Remedial Investigation and Cost Estimate
Former Waste Lagoons
Former Tyson Foods Facility
9943 Old Ocean City Boulevard
Berlin, Maryland 21811

Prepared for:

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LIST OF ACRONYMS AND ABBREVIATIONS

AST	Aboveground Storage Tanks
ATC	Anticipated Typical Concentration
BOD	Biological Oxygen Demand
CTD	Conductivity, Temperature, and Density
CREC	Controlled Recognized Environmental Condition
DEM	Digital Elevation Model
EA	EA Engineering, Science, and Technology, Inc., PBC
ESA	Environmental Site Assessment
ft	Foot or Feet
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
HREC	Historical recognized environmental condition
in	Inch or Inches
MDE	Maryland Department of Environment
Msl	Mean Sea Level
NAVD 83	North American Vertical Datum of 1983
NAD 88	North American Datum of 1988
NFRD	No Further Requirements Determination
NGS	National Geodetic Survey
PAH	Polycyclic Aromatic Hydrocarbon
REC	Recognized Environmental Condition
RI	Remedial Investigation
RTK	Real Time Kinematic
TSS	Total Suspended Solids
TKN	Total Kjehldahl Nitrogen
QA	Quality Assurance
QC	Quality Control

LIST OF ACRONYMS AND ABBREVIATIONS CONTINUED

USACE	United States Army Corps of Engineers
USGS	United States Geological Survey
UST	Underground Storage Tanks
VCP	Voluntary Cleanup Program
VOC	Volatile Organic Compounds
VRS	Virtual Reference Station

1.0 INTRODUCTION

EA Engineering, Science, and Technology, Inc., PBC (EA) was contracted by the Town of Berlin to develop viable conceptual remediation approaches and conceptual level cost estimates to remove sediments that have accumulated within the waste lagoons of the former Tyson Foods Facility located at 9943 Old Ocean City Boulevard (Site) located in Berlin, Maryland 21811.

1.1 PURPOSE AND SCOPE

The scope of work for this remedial investigation (RI) was developed based on a review of available historic documents and environmental reports for the Site, as well as review of site investigations performed by EA in previous phases of the project. To further support the remedial cost assessment, EA performed an additional site investigation in March 2017. While previous environmental assessment sampling and analysis efforts did not identify significant environmental exposure concerns associated with the existing sediments within the lagoons, EA understands the historical uses of the lagoons present challenges to their potential reuse. The Town of Berlin may want to consider addressing the sediments within the lagoons before repurposing the lagoons for public recreation.

The Site has a recorded Activity and Use Limitation for industrial, commercial, and limited recreational use. The goal of the RI was to evaluate the characteristics of in-place sediments that have accumulated at the bottom of three engineered wastewater management lagoons located on the property for potential future use as a public recreation area.

Field activities conducted at the Site consisted of the following:

- Sediment probing was performed by EA to identify the elevation of the water surface and sediment surface, and the elevation of the firm subgrade material at 25 locations in the lagoons.

- Piston coring was utilized by EA to collect twelve (12) sediment samples and two duplicate samples from the wastewater management lagoons.

- Bathymetric and topographic surveys were performed by EA to characterize the morphology of the wastewater lagoons and the surrounding basin, and to estimate the volumes of the soft sediment overburden present in the lagoons.

This report provides a detailed synopsis of the sediment coring and probing, and bathymetric and topographic surveys results conducted during the March 2017 field event.

2.0 SITE AND PROJECT BACKGROUND

2.1 SITE LOCATION AND DESCRIPTION

The Site consists of three adjoining parcels of land located at 9943 Old Ocean Town Boulevard within Worcester County in Berlin, Maryland. Identified as Map 0025, Grid 0009, and Parcels 0052, 0057, and 0410, the Site is currently comprised of approximately 56.72 acres and is zoned I-2, heavy industrial and municipal. The Site location is illustrated in Figure 2-1. The Site is bordered by an on-ramp to Route 113 to the north, commercial properties to the south, Route 113 to the west, and a railroad track to the east.

The Site is located on the United States Geological Survey (USGS) Berlin, Maryland 7.5-minute topographic quadrangle. The elevation of the Site is approximately 25 ft above mean sea level (msl), with the exception of the lagoons. The nearest natural surface water feature is Kitts Branch which flows through the northern portion of the Site. The Site is relatively flat.

Review of the Web Soil Survey (United States Department of Agriculture, Natural Resources Conservation Service, http://websoilsurvey.nrcs.usda.gov/app/WebSoilSurveny.aspx) indicates that the southwest portion of the Site is classified as an Urban Land Complex consisting of areas where much of the ground surface is covered with asphalt, concrete, buildings, or other impervious material. The majority of the southern portion of the Site is classified as the Mullica-Berryland complex, which is characterized by a 0 to 2 percent slope and is very poorly drained mucky, sandy, loam weathered from sandy eolian deposits and/or fluviomarine sediments.

The remainder of the Site is classified as: the Urban land-Udorthents Complex, which is characterized by a 0 to 5 percent slope, are 50% Urban Land and 35% well-drained sandy loams weathered from fluviomarine deposits; the Woodstown sandy loam, which is characterized by 2 to 5 percent slopes and are moderately well-drained sandy loams weathered from loamy fluviomarine deposits; and the Udorthents, which is characterized by 0 to 5 percent slopes and are well-drained loamy soils weathered from fluviomarine deposits.

2.2 SITE HISTORY

The Site operated as a poultry processing plant starting in the mid-1940s. In 1965, the Site was purchased by the Ralston Purina Company, which further developed the Site with construction of a poultry processing building, rendering plant addition, a scale house, a shop, an ice storage, additions to the plant, a garage/office space, a cooling shed, and an accessory structure to cover the wastewater treatment plant. Circa 1972, Chesapeake Foods, Inc. (which later became Tyson Foods, Inc.) purchased the Site, with further development that included construction of a new processing front, employee facility, office building, refrigeration facility, feather dryer enclosure, cooler expansion, 4-bay live haul building, cold storage cooler, lime silo, addition to the live haul shed, secondary clarifier for the wastewater treatment plant, and additions to the plant on Parcel 0057, and construction of a process water upgrade fire pump house with a 150,000-gallon tank on Parcel 0052. In 2005, Berlin Properties North, LLC purchased the Site which at the time also included Parcel 1705; however, Parcel 1705 was eventually purchased by the County Commissioners of Worcester County, Maryland in 2008. From 2008 through 2011, five buildings on Parcel 0057 and the wastewater treatment structure on Parcel 0052 were demolished.

The Site was issued a discharge permit State No. 79-DP-0375 to discharge treated chicken processing and rendering wastes to Kitts Branch. The permit noted that storm water runoff did not enter the treatment system. The permit required testing for biological oxygen demand (BOD), total suspended solids (TSS), oil and grease, dissolved oxygen, residual chlorine, fecal coliform, pH, total kjehldahl nitrogen (TKN), nitrate, ammonia, and phosphate.

2.3 PREVIOUS ENVIRONMENTAL REPORTS

Prior environmental investigations are documented in the Phase I ESA (EA, June 2015). The most recent studies conducted by EA are discussed below.

<u>Phase I ESA Former Tyson Foods Facility Berlin, Maryland June 2015</u>

EA identified the following recognized environmental conditions (REC) and provided recommendations:

- Remnant unused material was identified in various outbuildings on the subject site, which included industrial process chemicals, compressed gas cylinders, and aboveground storage tanks (AST). A recommendation was made for removal/disposal of remnant materials.

- The underground storage tank (UST) removal cases and elevated levels of volatile organic carbons (VOC) identified in on-site wells are considered a historical recognized environmental condition (HREC). The UST cases were closed by MDE through removal actions or abandoning in place. The elevated VOCs were investigated as part of an area-wide impact investigation and determined not to be attributed to the subject site. A recommendation was made to revise the approved use category of the subject site.

- The subject site has a recorded Activity and Use Limitation for industrial use. The proposed future use of the project is recreational and, therefore, the Activity and Use Limitation must be revised to allow for the future proposed recreational use. EA recommended that the Scope of Work for additional sampling provided by MDE Voluntary Cleanup Program (VCP) in the December 22, 2005 letter be completed.

The findings listed above can be characterized as *de minimis* conditions, CRECs, HRECs, or RECs dependent on various factors related to whether or not the potential for an adverse environmental impact on the subject site exists. HRECs and RECs were identified based on past investigations and the proposed future use of the project site. Based on all findings in this Phase I ESA, additional investigations were recommended to support the planned approved recreational use category of the subject site.

Phase II ESA Former Tyson Foods Facility Berlin, Maryland July 2015

EA performed a Phase II ESA to evaluate the potential for the historical site activities to have impacted the environmental integrity of areas of the site not addressed by previous investigations in order to meet the MDE requirements to revise the Activity and Use Limitation for proposed future recreational use. The results of the site investigation efforts confirmed the following:

- Concentrations of arsenic were reported slightly greater than the MDE Residual Soil Clean-up Standards throughout the site in surface and subsurface samples. However, no results were reported that exceeded the MDE anticipated typical concentrations (ATC).

- Benzo(a)pyrene and benzo(a)anthracene were reported greater than MDE Residential Soil Clean-Up Standards in a single surface sample located adjacent to the former maintenance room. Based on the results from prior investigations and the proposed recreational land use, the levels of PAHs observed are not anticipated to represent an exposure concern for the recreational user.

- E. coli and enterococci reported in surface water sample SW-03, located at the northernmost edge of the lagoons indicate an exposure concern associated with the recreational use of the lagoon water.

Based on review of the soil and groundwater analytical data, it appeared that there were no analytes of concern detected at concentrations in these matrices that would represent a human health concern for future recreational users of the site. However, concentrations of E. coli and enterococci reported at the northernmost edge of the lagoons indicated an exposure concern associated with the recreational use of the lagoon water. It should be noted that the MDE VCP determination is based solely on chemical exposure criteria and does not address physical or biological hazards.

MDE VCP No Further Requirements Determination (NFRD) Letter May 2016

MDE determined there was no further requirements related to the investigation or remediation of controlled hazardous substances or oil identified at the subject site provided the property is used for unrestricted commercial (Tier 2B) or unrestricted industrial (Tier 3B) purposes or medium frequency public recreational area use (Tier 4B) and compliance is maintained with the land use requirement.

3.0 REMEDIAL SITE INVESTIGATION

EA performed a remedial site investigation between 27 March and 31 March 2017. The purpose of this investigation was to evaluate the characteristics of in-place sediments that have accumulated at the bottom of three engineered wastewater management lagoons located on the property (Figure 3-1). The data collected during the March 2017 field effort were used in conjunction with the existing data sets to support the development of cost estimates for several proposed remedial design options for the Site, provided in Appendix A.

3.1 FIELD INVESTIGATION METHODS

The remedial site investigation effort consisted of the collection of sediment probe data and sediment core samples from pre-determined locations distributed throughout the three wastewater management lagoons. In addition, a bathymetric survey and upland topographic survey were performed in order to characterize the morphology of the lagoons and the surrounding basin, and ultimately develop a digital elevation model (DEM) of the Site. The combination of survey data and sampling data was used to support site planning and design efforts, evaluation of remedial options, and generation of the cost estimate.

3.1.1 Precision Navigation and Horizontal Control

Precision navigation for the field investigation was provided by a roving Trimble R8S Global Navigation Satellite System (GNSS) receiver coupled with a Trimble TSC3 handheld controller. The unit provided horizontal positioning in the Maryland State Plane (FIPS 1900) coordinate system in the units of U.S. Survey Feet relative to North American Datum of 1983 (NAD 83). Precise elevation information relative to North American Vertical Datum (NAVD 88) was provided as well. Differential corrections for the satellite positioning data were received real time through a subscription to the KeyNetGPS Virtual Reference Station (VRS) network (http://www.ketnetgps.com). The KeyNetGPS network provided corrections output by the reference station located in Ocean City, Maryland (MDOC; 246516.4N, 1860282.5E); approximately 8 miles from the Site. Following corrector application, the positional information generated by the GNSS unit reliably provided a geodetic accuracy of 0.2 feet (ft) (5 centimeters) in the horizontal and vertical planes.

Prior to initiating the survey effort, two National Geodetic Survey (NGS) benchmarks located outside of the Site were identified as the cross-check marks to confirm geodetic accuracy for the field operation. The NGS benchmark HU0244 located in Berlin, Maryland was utilized to establish vertical control. The NGS benchmark SPEICHER located in Ocean City, Maryland provided horizontal and vertical control. Position comparisons between the published coordinates of the benchmarks and the observed readings of the GNSS unit were made prior to the commencement of the bathymetric and topographic surveys, and served as a quality control (QC) measure. The results of the QC check demonstrated the accuracy of the system, as well as the validity of the corrections produced by MDOC for use at the Site.

3.1.2 HYPACK Navigation and Data Acquisition Software

The positioning information provided by the roving GNSS receiver described above was ported directly to HYPACK navigation and data acquisition software running on a computer laptop onboard the vessel via serial connection. The data were transmitted as National Marine Electronics Association (NMEA) strings (i.e., GGA – position and accuracy, heading in degrees true, and ZDA – GPS time reference to Zulu Time or Universal Time Coordinated) providing time, position and vessel heading, and elevation.

HYPACK served as the primary survey management system; logging time, geographic position, and depth data continuously. It also provided a helmsman display, allowing the vessel operator to maneuver the vessel and associated sensors along the pre-determined survey lines. As the data were received in HYPACK, the geodetic coordinates were converted to Maryland State Plane coordinates in the units of U.S. Survey Feet in real time, based on NAD 83. The ellipsoidal height information from the GNSS unit was passed through the Continental Unites States 2012a (CONUS 12A) Geoid model that converted the information to elevation (orthometric height) tied to the vertical datum of NAVD 88 in real time.

3.2 SEDIMENT PROBE SAMPLING INVESTIGATION

EA conducted a series of sediment probes at 25 pre-determined locations within the three wastewater management lagoons between 30 March and 31 March 2017 (Figure 3-2). The probe data were used to identify the elevation of the water and sediment surfaces, as well as the elevation of the firm subgrade material at each location.

The Trimble R8S GNSS unit was mounted to the top of a fiberglass probe to provide horizontal and vertical positioning in the Maryland State Plane coordinate system (Figure 3-3). At each location, the probe was pushed into the sediment until refusal was met, or until the probe reached its full extent of 13.1ft. Three positional fixes were logged at each location: (1) water surface, (2) top of sediment, and (3) bottom of sediment. By obtaining three positional fixes, the water depth and overall thickness of the fine-grained sediment overburden was calculated for each location based on the difference of the various elevation values.

3.3 SEDIMENT CORE SAMPLING INVESTIGATION

The objective of the sediment coring effort was the collection of intact, cross-sectional samples in order to examine the sediment strata within the wastewater management lagoons. Twelve (12) locations established in a previous phase of the Site characterization were re-occupied for the collection of sediment core samples in order to sample the fine-grained material of concern (Figure 3-4). On 30 March and 31 March 2017, a 2.75-inch diameter piston corer was utilized by EA to collect 12 core samples and two duplicate core samples throughout the lagoons to a maximum depth of 5 ft below the sediment surface (Figure 3-5). Sediment core samples included:

- Four samples located within the north lagoon (SC-1N; SC-3N; SC-5N; SC-9N)

- Four samples located within the middle lagoon (SC-2S; SC-5S; SC-8S; SC-9S)
- Two samples located within the western half of the south lagoon (WWP-1; WWP-2)
- Two samples located within the eastern half of the south lagoon (WWP-3; WWP-4)

Additionally, two duplicate core samples were collected from the western half of the south wastewater lagoon (WWP-1.1; WWP-2.1). Sampling locations were located via GNSS by EA prior to sampling and are presented in Figure 3-4.

The hand-deployed piston corer was utilized to push a 5-ft long, clear Lexan tube into the upper sediment column and withdraw cross-sectional samples. The corer was mounted to the end of a 10ft aluminum rod, which facilitated the driving of the Lexan tube into the sediment column via direct push, as well as withdrawal and recovery of sediment samples. Upon recovery, each core sample was capped, taped, labeled, and stored at 4° Celsius until processed.

3.4 BATHYMETRIC AND TOPOGRAPHIC SURVEYS INVESTIGATION

EA performed a single-beam bathymetric survey and upland topographic survey between 27 March and 31 March 2017 to characterize the morphology of the lagoons and the surrounding basin. Due to the shallow water depths and varying water basin sizes at the Site, EA utilized two vessels to complete the survey effort. The motor vessel (M/V) *Shocker*—a shallow draft, 17-ft Jon boat—served as the primary survey platform for the field effort in the north and middle lagoons (Figure 3-6). Work performed in the south wastewater lagoon was conducted using a smaller, 14-ft Jon boat due to limited access and the frequent need to launch and recover the vessel to cover the entire lagoon.

The hydrographic survey operation involved the collection of data over a total of 83 main-scheme survey lines, oriented east-west in the middle wastewater lagoon and north-south in the north wastewater lagoon, and spaced at 25-ft intervals. In addition, a series of 13 cross-check survey tie lines oriented perpendicular to the main-scheme lines were occupied, providing an added level of quality assurance (QA) following the post-processing. Depth soundings were collected along each of the main-scheme lines, as well as the tie lines, ultimately yielding elevation cross-sections every 25-ft.

The bathymetric survey was conducted in accordance with the U.S. Army Corps of Engineers (USACE)-approved methods described in the USACE Hydrographic Survey Manual EM 1110-2-1003 (USACE, 2013). The surveying methodology was verified to yield the necessary accuracies in the horizontal and vertical planes to support the selection and planning of one or more remedies for the Site. In addition, cross-check comparisons were made between the bathymetric and topographic surveys at overlapping points. These comparisons demonstrated strong agreement between the two data acquisition methodologies and served as a QA measure to further verify the validity of the processed bathymetric and topographic data.

3.4.1 Bathymetric Survey Element

Bathymetric surveying is a technique used for characterizing and mapping underwater topography. A down-looking sonar transducer is mounted to a vessel via a mounting system or directly to the vessel's hull. As the vessel moves across an area, the transducer emits pings at a specific frequency and rate. The individual acoustic pings make contact with the bottom and are reflected back to the transducer. The two-way travel time between the transmit and return pulses is recorded by the instrument, then divided in half and compared to the sound velocity within the water column to determine a depth value. Following data acquisition, the acoustic soundings are merged together to form a complete surface of the surveyed area.

The March 2017 survey utilized a dual frequency [200 kilohertz (kHz) and 24kHz] transducer, which allowed distinct sediment layers to be profiled based on differences in density. Higher frequency, shorter wavelength acoustic pulses attenuate rapidly in the water column, but also reflect off the first density interface encountered (sediment surface). Lower frequency pulses are longer in wavelength and have the ability to penetrate through the sediment surface and detect an acoustic reflector deeper in the sediment column. This acoustic reflector is commonly a density interface within the sediment column, which typically represents a change in stratigraphy or a buried object.

Bathymetric Data Acquisition

A CEE Hydrosystems CEESCOPE single-beam survey fathometer interfaced with a dual frequency (200 kHz and 24 kHz) transducer was used to collect depth soundings over each survey line. The high frequency (200 kHz) sonar reflected off the sediment surface and provided an instantaneous measurement of water depth. The low frequency (24 kHz) sonar penetrated through the fine-grained surficial sediments, striking the firmer subgrade below, providing an elevation of the subgrade material. The transducer was pole-mounted to the starboard side of the vessels and set at a fixed depth below the water's surface (draft). The raw depth soundings obtained by the CEESCOPE were ported directly to HYPACK, where they were time-tagged and merged with positioning information; creating continuous depth records along the survey track. These data were then stored for post-processing and analysis at the conclusion of the survey.

Water column sound velocity is a function of water density, which varies in a freshwater body with temperature. To yield accurate sound velocity measurements throughout the survey, the water column was profiled at the start and end of each survey day using a Yellow Spring Instruments (YSI) CastAway Conductivity, Temperature, and Density (CTD) probe. Prior to deployment, the internal GPS receiver tracked satellites and achieved a precise geographic position. The instrument was then hand-lowered into the water, collecting measurements as it moved through the water column, and recovered once the sediment surface was reached. The data collected by the CTD probe were archived for inclusion in post-processing of the bathymetric data.

The use of VRS Real Time Kinematic (RTK)-corrected GNSS data allowed HYPACK to record water surface elevations relative to NAVD 88 as the survey progressed, which yielded lagoon bed elevation data in real time when coupled with the bathymetric soundings. As an added QA measure, EA deployed two Onset HOBO U20 pressure sensor/water level recorders in the north and middle lagoons. The units were deployed on 28 March 2017 and left undisturbed until their recovery on 31 March 2017. The units recorded absolute pressure and bottom water temperature observations on a 6-minutes interval for a period of 4 days. Upon recovery, the data were downloaded, verified for validity, and stored for processing.

Bathymetric Data Processing

Upon completion of the survey, all of the raw depth soundings obtained along the main-scheme and tie lines were reviewed, corrected for water column sound velocity, and then normalized to NAVD 88 in HYPACK's single-beam editor module. Erroneous data points associated with cavitation in the water column, insufficient water depth, or suspect data points were flagged and removed from further processing and eventual data output. As a QC measure, the main-scheme and tie line soundings were overlaid in HYPACK, and values were compared at numerous crossings to verify all correctors were properly applied and that there was strong agreement between the overlapping soundings. The cross-check comparisons showed consistent agreement between the main-scheme and tie lines.

At the conclusion of the post-processing effort, the bathymetric survey data set was compiled into a comprehensive XYZ text file consisting of X and Y position coordinates referenced to Maryland State Plane and positive elevations (Z) referenced to NAVD 88. The first Z value output was the high frequency (200 kHz) transducer output used to track the sediment surface and represent the lagoon bed elevation. In addition, a second Z value representing the elevation of the hard subgrade material detected by the low frequency (24k Hz) pulse was output.

3.4.2 Topographic Survey Element

In order to develop a complete DEM of the Site, a series of land-water interface transects were performed along the margins of each lagoon. Individual positional fixes were logged above the waterline using the Trimble R8S GNSS unit and collected high-resolution elevation measurements along all accessible stretches of shoreline within the project area.

Topographic Data Acquisition

Individual transect lines spaced at 100-ft intervals and oriented perpendicular to the banks of each lagoon (shore normal) were occupied with a minimum of 10 positional fixes recorded along each line. The GNSS receiver was mounted to a surveying rod and walked along each transect to obtain position and elevation data from the water's edge, up the bank, and extending to the tree line. A 6.562ft elevation corrector was applied the data in real time by the handheld Trimble TSC3 controller to correct for the height added by the pole-mount. In addition, point measurements were collected using this approach to supplement bathymetric soundings in areas where shallow water depths prevented the collection of valid acoustic data.

Topographic Data Processing

Following the survey effort, the topographic data were compiled into a comprehensive XYZ text file consisting of X and Y position coordinates referenced to Maryland State Plane and positive elevations (Z) referenced to NAVD 88. The data set was exported to a Geographic Information

System (GIS) database, where it was merged with the bathymetry data and further processed to support gridding routines and serve as a component of the DEM for the Site. The finalized DEM was ultimately used to generate contour maps and facilitate description of bottom topography within the survey area.

3.4.3 Geographic Information System

The bathymetric survey covered an area of approximately 26 acres of lagoon bed. The data from the survey consist of a series of XYZ files. When processed together, a comprehensive view of the lagoon bed morphology was developed. The final element of the bathymetric and topographic data processing included the output of the geo-referenced XYZ files for incorporation into a geodatabase and use in a GIS framework. The individual bathymetric survey lines and topographic transect lines were combined in ArcGIS to create a digital, geo-referenced elevation surface of the study area. Merging the data sets resulted in the development of a seamless DEM covering the upland, shoreline, and in-water areas of the Site.

The combined data set of bathymetric soundings and topographic measurements were subjected to a series of gridding routines, which were then used to develop raster surfaces or elevation models. The models were then used to derive information regarding water depth within each pond, elevation of the sediment surface, as well as the elevation of the underlying strata. Contour, or isopach, maps of the surveyed areas were then produced to illustrate the Site's morphology. These results were used to inform the remedial design efforts and to estimate the volumes of soft sediment present in the survey area.

4.0 RESULTS

Figure 4-1 displays the seamless DEM developed from the merged bathymetric and topographic data sets. When normalized to a surface water elevation of 26.3ft (NAVD 88) for the north and middle lagoons and 31.5ft for the south lagoon, a map of water depths within each lagoon was produced (Figure 4-2). Figure 4-3 illustrates the elevation measurements of the subgrade material as detected throughout the survey area using the low frequency (24 kHz) data. Comparison between the elevation of the sediment surface to that of the subgrade material at depth within each lagoon yielded a model of soft sediment thickness within each basin (Figure 4-4). This data product was then used to calculate volume estimates for the amount of material that would be encountered and/or managed as part of the various remedial alternative presented in Section 5.0.

Figures 4-5 and 4-6 provide cross-sectional representations of the stratification of sediment present in the lagoons. The bottom-most layer represents the firm subgrade material. The soft sediment layer overlays the subgrade layer in varying thicknesses. The uppermost layer represents the water column.

A total of 25 sediment probes were conducted throughout the survey area. The probe met refusal at 21 locations distributed throughout the wastewater lagoons, and was pushed to extent (~13ft depth) at four locations in the south wastewater lagoon. The data collected were utilized in determining the volume of the soft sediment layer present in the lagoons. Table 4-1 provides the measured depths obtained at each location.

A total of 12 sediment cores, and two duplicate cores, were collected during the field investigation. The coring locations were distributed among the wastewater lagoons, providing a cross-sectional representation of the subsurface lithology. Table 4-2 provides the locations and measured recovery of each sediment core. A photographic record of all collected core samples is provided in Appendix B.

4.1 NORTH WASTEWATER LAGOON

4.1.1 Bathymetric and Topographic Surveys Results

Evaluating the high frequency soundings, the north wastewater lagoon exhibited water depth ranges from zero (26.3ft NAVD 88) along the margins to 3.5ft (23.5ft NAVD 88) near the center of the basin. The shallow, nearshore extents around the perimeter of the lagoon gradually slope to the deepest portion in the center of the lagoon, forming a bowl-shaped basin (Figure 4-1). The deepest portion of the lagoon measures 450ft wide at its center, and 600ft long. The use of the low frequency (24 kHz) data provided insight into the elevation of the denser subgrade material present in the lagoons (Figure 4-3). The north lagoon exhibited a subgrade material elevation range from 21ft to 25ft (NAVD 88). It is assumed that the subgrade material is comprised of ambient soils, similar in composition to those described in Section 2.1.

Figure 4-4 illustrates the distribution of soft sediment throughout the wastewater lagoons. As described in Section 3.4, the high and low frequencies of the sonar transducer detected two distinct sediment layers. The high frequency return provided elevation measurements of the soft sediment surface, while the low frequency return penetrated through the soft sediment to provide elevation measurements of the firm subgrade layer. The high frequency return was subtracted from the low frequency return, and the difference represented the estimated thickness of soft sediment present in the lagoon. The north lagoon exhibited a soft sediment thickness range from near zero at the margins to approximately 4.5ft. The thickest deposits of soft material were present along the northwestern margin, as well as in the southeastern corner of the lagoon. A series of in-filled pits were detected adjacent to the shoreline, extending from the northern-most point of the lagoon to the shoreline surrounding the small water treatment wells located between the north and middle lagoons.

The estimated volume of soft sediment present in the north lagoon was calculated in order to determine remedial design options for the Site. As described above, the soft sediment thickness was estimated by measuring the difference between the high and low frequency returns of the sonar. The total thickness represented the total soft sediment volume, which was calculated as 14,383 cubic yards.

Moving from the margins to the center of the basin, the water depth increased, and the apparent thickness of the soft sediment deposits decreased to values between 0.5ft and 1.0ft. The pattern of soft sediment distribution in the north lagoon indicated that it was not the primary placement area for wastewater. Wastewater was initially pumped into the middle lagoon, where most of the sediment settled out of suspension due to the low energy environment. Only a small percentage of the finer-grained sediment that could remain in suspension was ultimately transported into the north lagoon where it eventually settled as bedded material.

The distinct contrast between the topographic and bathymetric data is illustrated in Figure 4-1. The dirt road located along the perimeter of the Site is clearly visible due to its elevation, ranging from 29ft to 36ft (NAVD 88). The road outlining the north and middle lagoons is approximately 3ft higher in elevation than the surface water level of both lagoons. The road surrounding the south lagoon displayed the highest elevation, ranging from 34ft to 36ft (NAVD 88); approximately 5ft higher in elevation than the surface water level of the south lagoon.

The Site was constructed using a system of engineered berms, with all land outside of the perimeter displaying lower elevations. Topographic data points were obtained around each lagoon and along the southwestern extent of the Site, in close proximity to the former wastewater holding tank. Elevations of the berms ranged from 23.5ft at the base to 36ft (NAVD 88) at the edge of the south lagoon (Figure 4-1). However, the elevation of the roadway surrounding the north and middle lagoons was commonly 30ft (NAVD 88).

4.1.2 Sediment Probe Results

Nine (9) sediment probes were conducted in the north wastewater lagoon, with three elevations recorded at each location: (1) water surface, (2) top of sediment, and (3) bottom of sediment.

Refusal was met at all nine (9) probe locations, verifying the presence of a firmer subgrade. The measured elevations of the firm subgrade exhibited small variances between probe locations (Figure 4-3). The greatest variances were:

- Probe location 4N exhibited the highest firm subgrade elevation at 22.3ft (NAVD 88).
- Probe location 1N exhibited the lowest firm subgrade elevation at 21.1ft (NAVD 88).

The estimated depth of firm subgrade at each location was calculated using the measured elevations of the soft sediment and firm subgrade. Table 4-1 provides the water depth, firm subgrade depth, and estimated thickness of soft sediment at each probe location calculated using the measured elevations.

4.1.3 Sediment Core Results

Sediment was collected at four locations distributed throughout the north wastewater lagoon. The cross-sectional samples were collected from the sediment surface to a maximum depth of 5ft. The core penetration/recovery depths below the sediment surface ranged from a minimum of 1.4ft (16.5 inches [in]) in length to a maximum of 2.75ft (33in). Sediment recovery by location is provided in Table 4-2.

The soft sediment comprised of sandy silt was present at varying thicknesses in all four sediment samples, ranging from zero to 2.75ft (Table 4-2). An underlying layer of a firm, white/grey material was present in three of the samples. This material was presumed to be the firm subgrade verified by the sediment probe effort. The sediment sample obtained at location 3N did not capture the firm subgrade, and was the only sample in the north lagoon to present a strong odor upon core collection.

4.1.4 Combined Bathymetric and Sediment Probe Results

The sediment probe results were utilized as a QA check to verify the validity of the bathymetry data. Figure 4-3 illustrates the firm subgrade elevations detected by the low frequency sonar. The elevation of this same layer measured at each sediment probe location is labeled on the figure as well, allowing for a clear comparison to be made between the bathymetry data and the probe data. In the north lagoon, the firm subgrade elevation of the 9 probe locations ranged from 21.1ft to 22.3ft (NAVD 88), and the surrounding basin elevation ranged from 21ft to 23.5ft (NAVD 88). The comparisons made at each location in the north lagoon showed consistent agreement between the bathymetry and probe data.

Similarly, the estimated thickness of soft sediment calculated at each probe location is labeled on Figure 4-4. Comparisons were made between the thickness calculated using the bathymetry data and the labeled thickness at each probe location. The probe location thickness ranged from 2.19ft to 3.38ft, and the surrounding basin thickness ranged from 1ft to 4ft.

4.2 MIDDLE WASTEWATER LAGOON

4.2.1 Bathymetric and Topographic Surveys Results

Evaluating the high frequency soundings, the middle wastewater lagoon displayed water depth ranges from zero (26.3ft NAVD 88) near the margins to 1.5ft (25.5ft NAVD 88) near the center of this water body (Figures 4-1 and 4-2). In contrast to the north lagoon, the bed in the middle lagoon exhibited a relatively flat, featureless topography when viewing the 200 kHz data. The lower frequency, 24 kHz data suggested that the subgrade material was present at elevations ranging from 19.5ft to 24.5ft (NAVD 88) (Figure 4-3).

Subtracting the high frequency return from the low frequency return resulted in an estimated thickness of the soft sediment layer present in the middle lagoon (Figure 4-4). The lagoon exhibited soft sediment thickness ranging from 1.0ft to 6.0ft. Similar to the north lagoon, series of pits were present along the nearshore areas of the middle lagoon, which have been subjected to the highest amounts of in-filling over time. As a result, the greatest volume of soft sediment was detected in these nearshore areas, decreasing in thickness to an average of 4ft in the approximate center of the water body.

The estimated volume of soft sediment present in the middle lagoon was calculated in order to determine remedial design options for the Site. As described above, the soft sediment thickness was estimated by measuring the difference between the high and low frequency returns of the sonar. The total thickness represented the total sediment volume, which was calculated as 66,173 cubic yards.

In general, it appears that the middle lagoon basin has in-filled significantly with soft sediment over time. When first constructed, the north and middle lagoons were most likely established at the same elevation and exhibited similar bowl-shaped basins. Over time, the soft sediment deposited into the lagoon filled the basin, reducing the appearance of the bowl-shape and flattening the lagoon bed.

In addition to displaying the thickness of soft sediment present in the wastewater lagoons, Figure 4-4 provides insight into the behavior of the sediment as it was discharged into the lagoons. The wastewater and sediment were discharged directly into the middle lagoon, and moved into the north lagoon via the small opening on the eastern side of the Site. The outlet into the north lagoon behaved similarly to a river outlet; a small delta feature was formed by the sediment deposition as material was transported between the middle and north lagoons.

4.2.2 Sediment Probe Results

Eleven (11) sediment probes were conducted in the middle wastewater lagoon. Three elevations were recorded at each location: (1) water surface, (2) top of sediment, and (3) bottom of sediment. Refusal was met at all 11 probe locations, verifying the presence of a firmer subgrade. The measured elevations of the lagoon bed and firm subgrade exhibited small variances between probe locations (Figure 4-3). The greatest variances were:

- Probe location 11S exhibited the highest firm subgrade elevation at 22.1ft (NAVD 88).
- Probe location 7S exhibited the lowest firm subgrade elevation at 20.3ft (NAVD 88).

The estimated depth of firm subgrade at each location was calculated using the measured elevations of the soft sediment and firm subgrade. Table 4-1 provides the water depth, firm subgrade depth, and estimated thickness of soft sediment at each probe location calculated using the measured elevations.

4.2.3 Sediment Core Results

Sediment was collected from four locations in the middle wastewater lagoon. The cross-sectional samples were collected from the sediment surface to a maximum depth of 5ft. The cores ranged from a minimum of 1.75ft (21in) in length to a maximum of 2.54ft (30.5in). Sediment recovery by location is provided in Table 4-2.

The soft sediment comprised of sandy silt was present at varying thickness in all samples, ranging from zero to 2.54ft (Table 4-2). An underlying layer of a firm white/grey material was present in three of the samples. As in the north lagoon, this material is presumed to be the firm subgrade material verified by the sediment probe effort. The sediment sample obtained at location 9S did not capture the firm subgrade, and was the only sample in the middle lagoon to present a strong odor upon core collection.

4.2.4 Combined Bathymetric and Sediment Probe Results

The sediment probe results were utilized as a QA check to verify the validity of the bathymetry data. Figure 4-3 illustrates the firm subgrade elevations detected by the low frequency sonar. The elevation of this same layer measured at each sediment probe location is labeled on the figure as well, allowing for a clear comparison to be made between the bathymetry data and the probe data. In the middle lagoon, the firm subgrade elevation of the 11 probe locations ranged from 20.3ft to 22.1ft (NAVD 88), and the surrounding basin elevation ranged from 19.5ft to 22ft (NAVD 88). The comparisons made at each location in the north lagoon showed consistent agreement between the bathymetry and probe data.

Similarly, the estimated thickness of soft sediment calculated at each probe location is labeled on Figure 4-4. Comparisons were made between the thickness calculated using the bathymetry data and the labeled thickness at each probe location. The probe location thickness ranged from 3.03ft to 4.95ft, and the surrounding basin thickness ranged from 3.5ft to 5ft.

4.3 SOUTH WASTEWATER LAGOON

4.3.1 Bathymetric and Topographic Surveys Results

Evaluating the high frequency soundings, the south wastewater lagoon exhibited water depth ranges from zero (31.5ft NAVD 88) near the margins to 11ft (20ft NAVD 88) near the lagoon center. In contrast to the north and middle lagoons, the south lagoon exhibits a strong vertical profile along its perimeter (Figure 4-1 and 4-2). Additionally, the south lagoon sits at a higher elevation than the north and middle lagoons and was established at a lower elevation than the north and middle lagoons. The topographic coverage adjacent to the south lagoon displayed an elevation of 23.5ft (NAVD 88) at its lowest point; 3.5ft higher than the lowest elevation present in the south lagoon (Figure 4-1). The 24 kHz data exhibited a firm subgrade elevation ranging from 19ft to 30.5ft (NAVD 88).

In contrast to the north and middle lagoons, the difference between the high and low frequency soundings was very small, excluding the nearshore extents along the lagoon perimeter, indicating only a thin layer of soft sediment overburden. The thickness ranged from <0.5ft to 1.0ft in a majority of the pond. Similar to the north and middle lagoons, the thickness was highest in proximity to the banks due to the series of pits that were apparently dug during construction. The greatest concentration of the deeper pits was in the western half of the south lagoon, displaying soft sediment thickness values ranging from 0.5ft to 3.5ft. In contrast, the pits in the eastern portion contained sediment thicknesses ranging from 0.5ft to 2.0ft.

Since the south lagoon presented a very thin layer of soft sediment in comparison to the north and middle lagoons, an estimated volume of soft sediment was not calculated. However, in order to determine remedial design options, the water volume for the south lagoon was calculated, and measured approximately 49,447 cubic yards. In addition, the total capacity of the lagoon was calculated to estimate holding potential, and measured approximately 78,200 cubic yards.

4.3.2 Sediment Probe Results

Five (5) sediment probes were conducted in the south wastewater lagoon. Three elevations were recorded at each location: (1) water surface, (2) top of sediment, and (3) bottom of sediment. Four of the probe locations did not meet refusal due to the probe meeting its full extent (~13ft) and unable to advance further (Table 4-1). Refusal was met at one probe location:

- Probe station 1W exhibited a firm subgrade elevation of 19.8ft (NAVD 88) (Figure 4-3).

The estimated depth of firm subgrade at each location was calculated using the measured elevations of the soft sediment and firm subgrade. Table 4-1 provides the water depth, firm subgrade depth, and estimated thickness of soft sediment at each probe location calculated using the measured elevations.

4.3.3 Sediment Core Results

Sediment was collected from four locations in the south wastewater lagoon. The cross-sectional samples were collected from the sediment surface to a maximum depth of 5ft. The core penetration depths range from a minimum of 0.2ft (2.25in) in length to a maximum of 3.02ft (36.25in). Sediment recovery by location is provided in Table 4-2.

In contrast to the north and middle lagoons, the layers of sediment captured in the samples obtained in the south lagoon were not clearly stratified. The cores presented a varied lithology, containing layers of sediment ranging in grain size, composition, and color (Table 4-2). The sediment sample obtained at location WWP2 exhibited gas pockets within the layers of soft sediment, most likely indicating the presence of methane below the sediment surface. The samples captured in the western half of the south lagoon displayed the most varied stratification and lithology. The two samples from the eastern half were composed of the firm white/grey material.

4.3.4 Combined Bathymetric and Sediment Probe Results

As described in Section 4.3.2, the sediment probe only met refusal at one location in the south lagoon. The firm subgrade elevation measured as 19.8ft (NAVD 88) was compared to the surrounding basin, which ranged from 19ft to 21.5ft (NAVD 88) (Figure 4-3). This comparison served as a QA check to verify the validity of the bathymetry data.

The estimated thickness of soft sediment was calculated at the one probe location that met refusal. The soft sediment layer measured 1.4ft thick, and the surrounding basin thickness ranged from 0.5ft to 1ft.

5.0 DISCUSSION

The results of the field investigation were used to estimate volumes of the soft sediment overburden present in the lagoons and were used as the basis for developing remedial design alternatives. Potential remedial design efforts require the removal of this sediment prior to any public site usage. The sediment volume was estimated by determining the difference between the high frequency acoustic returns and the low frequency acoustic returns. The high frequency transducer recorded the elevation of the sediment surface, and the low frequency transducer recorded the elevation of the hard subgrade beneath the sediment surface. The difference calculated between the separate returns represented the thickness of soft sediment.

Figure 4-4 displays the estimated volume of soft sediment thickness present in the lagoons. The sediment ranges in thickness from 0.5ft to 5.5ft in the north and middle wastewater lagoons, and from zero to 2.0ft in the south wastewater lagoon.

The middle lagoon exhibits a greater estimated volume than the north lagoon (Figure 4-4). The thickness ranges from 3.5ft to 5.5ft, and the total volume was calculated as 66,173 cubic yards. The sediment thickness in the north lagoon ranges from 0.5ft to 4.0ft, and the total volume was calculated as 14,383 cubic yards.

A volume calculation was not performed for the south wastewater lagoon due to the negligible amount of soft sediment present. This lagoon would potentially be drained and utilized as a holding tank for material removed from the north and middle wastewater lagoons. The total volume of the lagoon was calculated to determine potential holding capacity and measured 78,200 cubic yards.

Table 5-1 provides a summary of the RI findings for each wastewater lagoon.

5.1 TECHNOLOGY SCREENING AND REMEDIATION ALTERNATIVE DEVELOPMENT

Two remediation alternatives to address sediment in the wastewater lagoons were developed according to the process described below. Each of the two remediation alternatives integrate anticipated means and methods of construction to implement the project, and includes detailed conceptual cost estimates to support the Town of Berlin’s (Town) ongoing planning for the Site. The two alternatives result in different outcomes for the wastewater lagoons (primarily for the south wastewater lagoon) and the final disposition of the dredged sediment, and each alternative can be compared in terms of both the distinguishing factors in technical approach that may lend one alternative to be preferable to the Town than the other, as well as differences among the estimated costs. The detailed cost estimates are provided in Appendix A. The process to determine the major components for remediation alternatives that would be considered most likely to achieve success, involved a focused screening of candidate technologies for sediment removal, dewatering, and disposal. For the purpose of this evaluation, “Most likely to achieve success” is broadly defined as meeting these project objectives:

- Compatibility with Town's proposed future land-use for the Site as a public recreation area;
- Effectiveness in removal of process residuals from the lagoons, referred to generally as "sediment",
- Technical and administrative feasibility to implement (e.g., availability of contractors with requisite experience, availability of equipment and materials, permitting implications and public acceptance); and
- Cost-effectiveness of approach.

Technologies for sediment removal, dewatering, and disposal were combined based upon these stated objectives, available site information and generalized assumptions for sediment properties, and EA's experience with similar projects. Technologies were then evaluated based upon two main criteria: general effectiveness and the ability to implement the technology, and expected relative cost. Table 5-2 below provides the qualitative screening evaluation of technologies in terms of high, medium, or low ranking. A "low to medium" or "low" overall ranking is eliminated from consideration, while "medium to high" or "high" overall ranking is retained for further consideration in developing the remediation alternatives for more in-depth evaluation and cost estimating.

In general, the process of removing sediments from any water body requires three primary tasks that are evaluated by the following categories: (1) removal of sediment, (2) dewatering of sediment, and (3) disposal of sediment. Technologies assessed for each task are commercially available and are further explained below:

Removal:

- In-dry excavation: This process includes dewatering lagoons by pumping out the water, treating water to remove suspended solids, and discharging it in accordance with the existing NPDES permit. This avoids removal of sediment through the water column as with dredging methods. Assuming appropriate geotechnical stability of the subsurface materials, direct access to the sediment is subsequently provided for equipment to remove and transport by truck, conveyor, or by additional handling to an adjacent dewatering area.
- Mechanical dredging: This method of dredging involves the use of barge-based equipment (i.e., clamshells and buckets, backhoes, bucket ladder dredges) to remove sediment to be transported by a separate barge to offload, or otherwise allow dredged material to be transferred to an adjacent dewatering area.

- Hydraulic dredging: This method of dredging involves the use of hydraulic pumps to remove sediment as a dredged material slurry, and transport by pipeline to an adjacent dewatering facility.

Dewatering:

- Gravity dewatering using drying agents: Drying agents or amendments such as lime, Portland cement, or iron salts are added to the dredged material to allow for better drying by absorbing water. This technology applies to sediment that is removed by in-dry or mechanical dredging methods whereby the dredged material is near the *in situ* moisture content. Dewatering methods may include gravity drainage (takes significant time), air drying with overturning of the material in stockpiles, and/or use of drying agents or amendments to eliminate free water that does not gravity drain. Some additives will also increase the strength and geotechnical suitability of the dredged material for beneficial reuses.

- Geotubes: This method of dewatering consists of three stages: (1) containment, (2) dewatering, and (3) consolidation. The dredged material is pumped into the tube in a containment facility. In the second stage, all free water is allowed to drain out of the pores of the geotextile fabric. In the third stage, after all water has been removed, the soil is dried out for final transport off-site.

- Mechanical/ belt presses: This method of dewatering involves the use of a belt filter press, in which the waste material is squeezed to remove moisture and create a dewatered product. A plate-frame filter press involves pumping the dredged material slurry inside filters, which similarly uses pressure to force water from the pore space between fine-grained sediment particles. Use of mechanical dewatering methods such as these also include complementary steps in the process to remove some materials prior to reaching the presses, such as debris and coarse material screens, hydroclones or sand separation screens, and polymer injection for fine-grained sediment coagulation.

Disposal:

- On-site management: This method of disposal involves the implementation of a designated containment area within the extents of the project site, namely the south lagoon. The dredged material is contained and dewatered within the available volume of the south lagoon, capped with a low permeability layer of soil to limit surface water infiltration into the contained sediment.

- Beneficial reuse: This method of dredged material management is appropriate when a material is not regulated as industrial waste, which involves processing to the extent necessary to meeting the specifications for use, such as debris removal, dewatering, and if needed using amendments to improve geotechnical suitability for handling, transporting, and placing the materials, such as reuse as upland fill, landfill daily cover, or similar options that are lower in cost than landfill disposal.

- Landfill daily cover: If the dredged material meets the specifications for reuse and appropriate timing for a given landfill's operations, it may be accepted by a landfill for covering wastes contained in disposal cells.
- Landfill cell disposal: If the dredged material does not meet the specifications, such as geotechnical suitability for reuse as daily cover, it will be placed as part of the waste materials in the landfill cells and therefore be subject to a fee for disposal.

Table 5-2: Technology Screening Evaluation for Remedial Alternatives

Technology Category	Technology	General Effectiveness and Implementability	Expected Relative Cost*	Screening Outcome
Removal	In-dry excavation	Low – requires full dewatering of lagoons, the management, treatment, and discharge of a significant quantity of impacted water, and creation of access ramps and roads into lagoons to remove sediment (subsurface soil conditions below lagoons must be suitable for safely supporting equipment and personnel); the very soft sediment conditions in middle lagoon would not support construction equipment or efficient sediment removal using conventional excavation equipment, i.e., low technically feasibility; this also would include disposal of water, requiring a possible revision to the existing discharge permit and possibly water treatment, which is not required for other approaches.	Low	Eliminated (low)
	Mechanical dredging	Low to Medium – soft sediment conditions, particularly in middle lagoon, which may include sediment conditions that are similar to a slurry, combined with the limited depths of sediment removal above sand, reduces effectiveness of this technology. Additionally, dewatering and water treatment options are less compatible	Medium	Eliminated (low to medium)

		with approaches that allow direct recycling of water back to the lagoons.		
	Hydraulic dredging	High – generally preferable for soft sediment conditions in the lagoon lagoons; additionally, water can be managed cost-effectively by recycling water used for dredging back into the lagoons; hydraulic dredging in industrial lagoons and water treatment plants has prior precedent.	High	Retained (high)
Dewatering	Gravity dewatering using drying agents	Low to Medium – for saturated sediment dewatering by gravity drainage requires significant time without taking steps to enhance drainage and/or improve engineering properties such as strength; use of drying agents to such as lime, cement, or absorbents would be required at potentially significant quantities to allow transport and disposal, as well as improved geotechnical suitability for low cost disposal or some beneficial reuse options.	Low	Eliminated (low to medium)
	Geotubes	Medium to High – technology is commonly used for lagoon sludge dewatering (at least one other Tyson plant has utilized geotubes for dewatering process residuals – Attachment B is included for reference purposes courtesy of Tencate and WaterSolve); requires use of polymers for technical feasibility and to improve dewatering time; requires use of experienced technicians.	Medium	Retained (medium to high)
	Mechanical presses/ belt presses	Medium to High – technology is commonly used for sludge dewatering; presses have limited availability to lease; skilled technicians are required for maintenance and repairs during construction; a significant benefit is the technology typically achieves the greatest degree of dewatering and therefore most reduction in sediment volume, than other methods.	Medium	Retained (medium to high)

Disposal	On-site management	High – On-site management of sediment requires dewatering t to a volume less than existing in-situ condition and closure of south lagoon by placing dewatered sediment from the north and middle lagoons in the south lagoon; expectation is an improved overall efficiency and shorter schedule duration compared to other sediment management options.	High	Retained (high)
	Beneficial reuse	High – once sediment is characterized and meets residential or industrial soil criteria, and potentially other testing depending on targeted reuse opportunities, a low-cost beneficial reuse option may become available; sediment must be dewatered sufficiently for transport and be amended to meet geotechnical suitability of the beneficial reuse option (insufficient data was available to select this as the preferred technology).	High	Retained (high)
	Landfill daily cover	Medium – requires that sediment is not contaminated with EPA priority pollutants and is dewatered and amended as necessary to achieve minimum requirements for geotechnical suitability, e.g., compressive strength, stackability, compactability, etc. (EA assumed these conditions are potentially viable for the Tyson sediment, though additional treatability testing would be needed to confirm).	High	Retained (medium to high)
	Landfill cell	Low – if not feasible for sediment to achieve landfill requirements for daily cover, this higher cost disposal is often necessary.	Low	Eliminated (low)

From the above table, the technologies were combined into the two remediation alternatives as appropriate that included more detailed conceptual cost estimating than the relative cost screening reflected in Table 5-2. These additional factors were incorporated into decision-making for developing two remediation alternatives:

- Beneficial reuse options may be available for the sediment, allowing for the low-cost management of the materials; however, the determination of applicability for Tyson sediment for beneficial reuse would follow physical and chemical characterization of sediment, as well detailed planning to identify and explore viable solutions for reuse;

- Permitting implications and public acceptance were considered equivalent among available approaches and not distinct enough to be a distinguishing factor for one remediation alternative over the other. In general, the cost estimate has considered the permitting effort required to obtain necessary approvals for construction as being relatively straight-forward;

- Dewatering techniques for sediment removed by hydraulic dredging is considered most suitable for this project accompanied by dewatering using geotubes or presses. Due to the uncertainty with availability of presses for leasing, qualified technicians for maintenance and repairs, and construction contractors in the region with press experience, this approach was not included within either remediation alternative. It is generally advisable to consider this approach further in subsequent studies in the event regional experience makes this technology cost-competitive with geotubes; and

- Physical properties of the sediment were not characterized at the time of this study, so EA assumed each remediation alternative is feasible and appropriate, though additional characterization and treatability studies are recommended to confirm technical feasibility; chemical properties data is available based on the NFRD finding by MDE through the voluntary cleanup process, so EA has assumed that limited waste profiling may be necessary for landfill disposal options and that all project permitting is administratively feasible and straight-forward.

Based on the screening evaluation and additional factors described above, the following alternatives were assembled from the retained technologies from Table 5-2:

- Alternative 1: Removal with On-site Management.

- Alternative 2: Removal with On-site Management and Off-site Disposal.

The following estimated volumes and areas of each lagoon were considered when developing the alternatives:

North lagoon

- Sediment volume: 14,383 cubic yards
- Total surface area: 464,398 square ft

Middle lagoon

- Sediment volume: 66,173 cubic yards
- Total surface area: 478,984 square ft

South lagoon

- Water volume: 49,447 cubic yards
- Total surface area: 184,036 square ft
- Total capacity: 78,200 cubic yards

5.1.1 Alternative 1: Removal with On-site Management

Alternative 1 integrates hydraulic dredging of the north and middle wastewater lagoons sediment, and placement inside an array of adjacent geotubes in the south wastewater lagoon. A soil cover would be placed over the small lagoon footprint for closure. Additionally, a thin layer of sand would be placed upon the north and middle lagoons following dredging to cover any residual sediment that was missed by the dredging or re-suspended into the water column during dredging.

A hydraulic dredge incorporates a rotating head or cutter located at the end of an intake pipe. The rotating head dislodges sediment, and combined with the turbulence and entrainment of water from a pump, creates a low-solids-content slurry mixture entering the intake. Figure 5-1 provides an example of a hydraulic dredge. The resulting sediment slurry is transported by pipeline to the large geotube bags. The tubes generally measure 10ft to 20ft in diameter, and can be in excess 100ft in length, and allow the excess water to drain through the textile mesh of the tube fabric as filtrate (Figure 5-2).

Mobilization and Demobilization

Site mobilization and demobilization are standard items for construction contractor costs, and include deployment (and removal) of equipment and personnel, temporary facilities such as site trailers and utilities, and related activities.

Site Preparation and Access Development

Access for construction equipment and support vehicles to lagoons, shorelines, and surrounding area immediately adjacent to the lagoons will be necessary. Limited site grading for access and construction of temporary access roads has been included per detailed assumptions in cost estimate notes. This also includes the preparation of a staging area where storage of construction materials and temporary facilities will occur, and is based upon a gravel surfaced space. Additionally, access will integrate an efficient route for trucks entering and exiting the main site entrance and traveling to the staging area. In addition to laydown area for products delivered to the Site and storage of equipment, a small unlined storage and dewatering area would be required for demolition debris encountered during dredging required removal and reuse/recycling or disposal by the Town (demolition debris has been assumed to be a small fraction of the total project cost). Limited demolition has been included in the RI, consisting only of removal and staging of the metal framework present in the south lagoon, and removal and staging of the steel sheet pile wall. Based on aerial images of the Site's existing gravel lot, removal and relocation of several piles of miscellaneous materials on Town property will be necessary to create an approximately 2-acre area.

Dewatering System Installation and Operation

Alternative 1 includes the use of the south wastewater lagoon to contain the dredged sediment in geotubes. Prior to preparing the south lagoon and placing geotubes within the lagoon, the surface water will be withdrawn over a one to two-week period using a high capacity pump, which will discharge in the adjacent middle wastewater lagoon. This will result in a raise in water level in the north and middle lagoons by approximately 1.4ft. Once the geotubes are in place and dewatering sediment, a pump would withdraw filtrate water draining from the tubes at a sustained, but lower, pumping rate; similarly, this relatively clear filtrate water would be recycled into the middle lagoon. The design of this alternative will require a geotechnical evaluation to confirm the containment berm between the north and middle lagoons can accommodate the differential height of water this approach creates.

South Wastewater Lagoon Preparation

Based on the information from this study, it has been concluded that the south lagoon contains a negligible amount of soft sediment, which is preferable for Alternative 1. However, since subsurface soil lithology below the lagoon and the associated engineering properties such as shear strength and compressibility are unknown, the approach has included the placement of 2ft of gravel and a high-strength geotextile for soil reinforcement and separation from potentially soft and low-strength subgrade conditions. The gravel also provides a drainage layer below geotubes intended to limit erosion below the tube during the dewatering process. The base of the lagoon will include a sump at lowest elevation for pumping the filtrate to the adjacent lagoon during sediment dewatering. Pending additional subsurface information, limited equipment has been assumed to have access directly to the lagoon for this alternative. Small, low ground pressure equipment may be appropriate if further investigation reveals unstable conditions. Once the gravel layer is placed, the first layer of geotubes will be placed along with an interconnected pipe network, including the main dredge pipeline. Geotubes include a pipe manifold system, which is a series of separate pipes, one for each tube, connected to the main pipe with shut-off valves to control flow rate into the respective tube. During filling, either the effluent slurry from the dredge will be directed to all tubes uniformly, or selected individual tubes as needed for efficient filling. Once the tubes are filled to approximately 75 percent of total capacity, the second layer of tubes will be placed and connected to the manifold system. A port for polymer injection will also be placed in-line within the piping system between the dredge pipeline and manifold system. Polymers are used to promote agglomeration of individual fine-grained solid particles and colloids through two processes called flocculation and coagulation, which considerably enhances dewatering performance for most sediment types.

Hydraulic Dredging of the North and Middle Wastewater Lagoons

A hydraulic dredge vessel would be used to pump the sediment slurry from the north and middle lagoons to the geotubes. Even smaller sized hydraulic dredges that could be utilized for the project will generate a high rate of slurry flow during dredging, which is compatible with a geotubes operation for dewatering. A side effect from dredging by any methodology is that sediment is re-suspended into the water column, therefore it is anticipated that the water will become very turbid during the dredging project from both the act of dredging and the turbulence from effluent discharge that is recycling filtrate from geotubes. Colloidal-sized particles will remain in suspension in the north and middle lagoons for an extended period of time following dredging, likely after the contractor's demobilization, so a limited mass of sediment will eventually settle to the base of the lagoons. The recycling of clear filtrate water drained from the geotubes back into the north and middle lagoons will not significantly benefit the turbidity condition created by dredging (the filtrate water is typically clear).

Dredged Material Processing

The cost estimate provided in Appendix A includes the contractor's setup and operation of geotubes, manifold system, and polymer injection unit. Operation and maintenance is required during the filling of geotubes, not only to control the flow of dredged sediment slurry into the tubes, but also activities to aid in the tube dewatering process. Additionally, specialized technicians will monitor the flow rate and solids content of the slurry to adjust the polymer feed rate as necessary.

On-site Management

The cost estimate has assumed a 2-ft layer of soil cover placed above the geotubes. Some miscellaneous filling will be necessary to eliminate voids below and around tubes prior to placing the final soil cover. For this preliminary and conceptual planning evaluation, the early analysis suggests approximately 2ft of mounding above the existing adjacent grade is assumed. However, it is important to note that if the dewatering performance is as expected given experience with sediment, there may be no mounding in the south lagoon area following dewatering construction and long-term settlement. For design of Alternative 1, additional evaluation of volume change during dewatering is needed to better estimate the final grade of the two layers of geotubes after dewatering. This information will be generated by treatability studies and other pre-design investigation as described below. Since of closure of the south lagoon in this manner will experience settlement due to volume change in the geotubes, which includes both short-term during construction volume change and long-term settlement following construction, it is recommended that the Town's plans for this area avoid structures or site features that may incur damage or significant maintenance cost due to settlement.

Residual Solids Cover Placement

All dredging methods have a similar challenge with achieving maximum effectiveness due to sediment re-suspension during active dredging, and therefore residual solids should be expected in the lagoons immediately following dredging. One factor influencing re-suspension is sediment consistency, which for the middle lagoon, sampling and bathymetric survey interpreted sediment may behave closer to a dense fluid than a solid granular material; therefore, this layer will be easily disturbed and redistributed into the water column to some degree during dredging. Additionally, a higher organic content may contribute to colloidal-sized particles tending to remain in suspension in the water column for an extended timeframe when compared to mineralogical colloidal-sized particles that also tend to remain in suspension for a significant time (as observable turbidity). Although the bathymetric survey will improve a dredging design and limit areas that will be missed by the dredge, there will be areas of irregular bathymetry or variability sediment thickness above sand that is not removed by dredging. This factor, combined with the re-deposition of re-suspended sediment will be expected to result in residual sediment for the post-dredged condition of the north and middle lagoons. To address this effect to the extent practical, an imported sand will be placed as a thin layer has been included in the cost estimate for addressing residual sediment.

Material Placement and Reshaping of Lagoons

Some earthwork has been included in the cost estimate to account for site restoration to repair berm slopes and areas of construction access roads. Aggregate from access roads is assumed to be removed and placed in areas of the Site that would benefit from reshaping with slight grading changes to reduce steepness of slopes or to provide more uniform grades around the lagoons.

Site Restoration

Site restoration includes revegetation of areas within limits of the disturbance of construction, primarily for erosion control on slopes and for compliance with sediment erosion control plans. Revegetation with trees and shrubs has not been included in the cost estimate.

Pre-design Studies and Additional Project Costs

Additional costs are identified for Alternative 1 in Table 1 of the Cost Estimate Analysis provided in Appendix A and are briefly explained below:

- Treatability studies would be necessary to select the polymer that is most successful in agglomerating the site sediment, which dramatically increases the dewatering performance for most fine-grained sediment and lagoon sludge materials. Due to removing all surface water from the south lagoon for Alternative 1, up to six geotechnical borings distributed among the lagoon bed and containment berm between the north and middle lagoons would be performed to inform berm slope stability considerations. The data collection activities would include sampling for laboratory testing of shear strength and consolidation for these important engineering properties, as well as basic physical properties testing (gradation, plasticity behavior of fine-grained fraction, specific gravity of solids, moisture content, organic matter content, and bulk density). This sampling and analysis also includes physical properties of sediment in the north and middle lagoons to support dredging design and geotube dewatering design.

- Engineering and permitting are included as percentages of total capital cost to cover the design development of construction drawings and specifications. Permitting has been assumed to be a relatively straightforward process, consisting of standard permits obtained by the construction contractor from the Town.

- Construction management and administration includes bid period and construction phase support to the Town to prepare the design for solicitation of construction bids, then to assist the Town to prequalify and review construction bids for an assumed best value selection during the bidding period. This line item also includes on-site field observation of construction activities during implementation, and office engineering support, to verify the contractor's compliance with permits and performance according to project drawings and specifications.

- A contingency of 15 percent is included in the cost estimate. The contingency is necessary to account for significant uncertainties that exist at this very early stage of planning prior to the completion of the remedial design. As the remedial design is developed, the contingency percentage may be reduced in amount as unknowns are addressed.

5.1.2 Alternative 2: Removal with On-site Management and Off-site Disposal

Alternative 2 integrates hydraulic dredging of the north and middle wastewater lagoons sediment. This alternative includes the same approach to implementation regarding removal and dewatering technologies, as illustrated in Figures 5-2 and 5-3. In contrast to Alternative 1, the south wastewater lagoon would not be used for containing dewatered, dredged sediment. The large lot adjacent to the lagoons would be used to construct a lined dewatering area, and geotubes would be staged in this area for dewatering. Once dewatering has occurred to a sufficient degree, the geotubes would be opened and sediment inside excavated, loaded into trucks, and transported off-site to the nearest regional landfill for use as a daily cover material. No dredging has been assumed for the south lagoon, though a thin layer of sand will be placed in all lagoons as a residual solids cover.

The following text includes additional description of the approach for Alternative 2, organized by major activity similar to the cost estimate tables. Additional detail on specific assumptions of materials, quantities, and implementation are included in the "Basis of Budgetary Estimate" notes following the Alternative 2 cost estimate table (Table 2) provided in Appendix A.

Site Mobilization and Demobilization

The site mobilization and demobilization are equivalent to Alternative 1, expressed as an assumed percentage of capital cost.

Site Preparation and Access Development

This is equivalent to Alternative 1.

Dewatering System Installation and Operation

As with Alternative 1, this includes operation of a pump that will withdraw filtrate water draining from the geotubes at a sustained pumping rate and recycling the filtrate water into the middle lagoon. This item for Alternative 2 does not include water withdrawal to dewater the south lagoon, since the geotubes are not located in the south lagoon.

Dewatering and Sediment Processing Pad Construction

For Alternative 2, this approach requires that a 4.2-acre area of the gravel lot be converted to a large dewatering facility for geotubes. This primarily includes an impermeable geo-membrane overlain with free-draining gravel. Gravel will be rounded or sub-rounded to avoid damage to the geo-membrane or geotube fabric. The gravel layer provides a stable base for the geotubes, allowing drainage to a sump for collection and pumping of filtrate water to the middle lagoon. Some sub-grade preparation would occur prior to placing the geo-membrane, and it is generally expected that the 12in-thick gravel layer assumed in the cost estimate would be some combination of thickness of gravel above and below the geo-membrane to reduce the risk of construction-induced damage. The purpose of the geo-membrane is for efficient management of filtrate water from the tubes, and to avoid potential side effects from water infiltration directly to the subsurface in the contractor's work area, such as destabilizing sub-grade allowing rutting, erosion, and mucking of the area ground.

Hydraulic Dredging of the North and Middle Wastewater Lagoons

This approach is equivalent to that of Alternative 1.

Dredged Material Processing

This approach is equivalent to that of Alternative 1, except the geotubes are located adjacent to the lagoons on the existing gravel lot area.

Off-site Disposal of Processed Dredged Material

This approach includes final dewatering, amending the sediment to meet landfill requirements for geotechnical suitability (as needed), and disposing of sediment at a landfill as cover material. Disposal as daily cover in a landfill facility is typically lower cost than placement of sediment in a landfill cell. Additionally, as previously discussed, use of the sediment in a lower cost beneficial reuse scenario that does not include landfill disposal may also be feasible following further investigation. The approach for processing and disposal of dewatered sediment within geotubes is that once the sediment has achieved sufficient dewatering to no longer contain free water that liberates from sediment during handling and loading in trucks, the geotubes would be torn open and sediment either amended with a drying agent or cement to improve geotechnical suitability for placement and compaction, or directly loaded for transport to off-site disposal. Waste characterization sampling and analysis would be required to meet the landfill's permit requirement for accepting materials as daily cover.

Residual Solids Cover Placement

The assumptions are equivalent to Alternative 1, with the exception that the south lagoon is included.

Restoration Earthwork

This includes similar site restoration activities as Alternative 1, with the exception that the south lagoon will not be utilized as a disposal facility, therefore, no soil cover has been included.

Site Restoration

The assumptions are equivalent to Alternative 1, with the exception that a larger area of restoration is required with the removal of the dewatering area, replacing the generally gravel-sized aggregate as fill in a larger area surrounding lagoons.

Pre-design Studies and Additional Project Costs

Additional costs unique to Alternative 2 are briefly explained below:

- In design, treatability studies will include additional testing of engineering properties using amendments such as cement to determine both dewatering rates for geotubes and geotechnical testing to meet suitability expectations that a daily cover material would require.

6.0 REFERENCES

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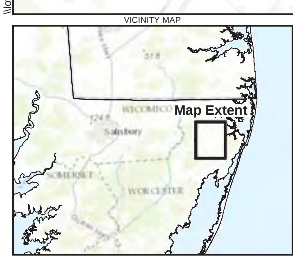
- MDE. 2016. Letter regarding VCP No Further Requirements Determination. 09 May.
- United States Army Corps of Engineers (USACE). 2013. *USACE Hydrographic Survey Manual, EM-1110-2-1003*. November.
- United States Department of Agriculture, Natural Resource Conservation Service. 2015. Web Soil Survey of Worcester County, Maryland. (http://websoilsurvey.nrcs.usda.gov/app/).

Figures

\\lovetongis\GIS\data\StateandLocal\NortheastMaryland\TysonPond\MXD\Figure 2-1 Site Location.mxd



0 2,000 4,000
Feet

N

Figure 2-1
Site Location
Tyson Lagoon
Berlin, Maryland

Map Date: 6/21/2017
Source: ESRI, 2017
Projection: NAD 1983 State Plane
Maryland Foot US

\\Iovetongis\GIS\data\StateandLocal\Northeast\Maryland\TysonPond\MXD\Figure 3-1 Former Waste Lagoons.mxd

0 100 200
Feet

N

Figure 3-1
Former Waste Lagoons
Tyson Lagoon
Berlin, Maryland

Map Date: 6/23/2017
Source: Google Earth, 2013
Projection: NAD 1983 State Plane
Maryland Foot US

\\Wvetongis\GIS\data\StateandLocal\Northeast\Maryland\TysonPond\MXD\Figure 3-2 Sediment Probe Locs.mxd

VICINITY MAP

Legend

- Sediment Probe
- Sediment Probe - Did Not Meet Refusal

Figure 3-2
Sediment Probe Locations
Tyson Lagoon
Berlin, Maryland

0 100 200
Feet

N

Map Date: 6/21/2017
Source: Google Earth, 2013
Projection: NAD 1983 State Plane
Maryland Foot US

Figure 3-3 Sediment Probe Setup

\\Wovetongis\GIS\data\State and Local\Northeast\Maryland\TysonPond\MXD\Figure 3-4 Sediment Core Locs.mxd

Legend

Sediment Core

Figure 3-4
Sediment Core Locations
Tyson Lagoon
Berlin, Maryland

0 100 200
Feet

N

Map Date: 6/21/2017
Source: Google Earth, 2013
Projection: NAD 1983 State Plane
Maryland Foot US

Figure 3-5 Piston Corer Setup

Figure 3-6 M/V *Shocker*

\\lovetongis\GISdata\StateandLocal\Northeast\Maryland\TysonPond\MXD\Figure 4-1 Digital Elevation Model – High Frequency 200kHz.mxd

VICINITY MAP

0 100 200

Feet

N

Legend

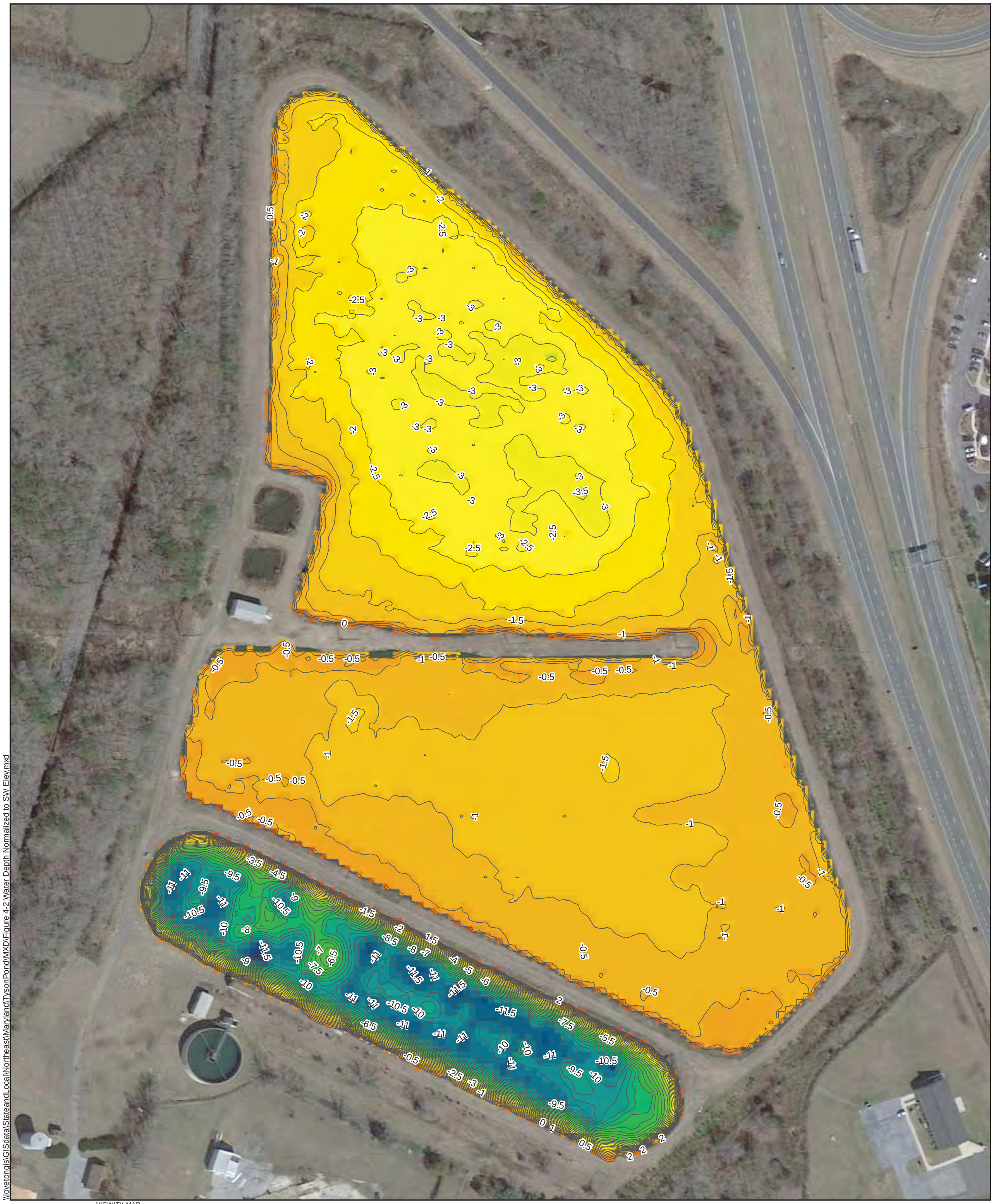
Elevation Contour (0.5 foot interval)

Elevation (NAVD88 US Feet)

18.7 - 19	22.1 - 22.5	27.1 - 27.5	32.1 - 32.5
19.1 - 19.5	22.6 - 23	27.6 - 28	32.6 - 33
19.6 - 20	23.1 - 23.5	28.1 - 28.5	33.1 - 33.5
20.1 - 20.5	23.6 - 24	28.6 - 29	33.6 - 34
20.6 - 21	24.1 - 24.5	29.1 - 29.5	34.1 - 34.5
21.1 - 21.5	24.6 - 25	29.6 - 30	34.6 - 35
21.6 - 22	25.1 - 25.5	30.1 - 30.5	35.1 - 35.5
	25.6 - 26	30.6 - 31	35.6 - 36
	26.1 - 26.5	31.1 - 31.5	36.1 - 36.5
	26.6 - 27	31.6 - 32	36.6 - 37

Figure 4-1
Digital Elevation Model –
High Frequency (200 kHz)
Tyson Lagoon
Berlin, Maryland

Map Date: 6/21/2017
Source: Google Earth, 2013
Projection: NAD 1983 State Plane
Maryland Foot US



VICINITY MAP

0 100 200
Feet

N

Legend

Elevation Contour (0.5 foot interval)

Elevation (NAVD88 US Feet)

- -12.8 - -12.5
- -12.4 - -12
- -11.9 - -11.5
- -11.4 - -11
- -10.9 - -10.5
- -10.4 - -10
- -9.9 - -9.5
- -9.4 - -9
- -8.9 - -8.5
- -8.4 - -8
- -7.9 - -7.5
- -7.4 - -7
- -6.9 - -6.5
- -6.4 - -6
- -5.9 - -5.5
- -5.4 - -5
- -4.9 - -4.5
- -4.4 - -4
- -3.9 - -3.5
- -3.4 - -3
- -2.9 - -2.5
- -2.4 - -2
- -1.9 - -1.5
- -1.4 - -1
- -0.9 - -0.5
- -0.4 - 0
- 0.1 - 0.5
- 0.6 - 1
- 1.1 - 1.5
- 1.6 - 2
- 2.1 - 2.5
- 2.6 - 3
- 3.1 - 7

Note:
The measured surface water elevation for the North and Middle ponds was 26.31 ft.
The measured surface water elevation for the South pond was 31.5 ft.

Figure 4-2
Water Depth Normalized to Surface Water Elevation
Tyson Lagoon
Berlin, Maryland

Map Date: 6/21/2017
Source: Google Earth, 2013
Projection: NAD 1983 State Plane Maryland Foot US

\\Wovetongis\GISdata\StateandLocal\Northeast\Maryland\TysonPond\MXD\Figure 4-2 Water Depth Normalized to SW Elev.mxd

VICINITY MAP

0 100 200
Feet

N

Legend

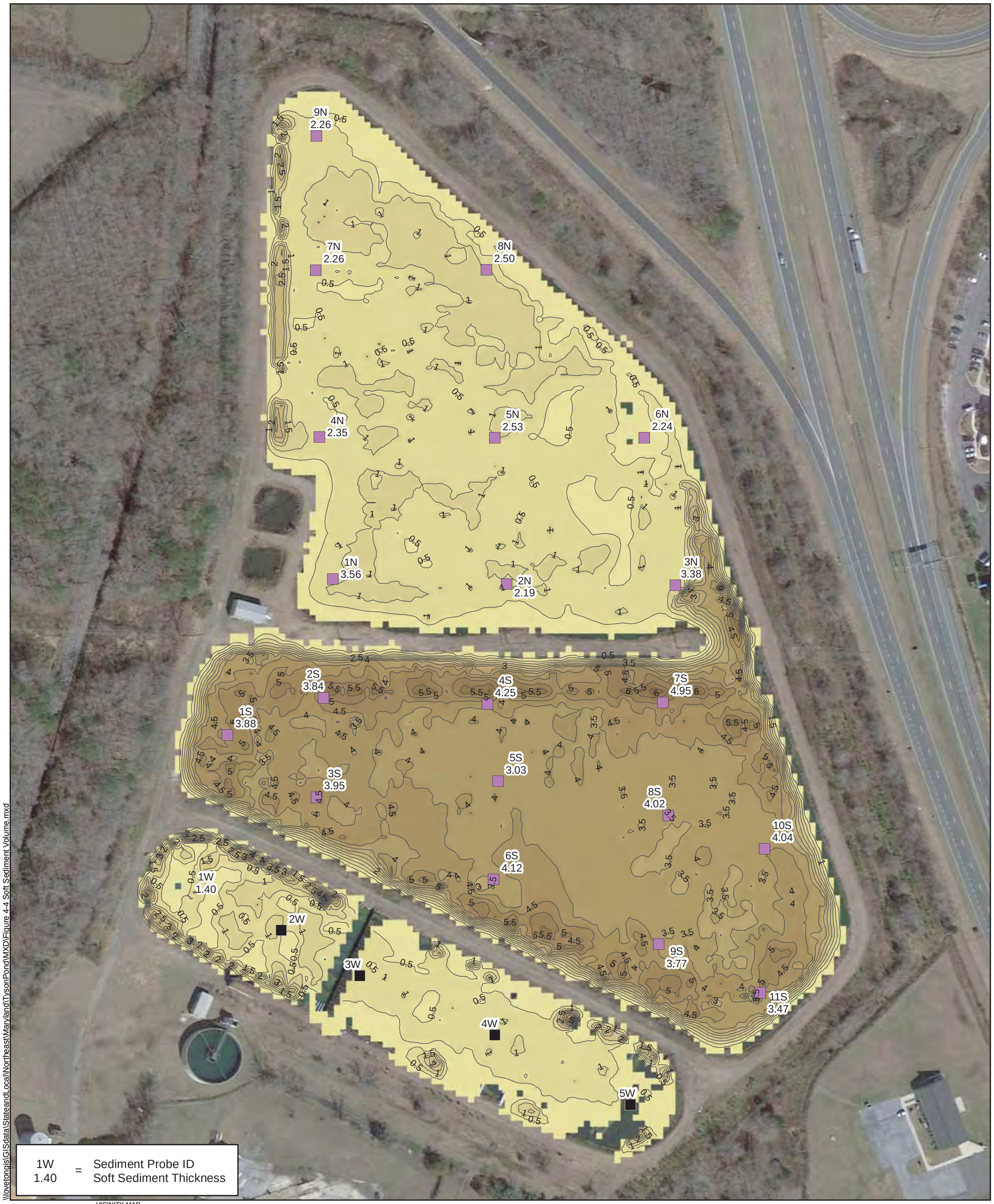
- Sediment Probe
- Sediment Probe - Did Not Meet Refusal
- Elevation Contour (0.5 foot interval)

Elevation (NAVD88 US Feet)

17.6 - 18	20.1 - 20.5	25.1 - 25.5	30.1 - 30.5
18.1 - 18.5	20.6 - 21	25.6 - 26	30.6 - 31
18.6 - 19	21.1 - 21.5	26.1 - 26.5	31.1 - 31.5
19.1 - 19.5	21.6 - 22	26.6 - 27	31.6 - 32
19.6 - 20	22.1 - 22.5	27.1 - 27.5	32.1 - 32.5
	22.6 - 23	27.6 - 28	32.6 - 33
	23.1 - 23.5	28.1 - 28.5	33.1 - 33.5
	23.6 - 24	28.6 - 29	33.6 - 34
	24.1 - 24.5	29.1 - 29.5	34.1 - 34.5
	24.6 - 25	29.6 - 30	34.6 - 35

Figure 4-3
Digital Elevation Model – Low Frequency (24 kHz)
Tyson Lagoon
Berlin, Maryland

Map Date: 6/22/2017
Source: Google Earth, 2013
Projection: NAD 1983 State Plane
Maryland Foot US



VICINITY MAP

0 100 200
Feet

N

Legend

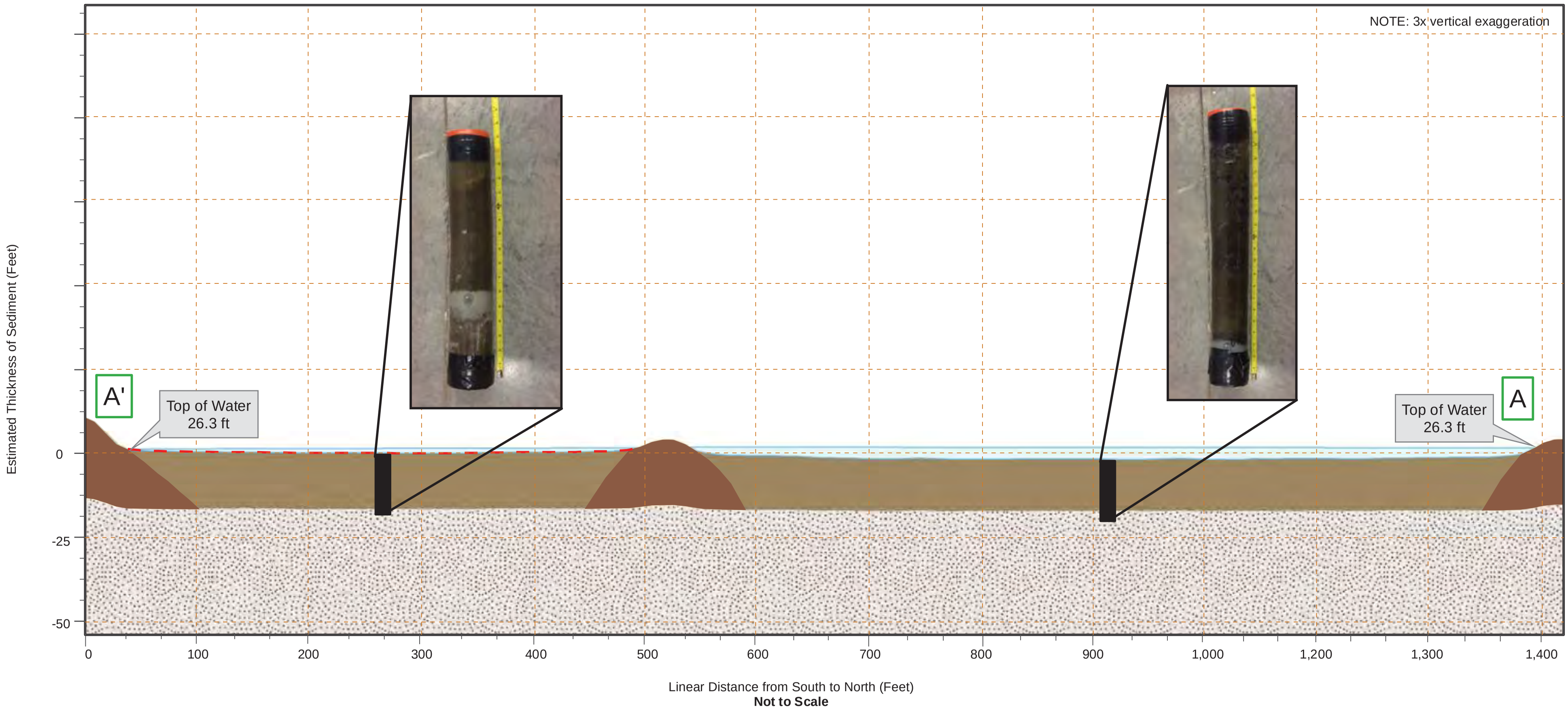
- Sediment Probe
- Sediment Probe - Did Not Meet Refusal
- Sediment Depth Contour (0.5 foot interval)

In-Water Sediment Depth

- 0
- 0.1 - 0.5
- 0.6 - 1
- 1.1 - 1.5
- 1.6 - 2
- 2.1 - 2.5
- 2.6 - 3
- 3.1 - 3.5
- 3.6 - 4
- 4.1 - 4.5
- 4.6 - 5
- 5.1 - 5.5
- 5.6 - 6
- 6.1 - 6.5
- 6.6 - 7
- 7.1 - 7.5
- 7.6 - 8
- 8.1 - 8.5
- 8.6 - 9

Figure 4-4
Soft Sediment Volume
Tyson Lagoon
Berlin, Maryland

Map Date: 6/21/2017
Source: Google Earth, 2013
Projection: NAD 1983 State Plane
Maryland Foot US



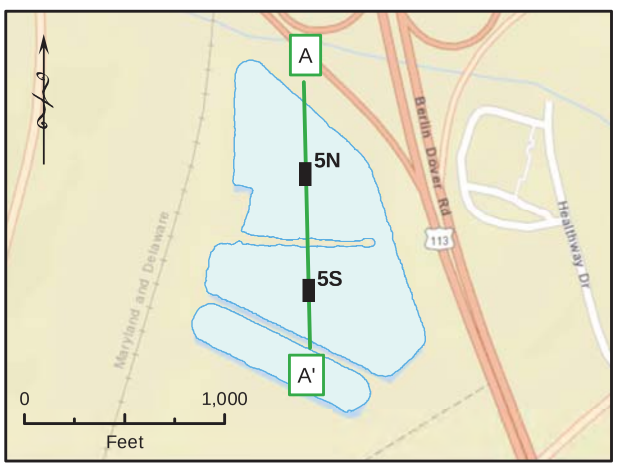
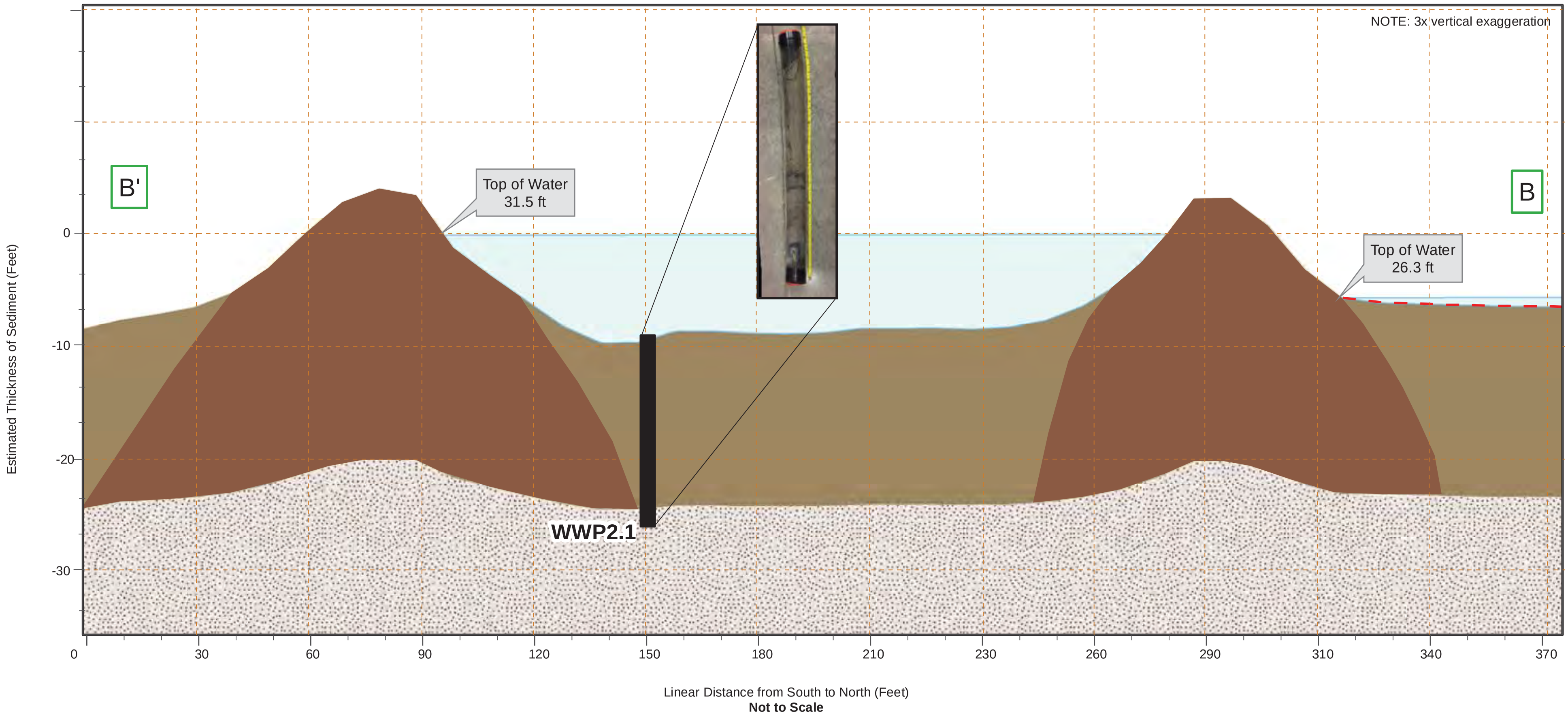


Figure 4-5
Cross-section of North and Middle Lagoons

Legend

- Cross Section Line
- Nepheloid Sediment Zone
- Water
- Soft Sediment
- Firm Subgrade
- Berm
- Sediment Core Sample

\\lovetonGIS\GISdata\StateandLocal\Northeast\Maryland\TysonPond\MXD\Figure 4-5 Cross-section of North and Middle Lagoons.mxd



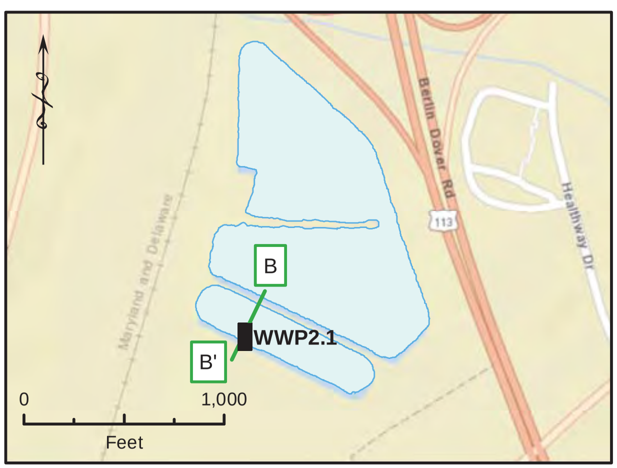


Figure 4-6
Cross-section of South Lagoon

Legend

- Cross Section Line
- Nepheloid Sediment Zone
- Water
- Soft Sediment
- Firm Subgrade
- Berm
- Sediment Core Sample

\\lovetonGIS\GISdata\StateandLocal\Northeast\Maryland\TysonPond\MXD\Figure 4-6 Cross-section of South Lagoon.mxd

Figure 5-1 Standard Hydraulic Dredge (http://www.dredge.com)

Figure 5-2 Dewatering Using Geotubes (http://www.gowatersolve.com/geotube)

Tables

TABLE 4-1. SEDIMENT PROBE RESULTS. BERLIN, MD. (MARCH 2017)

Wastewater Lagoon	Sediment Probe Location	Coordinates (MD State Plane)		Water Depth (ft)	Probe Met Refusal?	Depth to Firm Subgrade (ft)	Thickness of Soft Sediment Layer (ft)
		Northing	Easting				
South lagoon	1W	249223.599	1823853.226	9.87	YES	11.27	1.40
		249223.477	1823853.111				
	2W	249165.476	1823997.426	8.07	NO	~11.50	>3.43
		249165.525	1823997.539				
	3W*	249090.11	1824126.921	10.07	NO	~11.32	>1.25
		249090.678	1824126.341				
	4W	248993.29	1824348.322	9.91	NO	~11.58	>1.67
		248993.329	1824348.042				
	5W	248879.323	1824570.924	9.23	NO	~11.15	>1.92
		248879.3	1824570.523				
Middle lagoon	1S	249486.01	1823909.323	1.03	YES	4.91	3.88
		249485.88	1823909.165				
	2S	249547.359	1824066.986	1.36	YES	5.20	3.84
		249547.346	1824066.996				
	3S	249384.112	1824055.384	1.03	YES	4.97	3.95
		249384.034	1824055.227				
	4S	249537.053	1824335.746	1.37	YES	5.61	4.25
		249537.383	1824335.575				
	5S	249537.053	1824335.746	1.70	YES	4.73	3.03
		249537.383	1824335.575				

*Note: 3W location shifted slight to west of target coordinated due to silt curtains/tarp material on bottom at target location

TABLE 4-1. SEDIMENT PROBE RESULTS. BERLIN, MD. (MARCH 2017)

Wastewater Lagoon	Sediment Probe Location	Coordinates (MD State Plane)		Water Depth (ft)	Probe Met Refusal?	Depth to Firm Subgrade (ft)	Thickness of Soft Sediment Layer (ft)
		Northing	Easting				
Middle lagoon	6S	249249.071	1824345.973	1.37	YES	5.49	4.12
		249248.821	1824345.665				
	7S	249539.857	1824623.697	1.36	YES	6.31	4.95
		249539.856	1824623.729				
	8S	249354.237	1824632.517	1.37	YES	5.38	4.02
		249354.279	1824632.436				
	9S	249143.141	1824616.894	1.37	YES	5.14	3.77
		249143.04	1824616.516				
	10S	249299.05	1824790.204	1.04	YES	5.08	4.04
		249299.042	1824790.01				
	11S	249063.164	1824783.463	1.04	YES	4.51	3.47
		249063.225	1824783.405				
North lagoon	1N	249486.01	1823909.323	1.49	YES	5.05	3.56
		249485.88	1823909.165				
	2N	249547.359	1824066.986	2.15	YES	4.34	2.19
		249547.346	1824066.996				
	3N	249384.112	1824055.384	1.49	YES	4.87	3.38
		249384.034	1824055.227				
	4N	249537.053	1824335.746	1.51	YES	3.86	2.35
		249537.383	1824335.575				

TABLE 4-1. SEDIMENT PROBE RESULTS. BERLIN, MD. (MARCH 2017)

Wastewater Lagoon	Sediment Probe Location	Coordinates (MD State Plane)		Water Depth (ft)	Probe Met Refusal?	Depth to Firm Subgrade (ft)	Thickness of Soft Sediment Layer (ft)
		Northing	Easting				
North lagoon	5N	249410.22	1824353.262	2.50	YES	5.02	2.53
		249410.153	1824353.282				
	6N	249249.071	1824345.973	1.82	YES	4.06	2.24
		249248.821	1824345.665				
	7N	249539.857	1824623.697	1.82	YES	4.08	2.26
		249539.856	1824623.729				
	8N	249354.237	1824632.517	2.48	YES	4.98	2.50
		249354.279	1824632.436				
	9N	249143.141	1824616.894	1.80	YES	4.06	2.26
		249143.04	1824616.516				

TABLE 4-2. SEDIMENT CORE REOCVERY. BERLIN, MD. (MARCH 2017)

Wastewater Lagoon	Sediment Core Location	Geographic Coordinates (MD State Plane)		Water Depth (ft)	Depth to Firm Subgrade (ft)	Thickness of Soft Sediment Layer (ft)	Total Recovery (ft)	Notes
		Northing	Easting					
South lagoon	WWP1	249278.685	1823934.329	6.56	7.60	1.04	2.79	0-0.37ft: Brown sand. 0.37ft-1.25ft: Black sandy silt. 1.25ft-1.35ft: Black silty sand material. 1.35ft- 1.5ft: Grey/black sandy material. 1.5ft-2.79ft: Black silty sand material.
	WWP1.1						2.48	0-0.31ft: Brown sand. 0.31ft- 0.6ft: Grey/black sandy material. 0.6ft-1.4ft: Black silty sand. 1.4ft-1.65ft: Grey/black sandy material. 1.65ft- 2.48ft: Black silty sand material. Dr. Jennifer Nyland takes core for independent analysis
	WWP2	249072.136	1824011.484	5.75	6.03	0.28	3.02	0-0.6ft: Black/grey silty sand material. 0.6ft- 1.27ft: White/grey silty sand material. 1.27ft-1.57ft: Dark brown sand. 1.57ft-3.02ft: White/grey silty sand material. Air pockets from escaping gases present

TABLE 4-2. SEDIMENT CORE REOCVERY. BERLIN, MD. (MARCH 2017)

Wastewater Lagoon	Sediment Core Location	Coordinates MD State Plane)		Water Depth (ft)	Depth to Firm Subgrade (ft)	Thickness of Soft Sediment Layer (ft)	Total Recovery (ft)	Notes
		Northing	Easting					
South lagoon	WWP2.1	249072.136	1824011.484	5.75	6.03	0.28	3.02	0-0.93ft: Grey/brown, coarse-grained sandy material. 0.93ft-1.43ft: Grey/brown sandy material. 1.43ft- 1.68ft: Dark brown sandy material. 1.68ft- 3.02ft: Grey' white silty sand material. Air pockets from escaping gases present. Milky liquid at bottom 5in of sample
	WWP3	249067.874	1824307.061	10.35	11.15	0.80	0.19	0-0.19ft: Compacted white sand underlying fine, brown silt
	WWP4	249097.494	1824317.941	3.40	5.78	2.38	2.23	0-2.23ft: White/grey sand material. <1in organic material at top of core
Middle lagoon	2S	249546.637	1824087.074	1.37	5.21	3.84	1.83	0-1.42ft: Dark brown silt. 1.42ft-1.83ft: White sandy material. No odor/sheen
	5S	249395.136	1824355.024	1.70	4.74	3.03	1.75	0-1.42ft: Dark brown silt. 1.42ft-1.75ft: White sandy material with cloudy liquid. No odor/sheen
	8S	249351.384	1824627.673	1.36	5.38	4.02	2.46	0-2.1ft: Dark brown silt. 2.1ft-2.46ft: White sandy material with cloudy liquid. Slight odor
	9S	249147.78	1824632.785	1.37	5.14	3.77	2.54	0-2.54ft: Dark brown silt. Strong odor

TABLE 4-2. SEDIMENT CORE REOCVERY. BERLIN, MD. (MARCH 2017)

Wastewater Lagoon	Sediment Core Location	Coordinates (MD State Plane)		Water Depth (ft)	Depth to Firm Subgrade (ft)	Thickness of Soft Sediment Layer (ft)	Total Recovery (ft)	Notes
		Northing	Easting					
North lagoon	1N	249742.635	1824079.029	1.46	5.02	3.56	2.44	0-1.86ft: Dark brown silt. 1.86ft-2.44ft: White sandy material with cloudy liquid. No odor/sheen
	3N	249726.211	1824660.572	1.44	4.82	3.38	2.75	0-2.75ft: Dark brown silt. Strong odor. Woody debris present
	5N	249973.499	1824348.601	2.45	4.98	2.53	1.44	0-0.9ft: Dark brown silt. 0.9ft-1.1ft: White/grey sandy material. 1.1ft-1.44ft: Dark brown silt. No odor/sheen
	9N	250460.35	1824056.967	1.79	4.05	2.26	1.38	0-1.10ft: Dark brown silt. 1.10ft-1.22ft: White/grey material. 1.22ft-1.38ft: Dark brown silt. No odor/sheen

TABLE 5-1. REMEDIAL INVESTIGATION FINDINGS SUMMARY

Wastewater Lagoon	Total Area of Lagoon (sqft)	Water Depth (ft)		Estimated Volume of Water (cy)	Thickness of Soft Sediment Layer (ft)		Estimated Volume of Soft Sediment (cy)	Total Capacity of Lagoon (cy)	Description of Sediment Layers
		Min.	Max.		Min.	Max.			
South lagoon	184,036	0	11.0	49,447	<0.5	3.5	--	78,200	Thin layer of dark brown, silty sediment present in lagoon. Concentrated primarily along the lagoon margins. The underlying layer consists of a white/grey, coarse-grained material present throughout the lagoon.
Middle lagoon	478,984	0	1.5	--	1.0	6.0	66,173	--	Very thin layer of fine-grained sediment particles (nepheloid layer). Nepheloid layer is followed by a thick layer of dark brown, silty sediment. Greatest concentration of this layer is along the northwestern margin. This lagoon contains the greatest volume of soft sediment. The underlying layer consists of a white/grey, coarse-grained material present throughout the lagoon.
North lagoon	464,398	0	3.5	--	0	4.5	14,383	--	Layer of dark brown, silty sediment. Greatest concentrations of this layer are along the lagoon margins and southeastern extent where north and middle lagoons connect. The underlying layer consists of a white/grey, coarse-grained material present throughout the lagoon.

Appendix A

Cost Estimate Analysis

City of Berlin
Former Tyson Property Remediation
Berlin, Maryland

TABLE 5-2: Alternative 1 - Remediation with On-Site Management and South Pond Filling
Preliminary Engineering Cost Estimate

Item No.	Description	Estimated Quantity	Unit	Unit Cost	Estimated Cost
Construction Cost					
1	Mobilization/Demobilization	5%	%	n/a	$ 257,270
2	Site Preparation and Access Development	1	LS	$ 147,600	$ 147,600
3	Dewatering System Installation and Operation	5	Month	$ 13,800	$ 69,000
4	South Pond Preparation	1	LS	$ 497,200	$ 497,200
5	Hydraulic Dredging of Lagoon	89,300	CYD	$ 16	$ 1,428,800
6	Dredge Material Processing	89,300	CYD	$ 14	$ 1,250,200
7	South Pond Filling (using geotubes)	1	LS	$ 460,000	$ 460,000
8	Residual Solids Cover Placement	21,800	CYD	$ 30	$ 654,000
9	Material Placement and Reshaping of Lagoon	19,000	CYD	$ 6	$ 114,000
10	Site Restoration	8	AC	$ 3,000	$ 24,600
				Subtotal Construction Cost	$ 4,902,670
				Treatability Studies and Pre-Design Investigations	$ 300,000
				Engineering and Permitting (10%)	$ 490,267
				Construction Management and Administration (8%)	$ 392,214
				Contingency (15%)	$ 735,401
				TOTAL ESTIMATED CONSTRUCTION COST	$ 6,820,551
				ROUNDED TO	$ 6,821,000

Basis of Budgetary Estimate:

1 Mobilization/demobilization includes cost for deployment of equipment and personnel, contractor QC controls (e.g., survey, testing, etc.), security measures, and associated temporary facilities. Cost allowance of $25,000 has been included for contractor planning, submittal preparation, and utility clearance. Mobilization/demobilization costs have been estimated as a percentage of the total cost (less transportation and disposal, where applicable). This estimate assumes no odor management system will be required.

2 Site preparation and access development includes the development of access into the site to support construction activities as well as establishing staging areas for equipment and the management of dredge materials and clean imported materials. Temporary access roads (assumed 2,000 linear feet estimated at $20/LF) have been assumed to be constructed of aggregate underlain by non-woven geotextiles. This cost estimate assumes the existing gravel areas are sufficient to construction equipment and material staging and no additional cost for this item has been included. Staging areas and access road materials will be incorporated into the final reshaping of the lagoons. Additionally this item includes modest temporary erosion and sedimentation controls as well as work zone controls (estimated at $20,000). Costs for the preparation of the south lagoon (excluding dewatering) has been included and would likely consist of demolition of existing features consisting of metal framework floats and sheet pile wall and frame, modest regrading, and access development (estimated at $75,000). It is assumed the gravel lot and surrounding area immediately to the south of the south lagoon is available for staging and project use.

3 Dewatering System Installation and Operation includes the installation of pumps, piping, and temporary dewatering sumps for the dewatering of lagoon sediments to facilitate processing in the south lagoon. Assumed treated water volume for this activity will be approximately 10,000,000 gallons, based on calculations in GIS indicate that approximately 1,335,000 cubic feet of water would require transfer to the north and middle lagoons, raising the elevation of the north and middle lagoons by 1.4 feet. An additional 29,000,000 gallons would require collection and discharge to the ponds as a result of dewatering efforts. A geotechnical evaluation of pond geometry and berms may be necessary in the future to ensure this increased water elevation and south pond dewatering would not have a detrimental effect on existing separation berm global slope stability. A portion of this water (standing water in the south lagoon) will require dewatering prior to commencing sediment management operations. Assumes a 700 gallon per minute initial dewatering capability will be required for this activity and 300 gallons per minute discharge during sediment dewatering operations.

4 South Pond Preparation consists of the dewatering (costs included above), mechanical dredging of any visible perimeter process solids material above sand (in the dry removal), demolition of existing features, removal of existing piping connections to the middle lagoon, regrading and shaping of the surface and development of access. It is assumed the pond bottom is water tight and can be dewatered. Field activities to date have indicated that sediment within this lagoon is minimal and primarily along the perimeter. This item includes the placement of high strength woven monofilament geotextile with 2 feet of 1-3" bank run gravel (or pumpable gradation of well-graded sand+gravel - approximately 21,800 tons of material) placed in ~6" lifts fully across pond per lift to reduce mudwaving risk.

5 Hydraulic Dredging of Lagoon includes setup and operation of a floating hydraulic dredging operation with suction/cutterhead dredges. Dredged material will be conveyed via floating HDPE piping to the south lagoon where the sediment material will be dewatered and the filtrate water (some very limited turbidity after geotubes) will be returned to the lagoon. It is assumed the quantity of debris in the lagoons is minimal and the sediment characteristics are suitable for hydraulic dredging. Total volume of material assumed to be hydraulically dredged is 89,300 cyds based on sediment thicknesses observed in the field assessment and calculated in GIS. This quantity accounts for up to six inches of overdredging for 1/2 the pond bed in the in-situ volume, i.e., specification of +/- 6 inches for dredging design. Due to the incorporation of a residual cap and the likely remedial objectives for the project, it has been assumed dredging will be focused on mass removal of existing sediments and will not require extensive clean-up passes or post-removal testing. No post remediation of lagoon water has been assumed to be required and any residual sediments in the water column will be allowed to settle.

City of Berlin
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TABLE 5-2: Alternative 1 - Remediation with On-Site Management and South Pond Filling

6 Dredge material processing includes the setup and operation of a geotube operation for the processing and dewatering of dredged sediment. Processing assumptions include solids for the sediment is at 12%, dredge material will be pumped at 6%, and the material will be dewatered in GT500D geotubes with polymer addition at a rate of 10/lbs per dry ton. This cost includes a six-inch diameter manifold system for delivery of the dredged material to the geotubes. Cost for this element was developed with support from WaterSolve LLC of Caledonia, Michigan. Costs have been included for the supply and installation of a manifold system for the geotube system ($40,000).

7 South Pond Filling includes the placement of fill as soil cover and to fill void space within the southern-most lagoon needed to supplement the dredged material processed and remaining in geotubes. Calculations have been performed to determine the processed volume and weight of material. Assumes 2 feet of clean fill soil (20,000 cubic yards of total material - 25% top soil and 75% subsoil) will be imported and placed over the processed sediment material. Pond capacity is approximately 88,000 cy and dewatered sediment volume is less than this, however, two layers of geotextile tubes will rise above the adjacent ground surface until dewatered sufficiently for soil cover placement (this duration requires design calculations).

8 Residual Solids Cover Placement includes the hydraulic placement of a six-inch thick residual cap comprised of imported sand material. Assumes material will be conveyed hydraulically without stringent standards for layer thickness. Sediment particles represented by turbidity in the water post-dredging may settle after placement of the residual solids cover, but material quantities have been assumed to be minimal.

9 Material placement and reshaping of lagoons consists of the loading, hauling, and placement of the processed dredged material for expanding and contouring some sections of the lagoons. This item includes some miscellaneous restoration earthwork activities repair any areas of lagoon berm slopes above the water surface. It is assumed most of the berms around the existing middle and north lagoons would remain, but would be regraded to make them less steep. The volume of earthwork associated with this activity for the purpose of this estimate is approximately 19,000 cyds (15000 cys miscellaneous grading, 2,500 cyd berm reshaping, and 1,500 cyds in pad material).

10 Site restoration includes reestablishing a vegetative cover over areas disturbed by remediation activities as well as the incorporation of staging area and access road aggregate materials in the south pond closure. Trees, shrubs, and recreation facilities have not been included in this estimate.

11 Due to the voluntary nature of the activity, limited constituents of concern, and no planned discharge off-site of water generated during the project, permitting requirements for this project have been assumed to be modest, consisting primarily of general grading permits and a sediment and erosion control permit.

A Preliminary Engineering Cost estimates are based on 2017 dollars.

B Preliminary Engineering Cost Estimates based on past experience, analogous cost estimates, and approximate take-offs from the available information. Except for geotextile tubes, limited direct vendor or outside material estimates were obtained in the development of this estimate and the actual cost may differ.

C Based on sediment type, sediment volume, sediment thickness, limited constituents of concern, and site access, the conceptual approach for this cost estimate consists of hydraulic dredging with geotube dewatering and on-site management and disposal of dewatered sediments. Based on further site investigation and conceptual studies additional options may and should be considered to ultimately find the alternative that best meets the Town of Berlin objectives for the project, complies with all appropriate rules and regulations, and is cost-effective.

City of Berlin
Former Tyson Property Remediation
Berlin, Maryland

TABLE 5-3: Alternative 2 - Remediation with On-site Management and Off-Site Disposal
Preliminary Engineering Cost Estimate

Item No.	Description	Estimated Quantity	Unit	Unit Cost	Estimated Cost
Construction Cost					
1	Mobilization/Demobilization	5%	%	n/a	$ 229,900
2	Site Preparation and Access Development	1	LS	$ 87,600	$ 87,600
3	Dewatering System Installation and Operation	6	Month	$ 13,800	$ 82,800
4	Dewatering and Sediment Processing Pad Construction	1	LS	$ 325,500	$ 325,500
5	Hydraulic Dredging of Lagoon	89,300	CYD	$ 16	$ 1,428,800
6	Dredge Material Processing	89,300	CYD	$ 14	$ 1,250,200
7	Off-Site Disposal of Processed Dredge Material	47,747	Ton	$ 15	$ 716,205
8	Residual Solids Cover Placement	26,100	CYD	$ 30	$ 783,000
9	Material Placement and Reshaping of Lagoon	19,000	CYD	$ 6	$ 114,000
10	Site Restoration	9	AC	$ 3,000	$ 26,100
				Subtotal Construction Cost	$ 5,044,105
				Treatability Studies and Pre-Design Investigations	$ 200,000
				Engineering and Permitting (10%)	$ 432,790
				Construction Management and Administration (8%)	$ 346,232
				Contingency (15%)	$ 756,616
				TOTAL ESTIMATED CONSTRUCTION COST	$ 6,779,743
				ROUNDED TO	$ 6,780,000

Basis of Budgetary Estimate:

1 Mobilization/demobilization includes cost for deployment of equipment and personnel, contractor QC controls (e.g., survey, testing, etc.), security measures, and associated temporary facilities. Cost allowance of $25,000 has been included for contractor planning, submittal preparation, and utility clearance. Mobilization/demobilization costs have been estimated as a percentage of the total cost (less transportation and disposal, where applicable). This estimate assumes no odor management system will be required.

2 Site preparation and access development includes the development of access into the site to support construction activities as well as establishing staging areas for equipment and the management of dredge materials and clean imported materials. Temporary access roads (assumed 2,000 linear feet estimated at $20/LF) have been assumed to be constructed of aggregate underlain by non-woven geotextiles. This cost estimate assumes the existing gravel areas are sufficient to construction equipment and material staging and no additional cost for this item has been included.. Access road materials will be incorporated into the final materials used for reshaping the lagoons. Additionally this item includes modest temporary erosion and sedimentation controls as well as work zone controls (estimated at $20,000). It is assumed the gravel lot and surrounding area immediately to the south of the south lagoon is available for staging and project use. Includes an estimate of $75,000 for the demolition of existing features in the south lagoon (consisting of metal framework, floats, and sheet pile wall).

3 Dewatering System Installation and Operation includes the installation of pumps, piping, and temporary dewatering sumps for the dewatering operations for lagoon sediments. Approximately 32,000,000 gallons would require collection and discharge to the ponds as a result of dewatering efforts. Assumes a 300 gallons per minute for discharge during sediment dewatering operations

4 Dewatering and Sediment Processing Pad Construction includes the construction of a 4.2 acre geomembrane and gravel cap for geotube operations in the flat area south of the south pond. Pad construction ($1.75/sf) will include general grading and surface preparation, two-foot berm construction, installation of 4.2 acres of 186,000 square feet of geombrane, overlain with 10 oz. nonwoven geotextile, and covered with 12-inches of sand and gravel (6,900 cubic yards).

5 Hydraulic Dredging of Lagoons includes setup and operation of a floating hydraulic dredging operation with suction/cutterhead dredges. Dredged material will be conveyed via floating HDPE piping to the dewatering pad where the sediment material will be dewatered and the filtrate water (some very limited turbidity after geotubes) will be returned to the lagoons. It is assumed the quantity of debris in the lagoons is minimal and the sediment characteristics are suitable for hydraulic dredging. Total volume of material assumed to be hydraulically dredged is 89,300 cyds based on sediment thicknesses observed in the field assessment and calculated in GIS. This quantity accounts for up to six inches of overdredging for 1/2 the pond bed in the in-situ volume, i.e., specification of +/- 6 inches for dredging design. Based on field results, no dredging for the south pond is assumed to be required. Due to the incorporation of a residual cap and the likely remedial objectives for the project, it has been assumed dredging will be focused on mass removal of existing sediments and will not require extensive clean-up passes or post-removal testing. No post remediation of lagoon water has been assumed to be required and any residual sediments in the water column will be allowed to settle.

6 Dredge material processing includes the setup and operation of a geotube operation for the processing and dewatering of dredged sediment. Processing assumptions include solids for the sediment is at 12%, dredge material will be pumped at 6%, and the material will be dewatered in GT500D geotubes with polymer addition at a rate of 10/lbs per dry ton. This cost includes a six-inch diameter manifold system for delivery of the dredged material to the geotubes. Cost for this element was developed with support from WaterSolve LLC of Caledonia, Michigan. Costs have been included for the supply and installation of a manifold system for the geotube system ($40,000). It is assumed processing will sufficiently dewater the sediment to allow the passing of a paint filter test to meet requirements for transportation of this material over public roads.

7 Off-Site Disposal of Processed Dredge Material consists of the loading, transportation, and disposal of dredged sediments at an off-site commercial landfill. Calculations have been performed (accompanying spreadsheets) to determine the processed volume and weight of material. It is assumed the material is classified as non-hazardous and may be disposed of in a Subtitle D Commercial Landfill Facility (assumed for this estimate as Worcester County CLF). Assumed the Worcester County CLF would waive the tipping fee for the material as it would be used for cover material. The volume for disposal include staging area materials used for sediment processing and hauling. This disposal volume includes the addition of 6,900 cubic yards of material (assuming 1.6 tons/cyd density) required for construction of the dewatering and sediment processing pad.

City of Berlin
Former Tyson Property Remediation
Berlin, Maryland

TABLE 5-3: Alternative 2 - Remediation with On-site Management and Off-Site Disposal

8 Residual Solids Cover Placement includes the hydraulic placement of a six-inch thick residual cap comprised of imported sand material. Assumes material will be conveyed hydraulically without stringent standards for layer thickness. Sediment particles represented by turbidity in the water post-dredging may settle after placement of the residual solids cover, but material quantities have been assumed to be minimal.

9 Restoration Earthwork and Closure of South Pond includes the miscellaneous restoration earthwork activities to facilitate the final end use of the facility as well as the final earthwork activities necessary to remove operations associated with sediment processing in the south pond. The volume of earthwork associated with this activity for the purpose of this estimate is approximately 19,000 cyds (15,000 cyd miscellaneous grading, 2,500 cyd berm reshaping, and 1,500 cyds in pad material). It is assumed most of the berms around the existing lagoons would remain, but would be regraded to make them less steep

10 Site restoration includes reestablishing a vegetative cover over areas disturbed by remediation activities. Trees, shrubs, and recreation facilities have not been included in this estimate.

11 Due to the voluntary nature of the activity, limited constituents of concern, and no planned discharge off-site of water generated during the project, permitting requirements for this project have been assumed to be modest, consisting primarily of general grading permits and a sediment and erosion control permit.

A Preliminary Engineering Cost estimates are based on 2017 dollars.

B Preliminary Engineering Cost Estimates based on past experience, analogous cost estimates, and approximate take-offs from the available information. Except for geotextile tubes, limited direct vendor or outside material estimates were obtained in the development of this estimate and the actual cost may differ.

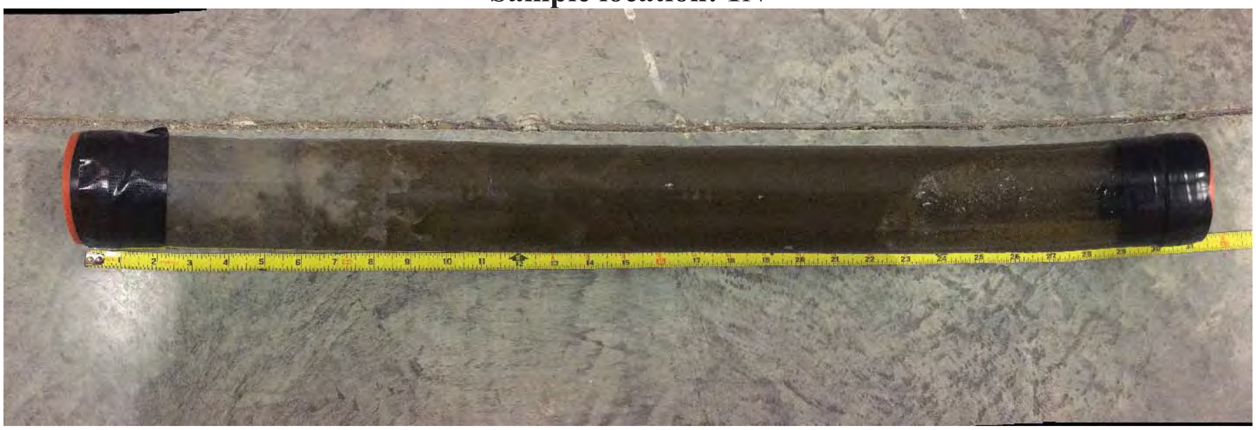
C Based on sediment type, sediment volume, sediment thickness, limited constituents of concern, and site access, the conceptual approach for this cost estimate consists of hydraulic dredging with geotube dewatering and off-site commercial disposal of dewatered sediments. Based on further site investigation and conceptual studies additional options may and should be considered to ultimately find the alternative that best meets the Town of Berlin objectives for the project, complies with all appropriate rules and regulations, and is cost-effective.

Appendix B

Photograph Log

Photographic Record

Sample location: 1N



Sample location: 3N

Sample location: 5N

Photographic Record

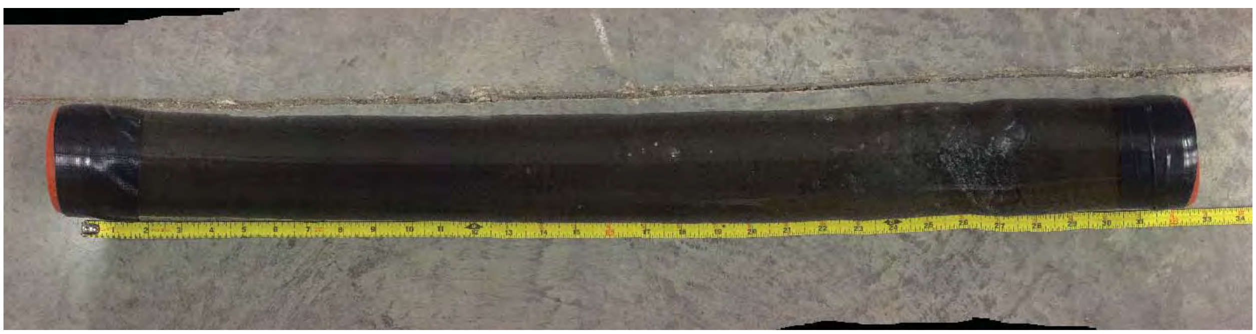
Sample location: 9N

Sample location: 3S

Sample location: 5S

Photographic Record
Sample location: 8S

Sample location: 9S

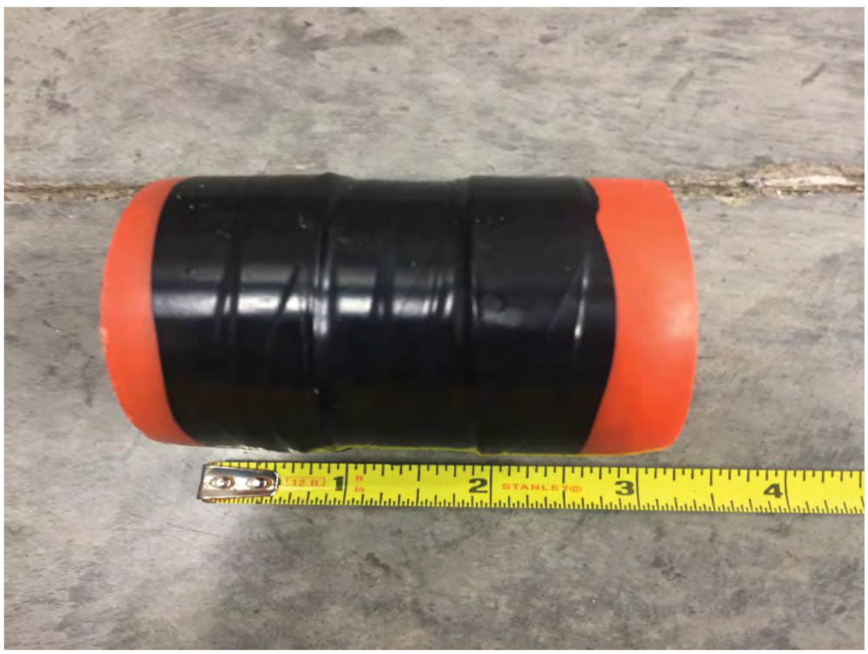


Sample location: WWP1

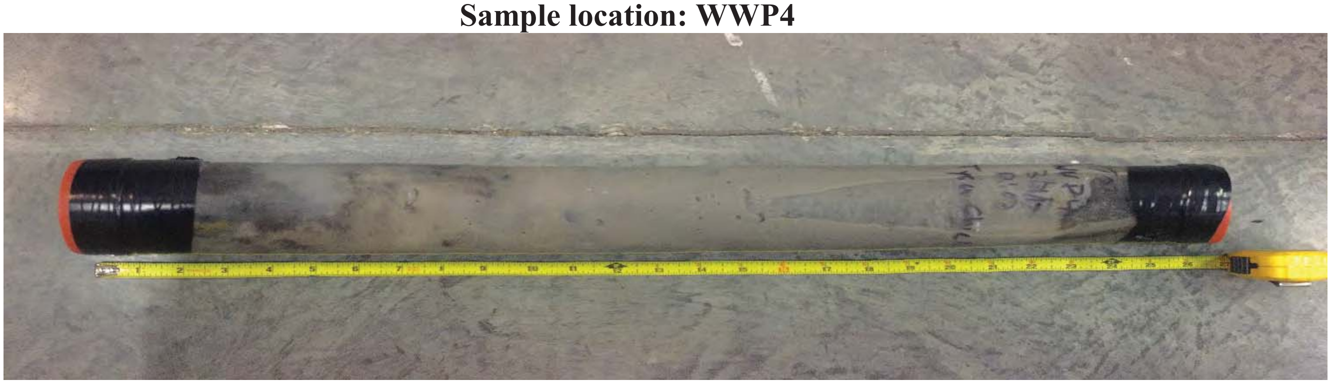
Photographic Record

Sample location: WWP2

Sample location: WWP3



Sample location: WWP4



EA Engineering, Science, and Technology, Inc., PBC

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www.eaest.com

August 4, 2017

Ms. Laura Allen Town
Administrator Town of
Berlin
10 Williams Street
Berlin, MD 21811

RE: Executive Summary
Remedial Investigation and Cost Estimate Former
Tyson Foods Facility
9943 Old Ocean City Boulevard Berlin,
Maryland

Dear Ms. Allen:

EA Engineering, Science, and Technology, Inc., PBC (EA) was contracted by the Town of Berlin to develop viable conceptual remediation approaches and conceptual level cost estimates to remove sediments that have accumulated within the waste lagoons of the former Tyson Foods Facility located at 9943 Old Ocean Town Boulevard (Site) located in Berlin, Maryland 21811.

The scope of work for this remedial investigation (RI) was developed based on a review of available historic documents and environmental reports for the Site, as well as review of site investigations performed by EA in previous phases of the project. To further support the remedial cost assessment, EA performed an additional site investigation in March 2017. While previous environmental assessment sampling and analysis efforts did not identify significant environmental exposure concerns associated with the existing sediments within the lagoons, EA understands the historical uses of the lagoons present challenges to their potential reuse. The Town of Berlin may want to consider addressing the sediments within the lagoons before repurposing the lagoons for public recreation.

EA's investigation determined the depth of water and sediment of the 3 lagoons. Results are shown below:

North lagoon – water depth ranges from 1.5ft-2.5ft and sediment thickness ranges from 0.5ft-4ft – total sediment volume estimated at approximately 14,383 cubic yards

Middle lagoon – water depth ranges from 1ft-1.7ft and sediment thickness ranges from 3.5ft- 5.5ft – total sediment volume estimated at approximately 66,173 cubic yards

South lagoon – water depth ranges from 8.1ft-10.1ft and sediment thickness ranges from 0-2ft – total volume was not calculated due to lack of sediment

Two remediation alternatives to address sediment in the former wastewater lagoons were developed. In general, the process of removing sediments from any water body requires three primary tasks that are evaluated by the following categories: (1) removal of sediment, (2) dewatering of sediment, and (3) disposal of sediment.

Alternative 1) Removal with On-site Management --- $6,821,000

Alternative 1 integrates hydraulic dredging of the north and middle wastewater lagoons sediment, and placement inside an array of adjacent geotubes in the south wastewater lagoon.

Alternative 2) Removal with On-site Management and Off-site Disposal --- $6,780,000

Alternative 2 integrates hydraulic dredging of the north and middle wastewater lagoons sediment, and placement inside an array of adjacent geotubes. In contrast to Alternative 1, the south wastewater lagoon would not be used for containing dewatered, dredged sediment. The large lot adjacent to the lagoons would be used to construct a lined dewatering area, and geotubes would be staged in this area for dewatering. Once dewatering has occurred to a sufficient degree, the geotubes would be opened and sediment inside excavated, loaded into trucks, and transported off-site to the nearest regional landfill for use as a daily cover material.

It should be noted that the current site uses related to the lagoons (including no water contact, passive use) can continue and would not require remedial action of the existing sediments. However, the Town of Berlin is considering renovating the site for recreational purposes and has requested consideration of the following options not presented in the report:

Option 1) Removal of sediments from the middle lagoon and On-site Management:

Option 1 involves hydraulic dredging of the middle wastewater lagoons sediment, and placement inside an array of adjacent geotubes in the south wastewater lagoon.

Estimated cost --- $5,000,000

Option 2) Filling of south lagoon with off-site soil fill source

Option 2 involves site preparation, purchasing and placement of off-site soil sufficient to fill in the south lagoon.

Estimated cost --- $2,500,000

EA greatly appreciates the opportunity to serve you on this project. If I can be of any further assistance, please do not hesitate to contact me at 410-329-5125.

Sincerely,

James Hulbert
Project Manager