Journal of Science and Multidisciplinary Research
Volume 5, No. 2, 2013
ISSN: 2277-0135

BATHYMETRIC SURVEY FOR THE DREDGING OF SAN BARTHOLOMEW RIVER IN AKUKUTORU LOCAL GOVERNMENT AREA OF RIVERS STATE, NIGERIA

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Abstract: Data acquisitions started by using the designed map obtained from Shell Petroleum Development Company (SPDC). Controls used along the pipeline right-of-way were established and confirmed using the Leica 406 Total Station and Leica NA42 Automatic Level instruments. Traversing and Profile levelling were done also along the existing pipeline route. Data processing and analysis were carried out via the AutoCAD 2007 and Hypack Survey Navigation Software. Levelling data was reduced to Nembe Lowest Low Water Level (NLLWL) and elevation below NLLWL was obtained and plotted in AutoCAD 2007. Trimble SPS 361 Global Positioning System (GPS) receiver was interfaced with SyQuest Bathy 500 multi-frequency Echo Sounder and used for the pre and post bathymetric survey. The Hypack Navigation Survey Software was used to process the bathymetric data. As a result dredged quantities volume was obtained as 367165 cubic metres (m^3) together with the profile of river bed and depth of dredging. The process of online dredging system using the GPS and the Dredge Pack Presentation System (DTPS) software was used to guide the suction dredger system.

Keywords: Dredging, Bathymetric Survey, Safe Navigation. Answered

INTRODUCTION

Kufoniyi and Bouloucus (1994) said that Geoinformatics is a family name of sciences and technologies involving primarily Surveying and Mapping, Remote Sensing (RS), Global Positioning System (GPS) and Geographic Information System (GIS). It is indeed the science and technology which develops and uses information science infrastructure to address the problems of mankind in the areas of navigation, agriculture, engineering, mineral prospecting, forestry and wild life management, just to mention but a few (Arnof, 1989).

Geoinformatics combines with Geospatial analysis and modelling, development of Geospatial databases, information system design, human-computer interaction and both wired and wireless networking technologies (Kufoniyi, 1998). It further uses geo-computation and geo-visualisation for analyzing geoinformation. Prominent amongst these areas is the area of sea or river navigation or mineral prospecting of which dredging is one of it. Dredging may then be defined as a process of using an equipment inform of a bucket dredger, grab or suction device to remove sediments, sand silt or wrecked materials from river or sea bed channels in shallow or deep waters for the purpose of gathering up bottom sediments and disposing them at a different location. A dredger is a ship or boat equipped with a dredge. Bannister and Raymond (1990), Ingham (1987) and Kraus (2000) observed that dredging is done for many purposes and the kinds of dredging derive their names as such, such as Capital Dredging, Preparatory Dredging, Maintenance Dredging, Land Reclamation Dredging or Beach Nourishment Dredging. Capital dredging is undertaken to create a new harbour, berth or waterway or to deepen existing seaway facility in order to allow large ships easy access free under-keel

clearance for safe navigation. Maintenance dredging is done for the purpose of deepening or maintaining navigable waterway or channel which are threatened to become silted with passage of time due to sediment, sand, mud and wreckages. Preparatory Dredging is done in preparation to repair or replace pipeline, build bridges, reservoirs etc. This study falls in the realm of preparatory and maintenance dredging. The existing 0.762m x 1300m crude oil pipeline of San Bartholomew River right-of-way was corroded and needed replacement and there became an increasing need to replace it as soon as possible to avoid the transported crude oil products from affecting the end users equipment and facilities negatively. This therefore necessitated the process of preparatory and maintenance dredging activities to be carried out to replace the corroded pipeline. The study was therefore aimed at carrying out a pre and post dredging survey for the purpose of replacement of corroded oil pipeline (Dania, 2000; Demers, 1997).

AREA OF STUDY

The study area (San Bartholomew River) located in Koula community in Akukutoru Local Government Area of Rivers State, Nigeria. It lies within latitudes 4° 30'26"N and 4° 30' 35"N of the Equator and longitudes 6° 41'17.66"E and 6° 42'02"E of the Greenwich Meridian (see fig 1 below). The climate of the area is described as mangrove forest with two major seasons wet and dry seasons. The wet or rainy season starts from March to December while the January and February are regarded as dry season. The mean annual rainfall is 86 inches or 218.44 cm. The study area lies in the crystalline uplands of Atlantic Ocean. The people are into fishing and faming and with a population of about 35 people (Encarta, 2010).

MATERIALS AND METHODS

The materials used in this study include design map of the project site which contained the controls used. Total station instrument (Leica TC 406) was used. The GPS Trimble SPS 757 base station was mounted on a ground control point which defined the position of the dredger using the Real Time Kinematic (RTK) technique while the heading GPS was used to define the heading/direction of the dredger and interfaced with the computer having the Dredge Track Presentation System (DTPS) software. This system maintained the profile of the channel dredged on the right-of-way. An Echo Sounder interface with a GPS and having the Hypack Survey Navigation Software was used for efficient monitoring and data acquisition of the pre and post dredged channel survey. The pre dredging Bathymetric survey involved the following equipment as:

- Yamaha 40 horse power speed boat
- Syqwest Bathy 500 Multi-frequency Echo Sounder
- Trimble SPS 361 GPS Receiver
- Hypack Navigation Survey software
- Dell Latitude D800 Laptop computer

The sounding operation was done to obtain positions (x, y and z) along the proposed centreline of the pipeline route. The sounding data was reduced to Nembe Lowest Low Water Level (NLLWL) as sounding datum as advised in Orisakwe (2011). All elevation below the NLLWL was plotted in AutoCAD 2007.

Prior to actual dredging operation, the Geodesy Menu in DTPS software was configured to match the site coordinate system in the Universal Transverse Mercator (UTM) and uploading of the designed project drawing onto the DTPS onboard the Dredger. The DTPS enabled the

display of the centreline of the entire channel, Digital Terrain Model (DTM) and the dredge depth. The Trimble base station GPS SPS 576 receiver and antenna were setup on one of the known ground control points (NCTL 431) along the right-of-way. The control coordinates were keyed-in to the ground base station and RTK technique signals were steadily transmitted to the two SPS 575 GPS (Moving Base and the Heading GPS Receivers) mounted on the dredger and interfaced with the computer system within the DTPS software which enabled to refine the Easting, Nothing and Height for dredging. The dredger was positioned at a control station 470223.249m E, 56381.595m N and 11.95m Elevation with respect to NLLWL (see fig. 2 below) which was along the centreline of the design channel to be dredged. The dredging commenced when the dredger was positioned at the centreline of the channel. This was to avoid the dredged materials to fall back to the channel. This process followed a post dredge Bathymetric survey and sounding which acted as-built dredge of the channel (Admiralty Manual of Hydrographic Surveying Vol. II, 1969 and Ingham, 1987).

RESULTS AND DISCUSSION

Figure 1 below shows the creation and design of the channel and the centreline of the pipeline in Dredge Pack Presentation System software environment.

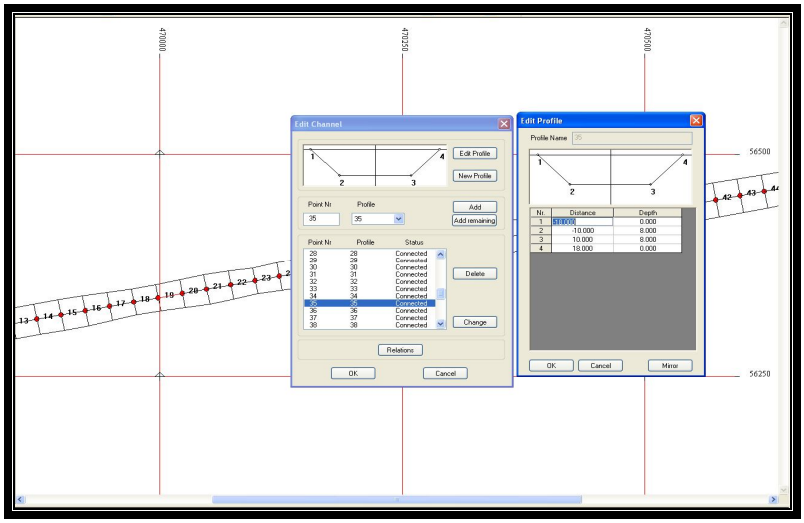

Figure 1: Creation / Design of the Centre Line and Channel of the Pipeline

Presentation System (DTPS) Software

Figure 2 below shows the channel, the centreline of the pipeline route and the Digital Terrain Model (DTM) in the Dredge Pack Presentation System (DPPS) software environment. It further shows pre-dredged sounding data obtained longitudinally at 25 m interval along the centreline of the pipeline route.

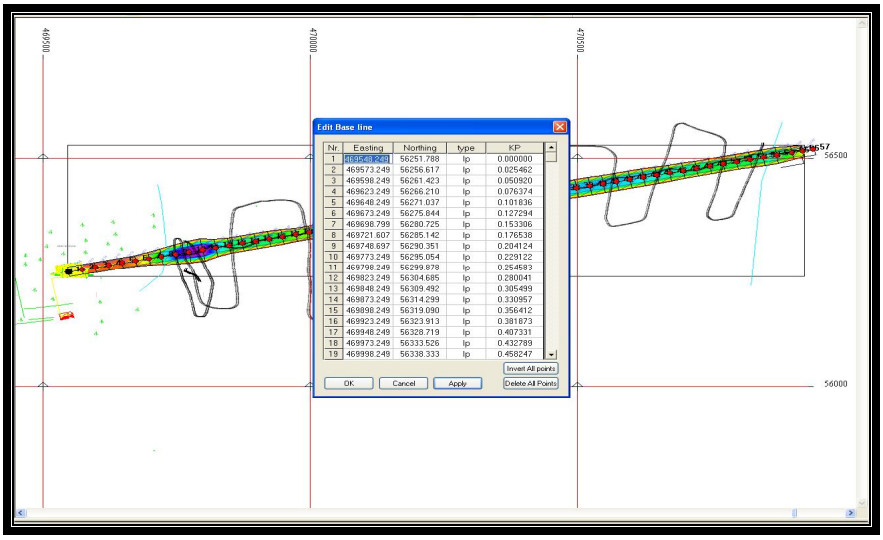

Figure 2: Creation / Design of the Centre Line, Channel and DTM of the Pipeline

Table 1 below shows the pre-dredged sounding data which comprised the planimetric coordinates of points (Easting and Northing), Depth (Elevation) at that instant and time of observation.

Table 1: Pre-Dredging Sounding

S/n	Easting	Northing	Elevation	Date	Time
1	469723.2	56285.46	1.67	12 Aug, 2011	7:51:05
2	469748.2	56290.27	4.41	12 Aug, 2011	7:51:38
3	469773.2	56295.07	9.08	12 Aug, 2011	7:52:11
4	469798.2	56299.88	13.45	12 Aug, 2011	7:52:44
5	469823.2	56304.69	13.79	12 Aug, 2011	7:53:17
6	469848.2	56309.49	14.13	12 Aug, 2011	7:53:50
7	469873.2	56314.3	13.7	12 Aug, 2011	7:54:23
8	469898.2	56319.11	14.02	12 Aug, 2011	7:54:56
9	469923.2	56323.91	13.15	12 Aug, 2011	7:55:29
10	469948.2	56328.72	12.07	12 Aug, 2011	7:56:02
11	469973.2	56333.53	10.26	12 Aug, 2011	7:56:35
12	469998.2	56338.33	9.62	12 Aug, 2011	7:57:08
13	470023.2	56343.14	10.08	12 Aug, 2011	7:57:41
14	470048.2	56347.95	9.45	12 Aug, 2011	7:58:14
15	470073.2	56352.75	8.66	12 Aug, 2011	7:58:47
16	470098.2	56357.56	7.05	12 Aug, 2011	7:59:20
17	470123.2	56362.37	6.17	12 Aug, 2011	7:59:53
18	470148.2	56367.17	5.1	12 Aug, 2011	8:00:26
19	470173.2	56371.98	4.61	12 Aug, 2011	8:00:59
20	470198.2	56376.79	4.3	12 Aug, 2011	8:01:32
21	470223.2	56381.6	3.56	12 Aug, 2011	8:02:05
22	470248.2	56386.4	2.77	12 Aug, 2011	8:02:38
23	470273.2	56391.21	3.52	12 Aug, 2011	8:03:11
24	470298.2	56396.02	3.33	12 Aug, 2011	8:03:44
25	470323.2	56400.82	3.14	12 Aug, 2011	8:04:17
26	470348.2	56405.63	3.03	12 Aug, 2011	8:04:50
27	470373.2	56410.44	2.84	12 Aug, 2011	8:05:23
28	470398.2	56415.24	2.61	12 Aug, 2011	8:05:56
29	470423.2	56420.05	2.41	12 Aug, 2011	8:06:29
30	470448.2	56424.86	2.22	12 Aug, 2011	8:07:02
31	470473.2	56429.66	1.61	12 Aug, 2011	8:07:35
32	470498.2	56434.47	1.81	12 Aug, 2011	8:08:08
33	470523.2	56439.28	1.7	12 Aug, 2011	8:08:41
34	470548.2	56444.08	2.07	12 Aug, 2011	8:09:14
35	470573.2	56448.89	2.69	12 Aug, 2011	8:09:47
36	470598.2	56453.7	3.44	12 Aug, 2011	8:10:20
37	470623.2	56458.5	6.42	12 Aug, 2011	8:10:53
38	470648.2	56463.31	5.05	12 Aug, 2011	8:11:26
39	470673.2	56468.12	4.88	12 Aug, 2011	8:11:59
40	470698.2	56472.93	4.86	12 Aug, 2011	8:12:32
41	470723.2	56477.73	4.62	12 Aug, 2011	8:13:05
42	470748.2	56482.54	4.9	12 Aug, 2011	8:13:38
43	470773.2	56487.35	5.13	12 Aug, 2011	8:14:11
44	470798.2	56492.15	4.93	12 Aug, 2011	8:14:44
45	470823.2	56496.96	4.74	12 Aug, 2011	8:15:17
46	470848.2	56501.77	4.44	12 Aug, 2011	8:15:50
47	470872.5	56506.42	2.48	12 Aug, 2011	8:16:23

S/n	Easting	Northing	Elevation	Date	Time
1	469623.249	56266.23		25 Sept, 2011	9:10:01
2	469648.249	56271.037	4.34	25 Sept, 2011	9:11:18
3	469673.249	56275.844	5.81	25 Sept, 2011	9:12:35
4	469698.799	56280.725	8.48	25 Sept, 2011	9:13:52
5	469723.249	56285.458	11.05	25 Sept, 2011	9:15:09
6	469748.249	56290.265	14.23	25 Sept, 2011	9:16:26
7	469773.249	56295.071	18.08	25 Sept, 2011	9:17:43
8	469798.249	56299.878	20.47	25 Sept, 2011	9:19:00
9	469823.249	56304.685	21.55	25 Sept, 2011	9:20:17
10	469848.249	56309.492	22.11	25 Sept, 2011	9:21:34
11	469873.249	56314.299	21.8	25 Sept, 2011	9:22:51
12	469898.249	56319.106	21.33	25 Sept, 2011	9:24:08
13	469923.249	56323.913	20.7	25 Sept, 2011	9:25:25
14	469948.249	56328.719	19.84	25 Sept, 2011	9:26:42
15	469973.249	56333.526	18.91	25 Sept, 2011	9:27:59
16	469998.249	56338.333	18.22	25 Sept, 2011	9:29:16
17	470023.249	56343.14	17.64	25 Sept, 2011	9:30:33
18	470048.249	56347.947	17.03	25 Sept, 2011	9:31:50
19	470073.249	56352.754	16.08	25 Sept, 2011	9:33:07
20	470098.249	56357.561	15.55	25 Sept, 2011	9:34:24
21	470123.249	56362.367	14.86	25 Sept, 2011	9:35:41
22	470148.249	56367.174	15.08	25 Sept, 2011	9:36:58
23	470173.249	56371.981	14.6	25 Sept, 2011	9:38:15
24	470198.249	56376.788	13.31	25 Sept, 2011	9:39:32
25	470223.249	56381.595	13.56	25 Sept, 2011	9:40:49
26	470248.249	56386.402	13.13	25 Sept, 2011	9:42:06
27	470273.249	56391.208	13.35	25 Sept, 2011	9:43:23
28	470298.249	56396.015	13.1	25 Sept, 2011	9:44:40
29	470323.249	56400.822	12.95	25 Sept, 2011	9:45:57
30	470348.249	56405.629	12.39	25 Sept, 2011	9:47:14
31	470373.249	56410.436	12.1	25 Sept, 2011	9:48:31
32	470398.249	56415.243	12.1	25 Sept, 2011	9:49:48
33	470423.249	56420.05	12.1	25 Sept, 2011	9:51:05
34	470448.249	56424.856	12.01	25 Sept, 2011	9:52:22
35	470473.249	56429.663	12	25 Sept, 2011	9:53:39
36	470498.249	56434.47	12.26	25 Sept, 2011	9:54:56
37	470523.249	56439.277	12.52	25 Sept, 2011	9:56:13
38	470548.249	56444.084	12.78	25 Sept, 2011	9:57:30
39	470573.249	56448.891	13.03	25 Sept, 2011	9:58:47
40	470598.249	56453.698	13.87	25 Sept, 2011	10:00:04
41	470623.249	56458.504	14.2	25 Sept, 2011	10:01:21
42	470648.249	56463.311	14.12	25 Sept, 2011	10:02:38
43	470673.249	56468.118	14.1	25 Sept, 2011	10:03:55
44	470698.249	56472.925	13.84	25 Sept, 2011	10:05:12
45	470723.249	56477.732	13.25	25 Sept, 2011	10:06:29
46	470748.249	56482.539	13.2	25 Sept, 2011	10:07:46
47	470773.249	56487.346	13.79	25 Sept, 2011	10:09:03
48	470798.249	56492.152	13.59	25 Sept, 2011	10:10:20
49	470823.249	56496.959	13.26	25 Sept, 2011	10:11:37
50	470848.249	56501.766	11.16	25 Sept, 2011	10:12:54
51	470872.46	56506.421	8.33	25 Sept, 2011	10:14:11
52	470897.01	56511.143	6.24	25 Sept, 2011	10:15:28
53	470921.56	56515.865	3.55	25 Sept, 2011	10:16:45

Table 2: Post-Dredge Sounding

Figure 3 below shows the general view of the online dredging system integrated with Global Positioning System (GPS) and Dredge Pack Presentation System.

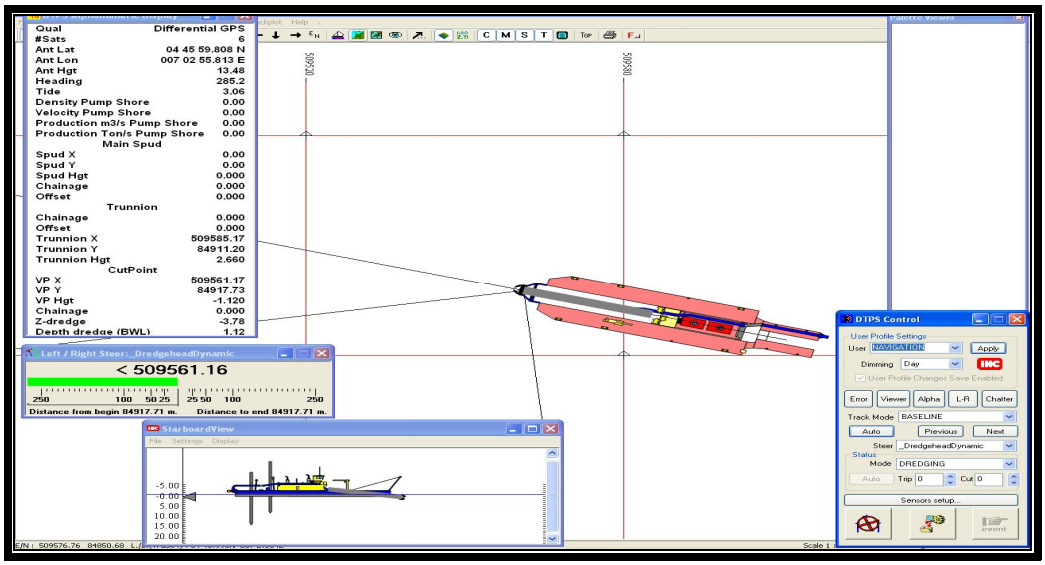

Figure 3: General View of the Online Dredging System

Table 3 below shows the volume computation data of dredged materials along the pipeline route. It further shows the distances of 25m interval, Trench width of 30m, natural elevation, Bottom of ditch, excarvation depth, slope ratio, area covered in square metres and the volume of erthwork involved per area. The total area covered was 14747.79 square metres and the volume of earthwork removed was 367165 cubic metres.

Table 3: Volume Computation of the Earthwork Materials Dredged

VOLUME COMPUTATION FOR SAN BATHOLOMEW PIPELINE RIVER CROSSING

NCTL | SAN BARTH cover=75mm | 15/ 08/ 2011

EQUIPMENT NAME?

Distance Bend	Trench Width	Natural Elevation	Bottom of Ditch	Excavation Depth	Slope 1:x	Area sqm	Volume cbm
0	30	-1.20	-2.28	1.08	1	21.20	0
25	30	-1.20	-3.13	1.93	1	61.62	1,035
25	30	-1.29	-5.25	3.96	1	134.48	2,451
25	30	-1.59	-8.63	7.04	1	260.76	4,941
25	30	-4.26	-13.12	8.86	1	344.30	7,563
25	30	-7.50	-16.97	9.47	1	373.78	8,976
25	30	-13.45	-19.54	6.09	1	219.79	7,420
25	30	-14.36	-20.96	6.60	1	241.56	5,767
25	30	-14.36	-21.30	6.94	1	256.36	6,224
25	30	-14.03	-21.28	7.25	1	270.06	6,580
25	30	-13.67	-20.98	7.31	1	272.74	6,785
25	30	-13.15	-20.99	7.84	1	296.67	7,118
25	30	-12.31	-19.29	6.98	1	258.12	6,935
25	30	-10.84	-18.35	7.51	1	281.70	6,748
25	30	-9.35	-17.46	8.11	1	309.07	7,385
25	30	-8.67	-16.63	7.96	1	302.16	7,640
25	30	-8.25	-15.86	7.61	1	286.21	7,355
25	30	-7.83	-15.13	7.30	1	272.29	6,981
25	30	-6.99	-14.47	7.48	1	280.35	6,908
25	30	-5.96	-13.86	7.90	1	299.41	7,247
25	30	-4.99	-13.30	8.31	1	318.36	7,722
25	30	-4.52	-12.79	8.27	1	316.49	7,936
25	30	-4.21	-12.35	8.14	1	310.46	7,837
25	30	-3.90	-11.95	8.05	1	306.30	7,710
25	30	-3.61	-11.61	8.00	1	304.00	7,629
25	30	-3.43	-11.32	7.89	1	298.95	7,537
25	30	-3.28	-11.10	7.82	1	295.75	7,434
25	30	-3.07	-10.92	7.85	1	297.12	7,411
25	30	-2.86	-10.80	7.94	1	301.24	7,480
25	30	-2.64	-10.73	8.09	1	308.15	7,617
25	30	-2.43	-10.72	8.29	1	317.42	7,820
25	30	-2.24	-10.76	8.52	1	328.19	8,070
25	30	-2.09	-10.86	8.77	1	340.01	8,353
25	30	-1.87	-11.01	9.14	1	357.74	8,722
25	30	-1.61	-11.21	9.60	1	380.16	9,224
25	30	-1.61	-11.48	9.87	1	393.52	9,671
25	30	-1.98	-11.83	9.85	1	392.52	9,826
25	30	-2.60	-12.27	9.67	1	383.61	9,702
25	30	-3.12	-12.80	9.68	1	384.10	9,596
25	30	-3.62	-13.18	9.56	1	378.19	9,529
25	30	-4.13	-13.02	8.89	1	345.73	9,049
25	30	-4.56	-12.62	8.06	1	306.76	8,156
25	30	-4.61	-12.29	7.68	1	289.38	7,452
25	30	-4.74	-12.06	7.32	1	273.18	7,032
25	30	-5.02	-11.91	6.89	1	254.17	6,592
25	30	-5.13	-11.82	6.69	1	245.46	6,245
25	30	-4.93	-11.77	6.84	1	251.99	6,218
25	30	-4.65	-11.41	6.76	1	248.50	6,256
25	30	-4.25	-9.92	5.67	1	202.25	5,634
25	30	-2.16	-7.27	5.11	1	179.41	4,771
25	30	0.76	-4.36	5.12	1	179.81	4,490
25	30	0.76	-2.68	3.44	1	115.03	3,686
25	30	0.76	-2.30	3.06	1	101.16	2,703
1300						14,747.79	367,165

CONCLUSION

The use of digital equipment and methods in modern day dredging has demonstrated the efficacy and high accuracy of data of the dredging information system to the delight of decision makers and decision making processes more especially the Civil Engineers, Structuctural Engineers and Builders to mention but a few.

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