

**REPUBLIC OF IVORY COAST
TRAFIGURA BEHEER BV**

ABIDJAN

Environmental audit pursuant to
clause 2.2 of the protocol agreement
signed on 13/02/07 between the Parties, the State
of Ivory Coast and Trafigura

Dumping sites on the Alépé Road, commune of Abobo
Phase 2 (paragraphs 1 to 4) - Supplementary investigations
Phase 3 (paragraph 5) - recommendations for rehabilitation

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Phase 2 - Alépé Road sites

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1 - Summary of the aims of the investigations planned

The course to be followed by the Audit and its methodological nature were laid down following various discussions between the representatives of the Parties, namely Trafigura and the State of Ivory Coast. The environmental Audit was thus divided into three phases:

Phase 1: Gathering of the existing data and preparation of a plan for supplementary investigations

Phase 2: Supplementary investigations on the dumping sites

Phase 3: Defining of supplementary depollution work

The first phase took place from the month of May to the month of June 2007 and was the subject of a provisional report Rie00014/1.19002 dated 07/06/2007. This report is currently being updated to include the observations made by the two Parties' experts.

At the meeting to review the first phase which was held in Paris on 6 July 2007, the two Parties expressed a wish to amend the course to be followed by the follow-up of the Audit by making action on the two sites on the Alépé Road in the commune of Abobo a priority; an assignment to take samples for analyses was carried out from 16 to 23 July (falling within the framework of phase 2). A summary of the results obtained and of the recommendations for supplementary depollution work (falling within the framework of phase 3) appears in paragraph 5 of the present report.

2 – Phase 2: Plan for taking of samples of soil, water and atmospheric air

The aim of the sampling carried out was to give an overview of the sites which had been the subject of digging out to find out whether all the ground affected by the slopes dumped had been dug out. In the event of there being a residue of ground affected and in the light of the results of the analyses carried out in the laboratory, the Audit would need to define a supplementary plan of action the aim of which would be to make the sites safe from both the health and environmental points of view.

The grid in which the sampling points were laid out was defined in the light of the topography of the existing soils and from verbal information supplied by the representatives of BNETD and CIAPOL on the extent of the work carried out by TREDI. The samples sent to the laboratory were all packaged in bottles suitable for the types of analyses required and provided by the laboratory itself.

A sampling plan was drawn up at the time of the detailed inspection of the two sites on 17 July 2007. It was finalised and approved by the representatives of the two Parties on the morning of the 18th before the soil investigations began. This plan was followed or improved on in the light of the observations made when the on-site work was being done.

	Site No. 1 South on Alépé Road	Site No. 2 North on Alépé Road	Total
Soil samples	6	8	14
Samples of sediments from ditches or streams	-	7	7
Samples of groundwater	-	2	2
Samples of surface water	-	3	3
Samples of atmospheric air	-	2	1
Blank samples transport (water)	-	-	1

Plans of the layouts of the sampling points are shown in Figs. 1 and 2

DJIBI = DJIBI
 Zone de déversement = Dumping zone
 Source = Spring
 Emergence AEP = Point of emergence to supply drinking water
 Fossé d'écoulement aérien ... = Ditch for overhead flow from the spring
 BASSIN = BASIN
 Djibi amount = Djibi, upstream
 S 10 (échantillon moyen ... = S10 (average combined sample of the sampling points)
 Source captée = Spring water collected
 Canalisation PVC = PVC pipe
 Ruisseau = Stream
 Buse = Culvert
 S 14: Buse aval route = Culvert, downstream of road
 Habitation = Dwelling
 S 13: Ruisseau = S 13: Stream
 ROUTE D'ALEPE = ALEPE ROAD
 S 20: Buse amont route = S 20: Culvert, upstream of road
 S 11: Fossé de débordement amont = S 11: Storm ditch, upstream
 S 12: Fossé de débordement aval = S 12: Storm ditch, downstream
 fossé = Ditch
 Djibi aval = Djibi, downstream
 Piste = Track
 Prélèvement d'air atmosphérique ... = Sampling of atmospheric air, ALEPE 2 (2 hours)
 Clôture interdisant ... = Fence preventing access to the site
 LEGENDE = KEY ◇ Sampling point for soil
 △ Sampling point for sediment
 → Direction of flow of water
 ○ Sampling point for surface water and groundwater
 □ Sampling point for atmospheric air

<i>BURGEAP</i>	LAYOUT PLAN OF INVESTIGATIONS ON A LEVEL WITH AND DOWNSTREAM OF ALEPE SITE NO.2	Figure 1 CEi070316
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Prélèvement d'air atmosphérique ... = Sampling of atmospheric air, ALEPE 1 (1 hour), ALEPE 1 (5 hours)
 Clôture interdisant ... = Fence preventing access to the site
 ROUTE D'ALEPE = ALEPE ROAD

LEGENDE = KEY

- → Gully erosion and direction of flow
- ◇ Sampling point for soil
- Sampling point for atmospheric air

<i>BURGEAP</i>	LAYOUT PLAN OF INVESTIGATIONS ON A LEVEL WITH ALEPE SITE NO.1	Figure 2 CEi070316
	Audit under the protocol agreement signed between the State of Ivory Coast and the Trafigura company PHASE 2	

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Sampling point for atmospheric air on the Alépé 1 site

Geological section showing the soil which was added by TREDI after the digging out (Alépé 2)
The red soil was added; the blackish soil contains patches of vegetable debris and forms the in situ
soil which was not dug out by TREDI.

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Making of bores by auger and taking of samples (Alépé 2)

Making of Drager colorimetric measurements off the sampling sites

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Sampling point for groundwater (Alépé spring)

Djibi blockage upstream of the Alépé Road

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Illustration of the appearance of the soil that had a characteristic smell of slops

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3 – Phase 2: Packing and transportation of samples to the analysing laboratory

The samples were packed in glass bottles which were supplied by the laboratory and which were suited to the tape and standard of analysis adopted. The sampling log sheets are appended to the report.

At the time of the sampling campaign, the weather was dry with a slight wind in the north-to-south direction; we noted that there was no significant precipitation during the week before the work.

Before any boring or digging work was done, when we were on a level with the zones which had been reached by the slops which were dumped, we were aware of a strong smell of garlic. This awareness became greater when we made the bores to take the samples, to the point where it became unpleasant at a depth of 1 or 2 m (bores S4, S5, S8 and S9) below the clean covering earth which had been added after the digging out done by TREDI. We feel that the soil in question had been reached by the dumping but had not been dug out, and had then been covered by one to two metres of clean earth as can be seen in the section which is shown in the photo on the preceding pages.

A single batch of water samples was made up for the laboratory and each sample was packed into three bottles (1 L and 2 x 250 mL).

Apart from the batches of samples of soil and sediment, which were packed in ice boxes and sent to the ITS laboratory in Holland by DHL, three other batches of specimens were taken from each sample:

- one batch packed in plastic bags for performing Drager colorimetric analyses (H₂S, petrol hydrocarbons and mercaptan),
- one batch packed in 250 gramme polypropylene tubs, which were kept in reserve in a refrigerator at CIAPOL,
- one batch packed in glass jars, which were handed over to CIAPOL and kept in reserve in CIAPOL's refrigerator.

Bearing in mind the conditions of transport by air and then by land by DHL and despite all the precautions which were taken when the samples were packed, 12 glass bottles containing water samples arrived at the laboratory broken as also did one tub containing a soil sample. The water analyses were able to be carried out on the following samples: Djibi, upstream; the stream; the Alépé spring and blank for transport. For follow-up investigations on the other sites, unbreakable bottles must be used.

Packing of samples with protection by polystyrene balls and refrigeration pack, with the assistance of technicians from BNETD, CIAPOL, Trafigura, court messenger and Burgeap

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4 – Phase 2: Results of the analyses

The samples which were the subject of colorimetric measurements in the head space did not show any positive results. Just to be sure, we took the analysis of 4 samples on beyond the volume of air laid down by the manufacturer by increasing the number of pump strokes (100 mL):

Sample no. (Alépé 2 site)	Compounds looked for	Standard number of strokes of Drager pump	Number of strokes of pump actually made	Result estimated by extrapolation
S5	Petrol hydrocarbons	5	20	0
S6	Petrol hydrocarbons	5	10	0
S7	Petrol hydrocarbons	5	10	0
S7	Mercaptan	5	10	0.25 ppm V

Sample S7 reacted for mercaptan with a very slight coloration, enabling a qualitative estimate to be made of the result by extrapolation.

The laboratory analyses which were planned are summarised in the table below

Compounds or elements	Method of analysis	Soil - Limit of detection	Water - Limit of detection
Dry matter		% m/m	
Hydrocarbons	GC-FID (C5-C10) and total hydrocarbons (C10-C40 mineral oils)	1 µg/Kg of dry matter and 50 µg/Kg of dry matter	50 µg/L
BTEX	GC-MS	0.1 mg/Kg of dry matter (benzene) and 0.2 mg/Kg of dry matter (other compounds)	0.1 µg/L (benzene) and 0.2 µg/L (other compounds)
PAH	GC-MS	0.01 mg/Kg of dry matter	0.01 µg/L
Pb, As, Cr, Cu, Cobalt	ICP-OES (soil, sediment) and GFAAS (water)	1 mg/Kg of dry matter	1 µg/L
Total sulphur and H ₂ S	(1) Photometric	1 and 0.1 mg/Kg of dry matter	100 µg/L
Mercaptan	GC	10 mg/Kg of dry matter	10 µg/L
pH	-	-	-

(1) When the concentration in the sample was greater than 10 mg/Kg of dry matter, an analysis was made by GC-MS to find ethyl-n-propyl disulphide, diethyl disulphide, disulphide bis, disulphide dipropyl and ethyl n-butyl disulphide.

The results of the analysis are shown in the following tables and confirmation and an interpretative commentary have been asked for from the quality officers at the laboratory (see appendix).

The water analyses were carried out on 4 bottles (Djibi, upstream; spring water collected, blank for transport, stream before joining the Djibi) which arrived at the laboratory in good condition. The results show the presence of metals in the form of traces well below the standards used for drinking water by the WHO, an absence of BTEX's, of mercaptan and of H₂S, a trace amount of 50 µg/L (the quantification threshold) of total dissolved hydrocarbons in one sample (surface water taken from the upstream Djibi, which is outside the zone affected by the dumping site).

The blank sample was formed by AWA mineral water.

The water which is collected from the spring, which is used as drinking water and for the domestic requirements of the dwelling, was free of pollutants; however its pH was low (4.1 to 4.5), which was probably to the nature of the soil containing the water resource, which is collected from the topographical drainage basin which is quite separate from the dumping site.

Test certificate shown here in the original is in English

Excerpt from schedule of water analyses

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Test certificate shown here in the original is in English

Excerpt from schedule of water analyses

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Results of the analyses of atmospheric air

Test report no.: UPA 07-00346-1

Massy,
09/08/2007

Project: BDC As 1985

Sample no.		07-053314-01	07-053314-01-1	07-053314-02
Designation of sample		ALEPE 2	ALEPE 2	ALEPE 1 BETWEEN 17 AND 18
		Measurement layer	Control layer	Measurement layer
Benzene $\mu\mu\mu$	$\mu\text{g abs}$	<0.05	<0.05	<0.05
Toluene $\mu\mu\mu$	$\mu\text{g abs}$	0.451	0.379	0.508
Ethyl benzene $\mu\mu\mu$	$\mu\text{g abs}$	<0.05	<0.05	<0.05
m-, p-xylene $\mu\mu\mu$	$\mu\text{g abs}$	<0.05	<0.05	<0.05
o-xylene $\mu\mu\mu$	$\mu\text{g abs}$	<0.05	<0.05	<0.05
Dimethyl sulphites $\mu\mu\mu$	$\mu\text{g abs}$	<0.05	<0.05	<0.05
Dimethyl disulphides $\mu\mu\mu$	$\mu\text{g abs}$	<0.05	<0.05	<0.05
C5-C12 hydrocarbons $\mu\mu\mu$	$\mu\text{g abs}$	<5	<5	<5

Sample no.		07-053314-02-01	07-053314-03	07-053314-03-01
Designation of sample		ALEPE 1 BETWEEN 17 AND 18	ALEPE 1 - 5 hours	ALEPE 1 - 5 hours
		Control layer	Measurement layer	Control layer
Benzene $\mu\mu\mu$	$\mu\text{g abs}$	<0.05	0.072	<0.05
Toluene $\mu\mu\mu$	$\mu\text{g abs}$	0.354	0.477	0.338
Ethyl benzene $\mu\mu\mu$	$\mu\text{g abs}$	<0.05	<0.05	<0.05
m-, p-xylene $\mu\mu\mu$	$\mu\text{g abs}$	<0.05	<0.05	<0.05
o-xylene $\mu\mu\mu$		<0.05	<0.05	<0.05
Dimethyl sulphites $\mu\mu\mu$	$\mu\text{g abs}$	<0.05	<0.05	<0.05
Dimethyl disulphides $\mu\mu\mu$	$\mu\text{g abs}$	<0.05	<0.05	<0.05
C5-C12 hydrocarbons $\mu\mu\mu$	$\mu\text{g abs}$	<5	<5	<5

Substances	Methods
Benzene	HS-GC/MS
Toluene	HS-GC/MS
Ethyl benzene	HS-GC/MS
m-, p-xylene	HS-GC/MS
o-xylene	HS-GC/MS
Dimethyl sulphites	HS-GC/MS
Dimethyl disulphides	HS-GC/MS
C5-C12 hydrocarbons	HS-GC/MS

The analyses of the soil samples carried out by INTERTEK show (a single bottle broken: sediment, upstream of culvert, Alépé 2):

- Cobalt is still below the detection threshold (1 mg/Kg)
- no BETX's
- no PAH's,
- traces of a few mg/Kg of heavy metals present systematically, even in the case of the control samples taken outside the zones affected by the dumping at the two sites,
- pH acid except in the case of sample S17 (Alépé 1),
- concentrations of 65, 130 and 56 mg/Kg respectively for total hydrocarbons (mineral oils) in the case of samples S13 (Alépé 2, sediment from stream being joining the Djibi), S17 (Alépé 1) and S8 (Alépé 2),
- traces of C5-C10 hydrocarbons at Alépé 1 (S17, S18) and Alépé 2 (S1 blank, S2 blank, S3 blank, S7, S12, S14, S9, S4, S8). *Intertek's analytical expert explained that "in conditions where temperatures are high, the majority of the light compounds of hydrocarbons evaporate and what remains is bio-degraded making oxygen present in the air in the ground. A year after the dumping, most of the hydrocarbon compounds had disappeared or evaporated."*
- the analyses of H2S by the photometric method after extraction with basic water and measurement of the colorimetric intensity did not reveal any traces; however, the black colour of certain samples meant that this technique did not perform very well. It was therefore supplemented by analyses of total sulphur (all the organic and inorganic sulphur compounds). The concentrations varied widely with some values exceeding 100 mg/Kg of dry matter at Alépé 2 (S5, S1, S7, S9, S12) and Alépé 1 (S16, S17). *Intertek's analytical expert explained that "a year after the dumping, the majority of the volatile sulphurous compounds have disappeared; in anaerobic conditions, these compounds would similarly have converted to FeS or FeS2 (pyrite) and the latter, if there is heavy rain, converts to sulphuric acid"*,
- mercaptan detected at Alépé 1 (S17 with 13.4 mg/Kg of dry matter, S18 with 11.8 mg/Kg of dry matter, S16 with 13.16 mg/Kg of dry matter) and Alépé 2 (S12 with 12.1 mg/Kg of dry matter, S13 with 11.2 mg/Kg of dry matter).

In view of the results obtained, the Auditor decided to have a confirmation analyses [sic] by another laboratory, EUROFINS, on an average sample made up of a mixture of the reserve samples removed with the smelliest bores from the Alépé 2 site: S4, S5, S8 and S9. The complete results of the analyses are attached as appendices and summarised in the following table:

Compound	unit	results	observation
Dry matter	%	88.4	
Iron	mg/Kg MS	9940	No VDSS's
Sulphur	mg/Kg MS	<5.6	
Soluble sulphite	mg/Kg MS	<5.6	
Soluble sulphate	mg/Kg MS	<20	
Hydrocarbons index		<15	C10-C40
C10-C12		0	
C12-C16		0	
C16-C20		0	
C20-C24		0	
C24-C28		0	
C28-C32		0	
C32-C36		0	
C36-C40		0	

Volatile hydrocarbons index		HS/GC/MS	
C5-C8	mg/Kg MS	<1	
C8-C10	mg/Kg MS	<1	
Mercaptans			
1-Butanthiol	mg/Kg MS	<0.1	
1-Propanthiol	mg/Kg MS	<0.1	
2-Butanthiol	mg/Kg MS	<0.1	
2-Methyl-1 Propanthiol	mg/Kg MS	<0.1	
2-Propanthiol	mg/Kg MS	<0.1	
Ethanthiol	mg/Kg MS	0.04	
Methanthiol	mg/Kg MS	0.04	
Volatile compound screening		(molecules sought: COHV, benzene derivatives, brominated halogenated derivatives)	
Diethyl disulphide	Sulphur compound		C4H10S2
Disulphide, ethyl 1 -methyl	Sulphur compound		C5H12S2
Semi-volatile compound screening		(molecules sought: Phenolic compounds, phthalates, PCBs, POC organochlorates, organophosphates, organic nitrogen compounds,...) : no compounds detected	

As an indication let us recall the reference values used in France which were established on the basis of the standards applied in the Netherlands, the United States, Quebec or recommended by the WHO.

Reference values used in France to qualify polluted sites and soils and their impact on the environment

Compound	Soil VDSS	Soil VCI		Water VCI	
		Sensitive use	Non-sensitive use	Sensitive use	Non-sensitive use
Cobalt	120	240	1200	-	-
Lead	200	400	2000	25	125
Total chromium	65	130	7000	50	250
Copper	95	190	950	2000	4000
Arsenic	19	37	120	10	100
Mercury	3.5	7	600	1	5
pH	-	-	-	-	-
Total sulphur	-	-	-	-	-
H2S	-	-	-	-	-
Mercaptan	-	-	-	-	-
Benzene	1	2.5	-	1	5
Ethyl benzene	25	50	250	300	1500
Toluene	5	10	120	700	3500
Xylenes	5	10	100	500	2500
Hydrocarbons	2500	5000	25000	10	1000

The values are given in mg/Kg of dry matter for soil and in µg/L for water.

VDSS (Valeur de definition de source sol) = Defining value for soil source

Soil VCI (valeur de constat d'impact) for sensitive use = impact value found where the ground is used for dwellings

Soil VCI for non-sensitive use = impact value found for industrial use

Water VCI for sensitive use = impact value found for use as drinking water

Water VCI for non-sensitive use = impact value found for use other than as drinking water

Generally speaking, all the concentrations quantified by the laboratory were low and were well below the standards which are applied in France to qualify, by the rules which apply, the impact which pollution has on soil and water.

The analyses of the quality of the atmospheric air did not reveal the presence of any compounds other than toluene which was not detected in the analyses of the soil and water; we therefore feel that the toluene cannot be linked with the problem of the slop dumping.

To add to these results of laboratory analyses, we made the following observations on the site:

- when the samples of soil were being taken on both the sites, strong smells of garlic characteristic of sulphurous slops were detected by the persons present on the sites. Particularly on the Alépé 2 site, these smells became very strong when the earth was reached which was below the cover of "clean" earth which had been put in place after the digging out work by TREDI;
- sample S5, which taken on the slope down from the Alépé 2 dumping site, had a smell which was more like a light hydrocarbon than the smell of garlic which the other polluted samples were found to have;
- the "smelly" soil samples were often associated with a blackish colour and sometimes had a secondary smell of decomposing organic matter;
- the samples which were taken on the Alépé 1 site were taken at a shallow depth (less than 1 metre); they had a smell of more marked persistence than the samples taken on the Alépé 2 site;
- the "deep" bores which were made on the Alépé 2 sites showed, as from an average depth of 2 m, the presence of moisture, which was probably connected with a small local water table; the nature of the soil, becoming sandy as it did, did not allow samples to be taken at the level in question. This presence of moisture will need to be covered in the organisation of the work since, in rainy weather, the work may be interfered with as far as the digging out and packing in big-bags are concerned;
- generally speaking, the smells were more apparent when the soil was wet. This finding was verified particularly from sample S5 at the time of the second soil sampling campaign in August undertaken with the Biogénie company, which took soil samples for biodegradation tests.

5 - Phase 3: Recommendations for supplementary work to depollute the two sites and make them safe

The investigations and observations made on the two sites on the Alépé Road clearly show, because of the smells, that there is a residual impact from the slop dumping on the soil which is still in situ. All the concentrations measured in the soils sampled are low and well below the standards for polluted sites and soils which are applied in France.

The Alépé 2 site does not show any residual impact on the quality of the water which is collected by the dwelling at the bottom of the thalweg, or on the water of the Djibi.

The soils remaining in place thus present low traces of pollutants linked to the slops. As a comparison, in the light of the concentrations measured in the ground and the water, and in technical and statutory terms, by applying the criteria employed in France the two sites would be classed as "Class 3 to be made available for general use".

On the basis of experience of polluted sites and soil, olfactory perception starts with concentrations in the soil of the order of nanograms per Kg not quantifiable during analyses of soil or air even in the laboratory. This olfactory nuisance is perceived in situ, in particular after periods of rain (according to evidence subsequently verified in situ by the auditor).

As an indication, according to the works of A. Laplanche (E.N.S. in chemistry at Rennes in France) the threshold values of sulphur compounds are very low; they are summarised in the following table:

Compound	Olfactory threshold ppb (v/v)	smell	Toxicity threshold ppb (v/v)	Value measured on sites studied
H2S	8	Rotten egg	14000	Some ppmV's during excavations by TREDI (drager in a closed bag, upper value)
CH3SH (mehtylmer[c]aptan)	1.1 to 1.6	Cabbage, garlic	1000	<0.03 to <0.09 ng/L (Dimethylsulphides) (Dimethyldisulphides) and mercaptan (drager in a closed bag, upper value)

ppb : parts per billion

Overall, the results of the analyses of air, water and soil enable us to conclude the absence of risk to the environment and health without however excluding the possibility of olfactory nuisance.

However, to take account of the actual social, psychological and nuisance conditions affecting those living around and because of the wishes of the two Parties (Trafigura and State of Ivory Coast) to consider the Alépé road sites as a "pilot", the recommendations of the Audit contemplate making the two sites safe on the basis of a neutralisation of the sources from which the smells are coming rather than on criteria of toxicity or health risks. These provisions will also enable preventive surveillance of the preservation of the quality of the water resource in the area.

On the basis of the concentrations measured, treatment of the excavated earth can be effected by gentle techniques of the natural or assisted biodegradation type which enable the pollutant molecules to be broken down and which neutralise the source of the smells. They also have the advantage of

being in place in the Abidjan region. In the event of its being impossible for this mode of treatment to be employed, removal by incineration will be envisaged.

The measures proposed for selecting the ground to be dug out and treated are set as follows:

- In a first phase, on site by visual and olfactory detection, which may be associated with the colorimetric measurements of mercaptan by taking the measurement beyond the limits laid down by the manufacturer to up to 20 x 10 mL pump strokes,
- off site, on the basis of olfactory detection while blind by 2 persons nominated by the auditing company. Their opinion will have to be validated by the auditor. These persons will be asked to test samples from the floor of the dig and unpolluted control samples. The selection of the samples to be tested and the decision on when to stop digging will be the responsibility of the auditor. The panel will meet at least twice a day at a place situated off the site of the work.
- In the event that it is possible to use soil analysis equipment suitable for on-site measurements enabling us to obtain results quickly, the auditor will recommend its use,
- off site on the basis of an acceptance check made by analyses of soil samples carried out in a laboratory on samples taken from the floor of the dig and from the sides.

Zone to be dug out:

In view of the clayey nature of the in situ soil and the quantity of slops dumped, we feel that a maximum depth of 4 m from the initial natural soil level would have been affected by the dumping. This depth also corresponds to the choice of digging equipment in the form of a mechanical shovel, which does not call for any heavyweight supporting works, which would be very difficult to put in place, particularly at the foot of the slope from the road on the Alépé 2 site. The zones to be excavated correspond to the natural topographic traces which the slops would have followed when they were dumped; this trace is marked laterally over an approximate width; in reality regular analyses will have to be carried out in the excavation phase in order to guide the project managers and the auditor to determine the limits of the zones to be excavated. As an indication, the recommended sectors [are]:

- an Alépé 2 zone contained between the stream and the slope from the road and of a length of 80 m and an average width of 20 m and also including the bed of the stream for a length extending between the foot of the dump slope and the point where the culvert goes under the Alépé Road.
The earth to be dug out is situated below the so-called clean earth and the average depth to be dug out is estimated at between 1 and 2 m, i.e. a depth of between 1 and 4 m from the current natural ground level. The volume to be dug out is estimated at around 3500 m³.
The cleaning out of the ditch for a length of 200 m will represent about 250 m³.
- an Alépé 1 zone is defined, around the bores made, to cover an area of about 100 x 30 m and to go to an average depth of one metre; the volume of earth to be dug out is estimated at 3000 m³.

The predicted maximum volume of earth to be dug out on the two sites is thus estimated at around 7000 m³

The neutralising work will be carried out in phases as follows:

- 1 - Delimitation of the zones where traces of polluted soil have been identified. This task will be performed by the auditing company. The stream water needs to be collected and

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diverted upstream of the excavation zones. It is recommended that this drainage equipment remains operational in situ after the end of the work.

- 2 - Defining of a platform for the packing and loading into big-bags of the polluted soil, close to the digging-out zones. These platforms will need to take into account the possibility of dripping from the containers, in order to preserve the natural environment from any fresh sources of possible pollution in the form of this water. This task will be performed by the depolluting company. To facilitate the work, the big-bags will at all times be handled on pallets.
- 3 - Defining of a site for temporary storage prior to treatment or of a definitive site to be used for treating the polluted earth. This task will need to be performed and validated by the group of experts and the auditor.
The preparation of the tracks for access to the sites (for dumping and loading) will need to be done in such a way as to allow for any difficulties there may be relating to the nature of the clayey ground when there is rain.
The ditch situated on a level with the site will need to be managed in order to enable surface runoff to take place in rainy weather without hampering the work on the digging-out site.
The so-called "clean" earth on the Alépé 2 site will need to be taken off and stored temporarily on the site so that it can be used again for backfilling. These tasks will be the responsibility of the company doing the digging work.
- 4 - Digging out of the polluted earth and handling off it to the loading platform, which will be made safe and sheeted over. This task will be the responsibility of the company doing the digging work. The packing into the big-bags and the transport off the digging sites will be the responsibility of the depolluting company.
- 5 - Treatment of the earth dug out, either in the Ivory Coast (biodegradation) or, if necessary, abroad (export and removal at an approved centre). This task will be the responsibility of the depolluting company.
- 6 - Checking of the digging-out work including the taking of soil samples for qualitative analyses (olfactory analyses on site and off site) and acceptance analyses in the laboratory (same list of compounds analysed for as in the present report). This task will be carried out by the auditing company.
- 7 - Backfilling of the diggings as the work progresses to enable matters relating to leaching and rainfall to be managed in the best possible way. This task will be the shared responsibility of the company doing the digging work and the depolluting company.
- 8 - The organisation of the site, the co-ordination of the work and the health and safety measures will need to be seen to with particular care. This task will be the responsibility of the customer.

In order not to delay the start of the digging-out work, it is proposed that the site work **be organised in two phases:**

- Digging out and making safe of the sites and of the polluted earth which is dug out, either on a temporary site or on the definitive treatment site.
- Putting in place of the means required for treating the earth, either by a biopile or by some other means if necessary.

Surveillance equipment:

During the phase when the digging-out, transporting and treatment work is being done, full provisions for making safe and preserving the receiving environments and the neighbouring areas will need to be envisaged and put in place. We would draw particular attentions to the questions relating to the runoff of rainwater and to water dripping from the wet earth which is dug out. It is a matter of providing a system for diverting the runoff water so that there is no interference with the digging site and of restricting the water which gets into the pit, and then of restricting the zone where dripping takes place on the digging site itself in order not to produce any secondary pollution.

The experiments carried out in Canada, the United State and Europe have shown, over thousands of cases treated both in the laboratory on experimental research and development sites and on actual

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sites polluted by hydrocarbons, that the zones affected by dumping remain limited in extent and that the zones affected by the flow of water do not extend for more than a few hundred metres. These findings are due in essence to the organic characteristics of the substances concerned, which are naturally biodegradable, and to the fact that their lightest compounds are highly volatile.

However, to preventatively preserve the current and potential uses of the water resource, we recommend the following surveillance measures.

- Installation of piezometers which reach the surface water table which receives the local rainwater seepage and which may be drained by the Djibi towards the downstream end of the valley. Two or three piezometers going to a depth of not more than 10 m will need to be installed immediately downstream of the Alépé 2 site and on a level with the stream flowing into the Djibi.
- Taking of samples of groundwater from the piezometers which are installed, and making of analyses (THC's, H₂S, pH, BTEX, total hydrocarbons); the frequency of sampling will need to be six-monthly including at least one campaign at the height of the rainy season.
- Tracking of the quality of the spring supplying the dwelling belonging to the fish farm; the frequency of sampling will need to be six-monthly including at least one campaign at the height of the rainy season.
- In the site-work phase, there will be special surveillance of the zones where there is runoff from the loading platforms and from the sites where the polluted earth is stored.

Appendices

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Environmental audit pursuant to clause 2.2 of the protocol agreement signed on 13/02/07 between the Parties, the State of Ivory Coast and Trafigura

Phase 2 - Execution of supplementary investigations

Description of sampling protocol, analyses and interpretation of results from the samples taken

The protocol will be implemented as from the first "urgent phase" which was decided on by the two Parties' working party at the meeting held in Paris on 06/07/07 and which is to be undertaken on site no. 2 on the Alépé Road. Depending on the conditions and constraints governing the action taken, the protocol may need to be adjusted or amended to make the best possible allowance for the on-site situation.

1. Protocol for sampling and in situ analyses:

The soil sampling will be carried out either from bores made by hand with an auger or from bores made with a mechanical shovel, as dictated by the nature of the ground, accessibility and the depth to be reached. For each sampling point there will be 3 packed, labelled batches consisting of:

- batch 1: in situ analysis in the head space of the ground gases (see next bullet point); this same batch will also be used for the detection of olfactory traces at a place away from the sampling point,
- batch 2: a first analysis in the laboratory (mercaptan, hydrocarbons, BTEX, PAH, heavy metals, HVOC's, total sulphur, cobalt (catalyst used for the slops),
- batch 3: if the analysis of the sample shows interesting results, a second, more detailed analysis will be carried out on batch no. 3.

We have made provision for **41 soil analyses** in the laboratory.

Depending on the wishes of the experts from the Parties, the State of Ivory Coast and Trafigura, supplementary packs may be made up and held in reserve or analysed, as they desire.

The semi-quantitative analyses of the ground gases will be carried out in situ using the head space method and Drager colorimetric tubes, for mercaptan, H₂S and petrol hydrocarbons. We have made provision for **85 in situ analyses** to be carried out, to enable the soil samples which are to be analysed in the laboratory to be selected.

The sampling of atmospheric gas will be carried out when the site for taking soil samples is set up on the sites adopted. A tube fitted with a pump will take a sample of air through a tube of activated carbon over a whole day. The throughout of air will be measured and the analysis will be made after extraction on the activated carbon. The same gases will be analysed for: mercaptan, H₂S, total hydrocarbons. We have made provision for **3 samples** plus analyses.

The sampling of the surface water and the groundwater will be carried out either in the streams which may have been affected by the dumping sites, or in the private wells identified by CIAPOL, or from certain deep piezometers to which SODECI is said to have access. We have made provision for **15 samples**, which will be taken from sources which, according to reliable documentary information, are representative.

The sampling of sediment is planned in:

- certain ditches or watercourses (Coco service) which were affected by the dumping,
- certain manholes on the sewer system (Police School),
- at the Cocody retention
- at the outlet to the Cocody lagoon;
- in a pond on the fish farm (Alépé road);
- in the sludge of the pond on the Akouedo dump.

Provision has been made for **27 analyses**.

In the case of the Cocody lagoon, which forms the final discharge point for the runoff water from the drainage basin affected by the dumping sites in the commune of Abobo (apart from the sites on the Alépé Road), and in view of the loss caused by the deterioration of this environment, we have made provision to take samples of sediments at the point of entry to the lagoon and at a number of point along the sewer as far as Abobo.

2. Adjustment of the investigation specific to site no.2 on the Alépé Road

The prior inspection of site no.2 on the Alépé Road which was carried out on 18/07/07 by Burgeap and the technical people from CIAPOL enabled a coverage and sampling plan to be drawn up which is shown in the freehand drawing included with the present report.

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The samples concerned are these:

- soil: 8 samples including 1 background-noise sample and one average sample taken along the low side of the Alépé Road
- ditch or stream sediments: 6 samples
- groundwater (from a point of emergence): the spring as local background noise and the point of emergence used by the dwelling for its drinking water supply and domestic uses
- surface water (the tributary of the Djibi and the Djibi itself): 3 samples, of which 1 will be considered background noise and will be taken from the Djibi upstream of where the stream affected by the dumping joins it.
- atmospheric air: 2 samples of which one will be taken at the foot of slope from the dumping point and 1 on a level with the dwelling at the fish farm.

3. Protocol for laboratory analyses:

Leaving aside the SGS laboratory, which is performing checking duties for the State of Ivory Coast Party, 3 analysing laboratories have been consulted: ALCONTROL (Holland), LANEX (France) and ITS Polychem Lab (Holland). The choice was made of ITS, which has the expertise and resources to undertake all the analyses asked for on its own premises without calling on sub-contractors, while meeting the Quality provisions laid down (ISO9001/200 and ISO17025 accreditation).

ITS's subsidiary at Abidjan will be made responsible for the whole of the logistics between the laboratory in Holland and the Ivory Coast. The bottling and the transport containers will be prepared by the laboratory. Transportation will be undertaken by the DHL company (door-to-door Holland-Abidjan-Holland) in a maximum time of 3 days; the containers will be provided with blocks of ice to keep the samples in relatively correct conditions.

Results of analyses will be passed on by the laboratory in a maximum time of 5 days.

Compounds or elements	Method of analysis	Soil - Limit of detection	Water - Limit of detection
Total hydrocarbons	GC-FID (C10-C40)	50 µg/Kg of dry matter	50 µg/L
BTEX	GC-MS	01. mg/Kg of dry matter (benzene) and 0.2 mg/Kg of dry matter (other compounds)	0.1 µg/L (benzene) and 0.2 µg/L (other compounds)
PAH	GC-MS	0.01 mg/Kg of dry matter	0.01 µg/L
Pb, As, Cr, Cu, Cobalt	ICP-OES (soil, sediment) and GFAAS (water)	1 mg/Kg of dry matter	1 µg/L
H2S	Photometric	0.1 mg/Kg of dry matter	0.1 µg/L
Mercaptan	GC	10 mg/Kg of dry matter	10 µg/L

The protocol provides for the eventuality of supplementary analyses being carried out on certain samples from the reserve batch, as dictated by the requirements of the Audit. These analyses will be decided on either in response to the observations made on site, or on receipt of the results of the first laboratory analyses described above.

4. Methods of interpreting the results

As part of the interpretative approach we will make a distinction between two categories of site:

- **category A:** the sites which fit into a known historical context in which there have been one or more dumps for rubbish or industrial waste (CoCo Service, the Akouedo dump, a point for emptying septic tanks, the sewer line between Coco Service and the Cocody lagoon, the Cocody lagoon, VRIDI, etc.),
- **category B:** the other sites where there no other history of dumping is known a priori, among which are the two sites on the Alépé Road.

In situ analyses of the ground gases: the results will be semi-quantitative and the values obtained in ppm by volume will be converted into concentrations by mass by way of indication. The purpose of these measurements is to obtain an order of magnitude for the values being looked for for the volatile compounds (mercaptan, H2S and petrol hydrocarbons); this order of magnitude will be used as a guide for the selection of the samples to be analysed in the laboratory to enable the maximum and average concentrations to be ascertained as well as possible, and also the extent of the polluted zone at each site.

The samples will be packed in hermetically sealed plastic bags and the analysis will be made in the head space, off the site to prevent the local background noise from interfering in any way. The same samples will be used to log the olfactory indications.

At the end of the operation, the samples not used for analyses will be taken to the Oleatec site and stored in containers on standby.

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Analyses of the soil and sediments (referred to as waste in the report on phase I of the Audit) **in the laboratory:** the compounds to be looked for are listed in the table in section 2.

The protocol makes provision at each of the sites investigated for soil samples to be taken of the same texture and the same geological nature as the Wastes, but situated away from the zone affected by the dumping concerned. These samples will be called local "background noise".

The sites in category A will be the subject of a particular interpretative procedure to enable the Wastes coming from the Probo Koala to be distinguished as clearly as possible from the other historical wastes:

- In a first phase, the compounds present in the samples called "background noise" will be neutralised.
- then, what will be taken as a basis is any coincidence of the indicators which one has at the moment: colour of the soil (green/bluish or blackish), smell (garlic and rotten eggs), presence of H₂S and mercaptan, light (less than C₂₀) hydrocarbonated fraction, presence of cobalt-based compounds.

The results will be compared with the standards applied in the Ivory Coast or, if there are no international standards from the WHO, those applied in the field of health risks.

In the particular case of the Cocody lagoon, the interpretation of the potential impact of the slops from the Probo Koala on the quality of the lagoon will be based on a differential comparison between the samples from the lagoon, the samples from the main sewer and the samples from the dumping sites situated upstream of the drainage basin supplying the lagoon.

Analyses of water (groundwater and surface water)

The results will be compared with the standards applied in the Ivory Coast or, if there are no international standards from the WHO, those applied in the field of health risks.

The protocol makes provision on each of the sites investigated for samples of water to be taken from wells or streams situated which are upstream from the point of view of water or outside the zone affected by the dumping concerned. These samples will be called local "background noise".

Regarding the analyses of groundwater, estimates will be made of the transit times of the water between the dumping sites and the points which are potentially affected and from which samples are taken. The results of the analyses for the wells in question will be compared with the quality of the water samples taken at the control points called "background noise". Each point sampled will be described in its hydro-geological context vis-à-vis the sites of dumpings.

Analyses of the atmospheric gases sampled on the sites investigated

The results will be compared with the standards applied in the Ivory Coast or, if there are no international standards from the WHO, those applied in the field of health risks.

Abidjan, 13/07/07

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Table showing how the water sample numbers in Fig. 1 and the numbers in the INTERTEK laboratory correspond

INTERTEK sample number (Schedule)	Bottle analysed	INTERTEK bottling no. (Characterisation)	BURGEAP sample number (Figure 1)	Sampling site
1	X	A001	DJIBI, UPSTREAM	Alépé 2
		B001		
7	Broken	B002		
2	X	A002	"AWA" BLANK	Alépé 2
		B003		
13	Broken	B009		
3	Broken	A003	POINT OF EMERGENCE FOR DRINKING WATER (dwelling)	Alépé 2
10	Broken	B006		
11	Broken	B007		
4	Broken	A004	DJIBI, DOWNSTREAM	Alépé 2
8	Broken	B004		
12	Broken	B008		
5	X	A005	STREAM	Alépé 2
9	Broken	B005		
14	Broken	B010		
6	Broken	A006	SPRING	Alépé 2
15	X	B011		
16	Broken	B012		

At the request of the laboratory, each sample was packed in three bottles.

Complete schedule of soils analyses made in the INTERTEK laboratory

Table correlating numbers of soil numbers

INTERTEK sample number (Schedule)	INTERTEK bottling number (Characterisation)	BURGEAP sample number (Figs. 1 and 2)	Sampling site
1	C001	S1	Blank - Alépé 2
2	C004	S2	Blank - Alépé 2
3	C006	S5	Slope - Alépé 2
4	C007	S3	Blank - Alépé 2
5	C010	S11	Ditch by road - Alépé 2
6	C011	S7	Ditch downstream of site - Alépé 2
7	C012	S12	Ditch by road - Alépé 2
8	C015	S6	Ditch upstream of site - Alépé 2
9	C017	S13	Stream - Alépé 2
10	C020	S17	Alépé 1
11	C022	S18	Alépé 1
12	C024	S10	Low side of remade road - Alépé 2
13	C025	S19	Alépé 1
14	C027	S15	Blank - Alépé 1
15	C028	S16	Alépé 1
16	C032	S14	Culvert exit - Alépé 2
17	C103	S20	Culvert entrance - Alépé 2
18	C105	S9 - 3.2 m	Alépé 2
19	C107	S9 - 1.5 m	Alépé 2
20	C109	S4	Alépé 2
21	C110	S8	Alépé 2

Schedule of soil analyses carried out by INTERTEK

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Confirmation of receipt by DHL of samples broken by the INTERTEK laboratory in Amsterdam

DHL International Côte d'Ivoire

Abidjan 18 October 2007

[Stamp:] **Arrived**
22 OCT 2007

ATTN
MR JOSHUA A.

ABIDJAN

Subject: Incident report LTA No. 615 1659 3452

Dear Sir

Further to the damage reported on your package of hazardous products samples sent for analysis to Amsterdam under number LTS 615 1659 3452, please find attached the report of this incident.

From the report made by your laboratory in AMSTERDAM, it appears that the packages arrived partly damaged. Certain bottles arrived broken as evidenced by the photographs which we received from your laboratory.

After checking with our operations department, it appears that before their departure from Abidjan the packages were handled with the greatest care. Furthermore, all precautions as regards packing and labelling were taken to avoid any damage during their carriage.

In fact, given their too fragile nature, certain of the bottles were unable to stand up to the conditions of transport through our network.

Please be assured that everything will be done to avoid any such damage on future consignments. Sheets with air bubbles (foils) will be used for future consignments to wrap the bottles. This material is already in stock at your laboratory.

Yours faithfully

[signed]
Amadou DIABATE
Field Sales Executive DHL CI

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Sampling records of air, soil and water samples

State of Ivory Coast – Trafigura
Phase 2 report review meeting
Alépé road sites 1 and 2
(commune of Abobo)
02/10/2007

1. Schedule of investigations
2. Sampling work
3. Results of laboratory analyses (Intertek and Eurofins)
4. Conclusion

The presentation will confine itself to the terms of reference
of the Audit phase 2 assignment

Environmental audit pursuant to protocol agreement – phase 2

State of Ivory Coast – Trafigura
Inventory of dump sites

[Chart – captions/legends illegible]

Environmental audit pursuant to protocol agreement – phase 2

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State of Ivory Coast – Trafigura

Site 1 South of Alépé road		
Prélèvement d'air atmosphérique ... = Sampling of atmospheric air, ALEPE 1 (1 hour), ALEPE 1 (5 hours) Clôture interdisant ... = Fence preventing access to the site ROUTE D'ALEPE = ALEPE ROAD LEGENDE = KEY ——— → Gully erosion and direction of flow ◇ Sampling point for soil □ Sampling point for atmospheric air		
<i>BURGEAP</i>	LAYOUT PLAN OF INVESTIGATIONS ON A LEVEL WITH ALEPE SITE NO.1 Audit under the protocol agreement signed between the State of Ivory Coast and the Trafigura company PHASE 2	Figure 2 CEi070316

Environmental audit pursuant to protocol agreement – phase 2

Site 2 North of Alépé road		
Zone de déversement = Dumping zone Source = Spring Emergence AEP = Point of emergence to supply drinking water Fossé d'écoulement aérien ... = Ditch for overhead flow from the spring BASSIN = BASIN Djibi amount = Djibi, upstream S 10 (échantillon moyen ... = S10 (average combined sample of the sampling points) Source captée = Spring water collected Canalisation PVC = PVC pipe Ruisseau = Stream Buse = Culvert S 14: Buse aval route = Culvert, downstream of road Habitation = Dwelling S 13: Ruisseau = S 13: Stream ROUTE D'ALEPE = ALEPE ROAD S 20: Buse amont route = S 20: Culvert, upstream of road S 11: Fossé de débordement amont = S 11: Storm ditch, upstream S 12: Fossé de débordement aval = S 12: Storm ditch, downstream fossé = Ditch Djibi aval = Djibi, downstream Piste = Track Prélèvement d'air atmosphérique ... = Sampling of atmospheric air, ALEPE 2 (2 hours) Clôture interdisant ... = Fence preventing access to the site LEGENDE = KEY ◇ Sampling point for soil △ Sampling point for sediment → Direction of flow of water ○ Sampling point for surface water and groundwater □ Sampling point for atmospheric air		
<i>BURGEAP</i>	LAYOUT PLAN OF INVESTIGATIONS ON A LEVEL WITH ALEPE SITE NO.1 Audit under the protocol agreement signed between the State of Ivory Coast and the Trafigura company PHASE 2	Figure 1 CEi070316

Environmental audit pursuant to protocol agreement – phase 2

State of Ivory Coast – Trafigura

Summary of investigations carried out

	Alépé road site no. 1 south	Alépé road site no. 2 north	Total	
Soil sampling	6	8	14	21
Ditch or stream sediment sampling	-	7	7	
Underground water sampling	-	2	2	6
Surface water sampling	-	3	3	
Transport blank (water) sampling	-	-	1	
Atmospheric air sampling	2 (2h and 5h)	1 (2h)	3	

Environmental audit pursuant to protocol agreement – phase 2

State of Ivory Coast – Trafigura

Site 2 North of Alépé road

Environmental audit pursuant to protocol agreement – phase 2

State of Ivory Coast – Trafigura

Site 2 North of Alépé road

Environmental audit pursuant to protocol agreement – phase 2

State of Ivory Coast – Trafigura

Site 1 South of Alépé road

Gulley erosion

Environmental audit pursuant to protocol agreement – phase 2

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State of Ivory Coast – Trafigura

Results of air analyses

Sample no.		07-053314-01	07-053314-02	07-053314-03
Designation of sample		ALEPE 2	ALEPE 1 BETWEEN 17 AND 18	ALEPE 1 - 5 Hours
		Measurement layer	Measurement layer	Measurement layer
Benzene ^{aa}	µg abs	<0.05	<0.05	0.072
Toluene ^{aa}	µg abs	0.451 (0.8 ng/L)	0.508 (0.9 ng/L)	0.477 (0.3 ng/L)
Ethyl benzene ^{aa}	µg abs	<0.05	<0.05	<0.05
m-, p-xylene ^{aa}	µg abs	<0.05	<0.05	<0.05
o-xylene ^{aa}	µg abs	<0.05	<0.05	<0.05
Dimethyl sulphites ^{aa}	µg abs	<0.05	<0.05	<0.05
Dimethyl disulphides ^{aa}	µg abs	<0.05 (<0.9 ng/L)	<0.05	<0.05 (<0.3 ng/L)
C5-C12 hydrocarbons ^{aa}	µg abs	<5 (9 ng/L)	<5	<5 (<3.7 ng/L)

Environmental audit pursuant to protocol agreement – phase 2

State of Ivory Coast – Trafigura

Result of water analyses

VCI us Upstream Djibi Blank Stream before Djibi

[Table in English]

6 samples were not able
to be analysed

VCI us Alépé spring

[Table in English]

Environmental audit pursuant to protocol agreement – phase 2

State of Ivory Coast – Trafigura

Results of soil analyses (Intertek)

[Table in English]

Environmental audit pursuant to protocol agreement – phase 2

State of Ivory Coast – Trafigura

Results of soil analyses (Intertek)

[Table in English]

Environmental audit pursuant to protocol agreement – phase 2

State of Ivory Coast – Trafigura

Results of soil analyses (Intertek)

[Table in English]

Environmental audit pursuant to protocol agreement – phase 2

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Results of soil analyses (Intertek)

[Table in English]

Environmental audit pursuant to protocol agreement – phase 2

State of Ivory Coast – Trafigura

Results of soil analyses (Intertek)

[Table in English]

Environmental audit pursuant to protocol agreement – phase 2

State of Ivory Coast – Trafigura

Soil analyses:
Comments by Intertek laboratory

[in English]

Environmental audit pursuant to protocol agreement – phase 2

State of Ivory Coast – Trafigura

Results of soil analyses (Eurofins) – S4/S5/S8/S9

Parameters	Unit	Results	Observations
Dry matter	%PB	88.4	
Iron	mg/kg MS	9940	No VDSS
Sulphur	mg/kg MS	<5.6	
Soluble sulphite	mg/kg MS	<5.6	
Soluble sulphate	mg/kg MS	<20	
Hydrocarbons index		<15	C10-C40
C10-C12		0	
C12-C16		0	
C16-C20		0	
C20-C24		0	
C24-C28		0	
C28-C32		0	
C32-C36		0	
C36-C40		0	
Volatile hydrocarbons index			HS/GC/MS
C5-C8	mg/Kg MS	<1	
C8-C10	mg/Kg MS	<1	
Total C5-C10	mg/Kg MS	<2	

Environmental audit pursuant to protocol agreement – phase 2

State of Ivory Coast – Trafigura

Results of soil analyses (Eurofins) – S4/S5/S8/S9

Mercaptans			
1-Butanthiol	mg/kg	<0.1	
1-Propanthiol	mg/kg	<0.1	
2-Butanthiol	mg/kg	<0.1	
2-Methyl-1 Propanthiol	mg/kg	<0.1	
2-Propanthiol	mg/kg	<0.1	
Ethanthiol	mg/kg	0.04	
Methanthiol	mg/kg	0.04	
Volatile compounds screening	(COHV's, BTEX's, benzene derivatives, brominated halogenated derivatives...)		
Diethyl disulphide	Sulphurated compound		C4H10S2
Disulphide, ethyl 1 -methyl	Sulphurated compound		C5H12S2
Semi-volatile compounds screening :	(molecules sought: Phenolic compounds, phthalates, PCB's, POC organochlorates, organophosphates, organic nitrogen compounds,...) : No compounds detected		

Environmental audit pursuant to protocol agreement – phase 2

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State of Ivory Coast – Trafigura

Interpretation of analyses:

1. Quality of atmospheric air:

- Absence of compounds linked to the slops

Environmental audit pursuant to protocol agreement – phase 2

State of Ivory Coast – Trafigura

Interpretation of analyses:

2. Quality of water resource:

- naturally acidic pH
- the spring used by the dwelling is free of traces of pollutants
- the Djibi tributary stream is free of traces of pollutants

Environmental audit pursuant to protocol agreement – phase 2

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State of Ivory Coast – Trafigura

Interpretation of analyses/observations:

We should remember that the reference applied is that used in France.
It was established on the basis of the standards applied in the Netherlands, Québec, the United States and by the WHO

The soil remaining in place shows weak residual traces of pollutants.

It is not considered as Source of the pollution in the regulatory sense.

Environmental audit pursuant to protocol agreement – phase 2

State of Ivory Coast – Trafigura

Conclusion:

The results of the analyses of air, water and soils enable us to conclude the absence of risk to the environment and health without however excluding the possibility of olfactory nuisance

According to A. Laplanche (ENS in Chemistry, Rennes)
Threshold values of sulphurated compounds

	Olfactory threshold ppb (v/v)	ppb (v/v)	smell	Toxicity threshold ppb (v/v)	Value measured
H ₂ S	8		rotten egg	14000	
CH ₃ SH (Methylmercaptan)	1.1 to 1.6		cabbage, garlic	1000	<0.03 - <0.09 ng/L (Dimethylsulphides) (Dimethyldisulphides) and Mercaptan Drager 250 ppb (in a closed bag, upper value)

Environmental audit pursuant to protocol agreement – phase 2

Explanatory supplements of implementation of hydrocarbon pollution resulting from dumping at surface level, and influenced by the fluctuations in ground water

Creation of an impregnation body by the hydrocarbons
Role of restriction to depth progression linked to presence of ground water

Pollutants lighter than water
Case of a product in phase reaching the ground water
Effects of fluctuations in ground water on the floating product lens

Aerated zone

Impregnation body

Capillary fringe
Top of ground water

“Free” oil likely to be
set in motion again

Residual oil

“Free” oil after fall
or rise of ground water