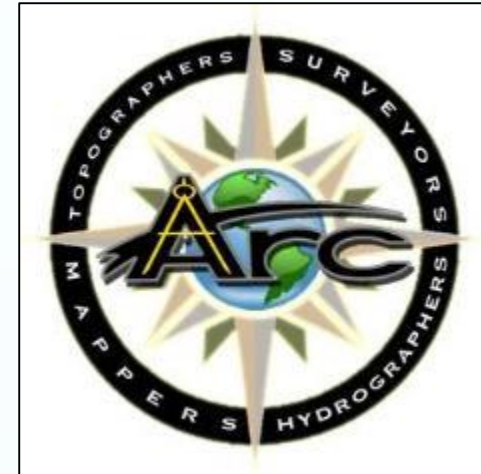


AAPA 2019 Facilities Engineering Seminar
24 – 26 April 2019
Jacksonville, Florida



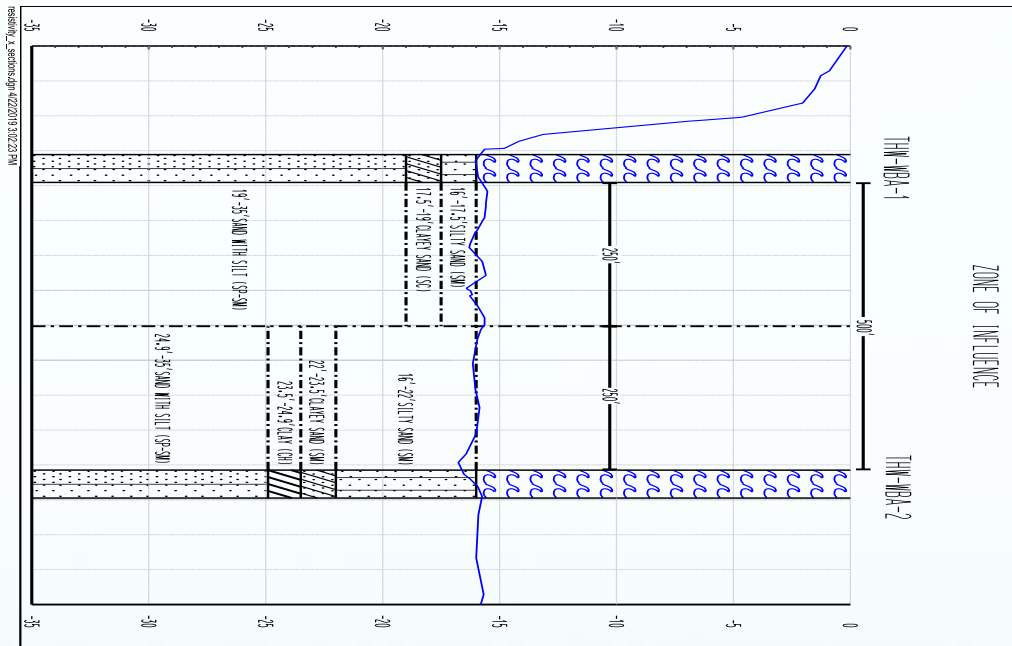
JACOBS



Bathymetric & Geophysical
Port Surveys
GIS/BIM Technology



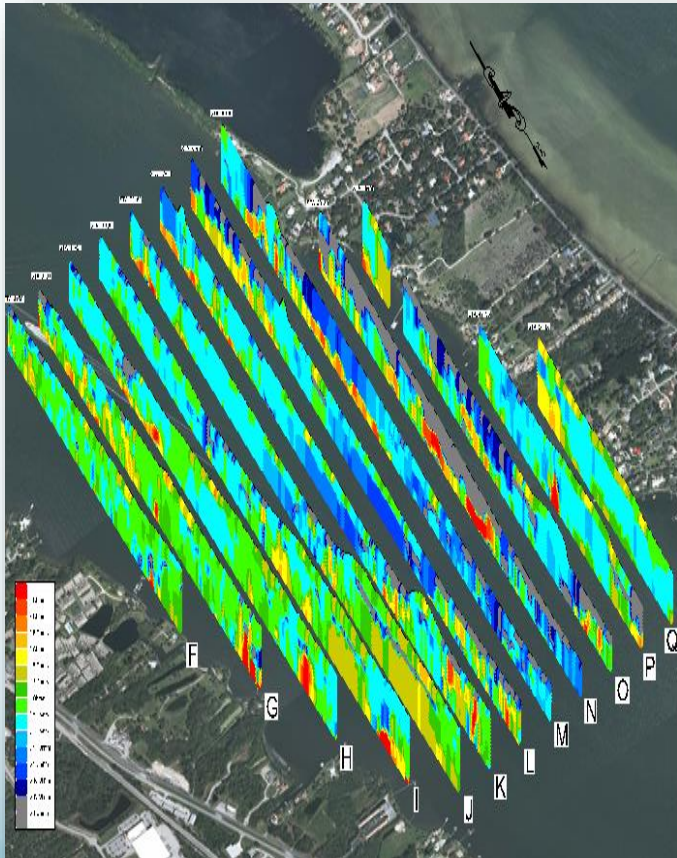
The Subsurface Problem



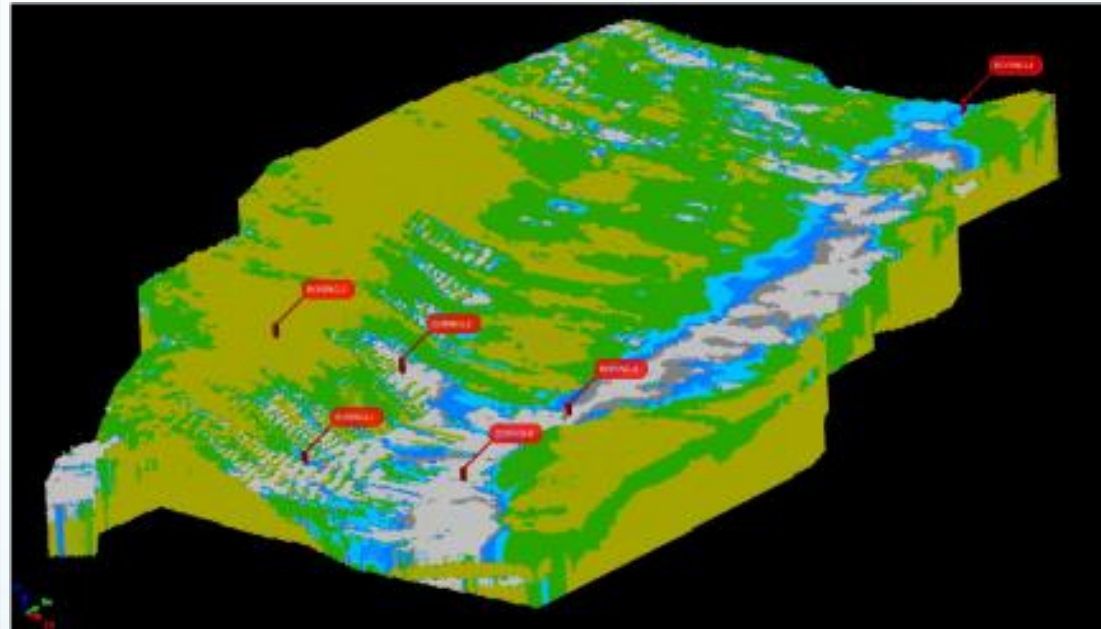
How do you describe subsurface conditions between individual borings?

The Geophysical Solution

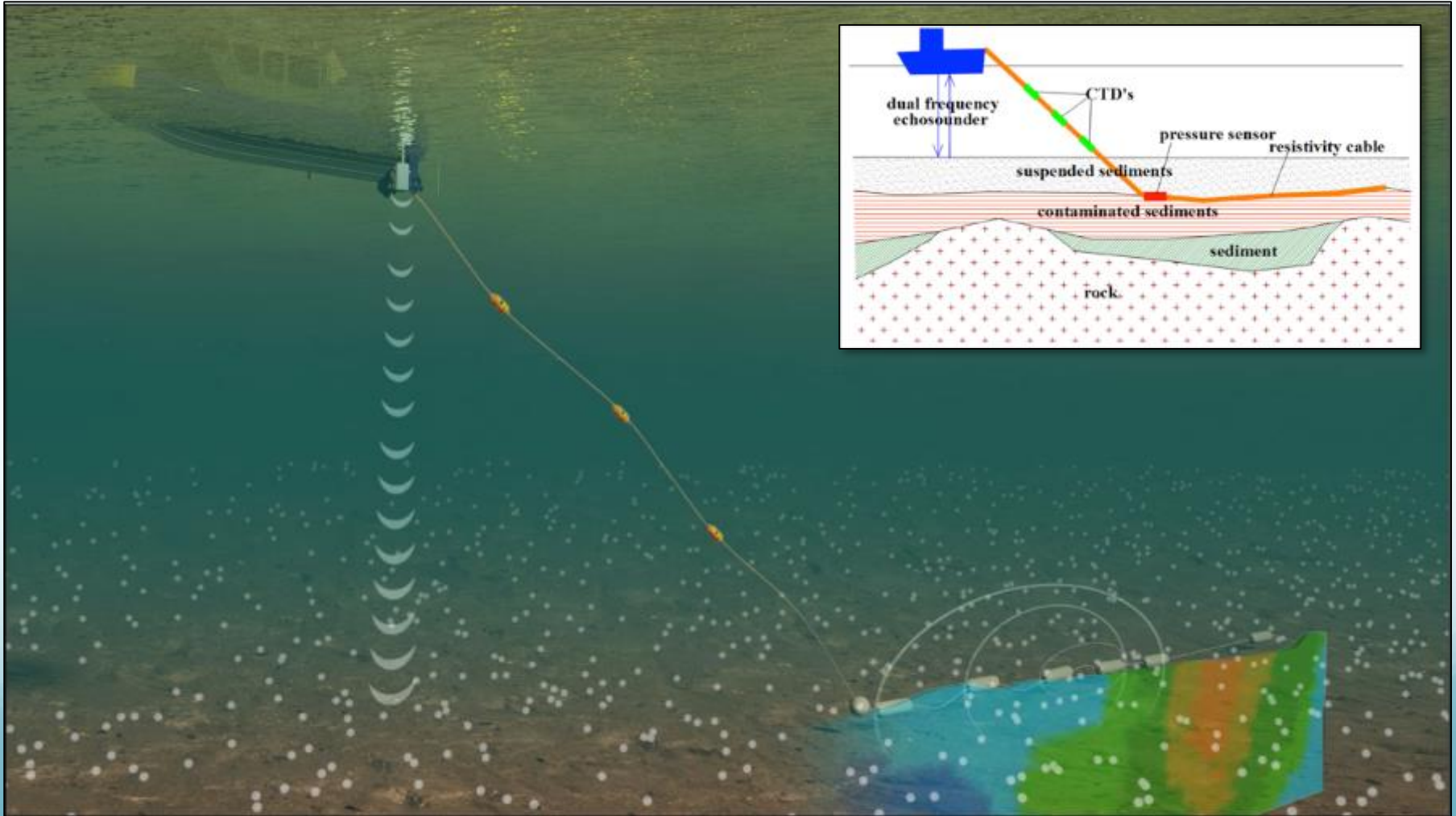
Resistivity Profiles



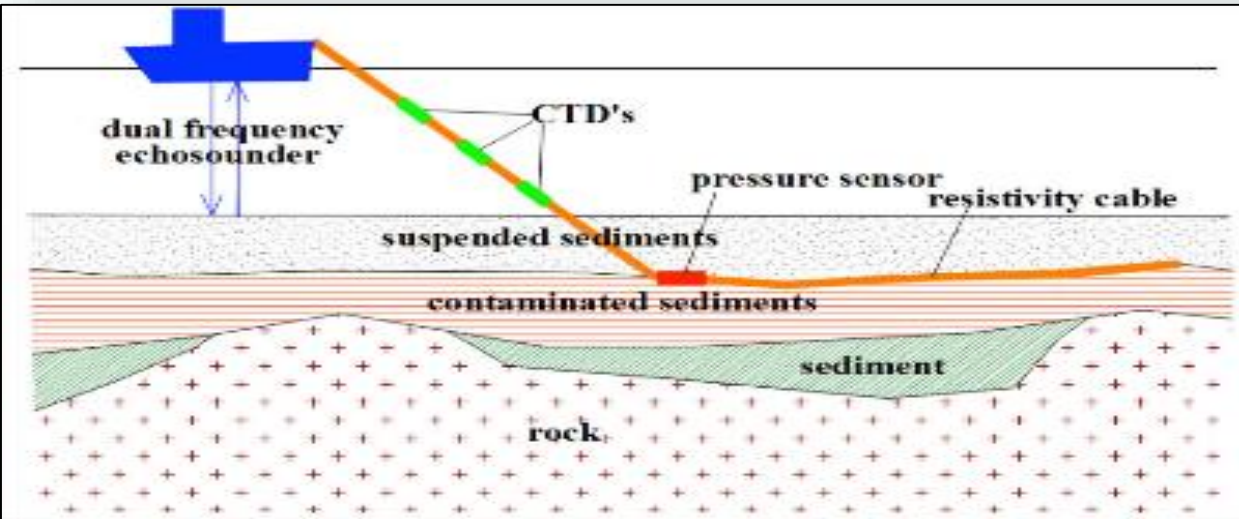
Generate a 4D Model *Choose Boring Locations*



The Aquares System



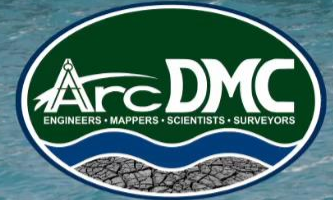
Geophysical Survey Procedure



- Horizontal & Vertical Control (RTK/GPS)
- Bathymetric Survey
- Resistivity Geophysical Survey
- Generate a 4D Geophysical Model
- Select Vibracore or Core Boring Locations
- Import Geotechnical Data into Model
- Characterization & Chemical Testing
- Provide Maps & Quantities



ArcDMC Sediment Solutions, LCC



Geophysical Contaminated Sediment Survey

Site Investigation Methods

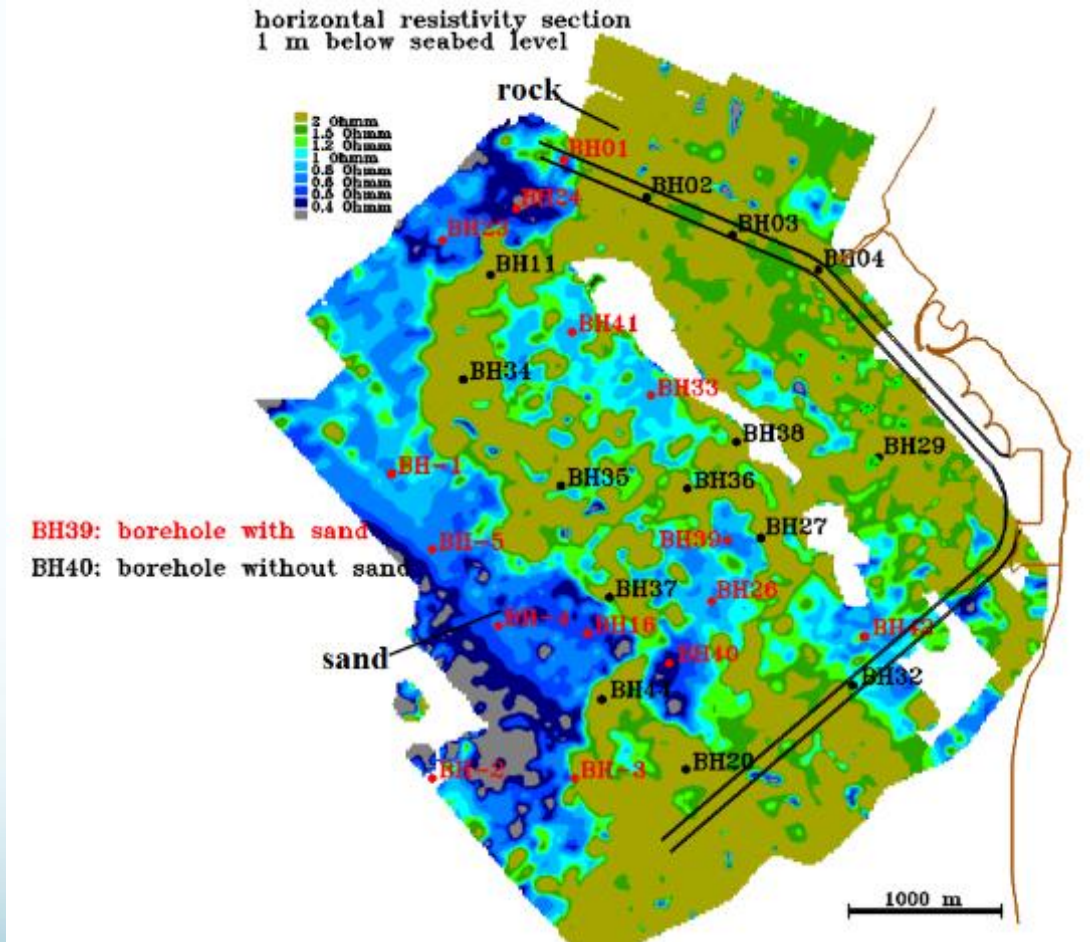
Geophysics

- Defining horizontal and vertical extent of geological structures
- Defining dredge volumes
- Relatively fast and inexpensive

Boreholes

- Targeting geophysical structures defined by geophysical methods
- Defining geotechnical parameters
- Expensive and time consuming

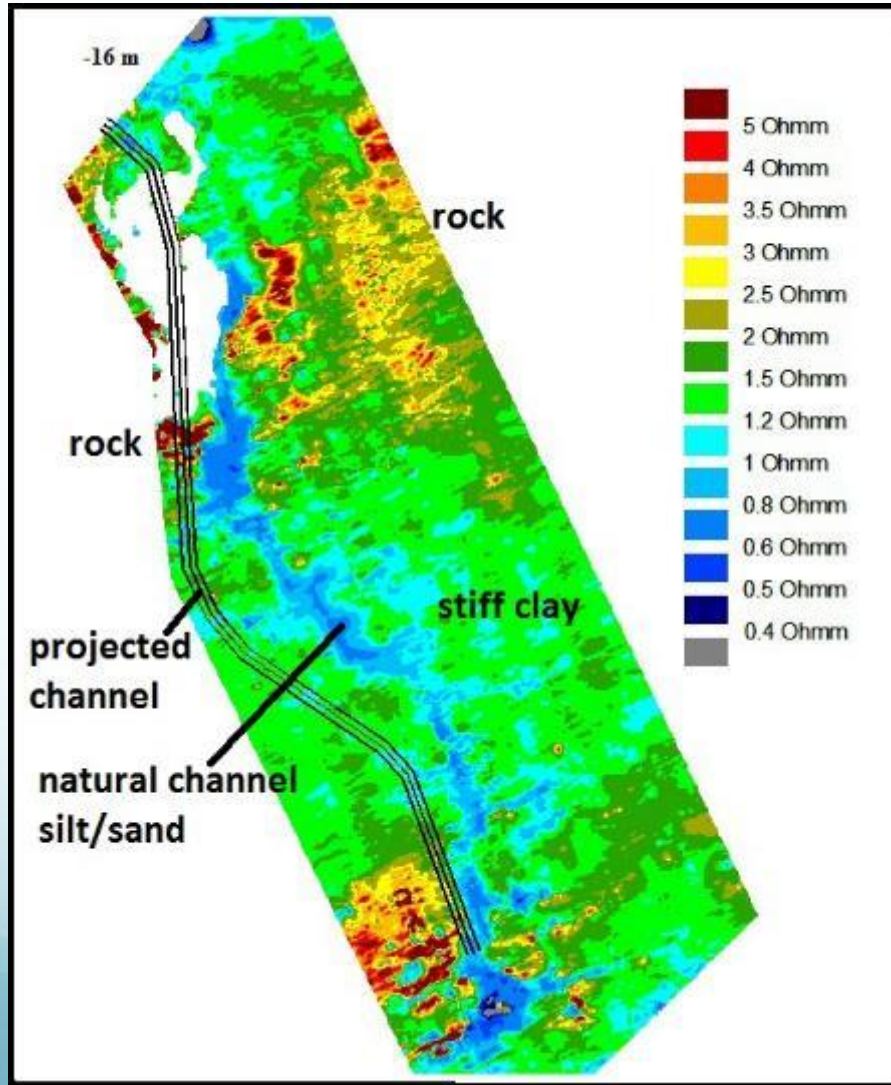
Borings Alone Can't Describe the Subsurface



Boreholes alone can not define the extent of geological structures!

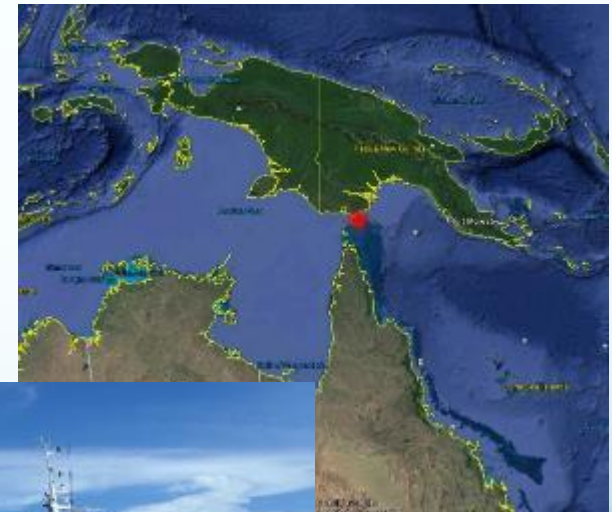


What if Major Geological Structures Remain Undiscovered?

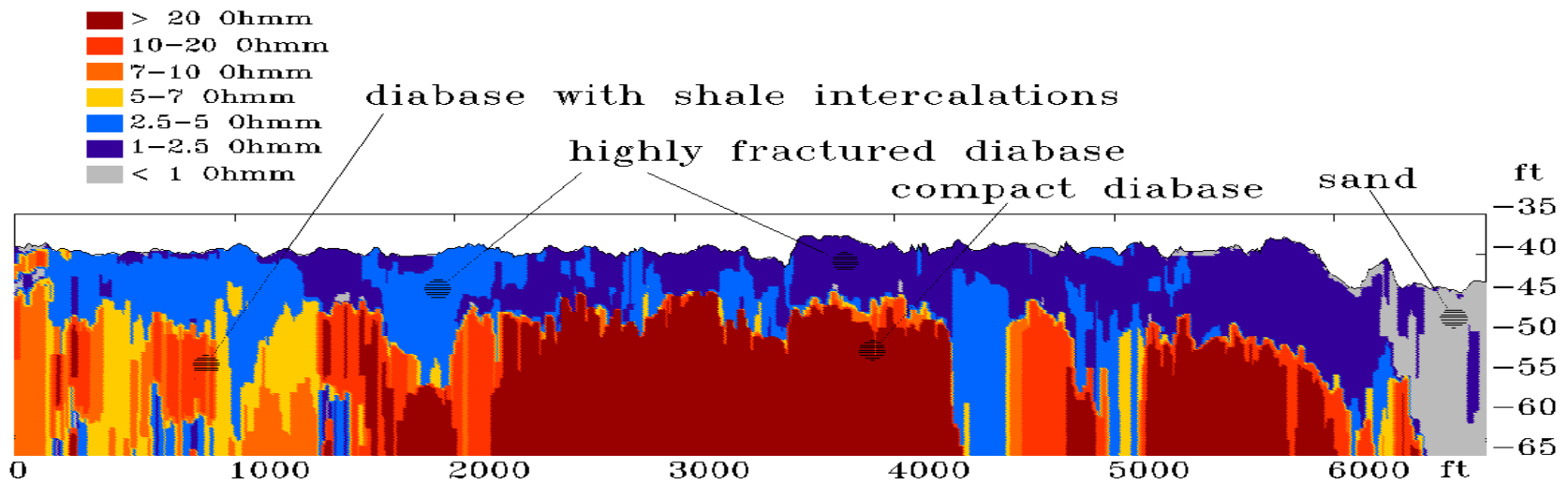
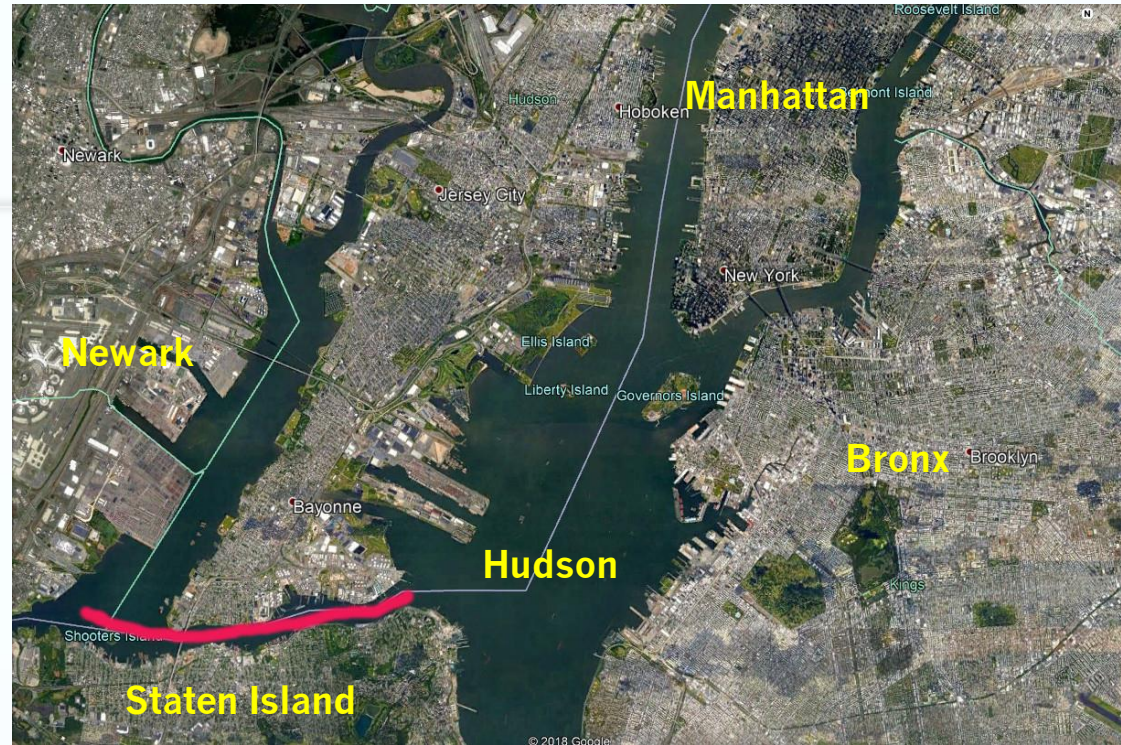


Previous investigations:

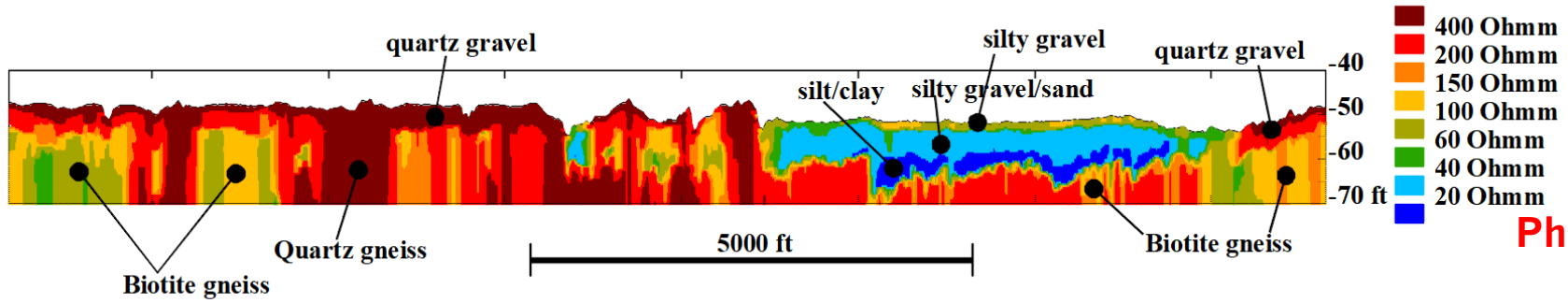
- seismic reflection
- 77 vibracores and 116 random boreholes
- 12 million dollar exploration costs
- no sand
- undefined dredging risks
- uncertainty regarding project viability



Kill Van Kull

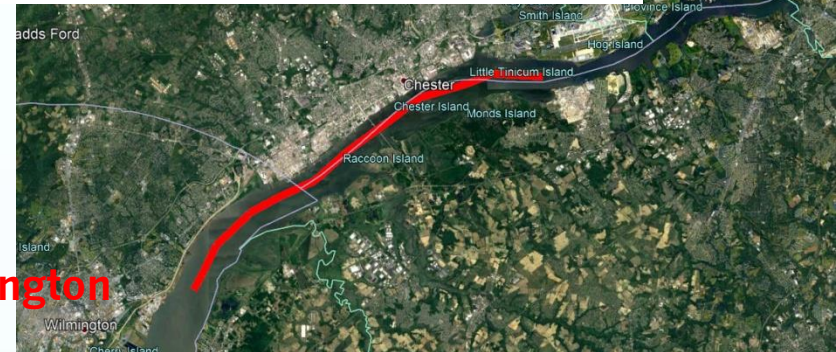


Delaware Deepening



Philadelphia

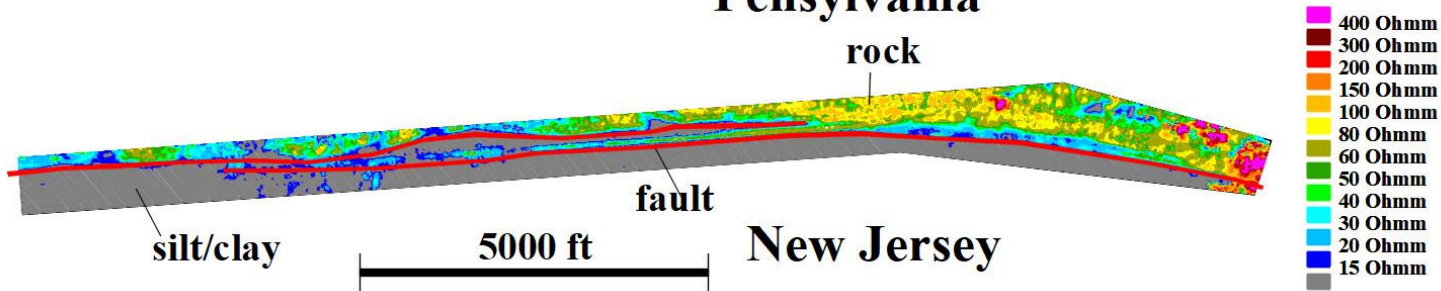
Wilmington



Pennsylvania

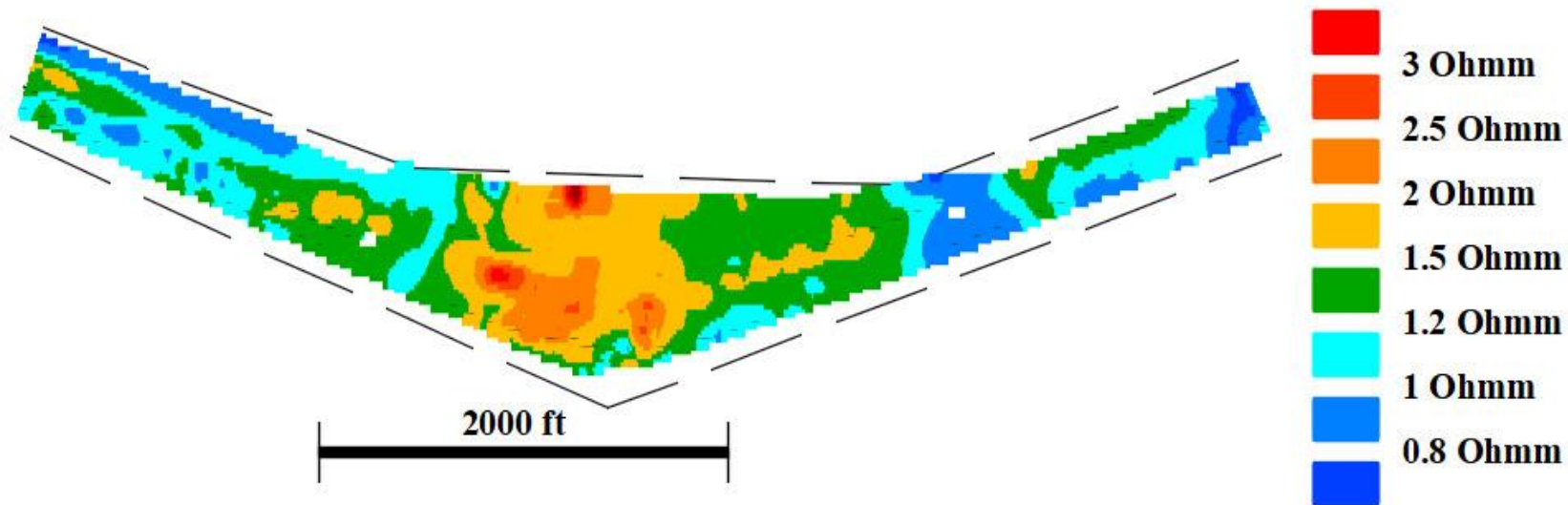
rock

New Jersey



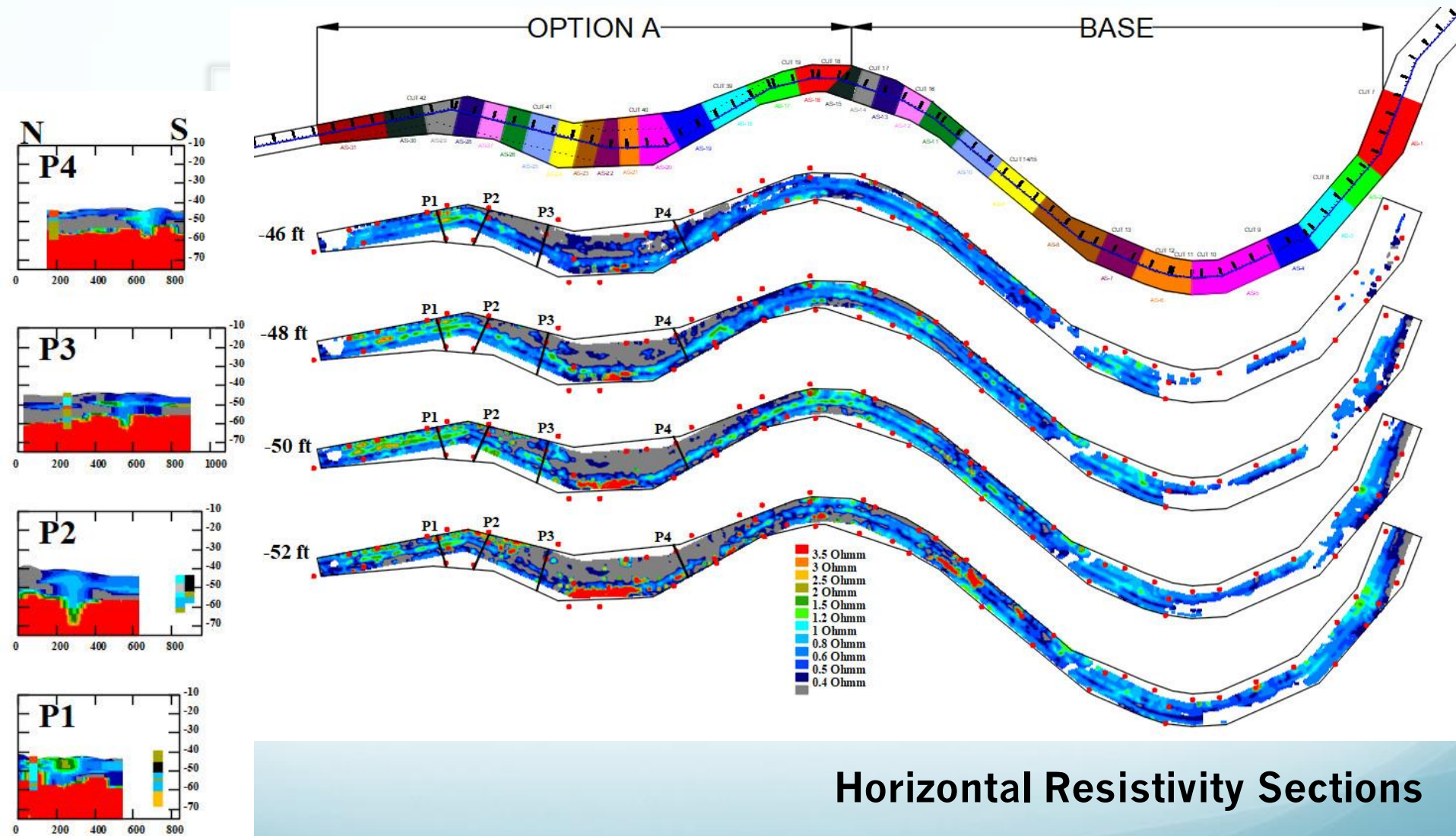
Horizontal Resistivity Section at -55 feet

Miami Harbor Deepening



Horizontal Resistivity Section at 50 ft below chart datum

St Johns River Plan Views @ 2 Ft Intervals



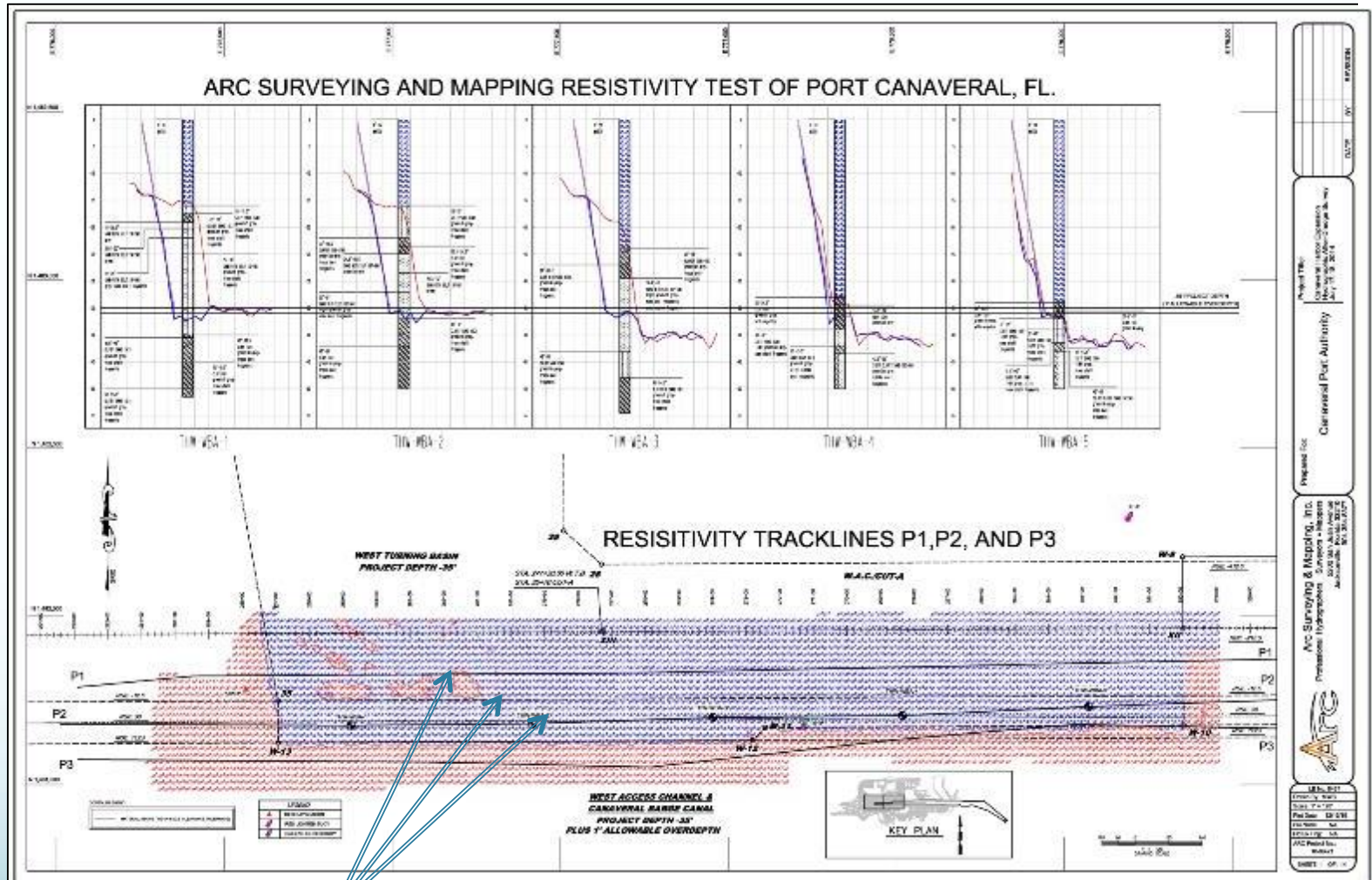
Horizontal Resistivity Sections

Vertical Cross sections

Port Canaveral Resistivity & Bathymetric Survey Jacobs Engineering/Canaveral Port Authority



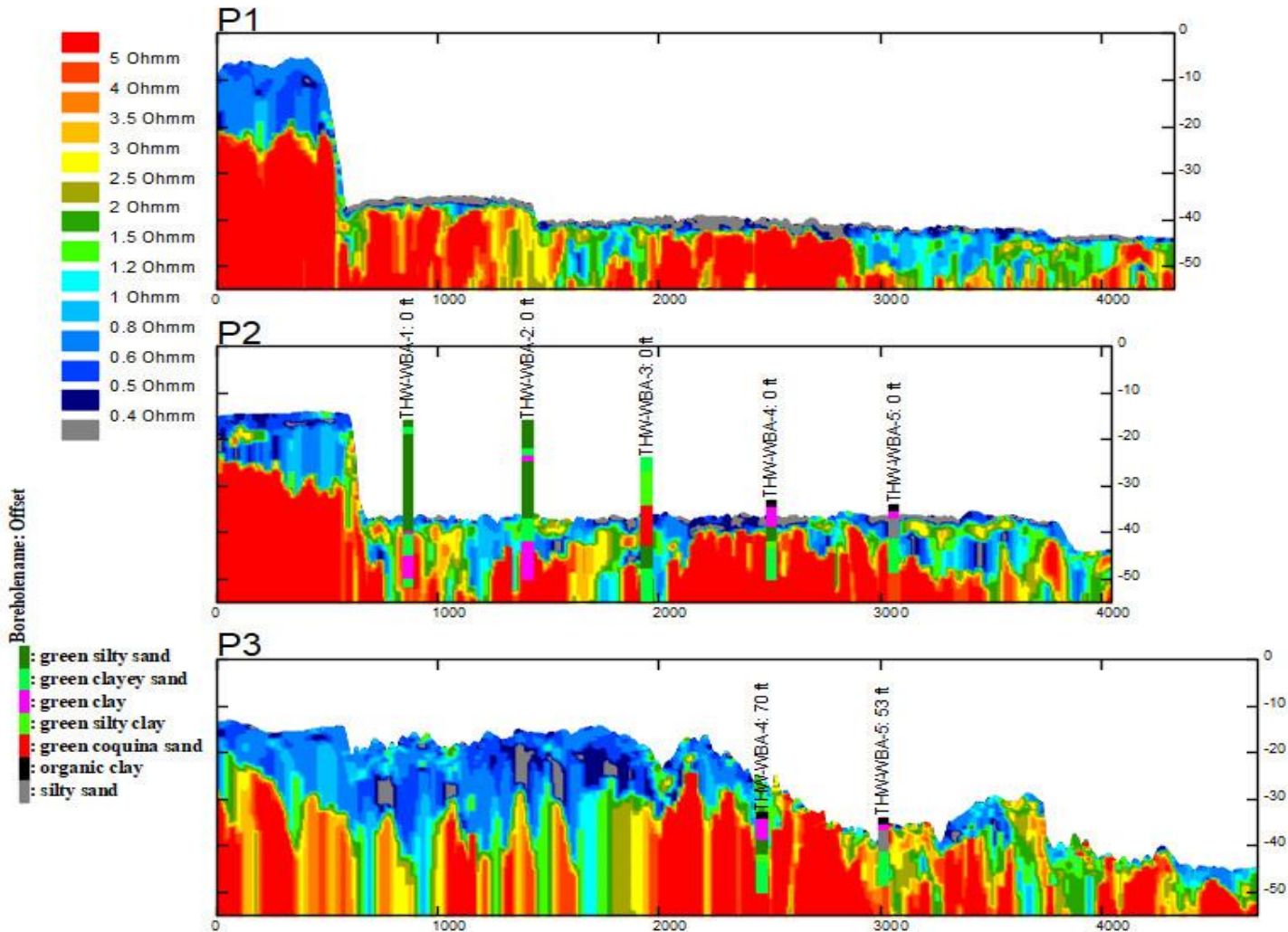
Multibeam Bathymetry & Resistivity Track lines



Geophysical Track Lines



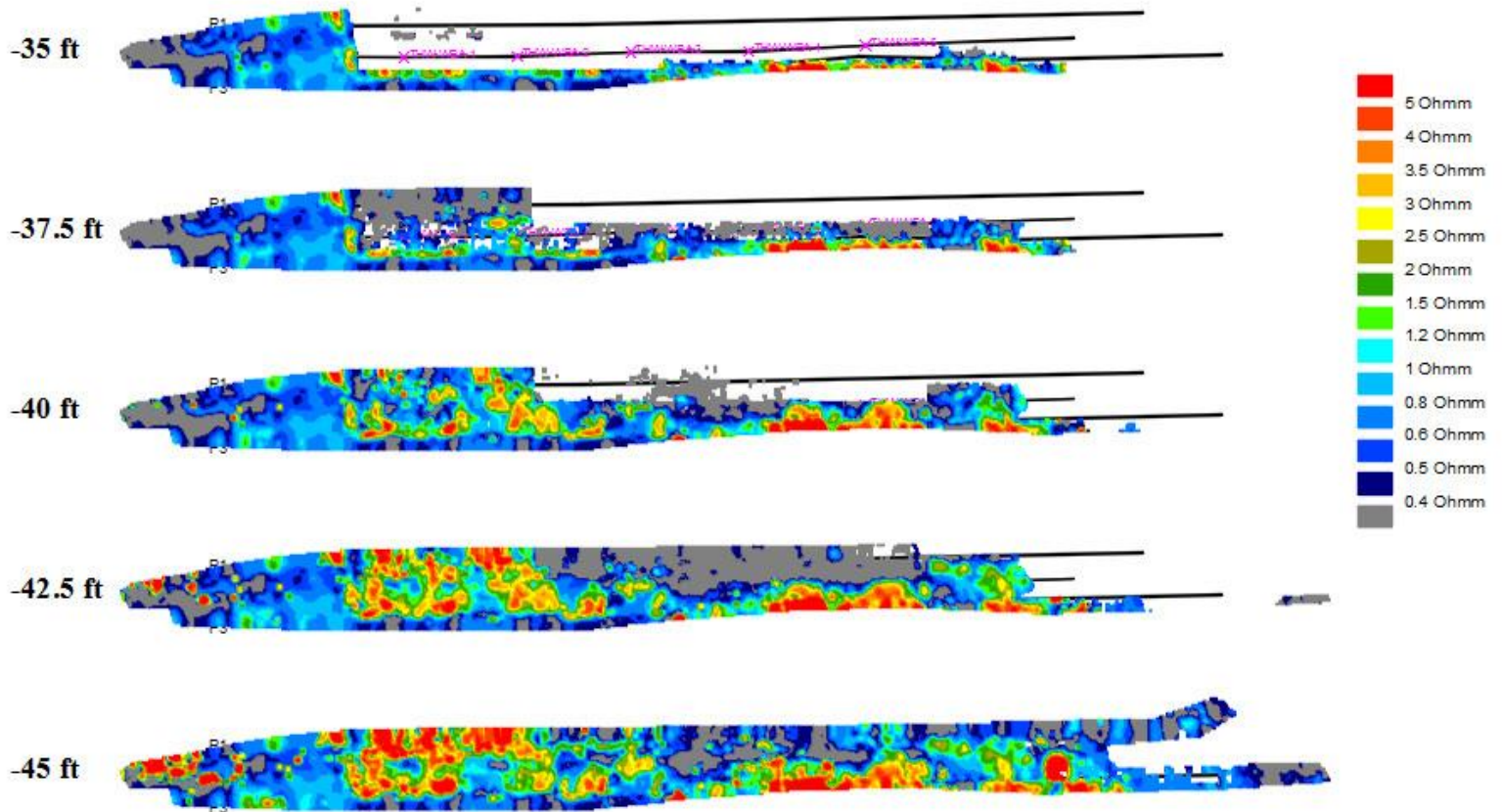
Port Canaveral – test Vertical Resistivity Sections

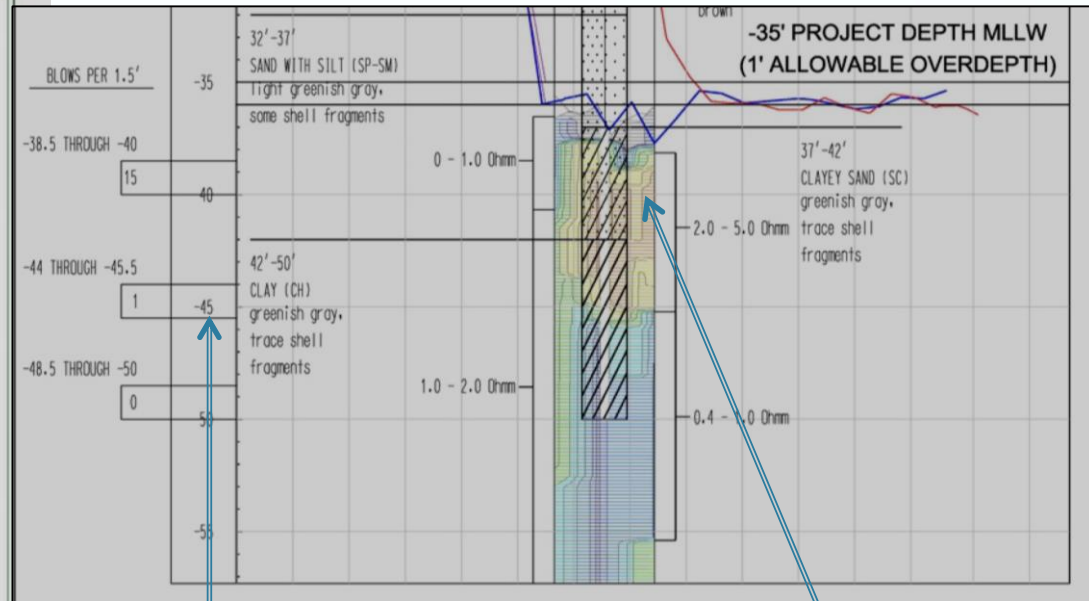
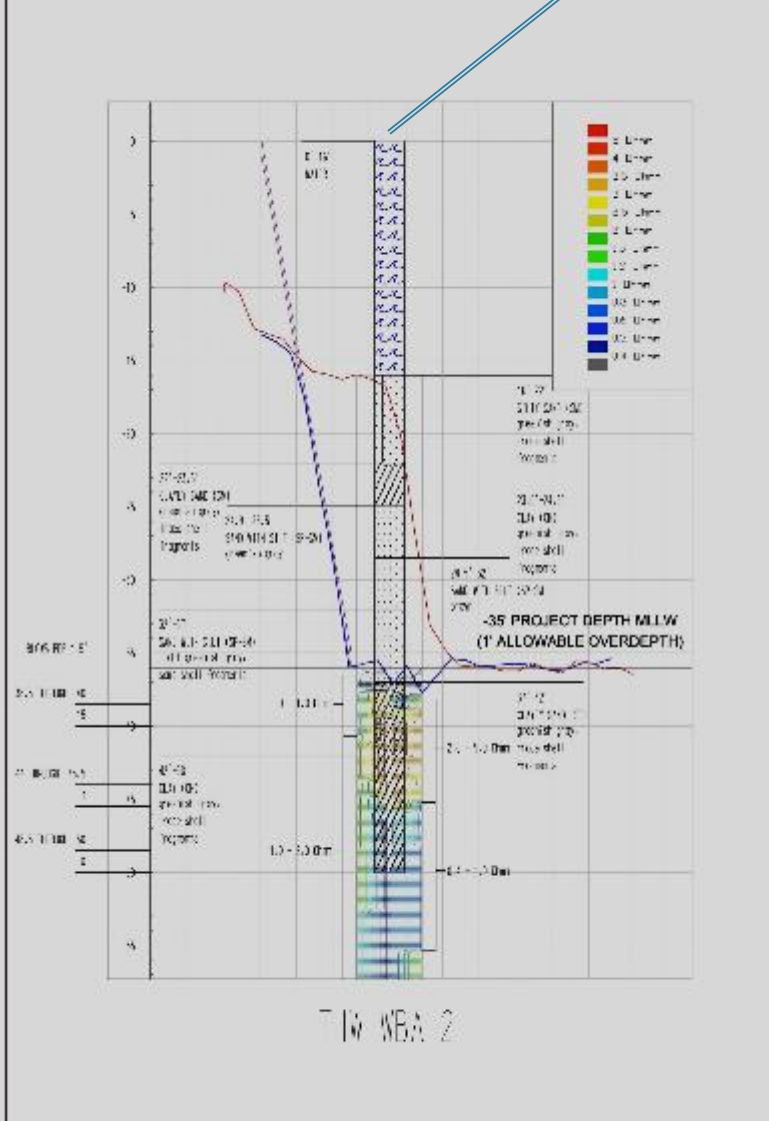
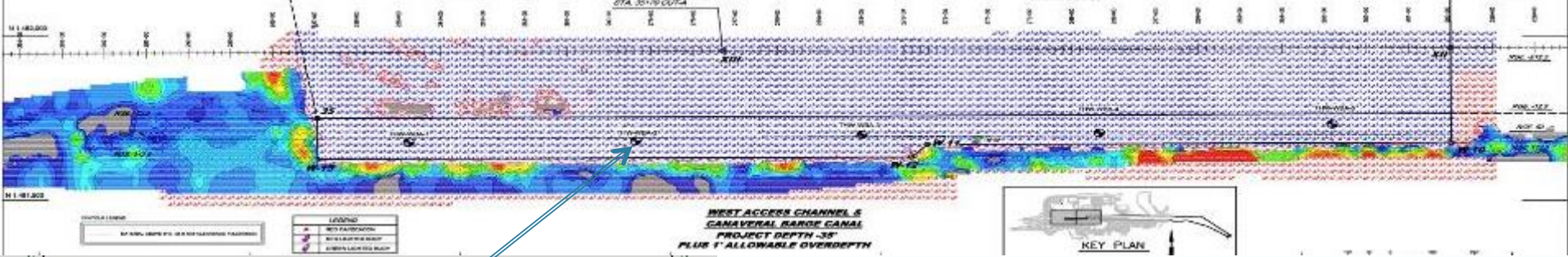




Port Canaveral – test Horizontal Sections

relative to chart datum





Boring # 2

Note: Blow Counts = 15 Blows Per Ft.
Resistivity Measures 4.0 to 5.0
Ohmm

Both indicating presence of firm
materials

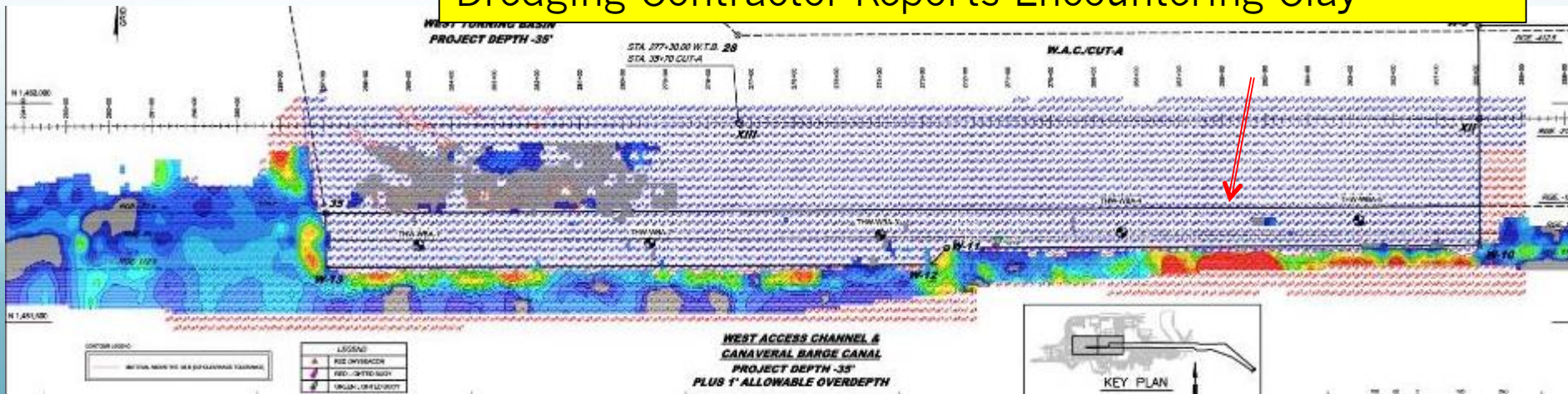




Resistivity Test Conclusions

- A resistivity survey describing subsurface material structures should be performed prior to obtaining core borings.
- A resistivity survey will help determine where borings are necessary rather than guessing best locations.
- NOTE: During the test it is observed that high resistivity values (red) fall between pre construction borings verifying that a resistivity survey should be performed before core boring locations are determined

Dredging Contractor Reports Encountering Clay





Port Canaveral – test

Detailed Interpretation



Port Canaveral Borings

Boring Designation THW-WBA-4

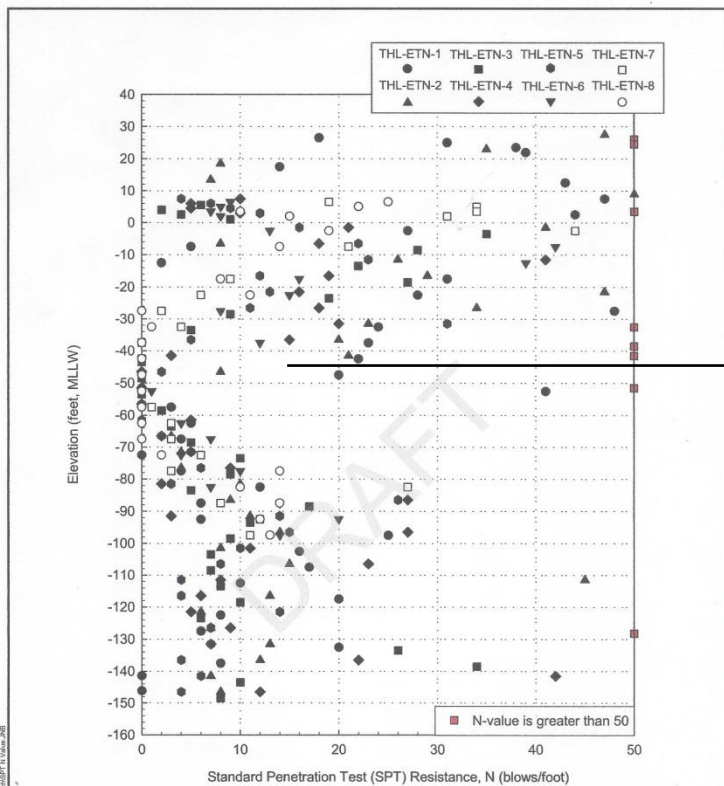
DRILLING LOG (Cont Sheet)					INSTALLATION		SHEET 2 OF 2 SHEETS											
PROJECT					COORDINATE SYSTEM		HORIZONTAL : VERTICAL											
CPA CHANNEL WIDENING					FL State Plane		NAD83 : MLLW											
LOCATION COORDINATES					ELEVATION TOP OF BORING													
N 1,481,705.1 E 778,518.2					0.0													
ELEV (ft)	DEPTH (ft)	Blows/0.3 ft	N _r	N ₆₀	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% REC	Samp No.	Laboratory						REMARKS			
									Gravel	Sand	Fines	LL	PI	MC		ASTM Class		
						0' to 33': WATER. (continued)												
-33.0	33.0																	
-34.5	34.5	0	0	0		33' to 34.5': CLAY (CH), greenish gray, with organics.	1						173	CH	Organic Content = 8.1%			
		0	0	0		34.5' to 39': CLAY (CH), greenish gray.	2											
		0	0	0			3		92				108	CH				
		0	0	0			4											
-39.0	39.0	2	5	7		39' to 42': SILTY SAND (SM), light greenish gray, some shell fragments.	5											
		2	3	5			6											
-42.0	42.0	0	0	0		42' to 43.5': SANDY CLAY (CL), greenish gray, silty, little shell fragments.	7		61				47	CL				
-43.5	43.5	0	0	0		43.5' to 50': SILTY CLAYEY SAND (SC-SM), greenish gray, little shell fragments.	8											
		0	0	0														
		0	0	0			9		45				38	SC-SM				
-50.0	50.0					Bottom of hole at 50 feet.												

- 2012
- Green sand/silt/clay

RPJ ACE MVD WITH RAPID CPT 2009_08_18 GDT 4/11/13



Port Canaveral SPT-Values



Dredge level

Coincidence?

SPT N-VALUE VERSUS ELEVATION

Note:

Ground surface elevations at the boring locations were estimated from the bathymetric map performed by Arc Surveying & Mapping, Inc. dated September 2012 (provided by CH2M) and 1991 Air Force topographic maps

Ardaman & Associates, Inc.
Geotechnical, Environmental and
Materials Consultants

EAST OF TRIDENT BASIN AND NORTH JETTY
CANAVERAL PORT AUTHORITY
PORT CANAVERAL, FLORIDA

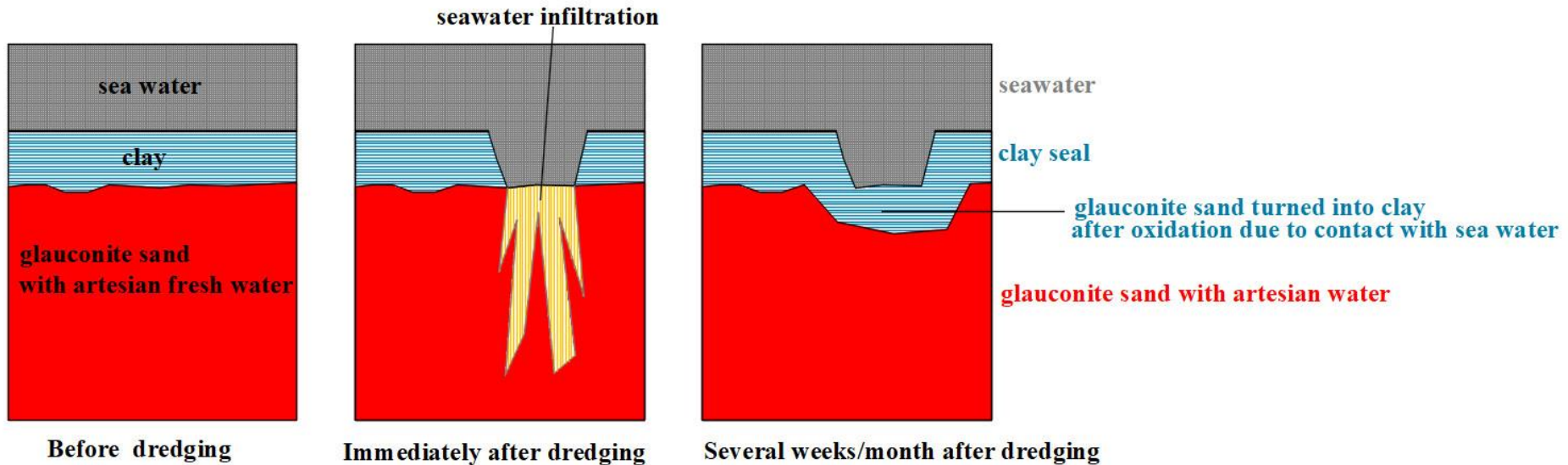
DRAWN BY: KL	CHECKED BY: APC	DATE: 07/14/16
FILE NO: 14-13-0100	APPROVED BY:	PAGE: 2



Port Canaveral Glauconite Artesian ground water

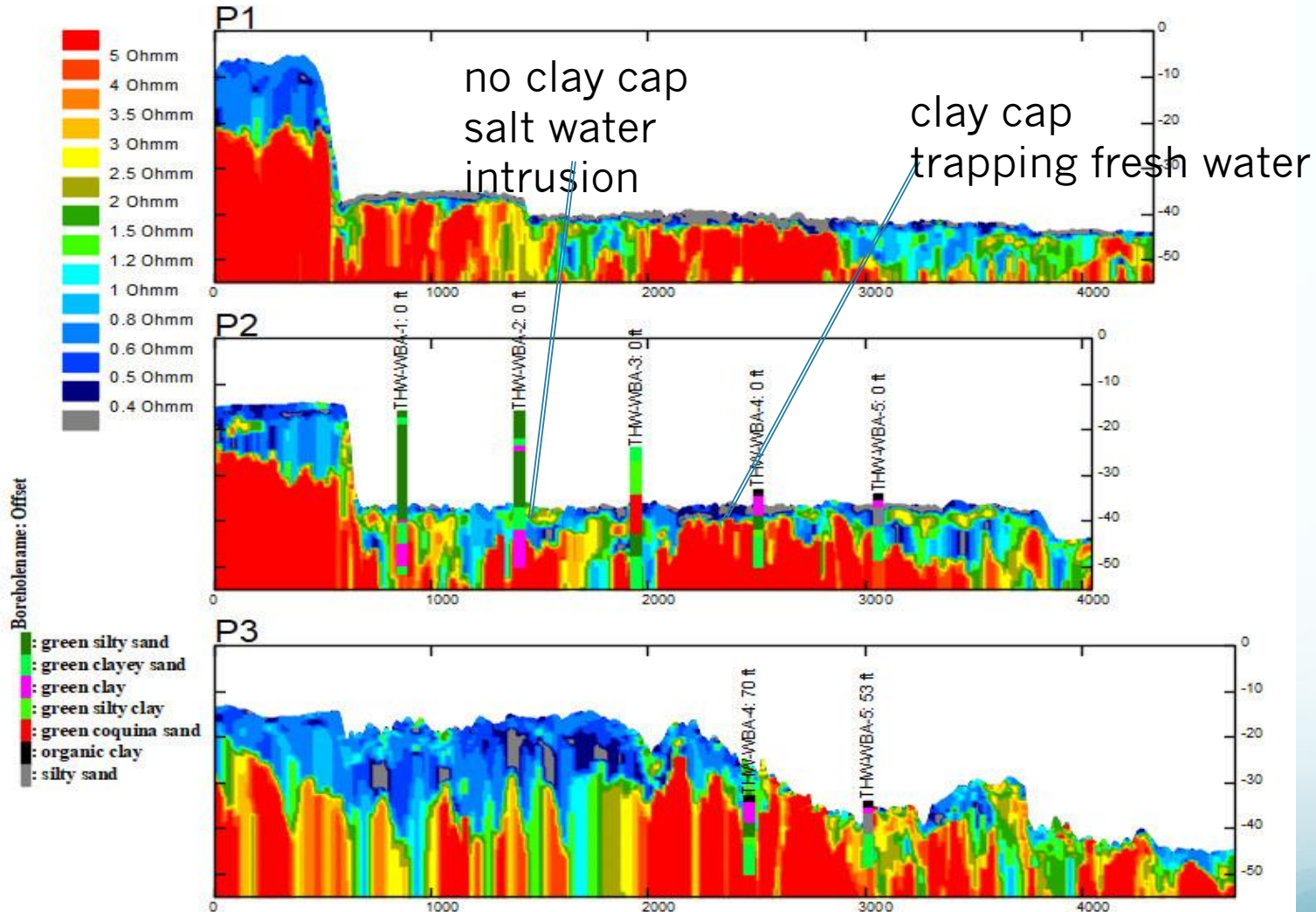


- Green sand
- Clay mineral $(K, Na, Ca)(Mg, Fe^{+++}, Al, Fe^{++})(Fe^{+++}, Al)_4O_{10}(OH)_2 \cdot nH_2O$
- Formation in reduced oxygen conditions – contains Fe^{++}
- Genesis in association with micro organisms (foraminifera)
- Unstable when exposed to oxygen (f.e. oxygen rich seawater)
- Turns into clay
- Existence known in Florida geology

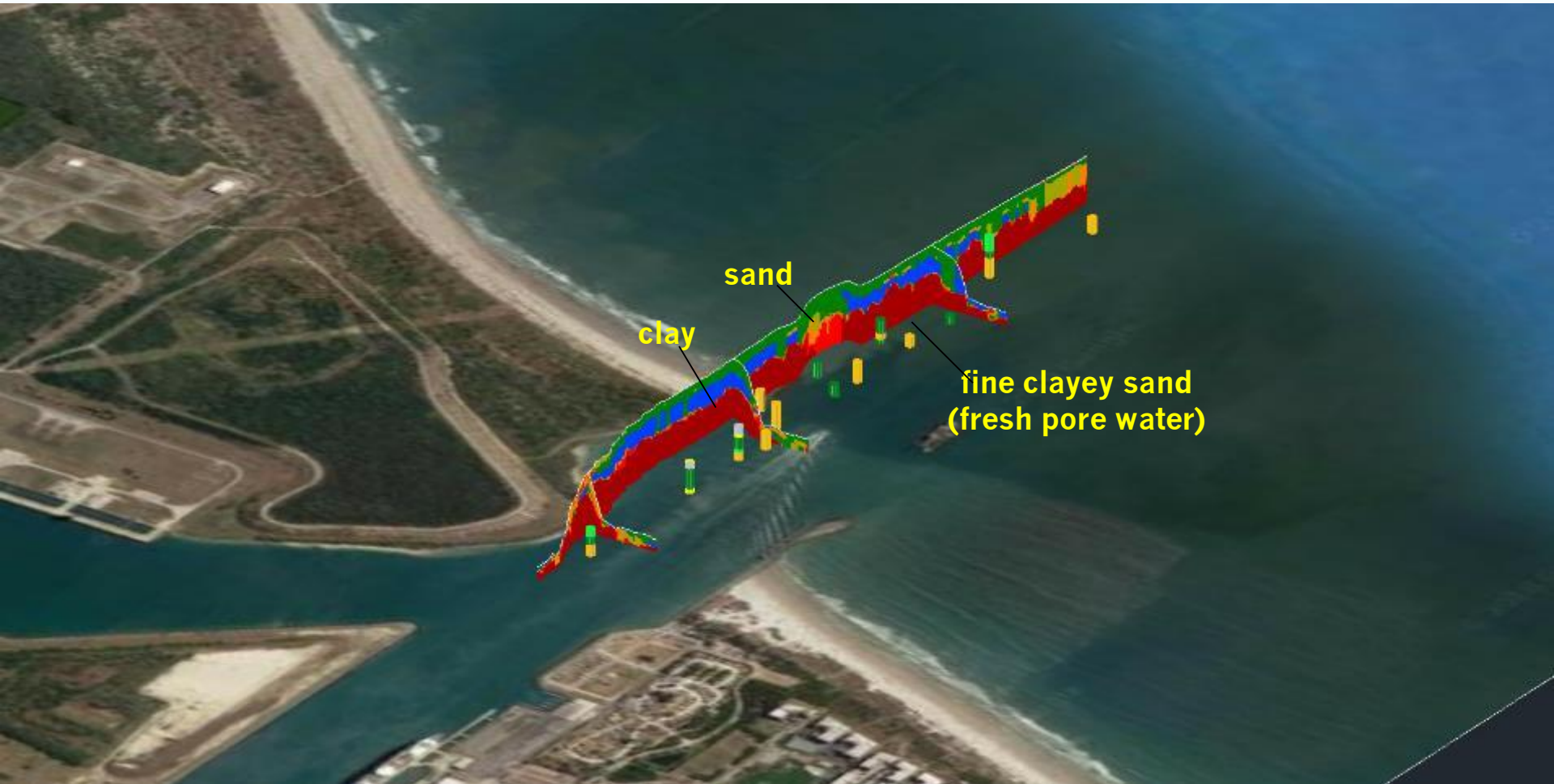




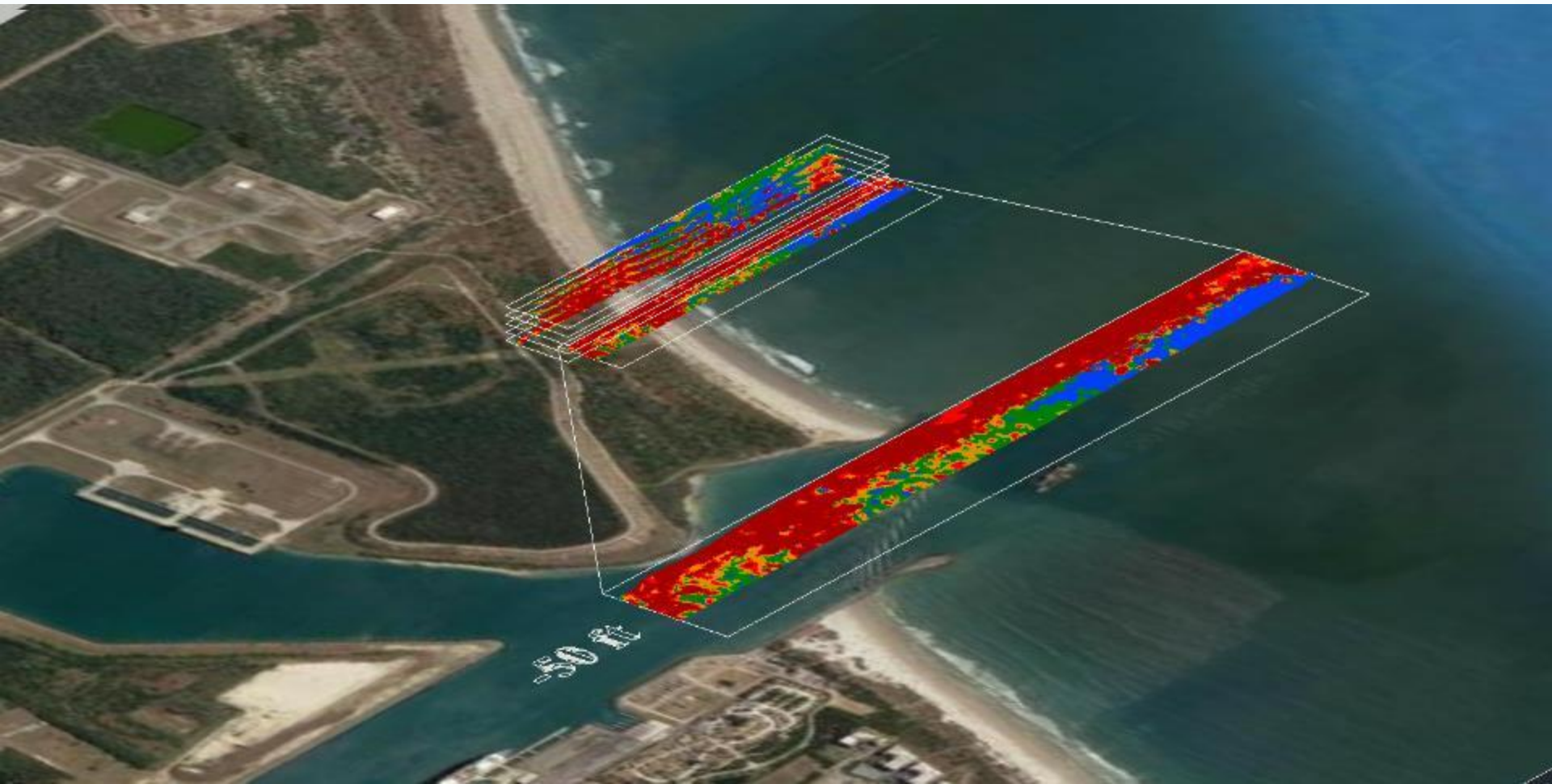
Port Canaveral test Glaucanite and Artesian water



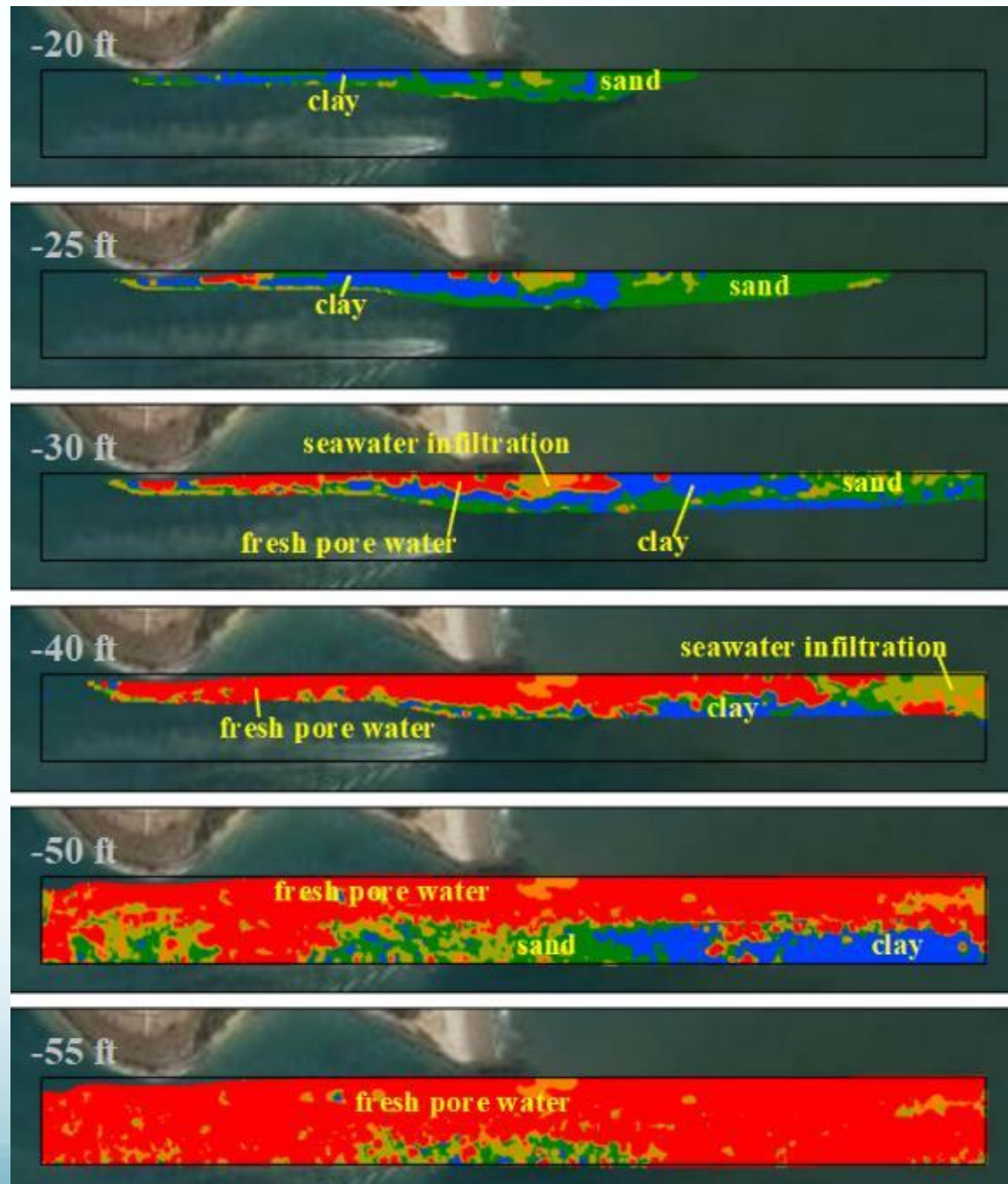
*Port Canaveral – Access channel
Vertical Resistivity Sections*



Bathymetric & Geophysical Survey Of the Port Canaveral Entrance Channel

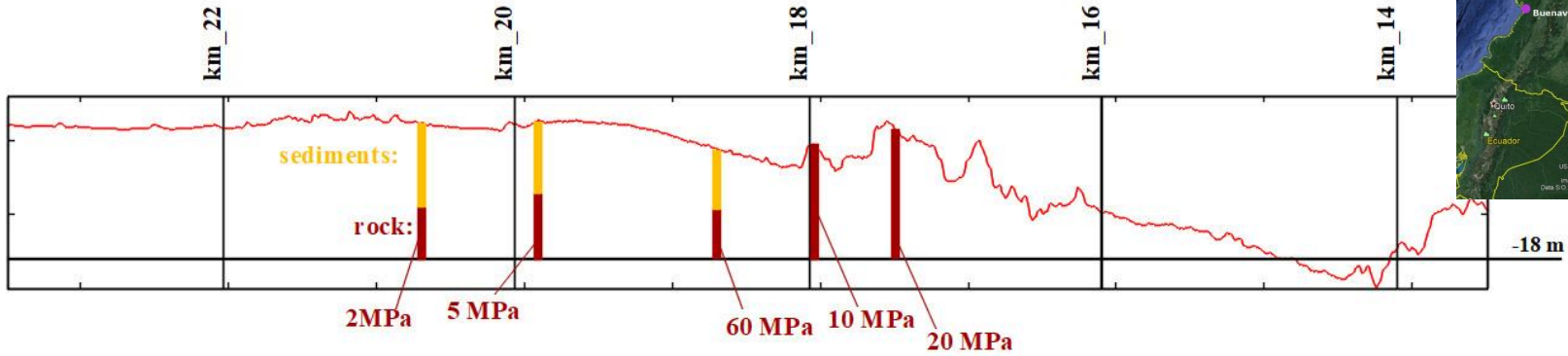
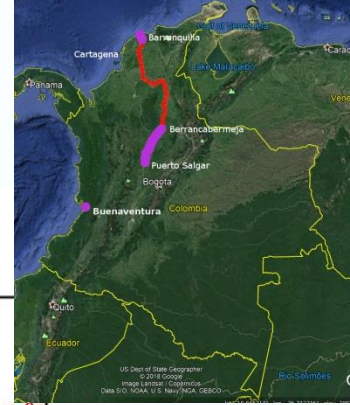


Port Canaveral
Horizontal Resistivity
Sections Relative to
Chart Datum



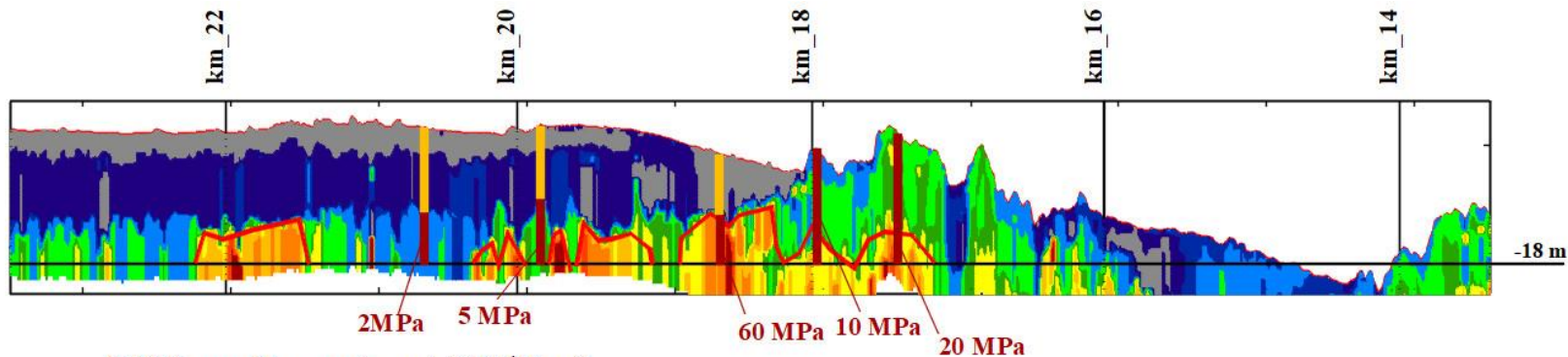


Cost savings related to Aquares technology Dredging project Buenaventura, Colombia



30% sediments at 20 \$/m³
70% hard rock at 100 \$/m³

Average: 76 \$/m³



70% sediments at 20 \$/m³
25% rock at 50 \$/m³
5% hard rock at 100 \$/m³

Average: 31 \$/m³

Estimated savings: 160 million \$

Summary and Conclusions

Advanced 4D geophysical site investigations provided by Arc Surveying & Mapping, Inc. are useful on dredging projects:

- Competitive response to dredging tenders based on high-quality geological information
- Identify selection of dredging equipment based on accurate geological information
- Efficient planning of dredging operations
- Compatible with popular dredging software formats
- Geological documentation identifying the subsurface
- Avoid changed/differing site conditions



*Thank You For Your Interest
Any Questions ?*

John F. Sawyer, Vice-president
Arc Surveying & Mapping, Inc.

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Mobile: (904) 237-5949

Email: jsawyer@arcsurveyors.com

Website: www.arcsurveyors.com