PUSAT KECEMERLANGAN KEJURUTERAAN & TEKNOLOGI
JABATAN KERJA RAYA

PROGRAM LATIHAN JABATAN KERJA RAYA MALAYSIA
TAHUN 2021

PROGRAM: KOMPETENSI MARITIM
KURSUS DREDGING & RECLAMATION

Tarikh : 14 – 15 Julai 2021

Tempat : Webex / Google Meet

DR. NIK & ASSOCIATES SDN. BHD.
ENGINEERING AND PROJECT MANAGEMENT CONSULTANTS

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DAY 01 – 14th July 2021

SESSION 3 | PART B Hydrographic Survey
(Dredging and Reclamation)

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GENERAL DEFINITION

- *Hydrography is the science of measuring and depicting those parameters that are necessary to describe*
  - **the precise nature and configuration of the sea-bed**
  - **its geographical relationship to the landmass**
  - **the characteristics and dynamics of the sea**.

- *The parameters encompass **bathymetry, geology, geophysics, tides, currents, waves**, and certain other physical properties of sea water*

ROLE OF HYDROGRAPHIC SURVEY FOR PROJECT

Hydrographic surveys are always employed

- to estimate the **dredging** requirements & quantities
- determine **dredging** contractor payment
- monitor the offshore disposal areas,
- certify final acceptance and clearance of a project to its authorized navigation depth.

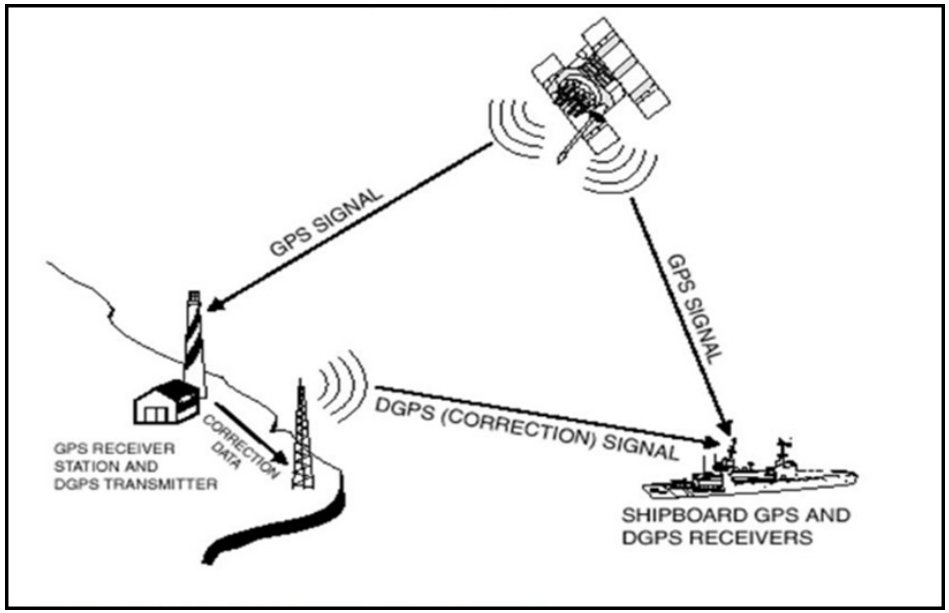
DATA TYPE

- **Bathymetry** : "measure of the depth," data provides depth contours of the bottom surface.
- "X,Y" = positioning data from Global Positioning System (GPS)
- "Z" = sounding data from echo sounder. Measures depth of water by time it takes for sound to transmit and return to transducer.
- Time = data used to correct for water level (tide) at time of data collection
- **Features**: data points, lines, and areas acquired to delineate natural and man-made charted features.

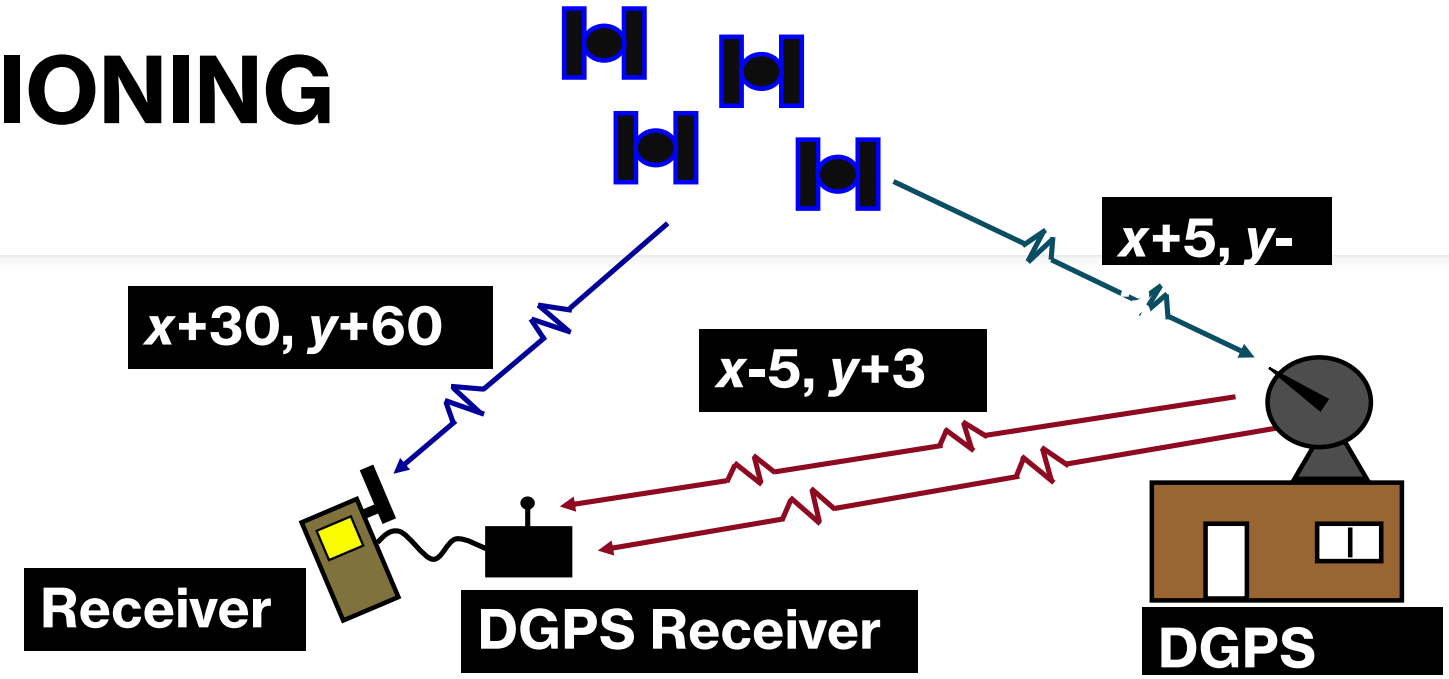
POSITIONING

1) Positioning (XY/Easting Northing or Latitude Longitude)

- Positioning of soundings will acquired by DIFFERENTIAL GLOBAL POSITIONING SYSTEM (DGPS) technique. A basic system of DGPS requires a GPS receiver (called a Reference or Base station) placed on a precisely known surveyed point and a user GPS receiver in the field which normally known as rover or remote receiver. Both GPS receivers were tracking and observing satellites in view that passes in the area at the same time. Since Base Station receiver was sited on a known coordinated point, error in the measurement of each satellite can be calculated at the Base Station and these errors were then transmitted and applied as corrections to the Rover receiver in the field.



POSITIONING



DGPS correction = *x*+(30-5) and *y*+(60+3)

True coordinates = *x*+25,

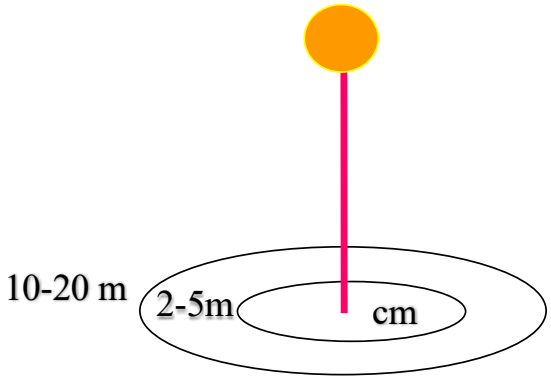
True coordinates = *x*+0, *y*+0

Correction = *x*-5,

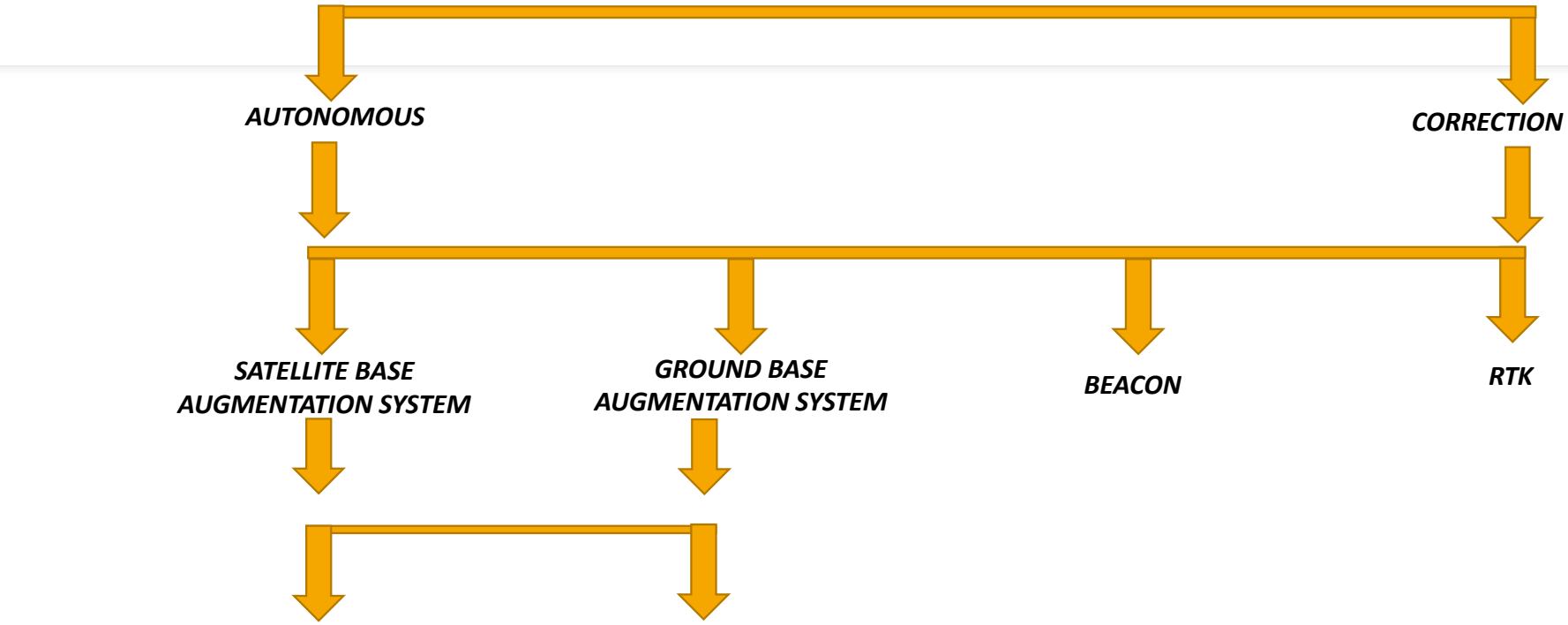
POSITIONING

Three Methods Or Accuracies Of Positioning

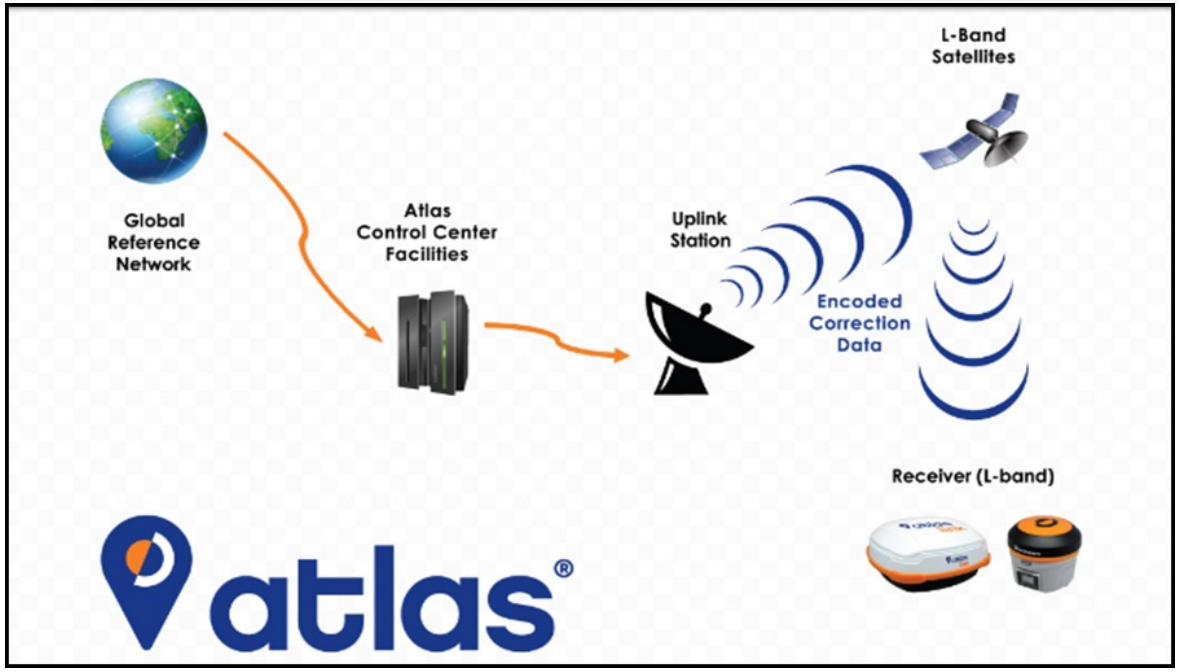
- AUTONOMOUS
  10-20 METERS
- DIFFERENTIAL
  2-5 METERS
- PHASE DIFFERENTIAL
  CENTIMETER



GLOBAL NAVIGATION SATELLITE SYSTEM (GNSS)



GLOBAL NAVIGATION SATELLITE SYSTEM (GNSS)



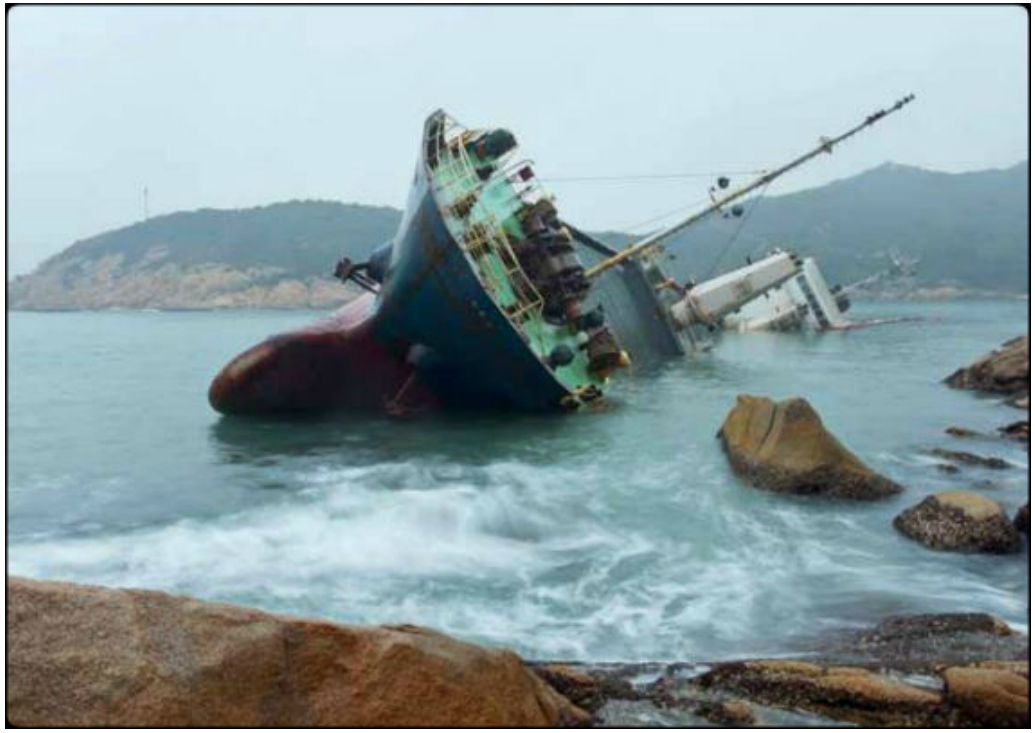
DEPTH MEASUREMENT

- The Sea Bed Level Is Normally Determined By Measuring The Depth Of Water Above The Sea Bed.
- The Measured Depth Values Are Simultaneously Recorded Relative To Some Appropriate Datum, Such As Chart Datum (Mostly The Local Level Of The Lowest Astronomical Tide : Lat)
- During The Period Of The Survey The Sea Level Must Be Recorded Accurately And Preferably At A Location Where The Sea Level Is At Any Time The Same As That In The Survey Area. In Some Cases Area The Difference In Sea Level Must Than Be Calculated By Using Long Wave Hydraulic Theory.
- There Are Three Ways To Measure Water Depth :

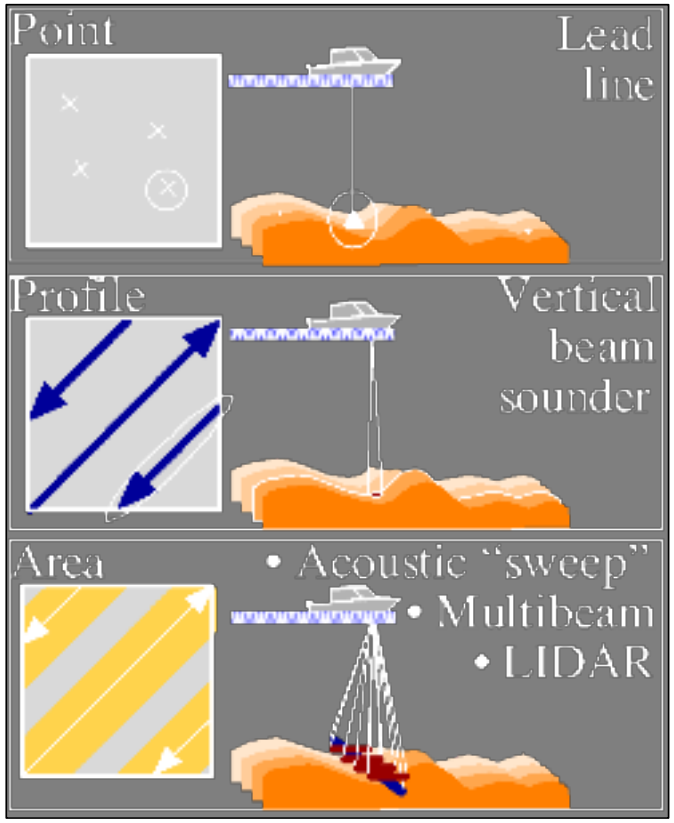
    1) Sounding Line (A Lead Line With Marks Every 0.1m)
    2) Sounding Pole (For Limited Depth Only)
    3) Echo Sounder (The Most Rapid And Convenient Method)

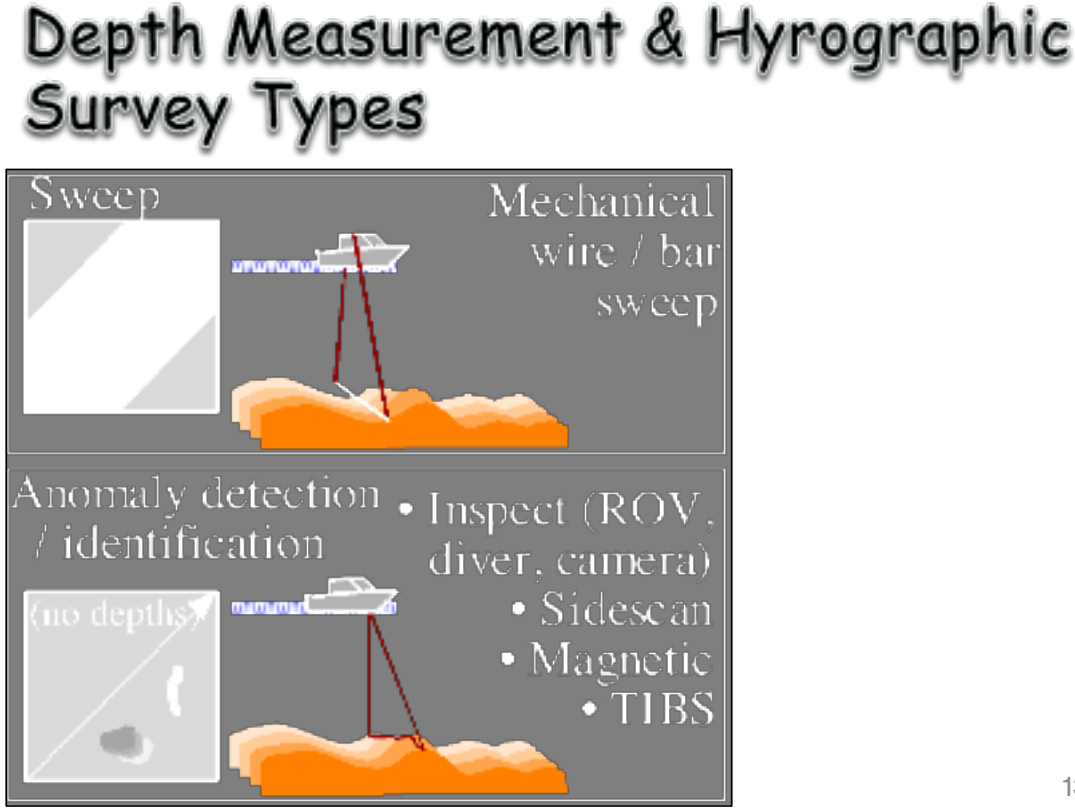
DEPTH MEASUREMENT

Why Depth Measurement Is Important



DEPTH MEASUREMENT





DEPTH MEASUREMENT

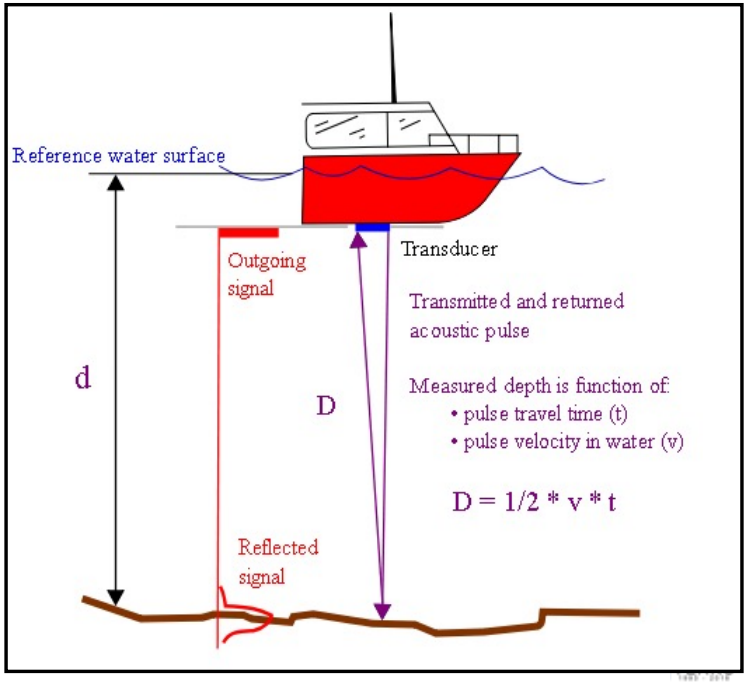
Accuracy Of Depth Measurement

- The Accuracy In Determining Sea Bed Levels Is Inferior To That Normally Attainable In Land Survey. When Sounding Close To Structures The Echo Sounder Can Be Affected By Side Echo's And A Lead Line Or Sounding Pole Should Be Used.
- The Accuracy Is Effected By The Characteristics Of The Sea Bed Material, The Surrents (Only When Using Lead Line), The Thru Position When Crossing Slopes And Wave Heights. For Consistent Results, The Method Of Sounding Should Not Vary, E.G The Same Type Of Echo Sounder Should Be Used During The Whole Project Duration.

ECHO SOUNDER

How Echo Sounder Works

- An Echo Sounder Measures The Time Lap Between The Moment Of Sending A Sound Signal And The First Reception Of The Reflection Of That Signal On The Sea Bottom (=The Echo).
- The Transducer And Receiving Hydrophone Are In One. Multiplying This Time Lap With The Speed Of Sound In Water Results In Twice The Distance Between The Transducer And The Sea Bottom.
- The Bundle Width Has A Great Effect On The Actual Measured Depth When The Bottom Has A Slope. This Is Because Of The Fact That The First Echo Is Displayed On The Screen As The Bottom Straight Vertical Below The Transducer And This Is Not True When The Bottom Has A Slope.



ECHO SOUNDER

How Echo Sounder Works

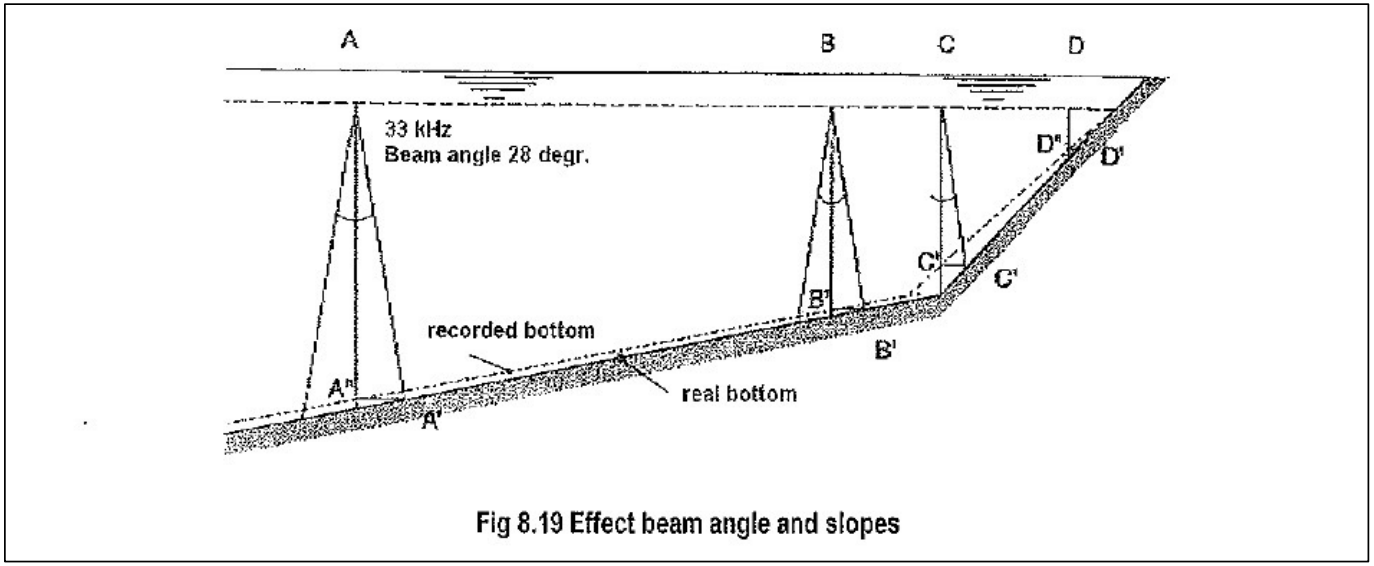
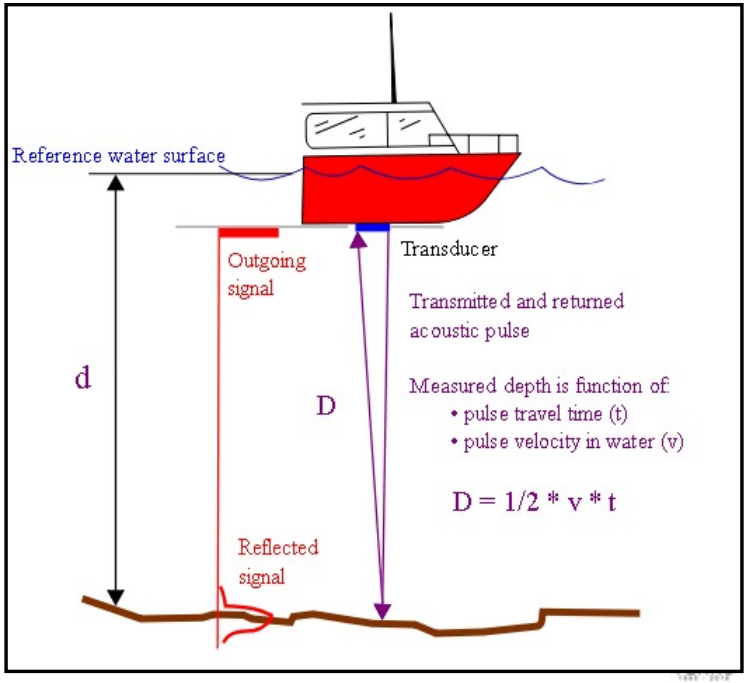


Fig 8.19 Effect beam angle and slopes



ECHO SOUNDER

WHAT ECHO SOUNDER DISPLAY

The top of the soft silt layer is reflecting the **200KHZ** signal and the harder rock and sand bottom are reflecting the low frequency **30KHZ** signal that travels through the soft silt layer.

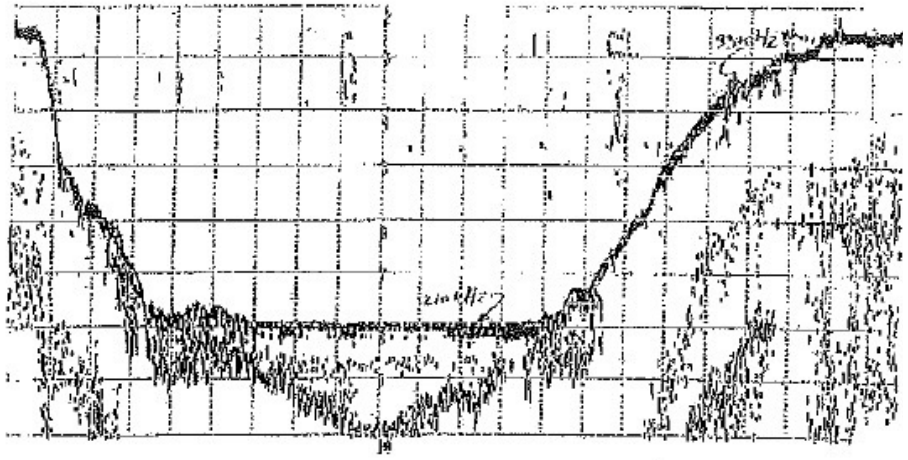


Fig 8.21 Silt in channel

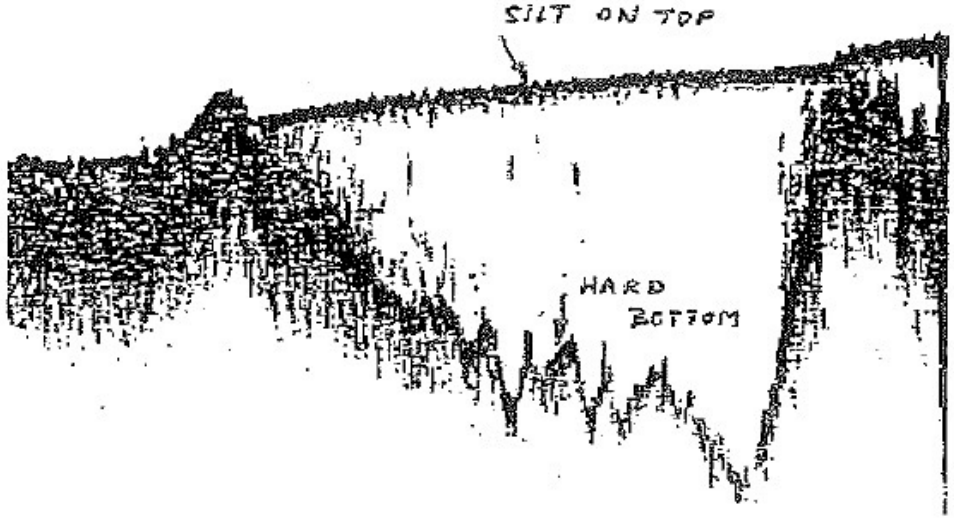


Fig 8.22 Silt on a rock bottom

ECHO SOUNDER

How Waves Effect Echo Sounder Result

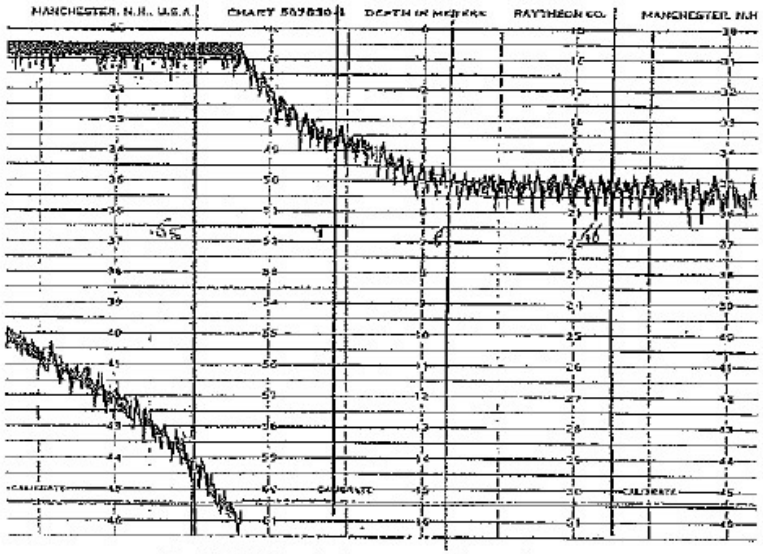


Fig 8.23 Effect of waves without heave compensation

- **THE EFFECT OF WAVES**

As Stated Above The Negative Effect Of Waves Can Be Considerable And Is Due To The Heave, Pitch And Roll Movements Of The Surveying Vessel. When No Compensation Is Made For The Heave Caused By Waves The Result Will Look Like The Photo Above :

ECHO SOUNDER

Calibration Of Echo Sounder

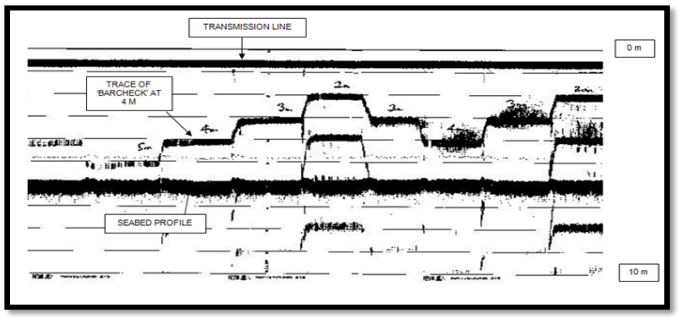


Figure 7.1.3 : Echogram of Bar Check

- **BAR CHECK**

The Echo Sounder Must Be Checked Regularly By Performing A So Called "Bar Check". This Is A Very Simple Procedure: A Horizontal Plate (On A Bar) Is Lowered Under The Echo Sounders Position At Several Known Depths While The Depth Of The Plate Is Measured By The Echo Sounder. Another Type Of Useful Control Is Sailing Over A Horizontal Plate Fitted On The Bottom At A Known Level.

MULTI BEAM ECHO SOUNDER (MBES)

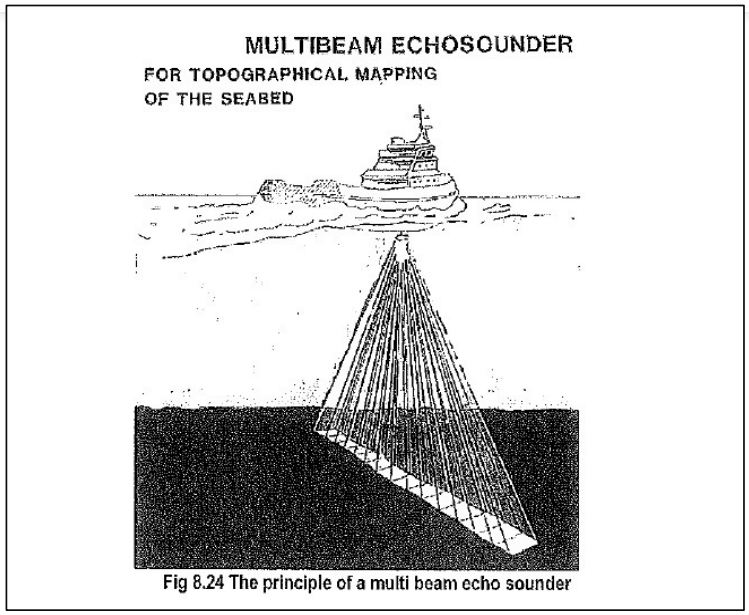
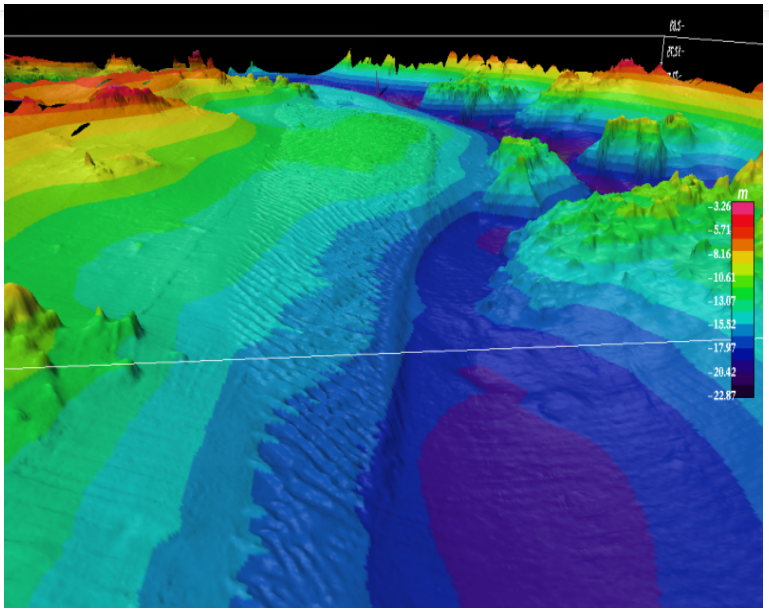


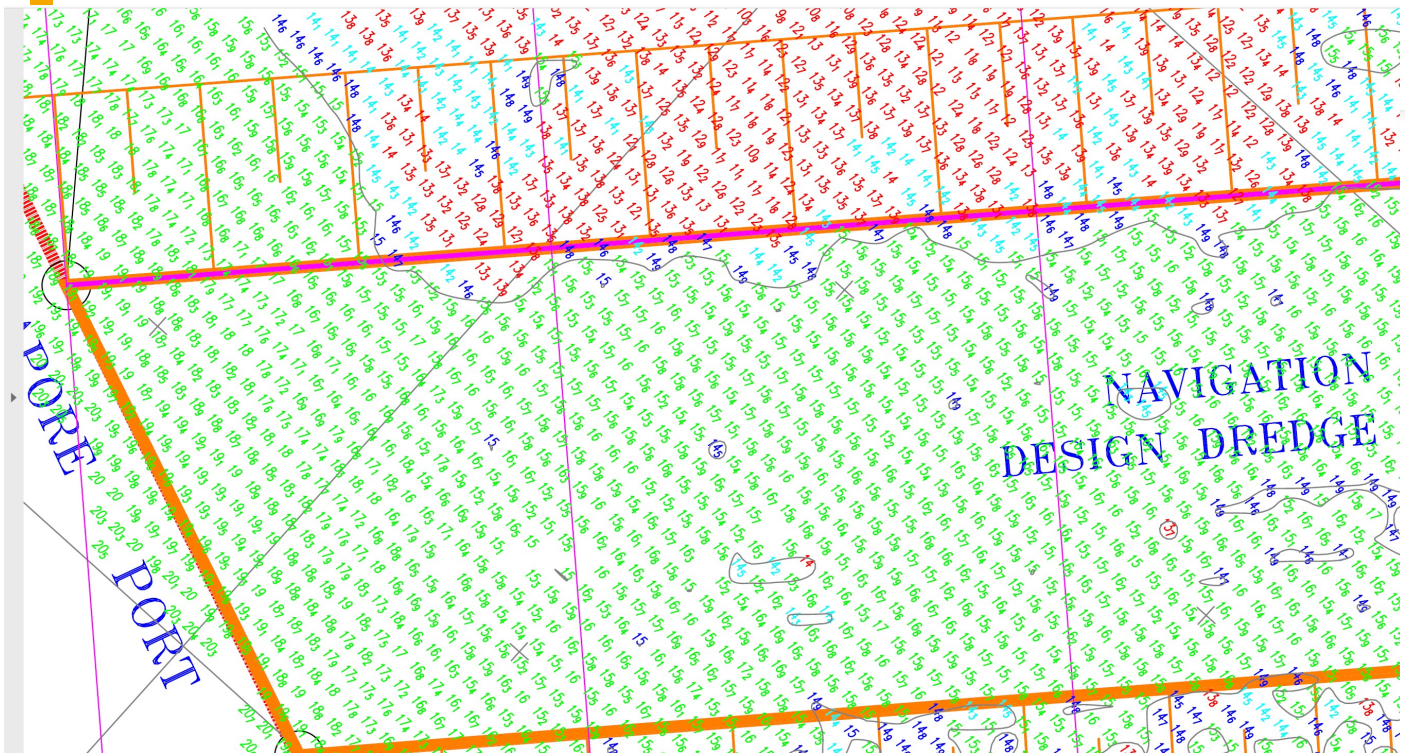
Fig 8.24 The principle of a multi beam echo sounder

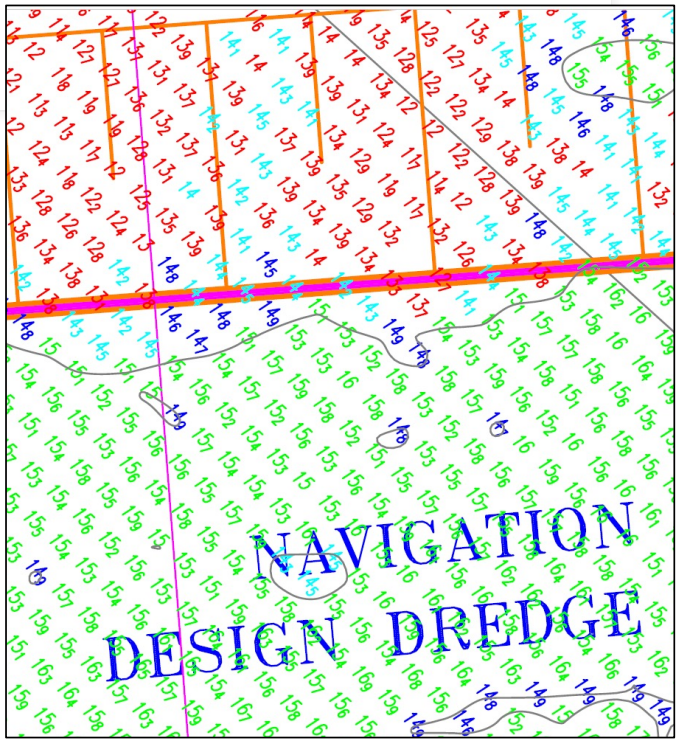


- **MULTIBEAM ECHO SOUNDER**

Modern Echo Sounding Techniques Use Many Narrow Beams At Once In One System Each Beam Targeted At A Slightly Different Angle As Referred To The Central Vertical Beam. These Echo Sounder Are Called Multibeam Systems

SURVEY RESLUTS

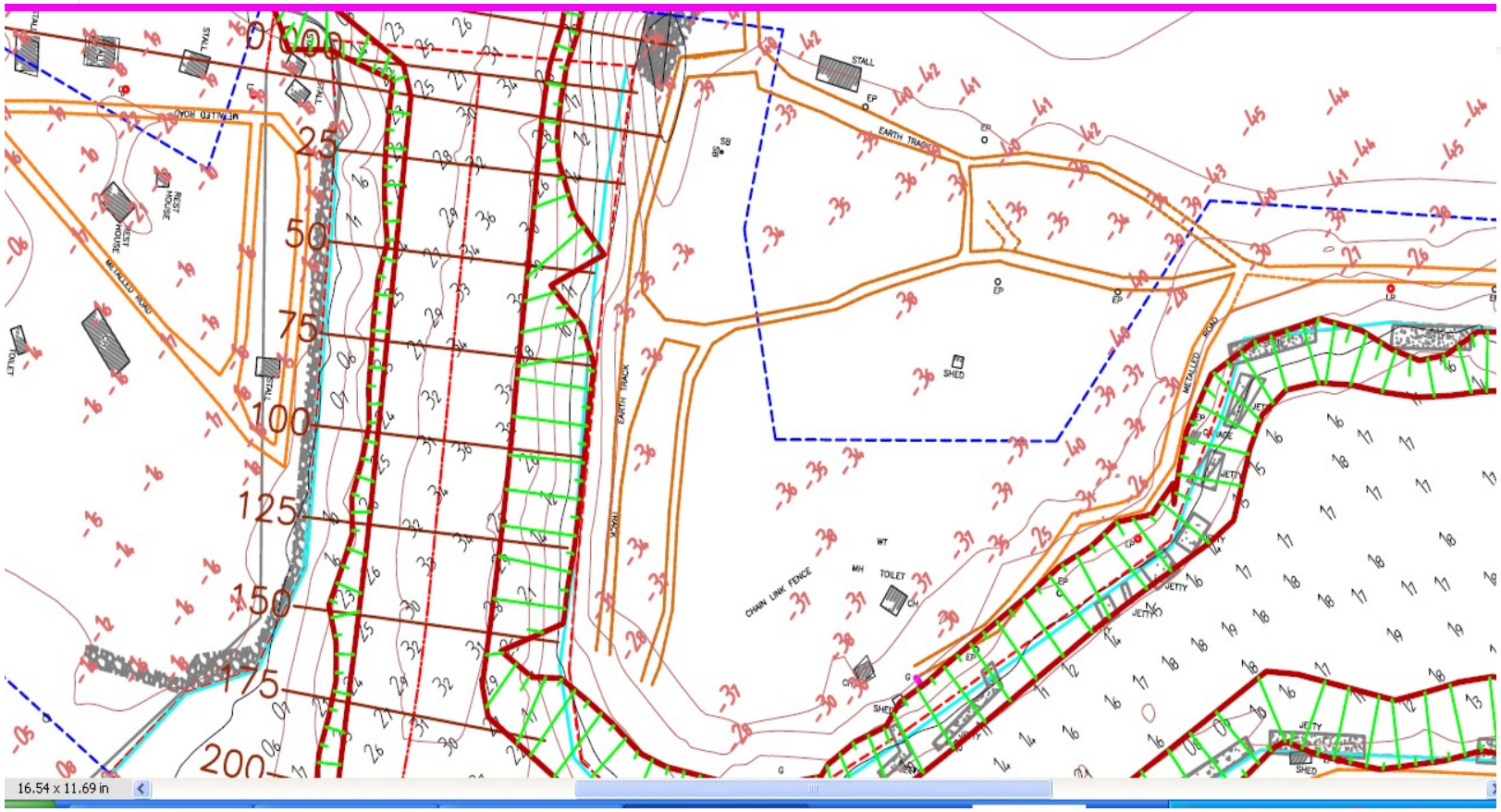




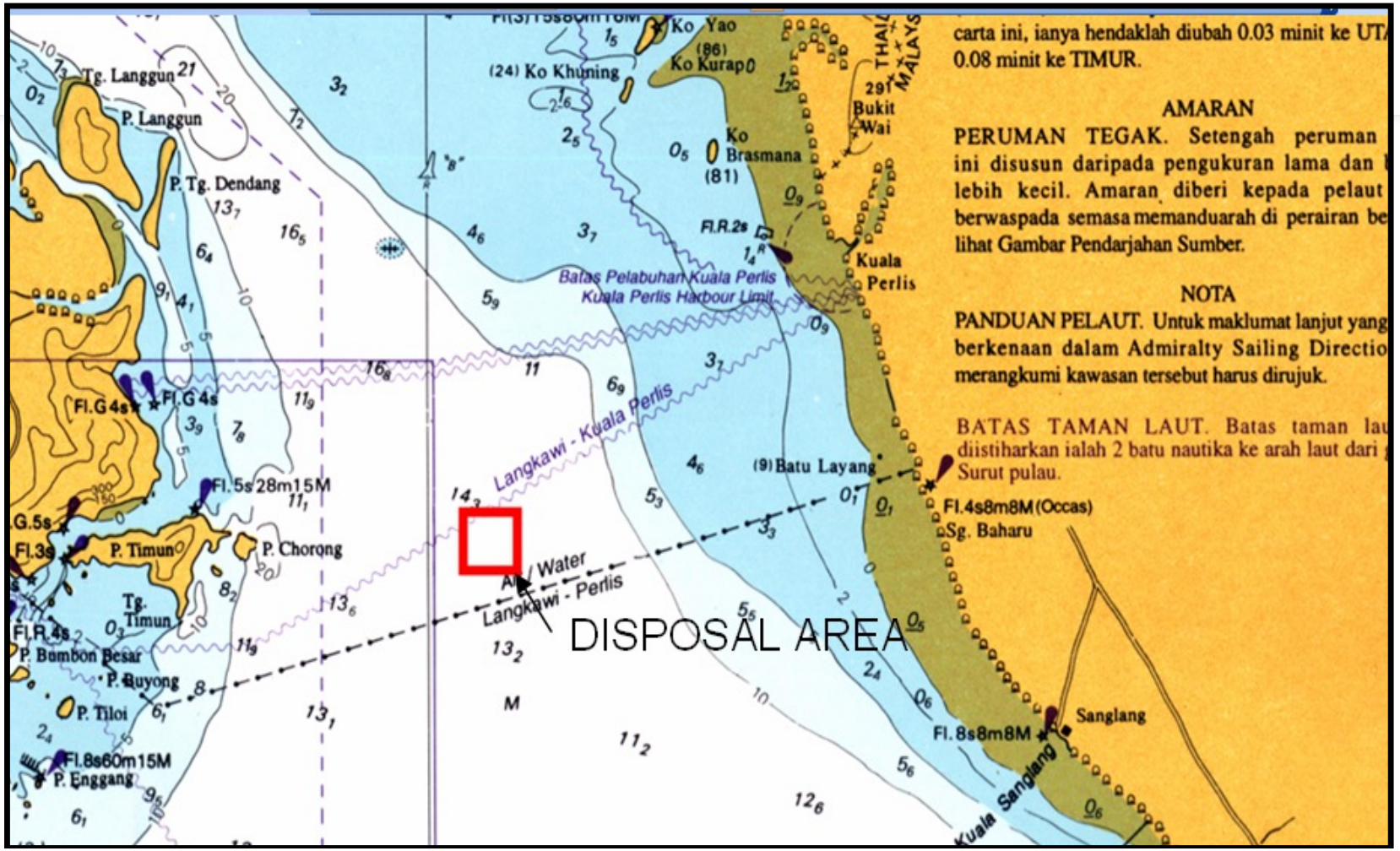
- **THE PRESENTATION OF SURVEY RESULTS**

Single Beam Echo Sounding (Sbes) Results Are Traditionally Presented As Numbers On A Map Indicating The Local Depth.

SURVEY RESLUTS



NAVIGATION CHART



DATUM

What Datum to choose?

WHAT IS DATUM?

USED AS A BASIS FOR CALCULATIONS OR MEASUREMENTS, AS A LEVEL FROM WHICH ELEVATIONS AND DEPTHS ARE MEASURED IN SURVEYING. (REFERENCE LEVEL)

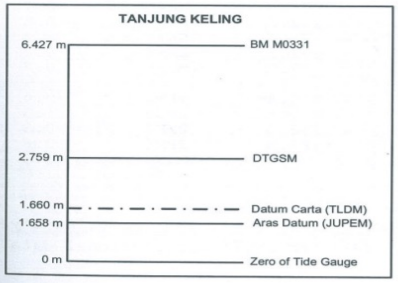
STANDARD PORT – CHART DATUM
LOCAL PORT/JETTY – MSL (MEAN SEA LEVEL)/ LAND SURVEY DATUM (NGVD)
NATIONAL GEODETIC VERTICAL DATUM.

DATUM

Datum and Relation

TANJUNG KELING

1. Kedudukan :		1. *Position :*	
Garislintang	02° 12' 54" U	*Latitude*	*02° 12' 54" N*
Garisbujur	102° 09' 12" T	*Longitude*	*102° 09' 12" E*
2. Aras Datum :		2. *Datum Level :*	
4.769 meter di bawah Tanda Aras Jabatan Ukur dan Pemetaan Malaysia, M 0331.		*4.769 metres below the Department of Survey and Mapping Malaysia's Bench Mark, M 0331.*	
3. Datum Carta :		3. *Chart Datum :*	
4.767 meter di bawah Tanda Aras Jabatan Ukur dan Pemetaan Malaysia, M 0331.		*4.767 metres below the Department of Survey and Mapping Malaysia's Bench Mark, M 0331.*	
4. Jenis Air Pasang : Surut	Bercampur (Semiharian Dominan)	4. *Type of Tide :*	*Mix (Dominant Semi-diurnal)*
Pasang Perbani	2.13 m	*Spring Rise*	*2.13 m*
Pasang Anak	1.54 m	*Neap Rise*	*1.54 m*
Julat Perbani	1.86 m	*Spring Range*	*1.86 m*
Sela Air Pasang Min	$06^{j}\ 50^{m}$	*Mean High Water Interval*	$06^{h}\ 50^{m}$
5. Sisihan piawai :		5. *Standard deviation :*	
Masa teramal	± 16.1 min	*Predicted time*	*± 16.1 mins*
Ketinggian teramal	± 7.8 sm	*Predicted height*	*± 7.8 cm*



69

ARAS PASANG SURUT SEPARUH HARIAN PELABUHAN PIAWAI
SEMI DIURNAL STANDARD PORT TIDAL LEVELS

Pelabuhan Piawai *Standard Port*	Air Surut Falak Terendah *Lowest Astronomical Tide*	Air Surut Perbani Min *Mean Low Water Spring*	Air Surut Anak Min *Mean Low Water Neap*	Aras Laut Min *Mean Sea Level*	Air Pasang Anak Min *Mean High Water Neap*	Air Pasang Perbani Min *Mean High Water Spring*	Air Pasang Falak Tertinggi *Highest Astronomical Tide*	Pihak Berkuasa (a) *Authority for (a)*			Tahun Cerapan (b) *Years of Tidal Observations (b)*
								Cerapan *Observations*	Pemalar *Constants*	Ramalan *Predictions*	
	m.	m.	m.	m.	m.	m.	m.				
Teluk Ewa	0.00	0.56	1.46	1.82	2.18	3.07	3.56	DSM	RMN	RMN	1991 - 04 (13 years)
Kuah	0.00	0.53	1.33	1.64	1.94	2.74	3.26	RMN	RMN	RMN	2005 - 09 (4 years)
Kuala Perlis	0.00	0.56	1.40	1.68	1.96	2.80	3.69	RMN	RMN	RMN	2005 (6 mths)
Kedah Pier, Pulau Pinang	0.00	0.72	1.45	1.71	1.96	2.69	3.09	DSM	RMN	RMN	1989 - 03 (13 years)
Butterworth	0.00	0.77	1.48	1.72	1.96	2.67	3.06	RMN	RMN	RMN	2004 - 06 (2 years)
Kuala Sepetang	0.00	0.82	1.45	1.76	2.06	2.69	2.96	RMN	RMN	RMN	2010 – 11 (1 years)
Lumut	0.00	0.75	1.45	1.85	2.24	2.94	3.45	DSM	RMN	RMN	1989 - 03 (13 years)
Bagan Datoh	0.00	0.52	1.25	1.72	2.20	2.93	3.48	RMN	RMN	RMN	2009 - 11 (2 years)
Pelabuhan Klang	0.00	0.98	2.35	3.03	3.72	5.09	5.82	DSM	RMN	RMN	1992 - 05 (13 years)
Permatang Sedepa	0.00	0.85	2.08	2.71	3.34	4.57	5.31	ITS	ITS	RMN	1979 (1 years)
Port Dickson	0.00	0.31	1.14	1.55	1.96	2.79	3.51	ITS	ITS	RMN	1979 (1 years)
Kuala Linggi	0.00	0.31	0.96	1.29	1.61	2.27	2.91	RMN	RMN	RMN	2007 - 09 (1 years)
Tanjung Keling	0.00	0.29	0.88	1.19	1.51	2.10	2.65	DSM	RMN	RMN	1991 - 02 (11 years)
Muar	0.00	0.28	0.83	1.17	1.51	2.06	2.59	RMN	RMN	RMN	2013 - 14 (1 years)
Kuala Batu Pahat	0.00	0.43	1.15	1.59	2.03	2.75	3.37	ITS	ITS	RMN	1979 (1 years)
Pulau Pisang	0.00	0.42	1.26	1.77	2.28	3.12	3.79	ITS	ITS	RMN	1979 (1 years)
Kukup	0.00	0.37	1.21	1.70	2.20	3.04	3.68	DSM	RMN	RMN	1989 - 03 (13 years)
Tanjung Pelepas	0.00	0.30	1.17	1.66	2.16	3.03	3.75	RMN	RMN	RMN	2004 - 05 (1 years)
Johor Bahru	0.00	0.99	1.67	2.20	2.73	3.41	4.00	DSM	RMN	RMN	1990 - 03 (13 years)
Pasir Gudang	0.00	0.92	1.56	2.05	2.54	3.18	3.62	RMN	RMN	RMN	1989 (1 years)
Tanjung Langsat	0.00	0.93	1.56	2.07	2.58	3.20	3.71	RMN	RMN	RMN	2010 - 13 (3 years)
Sungai Belungkor	0.00	0.99	1.61	2.11	2.60	3.22	3.86	RMN	RMN	RMN	2004 - 05 (1 years)
Kuala Lundu	0.00	0.97	1.63	2.39	3.15	3.81	4.39	SMD	POL	RMN	1976 (1 mths)
Kuala Santubong	0.00	1.33	2.11	3.02	3.93	4.71	5.54	SMD	POL	RMN	1977 (1mths)
Pulau Lakei	0.00	2.13	2.80	3.50	4.20	4.87	6.32	LSD	RMN	RMN	1988-90 (2 years)
Pending	0.00	1.23	2.22	3.34	4.46	5.45	6.03	SMD	POL	RMN	1980 (7 mths)
Sri Aman	0.00	0.92	1.52	2.31	3.10	3.70	6.00	SMD	POL	RMN	1975 (1 mths)
Sarikei	0.00	1.66	2.56	3.59	4.62	5.52	6.57	H	H	RMN	1936 (1 mths)
Tanjung Manis	0.00	1.49	2.47	3.50	4.53	5.51	6.33	SMD	H	RMN	1960 (1 mths)
Lahad Datu	0.00	0.33	0.98	1.19	1.40	2.05	2.54	DSM	RMN	RMN	1995-03 (7 years)
Semporna	0.00	0.29	0.95	1.17	1.38	2.04	2.55	RMN	RMN	RMN	2010-11 (2 years)
Tawau	0.00	0.64	1.67	2.01	2.35	3.39	3.84	DSM	RMN	RMN	1991-03 (12 years)

Aras pasang surut di atas merujuk kepada DATUM CARTA, di mana sama dengan nilai kosong (0) pada ramalan pasang surut dalam semua keadaan.
The above levels are referred to CHART DATUM, which is same as the zero of the tidal predictions in all cases.

Pengiraan aras pasang surut dilaksana menggunakan kaedah permalar harmonik.
All predictions are calculated using the harmonic method.

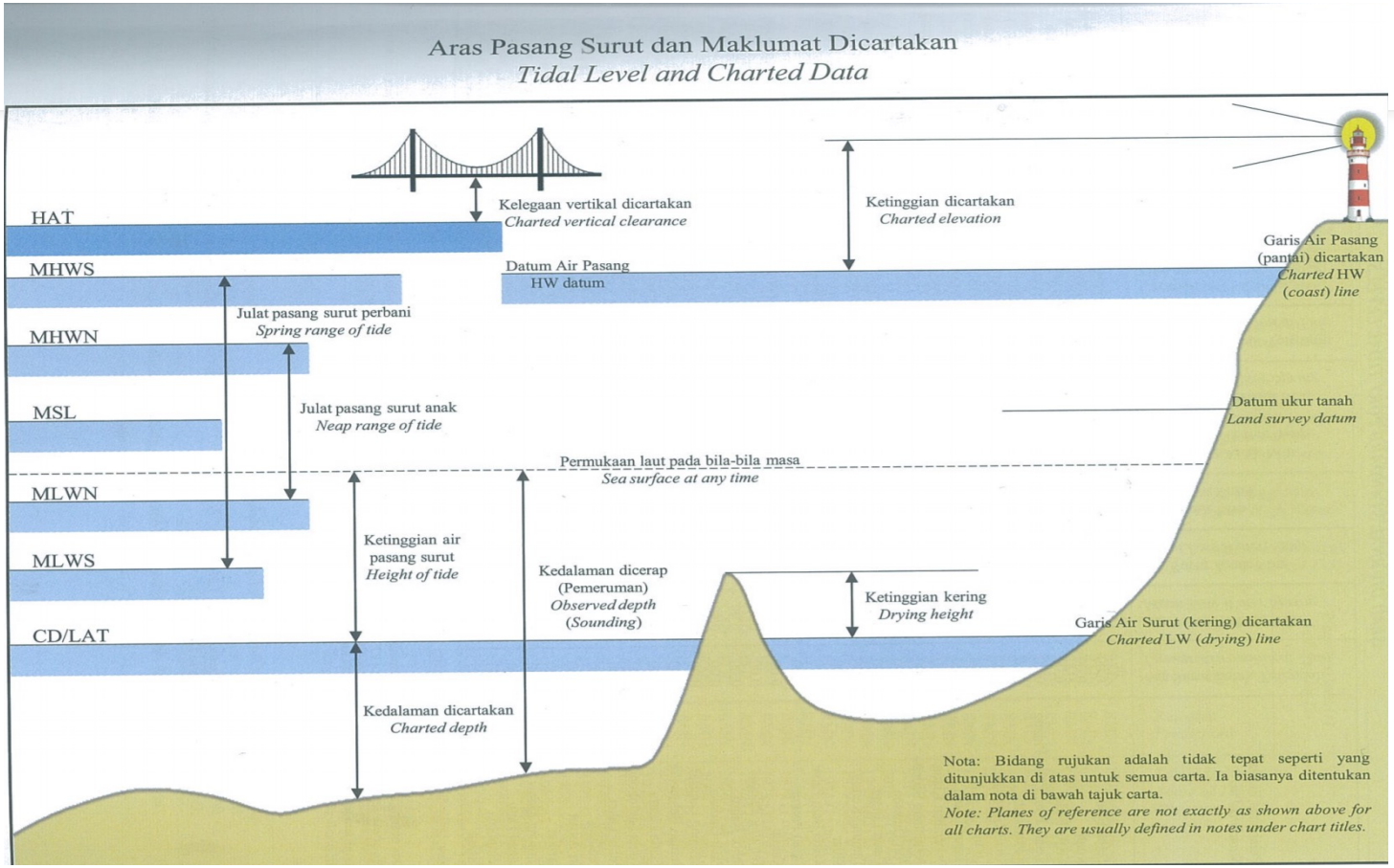
(a) *Abbreviations:*

DSM	*Department of Survey and Mapping, Malaysia.*	*H*	*Hydrographer of the Navy, U.K.*
HA	*Local Harbour Authority.*	*LSD*	*Land and Survey Department.*
POL	*Proudman Oceanographic Laboratory, U.K.*	*RMN*	*National Hydrographic Centre, Royal Malaysian Navy*
SMD	*Sarawak Marine Department.*	*ITS*	*International Tidal Survey*

(b) *The years between which the observations were obtained are given, the number of complete years observations in brackets.*

DATUM

Tides Types



PROJECT REQUIREMENT

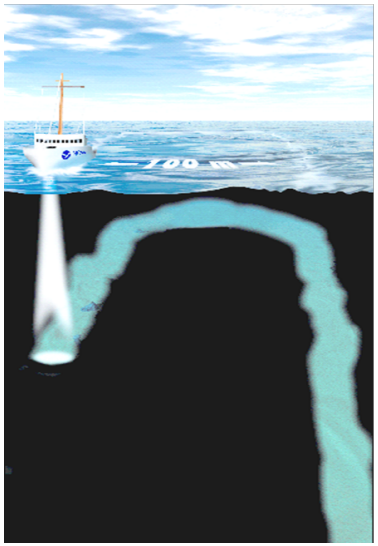
Requirements For Hydrographic Survey In Dredging & Reclamation Project

- **Dredging & Reclamation**

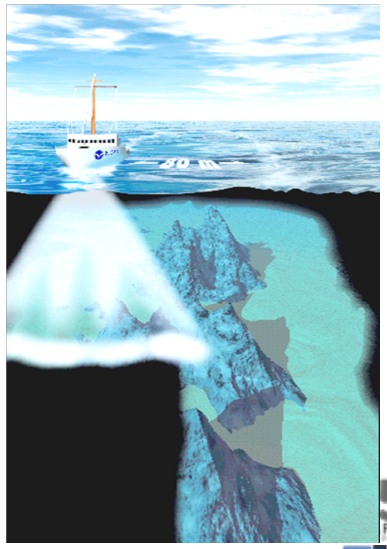
i) What Type Of Survey Needed?

Single Beam Echo Sounder (SBES) – shallow area < 5m – 10m depth average or
Multi Beam Echo Sounder (MBES) – deep area > 5m to 20m depth average
Combination of Bathymetric Survey & Topographic Survey (Reclamation)

Single Beam

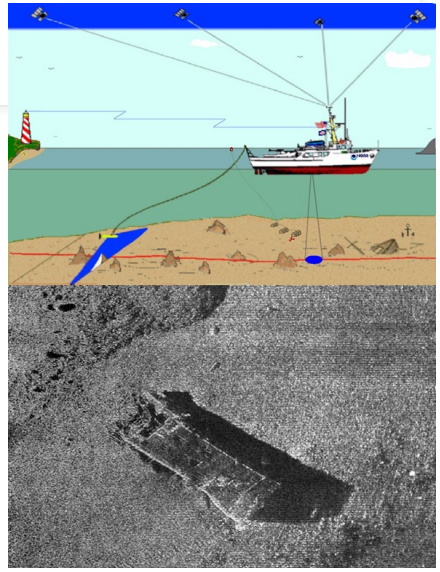


Multi Beam



PROJECT REQUIREMENT

Requirements For Hydrographic Survey In Dredging & Reclamation Project



ii) Standard Port – MBES
iii) Local port /Fisherman / RTB – SBES

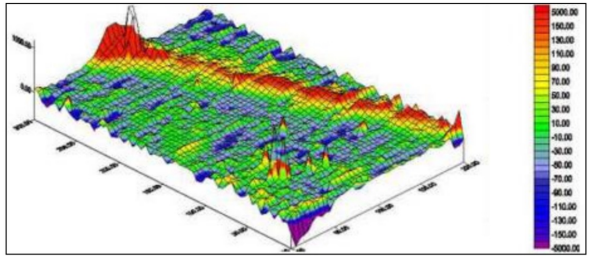
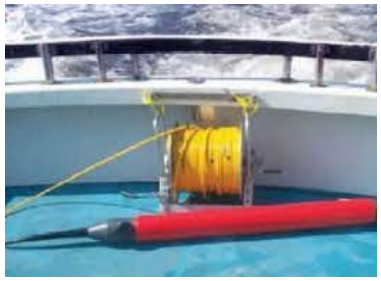
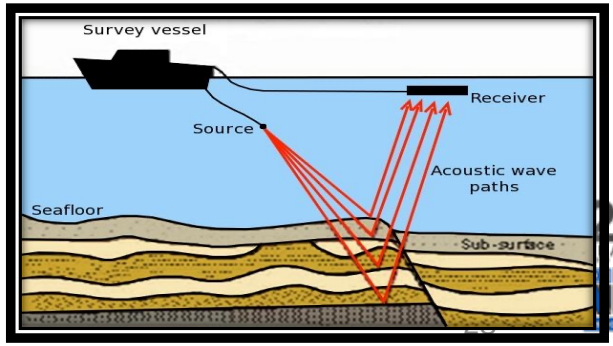


Figure 3: Sample of Magnetic Anomaly Data of 18-inch Stainless Steel Pipe Buried

iv) If there were cables /pipe /boulders /coral /wreckage underneath the proposed channel or Reclamation. What type of survey should be applied?

a. Magnetometer Survey – to identified metal element under the seabed/measure magnetic field.
b. Side Scan Sonar – to capture image ie. Ship wreck,coral or exposed big pipe.
c. Sub-bottom profiler – to gather layers of seabed profile ie. Rock,sand or mud etc





PROJECT REQUIREMENT

Requirements For Hydrographic Survey In Dredging & Reclamation Project

DREDGING & RECLAMTION cont..

vi) What Coordinate System to be used GDM 2000 CASSINI OR RSO / MRSO / UTM / WGS 84

Contractor for dredging usually apply UTM & WGS 84 which widely used globally
Contractor for reclamation mostly use RSO if the size of reclamation is enormous

However when the project is completed the client will engage Licensed Surveyor for land matters.
Licensed Surveyor will apply GDM2000 in their survey for Land Office approval.
Conversion between multiple coordinate systems are unavoidable. Conversion tends to produce error.

Hence, the accuracy of the survey is utmost important. There must be some standards to be followed as guidance.

HYDROGRAPHIC STANDARD

IHO STANDARDS FOR HYDROGRAPHIC SURVEYS (S-44)
5th Edition February 2008

TABLE 1
Minimum Standards for Hydrographic Surveys
(To be read in conjunction with the full text set out in this document.)

Reference	Order	Special	1a	1b	2
Chapter 1	**Description of areas.**	Areas where under-keel clearance is critical	Areas shallower than 100 metres where under-keel clearance is less critical but *features* of concern to surface shipping may exist.	Areas shallower than 100 metres where under-keel clearance is not considered to be an issue for the type of surface shipping expected to transit the area.	Areas generally deeper than 100 metres where a general description of the sea floor is considered adequate.
Chapter 2	**Maximum allowable THU 95% *Confidence level***	2 metres	5 metres + 5% of depth	5 metres + 5% of depth	20 metres + 10% of depth
Para 3.2 and note 1	**Maximum allowable TVU 95% *Confidence level***	a = 0.25 metre b = 0.0075	a = 0.5 metre b = 0.013	a = 0.5 metre b = 0.013	a = 1.0 metre b = 0.023
Glossary and note 2	***Full Sea floor Search***	Required	Required	Not required	Not required
Para 2.1 Para 3.4 Para 3.5 and note 3	***Feature Detection***	Cubic *features* > 1 metre	Cubic *features* > 2 metres, in depths up to 40 metres; 10% of depth beyond 40 metres	Not Applicable	Not Applicable
Para 3.6 and note 4	**Recommended maximum Line Spacing**	Not defined as *full sea floor search* is required	Not defined as *full sea floor search* is required	3 x average depth or 25 metres, whichever is greater For bathymetric lidar a spot spacing of 5 x 5 metres	4 x average depth
Chapter 2 and note 5	**Positioning of fixed aids to navigation and topography significant to navigation. (95% *Confidence level*)**	2 metres	2 metres	2 metres	5 metres
Chapter 2 and note 5	**Positioning of the Coastline and topography less significant to navigation (95% *Confidence level*)**	10 metres	20 metres	20 metres	20 metres
Chapter 2 and note 5	**Mean position of floating aids to navigation (95% *Confidence level*)**	10 metres	10 metres	10 metres	20 metres

SURVEY PROJECT (EXAMPLE)

PROJECT OVERVIEW

- Survey Area
- Geodetic Parameter
- Bathymetric Survey
- Tidal Observation/BM Location
- Bathymetric Survey Guideline
- Quality Control
- Survey Equipment
- Survey Team Organization
- Tentative Programme
- Other Possibility Method
- Video

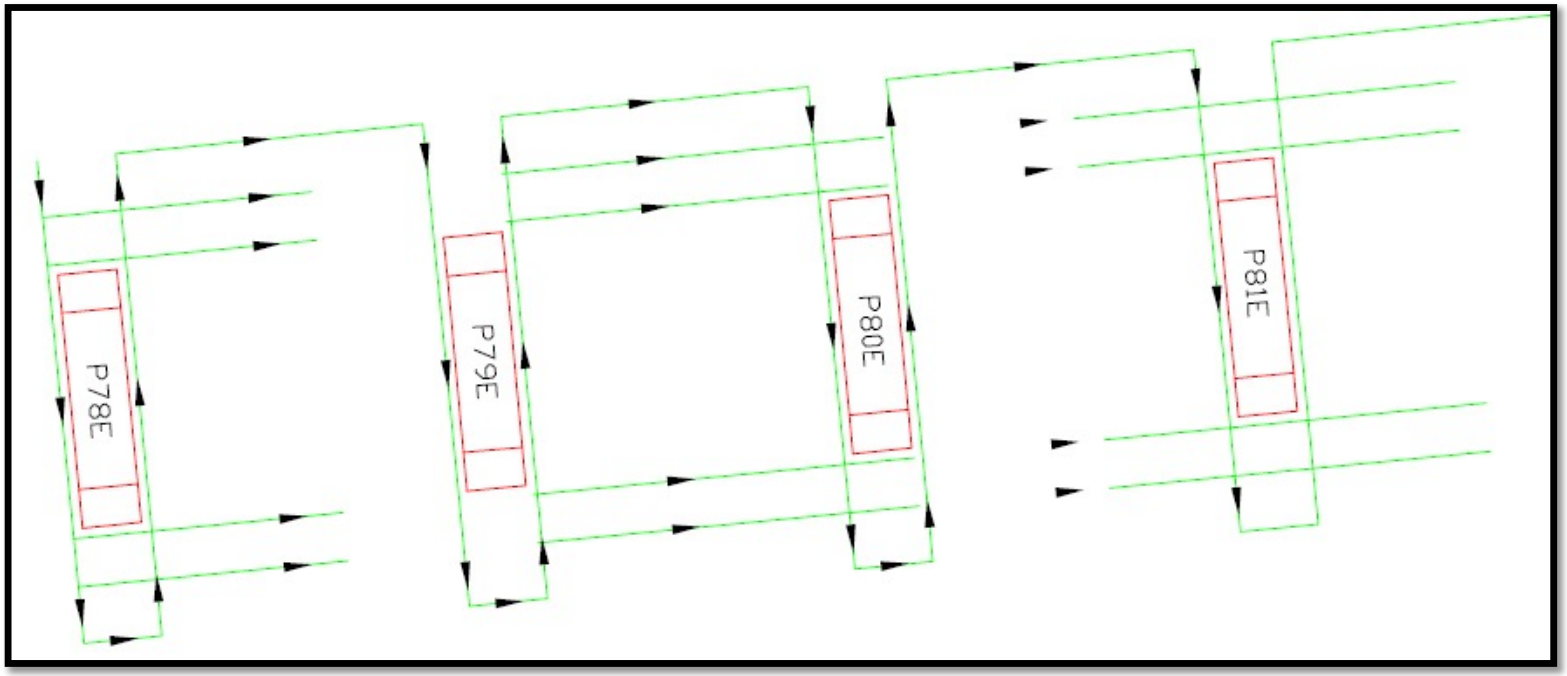
SURVEY AREA

PLAN VIEW

3D VIEW

SURVEY AREA

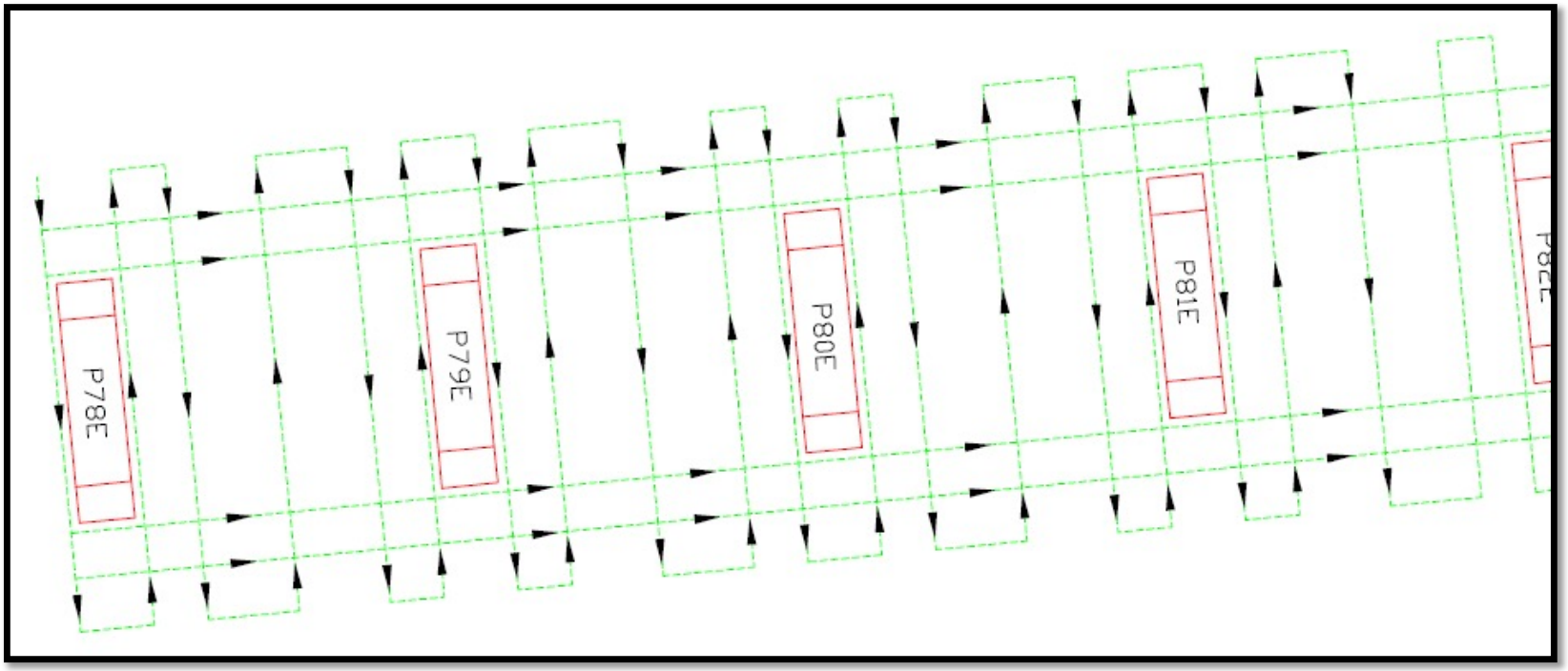
- **Original Sounding Lines**



Hydrographic survey at 1m interval offset from each / every pier

SURVEY AREA

❑ **Proposed Additional Lines For Additional Data**



Hydrographic survey at 10m interval

GEODETIC PARAMETER

SATELLITE GEODETIC SYSTEM (GPS)

Datum name	WGS 84
Reference spheroid	WGS 84
Semi-major axis	6 378 137.0 metres
Semi-minor axis	6 356 752.314 2 metres
Inverse flattening	298.257 223 563
Eccentricity squared	0.006 694 379 990 13

LOCAL GEODETIC REFERENCE SYSTEM AND MAPPING PROJECTION PARAMETERS

Datum Name	KERTAU (M'SIAN REVISED TRIANGULATION)
Reference Spheroid	Modified EVEREST
Semi-major axis	6 377 304.063 m
Semi-minor axis	6 356 103.039 m
Inverse flattening	300.8017
Eccentricity squared	0.006 637 846 63

GEODETIC PARAMETER (cont.)

LOCAL GEODETIC REFERENCE SYSTEM AND MAPPING PROJECTION PARAMETERS (cont.)

Projection system	Malayan Rectified Skew Orthomorphic (MRSO)
Projection type	Rectified Skew Orthomorphic
Unit of coordinates	Metres
Latitude of Origin	4° 00′ 00″ N
Longitude of Origin	102° 15′ 00″ E
Bearing of Initial Line (Alpha)	323° 01′ 32.8458″ E
Skew to Rectified (Gamma)	323° 07′ 48.3686″ E
Basic Longitude (Omega)	105° 14′ 11.19435″ E
False Origin (Easting)	804 671.30 metres
False Origin (Northing)	0.00 metres
Scale factor at Origin	0.999 84

GEODETIC PARAMETER (cont.)

DATUM TRANSFORMATION

Transformation from WGS 84 to Kertau (MRT) Datum

DX	379.77603 m
DY	-775.38371 m
DZ	86.60926 m
Rotation	X 2.59674 sec
Rotation	Y 2.10213 sec
Rotation	Z -12.11377 sec
Scale	1

WGS 84 Datum

Latitude	2° 01′ 43.447″ N
Longitude	102° 33′ 13.716″ E
Height	0.00 m

GEODETIC PARAMETER (cont.)

Kertau (MRT) Datum

Latitude	2° 01′ 43.799″ N
Longitude	102° 33′ 19.341″ E
Height	3.266 m

MRSO Grid

Easting	506 447.764 m
Northing	224 442.530 m

BATHYMETRIC SURVEY
Methodology

Positioning of Soundings

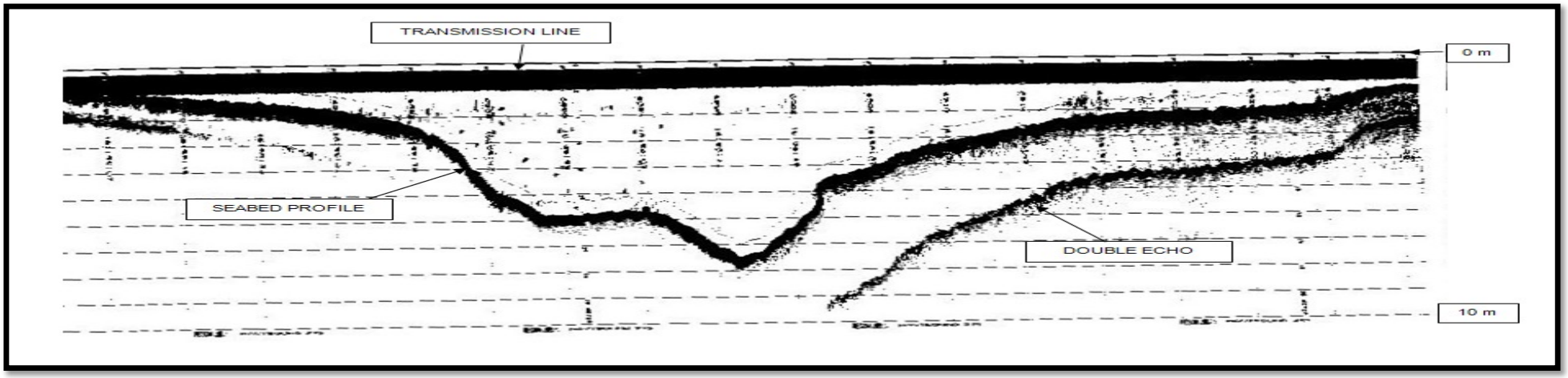
Digital Hydrographic Surveying System

Sample of Survey Boat / Vessel

Sounding Datum (Land Survey Datum)

BATHYMETRIC SURVEY

METHODOLOGY



Typical Seabed Profile Recorded On Echogram By Echo sounder

Option I : Single Frequency (High Frequency)

Option II : Dual Frequency (High & Low Frequency)

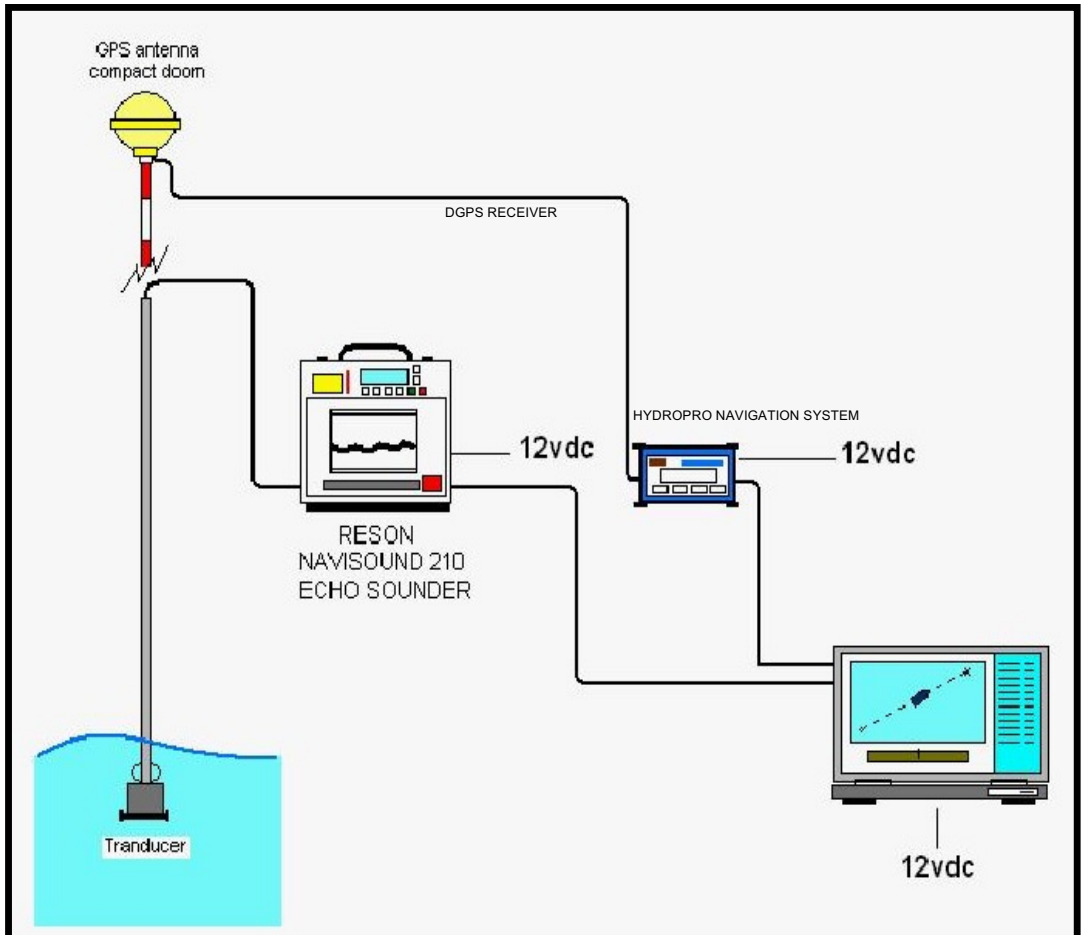
BATHYMETRIC SURVEY

POSITIONING OF SOUNDING

Illustration of OmniSTAR DGPS Operation Diagram

BATHYMETRIC SURVEY

DIGITAL HYDROGRAPHIC SURVEYING SYSTEM



Schematic Diagram Of Digital Hydrographic Surveying System

BATHYMETRIC SURVEY

DIGITAL HYDROGRAPHIC SURVEYING SYSTEM (cont.)

1 Digital Surveying Acquisition System

2 DGPS Receiver

3 Digital Echo Sounder System

BATHYMETRIC SURVEY

DIGITAL HYDROGRAPHIC SURVEYING SYSTEM (cont.)

Hydro Pro Navigation Software Interface

BATHYMETRIC SURVEY

SAMPLE OF SURVEY BOAT / VESSEL

BATHYMETRIC SURVEY

- **SOUNDING DATUM (Land Survey Datum)**

Sample of Benchmark

PROPOSED TIDAL OBSERVATION/TBM LOCATION

BATHYMETRIC SURVEY GUIDELINE

Date: 18 April 2013	**BATHYMETRIC SURVEY GUIDELINE**	**Client:** PLUS MALAYSIA BERHAD
Reference No: PB/ H04		

Location	Coordinate	Survey Area (Approx.)	Survey Class
PENANG BRIDGE	-	(approx 400m under the bridge toward Penang)	IHO Order 1B

Hydrographic Surveyor (Supervising)	**Certification**
CDR (R) Hj. Masrap Bin Hj. Mokhtar, RMN	'H' Charge, FIG/IHO Cat A Hydrographic Surveyor
Hydrographic Surveyor (Field Work)	**Certification**
Ahmad Sukri Bin Saad	Dip. of Land Surveying UiTM

Purpose of Survey	
Purpose of Survey & Survey area	**HYDROGRAPHIC SURVEY**

Horizontal Positioning	**Datum: Local Grid**
Connection to Horizontal Datum	Coordinate System will be referred to MRSO
Methods of Obtaining Horizontal Position	Differential Global Positioning System (DGPS) reference to World Geodetic System 84 (WGS84) with accuracy within 1.0 meter
Calibration Methods and Calibration Frequency	Known Coordinates within the area to be used for Differential GPS confidence check and verification at least once, before commencement of survey works
Dynamic Calibration of Survey System	Observing redundant lines of position or passing at fix object of known coordinate point

Vertical Datum	**Datum: Local Chart Datum**
Connection to Vertical Datum	Vertical Datum will be based on Chart Datum / LSD for bathymetric survey and LSD for topographic survey
Location of Tide Gauges	Where is appropriate and nearby
Method of Measuring Tidal Heights	Self recording tide gauge with 10 minute sampling interval

Depth Measurement	
Survey Vessel Description (Length, Beam, Type)	Proposed boat Specifications : Hull Material : Fiber Glass Boat length : 60 ft (18m) Boat Width : 13.5 ft (4m) Boat Draft : 4.5ft (1.0m) Engine : 2 x 200 BHP Cruising Speed : 15 Knots Number of Crew : 2 to 5 People
Method(s) to be used to Determine Least Depths	Running survey lines at closer intervals over the expected object
Echo Sounder Frequency(s)	Single Frequency of 210 kHz Range : 0.2 to 600m depth Accuracy : 1 cm at 210 KHz (1 sigma) Sample rate : 20 Hz
Method and Frequency of Echo Sounder Calibration	Bar Check Calibration before and after sounding works
Limiting Sea Conditions affecting Survey Quality	Sea state greater than 2 meters wave

Seabed Coverage	
Method to Ensure Seabed Coverage Criteria is met	Close sounding line interval of 5mm on paper with continuous depth measurement along the survey line
Echo Sounder Pulse Repetition Rate	20 pulses per second
Beam Widths - Along Track and Across Travel	7.5°
Survey Vessel Speed over Ground	6 -9 Knots
Sounding Line Spacing and Orientation	Sounding line between piers will be at 20 meters interval and adjacent to the piers on both sides. The Sounding lines is set to 20 meters parallel to the bridge for both sides.

BATHYMETRIC SURVEY GUIDELINE (cont.)

Sounding Reduction and Data Presentation	
Methods to Reduce Raw Data to Sounding Datum	Apply reduced tides from observed tide data
Principle and Method used in Sounding Selection	Setting depth selection parameter to "least depth" in Terramodel software
Positioning of Selected Soundings	Differential Global Positioning System (DGPS)
Method of Contour Generation	Trimble Terramodel software
Scale of Plans	1 : 5000 or an appropriate scale approved by the Client
Digital Format of Final Data	Autocad Format DWG in hardcopy and softcopy and digital ASCII Format of xyz data
Relevant Survey Records	Field books, calculation sheets, tide/water level records, levelling records, echo trace, datum relationship and track plots
Data Quality and Retention	
The Method(s) used to Derive the Quality of the Data and Ability to meet the Depth Tolerance as Required in the Standards	Standard Quality Procedure :IHO *(Please refer Table 1 as attached)* Depth : Echo Sounder Calibration using Bar Check method Position : Confident check position of survey boat at known coordinated point before start of sounding works

Survey guideline and the methods described herein conform to the survey specifications and met the minimum standard for hydrographic survey in accordance with the IHO Standard for Hydrographic Survey SP 44 5th Edition, February 2008, Order 1B.

Prepared by :

Sr. Najhan Shafie
Nano Geoexplore Sdn. Bhd.
Date : 18 April 2013

QUALITY CONTROL

Echo Sounder Calibration

Result of Barcheck

Trackplot

DGPS Integrity Check

Data Processing

Data Processing Flow Chart

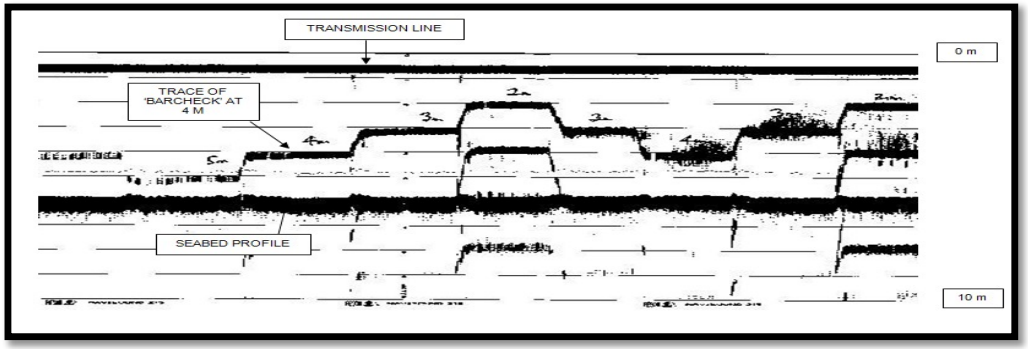
QUALITY CONTROL

Marking Of Chain For Bar Check

Bar Check Calibration In Progress

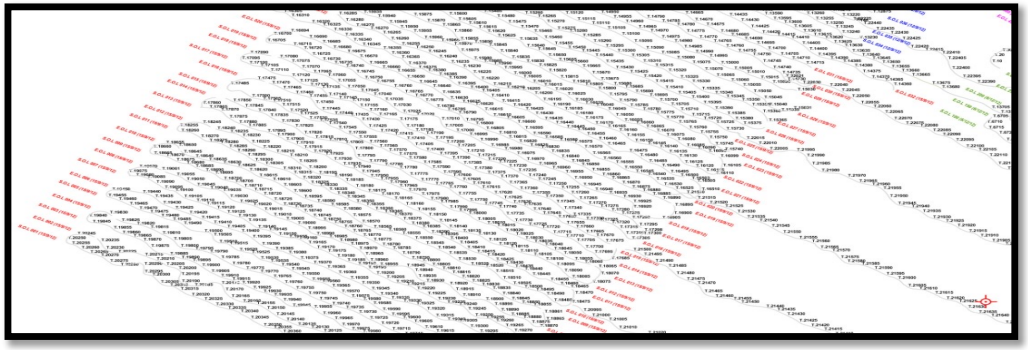
QUALITY CONTROL

❑ RESULT OF BARCHECK



Echogram of Bar Check

❑ TRACKPLOT



Trackplot Drawing

QUALITY CONTROL

❑ DGPS INTEGRITY CHECK

Project	Consultancy Services For The Bathymetric And Topographic Survey Works Of Dredging And Reclamation For Phase III Development Project At Pelabuhan Tanjung Pelepas
General Location	Tapak Kalibrasi GNSS Wangsa Maju
Station Name	Pillar No. 3
Grid Position	353659.0444 N 804320.4456 E
Geographic Position	03° 11' 45.46049" N 101° 44' 16.94198" E
Datum	WGS84
Projection	UTM Zone 47 North
DGPS Serial No	430 169 740001
Surveyor	Shukri, Reduan
Time	11:49:00
Date	January 2013

DGPS VERIFICATION CHECK

DGPS ANTENNA		Differences	
Easting	Northing	dE	dN
804320.515	353659.151	0.0694	0.1066
804320.515	353659.151	0.0694	0.1066
804320.525	353659.151	0.0794	0.1066
804320.535	353659.141	0.0894	0.0966
804320.565	353659.101	0.1194	0.0566
804320.525	353659.081	0.0794	0.0366
804320.535	353659.091	0.0894	0.0466
804320.545	353659.041	0.0994	-0.0034
804320.565	353659.051	0.1194	0.0066
804320.545	353659.051	0.0994	0.0066
804320.615	353659.081	0.1694	0.0366
804320.595	353659.061	0.1494	0.0166
Mean	804320.714	353659.040	0.2688	-0.0040
Maximum	804321.085	353659.151	0.6394	0.1066
Minimum	804320.425	353658.931	-0.0206	-0.1134
Range	0.660	0.220	0.6600	0.2200
S/Deviation	0.131	0.056	0.1310	0.0558

Remarks : The position was logged every 10 seconds using HydroPro ver 2.32 positioning and navigation system.

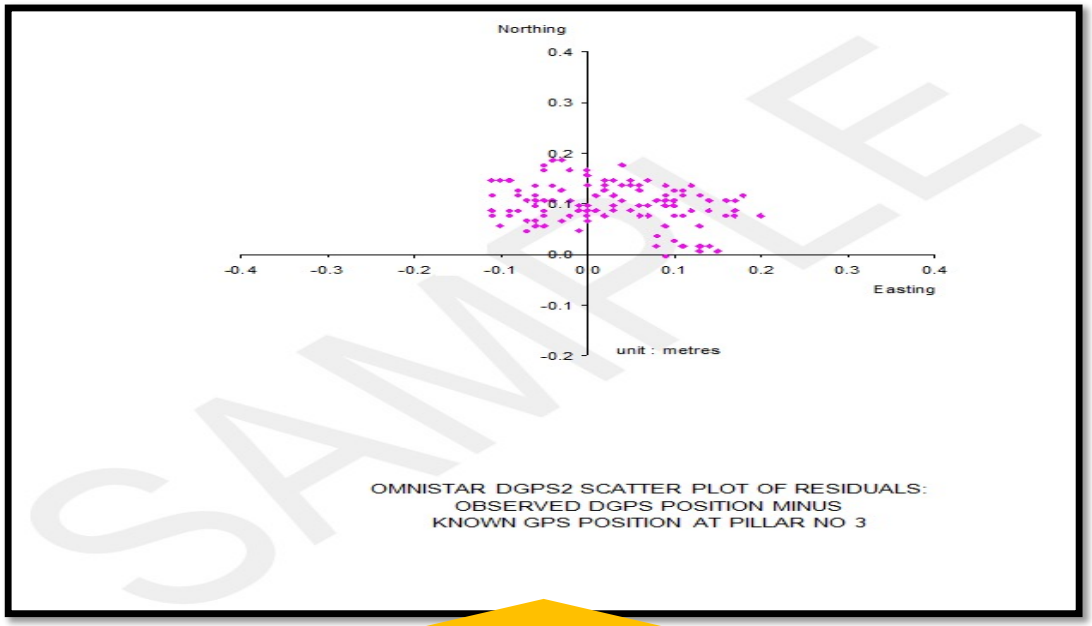
Results : dE 0.2688
dN -0.0040

Confident level (%) : Easting 100%
Northing 100%

Integrity Check

QUALITY CONTROL

- **DGPS INTEGRITY CHECK (cont.)**

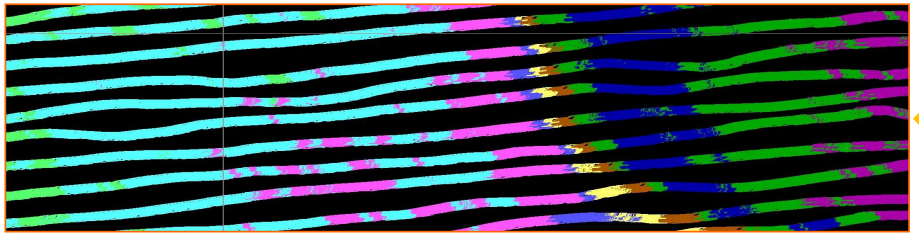


Scatter Plot of DGPS Positions during Integrity Check

DGPS Integrity Check At Known Point

QUALITY CONTROL

- DATA PROCESSING

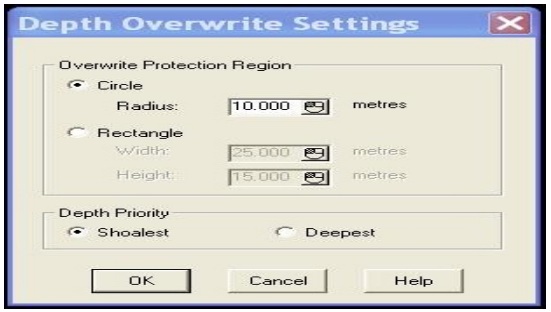


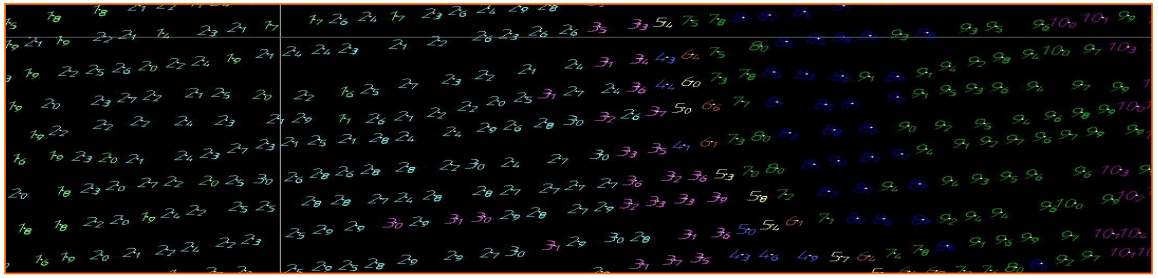
Large Amount of Depths Data Display on Terramodel

1

2

Depth Selection Menu



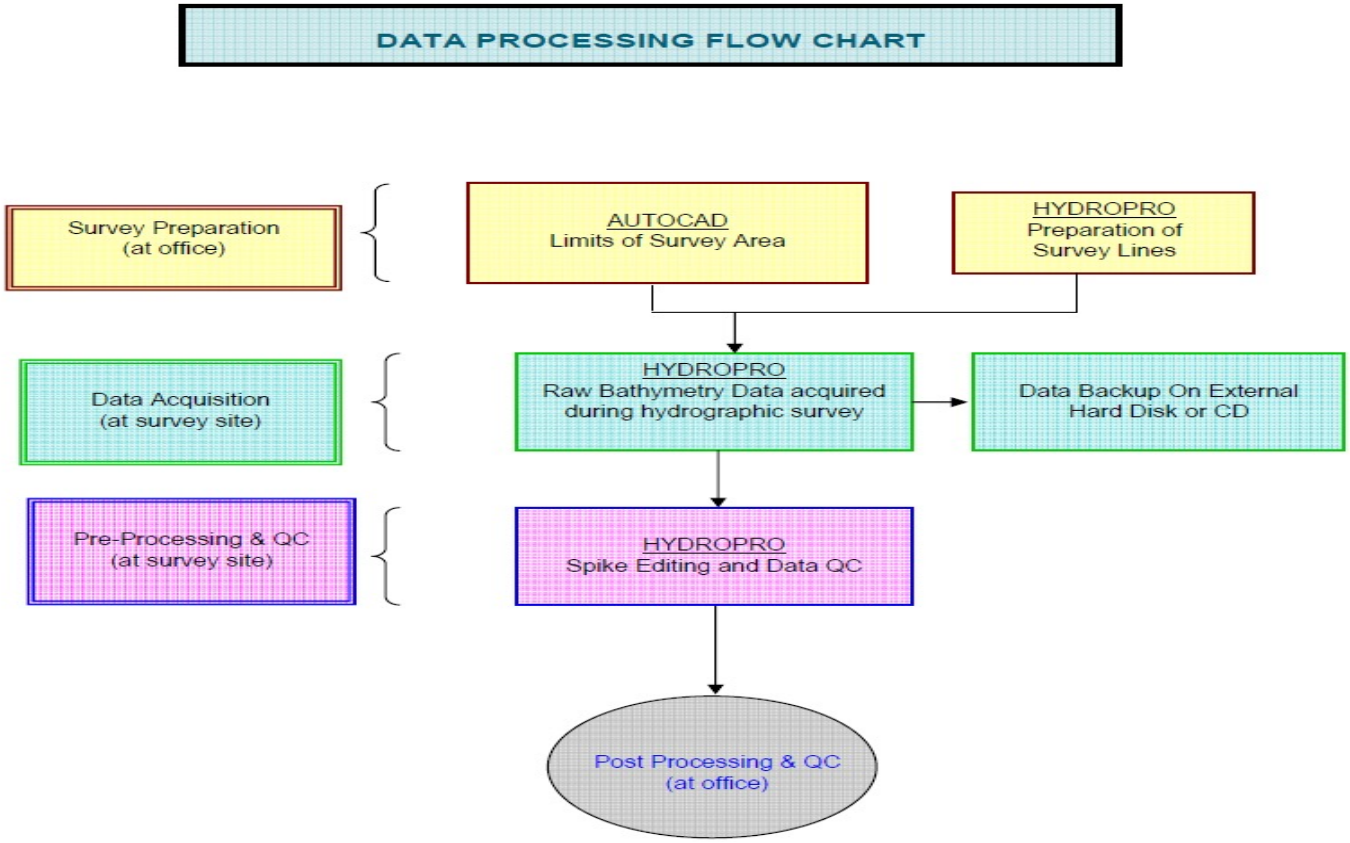


Depths Data Display on Terramodel After Sounding Selection

3

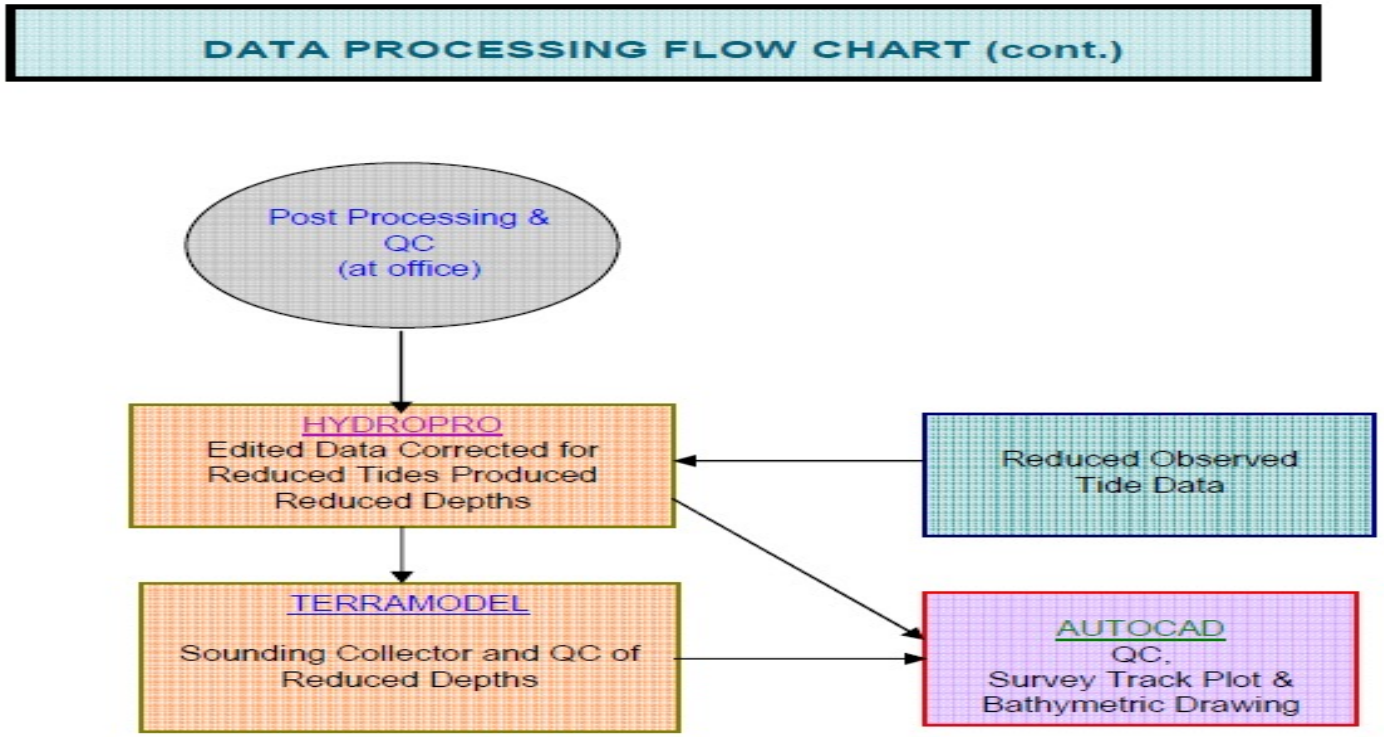
QUALITY CONTROL

- **DATA PROCESSING FLOW CHART**



QUALITY CONTROL

- **DATA PROCESSING FLOW CHART (cont.)**

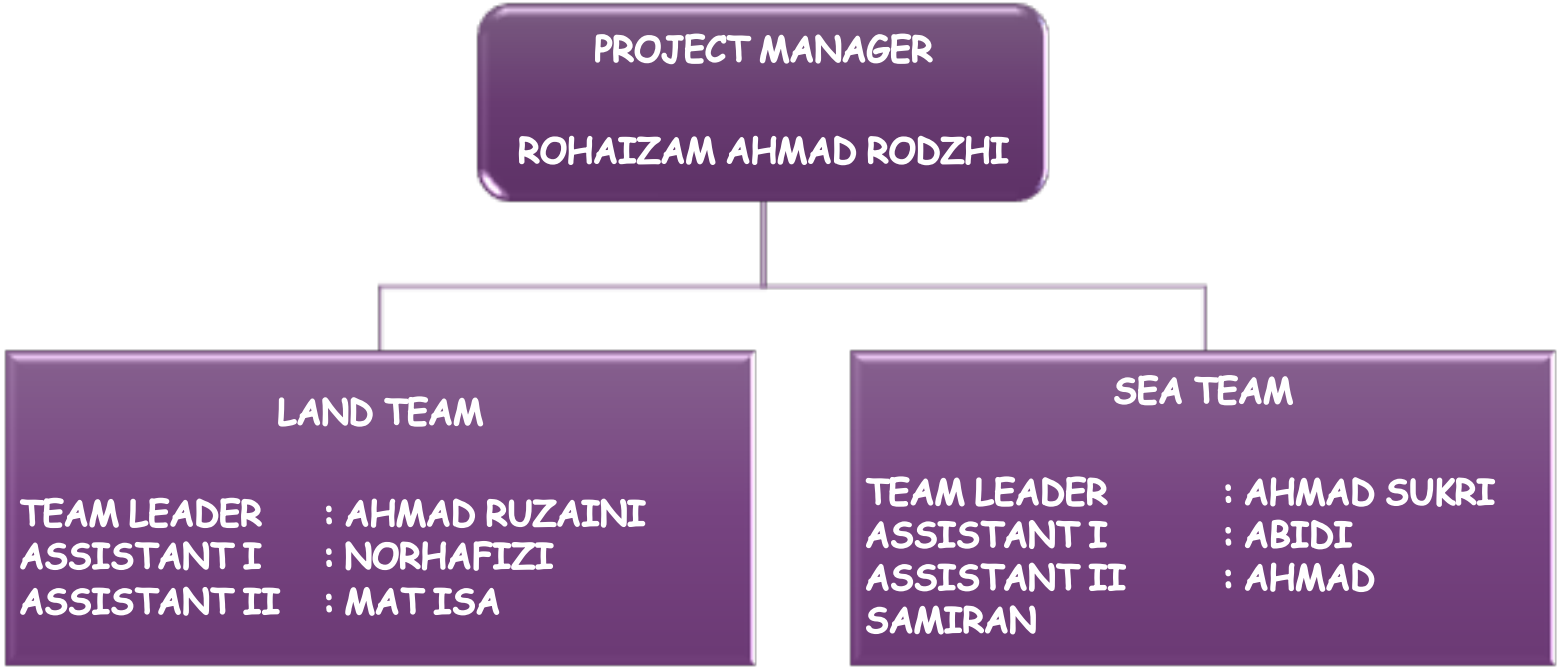


SURVEY EQUIPMENT

- **PROCESSING SOFTWARE**
  - AutoCAD
  - Terramodel

- **SURVEY EQUIPMENT**
  - Reson Navisound Single Beam Echo Sounder
  - Trimble Hydropro Software
  - Fugro Omnistar DGPS 12 Channels
  - RBR Seabed Tide Gauge
  - Automatic Level
  - Bar Check
  - Survey Boat

SURVEY TEAM ORGANIZATION

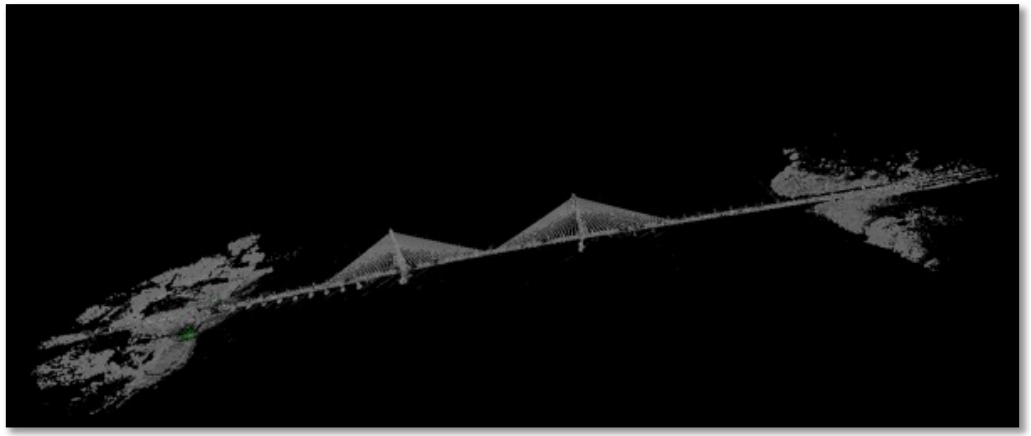


TENTATIVE PROGRAMME

DATE	WORK PROGRESS	EXPECTED COMPLETED
29 APRIL	LAND TEAM	5 WEEKS
7 MAY	SEA TEAM	1 WEEK
15 MAY	PROCESSING DATA	4 WEEKS

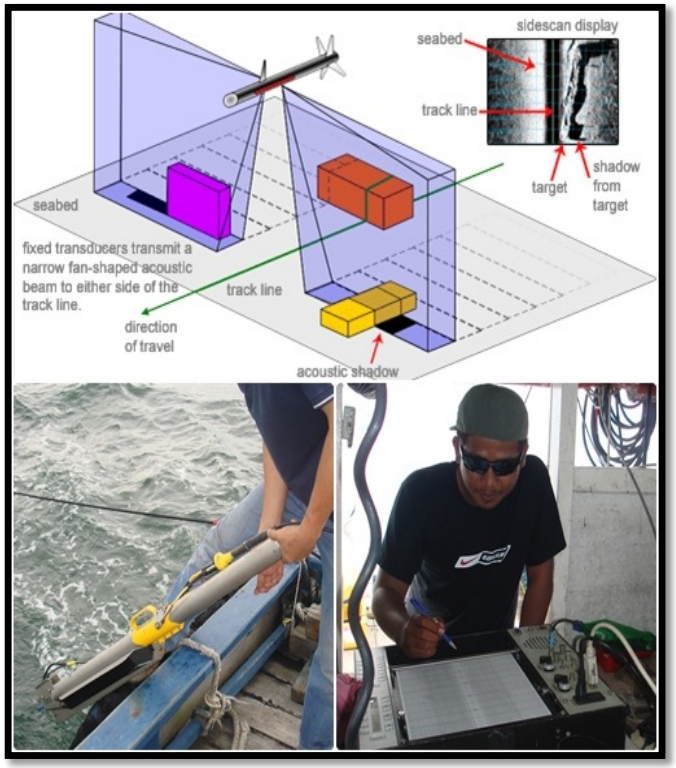
OTHER POSSIBILITY METHOD

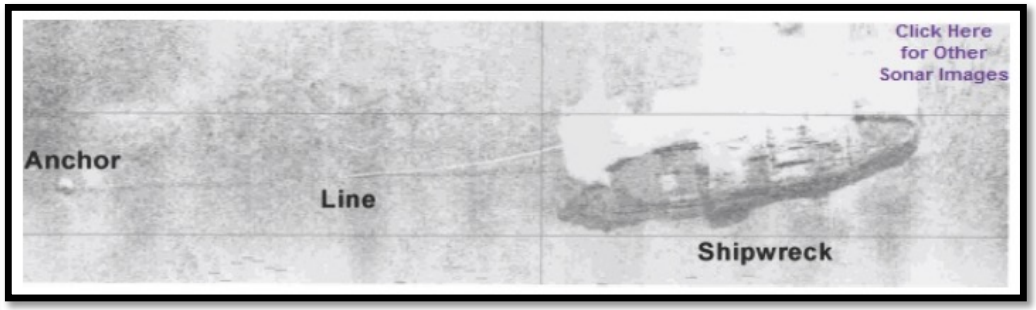
- TERESTRIAL 3D SCANNER

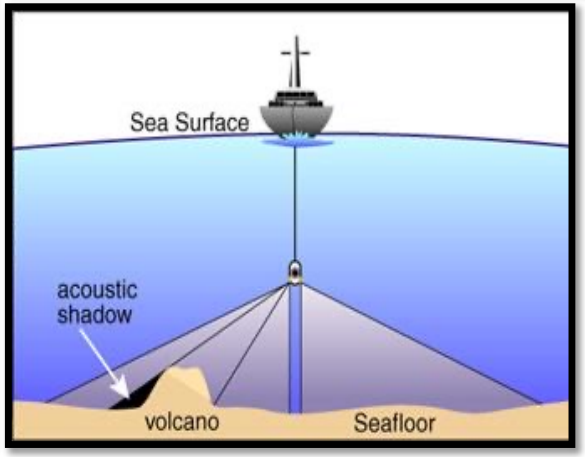


OTHER POSSIBILITY METHOD

- **SIDE SCAN SONAR**

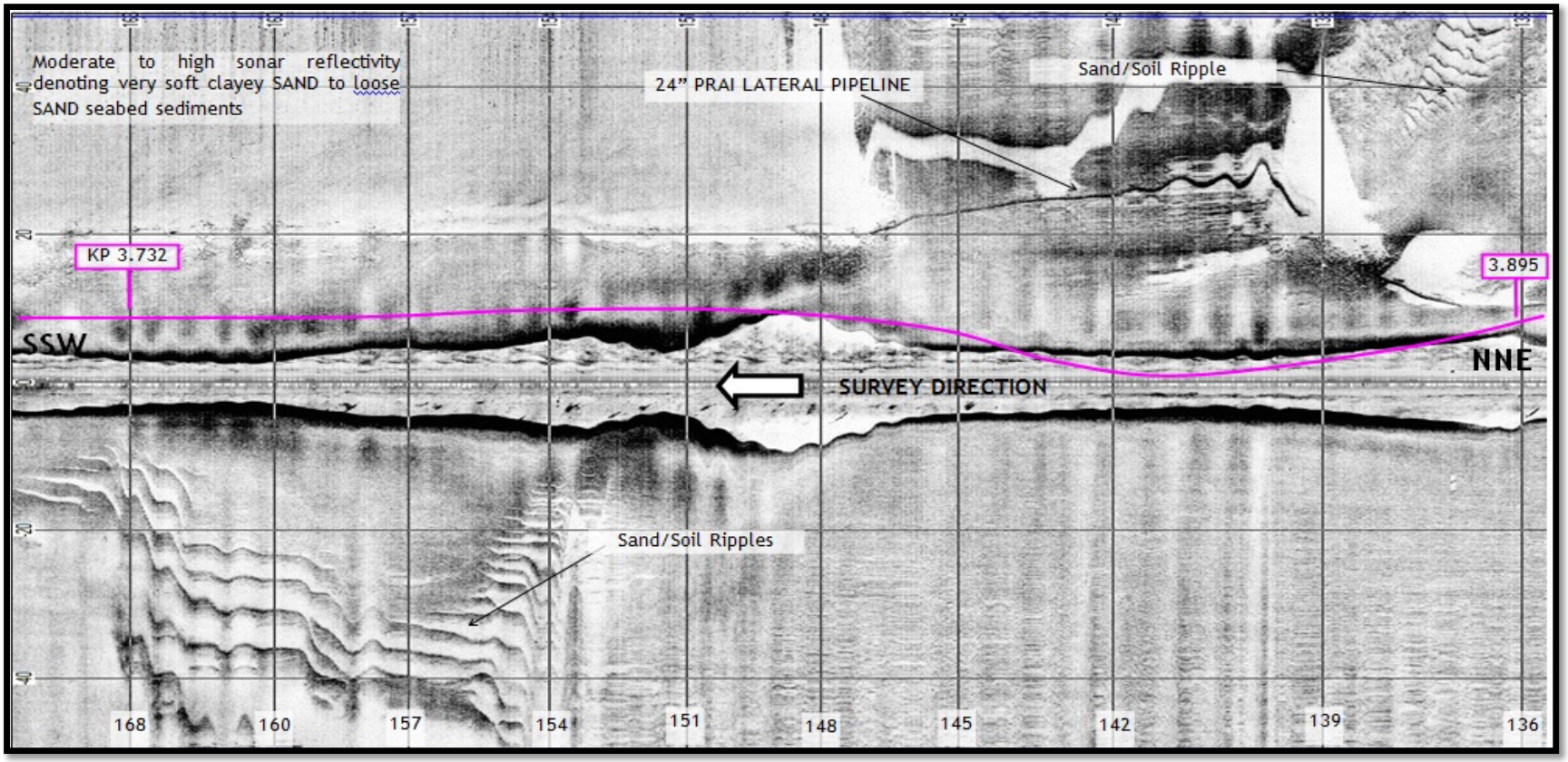






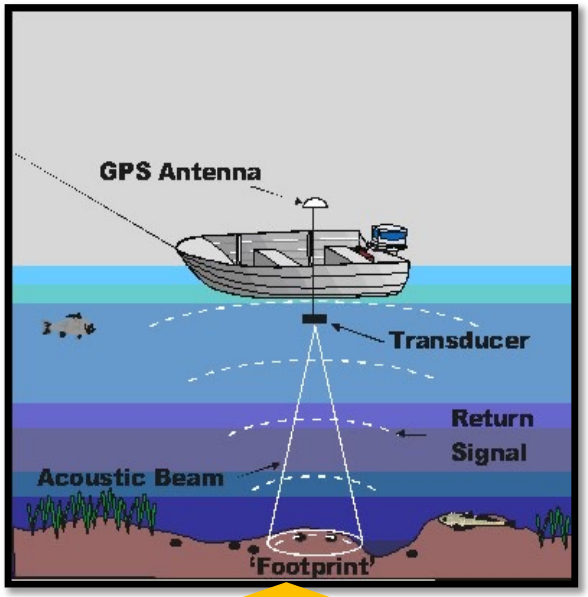
OTHER POSSIBILITY METHOD

- **SIDE SCAN SONAR RESULT**



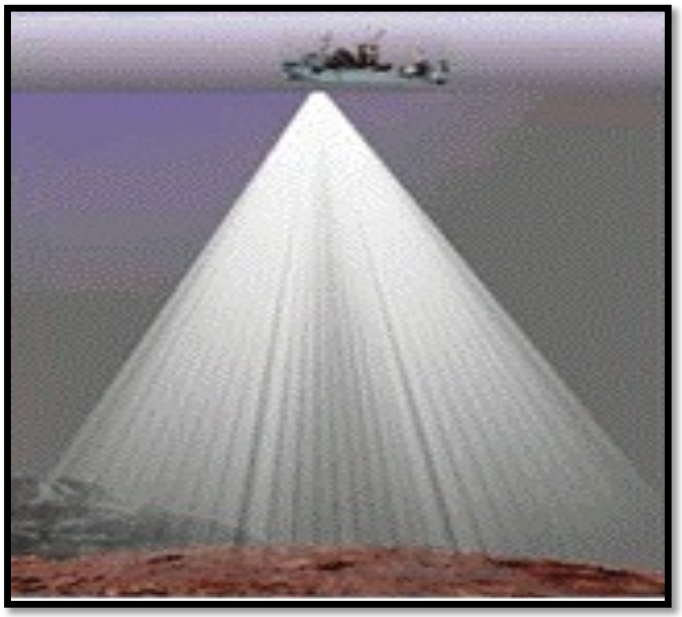
OTHER POSSIBILITY METHOD

- MULTI BEAM



Single Beam Hydrographic Survey System

Send out 1 sound at a time & find depth directly under the ship



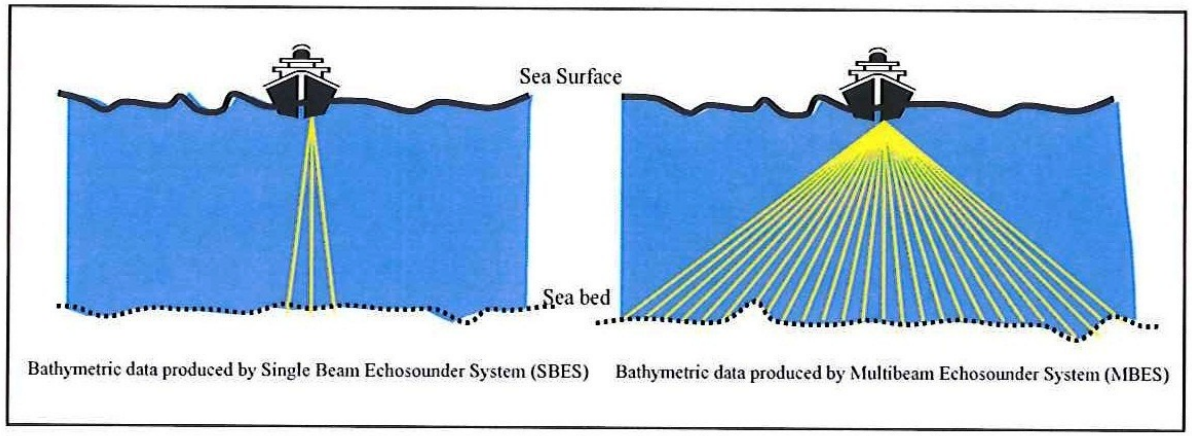
Multi Beam Hydrographic Survey System

Send out an array of sound in a fan shape & returns depth underneath the ship & from other side as well

OTHER POSSIBILITY METHOD

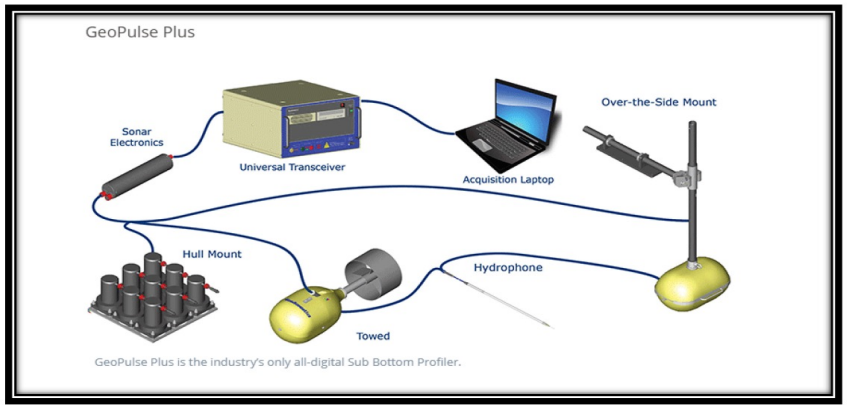
- **MULTI BEAM : DIFFERENCE BETWEEN SINGLE BEAM & MULTI BEAM**

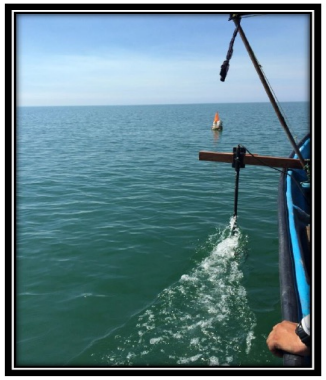
MULTI BEAM	SINGLE BEAM
Wide Coverage	Low Coverage
Large Area	Small Area
High Resolution	Low Resolution
Reduce Ship Survey Timing	Longer Survey Timing
Total Coverage of Bottom (3D)	Spot Height Only
High Accuracy	Low Accuracy



OTHER POSSIBILITY METHOD

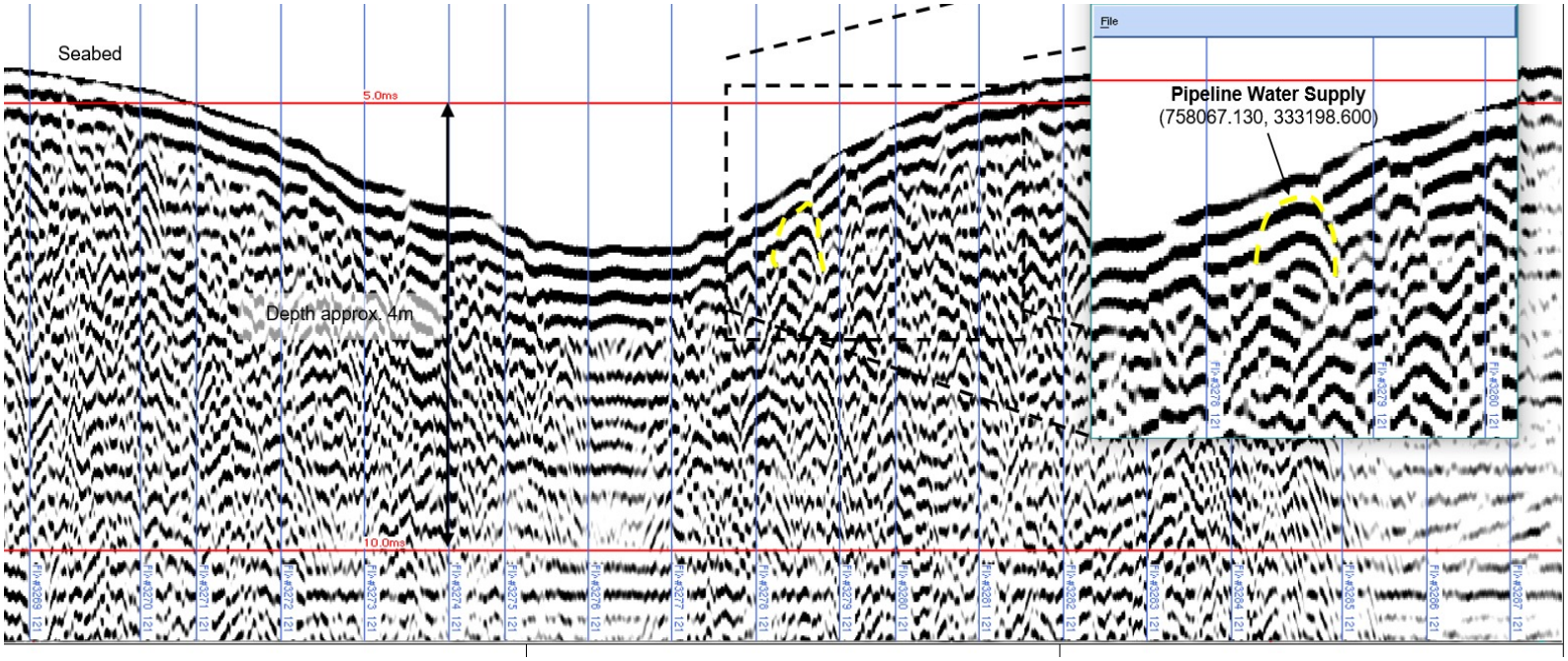
- **SUB BOTTOM PROFILING**





OTHER POSSIBILITY METHOD

- **SUB BOTTOM PROFILING RESULT**



Survey Scope of Work

DIVIDED INTO 3 CATEGORIES

1. **PRE SURVEY**
2. **INTERIM SURVEY / PROGRESS SURVEY**
3. **AS-BUILT SURVEY**

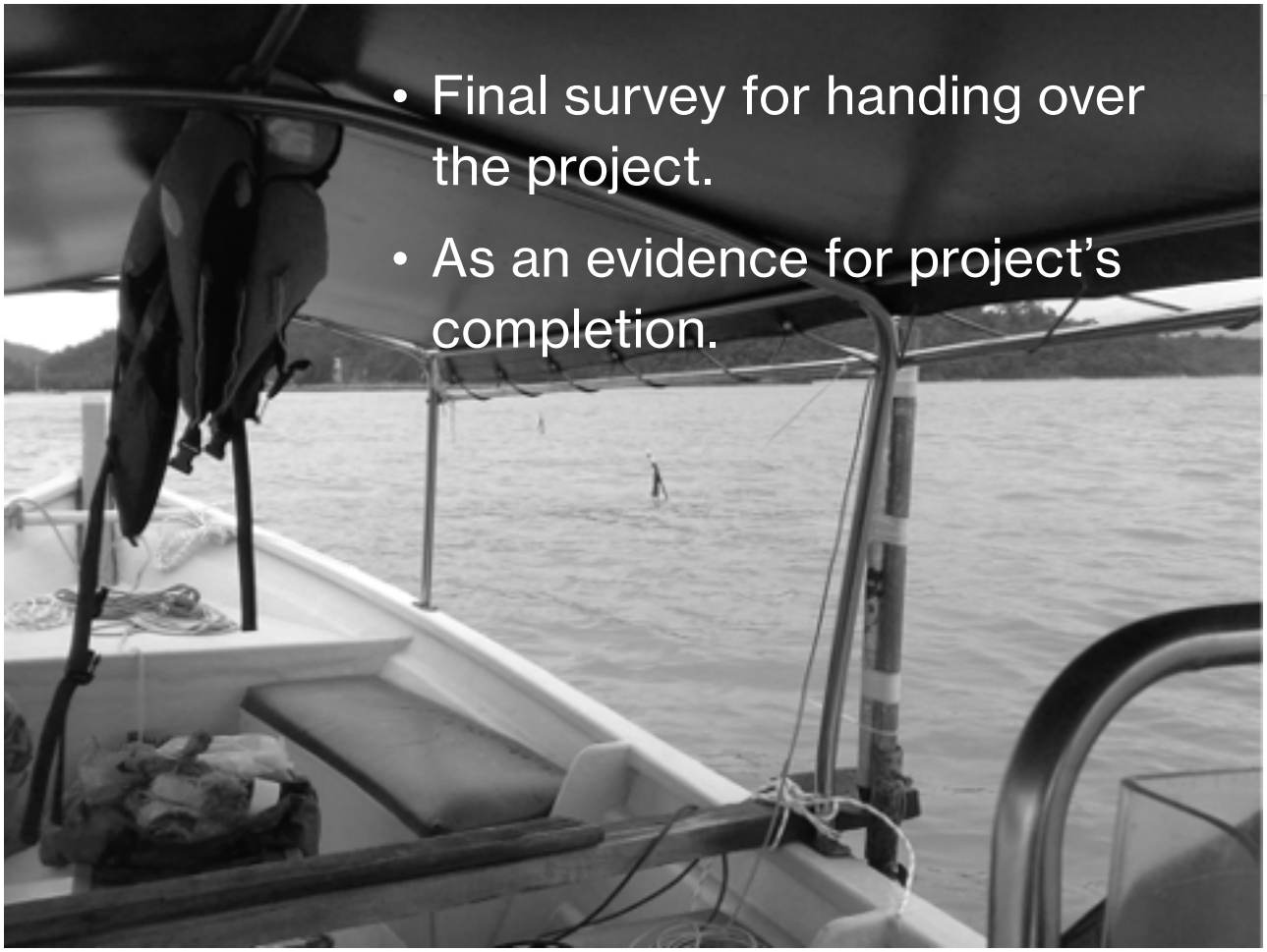
PRE SURVEY

- Latest profile or topographic of sea or riverbed of dredging area.
- Determine the total amount of soil to be removed.
- Quantities is major contributor to the project evaluation.

Interim / Progress Survey

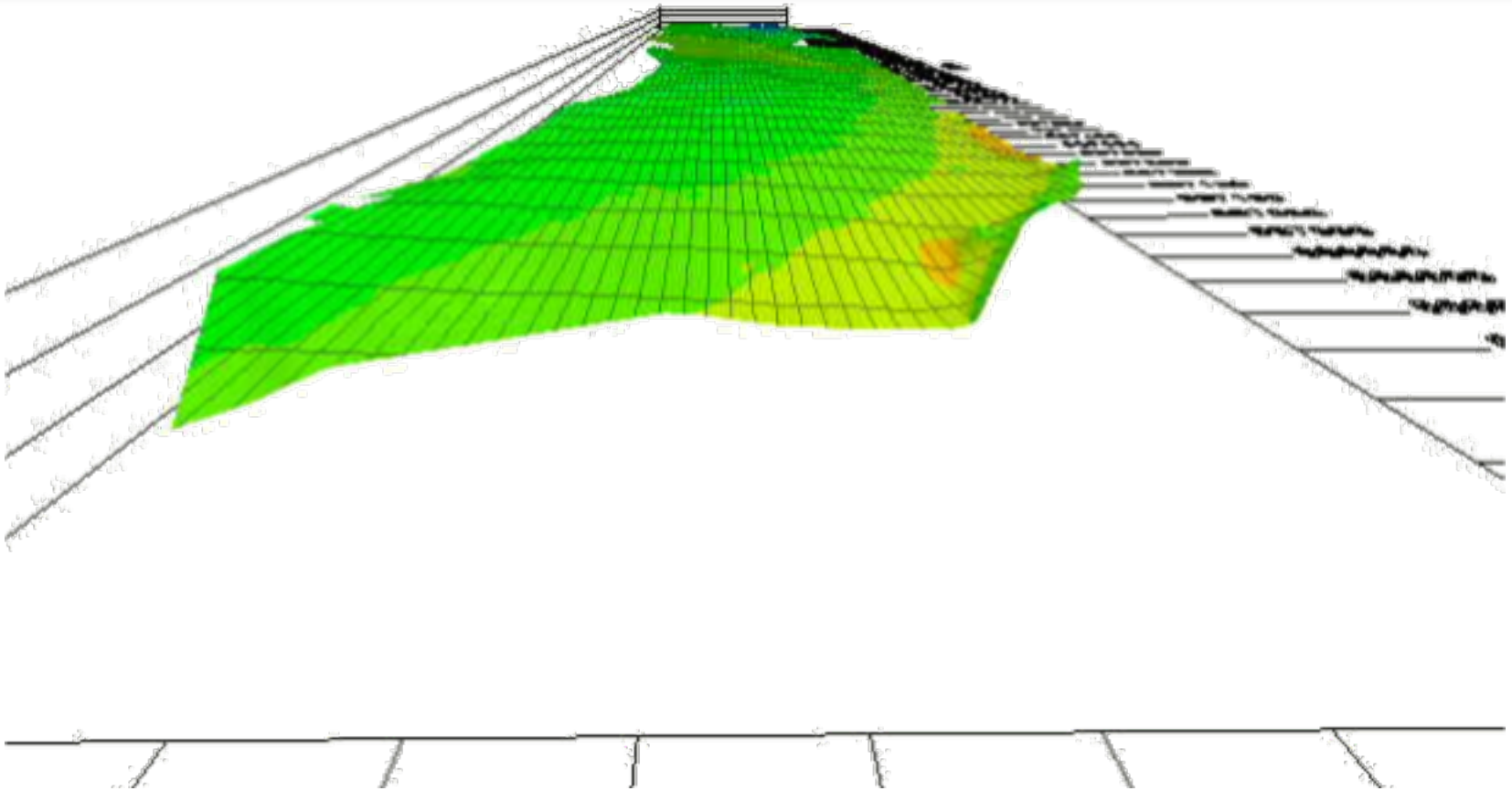
- Done after dredging works completed at certain agreed distance, chainage or block.
- To check or confirm the dredge depth has reach the design depth.
- Determine the dredged quantities.
- Usually witness by the Client, Consultant and the contractor.
- The survey results are part of interim payment documents.

As-built Survey

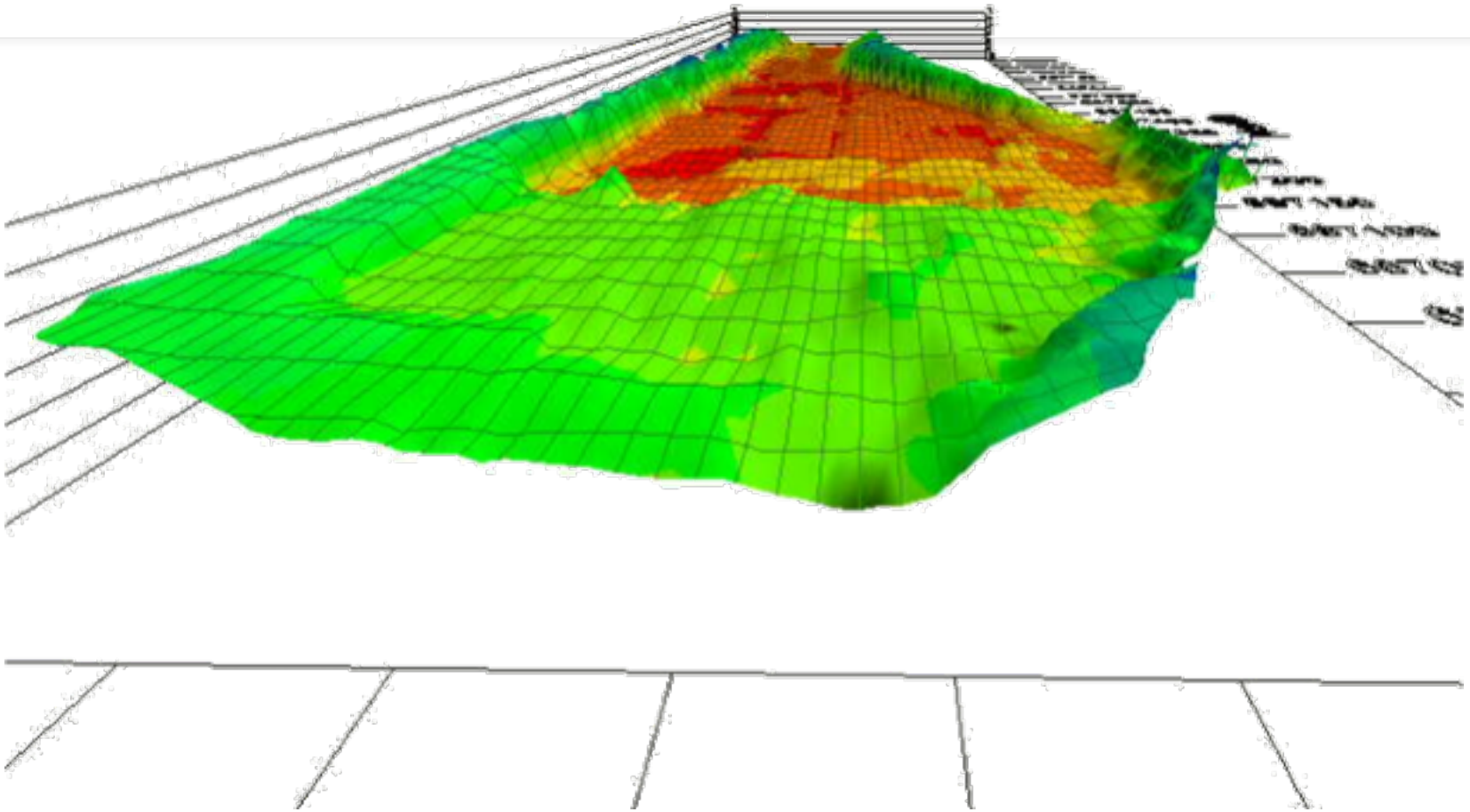


- Final survey for handing over the project.
- As an evidence for project's completion.

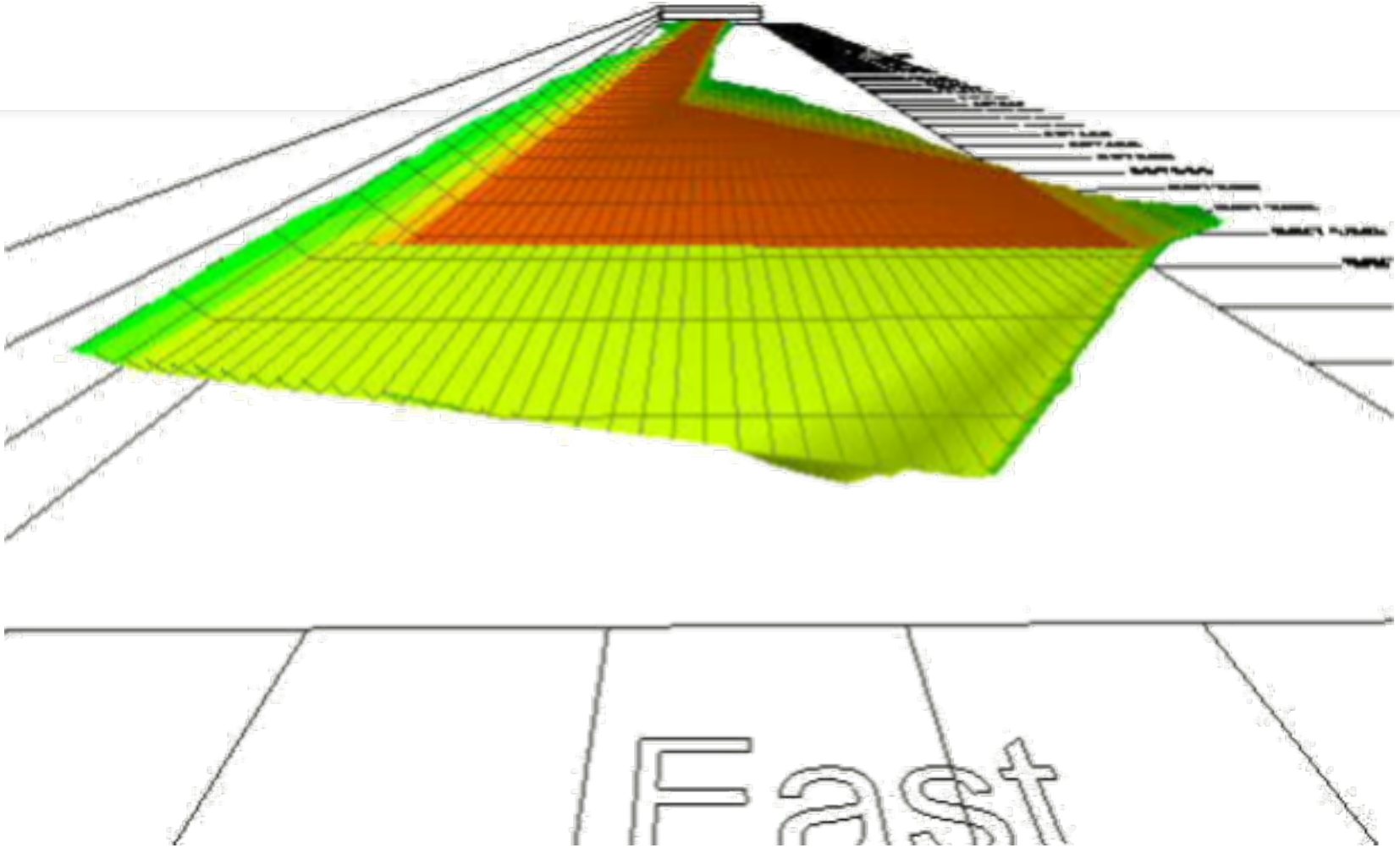
BEFORE DREDGING



AFTER DREDGING



DESIGN CHANNEL



VIDEO

THANK YOU