Structure Condition Indexing, Rubble-mound Coastal Structures

Stan Boc

Cheryl Pollock

The Corps of Engineer' policy relative to periodic inspection

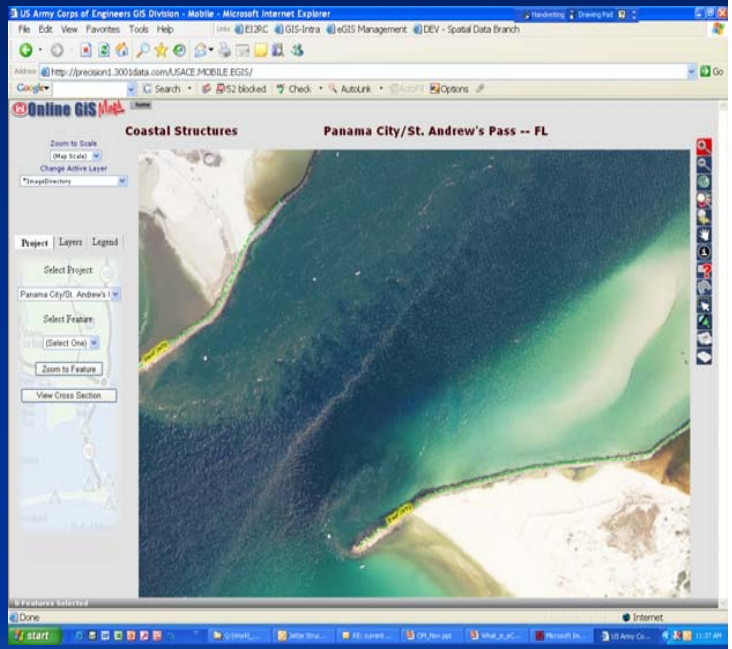
"Civil works structures, whose failure or partial failure could jeopardize the operational integrity of the project, endanger the lives and safety of the public, or cause substantial property damage shall be periodically inspected and evaluated to ensure their structural stability, safety, and operational adequacy."

Problem

- Inconsistent application of condition indexes
- Digital technology has not been applied
- Tools for data collection and analysis
- Measurable, repeatable, and comparable system is needed
- No centralized database is available
- Reporting is not standardized
- Breakwaters program runs on DOS, not viable

Improved Condition Indexes for Coastal Structures

- Tool Development
  - Structure inspection form
  - COSCA
  - HAMMER
  - Integrated Survey System



Condition Indexing Complete Package

Standardized Field Inspection Methods

Hammer System

Form

Teams

Accurate Survey Techniques to Quantify Project Conditions

Terrestrial / Mobile Laser & Integrated Interferometric Multi- Beam

Standardized Data Analysis Tools to Create Standardized Inspection Reports and Analyze Data to Document Changes in Project Condition

COSCA GIS Tool Box

Develop Plans and Specs for Maintenance and New Construction on Projects

COSCA GIS Tool Box

Objectives for Inspection Form
Tool #1

- Create uniform procedures for accessing the condition of structures
- Assessment procedures should be:
  - Repeatable from yr to yr
  - Repeatable by different people
  - Comparable from structure to structure and from district to district
  - Comparable from yr to yr
  - Computer based data storage
  - Computer based yr to yr comparison tools
  - Measurable objective index, not subjective
  - Key words are repeatable, measurable and comparable
  - Employ new technologies
  - Team approach

STRUCTURAL RATING FOR RUBBLE BREAKWATERS AND JETTIES Page_____of_____

PROJECT NAME:		Reach:
STRUCTURE NAME:		Sta: From_____To_____
INSPECTION TEAM: NAME: OFFICE SYMBOL: PHONE:	DATE:	TIME: Begin_____End_____

WAVE HEIGHT (ft)
DAY OF INSPECTION:

WAVE ACTION ON STRUCTURE:
A. Overtopping
B. Non-overtopping

TIDE LEVEL:
A. High B. Medium
C. Low
Stage: _____feet

WEATHER
DAY OF INSPECTION:
A. Fair
B. Rain
C. Fog
D. Storming

TYPE OF INSPECTION: WALKING BOATING OTHER _____ (CIRCLE)

RATING CATEGORIES: Rate all Items (Circle applicable lettered items)	CREST / CAP CR			SEASIDE (or HEAD) SE			CHANNEL / HARBOR SIDE CH		
	Rating 1-6	Damage Length	Comment Numbers	Rating 1-6	Damage Length	Comment Numbers	Rating 1-6	Damage Length	Comment Numbers
Breach: (A) Displaced Cap/Armor (B) Settling Cap/Armor									
Core (or Underlayer) Exposure/Loss									
Armor Loss: (A) Displaced (B) Settling (C) Bridging									
Loss of Armor Contact / Armor Interlock									
Armor Quality Defects: (A) Rounding (B) Cracking (C) Spalling (D) Fracturing									
Slope Defects: (A) Steepening (B) Sliding									

Rating Guide: If rating ≥4, measure length of damage area and enter in the second column.		
Rating	Damage Condition Level	Description
1	Insignificant	No significant defects - only minor defects or deterioration are evident.
2	Minor	Deterioration is clearly evident, but the structure still appears sound.
3	Moderate	Structure is showing deterioration that may require attention in near future and progression of damage should be monitored & documented - may require further investigation for any rating greater than a 3.
4	Serious	A portion of the reach has deteriorated to a condition that repairs are indicated.
5	Severe	Extension deterioration indicating repair for the majority of the reach.
6	Failed	General failure of reach.

STRUCTURAL RATING FOR RUBBLE BREAKWATERS AND JETTIES (CONTINUED)

Comments:
FOUNDATION FAULT SUSPECTED IN: (A) Armour Displacement (B) Slope Steepening (C) Slope Sliding

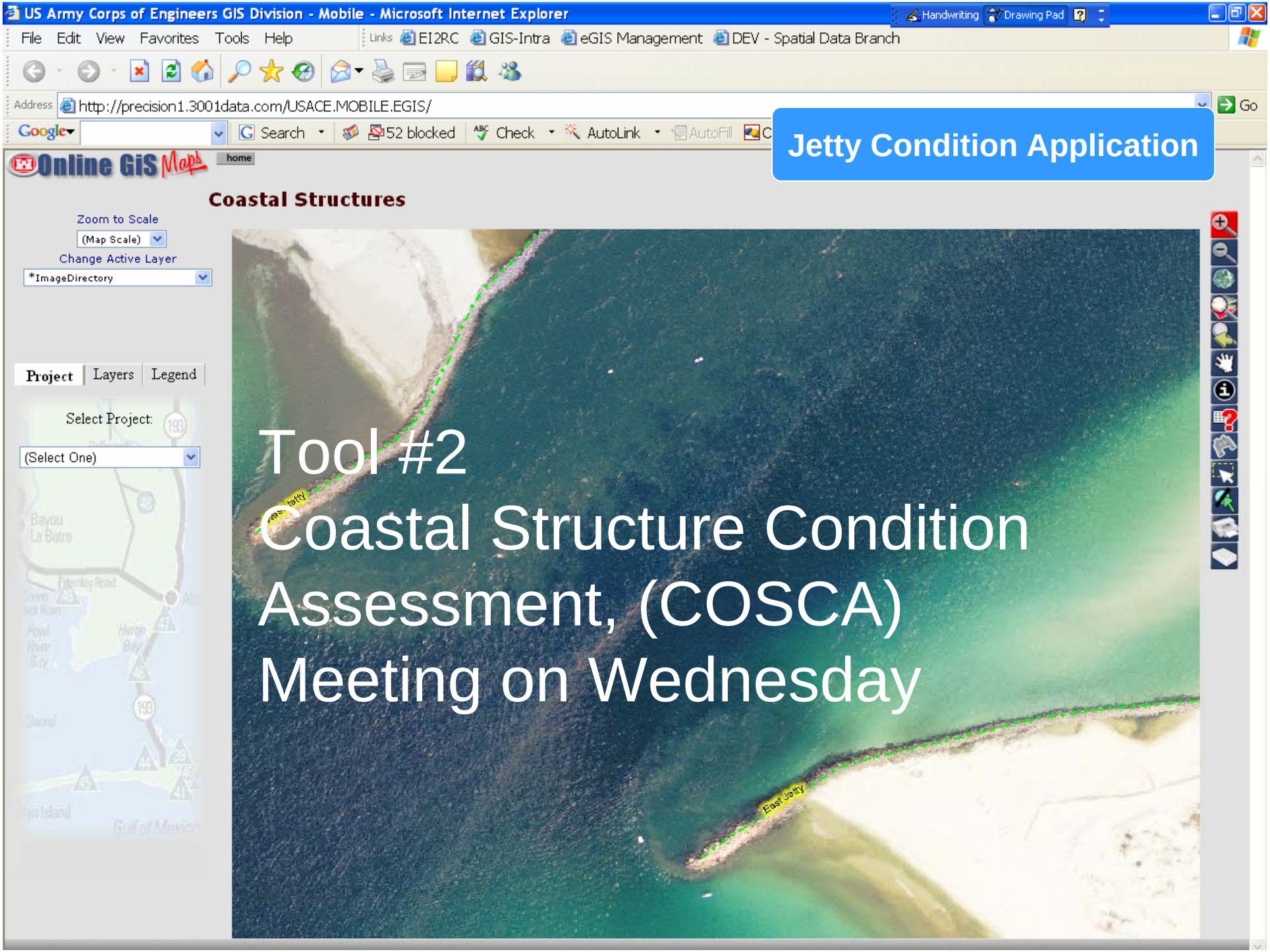
Caused By: (a) Scour (b) Settlement (c) Shear (d) Liquefaction

_____ Item (A) (B) (C) -- (a) (b) (c) (d) Sta
_____ Item (A) (B) (C) -- (a) (b) (c) (d) Sta
_____ WARNING SIGNS/GATES
_____ AUXILIARY STRUCTURES (walkways, stairs, navigation lights, etc.)
_____ AMOUNT OF DEBRIS IN ARMOR (rubble, trash, logs, etc.)

SUGGESTED ACTIONS: (IA) Immediate Action (AS) Action Soon (W) Watch (IF) Investigate Further

Comment Number	Suggested Action	Station Location(s)	COMMENTS AND SKETCHES

CI	DP =	Indicate District priority for this project: (1) high; (2) medium; (3) low.
	SI =	Calculate similar to old method; but ratings are 1-6 with highest number being worst condition.
	DI =	Damage index. For each reach that has an R ≥ 4 a measurement of the length of the damage region is entered in the inspection table. The R value is multiplied by the length of the damage area and these values are summed. $DI = \sum R_{4,5,6} \bullet$ length of damage.



Jetty Condition Application

COSCA Tool Box

GIS Based Analysis tool for integrating Hammer reports, As built surveys and Inspection surveys to monitor changes at the site.

- Track elevation changes
- Compare cross sections
- Quantify change in volumes
- Determine quantities for materials
- Prepare cost figures based upon analysis results
- Prepare construction plans for maintenance purposes

US Army Corps of Engineers GIS Division - Mobile - Microsoft Internet Explorer

File Edit View Favorites Tools Help

Links EI2RC GIS-Intra eGIS Management DEV - Spatial Data Branch

Address http://precision1.3001data.com/USACE.MOBILE.EGIS/

Online GiS Maps

home

Zoom to Scale

(Map Scale)

Change Active Layer

*ImageDirectory

Project | Layers | Legend

Select Project:

Panama City/St. Andrew's I

Select Feature:

East Jetty

Zoom to Feature

View Cross Section

http://precision1.3001data.com - CoastalGraph - Microsoft Internet Explorer

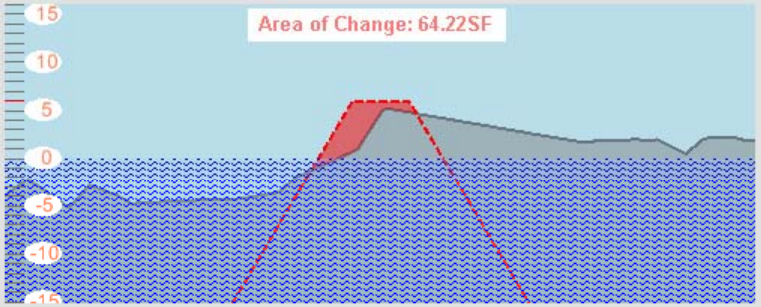
Online GiS Maps

Coastal Structure Profile

Jetty Name: *East Jetty*

☑ Label Area ☑ Track On Map ☑ Sea Level 0 Update

Generate Report



First Previous CS: 80 Next Last

Active Survey:

☐ Previous Survey 9/1/2003 ☐ Next Survey

Calculate Missing Volume Between (Active Survey Only):

CS: 2 and CS: 2

Cubic Yards

Calculate

☐ Include In Report

Done Internet

0 Features Selected

http://precision1.3001data.com - Selected Feature Report - Microsoft Internet Explorer

File Edit View Favorites Tools Help

Google Search 52 blocked Check AutoLink AutoFill Options

USACE Jetty Condition Report

East Jetty

Online GiS Maps

Survey Information

Survey Date: 9/1/2003

Cross Section Number: 1

Area of Change: 1.58 sf

Jetty Information

Operation Status: RUINED

Latitude: -85.7283

Longitude: 30.1191

Design Cap Elevation: 6

Design Cap Width: 15

Design Base Elevation: -55

Design Base Width: 200

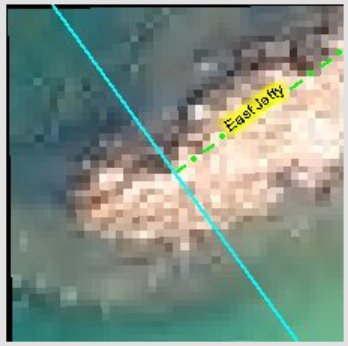


Fig. 1A - *Curent Cross Section Selection*

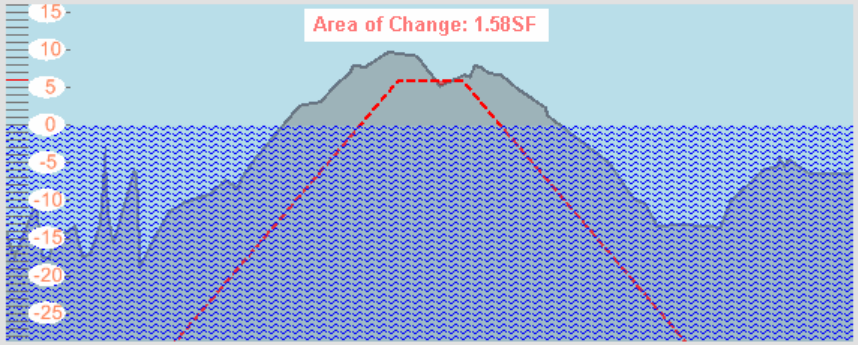


Fig. 1B - *Lidar Generated Cross Section Profile Against Original Desgin Profile*

Jetty Condition:

Comments:

Done Internet

HAMMER
Tool #3

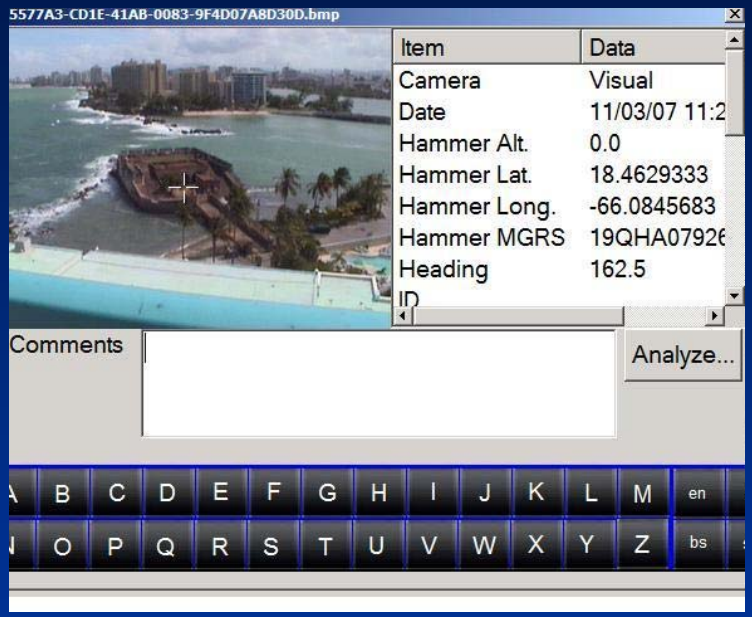
- Infield digital data collection recorded on site
- GPS stamped data
- Stand off measurements
- Maintain archives
- Data base recall on site
- Seamless data transfer
- Linking of information and photos
- GIS capable
- In field analysis and report generation

HAMMER

Providing Secure Intelligence Capabilities for 360° Situational Awareness

Standoff Geospatial Awareness

- Real-time 360° Situational Awareness
- Standoff Geospatial Awareness
  - Target Positioning
  - Data Enhanced Image Capture
- Variety of Optics EO/IR
- Laser Distance Meter/Designator



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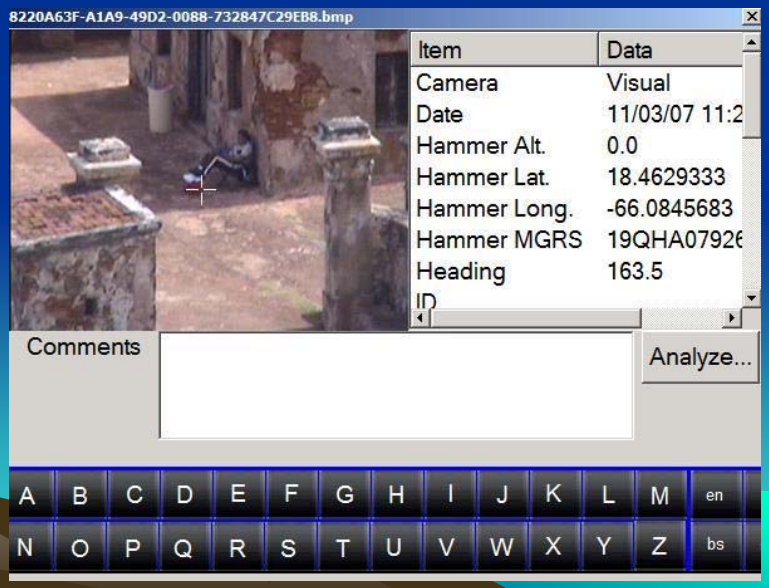


10X

Integrated GIS Mapping Software

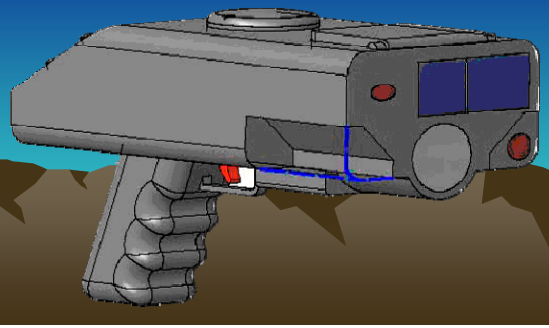
Attributes of manhole_sanitary

FID	Shape*	IMAGE	GPSTIME	LABEL	WATER	COMMENT	FLOODED	Q_DIR	I1_DIR
58	Point	\Storage Card\ik	1316 431350 2005-03-31-17-50-43	lift station	0	nort			
57	Point	\Storage Card\ik	1316 431160 2005-03-31-17-47-34	sann45	0	nea			
49	Point	\Storage Card\ik	1316 422213 2005-03-31-15-18-35	san61n-01	0	sou			
48	Point	\Storage Card\ik	1316 421071 2005-03-31-14-59-35	sann32	1				
41	Point	\Storage Card\ik	1316 412819 2005-03-31-12-42-04	san61-standpipe	0				
40	Point	\Storage Card\ik	1316 412739 2005-03-31-12-40-44	san61-standpipe	0				
39	Point	\Storage Card\ik	1316 412482 2005-03-31-12-36-27	san61-septic	0	mult			
3	Point	\Storage Card\ik	1315 325627 2005-03-23-12-28-44	sann01	1				
2	Point	\Storage Card\ik	1315 325027 2005-03-23-12-18-49	sann00	0	one			

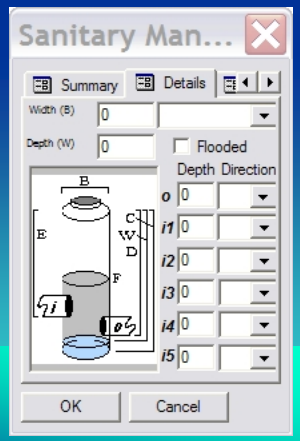
Record: 0 Show: All Selected Records (0 out of 162 Selected.) Opt

Pitch: -13.79 | Heading: 166.99 | Target: 64.61 | PDOP: N/A

- GIS "On-the-Fly"
- Tagging, Tracking and Locating
- Multi-Sensor Data Fusion
  - Images, Audio, Video, Sensor
- Images and Data Auto-Synchronized
- Encrypted Metadata Archiving
- Enables "Common Operating Picture"



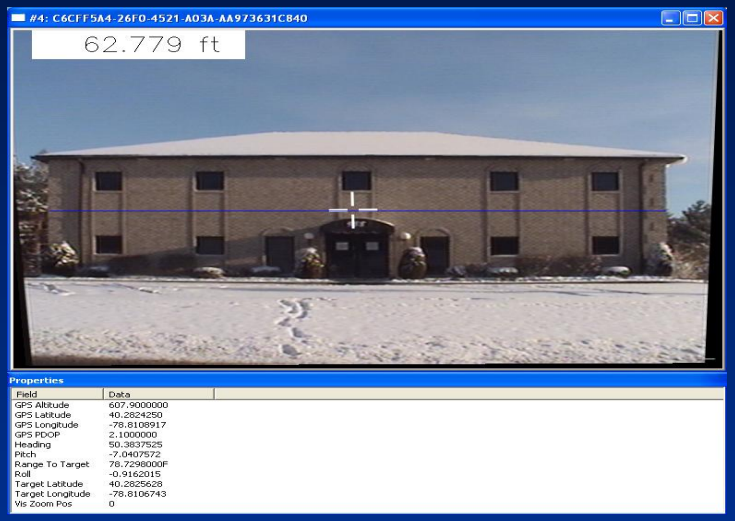
- Data Collection Forms
  - Standard / Custom
  - Enhances Data Collection Process
- Speech Enabled Forms
- Form Data Archived with Geospatial / Image Data



Real-time Image Processing

Data Enriched Image Processing

- Ability to Dimension Targets
- Target Feature Analysis
  - Size, Shape, etc.
- Automated Software Analysis



Applications

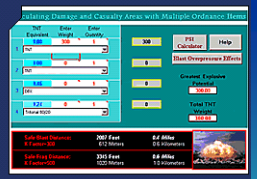
- 3-D Urban/Terrain Modeling
- Automated UXO Recognition Algorithms
- Rapid Condition/Damage Assessment

Enhance Existing DoD Software

- Tactical Decision Aids
- Information Databases
- Situational Awareness Systems

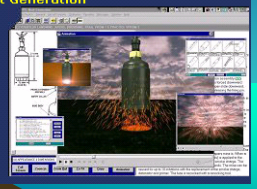
EOD Tactical Decision Aids (TDA)

On-scene technicians must quickly determine safe withdrawal distances, calculate stay times, determine necessary damage mitigation actions and potentially perform calculations to limit personnel and property hazards. A multifunctional TDA was developed for calculating k-factor formulas for blast and fragmentation distances, downwind hazard areas, safe separation times, firing-train burn times, estimated crater sizes, and other critical information. Field technicians may currently run the software on a PC, however future development will allow them to use the TDA with a palmtop device. The TDA has been fielded to Joint Service EOD, the FBI and ATF, and utilized during Operation Enduring Freedom and Operation Iraqi Freedom.



Advanced Explosive Ordnance Disposal Publication System – Next Generation

The Advanced Explosive Ordnance Disposal Publication System – Next Generation (AEODPS-NG) was fielded to Army, Navy, Air Force and Marine Corps EOD units around the world as well as to other domestic agencies. The AEODPS-NG system provides an improved ordnance search capability, with more data and digital images than the previous system. The 1650 sets shipped in December 2003 will be used as secondary publication systems until the Defense Information Technology Security Certification and Accreditation Process (DITSCAP) is completed and final EOD approval is granted. It is anticipated that AEODPS-NG will become the primary EOD publication system for U.S. forces by March 2004.

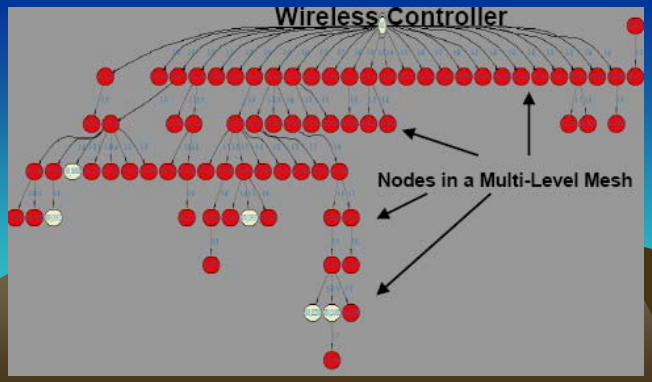


Multi-Sensor Mesh Network Wireless Sensing

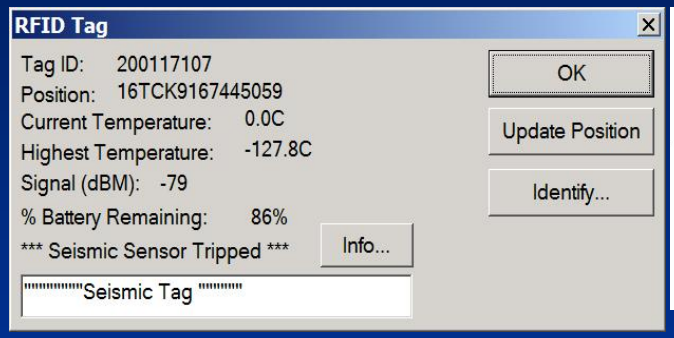
Technology Overview

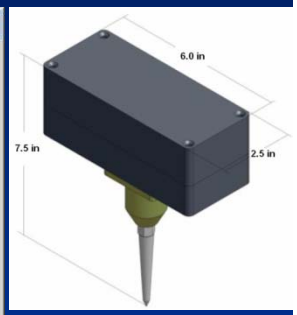
- **Advanced Wireless Sensing**
  - **Mesh Network Communication**
  - **IEEE 802.15.4 @ 2.4GHz**
  - **+100m Range**
  - **Up to 4MB Local Data Storage**
  - **Data Encryption / Network Security**
  - **5yr Battery Life**

- **Sensor Options**
  - **Proximity**
  - **Humidity**
  - **Temperature**
  - **CBRNE**
  - **Tilt**
  - **Seismic**
  - **Particulate**
  - **Acoustic**
  - **Accelerometer**
  - **Position**

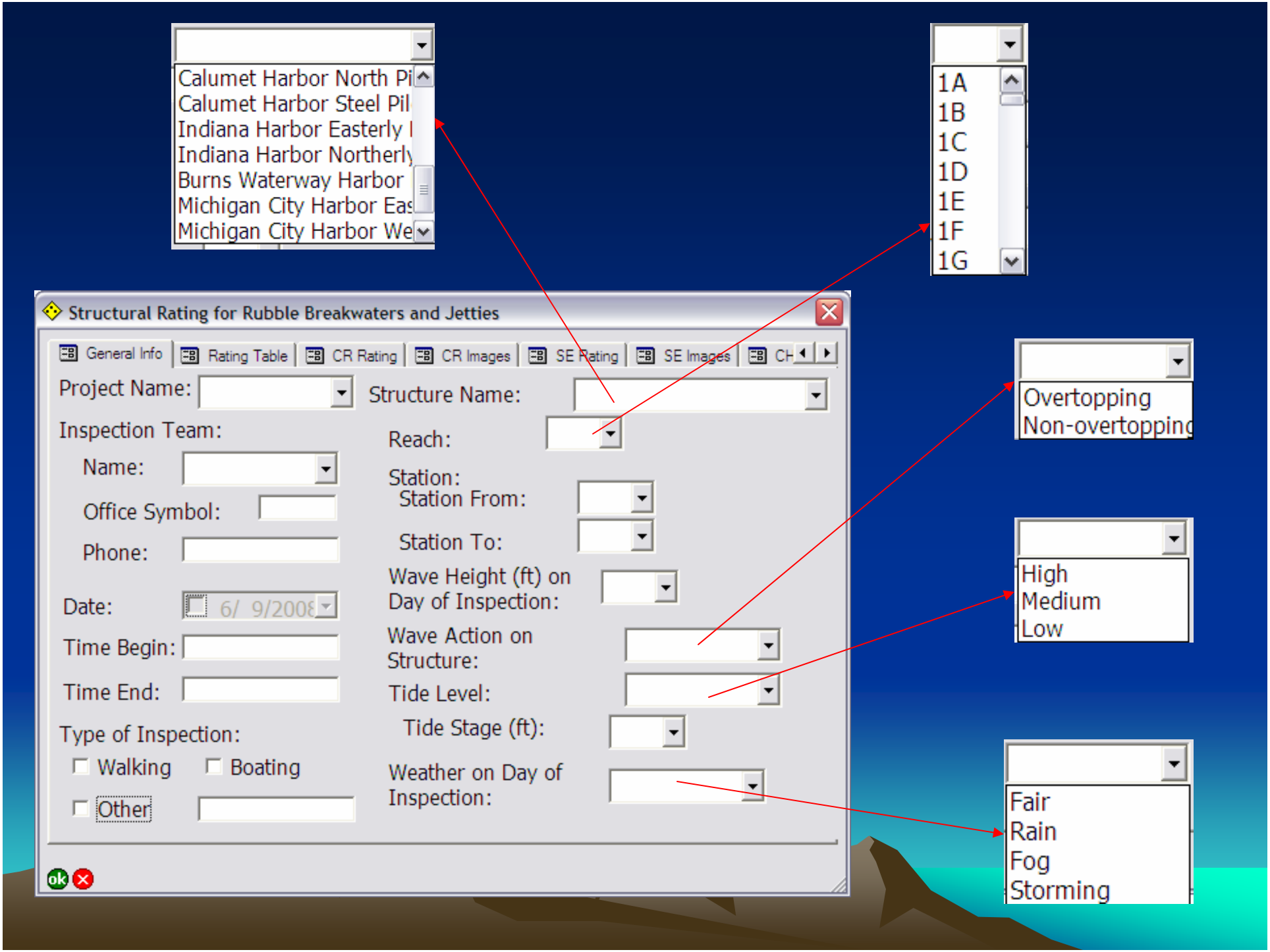


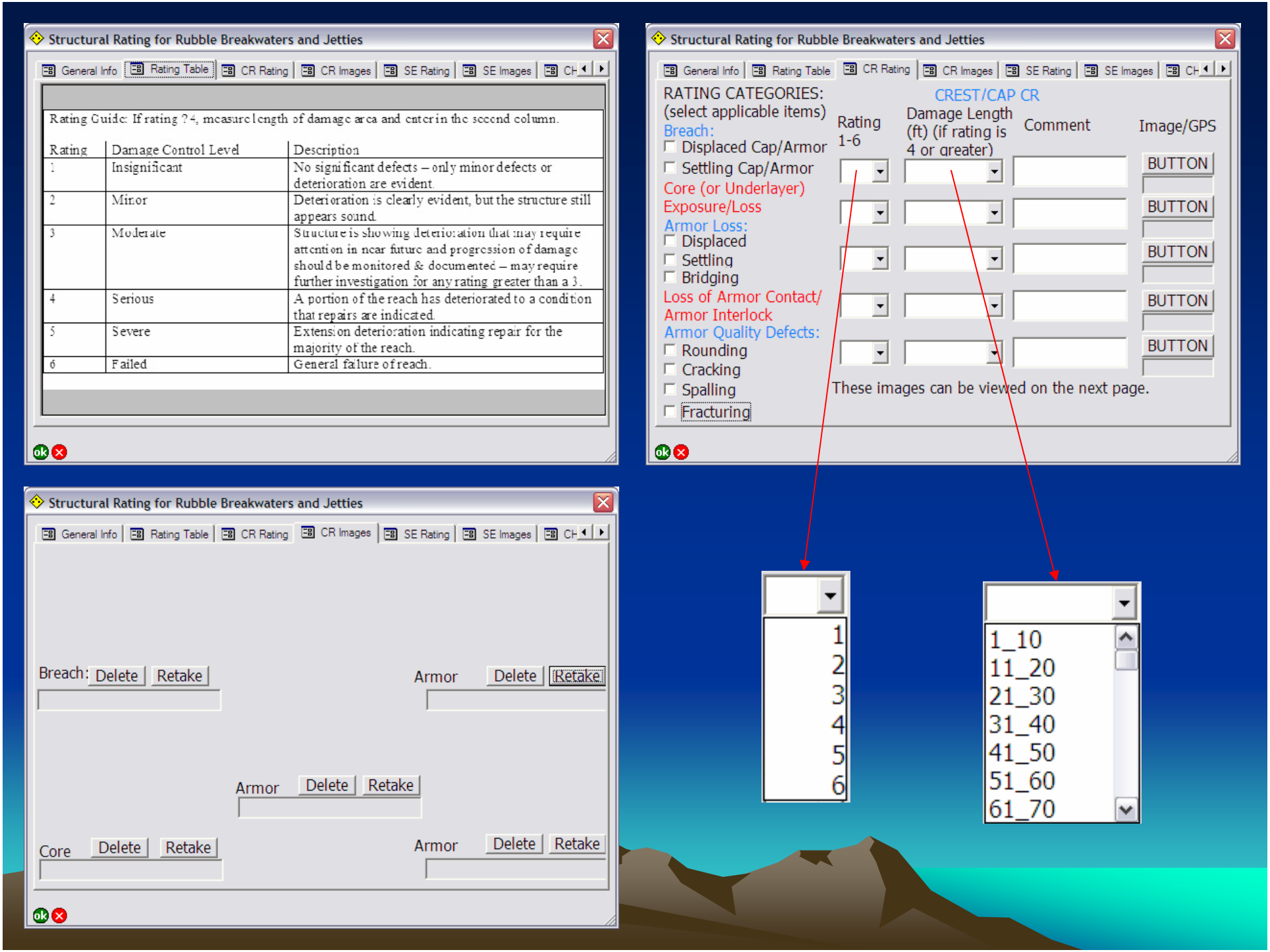
Seismic Sensor CONOP





- **Network of Fixed Site Covert Detection Sensors**
  - **Geo-located using the SAPPER**
- **Monitor Intrusions in Restricted Areas**
- **Multi-Sensor Tuned Detection Algorithm**
  - **Seismic, Tilt, Accelerometer, etc.**
- **RF Passive Until Pinged**
- **Rugged / Low Cost**
- **After Deployment - Detection Network Can be Scanned with Standard Reader**


Calumet Harbor North Pi
Calumet Harbor Steel Pil
Indiana Harbor Easterly
Indiana Harbor Northerly
Burns Waterway Harbor
Michigan City Harbor Eas
Michigan City Harbor We
1A
1B
1C
1D
1E
1F
1G
Structural Rating for Rubble Breakwaters and Jetties
General Info
Rating Table
CR Rating
CR Images
SE Rating
SE Images
Project Name:
Structure Name:
Inspection Team:
Name:
Office Symbol:
Phone:
Reach:
Station:
Station From:
Station To:
Date:
6/ 9/2008
Wave Height (ft) on Day of Inspection:
Time Begin:
Wave Action on Structure:
Time End:
Tide Level:
Tide Stage (ft):
Type of Inspection:
Walking
Boating
Other
Weather on Day of Inspection:
ok
Overtopping
Non-overtopping
High
Medium
Low
Fair
Rain
Fog
Storming


Structural Rating for Rubble Breakwaters and Jetties
General Info
Rating Table
CR Rating
CR Images
SE Rating
SE Images
Rating Guide: If rating ?4, measure length of damage area and enter in the second column.
Rating | Damage Control Level | Description
1 | Insignificant | No significant defects – only minor defects or deterioration are evident.
2 | Minor | Deterioration is clearly evident, but the structure still appears sound.
3 | Moderate | Structure is showing deterioration that may require attention in near future and progression of damage should be monitored & documented – may require further investigation for any rating greater than a 3.
4 | Serious | A portion of the reach has deteriorated to a condition that repairs are indicated.
5 | Severe | Extension deterioration indicating repair for the majority of the reach.
6 | Failed | General failure of reach.
Structural Rating for Rubble Breakwaters and Jetties
RATING CATEGORIES:
(select applicable items)
Breach:
Displaced Cap/Armor
Settling Cap/Armor
Core (or Underlayer)
Exposure/Loss
Armor Loss:
Displaced
Settling
Bridging
Loss of Armor Contact/
Armor Interlock
Armor Quality Defects:
Rounding
Cracking
Spalling
Fracturing
CREST/CAP CR
Rating 1-6
Damage Length (ft) (if rating is 4 or greater)
Comment
Image/GPS
BUTTON
These images can be viewed on the next page.
1
2
3
4
5
6
1_10
11_20
21_30
31_40
41_50
51_60
61_70
Structural Rating for Rubble Breakwaters and Jetties
Breach:
Delete
Retake
Armor
Core

Structural Rating for Rubble Breakwaters and Jetties

General Info | Rating Table | CR Rating | CR Images | SE Rating | SE Images | CH

SEASIDE (or HEAD) SE

RATING CATEGORIES: (select applicable items)	Rating 1-6	Damage Length (ft) (if rating is 4 or greater)	Comment	Image/GPS
Core (or Underlayer) Exposure/Loss				BUTTON
Armor Loss: ☐ Displaced ☐ Settling ☐ Bridging				BUTTON
Loss of Armor Contact/ Armor Interlock				BUTTON
Armor Quality Defects: ☐ Rounding ☐ Cracking ☐ Spalling ☐ Fracturing				BUTTON
Slope ☐ Steepening ☐ Sliding				BUTTON

These images can be viewed on the next page.

ok

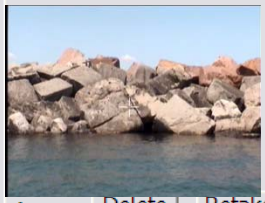
Structural Rating for Rubble Breakwaters and Jetties

General Info | Rating Table | CR Rating | CR Images | SE Rating | SE Images | CH

Core Delete Retake

Armor Delete Retake

Armor Delete Retake



Armor Delete Retake

Slope: Delete Retake

ok

Structural Rating for Rubble Breakwaters and Jetties

Rating Table | CR Rating | CR Images | SE Rating | SE Images | CH Rating | CH I

CHANNEL/ HARBOR SIDE CH

RATING CATEGORIES: (select applicable items)	Rating 1-6	Damage Length (ft) (if rating is 4 or greater)	Comment	Image/GPS
Core (or Underlayer) Exposure/Loss				BUTTON
Armor Loss: ☐ Displaced ☐ Settling ☐ Bridging				BUTTON
Loss of Armor Contact/ Armor Interlock				BUTTON
Armor Quality Defects: ☐ Rounding ☐ Cracking ☐ Spalling ☐ Fracturing				BUTTON
Slope ☐ Steepening ☐ Sliding				BUTTON

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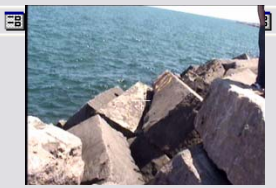
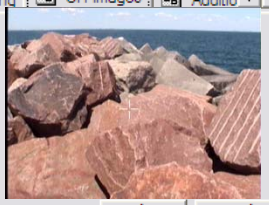
ok

Structural Rating for Rubble Breakwaters and Jetties

SE Rating | SE Images | CH Rating | CH Images | Additio



Core Delete Retake



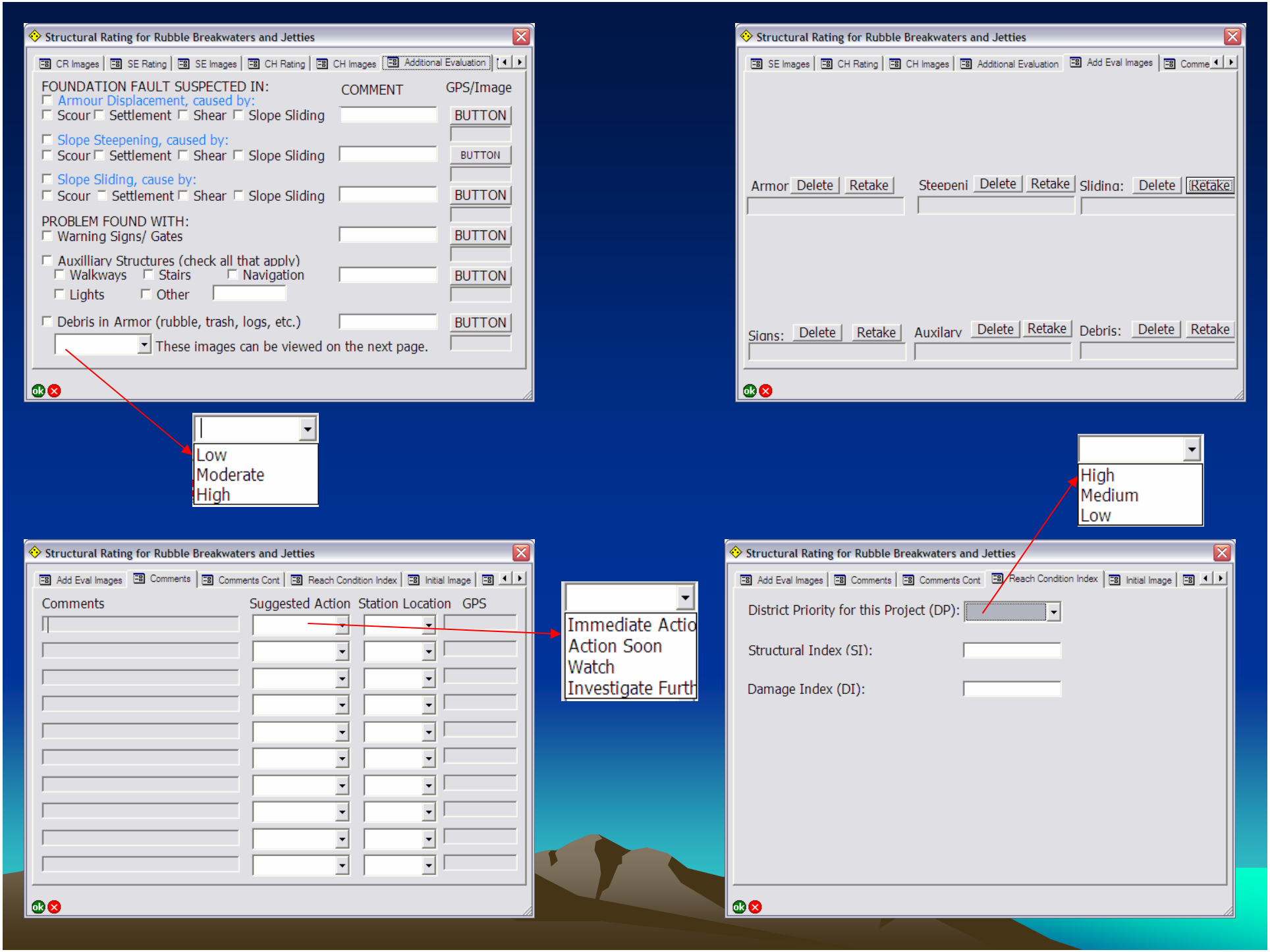
Armor Delete Retake

Armor Delete Retake

Armor Delete Retake

Slope: Delete Retake

ok


Structural Rating for Rubble Breakwaters and Jetties
CR Images
SE Rating
SE Images
CH Rating
CH Images
Additional Evaluation
FOUNDATION FAULT SUSPECTED IN:
COMMENT
GPS/Image
Armour Displacement, caused by:
Scour Settlement Shear Slope Sliding
BUTTON
Slope Steepening, caused by:
Scour Settlement Shear Slope Sliding
BUTTON
Slope Sliding, cause by:
Scour Settlement Shear Slope Sliding
BUTTON
PROBLEM FOUND WITH:
Warning Signs/ Gates
BUTTON
Auxilliary Structures (check all that apply)
Walkways Stairs Navigation
Lights Other
BUTTON
Debris in Armor (rubble, trash, logs, etc.)
BUTTON
These images can be viewed on the next page.
Low
Moderate
High
Structural Rating for Rubble Breakwaters and Jetties
SE Images
CH Rating
CH Images
Additional Evaluation
Add Eval Images
Armor Delete Retake
Steepeni Delete Retake
Sliding: Delete Retake
Signs: Delete Retake
Auxilary Delete Retake
Debris: Delete Retake
High
Medium
Low
Structural Rating for Rubble Breakwaters and Jetties
Add Eval Images
Comments
Comments Cont
Reach Condition Index
Initial Image
Comments
Suggested Action
Station Location
GPS
Immediate Actio
Action Soon
Watch
Investigate Furth
Structural Rating for Rubble Breakwaters and Jetties
Add Eval Images
Comments
Comments Cont
Reach Condition Index
Initial Image
District Priority for this Project (DP):
Structural Index (SI):
Damage Index (DI):

STRUCTURAL RATING FOR RUBBLE BREAKWATERS AND JETTIES Page_____of_____

PROJECT NAME:		Reach:
STRUCTURE NAME:		Sta: From_____To_____
INSPECTION TEAM: NAME: OFFICE SYMBOL: PHONE:	DATE:	TIME: Begin_____End_____

WAVE HEIGHT (ft)
DAY OF INSPECTION:

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B. Non-overtopping

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C. Fog
D. Storming

TYPE OF INSPECTION: WALKING BOATING OTHER _____ (CIRCLE)

RATING CATEGORIES: Rate all Items (Circle applicable lettered items)	CREST / CAP CR			SEASIDE (or HEAD) SE			CHANNEL / HARBOR SIDE CH		
	Rating 1-6	Damage Length	Comment Numbers	Rating 1-6	Damage Length	Comment Numbers	Rating 1-6	Damage Length	Comment Numbers
Breach: (A) Displaced Cap/Armor (B) Settling Cap/Armor									
Core (or Underlayer) Exposure/Loss									
Armor Loss: (A) Displaced (B) Settling (C) Bridging									
Loss of Armor Contact / Armor Interlock									
Armor Quality Defects: (A) Rounding (B) Cracking (C) Spalling (D) Fracturing									
Slope Defects: (A) Steepening (B) Sliding									

Rating Guide: If rating ≥4, measure length of damage area and enter in the second column.		
Rating	Damage Condition Level	Description
1	Insignificant	No significant defects - only minor defects or deterioration are evident.
2	Minor	Deterioration is clearly evident, but the structure still appears sound.
3	Moderate	Structure is showing deterioration that may require attention in near future and progression of damage should be monitored & documented - may require further investigation for any rating greater than a 3.
4	Serious	A portion of the reach has deteriorated to a condition that repairs are indicated.
5	Severe	Extension deterioration indicating repair for the majority of the reach.
6	Failed	General failure of reach.

STRUCTURAL RATING FOR RUBBLE BREAKWATERS AND JETTIES (CONTINUED)

Comments:

FOUNDATION FAULT SUSPECTED IN: (A) Armour Displacement (B) Slope Steepening (C) Slope Sliding

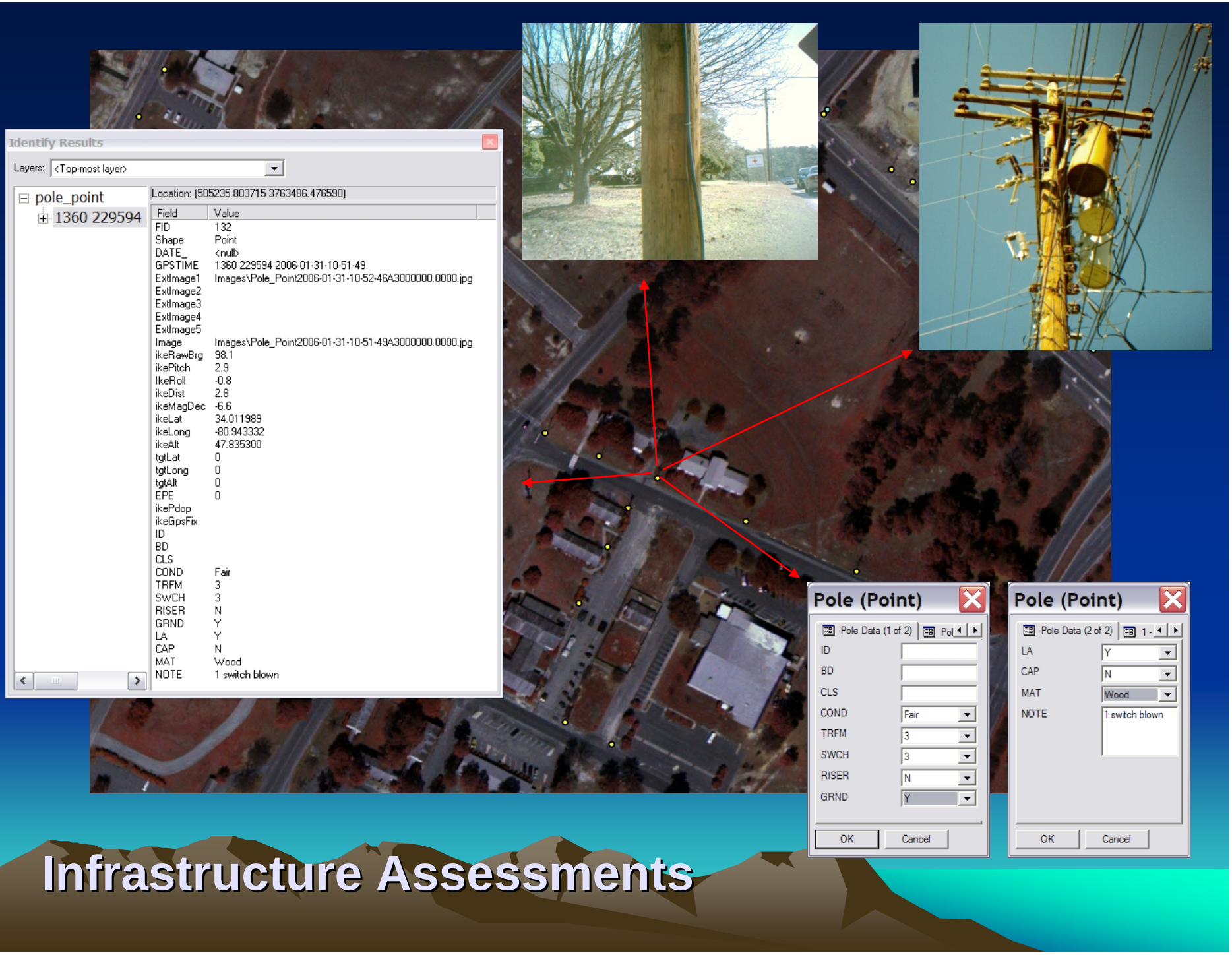
Caused By: (a) Scour (b) Settlement (c) Shear (d) Liquefaction

_____ Item (A) (B) (C) -- (a) (b) (c) (d) Sta
_____ Item (A) (B) (C) -- (a) (b) (c) (d) Sta
_____ WARNING SIGNS/GATES
_____ AUXILIARY STRUCTURES (walkways, stairs, navigation lights, etc.)
_____ AMOUNT OF DEBRIS IN ARMOR (rubble, trash, logs, etc.)

SUGGESTED ACTIONS: (IA) Immediate Action (AS) Action Soon (W) Watch (IF) Investigate Further

Comment Number	Suggested Action	Station Location(s)	COMMENTS AND SKETCHES

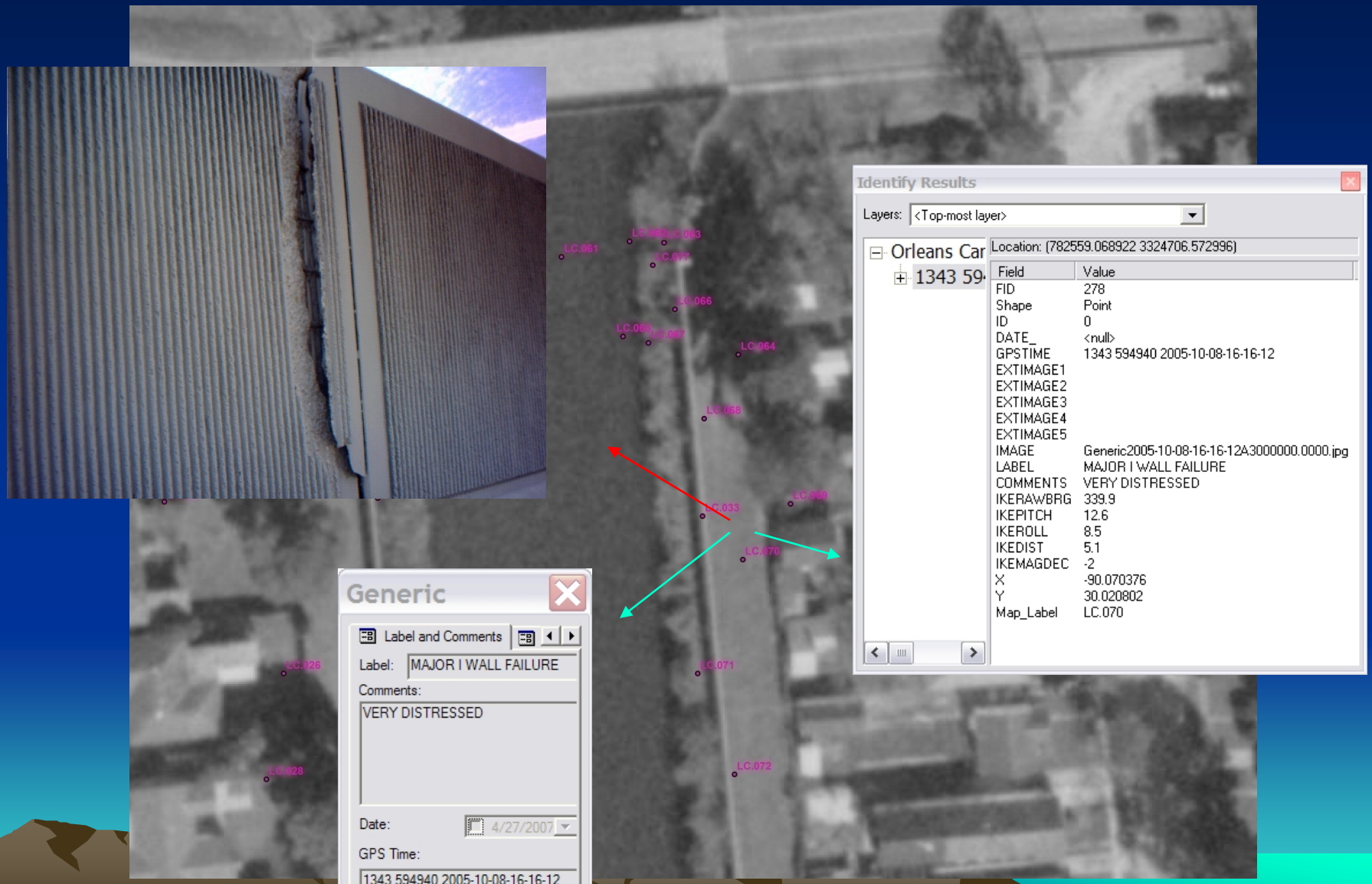
CI	DP =	Indicate District priority for this project: (1) high; (2) medium; (3) low.
	SI =	Calculate similar to old method; but ratings are 1-6 with highest number being worst condition.
	DI =	Damage index. For each reach that has an R ≥ 4 a measurement of the length of the damage region is entered in the inspection table. The R value is multiplied by the length of the damage area and these values are summed. $DI = \sum R_{4,5,6} \bullet$ length of damage.



Infrastructure Assessments

The Access Control Program Survey

Post-Katrina Levee Survey in New Orleans



Teaming Arrangements

COMPASS SYSTEMS

Department of Systems Engineering
USMA
EST 1959

ROPER mobile technology

US Army Corps of Engineers®
Engineer Research and Development Center

BNet
Wireless Solutions for Real-time Asset Visibility

VANTEON
EMBEDDED FOR YOUR FUTURE

Accipiter Systems
Developing innovative data communications solutions

Technical POC:
Mr. David Bjornberg
Project Engineer
Compass Systems, Inc.
938 Mt. Airy Drive
Johnstown, PA 15904
Phone (814) 266-8560
Fax (814) 266-8561
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Program POC:
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Researcher/PM
Compass Systems, Inc.
60 Hazelwood Drive
Champaign, IL 61820
Phone (217) 552-2478
Fax (217) 403-0265
tad.britt@compass-sys-inc.com

Integrated Survey System
Tool #4

- Combine vessel-mounted survey systems
  - Topo/laser system
  - Multi-beam Sonar system
  - Video/photo
- Combine platforms
- Link data collection
- Districts are manually linking high density topo survey and multi-beam surveys.
- Need automated system

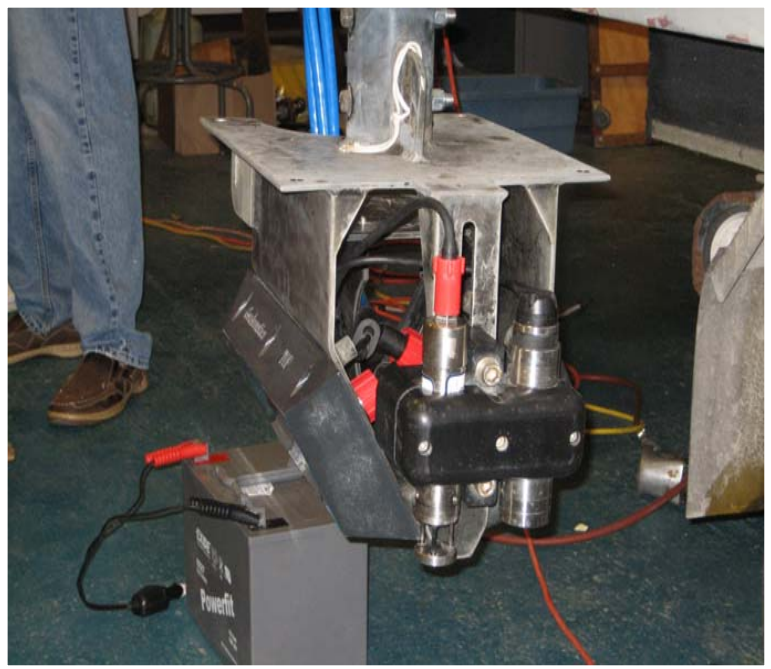
Mobile Laser and Interferometric Multi-Beam Survey Techniques

Principal Investigators: Stan Boc and Cheryl Pollock

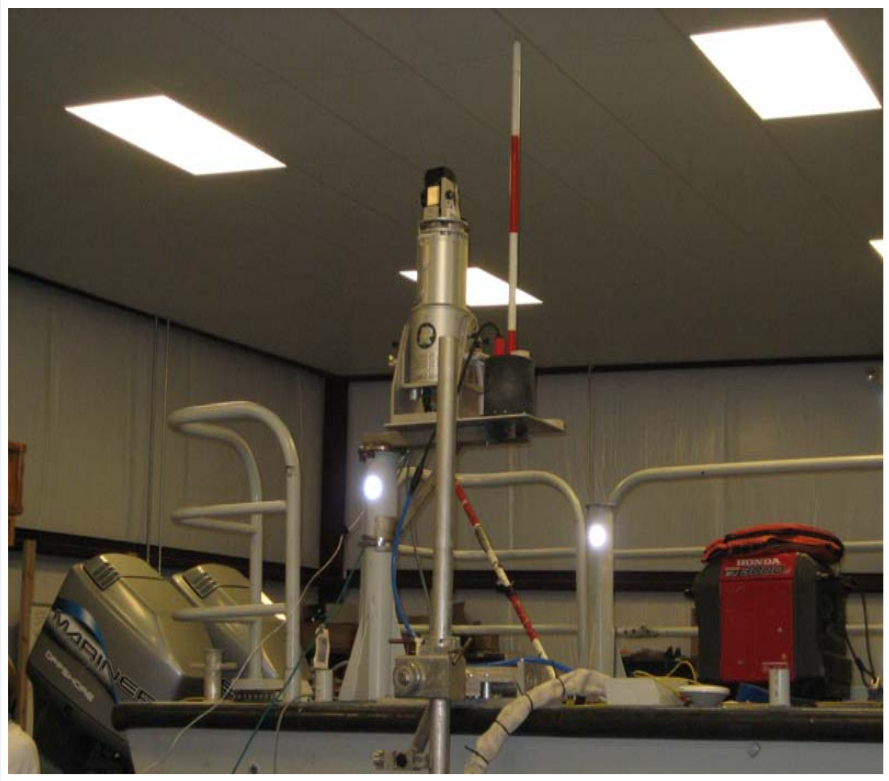
Work performed under the Condition Indexing Work Unit of the Navigation Program

Development Team: Thad Pratt, William Butler and Terry Waller

Integrated Terrestrial Laser and Interferometric Multi-beam Survey System

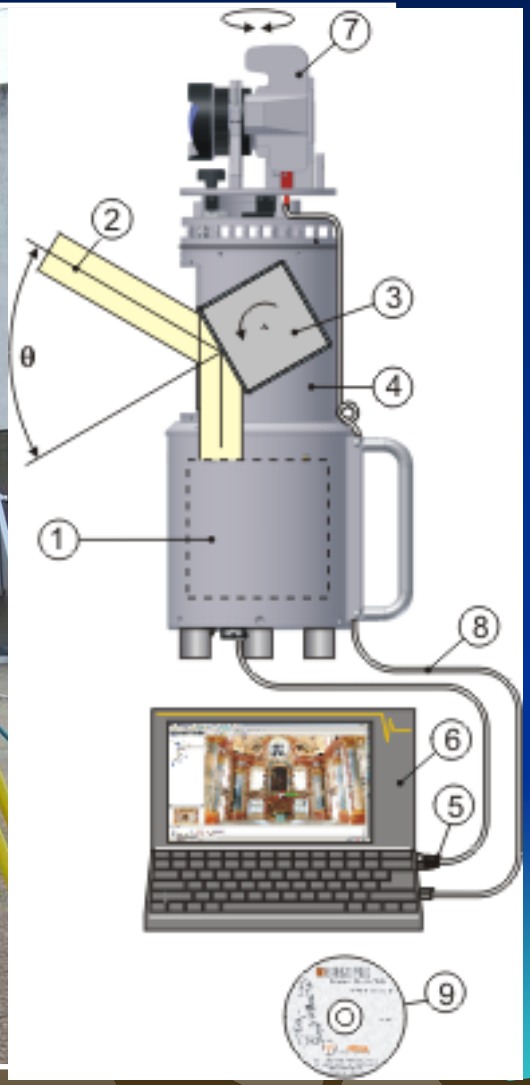


GeoSwath Interferometric Multi-Beam



Riegl Vessel-Mounted Lidar

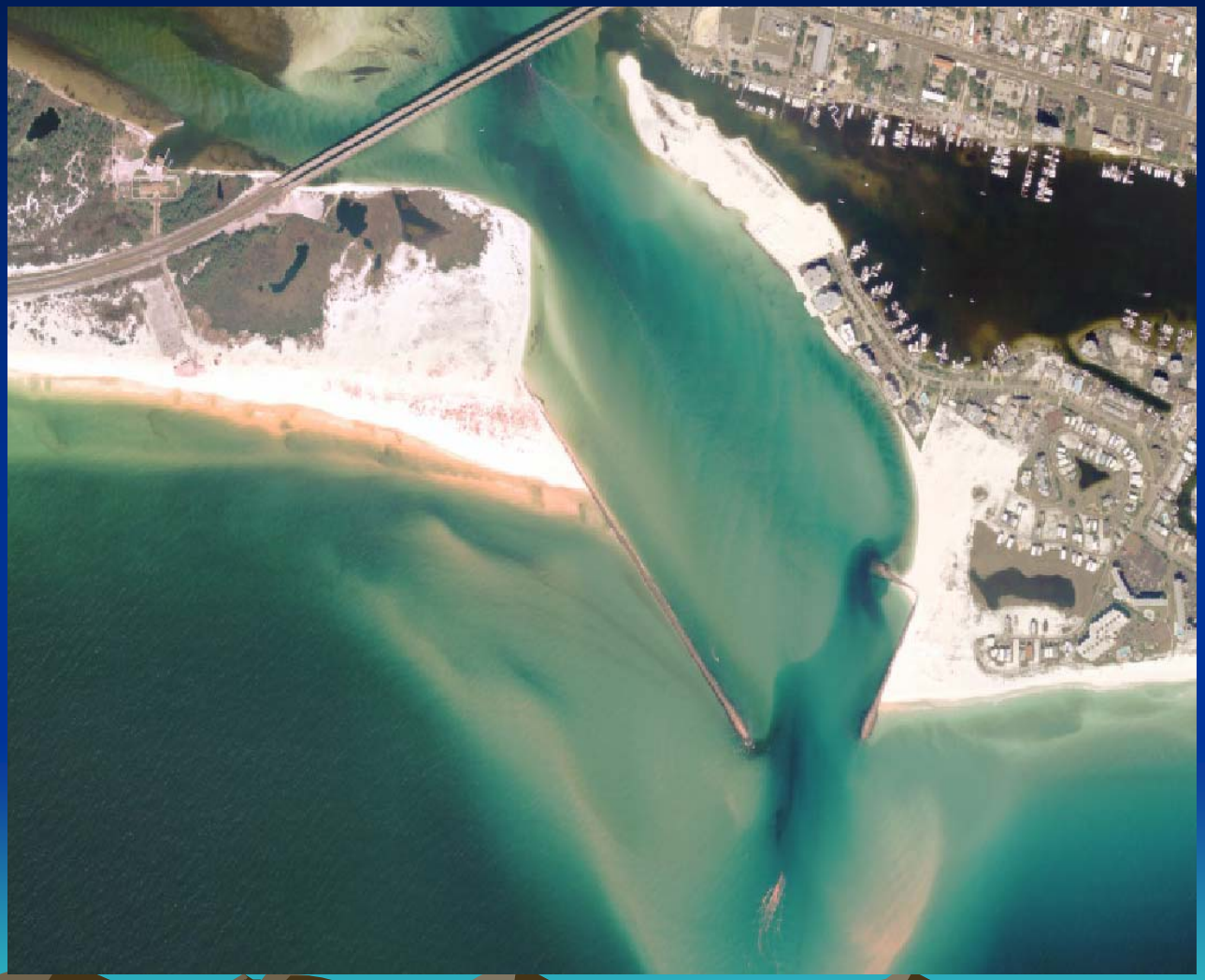
Laser



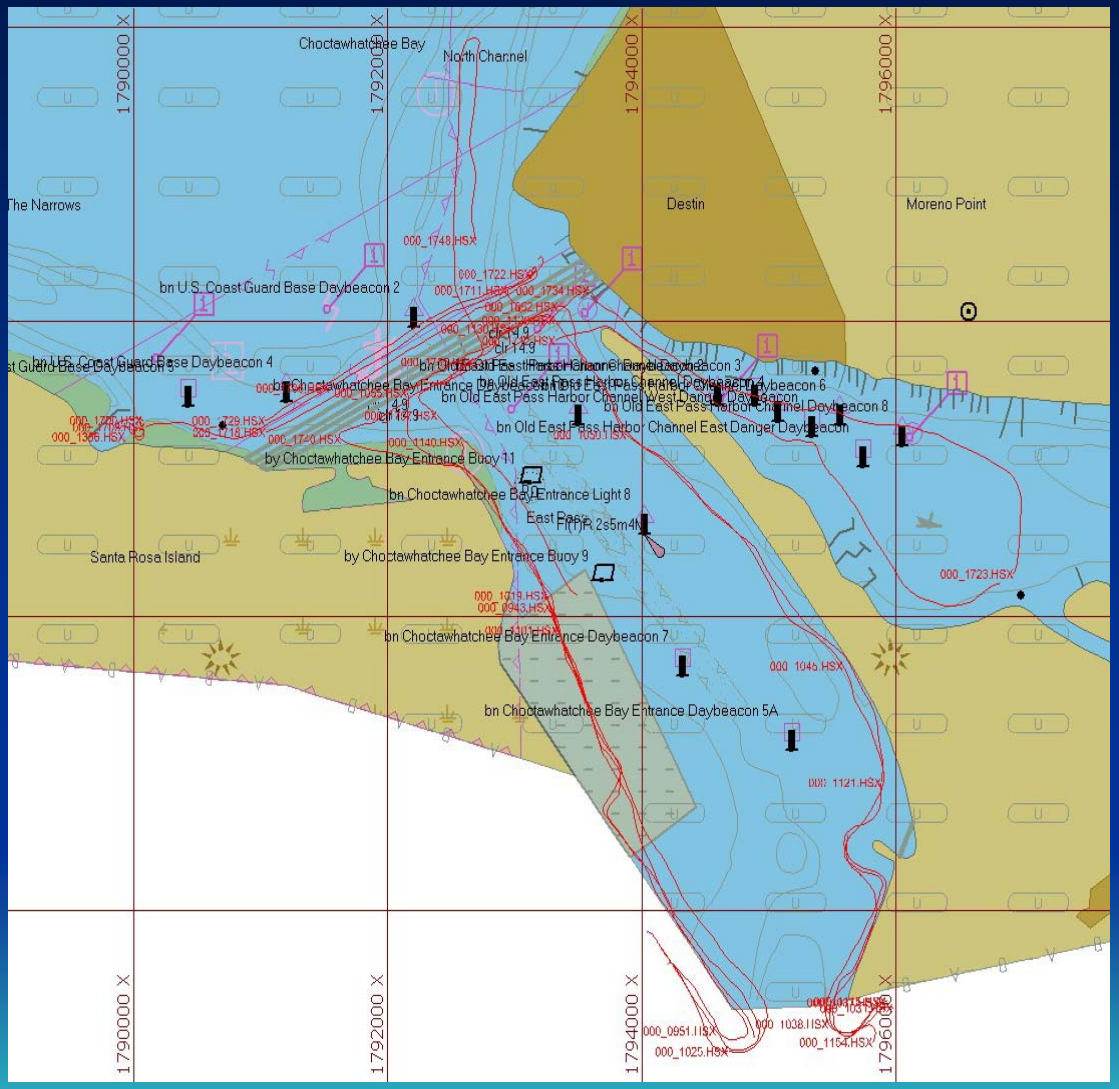
KEY FEATURES

- **Range up to 400 m @ Laser Class 1**
- **Repeatability up to 2 mm Measurement rate up to 11000 pts / sec Field of View up to 80° x 360°**
- **Operated by any standard PC or Notebook, Fully portable, rugged & robust**

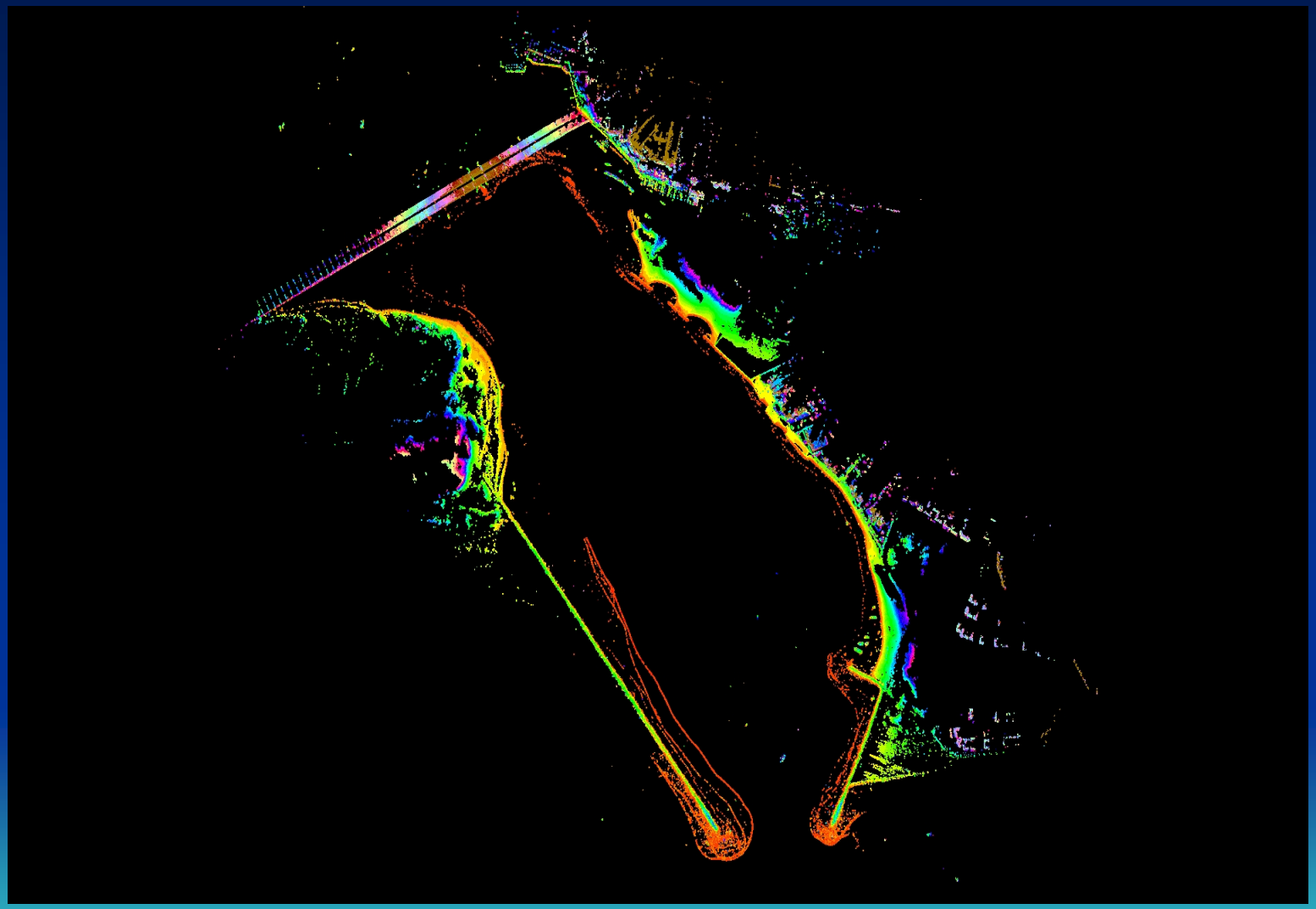
Test Site Fort Walton / Destin Florida



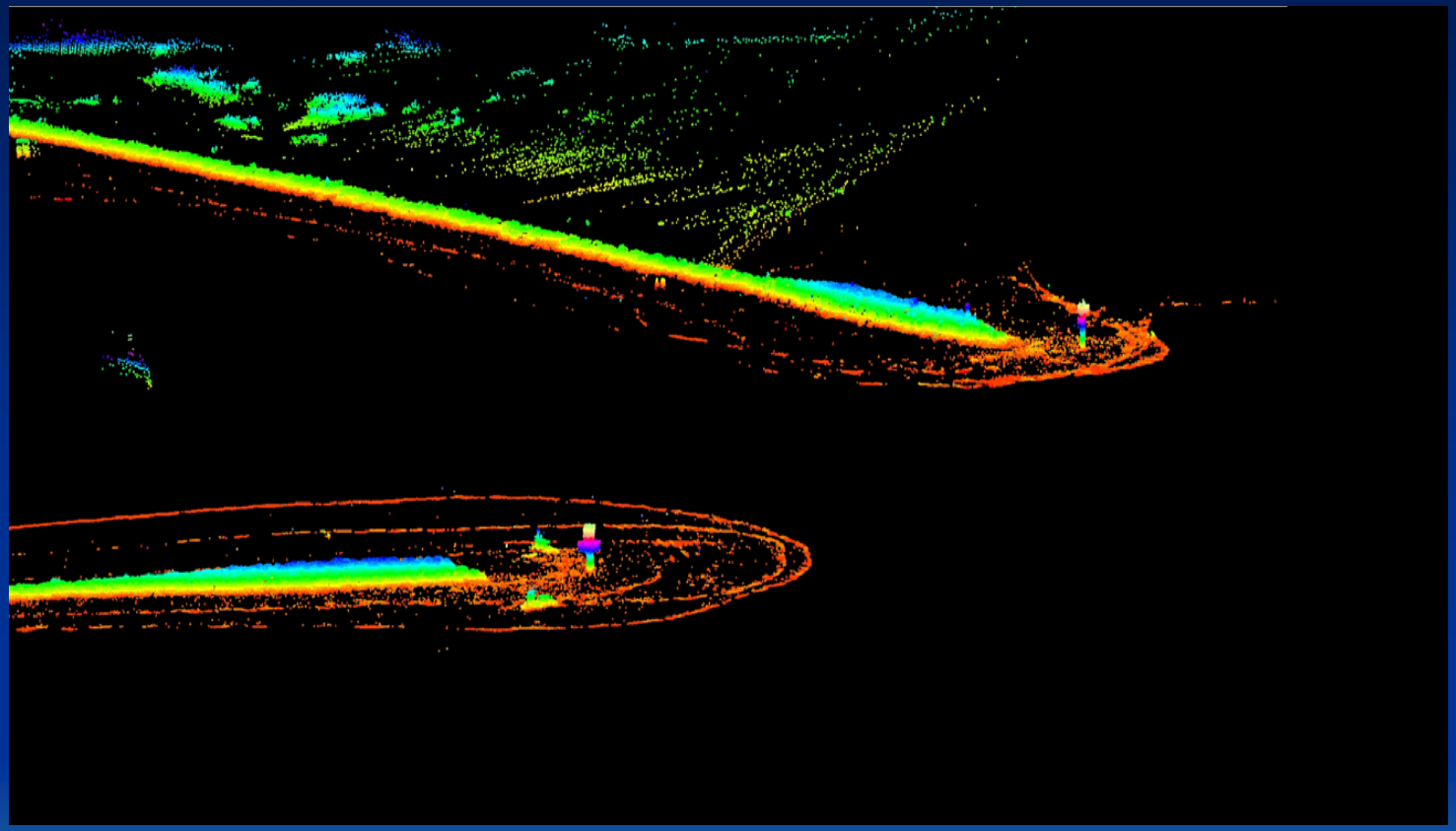
Test Site Fort Walton / Destin Florida



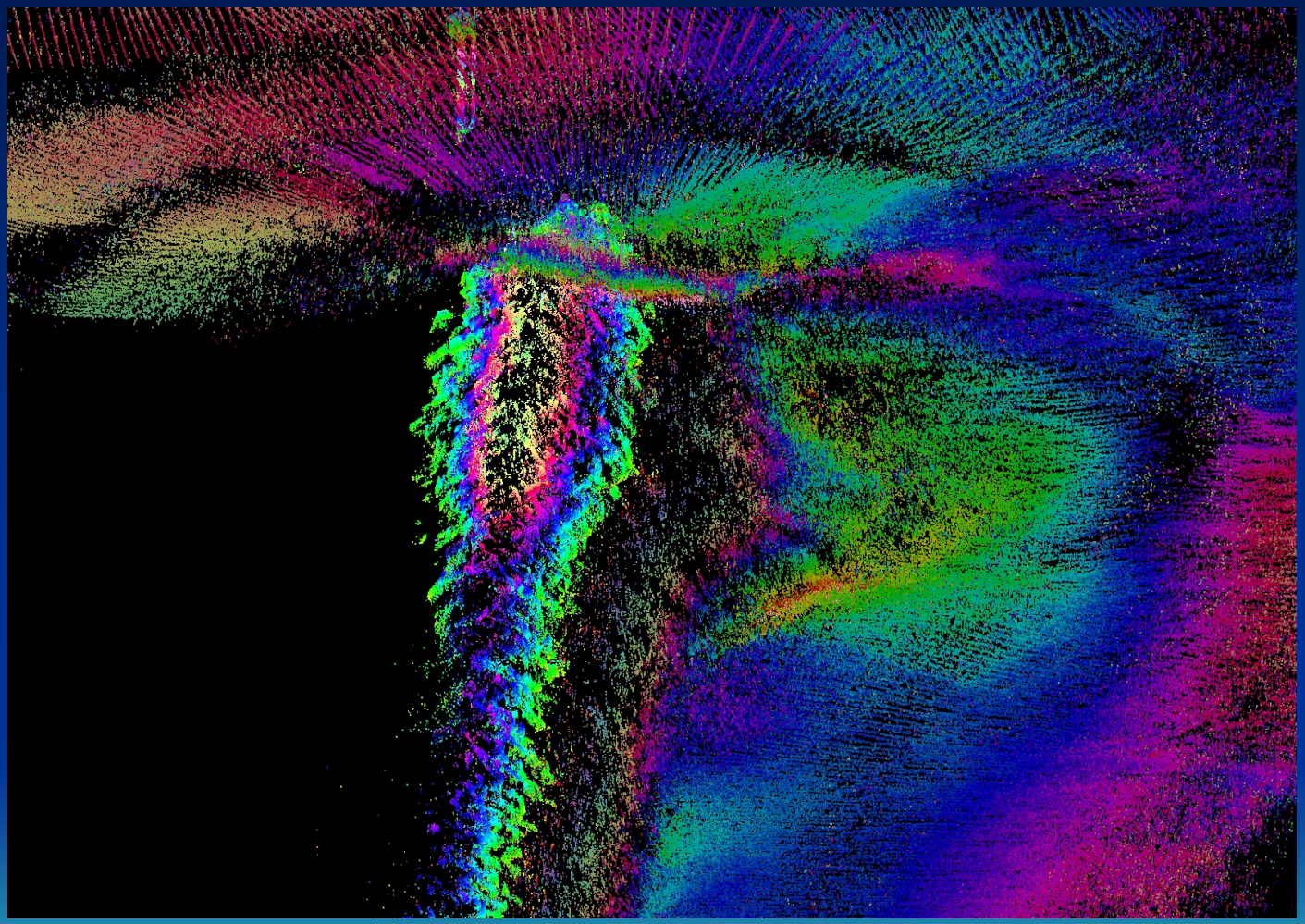
Test Site Fort Walton / Destin Florida UnEdited Data



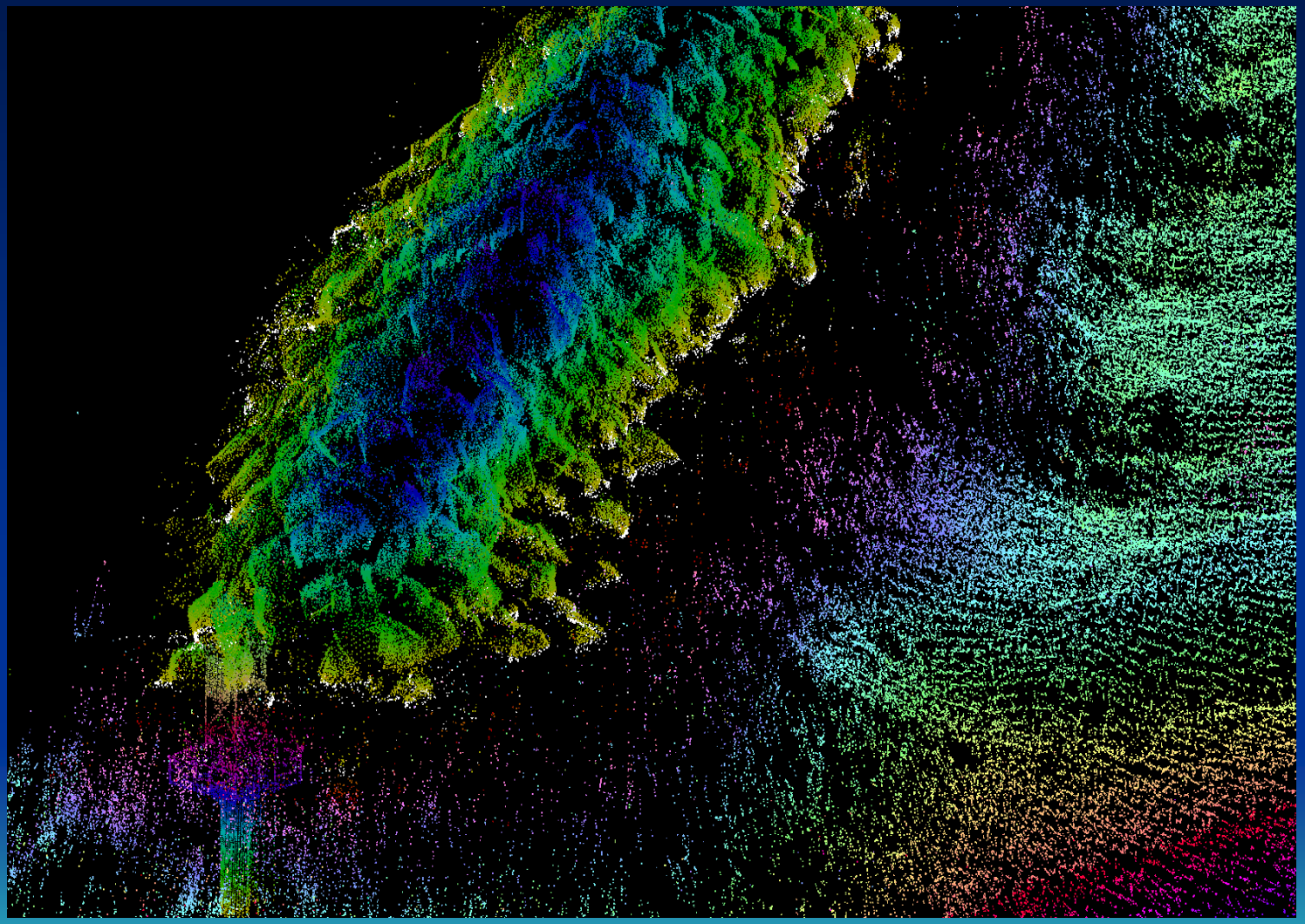
HyPack Screen Showing The Track Lines



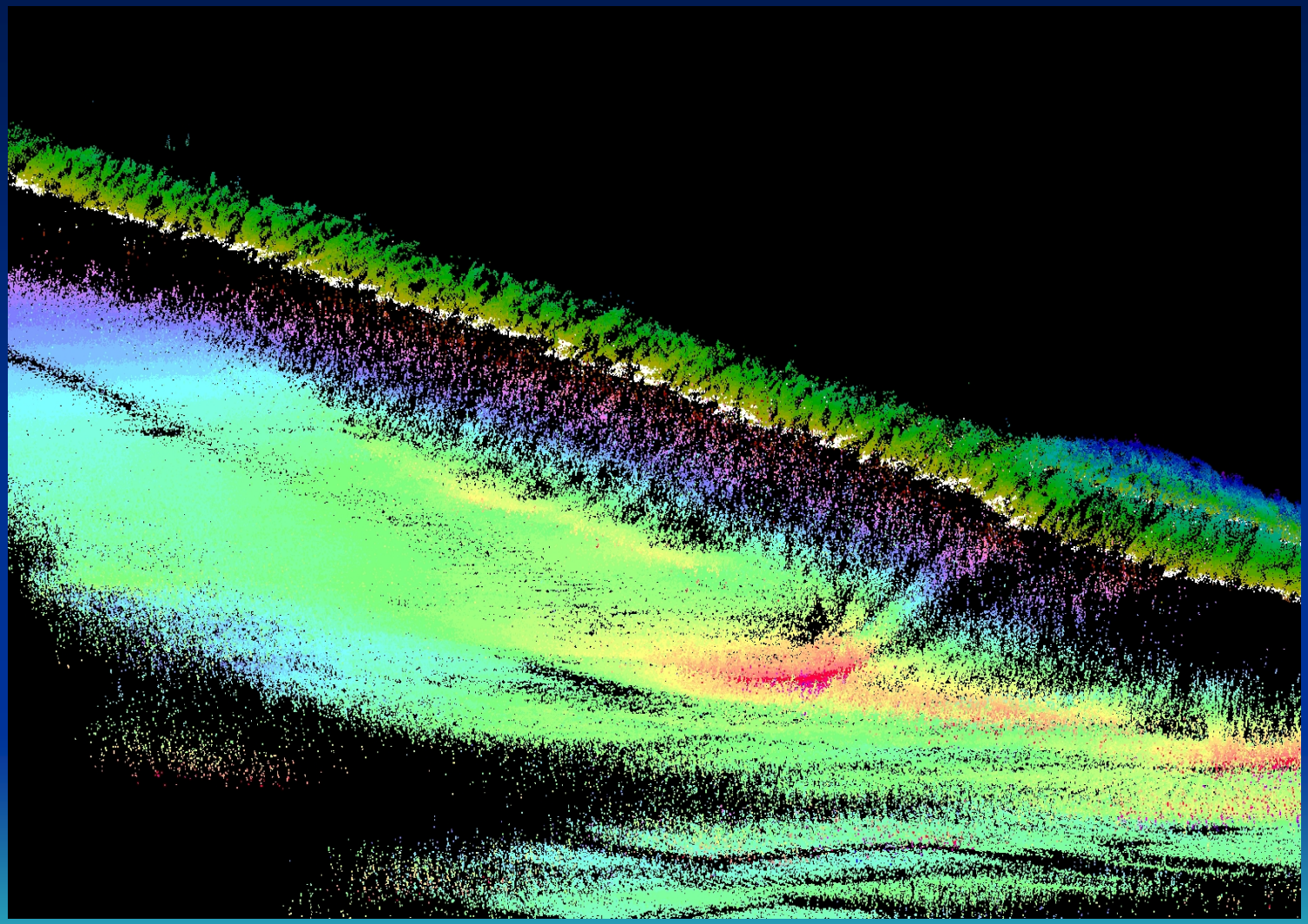
Looking South on East Jetty



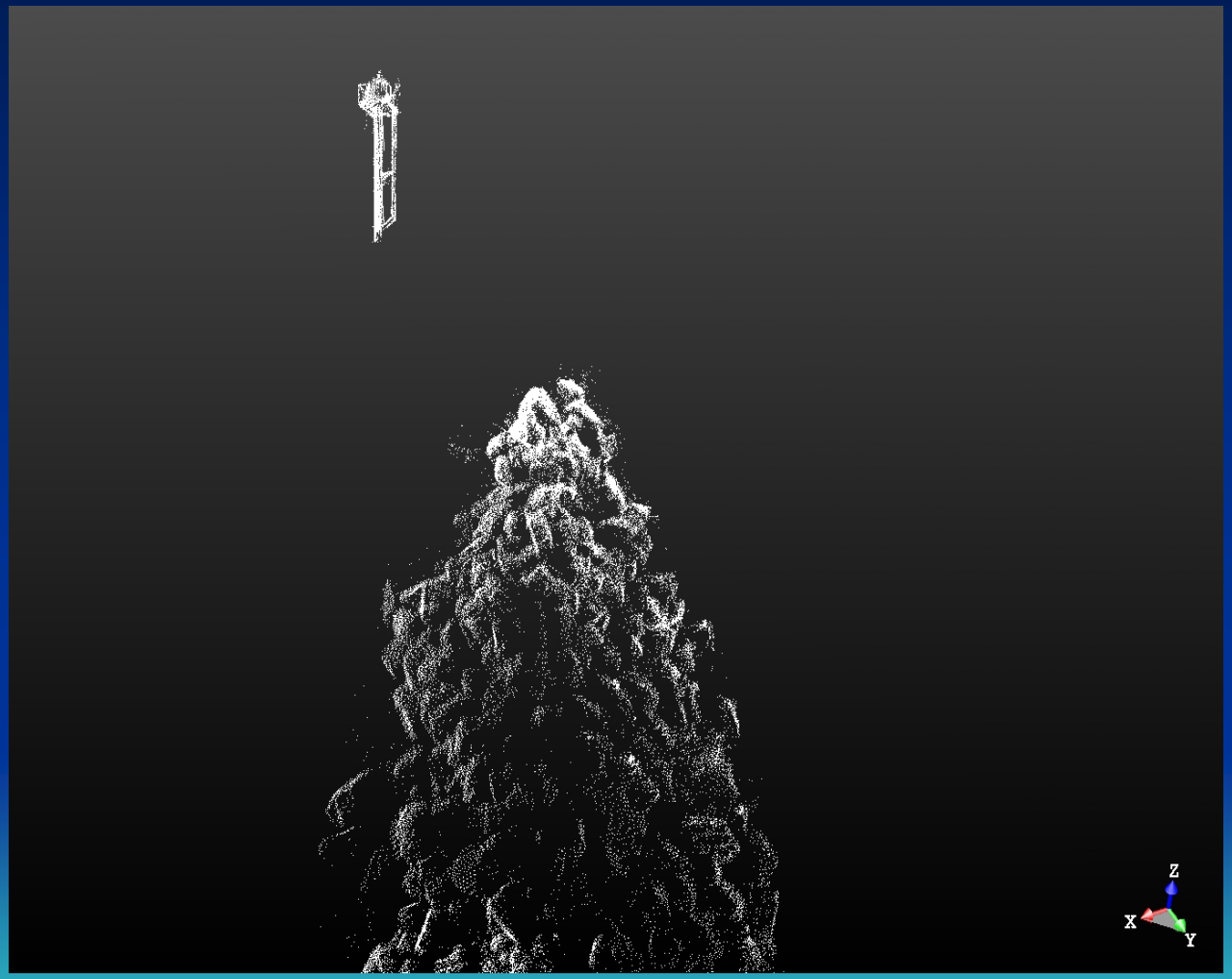
End of West Jetty



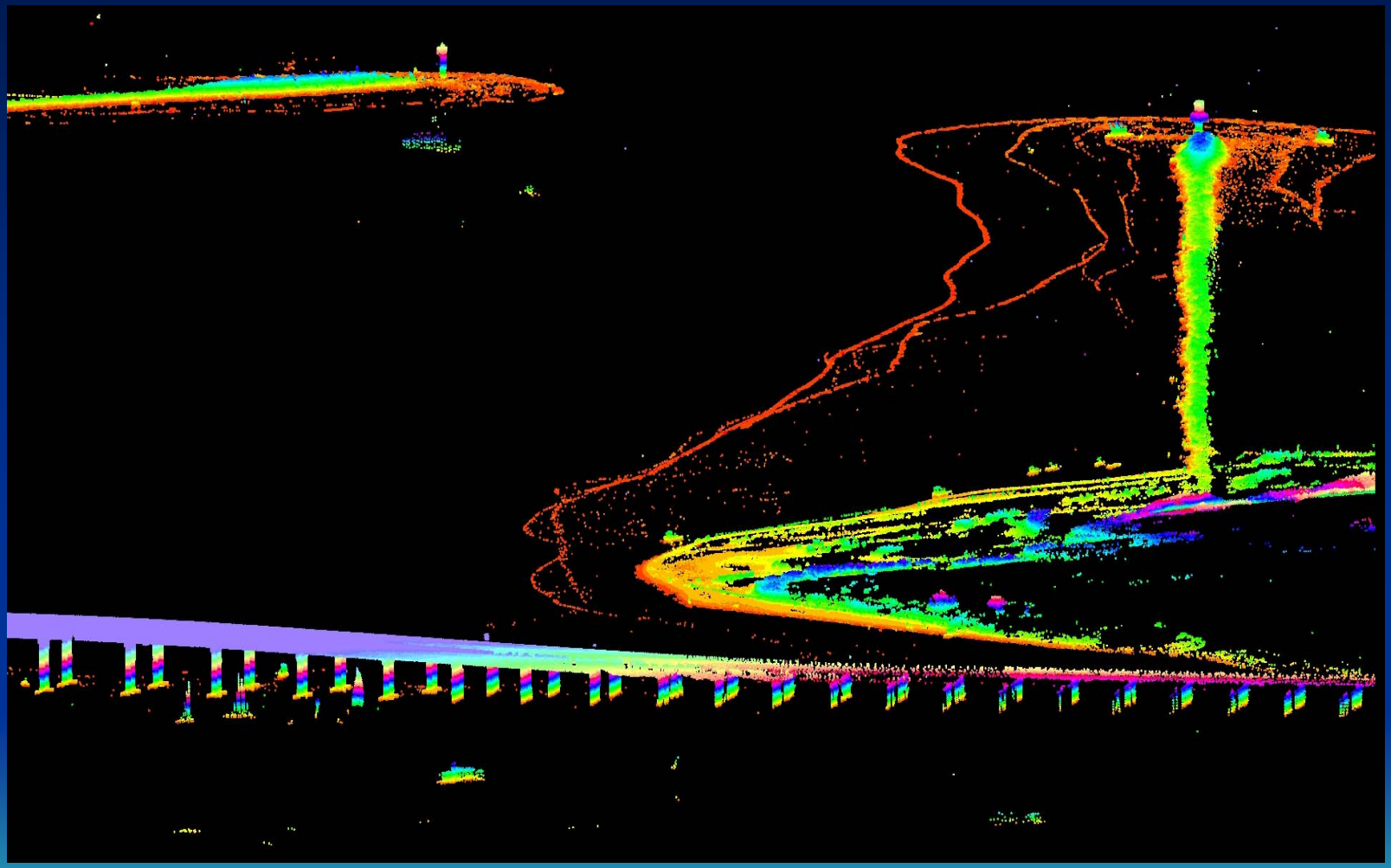
West Side of East Jetty



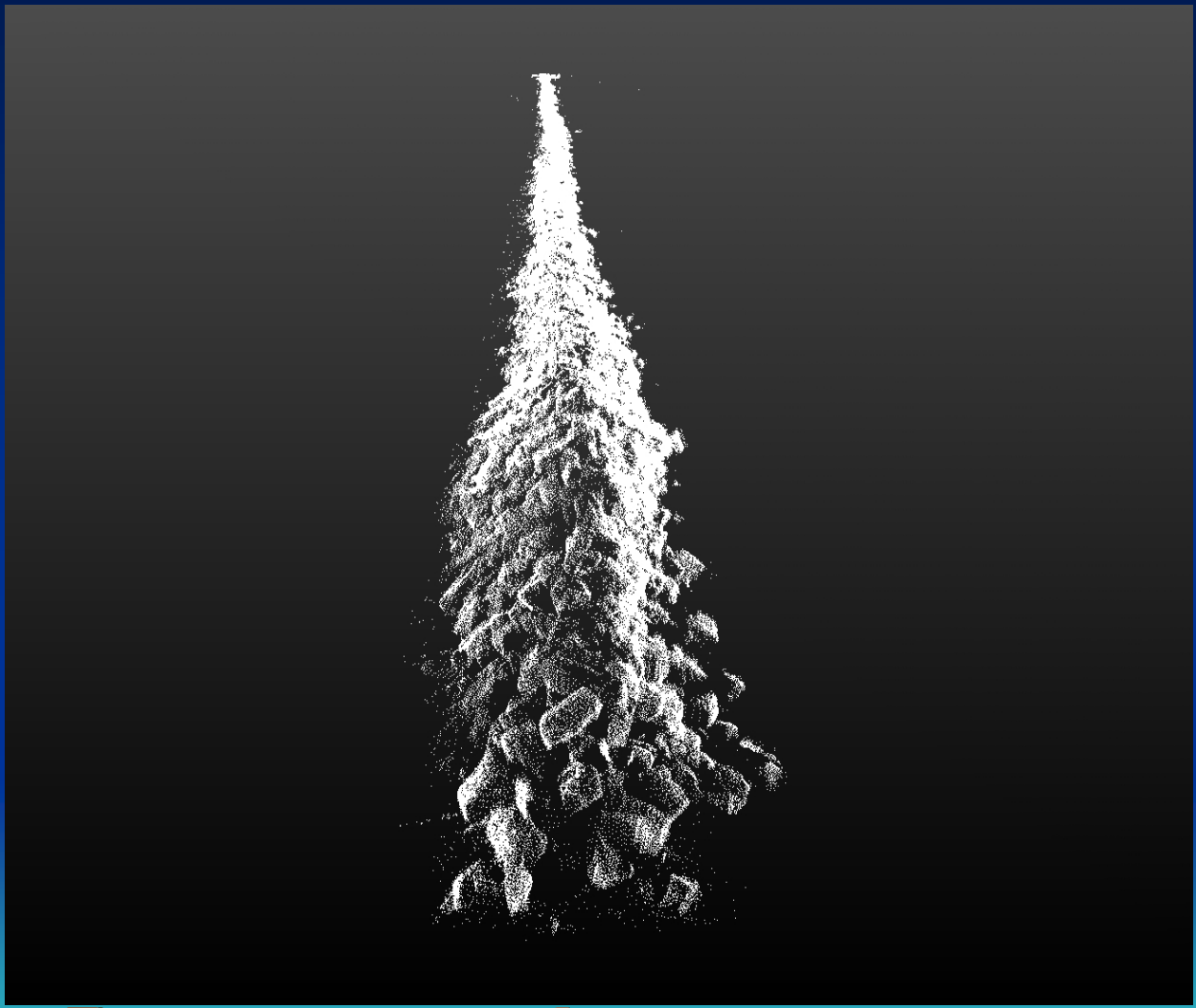
Laser Data at The Head Of the Structure



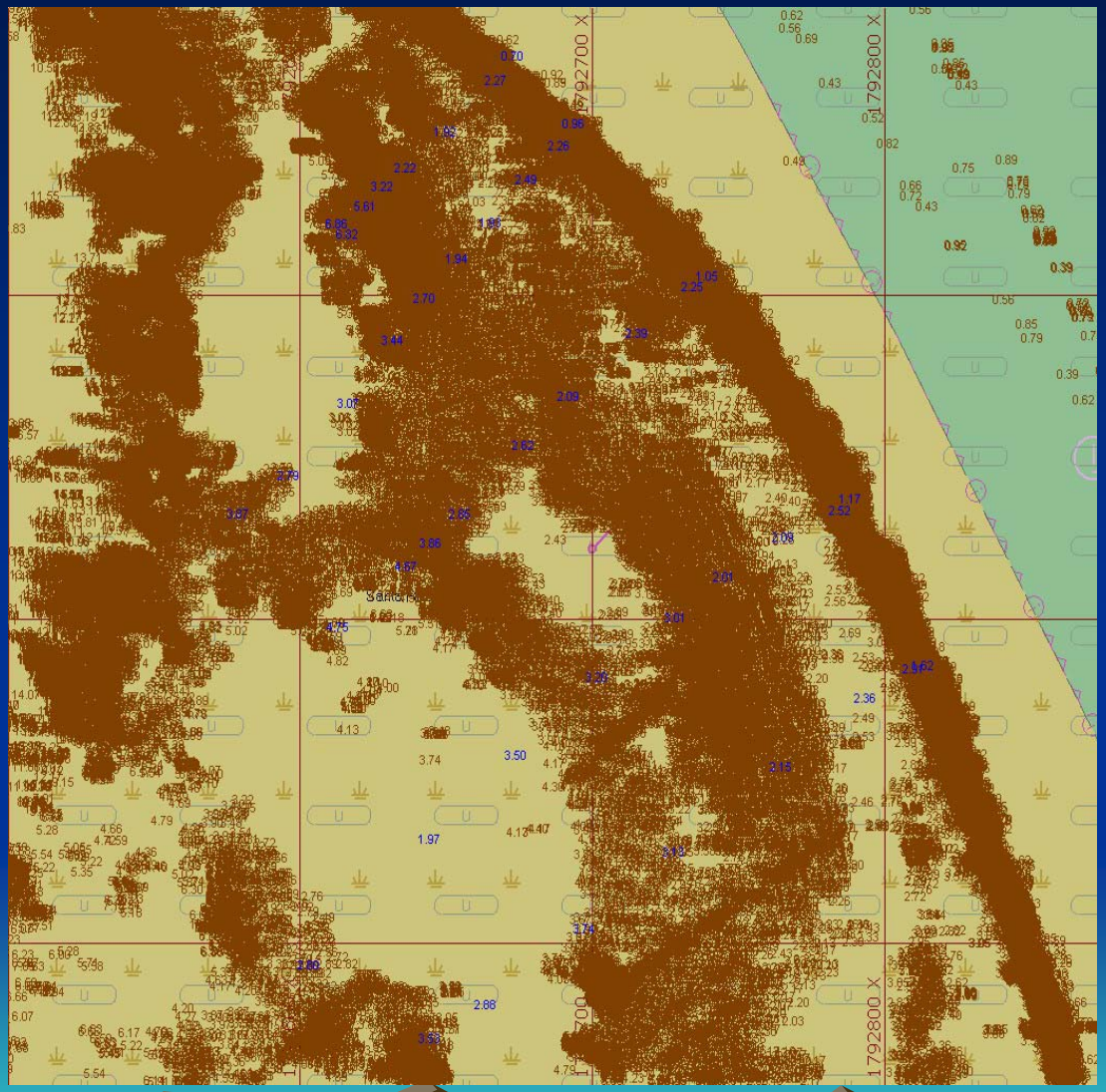
View Looking Along West Jetty



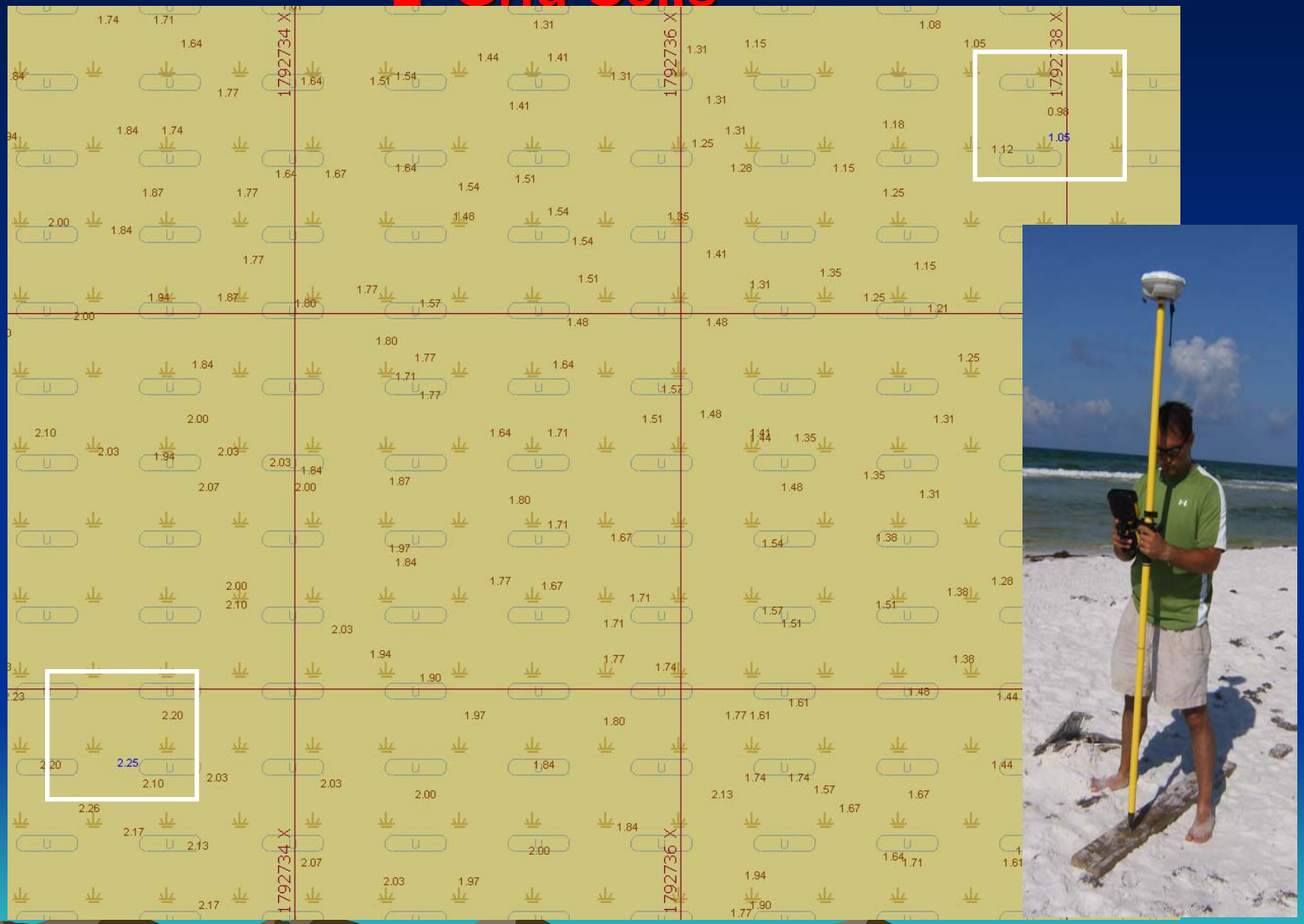
West Jetty Mobile Laser Data Only



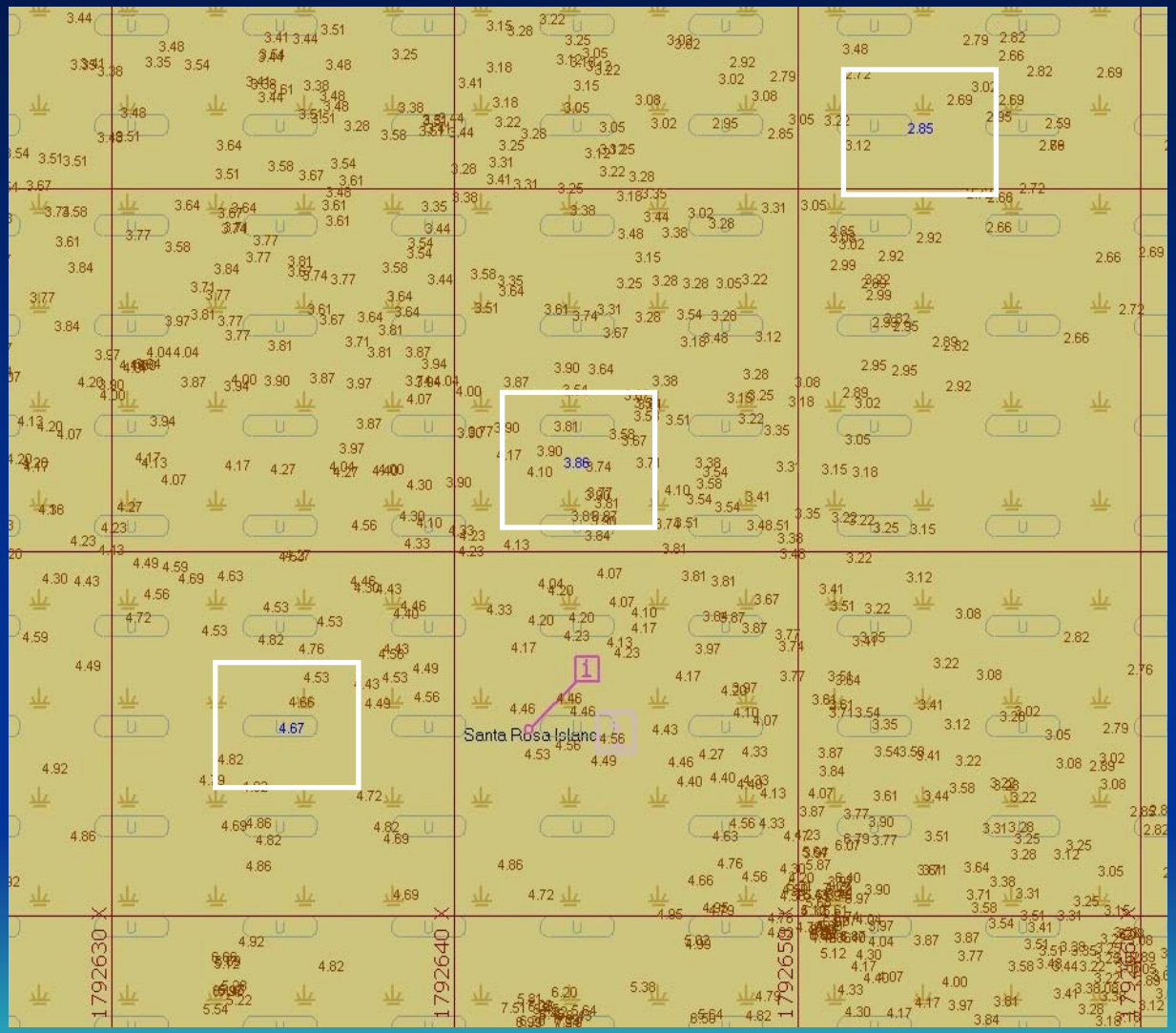
Beach Comparison of Mobile Laser to RTK GPS Data



Beach Comparison of Mobile Laser to RTK GPS Data
2’ Grid Cells

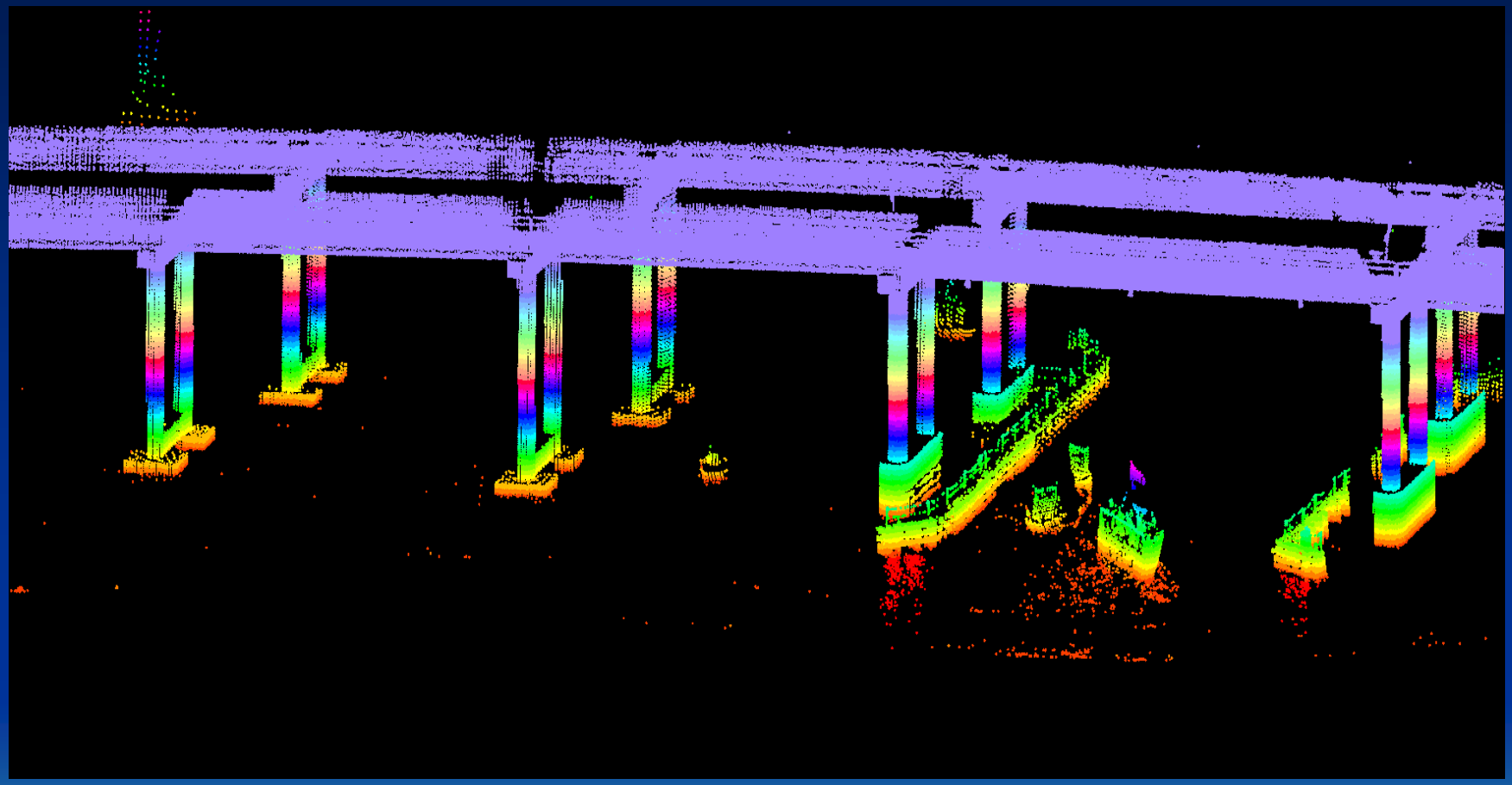


Beach Comparison of Mobile Laser to RTK GPS Data

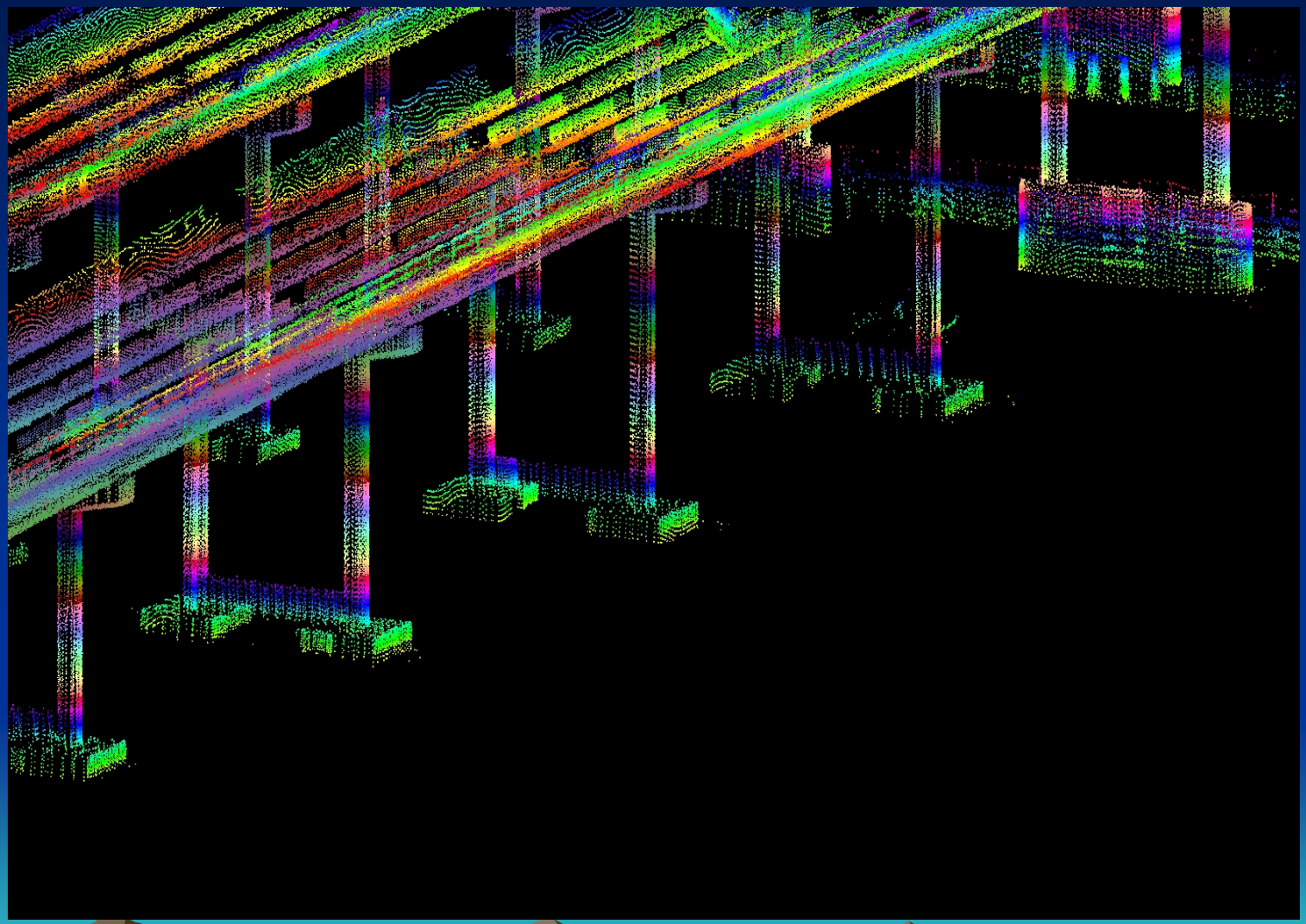


Bridge Structure

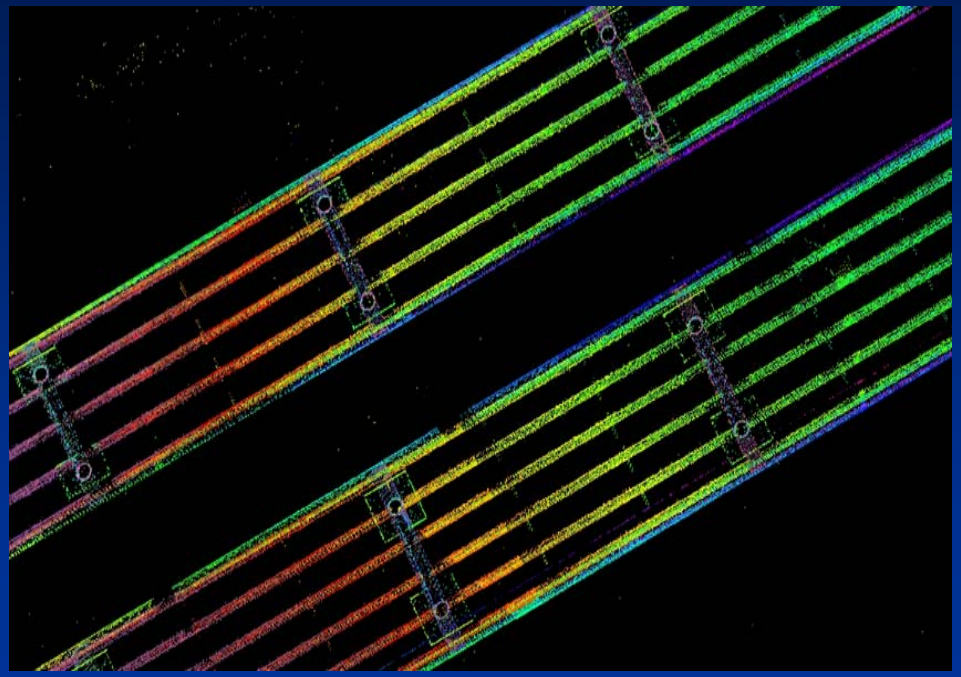
Bridge Structure

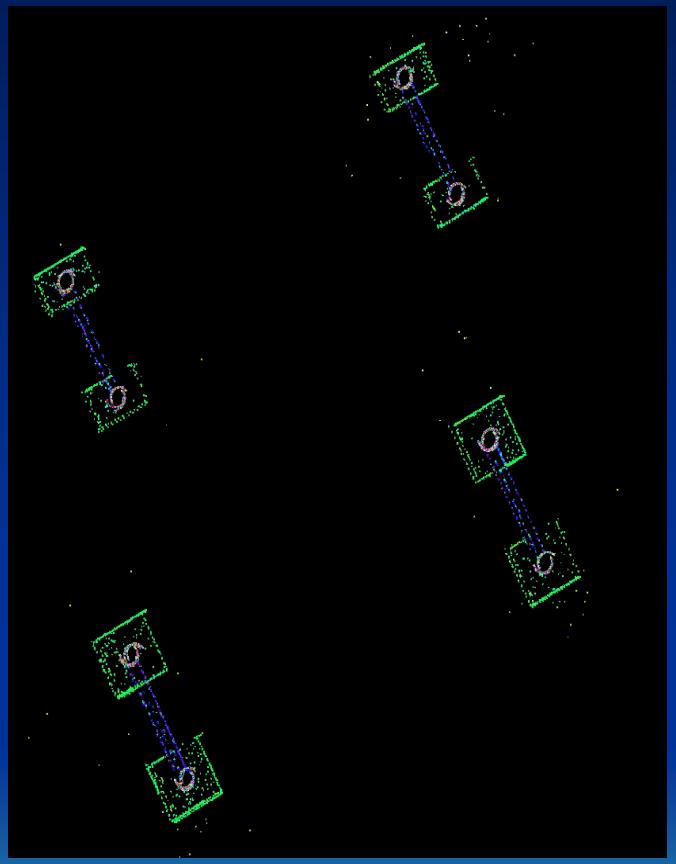


Bridge Structure



Bridge Structure Roll, Pitch and Yaw Adjustments





Fixed Scans Data collection

Fixed Scans Setting Control

Collecting The Fixed Scan Data

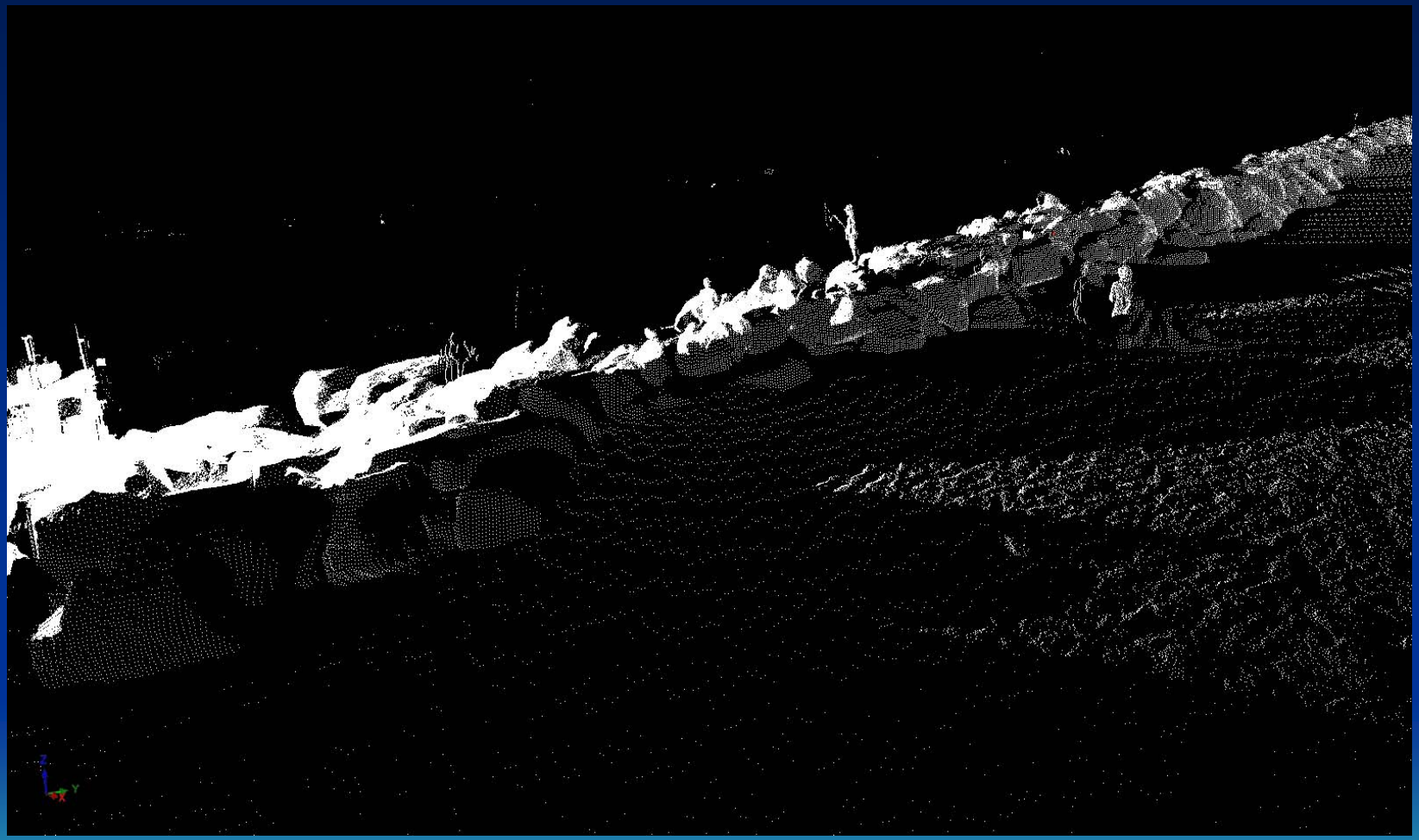
Collecting The Fixed Scan Data

Close-Up view of Stones

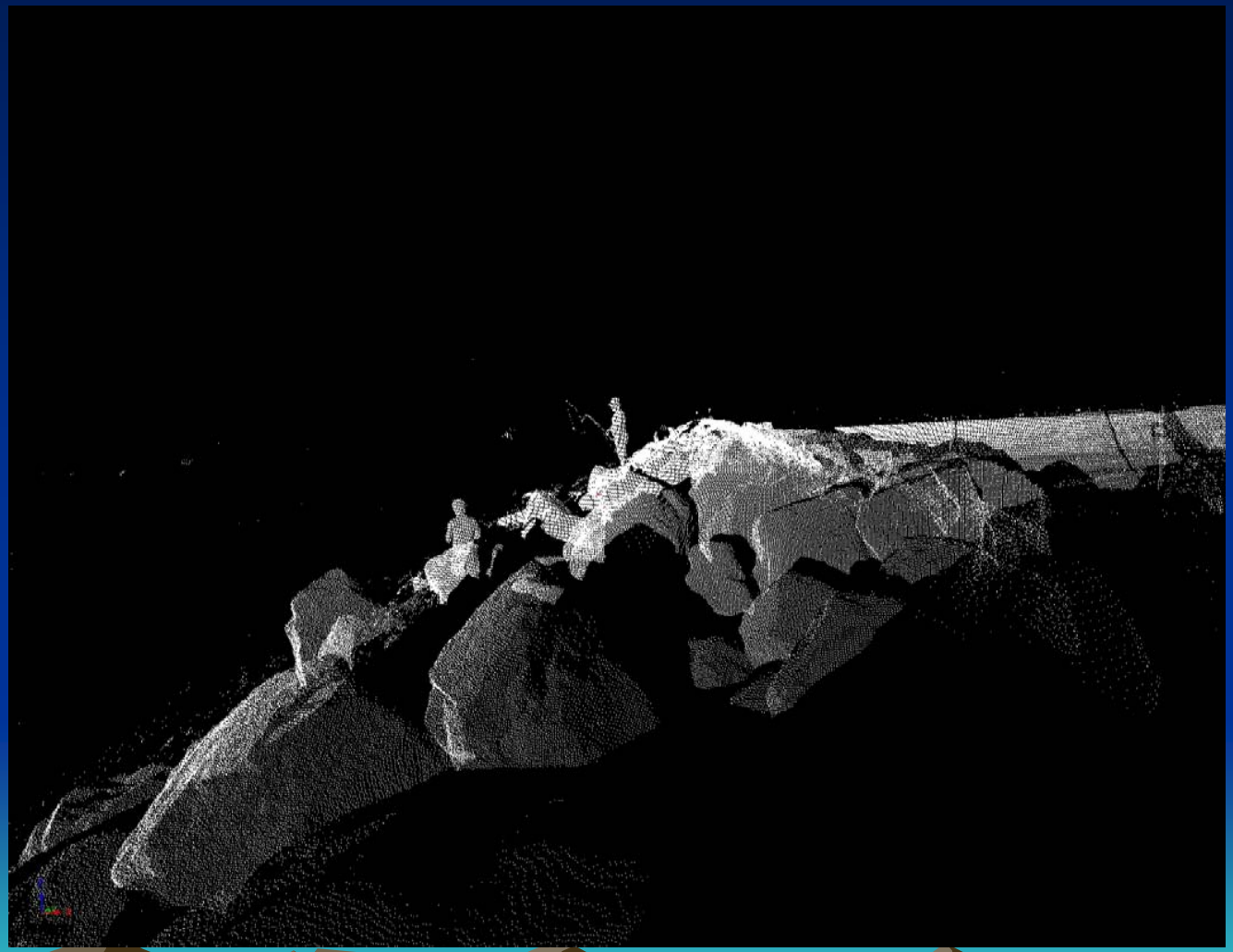
Birds Eye View of Both Scan Positions

East Side of West Jetty Looking South

West Jetty Looking East

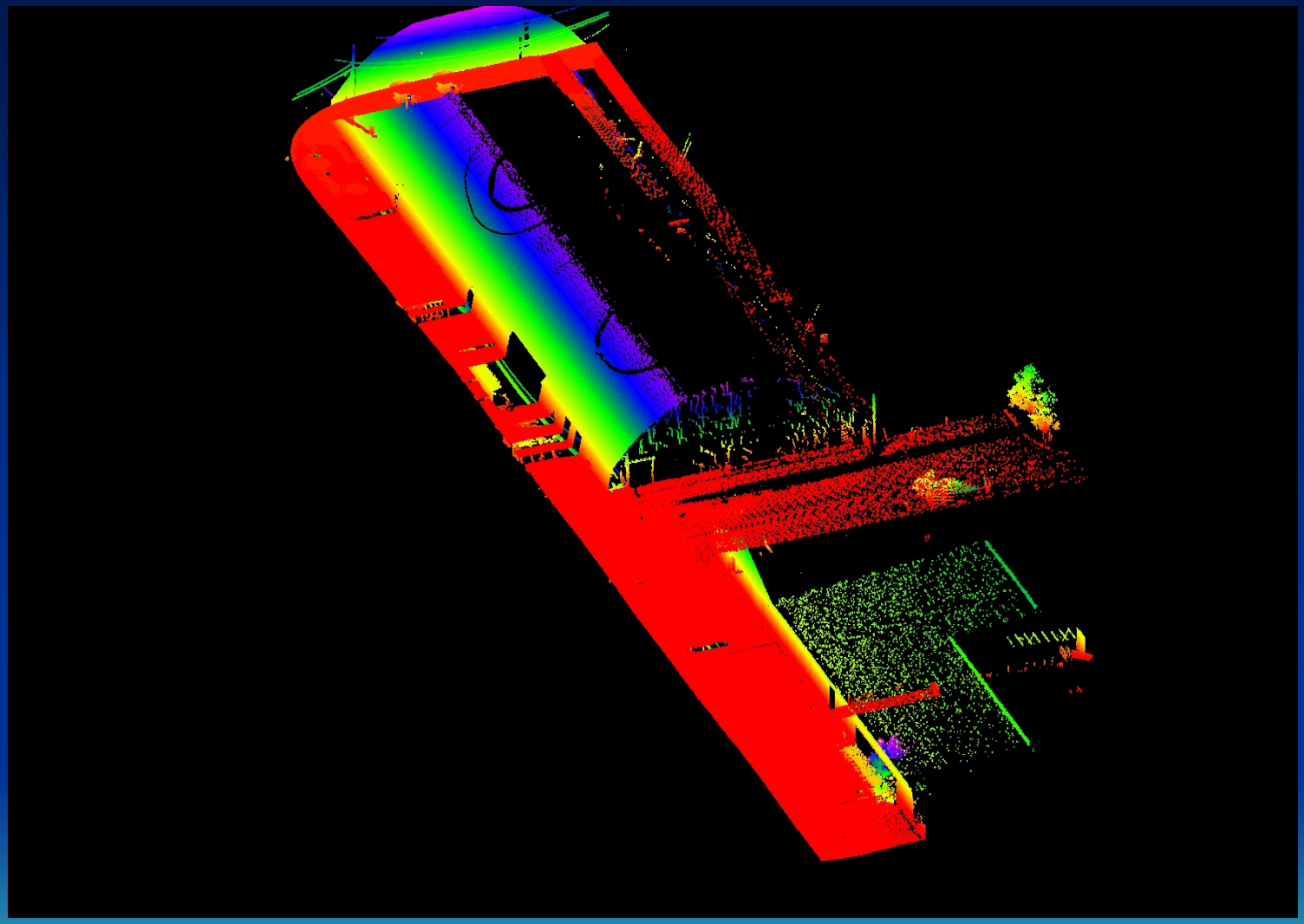


West Jetty Looking South

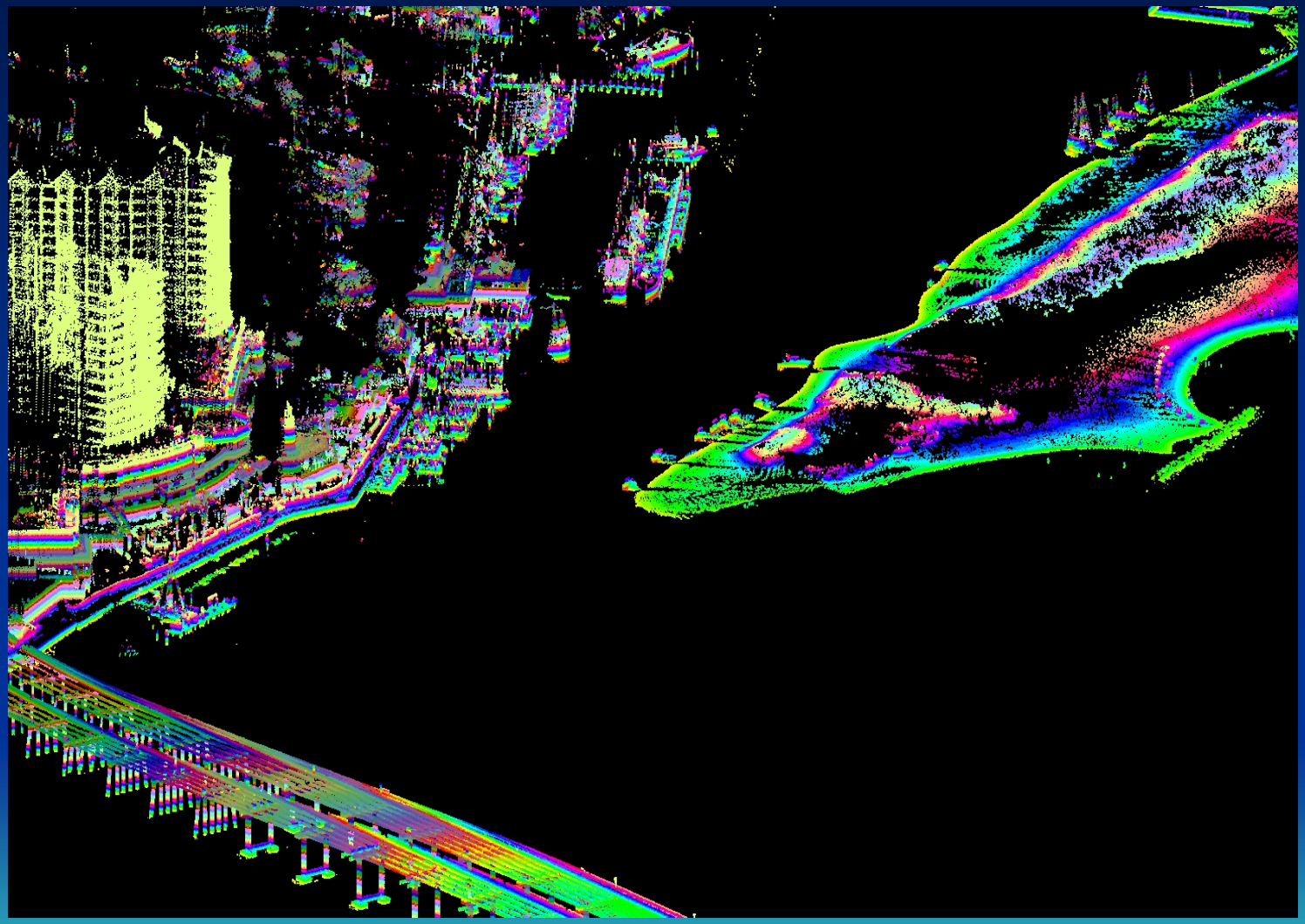


West Jetty Looking South Colored with Pictures

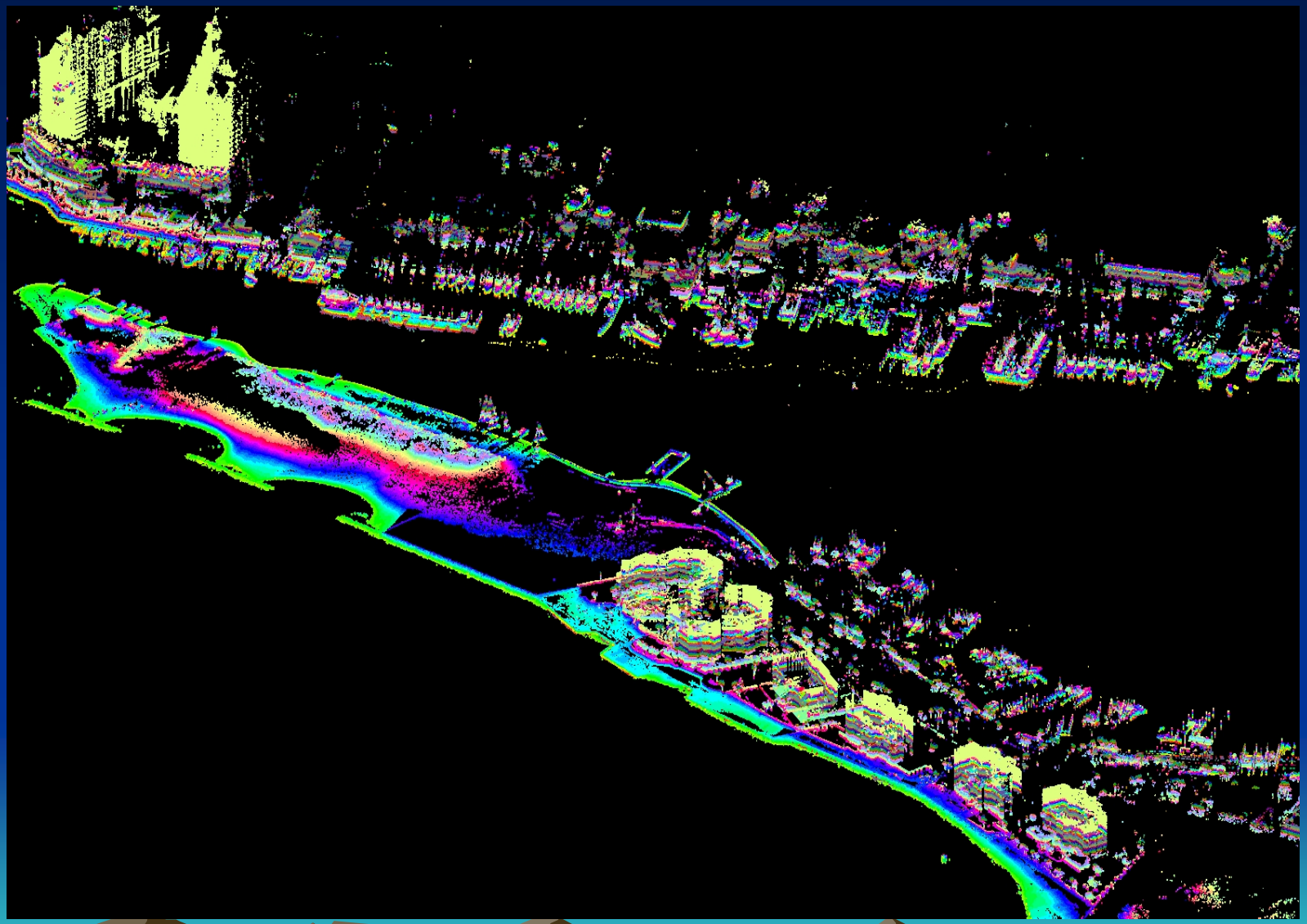
Scene Development

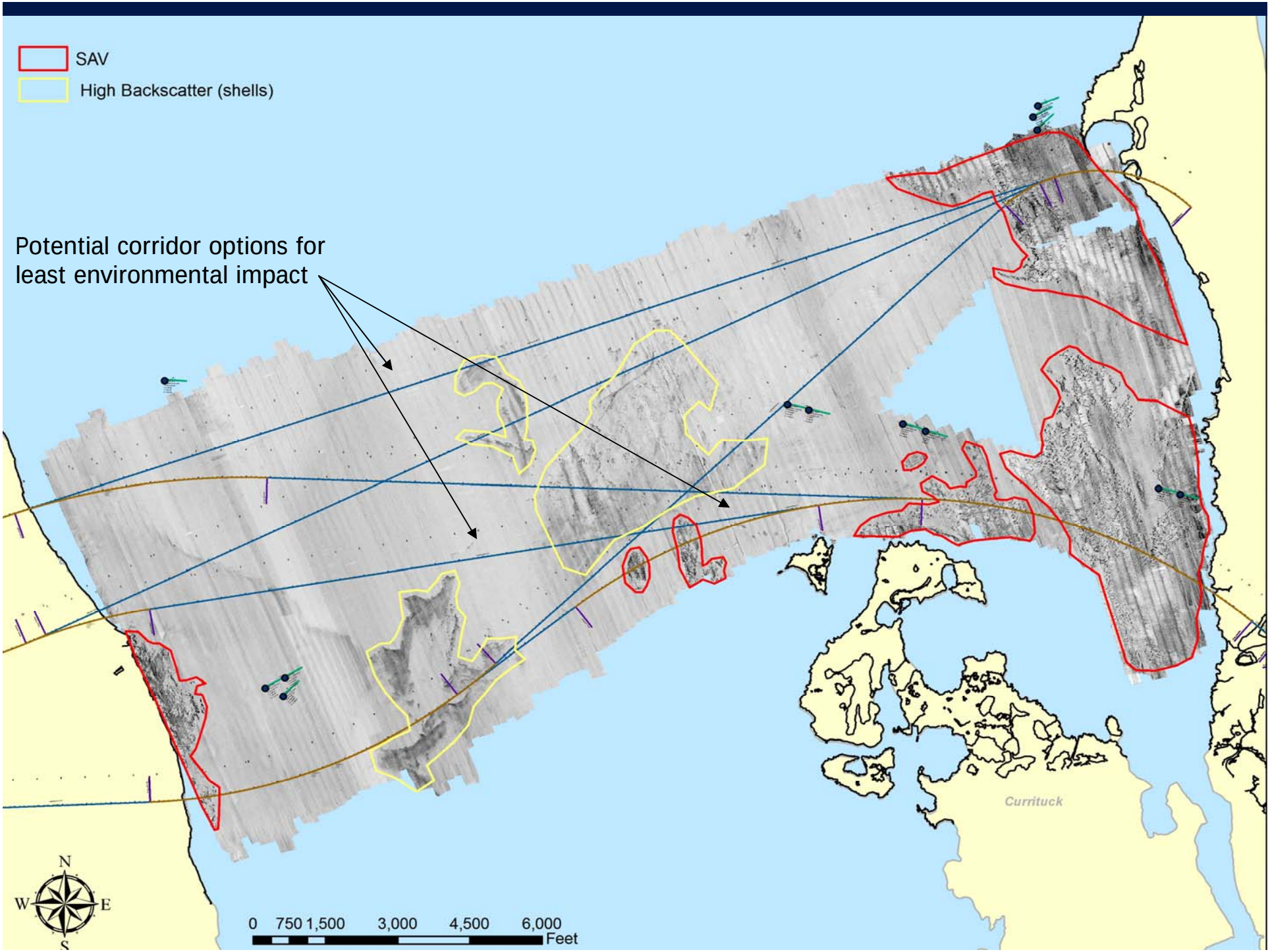


Scene Development



Scene Development



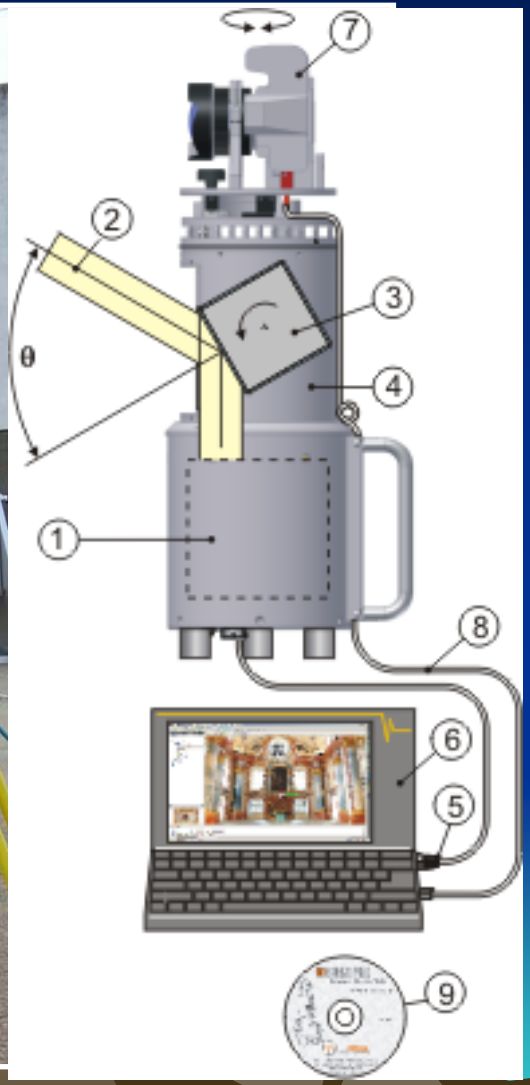

SAV
High Backscatter (shells)
Potential corridor options for least environmental impact
Currituck
N
W
E
S
0 750 1,500 3,000 4,500 6,000
Feet

Summary

- This system is ready for production use
- This system can be used for inspection of all structures above and below water:
  - Rubble mound structures
  - Beach fills
  - Levees
  - Bridges
  - Dams
  - Asset inventory

VICKSBURG FIELD EXPERIMENT

Static Method



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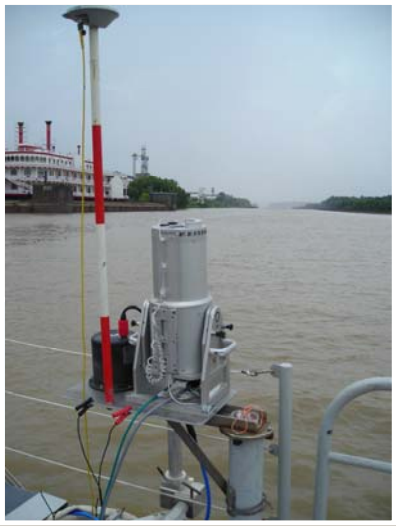
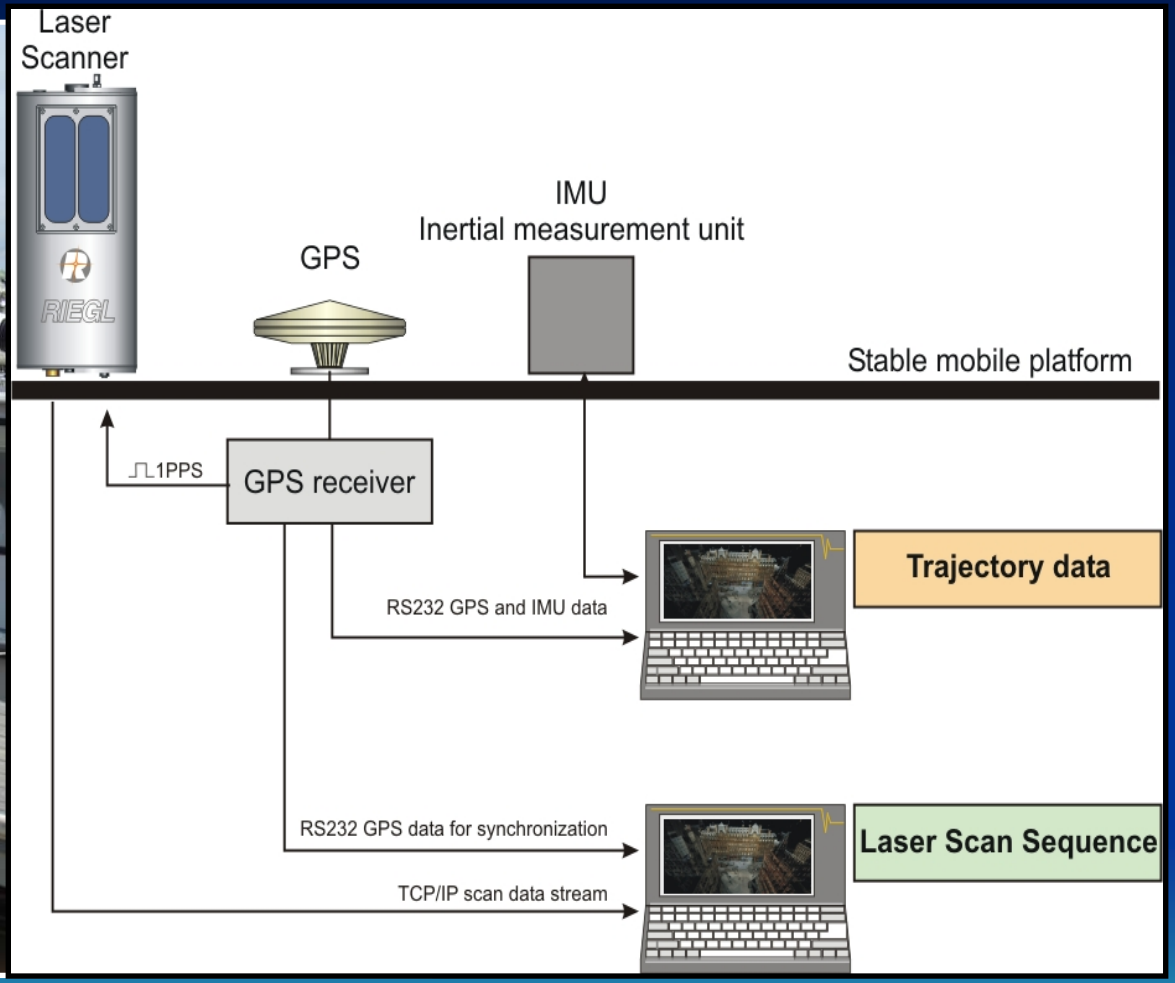
- **Operated by any standard PC or Notebook, Fully portable, rugged & robust**

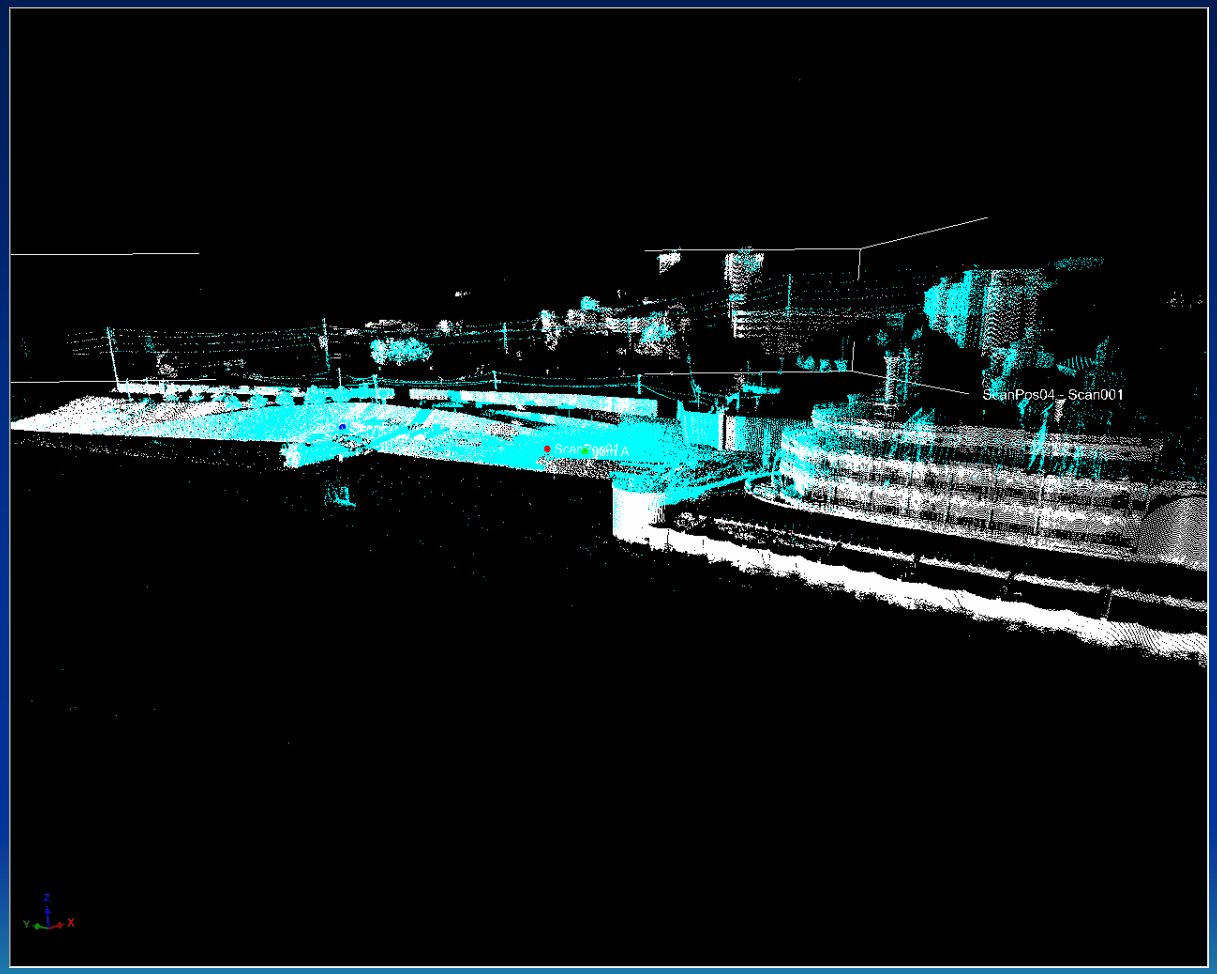
Dynamic Method



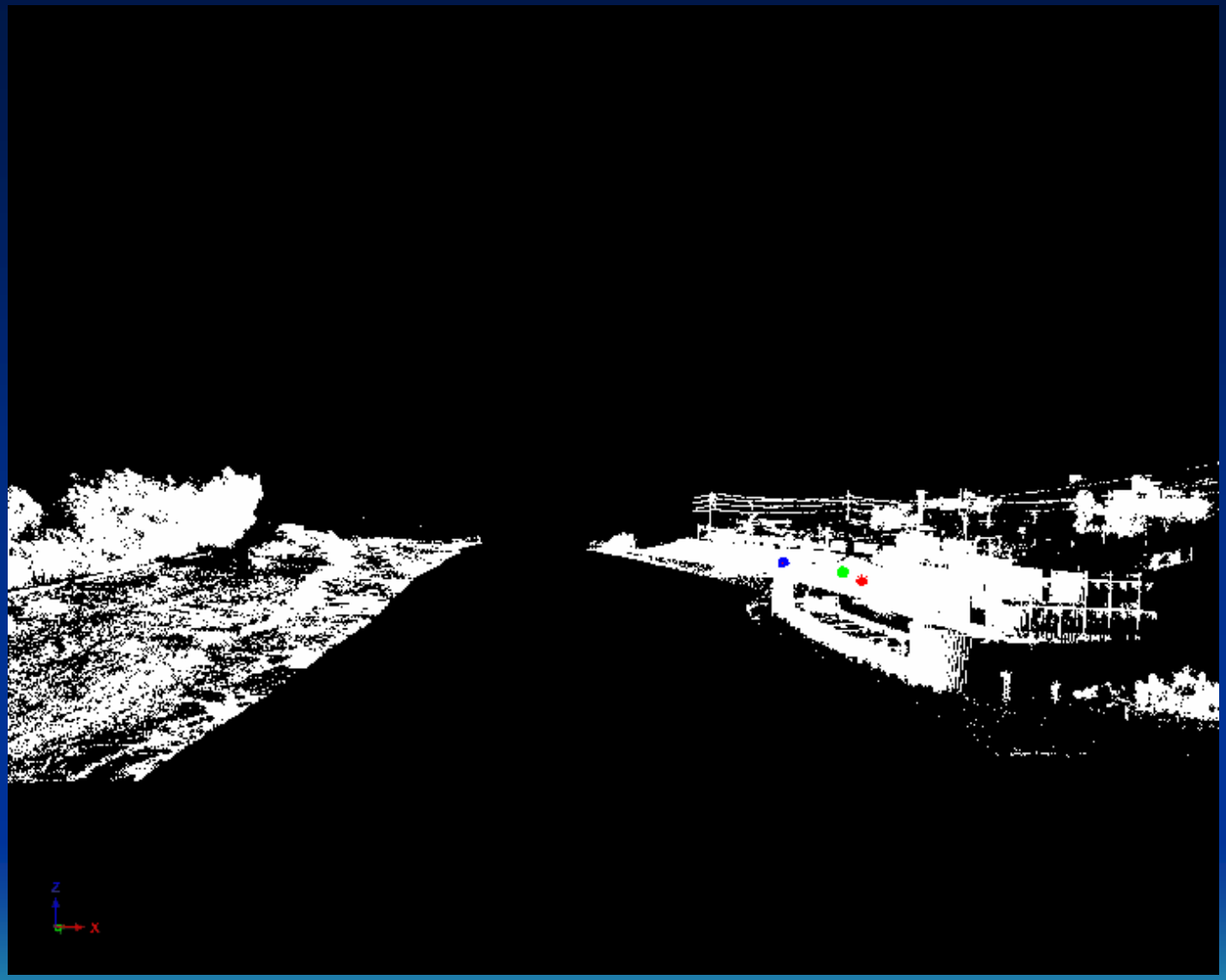


GPS + IMU + LASER

Initial Results at Vicksburg Waterfront

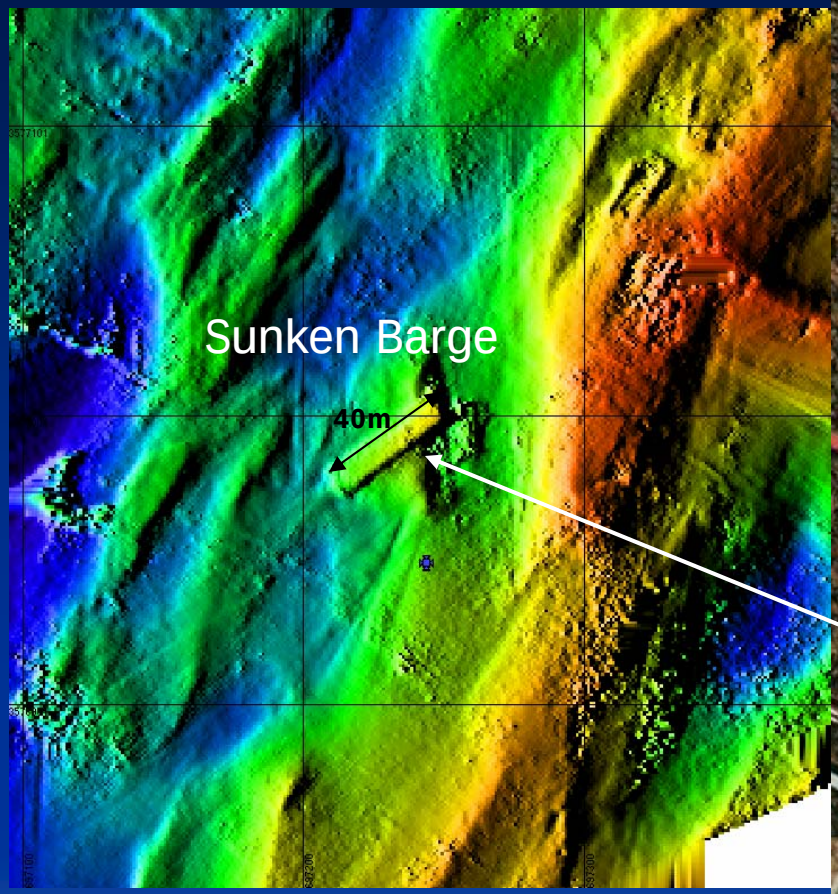


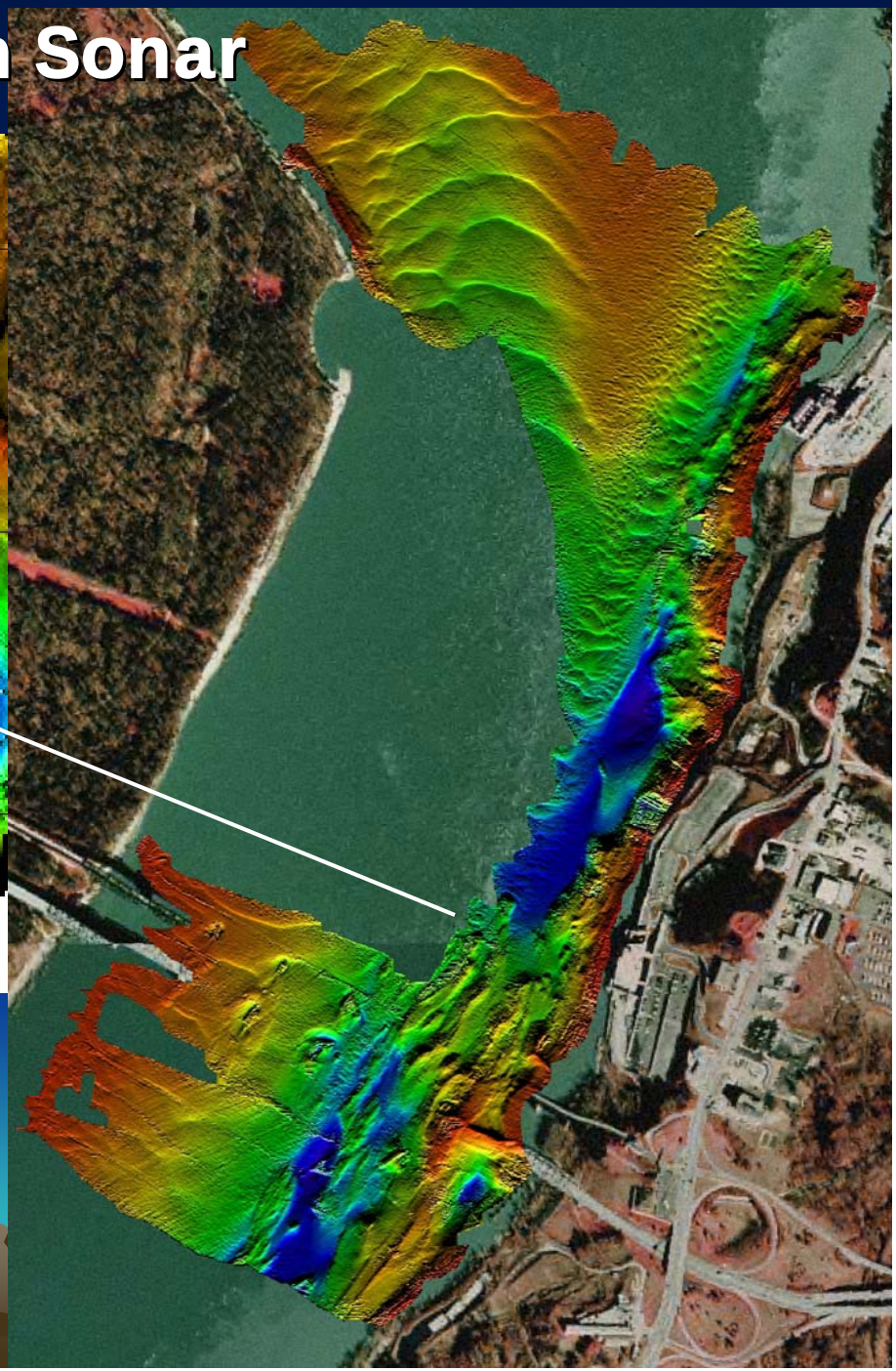
- Preliminary analysis shows dynamic data (white) compares very well to ground survey static data (blue)



- Initial test results indicate successful reconstruction of dynamically acquired Lidar data

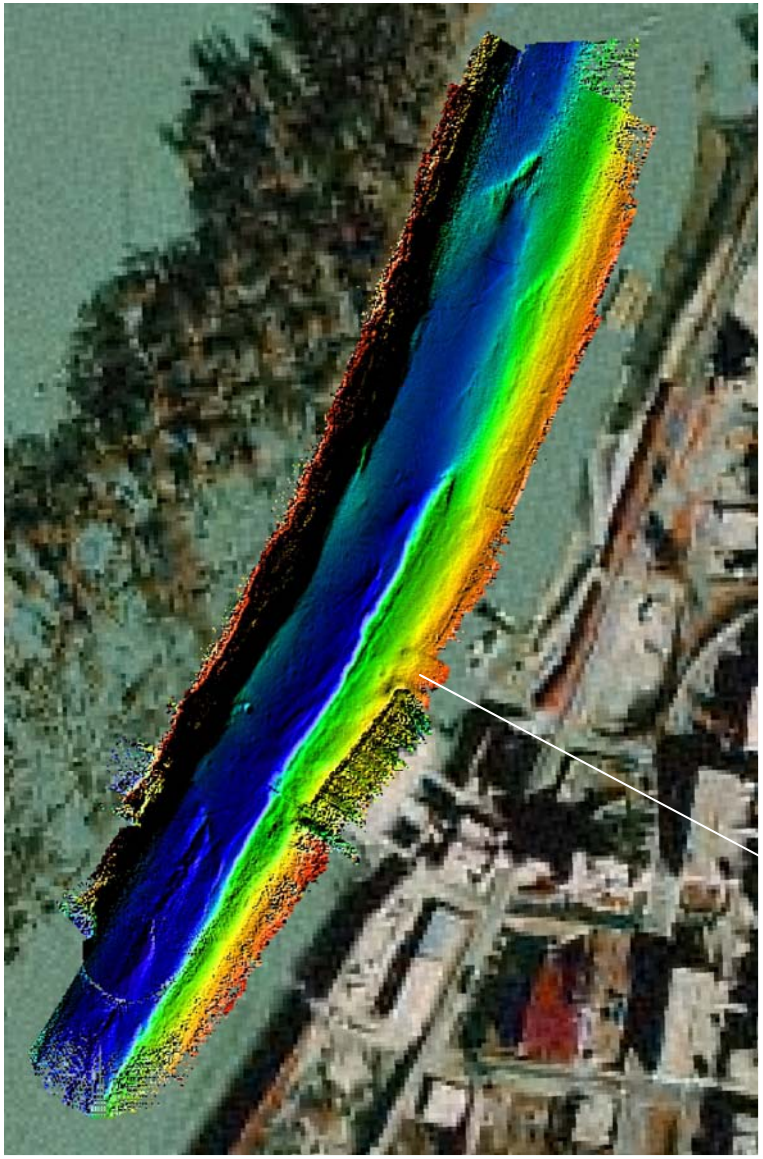
Integration w/ Geo-Swath Sonar





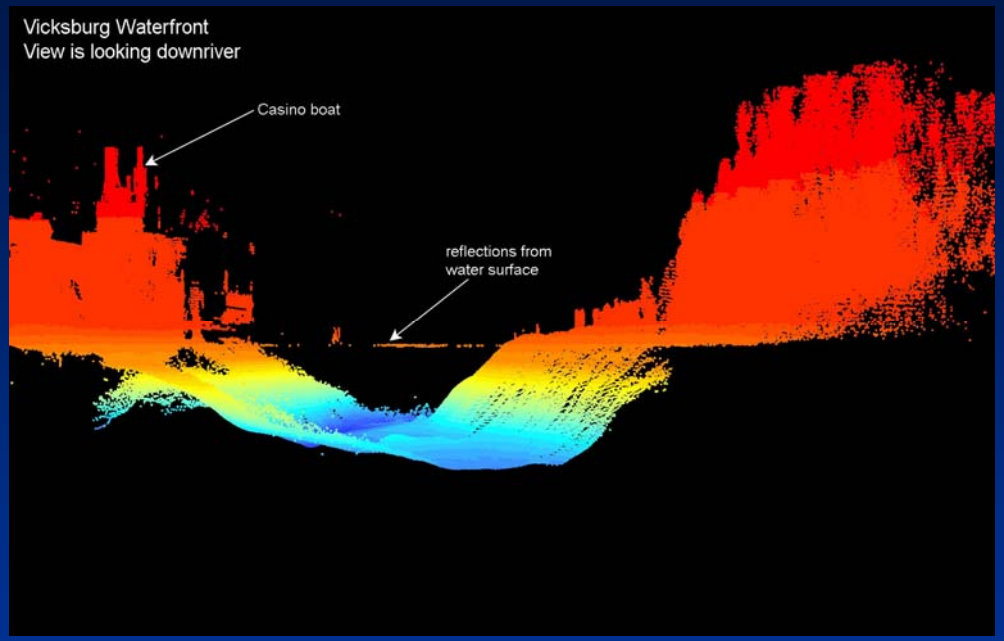
Geo-Swath and Lidar Data collected along the River Bank to look at the effect of distance from the structure and the ability to resolve features with both systems.

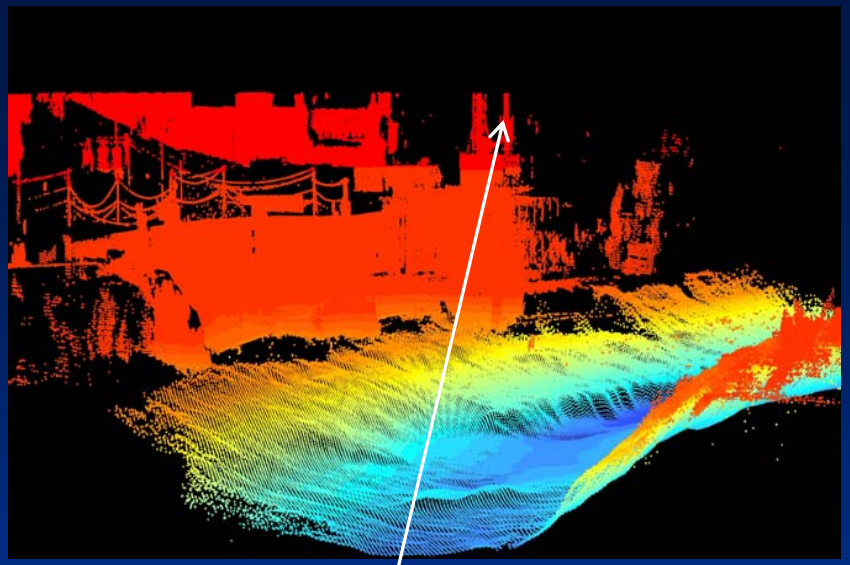
High Resolution Detail

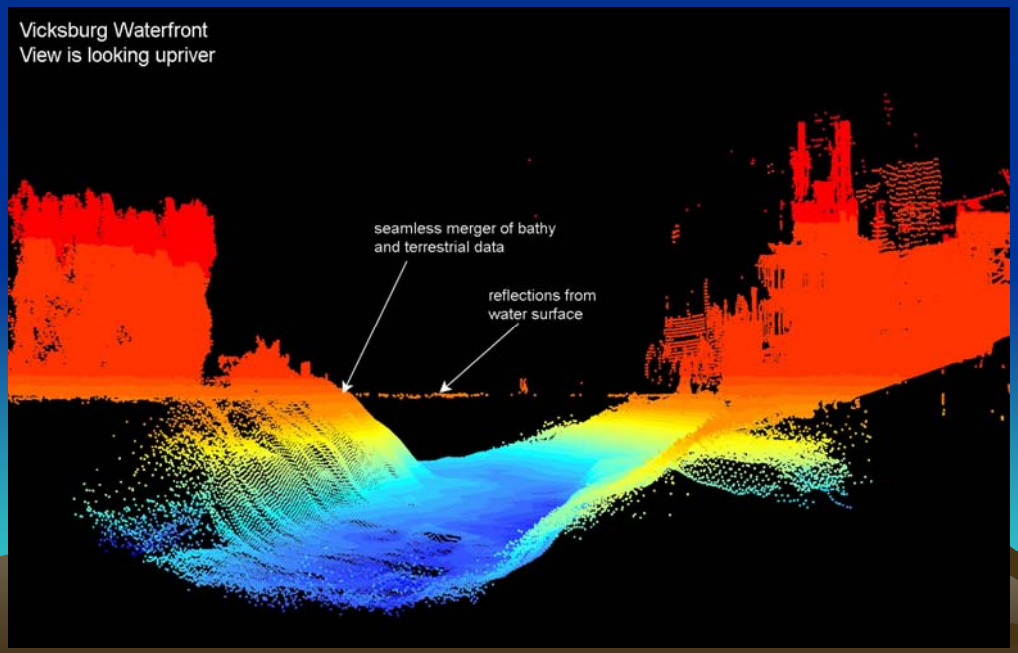


- 1.0 m grid resolution or less

Integrated Sonar and Lidar Data







Integrated Survey System Status

- FY07 milestone, List of Co. capability to develop & demo Integrated Survey System
- Found what we wanted - Reigl Terrestrial Laser selected for ability to collect data on the fly
- Requested additional funds to Demo, May 07
- Demo, Vicksburg Waterfront, July/Aug 07
- Field study, Preliminary success!
- Slight problem-contractor positioning
- Results successful enough that PMAB used end of the year funds to purchase Reigl Terrestrial Laser.
- FY08 milestone, evaluation and cost estimate
- FY08 2nd field test using High pack

FY07 Milestones

- Participate in East Coast COP workshop Q1/07
- Meet with Districts to gather data Q2/07
- Beta version of revised structure condition index field form (Task I) Q3/07
- Identify company and develop SOW for the hand-held field tablet computer (Task II) Q3/07
- Revise structure condition indexing field form for rubble mound structures. (Task I) Q4/07
- List of companies capable to develop and demo the sub-aerial survey tool (Task III) Q4/07
- Abstract on software to analyze structures utilizing existing LIDAR data (Task II) Q4/07

FY08 Milestones

- PDT meeting to review investigation findings Q2/08
- Hand-held field tablet computer system with camera and laser distance meter in beta version (Task II). Q4/08
- Field test of Hand-held tablet computer system (Task II) Q4/08
- Sub-aerial inspection tool evaluation and cost estimate draft document (Task III) Q4/08
- Draft TR on Rubble-mound Structure indexing field Form application (Task I) Q4/08

Minimum Funding Requirements FY08

- Opportunities taken in FY07 have allowed the reduction in cost for FY08

- Funding Allocated FY08 $445K
- Minimum Funding Required $375K
- Shareable $ $ 70K
  - Impact, minimum funding for development and testing of Integrated Survey System and Hammer. Risk-no funding for unforeseeable problems, delayed completion.