g. The MANUFACTURER'S written instructions for storing, handling, installing, seaming, protecting from hydration, and repairing the proposed geomembrane, including recommendations for handling equipment (model number and load capacity).
h. Samples product warranty.

2. CONTRACTOR'S Information:
   a. CONTRACTOR'S name and address and primary contact.
   b. CONTRACTOR'S qualifications including a list of at least three previous projects of similar size to this project, including project name, location, size and date of installation, and evidence of installing at least 1 million square feet of geomembrane.
   c. The Construction Quality Control (CQC) Plan, including examples of subgrade certification documents, daily record documents, methods for repairing geomembrane and subgrade and example documents to certify repairs, method for removing rejected materials, proposed staffing, and proposed equipment.
   d. Description of welding equipment, techniques, and material, including a list of proposed equipment.
   e. A complete set of forms to be used for record installation CQC data.
   f. Résumés of key installation personnel. The Installation Supervisor, Master Seamers, and QC Representative must be clearly identified.
   g. Workmanship warranty.

D. The CONTRACTOR shall furnish SHOP DRAWINGS to the OWNER and ENGINEER as follows:

1. Installation layout SHOP DRAWINGS.
   a. Must show proposed panel layout including field seams and details.
   b. Must show panel identification numbers.
   c. Installed square footage of the geomembrane.
   d. Must be approved prior to installing the geomembrane.
   e. Approved SHOP DRAWINGS will be for concept only and actual panel placement will be determined by site conditions.

E. CONTRACTOR'S geomembrane field installation quality assurance plan.

F. The CONTRACTOR will submit the following to the OWNER and ENGINEER upon completion of installation:

1. Certificate stating the geomembrane have been installed in accordance with the contract documents.
2. Material and installation warranties:
   a. Material shall be warranted against MANUFACTURER's defects for a period of five (5) years from the date of geomembrane installation.
   b. Installation shall be warranted against defects in workmanship for a period of one (1) year from the date of geomembrane completion.
3. As-built drawings showing actual geomembrane placement, seams, testing locations and results, and anchor trench details.

1.3 REFERENCES

Note: Where reference is made to one of the standards listed below, the revision in effect at the time of bid opening shall apply.

A. American Society for Testing and Materials (ASTM)

1. ASTM D792 – Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement

2. ASTM D1004 – Test Method for Initial Tear Resistance of Plastic Film and Sheeting

3. ASTM D1238 – Test Method for Melt Flow Rates of Thermoplastics by Extrusion Plastometer

4. ASTM D1603 - Standard Test Method for Carbon Black Content in Olefin Plastics

5. ASTM D3895 – Standard Test Method for Oxidative-Induction Time of Polyolefins by Differential Scanning Calorimetry

6. ASTM D4218 – Test Method for Determination of Carbon Black Content in Polyethylene Compounds by the Muffle-Furnace Technique

7. ASTM D4716 - Standard Test Method for Determining the (In-Plane) Flow Rate Per Unit Width and Hydraulic Transmissivity of a Geosynthetic Using a Constant Head

8. ASTM D4873 Standard Guide for Identification, Storage, and Handling of Geosynthetic Rolls and Samples

9. ASTM D4833 – Test Method for Index Puncture Resistance of Geomembranes and Related Products

10. ASTM D5035 - Standard Test Method for Breaking Force and Elongation of Textile Fabrics (Strip Method)

11. ASTM D5199 - Standard Test Method for Measuring the Nominal Thickness of Geomembrane

12. ASTM D5596 – Test Method for Microscopic Evaluation of the Dispersion of Carbon Black in Polyolefin Geomembrane

13. ASTM D5641 – Standard Practice for Geomembrane Seam Evaluation by Vacuum Chamber

14. ASTM D5820 – Standard Practice for Pressurized Air Channel Evaluation of Dual Seamed Geomembranes

15. ASTM D5885 - Standard Test Method for Oxidative Induction Time of Polyolefin Geomembrane by High-Pressure Differential Scanning Calorimetry

16. ASTM D5994 – Test Method for Measuring Core Thickness of Textured Geomembrane

17. ASTM D6364 - Standard Test Method for Determining Short-Term Compression Behavior of Geomembrane

18. ASTM D6392 – Test Method for Determining the Integrity of Non-Reinforced Geomembrane Seams Produced Using Thermo-Fusion Methods

19. ASTM D6693 – Test Method for Determining Tensile Properties of Non-Reinforced Polyethylene and Non-Reinforced Flexible Polypropylene Geomembranes

20. ASTM D7179 - Standard Test Method for Determining Geomembrane Breaking Force

21. ASTM D7406 - Standard Test Method for Time-Dependent (Creep) Deformation Under Constant Pressure for Geosynthetic Drainage Products

22. ASTM D7466 – Standard Test Method for Measuring the Asperity Height of Textured Geomembrane

B. Geosynthetic Research Institute (GRI)

1. GRI-GM9 Cold Weather Seaming of Geomembranes.

2. GRI GM10 – Specification for the Stress Crack Resistance of Geomembrane Sheet.

3. GRI GM12 – Measurement of the Asperity Height of Textured Geomembranes Using a Depth Gage.

4. GRI GM13 – Test Properties, Testing Frequency for HDPE Smooth and Textured Geomembranes.

5. GRI GM14 – Test Frequencies for Destructive Seam Testing Selecting, Variable Intervals for Taking Geomembrane Destructive Samples Using the Method of Attributes.

6. GRI GM 19 – Seam Strength and Related Properties of Thermally Bonded Polyolefin Geomembranes.

1.4 DEFINITIONS

A. Lot – A quantity of resin (usually the capacity of one rail car) used in the manufacture of geomembrane. Finished roll will be identified by a roll number traceable to the resin lot used.

B. ENGINEER – Party, independent from manufacturer and CONTRACTOR, that is responsible for observing and documenting activities related to quality assurance during the lining system construction.

C. Geomembrane Manufacturer – The party responsible for manufacturing the geomembrane rolls.

D. Geosynthetic Quality Assurance Laboratory (testing laboratory) – Party, independent from the OWNER, manufacturer, and CONTRACTOR, responsible for conducting laboratory tests on samples of geomembrane obtained at the site or during manufacturing.

E. CONTRACTOR – Party responsible for field handling, transporting, storing, deploying, seaming and testing of the geomembrane seams.

F. Minimum Average Roll Value (MARV): Property value calculated as typical minus two standard deviations. Statistically, it yields a 97.7% degree of confidence that any sample taken during quality assurance testing will exceed value reported.

G. Panel – Unit area of a geomembrane that will be seamed in the field that is 10 square yards or larger.

H. Patch – Unit area of a geomembrane that will be seamed in the field that is less than 10 square yards.

I. Subgrade Surface – Soil layer surface which immediately underlies the geosynthetic material(s).

1.5 QUALIFICATIONS

A. MANUFACTURER

1. MANUFACTURER shall have manufactured a minimum of 10 million square feet of HDPE geomembrane material during the last year.
2. MANUFACTURER shall have manufactured a minimum of 10,000,000 square feet of polyethylene geomembrane material during the last year.
3. MANUFACTURER shall have a GAI-LAP Accredited Laboratory at the manufacturing facility.
4. MANUFACTURER shall have ISO 9001; 2008 certification.

B. CONTRACTOR

1. CONTRACTOR shall have installed a minimum of 10,000,000 square feet of geomembrane in the last 3 years.
2. CONTRACTOR shall have worked in a similar capacity on at least 3 projects similar in complexity to the project described in the contract documents, and within a total of at least 400,000 square feet of geomembrane installation on each project.
3. The Installation Supervisor shall have worked in a similar capacity on at least 3 projects similar in size and complexity to the project described in the Contract Documents in the last 5 years.

1.6 MATERIAL LABELING, DELIVERY, STORAGE, AND HANDLING

A. Geomembrane labeling, shipment, and storage shall follow ASTM D4873. Product labels shall clearly show the manufacturer or supplier name, style name, and roll number.

B. Each geomembrane roll shall be wrapped with a material that will protect the geomembrane from damage due to shipment, water, sunlight, and contaminants.

C. The CONTRACTOR shall note any visible damage to roll materials on the Bill of Lading prior to unloading roll materials. Should any visible damage be noted, CONTRACTOR or ENGINEER shall notify the MANUFACTURER in writing immediately.

D. Labeling – Each roll of geomembrane delivered to the site shall be labeled by the manufacturer. The label will identify:

1. Manufacturer's name
2. Product identification
3. Thickness
4. Length
5. Width
6. Roll number
7. Date and time of production
8. Resin lot number

E. Delivery – Rolls of liner will be prepared to ship by appropriate means to prevent damage to the material and to facilitate off-loading.

F. Storage – The on-site storage location for geomembrane material, provided by the CONTRACTOR to protect the geomembrane from punctures, abrasions and excessive dirt and moisture, should have the following characteristics:

1. Level (no wooden pallets)
2. Smooth
3. Dry
4. Protected from theft and vandalism
5. Adjacent to the area being lined
6. Geomembrane shall not be stacked higher than three rolls

G. Handling – Materials are to be handled to prevent damage. The CONTRACTOR shall take any necessary precautions to prevent damage to underlying layers during placement of the geomembrane.

1.7 WARRANTY

A. Material shall be warranted, against manufacturer's defects for a period of five (5) years from the date of geomembrane installation.

B. Installation shall be warranted against defects in workmanship for a period of one year from the date of geomembrane completion.

PART 2 - PRODUCTS

2.1 HIGH DENSITY POLYETHYLENE (HDPE) GEOMEMBRANE

A. Material shall be **smooth (both sides) 40-mil black LLPDE** and **60-mil grey HDPE (textured on one side and smooth on other)** or equivalent HDPE geomembrane meeting the thickness, texture, and color requirements as shown on the DRAWINGS.

B. Geomembrane Rolls

1. Geomembrane rolls must not exceed a combined maximum total of 1 percent by weight of additives other than carbon black.
2. Geomembrane shall be free of holes, pinholes, bubbles, blisters, excessive contamination by foreign matter, and nicks and cuts on roll edges.