TGS GEOPHYSICAL COMPANY (UK), LTD.

PROJECT SUMMARY

for

Environmental Authorization Application to the EPA for Offshore 2D Seismic, Multibeam and Coring Acquisition Survey

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Project Title

TGS Guyana Offshore 2D Seismic, Multibeam, and Coring Acquisition Survey

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Date: June 7, 2017

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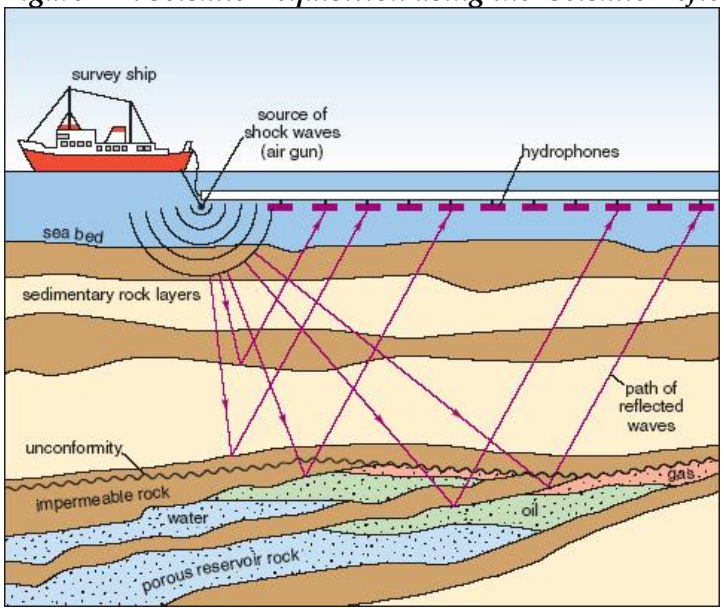
1. Non-technical Explanation of the Project

TGS is planning to conduct a reconnaissance survey offshore Guyana, including a seismic, multibeam and coring acquisition campaign surveys. The purpose of the Project is to acquire and process, a grid of 2D seismic data and 3D bathymetric data that creates a regional framework for geophysical and geological analysis. The surface cores taken over the project area will provide geochemical measurements for hydrocarbon systems and basin modelling.

Seismic surveys are routinely used in offshore oil and gas exploration activities worldwide to detect and define geological structures under the seabed. Marine seismic data acquisition is based on the principle of 'seismic reflection'. The method involves releasing pulses of acoustic energy (i.e., sound waves[1]) at regular intervals along designated transect lines. In general, the energy penetrates subsurface formations and is reflected back to the surface where it can be detected by acoustic receivers, or hydrophones, encased in a long cable (i.e., streamer), which is towed behind the seismic vessel as shown in Figure 1-2.

Figure 1-1: Seismic Acquisition using the 'Seismic Reflection' Method

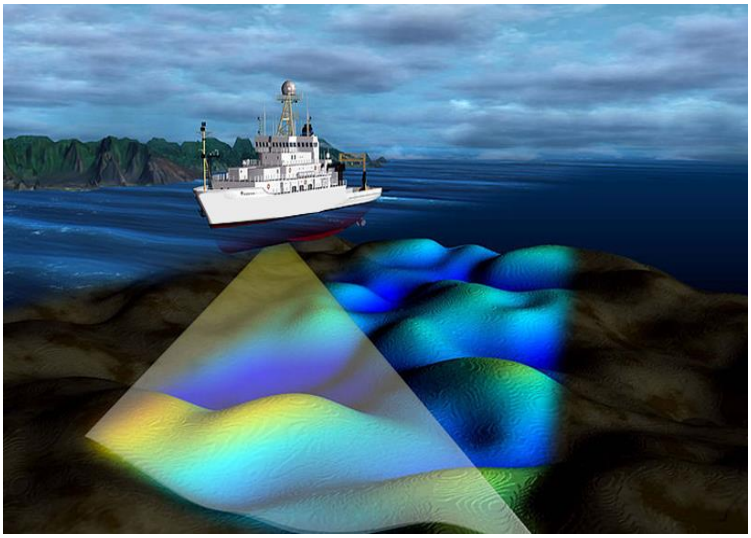


Source: EPA's Web Archive. Accessed, April 2017 at https://archive.epa.gov/esd/archive-geophysics/web/html/marine_seismic_methods.html).

Each time a seismic pulse meets a change in rock properties; part of the pulse is reflected back to the surface and received by the hydrophones. Consequently, by measuring precisely the difference in arrival time of reflected seismic energy, distinct subsurface rock layers can be identified, and subsequently mapped.

A multibeam echosounder is a type of sonar that is used to map the seabed. Like other sonar systems, multibeam systems emit sound waves in a fan shape beneath a ship's hull. The amount of time it takes for the sound waves to bounce off the seabed and return to a receiver is used to determine water depth. In a multibeam survey, data is used to produce three-dimensional (3D) bathymetric maps of the sea floor.

Figure 1-2: Collecting Multibeam Data



Source: Public domain image courtesy of NOAA National Ocean Service

Coring is favored as a subsequent sampling method after completion of a multibeam sonar survey when exploring a new area where little is known of the seabed geology. The piston corer is a long, heavy tube plunged into the seafloor from 6 to 20 meters to extract samples of mud sediment as shown in Figure 1-3.

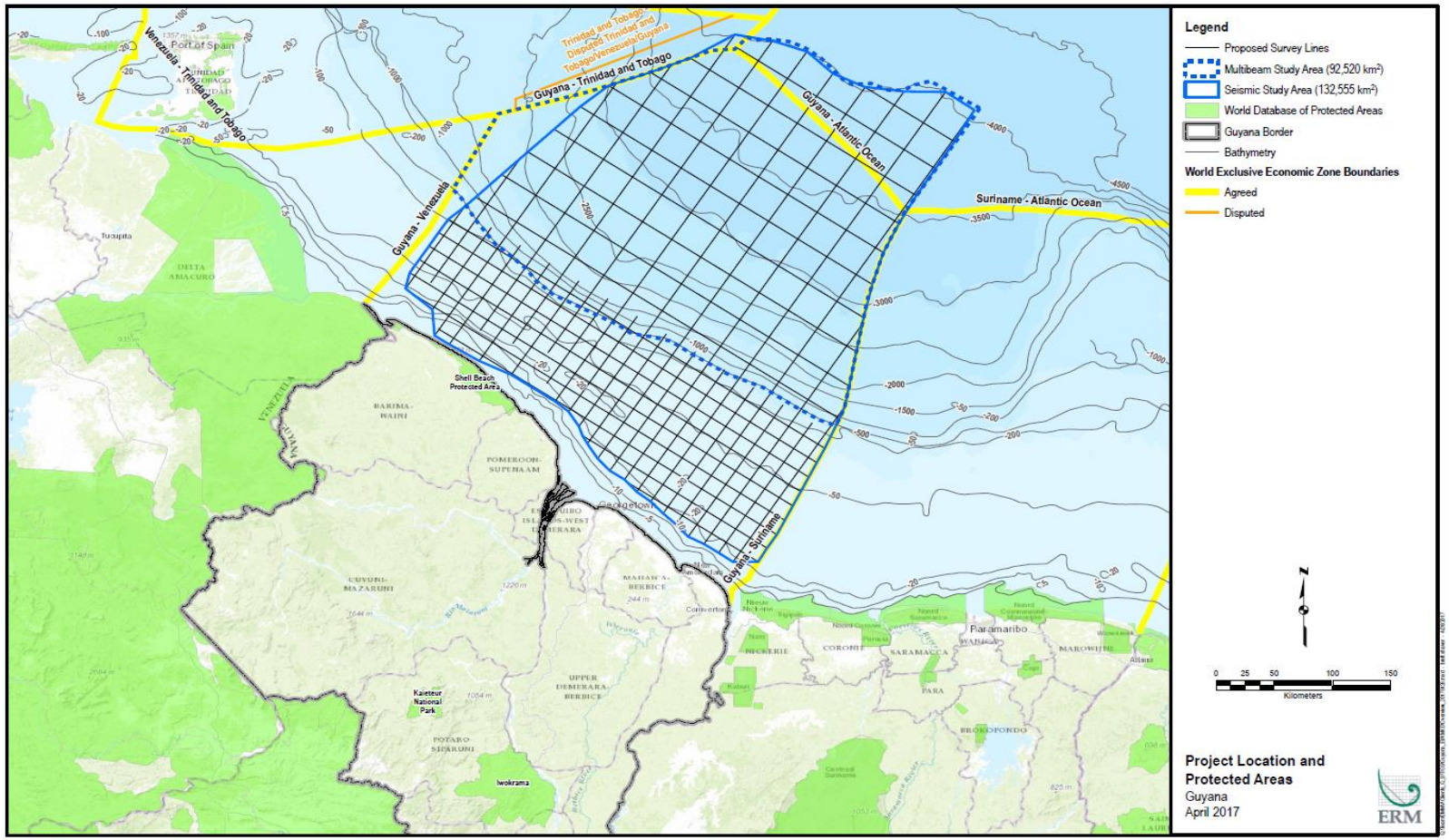
Figure 1-3: Piston Core Sampling

Source: TGS, 2017

2. Description of Project Site

The Project is located in the Atlantic Ocean, off the coast of Guyana, within the Guyana Exclusive Economic Zone (EZZ), and extending into international waters. The closest point to shore is approximately 3.5 km offshore Guyana. The project comprises 2D Seismic, Multibeam and Coring Acquisition Surveys. The 2D seismic survey area is 132,555 square kilometers (km²) whereas the multibeam and coring area is approximately 92,430 km² as shown in Figure 1-4. Appendix A provides the coordinates of the acquisition surveys.

Figure 2-1: Location of the Project



3. Project Design

The Project will conduct a reconnaissance survey offshore Guyana, including a seismic, multibeam and coring acquisition campaign surveys. The purpose of the Project is to acquire and process a grid of 2D and 3D data that creates a regional framework for geophysical and geological analysis. The surface cores taken over the project area will provide geochemical measurements for hydrocarbon systems and basin modelling.
The scope of the Project comprises two phases: a preparatory phase and an operational phase.

Phase 1: Preparatory Phase Activities

This phase includes the following:

- Design and develop the technical specifications of the seismic, multibeam, and coring survey programs;
- Define the study area;
- Develop the Project Terms of Reference;
- Conduct the Environmental Impact Assessment;
- Obtain relevant permits and authorizations by competent authorities; and
- Compile and procurement of equipment and material necessary for the Project.

Phase 2: Operational Phase

During this phase, the following activities will take place:

- Mobilization of the Project vessels to the survey area;
- Deployment of the towed equipment;
- 2D seismic, multibeam data acquisition;
- Coring acquisition;
- Demobilization of vessels; and
- Data processing.

3.1 Source of Water and Power

The Project will be conducted entirely offshore, with the vessels coming to port only for resupply of provisions, crew changes and refueling operations. The Project will therefore not require access to basic services available onshore, or onshore facilities/infrastructure as all basic service needs will be provided onboard the Project vessels.

Water will be acquired onshore and undergo treatment by way of a water treatment system, and stored in a potable water storage tank. The desalinization systems are able to create fresh water at rates of 8 m^3 per day. Additionally, all Project's vessel will be supplied with bottled water for human consumption. Energy required for operations will be provided by way of fuel and generators on board the Project vessels.

3.2 Waste Management

Waste generated during the Project´s operations will comprise of:

- Non-hazardous solid wastes, which include domestic food waste and general refuse (e.g., packaging materials, paper/ plastic bags and containers); and
- Hazardous wastes, which include solvent, thinner, spent lubrication oil, hydraulic fluids, fluid, oily rags, lithium batteries, slop oil and oil contaminated materials (e.g., containers used to store lubricating fluids).

Vessels will comply with International Conventions (MARPOL 73/78 Annex V regulations) which require that a waste management plan will be developed and implemented, and waste volumes, types and disposal routes will be recorded. As such all hazardous wastes will be stored in the vessels and dispose at authorized onshore facilities. Discharge to the sea is prohibited.

All solid waste will be separated, compacted when possible, and stored aboard until they can be disposed of properly at the next landing port. Food waste can be discharged into the sea after passing through a process of milling or grinding, at a minimum distance of 12 nautical miles from the coast. However, when possible, food wastes will be transported to the port and brought onshore to be managed by authorized local companies.

Additionally, some materials can be reused on the vessels or recycled onshore, these are:

- Cooking oil;
- Glass;
- Aluminum cans;
- Paper, corrugated cardboard;
- Wood;
- Metals; and
- Plastic.

A waste management plan will be developed and waste volumes, types and disposal routes will be recorded in accordance with International Convention (MARPOL 73/78 Appendix V).Tables presenting the amount of wastes estimated to be produced for each one of the Project vessels and its disposal method are presented in Appendix B.

3.2.1. Vessel Discharges into the Marine Environment

The principal effluents generated by the Project's vessels will comprise:

- Grey water from sanitary effluent (e.g., wash water and laundry discharges);
- Treated black water (e.g., treated sewage effluent);
- Drainage water (e.g., bilge water and machinery spaces drainage); and
- Service water / vessel engine cooling water.

Estimated discharge of black and grey water is presented in Table 3-1.

Table 3-1: Estimated Discharges into the Marine Environment

Seismic Vessel	*Operating days on Project*	*Persons on board*	*Maximum Daily Black water discharge (liters) for total Project duration*	*Maximum Daily Grey water discharge (liters) for total Project duration*
TBD	150	35-40	7500	600,000
Multibeam Vessel	**Operating days on Project**	**Persons on board**	**Maximum Daily Black water discharge (liters)**	**Maximum Daily Grey water discharge (liters)**
TBD	63	35	800	4,000
Coring Vessel	*Operating days on Project*	*Persons on board*	*Maximum Daily Black water discharge (liters)*	*Maximum Daily Grey water discharge (liters)*
TBD	70	30	5,760	3,840

Source: TGS, 2017

The Project vessels will comply with the requirements of MARPOL 73/78 with respect to treatment prior to discharge. The grey and black waters that are generated during the Project will be treated with a primary adaptation, chlorination and dechlorinating treatment system. The treated effluent can be discharged at sea, as is the practice of ocean vessels, at a minimum distance of 12 nautical miles (nm) from shore; or can be contained and discharged in appropriate facilities onshore.

4. Employment by the Project:

Preliminary workforce estimates are provided in Table 4-. Given the nature of the highly specialized work, most of the workforce will be foreign. Some positions may be filled with local workforce if properly trained, such as Marine Mammal Observers (MMOs) or Passive Acoustic Monitoring (PAM) operators.

Table 4-1: Workforce Estimates by Project Component

Project Component	Estimated Workforce
Seismic	40-45
Multibeam	35
Coring	30

Source: TGS, 2017

5. Project Duration:

Seismic acquisition is estimated to take approximately 5 months and is expected to start in September granted permit is in place. Once the data has been collected, it will be transferred to a data processing center and processed. Processing is expected to take approximately 10 months from receipt of all data from the field.

Multibeam acquisition is expected to take 9 weeks. Coring would normally start at approximately 3-4 weeks after multibeam acquisition has begun and expected to take 10 weeks. Once cores are collected, the geochemical analyses will take approximately one month from the day samples arrive at the analysis facility. Therefore, the time window of the entire multibeam and coring acquisition surveys is estimated to be from September 2017 until January 2018 (provided that the required permissions and permits are in place).

6. Potential Effects on the Environment & Mitigation Plans

The Project will have the potential to affect air quality, seawater quality, marine wildlife, and marine navigation, as briefly described below.

6.1. Air Quality

The principal sources of air emissions will be exhaust gases from the survey- - vessels.
The mitigations measures will include:

- Regularly maintain and monitor equipment;
- Economic cruising speed to be used whenever possible to reduce fuel consumption;
- Minimize idling of equipment; and
- No hazardous materials to be incinerated.

6.2 Seawater Quality

In order to minimize the potential effects to seawater quality, TGS will comply with International Conventions (MARPOL 73/78) with respect to vessel discharges. The following

measures will be included:

- Sewage will be held onboard for appropriate disposal at onshore facilities.
- If appropriate facilities do not exist, treated sewage may be discharged to sea at a distance greater than 12 nm from the coast, in-line with MARPOL requirements.
- No discharge of solid waste to the sea will be permitted and hazardous waste will be stored in a secure manner.
- Food wastes will be discharged directly to the sea following maceration. All food waste will be macerated to less than 25 mm (in accordance with MARPOL specifications) prior to discharge.

6.3 Marine Wildlife - Fish, Birds, Turtles and Mammals

There are a number of Project operations that may potentially impact marine wildlife such as fish, birds, turtles and mammals. These operations include maneuvers during transit to and from the survey area, deployment of the seismic survey equipment, sound associated with acoustic energy sources utilized in the survey, and movement of the survey vessel. Mitigation measures will include: slow speed of the vessels during operations, use of a chase vessel usually positioned several kilometers ahead, use of PAM systems during periods of poor visibility and/or darkness, soft start and ramp up procedure and trained , trained Marine Mammal Observers (MMO) on vessels.

6.3.1 Physical Presence of Seismic Vessel

Marine mammals and other pelagic species are typically able to move away from the source of disturbance, and are expected to return to the area once activities are completed. Nevertheless, the following mitigation measures are proposed: liaise with the Maritime Administration of Guyana to ensure that all local, national and international maritime users are warned of the survey and can avoid the area.

6.3.2 Lighting

Bright lights used on the survey and supply boats at night can disturb and disorientate pelagic seabirds feeding in the area. Fish and squid may be attracted to the lights where they can be more easily preyed upon by other fish and by seabirds. Illumination also poses the risk to disorientate and disturb sea turtle migration to nesting areas.

To minimize these potential impacts, lights will be down-shielded where practicable, and the overall lighting, particularly that shining directly down onto the water will be decreased to the extent possible, without adversely affecting maritime or operational safety.

6.3.3. Noise

Operation of the vessels used to conduct the surveys and operation of various vessel-based equipment (e.g., generators, winches, cranes) will have the potential to generate noise above and below the surface of the water. The most significant source of sub-surface noise will be the seismic source. The main issues of concern with respect to underwater noise generated by the acoustic energy source are:

- Potential for injury or disturbance, leading to behavioral changes, to marine organisms as a result of the exposure to high sound levels or the associated pressure pulsations;

- Interference with echolocation pulses used by certain marine mammals for location of prey and other objects; and

- Interference with marine mammal communication.

In order to minimize the potential effects to marine organisms due to sound, TGS would implement the JNCC Guidelines for Minimizing Disturbance to Marine Mammals from Seismic Surveys. This includes a watch time, soft-start and ramp-up procedures for acoustic energy sources, trained Marine Mammal Observers (MMO) on seismic vessel, use of Passive Acoustic Monitoring (PAM), and pre- established safety radius.

6.4 Marine Navigation

Disturbance of shipping routes and traffic may result from the survey operations. The mitigations measures the project will implement are as follows:

- Inform local authorities (including the Port Authority) about planned maritime traffic increase, survey location, and associated safety measures to be utilized;

- Communication with, and notification to, the coastal authorities; if other sea users are present within the immediate survey area;

- In line with the International Convention for the Safety of Life at Sea (SOLAS) and other international best practices, the Project will implement an exclusion zone[2], using chase vessels to watch for and ward off vessels in the vicinity, to ensure the safety of Project and nearby vessels navigating in the vicinity of the seismic acquisition activities;

- Hydrophone strings shall not be deployed until other sea users have been notified and have moved away from the survey exclusion zone; and

- Display the internationally-recognized signals for "towing in progress on the seismic vessel".

[2] Exclusion zone of 5 km from the bow of the seismic vessel, 5 km from the very end of the streamer/tail buoy and 5 km either side (starboard and port)the entire length of the cable.

Appendix A
Project Coordinates

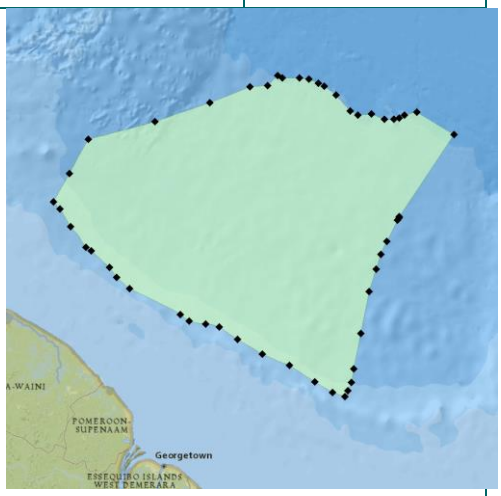
Table 2: Seismic Survey Coordinates wgs 84 Zone 21N

Point#	Latitude	Longitude	Point#	Latitude	Longitude
1	-57.1171	6.3653	39	-57.4532	10.6185
2	-57.2285	6.4427	40	-57.1012	10.8160
3	-57.3427	6.5161	41	-56.8069	10.7640
4	-57.4640	6.5787	42	-56.5383	10.6735
5	-57.5590	6.6811	43	-56.3339	10.4877
6	-57.6599	6.7745	44	-56.0897	10.3750
7	-57.7565	6.8745	45	-55.7789	10.3338
8	-57.8649	6.9566	46	-55.4530	10.3285
9	-57.9600	7.0590	47	-55.2277	10.1742
10	-58.0737	7.1333	48	-55.3849	9.9088
11	-58.1683	7.2365	49	-55.5354	9.6823
12	-58.2489	7.3609	50	-55.6856	9.4557
13	-58.2863	7.4286	51	-55.82160	9.2197
14	-58.3155	7.5067	52	-55.9434	8.9744
15	-58.3956	7.6321	53	-56.0315	8.7068
16	-58.5015	7.7176	54	-56.0996	8.4260
17	-58.8434	7.9404	55	-56.1103	8.3718
18	-59.0925	8.0562	56	-56.1565	8.1378
19	-59.3267	8.1948	57	-56.2134	7.8497
20	-59.4414	8.2678	58	-56.2479	7.6753
21	-59.4594	8.4883	59	-56.2891	7.5741
22	-59.669	8.6645	60	-56.4044	7.3248
23	-59.6380	8.7962	61	-56.4665	7.2031
24	-59.5636	8.9097	62	-56.5285	7.0813
25	-59.4891	9.0233	63	-56.5905	6.9596
26	-59.4146	9.1368	64	-56.6524	6.8378
27	-59.3401	9.2503	65	-56.7144	6.7161
28	-59.2174	9.3529	66	-56.7771	6.5949
29	-59.1286	9.4370	67	-56.8524	6.4820
30	-58.9254	9.6292	68	-56.9224	6.3656
31	-58.7847	9.7621			
32	-58.7221	9.8213			
33	-58.5185	10.0133			
34	-58.3146	10.2052			
35	-58.0918	10.3849			
36	-58.0318	10.4053			
37	-57.7643	10.4964			
38	-57.6003	10.5607			

Source: TGS, 2017

Table 3: Multibeam Survey Coordinates WGS 84 Zone 21N

Point #	Latitude	Longitude	Point#	Latitude	Longitude
1	534900.3743	1189237.5476	39	602721.0542	950036.2033
2	545854.1462	1184792.53870	40	593542.4805	902842.0081
3	552362.9092	1181300.0317	41	585681.1637	862487.8653
4	565562.7143	1171139.0307	42	582735.9383	847446.1832
5	581414.2173	1153677.4765	43	578638.4339	837809.3599
6	589827.9841	1149073.7173	44	575243.3809	830960.6523
7	605209.6521	1150099.6453	45	561445.6059	835916.0798
8	620202.2115	1143950.7123	46	541578.2105	847723.8193
9	630785.5660	1143993.7071	47	512788.1093	866390.3371
10	636950.3700	1145776.3409	48	482145.6666	879105.4178
11	643009.3405	1148756.2167	49	454388.8932	895929.0316
12	656503.1175	1152248.7236	50	433586.3227	909664.3129
13	698831.1982	1126866.3338	51	418737.4974	913407.0730
14	399897.2096	916583.0804			
15	389893.5411	923960.0434			
16	332741.1825	953173.4623			
17	317938.0614	966064.7337			
18	310064.6929	976828.8521			
19	289510.1613	995402.5294			
20	283561.2049	999637.7534			
21	265885.4502	1023302.3577			
22	254139.0605	1042958.4318			
23	246853.8973	1051219.3869			
24	264501.7661	1083198.3482			
25	285801.3665	1121791.2986			
26	361487.8706	1141794.6709			
27	423001.2104	1163000.49360			
28	468623.1090	1181029.4841			
29	488434.3668	1182071.1592			
30	499762.3175	1193267.9683			
31	505010.3353	1190600.1545			
32	523994.2274	1190798.5924			
33	636501.6506	1033161.5099			
34	637064.6185	1034435.2335			
35	634449.6908	1030633.6659			
36	622929.0927	1006595.3490			
37	616037.2491	991854.8147			
38	610577.5661	975028.7212			



Source: TGS, 2017

The exact number of coring locations for the Guyana survey has not yet been determined. The results of the multibeam and backscatter will help determine the number and locations of the cores.

Appendix B Estimated Waste Generation & Disposal Method

Table 3: Seismic Vessel Estimated Type of Waste Generation

Monthly Waste Generation and Method of Disposal			
Waste Type	*Sub Category*	*Generated during one month (cubic meters)*	*Disposal Method*
Plastic		2	Discharge to shore facilities
Food waste		2.5	To sea under Marpol 73/78 Appendix V regulations
Domestic waste	Paper	2	Incineration/Discharge to shore facilities
	Metal Cans	1	Discharge to shore facilities
	Glass	0.5	Discharge to shore facilities
	Tetrapack	0.5	Discharge to shore facilities
Cooking Oil		0.02	Discharge to shore facilities
Incinerator Ashes		0.05	Discharge to shore facilities
Operational waste	Oily rags, filters, contaminated by paint cans, brushes, rollers and rags	1	Discharge to shore facilities
	Lamps (including fluorescent)	0.05	Discharge to shore facilities
	Batteries	0.01	Discharge to shore facilities
	Metal	1	Discharge to shore facilities
	Wood	0.5	Discharge to shore facilities
	Cartridges	0.02	Discharge to shore facilities
	Expiring medicines	Less 0.01	Discharge to shore facilities

Source: TGS, 2017

Table4:Multibeam Vessel Estimated Waste Generation

Type of Waste	*Subcategory*	*Estimated Quantity*	*Disposal Method*
Non Hazardous	Food Waste	0.28 m^3 / month	To sea under Marpol 73/78 Appendix V regulations
	Household Waste	0.82 m^3 / month	Discharge to shore facilities
	Non-recyclable plastic and bottles	4 m^3 / month	Discharge to shore facilities
	Cardboard / Paper	1.64 m^3 / month	Incineration/Discharge to shore facilities
	Scrap metal	7.92 kg	Discharge to shore facilities
	Rags	n/a	Discharge to shore facilities
Hazardous or special	Used oil	0.28 m^3 / month	Discharge to shore facilities
	Chemicals (solvents, thinners)	0 liters / month	Discharge to shore facilities
	Filters	2 / month	Discharge to shore facilities
	Batteries and paint buckets	100 batteries every 3 month. 1 paint can per month	Discharge to shore facilities
	Fluorescent lamps	1 unit every 3 months	Discharge to shore facilities
	Isopar-M (kerosene)	0 liters / month	Discharge to shore facilities
	Spray Cans	1 can every 3 months	Discharge to shore facilities
	Cartridges	2 units per month	Discharge to shore facilities

Source: TGS, 2017

Table 5: Coring Vessel Estimated Waste Generation

Type of Waste	*Subcategory*	*Estimated Quantity*	*Disposal Method*
Non Hazardous	Food Waste	0.28 m^3 / month	To sea under Marpol 73/78 Appendix V regulations
	Household Waste	0.82 m^3 / month	Discharge to shore facilities
	Non-recyclable plastic and bottles	4 m^3 / month	Discharge to shore facilities
	Cardboard / Paper	1.64 m^3 / month	Incineration/Discharge to shore facilities
	Scrap metal	7.92 kg	Discharge to shore facilities
	Rags	n/a	Discharge to shore facilities
Hazardous or special	Used oil	0.28 m^3/ month	Discharge to shore facilities
	Chemicals (solvents, thinners)	38 liters / month	Discharge to shore facilities
	Filters	Oil: 35 / month Water: 12 / month Air: 6 / m0nth	Discharge to shore facilities
	Batteries and paint buckets	100 batteries every 3rd month. 10 paint cans per month	Discharge to shore facilities
	Fluorescent lamps	5 units per month	Discharge to shore facilities
	Isopar-M (kerosene)	0 liters per month	Discharge to shore facilities
	Spray Cans	5 cans per month	Discharge to shore facilities
	Cartridges	5 units per month	Discharge to shore facilities

Source: TGS, 2017