The facilitation economical dredging using Stema Systems Silas sub-bottom profiling for the seismic investigation of sand aggregates in the Maas river

Introduction

Problem description

In order to enable the most cost efficient dredging it was decided to execute a seismic site investigation to gauge the occurrence and distribution of sand aggregates in the Maas river, between Arcen and Venlo. Thus allowing the dredging party to best plan and execute according to the findings.

The major purpose of this investigation was to investigate the location of claydeposits as this information was used for volume calculations resulting in the economical dredgeable sand and gravel deposits.

Site description

Environment
The investigated area is located in the Maas river between Venlo and Arcen in the Netherlands, at a water depth of about 4 to 5 meter.

Geology
At the top of the river bed Holocene river deposits occur with clay and sands. In investigated area often 1-2 m thick clay lenses occurs, which could prevent economical dredging of underlying sand and gravel deposits.

At many locations underneath the top of the river bed older Pleistocene glacial meltwater deposits are found. These deposits consist of clay, peat, sand, gravel and loam and have partly been reworked by river transport. These layers can have a large inclination and show large scale foreset or folding structures. The overall setting is that of a very irregular depositional relief with merely sand and gravel and intermixed clay lenses.

Methodology

In order to perform the most accurate investigating and analysis of the results of the riverbed Stema Systems decided to use its own developed Silas EBP-10 transceiver system incorporating a high resolution seismics with a 5 kHz frequency source array.
The full signal of EBP – 10 array was recorded using the Silas software package and positioning

The investigation was complemented by superimposing the results of numerous boreholes made possible by employing the Silas Site software thus allowing both seismic and borehole datasets to be combined.

The full signal was recorded using the afore mentioned software package and positioning was carried out using Stema Systems 960 RTK and Qinsy survey software.

The 5 kHz was decided to be the best frequency which would be able to penetrate several meters of sand and gravel while providing accurate resolution to map all clay lenses.
In order to obtain accurate riverbed elevation data it was decided to carry out Multibeam measurements simultaneously.
The survey was carried out using a small vessel.

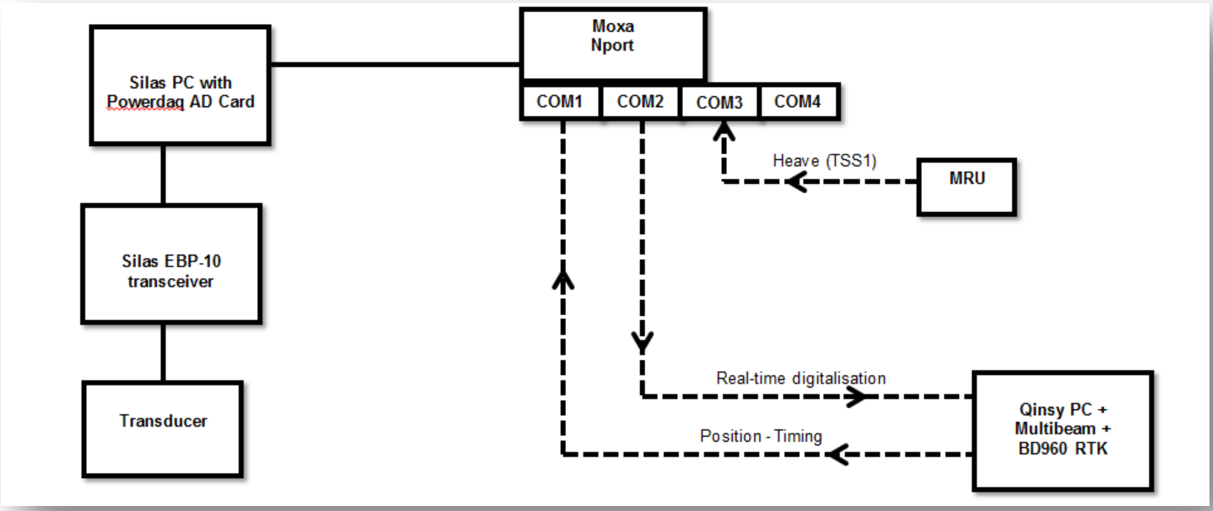

Fig. 1:The specifically Stema Systems designed system setup (schematically)

Results

After completion of the seismic survey the seismic data was combined in the Silas Site processing program with all available borehole data (fig. 5) resulting in a highly accurate mapping of the clay lenses (fig 6),

The Stema Systems EBP-10 system being accurate enough to further detect the other sediment types present in the area in an highly accurate manner. The system not only detected clay layers, but also the distribution and thickness of sand layers (see fig. 7a, 7b)

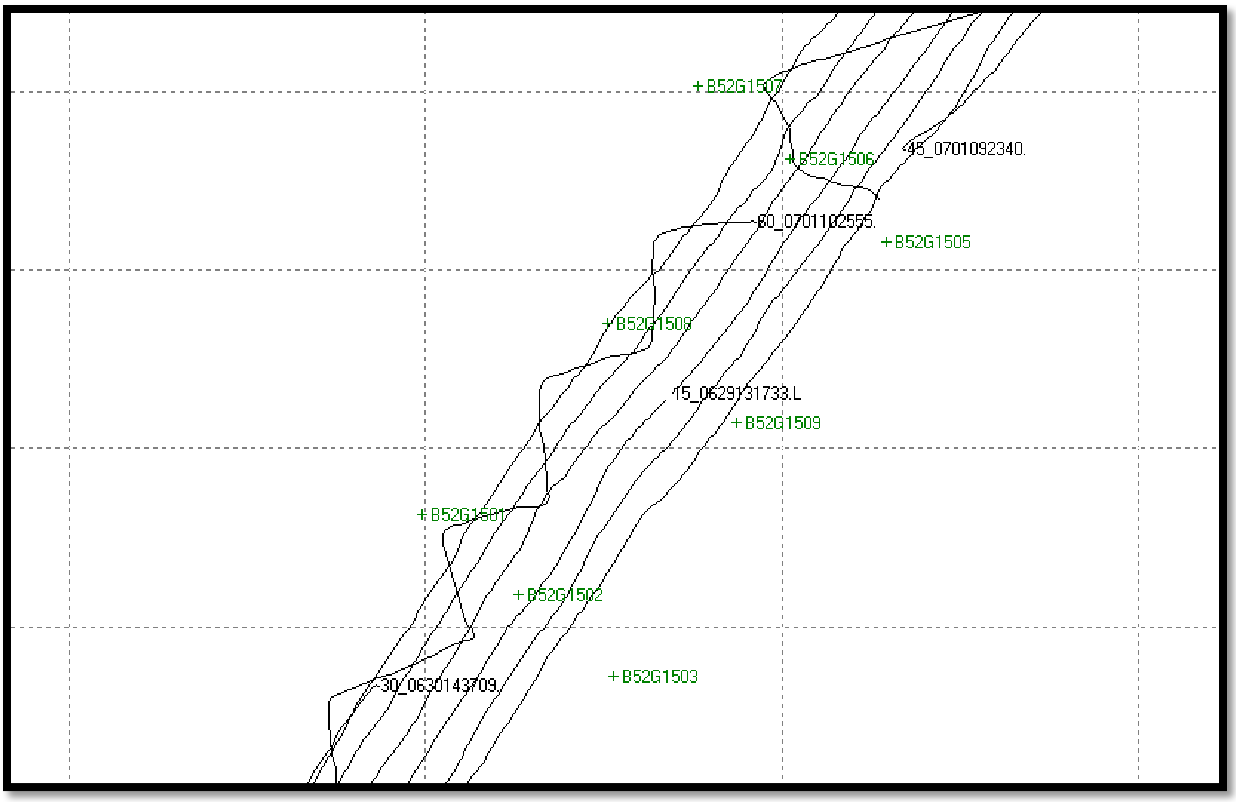

Fig. 5 Plan view example of map with integrated boreholes and seismic in part of investigated area. Green crosses with code: borehole locations with code.

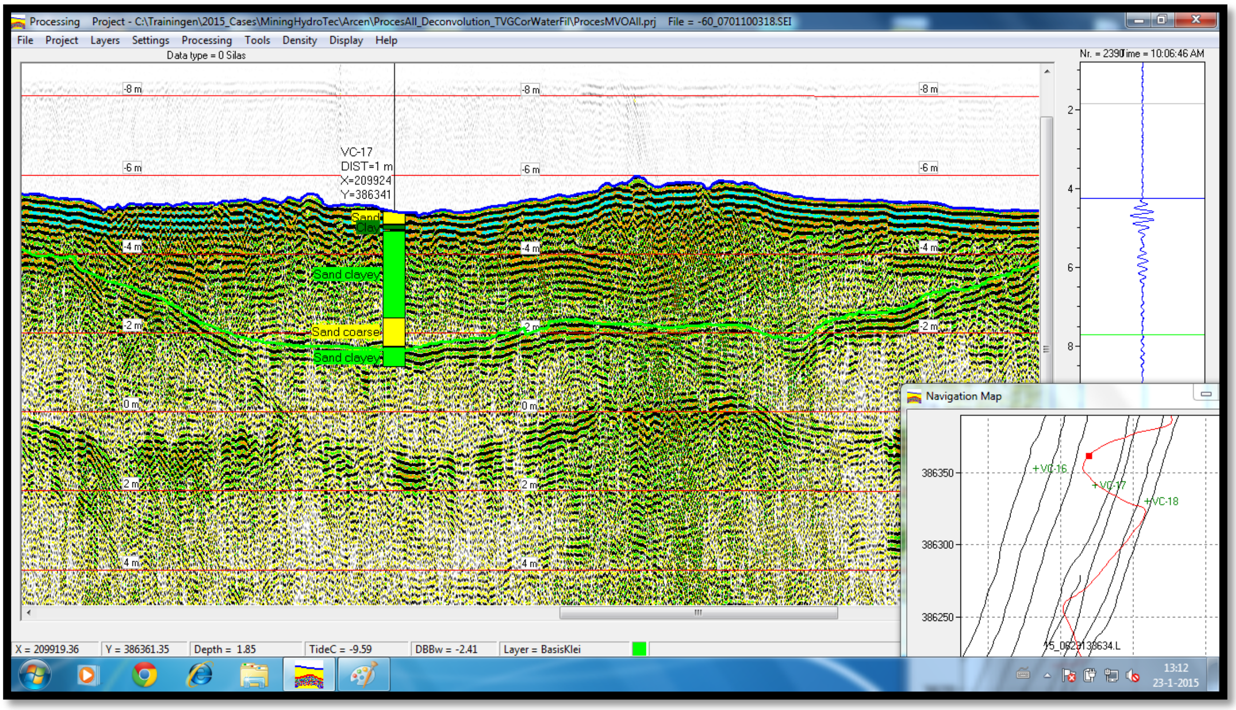

Fig.6 : example of correlation of borehole data (Vibrocore VC-17) and 5 kHz seismic data.This allowed mapping of the base of a clayey sand layer (green line). Inset: Plan view location of lines and boreholes as shown by Silas processing program. Redline in inset: activated seismic line).

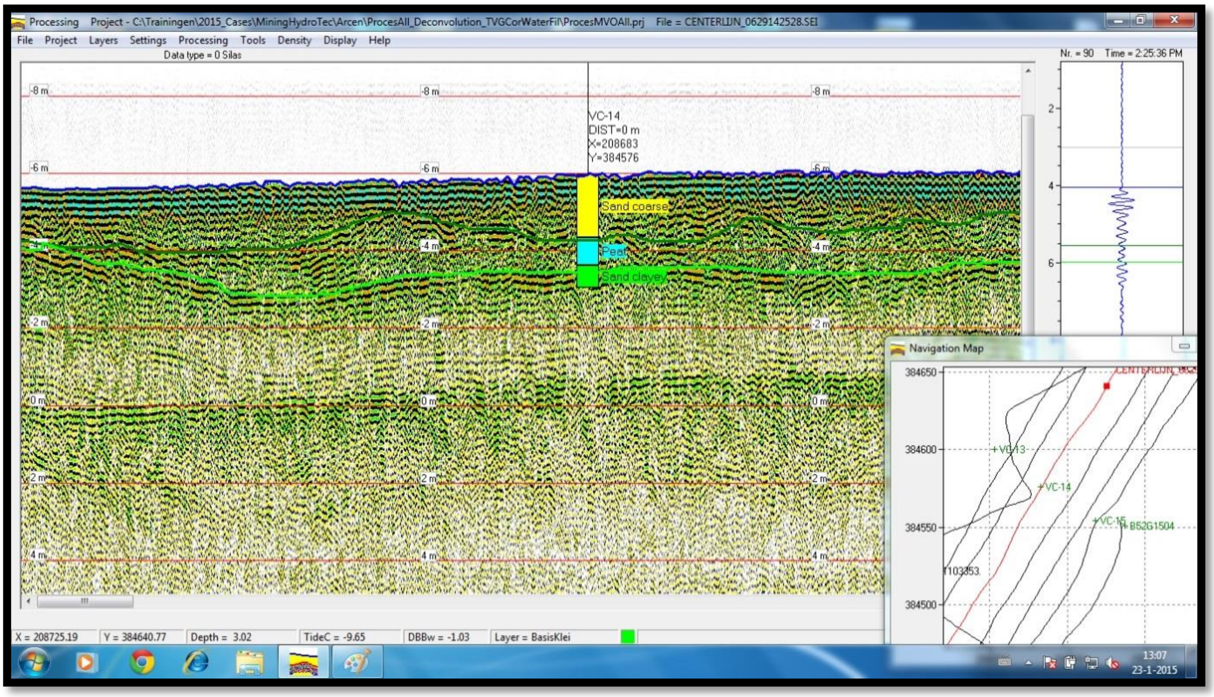

Fig.7a : example of correlation of borehole data (Vibrocore VC-14) and 5 kHz seismic data. This allowed mapping of the base of a sand layer (dark green line) and the base of a clayey peat layer (light green line).. Inset: Plan view location of lines and boreholes as shown by Silas processing program.

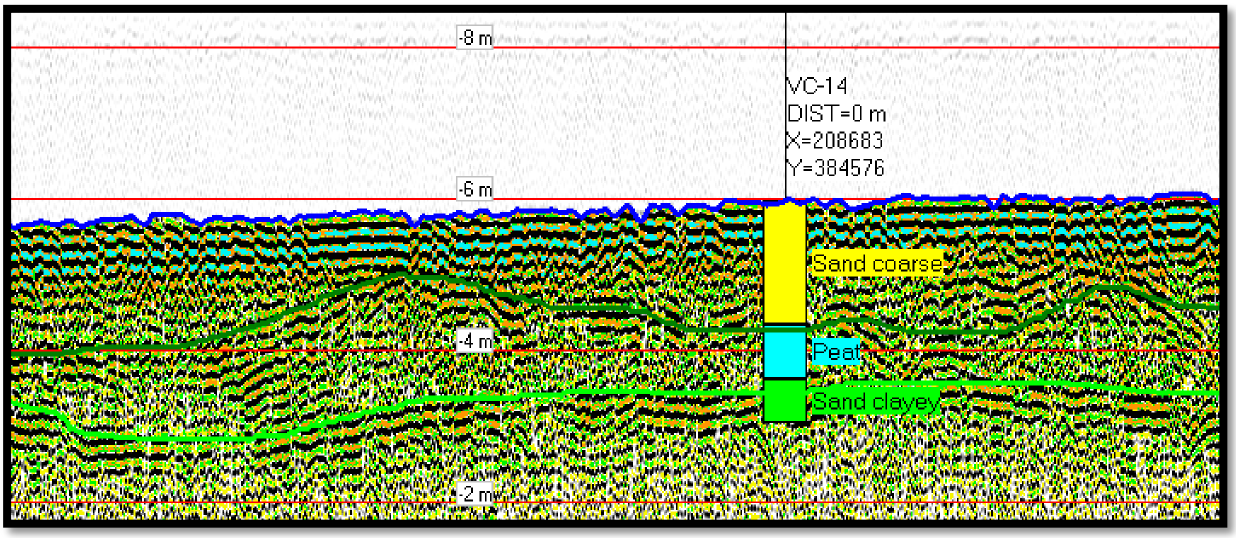

Fig.7b (Enlargement of fig 7 a) : example of correlation of borehole data (Vibrocore VC-14) and 5 kHz seismic data.This allowed mapping of the base of a sand layer (dark green line) and the base of a clayey peat layer (light green line).

As can be seen in figure 8 in the northern part of the area the clay lenses gradually grade into an alternation of sand and clay layers, which are often inclined and show large scale “foreset” structures. In figure 9 the base of coarser gravel deposits was also detected by the EBP-10 system which are located in the northern part of the area.

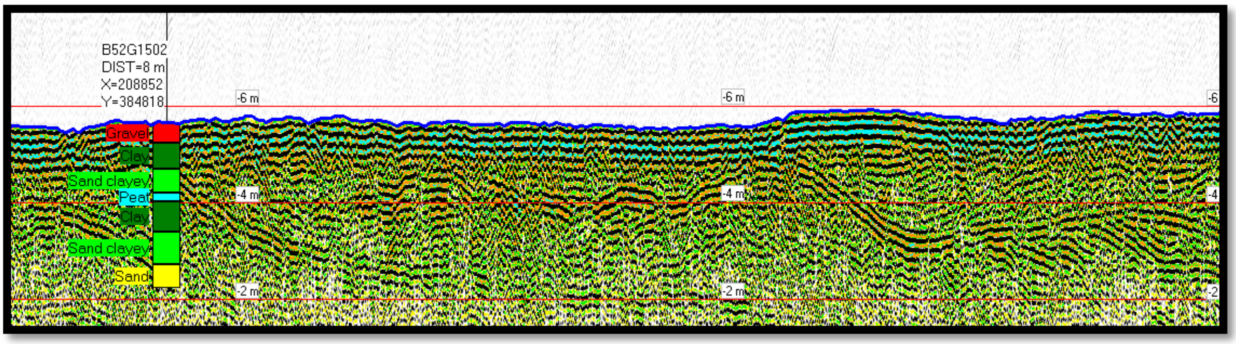

Fig.8 : example of correlation of borehole data (Vibrocore B52G1502) and 5 kHz seismic data showing inclined sand claylayers with large scale “foreset” structures.

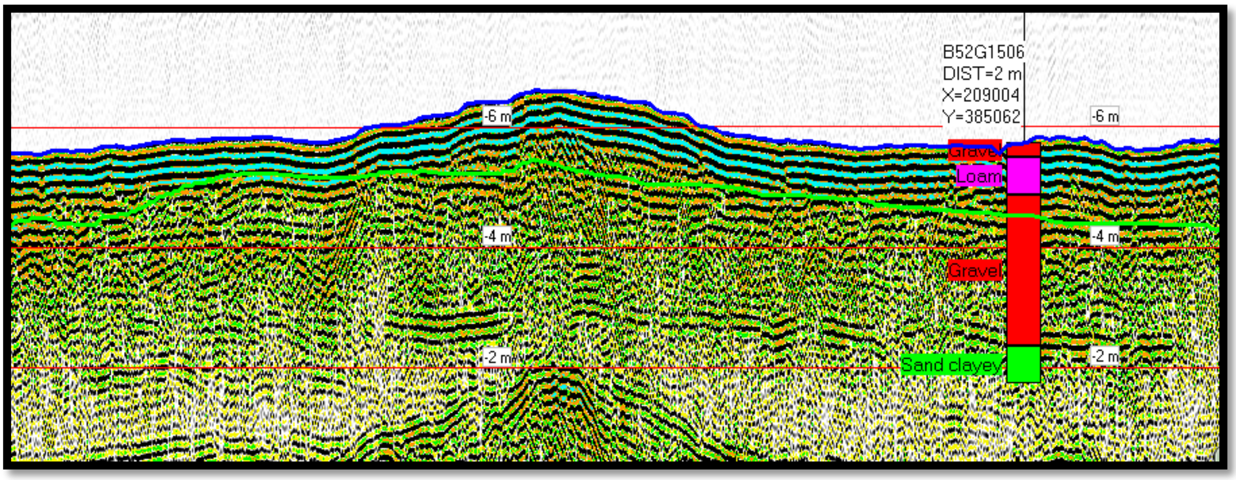

Fig.9 : example of correlation of borehole data (Vibrocore B52G1506) and 5 kHz seismic data.This allowed mapping of the base of a loam layer (light green line) and the base of a deeper gravel layer (not interpreted,see correlation of reflectors with borehole) .

Combining all the above mentioned data it enabled the surveyors to obtain a highly detailed distribution model of clay lenses in the area was analysed as illustrated in figure 10a & 10b. in order to base their conclusions and further actions on

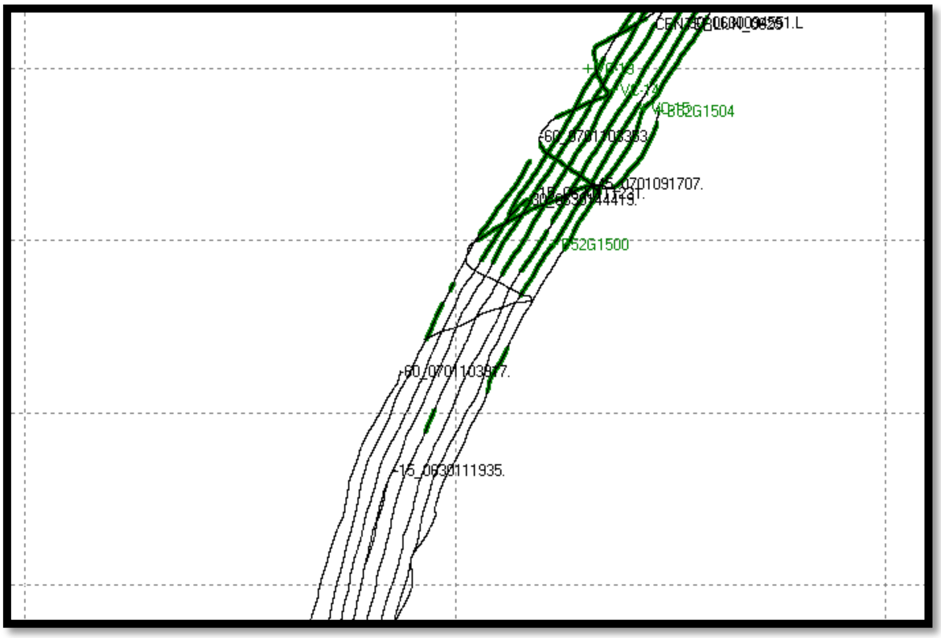

Fig. 10a Example map of distribution of clay lenses in part of investigated area. Black: investigated lines. Green: Location of clay lenses.

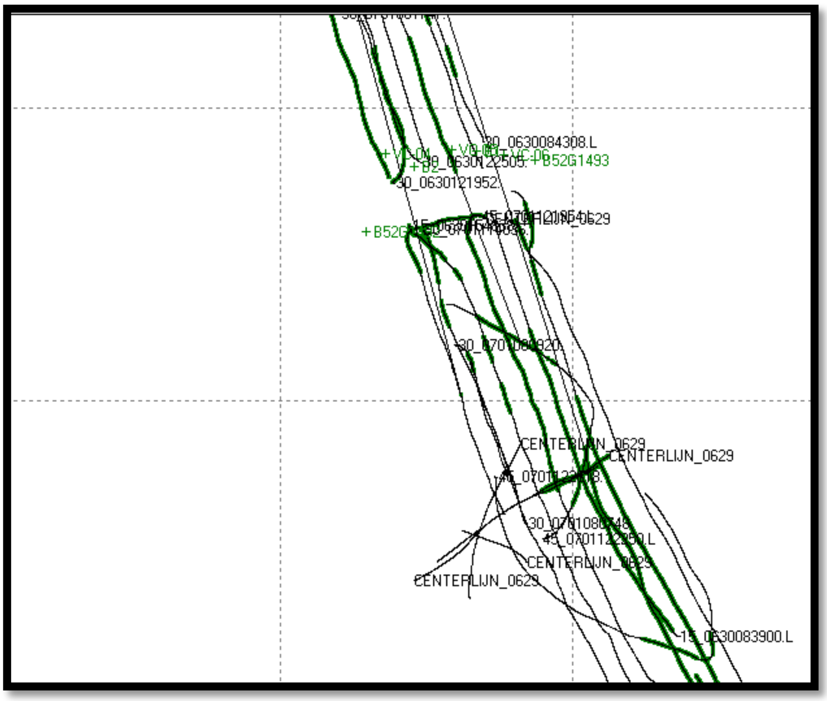

Fig. 10b Example map of distribution of clay lenses in part of investigated area. Black: investigated lines. Green: Location of clay lenses.

A further benefit of the mentioned surveying methodology is that during the mapping the depth of the top and base of each clay lenses was also accurately mapped and made available for other programs after export to ASCII using the Silas processing program.

Lastly a benefit of this methodology was that older borehole results were used easily due to the chart datum projection option of the borehole module. In this way older deposits which are no longer present (now projected in the watercolumn) were able to be discounted

Conclusion

As can be seen from the results provided above it is the conclusion of the author that the application of the Silas Site module successfully integrated borehole results and seismic which provided a survey that the dredging party could base its action plan on resulting in a more efficient use of both resources and time, by quick identification of the sub-bottom profile verified and complimented by the borehole sample taken previously.

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