACTERISTICS

This section describes the physical and chemical nature of material disposed of at the City of Torrington industrial sludge landfill. The Waste Analysis Plan describes the sampling, testing, and evaluation procedures necessary to ensure safe and efficient handling of the wastes received at the industrial sludge landfill.

3.1 Chemical and Physical Analyses

Hazardous wastes are not generated, treated, or stored at the landfill. Dewatered industrial wastewater treatment facility sludge cake is accepted at the landfill for disposal only. The design capacity for ultimate disposal volume is discussed in Section 4.0. The anticipated annual volume of sludge cake to be accepted at the landfill is discussed later in this Section and in Section 4.0. The dewatered sludge received at the landfill is disposed of by the cell method which is discussed in Section 4.0.

The material presently accepted at the City of Torrington industrial sludge landfill is dewatered metal hydroxide sludge generated by four manufacturing firms located within City limits. The wastewater sludges are generated by the treatment of metal finishing rinse waters. The sludges are, therefore, classified as listed hazardous wastes from non-specific sources - EPA Number F006, Wastewater Treatment Sludges From Electroplating Operations. This material by nature does not exhibit the characteristics of ignitability, corrosivity, reactivity, or being acutely hazardous. The material is classified as being toxic.

Table 3.1 presents a list of the industries generating sludges accepted at the Torrington industrial sludge landfill, and the anticipated sludge volumes to be disposed of by landfilling.

Table 3.2 presents the results of laboratory analyses performed on representative sludge cake samples collected in

TABLE 3.1
METAL HYDROXIDE SLUDGE GENERATORS

<u>Generator</u>	<u>Projected Dewatered Sludge Volume¹ (cu. yds.)</u>
Union Tubular ² 535 Migeon Avenue Torrington, CT 06790 (203) 489-9254 EPA ID# CTD001980911	350
Torrington Company ³ 59 Field Street Torrington, CT 06790 (203) 482-9511 EPA ID# CTD001148717 (Standard)	200
Turner & Seymour ⁴ 100 Lawton Street Torrington, CT 06790 (203) 489-9214 EPA ID# CTD001148758	140
Colonial Bronze ³ 511 Winsted Road Torrington, CT 06790 (203) 489-9233 EPA ID# CTD058508722	2

¹Projected sludge generation for January-December, 1984.

²Sludge dewatered by generator. Average solids content 40%.

³Sludge dewatered at City of Torrington industrial sludge drying beds. Average solids content 20%.

⁴Sludge dewatered by generator. Average solids content 25%.

TABLE 3.2
SOLID WASTE ANALYSIS BY GENERATOR
EP TOXICITY RESULTS (mg/l)

Parameter	Union Tubular 12/83	Union Tubular 1980	Torrington Co. 12/83	Torrington Co. 1980	Turner & Seymour 04/84	Turner & Seymour 1980	Pheol of ¹ New England 1980	Colonial Bronze	EP Toxicity Limit
Aluminum	--	<1.0	--	1.8	--	--	<1.0	Not	--
Arsenic	<0.8	--	<0.8	--	<0.5	--	--		5.0
Barium	<0.5	--	<0.5	--	<0.5	--	--	Tested	100.0
Cadmium	<0.05	<0.025	0.87	3.69	5.84	10.7	0.113		1.0
Chromium	1.68	<0.05	<0.10	<0.10	0.25	<0.1	<0.1	Yet	5.0
Lead	0.4	<0.5	<0.2	0.5	0.4	<0.5	0.4		5.0
Mercury	<0.02	--	<0.02	--	<0.02	--	--		0.2
Selenium	<0.5	--	<0.5	--	<0.5	--	--		1.0
Silver	<0.2	--	<0.2	--	<0.2	--	--		5.0
Nickel	33.2	66.0	0.54	4.4	35.1	208	--		10.0*
Copper	<0.2	0.04	8.09	7.8	5.85	39.0	4.7		10.0*
Zinc	3.82	43.2	1.15	71.3	7.17	437	33.5		10.0*
Iron	--	0.18	--	490.0	--	<0.12	0.21		--
pH (S.U.)		7.1		8.6		9.1	10.3		N/A
Moisture (%)		--		--		--	--		N/A
Organics (GC Scan)		0		0		0	0		N/A

¹Pheol of New England no longer generates sludge for disposal at the City of Torrington landfill.

*Connecticut Department of Environmental Protection Limits.

TABLE 3.3
WASTE ANALYSIS PLAN¹

Waste Material:	Metal Hydroxide Sludge
Analytical Parameters:	pH, % Solids, EP Toxicity (Standard Metals - Arsenic, Barium, Cadmium, Chromium, Lead, Mercury, Selenium, Silver, and Nickel, Copper, Zinc, Iron, and Aluminum).
Rationale:	<p>pH and % Solids; Indication of physical characteristics of sludge as received.</p> <p>EP Toxicity - The sludges are listed as hazardous wastes (F006) containing varying amounts of these metals.</p>
Test Methods:	<p>pH - Electrometric - Test methods for evaluating solid waste. Physical/Chemical Methods EPA SW-846.</p> <p>% Solids Gravimetric, EPA Method #270</p> <p>EP Toxicity - EP Toxicity test procedure 40-CFR 261, Appendix II.</p>
Sampling Procedure:	<p>Sampler - Waste Pile Sampler</p> <p>Sample Type - Composite of samples withdrawn from a minimum of three different points near the top of the pile to points diagonally opposite the point of entry.</p> <p>Reference - Test methods for the evaluation of solid waste. Physical/Chemical Methods, EPA SW-846.</p>
Frequency of Analysis:	Annually for each generator and individual source unless generator processes change, or visual observation indicates deviation from normal requiring additional sampling.

¹Applies to sludge cake from each generator.

1980 and 1983/84. The recent results illustrate the quality of sludge currently accepted at the landfill. At present, the sludges, in addition to being ~~categorically~~ classified as hazardous, also exhibit EP Toxicity as summarized below:

<u>Generator</u>	<u>Hazard</u>	<u>Basis for Designation</u>
Union Tubular	Toxic	EP Toxic Nickel
Torrington Company	Toxic	EP Toxic Cadmium
Turner & Seymour	Toxic	EP Toxic Cadmium and Nickel
Colonial Bronze		

3.2 Waste Analysis Plan

The Waste Analysis Plan utilized in operating the industrial sludge landfill ensures that the analysis of hazardous material is accurate, and in accordance with the objective and requirements of 40 CFR 264.13 3.2.1 Analysis Plan. The Analysis Plan uses data on each generator's sludge as acquired and analyzed by the City of Torrington's consulting engineering/laboratory firm. The Waste Analysis Plan is presented as Table 3.3. The Plan includes analytical parameters tested for and the rationale for their inclusion, laboratory test methods utilized, sampling procedures, and frequency of sampling/analysis.

3.2.1 Compatibility

The dewatered sludges accepted at the industrial landfill are non-corrosive, non-reactive, non-ignitable, and are in no way incompatible with each other. As such, no provisions have been made in the Waste Analysis Plan for these considerations.

3.2.2 Additional Requirements for Waste Generated Off-Site

As Table 3.3 indicates, a representative sample of dewatered sludge from each generator will be analyzed on a yearly basis. The metal hydroxide sludges generated by

industry do not change significantly. The minimum sampling frequency will continue as long as the generators do not significantly alter their production practices. The generators are required to notify the City as soon as possible in the event that a process change is planned, or in the event of a major facility upset.

To ensure that the characteristics of sludge disposed of in the landfill do not vary significantly from that specified by the generator, the landfill operator will keep a log book with sections for each generator. Whenever a shipment of sludge cake is received at the landfill, the visual characteristics (i.e., color, consistency, and physical appearance indicating solids content and stability) of the dewatered sludge will be observed and recorded. If a load of sludge does not conform with expected (historical) characteristics, this load will be turned away until laboratory analyses and/or operator judgement based upon past experience indicate that the material may be safely disposed of in the landfill.

APPENDIX B
WASTE ANALYSIS PLAN
(FROM PART B PERMIT APPLICATION)

APPENDIX C
CONSTRUCTION SPECIFICATIONS

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SECTION 01010
SUMMARY OF WORK

PART 1: GENERAL

1.01 LOCATION OF WORK

A. The Contractor shall furnish all materials labor, equipment, and incidentals to perform the following:

1. The work consists of clearing and grading approximately 2.63 acres of land; stabilization of covered sludge; construction of clay/till soil layer, synthetic membrane liner, drainage soil layer, filter fabric, sandy loam and topsoil layer with hydro-seeding over approximately 2.63 acres of land; construction of approximately 1,400 linear feet of drainage ditches and piping; emplacement of approximately 35,000 square feet of erosion control matting; installation of approximately 1,400 linear feet of fencing; and installation of 30 warning signs.

1.02 ABBREVIATIONS AND REFERENCES

AASHTO	-	The American Association of State Highway Officials
ACI	-	American Concrete Institute
AGMA	-	American Gear Manufacturers Association
AIEE	-	American Institute of Electrical Engineers
AISC	-	American Institute of Steel Construction
AISI	-	American Iron and Steel Institute
ANSI	-	American National Standards Institute
ASCE	-	American Society of Civil Engineers
ASME	-	American Society of Mechanical Engineers
ASTM	-	American Society of Testing Materials
AWPA	-	American Wood Preservers Association
AWS	-	American Welding Society
AWWA	-	American Water Works Association
Fed. Spec.	-	Federal Specifications
DIPRA	-	Ductile Iron Pipe Research Association
NCPI	-	National Clay Pipe Institute
NEMA	-	National Electrical Manufacturers Association
NFPA	-	National Fire Protection Association
NEWWA	-	New England Water Works Association

Where reference is made to a specifications by one of the above-mentioned or other associations, it is understood that the latest revisions thereof shall apply.

SECTION 01035
CONTROL OF WORK

PART 1: GENERAL

1.01 PLANT

- A. The Contractor shall furnish plant and equipment which will be efficient, appropriate, and large enough to secure a satisfactory quality of work and a rate of progress which will ensure the completion of the work within the time stipulated in the Proposal. If at any time such plant appears to the Engineer to be inefficient, inappropriate or insufficient for securing the quality of work required or for producing the rate of progress aforesaid, he may order the Contractor to increase the efficiency, change the character, or increase the plant equipment, and the Contractor shall conform to such order. Failure of the Engineer to give such order shall in no way relieve the Contractor of his obligations to secure the quality of the work and rate of progress required.

1.02 PRIVATE LAND

- A. The Contractor shall not enter or occupy private land outside of easements, except by permission of the owner of said private land.

1.03 OPEN EXCAVATIONS

- A. All open excavations shall be adequately safeguarded by providing temporary barricades, caution signs, lights and other means to prevent accidents to persons, and damage to property. The Contractor shall, at his own expense, provide suitable and safe bridges and other crossings for accommodating travel by pedestrians and workmen. Bridges provided for access during construction shall be removed when no longer required. The length or size of excavation will be controlled by the particular surrounding conditions, but shall always be confined to the limits prescribed by the Engineer.
- B. The Contractor shall take precautions to prevent injury to the public due to open trenches. All trenches, excavated material, equipment, or other obstacles which could be dangerous to the public shall be well lit at night.

1.04 TEST PITS

- A. Test pits for the purpose of locating underground pipeline or structures or to determine soil conditions in advance of the construction shall be excavated and backfilled by the Contractor at the direction of the Engineer. Test pits shall be backfilled immediately after their purpose has been satisfied and the surface restored and maintained in a manner satisfactory to the Engineer.

1.05 CARE AND PROTECTION OF PROPERTY

- A. The Contractor shall be responsible for the preservation of all public and private property, and shall use every precaution necessary to prevent damage thereto. If any direct or indirect damage is done to public or private property by or on account of any act, omission, neglect, or misconduct in the execution of the work on the part of the Contractor, such property shall be restored by the Contractor, at his expense, to a condition similar or equal to that existing before the damage was done, or he shall make good the damage in other manner acceptable to the Engineer.

1.06 PROTECTION AND RELOCATION OF EXISTING STRUCTURES AND UTILITIES

- A. The Contractor shall assume full responsibility for the protection of all buildings, structures, and utilities, public or private, including poles, signs, services to buildings, utilities in the street, gas pipes, water pipes, hydrants, sewers, drains, and electric and telephone cables, whether or not they are shown on the Drawings. The Contractor shall carefully support and protect all such structures and utilities from injury of any kind. Any damage resulting from the Contractor's operations shall be repaired by him at his expense.

1.07 WATER FOR CONSTRUCTION PURPOSES

- A. Water for construction purposes will be made available to the Contractor from locations determined by the Owner, specifically the Torrington Water Department. The Contractor will pay for the use of such water at a rate determined by the Owner.
- B. The express approval of the Owner shall be obtained before water is used. Waste of water by the Contractor shall be sufficient cause for withdrawing the privilege of use. Hydrants shall only be operated under the supervision of the Owner's personnel.

1.08 COOPERATION WITHIN THIS CONTRACT

- A. All firms or persons authorized to perform any work under this Contract shall cooperate with General Contractor and his Subcontractors or trades, and shall assist in incorporating the work of other trades where necessary or required.
- B. Cutting and patching, drilling and fitting shall be carried out where required by the trade or Subcontractor having jurisdiction, unless otherwise indicated herein or directed by the Engineer.

1.09 CLEAN-UP

- A. During the course of the work, the Contractor shall keep the site of his operations in as clean and neat a condition as is possible. He shall dispose of all residue resulting from the construction work and, at the conclusion of the work, he shall remove and haul away any surplus excavation, broken pavement, lumber, equipment,

temporary structures, and any other refuse remaining from the construction operations, and shall leave the entire site of the work in a neat and orderly condition.

SECTION 01151
MEASUREMENT AND PAYMENT

PART 1: GENERAL

1.01 BASE BID, PART I

- A. The work of Part I of the Base Bid in the Proposal shall include the furnishing of all labor, materials, equipment, and incidentals required to construct Contract No. 1, Closure Plan for Torrington Metal Hydroxide Sludge Landfill in its entirety as shown on the Drawings and as specified.
- B. Construct Closure Plan for Torrington Metal Hydroxide Sludge Landfill (Item 1).

1. Measurement and Payment

- a. Payment of the lump sum bid in the Proposal for Item 1, shall be full compensation for all labor, materials, equipment, and incidentals required, except that required under Items 2a, 2b, 3, and 4 of Part I to construct Contract No. 1, Closure Plan for Torrington Metal Hydroxide Sludge Landfill in its entirety, including site preparation, earth work and grading, synthetic membrane, drainage soil layer, sandy loam layer, bedding material layer, filter fabric, warning signs, drainage ditches, groundwater monitoring well extensions, site restoration work, loaming and hydroseeding and appurtenant work, all as shown on the Drawings and specified in the Information for Bidders, Bid Form, General and Supplementary Conditions and Divisions 1 and 2. Payment under this item shall fully compensate the Contractor for any other work not specified or shown, but evidently required to complete the work.

- C. Rock and Boulder Excavation (Items 2a and 2b).

1. Measurement

- a. When rock is encountered, the material shall be uncovered and the Engineer notified. The Engineer will then take cross sections of the rock surface. Failure to uncover the ledge, notify the Engineer, and allow ample time for cross-sectioning the undisturbed material shall not give right of claim to any classification other than that allowed by the Engineer. Removal of old concrete foundations, if any, shall be classified as rock.
- b. At structures, measurement will be to the neat lines of the structure and below the bottom of the slab to the depth indicated on the Drawings. No allowance will be made for over-breakage.

- c. Measurement for rock excavation will extend to a depth below the invert of the drainage ditches and to a width as specified by the Engineer. Trench widths referred to herein are the distances separating the vertical planes between which the drainage ditches are constructed. In computing the amount of rock excavation in trenches for payment, the width of the trench shall be as shown or as directed by the Engineer.
- d. The top of the trench will be the ground elevation as determined by the Engineer prior to excavation. The grades of the invert of the ditch shall be as shown on the Drawings. In computing the amount of rock excavation, the depth of the trench shall be as indicated on the Drawings.
- e. Normal grade of the bottom of the trench, as used hereinafter, is defined as the limit of excavation shown on the Drawings.
- f. Boulders more than 1 cubic yard in volume when encountered in earth or trench excavation within limits specified will be measured for payment. Removal of boulders of whatever size will not be paid for when encountered in borrow areas.
- g. The quantity of rock and boulder excavation to be paid for shall be the number of cubic yards of rock or boulders measured in place, as directed by the Engineer, within the limits herein specified.

2. Payment

- a. Payment for rock and boulder excavation will be made for the quantities as determined above, measured in cubic yards, at the unit price for Items 2a and 2b bid in the Proposal, which price and payment shall be full compensation for excavation, blasting and disposal of rock, back-filling, and providing borrow for any deficiency of back-fill, and all work incidental thereto for which payment is not provided under other items.

D. Excavation of Unsuitable Materials and Refill (Item 3).

1. Measurement

- a. Measurement of excavation of unsuitable material and refill will extend only downward from the excavation limits shown on the Drawings to the depth authorized by the Engineer.

- b. If the bottom of excavation is below that indicated on the Drawings through error of the Contractor, or for the convenience of the Contractor, or if improper drainage softens the subgrade and additional excavation beneath pipe or structures is required, such removal and replacement of material will not be measured for payment.

2. Payment

- a. Payment for excavation of unsuitable materials and refill with general fill will be made for the quantity as above determined at the price per cubic yard bid under Item 3 in the Proposal, which price and payment shall be full compensation for excavation and disposal of all unsuitable materials below limit of excavation shown, furnishing and placing general fill, additional costs of sheeting and drainage, and all work incidental thereto, for which separate payment is not provided under other items.

E. Common Fill (Item 4).

1. Measurement

- a. If additional common fill to that required for grading in Item 1 is required to fully complete the project as a result of conditions substantially differing from those shown on the Drawings and not reasonably anticipated or at direction of the Engineer, the Contractor shall immediately notify the Engineer. If certified by the Engineer that such additional fill is beyond the work to be provided under the lump sum, the Engineer will then take cross sections of the area to establish the quantity of fill for any payment under this item. Failure to notify the Engineer and allow ample time for cross-sectioning shall not give right of claim to any classification other than that allowed by the Engineer.

2. Payment

- a. Payment for common fill will be made for the quantities as determined above, measured in cubic yards, at the unit price for Item 4 bid in the Proposal, which price and payment shall be full compensation for providing such common fill and all work incidental thereto for which payment is not provided under other items.

1.02 PAYMENT, TOTAL BASE BID, PART I

- A. Payment of the total price bid in the Proposal for Part I shall fully compensate the Contractor for furnishing all labor, materials, equipment, and incidentals required to complete the work as outlined above and under Section 01010, including site preparation, earth work and grading, compaction of bulked sludge, clay/fill layer, synthetic membrane liner, drainage soil layer, filter fabric, sandy

loam and topsoil layer, loaming and hydroseeding, drainage ditches and piping, erosion control matting, fencing, warning signs, site restoration work, and all appurtenances required to complete the work as specified and shown on the Drawings. Payment shall also include compensation for any other work required to complete the project as described in the Specifications and/or shown on the Drawings and not specifically mentioned under Part I.

1.03 EXTRA WORK

- A. Extra work, if any, will be performed in accordance with Article 10 of the General Conditions and will be paid for in accordance with the provisions of Article 11.

SECTION 01340
SUBMITTALS

PART 1: GENERAL

1.01 DESCRIPTION OF REQUIREMENTS

- A. This Section specifies the general methods and requirements of submittals applicable to the following work-related submittal: (1) Shop Drawings, Product Data, and Samples. Additional general submittal requirements are contained in Paragraphs 6.23 through 6.28 of the General Conditions. Detailed submittal requirements will be specified in the technical specifications sections.

1.02 SHOP DRAWINGS, PROJECT DATA, SAMPLES

A. Shop Drawings

1. Shop drawings, as defined in the General Conditions, and as specified in individual work Sections include, but are not necessarily limited to, custom-prepared data such as fabrication and erection/installation drawings, scheduled information, setting diagrams, actual shop work manufacturing instructions, custom templates, special wiring diagrams, coordination drawings, individual system or equipment inspection, and test reports including performance curves and certifications, as applicable to the work.
2. All shop drawings submitted by subcontractors for approval shall be sent directly to the Contractor for preliminary checking. The Contractor shall be responsible for their submission at the proper time so as to prevent delays in delivery of materials.
3. The Contractor shall check all subcontractor's shop drawings regarding measurements, size of members, materials, and details to satisfy himself that they conform to the intent of the Drawings and Specifications. Drawings found to be inaccurate or otherwise in error shall be returned to the subcontractors for correction before submission thereof.
4. All details on shop drawings submitted for approval shall show clearly the elevations of the various parts to the main members and lines of the structure, and where correct fabrication of the work depends upon field measurements, such measurements shall be made and noted on the Drawings before being submitted for approval.

B. Product Data

1. Product data as specified in individual Sections include, but are not necessarily limited to, standard prepared data for manufactured products (sometimes referred to as catalog data),

such as the manufacturer's product specifications and installation instructions, availability of colors and patterns, manufacturer's printed statements of compliances and applicability, roughing-in diagrams and templates, catalog cuts, product photographs, standard wiring diagrams, printed performance curves and operational-range diagrams, production and quality control inspection and test reports and certifications, mill reports, product operating and maintenance instructions and recommended spare-parts listing, and printed product warranties, as applicable to the work.

C. Samples

1. Samples specified in individual Sections include, but are not necessarily limited to, physical examples of the work such as sections of manufactured or fabricated work, small cuts or containers of materials, complete units of repetitively-used products, color/texture/pattern swatches and range sets, specimens for coordination of visual effect, graphic symbols, and units of work to be used by the Engineer or Owner for independent inspection and testing, as applicable to the work.

1.03 CONTRACTORS RESPONSIBILITIES

- A. The Contractor shall review shop drawings, product data and samples prior to submission to determine and verify the following:
 1. Field measurements.
 2. Field construction criteria.
 3. Catalog numbers and similar data.
 4. Conformance with the Specifications.
- B. Each shop drawing, working drawing, sample and catalog data submitted by the Contractor shall have affixed to it the following Certification Statement, signed by the Contractor: "Certification Statement: by this submittal, I hereby represent that I have determined and verified all field measurements, field construction criteria, materials, dimensions, catalog numbers, and similar data, and I have checked and coordinated each item with other applicable approved shop drawings and all Contract requirements".
- C. Notify the Owner in writing, at the time of submittal, of any deviations in the submittals from the requirements of the Contract Documents.
- D. The review and approval of shop drawings, samples or catalog data by the Engineer shall not relieve the Contractor from his responsibility with regard to the fulfillment of the terms of the Contract. All risks of error and omission are assumed by the Contractor, and the Engineer will have no responsibility therefore.

- E. No portion of the work requiring a shop drawing, working drawing, sample, or catalog data shall be started nor shall any materials be fabricated or installed prior to the approval or qualified approval of such item. Fabrication performed, materials purchased or on-site construction accomplished which does not conform to approved shop drawings and data shall be at the Contractor's risk. The Owner will not be liable for any expense or delay due to corrections or remedies required to accomplish conformity.
- F. Project work, materials, fabrication, and installation shall conform with approved shop drawings, working drawings, applicable samples, and catalog data.

1.04 SUBMISSION REQUIREMENTS

- A. Make submittals promptly in accordance with approved schedule, and in such sequence as to cause no delay in the work or in the work of any other Contractor.
- B. Number of submittals required:
 - 1. Shop Drawings: In Article 6.23, Line 4, of the General Conditions, delete "5 copies" and insert therefore "6 copies".
 - 2. Product Data: Submit six copies.
 - 3. Samples: Submit the number stated in the respective Specification Sections.
- C. Submittals shall contain:
 - 1. The date of submission and the dates of any previous submissions.
 - 2. The Project title and number.
 - 3. Contractor identification.
 - 4. The names of:
 - a. Contractor
 - b. Supplier
 - c. Manufacturer
 - 5. Identification of the product, with the specification section number.
 - 6. Field dimensions, clearly identified as such.
 - 7. Relation to adjacent or critical features of the work or materials.

8. Applicable standards, such as ASTM or Federal Specification numbers.
9. Identification of deviations from Contract Documents.
10. Identification of revisions on resubmittals.
11. An 8" x 8" blank space for Contractor and Engineer stamps.

1.05 RESUBMISSION REQUIREMENTS

- A. Make any corrections or changes in the submittals required by the Engineer and resubmit until approved.
- B. Shop Drawings and Product Data:
 1. Revise initial drawings or data, and resubmit as specified for the initial submittal.
 2. Indicate any changes which have been made other than those requested by the Engineer.
- C. Samples: Submit new samples as required for initial submittal.

1.06 DISTRIBUTION

- A. Distribute reproductions of approved shop drawings and copies of approved product data and samples, where required, to the job site file and elsewhere as directed by the Engineer. Number of copies shall be as directed by the Engineer but shall not exceed 6.

1.07 GENERAL PROCEDURES FOR SUBMITTALS

- A. Coordination of Submittal times: Prepare and transmit each submittal sufficiently in advance of performing the related work or other applicable activities, or within the time specified in the individual work sections, of the Specifications, so that the installation will not be delayed by processing times, including disapproval and resubmittal (if required), coordination with other submittals, testing, purchasing, fabrication, delivery, and similar sequenced activities. No extension of time will be authorized because of the Contractors failure to transmit submittals sufficiently in advance of the Work.
- B. Within 10 days after award of Contract, the Contractor shall submit to the Engineer in triplicate a breakdown of the lump sum items. This breakdown shall be subject to approval by the Engineer, and when so approved, shall become the basis for determining progress payments and for negotiation of change orders, if required.

SECTION 01601
CONTROL OF MATERIALS

PART 1: GENERAL

1.01 APPROVAL OF MATERIALS

- A. Unless otherwise specified, only new materials and equipment shall be incorporated in the work. All materials and equipment furnished by the Contractor shall be subject to the inspection and approval of the Engineer. No material shall be delivered to the work without prior approval of the Engineer.
- B. As specified in Section 01340, the Contractor shall submit to the Engineer data relating to materials and equipment he proposes to furnish for the work. Such data shall be in sufficient detail to enable the Engineer to identify the particular product and to form an opinion as to its conformity to the specifications.
- C. Facilities and labor for handling and inspection of all materials and equipment shall be furnished by the Contractor. If the Engineer requires, either prior to beginning or during the progress of the work, the Contractor shall submit additional samples or materials for such special tests as may be necessary to demonstrate that they conform to the specifications. Such samples shall be furnished, stored, packed, and shipped as directed at the Contractor's expense. Except as otherwise noted, the Owner will make arrangements for and pay for the initial tests. Any additional costs for testing that may be required as a result of materials not complying with these specifications will be borne by the Contractor.
- D. Any delay of approval resulting from the Contractor's failure to submit samples or data promptly shall not be used as a basis of a claim against the Owner or the Engineer.
- E. The materials and equipment used on the work shall correspond to the approved samples or other data.

1.02 HANDLING AND STORAGE OF MATERIALS

- A. All materials and equipment to be incorporated in the work shall be handled and stored by the manufacturer, fabricator, supplier, and Contractor before, during, and after shipment in a manner to prevent warping, twisting, bending, breaking, chipping, rusting, and any injury, theft or damage of any kind whatsoever to the material or equipment.
- B. Cement and lime shall be stored under a roof and off the ground, and shall be kept completely dry at all times. All structural, miscellaneous, reinforcing steel shall be stored off the ground or otherwise to prevent accumulations of dirt or grease, and in a position to prevent accumulations of standing water and to minimize rusting.

Block and similar masonry products shall be handled and stored in a manner to reduce breakage, chipping, cracking, and spalling to a minimum.

- C. All mechanical equipment subject to corrosive damage by the atmosphere if stored outdoors (even though covered by canvas) shall be stored in a building to prevent injury. The building may be a temporary structure on the site or elsewhere, but it must be satisfactory to the Engineer.
- D. All materials which, in the opinion of the Engineer, have become so damaged as to be unfit for the use intended or specified shall be promptly removed from the site of the work, and the Contractor shall receive no compensation for the damaged material or its removal.

SECTION 02100
SITE PREPARATION

PART 1: GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment, and incidentals required and perform all clearing and grubbing complete as shown on the Drawings within the Limits of Work and as specified herein.

PART 2: PRODUCTS (None this Section)

PART 3: EXECUTION

3.01 CLEARING AND GRUBBING

- A. Except as otherwise directed, cut, grub, remove and dispose of all trees, stumps, brush, shrubs, roots, and any other objectionable material within the limits defined on the Drawings.
- B. Trees or groups of trees designated by the Engineer to remain shall be protected from damage by all construction operations by erecting suitable barriers, or by other approved means. Clearing operations shall be conducted in a manner to prevent falling trees from damaging trees designated to remain.
- C. Areas outside the Limits of Work as defined on the Drawings shall be protected and no equipment or materials shall be stored or allowed to damage these areas.
- D. No stumps, trees, limbs, or brush shall be buried in any fills or embankments.

3.01 DISPOSAL OF MATERIALS

- A. All tree trunks, limbs, roots, stumps, brush and other vegetation shall become the property of the Contractor at the Contractor's discretion and removed by him off the project site for disposal or sale.
- B. All tree trunks, roots, stumps, and other vegetation, shall be removed by the Contractor.
- C. Burning of cleared and grubbed materials will not be permitted.

SECTION 02221
TRENCHING, BACKFILLING, COMPACTION, AND GRADING

PART 1: GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment, and incidentals necessary to perform all trenching for drainage ditches, including drainage, filling, backfilling, grading of landfill site, and disposal of surplus material.
- B. Excavation shall extend to the width and depth shown on the Drawings or as specified.
- C. The bottom of the excavation shall be firm, and in all respects, acceptable. If conditions warrant, the Contractor may be ordered to deposit gravel refill for excavation below grade, directly on the bottom of the trench immediately after excavation has reached the proper depth and before the bottom of the trench has become softened or disturbed by any cause whatever.

1.02 RELATED WORK NOT INCLUDED

- A. Granular fill materials are included in Section 02223.
- B. Topsoil placement and hydroseeding are included in Section 02485.

PART 2: PRODUCTS (None this Section)

PART 3: EXECUTION

- A. Construction of all drainage ditches shall be done by excavating existing grades to the point that they match those grades and locations as shown on the Drawings.
- B. Drainage ditch cross sections shall approximate the typical cross section as shown on the Drawings.
- C. Rip-rap shall be placed at the downstream ends of the drainage ditches at the west end of the side to a point which extends 15 feet from the ends of the ditches as shown on the Drawings.
- D. Rip-rap to be placed at the end of the drainage ditches shown on the Drawings shall be as specified in Section 02223.
- E. Erosion control matting to be placed throughout drainage ditches as shown on the Drawings.

3.02 COMPACTION

- A. Present overburden, low permeability layer, drainage soil layer (sand), bedding material layer and sandy loam layer in open areas shall be placed in layers not to exceed six inches in thickness as

measured before compaction. Each layer shall be compacted to at least 90% of maximum dry density as determined by ASTM D1557, Method B, C, D, as applicable.

- B. Compaction shall be performed as specified for the particular materials and operations.
 - 1. Self-propelled compactor consisting of a fully loaded 10-wheel dump truck or tractor weighing 30,000 pounds shall make compaction passes at a speed of not more than 5 miles per hour for open area compaction.
 - 2. A pass shall be one complete coverage of the area compacted by the rear wheel tire treads or tractor treads in contact with the flat earth surface.
 - 3. Areas inaccessible to a tractor or truck shall be compacted with approved mechanical compaction equipment. The material compacted by mechanical compactors shall be placed in 6 inch layers and thoroughly tamped over the entire surface to specified compaction. Compaction equipment is subject to approval by the Engineer.
- C. It is the intention that the fill materials with respect to moisture be used in the condition they are excavated insofar as this is practicable. Material which is too wet shall be spread on the fill area and permitted to dry, assisted by harrowing if necessary, until the moisture content is reduced to allowable limits. Fill materials shall have a moisture content not wetter than 5 percentage points above nor less than 2 percentage points below the optimum moisture content as determined by the Modified Proctor Test ASTM D1557, Method B, C, or D, as applicable.
- D. If the Engineer determines that added moisture is required, water shall be applied by sprinkler tanks or other sprinkler systems, which will ensure uniform distribution of the water over the area to be treated, and give complete and accurate control of the amount of water to be used. If too much water is added, the area shall be permitted to dry before compaction is continued.
- E. The Contractor shall supply all hose, piping, valves, sprinklers, pumps, sprinkler tanks, hauling equipment, and all other materials and equipment necessary to apply water to the fill in the manner specified. Water shall be obtained at the Contractor's expense.
- F. Compacted Common Fill used for pre-grading the site shall be placed in maximum 6 inch thick loose lifts and compacted to a minimum of 90% of the maximum density as determined by a laboratory compaction test (ASTM D1557). The series of compacted lifts shall be done until matching the elevations shown on the Drawings.
- G. Compacted granulated fill used for the soil drainage layer as shown on the Drawings shall be placed in maximum 6 inch loose lifts and compacted to a minimum of 90% of the maximum density as determined

by a laboratory compaction test (ASTM D1557). The series of compacted lifts shall be done until a compacted thickness of 12 inches for the soil layer is reached, matching the elevations shown on the Drawings.

3.03 SOIL TESTING

- A. At least ten days prior to anticipated use of the materials identified in Section 02223, the Contractor shall provide a one-pint sample of the proposed material for hydraulic conductivity testing and approval. The Contractor shall cooperate fully in obtaining the information desired.
- B. Previous to the general placement of the fill, and during such placement, the Engineer may select areas within the limits of the fill for testing the degree of compaction obtained and hydraulic conductivity after compaction. The Contractor shall cooperate fully in obtaining the information desired.
- C. Payment for initial testing prior to material acceptance will be made by the Contractor. Acceptance of materials requires certified laboratory testing according to ASTM Standards specified for each material. Payment for testing during construction will be made by the Owner. If test results are unsatisfactory, all costs involved in correcting deficiencies in compacted materials to the satisfaction of the Engineer will be borne by the Contractor.

3.04 GRADING

- A. Grading shall be performed at such places as are indicated on the Drawings, to the lines, grades, and elevations shown or as directed by the Engineer. During the process of excavation, the grade shall be maintained in such condition that it will be well drained at all times. Temporary drains and drainage ditches shall be installed to intercept or divert surface water which may affect the prosecution or condition of the work.
- B. Stones or rock fragments larger than 4 inches in their greatest dimensions will not be permitted in the top 6 inches of the sub-grade line of all fills or embankments.
- C. All fill slopes shall be uniformly cressed to the slope, cross-section and alignment shown on the Drawings, or as directed by the Engineer.
- D. The right is reserved to make minor adjustments or revisions in lines or grades if found necessary as the work progresses, due to discrepancies on the Drawings or in order to obtain satisfactory construction.

3.05 DISPOSAL OF UNSUITABLE MATERIAL

- A. No excavated materials shall be removed from the site of the work or disposed of by the Contractor except as directed by the Engineer. Materials shall be neatly piled so as to inconvenience as little as possible normal work procedures, until used or otherwise disposed of as directed. Material shall be stored in an area of sufficient distance from excavations so as to not create a surcharged soil loading adjacent to the excavation.
- B. Suitable excavated material shall be used for fill embankments or backfill on the differential parts of the work as required.
- C. Excavated material when suitable shall be used to fill depressions or for other purposes as the Engineer may direct. Surplus and unsuitable material shall be stored at this site at an area designated by the Engineer.

3.06 DISPOSAL AND REPLACING OF ROCK

- A. The Contractor shall remove and dispose of off-site, all pieces of ledge and boulders which are not suitable for use in other parts of the work. Rock disposed of by hauling away to spoil areas is to be replaced by approved surplus excavations obtained elsewhere on the work, insofar as it is available. Any deficiency in the backfill material shall be made up with acceptable material approved by the Engineer.
- B. Fragments of ledge and boulders smaller than 20 pound weights may be used as common fill unless in the opinion of the Engineer the quantity is excessive, in which case he may order the removal and disposal of some of this rock.
- C. Rock may be used in fill only with the approval of the Engineer.

SECTION 02223
GRANULAR FILL MATERIALS

PART 1: GENERAL

1.01 DESCRIPTION

- A. Granular fill materials are specified in this Section, but their use for bedding pipe, replacement of unsuitable material, gravel cushion in ledge excavation, and similar uses are specified in detail elsewhere. The Engineer may order the use of fill materials for purposes other than those specified in other Sections if, in his opinion, such use is advisable.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Screened gravel shall consist of hard, durable, rounded particles of proper size and gradation, free from sand, loam, clay, excess fines, and deleterious materials. The size of the particles shall be uniformly graded gravel such that not less than 95% of the particles will pass a 1/2 inch sieve, and not more than 5% will pass a No. 4 sieve.
- B. Select common fill shall consist of mineral soil, substantially free of clay, organic material, loam, wood, trash, snow, ice, frozen soil,, and other objectionable material which may be compressible, or which cannot be compacted properly. Select common fill shall not contain stones larger than 2 inches in any dimension, broken concrete, masonry, rubble, asphalt pavement, or other similar materials. It shall have physical properties, as approved by the Engineer, such that it can be readily spread and compacted and shall be from an off-site source.
- C. Coarse gravel shall consist of sound, durable stone, free of any foreign material, angular in shape, free from structural defects and comparatively free of chemical decay. The stone shall be well graded between 1-1/2 inches and 3 inches, with not more than 5% by weight passing a No. 4 sieve.
- D. Rip-rap shall be sound, durable rock which is roughly rectangular shape and of suitable quality to ensure permanence in the condition in which it is to be used. Rounded stones, boulders, sandstone or similar soft stone will not be acceptable. Material shall be free from overburden, spoil, shale, and organic material, meet the Engineer's approval, and be well graded within the following limits:

<u>Weight of Stone</u>	<u>Percent Finer By Weight</u>
100 Lbs.	100
60 Lbs.	90
25 Lbs.	50
2 Lbs.	10

- E. Sand material for the drainage soil layer and for the bedding material layer as detailed on the Drawings shall conform to ASTM-C33 for fine aggregate. At least ten days prior to anticipated use of material, the Contractor shall supply the Engineer with a one-pint sample of the sand material for testing and approval. Based on tests performed by the Engineer, the material shall be identified as acceptable, acceptable with conditions or unacceptable. If the sand material is found unacceptable, the Contractor shall be responsible for identifying another source and shall incur all expenses associated with testing. The soil drainage layer shall exhibit a hydraulic conductivity after compaction as defined of not less than 1×10^{-3} cm/sec. as determined by testing as described in Section 02221. The bedding material layer shall have no sharp edged aggregates that may in any way impair the synthetic membrane.
- F. Sandy loam shall be loose friable soil from the "A" or "B" horizons of the soil profile and meet the textural class as defined by the USDA textural triangle containing not more than 80% sand. It shall be free from refuse, stumps, roots, brush, weeds, and rock and stones, 2 inches in overall dimensions. The soil shall have a true pH value of 5.6 to 6.5, and shall be free from any material that will prevent the proper growth of vegetation. At least 10 days prior to anticipated use of material, the Contractor shall supply the Engineer with a one pint sample of the sandy loam for testing and approval. Based on tests performed by the Engineer, the material shall be identified as acceptable, acceptable with certain additives or unacceptable. If the sandy loam is found unacceptable, the Contractor shall be responsible for identifying another source and shall incur all expenses associated with testing. All sandy loam incorporated into the work shall match the sample provided to the Engineer for testing and approval. At the Contractor's option topsoil, as approved under Section 02485 of this Specification, may be utilized in place of sandy loam. The Contractor shall request approval of this substitution from the Engineer prior to initiating grading work or soil testing.
- G. Low permeability fill shall consist of low to medium compatibility clays, sandy, or silty clays, and shall conform to Group A-6 of the AASHTO Classification System. The fill shall have a minimum of 50% by weight finer than No. 200 sieve, and shall be substantially free from organic material, wood, trash, snow, ice, frozen materials, or stone larger than 1/2 inches. It shall exhibit a hydraulic conductivity after compaction of less than 1×10^{-7} cm/sec. as determined by testing as described in Section 02221. At least ten days prior to anticipated use of material, the Contractor shall supply the Engineer with a one-pint sample of the low permeability fill for testing and approval. Based on tests performed by the Engineer, the material shall be identified as acceptable, acceptable with conditions or unacceptable. If the low permeability fill is found unacceptable, the Contractor shall be responsible for identifying another source, and shall incur all expenses associated with testing.

SECTION 02444
WARNING SIGNS

PART 1: GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment, and incidentals required to install signage as specified and scheduled herein.

PART 2: PRODUCTS

2.01 MATERIALS

- A. Sign posts shall be hot dipped galvanized standard weight 1.90 in. O.D. seamless steel pipe.
- B. Warning signs shall withstand a wind loading of 35 psf without damage or permanent deflection.
- C. Warning sign panels shall be Type C aluminum of material and thickness capable of withstanding the wind loading detailed in Part 2, Paragraph B of this section. Provide 1 inch corner radii.
- D. Warning signs shall be secured to sign posts with aluminum hardware drilled through and bolted to the posts.
- E. Shop prepare and paint warning sign panels according to manufacturer's recommendations and in a color approved by the Engineer. Shop apply 2-1/2 inch Helvetica Medium, uppercase letters by the photo silk screen process using approved ink conforming to the manufacturer's recommendations and in accordance with the approved samples.
- F. Warning signs shall read:

DANGER
UNAUTHORIZED ENTRY
IS
PROHIBITED

PART 3: EXECUTION

3.01 INSTALLATION

- A. Signage shall be installed on sign post at distances no greater than 50 feet around the perimeter of the site and at 6 feet above the finished grade, in accordance with manufacturer's recommendations and approved shop drawings.

SECTION 02485
TOPSOIL PLACEMENT, HYDROSEEDING, AND EROSION CONTROL

PART 1: GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment, and incidentals required, provide erosion control, and place topsoil, finish grade, apply lime and fertilizer, hydraulically apply seed and mulch and maintain all seeded areas as shown on the Drawings and as specified herein, including all areas disturbed by the Contractor.

1.02 RELATED WORK NOT INCLUDED

- A. Clearing, grubbing, and stripping is included in Section 02100.
B. Excavation, backfill, fill, and grading including placement of sandy loam sub-grade is included in Section 02221.

1.03 SAMPLES AND APPROVAL OF MATERIAL

- A. Samples of all materials shall be submitted for inspection and acceptance upon Engineer's request.

PART 2: PRODUCTS

2.01 MATERIALS

- A. Topsoil shall be fertile, friable, natural topsoil typical of topsoil of the locality, and shall be obtained from a well drained site that is free of flooding. It shall be without admixture of subsoil or slag and free of stones, lumps, plants, or their roots, sticks, clay, peat, and other extraneous matter, and shall not be delivered to the site or used while in a frozen or muddy condition. Topsoil as delivered to the site or stockpiled shall have pH between 6.0 and 7.0, and shall contain not less than 3% organic matter as determined by loss of ignition of moisture-free samples dried at 100°C. The topsoil shall meet the following mechanical analysis:

	<u>Percentage Finer</u>
1 Inch Screen Opening	100
No. 10 Mesh	95 - 100
No. 270 Mesh	35 - 75
0.002 mm*	5 - 25

*Clay size fraction determined by pipe or hydrometer analysis.

At least 10 days prior to anticipated start of topsoiling operations, a one pint sample of topsoil material shall be delivered to the Engineer for testing and approval. Based on tests performed by the Engineer, the topsoil shall be identified as acceptable, acceptable with certain fertilizer and limestone applications or unacceptable. If the topsoil is found acceptable, the fertilizer and lime requirements will be as specified or as recommended by the Engineer. If the topsoil is found unacceptable, the Contractor shall be responsible for identifying another source of topsoil and shall incur all expenses associated with testing additional samples. All loam incorporated into the site work shall match the sample provided to the Engineer for testing. Topsoil stockpiled under other Sections of this Division may be used subject to the testing and approval outlined above. Contractor will be responsible for screening stockpiled topsoil and providing additional topsoil as required at his own expense.

- B. Fertilizer shall be commercial mixed free flowing granules or pelleted fertilizer, 10-20-10 (N-P₂O₅-K₂O) grade for seeded areas. Fertilizer shall be delivered to the site in original unopened containers each showing the manufacturer's guaranteed analysis conforming to applicable State fertilizer laws.
- C. Lime shall be ground limestone containing not less than 85% calcium and magnesium carbonates and be ground to such fineness that at least 50% shall pass a 100-mesh sieve, and at least 90% shall pass a 20-mesh sieve.
- D. Seed shall be labeled in accordance with USDA Rules and Regulations under the Federal Seed Act and applicable State seed laws. Seed shall be furnished in sealed bags or containers bearing the date of the last germination, which date shall be within a period of 6 months prior to commencement of planting operations. Seed shall be from same or previous year's crop; each variety of seed shall have a purity of not less than 85%, a percentage of germination not less than 90%, shall have a weed content of not more than 1%, and contain no noxious weeds. The seed mixtures shall consist of seed proportioned by weight as follows:

Perennial Rye	70%
Red Top	20%
Alsike Clover	10%

- E. The seed shall be furnished and delivered pre-mixed in the proportions specified above. A manufacturer's certificate of compliance to the specified mixes shall be submitted by the manufacturers for each seed type. These certificates shall include the guaranteed percentages of purity, weed content, and germination of the seed, and also the net weight and date of shipment. No seed may be sown until the Contractor has submitted the certificates.
- F. Seed shall be delivered in sealed containers bearing the dealer's guaranteed analysis.

G. Mulch

1. For areas with slopes of 3 horizontal to 1 vertical or greater, mulch shall be comprised of threshed straw of oats, wheat, barley, rye, native hay or wood fiber.
2. For areas with slopes of less than 3 horizontal to 1 vertical, mulch shall be specially processed cellulose fiber containing no growth or germination-inhibiting substances. Mulch shall be manufactured in such a manner that after addition and agitation in slurry tanks with water, the fibers in the material become uniformly suspended to form a homogeneous slurry. When sprayed on the ground, the material shall allow absorption and percolation of moisture. Each package of the cellulose fiber shall be marked by the manufacturer to show the air dry weight content and not contain in excess of 10% moisture.

PART 3: EXECUTION

3.01 APPLICATION

- A. Unless otherwise shown on the Drawings, topsoil shall be placed to a minimum depth of 6 inches on all parts of the site not covered with structures, pavement, or existing woodland.
- B. For all seeded areas:
 1. Lime shall be applied at the rate of 100 pounds per 1,000 square feet, or as determined by the soil test to bring topsoil pH to a range of 6.0 to 7.0.
 2. Fertilizer (10-20-10) shall be applied at the rate of 30 pounds per 1,000 square feet or as determined by the soil test.
 3. Seed shall be applied at the rate of 6 pounds per 1,000 square feet.
 4. Fiber mulch shall be applied at the rate of 40 pounds per 1,000 square feet.
 5. Hay mulch shall be applied at a rate of 75 pounds per 1,000 square feet and tacked with asphalt spray at a rate of 10 gallons per 1,000 square feet.
- C. Limestone may not be mixed with fertilizer for application and shall be applied a minimum of two weeks prior to fertilizer application.
- D. After the topsoil is placed and before it is raked to true lines and rolled, limestone shall be spread evenly over the loam surface and thoroughly incorporated by heavy raking to at least one-half the depth of topsoil.

- E. The application of fertilizer may be performed hydraulically in one operation with hydroseeding and fiber mulching. The Contractor is responsible for cleaning all structures and paved areas of unwanted deposits of the hydroseeded mixture.
- F. If fertilizer is spread mechanically, the fertilizer shall be uniformly spread and immediately mixed with the upper 2 inches of topsoil.

3.02 INSTALLATION

- A. Previously established grades, as shown on Drawings, shall be maintained in a true and even condition.
- B. Sub-grade sandy loam shall be prepared by tilling prior to placement of topsoil to obtain a more satisfactory bond between the two layers. Tillage operations shall be across the slope. Tillage shall not take place on slopes steeper than 2 horizontal to 1 vertical or where tillage equipment cannot be operated.
- C. The 6 inch topsoil layer shall not be compacted. However, it shall be placed loose so that after natural settlement and light rolling, the complete work will conform to the lines, grades, and elevations indicated. No loam shall be spread in water or while frozen or muddy.
- D. After topsoil has been spread, it shall be carefully prepared by scarifying or harrowing and hand raking. All stiff clods, lumps, roots, litter, and other foreign material shall be removed from the loamed area and disposed of by the Contractor. The areas shall also be free of smaller stones, in excessive quantities, as determined by the Engineer. The whole surface shall then be rolled with a hand roller weighing not more than 100 pounds per foot of width. During the rolling, all depressions caused by settlement of rolling shall be filled with additional loam, and the surface shall be regraded and rolled until a smooth and even finished grade is created.
- E. Seeding, mulching, and conditioning shall only be performed during those periods within the seasons which are normal for such work as determined by the weather and locally accepted practice, as approved by the Engineer. The Contractor shall hydroseed only on a calm day.
- F. Schedules for seeding and fertilizing must be submitted to the Engineer for approval prior to the work. Seeding as specified herein shall be accomplished between the period of March 15 to June 15, or August 15 to October 1. Seeding during the period from October 2 to March 14 shall only be undertaken upon approval of the Engineer. Seeding during the period from June 16 to August 14 shall only be performed if irrigation is provided.
- G. Seeding shall be done within ten days following soil preparation. Seed shall be applied hydraulically at the rates and percentages indicated. The spraying equipment and mixture shall be so designed

that when the mixture is sprayed over an area, the grass seed and mulch shall be equal in quantity to the specified rates. Prior to the start of work, the Contractor shall furnish the Engineer with a certified statement as to the number of pounds of materials to be used per 100 gallons of water. This statement shall also specify the number of square feet of seeding that can be covered with the quantity of solution in the Contractor's hydroseeder. Upon completion of seeding operations, the Contractor shall furnish the Engineer with a certified statement on the actual quantity of solution applied.

- H. In order to prevent unnecessary erosion of newly topsoiled and graded slopes and unnecessary siltation of drainage ways, the Contractor shall carry out seeding and mulching as soon as he has satisfactorily completed a unit or portion of the project. For the purpose of this project, a unit is defined as 20,000 square feet. When protection of a newly loamed and graded area is necessary at a time which is outside of the normal seeding season, the Contractor shall protect those areas by whatever means necessary as approved by the Engineer and shall be responsible for prevention of siltation in the areas beyond the limit of work.
- I. When newly graded sub-grade areas cannot be topsoiled and seeded because of season or weather conditions and will remain exposed for more than 30 days, the Contractor shall protect those areas against erosion and washouts by whatever means necessary such as straw applied with a tar tack, wood chips, or by other measures as approved by the Engineer. Prior to application of topsoil, any materials applied for erosion control shall be thoroughly incorporated into the sub-grade by discing. Fertilizer shall be applied prior to spreading of topsoil.
- J. On slopes, the Contractor shall provide against washouts by an approved method. Any washout which occurs shall be regraded and reseeded at the Contractor's expense until a good sod is established.
- K. Erosion control practices shall be consistent with procedures outlined in "Erosion and Sediment Control Handbook - Connecticut" (USDA-SCS, 1976 as amended).

3.03 MAINTENANCE AND PROVISIONAL ACCEPTANCE

- A. The Contractor shall keep all seeded areas watered, mowed, and in good condition, reseeding all areas if and when necessary until a good, healthy, uniform growth is established over the entire area seeded, and shall maintain all seeded areas in an approved condition until provisional acceptance.
- B. The Engineer will inspect all work for provisional acceptance at the end of the ten week turf maintenance period, upon the written request of the Contractor received at least ten days before the anticipated date of inspection.

- C. A satisfactory stand will be defined as a section of turf of 10,000 square feet or larger that has:
 - 1. No bare spots larger than 3 square feet.
 - 2. No more than 10% of total area with bare spots larger than 1 square foot.
 - 3. Not more than 15% of total area with bare spots larger than 6 inches square.
- D. The Contractor shall furnish full and complete written instructions for maintenance of the seeded areas to the Owner at the time of provisional acceptance.
- E. The inspection by the Engineer will determine whether maintenance shall continue in any area or manner.
- F. After all necessary corrective work and clean-up has been completed, and maintenance instructions have been received by the Owner, the Engineer will certify in writing the provisional acceptance of the turf areas. The Contractor's responsibility for maintenance of turf, or parts of seeded area shall cease on receipt of provisional acceptance.

3.04 GUARANTEE PERIOD AND FINAL ACCEPTANCE

- A. All seeded areas shall be guaranteed by the Contractor for not less than one full year from the time of provisional acceptance.
- B. At the end of the guarantee period, inspection will be made by the Engineer upon written request submitted by the Contractor at least 10 days before the anticipated date. Seeded areas not demonstrating satisfactory stands as outlined above, as determined by the Engineer, shall be renovated, reseeded, and maintained meeting all requirements as specified herein.
- C. After all necessary corrective work has been completed, the Engineer shall certify in writing the final acceptance of the seeded areas.

SECTION 02598
SYNTHETIC MEMBRANE

PART 1: GENERAL

1.01 SCOPE OF WORK

- A. The Contractor shall furnish all labor, materials, equipment, and incidentals required to install the synthetic membrane as shown on the Contract Drawings and as specified herein. The work shall include placement and seaming of the synthetic membrane and placement and compaction of soil cover on the synthetic membrane, and all other work as shown on the Contract Drawings and as specified herein.

1.02 RELATED WORK NOT INCLUDED

- A. Related work in other sections is as follows:
1. Site preparation as specified in Section 02100.
 2. Granular fill materials are included in Section 02223.

1.03 QUALITY ASSURANCE

- A. Codes and Standards: Perform all work in compliance with applicable requirements of governing authorities having jurisdiction.
- B. Qualifications: The manufacturer and installer of the synthetic membrane shall have demonstrated by previous experience his ability to do the work. The required previous experience shall consist of having successfully installed not less than five comparable installations now giving satisfactory service in the United States.
- C. Material Guarantee
1. The materials supplied under these specifications shall be first quality products designed and manufactured specifically for the purposes of this work as specified herein and which have been satisfactorily demonstrated by prior use to be suitable and durable for such purposes. Prior to furnishing and installing the synthetic membrane, the Contractor shall supply the Engineer with the name of the lining fabricator and shall submit to the Engineer an affidavit from the manufacturer that guarantees that synthetic membrane material meets the performance requirements specified herein.
- D. Vegetation Guarantee
1. The Contractor shall guarantee that at no time will vegetation under the synthetic membrane cause the synthetic membrane to be punctured. The Contractor shall submit to the Engineer for approval the method by which this guarantee will be met. Under no circumstances will herbicides be allowed for vegetation control.

E. Technical Assistance

1. A representative of the manufacturer shall be present during the entire installation procedure and shall provide technical assistance for the installation of the synthetic membrane.

1.04 SUBMITTALS

A. Prior to furnishing and installation of the synthetic membrane, the Contractor shall submit to the Engineer for approval the following:

1. Samples of synthetic membrane material and field seams for visual inspection and testing.
2. Shop Drawings showing the following:
 - a. Proposed layout of the synthetic membrane system.
 - b. Details of jointing, synthetic membrane systems, anchoring, penetrations and other construction details.
3. Certificates of compliance with the requirements of standards specified herein for the synthetic membrane and its installation.
4. Installation and erection data and schedule.
5. Maintenance and repair requirements.
6. Manufacturer's standard guarantee.

1.05 JOB CONDITIONS

A. Site Preparation

The synthetic membrane shall be placed over prepared surfaces as specified herein and in Section 02221, and at the elevations shown on the Contract Drawings.

B. Synthetic Membrane Protection

1. The surface of the complete sub-grade shall be smooth, uniform, free from sudden changes in grade, and shall be prepared as shown on the Contract Drawings and as specified in Section 02221.
2. The earth sub-grade shall be approved by the Engineer prior to installation of the synthetic membrane. The sub-grade shall be maintained in a smooth, uniform, and compacted condition during installation of the synthetic membrane.
3. The Contractor shall take all necessary measures to prevent excess ponding on the synthetic membrane surface.

4. No mechanical equipment shall be allowed directly on the PVC material. A minimum of 12 inches of granular material (drainage soil layer) shall be placed on the synthetic membrane before mechanical equipment shall be allowed over the covered areas.
5. All areas of the synthetic membrane damaged during installation as determined by the Engineer shall be repaired by the Contractor as specified herein and at no additional expense to the Owner.

1.06 MATERIAL WARRANTY

- A. The synthetic membrane manufacturer shall warrant the membrane against manufacturing defects and material degradation in the outdoor exposure for a period of two years from the date of installation. The manufacturer shall replace at no expense to the Owner any material which fails from the above causes within the warranty period. The manufacturer shall furnish the Owner with a written warranty covering the requirements of this paragraph.

1.07 GUARANTEE

- A. The Contractor shall guarantee the synthetic membrane system against defects in installation and workmanship for the period of two years commencing with the date of final acceptance. The guarantee shall include the services of qualified service technicians and all materials required for the repairs at no expense to the Owner.

PART 2: PRODUCTS

2.01 MATERIALS, POLYVINYL CHLORIDE (PVC) SYNTHETIC MEMBRANE

A. General

1. The synthetic membrane material shall be polyvinyl chloride (PVC) produced from resin as manufactured by Watersaver Company, Inc. or approved equal.
2. The synthetic membrane shall be manufactured, furnished and installed by one company.

B. PVC Sheet Material

1. The PVC material shall conform to the following minimum physical properties:

<u>Properties</u>	<u>Value</u>	<u>Test Method</u>
Color	Black	--
Thickness, Mils., \pm 5%	20	ASTM D-1593
Tensile Strength, Min., psi (Lbs./In. Width, Min.)	2,400 (48)	ASTM D-882

<u>Properties</u>	<u>Value</u>	<u>Test Method</u>
Modulus at 100% Elongation Min. psi (Lbs./In. Width, Min.)	1,000 (20)	ASTM D-882 ASTM D-882
Ultimate Elongation, % Min.	300	ASTM D-882
Tear Resistance:		
(a) Elmendorf, Grams, Min. (Gms./Mil., Min.)	4,000 (200)	ASTM D-1922
(b) Graves Tear, Lbs. Min. (Lbs./In. Min.)	5.5 (275)	ASTM D-1004
Low Temperature Impact, Pass, °F	-20	ASTM D-1790
Volatility, % Loss, Max.	1.0	ASTM D-1203
Water Extraction (at 104°F, 24 Hrs.) % Loss, Max.	0.3	ASTM D-1239
Specific Gravity, Min.	1.23	ASTM D-792
Dimensional Stability (at 212°F, 15 Min.) % Max. Change	5.0	ASTM D-1204
Resistance to Soil Burial:		
Tensile Strength Loss, % Max.	5.0	ASTM D-3083
Elongation Loss, % Max.	20.0	

C. Other Materials

1. Solvent for cleaning contact surfaces of field joints and for other required uses shall be as recommended by the manufacturer or approved fabricator of the polyvinyl chloride membrane.
2. All seaming, sealing, and high solids adhesives shall be of a type or types recommended by the manufacturer or approved fabricator of the polyvinyl chloride membrane and shall be delivered in original sealed containers each with an indelible label bearing the brand name and complete directions as to proper storage, use and application of the adhesive.
3. Cements and adhesives shall be kept free from extreme heat or cold.
4. All other required solvents, cements, adhesives, and fasteners required for proper installation of the synthetic membrane shall be provided by the Contractor as recommended by the synthetic membrane manufacturer.

PART 3: EXECUTION

3.01 SUB-BASE PREPARATION

A. General

1. Preparation of the sub-base is specified in Section 02221.
2. Prior to ordering synthetic membrane material, the Contractor shall submit, for the Engineer's approval, Shop Drawings showing lining sheet layout with proposed size, number, position of

2. Defects found during the testing shall be repaired and retested. Such tests and adjustments shall be repeated until, in the opinion of the Engineer, the repairs are complete. All repairs shall be made by the Contractor at no additional expense to the Owner.
3. The Contractor shall repair all areas damaged by testing immediately after the test is performed. The repairs shall be made at no additional expense to the Owner.

E. Repairs to PVC

1. Any necessary repairs to the PVC shall be patched with the synthetic membrane material itself and cold applied vinyl to vinyl splicing adhesive. The splicing adhesive shall be applied to the contract surfaces of both the patch and lining to be repaired, and the two surfaces pressed together immediately. Any wrinkles shall be smoothed out.

3.03 SOIL COVER

A. General

1. All synthetic membrane surfaces shall be covered with a drainage soil layer as shown on the Contract Drawings.
2. Soil for the cover shall be as specified in Section 02223, Paragraph G.
3. The Contractor shall comply with the requirements of Paragraph 1.05 of this Section for Synthetic Membrane Protection during soil cover placement.

B. Placement of Soil Cover

1. The soil cover shall be placed with mechanical equipment; however, no mechanical equipment shall be allowed directly on top of the PVC cap material. Equipment shall be driven on pre-deposited soil.
2. Soil cover shall be brought in with earth-carrying equipment, deposited on the previous pile of earth, then pushed onto the uncovered portion of the synthetic membrane with graders or bulldozers. This operation shall be repeated until the total area is covered.
3. Sand covering for the side slopes of the PVC synthetic cap shall be placed at the bottom and pushed up so as to reduce any tension on the membrane.
4. Damage to the synthetic membrane occurring during the placement of cover soil shall be repaired immediately by the Contractor at no additional expense to the Owner.

all factory-fabricated sheets, and indicating the location of all field joints. Shop Drawings shall also show complete details and/or methods for anchoring the lining at the top of the slope and making field joints.

3. The anchor trench shall be constructed as shown on an approved Shop Drawing.
4. The earth sub-grade shall be maintained in a smooth, uniform, and compacted condition during installation of the synthetic membrane.

3.02 INSTALLATION AND PREPARATION PVC SYNTHETIC MEMBRANE

A. Preparation

1. The synthetic membrane material shall be cleaned of all debris and materials which may negatively affect the performance of the system.

B. Installation

1. Each panel of the membrane shall be laid out and installed in accordance with the approved Shop Drawings prepared by the Contractor. The layout shall be designed to keep field joining of the synthetic membrane to a minimum and consistent with proper methods of synthetic membrane installation.
2. The synthetic membrane shall be installed by crews experienced in making lining installations.
3. The panels shall be placed to permit termination at the bottom of the ditches and adjacent to penetrations as shown on the Contract Drawings. Panels shall be positioned to minimize the number and length of fusion joinings required.

C. Field Joints

1. Lap joints will be used to seal factory fabricated panels of PVC together in the field. Lap joints shall be formed by lapping the edges of panels a minimum of 4 inches (100 mm). The contact surfaces of the panels shall be wiped clean to remove all dirt, dust, or other foreign materials. Sufficient cold-applied vinyl to vinyl bonding adhesive shall be applied to the contact surfaces in the joint area, and the two surfaces pressed together immediately. Any wrinkles shall be smoothed out. Field made splices shall have a strength of 80% of the specified sheet strength.

D. Field Quality Control

1. All fusion joined seams shall be visually examined and probed for voids or imperfect bonds.

5. Placement and compaction of the soil cover shall be as specified in Section 02221.

3.04 DISPOSAL OF WASTE MATERIAL

- A. On completion of installation, the Contractor shall dispose of all trash, waste material, and equipment used in connection with the work herein as specified elsewhere, and shall leave the premises in a neat and acceptable manner.

3.05 FINAL TESTS AND INSPECTIONS

- A. Upon completion of the work, the synthetic membrane installation shall be subjected to a final inspection. All work in the system therein being tested shall be complete, cleaned, and ready for use. All work shall meet the requirements as to line, grade, cleanliness, and workmanship.
- B. All seams for the PVC synthetic membrane shall be tested using an air lance test. Air lancing shall utilize a high pressure jet of air to test the seam. The air lance shall have a 3/16 inch nozzle. The air pressure shall be a minimum of 50 psi. The air lance shall be held no more than 6 inches from the seam.
- C. All discrepancies shall be noted and repaired by the Contractor at no additional expense to the Owner.

SECTION 02599
FILTER FABRIC

PART 1: GENERAL

1.01 SCOPE OF WORK

- A. This Section includes requirements for furnishing and installation of filter fabric for protection of the soil drainage layer from clogging. The work shall include the installation and non-woven fabric between the topsoil layer and the soil drainage layer, and all other related work as shown on the Contract Drawings or as specified herein.

1.02 RELATED WORK NOT INCLUDED

- A. Work specified in other Sections is as follows:
1. Site preparation as specified in Section 02100.
 2. Granular fill and clay materials as specified in Section 02223.
 3. Synthetic membranes as specified in Section 02598.

1.03 QUALITY ASSURANCE

A. Code and Standards

1. Perform excavation work in compliance with applicable requirements of governing authorities having jurisdiction.

- B. The materials supplied under these specifications shall be first quality products designed and manufactured specifically for the purposes of this work, and which have been satisfactorily demonstrated by prior use to be suitable and durable for such purposes. The Contractor shall, at the time of bidding, supply the Engineer with the name of the fabric manufacturer and later a certified test report from the fabric producer that the filter fabric meets these specifications for durable filter fabric material.

C. Technical Assistance

1. A representative of the fabric manufacturer shall be present for a minimum of one day during the installation, and shall provide technical assistance for the installation of the fabric.

1.04 JOB CONDITIONS

A. Fabric Protection

1. The subsoil surface shall be inspected and approved by the Engineer prior to the installation of the filter fabric. The

subsoil shall be maintained in a smooth, uniform, and compacted condition during the installation of the filter fabric.

2. No mechanical equipment shall be driven directly on top of the filter fabric unless permitted by the Engineer.
3. The fabric shall be stored in such a way that it is protected from prolonged exposure to ultraviolet radiation.

PART 2: PRODUCTS

2.01 MATERIAL

A. General

1. The filter fabric shall be non-woven Marafi 140N filter fabric or approved equal.

B. Filter Fabric

1. Fabric installed shall be of the non-woven type.
2. The equivalent opening size for non-woven fabrics used shall be 100 in accordance with the Corps of Engineers Classification CW-02215-77. The water flow rate shall be a minimum of 285 gal./min./sf as determined by ASTM D-737, and the coefficient of permeability shall be a minimum of 0.20 cm./sec.
3. The grab tensile strength shall be a minimum of 120 pounds, and the grab tensile elongation shall be a minimum of 55% as measured by ASTM D-1682-64.
4. The burst strength as measured by the Diaphragm Method of ASTM D-3786-80 shall be a minimum of 210 psi. The minimum trapezoid tear strength shall be 50 pounds in accordance with ASTM D-1117-80.
5. The material shall be resistant to rot, mildew, ageing, rodents, and insects. The fabric shall withstand the abuses of placement by men and equipment without tearing or being punctured.
6. The fabric shall be inert to acids and alkalies within a pH range of 3 to 11.

PART 3: EXECUTION

3.01 SUB-BASE PREPARATION

A. General

1. Preparation of the sub-base is specified in Section 02221.

2. Prior to ordering filter fabric material, the contractor shall submit, for the Engineer's approval, Shop Drawings showing sheet layout with proposed size, number, position of all factory-fabricated sheets, and indicating the location of all field joints. Shop Drawings shall also show complete details and/or methods for anchoring the fabric at the top of the slope and making field joints.
3. The anchor trench shall be constructed as shown on an approved Shop Drawing.
4. The earth sub-grade shall be maintained in a smooth, uniform, and compacted condition during installation of the filter fabric.

3.02 FILTER FABRIC INSTALLATION

A. Installation

1. The filter fabric shall be unrolled and placed onto the prepared area.
2. Enough fabric shall remain at the surface to allow for 12 inches of fabric overlap to close the lap.
3. Where more than one section of fabric is required, the fabric shall be overlapped no less than 12 inches to assure the continuity of the filter.
4. The lap shall be in the direction such that the aggregate being spread does not push the fabric apart.
5. Fabric shall be placed at the specified depths and on a satisfactory base as approved by the Engineer.

B. Repairs to Damaged Fabric

1. If the fabric is damaged during installation, it shall be immediately repaired. All soil shall be removed from the affected area and a patch of fabric large enough to cover the damage, plus an 18 inch overlap shall be placed on top of the damaged section.

3.03 SOIL COVER

A. General

1. All filter fabric surfaces shall be covered with a sandy loam layer as shown on the Contract Drawings.
2. Soil for the cover shall be as specified in Section 02223.

3. The Contractor shall comply with the requirements of Paragraph 1.04 of this Section for filter fabric protection during soil cover placement.

B. Placement of Soil Cover

1. The soil cover shall be placed with mechanical equipment; however, no mechanical equipment shall be allowed directly on top of the filter fabric material. Equipment shall be driven on pre-deposited soil.
2. Soil cover shall be brought in with earth-carrying equipment, deposited on the previous pile of earth, then pushed onto the uncovered portion of the filter fabric with graders or bulldozers. This operation shall be repeated until the total area is covered.
3. Sandy loam covering for the side slopes of the filter fabric shall be placed at the bottom and pushed up so as to reduce any tension on the fabric.
4. Damage to the filter fabric occurring during the placement of cover soil shall be repaired immediately by the Contractor at no additional expense to the Owner.

3.04 DISPOSAL OF WASTE MATERIAL

- A. On completion of installation, the Contractor shall dispose of all trash, waste fabric, and equipment used in connection with the work herein, and shall leave the premises in a neat and acceptable manner as approved by the Engineer.

3.05 FINAL INSPECTION

- A. Upon completion of the work, the fabric installation shall be subjected to a final inspection. All work in the system therein being inspected shall be complete, clean, and ready for use. All work shall meet the requirements as to line, grade, cleanliness, and workmanship as determined by the Engineer.
- B. All discrepancies shall be noted and repaired by the Contractor at no additional expense to the Owner. Final acceptance of the system shall be contingent upon the approval of the Engineer.

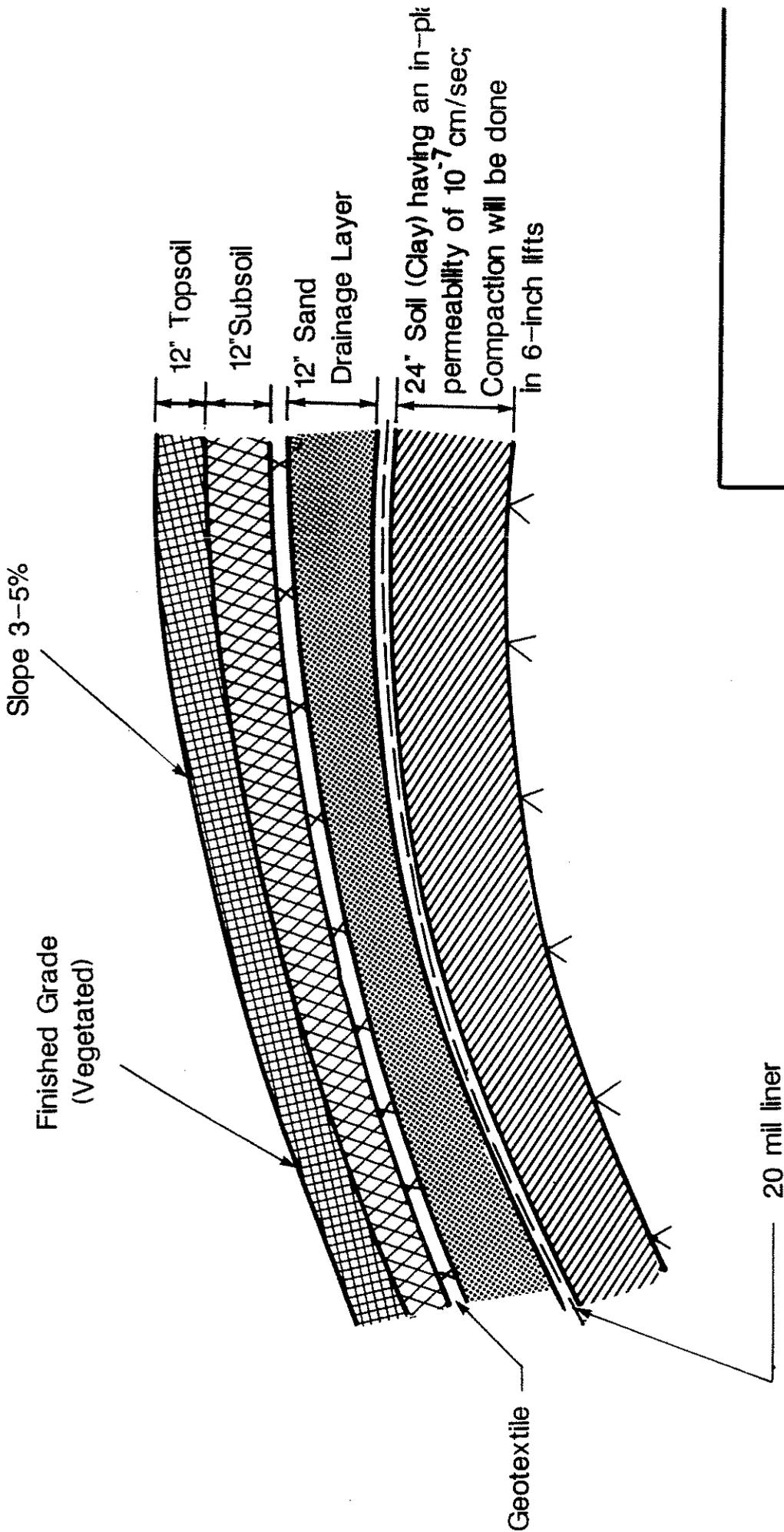


FIGURE 6-1
Typical Cap
Crown Section

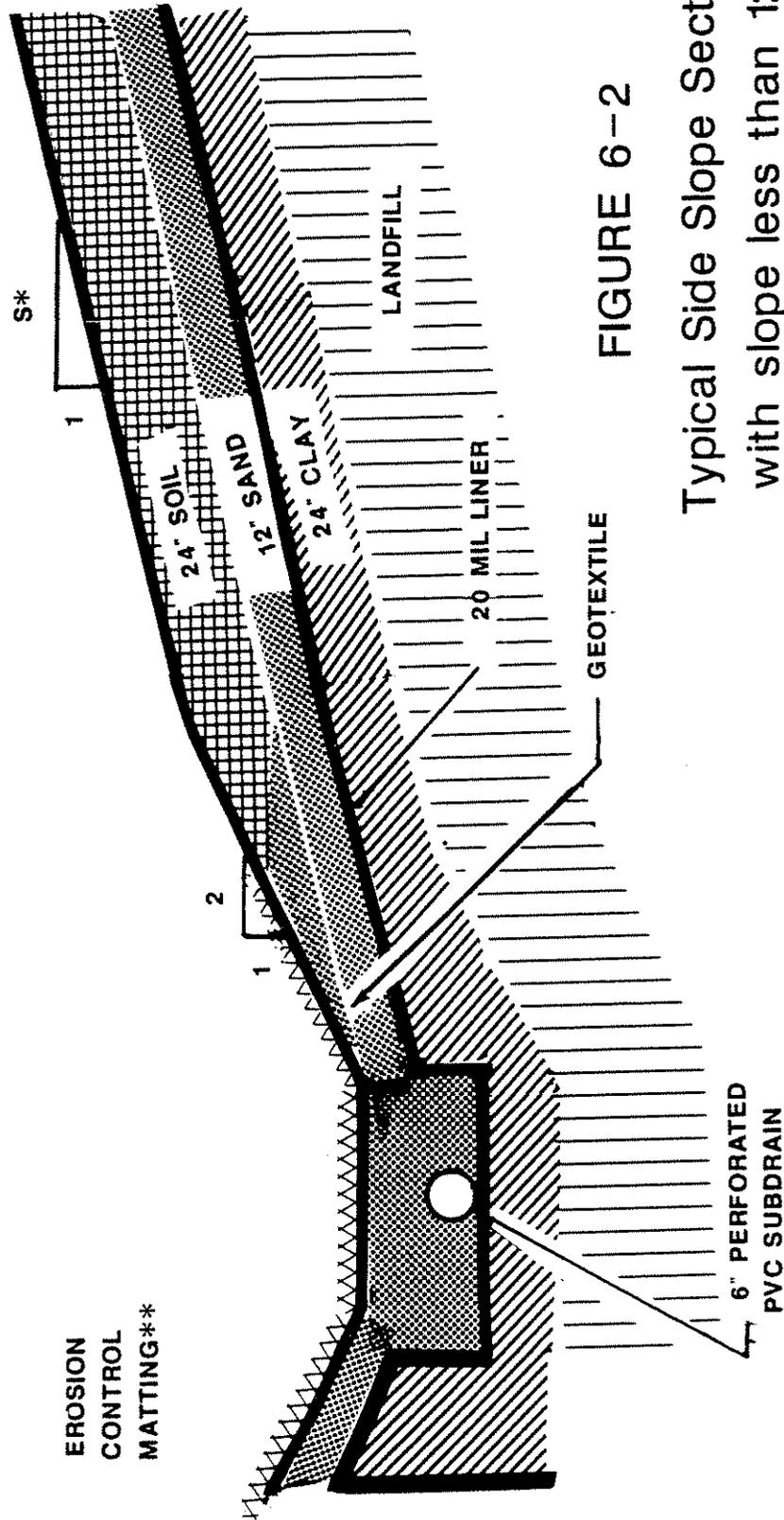


FIGURE 6-2

Typical Side Slope Section
with slope less than 1:2

* -Slope variable; less than 1:2
 ** -Grass will be grown on the matting for additional erosion control

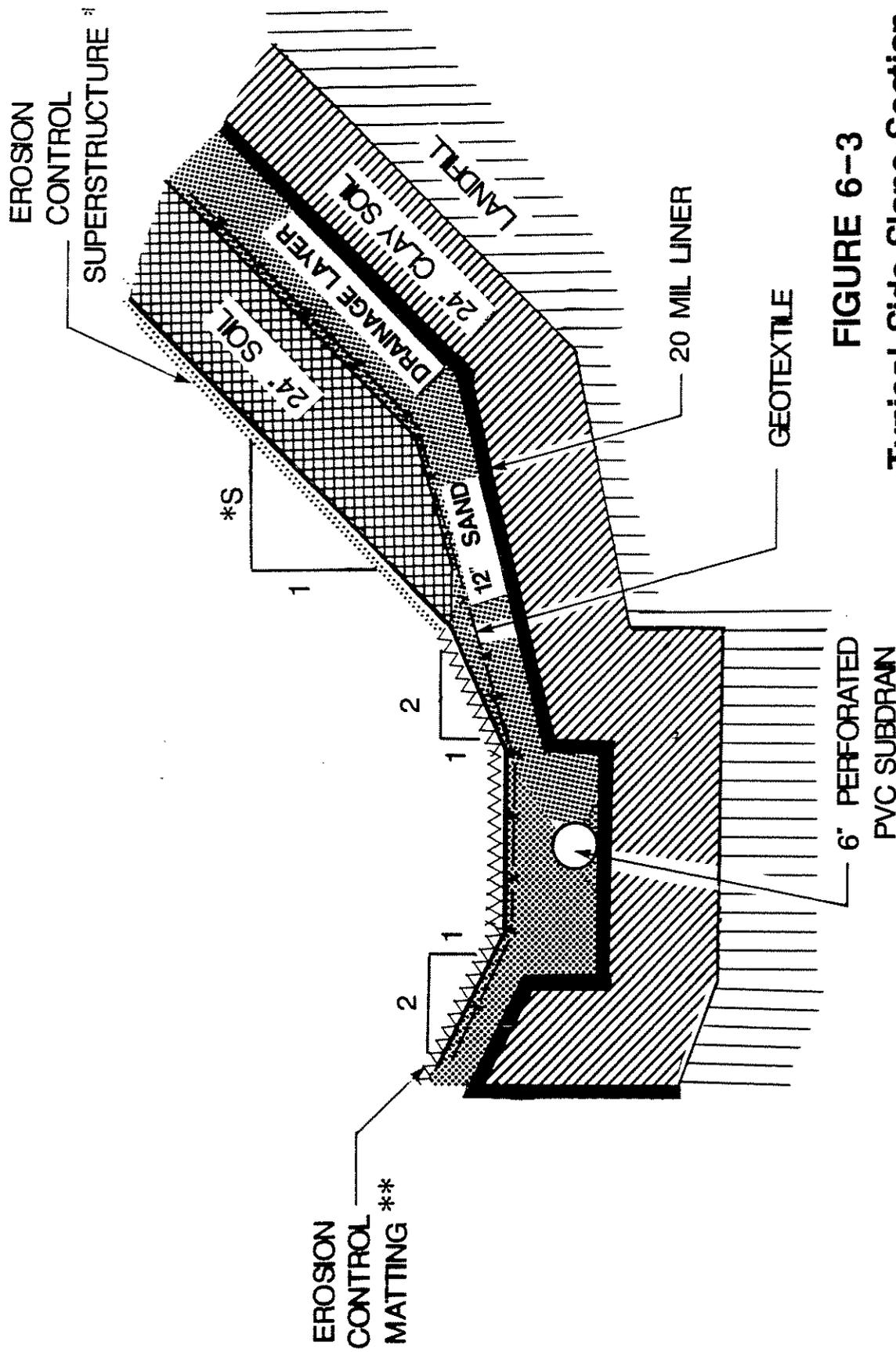


FIGURE 6-3
Typical Side Slope Section
with drainage channel slope
greater than 1:2

* : Slope variable; greater than 1:2 up to 1:1 maximum

** - Grass will be grown on both the matting and superstructure for additional erosion control

APPENDIX D

For Groundwater Monitoring Program see "Scope of Study, Torrington Landfill Environment Assessment and Hydrogeologic Evaluation" Report, June 1986

First Revision: May 1987

Second Revision: March 1988