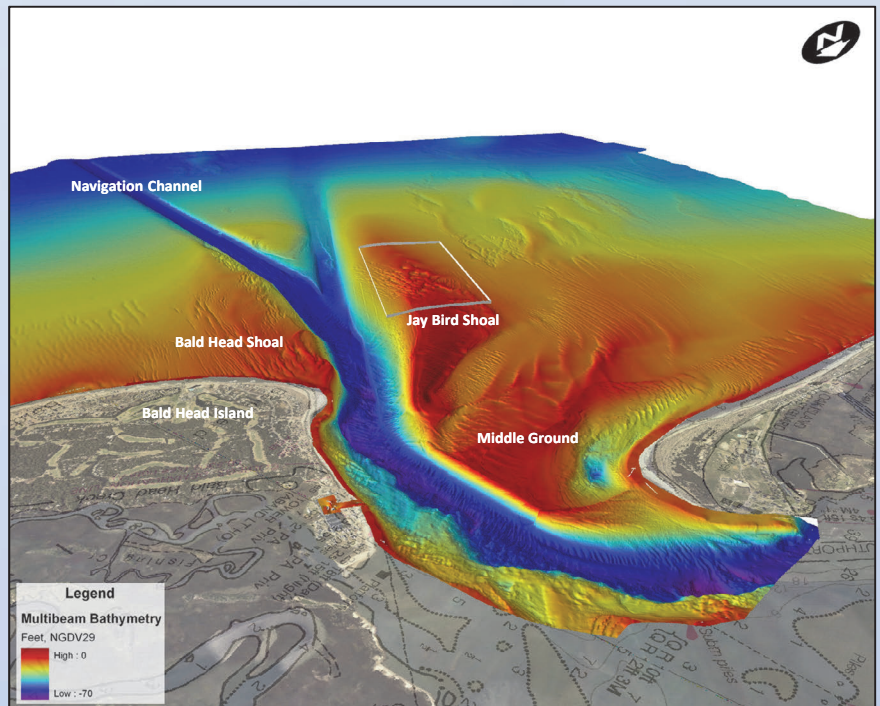




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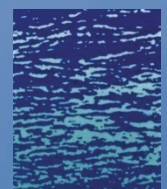
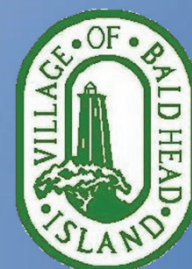
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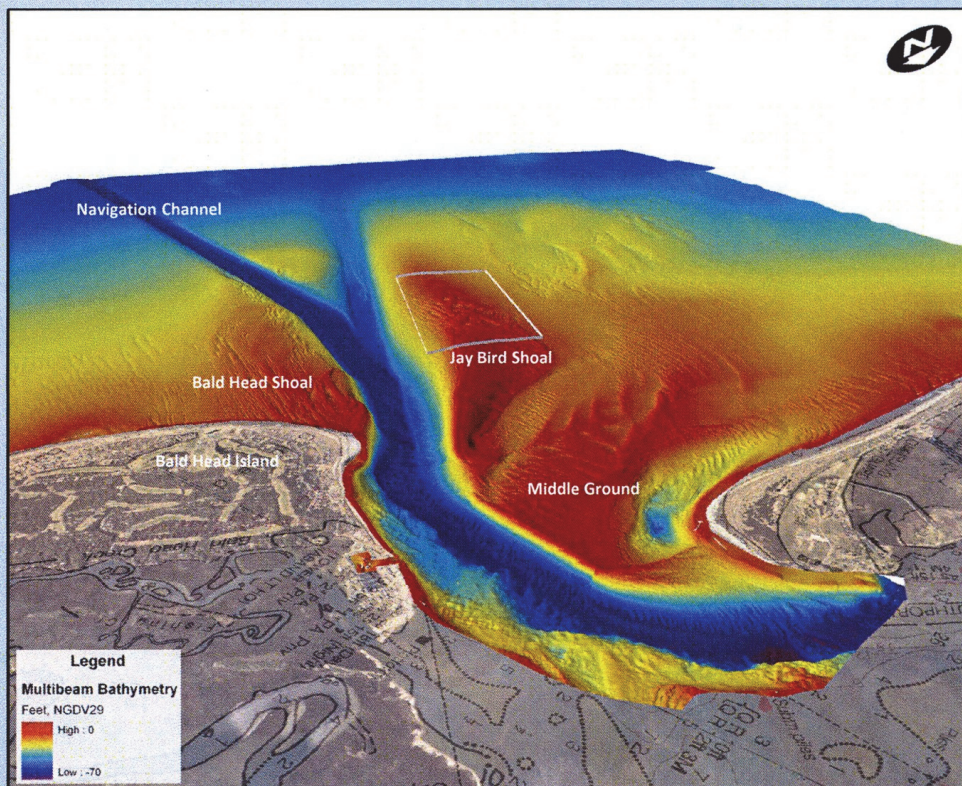
Olsen Associates, Inc.
2618 Herschel Street
Jacksonville, FL 32204
(904) 387-6114
(Fax) 384-7368
olsen-associates.com
C-1468

August 2017

Bald Head Island, N.C. Jay Bird Shoals Borrow Site Re-Evaluation



olsen
associates, inc.
coastal engineering



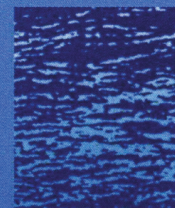
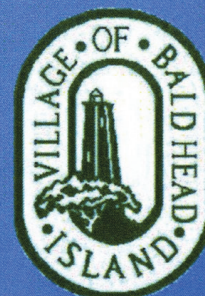
Prepared for:

Village of
Bald Head Island, N.C..

Prepared by:

Olsen Associates, Inc.
2618 Herschel Street
Jacksonville, FL 32204
(904) 387-6114
(Fax) 384-7368
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August 2017

JAY BIRD SHOALS BORROW SITE RE-EVALUATION

**Submitted by:
Olsen Associates, Inc.
2618 Herschel Street
Jacksonville, Florida 32204
C-1468**

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APPENDIX A – Geotechnical Vibracore Report Jay Bird Shoals, Bald Head Island

JAY BIRD SHOALS BORROW SITE RE-EVALUATION

Report Submitted To:

Village of Bald Head Island, N.C.

Report Submitted By:

Olsen Associates, Inc.
2618 Herschel Street
Jacksonville, FL 32204

August 2017

BACKGROUND

The Village of Bald Head Island Beach Management Plan has been largely predicated upon beach disposal activities performed in accordance with Wilmington Harbor Sand Management Plan (WHSMP) implemented by the Wilmington District, (USACOE, 2000). The latter was required pursuant to permits and agreements associated with the 2001 Wilmington Harbor Deepening Project. Initially, as part of project construction South Beach received a 1.58 Mcy sand placement along the majority of its oceanfront shoreline. In 2005, a 1.2 M federal disposal event was constructed along approximately the westernmost half of S. Beach. Subsequently, in 2007, Bald Head Island received approximately 1 Mcy of channel maintenance sand again along the westernmost segment of South Beach.

Pursuant to the terms of the WHSMP the next scheduled federal disposal project (in 2009) would be constructed at Oak Island. As a result, it was understood at the time that the Bald Head Island would not experience beach disposal again until at least 2011 – i.e. some 4 or more years after the 2007 South Beach disposal operation.

In order to plan for and address expected sediment deficits and dredging impacts over the next four (4)+ years, the Village of Bald Head Island had determined the need to implement a privately funded beach restoration project intended to maintain the integrity of the South Beach shoreline. A portion of West Beach was to be addressed at the same time on a more limited basis. The volume of sand to be placed for such a project would be sufficient to both address expected sediment losses between federal disposal events, as well as ensure an adequate improved *base* beach width along the entirety of the South Beach shorefront at all times. The project volume was expected to be approximately 1.5 to 2 Mcy (as measured in place for payment). The project would be scheduled for construction in the winter of 2009/2010 – at the latest. At that time, it was proposed that the borrow source for the Village project would be located on the southernmost portion of Jay Bird Shoals (See **Figure 1**). The general borrow site layout was as defined by **Figure 2**.

The tentative identification of the Jay Bird Shoals area as a candidate borrow site for beach fill construction was influenced principally by the following factors:

1. Its physical proximity to South Beach allowing for the use of a cutter suction dredge,
2. The fact that the Jay Bird Shoals formation has been heavily influenced by prior and ongoing navigation channel construction and maintenance activities,
3. The fact that the seaward portion of Jay Bird Shoals is a relatively modern depositional feature which has formed over time as a direct result of navigation project construction, and
4. The propensity for any Jay Bird Shoal excavation area to both physically and biologically recover. Biological recovery was expected to be rapid and was eventually documented via monitoring – see LMG (2013). Physical recovery was expected to be much more gradual – but relatively certain and consistent over time.

The fact is that any future navigation channel deepening, widening or relocation (as recommended by the Village) was expected to occur within the shoal feature itself (i.e. in a westerly direction away from Bald Head Island). As a result it was opined that any future removal of sand from portions of Jay Bird Shoal in the vicinity of Bald Head Island could only

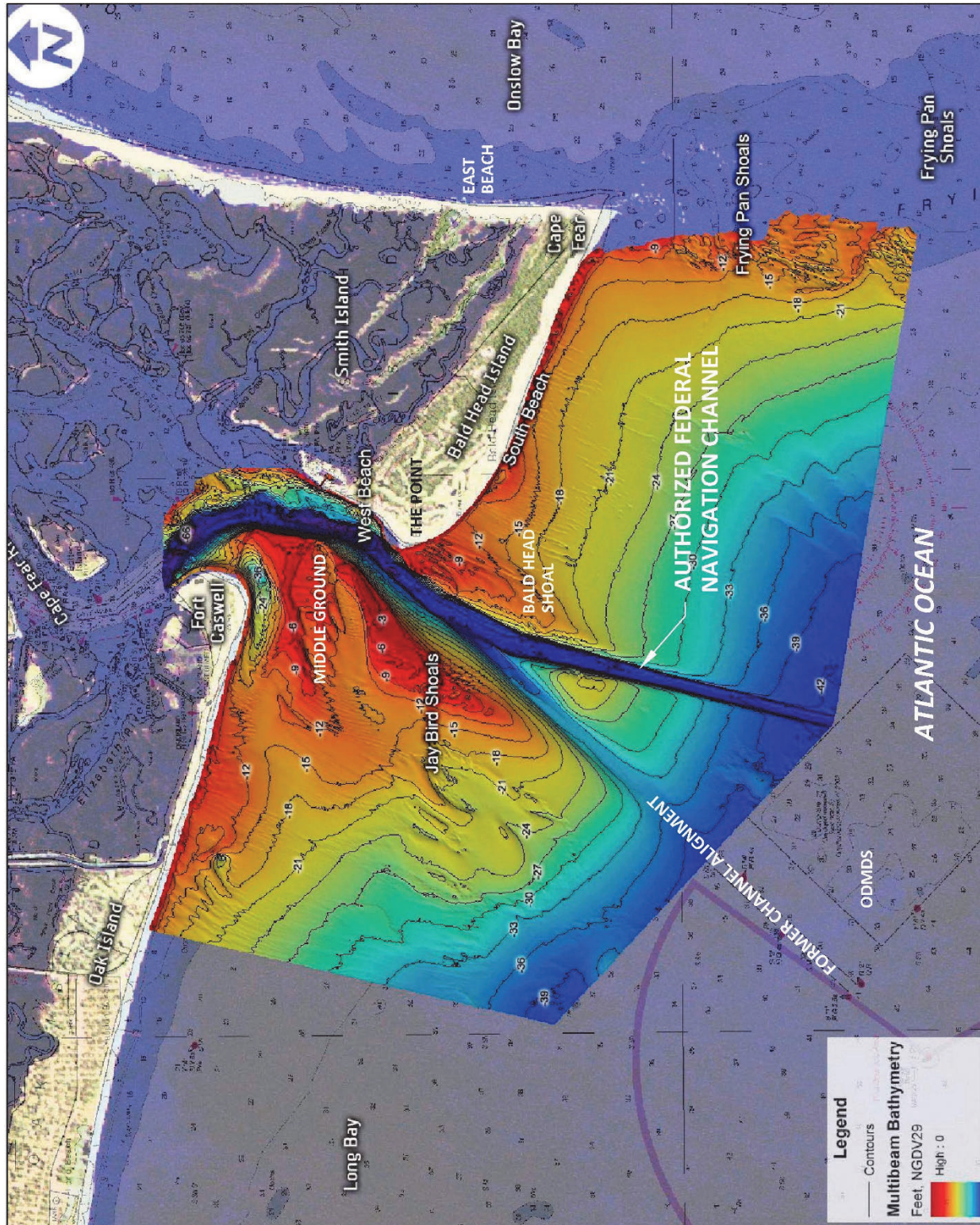


Figure 1: Location of Jaybird Shoals relative to Bald Head Island.

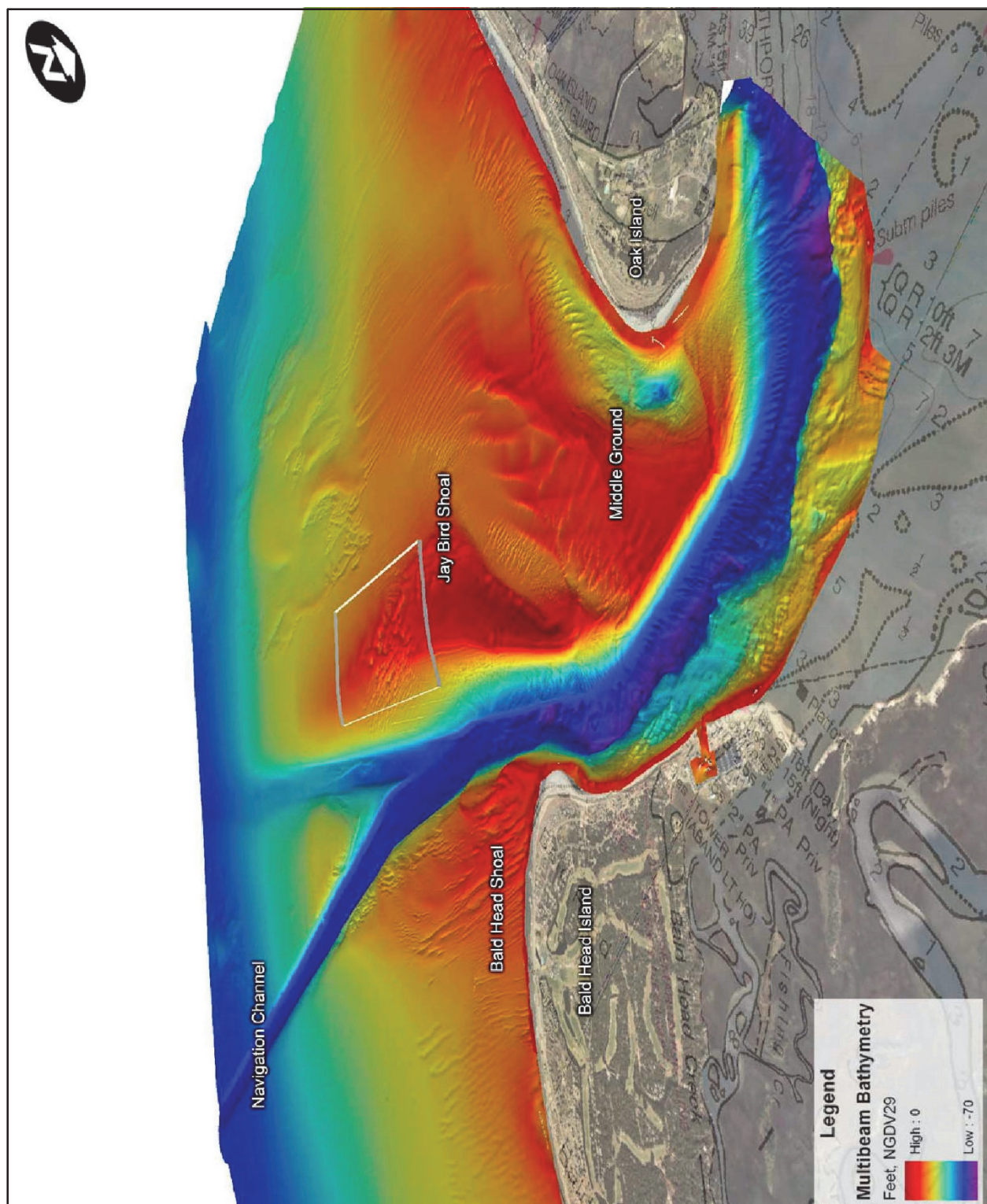


Figure 2: Oblique view of Jay Bird Shoals borrow site.

serve to reduce -- rather than exacerbate -- impacts associated with federal channel dredging operations in the vicinity of the Point. A discussion of documented navigation project effects to Bald Head Island is provided in Olsen (2003).

Comprehensive beach monitoring over the past 17 years by the Village of Bald Head Island has resulted in the conclusion that sand placement alone had *not* served to successfully offset navigational channel impacts to the west end of South Beach which have resulted in chronic rates of erosion and consistent northerly recession and migration of the Point. The net result of these phenomena had been accelerating erosion and ensuing threat to public infrastructure, homes, protective dunes and wildlife habitat.

As a result, the Village was ultimately forced to “change the existing dynamic” at the Point by constructing a single terminal groin designed to complement the placement of beach fill at a documented South Beach erosional “hot spot”. The project was to be performed in two Phases. Simplistically, the structure was intended to serve as a “template” for fill material placed eastward thereof on South Beach. The Phase I 1,300 ft. long terminal groin (completed in Nov. 2015), was designed as a “leaky” structure (i.e. semi-permeable) so as to provide for some level of continuing sand transport to West Beach and portions of the Point (located northward of the groin stem). It was predicted that the construction of such a structure would potentially have some level of coincident direct benefit to the abutting navigation channel. Additional post-construction monitoring data required by Permit was intended to assist in the quantification of the terminal groin’s effects on littoral processes and resultant shoreline configurations – both updrift and downdrift. Pragmatically, such an evaluation takes a number of years and will necessitate multiple sand fill applications until some level of dynamic equilibrium of the post-structure shoreline can be defined.

In early 2017, the Village submitted permits and associated studies and environmental analyses necessary to develop a borrow site located within Frying Pan Shoals (see **Figure 3**). The purpose of such a borrow site was to ensure compliance with Permit Conditions necessitating the long term maintenance of the updrift fillet associated with the 2015 terminal groin project. It was predicted that the borrow site would be needed for limited sand placement

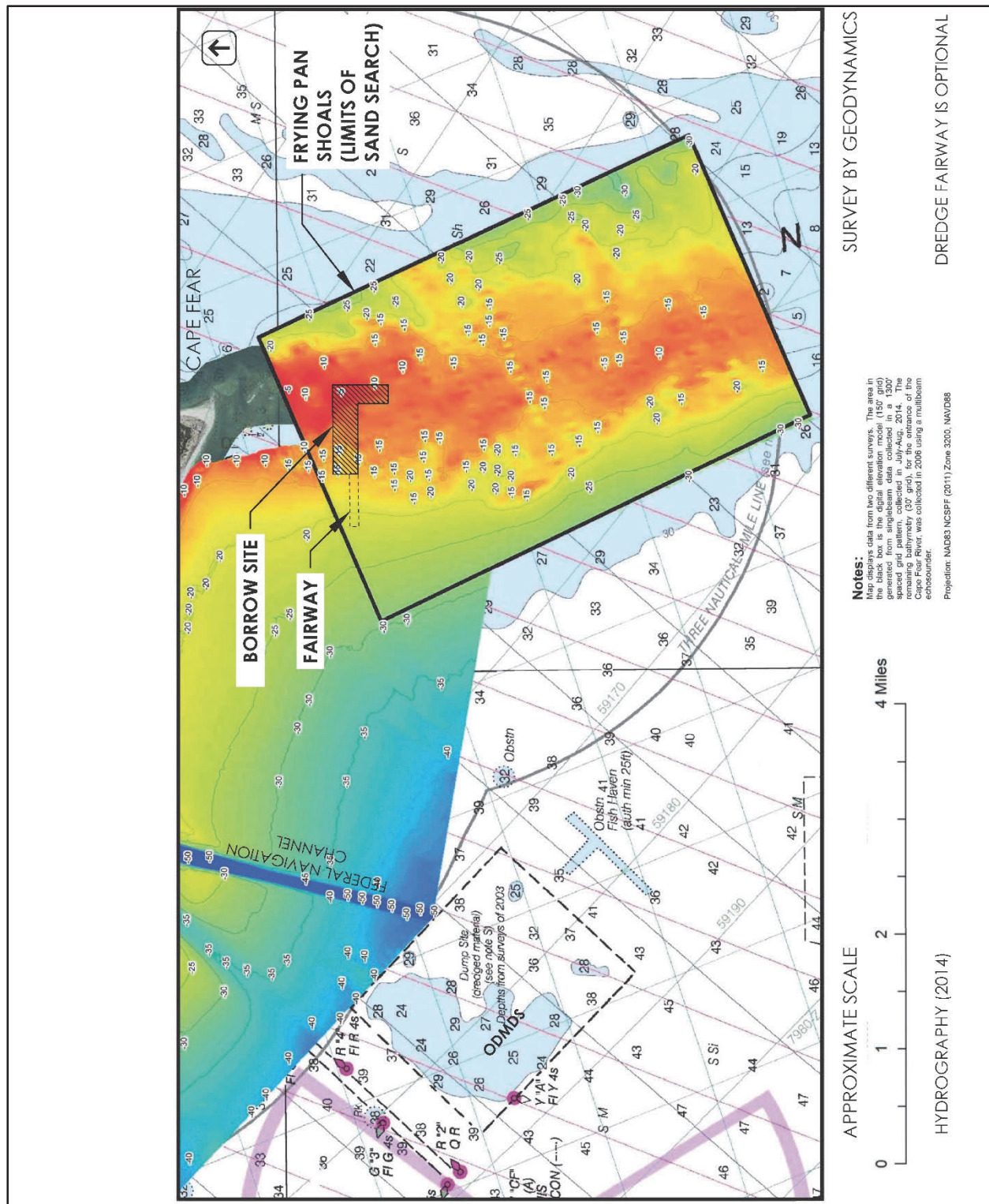


Figure 3: Proposed Frying Pan Shoals borrow site.

along South Beach in 2018/19 between the terminal groin and Sta. 134+00 (9,000 ft to the east). This conclusion resulted from the scheduled hiatus in the disposal of channel maintenance sand on Bald Head Island by the Wilmington District, USACOE. Pursuant to the existing tenets of the Wilmington Harbor Sand Management Plan, all beach quality channel maintenance material excavated in 2017/2018 will be placed at Oak Island. The next potential federal disposal on Bald Head Island would therefore be in 2020 or 2021. Hence an interim fill project at S. Beach would be required. The global estimate for such a project is 1 Mcy of sand (as measured in place).

PRESENT DAY CONDITIONS

Monitoring Report No. 15 (Olsen 2017) documented that between April 2016 and May 2017, South Beach at Bald Head Island lost a total of 619,000 cy (above elevation -16 ft NGVD). This amount well exceeded average annual losses measured over the last 17 years and was due to the effects of Hurricanes Hermine and Matthew in 2016. As a result, the Village Council has authorized the design and permitting of the 1 Mcy interim beach fill discussed above to be constructed in the winter of 2018-19.

Presently, formal permit applications for the development of a long-term borrow site within Frying Pan Shoals are being processed. The applications request a major modification of State Permit No. 91-4 and federal permit SAW-2012-00040 – which were issued for *both* the terminal groin constructed in 2015 *and* subsequent fill activities required to keep the structure updrift fillet full pursuant to N.C. Statutory requirements.

In June 2017, the National Marine Fisheries Service (NMFS) issued concerns related to the near term use of the Frying Pan Shoals (FPS) borrow site without first exploring and exhausting other viable sand-source alternatives. In consideration of the NMFS concerns, the Village agreed to evaluate options to prioritize the use of the previously authorized borrow site located on Jay Bird Shoals (JBS) (including both the partially recovered area dredged in 2009 and the remaining undredged portion of the borrow site). Realistically, the only alternate borrow site available for near term sand placement at Bald Head Island (BHI) is sand remaining in the developed JBS borrow site. Options other than JBS and FPS are not feasible. For instance, there is not sufficient sand within the Bald Head Creek borrow area. Moreover, only a very small

dredge can be utilized at that location. Therefore, the Bald Head Creek site is not suitable for any large-scale nourishment event. With respect to the Wilmington Harbor Channel as a potential sand source, all sand excavated by the Corps of Engineers (COE) in 2017/18 as part of their regularly occurring channel maintenance will be placed on Oak Island pursuant to the Wilmington Harbor Sand Management Plan (WHSMP). Hence, there will *not* be sufficient sand quantities from that source available to the Village in the near future for placement at South Beach.

Within the originally developed JBS borrow site, monitoring surveys (Olsen 2017) document that there is an estimated 900,000 of sand remaining in the undredged portion of the site – lying outside a Cultural Resource Exclusion area. Additionally, there is almost 1 Mcy of depositional material available which lies within the area previously excavated in 2009 although not all of it is accessible by a dredge. The predicted volume required to be placed within a design template on South Beach in 2018/19 is approximately 1 Mcy. Subsequent to that sand placement, the Village will be the recipient of the next two (2) federal channel maintenance/beach disposal projects pursuant to the WHSMP. This would theoretically allow the use of the FPS borrow area to be deferred nearly 10 years into the future. It does not, however, obviate the need to complete the permitting of the Frying Pan Shoals borrow site since it may likely be required as a sand source after a hurricane or severe storm event.

The use of the JBS site (if viable in terms of both sand quality and quantity) would address the more immediate nourishment needs for South Beach and the terminal groin fillet. It should be noted that a long-term borrow site consisting of large volumes of beach-compatible sand (from a borrow site exhibiting physical conditions conducive for relatively rapid recovery) will ultimately be needed to offset long-term sand deficits along South Beach and West Beach. To that end, the Village intends to continue its request for authorization for the future use of the proposed FPS borrow site. In the interim, use of the JBS site will likely be able to address the more immediate nourishment needs while deferring and ultimately reducing physical disturbance to the FPS site – pursuant to the recommendations of the NMFS.

PURPOSE

The original 226A JPS borrow area as developed for the locally constructed 2009 beach fill (Olsen 2007a) was defined by approximately 31 VIBRACORES (see **Figure 4**). To a maximum dredge depth of -24 NGVD 29, the site contained approximately 3 Mcy of available beach quality sand – not including a 12.5 A Exclusion Area associated with *potential* cultural resources (TAR 2007). Over the course of the 2009 project, approximately 158 A of seabed within the permitted borrow site was dredged (see **Figure 5**) yielding a gross fill volume of about 1.85 Mcy +. As shown in **Figure 5**, the dredge contractor was strategically limited to working only within Borrow Site Areas 1 and 2, thereby leaving Area 3 for future use. The residual volume of available sand within Area 3 after construction exceeded 1 Mcy. The project was constructed by Norfolk Dredging Company using an Ocean Certified 27” cutter suction dredge.

During the permitting of the JBS borrow area, Olsen Associates, Inc. performed numerical modeling of a theoretically excavated borrow site for purposes of evaluating any potential impacts to the shores of Oak Island (Olsen 2007b). In addition, during the permitting of the 2015 terminal groin project, a separate and distinct borrow site impact analysis was performed using the more robust DELFT 3D numerical model (Olsen 2013). Both investigations *conservatively* assumed the JBS borrow site was excavated in its entirety (including the exclusion area) – when as described above it was not. Neither numerical modeling exercise predicted quantifiable impact to Oak Island.

None-the-less, when Permits were issued by State and Federal agencies, a Condition was added at the request of certain interests on Oak Island that should the permittee receive a future modification to dredge more than 250,000 cy of material from the JBS borrow site (presumably from the unexcavated Segment 3 area), the Village would be required to monitor and analyze a large segment of eastern Oak Island. At the time of permit issuance, severe time constraints associated with the bid and construction schedule for the terminal groin necessitated that the Village not seek to negate such a Condition. In order to comply with the recently stated request of the NMFS, it is the intent of the Village to request a permit modification authorizing the dredging of approximately 1 Mcy of sand from the JBS site. Assuming satisfactory results of an updated VIBRACORE sampling of the infill areas of the previously dredge JBS site and the

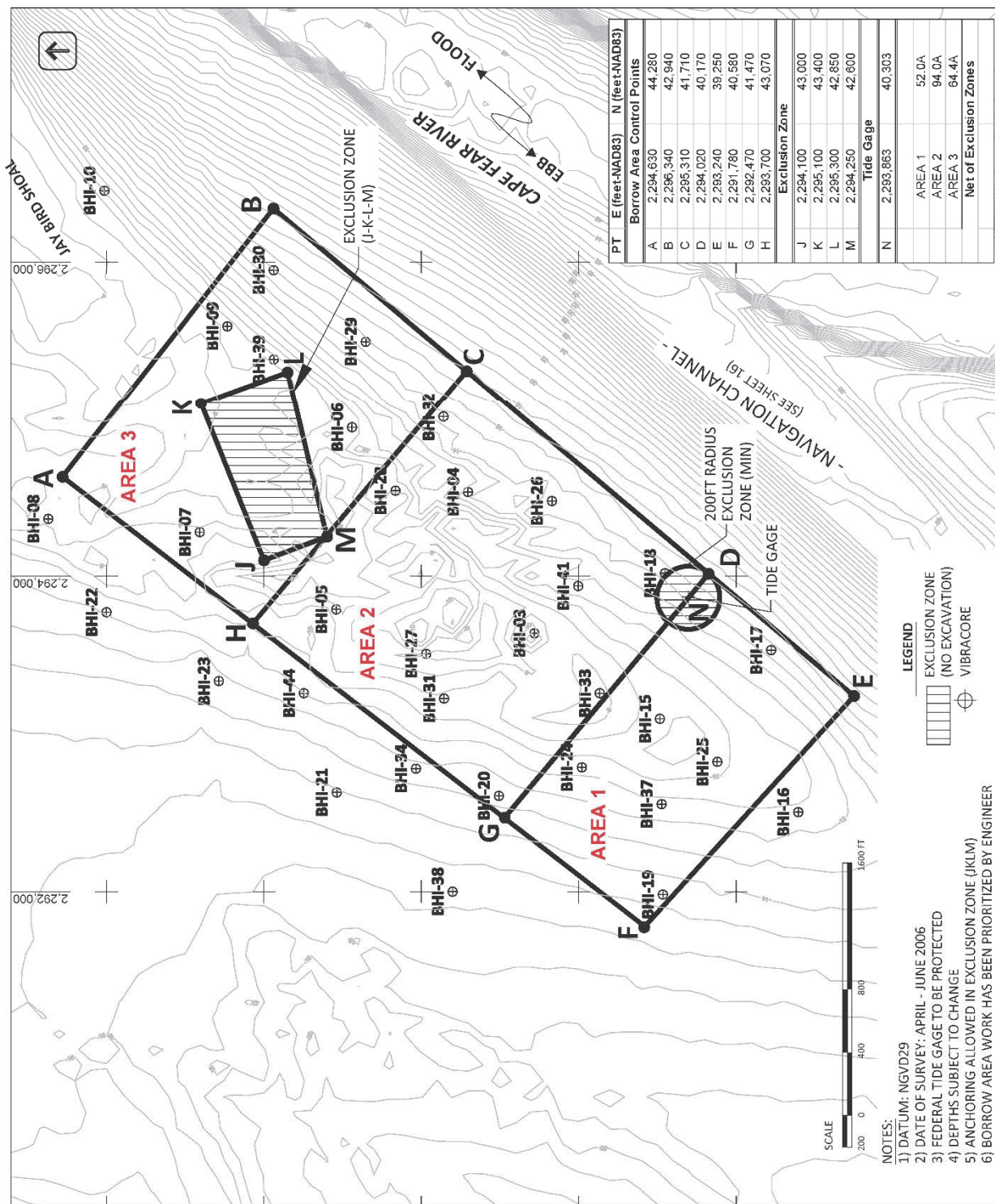


Figure 4: 2009 Jay Bird Shoals borrow site area.

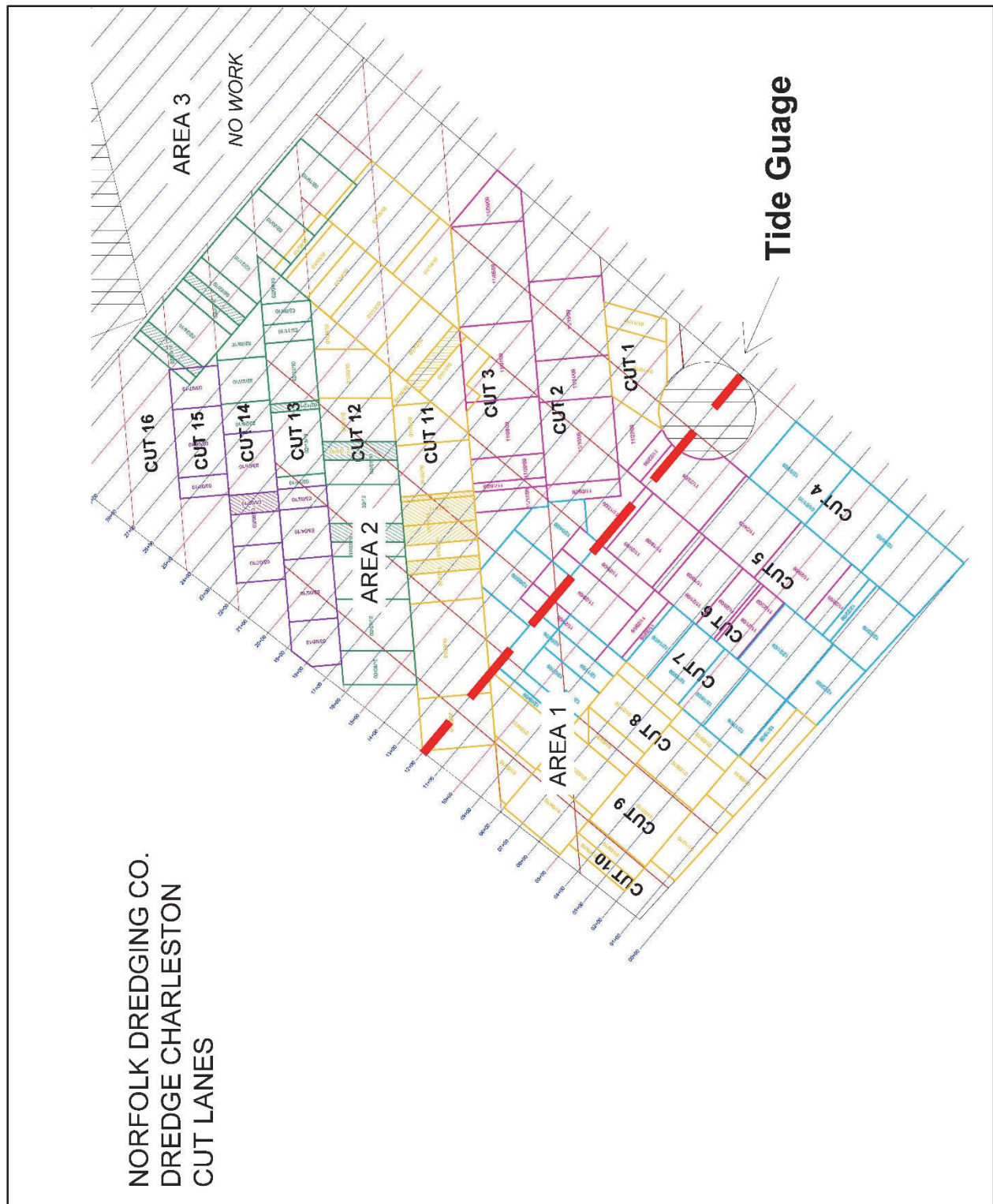


Figure 5: Borrow Site “Cut” lanes.

demonstration of adequate volumes of high quality, beach-compatible sand, the Village will seek to excavate 750,000 cy from dredge Areas 1 and 2 which have infilled via deposition of sand since the 2009 dredge permit and to obtain the remaining needed volume of 250,000 cy from the unexcavated Segment 3 portion of the site. It is believed that such a plan should be deemed favorable at this time based upon the following considerations:

1. It helps to defer the use of the FPS borrow site over the next several years (potentially up to a decade into the future) pursuant to the recommendations of NMFS.
2. It meets the intent of the terminal groin Permit Condition which limits the volume of dredging to 250,000 cy in the unexcavated portion of JBS (i.e. Area 3) without triggering intensive monitoring of the Oak Island shoreline; and
3. It addresses the requirement stipulated by both Permit Condition and State Statute for the Sponsor of a terminal groin project to keep the updrift fillet of the structure full.

JBS BORROW AREA RE-EVALUATION

The JBS borrow site has been surveyed every 1 to 2 years subsequent to its use in 2009/10. The April 2017 monitoring survey shows areas of gross deposition amounting to 891,000 cy (see **Figure 6**). It is therefore possible to construct a 1M cy beach fill utilizing depositional material within borrow site Areas 1 and 2 in combination with 250,000 cy from the previous unexcavated Area 3.

Having quantified sediment availability, the Village authorized the acquisition of 8 VIBRACORES within the largest candidate depositional area in order to verify *sediment quality* or acceptability as beach fill at South Beach. Core locations are as depicted by **Figure 7**. More specifically the firm of Athena Technologies, Inc. (Athena) was contracted to collect 8 VIBRACORES using the research vessel *Artemis*. Subsequently, all cores were logged, photographed and composite sediment samples removed and sent to the soils laboratory TERRACON in Jacksonville, Florida. Each composite sample extended over the apparent absolute depth of visible, desirable material in each core which generally extends to -24 ft NGVD29, mol. The latter horizon of beach quality sediment was identified in the 2007 Sand Search performed for JBS (Olsen, 2007a). In addition to well defined grain size distribution

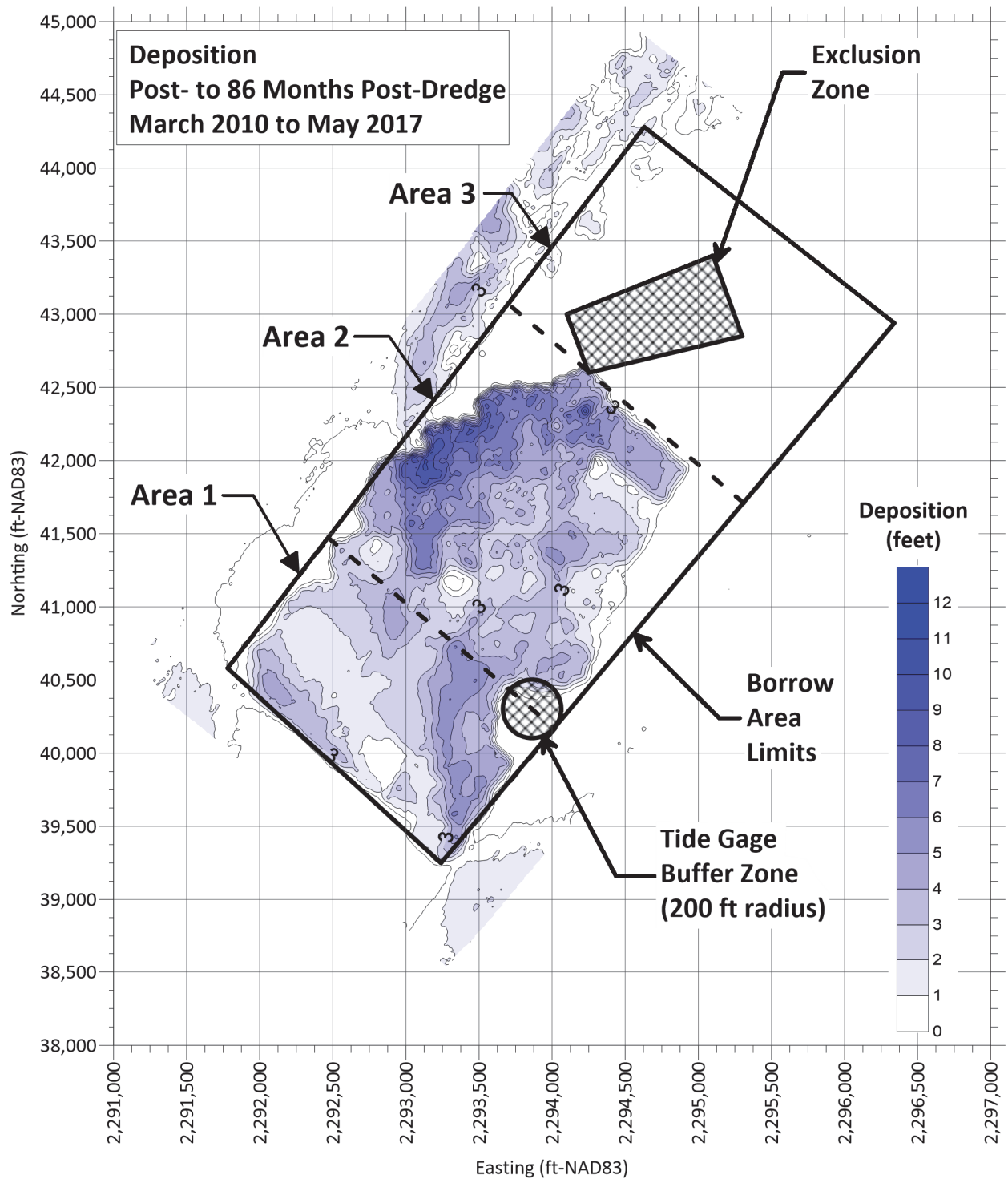


Figure 6: Jay Bird Shoals area of deposition since project completion (March 2010 to May 2017).

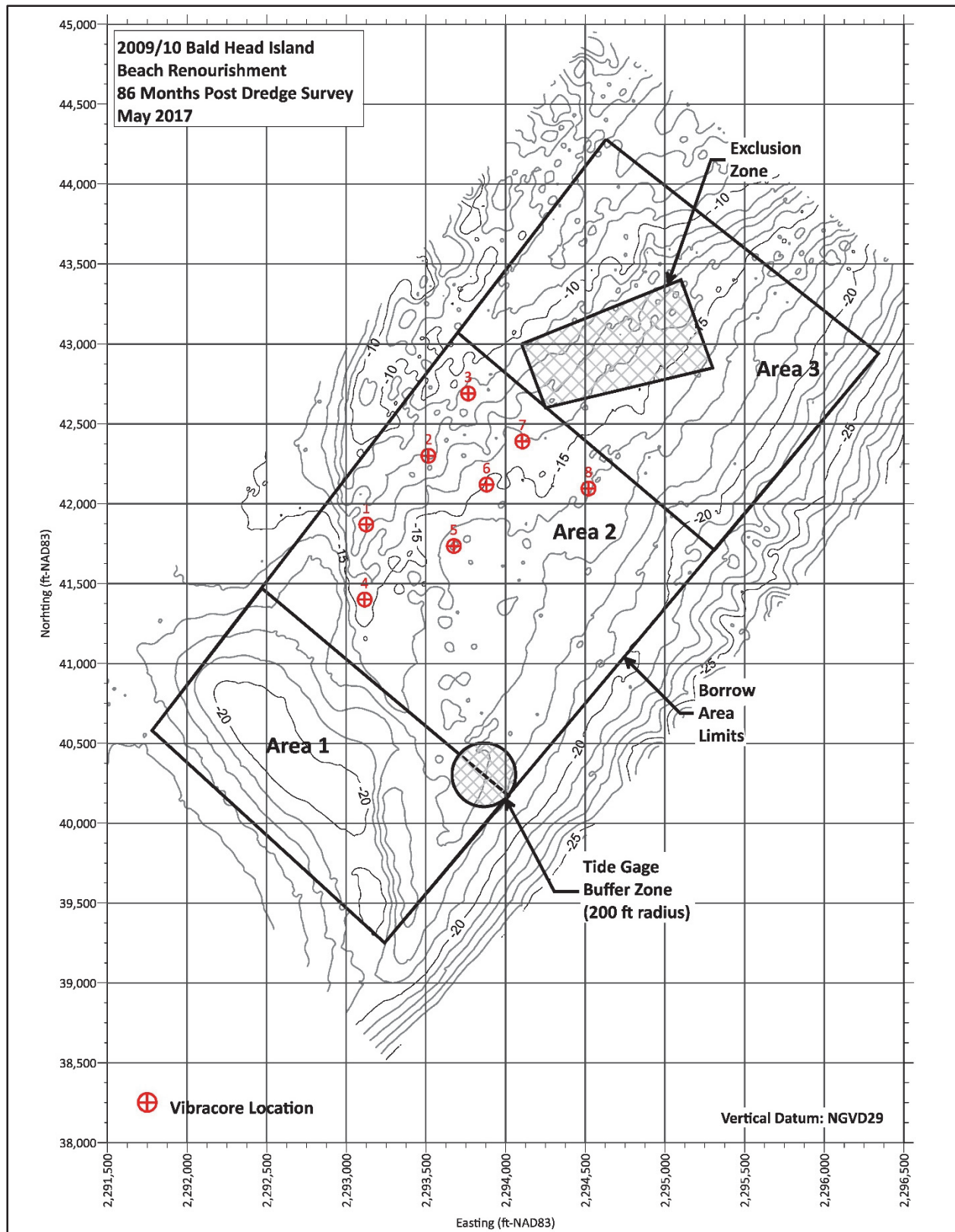


Figure 7: Additional vibracores acquired in July 2017.

analyses, the percentage carbonate material as well as fines were computed for each composite. A brief Report of Findings as well as all data, photographs of cores, core logs, GSD curves, etc. are included as **Appendix A** to this report.

Simplistically, all JBS depositional material considered for placement on South Beach (above elevation -24 ft NGVD29) is fine sand classified as being predominately SP. For the eight (8) cores acquired, the average mean grain size is .21 mm. Carbonate percentages from the composite samples ranged from 4.1% to 8.2% with an average of 5.8%. In general, the fine grained content (based upon a no. 230 sieve was less than 2.9% in each of the composite samples from site wide curves. A summary of size and content characteristics for the eight cores is included as **Table 1**.

Table 1. Jay Bird Shoals – 2017 Vibracore Sediment Characterization
Size Classification (% by Wt.)

Core No.	Gravel	Granular	Sand	Fines	CaCO3%
BHI – 2017-01	0	.1	97.0	2.9	4.4
BHI – 2017-02	0	.2	97.8	2.0	4.7
BHI – 2017-03	.4	1.5	97.0	1.1	7.2
BHI – 2017-04	1.5	1.5	94.1	2.9	6.2
BHI – 2017-05	1.3	1.4	96.1	1.2	8.2
BHI – 2017-06	.3	.5	97.7	1.5	4.1
BHI – 2017-07	.1	1.0	96.8	1.2	5.5
BHI – 2017-08	.5	1.0	97.2	1.3	6.4
AVERAGE VALUE	.5	.9	96.7	1.8	5.8

Definition:

- Gravel: 4.76mm – 76mm
- Granular: 2mm – less than 4.76mm
- Sand: .0625mm – less than 2 mm
- Fines: Less than .0625mm

It is important to note that there are no relevant “native beach” characteristics for South Beach since it has been the recipient of the placement of over 8 Mcy of sediment (most from the W.H. Navigation Project channel) since 2000. In reality, the only undisturbed native beach existing on Bald Head is East Beach which faces Onslow Bay. This was recognized by the State in 2007 when the Jay Bird Shoals borrow site was developed. Accordingly, the Village was directed to compare the borrow site characteristics to those of a limited number of composite cross-shore sediment samples for South Beach and East Beach. The latter exercise was basically for “science” – since East Beach is *not* a proposed fill area.

Standards for the determination of compatibility of borrow site material, as compared to the recipient (i.e. native) beach, are specifically defined by the State of N.C. The latter address the four (4) size classifications as well as percentage composition of calcium carbonate. Accordingly, **Table 2.** describes the sediment composition averages and grand means for both the recipient beach (measured 3 ways), as well as the eight cores representing depositional material. From these statistics, compatibility of the sediments to be borrowed can be determined.

Table 2. Sediment Characterization for Compatibility Analysis
Size Classification
(% by Wt.)

Composite Sample	Gravel	Granular	Sand	Fines	Carbonate
JBS – 8 Cores	.05	.9	96.7	1.8	5.8
East Beach Composite	.37	1.37	97.75	.42	9.67%
South Beach Composite	.07	1.08	98.10	.75	7.57%
EB & SB Mean	.22	1.23	97.93	.59	8.41%

For the currently analyzed JBS depositional area being proposed for re-excavation, the following criteria are established by the State of N.C. for purposes of determining “compatibility” of the borrow sediments relative to those of the recipient beach:

- a) The average percentage (by weight) of *fine* grained sediment (less than 0.0625mm) shall not exceed the average percentage (by weight) of fine grained sediment of the recipient beach characterization by five (5%) percent.

- Determination

• Borrow Site Av	1.80%
• Recipient Beach	
▪ SB Mean	.75%
▪ EB Mean	.42%
▪ Grand Mean for all transects	.59%

- **Result – Borrow site material complies with standard.**

- b) The average percentage (by weight) of *granular* sediment (greater than 2mm and less than 4.76mm) in the borrow site shall not exceed the average percentage (by weight) of coarse-sand sediment of the recipient beach characterization plus five (5%) percent.

- Determination

• Borrow Site Av	.9%
• Recipient Beach	
▪ SB Mean	1.08%
▪ EB Mean	1.37%
▪ Grand Mean for all transects	1.23%

- **Result – Borrow site material complies with standard.**

- c) The average percentage (by weight) of *gravel* (greater than or equal to 4.76mm) in the borrow site shall not exceed the average percentage (by weight) of gravel-sized sediment of the recipient beach characterization plus five (5%) percent.

- Determination

• Borrow Site Av	.5%
• Recipient Beach	

▪ SB Mean	.07%
▪ EB Mean	.37%
▪ Grand Mean for all transects	.22%

• **Result – Borrow site material complies with standard**

- d) The average percentage (by weight) of *calcium carbonate* in the borrow site shall not exceed the average percentage (by weight) of calcium carbonate sediment of the recipient beach characterization plus fifteen (15%) percent.

▪ Determination

• Borrow Site Av	5.8%
• Recipient Beach	
▪ SB Mean	7.57%
▪ EB Mean	9.67%
▪ Grand Mean for all transects	8.41%

▪ **Result – Borrow site material complies with standard.**

CONCLUSIONS/RECOMMENDATIONS

It is recommended that the Village of Bald Head Island seek a modification of CAMA 91-4 and USACE No. SAW-2012-00040 sufficient to dredge portions of a previously developed borrow site located at Jay Bird Shoals. More specifically, a contract should be formulated whereby 250,000 cy would be dredged from Area 3 of the site which was *not* designated for excavation in 2009. An additional volume amounting to 750,000 cy, mol. would be excavated from material deposited within Areas 1 and 2 of the JBS borrow site which were dredged in 2009. It should be noted that not all depositional material in Areas 1 and 2 is physically accessible by a large dredge. All sand would be placed on S. Beach eastward of the terminal groin constructed in 2015. The proposed timing of the work would be between 1 November 2018 and 1 April 2019. Work would be performed by a cutter suction dredge with direct deposit on S. Beach by pipeline. Where the submerged pipeline crosses the federal navigation project, it would need to be placed below the authorized channel depth of -44ft. MLW. Any such material

excavated to trench the pipeline below the channel would be placed on S. Beach – as was done for the 2009 project.

The sediments within the *original* Jay Bird Shoal borrow site limits (Areas 1, 2 and 3) were determined to be beach compatible by way of a comprehensive Sand Search (Olsen, 2007) performed prior to the 2009 project. A Cultural Resource Exclusion Zone totaling 12.5 A was required. It is recommended that the Village seek a re-evaluation of the limits of that zone – due to changed seabed conditions – using the professional services of Tidewater Atlantic Research, Inc. (T.A.R.). The goal would be to reduce the limits of the buffer through additional field investigation performed by Dr. Gordon Watts – if determined to be warranted.

Depositional sediments which are being proposed for re-excavation during a beach fill project in the winter of 2018-2019 were evaluated through the acquisition of eight (8) additional VIBRACORES in July of 2017 by the firm of Athena Technologies, Inc. Subsequent laboratory analyses of composite samples over the assumed depth of excavation – i.e. from the existing seabed to -24 ft NGVD29 – were performed and reported (**Appendix A**). All composite sample sediments over depth meet State Standards for placement as beach fill on South Beach at Bald Head Island. The proposed limit of fill would extend from the terminal groin to baseline Sta. 134+00 located approximately 9,000 ft. eastward thereof – as addressed by existing permits.

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APPENDIX A

Geotechnical Vibracore Report
Jay Bird Shoals, Bald Head Island

By
Athena Technologies, Inc.

July, 2017



**Geotechnical Vibracore Report
Jay Bird Shoals, Bald Head Island,
North Carolina
July 2017**

Prepared for:

Olsen Associates, Inc.
2618 Herschel Street
Jacksonville, Florida 32204

Prepared by:

Athena Technologies, Inc.
1293 Graham Farm Road, PO Box 68
McClellanville, South Carolina 29458



1293 Graham Farm Road, PO Box 68
McClellanville, South Carolina 29458
(843) 887-3800
www.athenatechnologies.com

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Appendix B: Terracon Carbonate Content Summary

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Section 1: Methodology

Athena Technologies, Inc. (Athena) was contracted by Olsen Associates, Inc. (OAI) of Jacksonville, Florida to collect geotechnical vibracore samples in the vicinity of Jay Bird Shoals, which is located west of Bald Head Island, North Carolina (Figure 1). A total of 8 vibracores of varying lengths were collected on 26 July 2017, in accordance with the following methodology.

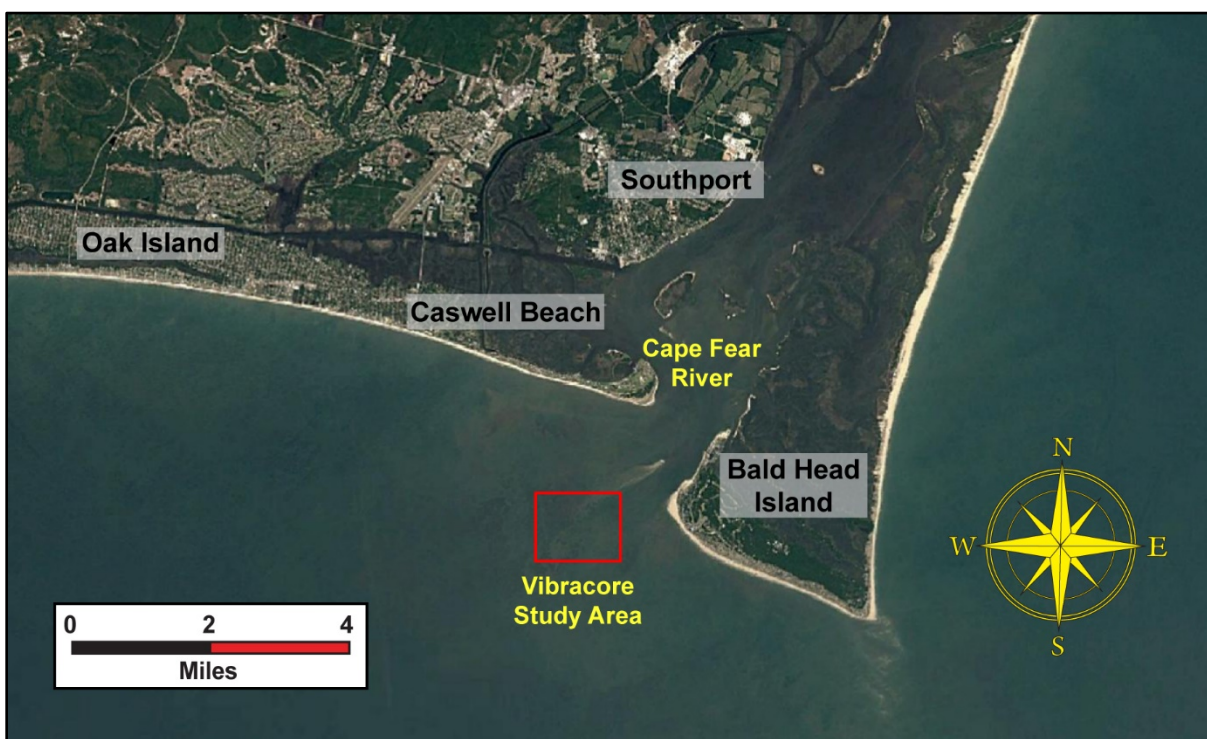


Figure 1: Vibracore Study Area, Jay Bird Shoals, Bald Head Island, North Carolina.
(Image Source: Google Earth)

Athena utilized the 35-foot research vessel, *Artemis* (Figure 2), to act as the sampling platform for this project. *Artemis* was equipped with all required US Coast Guard (USCG) safety gear and was operated by a USCG-certified, 100 Ton Master Captain. A Trimble Differential Global Positioning System (sub-meter accuracy) interfaced with HYPACK was utilized for primary navigation. Horizontal coordinates were recorded in North American Datum of 1983 State Plane Coordinate System, North Carolina (Zone 3200), U.S. Survey Feet. Real-time tide elevation data was obtained using a Champion TKO Global Navigation Satellite System receiver interfaced with the North Carolina Continuously Operating Reference Station Network, which served as the base station.



Figure 2: Research Vessel Artemis offshore of Mobile Bay, Alabama.

During field operations, *Artemis* was immobilized over the desired sample sites (provided by OAI) using a triple-point anchor system. Once on station, the coordinates at the vessel location were compared with the coordinates for the desired sample location to ensure accurate vessel positioning. Upon satisfactory positioning, a water depth was collected via lead line or fathometer. Tide elevation data was recorded in relation to North American Vertical Datum of 1988, and subsequently converted to values referenced to National Geodetic Vertical Datum of 1929 (NGVD 29) via the National Oceanic and Atmospheric Administration's VDatum (Version 3.6.1) conversion program. The tide elevation data was utilized to determine the sediment surface elevation at each sample location.

A custom-designed and fabricated vibracore system was utilized to collect the geotechnical cores. The system consists of a generator with a mechanical vibrator attached via cable. The vibrator is attached directly to a 3-inch diameter, galvanized sample barrel. The sample barrel was lowered until the bottom of the barrel was directly above the sediment surface. The vibracore machine was turned on and the sample barrel was allowed to penetrate to a depth of 20 feet below sediment surface, or to refusal. Vibracore penetration was recorded from the deck using marked drill stems. Once the sample barrel reached the desired depth, the machine was turned off and the sample barrel was retrieved using an electric winch. The recovered core length was measured following core retrieval, and percent recovery was verified. The cores were then capped, labeled, and cut into 5-foot sections. A vibracore summary table containing final location coordinates, elevation data, and penetration and recovery lengths has been included as Table 1. Sample locations are depicted on Figure 3.



Figure 3: Vibracore Location Map, Jay Bird Shoals, Bald Head Island, North Carolina. (Image Source: Google Earth)

Table 1
Vibracore Summary

Boring ID	Collection Date	Time	East (x)	North (y)	Water Depth (ft)	Tide Elevation (ft NGVD 29)	Top of Core Elevation (ft NGVD 29)	Bottom of Boring Elevation (ft NGVD 29)	Penetration (ft)	Recovery (ft)	Notes
BHI2017-01	7/26/2017	8:29	2293127	41872	15.4	2.1	-13.3	-31.3	18.0	15.6	
BHI2017-02	7/26/2017	9:05	2293512	42296	15.1	3.2	-11.9	-24.9	13.0	11.3	Made 2 attempts; refusal encountered at 13.0' below sediment surface; second core retained
BHI2017-03	7/26/2017	10:05	2293771	42688	14.3	3.8	-10.4	-22.9	12.5	10.2	Made 3 attempts; refusal encountered at 12.5' below sediment surface; third core retained
BHI2017-04	7/26/2017	8:00	2293117	41400	15.4	1.9	-13.5	-34.5	21.0	20.1	
BHI2017-05	7/26/2017	7:05	2293676	41730	15.3	0.5	-14.9	-34.9	20.0	17.1	
BHI2017-06	7/26/2017	7:31	2293879	42117	15.2	1.1	-14.1	-32.1	18.0	15.9	
BHI2017-07	7/26/2017	9:35	2294099	42388	16.3	4.0	-12.3	-29.0	16.7	14.4	
BHI2017-08	7/26/2017	6:31	2294521	42096	14.9	0.3	-14.6	-27.1	12.5	11.0	Made 2 attempts; refusal encountered at 12.5' below sediment surface; second core retained
Notes	ft = feet										
	NGVD 29 = National Geodetic Vertical Datum of 1929										
	Coordinates were recorded in North American Datum of 1983, State Plane Coordinate System, North Carolina (Zone 3200), US Survey Feet.										
	Elevation data collected using a Champion TKO GNSS receiver interfaced with the North Carolina Continuously Operating Reference Station Network.										

The completed cores were opened longitudinally at Athena's core processing facility in McClellanville, South Carolina. The cores were logged in accordance with ASTM D 2487 (the Unified Soil Classification System) and were photographed after opening. Draft logs and photo-mosaic images of each core were provided to OAI for selection of sub-sample intervals for laboratory analysis. Once sample selections were received from OAI, Athena extracted and shipped the sub-samples to Terracon Consultants, Inc. (Terracon) in Jacksonville, Florida. Terracon is a USACE-certified geotechnical laboratory. One composite sample was collected from each core. The composite samples were analyzed in accordance with ASTM D 422 to determine grain size and soil classification, using the following sieve sizes: 3/4 in., 5/8 in., No. 3.5, No. 4, No. 5, No. 7, No. 10, No. 14, No. 18, No. 25, No. 35, No. 45, No. 60, No. 80, No. 120, No. 170, No. 200, and No. 230. The composite samples were also analyzed in accordance with the Twenhofel and Tyler (1941) acid digestion method to determine carbonate content percentages for each core.

Vibracore logs were developed using gINT (Version 8.2), and laboratory analytical data were incorporated into the gINT project file for statistical evaluation. A tabular summary of grain size data is presented in Table 2. Core logs, photographs, sieve analysis curves, and grain size distribution data are included in Appendix A. Carbonate content data, as reported by Terracon, are included in Appendix B. Graphs depicting percent accessory components (i.e., carbonate, gravel, silt, etc.) and grain size distribution parameters (e.g., mean grain size, percent passing the No. 200 sieve, etc.) have been included as Appendix C.

Table 2
Grain Size Data Summary

Boring ID	Sample ID	Top of Sample Interval (ft bss)	Bottom of Sample Interval (ft bss)	USCS Classification	Percent Gravel-Size Material ^[1]	Percent Passing #200 Sieve	Percent Passing #230 Sieve	Percent Carbonate ^[2]	Mean Size (phi)	Mean Size (mm)	Median Size (phi)	Median Size (mm)	Sorting	Skewness	Kurtosis
BHI2017-01	COMP	0.0	10.7	SP	0.00	3.08	2.90	4.4	2.54	0.17	2.67	0.14	0.61	-1.75	8.33
BHI2017-02	COMP	0.0	11.3	SP	0.00	2.12	1.96	4.7	2.37	0.19	2.56	0.16	0.72	-1.72	7.12
BHI2017-03	COMP	0.0	10.2	SP	0.38	1.16	1.14	7.2	1.77	0.29	2.00	0.27	0.98	-1.45	6.07
BHI2017-04	COMP	0.0	10.5	SP	1.35	3.08	2.87	6.2	2.41	0.19	2.65	0.14	1.02	-3.35	16.36
BHI2017-05	COMP	0.0	9.1	SP	1.11	1.32	1.20	8.2	2.27	0.21	2.58	0.16	1.04	-2.75	12.55
BHI2017-06	COMP	0.0	9.9	SP	0.29	1.52	1.45	4.1	2.30	0.20	2.53	0.16	0.79	-2.40	12.41
BHI2017-07	COMP	0.0	11.7	SP	0.10	1.31	1.23	5.5	2.33	0.20	2.57	0.15	0.83	-2.10	8.56
BHI2017-08	COMP	0.0	9.4	SP	0.34	1.44	1.34	6.4	2.16	0.22	2.49	0.17	0.97	-1.95	7.70
Notes	[1] = Defined as the sample fraction which is retained on the Number 4 sieve (i.e., greater than 4.75 millimeters).														
	[2] = Percent carbonate determined using the Twenhofel and Tyler (1941) acid digestion method.														
	ft bss = feet below sediment surface														
	USCS = Unified Soil Classification System														
	mm = millimeters														

Section 2: Discussion

The vibracore study area (depicted on Figure 1) was located approximately 1.5 miles to the west southwest of Bald Head Island, near the entrance to the Cape Fear River. More specifically, the vibracores were positioned to the southwest of Jay Bird Shoals, which is an intertidal to subaqueous linear sand ridge located northwest of the Cape Fear River main channel. The mean tidal range at the study area is approximately 4.5 feet, and tidal current velocities in the channel adjacent to the study area range from 0.5 to greater than 1.5 knots during peak tidal exchange periods (National Oceanic and Atmospheric Administration).

Water depths at the sample locations within the study area ranged from 14.3 to 16.3 feet and sediment surface elevations ranged from -10.4 to -14.9 feet NGVD 29. In general, the maximum penetration depth achieved while vibracoring decreased with increasing sediment surface elevation. The increase in density at the shallower sample locations is likely caused by a greater exposure to higher energy wave action at those locations. As a result, vibracore penetration depths ranged from 12.5 feet to 21 feet below sediment surface in the study area; core termination depths ranged from -22.9 to -34.9 feet NGVD 29. It should be noted that the relatively shallow nature of the study area, in conjunction with the study area's exposure to open ocean processes (e.g., wave refraction), resulted in amplified wave heights and variable wave directions at the sample locations. The wave action within the study area caused the vessel to pitch and surge in a non-uniform manner, which made safety an overriding concern during vibracore operations. All reasonable efforts were made to collect vibracores from the desired locations while minimizing risk to crew and equipment.

The composite sediment samples were collected to a depth of -24 feet NGVD 29 for each of the cores.¹ Laboratory analytical data indicates that the clastic (i.e., non-shell) fraction in each core was predominantly fine to medium-grained, poorly graded quartz sand. The average mean grain size for all composite samples was 0.21 millimeters (mm). Carbonate percentages from all composite samples ranged from 4.1 percent to 8.2 percent, with an average of 5.8 percent. In general, the fine-grained content (i.e., silt and clay-sized sediment) was less than 3.1 percent in each of the composite samples collected from site wide cores.

¹ The composite samples for BHI2017-02 and BHI2017-03 were collected to the bottom of each core, which correlated to depths of -23.2 feet and -20.6 feet NGVD 29, respectively.

Tidal bedding and silt-lined burrows were commonly observed in the surficial sand layer for each core. A majority of the bioclastic material in the cores was comprised of fragmented marine bivalve shells, and the percentage of bioclastic material generally increased with depth in the surficial sand layer. Cores BHI2017-01, -02, B-04, and -08 terminated in a sediment interval with an increased percentage of fine-grained material (i.e., greater than 5 percent but less than 15 percent). The elevation of the finer-grained interval in the abovementioned cores ranged from -22.5 feet to -24.9 feet NGVD 29. In general, the grain size distribution curves for each of the sediment samples correlate well, which indicates relatively uniform sediment characteristics (to a depth of -24' NGVD 29) at the eight sample locations.

Section 3: References

ASTM D422-63. Standard Test Method for Particle-Size Analysis of Soils, ASTM International, West Conshohocken, PA. 2007.

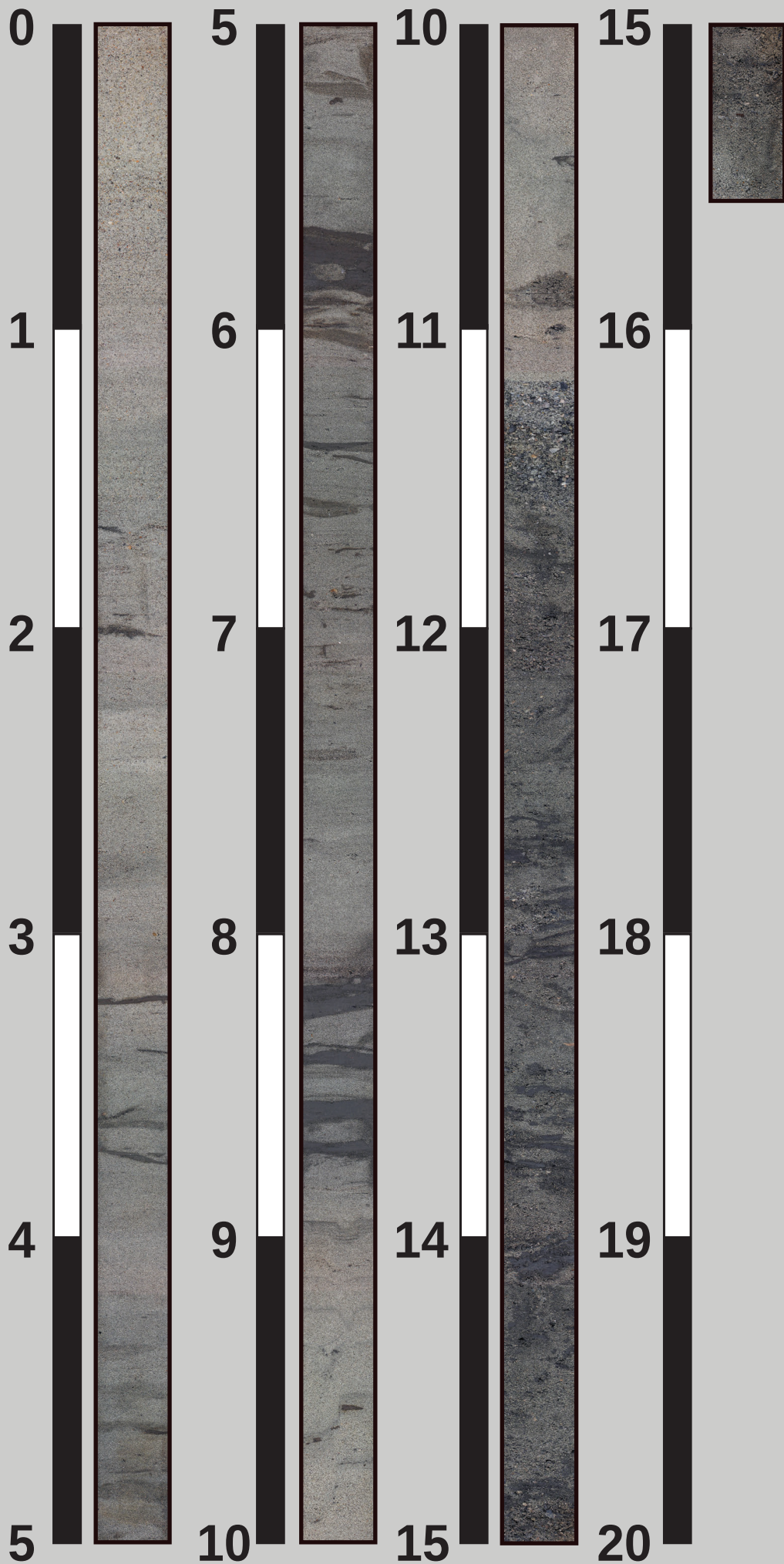
ASTM D2487-06. Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System), ASTM International, West Conshohocken, PA. 2008.

National Oceanic and Atmospheric Administration. Tide Predictions for Station ID: 8658901 (Bald Head Island, Cape Fear River, NC). Obtained from:
<https://tidesandcurrents.noaa.gov/noaatidepredictions.html?id=8658901>.
Accessed on 10 August 2017.

National Oceanic and Atmospheric Administration. Current Predictions for Station ID: CFR1626 (Bald Head Shoal). Obtained from:
<https://tidesandcurrents.noaa.gov/noaacurrents/Predictions?id=CFR1626>.
Accessed on 10 August 2017.

Twenhofel, W.H. and Tyler S.A. (1941). Methods of Study of Sediments, McGraw-Hill, New York, p. 183

Appendix A: Core Photographs, Logs, Sieve Analysis Curves, and Grain Size Data



**Olsen
Associates, Inc.**

**Jay Bird Shoals,
Bald Head Island,
North Carolina
July 2017**

BHI2017-01

Notes:
Scale in Feet
Photo Mosaic Image

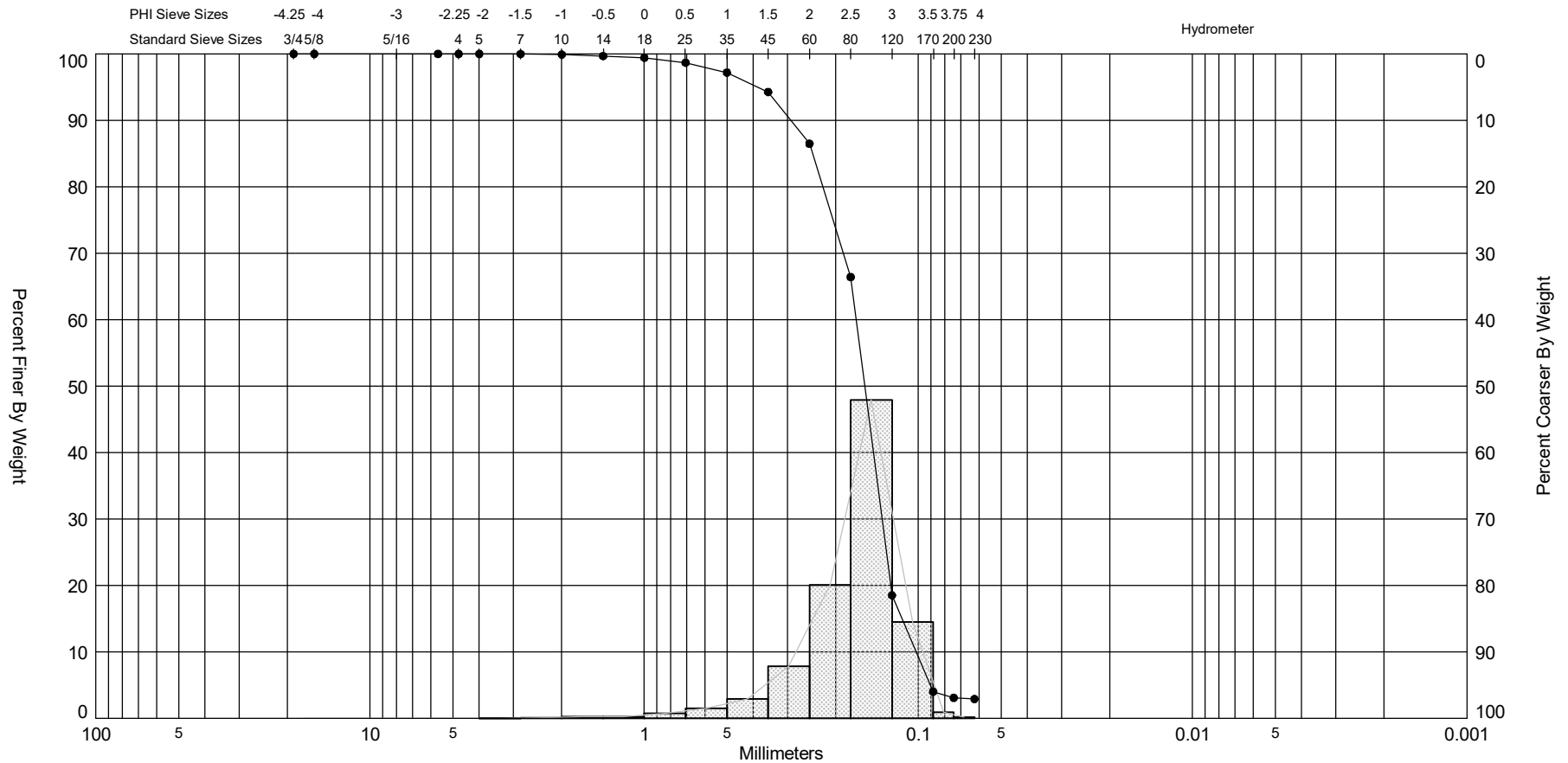


Athena Technologies, Inc.
1293 Graham Farm Road
McClellanville, SC 29458
www.athenatechnologies.com
(843) 887-3800

DRILLING LOG		CLIENT Olsen Associates, Inc.	PROJECT OWNER	SHEET 1 OF 1 SHEETS
1. PROJECT Jay Bird Shoals Geotechnical Evaluation Bald Head Island, North Carolina		9. SIZE AND TYPE OF BIT 3.0 In.		
2. BORING DESIGNATION BHI2017-01		10. COORDINATE SYSTEM/DATUM NC State Plane		
LOCATION COORDINATES X = 2,293,127 Y = 41,872		HORIZONTAL NAD 1983 VERTICAL NGVD 29		
3. DRILLING AGENCY Athena Technologies, Inc.		11. MANUFACTURER'S DESIGNATION OF DRILL ☐ AUTO HAMMER ☐ MANUAL HAMMER		
CONTRACTOR FILE NO.		12. TOTAL SAMPLES 1		
4. NAME OF DRILLER P. McClellan		13. TOTAL NUMBER CORE BOXES		
5. DIRECTION OF BORING ☒ VERTICAL ☐ INCLINED		14. WATER DEPTH 15.4 Ft.		
DEG. FROM VERTICAL		15. DATE BORING 07-26-17 08:29		
BEARING		COMPLETED 07-26-17		
6. THICKNESS OF OVERBURDEN 0.0 Ft.		16. ELEVATION TOP OF BORING -13.3 Ft.		
7. DEPTH DRILLED INTO ROCK 0.0 Ft.		17. TOTAL RECOVERY FOR BORING 15.6 Ft.		
8. TOTAL DEPTH OF BORING 18.0 Ft.		18. SIGNATURE AND TITLE OF INSPECTOR A. Freeze		

ELEV. (ft)	SCALE (ft)	LEGEND	CLASSIFICATION OF MATERIALS Depths and elevations based on measured values	% REC.	BOX OR SAMPLE	REMARKS
-13.3	0.0					
-14.2	0.9		Fine to medium quartz SAND, few fine to medium sand-size shell, poorly graded, loose, subangular to subrounded, light olive gray (5Y-6/2), (SP).			
			Fine quartz SAND, trace silt in laminations, rip-up clasts, and flaser beds, trace fine to medium sand-size shell, poorly graded, loose, subangular, color grades to gray (5Y 5/1) from, olive gray (5Y-5/2), (SP).			
-19.0	5.7					
-19.3	6.0		Sandy SILT, little fine quartz SAND in laminations and burrows, trace fine sand-size shell, soft, dark gray (5Y-4/1), (ML).			
			Fine quartz SAND, trace silt in laminations, rip-up clasts, and flaser beds, trace fine to medium sand-size shell, poorly graded, loose, subangular, gray (5Y-5/1), (SP).			
-21.4	8.1					
-22.0	8.7		Sandy SILT, little fine quartz SAND in laminations and burrows, trace fine sand-size shell, soft, dark gray (5Y-4/1), (ML).			
			Fine quartz SAND, trace silt in burrows and rip-up clasts, trace fine to medium sand-size shell, poorly graded, loose, subangular, olive gray (5Y-5/2), (SP).			
-24.5	11.2					
-24.9	11.6		Fine to medium quartz SAND, little fine to coarse sand-size shell, poorly graded, loose, subangular to subrounded, gray (5Y-5/1), (SP).			
			Fine to medium quartz SAND, few silt in burrows and laminations, trace fine to coarse sand-size shell, poorly graded, loose, subrounded, very dark gray (5Y-3/1), (SP-SM).			
-28.9	15.6					
			End of Boring			

Sample #COMP 1, Depth = 10.7'
Mean (mm): 0.17, Phi Sorting: 0.61
Carbonate: 4.4%, Fines (#200) - 3.08 (SP)



Gravel		Sand			Silt and Clay
Coarse	Fine	Coarse	Medium	Fine	

Sample	Symbol	Elev. (ft)	USCS	% Fines	% Organics	% Carbonates	Median	Mean	Skew	Kurt	Sort	Sample Information	
BHI2017-01 #COMP 1	—●—	-24.0	SP	#200 - 3.08 #230 - 2.90		4.40	2.67	2.54	-1.75	8.33	0.61	Project Name:	Jay Bird Shoals Geotechnical Evaluation
Comments: Sample Interval = 0 - 10.7'												Analysis Date:	08-03-17
Depths and elevations based on measured values												Analyzed By:	CM
						Athena Technologies, Inc. 1293 Graham Farm Road McClellanville, SC 29458 Office: 843-887-3800						Easting (X, ft):	2,293,127
												Northing (Y, ft):	41,872
												Horizontal System:	NAD 1983
												Vertical System:	NGVD 29



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Jacksonville, Florida 32257

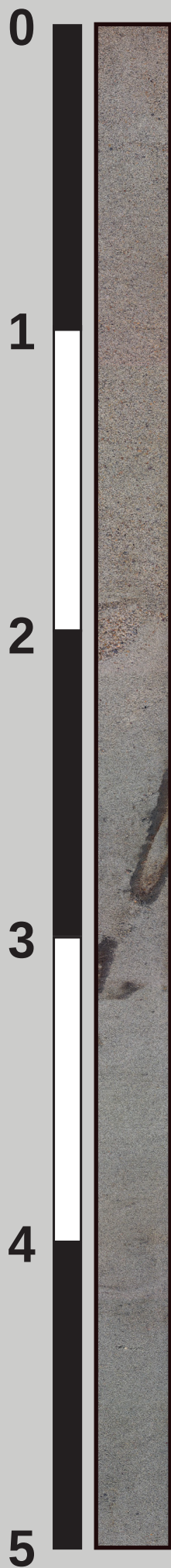
(904) 900-6494 (Tel) • (904) 268-5255 (Fax)

GRAIN SIZE

Project:	Jay Bird Shoals	Depth:	0- 10.7
Project No.:	EQ175068	Date:	8/3/2017
Boring No.:	BHI2017-01		
Sample No.:	Comp 1		
Description:	Sand, poorly graded, mostly medium to fine quartz, few carbonate, trace silt (SP) 5Y 6/3		

Tare Weight, (g):	49.52	
Dry Wt. Before Washing (g):	160.35	(with tare)
Dry Weight After Washing (g):		(with tare)

Sieve Size (Name)	Sieve Size (mm)	Weight Retained (g)	% Passing
3/4"	19.000	0.00	100.00
5/8"	16.000	0.00	100.00
#3.5	5.600	0.00	100.00
#4	4.750	0.00	100.00
#5	4.000	0.00	100.00
#7	2.800	0.02	99.98
#10	2.000	0.11	99.90
#14	1.400	0.36	99.68
#18	1.000	0.61	99.45
#25	0.710	1.45	98.69
#35	0.500	3.10	97.20
#45	0.355	6.34	94.28
#60	0.250	14.99	86.47
#80	0.180	37.23	66.41
#120	0.125	90.30	18.52
#170	0.090	106.39	4.01
#200	0.075	107.42	3.08
#230	0.063	107.62	2.90



**Olsen
Associates, Inc.**

**Jay Bird Shoals,
Bald Head Island,
North Carolina
July 2017**

BHI2017-02

Notes:
Scale in Feet
Photo Mosaic Image

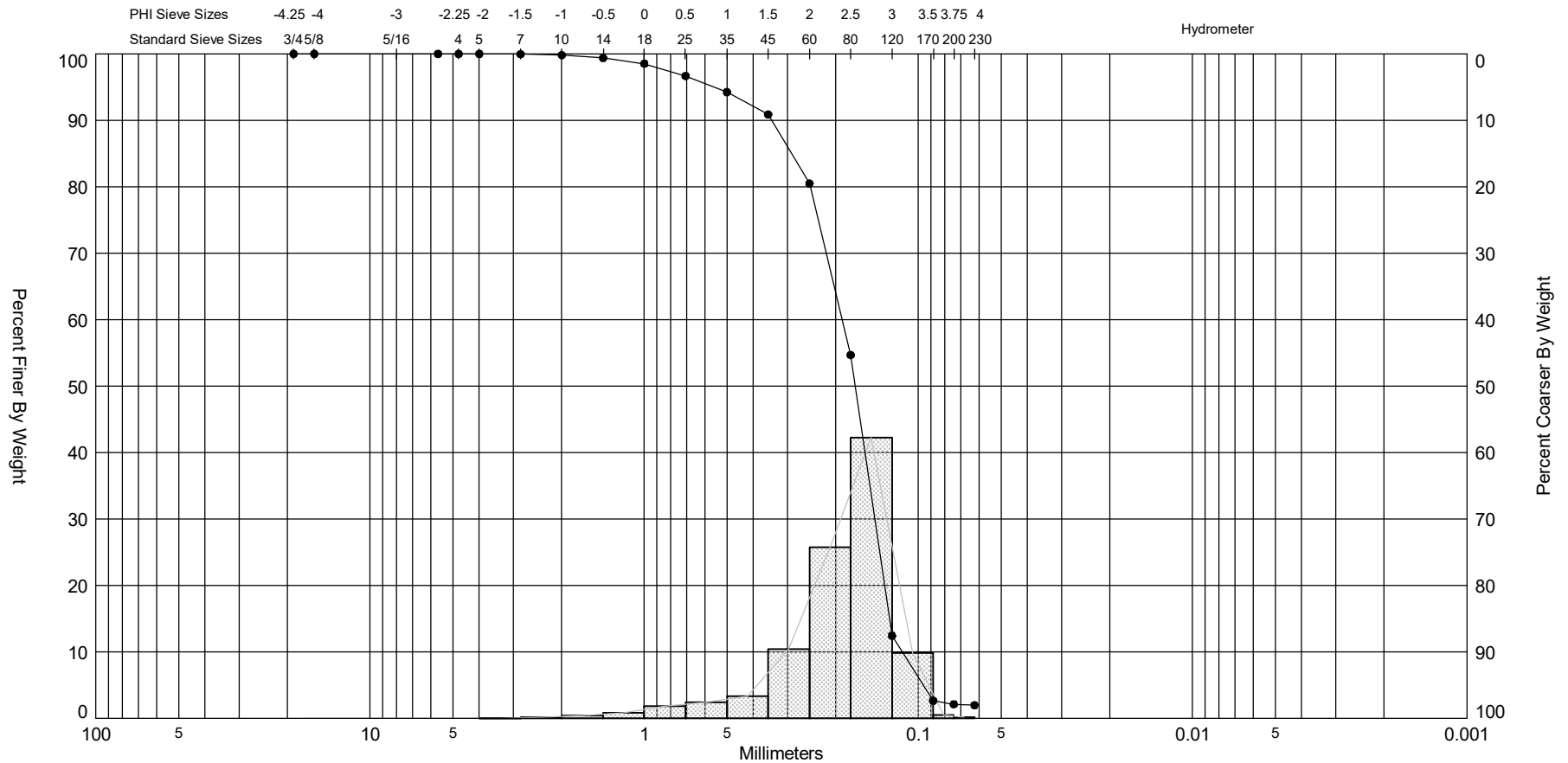


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1293 Graham Farm Road
McClellanville, SC 29458
www.athenatechnologies.com
(843) 887-3800

DRILLING LOG		CLIENT Olsen Associates, Inc.		PROJECT OWNER		SHEET 1 OF 1 SHEETS	
1. PROJECT Jay Bird Shoals Geotechnical Evaluation Bald Head Island, North Carolina				9. SIZE AND TYPE OF BIT 3.0 In.			
2. BORING DESIGNATION BHI2017-02				10. COORDINATE SYSTEM/DATUM NC State Plane		HORIZONTAL NAD 1983	
LOCATION COORDINATES X = 2,293,512 Y = 42,296				11. MANUFACTURER'S DESIGNATION OF DRILL		☐ AUTO HAMMER ☐ MANUAL HAMMER	
3. DRILLING AGENCY Athena Technologies, Inc.				12. TOTAL SAMPLES		DISTURBED 1	
CONTRACTOR FILE NO.				13. TOTAL NUMBER CORE BOXES		UNDISTURBED (UD)	
4. NAME OF DRILLER P. McClellan				14. WATER DEPTH 15.1 Ft.			
5. DIRECTION OF BORING ☒ VERTICAL ☐ INCLINED		DEG. FROM VERTICAL		15. DATE BORING		STARTED 07-26-17 09:05	
		BEARING				COMPLETED 07-26-17	
6. THICKNESS OF OVERBURDEN 0.0 Ft.				16. ELEVATION TOP OF BORING -11.9 Ft.			
7. DEPTH DRILLED INTO ROCK 0.0 Ft.				17. TOTAL RECOVERY FOR BORING 11.3 Ft.			
8. TOTAL DEPTH OF BORING 13.0 Ft.				18. SIGNATURE AND TITLE OF INSPECTOR A. Freeze			

ELEV. (ft)	SCALE (ft)	LEGEND	CLASSIFICATION OF MATERIALS Depths and elevations based on measured values	% REC.	BOX OR SAMPLE	REMARKS
-11.9	0.0					
-14.0	2.1		Fine to medium quartz SAND, few fine to medium sand-size shell, poorly graded, loose, subangular to subrounded, olive gray (5Y-5/2), (SP).			
-17.9	6.0		Fine quartz SAND, trace silt in burrows, trace fine to medium sand-size shell, poorly graded, loose, subangular, 2.5 - 3.1' = silt-lined Callianassa major burrow, gray (5Y-5/1), (SP).			
-20.7	8.8		Fine to medium quartz SAND, few fine to coarse sand-size shell, trace silt, poorly graded, loose, subangular to subrounded, color grades to light olive gray (5Y 6/2) from, gray (5Y-5/1), (SP).			
-22.5	10.6		Fine quartz SAND, trace silt in burrows and laminations, trace fine sand-size shell, poorly graded, loose, subangular to subrounded, gray (5Y-5/1), (SP).			
-23.2	11.3		Fine quartz SAND, few silt in burrows and laminations, poorly graded, loose, subangular, dark olive gray (5Y-3/2), (SP-SM).			
			End of Boring			

FLORIDA DEP ROSS OAI JAY BIRD SHOALS (BALD HEAD ISLAND) NC JULY 2017 GPJ FL DEP ROSS GDT 8/9/17



Gravel		Sand			Silt and Clay
Coarse	Fine	Coarse	Medium	Fine	

Sample	Symbol	Elev. (ft)	USCS	% Fines	% Organics	% Carbonates	Median	Mean	Skew	Kurt	Sort	Sample Information	
BHI2017-02 #COMP 1	—●—	-23.2	SP	#200 - 2.12 #230 - 1.96		4.70	2.56	2.37	-1.72	7.12	0.72	Project Name:	Jay Bird Shoals Geotechnical Evaluation
Comments: Sample Interval = 0 -11.3'												Analysis Date:	08-03-17
Depths and elevations based on measured values												Analyzed By:	CM
												Easting (X, ft):	2,293,512
												Northing (Y, ft):	42,296
												Horizontal System:	NAD 1983
												Vertical System:	NGVD 29
Athena Technologies, Inc. 1293 Graham Farm Road McClellanville, SC 29458 Office: 843-887-3800													



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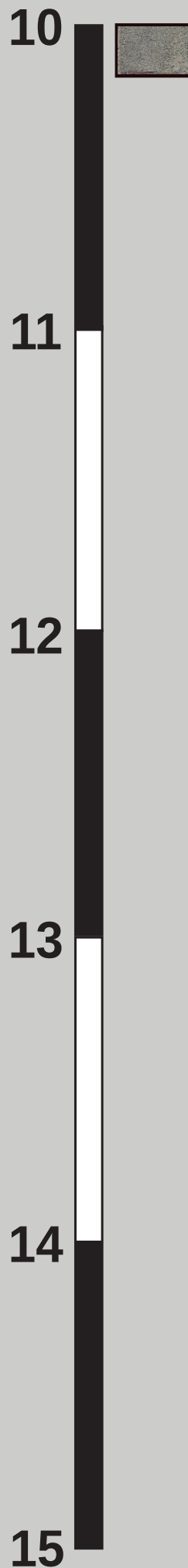
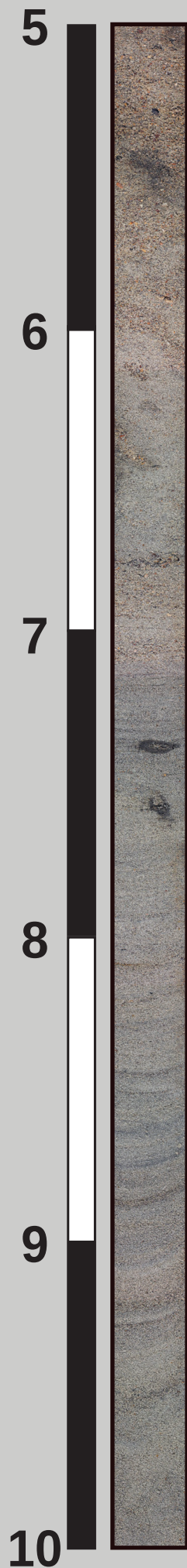
9455 Florida Mining Blvd. West, Ste. 509
Jacksonville, Florida 32257
(904) 900-6494 (Tel) • (904) 268-5255 (Fax)

GRAIN SIZE

Project:	Jay Bird Shoals	Depth:	0- 11.3
Project No.:	EQ175068	Date:	8/3/2017
Boring No.:	BHI2017-02		
Sample No.:	Comp 1		
Description:	Sand, poorly graded, mostly medium to fine quartz, few carbonate, trace silt (SP) 5Y 6/3		

Tare Weight, (g):	46.08	
Dry Wt. Before Washing (g):	152.82	(with tare)
Dry Weight After Washing (g):		(with tare)

Sieve Size (Name)	Sieve Size (mm)	Weight Retained (g)	% Passing
3/4"	19.000	0.00	100.00
5/8"	16.000	0.00	100.00
#3.5	5.600	0.00	100.00
#4	4.750	0.00	100.00
#5	4.000	0.00	100.00
#7	2.800	0.04	99.96
#10	2.000	0.19	99.82
#14	1.400	0.66	99.38
#18	1.000	1.56	98.54
#25	0.710	3.53	96.69
#35	0.500	6.14	94.25
#45	0.355	9.74	90.88
#60	0.250	20.84	80.48
#80	0.180	48.36	54.69
#120	0.125	93.45	12.45
#170	0.090	103.92	2.64
#200	0.075	104.48	2.12
#230	0.063	104.65	1.96



**Olsen
Associates, Inc.**

**Jay Bird Shoals,
Bald Head Island,
North Carolina
July 2017**

BHI2017-03

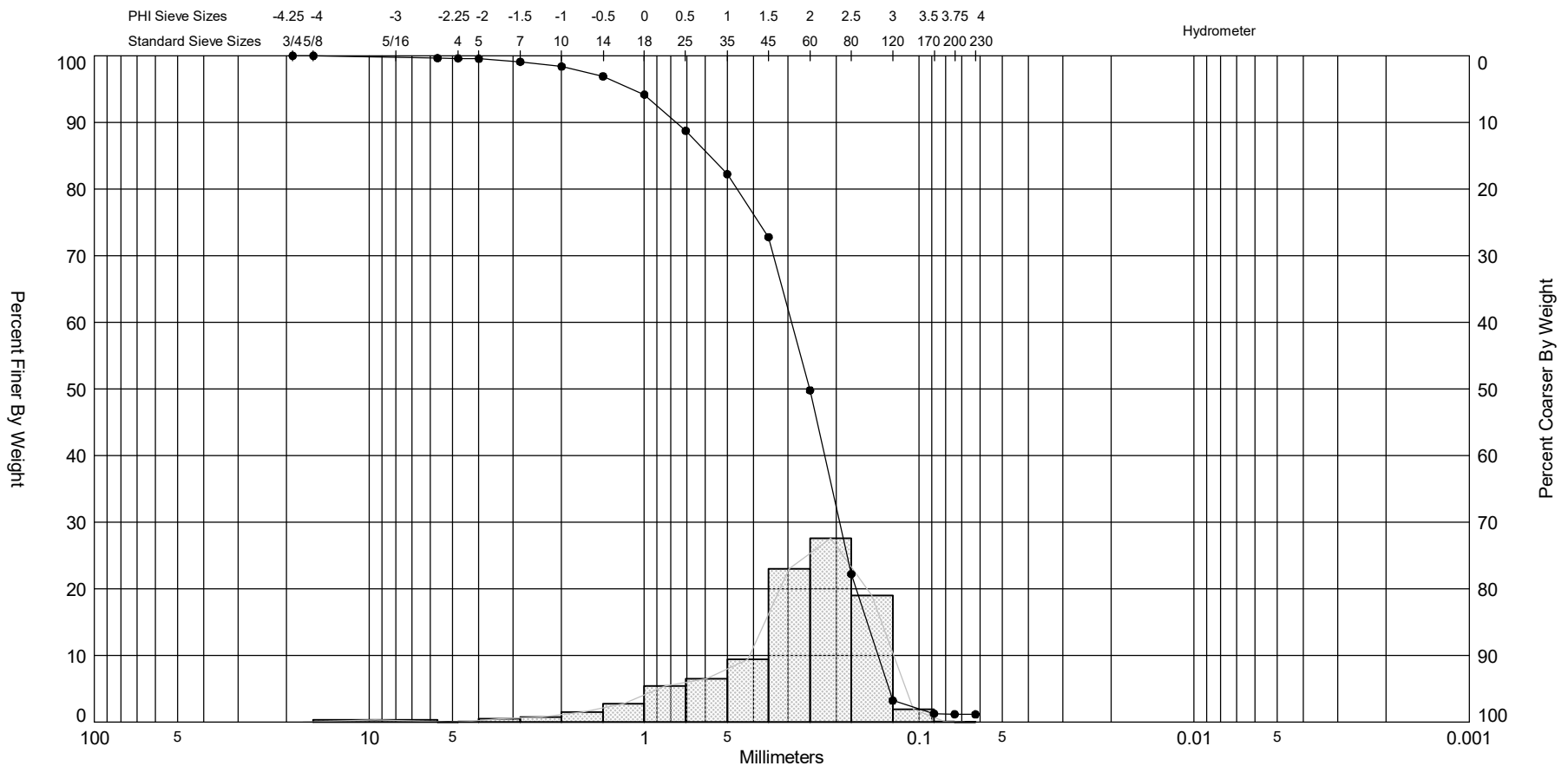
Notes:
Scale in Feet
Photo Mosaic Image



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DRILLING LOG		CLIENT Olsen Associates, Inc.		PROJECT OWNER		SHEET 1 OF 1 SHEETS	
1. PROJECT Jay Bird Shoals Geotechnical Evaluation Bald Head Island, North Carolina				9. SIZE AND TYPE OF BIT 3.0 In.			
2. BORING DESIGNATION BHI2017-03				10. COORDINATE SYSTEM/DATUM NC State Plane		HORIZONTAL NAD 1983	
LOCATION COORDINATES X = 2,293,771 Y = 42,688				11. MANUFACTURER'S DESIGNATION OF DRILL		☐ AUTO HAMMER ☐ MANUAL HAMMER	
3. DRILLING AGENCY Athena Technologies, Inc.				CONTRACTOR FILE NO.		12. TOTAL SAMPLES 1	
4. NAME OF DRILLER P. McClellan				13. TOTAL NUMBER CORE BOXES			
5. DIRECTION OF BORING ☒ VERTICAL ☐ INCLINED				DEG. FROM VERTICAL		BEARING	
6. THICKNESS OF OVERBURDEN 0.0 Ft.				14. WATER DEPTH 14.3 Ft.			
7. DEPTH DRILLED INTO ROCK 0.0 Ft.				15. DATE BORING		STARTED 07-26-17 10:05 COMPLETED 07-26-17	
8. TOTAL DEPTH OF BORING 12.5 Ft.				16. ELEVATION TOP OF BORING -10.4 Ft.			
				17. TOTAL RECOVERY FOR BORING 10.2 Ft.			
				18. SIGNATURE AND TITLE OF INSPECTOR A. Freeze			

ELEV. (ft)	SCALE (ft)	LEGEND	CLASSIFICATION OF MATERIALS Depths and elevations based on measured values	% REC.	BOX OR SAMPLE	REMARKS
-10.4	0.0					
-17.5	7.1		Medium quartz SAND, few fine to coarse sand-size shell, trace silt in burrows, poorly graded, loose, subrounded, color grades to olive gray (5Y 5/2) from, olive gray (5Y-4/2), (SP).		COMP 1	Sample #COMP 1, Depth = 10.2' Mean (mm): 0.29, Phi Sorting: 0.98 Carbonate: 7.2%, Fines (#200) - 1.16 (SP)
-20.6	10.2		Fine to medium quartz SAND, trace silt in burrows (primarily between 7.4 - 7.6'), trace fine to medium sand-size shell, poorly graded, loose, subangular to subrounded, gray (5Y-5/1), (SP).			
			End of Boring			



Gravel		Sand			Silt and Clay
Coarse	Fine	Coarse	Medium	Fine	

Sample	Symbol	Elev. (ft)	USCS	% Fines	% Organics	% Carbonates	Median	Mean	Skew	Kurt	Sort	Sample Information	
BHI2017-03 #COMP 1		-20.6	SP	#200 - 1.16 #230 - 1.14		7.20	2	1.77	-1.45	6.07	0.98	Project Name:	Jay Bird Shoals Geotechnical Evaluation
Comments: Sample Interval = 0-10.2'												Analysis Date:	08-03-17
Depths and elevations based on measured values												Analyzed By:	CM
						Athena Technologies, Inc. 1293 Graham Farm Road McClellanville, SC 29458 Office: 843-887-3800						Easting (X, ft):	2,293,771
												Northing (Y, ft):	42,688
												Horizontal System:	NAD 1983
												Vertical System:	NGVD 29



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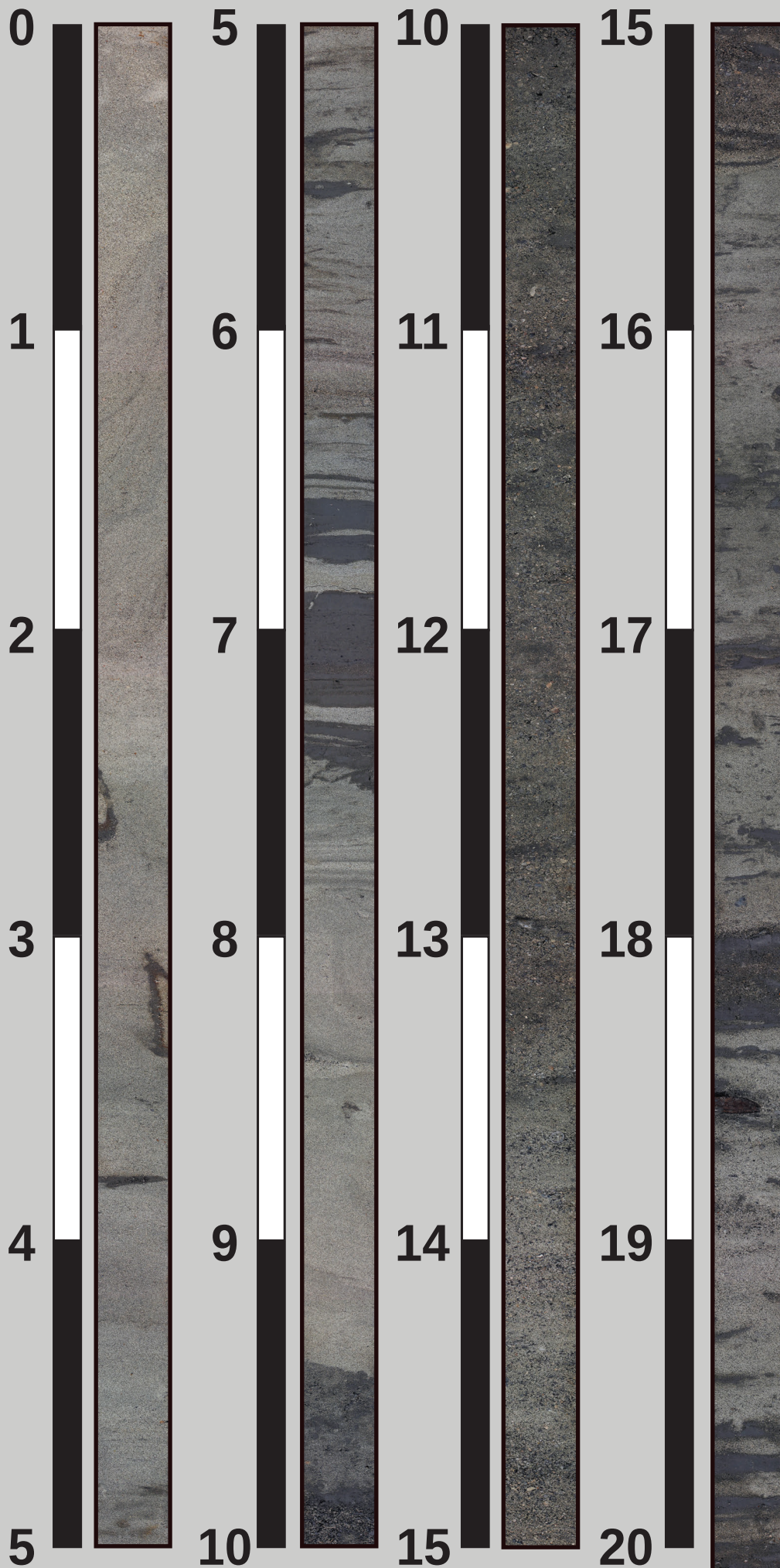
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Jacksonville, Florida 32257
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GRAIN SIZE

Project:	Jay Bird Shoals	Depth:	0- 10.2
Project No.:	EQ175068	Date:	8/3/2017
Boring No.:	BHI2017-03		
Sample No.:	Comp 1		
Description:	Sand, poorly graded, mostly medium to fine quartz, few carbonate, trace silt (SP) 5Y 6/3		

Tare Weight, (g):	49.41	
Dry Wt. Before Washing (g):	164.28	(with tare)
Dry Weight After Washing (g):		(with tare)

Sieve Size (Name)	Sieve Size (mm)	Weight Retained (g)	% Passing
3/4"	19.000	0.00	100.00
5/8"	16.000	0.00	100.00
#3.5	5.600	0.40	99.65
#4	4.750	0.44	99.62
#5	4.000	0.51	99.56
#7	2.800	1.03	99.10
#10	2.000	1.85	98.39
#14	1.400	3.54	96.92
#18	1.000	6.68	94.18
#25	0.710	12.93	88.74
#35	0.500	20.41	82.23
#45	0.355	31.26	72.79
#60	0.250	57.68	49.79
#80	0.180	89.36	22.21
#120	0.125	111.17	3.22
#170	0.090	113.41	1.27
#200	0.075	113.54	1.16
#230	0.063	113.56	1.14



**Olsen
Associates, Inc.**

**Jay Bird Shoals,
Bald Head Island,
North Carolina
July 2017**

BHI2017-04

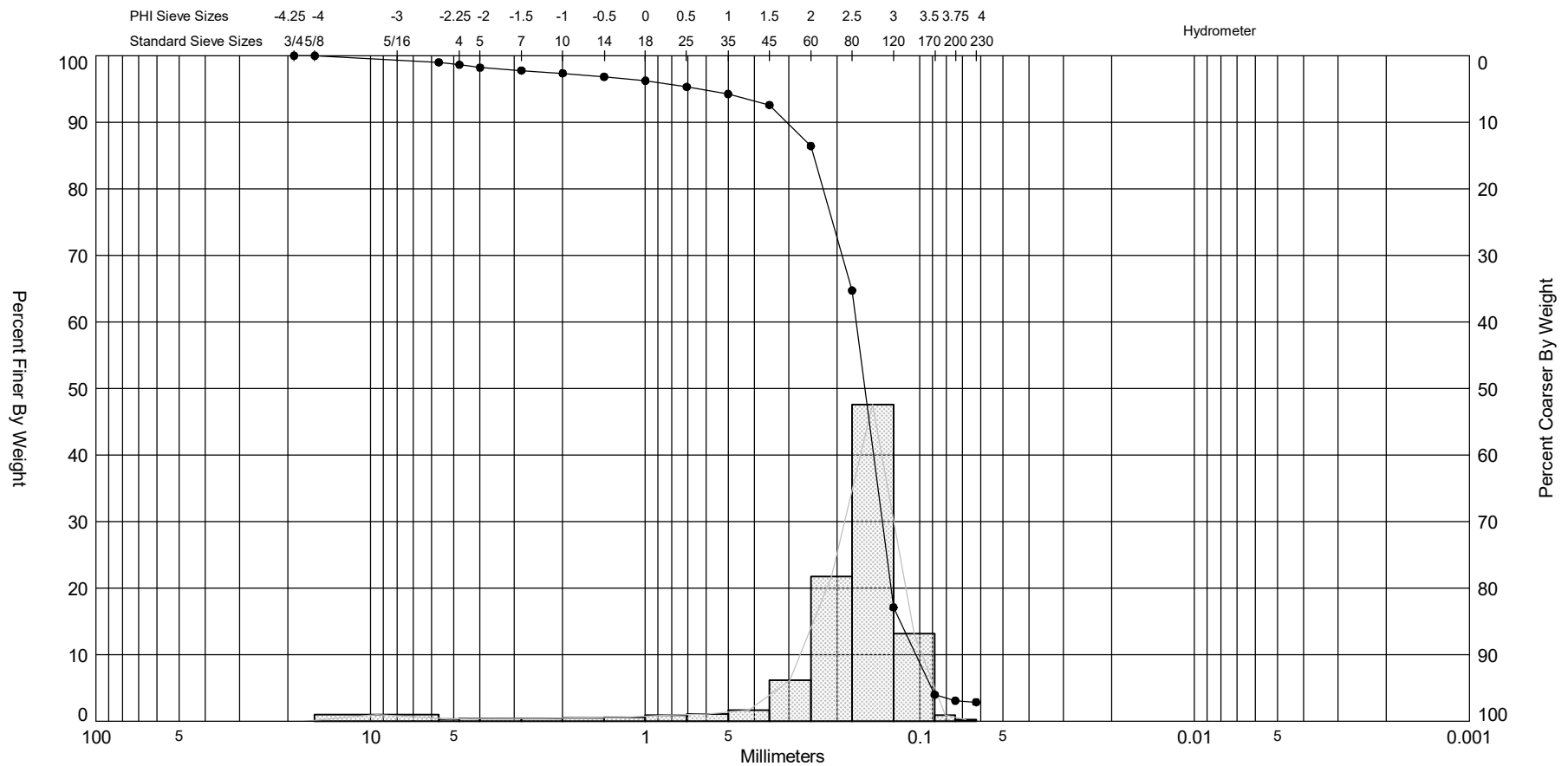
Notes:
Scale in Feet
Photo Mosaic Image



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(843) 887-3800

DRILLING LOG		CLIENT Olsen Associates, Inc.		PROJECT OWNER		SHEET 1 OF 1 SHEETS	
1. PROJECT Jay Bird Shoals Geotechnical Evaluation Bald Head Island, North Carolina				9. SIZE AND TYPE OF BIT 3.0 In.			
2. BORING DESIGNATION BHI2017-04				10. COORDINATE SYSTEM/DATUM NC State Plane		HORIZONTAL NAD 1983	VERTICAL NGVD 29
3. DRILLING AGENCY Athena Technologies, Inc.				11. MANUFACTURER'S DESIGNATION OF DRILL ☐ AUTO HAMMER ☐ MANUAL HAMMER			
4. NAME OF DRILLER P. McClellan				12. TOTAL SAMPLES 1			
5. DIRECTION OF BORING ☒ VERTICAL ☐ INCLINED				13. TOTAL NUMBER CORE BOXES			
6. THICKNESS OF OVERBURDEN 0.0 Ft.				14. WATER DEPTH 15.4 Ft.			
7. DEPTH DRILLED INTO ROCK 0.0 Ft.				15. DATE BORING 07-26-17 08:00			
8. TOTAL DEPTH OF BORING 21.0 Ft.				16. ELEVATION TOP OF BORING -13.5 Ft.			
				17. TOTAL RECOVERY FOR BORING 20.1 Ft.			
				18. SIGNATURE AND TITLE OF INSPECTOR A. Freeze			

ELEV. (ft)	SCALE (ft)	LEGEND	CLASSIFICATION OF MATERIALS Depths and elevations based on measured values	% REC.	BOX OR SAMPLE	REMARKS
-13.5	0.0					
-18.3	4.8		Fine to medium quartz SAND, trace silt in burrows and laminations (primarily at 3.8'), trace fine sand-size shell, poorly graded, loose, subangular to subrounded, 2.4 - 3.4' = silt-lined Callianassa major burrows, color grades to gray (5Y 5/1) from, olive gray (5Y-5/2), (SP).		COMP 1	Sample #COMP 1, Depth = 10.5' Mean (mm): 0.19, Phi Sorting: 1.02 Carbonate: 6.2%, Fines (#200) - 3.08 (SP)
-20.1	6.6		Fine quartz SAND, trace silt in burrows and laminations, trace fine sand-size shell, poorly graded, loose, subangular, gray (5Y-5/1), (SP).			
-21.0	7.5		Sandy SILT, some fine quartz sand in laminations and layers, trace organic silt, soft, low plasticity, dark olive gray (5Y-3/2), (ML).			
-22.9	9.4		Fine quartz SAND, trace fine to medium sand-size shell, trace silt, poorly graded, loose, subangular, gray (5Y-5/1), (SP).			
-23.4	9.9		Fine quartz SAND, few silt in burrows, trace fine to coarse sand-size shell, poorly graded, loose, subangular, dark gray (5Y-4/1), (SP-SM).			
-29.0	15.5		Medium quartz SAND, little fine sand to fine gravel-size shell, few silt in burrows, poorly graded, loose, subrounded, color grades to gray (5Y 5/1) from, very dark gray (5Y-3/1), (SP-SM).			
-33.6	20.1		Fine to medium quartz SAND, few silt in burrows, laminations and layers, trace fine to medium sand-size shell, poorly graded, loose, subangular to subrounded, 18.6' = wood fragment, gray (5Y-5/1), (SP-SM).			
			End of Boring			



Gravel		Sand			Silt and Clay
Coarse	Fine	Coarse	Medium	Fine	

Sample	Symbol	Elev. (ft)	USCS	% Fines	% Organics	% Carbonates	Median	Mean	Skew	Kurt	Sort	Sample Information	
BHI2017-04 #COMP 1	—●—	-24.0	SP	#200 - 3.08 #230 - 2.87		6.20	2.65	2.41	-3.35	16.36	1.02	Project Name:	Jay Bird Shoals Geotechnical Evaluation
Comments: Sample Interval = 0-10.5'												Analysis Date:	08-03-17
Depths and elevations based on measured values												Analyzed By:	CM
												Easting (X, ft):	2,293,117
												Northing (Y, ft):	41,400
												Horizontal System:	NAD 1983
												Vertical System:	NGVD 29
Athena Technologies, Inc. 1293 Graham Farm Road McClellanville, SC 29458 Office: 843-887-3800													



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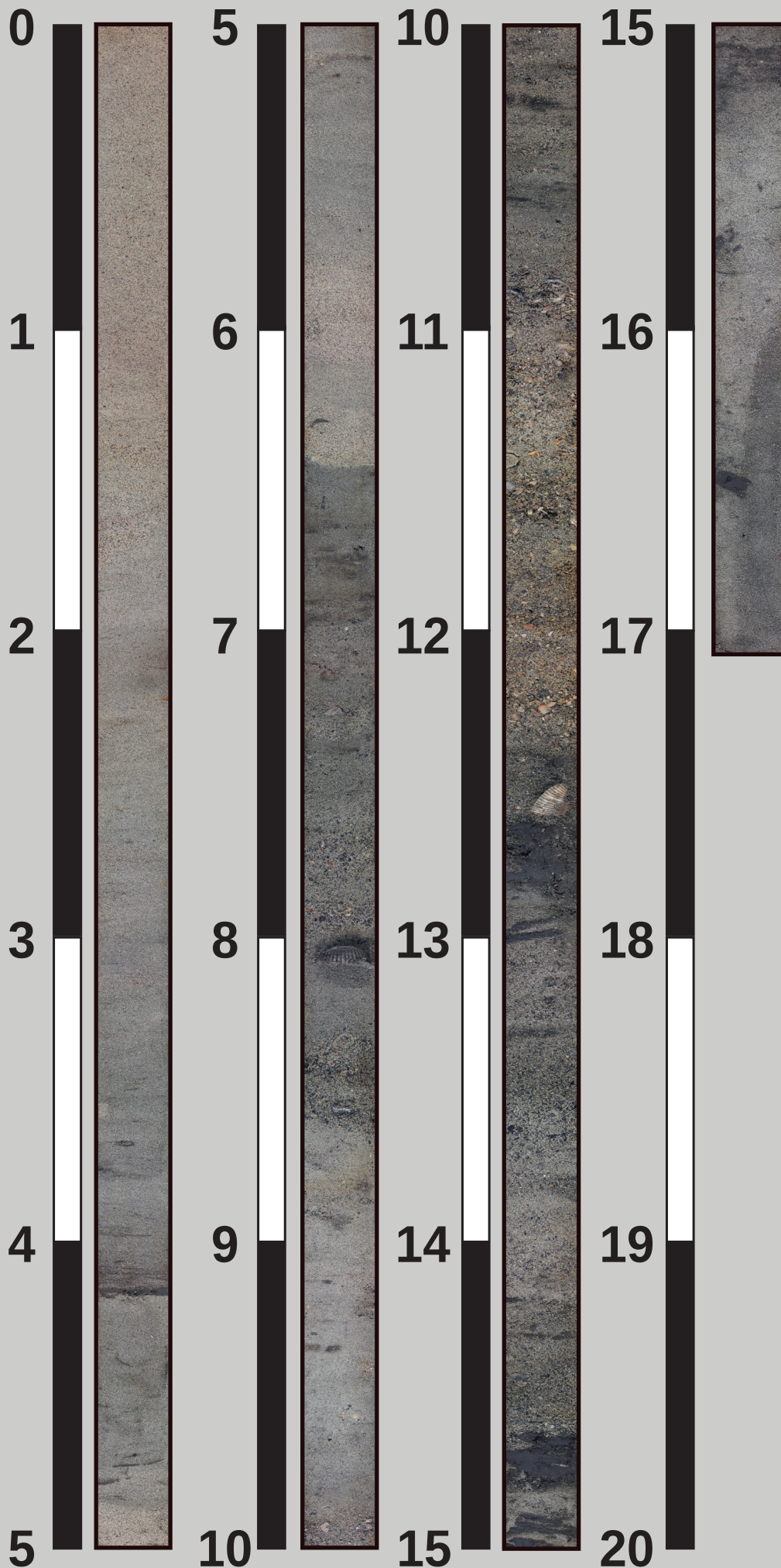
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Jacksonville, Florida 32257
(904) 900-6494 (Tel) • (904) 268-5255 (Fax)

GRAIN SIZE

Project:	Jay Bird Shoals	Depth:	0- 10.5'
Project No.:	EQ175068	Date:	8/3/2017
Boring No.:	BHI2017-04		
Sample No.:	Comp 1		
Description:	Sand, poorly graded, mostly medium to fine quartz, few carbonate, trace silt (SP) 5Y 6/3		

Tare Weight, (g):	49.91	
Dry Wt. Before Washing (g):	163.99	(with tare)
Dry Weight After Washing (g):		(with tare)

Sieve Size (Name)	Sieve Size (mm)	Weight Retained (g)	% Passing
3/4"	19.000	0.00	100.00
5/8"	16.000	0.00	100.00
#3.5	5.600	1.12	99.02
#4	4.750	1.54	98.65
#5	4.000	2.04	98.21
#7	2.800	2.52	97.79
#10	2.000	3.00	97.37
#14	1.400	3.62	96.83
#18	1.000	4.29	96.24
#25	0.710	5.35	95.31
#35	0.500	6.56	94.25
#45	0.355	8.44	92.60
#60	0.250	15.47	86.44
#80	0.180	40.25	64.72
#120	0.125	94.55	17.12
#170	0.090	109.54	3.98
#200	0.075	110.57	3.08
#230	0.063	110.81	2.87



Olsen
Associates, Inc.

Jay Bird Shoals,
Bald Head Island,
North Carolina
July 2017

BHI2017-05

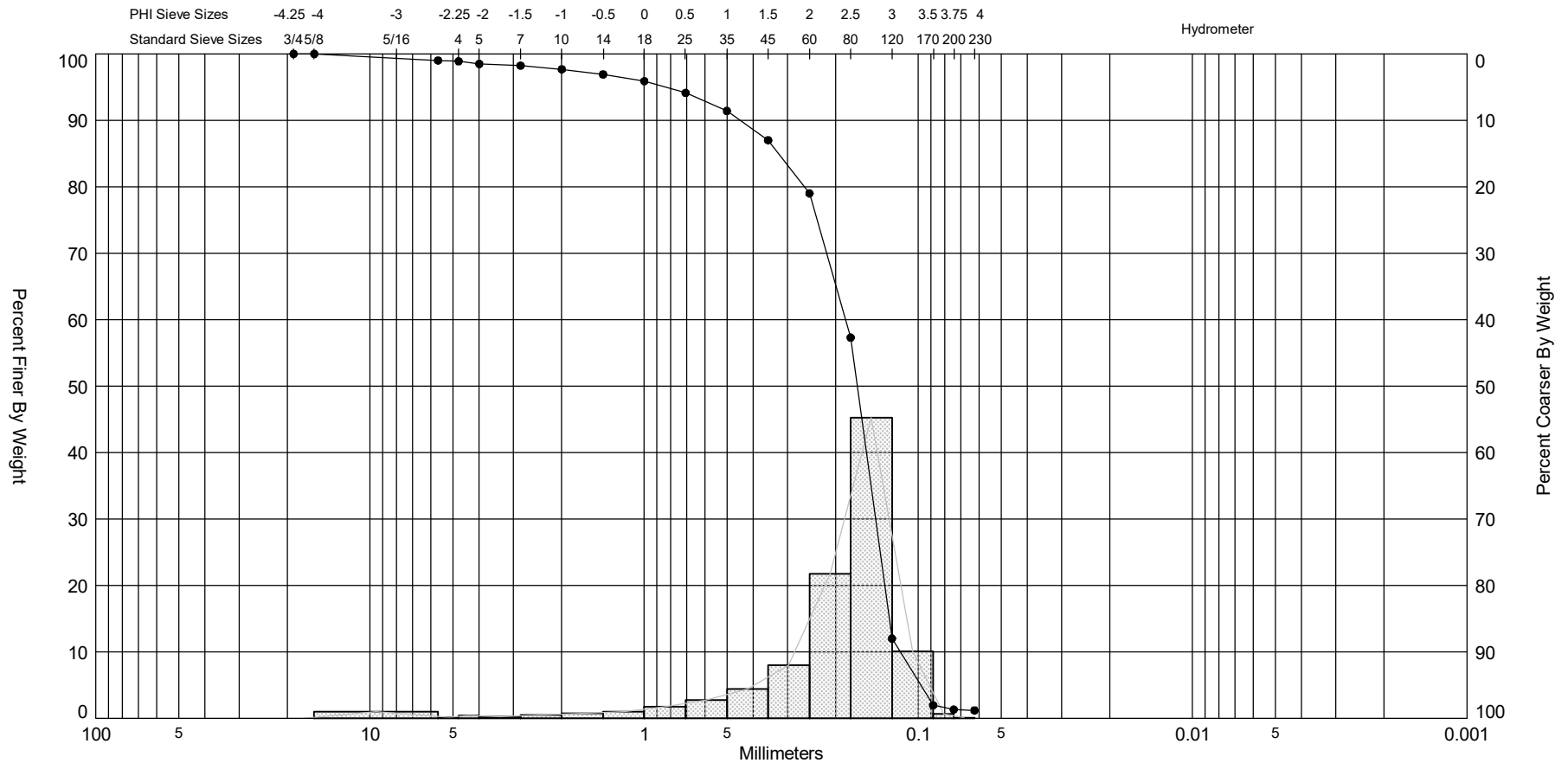
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DRILLING LOG		CLIENT Olsen Associates, Inc.	PROJECT OWNER	SHEET 1 OF 1 SHEETS
1. PROJECT Jay Bird Shoals Geotechnical Evaluation Bald Head Island, North Carolina		9. SIZE AND TYPE OF BIT 3.0 In.		
2. BORING DESIGNATION BHI2017-05		10. COORDINATE SYSTEM/DATUM NC State Plane		
LOCATION COORDINATES X = 2,293,676 Y = 41,730		HORIZONTAL NAD 1983		
3. DRILLING AGENCY Athena Technologies, Inc.		11. MANUFACTURER'S DESIGNATION OF DRILL ☐ AUTO HAMMER ☐ MANUAL HAMMER		
CONTRACTOR FILE NO.		12. TOTAL SAMPLES 1		
4. NAME OF DRILLER P. McClellan		13. TOTAL NUMBER CORE BOXES		
5. DIRECTION OF BORING ☒ VERTICAL ☐ INCLINED		14. WATER DEPTH 15.3 Ft.		
DEG. FROM VERTICAL		15. DATE BORING 07-26-17 07:05		
BEARING		COMPLETED 07-26-17		
6. THICKNESS OF OVERBURDEN 0.0 Ft.		16. ELEVATION TOP OF BORING -14.9 Ft.		
7. DEPTH DRILLED INTO ROCK 0.0 Ft.		17. TOTAL RECOVERY FOR BORING 17.1 Ft.		
8. TOTAL DEPTH OF BORING 20.0 Ft.		18. SIGNATURE AND TITLE OF INSPECTOR A. Freeze		

ELEV. (ft)	SCALE (ft)	LEGEND	CLASSIFICATION OF MATERIALS Depths and elevations based on measured values	% REC.	BOX OR SAMPLE	REMARKS
-14.9	0.0					
-16.7	1.8		Fine to medium quartz SAND, few fine to medium sand-size shell, poorly graded, loose, subangular to subrounded, olive gray (5Y-5/2), (SP).			
-19.8	4.9		Fine quartz SAND, trace silt in burrows, laminations, and flaser beds, trace fine sand-size shell, poorly graded, subangular, gray (5Y-5/1), (SP).			
-21.4	6.5		Fine to medium quartz SAND, trace fine to medium sand-size shell, trace silt in burrows, poorly graded, loose, subangular to subrounded, olive gray (5Y-5/2), (SP).			
-23.5	8.6		Fine to medium quartz SAND, few medium sand to fine gravel-size shell, trace silt in burrows, poorly graded, subrounded, 8.1' = coarse gravel-size clam shell, olive gray (5Y-4/2), (SP).			
-24.8	9.9		Fine quartz SAND, trace silt in burrows, trace fine to coarse sand-size shell, poorly graded, loose, subangular, gray (5Y-6/1), (SP).			
-29.5	14.6		Fine to medium, grading to medium, quartz SAND, little medium sand to fine gravel-size shell, trace silt in burrows and laminations (primarily between 12.4 - 13.0'), poorly graded, loose, subrounded, 12.5' = coarse gravel-size clam shell, olive gray (5Y-4/2), (SP).			
-29.9	15.0		Interbedded SILT (ML), silty SAND (SM), and fine quartz SAND (SP), trace fine to medium sand-size shell, loose/soft, very dark gray (5Y-3/1), (SM).			
-32.0	17.1		Fine quartz SAND, trace silt in burrows, trace fine sand-size shell, poorly graded, loose, subangular, gray (5Y-5/1), (SP).			
			End of Boring			





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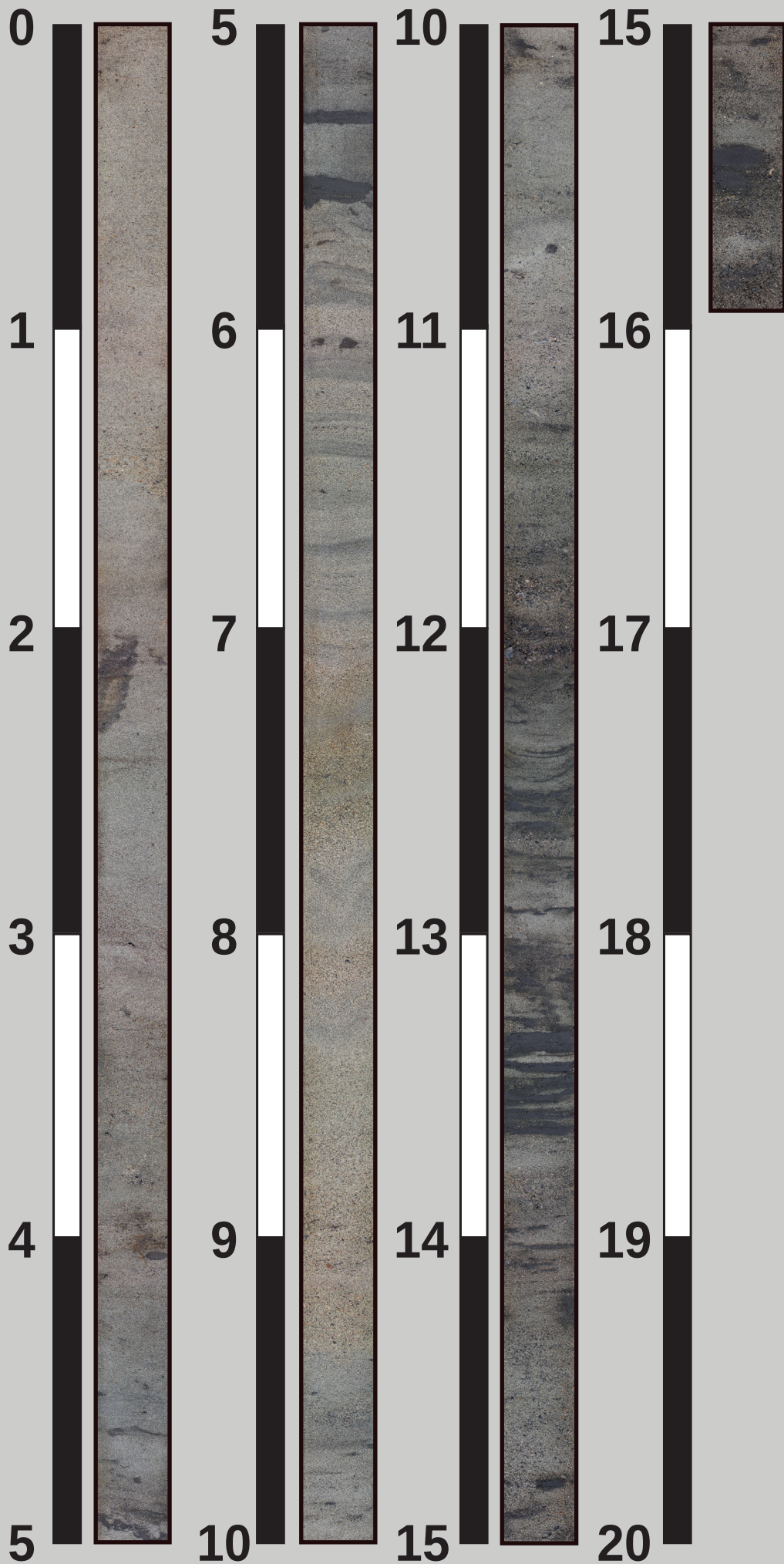
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GRAIN SIZE

Project:	Jay Bird Shoals	Depth:	0- 9.1
Project No.:	EQ175068	Date:	8/3/2017
Boring No.:	BHI2017-05		
Sample No.:	Comp 1		
Description:	Sand, poorly graded, mostly medium to fine quartz, few carbonate, trace silt (SP) 5Y 6/3		

Tare Weight, (g):	49.62	
Dry Wt. Before Washing (g):	167.58	(with tare)
Dry Weight After Washing (g):		(with tare)

Sieve Size (Name)	Sieve Size (mm)	Weight Retained (g)	% Passing
3/4"	19.000	0.00	100.00
5/8"	16.000	0.00	100.00
#3.5	5.600	1.16	99.02
#4	4.750	1.31	98.89
#5	4.000	1.78	98.49
#7	2.800	2.09	98.23
#10	2.000	2.72	97.69
#14	1.400	3.63	96.92
#18	1.000	4.84	95.90
#25	0.710	6.92	94.13
#35	0.500	10.12	91.42
#45	0.355	15.31	87.02
#60	0.250	24.75	79.02
#80	0.180	50.37	57.30
#120	0.125	103.79	12.01
#170	0.090	115.65	1.96
#200	0.075	116.40	1.32
#230	0.063	116.54	1.20



Olsen
Associates, Inc.

Jay Bird Shoals,
Bald Head Island,
North Carolina
July 2017

BHI2017-06

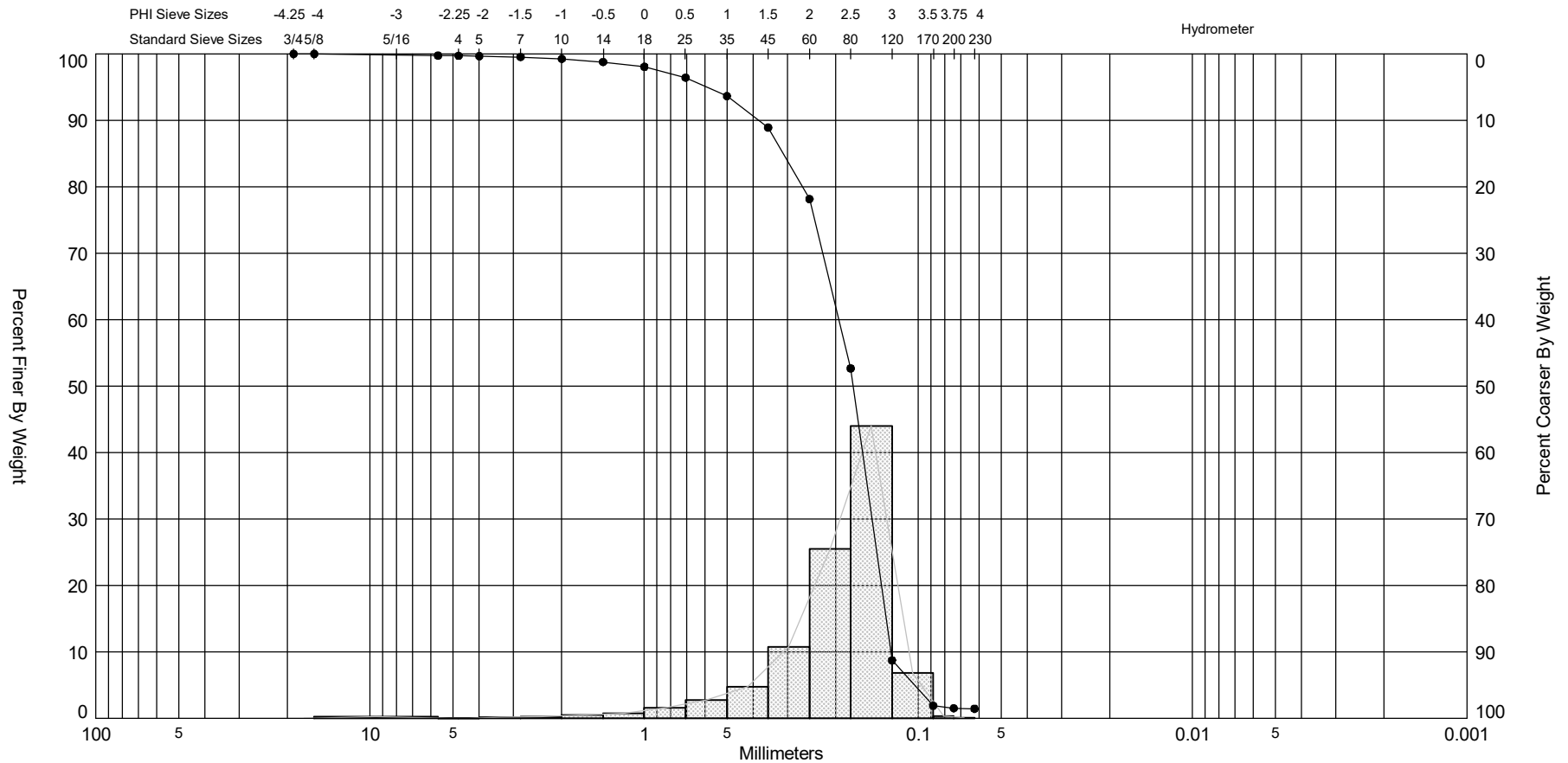
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DRILLING LOG		CLIENT Olsen Associates, Inc.		PROJECT OWNER		SHEET 1 OF 1 SHEETS	
1. PROJECT Jay Bird Shoals Geotechnical Evaluation Bald Head Island, North Carolina				9. SIZE AND TYPE OF BIT 3.0 In.			
2. BORING DESIGNATION BHI2017-06				10. COORDINATE SYSTEM/DATUM NC State Plane		HORIZONTAL NAD 1983	
3. DRILLING AGENCY Athena Technologies, Inc.				11. MANUFACTURER'S DESIGNATION OF DRILL		☐ AUTO HAMMER ☐ MANUAL HAMMER	
4. NAME OF DRILLER P. McClellan				12. TOTAL SAMPLES		DISTURBED 1	
5. DIRECTION OF BORING ☒ VERTICAL ☐ INCLINED				13. TOTAL NUMBER CORE BOXES		UNDISTURBED (UD)	
6. THICKNESS OF OVERBURDEN 0.0 Ft.				14. WATER DEPTH 15.2 Ft.		15. DATE BORING	
7. DEPTH DRILLED INTO ROCK 0.0 Ft.				16. ELEVATION TOP OF BORING -14.1 Ft.		STARTED 07-26-17 07:31	
8. TOTAL DEPTH OF BORING 18.0 Ft.				17. TOTAL RECOVERY FOR BORING 15.9 Ft.		COMPLETED 07-26-17	
				18. SIGNATURE AND TITLE OF INSPECTOR A. Freeze			

ELEV. (ft)	SCALE (ft)	LEGEND	CLASSIFICATION OF MATERIALS Depths and elevations based on measured values	% REC.	BOX OR SAMPLE	REMARKS
-14.1	0.0					
-15.6	1.5		Fine quartz SAND, few fine to medium sand-size shell, poorly graded, loose, subangular, olive gray (5Y-5/2), (SP).			
-21.4	7.3		Fine quartz SAND, trace silt in burrows, laminations, and rip-up clasts, trace fine to medium sand-size shell, poorly graded, loose, subangular, 2.0 - 2.3' = silt-lined Callianassa major burrow, color grades to gray (5Y 5/1) from, olive gray (5Y-5/2), (SP).		COMP 1	Sample #COMP 1, Depth = 9.9' Mean (mm): 0.20, Phi Sorting: 0.79 Carbonate: 4.1%, Fines (#200) - 1.52 (SP)
-23.4	9.3		Fine to medium quartz SAND, few fine to medium sand-size shell, poorly graded, loose, subrounded, olive gray (5Y-5/2), (SP).			
-24.9	10.8		Fine quartz SAND, trace silt in burrows, trace fine to medium sand-size shell, poorly graded, loose, subangular, gray (5Y-5/1), (SP).			
-26.2	12.1		Fine to medium quartz SAND, few fine to coarse sand-size shell, trace silt, poorly graded, loose, subrounded, gray (5Y-5/1), (SP).			
-27.8	13.7		Fine quartz SAND, few silt in burrows and laminations, poorly graded, loose, subangular, dark gray (5Y-4/1), (SP-SM).			
-30.0	15.9		Fine to medium quartz SAND, few fine to coarse sand-size shell, trace silt in burrows, laminations, and rip-up clasts, poorly graded, loose, subrounded, color grades to very dark gray (5Y 3/1) from, gray (5Y-5/1), (SP).			
			End of Boring			



Gravel		Sand			Silt and Clay
Coarse	Fine	Coarse	Medium	Fine	

Sample	Symbol	Elev. (ft)	USCS	% Fines	% Organics	% Carbonates	Median	Mean	Skew	Kurt	Sort	Sample Information	
BHI2017-06 #COMP 1	—●—	-24.0	SP	#200 - 1.52 #230 - 1.45		4.10	2.53	2.3	-2.4	12.41	0.79	Project Name:	Jay Bird Shoals Geotechnical Evaluation
Comments: Sample Interval = 0-9.9'												Analysis Date:	08-03-17
Depths and elevations based on measured values												Analyzed By:	CM
 Athena Technologies, Inc. 1293 Graham Farm Road McClellanville, SC 29458 Office: 843-887-3800												Easting (X, ft):	2,293,879
												Northing (Y, ft):	42,117
												Horizontal System:	NAD 1983
												Vertical System:	NGVD 29



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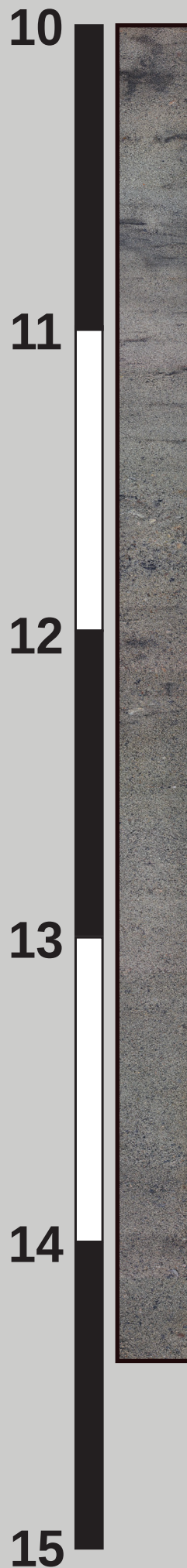
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GRAIN SIZE

Project:	Jay Bird Shoals	Depth:	0- 9.9
Project No.:	EQ175068	Date:	8/3/2017
Boring No.:	BHI2017-06		
Sample No.:	Comp 1		
Description:	Sand, poorly graded, mostly medium to fine quartz, few carbonate, trace silt (SP) 5Y 6/3		

Tare Weight, (g):	50.28	
Dry Wt. Before Washing (g):	163.99	(with tare)
Dry Weight After Washing (g):		(with tare)

Sieve Size (Name)	Sieve Size (mm)	Weight Retained (g)	% Passing
3/4"	19.000	0.00	100.00
5/8"	16.000	0.00	100.00
#3.5	5.600	0.28	99.75
#4	4.750	0.33	99.71
#5	4.000	0.38	99.67
#7	2.800	0.52	99.54
#10	2.000	0.83	99.27
#14	1.400	1.38	98.79
#18	1.000	2.22	98.05
#25	0.710	4.05	96.44
#35	0.500	7.22	93.65
#45	0.355	12.60	88.92
#60	0.250	24.85	78.15
#80	0.180	53.82	52.67
#120	0.125	103.81	8.71
#170	0.090	111.56	1.89
#200	0.075	111.98	1.52
#230	0.063	112.06	1.45



**Olsen
Associates, Inc.**

**Jay Bird Shoals,
Bald Head Island,
North Carolina
July 2017**

BHI2017-07

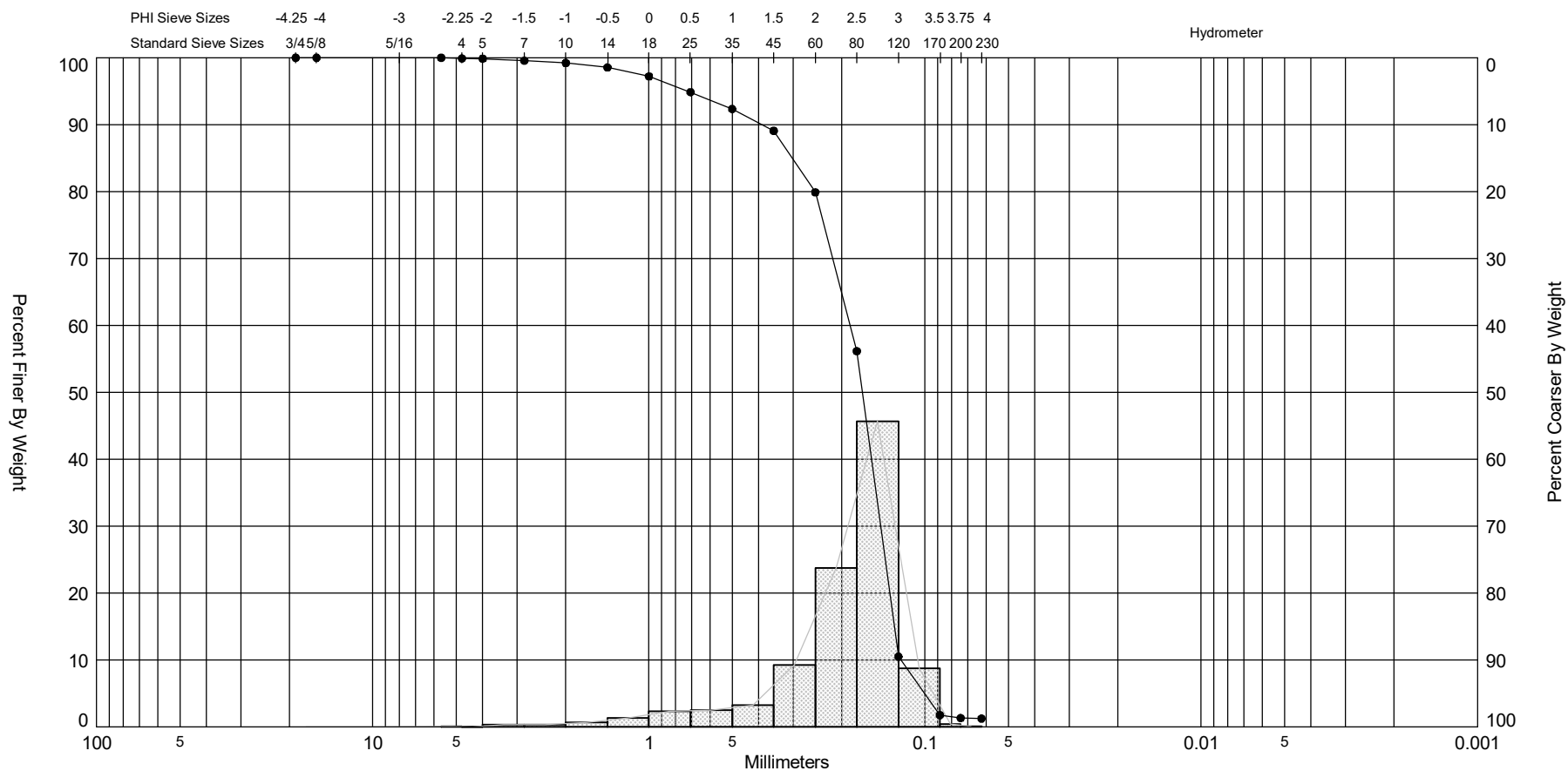
Notes:
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DRILLING LOG		CLIENT Olsen Associates, Inc.		PROJECT OWNER		SHEET 1 OF 1 SHEETS	
1. PROJECT Jay Bird Shoals Geotechnical Evaluation Bald Head Island, North Carolina				9. SIZE AND TYPE OF BIT 3.0 In.			
2. BORING DESIGNATION BHI2017-07				10. COORDINATE SYSTEM/DATUM NC State Plane		HORIZONTAL NAD 1983	VERTICAL NGVD 29
3. DRILLING AGENCY Athena Technologies, Inc.				11. MANUFACTURER'S DESIGNATION OF DRILL ☐ AUTO HAMMER ☐ MANUAL HAMMER			
4. NAME OF DRILLER P. McClellan				12. TOTAL SAMPLES 1			
5. DIRECTION OF BORING ☒ VERTICAL ☐ INCLINED				13. TOTAL NUMBER CORE BOXES			
6. THICKNESS OF OVERBURDEN 0.0 Ft.				14. WATER DEPTH 16.3 Ft.			
7. DEPTH DRILLED INTO ROCK 0.0 Ft.				15. DATE BORING 07-26-17 09:35			
8. TOTAL DEPTH OF BORING 16.7 Ft.				16. ELEVATION TOP OF BORING -12.3 Ft.			
				17. TOTAL RECOVERY FOR BORING 14.4 Ft.			
				18. SIGNATURE AND TITLE OF INSPECTOR A. Freeze			

ELEV. (ft)	SCALE (ft)	LEGEND	CLASSIFICATION OF MATERIALS Depths and elevations based on measured values	% REC.	BOX OR SAMPLE	REMARKS
-12.3	0.0					
-13.7	1.4		Fine to medium quartz SAND, few fine to coarse sand-size shell, poorly graded, loose, subrounded, olive gray (5Y-5/2), (SP).			
-20.7	8.4		Fine quartz SAND, trace silt in burrows and flaser beds, trace fine to medium sand-size shell, poorly graded, loose, subangular, 1.7' = silt-lined Callianassa major burrow, gray (5Y-5/1), (SP).		COMP 1	Sample #COMP 1, Depth = 11.7' Mean (mm): 0.20, Phi Sorting: 0.83 Carbonate: 5.5%, Fines (#200) - 1.31 (SP)
-21.6	9.3		Fine to medium quartz SAND, few fine to medium sand-size shell, trace silt in burrows, poorly graded, loose, subrounded, olive gray (5Y-5/2), (SP).			
-23.8	11.5		Fine quartz SAND, trace silt in burrows, trace fine sand-size shell, poorly graded, loose, subangular, gray (5Y-5/1), (SP).			
-26.7	14.4		Fine to medium quartz SAND, few fine to coarse sand-size shell, trace silt in burrows, poorly graded, loose, subrounded, gray (5Y-5/1), (SP).			
			End of Boring			



Gravel		Sand			Silt and Clay
Coarse	Fine	Coarse	Medium	Fine	

Sample	Symbol	Elev. (ft)	USCS	% Fines	% Organics	% Carbonates	Median	Mean	Skew	Kurt	Sort	Sample Information	
BHI2017-07 #COMP 1	—●—	-24.0	SP	#200 - 1.31 #230 - 1.23		5.50	2.57	2.33	-2.1	8.56	0.83	Project Name:	Jay Bird Shoals Geotechnical Evaluation
Comments: Sample Interval = 0-11.7'												Analysis Date:	08-03-17
Depths and elevations based on measured values												Analyzed By:	CM
												Easting (X, ft):	2,294,099
												Northing (Y, ft):	42,388
												Horizontal System:	NAD 1983
												Vertical System:	NGVD 29
Athena Technologies, Inc. 1293 Graham Farm Road McClellanville, SC 29458 Office: 843-887-3800													



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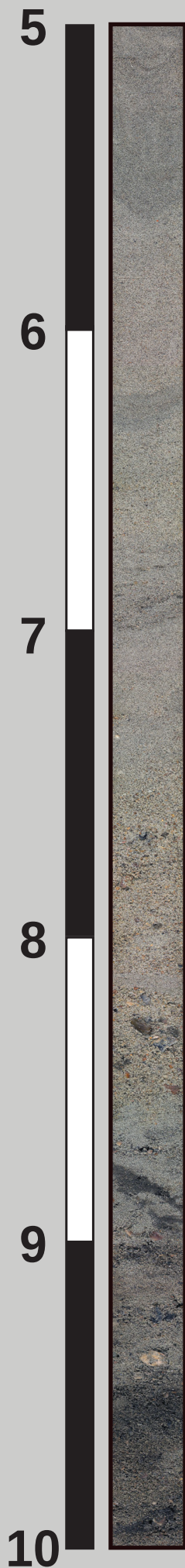
9455 Florida Mining Blvd. West, Ste. 509
Jacksonville, Florida 32257
(904) 900-6494 (Tel) • (904) 268-5255 (Fax)

GRAIN SIZE

Project:	Jay Bird Shoals	Depth:	0- 11.7
Project No.:	EQ175068	Date:	8/3/2017
Boring No.:	BHI2017-07		
Sample No.:	Comp 1		
Description:	Sand, poorly graded, mostly medium to fine quartz, few carbonate, trace silt (SP) 5Y 6/3		

Tare Weight, (g):	48.99	
Dry Wt. Before Washing (g):	172.29	(with tare)
Dry Weight After Washing (g):		(with tare)

Sieve Size (Name)	Sieve Size (mm)	Weight Retained (g)	% Passing
3/4"	19.000	0.00	100.00
5/8"	16.000	0.00	100.00
#3.5	5.600	0.00	100.00
#4	4.750	0.12	99.90
#5	4.000	0.16	99.87
#7	2.800	0.53	99.57
#10	2.000	0.96	99.22
#14	1.400	1.79	98.55
#18	1.000	3.44	97.21
#25	0.710	6.32	94.87
#35	0.500	9.43	92.35
#45	0.355	13.45	89.09
#60	0.250	24.81	79.88
#80	0.180	54.07	56.15
#120	0.125	110.37	10.49
#170	0.090	121.13	1.76
#200	0.075	121.68	1.31
#230	0.063	121.78	1.23



**Olsen
Associates, Inc.**

**Jay Bird Shoals,
Bald Head Island,
North Carolina
July 2017**

BHI2017-08

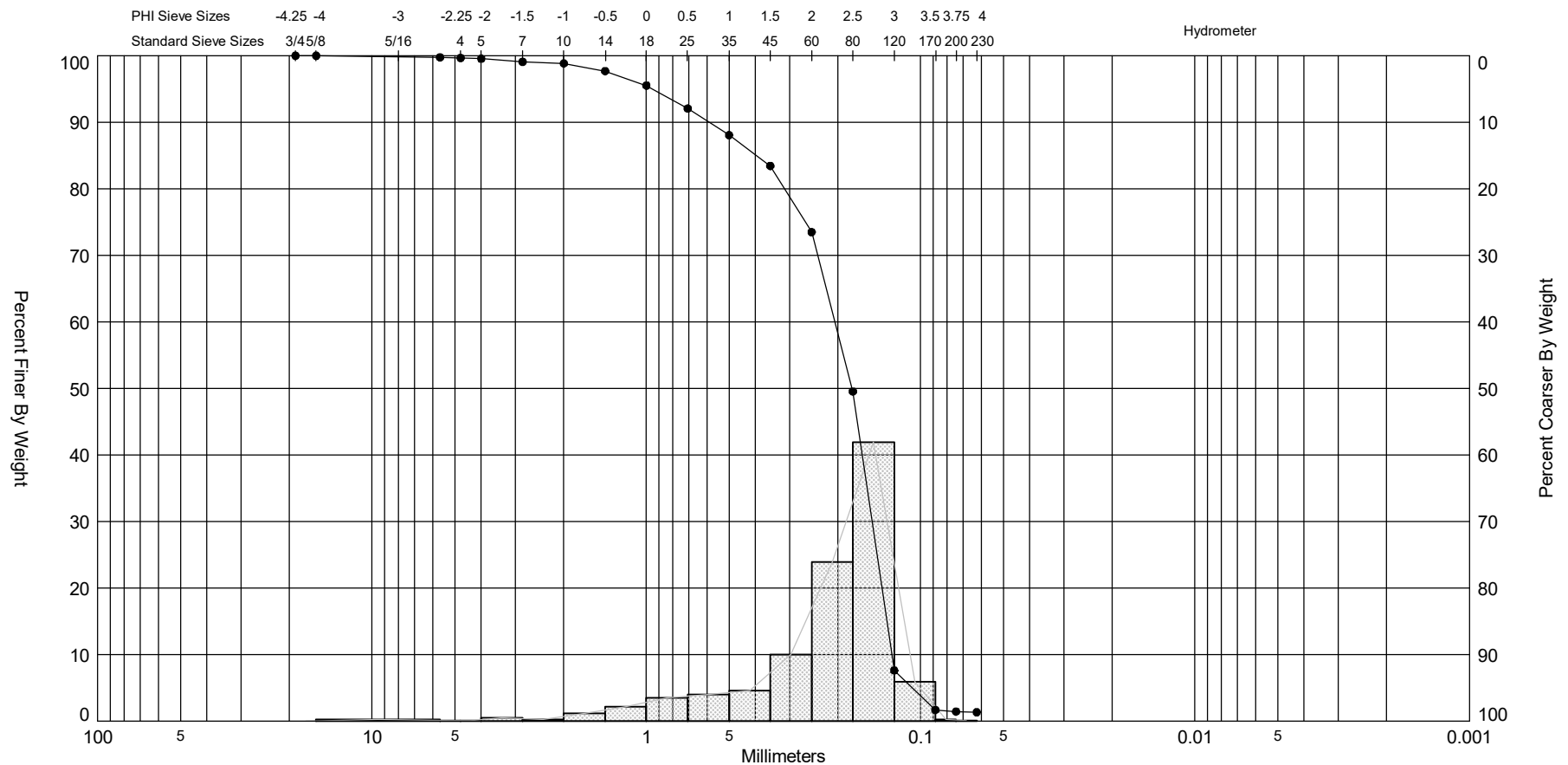
Notes:
Scale in Feet
Photo Mosaic Image



Athena Technologies, Inc.
1293 Graham Farm Road
McClellanville, SC 29458
www.athenatechnologies.com
(843) 887-3800

DRILLING LOG		CLIENT Olsen Associates, Inc.	PROJECT OWNER	SHEET 1 OF 1 SHEETS
1. PROJECT Jay Bird Shoals Geotechnical Evaluation Bald Head Island, North Carolina		9. SIZE AND TYPE OF BIT 3.0 In.		
2. BORING DESIGNATION BHI2017-08		10. COORDINATE SYSTEM/DATUM NC State Plane		
LOCATION COORDINATES X = 2,294,521 Y = 42,096		HORIZONTAL NAD 1983 VERTICAL NGVD 29		
3. DRILLING AGENCY Athena Technologies, Inc.		11. MANUFACTURER'S DESIGNATION OF DRILL ☐ AUTO HAMMER ☐ MANUAL HAMMER		
CONTRACTOR FILE NO.		12. TOTAL SAMPLES 1		
4. NAME OF DRILLER P. McClellan		13. TOTAL NUMBER CORE BOXES		
5. DIRECTION OF BORING ☒ VERTICAL ☐ INCLINED		14. WATER DEPTH 14.9 Ft.		
DEG. FROM VERTICAL		15. DATE BORING 07-26-17 06:31		
BEARING		COMPLETED 07-26-17		
6. THICKNESS OF OVERBURDEN 0.0 Ft.		16. ELEVATION TOP OF BORING -14.6 Ft.		
7. DEPTH DRILLED INTO ROCK 0.0 Ft.		17. TOTAL RECOVERY FOR BORING 11 Ft.		
8. TOTAL DEPTH OF BORING 12.5 Ft.		18. SIGNATURE AND TITLE OF INSPECTOR A. Freeze		

ELEV. (ft)	SCALE (ft)	LEGEND	CLASSIFICATION OF MATERIALS Depths and elevations based on measured values	% REC.	BOX OR SAMPLE	REMARKS
-14.6	0.0					
-15.1	0.5		Fine to medium quartz SAND, few medium to coarse sand-size shell, poorly graded, loose, subrounded, grayish brown (2.5Y-5/2), (SP).			
			Fine quartz SAND, trace silt in burrows, laminations, and flaser beds, trace fine to medium sand-size shell, poorly graded, loose, subangular, gray (5Y-5/1), (SP).		COMP 1	Sample #COMP 1, Depth = 9.4' Mean (mm): 0.22, Phi Sorting: 0.97 Carbonate: 6.4%, Fines (#200) - 1.44 (SP)
-22.1	7.5		Medium quartz SAND, few medium sand to fine gravel-size shell, trace silt in burrows, poorly graded, loose, subrounded, grayish brown (2.5Y-5/2), (SP).			
-23.1	8.5		Fine to medium quartz SAND, few medium sand to fine gravel-size shell, trace silt in burrows, trace coarse quartz sand, poorly graded, loose, subangular to subrounded, gray (5Y-5/1), (SP).			
-24.1	9.5		Medium quartz SAND, few silt, trace medium to coarse sand-size shell, poorly graded, loose, subrounded, dark olive gray (5Y-3/2), (SP-SM).			
-25.6	11.0		End of Boring			



Gravel		Sand			Silt and Clay
Coarse	Fine	Coarse	Medium	Fine	

Sample	Symbol	Elev. (ft)	USCS	% Fines	% Organics	% Carbonates	Median	Mean	Skew	Kurt	Sort	Sample Information	
BHI2017-08 #COMP 1		-24.0	SP	#200 - 1.44 #230 - 1.34		6.40	2.49	2.16	-1.95	7.7	0.97	Project Name:	Jay Bird Shoals Geotechnical Evaluation
Comments: Sample Interval = 0-9.4'												Analysis Date:	08-03-17
Depths and elevations based on measured values												Analyzed By:	CM
						Athena Technologies, Inc. 1293 Graham Farm Road McClellanville, SC 29458 Office: 843-887-3800						Easting (X, ft):	2,294,521
												Northing (Y, ft):	42,096
												Horizontal System:	NAD 1983
												Vertical System:	NGVD 29



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GRAIN SIZE

Project:	Jay Bird Shoals	Depth:	0- 9.4
Project No.:	EQ175068	Date:	8/3/2017
Boring No.:	BHI2017-08		
Sample No.:	Comp 1		
Description:	Sand, poorly graded, mostly medium to fine quartz, few carbonate, trace silt (SP) 5Y 6/3		

Tare Weight, (g):	50.38	
Dry Wt. Before Washing (g):	181.35	(with tare)
Dry Weight After Washing (g):		(with tare)

Sieve Size (Name)	Sieve Size (mm)	Weight Retained (g)	% Passing
3/4"	19.000	0.00	100.00
5/8"	16.000	0.00	100.00
#3.5	5.600	0.32	99.76
#4	4.750	0.45	99.66
#5	4.000	0.59	99.55
#7	2.800	1.19	99.09
#10	2.000	1.51	98.85
#14	1.400	3.01	97.70
#18	1.000	5.86	95.53
#25	0.710	10.40	92.06
#35	0.500	15.63	88.07
#45	0.355	21.68	83.45
#60	0.250	34.73	73.48
#80	0.180	66.09	49.54
#120	0.125	120.99	7.62
#170	0.090	128.76	1.69
#200	0.075	129.08	1.44
#230	0.063	129.21	1.34

Appendix B: Terracon Carbonate Content Summary



Carbonate Content Data

Project Name:	Jay Bird Shoals
Project Number:	EQ175068
Date:	8/4/2017

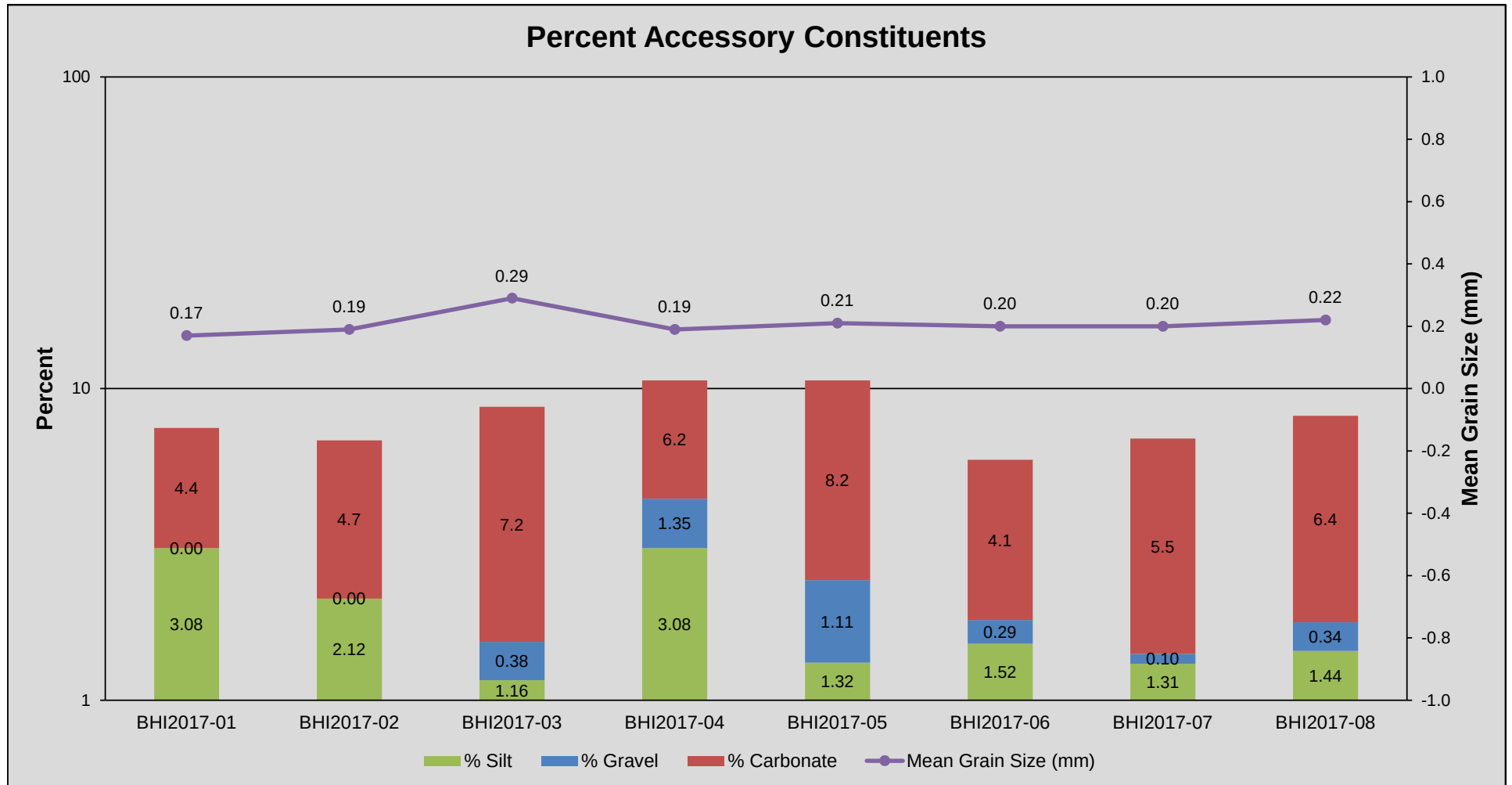
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Tested By: CRM Sr.

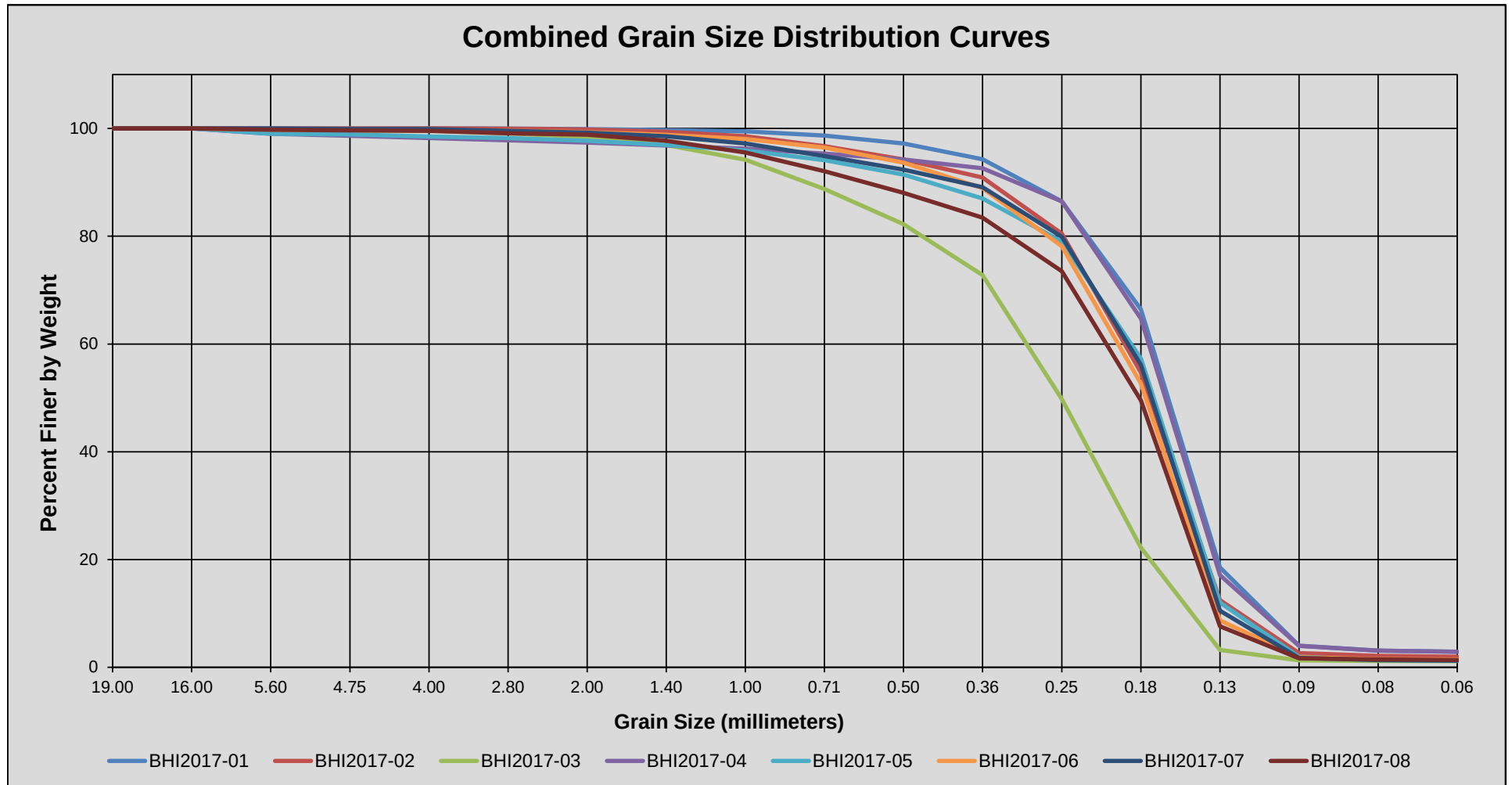
Reviewed By: TES

Appendix C: Grain Size Data Summary Graphs

Appendix C
Grain Size Data Summary Graphs
Olsen Associates, Inc.
Jay Bird Shoals, Bald Head Island, North Carolina
July 2017



Appendix C
Grain Size Data Summary Graphs
Olsen Associates, Inc.
Jay Bird Shoals, Bald Head Island, North Carolina
July 2017



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Grain Size Data Summary Graphs
Olsen Associates, Inc.
Jay Bird Shoals, Bald Head Island, North Carolina
July 2017

