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From : John Adrichem / Gerrit v.d. Zwaag, FEBV

Project No. : N4371/02

Subject : **Additional Burial Assessment Analysis MARS Cable Route**

1. PURPOSE AND SCOPE

In addition to the burial assessment analysis as presented in Fugro report No. 0304J001, Fugro was requested by Monterey Bay Aquarium Research Institute (MBARI) to provide a summary of estimates of total buried versus exposed cable for the MARS cable route.

The MARS project consists of a single submarine fiber optic cable route tied to the end of an offshore pipeline, at a water depth of 17.5 meters, located to the north of MBARI facilities off Moss Landing (Monterey Bay, California). From the end of the pipeline, the route extends towards the northwest, to the north of the Monterey Canyon, and along the continental margin out to the proposed location of an observatory node on the southeastern part of the Smooth Ridge feature, at a water depth of 891 meters. The total route length of the system is approximately 51 kilometers.

The engineering study scope of work presented in this fax is as follows:

- Review of geotechnical data and predicted burial depths as presented in Fugro report No. 0304J001
- Review of data geophysical survey as presented in Fugro report No. 0304J001
- Assessment of total buried versus exposed cable for the MARS cable route.

2. DATA SOURCE INSPECTION

The available data included but was not limited to the following:

- 31 Mini Cone Tests performed in 2003 along the MARS route
- Additional cone penetration tests (of which 37 along MARS route) and push samples (4) performed in 1999 for the Southern Cross Fiber Optic Cable route
- Interpretations of side-scan sonar imagery and subbottom profiler data, as incorporated on the alignment sheets (RPL Final Rev. D 2-20-04)
- Bathymetric data, provided by MBARI, as incorporated on alignment sheets.

This report summarizes and uses selected information, where appropriate.

3. BURIAL ASSESSMENT

In order to obtain a more detailed assessment of burial feasibility along the MARS route, additional analyses were performed on cone penetration test results from the Southern Cross Fiber Optic Cable route survey. Together with the burial analysis results for the MCT locations, presented in Appendix H of Fugro report No. 0304J001, this provided a relatively dense grid of data points where maximum burial depth could be estimated. For methods and procedures, reference is made to the main text and Appendix G of above report.

This extra information, combined with the available side-scan sonar, subbottom profiler and bathymetric data, provided a basis on which it was possible to make a reasonably accurate estimate of total buried versus exposed cable for the MARS cable route.

Table 1 presents CPT results of the Southern Cross Fiber Optic Cable route survey, including the expected maximum burial depth. A target burial depth of 1.0 m was assumed.



TABLE 1
CPTS SOUTHERN CROSS FIBER OPTIC CABLE ROUTE

Location	Latitude	Longitude	Soil Description	CPT Depth [m]	Expected Max. Burial [m]
MCI-CPT035	36°47.6007N	122°11.8853W	0.00 clay, sandy, very soft to soft -0.72 silt, sandy, medium dense to loose	-2.10	1.0
MCI-CPT036	36°47.7808N	122°11.6305W	0.00 clay, stiff to very stiff, locally weekly cemented	-2.10	0.1
MCI-CPT037	36°47.9637N	122°11.4015W	0.00 clay, stiff to very stiff, refusal at bottom	-1.67	0.5
MCI-CPT038	36°48.1494N	122°11.1542W	0.00 clay, hard, refusal at bottom	-1.96	0.1
MCI-CPT039	36°48.3344N	122°10.9246W	0.00 clay, very stiff to hard, refusal at bottom	-1.53	0.1
MCI-CPT040	36°48.5266N	122°10.6679W	0.00 clay, hard to very hard, refusal at bottom	-1.22	0.1
MCI-CPT041	36°48.7386N	122°10.4744W	0.00 clay, very stiff to hard, refusal at bottom	-0.88	0.1
MCI-CPT042	36°48.9879N	122°10.3397W	0.00 silt, very loose -0.18 clay, stiff to hard, refusal at bottom	-1.05	0.2
MCI-CPT043	36°49.2431N	122°10.2133W	0.00 clay, firm to very stiff, refusal at bottom	-1.59	0.4
MCI-CPT044	36°49.4948N	122°10.0843W	0.00 clay, stiff becoming very hard, refusal at bottom	-1.27	0.4
MCI-CPT045	36°49.6650N	122°09.8337W	0.00 clay, firm to stiff, refusal at bottom	-1.96	0.7
MCI-CPT046	36°49.8175N	122°09.5626W	0.00 clay, very soft -0.11 clay, hard, refusal at bottom	-0.71	0.1
MCI-CPT047	36°49.9776N	122°09.2854W	0.00 silt, soft becoming stiff refusal at bottom	-0.55	0.4
MCI-CPT048	36°50.1329N	122°09.0113W	0.00 clay, very hard, at top very soft, cemented, refusal at bottom	-0.45	0.1
MCI-CPT049	36°50.2838N	122°08.7341W	0.00 rock	-0.16	0.05
MCI-CPT050	36°50.4412N	122°08.4600W	0.00 rock	-0.16	0.05
MCI-CPT051	36°50.5941N	122°08.1845W	0.00 silt, very loose -0.33 sand, very dense, refusal at bottom	-1.42	0.4
MCI-CPT052	36°50.7352N	122°07.9024W	0.00 silt, very loose -0.17 rock	-0.43	0.2
MCI-CPT053	36°50.8658N	122°07.6046W	0.00 silt, very loose -0.26 sand, very dense, refusal at bottom	-0.58	0.3
MCI-CPT054	36°50.9907N	122°07.3066W	0.00 silt, very loose -0.14 rock	-0.33	0.15
MCI-CPT055	36°51.1149N	122°07.0057W	0.00 silt, very loose -0.19 sand, very dense, refusal at bottom	-0.44	0.25
MCI-CPT056	36°51.2444N	122°06.7097W	0.00 silt, very soft locally slightly cemented -0.77 sand, silty, medium dense becoming very dense, refusal at bottom	-1.53	0.8
MCI-CPT057	36°51.3743N	122°06.4131W	0.00 clay, sandy, very soft -0.22 clay, hard, refusal at bottom	-0.48	0.2



TABLE 1 (cont.)
CPTS SOUTHERN CROSS FIBER OPTIC CABLE ROUTE

MCI-CPT058	36°51.4814N	122°06.1120W	0.00 clay, sandy, very soft -0.88 clay, very hard, refusal at bottom	-1.10	0.85
MCI-CPT059	36°51.6051N	122°05.8157W	0.00 clay, sandy, very soft -1.04 sand, medium dense, refusal at bottom	-1.42	1.0
MCI-CPT060	36°51.7325N	122°05.5226W	0.00 clay, sandy, very soft, locally slightly cemented -1.01 clay, very hard, refusal at bottom	-1.39	1.0
MCI-CPT061	36°51.8895N	122°05.2828W	0.00 clay, sandy, very soft, with sand seams, locally slightly cemented -1.68 sand, medium dense to dense	-2.17	1.0
MCI-CPT062	36°52.0354N	122°04.9459W	0.00 clay, sandy, very soft, with some sand seams, locally slightly cemented	-2.20	1.0
MCI-CPT063	36°52.1831N	122°04.6784W	0.00 clay, sandy, very soft, locally slightly cemented	-2.15	1.0
MCI-CPT064	36°52.3336N	122°04.3897W	0.00 clay, sandy, very soft	-2.16	1.0
MCI-CPT065	36°52.4699N	122°04.1009W	0.00 clay, sandy, very soft	-2.17	1.0
MCI-CPT066	36°52.6257N	122°03.8314W	0.00 clay, sandy, very soft, locally slightly cemented	-2.16	1.0
MCI-CPT067	36°52.7753N	122°03.5432W	0.00 silt, sandy, very soft, locally slightly cemented	-2.16	1.0
MCI-CPT068	36°52.9070N	122°03.2455W	0.00 silt, sandy, very soft, locally slightly cemented	-2.17	1.0
MCI-CPT069	36°53.0680N	122°02.9872W	0.00 silt, sandy, very soft, locally slightly cemented	-2.15	1.0
MCI-CPT070	36°53.2120N	122°02.6840W	0.00 silt, sandy, very soft, locally slightly cemented	-2.17	1.0
MCI-CPT071	36°53.3674N	122°02.4101W	0.00 silt, sandy, very soft, locally slightly cemented	-2.15	1.0

In general it can be said that, starting from the easternmost location, full burial is expected between MCI-CPT071 and MCI-CPT059. Between locations MCI-CPT058 and MCI-CPT056, partial burial is expected, ranging between 0.2 m and 0.85 m. Subsequently the soil becomes even harder and the CPT results indicate that between MCI-CPT055 and MCI-CPT036, for the greater part no or very limited burial should be expected (0.2 m or less). Locally, partial burial will be possible, up to about 0.7 m (MCI-CPT045). West of location MCI-CPT036, softer soils are encountered again and at MCI-CPT035 full burial is predicted.

4. RESULTS

After combining above analyses with the burial feasibility results for the MCT locations and the available results of the geophysical survey as presented in Fugro report No. 0304J001, a detailed summary could be made of total buried versus exposed cable. Table 2 presents the expected burial feasibility (full, partial or no burial) correlated to KPs along the MARS route.

In most areas it was possible to determine the transition between full/partial/no burial reasonably accurately. Still, caution should be exerted when interpreting the results, since they are for a greater part based on point measurements and subsoil characteristics are expected to vary significantly along the MARS route. The subbottom profiler results remain fairly indecisive, especially in the area of difficulty between KP 30 and KP 42. The availability of RHOBAS or GAMBAS data would have probably made the current analysis easier. Around KP 30 and KP 42 the transition point could only be roughly predicted.



TABLE 2
SUMMARY RESULTS

KP	Soil Type	Burial	Comments
0.0 to 6.2	Loose to medium dense sand	Full	Possibly dense/coarse sand encountered between KP 0.8 – 1.6.
6.2 to 15.25	Very soft to soft clay	Full	Soft clay may not provide sufficient protection, a deeper target burial depth is advisable. Risk of plow sinkage.
15.25 to ±30	Very soft to firm clay	Full	Locally patches of sand/harder clay. Soft clay may not provide sufficient protection, a deeper target burial depth is advisable. Risk of plow sinkage.
±30 to 31.7	Very soft clay over very dense sand	Partial	Locally no burial may be achieved because of rock outcrops.
31.7 to 40.6	Very stiff to hard clay/rock	No	Rock outcrops. Very locally some burial may be achieved up to 0.7 m, possibly more. Risk of plow damage due to high angle slopes.
40.6 to ±42	Soft to very stiff clay, weakly cemented	Partial	Locally no burial may be achieved because of rock outcrops.
±42 to 51	Very soft to firm clay	Full	Risk of plow sinkage.

According to Table 2, total lengths of buried, partially buried and not buried sections would be as follows:

- Full burial (1.0 m) : 39 kilometers
- Partial burial (0.1 - 1.0 m): 3.1 kilometers
- No or very limited burial (<0.2 m): 8.9 kilometers

5. CLOSURE

We trust that this report meets your requirements. Please do not hesitate to contact us should you have any questions.

Best regards,

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