
SECTION 02 16 00

SEDIMENT DEWATERING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes
1. Dewatering requirements.
 2. Collection of carriage water.

1.2 SYSTEM DESCRIPTION

- A. Current Requirements
1. The design requires a screen for oversize removal followed by the use of geotextile tubes for sediment dewatering and/or passive dewatering cells.
 2. The Contractor shall determine whether a thickener is needed for the process, based on sediment characteristics.
 3. Acceptance of sediment dewatering area pad for operation of the dewatering work.
 4. Maintain loading and hauling areas and surfaces for dewatered sediments for use by others and coordinate with others.
 5. Maintain facilities for the collection of water from dewatering sediments and conveying these waters for discharge.
- B. Performance Requirements for Design or Alternate Design
Selected dewatering equipment and methods shall dewater dredged sediments to the degree required to achieve a minimum of 38% solids to achieve the efficient and effective dewatering of sediments, and to maximize the workability, dryness, and strength of the dredged sediments prior to stockpiling.
- C. Owner and Contractor will work together on a cooperative basis so that dewatered material can be handled in the optimal fashion at the dewatering facility site.

1.3 SUBMITTALS

- A. Quality Control Submittals
1. Submit for approval to the Owner and Engineer 14 days prior to dredging a dewatering site layout plan including berm location, berm construction methods, a dewatering and water treatment process flow diagram and calculations, suspended solids, control measures, erosion control measures, and loadout facilities.
 2. Submit a description of and specifications for the geotextile dewatering tubes and calculations indicating that the sediment will be dewatered to the required percent solid content of 38%.
 3. Submit a description of the dewatered sediment handling and loading operation.

4. Prepare a process flow diagram showing the proposed method of dredging, dewatering, and water treatment of sediments and carriage water complete with information on the volumes or weights of sediments and water to be handled by each unit process through loadout procedures, including amendment (polymer) type (if any), application location and anticipated amount (rate).
 5. Submit dewatering pad geomembrane liner material information, including supplier, installer, etc.
 6. Proposed polymer MSDS sheets.
- B. Submit manufacturer's literature describing physical size, capacity, and other pertinent data for each major piece of equipment and/or material proposed for use in the dewatering systems.
- C. Prepare a site layout plan for installation of dewatering and stabilization system upgrades including, but not limited to, the following:
1. Screening equipment
 2. Pumps and piping
 3. Polymer storage tanks and feed systems
 4. Geotextile tube layout
 5. Other proposed facilities associated with dewatering.
- D. Prepare a mass balance chart and calculations that estimates the daily production of dewatered sediment.
- E. Prepare a submittal describing procedures and methods as to how the Contractor will meet all discharge requirements and provisions of the WPDES Permit.

PART 2 - PRODUCTS

2.1 SOIL

- A. Soil used to construct containment berms shall be on-site soils compacted to a minimum of 90 percent of the maximum dry density as determined by ASTM D1557, Modified Proctor test.

2.2 POLYMER ADDITIVES

- A. Polymer additives shall be used at minimum dosages to allow for successful treatment to meet water discharge standards and not be toxic to fish or other fauna or flora when discharged to the lake in the effluent. Only state-approved polymers shall be used.

2.3 SEDIMENT DEWATERING PAD

- A. The sediment dewatering pad will be constructed as shown in the project drawings. PVC geomembrane liner will conform to specification Section 02 66 40.

2.4 GEOTEXTILE DEWATERING TUBES

- A. The Contractor shall supply geotextile dewatering tubes to dewater sediments at least 38% solids.

PART 3 - EXECUTION

3.1 DEWATERING OPERATIONS

- A. Conduct dewatering Operations as required to complete the Work within the project schedule and meet applicable WPDES discharge standards.
- B. Provide continuous operation of the dewatering process.
- C. Cover dewatered sediment stockpiles with tarpaulins or other approved materials to prevent precipitation from entering the dewatered sediment if large amounts of precipitation are anticipated and if the dewatered sediment is not sloped to shed water.
- D. Provide additional facilities and maintain existing facilities to prevent any leaks, spills, or other losses of sediment, carriage water or other contaminated substances on the site.
- E. Clean up any contamination caused by leaks, spills or other losses, including those otherwise associated with dewatering activities performed and kept on the dewatering pad that interface with proper operation of the dewatering pad, but excluding those caused by other contractors retained by the Owner.
- F. Sediment shall be dewatered to at least 38% solids by dry weight.

3.2 EQUIPMENT INSTALLATION AND INITIAL TESTING

- A. Install dewatering equipment and facilities in general conformance with approved site layout plans and shop drawings.
- B. Test all equipment, piping and fittings for leaks prior to beginning dredging. Repair all leaks found.

3.3 REMOVAL OF DEWATERING EQUIPMENT

- A. Upon completion of all dewatering operations, remove equipment from site.
- B. Upon removal of dewatering equipment, remove any remaining sediment from stockpile pads, truck loading areas, and other operating areas with power sweeping or other approved equipment. Remove geotextile tubes and dispose of properly off-site.

END OF SECTION

SECTION 02 23 00

SITE CLEARING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes:
1. Clearing, grubbing, and disposal.
 2. Stripping and stockpiling topsoil.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Topsoil
1. Topsoil is defined as the upper soil horizon consisting of mineral layers of maximum humus (organic) accumulation.

PART 3 - EXECUTION

3.1 CLEARING, GRUBBING, AND DISPOSAL

- A. General
Clear and grub the area of construction as identified on final Contractor submittal drawings.
- B. Clearing
Cut all brush, shrubs, stumps and trees to within 4 inches of the existing ground surface.
- C. Grubbing
1. Remove all stumps, roots, logs, and timber.
 2. Grubbing shall be carried to a minimum depth of 12 inches.
- D. Disposal
1. Contractor is responsible for the following:
 - a. Disposal of all material removed under clearing and grubbing.
 - b. Furnishing of a disposal site.
 - c. Obtain and conform to all necessary, federal, state, and local permits for land disturbance.
 - d. Conform to all requirements for disposal of diseased trees.
 - e. Burning of debris.

- E. Clearing operations shall be completed in a manner so as to prevent obstruction of traffic and to protect all remaining trees, shrubs, and other vegetation from injury.

3.2 STRIPPING AND STOCKPILING TOPSOIL

A. Stripping

1. Remove all topsoil beneath:
 - a. Structures.
 - b. Roadways.
 - c. All paved areas.
 - d. Liners.
2. Remove topsoil to a depth of 6 inches in:
 - a. Areas disturbed by utility construction.
 - b. Areas requiring cuts or significant fills (significant fills are fills which cannot be obtained by the addition of topsoil only).

B. Stockpiling

1. Contractor shall stockpile topsoil obtained in the stripping operation for replacement.
 - a. For areas where topsoil is to be replaced after underground utility construction.
 - b. For areas involving site grading where topsoil is to be replaced in order to sustain vegetative growth.
2. In areas where topsoil will not be required as specified above, Contractor shall remove and dispose of excess material as defined in other sections.

END OF SECTION

SECTION 02 32 50

DREDGING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Dredging
 2. Debris Removal
 3. Post-Dredge Sampling and Testing

1.2 REFERENCES

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.
1. Chapter 30 Permit
 2. WDNR Waterway marker Permit shall be obtained by the Contractor prior to placing marker buoys (Form 8700-058).

1.3 SUBMITTALS

- A. Quality Control Submittals
1. Submit Dredging Plan within 14 days prior to dredging to Owner and Engineer. Acceptance by the Owner's Representative is required prior to dredging work.
 2. Submit results of Contractor's QC bathymetric surveys when target elevations have been attained weekly.
 3. Contractor shall submit a spill preventions/response plan to the Owner and regulatory agency within 14 days of the date of the Notice to Proceed. This plan will include a separate section on equipment refueling and management of backwashing fines from pipelines.

1.4 QUALITY CONTROL

- A. Prepare a Dredging Plan to include:
1. The dredge types, number of dredges and manufacturer;
 2. Pump size and capacity.
 3. Size, material, joint details, pressure rating and location of slurry pipeline.
 4. Draft of dredge boat and procedure for controlling depth of cut and location of dredge.
 5. Procedure to minimize re-suspension of sediments.
 6. Sequence of dredging including dredge progression plan and proper slope dredging without causing unstable slopes.
 7. Procedure for removing debris and removing or relocating stones and rubble too large for the dredge to pump.
 8. A buoy and safety marker plan.

9. Polymer addition procedures, equipment, locations, etc.
10. Dredge booster pump(s) size, location, and capacity.
11. Effluent booster pump (at dewatering facility) size, location, and capacity.
12. Values assumed for in-place density of sediment to be dredged.
13. Values assumed for percent solids of the dredged slurry piped from the lake to the sediment dewatering facility.
14. Values assumed for percent solids of dewatered sediment.
15. Noise abatement measures.

- B. Comply with conditions and substantive requirements of all applicable permits and permit requirements.

1.5 PERFORMANCE REQUIREMENTS

- A. Volume of Material to be Removed in Dredge Locations:

Dredge Location	Approx. Dredge Prism Volume (cy) ⁽¹⁾	Dredge Volume ⁽²⁾ with 6" Overcut Allowance and 5% Contingency
West Channels	13,652	16,485
Northwest Channels	38,511	46,502
Northeast Channels	3,542	4,277
Bark River Inlet	27,818	33,590
Zastrow's Bay	6,746	8,146
Total	90,269	109,000

(1) In-situ lake sediment volume of dredge prism. Upland disposal volume, after dewatering, may be substantially less than the dredge prism volume.

(2) Assumes a 0.5 ft. overcut allowance to establish target elevation.

- B. Dredge Area Schedule

1. Contractor to begin with Stage 1 Dredge Area beginning with the West Channel, South Area. Upon completion of the Stage 1 area Contractor shall commence with the Stage 2 area. Contractor shall complete dredging in one season.

- C. Work Completion Time and Work Hours

1. Remove designated sediments during the following time periods:
 - a. To limit potential impacts to fish spawning, no dredging may occur from mid-March through June 30th of the calendar year. To avoid potential impacts to reptiles and amphibians, dredging may not occur from October 16th to April 1st of each calendar year, except in Zastrow's Bay.
 - b. No dredging will be conducted during holidays as specified in Section 00 10 00.
2. Provide equipment and personnel to dredge 24 hours per day, 7 days per week.
3. Dredge to target elevations or to hard pan.
 - a. Target dredge vertical and horizontal extent as shown on drawings.

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4. Contractor shall dredge to target elevations but not below hard pan where encountered.

1.6 PROJECT CONDITIONS

- A. The Project is located at Nagawicka Lake, Delafield, Wisconsin.
- B. Characteristics of Sediment Material to be Removed
 1. Samples have been taken by the Owner to determine the character of materials to be removed. Although the results of such explorations are representative of subsurface conditions near the sediment surface at their respective locations, local minor variations in the subsurface materials are to be expected and, if encountered, will not be considered materially different within the purview of the contract. Grain size curves of samples taken from the areas to be dredged, and a map of the locations where the samples were taken are provided in Appendix C. The material to be removed to accomplish the specified dredging work is anticipated to be generally highly organic silt or silty organics. The native lakebed is primarily gray clay. Table 1, attached as Appendix C, presents a summary of the physical characteristics and geotechnical test results for the sediment samples obtained. The Contractor is expected to examine the site of the work and confirm the character of the material.
- C. Utilities may be located within the Work Site.
 1. Locate all utilities and industrial and municipal water intake and discharge structures in the area of the Work prior to beginning dredging.
 2. Protect all utilities and structures from damage.
 3. All power required for pumps, lighting and communication is the responsibility of the Contractor.
- D. Selected Contractor shall be provided dredge prism control information from Engineer 15 days after Notice of Award. Dredge prism data will be available in text format or 3D model to establish vertical and horizontal control for the dredge areas.
- E. Noise Abatement
 1. Contractor shall employ necessary noise abatement methods to maintain not more than 85 db at 50 meters from the source in all areas during operations.

1.7 WORK AREA

- A. Access

The Contractor shall be responsible for providing and maintaining access necessary for his equipment to and from the work site, mooring area, and dewatering, and disposal areas. The Contractor shall ascertain the environmental conditions which can affect the access such as climate, winds, currents, waves, depths, shoaling, and scouring tendencies.
- B. Protection of Existing Waterways

The Contractor shall conduct his operations in such a manner that material or other debris are not pushed outside of dredging limits or otherwise deposited in existing side

channels, basins, docking areas, or other areas being utilized by vessels. The Contractor will be required to change his method of operations as may be required to comply with the above requirements. Should any bottom material or other debris be pushed into areas described above, as a result of the Contractor's operations, Contractor shall remove the material promptly.

C. Adjacent Property and Structures

The Contractor shall conduct the dredging operation such that it does not undermine, weaken or otherwise impair existing structures located in or near the areas to be dredged. The Contractor shall investigate the existing structures at the site and plan the dredging work accordingly.

D. Damage to private or public property or structures resulting from the dredging or disposal operations shall be repaired promptly by the Contractor at his expense. Damage to structures resulting from the Contractor's negligence will result in suspension of dredging and require prompt repair at the Contractor's expense as a prerequisite to the resumption of dredging.

E. Artificial Obstructions

The Contractor may encounter bottom debris such as, but not limited to, pieces of broken cable, rope, miscellaneous metal, and broken and derelict moorings. The Owner has no knowledge of existing wrecks, wreckage, or other artificial obstructions of such size or character as to require the use of explosives for its removal. During dredging operations, the Contractor shall remove all debris encountered unless otherwise directed by the Owner. Floating debris removed from the dredging area shall be separated and stockpiled for disposal. Disposal in accordance with local, Federal, and state laws and regulations shall be the responsibility of the Contractor.

F. Existing Utilities

There are no known utility lines in the areas to be dredged. Contractor is responsible for contacting Diggers Hotline prior to any work.

1.8 OVERCUT AND SIDE SLOPES

A. Allowable Overcut

To cover unavoidable inaccuracies of dredging processes, material may be removed to a maximum overcut of six inches below target elevations. The allowable overcut dredge volume within the dredging limits will be measured and paid for at full contract price.

B. Side Slopes

Material dredged to provide for final indicated side slopes will be measured and paid for at the applicable unit price. The material may be dredged from the original position or by dredging the space below the pay slope plane at the bottom of the slope for upslope material capable of falling into the cut. Payment will not be made for material in excess of the amount originally lying above the pay slope plane. The limiting amount of side-slope overcut will be measured vertically.

Dredging on side slopes shall follow, as closely as practicable, the cross sections indicated on the drawings.

- C. Excessive Dredging
Material taken from beyond the allowable overcut depth (greater than 6" overcut) will be considered excessive and will be deducted from the total amount dredged. Payment deduction will be applied for excessive dredged volumes. Penalties for excessive dredging shall be assessed as described in 00 22 01, L.3.

1.9 INSPECTION

- A. Inspect the work, keep records of work performed, and ensure that gages, targets, ranges, and other markers are in-place and useable for the intended purpose.
- B. Method of Communication
Provide a system of communication between the dredge crew, dewatering crew, and the Owner's representative. Portable two-way marine radios are acceptable.
- C. Transportation
The Contractor shall furnish, at the request of the Owner's representative, the use of such boats, boatmen, laborers, and material forming a part of the ordinary and usual equipment and crew as may be reasonably necessary in inspecting and monitoring the work.

1.10 DOCKS AND PIERS

- A. Active Moorings
Prior to the Contractor's mobilization at the site, individual property owner will be responsible for the removal and replacement of all portable visible moorings, floats, docks and piers from the dredge areas, at no cost to the Contractor. The Contractor shall coordinate and confirm the time schedule necessary for the removal of the moorings with the Owner.
- B. For those piers that are permanent, or left in place, dredging shall be conducted no closer than 10 feet from such structures.

PART 2 - PRODUCTS

2.1 DREDGING SYSTEMS

- A. Provide hydraulic dredging equipment which is capable of removing sediments from undisturbed deposits.
- B. Provide equipment redundancy necessary to provide continuous dredging operation.
- C. Dredge Slurry Pipelines

1. Provide floating pipelines unless otherwise approved by the Owner's Representative. Submerge at locations identified by Owner.
2. Provide single walled HDPE pipe.
3. Provide influent/effluent piping to/from dewatering facility and associated valves, fittings, etc., as necessary.
4. Provide pipeline anchoring system and pipeline marker buoys.

D. Booster Pump Stations

1. Provide booster pump stations, as necessary, in location shown on the Drawings.
2. Design pump/piping to manage slurry based on operational criteria and carry the slurry to the dewatering facility via route shown on the Drawings.
3. Provide equipment redundancy necessary to provide continuous dredging operation.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Mark the location and width of all dredge areas 7 days prior to dredging for Owner and regulatory acceptance of dredge areas.
- B. Provide facilities as necessary to protect structures, including piers and docks, from damage during the dredging operation.
- C. Provide 10-foot offset from permanent piers and docks, as identified by the Owner.
- D. Provide facilities necessary to control the re-suspension of sediments in the lake and protection of any industrial intakes.
- E. Debris, Wood, Cobbles and Other Rubble
 1. As is necessary, remove debris and rubble prior to and/or during hydraulic dredging.
 2. Cobbles, wood or other rubble in the dredge area which are too large to be removed by the hydraulic dredge will be removed from the lake and transported to the sediment dewatering area.
- F. Environmental Protection
 1. Protect against fuel or oil spills when refueling or servicing equipment. Immediately correct any fuel or oil leaks in waterborne equipment.
 2. Deploy oil absorption booms when refueling equipment in the water
 3. Wherever possible, use biodegradable hydraulic oil.
 4. Protect Oil or Other Petroleum Products Released from the Sediments During Dredging
 - a. Provide an oil adsorbent boom around the area being dredged to control the movement.
 - b. Use care in handling of any floating petroleum products released from the sediments during dredging.

5. Floating Debris:
 - a. Remove floating debris from the area daily.
 - b. Prevent floating debris from damaging silt curtains (if required) and escaping from the dredging area.
6. Provide necessary facilities to comply with Federal, State and local requirements concerning air, noise and water pollution.
7. Notify the city and the WDNR of fuel or oil spills immediately.

G. Provide and properly place water safety markers or other devices as to meet all local, state and federal navigations requirements. Contractor shall obtain Waterway Marker Permit prior to placing any buoys.

H. All equipment used for the project but not limited to tracked vehicles, barges, boats, silt or silt curtains, hoses, sheet pile, pumps, temporary docks and piers shall be decontaminated for invasive and exotic viruses and species prior to use. Contractor shall document decontamination procedures.

3.2 DREDGING

A. Dredging Limits

1. Remove sediment to the target dredge elevations from designated areas.
2. Preserve stable side slopes and avoid leaving residual sediment above the target elevations in any areas where dredging has been performed. In shoreline areas and at the termination of dredge cuts to other adjacent sediments, the maximum slope of the finished dredge cut shall not be steeper than 4 horizontal to 1 vertical (4H:1V).
3. Dredge shall not extend into native hardpan.

B. Dredge Slurry Pipeline

1. Pressure test all pipeline sections prior to putting them into service to ensure connections, welds, and piping are free from leaks. Pressure testing shall be conducted weekly prior to initiating dredging for any given week. Pressure test logs will be maintained by the Contractor at the project trailer.
2. Maintain pipelines in good condition free from leaks at all times during use.
 - a. Suspend dredging operation immediately upon any pipeline leak or break.
 - b. Repair breaks or leaks immediately upon identification.
 - c. Record pipeline breaks on daily reports.
 - d. Remove any material spilled during a pipeline break.
3. Mark floating pipelines as required by the appropriate government agency.
 - a. Provide approved lights for all floating pipelines, equipment, barges, markers and buoys for the period between sunset and sunrise.
 - b. Also provide approved lights whenever visibility is restricted to less than 200 feet.
4. Maintain submerged section of pipeline a minimum of 10 feet below water surface as shown on the Drawings and/or identified by Owner. If water depth is less than 10 feet, place pipe on lake bottom. Provide markings for identification of the location of the submerged section of pipeline.
5. Provide access points along floating section of pipeline to allow boat navigation.

C. Dredging Operations

1. Provide dredging using hydraulic dredging equipment and techniques.
 - a. Provide sufficient safe and efficient equipment and plant to meet the requirements of the Work.
 - b. Maintain equipment in satisfactory operating condition.
 - c. Make equipment available for inspection by Owner at any time.
2. Unless otherwise directed, dredge in a manner that prevents sloughing of sediments into dredged areas.
3. Minimize re-suspension of sediment
 - a. Control dredge speed and operations of cutterheads or other devices employed to loosen sediments as required to minimize the re-suspension of sediment into the water and to minimize the settling out of re-suspended solids in areas previously dredged.
 - b. Provide shrouds or other approved devices to reduce re-suspension over cutterheads or horizontal augers.
4. Overlap dredge cuts to avoid leaving ridges or windrows of sediments between adjacent cuts.
 - a. Use dredging procedures to remove sediment to target elevations while avoiding redistributing sediments from areas which are being dredged into areas where dredging has been completed.
 - b. Any material pushed, deposited or moved into areas outside the limits of dredging, as shown on the Drawings, or into areas previously dredged shall be removed at no additional cost to Owner.
5. Dredge to target elevations.
 - a. Minimize overcut necessary to achieve dredging to the target elevations.
 - b. Any areas determined by the post-dredge QA bathymetric survey to be above the target elevation shall either be redredged to achieve the target elevations or be determined by Engineer to be a "high subgrade area".
 - c. High subgrade areas are so designated when the proposed dredge area has hard clay or rock subgrade exposed above the target elevation.
 - 1) In order to determine the existence of a "high subgrade area" Engineer and Contractor will work together to perform high subgrade poling, and coring.
 - 2) All the cores shall indicate less than 4" of soft, targeted sediment existing above the underlying hard subgrade.
 - 3) Areas containing 4 inches or more of loose sediment shall be re-dredged to the targeted elevation at no additional cost to the Owner.
6. Costs for dredging and dewatering of sediment dredged beyond the planned Overcut Volume, as identified during the QA post-dredge bathymetric survey, shall be the sole responsibility of the Contractor.

D. Suspending Dredging Operations

1. Suspend dredging operations whenever weather, water stage or other conditions exist which might reasonably be expected to endanger the work or result in an environmental impact.
2. Dredging will be suspended if exceedances to the WPDES Permit conditions are exceeded.

3. Dredging will be immediately suspended if a leak is detected in any hose/pipe. All leaks and repairs shall be recorded in a log which is kept at the project site. **Any leak or spill of dredge material shall be reported to the WDNR within 24 hours of the occurrence.**
- E. Dredging will be considered complete when sediments have been removed to target elevations in at least 95% of each of the dredge locations (i.e., West Channels, Northwest Channels, etc.) and there are no contiguous areas remaining above target elevation that are an impairment to navigation as determined by the Owner.
- F. Upon completion of the Work, promptly remove dredging platforms including ranges, markers, buoys and other equipment.
- G. Interference with Navigation
Minimize interference with the use of channels and passages. The Owner may direct the shifting or moving of dredges or the interruption of dredging operations to accommodate the movement of vessels and floating equipment, if necessary. The Contractor shall comply with all requests from the Owner to move or interrupt dredging operations for a reasonable time period at no additional cost to the Owner.
- H. Debris Management
Debris removed from the bottom during dredging operations, which is not suitable for disposal at the specified disposal areas, shall be collected and removed from the site. Unsuitable materials include large items such as timbers, pilings, sections of piers, and metallic debris. A debris management plan shall be developed by the Contractor, reviewed by the Owner, and followed by the Contractor. Each day during dredging operations, the Contractor shall use a boat to collect and remove floating debris resulting from project activities. Floating debris shall also be removed from within scows or barges. Containers for temporary storage of the collected debris shall be maintained on the dredge or a support barge.

3.3 FIELD QUALITY CONTROL/QUALITY ASSURANCE

- A. Contractor QC Bathymetric Surveys
 1. Provide at a minimum weekly QC bathymetric surveys to track progress in achieving target elevations. The QC bathymetric surveys shall be completed every Monday across those areas dredged the prior week (7 days).
 2. Inform Owner's Representative when target elevations have been reached and the areas or sub-areas are ready for QA bathymetric survey.
 3. Submit QC bathymetric survey information to the Owner's Engineer upon request.
- B. QA Bathymetric Surveys
 1. Upon Contractor indicating that target elevation has been attained in each area or sub-area, Contractor shall perform a QA bathymetric survey of the completed area. Engineer shall accompany the Contractor during each QA bathymetric survey. The survey will be processed by the Engineer to determine pay volumes by the Contractor.

2. QA bathymetric surveys shall be conducted using acoustical methods following the standards established in the U.S. Army Corps of Engineers "Engineering and Design Hydrophonic Surveying Manual No. 1110-2-1003", current version. Echo sounder shall be single beam with 200 khz transducer. The same transects used for the pre-dredge survey shall be reoccupied for performance of the post-dredge QA surveys. Engineer may direct additional transects be performed for the post-dredge QA surveys and may also require poling be conducted to collect data in areas too confined to perform surveys with standard acoustical equipment.

3.4 FINAL CLEANUP

- A. Final cleanup shall include the removal of all of the Contractor's equipment either for disposal or reuse. Equipment and materials to be disposed of shall only be disposed in a manner and at locations approved by the Owner's representative. Unless otherwise approved by the Owner's representative, the Contractor will not be permitted to abandon any equipment in the dewatering area or other areas adjacent to the work site.
- B. Failure to promptly remove all equipment and materials upon completion of the dredging will be considered a delay in the completion of the final cleanup and demobilization work. In such case, the Owner will exercise its right to remove any equipment and materials at the Contractor's expense.
- C. All equipment used for the project but not limited to tracked vehicles, barges, boats, silt or turbidity curtain, hoses, docks, sheet pipe and pumps shall be decontaminated for invasive and exotic viruses after use following WDNR decontamination protocols.

END OF SECTION

SECTION 02 66 40

POLYVINYL CHLORIDE (PVC) LINERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes
1. PVC Geomembrane

1.2 REFERENCES

- A. American Society for Testing and Materials
1. ASTM D413 Test Methods for Rubber Property – Adhesion to Flexible Substrate
 2. ASTM D792 Test Method for Specific Gravity (Relative Density) and Density of Plastics by Displacement
 3. ASTM D882 Test Method for Tensile Properties of Thin Plastic Sheeting
 4. ASTM D1004 Test Method for Initial Tear Resistance of Plastic Film and Sheeting
 5. ASTM D1203 Test Methods for Volatile Loss from Plastics Using Activated Carbon Methods
 6. ASTM D1204 Test Method for Linear Dimensional Changes of Nonrigid Thermoplastic Sheeting or Film at Elevated Temperature
 7. ASTM D1239 Test Method for Resistance of Plastic Films to Extraction by Chemicals
 8. ASTM D1593 Specification for Nonrigid Vinyl Chloride Plastic Film and Sheeting
 9. ASTM D1790 Test Method for Brittleness Temperature of Plastic Sheeting by Impact
 10. ASTM D2240 Test Method for Rubber Property – Durometer Hardness
 11. ASTM D4545 Practice for Determining the Integrity of Factory Seams
 12. ASTM D5321 Test Method for Determining the Coefficient of Soil and Geosynthetic or Geosynthetic and Geosynthetic Friction by the Direct Shear Method
 13. ASTM D6392 Test Method for Determining the Integrity of Nonreinforced Geomembrane Seams Produced Using Thermo-Fusion Methods
- B. PVC Geomembrane Institute (PGI)
1. 1197, Specification for PVC Geomembrane
 2. Technical Bulletin, Specification for Thermal Welding of PVC Geomembranes, December 1998.

1.3 DEFINITIONS

- A. Boot
Watertight collar fabricated from geomembrane sheet for sealing geomembrane to pipes and other objects that penetrate geomembrane.
- B. Panel
Piece of geomembrane composed of two or more sheets, factory seamed together.
- C. Sheet
Seamless piece of geomembrane.
- D. Watertight
Geomembrane installation, free of flaws and defects that would allow passage of water and gases, liquids, and solids to be contained under anticipated service conditions.

1.4 SUBMITTALS

- A. Shop Drawing Submittals
 - 1. Manufacturer's specifications, literature for geomembrane furnished and products used to complete installation.
 - 2. Polymer Resin: Product identification and supplier.
 - 3. Geomembrane sheet/panel layout with proposed size, number, position, and sequence of sheet/panel placement, and location of field seams.
 - 4. Proposed equipment for material placement.
 - 5. Procedures for material installation.
- B. Quality Assurance Submittals
 - 1. Qualifications:
 - a. Manufacturer
 - b. Installer
 - c. Fabricator
 - 2. Qualifications of proposed independent geomembrane testing laboratory.
 - 3. Production dates for geomembrane.
 - 4. Quality Assurance Program(s): Written description of geomembrane manufacturer's and installer's formal programs for manufacturing, fabricating, handling, installing, seaming, testing, and repairing geomembrane.
 - 5. Manufacturer's Certificate of Compliance in accordance with Section 01640, Manufacturer's Services.
 - 6. Recommended methods for handling and storage of products.
 - 7. Factory Test Results: Peel and shear tests of factory seams in accordance with ASTM D4545 and for parent material in accordance with ASTM D882.
 - 8. Testing Equipment: Certified calibrations, manufacturer's product data, and test procedures.
 - 9. Field seam test results.
 - 10. Geomembrane Installer's Certification of Subsurface Acceptability: Form attached at end of this section.
 - 11. Manufacturer's Certificate of Proper Installation.

12. Record Documents: Include panel and sheet numbers, seaming equipment and operator identification, temperature and speed setting of equipment, date seamed, identity and location of each repair, cap, strip, penetration, boot, and sample taken from installed geomembrane for testing.
13. Material and seam test results.
14. Special guarantee.

1.5 QUALITY ASSURANCE

A. Qualifications

1. Manufacturer: Has successfully manufactured a minimum of 5 million square feet of PVC geomembrane material specified.
2. Fabricator and Installer: Has successfully installed a minimum of 5 million square feet with the geomembrane product specified in applications similar to the Project.
3. In the event that the fabricator is different than the installer, provide separate qualifications for each.

B. Pre-Installation Meetings

1. Meet at least once prior to commencing each of the following activities:
 - a. Manufacture of geomembrane sheets.
 - b. Fabrication of panels and boots.
 - c. Installation of geomembrane.
2. Attendees:
 - a. Subcontractor's designated quality control representative.
 - b. Contractor.
 - c. Representatives of geomembrane installer.
 - d. Others requested by Contractor.
3. Topics:
 - a. Specifications and Drawings.
 - b. Submittal requirements and procedures.
 - c. Schedule for beginning and completing geomembrane installation.
 - d. Training for installation personnel.
 - e. Installation crew size.
 - f. Establishing geomembrane marking system, to include sheet identification, defects, and satisfactory repairs, to be used throughout the work.
4. Seam Installation and Testing Demonstration: Performed by geomembrane installer, for each type of seam required.

1.6 DELIVERY, STORAGE AND HANDLING

A. Geomembrane

1. Individually package each sheet or fabricated panel of geomembrane in heavy cardboard, fully enclosed, and protect from damage during shipment.
2. Mark each package with identification of material type, size, and weight.

B. Epoxy Adhesive

1. Control temperature above 60°F.

2. If stored at temperatures below 60°F, test adhesive prior to use to determine if adhesive meets specified requirements.
3. Dispose of cartridges if shelf life has expired.

1.7 PROJECT ENVIRONMENTAL REQUIREMENTS

- A. Do not install geomembrane or perform seaming under the following conditions, unless it can be demonstrated to satisfaction of Engineer that performance requirements can be met under these conditions:
 1. Air temperature is less than 35°F or more than 90°F.
 2. Relative humidity is more than 90%.
 3. Raining, snowing, frost is in ground, or wind is excessive.
- B. Do not place granular materials on geomembrane when ambient temperature is less than 35°F or more than 100°F, unless it can be demonstrated to the satisfaction of Engineer that such materials can be placed at temperatures outside this range without damage to geomembrane.

1.8 WARRANTY

- A. Provide manufacturer's extended warranty, with Owner named as beneficiary, in writing, as special guarantee. Provide warranty for correction, or at option of Owner, removal and replacement of Work specified in this specification section found defective during periods below, commencing on date of Substantial Completion. Duties and obligations for correction or removal and replacement of defective Work as specified in General Conditions.
 1. Guarantee geomembrane against manufacturing defects, deterioration due to ozone, ultraviolet, and other exposure to elements for period of 20 years on a pro rata basis.
 2. Guarantee geomembrane against defects in material and factory seams for period of two years.
 3. Guarantee geomembrane against defects resulting from installation for period of two years.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. PVC Geomembrane
 1. Rocheux International, Inc., Carson, CA
 2. Hüls America, Inc., Edison, NJ
 3. Occidental Chemical Corp., Burlington, NJ
 4. Vernon Plastics, Haverhill, MA

2.2 MATERIALS

- A. Polyvinyl Chloride (PVC) Geomembrane
1. Compounded from domestic virgin polyvinyl chloride resin and high quality ingredients to produce flexible, durable, watertight product. Uniform throughout in color, thickness, and size, and surface quality.
 2. Completely disperse formula ingredients in mix stage prior to calendaring.
 3. Carbon Black Pigment:
 - a. Use to produce an opaque film ranging from dark gray to black in color.
 - b. Introduce during premix stage and evenly disperse so as to produce uniform color.
 - c. Film: Smooth, dull matte finish on both sides.
 4. Material shall be free from dirt, oil, foreign matter, scratches, cracks, creases, bubbles, pits, tears, holes, or other defects that may affect its serviceability.
 5. Physical properties shall meet or exceed manufacturer's most recent published specifications, and conforming to following requirements:

30-mil PVC Geomembrane Physical Properties

Property	Required Values	Test Method
Thickness	30 mils, plus or minus 5%	ASTM D5199
Specific Gravity	1.20 min.	ASTM D792
Elongation at Break	380% min.	ASTM D882, Method A
Tensile Strength	73 lbs/in. width, min.	ASTM D882, Method A
Tear Resistance, Each Direction	8.0 lbs. min.	ASTM D1004, Die C
100% Modulus	32 lbs/in.	ASTM D882, Method A
Water Extraction, as Compared to Blanks of Same Nominal Thickness	0.15% loss, max.	ASTM D1239
Volatility	0.7% loss, max.	ASTM D1203, Method A
Low Temperature, Pass	Minus 29 degrees F	ASTM D1790
Dimensional Stability, Each Direction	3% change, max. (100°C/15 min.)	ASTM D1204 (MD and TD)

- B. Chemical Adhesive
1. Manufacturer: Clifton Adhesive, Inc., Wayne, NH, or as recommended by geomembrane manufacturer.
 2. Use seaming chemical adhesives, including bodied chemical adhesive, used for making required geomembrane connections.
 3. Clear color or same as geomembrane.
 4. Provide film tearing bond within 48 hours of field seaming for seams.
- C. Termination Strip
1. Manufacturer and Product: Ameron Protective Linings Division, Brea, CA; Commodity Code No. 2600920 (black), 290052 (white).

D. Panel Fabrication

1. Fabricators:
 - a. Watersaver Co., Inc., Denver, CO
 - b. C.W. Neal Corp., Santee, CA
 - c. Environmental Protection, Inc., Mancelona, MI
2. Factory fabricate up to 20,000 square feet to minimize field seams.
3. Panel Marking:
 - a. Mark each panel with prominent, unique indelible identification conforming to approved panel/sheet layout.
 - b. Indicate proper direction for unrolling or unfolding to facilitate layout and positioning at site.
4. Seams:
 - a. Do not use prepared adhesive tapes for seaming.
 - b. Fully bonded across entire lapped area, including encapsulated edges, so that no loose edge is present on top side of fabricated panel.
 - c. Provide film tearing bond between sheets.
 - d. Make with liquid solvent-based adhesive or hot air with minimum ¾ inch lap; or dielectrically with minimum ½ inch lap; or hot wedge with minimum ½ inch lap.
 - 1) Bonded Seam Strength: Minimum 30 mils: 58.4 pounds per inch width, as determined in accordance with ASTM D4545, ASTM D6392 (for heat bonded seams), and ASTM D882 (for solvent bonded seams).
 - 2) Peel Adhesion: Minimum 30 mils: 15 pounds per inch width, as determined in accordance with ASTM D4545, ASTM D6392 (for heat bonded seams), and ASTM D413 (for solvent bonded seams).

2.3 SOURCE QUALITY CONTROL

- A. Test factory seams by air lance in accordance with ASTM D4545, or air channel testing in accordance with PGI Technical Bulletin – "Specifications for Thermal Welding of PVC Geomembranes."

PART 3 - EXECUTION

3.1 PREPARATION

- A. Do not place geomembrane until condition of previously installed geosynthetics is acceptable to Contractor.
- B. Subgrade
Maintain in smooth, uniform, and compacted condition, as specified in Section 02319, Subgrade Preparation, during installation of geomembrane.

3.2 GEOMEMBRANE INSTALLATION

- A. Protection During Construction

1. Do not use geomembrane surfaces as a work area for preparing patches, storing tools and supplies, or other uses. Use protective cover as work surface, if necessary.
2. Instruct workers about requirements for protection of geomembrane such as handling geomembrane material in high winds, handling of equipment, and walking on geomembrane surfaces. Shoes of personnel walking on geomembrane shall be smooth bonded sole or be covered with smooth type of overboot. Prohibit smoking, eating, or drinking on geomembrane, placing heated equipment directly on geomembrane, or other activities that may damage geomembrane.
3. Do not operate equipment without spark arrestors in vicinity of geomembrane material nor place generators or containers of flammable liquid on geomembranes.
4. Protect from vehicle traffic and other hazards.
5. Keep free of debris during placement.
6. Prevent uplift, displacement, and damage by wind.
7. Only small rubber-tired equipment, with maximum tire inflation pressures of 5 pounds per square inch, shall be allowed directly on geomembrane, unless otherwise approved by Contractor.

B. Placement

1. Unless specified otherwise, each product required for completion of geomembrane installation shall be installed in strict accordance with geomembrane manufacturer's recommendations.
2. Reduce field seaming to the minimum possible. Horizontal seams on slopes will not be acceptable. Seams parallel to toe shall be at least 5 feet from toe.
3. Prevent wrinkles, folds, or other distress that can result in damage or prevent satisfactory alignment or seaming. Provide for factors such as expansion, contraction, overlap at seams, anchorage requirements, seaming progress, and drainage.
4. Temporarily weight sheets with sandbags as necessary to anchor or hold down in position during installation. Use sandbags continuously along edges to reduce wind flow under sheet.
 - a. Bag Fabric: Sufficiently close knit to preclude fines from working through bags.
 - b. Bags: Contain not less than 40 nor more than 60 pounds of sand having 100 percent passing No. 8 screen and shall be securely closed after filling to prevent sand loss.
 - c. Do not use tires or paper bags, whether or not lined with plastic. Burlap bags, if used, shall be lined with plastic.
 - d. Immediately remove damaged or improperly sealed bags from work area, and immediately clean up spills.
5. Anchor perimeter of geomembrane as shown, or as otherwise approved by Contractor. Anchor and seal geomembrane to structures, pipes, and other types of penetrations as shown.
6. Place overlying geotextile and soil cover immediately following completion of geomembrane installation and field testing as acceptable to Contractor.

C. Field Seams

1. Adjust edges to be seamed and temporarily anchor to prevent wrinkling and shrinkage.
2. Wipe sheet contact surfaces clean to remove dirt, dust, moisture, and other foreign materials and prepare contact surfaces in accordance with seaming method accepted by Contractor.
3. Lap sheet edges minimum of 4 inches to form seams.
4. Make with seam supported on a firm, smooth. Avoid seam intersections involving more than three thicknesses of geomembrane material and offset seam intersections at least 2 feet.
5. Extend seams through anchor trench, boots, and mechanical attachments to sheet edges.
6. Capping of Field Seams:
 - a. Where lap seam is not possible, use 6 inch wide (minimum) cover strip of same thickness as geomembrane (and from same roll, if available).
 - b. Position strip over center of field seam and seal entire width in accordance with seaming requirements.
7. When ambient conditions result in temperatures below 85°F at time of seaming, warm geomembrane material, adhesive, or solvent by artificial means to temperature above 85°F.
8. Accessories:
 - a. Rags: Use clean, white cotton rags for seaming procedures. When rag shows discoloration from use, discard and replace with fresh one.
 - b. Scissors: Blades with rounded points.
9. Uneven Seams: Avoid fishmouths, pleats, folds, and tucks in field seams. Repair each one by slitting out far enough from seam to dissipate it and patch in accordance with this Specification.
10. Completed Seams: Sealed, smooth, watertight, and conforming with factory seam strengths specified in Article Panel Fabrication.

D. Boot Seals

1. Preparation: Thoroughly clean contact surfaces.
2. Place boot around penetrations so flange is supported everywhere and is free of wrinkles.
3. Seal boot to surrounding geomembrane as specified for field seams.
4. Tighten steel clamping bands until rubber pads are compressed minimum of 12 to 15 percent of total pad thickness.

3.3 PLACING PRODUCTS OVER GEOMEMBRANE

- A. Prior to placing material over geomembrane, notify Contractor. Do not cover installed geomembrane until after Contractor provides authorization to proceed.
- B. If tears, punctures, or other geomembrane damage occurs during placement of overlying products, remove overlying products as necessary to expose damaged geomembrane, and repair damage as specified in Article Repairing Geomembrane.

- C. Geomembrane installer shall remain available during placement of overlying products to repair geomembrane if damaged.

3.4 REPAIRING GEOMEMBRANE

- A. **Damaged Geomembrane Surface**
Mark and correct injury due to scuffing, penetration by foreign objects, or distress from rough subgrade by replacement or covering and sealing geomembrane with additional layer of geomembrane material of proper size.
- B. Geomembrane installer shall remain available during placement of overlying products to repair geomembrane if damaged.
- C. Repair damaged or rejected seams with pieces of flat and unwrinkled geomembrane material free from defects and seams. Patches shall be tightly bonded on completion of repair work.
- D. Patch shall be neat in appearance and size 6 inches larger in directions than areas to be repaired. Round corners of each patch to minimum 1 inch radius.
- E. Prepare contact surfaces and seam patch in accordance with Article Field Seams.
 - 1. Pull and hold flat receiving surface in area to be patched.
 - 2. Bond patches less than 12 inches in narrowest plan dimension across their entire width.
 - 3. Seam each patch more than 12 inches across in narrowest dimension with minimum bonded width of 4 inches along edge, with no free edge remaining.

3.5 FIELD QUALITY CONTROL

- A. **Installer's Certification**
Prior to starting geomembrane installation and daily thereafter for installation on subgrade, certify in duplicate that surface upon which geomembrane will be installed is acceptable.
- B. Identify each test by date of sample, date of test, sample location, name of individual who performed test, standard test method used, list of departures from standard test methods, at a minimum.
- C. **In-Place Observation and Testing**
 - 1. Visually inspect geomembrane sheets, seams, anchors, seals, and repairs for defects as installation progresses and again on completion.
 - 2. In addition, check seams and repairs using metal probe. Run metal probe, such as dull-pointed ice pick, along entire length of each seam, including repairs, to check for continuity of seams and absence of leak paths.
 - 3. Depending on seam welding equipment used, test each seam and repair, using air lance device or air channel pressure for double wedge welded seams.
 - 4. Perform testing in presence of Contractor.

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- D. Tensiometer for Field Testing
1. Motor driven portable tensile tester with jaws capable of traveling at measured rate of 2 inches per minute and 20 inches per minute.
 2. Equipped with gauge which measures force in unit pounds exerted between jaws
 3. Minimum capacity of 500 pounds.
- E. Field Seam Sampling
1. Verify that seaming equipment and operators are performing adequately. Produce test seam samples at beginning of each shift for each seaming crew. In addition, if seaming has been suspended for more than one-half hour, or if breakdown of seaming equipment occurs, produce test seam samples prior to resuming seaming.
 2. Minimum Sample Size: 12 inches wide plus seam width, and 30 inches long.
 3. Nondestructive Sampling:
 - a. Frequency: Minimum one sample per 500 feet of field seam, or portion thereof, and minimum one sample per seaming crew per 4 hour work period.
 - b. Produce samples using the same materials, equipment, personnel, and procedures as field seams made at time of the work in progress and under same conditions.
 4. Destructive Sampling:
 - a. Frequency: Determined by Contractor.
 - b. Remove samples from field seams at locations selected by Contractor.
 - c. Repair field seams in accordance with repair procedures specified in these specifications.
 5. Sample Identification:
 - a. Number, date, and identify each sample as to personnel making seam and location of sample or location of field seam work in progress at time sample is made.
 - b. Mark location of sample, or location of field seam in progress at time sample is made, on panel/sheet layout drawing.
 - c. Include at a minimum:
 - 1) Panel and sheet numbers.
 - 2) Seaming equipment and operator identification.
 - 3) Temperature and speed setting of equipment.
 - 4) Date seamed.
 - 5) Identity and location of each repair, cap strip, penetration, boot, and sample taken from installed geomembrane for testing.
- F. Field Seam Strength Sample Testing
1. Testing includes tensile and peel strength tests, air lance tests, air channel tests, and probing.
 2. General: Conform to ASTM D6392 for field thermo-fusion welds.
 - a. Test each sample for seam peel and tensile strength.
 - b. Save test samples, including specimens tested, until notified by Contractor relative to their disposal.
 - c. Each sample that fails under test shall be shipped immediately by express delivery to Contractor for determination of corrective measures required.
 3. Bonded Seam Strength of 30-mil PVC:

- a. In Shear: Minimum 58.4 pounds per inch width as determined in accordance with ASTM D6392 (for heat bonded seams) and D882 (for solvent bonded seams).
 - b. In Peel: Minimum film tearing bond 15 pounds per inch as determined in accordance with ASTM D6392 (for heat bonded seams) and D413 (for solvent bonded seams).
 4. Test Failure: Each sample tested shall be required to pass. If sample fails, entire field seam from which it was taken shall be considered as failure shall be rejected due to nonconformance with specification requirements. Comply with following corrective measures:
 - a. Nondestructive Sample Failure: Rerun field weld test using same sample. If that test passes, Contractor may assume an error was made in first test and accept field seam. If second test fails, cap each field seam represented by failed sample and submit new test sample made during capping procedure.
 - b. Destructive Sample Failure: Rerun field weld test using new sample from same seam. If that test passes, Contractor may assume an error was made in first test and accept field seam. If second test fail, either cap field seam between two previous passed seam test locations that include failed seam or take another sample on each side of failed seam location (10 feet minimum) and test both. If both pass, cap field seam between two locations. If either fails, repeat process of taking samples for test. Each field seam shall be bounded by two passed test locations prior to acceptance.
- G. Air Lance Testing
1. Perform on each seam including patches and factory seams in accordance with the following:
 2. Air Lance:
 - a. Created with 3/16 inch diameter orifice at minimum pressure of 50 psi, held not more than 2 inches from seam edge.
 - b. Direct jet of air at edges of seams and patches to result in lifting of unbonded seam areas.
 3. Perform air lancing in presence of Contractor and allow sufficient time for Contractor to mark leaks or suspicious areas for repair.
- H. Air Channel Pressure Testing for Double Hot Wedge Seam
1. Perform the following testing where seaming is done by the double hot wedge seaming method.
 - a. Insert a needle with gauge in air space between welds. Pump air into space to 25 pounds per square inch and hold for 5 minutes.
 - b. At end of 5 minutes, depressurize seam by placing needle hole in air space between welds at opposite end of seam and observe gauge.
 - c. Seam is acceptable if seam maintains at least 20 pounds per square inch during the 5 minute hold and the pressure drops within 30 seconds of depressurization.
 - d. Repair needle holes and retest seam by the same procedure or by air lance procedure if pressure drops below 20 pounds per square inch during the 5 minute hold, or does not drop during the 30 second depressurization period.
 - e. Air lance entire seam if the second air pressure test fails.

- 1) If air lance test passes, failure will be assumed to be in the inside seam and outer seam will be judged acceptable.
- 2) If air lance test fails, mark and repair defective area.

3.6 MANUFACTURER'S SERVICES

- A. Provide authorized representative of geomembrane manufacture on-site for technical supervision and assistance during installation of geomembrane system, and also during inspection of geomembrane prior to installation, during preparation and inspection of surfaces on which geomembrane is to be placed, and during placement of soil cover or other products over installed geomembrane.

3.7 CLEANUP

- A. Cleanup work area as the work proceeds. Take particular care to ensure that no trash, tools, and other unwanted materials are trapped beneath geomembrane and that scraps of geomembrane material are removed from work area prior to completion of installation.

END OF SECTION