Florida Department of Environmental Protection

Memorandum

TO: Jim Bradner, P.E.
Central District

FROM: Richard B. Tedder, P.E.
Solid Waste Section

DATE: December 21, 2000

SUBJECT: Buttrey Development Project
QA/QC Test Plan
UES Document No. 147247

I have reviewed the subject document and believe it is acceptable for the deflection liner project proposed by Buttrey Development. I have attached a copy of this document in case you did not receive one.

I have no further comments accept for recommending that you require a CQA report be signed and sealed by the CQA engineer and submitted to the Department upon completion of the project (Rules 62-701.400(7)(b)5 and (d), F.A.C.). I imagine you will do this anyway as one of the construction permit conditions.

Attachment

RBT/rt

cc: Mary Jean Yon
Chris McGuire
George Cheryan

Buttrey Development Two L.L.C.

12/22/2000

December 21, 2000

Mr. James Bradner, P.E.
FDEP Solid Waste
Central District
3319 Maguire Blvd., Ste. 232
Orlando, Florida 32803-3767

Subject: Request for additional information
Application Nos. SC48-0165969-001 & SO48-0165969-002

Dear Mr. Bradner:

The attached Universal Engineering Sciences Report is intended to satisfy the request for additional information dated December 12, 2000. This report was sent directly to Mr. Richard Tedder in Tallahassee on December 12, 2000. This report is to enhance the earlier report submitted on November 17 2000, following a telephone conversation with Mr. Tedder. All of the comments have been addressed to the best of my understanding and interpretation his intent. Attached along with this letter are two copies of the information already supplied to Mr. Tedder.

If you have any questions concerning these responses or need clarification or additional information please feel free to contact me at 407-296-0016.

Sincerely,

Ed Chesney

Ed Chesney, P.E.
Project Engineer

Attachments: as noted

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P.O. Box 1029 Clarcona, Florida 32710
Telephone: (407) 296-0016; FAX: (407) 294-8090

Florida Department of
Memorandum **Environmental Protection**

TO: Jim Bradner, P.E.
Central District

FROM: Richard B. Tedder, P.E.
Solid Waste Section

DATE: October 18, 2000

SUBJECT: Buttrey Development Project
Quality Assurance/Quality Control (QA/QC) Plan
September 18, 2000

As requested, I have reviewed the subject QA/QC Plan (Plan) to install a partial clay liner along the western, southern and eastern perimeters of the borrow area for the Buttrey project. This property is planned for use as a Class III landfill. Based on the figure provided, the total borrow area occupies approximately 36 acres and will be unlined except for the partial clay liner. The clay liner portion will be constructed on a 2:1 (2-horizontal to 1-vertical) slope and will have an area of approximately 3.86 acres. It will be constructed in three 6-inch thick lifts for a total thickness of 18 inches with a hydraulic conductivity $1x10^{-7}$ cm/sec. It is my understanding that the purpose of this project is to ensure that any leachate generated by the waste placed over the clay liner will be released to the unlined areas at a distance no closer than 100 feet to their adjacent property boundaries.

My comments on this submittal are as follows:

1. The Plan includes some of the key elements required but should be expanded to address the requirements of Rules 62-701.400(7) and (8), Florida Administrative Code. For example, there is no discussion of a field test strip to ensure the target hydraulic conductivity can be achieved in the field. Also, some of the required tests are missing such as moisture content, thickness measurements and percent fines.

2. What pass/fail criteria will be used to evaluate the test results from installing the clay to ensure it meets the required specifications? If it is determined that areas of the liner do not meet specifications, what repair steps will be taken?

3. What borrow source is anticipated for the clay? Is there any data to support the suggestion in the Plan that a 90%

Modified Proctor density will be adequate to achieve the target hydraulic conductivity?

4. Please describe the construction preparation planned for the 2:1 subbase before placement of the clay.

5. How will the clay be protected from desiccation cracks after compaction? If cover soils are planned for the compacted clay, please provide more details explaining the placement of these soils and their expected stability before waste is placed on the slopes.

6. Will a full time QA inspector be on-site at all times during construction?

7. What steps will be used during construction to ensure there is good contact between the clay lifts?

8. What compaction equipment is planned for this project? Due to possible difficulty of compacting clays on a 2:1 slope, what special precautions will be taken to ensure that the clay lifts are properly compacted?

RBT/rt

cc: Mary Jean Yon
Chris McGuire

UNIVERSAL
ENGINEERING SCIENCES

QA/QC TEST PLAN
HDPE
Synthetic Liner

B & B #91 - Class III Landfill
Orange County, Florida
UES Project No. 17862-085-06
UES Document No. 147247

1. INTRODUCTION

1.1 Terms of Reference

1.1.1 Purpose

This manual addresses the quality assurance and quality control of the installation of a 60 mil high density polyethelyne flexible membrane liner (HDPE)in the side of the B&B #91 Class III landfill. This manual therefore delineates the quality procedures and standards for production and installation.

This manual reflects the requirements of the Hazardous and Solid Waste Amendments of 1984 to the Resource Conservation and Recovery Act (RCRA), and "Construction Quality Assurance for Hazardous Waste Land Disposal Facilities, Public Comment Drafttl, Document EPA/530-SW-85-021, October 1985, and Florida Administrative Code 62-701.40.

1.1.2 Quality Assurance and Quality Control

In the context of this manual, quality assurance and quality control are defined as follows:

Quality Assurance - A planned and systematic pattern of all means and actions designed to provide adequate confidence that items or services meet contractual and regulatory requirements and will perform satisfactorily in service.

Quality Control - Those actions which provide a means to measure and regulate the characteristics of an item or service to contractual and regulatory requirements.

In the context of liner production and installation:

Quality assurance refers to means and actions employed by GLCC and GLS to assure conformity of the lining system production and installation with the Quality Assurance Plan.

drawings and specifications.

Quality control refers to those actions taken by the Manufacturer, Fabricator and Installer to ensure that the materials and the workmanship meet the requirements of the plans and specifications.

1.1.3 Lining Materials

The materials comprising the lining system Include geosynthetics; geomembranes, geotextiles, and geonets manufactured from synthetic polymers.

For purposes of this document, the term "geomembrane" is applied to flexible membrane liners. More specifically "geomembrane' refers to polyethylene geomembranes, with a textured surface for increased friction. These geomembranes include 1) high density polyethylene (HDPE) membranes which are made from resins with a specific gravity greater than 0.935.

The geomembranes are utilized either alone or in conjunction with low permeability soils as composite liners. Geomembranes are the key components of the lining system, and, therefore, none of the geomembrane requirements contained herein should be compromised in any way. Geotextiles, geonets and granular soils are utilized in combination for leachate collection systems.

The quality assurance of a geosynthetic liner system is addressed herein in its entirety, including all stages from manufacture to installation. The quality assurance of soils is only discussed relative to their interaction with the geosynthetics.

1.1.4 Scope of Quality Assurance and Quality Control

The scope of this manual includes the quality assurance applicable to manufacturing, shipment, handling, and installation of all geosynthetics. In particular, full time

quality assurance of the installation of geomembranes and the installation of other geosynthetics is essential.

This manual does not address design guidelines, installation specifications, or selection of geomembranes and other geosynthetics (which includes compatibility between geosynthetic and contained material).

This manual does not address the quality assurance of soils, except in cases where soil placement may have an influence on the geosynthetics.

1.1.5 Units

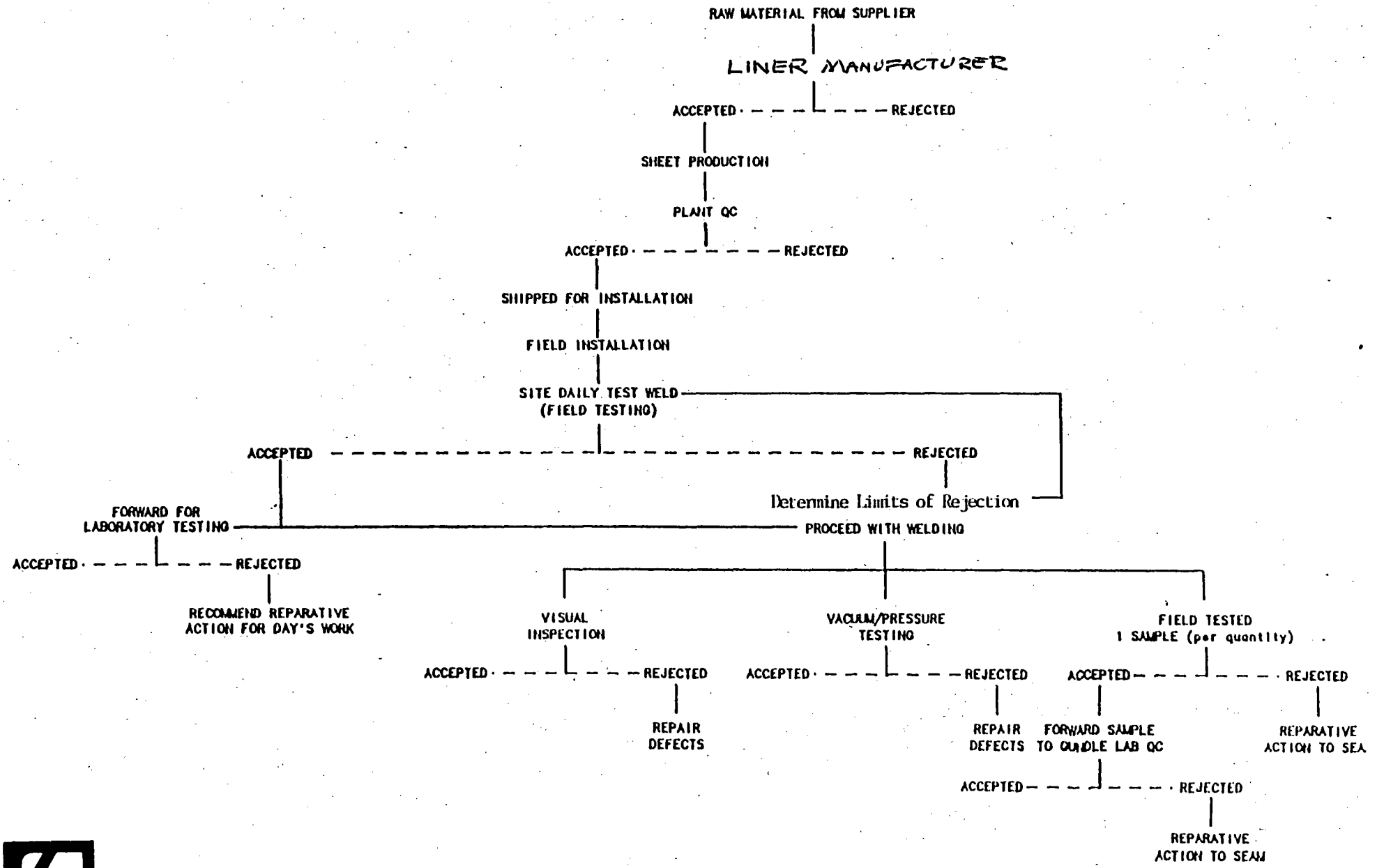
In this manual, all properties and dimensions are expressed in U.S. units, with "equivalent' SI units in parentheses. It should be noted that the conversion is typically only accurate within ten percent. In cases of conflict or clarification, the U.S. units shall be deemed to govern.

1.1.6 References

The manual includes references to test procedures of the American Society for Testing and Materials (ASTM), the Federal Test Method Standards (FTMS) and the "Standards for Flexible Membrane Liners" of the National Sanitation Foundation (NSF). Recognizing the changing nature of the above standards and the geosynthetic industry at large, this manual is subject to periodic revision.

1.2 Parties (See Organization Chart - Next Page)

The completion of a particular lined system is dependent on the interaction of many parties. The parties discussed below are those associated with the ownership, design, specification, manufacture, fabrication, transportation, installation, quality assurance of the liner system. The qualifications of the Installer and Geosynthetic Quality Assurance Consultant are particularly critical to the successful completion of the lining systems, and must be emphasized in the Quality Assurance Plans.


RAW MATERIAL FROM SUPPLIER
LINER MANUFACTURER
ACCEPTED
REJECTED
SHEET PRODUCTION
PLANT QC
ACCEPTED
REJECTED
SHIPPED FOR INSTALLATION
FIELD INSTALLATION
SITE DAILY TEST WELD
(FIELD TESTING)
ACCEPTED
REJECTED
Determine Limits of Rejection
FORWARD FOR
LABORATORY TESTING
PROCEED WITH WELDING
ACCEPTED
REJECTED
RECOMMEND REPARATIVE
ACTION FOR DAY'S WORK
VISUAL
INSPECTION
VACUUM/PRESSURE
TESTING
FIELD TESTED
1 SAMPLE (per quantity)
ACCEPTED
REJECTED
ACCEPTED
REJECTED
ACCEPTED
REJECTED
REPAIR
DEFECTS
REPAIR
DEFECTS
FORWARD SAMPLE
TO GUNDLE LAB QC
REPARATIVE
ACTION TO SEA
ACCEPTED
REJECTED
REPARATIVE
ACTION TO SEAM

1.2.1 Designer

The Designer is responsible for the design, drawings, plans, and specifications of the lining system.

1.2.2 Earthwork Contractor

The Earthwork Contractor is responsible for the preparation of the supporting soil on which the lining system is to be installed, and may also be the party responsible for placing earth and granular materials (if any) over the installed lining system.

1.2.3 Resin Supplier

The Resin Supplier produces and delivers the resin to the Manufacturer (GLS).

1.2.4 Geomembrane Manufacturer (GLS)

The Geomembrane Manufacturer is responsible for the production of geomembrane rolls from resin.

1.2.5 Installer (GLCC)

The Installer is responsible for field handling, placing, seaming, field testing, loading (against wind), and other aspects of the geosynthetics installation.

1.2.6 Transporter

The Transporter transports the rolls of geomembrane between the Manufacturer and the site.

1.2.7 Soils Quality Assurance Consultant

The Soils Quality Assurance Consultant is normally a party, independent from the Owner, Manufacturer, Fabricator and Installer that is responsible for observing, testing, and documenting activities related to the quality assurance of the earthwork at the site. He is also responsible for issuing a certification

report sealed by a Registered Professional Engineer.

1.2.8 Geosynthetic quality Assurance Laboratory

The Geosynthetic Quality Assurance Laboratory is a party responsible for conducting tests on samples of geosynthetics.

1.2.9 Owner

The Owner owns, and/or is responsible for, the lined facility. In this manual the term "Owner" shall apply equally to "operator"; i.e., the party responsible for operating the lined facility.

1.2.10 Project Manager

The Project Manager is the official representative of the owner. In this manual the term 'Project Manager" shall apply equally to "Construction Coordinator"; i.e., the individual in charge of coordinating field activities.

1.3 Meetings and Visits

To guarantee a high degree of quality during installation, open channels of communication are essential. To that end, meetings are critical.

1.3.1 Resolution Meeting

Following the completion of the design, plans, and specifications for the project, a Resolution Meeting may be held. This meeting should include all parties involved, including GLCC, the Soil Quality Assurance Consultant, the Design Engineer, and the Project Manager.

The purpose of this meeting is to begin planning for coordination of tasks, anticipate any problems which might cause difficulties and delays in construction, and above all, present the Geosynthetic Quality Assurance Plan to all the parties involved. It is very important that the rifles regarding testing, repair, etc., be known and accepted by all.

The first part of the Resolution Meeting may be devoted to a review of the design drawings and specifications for completeness and clarity.

This meeting should include (but not be limited to) all of the following activities:

Communicate to all parties any relevant documents;

Review critical design details of the project;

Review the panel layout drawing provided by GLOC (Panel layout is tentative and may be revised by Liner Manufacturer's site manager with the approval of the field engineer to suit field conditions at the time of installation. All such changes will be reflected on the As-Built Drawings.)

Review the Geosynthetic Quality Assurance Manual and make any appropriate modifications;

Make any appropriate modifications to the Geosynthetic Quality Assurance Manual to ensure that it specifies all quality assurance activities that are necessary;

Ensure that a site specific addendum is developed, if needed;

Make any appropriate modifications to the design criteria, plans, and specifications so that the fulfillment of all design specifications or performance standards can be determined through the implementation of the site specific addendum;

Reach a consensus on the quality control procedures, especially on methods of determining acceptability of the lining system;

Assign responsibilities of each party; depending on the number of seaming crews and on the type of seaming equipment;

Establish lines of authority and communication;

Prepare a time schedule for all operations (see Section 3.2.2.2); and

Any other site specific items pertinent to the lining installation.

The meeting shall be documented by a person designated at the beginning of the meeting, and minutes shall be transmitted to all parties. In certain instances, the Resolution Meeting and Pre-Construction Meeting may be combined, provided that all provisions of 1.3.1 and 1.3.2 are addressed.

1.3.2 Pre-Construction Meeting

A Pre-Construction Meeting shall be held at the site. As a minimum, the meeting shall be attended by GLCC, the Earthwork Contractor, the Soils Quality Assurance Engineer, and the Project Manager.

Specific topics considered for this meeting include:

Develop a site specific addendum;

Review the responsibilities of each party;

Review lines of authority and communication;

Review methods for documenting and reporting and for distributing documents and reports;

Establish riles for writing on the geomembrane; i.e., who is authorized to write, what can be written and in which color;

Outline procedures for packing and storing archive samples;

Review the time schedule for all operations;

Conduct a site walk-around to verify that earthwork construction is proceeding on schedule and to review material storage locations;

Review panel layout and numbering systems for panels and seams;

Finalize field cutout sample sizes;

Review seam testing procedures;

Review repair procedures; and

Review precautions to be taken against clay cracking (surface desiccation).

The meeting shall be documented by a person designated at the beginning of the meeting, and minutes shall be transmitted to all parties. In certain instances, the Resolution Meeting and Pre-Construction Meeting may be combined, provided that all provisions of 1.3.1 and 1.3.2 are addressed.

1.3.3 Progress Meetings

A daily progress meeting shall be held between the Earthwork Manager, GLCC, the Project Manager, and any other concerned parties. This meeting shall discuss current progress. Any matter requiring action which is raised in this meeting shall be reported to the appropriate parties.

1.3.4 Manufacturing Plant Visits

A geomembrane manufacturing plant visit may be carried out by a representative of the Owner or his designated alternate if he so chooses.

2. GEOMEMBRANE MANUFACTURING AND DELIVERY

2.1 Manufacturing

2.1.1 Raw Material

The raw material shall be first quality polyethylene resin containing no more than 2% clean recycled polymer by weight, and meeting the following specifications:

For HDPE: Specific Gravity (ASTM D792 Method A or ASTM 01505): > .935

Melt Index (ASTM D1238 Condition 190/2.16):0.05 - 0.3 g/10 mm
Quality control testing shall be carried out by as to demonstrate that the product meets this specification.

Prior to project completion, GLS shall provide the Project Manager with the following information:

The origin (resin supplier's name, resin production plant), identification (brand name, number) and production date of the resin;

A copy of the quality control certificates issued by the resin supplier noting results of density and melt index (see Figures 1-4 for examples of certificates)

Reports on the tests conducted by GIS to verify the quality of the resin used to manufacture the geomembrane rolls assigned to the considered facility [these tests should include specific gravity (ASTM 0792 Method A or ASTM D1505) and melt index (ASTM D1238 Condition 190/2.16)]; Reports on the tests conducted by GLS to verify the quality of the sheet.

2.1.2 Geomembrane Manufacturing

GLS shall provide the Project Manager/Owner with the following:

A properties sheet including, at a minimum, all specified properties, measured using test methods indicated in the specifications, or equivalent; (Please see example of material spec. sheet in Figures 5-8.);

The Owner or Owner's Representative shall verify that:

The property values certified by the Geomembrane Manufacturer meet all of the specifications; and

The measurements of properties by the Geomembrane Manufacturer are properly documented, and that the test methods used are acceptable.

2.1.3 Rolls

After receipt of material, GLS shall provide the Project Manager with one quality control certificate for every two rolls of geomembrane provided. The quality control certificate shall be signed by a

responsible party. The quality control certificate shall include:

Roll numbers and identification; and

Results of quality control tests. As a minimum, results shall be given for thickness, tensile strength, and tear resistance, evaluated in accordance with ASTM test methods approved by the Designer. (A standard quality control certificate is included in Figures 1015 based on quality control test frequencies specified in Figure 9).

2.2 Delivery

2.2.1 Transportation and Handling

Transportation of the geomembrane will be performed by as or GLCC through an independent trucking firm, or other party as agreed upon by the owner. If geomembrane arrives on site prior to GLCC project personnel, the customer is responsible for off-loading rolls. Material, when off-loaded, should be placed on a smooth surface free of rocks or any other protrusions which may damage the material. No special covering is necessary.

The following should be verified prior to off-loading the geomembrane:

Handling equipment used on the site is adequate and does not pose any risk of damage to the geomembrane; and

Personnel will handle the geomembrane with care.

Any welding rod delivered to the site prior to GLCC arrival should be kept covered and dry or placed in a storage facility.

Upon arrival at the site, GLCC shall conduct a surface observation of all rolls for defects and for damage. This inspection shall be conducted without unrolling rolls unless defects or damages are found or suspected. GIJCC shall indicate any damage to the Project Manager:

2.2.2 Storage

The Project Manager shall provide storage space in a location (or several locations) such that on-site transportation and handling are minimized. Storage space should be protected from theft, vandalism, passage of vehicles, and be adjacent to the area to be lined.

3. GEOMEMBRARE INSTALLATION

3.1 Crest Anchorage System

The anchor trench shall be excavated by the Earthwork Contractor(unless otherwise specified) to the lines and widths shown on the design drawings, prior to geomembrane placement. If the anchor trench is excavated in a clay liner susceptible to desiccation, no more than the amount of trench required for the geomembrane to be anchored in one day shall be excavated (unless otherwise specified) to minimize desiccation potential of the anchor trench clay soils.

Slightly rounded corners shall be provided in the trench where the geomembrane adjoins the trench so as to avoid sharp bends in the geomembrane. No loose soil shall be allowed to underlie the geomembrane in the anchor trench.

Backfilling of the anchor trench shall be conducted in accordance with Section 3.5.

3.2 Geomembrane Placement

Immediately prior to installation of the designed geomembrane liner, the surface shall be observed by GLCC and the owner or the owner's representative. The decision to repair cracks, if any, shall be made only by the Project Manager. The subgrade shall be walked by GLCC and the Project Manager for joint approval. GLCC will sign acceptance of the surface condition of the subgrade. The integrity of the underlying soil is the responsibility of the owner/earth work contractor.

Subgrade Preparation Recommendations

No liner shall be placed on surfaces not previously found acceptable by the GLOC project manager or his agent.

No sharp stones or other hard objects that will not pass through a 3/8 inch screen shall be present in the top 1 inch of the surfaces to be covered.

Surfaces to be lined shall be smooth and free of all rocks, sharp stones, sticks, roots, sharp objects, or debris of any kind. The surface should provide a firm, unyielding foundation for the membrane with no sudden, sharp or abrupt changes or break in grade.

3.2.1 Field Panel Identification

A field panel is the unit area of geomembrane which is to be seamed in the field; i.e., a field panel is a roll or a portion of roll cut in the field.

At the time of installation, the GLCC Field Supervisor shall give each field panel an "identification code" (number or letter-number) consistent with the layout plan. (Panel layout is tentative and may be revised by the site manager with the approval of the field engineer to suit field conditions at the time of installation. All such changes will be reflected on the As-Built Drawings.) This identification code shall be agreed upon by the Project Manager. This field panel identification code shall be as simple and logical as possible.

3.2.2 Field Panel Placement

3.2.2.1 Location

Field panels are installed at the location indicated in the layout plan, or as modified by the GLCC Field Supervisor based upon existing site conditions.

3.2.2.2 Installation Schedule

Field panels may be installed using any one of the following schedules:

All field panels are placed prior to field seaming (in order to protect the subgrade from erosion by rain or wind);

Field panels are placed one at a time, and each field panel is seamed immediately after its placement (in order to minimize the number of unseamed field panels); and

Any combination of the above.

GLCC shall record the identification code, location, and date of installation of each field panel (see Figure 17, example of Daily Progress Report). Daily Progress Report to be submitted to Project Manager for forwarding to Engineer (Owner) also on a daily basis.

3.2.2.3 Weather Conditions

Welding shall not take place during any precipitation, in the presence of excessive moisture, in an area of ponded water, or in the presence of excessive winds (unless wind barriers are provided).

3.2.2.4 Method of Placement

GLCC shall verify the following:

Any equipment used does not damage the geomembrane by handling, trafficking, excessive heat, leakage of hydrocarbons, or other means;

The prepared surface underlying the geomembrane has not deteriorated since previous acceptance and is still acceptable immediately prior to geomembrane placement;

Any geosynthetic elements immediately underlying the geomembrane are clean and free of debris;

All personnel working on the geomembrane do not smoke, wear damaging shoes, or engage in other activities which could damage the geomembrane;

The method used to unroll the panels does not cause scratches or crimps in the geomembrane and does not damage the supporting soil;

The method used to place the panels minimizes wrinkles (especially differential wrinkles between adjacent panels);

Adequate temporary loading and/or anchoring (e.g., sand bags, tires), not likely to damage the geomembrane, has been placed to prevent uplift by wind (in case of high winds, continuous loading, e.g., by adjacent sand bags, or soil is recommended along edges of panels to minimize risk of wind flow under the panels);

Direct contact with the geomembrane is minimized; i.e., the geomembrane is protected by geotextiles, extra geomembrane, or other suitable materials in areas where excessive traffic may be expected.

GLCC shall inform the Project Manager if the above conditions are not fulfilled.

3.2.2.5 Damage

GLCC shall inspect each panel after placement and prior to seaming for damage. GLCC shall advise the Project Manager which panels or portions of panels should be repaired or accepted. Damaged panels or portions of damaged panels which have been rejected shall be marked and their removal from the work area recorded by GLCC. Repairs shall be made according to procedures described in section 3.4.

3.3 Field Seaming

3.3.1 Seam Layout

Upon commencement of the installation, GLCC shall provide the Project Manager with a proposed panel layout drawing; i.e., a drawing of the facility to be lined based upon submitted engineering drawings. The proposed panel layout drawing is tentative and may be modified by GLCC Field Supervisor with Project Manager approval.

In general, seams should be oriented parallel to the line of maximum slope; i.e., oriented along, not across, the slope. In corners and odd-shaped geometric locations, the number of seams should be minimized. No horizontal seam should be less than 5 feet (1.5 m) from the toe of the slope or areas of potential stress concentrations unless otherwise authorized.

A seam numbering system compatible with a panel numbering system shall be agreed upon at the Resolution and/or Pre-Construction Meeting.

3.3.1.1 Field joints shall be made by overlapping adjacent sheets a minimum of 3 inches for extrusion welding and 4 inches for hot wedge welding (unless approved by the engineer).

3.3.1.2 Polyethylene pipe sleeves shall be used for pipe sleeves penetrating through the lined area.The polyethylene sheet shall be extrusion welded to the polyethylene pipe sleeve. When the pipe composition is polyethylene the sleeve should be extrusion welded directly to the pipe. For dissimilar materials, the sleeve should be fastened by mechanical means and sealant applied between the pipe and sleeve.

3.3.2 Seaming Equipment and Products

The approved processes for field seaming are extrusion welding and fusion (hot wedge) welding.

Proposed alternate processes shall be documented and submitted to the Owner or his representative for his approval.

The extrusion welding apparatus shall be equipped with gauges giving the temperature of the apparatus at the nozzle.

The fusion-welding apparatus must be an automated vehicular-mounted device which produces a double seam with an enclosed space or solid seam on thin mil material as specified.

The fusion welding apparatus shall be equipped with gauges giving the applicable temperatures.

GLCC shall verify that:

Equipment used for seaming is not likely to damage geomembrane;

The extrusion welder is purged prior to beginning a seam until all heat-degraded extrudate has been removed from the barrel;
The electric generator is placed on a smooth base such that no damage occurs to the geomembrane;

Buffing shall be completed no more than one (1) hour prior to extrusion welding (buffing is not necessary for hot wedge welding);

A smooth insulating plate or fabric is placed beneath the hot welding apparatus after usage;

The geomembrane is protected from damage in heavily trafficked areas.

3.3.3 Seam Preparation

GLCC shall verify that:

Prior to seaming, the seam area is clean and free of moisture, dust, dirt, debris of any kind, and foreign material;

Seams are aligned with the fewest possible number of wrinkles and "fishmouths".

3.3.4 Weather Conditions for Seaming

The normally required weather conditions for seaming are as follows:

The high temperature limit for welding is the temperature at which the well-being of the crew becomes uncertain.

Unless authorized in writing by the Project Manager, no seaming shall be attempted at ambient temperatures below 5 degrees Fahrenheit

The colder the weather, the slower the welding speeds possible for effective welding. Further detail for cold weather welding follows in this section.

In all cases, the geomembrane shall be dry and protected from wind.

GLCC shall verify that these weather conditions are fulfilled and will advise the Project Manager if they are not. The Project Manager shall then decide if the installation shall be stopped or postponed.

Cold Weather Seaming of Polyethylene Liners

Cold weather welding restrictions exist because problems associated with hot air seaming techniques have been mistakenly applied to extrusion welds. The extrusion weld, however, has been successfully employed in cold weather on several dozen job sites. With the assistance of preheating the sheet, the weld has been applied as low as -5 degrees Fahrenheit. Both the extrusion weld and hot wedge weld are able to overcome cold weather welding restrictions because of their unique designs.

The extrusion weld is not solely temperature dependent. It combines pressure, extrudate, and mixing action in addition to temperature, to bond the liner together. The mixing action means that convective heat transfer takes place in addition to conductive heat transfer. Overall heat transfer is thus improved and sensitivity to ambient temperature is dramatically reduced.

The extrusion welder should be capable of continuously monitoring and controlling the temperatures of the extrudate and the zone of contact for independence of environmental conditions. To control the molten bead temperature accurately and to ensure no fluctuation out of the predetermined range the machine has:

a. An over capacity heater band on the extruder.

b. An extra over capacity heater band on the nozzle.

c. A separate proportional temperature controller for each heater band.

d. The nozzle thermocouple positioned approximately 1/8 inch from the end of the nozzle which rides on sheet.

The hot wedge welder lifts the sheet slightly to minimize the effects of subcooling from a frozen sub-base. In addition the hot wedge welder comes equipped with a hot air blower attached to the welder which automatically preheats the sheet in the path of the hot wedge. Temperature controls can be adjusted to guarantee fully integrated welding as demonstrated by peel testing.

To guarantee quality welding in cold weather, the following procedures are recommended for the welds:

1. The sheet should be preheated before welding any time ice crystals are present in the weld path.

2. When strong winds are present, a shield of some sort should be set in place to prevent large convection heat losses from the welding gun during seaming. (Tunnels over the seams were used for such a purpose at the Midland, Michigan project.)

3. Test welds should always be prepared and tested before seaming in order to gauge appropriate welding conditions. (Example: Welding machine temperatures should be set higher and welding rates slowed down.)

3.3.5 Trial Seams

Trial seams shall be made on fragment pieces of geomembrane liner to verify that seaming conditions are adequate. Such trial seams shall be made at the beginning of each seaming period (start of day, mid-day, and anytime equipment is shut down) for each seaming apparatus used. Trial seams shall be made under the same conditions as actual seams.

The trial seam sample shall be at least 3 feet (1.0 m) long by 1 feet (0.3 in) wide (after seaming) with the seam centered lengthwise. Seam overlap shall be nominally 4 inches; 3 inches minimum.

Two adjoining specimens each 1 inch (25 mm) wide, shall be cut from the trial seam sample by the installer. The specimens shall be tested respectively in shear and peel using a field tensometer, and they should not fail in the seam. If the additional specimen fails, the entire operation shall be repeated. If the additional specimen fails, the seaming apparatus and seamer shall not be accepted and shall not be used for seaming until the deficiencies are corrected and two consecutive successful full trial welds are achieved.

3.3.6 General Seaming Procedure

Unless otherwise specified, the general seaming procedure used by GLCC shall be as follows:

The rolls of membrane shall be overlapped by a minimum of four (4) inches (100 rim) for fusion welding and three (3) inches (75 mm) for extrusion welding.

"Fishmouths" or wrinkles at the seam overlaps shall be cut along the ridge of the wrinkle in order to achieve a flat overlap. The cut "fishmouths" or wrinkles shall be seamed and any portion where the overlap is inadequate shall then be patched with an oval or round patch of the same geomembrane extending a minimum of 6 inches beyond the cut in all directions.

Seaming shall extend up the panels and well into the anchor trench.

All cross seams are to be extrusion welded where they intersect.

For fusion welding, a movable protective layer of plastic may be required to be placed directly below the overlapped membranes being seamed. This is to prevent any moisture buildup between the sheets to be welded and/or to provide consistent rate of speed for the wedge welding device.

3.3.7 Nondestructive Seam Continuity Testing

3.3.7.1 Concept

GLCC shall nondestructively test all field seams over their full length using a vacuum test unit, air pressure testing, or other approved method. (Vacuum testing is described in Section 3.3.7.2 and air pressure testing is described in Section (3.3.7.3). The purpose of nondestructive tests is to check the continuity of seams. It does not provide information on seam strength. Continuity testing shall be carried out as the seaming work progresses, not at the completion of all field seaming.

3.3.7.2 Vacuum Testing

The equipment shall be comprised of the following:

A vacuum box assembly consisting of a rigid housing, a transparent viewing window, a soft neoprene gasket attached to the bottom, port hole or valve assembly, and a gauge to indicate chamber vacuum;

A steel vacuum tank and pump assembly equipped with a pressure controller and pipe connections;

A rubber pressure/vacuum hose with fittings and connections;

A bucket and wide brush or spray assembly;

A soapy solution;

The following procedures shall be followed:

Energize the vacuum pump and reduce the tank pressure to approximately 5 psia (10 inches. of Hg.);

Wet a strip of geomembrane approximately 12 inches by 48 inches (0.3 in by 1.2 m) with the soapy solution;

Place the box over the wetted area;

Close the bleed valve and open the vacuum valve;

Ensure that a leak tight seal is created;

For a period of approximately 5 to 10 seconds, examine the geomembrane through the viewing window for the presence of soap bubbles;

If no bubble appears after 10 to 15 seconds, close the vacuum valve and open the bleed valve, move the box over the next adjoining area with a minimum 3 inches (75 mm) overlap, and repeat the process;

All areas where soap bubbles appear shall be marked and repaired in accordance with Section 3.4;

Vacuum tested seams are recorded on Daily Progress Reports (Figure 17).

3.3.7.3 PRESSURE TEST SPECIFICATIONS FOR DUAL TRACK HOT WEDGE WELDS

Sheet Thickness	Test Pressure (After 5 Mm.) PSI Min.	Max. Pressure Max.	Drop Allowed
30 mil	24	30	3 PSI
40 mil	24	30	3 PSI
60 mil	27	30	3 PSI
80 mil	27	30	3 PSI
100 mil & thicker	30	30	3 PSI

3.3.7.4 Air Pressure Testing (For Double Fusion Seam Only)

The equipment shall be comprised of the following:

an air pump (manual or motor driven) equipped with pressure gauge capable of generating and sustaining a pressure between 25 and 30 psi (160 and 200 kPa)

a rubber hose with fittings and connections;

a sharp hollow needle, or other approved pressure feed device.

The following procedures shall be followed:

seal both ends of the seam to be tested;

insert needle or other approved pressure feed device into the tunnel created by the fusion weld;

energize the air pump to a pressure between 25 and 30 psi (160 and 200 kPa, close valve, and sustain pressure for approximately five minutes;

if loss of pressure exceeds below listed values, or does not stabilize, locate faulty area and repair in accordance with Section 3.4;

remove needle or other approved pressure feed device and seal,

pressure tested seams are recorded on Daily Progress Reports (Figure 17).

3.3.8 Destructive Testing

3.3.8.1 Concept

Destructive seam tests shall be performed at random selected locations. The purpose of these tests is to check that welds are fully integrated with each other and to evaluate seam strength. Seam strength testing shall be done as the seaming work progresses, not at the completion of all field seaming.

3.3.3.2 Location and Frequency

The owner and/or owner's representative shall select locations where seam samples will be cut. These locations shall be established as follows:

A frequency shall be agreed upon by GLCC and the Project Manager at the Resolution and/or Pre-Construction Meeting. Unless otherwise specified, destructive samples should be pulled at intervals of 1 sample for every 500 linear feet of weld.

The seaming technician shall not be informed in advance of the locations where the seam samples will be taken.

3.3.8.3 Sampling Procedure

Samples shall be cut by GLCC as the seaming progresses in order to have

laboratory test results before the geomembrane is covered by another material. 01CC shall:

Cut samples;

Assign a number to each sample which is to be based upon seam and sample number and mark it accordingly (see Figure 19, example of sample sticker);

Record sample location on layout drawing and

All holes in the geomembrane resulting from destructive seam sampling shall be immediately repaired in accordance with repair procedures described in Section 3.4. The continuity of the new seams in the repaired area shall be tested according to section 3.3.7.

3.3.8.4 Size of Samples

At a given sampling location, two types of samples shall be taken by the Installer.

First, two samples for field testing should be taken. Each of these samples shall be 1 inch (0.25 mm) wide by 12 inches (0.3 m) long with the seam centered parallel to the length. The distance between these two samples shall be 42 inches.

If both samples pass the field test described in Section 3.3.8.5, a sample shall be cut into three parts and distributed as follows:

One portion to the Installer (01CC) for laboratory testing (GLS), 18 inches X 12 inches

One portion for Geosynthetic Quality Assurance Laboratory testing if applicable, 12 inches x 12 inches (0.3 m x 0.3 in); and

One portion to the Owner for archive storage, 12 inches x 12 inches (0.3 in x 0.3 in).

Final determination of the sample sizes shall be made at the Pre-Construction Meeting.

3.3.8.5 Field Testing

The two 1 inch (25 mm) wide strips, mentioned in Section 3.3.8.4 shall be tested in the field for peel and shear and shall not fail in the seam. If any field test sample fails to pass, then the procedures outlined in 3.3.8.7 shall be followed.

Hand tensometer testing in the field is also carried out. The following procedure is followed: If the test passes, the sample qualifies for testing in the laboratory. If it fails, the seam should be repaired in accordance with Section 3.4.

3.3.8.6 Laboratory Testing

Destructive test samples shall be packaged and shipped via express mail to the laboratory.

GLS Laboratory shall provide verbal test results no more than 24 hours after they receive the samples. Written results will follow within one week. (See Figure 20, example of destructive seam test report form.)

Destructive Testing of Seams

Destructive testing of seams is very important because it provides the only

direct evaluation of seam strength and bonding efficiency which indicates seam durability.

Destructive testing involves two techniques: 1) shear testing, and 2) peel testing. Shear testing applies a tensile stress from the top sheet through the weld and into the bottom sheet. Peel testing, on the other hand, peels the top sheet back against the overlapped edge of the bottom sheet in order to observe how separation occurs. The peel test indicates whether or not the sheets are continuously and homogeneously connected through the seam.

Pass/Fail Criteria for HOPE Seams

Minimum Recorded Stress Necessary To Pass (lbs. per inch width)

Test	Req'd to Pass (mil):	Type of Separation 20	30	40	60	80	100
Shear (ASTM 03Q83)	FTB[1]	45	63	86	126	171	216
Peel (ASTM 0413)	FTB[1]	25	35	48	70	95	115

FTB[1] = Film Tearing Bond. Polymer material tears, indicating a fully integrated connection between top and bottom sheets. (FTB separations are pictorially defined in Figures 21-22.)

Reasons for Pass/Fail Criteria

The FTB requirement is very important. With a fully integrated, continuous connection through the seam, no weld bead/sheet or sheet/sheet interface exists. Such an interface might be separated by absorbed chemicals, causing failure of the seam.

In addition to the FTB criterion a minimum stress level is specified. This is important in order to protect against legitimate tearing of a thin portion of polymer in the weld (as might occur if the weld is off center)

The minimum stress levels are necessarily lower than tensile yield strengths because of the different configuration of the test

specimens during destructive testing. Bending moments come into play along with straight tensile stresses especially as the sheets are bent back in peel. These bending moments depend on the shape of the welds which vary even within the same welding technique. The minimum stress values are based on the average performance values of passed weld specimens tested in the laboratory.

3.3.8.7 Procedures for Destructive Test Failure

The following procedures shall apply whenever a sample fails a destructive test. GLCC has two options:

1) Reconstruct the seam between any two passed test locations,

2) Trace the welding path to an intermediate locations [10 feet maximum from the point of the failed test in each direction] and take a small sample for an additional field test at each location. If these additional samples pass the field test, then full laboratory samples are taken. If these laboratory samples pass the tests, then the seam is reconstructed between these locations. If either sample fails, then the process is repeated to establish the zone in which the seam should be reconstructed.

All acceptable seams must be bounded by two locations from which samples passing laboratory destructive tests have been taken.

GLOC shall document all actions taken in conjunction with destructive test failures; e.g., capping of failed seam area.

3.4 Defects and Repairs

3.4.1 Identification

All seams and non-seam areas of the geomembrane shall be examined by GLCC for identification of defects, holes, blisters, undispersed raw materials and any sign of contamination by foreign matter.

3.4.1.1 Defective/damaged materials shall be identified via a deficiency report, either separately or on the Daily Report. Actions taken to resolve or correct the problem will also be recorded on the similar form.

3.4.1.2 Defects, holes, blisters, undispersed raw materials, signs of contamination by foreign matter, unacceptable welds and other unsatisfactory conditions will be identified on the Daily Report form. The repair/corrective action to "fix" the problem will also be recorded on a similar form.

3.4.2 Evaluation

Each suspect location both in seam and non-seam areas shall be non-destructively tested using the methods described in Section 3.3.7 as appropriate. Each location which fails the non-destructive testing shall be marked by GLOC and repaired. Work shall not proceed with any materials which will cover locations which have been repaired until laboratory test results with passing values are available.

3.4.3 Repair Procedures

Any portion of the geomembrane exhibiting a flaw or failing a destructive or nondestructive test shall be repaired. Several procedures exist for the repair of these areas. The final decision as to the appropriate repair procedure shall be agreed upon between the Project Manager and GLCC. The procedures available include:

Patching--used to repair large holes, tears, and contamination by foreign matter;

Buffing and re-welding--used to repair small sections of extruded seams;

Spot welding or seaming--used to repair small tears, pinholes, or other minor localized flaws;

Capping--used to repair large lengths of failed seams;

Topping--used to repair areas of inadequate seams which have an exposed edge;

In addition, the following provisions shall be satisfied:

Surfaces of the geomembrane which are to be repaired shall be abraded no more than one hour prior to the repair;

All surfaces must be clean and dry at the time of the repair;

All seaming equipment used in repairing procedures must be approved;

The repair procedures, materials, and techniques shall be approved in advance of the specific repair by the Project Manager and GLCC.

Patches or caps shall extend at least 6 in. beyond the edge of the defect, and all corners of patches shall be rounded with a radius of at least 3 inches.

3.4.4 Verification of Repairs

Each major repair requiring a patch or cap shall be identified on the as-built drawing. Each repair shall be non-destructively tested using the methods described in Section 3.3.7 as appropriate. Repairs which pass the nondestructive test shall be taken as an indication of an adequate repair. Failed tests indicate that the repair shall be re-done and re-tested until a passing test result is obtained.

3.5 Backfilling of Anchor Trench

The anchor trench, if any, shall be adequately drained to prevent ponding or otherwise softening of the adjacent soils while the trench is open. the anchor trench shall be backfilled by the Earthwork Contractor or as outlined in the specifications and bid documents.

Since backfilling the anchor trench can affect material bridging at toe of slope, consideration should be given to backfill the liner at its most contracted state; preferably during the cool of the morning or extended period of over-cast skies. Care shall be taken when backfilling the trenches to prevent any damage to the geosynthetics.

3.6 Lining System Acceptance

The geosynthetic lining system shall be accepted when:

The installation or portion for backfilling is finished;

Verification of the adequacy of all seams and repairs including associated testing is complete;

All documentation for installation is completed, and submitted to the engineer.

3.7 Soils in Contact with the Geomembrane

Important points for quality assurance of soils in contact with geomembranes include:

A geotextile or other cushion approved by the designer may be installed between angular aggregate and the geomembrane.

Equipment used for placing soil shall not be driven directly on the geomembrane.

A minimum thickness of 1 foot (0.3 m) of soil is recommended between a light dozer (such as a CAT D-3 or wide track caterpillar D-6 or lighter) and the geomembrane.

In heavily trafficked areas such as access ramps, soil thickness should be at least 2 to 3 feet (0.6-0.9m).

Soil/Earth Cover on ton of Geomembrane

Placement of soils, sand or other types of earth cover on top of the liner shall not be performed until all destructive and non-destructive testing has been performed and accepted.

Placement should be performed to minimize wrinkles. Equipment operators should be briefed on method of placement and affects to thermal expansion and contraction of the liner.

Material placed on top of the liner should be back-dumped on liner and, in order to avoid the formation of wrinkles, efforts should be made to load the soil so that it comes down on top of the liner rather than being pushed across the sheet. This is done by 1) using a front-end loader to place soil ahead of spreading soil cover, and 2) spreading soil by building a mound at the edge of soil, then pushing soil up and over the mound causing it to come down on the liner.

If a wrinkle forms, every effort should be made to walk the wrinkle out.

Minor folding over of wrinkles is acceptable providing an even transition occurs at the tail of the wrinkle. If excessive stress points are created at the tail of the wrinkle, the wrinkle should be cut out and repaired per Section 3.4.

These points shall be observed by GLCC.

TO: JIM BRAUER
FROM: JIM MCDONALD

CONFINEMENT RESTORATION
General Criteria

For landfill sites failing to meet the County criteria for demonstrating entitlement to a bottom liner exemption (reprinted below), the Division may consider a Confinement Restoration proposal. The proposal must be submitted to the Division for review and approval as a variance to the Solid Waste Management Ordinance and as part of the landfill permit application. To demonstrate eligibility for confinement restoration, the insitu confining soils throughout the proposed waste footprint must satisfy the County criteria for entitlement to a bottom liner exemption in the opinion of the County. The demonstration must include a water budget analysis for the entire landfill based on the assumption that the insitu confining soils are present beneath the entire waste footprint. All demonstrations and designs shall assume that large scale field determined hydraulic conductivities are approximately equal to insitu hydraulic conductivities and are one order of magnitude higher than laboratory determined hydraulic conductivities obtained from remolded samples from the same area. For purposes of this document, the term "confinement" means those insitu soils lying outside any anchor tie-in ring as defined below. The appropriate number and location of borings shall be approved by the Division based on site-specific conditions. In general, one boring per two acres of the horizontally projected waste footprint, containing confining soils, will be considered representative.

If the above condition for insitu confining soils is satisfied, the Division will consider Confinement Restoration designs of areas of non-confining soils it considers to be well defined sinkholes, any part of which lies in the proposed waste area, provided the designs for each and every such sinkhole area adequately addresses the following aspects:

- The stability of the sink area must be demonstrated, at a minimum, by conducting borings through the sink area to a depth that coincides with the Floridan aquifer, to provide supporting information regarding age, consolidation and raveling.

- The entire sink area is "plugged" with a natural or synthetic liner having a leakage rate equal to or less than the leakage rate of insitu confining soils.

- The full extent of the sink area is specifically located by locating a fully surrounding anchor tie-in ring of suitable insitu soil as further described below.

- The presence, alignment and depth of the tie-in ring required shall be confirmed by conducting Ground Penetration Radar (GPR) and by obtaining laboratory test results of samples, obtained every 2 ft. in the anchor ring soil, from SPT borings conducted a minimum of 2 ft. above the anchor grade. The boring grid pattern shall, at a minimum, consist radially of one ring around the sink area, located a minimum of 5 ft. beyond the edge of the sinkhole. The circumferencial spacing of the boring grid pattern shall be a maximum of 100 ft. The anchor tie-in ring shall have a minimum depth of 2 times the maximum anchor depth. The anchor shall be placed a minimum of 5 ft. beyond the edge of the sinkhole. The full volume of the anchor tie-in ring shall be composed of representative insitu soil having a hydraulic conductivity equal

to or less than the average hydraulic conductivity of the insitu borings described above. Borings are to extend into the tie-in ring a minimum of 2 times the anchor depth. A scale drawing of the boring pattern, anchor and anchor tie-in ring, in section and elevation. showing the precise location in 3 dimensions, along with copies of all test results, are to be provided with the Confinement Restoration proposal.

- The liner shall be placed at the bottom of the plug, as close as practical to the insitu tie-in ring, and so as to minimize the extent of the liner. The liner thickness and soil construction shall be such that after confinement restoration, the leakage rate through the restored sink area shall be equal or less that the leakage rate of the portion of the waste footprint underlain by confining soils. Soil is to be placed above the liner in maximum 12" compacted lifts, with each lift compacted to minimum 90% modified Proctor density, to the elevation of the proposed pit floor. The top of the plug is to have a minimum 3% grade to drain surface water away from the plug and into the operation phase stormwater management system in the most expedient way possible.

- The width and alignment of the anchor tie-in ring shall be field marked with grade stakes before excavation to the liner plug base grade commences.

- Confinement Restoration construction shall follow a Division approved Construction Quality Assurance Plan, prepared and sealed by a Florida registered Professional Engineer having experience in hydrogeology or Professional Geologist, and meeting or exceeding the requirements of 62-701.400(7)(b). Division approval shall precede commencement of any related construction.

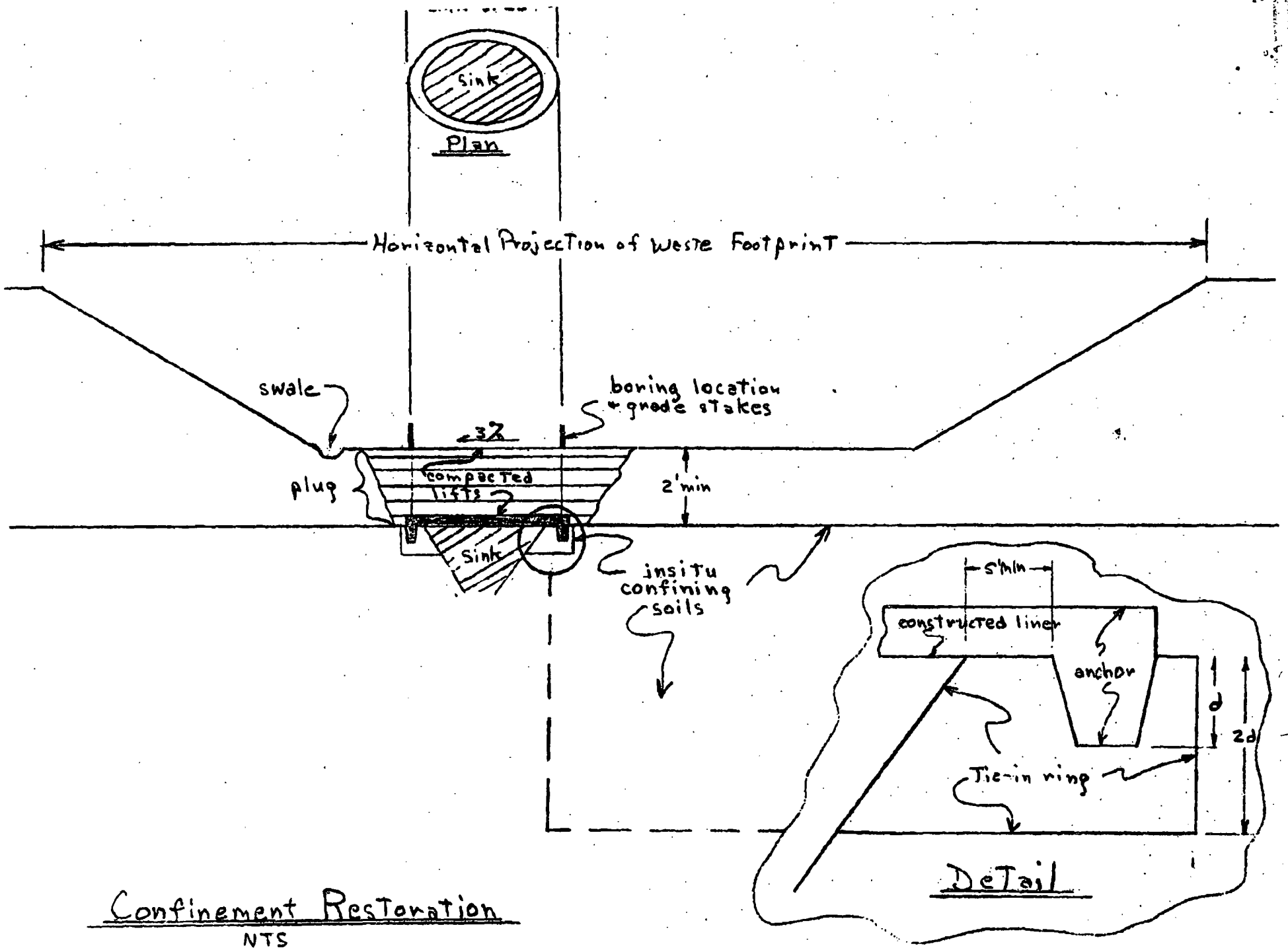
- The applicant shall pay the County's cost to perform Quality Assurance / Quality Construction (QA/QC) testing, inspection and development of a Construction Quality Assurance Certification Report.

- When completed, the entire pit floor shall be graded to cause surface water to run away from each plugged sink area and into the operation phase stormwater management system. Before accepting waste, the grades of the entire pit below proposed waste, including all plugged sink areas, will be surveyed; a topographic map, sealed by Florida Registered Land Surveyor, will be presented to the Division; and approved.

- A minimum of one upgradient and two downgradient Floridan monitoring wells will be added to the site Groundwater Monitoring Plan.

DEMONSTRATION OF ENTITLEMENT TO AN EXEMPTION TO A BOTTOM LINER REQUIREMENT AT A LANDFILL

To obtain entitlement, it must be shown, to the satisfaction of the County, that the confining layer is able to separate and prevent an overwhelming amount of the surficial aquifer groundwater from percolating downward to the drinking water aquifer below the waste footprint, and the ability of the confining layer to cause horizontal flow of the surficial aquifer, sufficient to allow effective interception and treatment of potential leachate, in an area beyond the waste footprint. In considering the demonstration, the County uses engineering judgement, on a case by case basis, to evaluate potential harm to the drinking water aquifer and the environment.



Confinement Restoration

NTS

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