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ENVIRONMENTAL ASSESSMENT OF THE PETROECUADOR-TEXACO CONSORTIUM OIL FIELDS

VOLUME I: ENVIRONMENTAL AUDIT REPORT

HBT AGRA Limited
Engineering & Environmental Services

AGRA
Earth & Environmental Group

DRAFT ONLY

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VOLUME I: ENVIRONMENTAL AUDIT REPORT

Prepared For:

PETROECUADOR-TEXACO Consortium

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PART 1 - INTRODUCTION

The PETROECUADOR-TEXACO Consortium of Quito, Ecuador has selected HBT AGRA Limited to undertake an environmental assessment of the consortium oil fields located in the Oriente District of Ecuador (Figure 1-1).

The evaluation has focused on operational practices for the period 1964 to 1990 which coincides with the period Texaco Petroleum Company acted as operator for the consortium.

Hydrocarbon development and production activities have caused environmental impacts in this part of the Amazon Region, and the consortium proposed to identify these impacts and to measure compliance with environmental regulations in effect during the period 1964 to 1990.

The objectives of this study are as follows:

- To carry out an integral environmental audit of the PETROECUADOR-TEXACO Consortium oil fields to determine their current environmental status.
- To determine possible environmental impacts generated by oil field development in the Consortium concession area, and to determine possible causes of these impacts.
- To determine actions and measures to be applied in order to reduce and control impacts caused by oil field development and production activities.
- To determine remediation and reclamation measures and to provide an estimate of costs of these measures.

The results of this study are presented in two volumes:

Volume I: Environmental Assessment Report

This report provides a summary of the results of the environmental assessment and a description of environmental liabilities within the study area.

Volume II: Environmental Management Plan

This report provides a description of remediation options including recommendations for the most feasible options and for remediation implementation.

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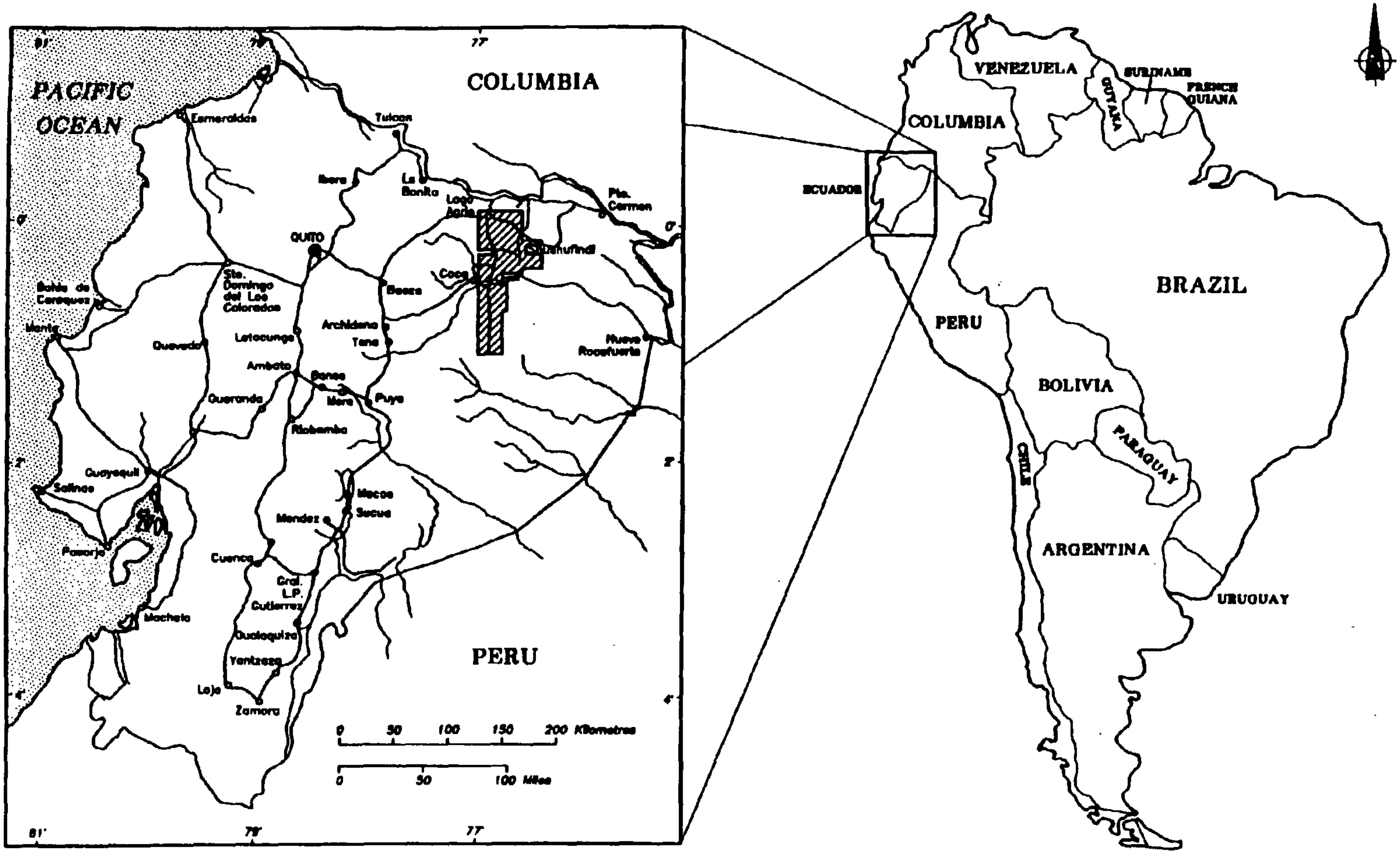

▨ STUDY AREA

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LOCATION OF STUDY AREA

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FIGURE 1-1

1.1 BACKGROUND

The Texaco and Gulf Oil joint venture concession dates back to 1964. The original lease agreement was altered in 1974 when Texaco relinquished much of the original acreage and retained its current 479,974 hectares. On August 6, 1973 Texaco and Gulf Oil signed a contract with the Ecuadorian government for the exploration and production of hydrocarbons in the Oriente Basin. On June 6, 1974 the Corporacion Estatal Petrolera Ecuatoriana (CEPE- today known as PETROECUADOR) acquired 25% of the rights and obligations of the Texaco-Gulf joint venture agreement with the following participation: CEPE = 25%, Texaco = 37.5% and Gulf = 35.7%. In January 1977, CEPE (today PETROECUADOR) acquired the rights and obligations of Gulf Oil (37.5%) thereby increasing its participation in the consortium to 62.5%.

The oil field operations of the Consortium were conducted to June 30, 1990 by Texaco Petroleum Company. Since then, the field operations have been managed by PETROAMAZONAS, an Ecuadorian government company.

The PETROECUADOR-TEXACO Consortium operated 15 petroleum camps and 22 production stations in the Oriente (Table 1-1). The concession is located in the Provinces of Sucumbrios and Napo of the Amazon region of Ecuador. The oil fields comprise approximately 325 wells of which approximately 232 are currently producing. Most oil is recovered by artificial lift, however two fields (Sacha and Shushufindi) have secondary recovery by water injection.

1.2 SCOPE OF WORK

The scope of work for this project was established by an Environmental Audit Technical Committee comprising representatives of PETROECUADOR, TEXACO, PETROAMAZONAS and the Ministry of Energy of the Government of Ecuador. This Technical Committee established the terms of reference for this study, and oversaw all technical aspects of the field programs and final approval of the reports.

A phased approach was used to undertake this study.

Phase I involved a Biophysical Survey, Historical Review, Regulatory Review, Facility Audit and Site Reconnaissance. This phase identified the potential for contamination and the type of contamination that may be present from visual observations and limited chemical characterization of the sites inspected.

Phase II involved groundwater and subsurface investigations on those sites where contamination or high potential for contamination was identified during Phase I.

TABLE 1-1

The PETROECUADOR-TEXACO Consortium Production Stations and Well Sites

Oil Field	Production Station	Number of Wells in Field
Lago Agrio (LA)	North Production Station Central Production Station	37
Parahuacu (PH)	Production Station	5
Atacapi (AT)	Production Station	6
Guanta (GU)	Production Station	9
Aguarico (AG)	Production Station	10
Shushufindi (SSF)	North Production Station Central Production Station South Production Station Southwest Production Station Water Injection Station	79
Sacha (SA)	North #2 Production Station North #1 Production Station Central Production Station South Production Station	120
Culebra (CU)	Production Station	2
Yulebra (YB)	Production Station	3
Yuca (YU)	Production Station	9
Yuca Sur (YUS)		1
Auca (AU)	Central Production Station South Production Station	27
Auca Sur (AUS)	Production Station	2
Rumiyacu (RM)		1
Cononaco (CN)	Production Station	13
Dureno (DU)	Production Station	1
TOTAL 16	23	325

1.3 LAYOUT OF REPORT

This report is organized in the following manner:

Section 2	provides an overview of existing biophysical conditions within the study area.
Section 3	provides a description of site history including land use and spill history for production stations, well sites, flowlines and pipelines.
Section 4	provides a summary of the regulatory review which was used to form the basis for assessing compliance of the oil field operations.
Section 5	provides the findings of an audit which examined operational practices for production facility management, well site management and pipeline management.
Section 6	summarizes the results of a site reconnaissance to all the production stations and 50 percent of the well sites within each oil field, and documents existing levels of contamination.
Section 7	provides a description of surface waters within the study area, including effluent sources and existing levels of contamination.
Section 8	provides a description of groundwaters within the study area including existing levels of contamination in subsoils and groundwater.
Section 9	provides a summary of the major environmental liabilities.
Section 10	provides a priority list of the major environmental liabilities and recommendations for further assessment and mitigation.

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PART 2 - BIOPHYSICAL OVERVIEW

2.1 INTRODUCTION

This section provides a brief description of biophysical resources within the study area. The following sources of information were used:

- published reports;
- air photos at a scale of 1:60,000 (July 1990); and
- field studies undertaken from May 19 to June 17, 1993.

During the field studies, observations were made on landforms, soils and vegetation within the study area. Soil and surface water samples were also collected from several locations to characterize background values. A detailed description of the surface water sampling program is given in Section 7.0.

2.2 CLIMATE

The climate of the Oriente District of Ecuador is tropical. Tropical climates are defined as "climatic regimes characterized by high temperatures (minimum average of 18°C) and heavy rainfall (yearly minimum above 1.5 metres) throughout the year" (New Lexicon Websters Dictionary).

Rainfall in the Oriente is generally heavy, ranging from 2,000 mm to 5,000 mm annually. There is no dry season in the Oriente (Library of Congress 1979). In most years, soils are dry for less than three consecutive months. Mean temperature in the Oriente is about 24°C (Sociedad Ecuatoriana de la Cienca del Suelo 1986).

2.3 TOPOGRAPHY

The study area lies within the Amazonia geographic region. The topography of this region is composed of gently sloping land and flat valleys that stretch from the eastern edge of the Andes to the headwaters of the Amazon River (Sociedad Ecuatoriana de la Cienca del Suelo 1986).

2.4 BEDROCK GEOLOGY AND SURFICIAL GEOLOGY

The Oriente Basin lies within the trend of Andean foreland basins that extend along the length of western South America east of the Andes. The basin is bounded by exposed Precambrian rocks of the Guyana shield located to the east, and by fault-bounded ridges of exposed Jurassic through Tertiary rocks to the west. The sedimentary section in the basin thins against basement arches to the north in Columbia and to the south in Peru. The basin forms a broad asymmetrical syncline, with a maximum thickness exceeding 10,000 meters. The axis of the basin plunges to the south-southwest. The Cretaceous Napo and Hollin formations are the oil producing formations in the basin, and most producing oil wells in the basin have been completed at depths ranging from 2,900 to 3,100 meters (Smith, 1989).

A Miocene to Holocene section of continental alluvial deposits are the primary sedimentary fill of the foreland basin and are exposed at the surface (Tschopp, 1956). The Tertiary section comprises the upper 2,500 to 5,000 meters of the basin fill, and is composed of fine to coarse clastic sediments of brackish to fresh-water facies. The soil profile along the Aguarico River developed on this Tertiary Section. Late Tertiary (Miocene through Quaternary) Curaray - Conambo Formation, Miocene Chambira Ushpa Formation, and the Oligocene Arajuno Pastaza Formation are exposed at the surface in the Oriente Basin. The Arajuno Pastaza Formation occurs near the confluence of the Rio Napo and Rio Coca, and consists of pebbly sandstones with some conglomerates in the lowermost portion, and red to red-brown clay or sandy clay in the upper portion. The Chambira Ushpa Formation is composed of sandstones in the lower portions, and of claystones with interbedded tuffaceous sandstones in the upper portion. The Chambira Formation occurs in the Auca Field and in the southern portion of the Sacha Field. The Curaray Formation which is exposed in the Shushufindi, Aguarico, and Lago Agrio Fields, consists of well-bedded, light-gray or reddish brown clays alternating with fine to medium grained sandstones. The abrupt vertical and horizontal lithologic facies changes in the Tertiary and Quaternary Sections, deep weathering of the parent rock material, and rarity of index fossils, make correlation of the formations very difficult.

2.5 SOILS

Soils in the Oriente are formed on alluvium volcanic and sedimentary materials. A summary of the main soil types are given in Table 2-1 and in the following descriptions.

Tropaguepts (Map Unit I a 1)

These are poorly drained soils found on level terraces, alluvial marshes and depressional areas. They are formed on recent alluvium (muds, clays) over older clayey sediments. These soils are permanently saturated with water (waterlogged), gleyed (grey colour) and acid. They have an organic horizon (fibrous material) over reddish to yellow clay that is grey with depth.

Distrandepts (Map Unit I d 3)

These are soils formed on recent volcanic ash deposited over older deposits of ash. They are moist to wet and of medium fertility. These soils are characteristically brown stratified mud and sand and are found on level to undulating topography.

TABLE 2-1

Soils of the Study Area

Terrain	Order	Sub-order	Great Group	Description
Alluvial plains	Inceptisols	Andepts	Dystrandepts (I d 3 - I f 3)	Volcanic projections; recent ash
Floodplains	Enceptisols	Aguepts	Tropaquepts (I a 1)	Sedimentary, allvuial clay over organic horizon
Hilly	Inceptisols	Tropepts	Dystropepts (I f 2)	Sedimentary, ancient, red compact clay, shallow, high toxic Al contents
Hilly plateau	Inceptisols	Tropepts	Dystropepts (I f 3)	Sedimentary, recent, clay, compact, poorly drained, high toxic Al contents

Sources: Fundacion Natura (1988); Instituto Geogrfico Militar (1986)

Distropepts (Map Units I f 2 and I f 3)

These are soils formed on sedimentary materials on undulating to hilly topography. They are moist to very moist, are leached with low fertility. They have a high clay content with a high content of aluminum.

2.6 VEGETATION

The Oriente is located within the Amazon Basin, which is known for its biological diversity. It is estimated that the lowland forests of the Oriente contain between 9,000 and 12,000 species of vascular plants. The Amazon Basin has been studied in a variety of areas, particularly in Brazil. However, very little is known specifically about the Oriente area in Ecuador. Therefore, only general information about the vegetation resources of the Amazon is available for this report.

The Amazon is characterized by its richness in diverse fauna and flora. Riparian vegetation and forests are found in the Oriente area. Riparian vegetation is dominant where regular flooding occurs on alluvial terraces adjacent to the rivers and streams. The extent of the riverine vegetation varies based on slope, proximity to the river channel, presence of bedrock and the frequency of flooding. The riparian zone is generally covered by a patchwork of low, dense vegetation, topped by scattered tall trees. Characteristically the trees are covered with lianas. The low areas contain a number of species of shrubs, herbs, lianas, and herbaceous vines. Grasses and ferns may also be common. The concentration and distribution of these species is influenced by localized light conditions. Flooding disturbance maintains the grasses and "liana forest" typical of the riparian zone.

Forests merge into the riparian zone. Adjacent to the riparian zone, these forests are affected by extreme flood events and represent a transition between riparian vegetation and upland forests. Plants typically found in forests include shrubs, lianas, hemiepiphytes (plants which germinate of a host tree and send roots to the ground), epiphytes (orchids, aroids, and boimeliads), herbs and mosses, as well as a wide variety of tree species. Of the tree species found in Ecuador, the following have some commercial value: cedar, sisin, walnut, mahogany, laurel of Puna, mountain laurel, oak, alder, canelo, arrayan, cherry, willow, eucapyptus, balsa wood, lignum-vitae, and myrtle. The trees range from 30 to 50 m high, and the canopy is closed (Cabrera and Willink 1973).

2.7 WILDLIFE RESOURCES

Many wildlife species are endemic to Ecuador, or the Amazon Basin. Because many areas of the Amazon experience prolonged flooding, the fauna has adapted to living in water or in treetops. For example, many species of monkeys, marsupials, birds, ants, and molluscs have adapted to treetop living.

A wide variety of monkeys are found in Ecuador, including the Three Banded (*Douroucouli*), Night (*Aotus*), Bald Ouakari (*Cacajao*), Dusky Titi (*Callicebus*), Silvery/Black Marmoset (*Callithrix*), and howler (*Alouta belzebul*) monkeys. The major carnivores in Ecuador include the puma, jaguar, coatimundi, fox, kinkajou, otter, peccary, raccoon, skunk, and weasel. Rodents are represented by several species of squirrels, the spotted cavy, agouti, and numerous rats. Herbivores are represented by small South American deer, the pudu, other species of deer (*Odocoeilus*) and tapir. Characteristic aquatic mammals include the manatee (*Tricherus inunguis*), the Boutu or Inia (*Inia geoffroyensis*) and the tucuxi (*Sotalia pallida*).

Jungle birds have been divided into categories on the basis of their preferred habitat in the canopy - low, medium and upper. Species of special interest occurring in Ecuador include a wide variety of hummingbirds (*Trochilidae*), scarlet macaw, parrots, parakeets (*Psittacidae*), toucans (*Ramphastidea*), cuckoos (*Cuclidae*), antbirds (*Formicaridae*), blue-crowned motmot, belted kingfisher, and raptors such as the great curassow and *Harpia*.

As with the mammals, reptiles and amphibians exhibit significant adaptations to living in trees or in water. Representatives of these species include a wide variety of turtles, lizards, alligators, chameleons, snakes and crocodiles.

Other species of interest, for which there is little known information, include fish and aquatic organisms such as molluscs, insects and bats (Cabrera and Willink 1973).

2.7.1 Endangered Species

Several species that are considered to be endangered include the following (Library of Congress 1979):

Callimico goeldii	Goeldi's mamoset
Alouatta villosa	Howler monkey
Tapirus bairdii	Central American tapir
Cacajar sp.	Uakari
Vultur gryphus	Andean condor
Panthera onca	Jaguar
Pharamachrus mocinno mocinno	Resplendant quetzal
Priodontes giganteus	Giant armadillo
Tremoritos giganteus	Speactacles bear
Pteronura brasiliensis	Giant otter
Felis pardalis	Ocelot

2.8 SURFACE WATER

The study area is drained by one main river system, the Rio Napo which is a tributary of the Rio Amazonas. Major tributaries of the Rio Napo are the Rio Coca and the Rio Aguarico. Tributaries of the Rio Aguarico which cross the study area include the Rio Teteye, Rio Eno, Rio Dureno, and Rio Shushufindi. Tributaries of the Rio Coca which cross the study area are the Rio Yanayacu, Rio Jivino, Rio Curiyacu, Rio Rumijacu, Rio Tiputini and Rio Tivacuno.

The Rio Napo and Rio Aguarico are the largest rivers and are about 150 - 200 m wide. The Rio Eno, Rio Tiputino and Rio Shiripuro are about 30 m wide. Most of the other rivers are less than 10 m wide. All of the rivers generally flow in an easterly or southeasterly direction.

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PART 3 - HISTORICAL REVIEW

3.1 INTRODUCTION

The objective of the historical review was to obtain information on the development, production and environmental history of the oil fields. This information can then be used to identify potential environmental liabilities and to determine the types of substances used in the operation and maintenance of the sites.

3.2 METHODOLOGY

The historical review used a number of different sources of information:

- file records from Ecuadorian Department of National Hydrocarbons;
- file records from PETROECUADOR; and
- July 1990 air photos at a scale of 1:60,000.

This information was collected and reviewed and the following information was extracted and summarized:

- well site identification;
- well status;
- well spud date;
- well completion date;
- well production date;
- cumulative well production to June 10, 1990;
- post 1990 well site workover records;
- 1973 to 1990 spill records; and
- previous environmental assessment documentation.

3.3 RESULTS

Information was obtained on the current well status, well spud date, well completion date, well production dates and cumulative well production to June 1990 for all 325 well sites within the study area. This information is given in Table A-1, Appendix A. A summary of well site completion history is given in Table 3-1. Approximately 37% of the well sites are located in the Sacha field, and 24% of well sites are located in the Shushufindi field. The majority of wells were completed during the period 1970 to 1979 and levelled off during the period 1980 to 1990. The first well sites were completed in Lago Agrio field in 1967. There were no well completions prior to 1967.

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Table 3 – 1
Well Site Completion History

Boxed areas indicate number of well completions by field per year.

Field	Completion Year																												Total
	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	Wells
Dureno						1																							1
Rumiyacu																			1										1
Yuca Sur																1													1
Culebra										1				1															2
Auca Sur																	1					1							2
Yulebra																	1					2							3
Parahuacu					1										3	1													5
Atacapi					1										2	2		1											6
Guanta																							4	5					9
Yuca							1									4	3	1											9
Aguarico						1	1			4	3						1												10
Cononaco									1											1	6	3						2	13
Auca							3				13	2	1		3	1	1		1								2		27
Lago Agrio				3	1		16	4		1			2	1		1	1	1	3	1		1		1					37
Shushufindi						2	3		15	18	9	6		4		1		2		4	4	5	3		2		1		79
Sacha						3	1	29	14	20	7		8	2	1	2	5	4	2	3	6	1	3	3	3		3		120
Total	0	0	0	3	3	7	25	33	30	44	32	8	11	8	9	13	13	9	7	9	16	13	10	9	5	0	6	2	325

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Information was also collected on those wells that were subjected to work-overs after June 1990 (Table A-2, Appendix A). At those particular wells, production fluids from the workover may have been added to fluids already present in the pits that were produced prior to 1990. At those sites, it will not be possible to distinguish between the contamination in the pits from treatment fluids and drilling muds produced prior to 1990 from that produced after 1990. The data indicates that 71 well sites were serviced in 1990, 17 in 1991, 22 in 1992 and 3 in 1993.

The historical review also included compilation of available spill records (Tables A-2, and A-3, Appendix A). These records were provided by the Ecuadorian Department of National Hydrocarbons and PETROECUADOR. Information recorded included location (well site), spill date, gross volume of spill, volume recovered, method of clean-up, cause of spill and natural resource affected by the spill. During the period 1973 to 1990, spills were recorded at 93 well sites and 10 production stations.

Previous environmental documentation was limited to that available from the Ecuadorian Department of National Hydrocarbons. The Department of National Hydrocarbons had undertaken an assessment of site conditions in 1987. Information was recorded for 202 (61%) of the 325 well sites in the concession (Table A-2, Appendix A). At each well site assessed, site condition was rated on a three point scale. The condition rating was based on presence of oil spills, presence of oil stains around well head, and whether the well site had been levelled and gravelled. The pit size at each well site was also noted. The adjacent land use was also recorded according to four different categories.

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PART 4 - REGULATORY REVIEW

4.1 INTRODUCTION

A review of Ecuadorian laws and regulations was undertaken to provide a basis for assessing compliance of the oil field operations. The specific objectives of the regulatory review are as follows:

- to specify the public sector institutions that administer use and management of petroleum resources; and
- to provide a summary of environmental laws and regulations in effect during the period of involvement of Texaco in the PETROECUADOR-TEXACO Consortium.

4.2 METHODOLOGY

Ecuadorian regulations pertinent to the operations of the oil fields that were reviewed are given in Table 4-1.

TABLE 4-1

Ecuadorian Environmental Laws and Regulations Relevant to Oil Field Operations During the Period 1964-1990

1. Concession Agreement, Decree No. 205 A Ord. No. 186 (February 21, 1964).
2. Hydrocarbon Law No. 1459 (September 27, 1971).
3. Contract with Texaco-Gulf (June 6, 1972).
4. Supreme Decree No. 925 (August 4, 1973).
5. Law on prevention and control of Environmental Pollution. Supreme Decree 374 (May 21, 1976) Register No. 530 (April 10, 1974).
6. Hydrocarbon exploration and exploitation regulations; or No. 530 (April 10, 1974).
7. Codification of Hydrocarbon Law, Decree No. 2967 (November 6, 1978).
8. Reform to the Hydrocarbon Law Decree No. 101 (August 19, 1982).
9. Law of Hydrocarbons No. 19775 (June 6, 1983).
10. Law of Hydrocarbons No. 19779 (June 7, 1983).
11. Regulation for the Prevention and Control of Environmental Pollution Related to Water Resources, Decree No. 2144 or No. 204 (June 5, 1989).

The first exploration wells were completed in the PETROECUADOR-TEXACO Consortium concession area in 1967 and brought into production in 1973. This drilling activity predates the introduction of environmental legislation in Ecuador. The first environmental measures were contained in the Ecuador Hydrocarbon Law Decree No. 1459 which was enacted in September 1971. In addition, according to the Hydrocarbon Law; Decree 101, enacted in August 1982, the operator was required to conduct their petroleum operations "in accordance with international practices in these matters". There was, therefore, a need to review typical exploration drilling and production practices for the petroleum industry in tropical rain forest areas. This would serve as an additional basis for assessing compliance of the oil field operations.

To determine typical operational practices in tropical rainforest areas, information was collected for petroleum operations in Columbia, Indonesia, and Trinidad. In addition, international guideline documents were reviewed including "Oil Exploration in the Tropics: Guidelines for Environmental Protection" (International Union for Conservation of Nature and Natural Resources 1991), and "Oil Industry Operating Guidelines for Tropical Rainforests" (E&P Forum 1991).

4.3 RESULTS

4.3.1 Ecuadorian Regulations

A review of Ecuadorian environmental laws and regulations has been completed and the results are presented in the "Final Assessment Criteria for an Environmental Evaluation of the PETRO-ECUADOR Consortium Oil Fields". A summary of the development of environmental legislation in Ecuador as it relates to the PETROECUADOR-TEXACO Consortium oil fields is given in Table 4-2.

Based on the review of Ecuadorian environmental laws and regulations, the following summary of provisions apply to drilling or production activities in the following time periods:

1964 to September 27, 1971
There are no environmental laws, regulations or decrees in place.

September 27, 1971 to August 4, 1973 **(Decree No. 1459)**
The operator was required:

- "To adopt all necessary measures for the protection of the flora, fauna, and other natural resources; and
- to prevent pollution of the water, the atmosphere, and the land."

However, no standards were developed to provide guidance for the application of Decree No. 1459.

TABLE 4-2

Environmental Legislation Development in Ecuador
PETROECUADOR-TEXACO Oriente Oil Fields

1964	1971	1973	1974	1976	1978	1982
PETROECUADOR-TEXACO Joint Agreement	Ecuador Hydrocarbon Law Decree No. 1459 (Sept. 27, 1971), Article 24 s. to adopt all necessary measures for the protection of the flora and fauna and other natural resource t. to prevent pollution of water, the atmosphere and land	TEXACO-GULF-PETROECUADOR contract, contained environmental control requirements: Decree No. 925, Clause 46.1 to minimize biophysical impacts. 46.1 "Contracts will adopt fitting measures for protection, the flora, fauna and other natural resources as well as avoiding pollution of water, the atmosphere and land under the control of state agencies". Comments a. Operational practices of petroleum operators in tropical humid rainforest areas should be from 1960 to June 1993.	Revised Ecuadorian Hydrocarbon Exploration and Exploitation Regulation (R.O. 530, Ch. VI) April 10, 1974 Chapter IV Production: b) prevents the escape and waste of hydrocarbons in order to avoid loss, damage and pollution. Comments Production was designed to reduce the impacts of free hydrocarbon entering rivers, streams, lakes and the atmosphere. a. The Joint venture has been operating under typical operational practices for the petroleum industry in tropical, humid rainforest areas.	Law on Prevention and Control of Environment Pollution: Supreme Decree 374 (May 21, 1976) a. This law made it illegal to not observe the corresponding technical standards and regulations for the prevention and control of both water and soil pollution. Comments No corresponding technical standards and regulations have been reviewed to date that provided levels of compliance for the petroleum industry at that time in tropical areas. Because of the absence of corresponding technical standards and regulations, the joint venture would have to comply to the Ecuadorian Hydrocarbon Exploration and Exploitation Regulation R.O. 530.	New Hydrocarbon Laws November 6, 1978 (N. 2967) s. To adopt the measures necessary for the protection of flora, fauna and other natural resources. t. Avoid polluting waters, the atmosphere and land. Comments Article s and t: reduced the required level of environmental compliance.	Reform to the Hydrocarbon Law Decree 101 (August 1982), Article 31 (item t); "to perform the petroleum operation as per the Law and Regulations to protect the environment and the national security and in accordance with international practices in these matters.

__August 4, 1973 to April 10, 1974__ **(Decree No. 925)**
The operator was required "to adopt fitting measures for protecting the flora, fauna and other natural resources as well as avoiding pollution of waters, the atmosphere and land under the control of State agencies".

No standards were developed to provide guidance for the application of this law.

__April 11, 1974 to May 27, 1976__ **(ORD No. 530)**
The operator was required to "prevent the escape and waste of hydrocarbons in order to avoid loss, damage and pollution". (Chapter IV Production Clause b)

Other measures included the following:

> "The operator should take all the necessary measures and precautions while performing its activities in order to avoid damages or injuries to persons, property, natural resources and to locations of religious, archaeological or tourist interest." (Article 41)
>
> "If salt water, drilling mud, oil samples or other elements may cause damage to the flora or fauna, the operator must propose to the Ministers the appropriate form of disposal in order to prevent such damages." (Article 42)

__May 22, 1976 to November 6, 1978__ **(Decree No. 374)**
The following measures related to prevention and control of pollution:

> "Without abiding by the corresponding technical standards and regulations, it is prohibited to vent or discharge pollutants into the atmosphere, if in the opinion of the Ministry of Health, such pollutants may impair human life and health, the flora, fauna, and state or privately owned resources or property, or may become a nuisance." (Chapter V, Article 11)
>
> "Without observing the corresponding technical standards and regulations, it is prohibited to discharge residual waters containing noxious pollutants that are dangerous to human health, flora, fauna and properties, into the sewage, the ravines, ditches, rivers, natural or artificial lakes, or to the sea, as well as to infiltrate these waters into the ground." (Chapter VI, Article 16)
>
> "Without observing the corresponding technical standards and regulations, it is prohibited to discharge pollutants or any kind that could affect the quality of the soil and affect human health, flora, fauna and other properties." (Chapter VII, Article 20)

These laws were designed to prevent pollution of the atmosphere, soil, and water resources. An Inter-Institutional Committee for Environmental Protection was established to enforce this law

(Decree 374). The committee consisted of representatives of: the Minister of Health, Minister of Natural and Energy Resources, Minister of Agriculture and Livestock, Minister of National Defense, Minister of Industry, Commerce and Integration, and the President of the National Planning and Coordination Board.

<u>November 6, 1978 to August 19, 1982</u> (Decree No. 2967)
The level of environmental compliance was reduced because of word changes within the articles affecting environmental controls. The relevant clauses are the following:

> "Adopt measures necessary for the protection of flora, fauna and other natural resources." (Article 28, Clause a)
>
> "Avoid polluting water, the atmosphere and land." (Article 28, Clause t)

<u>August 19, 1982 to June 6, 1983</u> (Decree No. 101)
According to Decree No. 101, the operator was required:

> "To perform the petroleum operations as per the Law and Regulations to protect the environment and the national security and in accordance with the international practices in these matters." (Clause t)

<u>June 6 and June 7, 1983 to June 5, 1989</u>
The Law of Hydrocarbons No. 1775 was introduced on June 6, 1983. The relevant measures were:

> "Perform all of the services which are the object of the contract, according to the best international practices and techniques generally accepted in the hydrocarbon industry. These services must be performed preserving in the environment without damaging public or private property. For the pollution caused by the contractor's operations, the latter must perform the corresponding decontamination works notwithstanding his responsibilities to third parties and the corresponding authorities." (Clause 204)
>
> "Contractor will adopt the measures necessary for protecting the flora, fauna and other natural resources and, at the same time, will avoid polluting air, water and soil as per the respective legal provisions and international agreement." (Clause 33)

The Law of Hydrocarbons No. 1771 was introduced on June 7, 1983. Provisions were similar to those contained in the Law of Hydrocarbons No. 1773.

<u>June 5, 1989 to June 1990</u> (Decree No. 2144)
A regulation for the prevention and control of environmental pollution related to water resources was introduced on June 5, 1989. This regulation established specific discharge requirements for

septic and industrial waste waters.

The above summary of development of Ecuadorian environmental laws and regulations indicates that there were numerous changes during the period of operation of the consortium. Basic provisions for protection of soil, atmosphere and water from pollution were introduced in 1971. This provision was maintained in some form through to 1990. However, the laws and regulations lack specific environmental standards against which to assess compliance.

In addition, provision was made for the operator to comply with international practices in the Hydrocarbon Law (Decree 101) introduced in August 1982. The following section provides a summary of typical operational practices for the petroleum industry in tropical rainforest areas.

4.3.2 Operational Practices in Tropical Rainforest Areas

A review of typical operational practices in tropical rainforest areas was completed and the results are presented in the report "Final Assessment Criteria for an Environmental Evaluation of the PETROECUADOR-TEXACO Consortium Oil Fields". A summary of typical exploration drilling practices from 1964 to 1990 is given in Table 4-3. A summary of typical development and production practices for the period 1964 to 1990 is given in Table 4-4.

4.4 COMPLIANCE ISSUES FOR OIL FIELD DEVELOPMENT AND OPERATIONS

Throughout the period of operation of the PETROECUADOR-TEXACO Consortium, there has been a consistent approach in the Laws and Regulations to the prevention of pollution of soil, water and the atmosphere. This can be summarized in the form of the three main compliance issues for oil field development and operations given in Table 4-5. No corresponding technical standards have been developed during this period to provide a basis for assessing compliance for the petroleum industry. However, criteria values for various parameters for soil and water were developed specifically for this project. These values are summarized in the report "Final Assessment Criteria for an Environmental Evaluation of the Petroecuador Consortium Oil Fields".

TABLE 4-3

Typical Exploration Drilling Practices for the Period 1964 to 1990

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	1964 to 1969	1970, 71, 72 and 73	1974, 75 and 76	1977, 78 and 79	1980, 81, 82 and 83	1984, 85 and 86	1987, 88, 89 and 90
Access	• Barges and short access roads from staging areas.	• Similar to previous section, but more activity.	• Similar to 1970-73.	• Roads constructed with large equipment.	• Roads developed if necessary.	• Roads developed in new areas.	
	• Wellsites located close to surface water courses.		• Proximity to water not as important.	• Lease not always located near water.	• One lease used for several wells.	• Noise considered impacting natives and animals.	
	• Helicopter not used until late 1969.	• Personnel moved by helicopter and planes.	• Large helicopters used for heavier loads.	• Helicopter used for rig moves.	• Helicopter widely used.		• Continued use of helicopters. Geotextiles used along access roads (1989).
	• Earth-moving equipment used for barge landings, staging areas, access roads, base camp clearings and wellsites.	• Low grade access roads. Staging areas 160 x 200 m. Site cut timber used as barge landing material.	• Roads built with large equipment and existing roads were extended for new leases.	• Leases are larger in size.			• Road and lease design to minimize impacts. Top soil stripped and stockpiled.
	• No erosion control, erosion hampered operations.						• Erosion control practices incorporated.
	• Surface drainage patterns were disrupted.		• Natural surface streams rerouted.				• Adopted international standards (1988).
Waste Handling	• Drill sumps dug at each lease.			• Sumps were not lined.	• Fluids collected in sumps, excess drained into surface water.		• Separate mud, sump and burn pits made. Water based muds and additives used.
	• One sump was used for all drilling wastes, located in the lowest possible spot.			• Oil and liquids burned before abd.			• Tanks used for oil based muds and not dumped.
	• Drilling muds and fluids were left in the sumps after testing and abandonment.	• Same, discharged to surface water.	• All waste and fluids collected in sump were disposed of to surface water.			• Drilling fluids were collected in larger sumps.	• Plans to contain, control and dispose of fluids and cuttings.
	• Soil dug from the sump was used to level the lease.						
	• Lease runoff was directed to surface water.						• Heavy metals precip generally avoided.
	• Water supply from surface water and shallow wells.						• Reinjection of drilling fluids.
	• Drilling muds and cuttings were flowed into the closest surface water.	• Same.	• Regulations for drilling waste introduced (1974). Air pollution protection introduced (1976).				
	• Wellhead BOP's were non-existent.						

TABLE 4-3 (CONT'D)

	1964 to 1969	1970, 71, 72 and 73	1974, 75 and 76	1977, 78 and 79	1980, 81, 82 and 83	1984, 85 and 86	1987, 88, 89 and 90
	• Excess flow test oil was drummed and shipped for analysis, remainder discharged to surface water.	• Same.	• Arsenic and acids containing organic inhibitors recom. disposal in landfills (1975).	• Production fluids tested in drill site tanks or tested at the battery.	• Testing into tanks or flowlines to batteries.	• Excess fluids discharged into forest.	• 1990 no regs regarding waste handling see 1971-83 regs.
	• Sanitary facilities were trench latrines.	• Sanitary sewage discharged to surface water.			• Untreated sewage discharged into surrounding area. Solid waste collected on site.	• Sewage was sometimes treated.	• Sewage treated before disposal. Refuse and HC waste incinerated and burned on site.
	• Camp and operation refuse was mixed, piled and burnt on site.	• Solid wastes, empty chem. drums piled on lease.					
	• Operations used more than one dump site per well.				• Natural revegetation on lease.		
Base Camps	• Temporary nature, modelled after military operations.	• Same. Site clearing = 40,000 to 50,000 m². Helicopter assisted. Sanitary sewage discharged to jungle.	• Same as 1960. Trailers were used for crews. Site selection processes were formalized (1975) to minimize spill risk. Potable water wells were drilled. Septic treatment of waste more common.	• Similar to 1974 standards.	• Existing facilities used more often.	• Began berming fuel storage areas.	• Camps were self contained. Waste and sewage treated.
Site Abandonment Restoration	• No reclaim/abd procedures used on lease, access or barge areas.	• Same.	• Abandoned wells were capped, cement plugs used. Wellhead piping removed and casing flanged.	• Leases not reclaimed after abd. Greater natural re-veg ability.	• Similar to late 1970.	• Started abd and reclaim practices to isolated lease.	• Abd wells properly plugged and zones isolated.
	• Wells were stripped of surface equipment.	• Clean-up was noted only on highly visible sites.	• Sites left for natural reveg. with increased change to re-establish.	• Some sites reveg by planting grass.		• Require to remove equipment.	• Wellhead, casing and collar removed.
	• Casing was welded, cement injected.					• Solid water collected and burned and buried.	• Pits were infilled without displacing contents.
	• Sumps were burned before leaving.						• Leases cleared of equipment and debris.
	• Abandonment based on future value.						• Revegetation established and access blocked.

TABLE 4-4

Typical Development and Production Practices for the Period 1964 to 1990

	1964 to 1969	1970, 71, 72 and 73	1974, 75 and 76	1977, 78 and 79
Access	• By land, on upgraded roads.	• Narrow roads built for lease/site access.	• Small airstrips built for emergency evacuation.	• Major access roads upgraded.
	• No erosion control.			
Base Camps	• Exploration camps used and permanent buildings constructed.	• Camps constructed from portable trailers.	• Similar to previous years.	• Camps upgraded to batteries. Harvesting local crops near clearings.
	• Site runoff through ditches or not addressed.			• Untreated sewage discharged to creeks.
	• Trench latrines.			• Solid waste collected in surface dumps which reveg.
	• Water supplied from surface or shallow wells.			
Drilling	• Practices follow exploration practices.	• Oil from test tanks was recovered.	• Artificial lift introduced (gas lift/water flood).	• See exploration practice.
	• All wastes discharged directly into surrounding environment or stored until next rainstorm.			
Production Operations	• Natural lift flowing wells.	• Gas separation at battery.		• Larger pits to hold more produced water.
	• Gas was flared in pits.	• Wash tanks and small open pits used.		• Pits built in series, discharge into streams.
	• Excess fluids discharged into environment.	• Produced gas was flared in pits or short stacks.		• Potable water from river, filtered and chlorinated.
		• Excess pit fluids drained to surrounding areas at batteries.		
		• Spills were common and left in place.		
Pipelines	• Pipelines not protected from corrosion.	• Same.		• More pipeline installation.
	• Leaks and breaks are common.	• Lack or preventative maintenance.		• Increased pipeline failures.
	• Oil may be removed by vacuum truck or left in place.	• Line breaks at road crossings, water crossings, line under high pressure.		• Spills larger but more remote than previously.
Site Abd and Restoration Base Camps	• Salvaged only valuable equipment.	• Equipment recovered from abd wells.		• Natural site remediation more effective.
	• No effort made to remediate or prevent erosion.	• No reclamation attempted. No soil erosion prevention.		• Little remediation effort.

TABLE 4-4 (CONT'D)

	1980, 81, 82 and 83	1984, 85 and 86	1987, 88, 89 and 90
Access	• Roads were rebuilt. • Larger airstrips built.	• Road erosion controlled by piles and metal sheets.	• New access roads planned for better access. • Upgrade existing roads. Provision for erosion/reduce stream sedimentation.
Base Camps	• Sewage from camps rudimentary treated in septic tank and overflow into surface water. • Water from river, filtered, chlorinated. • pH and chlorine testing of water.	• Larger, centralized camps.	• Large areas cleared and drained for facility dev. Temp. camps upgraded to perm facilities. • Septic tanks installed. Landfills centrally located, no liners, monitoring. Incinerators used. Hunting restricted.
Drilling	• See exploration practices.	• Service fluids (NaCl brines) discharged to area.	• Directional drilling increased. Pits used for drilling muds only. Remote sumps used. Mud reuse, landfarming, proper disposal injection.
Production Operations	• Solid waste collected and piled for reveg. • Solids, emulsions and fluids drained from tanks annually • Drained to surface water. • Excess gas flared at batteries. • Prod. water from high TDS, chlorides and temp. discharged to surface water.	• Spills in/around batteries covered with soil. • Bleeding gas, drains, tank lines, etc. continued. • Chemicals widely used in all operations. • Chem drums disposed of with solid waste. • Berm runoff directed into sumps/pits.	• Production facilities paved, veg. established. • River and pit drains sampled. • Tank bottoms used for dust control on roads. • Oil interceptor used for discharged water. • Recovery of gas considered.
Pipelines	• Cathodic protection first used on main lines. • Flowlines coated with carbon steel. • Line leaks repaired. • Pigging facilities built on major lines.	• Chems used to protect lines from corrosion. • Dispersants used for spills. • Existing lines upgraded to min. leaks. • Preventative measures started to control product loss.	• Satellite pumping stations used. • Pipeline leaks repaired. • Pipe inspection upgraded.
Site Abd and Restoration Base Camps	• Abd practices followed exploration practices.	• Salvage all site equipment, burn/bury solid waste on abd.	• Equipment salvaged and removed from site. Pits were filled, installations levelled.

TABLE 4-5

Summary of Compliance Issues Related to Ecuadorian Law as a Result of Oil Field Development and Operations

Issue Identified from Laws and Regulations	Potential Contaminant Source
Contamination of Soil	Oil/brine spills from wellheads, flowlines, pipelines. Dams and drains of tank basins. Disposal of tank bottoms. Disposal of chemicals and containers. Seepage from pits.
Contamination of Water	Oil/brine spills from wellheads, flowlines, pipelines. Dams and drains of tank basins. Disposal of tank bottoms. Wastes disposal. Disposal of chemicals and containers. Overflow and seepage from pits. Disposal of produced water.
Contamination of Air	Burning of oily wastes. Incineration of miscellaneous wastes. Use/disposal of produced gas.

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PART 5 - FACILITY AUDIT

5.1 INTRODUCTION

The main objective of the facility audit was to gather information on operational practices to provide an understanding of contaminants that may have entered the environment from past (pre 1990) practices. Specific objectives included:

- to obtain information relevant to operational procedures prior to June 1990 and post June 1990. This information will assist in determining possible causes of soil, ground and surface water contamination during the period 1964 to 1990; and
- to obtain information on operational practices to determine compliance with Ecuadorian Law and tropical rain forest practices as summarized in Part 4.0 and the Criteria document.

5.2 METHODOLOGY

Audit information was gathered from three different sources:

- preliminary information was gathered by reviewing office files from the PETROECUADOR office located in Quito, Ecuador;
- a preliminary audit questionnaire; and
- the facility audit.

5.2.1 Pre-Audit Questionnaire

The pre-audit questionnaire was developed from the information gathered from the file review. This questionnaire was sent to each of the main production facilities and information was requested including the names of personnel most knowledgeable on plant operations and field operations, waste disposal, spill response, environmental monitoring, historical documents and past practices. The availability of procedures documentation and government licences was also determined. Information was also requested on present and past treatment and disposal or abandonment practices for produced water, tank bottoms and residual oil, drilling fluids, pits, produced gas, chemicals, sewage, filters, drums, equipment taken out of service and materials contaminated by spills. A copy of the pre-audit questionnaire is given in Appendix B.

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5.2.2 Facility Audit

The information obtained from the pre-audit questionnaire was then used to refine the protocols developed for the audit. The facility audit was conducted from May 17 to June 3, 1993. The audit was conducted at the camp stations of the main oil fields. These stations include Lago Agrio, Shushufindi, Sacha and Auca. These main stations had personnel knowledgeable on the operation of all the fields. The operational records of the smaller fields were also located at these main camp stations. The facility audit at the four main stations therefore incorporated information from all 22 production stations (Table 5-1).

Audit information on the operational practices was gathered by the following methods:

- review of Department of National Hydrocarbons (DNH) and PETROECUADOR files; and
- operator interviews.

A master audit checklist (Appendix B) was used during the facility audit to record the source and availability of information for specific areas of oil field operational practices. This provided a screening mechanism so that information could be located and collected for relevant areas of operational practice.

Information on the three main areas of oil field operational practices was collected:

- facility management;
- well site management; and
- pipeline management.

A facility audit protocol list (Appendix B) was used to "key in" on specific aspects of oil field operational practices. It as organized according to the three main areas listed above.

The facility management section included such aspects as:

- general information;
- facility description;
- site history;
- site characteristics;
- air emissions;
- water/wastewater discharges;
- waste handling and storage, transportation and disposal;
- material handling and storage;
- storage tanks;
- use/disposal of produced gas;
- containment and control of crude oil spills;

TABLE 5-1

The Association Between the Four Camps, Where the Facility Audits were Conducted and the 22 Production Stations

Main Camp Station	Oil Field	Production Station
Lago Agrio	Lago Agrio	Central Production Station
		North Production Station
	Parahuacu	Production Station
	Atacapi	Production Station
	Guanta	Production Station
	Dureno	Production Station
Shushufindi	Shushufindi	Central Production Station
		North Production Station
		South Production Station
		Southwest Production
	Aguarico	Production Station
Sacha	Sacha	Central Production Station
		North #1 Production Station
		North #2 Production Station
		South Production Station
Auca	Auca	Central Production Station
		South Production Station
	Auca Sur	Production Station
	Culebra	Production Station
	Yulebra	Production Station
	Yuca	Production Station
	Yuca Sur	
	Rumiyacu	
	Cononoco	Production Station

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- radioactive materials;
- noise;
- disposal of produced water; and
- disposal of tank bottoms and residual oil.

The well site management section included such aspects as drilling and workover pits, disposal of tank bottoms and residual oil, management of residual wastes, disposal of excess chemicals and their containers.

The pipeline management section includes the condition, management and repair of the secondary and main pipelines within the fields.

The following is a list of the key personnel interviewed at the main camp stations. These people were originally identified in the pre-audit questionnaire as the most knowledgable about the different aspects of the facility operational practices.

Lago Agrio	
Isias Carrillo	Production Superintendent
Fausto Jara	Head of PETROAMAZONAS Environmental Unit
Antonio Troya	Environmental Unit
Jorge Pinafiel	
Carlos Chavez	
Shushufindi	
Marco Ochoa	Camp Supervisor
Patrico Flores	Materials
Galo Naranjo	Production
Luis Fierra	Production
Antonio Troya	Environmental Unit
Frenando Roman	Environmental Unit
Pablo Moreno	Head of Special Projects
Sacha	
Hector Diez	Camp Supervisor
German Velladares	Production
Marcelo Agula	Production
Antonio Troya	Environmental Unit
Fernando Roman	Environmental Unit
Auca	
Lauro Mora	Camp Supervisor
N. Grijalua	Production

Pablo Moreno	Head of Special Projects
M. Moran	
Antonio Troya	Environmental Unit
Fernando Roman	Environmental Unit

5.3 SITE DESCRIPTIONS

5.3.1 Lago Agrio

The topography of the Lago Agrio area is typically rolling hills with the Rio Aguarico flowing south of town. Much of the surrounding native jungle has been cleared for residential housing and livestock grazing. Numerous banana and coffee plantations have been planted in the area. The soil varies from sand to red clay to an unknown depth.

5.3.2 Shushufindi

The topography of the Shushufindi area is low rolling hills with numerous streams. The Aguarico River divides the Aguarico oil field from the Shushufindi field. This river is crossed by a small bridge along the central road. The surface geology shows silts and clays to unknown depths. The main facility is located on a flat area crossed by numerous streams. Lush forest growth surrounds the facility. Numerous fruit, coffee and banana plantations are present.

5.3.3 Sacha

The Sacha area is characterized by relatively flat topography with numerous creeks and streams flowing through the area. The field area is located north of the Rio Napo. The town of Coca is approximately 20 km southwest from the main camp. The main facility is located on an area which is fairly flat. Most of the native rain forest has been cut down for plantation and grazing purposes. The local industries located in the township of Sacha mainly exist to service the local population. Coca is more industrialized and contains services both for the oil industry and local services.

5.3.4 Auca

The topography of the Auca and outlying areas is typically hilly with numerous streams surrounded by native jungle and sparse plantations. The northern boundary of this area is the Rio Napo. Less colonization has taken place in this area compared to the northern areas studied. There are no surrounding urban centres and few services for the colonists. The Auca station is located on a hill and there are no critical wildlife habitats recognized in this area. Several large streams are in the vicinity of the Auca facility. The local surface geology is silts and clays to an unknown depth. River gravels and sands have been used to build the lease sites.

5.4 OVERVIEW OF FACILITY OPERATIONS

5.4.1 Process

A flow diagram which details the production process is shown on Figure 5-1 (Map pocket). The process collects produced fluids (oil, gas and water), separates and disposes gas and water and delivers crude oil to market via pipeline. The type, quantity and capacity of processing equipment used at the stations is also detailed on Figure 5-1. The separation process is conducted at eighteen outlying production stations and four central production stations. All twenty-two production stations are currently, or have at some time, discharged oily produced water to the environment and flared excess gas. The stations have processed a total of approximately 1.4 billion barrels of oil, 250 million cubic-feet of gas and 375 million barrels of produced water during the period 1964 to 1990.

Installations at production facilities include surge tanks, wash tanks, oil storage tanks, separators, manifolds, pumps, generators, metering stations, flaring systems and produced water separation pits.

5.4.2 Central Facilities

5.4.2.1 Lago Agrio

Lago Agrio is the largest of the central stations. The facilities at Lago Agrio include the following:

- main camp;
- north station;
- central station; and
- outlying stations including Parahuacu, Guanta, Atacapi and Dureno.

The main camp covers approximately 80 ha and approximately 196 people work and are accommodated within the camp. The camp includes PETROAMAZONAS offices, vehicle and equipment maintenance area, reforestation nursery, a fire station, camp water supply tanks, used equipment storage, chemical storage, accommodation, cafeteria, medical clinic, airport and recreation facilities.

A camp waste incinerator is located at the nearby north station.

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DIAGRAMA DE FLUJO DE RRODUCCION

DISTRITO ORIENTE

Figure 5-1

DISEÑO W.N. GOMEZ N.	APROBO PABLO MORENO	DEPARTAMENTO PROYECTOS ESPECIALES	REVISADO DEPARTAMENTO DE PRODUCCION

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The central station is divided into two areas, the process facility and the tank farm. The process facility collects the produced petroleum products from the outlying stations and nearby well sites for final processing before storage at the tank farm. This facility is larger than the field stations, but the process is similar. The product is then stored at the tank farm before being transported via pipeline to a refinery.

5.4.2.2 Shushufindi

The facilities within the Shushufindi field include:

- central production station;
- north production station;
- south production station;
- southwest production station; and
- Aguarico production station.

The volume of oil processed at the Shushufindi stations is currently approximately 105,000 barrels per day.

Facilities at the camp and central production station include hydrocarbon processing area, PETROAMAZONAS offices, maintenance area, vehicle maintenance, fire station, accommodation, cafeteria, medical clinic, airport and recreation facilities.

5.4.2.3 Sacha

The facilities at Sacha are divided into the following:

- central production station and main camp;
- north #1 production station;
- north #2 production station; and
- south production station.

The total volume of discharged fluids is 56,000 barrels per day from the Sacha facilities. The Central Station produces 20,000 bbl/d, North #1 station produces 2,700 bbl/d, North #2 station produces 2,900 bbl/d and South Station produces 7,000 bbl/d. The water injection system currently injects of 13,000 barrels of water into the reservoir.

The central production station and main camp covers approximately 47 ha and approximately 77 people work and are accommodated within the camp. Facilities at the camp include PETROAMAZONAS offices, vehicle maintenance, fire fighting capabilities, housing, cafeteria, medical clinic and recreation facilities. The central production station was constructed in 1971.

5.4.2.4 Auca

The facilities at Auca include the following:

- central production station and camp;
- south production station; and
- outlying production stations at Culebra, Yulebra, Yuca, Yuca Sur, Cononaco and Rumiyacu.

The Auca central station and camp occupy approximately 30 ha. Approximately 62 people work in the Auca oil field and production facilities and are accommodated within the camp. The camp includes PETROAMAZONAS offices, vehicle and equipment maintenance area, a fire station, accommodation, cafeteria, medical clinic and recreation facility. The camp supplies most of the services needed to operate the facilities.

5.5 SUMMARY OF FACILITY AUDIT OBSERVATIONS

The following sections provide a summary of the observations recorded during the facility audit. The information is organized according to the three main areas of operational practices: production facility management, well site management and pipeline management. The operational practices were found to be similar between facilities and are therefore summarized according to the main aspects of operational practices. Any differences in practices between different facilities have been noted below.

5.5.1 Production Facility Management

The production stations are all similar in design, the only variance is the capacity of each station. Each station uses a gravity separation system in conjunction with separators to separate the oil from the produced water. The oil is not refined on site but is sent via a pipeline to a refinery on the coast of Ecuador. The produced water is disposed of through a waste stream into the surrounding area. The excess gas produced with the oil is flared at each of the stations. A freshwater injection system has been developed for the Shushufindi and Sacha fields. Both systems inject freshwater into the production formations using abandoned production wells. The Shushufindi injection system has been in use since 1984.

Power generation for the camps, the production stations and the well sites is provided by gas fired turbines located at each of the central stations.

5.5.1.1 Air Emissions

Sources of atmospheric emissions from the stations include flare stack emissions, equipment exhaust, and an incinerator at the Lago Agrio north station. The incinerator burns non-biodegradable waste from the camp. The local people use the ash generated for crop fertilizer. The incinerator was built approximately 12 years ago and uses gas produced from the station to fuel the burners. No monitoring systems are in place or used to test the flare stack emissions or emissions from the incinerator stack.

A response procedure in event of accidental product release or complaint has not been developed. There have been no reported abnormal emission events.

5.5.1.2 Water/Wastewater Discharge

Potable Water

The source of potable and process water for Lago Agrio has been the Rio Teteye. This is currently changing to a well source, due to contamination from unknown sources in the river. The water is presently filtered, flocculated and chlorinated. Drinking water is further sampled and analyzed daily in the camp laboratory.

Process and potable water for the Shushufindi station and main camp is supplied by a nearby river. Potable water is disinfected by an ultraviolet purifier.

Process and potable water source for the Sacha stations is the Rio Blanco. Potable water treatment method was not described during the audit.

At the Auca facility, potable and process water is obtained from a large stream north of the facility. This stream also receives liquid wastes produced at the facility. No potable water contamination has ever been identified from this source.

Wastewater

Wastewater streams from the stations and camps include produced water, sewage, wash water from the laundry and car wash, runoff from the process area, surface drains and floor drains. These streams are either diverted back through the produced water system or collected in a system of ditches throughout the camp which discharge into nearby streams. There are no evaporation ponds or other wastewater impoundment areas at the main facilities. No testing is conducted on the wastewater prior to disposal into the river except at Shushufindi where wastewater bioassay testing has been conducted since 1990. These waste streams were similar prior to 1990.

Sewage has been treated at Lago Agrio in open pits since 1992. Prior to this, sewage was released on land or stored in pits that emptied into the local river. A system of heat treatment is presently being investigated for sewage treatment. Sewage at Shushufindi is held in a septic tank which discharges directly into a river. At Auca, the sewage stream is designed so that it flows into a cistern and then is released into the jungle. The sewage effluent is not analyzed before release.

Non-potable water used for fire fighting is stored in tanks at all of the central stations. Numerous creeks and rivers flow through the concession area. Produced water, run off from vehicle and equipment washing, surface run-off from the leases and stations as well as outflow from pits is diverted or discharged into these streams. Rainwater is directed into surface culverts and then diverted of off-site via ditches.

There is no required groundwater monitoring program for any of the fields assessed. No groundwater monitoring program was in place prior to 1990 at any of the stations. There are no water wells presently drilled at the facilities.

A groundwater monitoring program was reportedly initiated at Shushufindi in 1990. Groundwater samples are collected by an engineer. The operators reported that surface and subsurface contamination is present, however they did not provide specific information regarding well locations or monitoring data. Numerous shallow domestic water wells are used within the town and by rural residents.

A groundwater monitoring program has not been developed in Lago Agrio, Sacha or Auca. The operators are not aware of groundwater contamination. The water table is encountered at approximately one to two metres depth in most areas of the fields. Regional groundwater flow varies depending on the local topography. The depth to potable aquifers also varies, although most residential wells are hand dug.

5.5.1.3 Waste Handling, Storage, Transportation and Disposal

Prior to 1990, organic waste was disposed of at a Lago Agrio well site or at the facility and non-biodegradable material was stored in drums and disposed of at a local landfill. The location of this landfill was not provided. A new landfill is presently being constructed in Lago Agrio. Since 1990, the waste in the Lago Agrio field has been separated with the biodegradable material composted and the remaining waste incinerated at the North Station. Organic wastes are presently placed in a compost generator pit at the Shushufindi central station. Prior to 1990 waste was buried or burnt in a pit off site. Organic waste at Sacha is currently buried at Sacha 40 well site. Burial of waste at different well sites has taken place historically in this field. No incineration of wastes is presently done at the Shushufindi, Sacha, or Auca fields.

No waste materials are presently recycled as there is no facility that can accept this material. Waste reduction and pollution prevention plans are currently being developed. Prior to 1990 no plans were in place. It was reported that in the future, compost generated from organic wastes will be used during tree planting operations.

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A waste storage facility was constructed at the Shushufindi central station in 1991-92. Prior to the construction of this storage area there was no facility to securely store these wastes. Prior to 1990 all non organic waste was buried with no prior testing. The storage practices for this facility are to containerize the waste in 45 gallon drums and then stockpile the drums. Empty drums are also stored at this facility. A water collection drain constructed into the base of the concrete enclosure drains into a retention pit, which drains into the jungle.

Specific waste oils including lubrication, hydraulic, generator and cutting oils, are placed in drums and buried at Shushufindi. Waste oils from the Auca stations are disposed of in a concrete sump which drains directly off site without treatment. Oily sludge generated at Auca is also spread on the lease roads for dust control. Oily sludge from Lago Agrio is now reprocessed. Prior to 1990 these sludges were either reprocessed or spread on lease roads for dust control.

The commonly used chemicals in all fields include demulsifiers, descalers, anticorrosives, antifoaming agents, antiparaffin and acid bath chemicals. Additional chemicals in use at Shushufindi and Sacha include surfactant, bactericides, polyelectrolites, sodium hydrochloride, acetone and hydrochloric acid. These chemicals are stored on racks in 45 gallon drums in a fenced area, or in storage tanks in the tank farms. Empty chemical drums are returned to the supply company.

5.5.1.4 Material Handling and Storage

A material inventory list is generated at each station. A separate hazardous material list has not been made as no hazardous materials are recognized as such. Materials are received by contractor supply trucks and stored in drums on racks or in larger storage tanks. The drums are periodically inspected for signs of leakage.

No waste materials are presently recycled or reused. Waste reduction and pollution prevention plans are currently being developed.

5.5.1.5 Storage Tanks

American Petroleum Institute (API) standards are reportedly followed in the design and use of the aboveground storage tanks. The tanks are reportedly inspected visually for corrosion and leakage. Most of the corrosion damage reported is on the base of tanks due to water, and at the top from gas. Storage tanks have historically been repaired or dismantled as necessary, but not abandoned due to increased production throughout the fields. Underground storage tanks are reportedly not used at any of the stations due to the high water table and the highly corrosive nature of the soil.

The Shushufindi storage tanks were inspected by station personnel in April 1990. Over the past few years the tanks have been sonically tested on a regular basis. The Sacha storage tanks at Auca and Sacha are reportedly inspected visually for corrosion and leakage. Integrity testing on the tanks started in the late 1980's and is currently done.

5.5.1.6 Use and Disposal of Produced Gas

Produced gas is gathered through a series of compressors and fluid separation systems. Excess produced gas is flared only at the production stations, but venting may take place at the well sites. Produced gas has recently been used as fuel at the production stations. Prior to 1990 all excess gas was vented or flared. Knockout tanks are not in use along flare lines. Liquids in the flare line drain onto the ground or into nearby separation pits.

5.5.1.7 Containment and Control of Crude Oil Spills

Integrity testing of storage tanks started in November 1989 and use of spill prevention measures such as sonic testing began post 1990. Primary and secondary containment barriers such as berms and ditches and emergency containment equipment (e.g., absorbent materials) are designed to limit spill migration. Emergency containment equipment is stored at Lago Agrio and Shushufindi central station. Spills and leaks are detected by volume and pressure loss in the system. Oil spill material from the Sacha stations is disposed of into the produced water stream.

Prior to 1990, no spill prevention methods were in place. The recently formed PETROAMAZONAS Environmental Unit has recognized the need for additional spill control, reporting and spill site reclamation. Implementation of proposed methods has not taken place. A spill response plan, which has yet to be developed, will outline specific response and control responsibilities, training requirements and identify personnel designated to respond to public concerns. A plan that addresses spill response for road transports has not been developed.

5.5.1.8 Radioactive Materials

There are no radioactive materials reportedly used or generated at any of the production stations.

5.5.1.9 Noise

The principal sources of noise are compressors, pumps, generators and turbines. No complaints have been reported due to the noise levels. The operators were not aware of any regulations that have to be met or complied with due to noise production.

5.5.1.10 Disposal of Produced Water

The stations use a gravity separation process in the wash tank to separate oil from produced water. Produced water is then passed through a series of open, unlined pits. Oil is periodically skimmed off the surface and stored in tanks before reprocessing. The remaining oil emulsion and produced water is discharged into a local creek or river or in some instances directly into the jungle. For further information on produced water effluents, see Part 7.0. Produced water has historically not been tested prior to disposal, although irregular testing was reported to have taken place prior to 1990.

Deep well reinjection for a portion of the produced water is presently in use at the Shushufindi and Sacha fields. At Sacha, water injection began in 1986 and currently 13,000 bbl/day are reinjected. A produced water storage facility associated with the water injection wells at Sacha was constructed after 1990. A reinjection system is also being designed for Lago Agrio.

5.5.1.11 Disposal of Tank Bottoms and Residual Oil

Tank bottoms are not treated or analyzed before disposal and the volume of waste is not recorded. The material is presently disposed of on the roads or in pits. This practice is the same as before 1990. Treatment or recycling of tank bottom material and residual oil is not currently practised.

5.5.2 Well Site Management

Exploratory drilling and development drilling typically used freshwater based muds and salt based muds. Standard fluid circulation equipment included a shale shaker which was used to segregate the drilling fluids before recirculating into the main sump. Drilling muds at Lago Agrio were treated in the sump using flocculants and polymers. Muds were tested prior to disposal. Prior to 1990, muds containing lithium sulphate and other heavy metals were disposed of in sump pits.

Upon completion of the well, the wellhead cellars were filled with concrete and gravel. Some of the wellheads are protected against accidental impact by steel pipe fencing. All equipment and buildings associated with drilling and not necessary for the operation of the well have been removed from the well sites.

Workover, completion wastes, salt solutions and oil/water emulsions have historically been disposed of into well site pits. Currently some of these wastes are collected in tanks or deposited in concrete separation pits at the production stations. Little maintenance has reportedly been done on any of the pits at the well sites. Workover and completion wastes in the Lago Agrio field are reprocessed at the Lago Norte station. The acid water produced from workovers in all fields is now neutralized and disposed by the contracting company. Previously, this water was disposed of in the well site pits. All fractionation sands and related acidic chemicals are disposed of by the company contracted to do the work. The method and place of disposal for these wastes was not identified.

Since 1990, the suspended wells have been monitored similarly to the operational wells, but on a less frequent basis. Monitoring schedules before 1990 are not known. Prior to 1990, pits were not maintained. Since then erosional damage has typically been repaired. Post 1990 efforts have been made to minimize the working size of the well sites. Prior to 1990, no effort was made to minimize the lease size but natural infilling took place due to the growth rate of the surrounding vegetation.

An environmental unit of PETROAMAZONAS has been formed since 1990. This unit has recently recognized the need for spill prevention methods. Prior to the formation of this unit, no preventive measures other than occasional visual monitoring programs were undertaken. The current spill monitoring program involves visual inspection of the well sites every three months.

A reforestation program has begun through the development of the nursery facilities at Lago Agrio main camp. The main stations, except for Auca, are presently supplied with information and plants from the Lago Agrio nursery. The Auca reforestation program will be in place in 1994. Part of this reforestation program includes donating plants to farmers. Prior to 1990 no reforestation program for any of the fields was in place. Vegetation and weed control has historically been done by manual labour.

Protection of surface water quality was reportedly not considered during exploration drilling. Prior to 1990, some measures were taken in Shushufindi to protect surface water, fresh water and mineral resources from contamination depending on the lease location. Since 1990 limited protection measures have been instituted. As an example, waste streams are now being separated and tested prior to disposal at Sacha.

5.5.3 Pipeline Management

Pipelines are currently monitored every three months and a visual inspection is done during well servicing. Since 1990 sonic pipeline monitoring has been part of the program. Suspended flowlines are also visually monitored. Spills are recorded on a form and filed with the DNH. Spills are usually detected by a pressure or volume decline. Spills have reportedly always been assessed for remediation. Manual vegetation control programs have always been in place along the pipeline right of ways.

5.6 SUMMARY OF AUDIT FINDINGS

This section provides a comparison of the observations of oil field operational practices recorded during the facility audit to compliance issues identified from the regulatory review. A summary of the operational practices for the Consortium oil fields is given in Table 5-2. In most cases, the operational practices are the same before and after 1990. There are exceptions with regard to composting of organic wastes at Lago Agrio, testing of drilling fluids prior to discharge, well site revegetation and the frequency of pipeline and well site inspections.

5.6.1 Compliance of Operational Practices with Ecuadorian Law

As noted in the regulatory review (Part 4.0), Ecuadorian Laws and Regulations are concerned with three main issues, namely preventing pollution of soil, water and air. Oil field development and operations can cause pollution of soil, water and air as a result of several different activities. These are identified in Table 4-5. To assess whether the Consortium oil field operations were in compliance with Ecuadorian Law and Regulations for the period 1964 to 1990, operational practices prior to 1990 (from Table 4-5) were compared to activities identified from the facility audit as potential sources of contamination to soil, water and air (Table 5-2). The results of this comparison are presented in Table 5-3. In all cases, activities likely to cause contamination were identified from pre-1990 operational practices. Therefore, the Consortium oil field operations prior to 1990 were potentially not in compliance with Ecuadorian Law and Regulations.

No technical standards were developed in association with Ecuadorian Law for the period 1964-1990 which can provide a basis for assessing compliance of operational practices with the Laws and Regulations. For example, for a given oil spill there is no stated oil and grease value in soil which is considered unacceptable and would require remedial action. However, criteria values for various parameters for soil and water were developed specifically for this project. These values are summarized in the report "Final Assessment Criteria for an Environmental Evaluation of the PETROECUADOR Consortium Oil Fields". The criteria values have been used to verify contamination resulting from oil field operations and the results are presented in Part 6.0 of this report.

5.6.2 Conformance of Operational Practices with Typical Operational Practices in Tropical Rainforest Areas

A comparison was made with typical operational practices in tropical rainforest areas (Tables 4-3 and 4-4) with the operational practices recorded during the facility audit (Table 5-2). This was undertaken to assess conformance of the Consortium oil field operations with operational practices in tropical rainforest areas. The results of this comparison are presented in Table 5-4. This comparison indicated that the Consortium operational practices were similar for operational practices of the same period (1964 to 1990) in other tropical rainforest areas.

TABLE 5-2

Summary of Operational Practices for the Oil Fields for the Period Prior to 1990 and After 1990

	Pre 1990	Post 1990
Facility Management		
Air Emissions	Sources included flare stacks gas venting and equipment exhaust.	Same.
	Incinerator installed at Lago Agrio approx. 1980.	Incinerator still operational.
	No equipment used for any emission monitoring or testing.	Same.
Water/Wastewater Discharges	Local river used for potable and process water.	Same, although a well is coming on line for potable water for the Lago Agrio camp.
	Potable water not tested.	The potable water is tested and treated prior to use.
	Wastewater streams include produced water, car wash, laundry	Same.
	surface drainage, equipment area drainage and sewage.	Same.
	Surface runoff discharged into local streams.	Same.
	Sewage not tested or treated prior to disposal into a river.	Same, except for SSF where bioassay testing is conducted.
	No testing prior to discharge of wastewater.	Same.
	No treatment of wastewater conducted prior to discharge.	Same, except at SSF, groundwater monitoring program in place.
	No groundwater monitoring program in place.	

TABLE 5-2

Summary of Operational Practices for the Oil Fields for the Period Prior to 1990 and After 1990 (Continued)

	Pre 1990	Post 1990
Waste Handling and Storage, Transportation, and Disposal	Toxic wastes not treated.	SSF - toxic waste stored in designed pit.
	Oil sludge reprocessed or spread on roads.	Oil sludge is reprocessed.
	All drill muds disposed of in the sumps, with no testing.	Drilling muds are treated in the sumps and tested prior to discharge.
	Landfillable waste disposed of at the well site, facility or landfill.	Biodegradable waste is composted or incinerated at Lago Agrio, burnt or buried at SSF, buried at Sacha and Auca.
		Non-biodegradable waste is stored in drums and buried at the landfill.
	Hazardous waste buried.	Same.
	Specific waste oils put in drums and buried.	Same.
	No recycling of wastes or waste reduction.	Same.
Material Handling and Storage	—	Materials inventory list is made at each station.
	—	No hazardous materials list is made.
	—	Chemicals stored in drums are on racks.
	—	Waste reduction and pollution prevention plans being developed.
Storage Tanks	API standards followed in tank design.	Same.
	No underground storage tanks in place.	Same.
	Tanks inspected visually for corrosion and leakage.	Same, integrity testing by sonic is conducted.
		All tanks at SSF were assessed in April 1990.
Use/Disposal of Produced Gas	Produced gas gathered by compressor and separators.	Same.
	Produced gas flared at the production stations.	Same.
	Venting of gas at some well sites.	Same.
	Gas used for turbine fuel.	Same, gas is used for fuels at Lago Agrio and SSF.
	Knockout tanks not incorporated into the flare lines.	Same.

TABLE 5-2

Summary of Operational Practices for the Oil Fields for the Period Prior to 1990 and After 1990 (Continued)

	Pre 1990	Post 1990
Containment and Control of Crude Oil Spills	Sonic pipe testing started in the late 1980's.	Continued.
	Spills and leaks detected by volume and pressure loss.	Same.
	No environmental management personnel.	Formation of the Environmental Unit
	No spill response plan.	Same.
Radioactive Materials	No radioactive materials used or generated.	No radioactive materials used or generated.
Noise	Compressors, pumps and generators.	Compressors, pumps and generators.
	No complaints.	No complaints.
Disposal of Produced Water	Gravity separation process used in the wash tanks.	Same.
	Produced water passed through pits for oil recovery, then discharged into creek or river.	Same for most production stations.
	Discharged water is not tested prior to disposal.	Reinjection system used in SSF and Sacha fields, soon to be started in Lago Agrio.
	Irregular produced water testing done at Auca.	Water analysis started prior to disposal.
Disposal of Tank Bottoms and Residual Oil	Material not analyzed prior to disposal.	Same.
	Disposal onto roads and into pits.	Practice stopped in 1990.
	Volumes of material not recorded.	Same.
		SSF - treatment and recycling of tank bottoms is beginning.

TABLE 5-2

Summary of Operational Practices for the Oil Fields for the Period Prior to 1990 and After 1990 (Continued)

	Pre 1990	Post 1990
Well Site Management	Spill monitoring program not documented.	Visual spill inspection program every 3 months.
	Wellhead cellars infilled after completion.	Same.
		Contractor responsible for lease clean-up or debris and equipment.
	Suspended well sites not maintained.	Same.
		Pits are regularly inspected for damage.
	Workover and completion fluids disposed of into on-site pits.	Workover fluids are stored in tanks.
	Produced water disposed of into the jungle river.	Deep well injection program is in place at SSF and Sacha, soon to be started in Lago Agrio.
	Spraying of lease roads with crude oil (no tank bottoms).	Spraying of crude oils stopped around 1991.
	Frac sands and acids disposed of by contractor.	Same.
	All leases have been cleared of excess debris and equipment.	Same, Sacha not all equipment has been cleared from leases.
		Same, SSF - limited water resource protection is practised.
	No protection of water resources.	
	SSF - limited protection measures taken depending on well site location.	Same.
	Limited environmental protection measurements taken.	Suspended and operational wells monitored regularly.
	Well sites monitored irregularly.	Same, SSF - some pits have been infilled while containing sludge.
	Little or no maintenance done on the lease pits.	

TABLE 5-2

Summary of Operational Practices for the Oil Fields for the Period Prior to 1990 and After 1990 (Concluded)

	Pre 1990	Post 1990
Pipeline Management		Inspection done every 3 months with visual inspection during servicing.
		Sonic testing of pipe integrity.
	Spills assessed for remediation.	Same.
	Spills detected by pressure or volume decline.	Same.
	Brush control practised along pipeline rights-of-way.	Same.

TABLE 5-3

Summary of Compliance Issues Related to Ecuadorian Law as a Result of Oil Field Development and Operations

Compliance Issues Identified from Laws and Regulations	Potential Contaminant Source	Operational Practice Identified from Facility Audit	
		Pre-1990	Post-1990
Contamination of Soil	Oil/brine spills from wellheads, flowlines, pipelines.	Yes	Yes
	Dams and drains of tank basins.	Yes	Yes
	Disposal of tank bottoms.	Yes	Yes
	Disposal of chemicals and containers.	Yes	Yes
	Seepage from pits.	Yes	Yes
Contamination of Water	Oil/brine spills from wellheads, flowlines, pipelines.	Yes	Yes
	Dams and drains of tank basins.	Yes	Yes
	Disposal of tank bottoms.	Yes	Yes
	Wastes disposal.	Yes	Yes
	Disposal of chemicals and containers.	Yes	Yes
	Overflow and seepage from pits.	Yes	Yes
	Disposal of produced water.	Yes	Yes
Contamination of Air	Burning of oily wastes.	Yes	Yes
	Incineration of miscellaneous wastes.	Yes	Yes
	Use/disposal of produced gas.	Yes	Yes

TABLE 5-4

Summary of Conformance Issues Related to Typical Development and Production Practices for Tropical Rainforest Areas

Facility/Operation	Typical Operational Practices (Pre-1990) in Tropical Rainforest Areas	Operational Practice (Pre-1990) Identified from Facility Audit
Base Camps	Sewage discharged into surface water.	Same
	Solid waste deposited in landfills or incinerated.	Same
Drilling	Wastes discharged into pits or directly into environment.	Same
Production Operations	Gas flared in pits or short stacks.	Same
	Produced water passed through pits for oil recovery then discharged into creek or river.	Same
	Spills at well sites left in place.	Same
	Spills at batteries covered with sand.	Same
	Tank bottoms used for dust control.	Same
	Solid waste disposal at oil well sites or landfill.	Same
Pipelines	Line breaks repaired.	Same
	Clean-up of oil by vacuum truck.	Same
	Spills detected by pressure or volume decline.	Same
	Spills reported and assessed for remediation.	Same

PART 6 - SITE ASSESSMENT

DRAFT

6.1 INTRODUCTION

The main objective of the site assessment was to determine environmental impacts resulting from oil field development and production activities in the Consortium concession area during the period March 5, 1964 to June 30, 1990. Specific objectives included:

- to describe contaminated areas including the location and types of contamination; and
- to collect soil, sludge and water samples to characterize background and contaminated areas.

The site assessment was completed in two phases. Phase I consisted of a field survey of 50% of the well sites in each oil field, 20% of the flowlines and 20% of the length of secondary pipelines. Figure 6-1 (map pocket) shows the layout of the fields and the location of production stations and well sites. The Phase II studies consisted of more detailed surface water studies (see Part 7) and groundwater and subsurface investigations (see Part 8). The location of soil, surface water and groundwater samples collected during Phase II are shown on Figure 6-1.

6.2 METHODOLOGY

6.2.1 Site Selection

Environmental assessment was conducted at 50% (163) of the well sites, 20% (66) of the flowlines, 20% (38 km) of the total length of the secondary pipelines and all of the 22 production stations. The well sites, flowlines and secondary pipelines undergoing environmental assessment were randomly selected using computer software. A summary of well sites and flowlines chosen for assessment is provided in Table C-1, Appendix C. Approximately 50% of the well sites within each field were selected for assessment. The locations of these well sites is shown in Figure 6-1 (map pocket). Secondary pipeline segments selected for assessment are presented in Table C-2, Appendix C. Production stations requiring Phase I assessment are shown in Table C-3, Appendix C. Well sites were randomly selected by generating a random number between 0 and 1 adjacent each well site. Randomly generated numbers greater than 0.5 identified the site chosen for assessment. The selection process was completed for well sites in each of the 16 fields. Flowlines were selected in a similar manner, using only well sites which were selected for assessment as the base.

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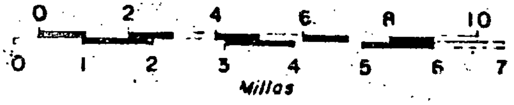

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PLANO DE CARRETERAS Y UBICACION DE POZOS

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DIS PROY ESP Miguel A. Ruiz Parra	REVISO Edwin Gomez	FECHA: Sept 17 de 1991	LAMINA
APROBO Pablo Cordova	DPTO PROY ESPECIALES	ESCALA: 1:100 000	

To check that the randomly selected well sites were representative of the oil fields, a comparison was made between well sites selected and the well site completion history for the oil fields. This comparison (Figure 6-2) indicates that the selected well sites represent approximately 50% of the wells completed within any given year.

Five of the well sites which were randomly selected for assessment were either not located in the field, not identified on the well site map or had been renamed. These well sites included SA76, SA90, SA4, SA48 and YU9. Well sites which were selected to replace these five included SAWIW3, SA13, SA34, SSF69 and YU5. One of the assessed well sites (SSF71) was drilled after June 1990 and was therefore not included in the concession. The water injection facility in the Shushufindi field was also assessed in addition to the production stations. The assessment results for this injection facility were reported with the results for production stations.

6.2.2 Historical Review

A historical review of production history and site history for all production stations, well sites and pipelines was undertaken prior to the Phase I field survey. The results of the review have been documented in Part 3. The development history, workover record and spill record for well sites and flowlines subject to Phase I assessment are given on Table C-4, Appendix C.

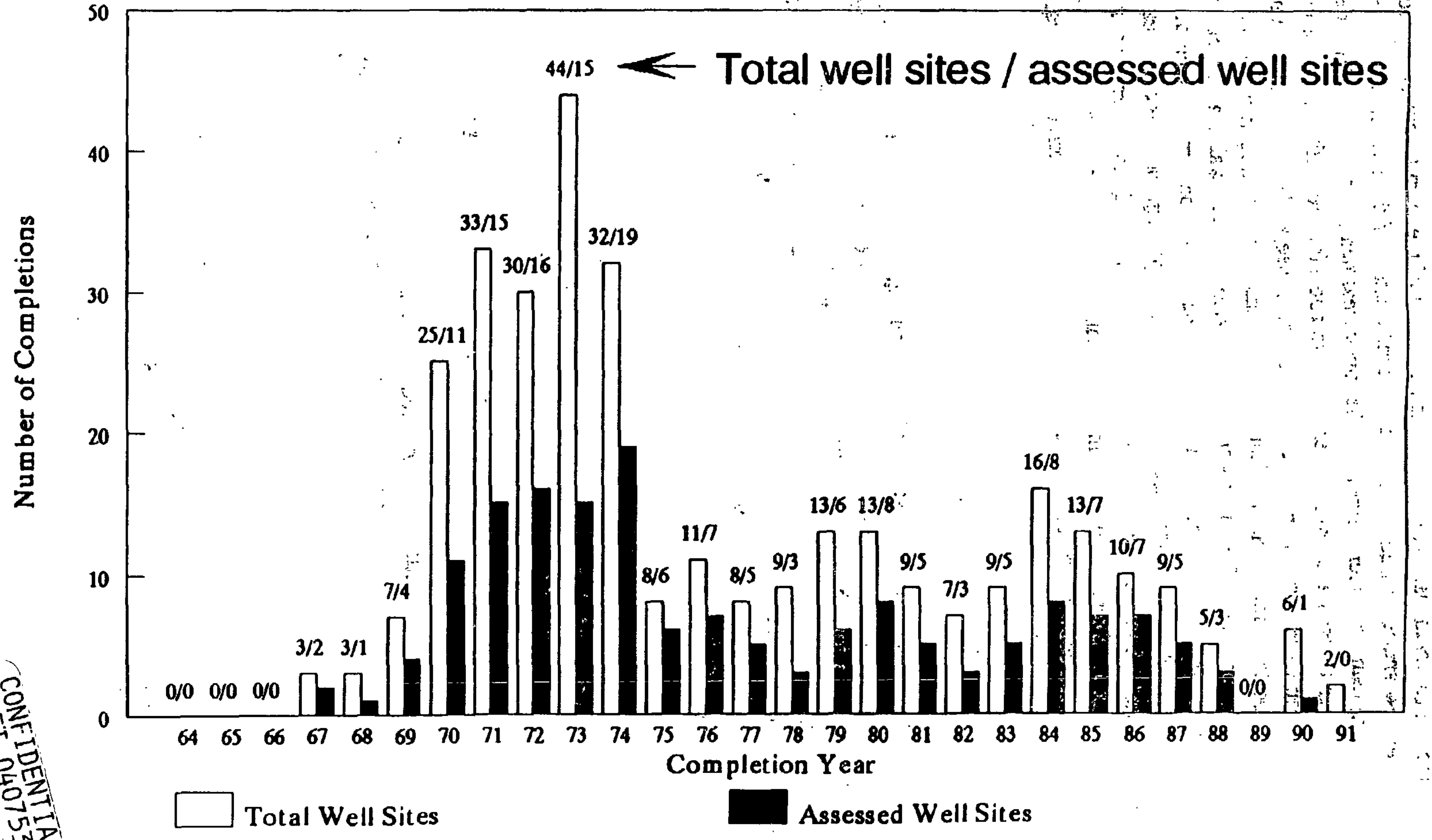
6.2.3 Field Survey

The Phase I field survey was completed by three teams during the period May 18 to June 3, 1993. Each team consisted of one assessor from HBT AGRA Limited and one technical assistant from BACHEQUERAECUADOR Limited.

A standard field assessment data sheet was completed at each site in order to facilitate consistent evaluations of site conditions. Examples of the assessment datasheets are provided in Appendix D. Observations recorded at each site included the following:

- location;
- age and status;
- available environmental documentation;
- site infrastructure;
- waste material present on site;
- general site description;
- adjacent land use;
- pit contaminant inventory;
- storage tank contaminant inventory;
- well head contaminant inventory;
- process equipment contaminant inventory;
- sample summary;
- photographic record; and
- a site sketch.

Figure 6 – 2
Comparison of Well Site Completion History With Assessed Well Sites



The Phase I well site assessments were completed in a methodical manner using data sheets to record observations. At each assessed site, one of the team members first conducted a brief site overview and identified the physical characteristics of the site and contaminant concerns. The second team member reviewed the pre-assessment summary which identifies past spills, workover records and environmental information for the well site. The environmental issues were then characterized and entered on the data sheets. Where possible, a hand-operated auger was used to estimate the vertical extent of staining resulting from spills and to identify soil materials present. The site reconnaissance also included walking around pits and auguring to determine if seepage of contaminants from the pit was occurring. One or more samples were obtained from some of the assessed well sites. A photographic record of each assessed site was completed. Some of the photos taken during the Phase I assessment program are presented in Appendix J. Sketch maps showing the location of features were completed in the field. The information collected on the data sheets was evaluated and entered onto a computer database for further evaluation.

6.2.4 Soil and Water Sampling

Soil and water samples were collected during the Phase I assessment program to help characterize any contamination. The soil samples were obtained using a hand auger and placed in containers for laboratory analysis. Each sample was assigned a unique number and labelled prior to placement in a cooler for shipment. All sample numbers were listed on a chain of custody form which described the contents of each cooler including the size and nature of each sample. The cooler was sealed for transport to the HBT Analytical Laboratory in Edmonton, Alberta, Canada.

6.2.5 Laboratory Analysis

Samples collected during the Phase I assessment program were analyzed at the HBT AGRA Analytical Laboratory. A description of the analytical methods used in given in Appendix G.

6.3 EXISTING LEVELS OF SURFACE DISTURBANCE

The concession is situated in an area that was essentially undisturbed rainforest prior to development. Initial exploration activities began in 1964 and the first producing wells were completed in the Lago Agrio field in 1967. Over 300 wells, 22 production facilities and five work camps had been completed by 1990. The concession covers approximately 400,000 hectares.

Typically, oil field exploration and development activities result in surface disturbances. The disturbance is generally in the form of removal of vegetation and preparation of the surface for roadway and site construction. Oil field exploration and development activities which are considered to be the main causes of surface disturbance include the construction of:

- roads;
- well sites;
- production stations;
- pipelines; and
- power transmission lines.

The development of the oil field has resulted in significant migration of people into the area and subsequent use of the land for agricultural activities. Increased access has opened the area to unrelated land uses such as logging, light industry and tourism. This report considers only physical disturbances related to hydrocarbon production activities.

A description of the existing levels of surface disturbance is provided in the following sections.

6.3.1 Roads

Well sites and production stations are accessible via a network of primary and secondary roads and well site access roads. Primary roads provide access into fields, secondary roads into groups of well sites and access roads into individual well sites. The extent of roadway development was determined by measurements made from an oil field map at a scale of 1:100,000 provided by PETROECUADOR. Table 6-1 shows the total estimated area of forest developed for roads as a result of oil field exploration and development activities. Approximately 310 kilometres of primary roadway had been in use by 1990.

The width of roadway corridors varies from approximately 20 metres for well site access roads to about 50 metres for primary roadways. Most of these roadways serve a dual purpose, pipelines usually occupy a portion of the roadway corridor.

The roads were constructed by cut and fill methods and using granular materials extracted from river beds. Primary and secondary roads are often coated with tank bottoms and residual oil. The application of oil is used to reduce road dust and limit the erosion of granular materials used in construction.

Vegetation has become reestablished in the unused portion of roadway corridors throughout the concession. Corridor vegetation is generally in the form of grasses and shrubs. Manual control of vegetation is common. The use of herbicides to control vegetation was not noted.

TABLE 6-1

Estimated Area of Forest Cleared Within the Concession Area as a Direct Result of Oil Field Development and Production Activities

Facility		Initial Cleared Area (ha)
Primary Roads		1,600
Well Site Access Roads		400
	TOTAL	2,000
Production Stations:		
Lago Agrio	Central Station	80
	North Station	10
Parahuacu		6
Atacapi		3
Guanta		8
Dureno		1
Aguarico		6
Shushufindi	Central Station	50
	North Station	13
	South Station	15
	Southwest Station	16
Sacha	Central Station	47
	North #1 Station	20
	North #2 Station	9
	South Station	5
Culebra		2
Yulebra		3
Yuca		12
Auca	Central Station	30
	South Station	9
Auca Sur		2
Cononaco		8
	TOTAL	355
Well Sites (325 sites @ 0.75 ha)		245
	GRAND TOTAL*	2,600

*Excludes transmission line corridors and pipeline corridors which are not adjacent to primary roads or well site access roads.

Bridges have been constructed to cross numerous rivers and streams in the study area. The smaller streams and rivers are usually spanned with "bailey" type bridges. The larger rivers, particularly the Aguarico in the north and the Napo in the south, are spanned with engineered bridges.

6.3.2 Well Sites

The well sites are generally equipped with a single well head, an aboveground flowline, a meter station and a transformer. An open drill sump/workover pit is also present at the majority of well sites. The estimated size of each of the assessed well sites is presented on Table E-1, Appendix E. Generally, the current size of the well sites averages less than one hectare. An estimate of the original size of the well site was attempted during site assessment. By determining the current size and the original size of the well site, an estimate of the amount of natural vegetation regeneration could be established. However, the presence of dwellings and agricultural activity adjacent to the majority of well sites made it difficult to determine the original size of the well site. Settler dwellings are located adjacent to a large number of well sites (Table E-1, Appendix E). It was noted that natural regeneration of vegetation adjacent to pits has occurred at a large number of sites.

Abundant vegetation and rapid regeneration in vegetation to disturbed areas has kept erosion at a minimum. However, erosion was observed at 15 of the assessed well sites. Table 6-2 provides a description of the soil erosion observed at well sites.

6.3.3 Production Stations

Twenty-two production stations and one water injection station were assessed. The production stations contain equipment necessary to separate water from oil, store crude oil and dispose of produced water to the environment. The equipment and processes used at each station are described in detail in Section 5.0. Four of the production stations reprocess product delivered from outlying stations. These four larger stations are located in Lago Agrio, Shushufindi, Sacha and Auca.

The size of cleared forest at each of the production stations is presented in Table 6-1. An estimate of the cleared forest was determined using 1:60,000 scale air photos taken in July 1990. The process area is separated from the flare and separation pit area by several hundred metres. This portion of land contains a corridor for flare lines and effluent water pipelines. The area is usually well vegetated with grasses. Reforestation projects are currently in place for this area at some of the production stations. Erosion was noted at 9 of the 23 assessed stations. Table 6-3 provides a description of the erosion observed.

Table 6 – 2
Description of Erosion at Well Sites

Assessed Well Site		Description of Erosion	Potential Source of Sediment Yes / No
LA	26	Minor erosion of well site fill material into plantation.	No
PH	5	Excessive exposed soil on well site.	No
AT	1	Excessive exposed soil on two sides of well site.	No
AT	3	Minor erosion along access road cut.	No
GU	5	Severe erosion and sedimentation over former pit.	Yes
SSF	B64	Severe erosion of slope adjacent well site.	Yes
SSF	68	Erosion and sedimentation into stream.	Yes
SA	9	Erosion present from well site into stream.	Yes
CU	2	Significant erosion adjacent former pit.	No
YB	2	Minor erosion along access road.	No
YUS	1	Extreme erosion adjacent former pit.	No
AU	19B	Exposed soil and eroding drainage ditch.	No
AU	24	Minor erosion of banks along well site boundary.	No
CN	11	Significant erosion along adjacent slope.	No
CN	12	Significant erosion in pit area.	No

Table 6 – 3
Description of Erosion at Production Stations

Production Station		Description of Erosion	Potential Source of Sediment Yes / No (a)
Lago Agrio	Central	None	No
	North	None	
Parahuacu		Some minor rill erosion of nonvegetated disturbed areas including area adjacent pit and mud spill area.	No
Atacapi		Severe gully erosion and exposed soil at southwest corner of site (adjacent pits). Potential for increased erosion on nonvegetated slopes is high.	Yes
Guanta		None noted.	No
Aguarico		Severe rill and gully erosion at former pit and stack locations.	Yes
Shushufindi	Central	None	No
	North	None	No
	South	Large area of exposed soil in pit and flare areas.	No
	Southwest	None	No
	Water Inj.	None	No
Sacha	Central	None	No
	North # 1	None	No
	North # 2	None	No
	South	None	No

6.3.4 Camps and Supply Depots

Camps and supply depots are located at Auca, Lago Agrio, Shushufindi, Sacha and Coca. All camps and supply depots, with the exception of the one at Coca, are located adjacent to production facilities and occupy the same large clearing. The camps are intricately landscaped and include recreational facilities for guests and workers. Supply depots store pipe and other equipment necessary to maintain and develop the oil field. Scrap yards are also in use at the four main stations. Used pipe, empty drums and unusable vehicles are often stored in these yards.

6.3.5 Pipelines

Flowlines deliver produced fluids from well sites to production stations while secondary pipelines deliver crude oil between stations located in the concession.

The majority of flowlines are located in narrow corridors immediately adjacent to roadways, thus minimizing the need for additional right-of-way construction. Generally, well site access road corridors contain a single flowline, secondary roads up to 9 flowlines and on primary roads up to 14 flowlines were observed present adjacent to the roadway. The majority of these pipelines are located aboveground. It was observed that these flowlines come into direct contact with the ground over significant distances. Vegetation control along pipeline rights-of-way is achieved manually. Vegetation is well established along virtually all of the assessed corridor.

6.3.6 Transmission Lines

Many well sites are equipped with a submersible electric pump. Power transmission lines are therefore required for those well sites. Transmission line corridors were not subject to assessment, however, it was noted that most transmission lines do not utilize roadway corridors. Where electrical power is in use, it is assumed that transmission line corridors occupy generally the same amount of corridor as do roadways.

6.4 EXISTING LEVELS OF CONTAMINATION

Oilfield development and production activities have caused contamination of soil and water at locations throughout the concession. Contamination of soil and water was observed at well sites, production stations and along roadways, flowlines and secondary pipelines.

6.4.1 Site Assessment Observations

Site assessment observations of contamination are summarized in the following sections. The observations are presented separately for well sites, production stations, flowlines and secondary pipelines. The observations include an estimate of the volume of contaminated soil associated

Table 6 – 3
Description of Erosion at Production Stations

Production Station		Description of Erosion	Potential Source of Sediment Yes / No (a)
Culebra		None	No
Yulebra		None	
Yuca		Minor to moderate rill and gulley erosion in pit discharge and flare areas.	
Auca	Central	Minor rill erosion on several exposed banks.	No
	South	Moderate to severe erosion in pit areas and at pit discharge pipe.	Yes
Auca Sur		Minor rill erosion in former pit area.	No
Cononaco		None	
Dureno		Minor rill erosion occurring below pit discharge pipe.	Yes

(a) Noted as "Yes" if sediment was entering a stream as a result of on–site erosion.

with each identified spill. The volume estimate was calculated using a visual estimate of the size of each spill and limited hand auger borings to determine the vertical extent of contamination. Observations on the use of oil on roads is also presented.

6.4.1.1 Well Sites

Table F-1, Appendix F provides a summary of contaminant observations for all assessed well sites. The spills have been categorized as produced fluid spills, refined product spills, solid waste and spills associated with pits. Produced fluids (crude oil and produced water) spills have been identified according to source. Produced fluid spill sources have been identified as the well, flowline, pump, tank or flare. Solid waste is identified as either domestic solid waste or industrial solid waste. Refined product spills are used oil, chemicals or fuel. Pits are identified as being open or covered. Spills which have migrated off the well site and contaminants which have migrated beyond the confines of a pit have also been noted. The total number of each type of spill is given at the base of the table.

Produced Fluids Spills

Table F-2, Appendix F provides a description of produced fluid spills identified at well sites, flowlines, pumps, tanks and flares. Estimated dimensions for each identified spill are given. Spills which have migrated off the well site are also identified. An estimate of the total spill area and volume is provided at the base of the table. Thirty-two spills have been identified as migrating off the site.

Spills which can be attributed to a broad range of sources have been identified as well site spills in Table F-2, Appendix F. These sources may include spreading of oily wastes originating off-site, well workovers, drilling or the disposal of oily wastes originating off-site. Well site spills have occurred at 158 of the 163 assessed sites. The majority of these spills were small and affected the area immediately around the wellhead. These spills can usually be attributed to well workovers and may have also occurred during drilling. Most of these spills were confined to the well site. The actual extent of individual spills was often difficult to determine. Spills are often covered with sand and sand and gravel forms the base of the well pad. These materials are difficult to penetrate using the hand-operated equipment available for the reconnaissance level assessment. Where penetration was possible, it was noted that up to 30 cm of granular materials have been placed over a clay base. Contaminant migration from these well site spills into the highly plastic red clays was generally observed to be minimal.

Thirty-nine of the produced fluid spills identified originated along a flowline (Table F-2, Appendix F). Thirteen of these spills have migrated off-site. Most of the well sites are not equipped with surface pumps. Spills originating at pump installations were observed at seven well sites. Three of these spills have migrated off-site. Tanks are normally not in use at well sites; spills originating at tanks were observed at only five sites. None of these spills were observed to have migrated off-site. Only one flare related spill was observed.

Refined Product Spills

Table F-3, Appendix F provides a description of refined product spills identified at well sites. Estimated dimensions for each spill are given and spills which have migrated off the site have been identified. An estimate of the total spill area and volume is provided at the base of the table. Eight refined product spills have been observed to migrate off the site.

Refined products are not in use at all well sites. Spills of either used oil, chemicals or fuel were identified at 22 well sites. Used oil spills generally originate at pump or compressor installations which require periodic motor oil changes. A common practice is to dispose of used oil on-site.

Chemicals, generally in the form of corrosion inhibitors, were observed to be in use at 35 of the 163 assessed well sites. Elevated chemical tanks are usually located in the fenced well site transformer compound. Spills originating from these chemical tanks were observed at six well sites. The spills were generally small and confined to the area below the tanks.

Fuel tanks are usually present at sites where pumps, generators or compressors are in use. Diesel spills were identified at five well sites. Two of the fuel spills have affected off-site land.

Solid Waste

Disposal of solid waste was observed at 46 of the 163 assessed well sites. Solid wastes were characterized as having either industrial or domestic origins. Industrial waste included used oil filters, pipe, pipe couplings or general metallic debris. Fluid spills were often associated with the disposal of used oil filters. Domestic waste was generally in the form of wood, paper, plastic, metal and household garbage.

Solid industrial waste is present at 31 well sites. The wastes are described in Table F-4, Appendix F. Most of these wastes are in the form of filters. Table F-4, Appendix F also provides a description of the domestic solid wastes which are present at 21 of the assessed sites.

Pit Wastes

The use of well site pits to contain oily waste fluids was observed at 125 of the assessed well sites. Table F-5, Appendix F provides a description of contamination associated with well site pits. The table identifies the status of the pit or pits for each assessed well site. Several variables were used to characterize a pit. These variables include:

- open or covered with soil;

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- oily wastes present or not present; and
- migration of contaminants observed beyond the confines of the pit.

A summary of the number of pits exhibiting each variable is given at the bottom of Table F-5, Appendix F. A total of 126 open or closed pits contain oily waste. Oily waste is confined within 50 of the pits and was found to be migrating in 76 cases. The estimated size of each pit was determined while in the field and is presented on Table F-5, Appendix F. Forty of the pits were estimated to be larger than 1,000 square metres, 20 between 500 and 1,000 square metres and 88 under 500 square metres in size.

Observations on the condition of the oil in open waste filled pits were made while in the field. The oil had a tar-like viscosity in 36 of the pits and was fluid in 52 of the pits. The thickness of oil in the pits varied from a thin film to a maximum estimated at 1 metre. In the majority of the pits containing waste fluids, the oil was estimated to be less than 5 cm thick.

Although it is reportedly common practice to void excess water out of the pits via a siphon, siphons were found to be present in only 14 of the pits. Dense vegetation surrounding most of the pits likely obscured a large number of siphon installations.

Evidence of seepage was noted at 69 of the pits. The presence of oily soil at covered pits, evidence of lateral migration of contaminants and oily discharge from siphons were considered to be indicators of seepage. Seepage or pit discharge to streams was observed to have occurred at 28 pit locations.

The presence or lack of berms around pits was also noted. Most of the pits were constructed by excavating to a depth of between 1 and 2 metres. The inside walls of the pits are generally not vertical but taper gradually to the middle. Berms were generally indicated as being present for pits constructed in this manner.

None of the assessed pits appear to have been constructed recently. Most appear to have been present for a considerable time and were probably constructed during or shortly after well completion.

Forty-six of the pits were covered at the time of assessment. Covering dates are not known; however, a relatively large number are believed to have been covered since 1990. Of the 46 covered pits, 33 were found to have oily waste present in soil in, or beyond the former confines of the pit.

Hydrocarbon containing sludges are present in all pits which contain oil. The thickness of these sludges was estimated to be less than one metre on average. The degree of oil seepage into soil below pits was not investigated during the Phase I assessment.

The wa materials associated with open and covered pits constitute the largest volume of waste materia present at well sites.

6.4.1.2 Flowlines

Descriptions of contamination associated with flowlines are presented on Table F-6, Appendix F. These observations exclude the section of flowline which is present on the well site. Observations were made for the length of flowline present from the edge of the assessed well site to the production station boundary. Spills associated with flowlines were identified along 11 of the 66 assessed routes.

Regeneration of vegetation along pipeline corridors has occurred along the majority of routes. Vegetation is controlled manually. Crews of up to ten workers were observed cutting vegetation below and around flowlines. Up to 14 flowlines were noted as being present in a single corridor. Some of the flowlines are elevated above ground using a series of steel support posts. Some flowlines have no support and are in contact with the ground over much of the route. Abundant dense vegetation in most flowline corridors made it difficult to detect all spills.

The observed method of line repair made it difficult to associate possible historic spills with evidence of line repair. Repairs were not easily detectable. The observed method of line repair is detailed at the bottom of Table F-6, Appendix F.

6.4.1.3 Production Stations

Twenty-two production stations and one waterflood facility were subject to Phase I assessment. Contamination observed at these sites is presented in Table F-6, Appendix F. The observed spills are characterized according to spill source, spill type, estimated dimensions, a description of on-site impacts and a description of off-site impacts. Descriptions of industrial solid waste and domestic solid waste, if present, are also provided on Table F-7, Appendix F.

Spills were identified around manifolds and separators, wash and surge tanks, pumps and compressors, fuel and chemical tanks, flare lines and flare stacks, process area drains and sumps, generators, vehicle maintenance areas and pits. The process flow diagram presented in Section 5 (Figure 5-1) provides a complete list of process related equipment present at each production station.

Spill types have been identified as either produced fluids, used oil, chemicals or fuel. The estimated dimensions of the spill are provided where possible. The actual size of spills was difficult to determine. In many instances, spills may migrate below equipment or into inaccessible off-site locations.

Manifold and Separator Spills

Table F-7, Appendix F describes separator spills at 15 of the 18 assessed stations which are equipped with separators.

Spills associated with manifolds and separators were generally small and confined to the area immediately around the separators. These surficial spills were routinely covered with sand. Separator spills which have affected off-site areas are located at Auca South, Sacha South, Sacha North #2 and Shushufindi Central stations. The off-site separator spills identified for Sacha South, Sacha North #2 and Shushufindi Central were a result of sump overflows. A sump is often present in the separator area. It is constructed of metal or concrete, is generally about one metre square and located below ground level. When full, the contents are normally removed and disposed of in the wash tank. However, sump overflows had occurred, typically to an on-site drainage system which discharges off-site. Sump overflow at the Sacha North #1 station appears to have resulted in groundwater contamination. Saturated sand with a distinct hydrocarbon odour was encountered in a hole hand augured to a depth of 2 metres in this area. A 5,000 barrel oil spill was reported to have occurred in 1992 as a result of separator malfunction or sabotage.

Wash and Surge Tank Spills

Table F-7, Appendix F describes 29 spills related to wash or surge tanks. These spills were usually confined to the area within the bermed enclosure; however, ten tank related spills have affected off-site land and/or water. The mechanism which allows off-site discharge of tank related spills is a drainage system comprised of open ditches, berm drains and sumps. This system of drains is often interconnected with process area drains which ultimately discharge to off-site locations. Tank spills appear to have resulted in shallow groundwater contamination at the Sacha South station.

Tank bottoms (oily sludge accumulations at the bottom of tanks) are periodically removed to a pit within the bermed area prior to disposal. This practice may have resulted in some of the spills associated with wash and surge tanks.

A gas boot (gravity separation of gases) is usually attached to the wash tank. Condensates (oily fluids) can accumulate in piping associated with gas boots. Small spills below these pipes were confined to areas inside the bermed enclosure and were identified as wash tank related spills.

The condition of product storage tank berms is described in Table F-8, Appendix F. Product storage tanks are not enclosed within a bermed area at the Yulebra, Auca Sur or Dureno stations. Generally, the condition of the tank berms was noted as good if the asphalt cover was intact and no breaches were observed. The berm condition was rated as poor at the Aguarico, Shushufindi Southwest, Sacha South, Yuca and Auca Central stations. All of the berms were noted as having drain control. The enclosed area was calculated to be sufficient to contain the contents of the tank unless the berm had been breached.

Pumps and Compressors

Table F-7, Appendix F describes 18 spills related to pumps or compressors. Pumps and compressors are motor driven and require periodic oil changes. Some of the pumps in use are electric and therefore require no oil changes. Pumps, either electrically or diesel fuel driven are located at all stations. Gas compressors were noted at eight stations. Sumps, intended to collect and drain used oil and/or crude oil spills, are located adjacent to pumps and compressors.

The spills associated with pumps and compressors are usually quite large. Twelve of the 18 identified spill areas were observed to have migrated off-site. Seven of the 12 spills which have affected off-site areas have done so via discharges to ditches, sumps or drains. The practice of discharging used oil to the environment has resulted in a particularly large spill at the Shushufindi water injection station. It was noted that pump workover at the Shushufindi South station resulted in oil discharge to a nearby river via a drainage ditch.

Fuel and Chemical Spills

Table F-7, Appendix F describes 16 fuel spills and 6 chemical spills. Fuel tanks are located at central stations and at stations where fuel is required to operate pumps, compressors or generators. Chemicals are in use at most stations. Products which have been identified as chemicals include solvents and corrosion inhibitors.

Fuel spills have contaminated groundwater at the Shushufindi Central station. Groundwater exhibiting hydrocarbon odours was encountered in a hole hand augured to a depth of 2 metres in this area. None of the identified fuel spills are believed to have contaminated off-site areas; however, a large fuel spill at the Sacha Central station has entered a ditch adjacent a plantation. Fuel spills were often identified outside and inside the bermed tank enclosures.

A large number of chemical spills have occurred within the drum storage compound at the Sacha Central station. The compound is located adjacent to land used for agricultural purposes. Leakage from chemical containing tanks at the Shushufindi Southwest station has resulted in chemicals entering a stream via sump and ditch drains. The groundwater below a methanol tank at the Shushufindi Central station appears to be contaminated. The methanol tank is located in the vicinity of diesel fuel tanks which have contributed to subsurface contamination in this area. Contaminated groundwater was encountered at a depth of 1 metre.

Flare Lines and Flare Stacks

Flare systems are located at most production stations. Table F-7, Appendix F identifies 22 spill areas which are associated with flare lines or flare stacks. The spills which have occurred below flare stacks were difficult to assess due to the safety concerns related to inspecting the area while the flares were in operation. Flare condensate knockout systems do not appear to be in use for any of the flares. Rather, condensates are allowed to drain from the bottom of the stack or flare and accumulate on the ground surface. A large number of the flare systems allow fluids to migrate to pits which are often present immediately adjacent the flares. The oil stained area below flare stacks was often quite large. Horizontal flares at the Shushufindi North station have emitted liquid crude into an off-site wetland.

The condition of flare stacks is described on Table F-8, Appendix F. Flare stacks at Aguarico, Shushufindi South and Southwest, Yuca and Auca Central stations are rated as poor because the stacks were not vertical, appeared bent or appeared burnt (i.e., ragged metal). The flare stacks at the remainder of the stations were rated as good.

Complete combustion was rated as "no" if smoke was emitted from the stack at any time during the assessment. Complete inspection of flare stacks was not possible because of the intense heat and safety concerns related to flare stacks.

Process Area Drains and Sumps

The larger stations have been equipped with sumps, surface drainage ditches and underground pipe drains. Although oily accumulations of wastes in sumps are disposed in the process (i.e., wash tank), it was noted that overflow has often occurred. The overflow generally affected the area around the sumps; however, when sump discharge is to ditches, off-site areas have been affected. Spills related to sumps and drains have been identified as being associated with adjacent process area equipment (i.e., separator, pump, compressor).

Generator Related Spills

Generator related spills were identified at Auca Central, Auca South and at Auca Sur stations. Table F-7, Appendix F provides a description of the spills. The used oil spill at the Auca South station appears confined to the area adjacent the equipment; however, sump overflow to wastewater pits was noted. Generator related spills occur during changes of motor oil.

Vehicle Maintenance Areas

Vehicle maintenance centres are located only at central stations. Table F-7, Appendix F identifies spills which have occurred in four vehicle maintenance areas. Large spills have resulted from the practice of discharging used oil on the ground at the Lago Agrio, Shushufindi, Sacha and Auca Central stations. The wash water is generally contaminated with oil that has accumulated on vehicles as a result of road oiling practices.

Used oil and wash water is discharged to a ditch which drains to an off-site location at the Lago Agrio Central station. A large accumulation of used oil is present on the ground adjacent the Sacha Central station vehicle maintenance yard. Used oil and wash water enters a ditch and runs off-site at the Auca Central station. Although accumulations of used oil were not noted around the maintenance area of the Shushufindi Central station, waste wash water is discharged off-site via a drainage system.

Production Station Pits

Table F-9, Appendix F describes contamination associated with 80 pits located at production stations. The information collected for each pit includes:

- pit status;
- pit use;
- separation stage number (if applicable);
- estimated dimensions including area, thickness of oil and depth of water;
- presence of oily sludge, overflow, berms, ditches, siphons, seepage and discharge; and
- the amount of freeboard remaining.

Additional comments related to each pit are also provided on the table.

Pit status is defined as either open, closed or breached. The majority (74) remain open and in use. Two pits located at the Aguarico station appear to have been breached or destroyed and are no longer in use. Six pits have been covered.

Fifty-four of the pits are used as holding and separation ponds for the disposal of produced water. Crude oil is present in the produced water discharged to these pits. The main function of the pits is to allow the crude oil to rise to the surface where it can be periodically collected and reintroduced into the process (i.e., wash tank). The thickness of oil present on the surface of the water in these separation pits ranged from a thin film to several centimetres. Oily sludge is present in all of the pits. The final stage separation pit at most of the stations is equipped with a siphon. Produced water is being discharged to the environment in all cases. Contamination of soil and water below the discharge pipe was noted in all cases. The degree of contamination noted was variable. The discharge of oily produced water to the environment has been recently discontinued at Yulebra, Culebra and Auca Sur stations.

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6.4.1.4 Secondary Pipelines

A description of observed contamination along assessed segments of secondary pipeline is presented on Table F-10, Appendix F. Fifteen segments averaging over 2.5 km in length were assessed. A spill was observed along only one of these fifteen segments. A small spill below a valve was noted on the segment located between the Shushufindi station and Aguarico station. Abundant vegetation regeneration has occurred along the pipeline corridor. The secondary pipeline corridor is located adjacent existing roadways over much of its length.

6.4.1.5 Roads

Oily waste has been applied to roads over a large portion of the concession. The oil is applied to the road surface by a tanker truck equipped with a spraying device. The oil is sprayed directly onto the road surface and is not worked into the underlying materials. Road application of oily waste appears to have occurred mainly on primary roads. Oil had been recently applied to segments of road in the assessed portions of the Atacapi, Parahuacu and Guanta fields. No evidence of oil migrating to roadside ditches was observed.

A large amount of oil had recently been applied to the segment of main road between the Aguarico River crossing and the Guanta field junction. Long stretches of primary road in the Sacha field and between the Sacha field and the town of Coca had recently been oiled. The main road through the town of Sacha received an extremely large amount of oil. No recent applications of oil were noted in the Shushufindi field or fields located south of the Napo River.

It was noted that road application of oil continues over bridges. Inspections of several oiled bridges revealed that oil is present over the entire bridge and that some spillage to the stream below may have occurred. Roadside vegetation did not appear to have been impacted from application of oil at any of the inspected locations.

6.4.2 Site Assessment Analytical Results

Table G-1, Appendix G provides a list of soil and water samples collected and identifies those samples for which selected analytical tests were performed. A total of 196 samples were collected and analyzed. The table also identifies the depth interval from which the samples were obtained, provides an indication of the degree of hydrocarbon odour, identifies the sample matrix material and the general area in which the sample was obtained. The number of samples selected for each analytical test is provided at the base of the table. The analytical tests performed were generally consistent with parameters for which assessment criteria were developed. The criteria cited are those presented in the report entitled "Final Assessment Criteria for an Environmental Evaluation of the PETROECUADOR Consortium Oil Fields". Parameters which were analyzed but which are not covered by the reported criteria included: electrical conductivity; benzene, toluene, ethylbenzene, xylenes (BTEX); and specific metals including aluminum, calcium, iron, magnesium, manganese, phosphorus, potassium, sodium and tellurium. The inclusion of these analytical tests was considered necessary to evaluate potential remediation options described in the Environmental Management Plan (Volume II).

6.4.2.1 Soil Samples

Oil and Grease

Table G-2, Appendix G presents the results for oil and grease tests performed on 165 soil samples. One hundred and fifty-six (95%) of the samples contain oil and grease above the average background level. Ninety-four (57%) of the samples contain oil and grease at a level which exceeds the criterion value of 5,000 $\mu g/g$. The results show that a wide variety of sampled areas contain oil and grease levels which exceed the criterion.

Soil pH

A total of 34 samples were tested for pH. Twenty-one of the samples were representative of contaminated soils. The remaining 13 pH results were obtained for soils representing background conditions. Background pHs range from 4.8 to 7.5 and average 5.5 (Table G-3, Appendix G). The proposed assessment criteria for pH is in the range of 6.0 to 8.5. Background soil pHs were therefore used to adjust pH criterion to a range of 4.5 to 7.5

The adjusted criteria for pH was marginally exceeded in 4 of the samples tested. These 4 samples also exceeded the criteria for oil and grease content. Nine of the 17 soil samples which exhibited pH levels within the range of the adjusted criteria exceeded the criteria for oil and grease.

Metals

Tables G-4 and G-5, Appendix G present the analytical results for metals in soil. Table G-4 includes metals for which assessment criteria are available. A total of 25 samples were analyzed. Nine of the samples were representative of background conditions. The remaining 16 samples were representative of soils containing hydrocarbon. In most cases, values of the metals: As, Hg, Se, Sn, Ba, Cd, Co, Cu, Pb, Mo, Ni and Zn were below criteria values. Only one result marginally exceeded the criteria value for tin. Two of the samples showed elevated levels of copper, lead and zinc; however, these levels were below criteria.

Table G-5, Appendix G presents the analytical results for metals for which criteria are not available. Four of the samples show levels of aluminum considerably higher than those found in background soils. It is not clear whether these elevated aluminum levels are a result of oil field operations. The most elevated aluminum level was for a reported drill mud spill at the Parahuacu production station. Criteria are not available for aluminum. Canadian criteria are presented for two of the metals (beryllium and vanadium). None of the samples tested showed elevated levels for either of these metals.

Cyanide, Sulphur, Bromide and Fluoride

Table G-6, Appendix G presents the results for nine samples which were tested for cyanide, sulphur, bromide and fluoride. One of the samples tested was representative of background soils while the remaining six were representative of soils containing hydrocarbon. None of the tested samples exceeded the criterion established for cyanide, bromide or fluoride. Five of the nine samples tested for total sulphur exceeded the criterion value. These samples were representative of pit discharge areas, pits and a spill at a crude oil tank drain.

Electrical Conductivity

Table G-7, Appendix G presents results for 34 samples tested for electrical conductivity. Average electrical conductivity for 13 samples representative of background soils is 0.02 mS/cm. Three of the samples tested exceeded the Canadian criteria of 2.0 mS/cm. Two of these samples also exhibited elevated copper, lead and zinc levels.

Benzene, Toluene, Ethylbenzene, Xylenes (BTEX)

Table G-8, Appendix G presents the results for eight samples which were tested for BTEX. The samples which were tested for BTEX exhibit elevated hydrocarbon levels and represented fuel spills, pits and a waste discharge area. Canadian soil quality criteria for BTEX were used. All BTEX parameter criteria were exceeded in two of the samples tested. One of the BTEX parameters (benzene) exceeded criteria in one additional sample. One of the samples which exceeded criterion for all BTEX parameters represented material present in a large waste pit located near the Shushufindi Southwest production station.

In summary, the analytical data suggest that the principle contaminant in analyzed soils is oil and grease. The data provide no evidence of widespread contamination by metals. Limited testing indicates that some of the samples analyzed contain some of the more mobile and toxic hydrocarbon compounds.

6.4.2.2 Water Samples

Table G-9, Appendix G presents water chemistry results for ten pit water samples. Six of the samples were obtained from produced water pits at production stations. The remaining four samples were obtained from pits located at well sites. Two additional pit water samples were broken in transit.

Eight of the ten samples exceeded at least one of the criteria values. None of the samples exceeded criterion values for pH or total phosphates. None of the well site pit samples exceeded the criterion for chloride. Produced formation water contains high levels of chloride. The relatively low level of chlorides found in well site pits may be a result of rainwater having replaced formation water in these pits. All but one of the produced water pit samples exceeded the criteria for chlorides, total suspended solids, total dissolved solids and sulphides. Six of the samples, including two from well sites and four from produced water pits exceeded the criterion for total petroleum hydrocarbons.

6.5 SUMMARY OF IMPACTS

The environmental liabilities identified from the site assessment were rated as to their environmental impact using the scoring system given in Table 6-4.

TABLE 6-4

Scoring System Used to Rate Potential Environmental Impacts

Rating	Description
Low	Environmental damage that can be naturally corrected or cleaned up on the scale of hours to days. *Spills, regardless of size, are confined to the site. No oil containing pit is present.*
Medium	Environmental damage that even after mitigative action will take days to weeks to regain pre-event conditions. *Spills, regardless of size, have migrated off-site. Pit containing oil is present. Contaminant appears confined within the pit.*
High	Environmental damage that may require extensive mitigative action or may be of long-term duration before recovery. *Pit containing oil is present. Contaminants appear to have migrated out of the pit.*

6.5.1 Well Sites

The results of this rating for the well sites are given in Table 6-5. Of the 163 well sites assessed, environmental liabilities at 51 (31%) sites were rated as having a low impact, 29 sites (18%) a medium impact, 66 sites (41%) a high impact and 16 sites (10%) no impact.

6.5.2 Production Stations

The results of the impact assessment rating for environmental liabilities identified at production stations is given in Table 6-6. Liabilities associated with separation pits were generally rated as high. Spills associated with a chemical tank and fuel storage tanks at Shushufindi Central Station were also rated high because of the potential for contaminant migration. Spills associated with the pump/compressor at Shushufindi Central and Shushufindi South Stations were also rated high because they have migrated off-site. Spills from the wash tank and surge tanks at Sacha South were rated as high because of the potential for groundwater contamination.

Table 6 – 5
Environmental Impact Rating for Contamination at Well Sites

Assessed Site		Rating (a)	Comments
LA	1	Medium	Pump spill off–site.
LA	2	Low	Pad spill. Used oil spill.
LA	5	Low	Pad spill.
LA	6	–	No spills noted.
LA	8	Low	Pad spill.
LA	9	–	No impact noted.
LA	10	Medium	Well pad spill. Flowline spill off–site.
LA	11B	Low	Well pad and flowline spills.
LA	12	Low	Well pad and flowline spills. Used oil spill.
LA	17	–	No spills noted.
LA	19	–	No spills noted.
LA	20	Low	Well pad spill.
LA	21	Low	Well pad spill. Used oil spill.
LA	26	Medium	Well pad spill off–site.
LA	29	Low	Well pad and flowline spills.
LA	32	Low	Well pad spill.
LA	33	Low	Well pad spill.
LA	34	Low	Well pad spill.
LA	35	Low	Well pad spill.
PH	2	Medium	Well pad spill off–site.
PH	5	Medium	Well pad spill off–site.
AT	1	Low	Flowline and pump spill.
AT	2	Medium	Pump spill off–site.
AT	3	Low	Well pad spill.
GU	1	High	Pit discharge to stream. Used oil spill.
GU	3	High	Pit discharge to stream.
GU	5	High	Pump spill. Pit seepage to stream. Used oil and fuel spill.
GU	8	Medium	Pad and flowline spills off–site.
AG	AG3	High	Well pad spill. Pit seepage. Used oil spill.
AG	AG6	High	Pit discharge to stream.
AG	AG8	High	Pit seepage.
AG	AG9	High	Well pad and flowline spills. Pit seepage.
AG	AG10	Medium	Well pad spills. Possible pit seepage.
SSF	B57	High	Well pad spills. Pit seepage.
SSF	B59	High	Well pad spills. Pit seepage. Chemical spill.
SSF	61	High	Well pad spills. Pit seepage.
SSF	B63	High	Well pad spills. Pit seepage. Used oil spill.
SSF	B64	High	Well pad spill. Pit discharge to stream.
SSF	A65	Low	Well pad spill.
SSF	B66	High	Well pad spill. Pit discharge to stream.
SSF	A67	Medium	Well pad spill. Pit present.
SSF	68	High	Well pad spill. Pit discharge to stream.
SSF	69	Low	Well pad and flowline spills.
SSF	71	Medium	Flowline spill. Pit present.
SSF	WIW2	–	No spills noted.
SSF	WIW4	–	No spills noted.
SSF	WIW7	–	No spills noted.

Table 6 – 5

Environmental Impact Rating for Contamination at Well Sites

Assessed Site		Rating (a)	Comments
SSF	A1	High	Well pad spills. Pit seepage.
SSF	A7	High	Well pad spills. Pit seepage.
SSF	A9	Low	Well pad spill.
SSF	A10	Low	Well pad spill.
SSF	A13	High	Well pad, flowline and pump spills. Pit discharge to stream.
SSF	B15	High	Well pad spill. Pit discharge to stream.
SSF	B16	High	Pit discharge to stream.
SSF	A20	Medium	Well pad spill. Pit present. Used oil spill.
SSF	A22B	Medium	Well pad and flowline spills. Pit present. Chemical spill.
SSF	A24	High	Well pad and flowline spills. Pit seepage.
SSF	A26	Low	Well pad spill.
SSF	A30	High	Pit discharge to stream.
SSF	B31	Medium	Well pad spill. Pit present.
SSF	A33	Medium	Pit present.
SSF	A34	–	No spills noted.
SSF	B36	High	Well pad spill off–site. Pit present. Used oil spill.
SSF	A38	High	Well pad spill. Pit discharge to stream.
SSF	A43	High	Well pad spill. Pit seepage.
SSF	6B	High	Well pad and flowline spills. Pit seepage.
SSF	A45	Medium	Flowline and pump spills off–site.
SSF	A45B	Medium	Well pad and flowline spills. Pit present.
SSF	46	Medium	Well pad spill off–site. Used oil spill. Fuel spill off–site.
SSF	B49	High	Well pad spill. Pit seepage.
SSF	A50	–	No spills noted.
SSF	B51	Medium	Well pad spill. Pit present.
SSF	B52	Medium	Well pad spill. Flowline spill off–site.
SSF	B55	High	Pit seepage.
SA	WIW1	Low	Well pad spill.
SA	WIW2	Medium	Pit present.
SA	WIW3	–	No spills noted.
SA	WIW4	Medium	Pit present.
SA	WIW5	High	Pit seepage.
SA	WIW6	Medium	Pit present.
SA	1	Medium	Well pad spill off–site. Used oil spill off–site.
SA	2	–	No spills noted.
SA	8	High	Well pad and flowline spills. Pit seepage.
SA	9	Low	Well pad spills.
SA	11	Medium	Well pad spill off–site. Pit present.
SA	12	High	Well pad spill. Pit seepage.
SA	13	Low	Well pad spills.
SA	16	High	Well pad spill. Pit seepage.
SA	18	High	Well pad and flowline spills. Pit seepage.
SA	19	High	Well pad spill. Pit discharge to stream.
SA	20	High	Well pad spill. Pit discharge to stream.
SA	21	Medium	Well pad and flowline spills. Pit present.
SA	25	High	Well pad spill off–site. Pit seepage.
SA	27	Medium	Well pad spill off–site.

Table 6 – 5

Environmental Impact Rating for Contamination at Well Sites

Assessed Site		Rating (a)	Comments
SA	28	Medium	Well pad spill. Flowline spill off–site.
SA	32	Medium	Well pad spill. Pit present.
SA	33	High	Well pad spill. Pit discharge to stream.
SA	34	Medium	Well pad spill. Flowline spill off–site.
SA	35	Low	Well pad spills.
SA	36	Medium	Pit present. Used oil, chemical and fuel spills.
SA	43	High	Well pad spill. Pit seepage.
SA	44	Medium	Pit present.
SA	46	Medium	Well pad spill. Flowline spill off–site. Pit present.
SA	54	Medium	Well pad spill. Pit present.
SA	55	Medium	Well pad spill off–site. Pit present.
SA	56	–	No spills noted.
SA	58	High	Well pad spill off–site. Pit seepage.
SA	59	High	Well pad and flowline spills. Pit seepage.
SA	60	High	Well pad spill. Pit discharge to stream.
SA	72	Medium	Well pad spill. Pit present.
SA	73	Low	Well pad spills.
SA	74	High	Well pad spill. Pit seepage.
SA	75	Medium	Well pad spill. Pit present.
SA	77	Medium	Well pad spill. Pit present.
SA	78	High	Well pad and flowline spills off–site. Pit discharge to stream.
SA	81	Medium	Well pad spill. Pit present.
SA	84	Low	Well pad and flowline spills.
SA	85	Medium	Well pad spill. Pit present.
SA	86	Medium	Well pad spill off–site. Pit present.
SA	91	Medium	Pit present.
SA	93	High	Well pad and flowline spills. Pit seepage.
SA	94	Medium	Well pad spill. Pit present.
SA	95	High	Well pad spill. Pit seepage.
SA	97	High	Well pad spill. Flowline spill off–site. Pit discharge to stream.
SA	100	High	Well pad spill. Pit seepage.
SA	103	High	Well pad spill. Pit discharge to stream.
SA	104	Medium	Well pad spill. Pit present.
SA	107	High	Well pad spill. Pit seepage.
SA	109	High	Well pad spill. Pit seepage.
SA	110	Low	Well pad spill.
SA	111	Medium	Well pad spill. Pit present.
SA	113	Medium	Well pad spill. Pit present.
CU	2	High	Well pad spill. Pit discharge to stream. Used oil spill.
YB	2	High	Pit discharge to stream.
YU	4	High	Well pad spill. Flowline spill off–site. Pit discharge to stream.
YU	6	–	No spills noted.
YU	5	Medium	Well pad spill. Tank spill. Pit present. Used oil spill off–site.
YU	12	High	Well pad spill. Flowline spill off–site. Pit seepage. Chemical spill
YUS	1	Low	Well pad spill. Chemical spill.
AU	1	High	Well pad spill. Pit seepage.
AU	4	High	Well pad spill. Pit seepage. Used oil and fuel spills off–site.

Table 6 – 5

Environmental Impact Rating for Contamination at Well Sites

Assessed Site		Rating (a)	Comments
AU	6	High	Well pad spill off–site. Tank spill. Pit seepage. Used oil sp
AU	7	Medium	Well pad spill off–site.
AU	9	Medium	Flowline spill off–site.
AU	11	High	Well pad and flowline spill. Pit discharge to stream.
AU	12	High	Well pad and flowline spill. Pit seepage.
AU	15	High	Well pad and flowline spill. Pit seepage. Chemical spill.
AU	16	High	Well pad spill. Pit seepage.
AU	17	High	Well pad and flowline spill. Pit discharge to stream.
AU	18	Low	Well pad and flowline spill.
AU	19B	High	Well pad and flowline spill. Pit seepage.
AU	21	High	Well pad and flowline spill. Pit seepage.
AU	24	High	Well pad and flowline spill. Pit seepage.
AUS	1	Low	Well pad and flowline spill. See production station ratings.
RM	1	Medium	Well pad spill. Pit present.
CN	1	High	Well pad spill. Pit seepage.
CN	2	High	Pit seepage.
CN	3	–	No spills noted.
CN	8	–	No spills noted.
CN	11	Medium	Well pad spill off–site.
CN	12	Medium	Well pad spill. Pit present.
DU	1	–	See production station ratings.
Total		Low	51 Well sites
		Medium	29 Well sites
		High	66 Well sites
		–	16 Well sites

(a)	Low	Environmental damage that can be naturally corrected or cleaned up on the scale of hours to days. *Spills, regardless of size, are confined to the site. No oil containing pit is present.*
	Medium	Environmental damage that even after mitigative action will take days to weeks to regain pre–event conditions. *Spills, regardless of size, have migrated off–site. Pit containi oil is present. Contaminant appears confined within the pit.*
	High	Environmental damage that may require extensive mitigative action or may be of long term duration before recovery. *Pit containing oil is present. Contaminants appear to have migrated out of the pit.*

Table 6 – 6
Environmental Impact Rating for Contamination at Production Stations

Station	Spill Source	Rating (a)	Comments
Lago Agrio Central	Separator	Low	
	Wash Tank	Low	These spills are generally small and confined to the adjacent area.
	Surge Tank	Low	
	Chemical Tank	Low	
	Fuel Tank (Diesel)	Low	
	Fuel Tank (Gas)	Low	
	Fuel Tank (Jet)	Low	
	Pump/Compressor	Low	
	Lined Sump	Low	
	Vehicle Maintenance	Medium	Spills drain to a low off–site area.
	Flare Stack	Low	Confined to area below stacks.
	Waste Pit	High	Overflow collects in low off–site area.
	Separation Pits	High	Widespread contamination of land below discharge.
Lago Agrio North	Separator	Low	
	Surge Tank	Low	These spills are generally small and confined to the adjacent area.
	Wash Tank	Low	
	Pump/Compressor	Low	
	Flare Stack	Low	
	Separation Pits	High	Contamination of channel below discharge.
Parahuacu	Well Site	Medium	Large barren area with no vegetation growth.
	Surge Tank	Low	
	Separator	Low	Spills are small or confined.
	Pump/Compressor	Low	
	Flare Line	High	Spill enters wetland adjacent flare line.
	Flare Stack	Low	Spills enter separation pit.
	Separation Pits	High	Widespread contamination of land below discharge.
Atacapi	Separator	Low	Spill confined to adjacent area.
	Separation Pits	High	Widespread contamination of land below discharge.
Guanta	Wash Tank	Medium	Spills ultimately merge at pit discharge area.
	Fuel Tank (Diesel)	Low	Spill confined to adjacent area.
	Pump/Compressor	Medium	Spill merges with pit discharge spill.
	Flare Line	Medium	Spill merges with pit discharge spill.
	Flare Stack	Low	Spill confined to adjacent area.
	Separation Pits	High	Widespread contamination of land below discharge.
Aguarico	Separator	Low	Spill appear confined to adjacent area.
	Wash Tank	Medium	Spills have entered off–site wetland via drain pipes.
	Surge Tank	Low	Spill appear confined to adjacent area.
	Lined Sump	Medium	Spills have entered off–site wetland.
	Flare Stack N.	Low	Spill appears confined to adjacent area.
	Flare Stack S.	Medium	Pit below flare is destroyed. Spills spread out.
	Pit	Medium	Pit is breached or destroyed. Spills spread out.
Shushufindi Central	Separator	Medium	Waste discharge via ditch to off–site area.
	Vehicle Maintenance	High	Drain system discharges off–site near runway.
	Wash Tank	Low	Drainage ditch adjacent berm contains oil.
	Surge Tank	Low	Drainage ditch adjacent berm contains oil.
	Chemical Tank	High	Groundwater appears contaminated.

Table 6 – 6
Environmental Impact Rating for Contamination at Production Stations

Station	Spill Source	Rating (a)	Comments
	Fuel Tank (Diesel)	High	Groundwater appears contaminated.
	Fuel Tank (Diesel)	High	Groundwater appears contaminated.
	Fuel Tank (Jet)	High	Groundwater appears contaminated.
	Pump/Compressor	High	Waste discharge has flowed off–site.
	Flare Stack	Low	Spills appear surficial.
	Separation Pits	Medium	Discharge of produced water to bog and stream.
Shushufindi North	Wash Tank	Medium	These spills have entered a ditch which drains off–site. Spills around the equipment appear small.
	Surge Tank	Medium	
	Chemical Tank	Medium	
	Pump/Compressor	Medium	
	Gas Vent	High	Oily waste has migrated downslope and entered river.
	Flare Stack	Medium	Surficial spills in area below stacks.
	Separation Pits	High	Discharge and overflows into wetland and river.
Shushufindi South	Pipeline	Low	These spills appear confined to the immediate area.
	Separator	Low	
	Wash Tank	Low	
	Surge Tank	Low	
	Pump/Compressor	High	Spills have entered river via a ditch.
	Lined Sump	High	Ditch drains to river.
	Flare Stack	Low	Small surficial spills under stacks.
	Separation Pits	High	Contamination appears confined to the channel.
Shushufindi Southwest	Separator	Low	Surficial spills.
	Wash Tank	Medium	Oil on surface and in ditch inside bermed area.
	Chemical Tank	Medium	Soil has solvent odour adjacent tanks.
	Fuel Tank (Diesel)	Low	The spill has migrated out of the bermed area.
	Pump/Compressor	Low	Surficial stains around equipment.
	Lined Sump	Medium	Sumps are located on–site but drain to off–site ditch.
	Flare Stack	Low	Horizontal flares knockout to separation pit.
	Off–Site Waste Pit	High	Severe contamination inside off–site pit.
	Separation Pits	High	Contamination appears confined extensive channel.
Shushufindi Water Inj.	Pump/Compressor	High	Extensive damage to stream.
Sacha Central	Vehicle Maintenance	Low	Wastes confined to adjacent area.
	Separator	Low	Surficial spills around equipment.
	Wash Tanks (2)	Medium	Spill entered adjacent drainage ditch.
	Surge Tank	High	Oily waste is discharged via ditch to plantation area.
	Chemical Storage	High	Numerous spills inside large compound.
	Fuel Tank (Diesel)	Low	Fuel spills inside and outside the bermed area.
	Fuel Tank (Diesel)	Medium	Spills enter ditch adjacent plantation via drain.
	Pump/Compressor	Low	Spills confined to adjacent areas.
	Flare Stack	Low	Spills confined to adjacent areas.
	Separation Pits	High	Widespread contamination at discharge.
Sacha North # 1	Separator	Low	Spills appear confined to adjacent areas.
	Wash Tank	Low	
	Fuel Tank (Diesel)	Low	
	Flare Stack	Low	

Table 6 – 6
Environmental Impact Rating for Contamination at Production Stations

Station	Spill Source	Rating (a)	Comments
	Separation Pits	Medium	Oily soil and water below discharge pipe.
Sacha North # 2	Separator	Low	
	Wash Tank	Low	
	Surge Tank	Low	Spills appear confined to adjacent areas.
	Pump/Compressor	Low	
	Flare Stack	Low	
	Separation Pits	High	Discharge of waste to stream.
Sacha South	Separator	Low	Surficial spills around equipment.
	Wash Tank	High	Oil on shallow groundwater within bermed area.
	Surge Tank	High	Oil on shallow groundwater within bermed area.
	Pump/Compressor	Low	Surficial spills around equipment.
	Flare Stack	Low	Surficial spills under each of five stacks.
	Separation Pits	High	Oily sediment and water below discharge pipe.
Culebra	Pipeline	Low	
	Wash Tank	Low	
	Fuel Tank (Diesel)	Low	Spills appear confined to adjacent areas.
	Pump/Compressor	Low	
	Former Pit	Low	
Yulebra	Wash Tank	Low	Spills appear confined to adjacent areas.
	Fuel Tank (Diesel)	Low	
	Pump/Compressor	Medium	Spills have flowed via ditch to off–site wetland.
	Lined Sump	Low	Spills appear confined to adjacent areas.
	Flare Stack	Low	
	Pit	High	Spills have flowed via ditch to off–site wetland.
Yuca	Separator	Low	
	Wash Tank	Low	
	Surge Tank	Low	
	Chemical Tank	Low	Spills appear confined to adjacent areas.
	Fuel Tank (Diesel)	Low	
	Fuel Tank (Jet)	Low	
	Pump/Compressor	Low	
	Lined Sump	Medium	Overflow has flowed downslope and off–site.
	Flare Stack	Low	Spills below stack.
	Separation Pits	High	Discharged fluid appears confined to narrow channel.
Auca Central	Vehicle Maintenance	Medium	Waste fluids enter ditch and flow off–site.
	Separator	Low	
	Fuel Tank (Diesel)	Low	Spills appear confined to adjacent areas.
	Pump/Compressor	Low	
	Generator	Low	
	Sumps	Medium	Sumps appear to drain to off–site.
	Flare Stack	Low	Spills below each of three stacks.
	Separation Pits	High	Waste is discharged to off–site stream.

Table 6 – 6
Environmental Impact Rating for Contamination at Production Stations

Station	Spill Source	Rating (a)	Comments
Auca South	Pipeline	Low	Spill below flowlines entering the station.
	Separator	Medium	Overflow has spilled down slope and moved off–site.
	Wash Tank	Medium	Pooled oily water in off–site wetland.
	Pump/Compressor	Medium	Spill has flowed downslope and off–site.
	Generator	Low	Spills confined to adjacent area.
	Flare Stack	Low	
	Separation Pits	High	Oil in stream below discharge pipe.
Auca Sur	Fuel Tank (Diesel)	Medium	Spill has entered low area.
	Pump/Compressor	Medium	Spill has entered low area.
	Generator	Medium	Spill has entered low area.
	Pit	High	Pit fluids disposed to off–site area.
Cononaco	Lined Sump	Medium	Off–site drainage ditch contains pooled oil.
	Flare Stack	Low	Spills at base of two stacks appear surficial.
	Separation Pit	High	Discharge to off–site channel. Oil in soil and water.
Dureno	Surge Tank	Low	
	Lined Sump	Low	Spills appear small.
	Flare Stack	Low	
	Separation Pit	High	Discharge is downslope to jungle and stream.
(a)		Low	Environmental damage that canbe naturally corrected or cleaned up on the scale of hours to days. *Spills, regardless of size, are confined to the site. Spills appear to be surficial.*
		Medium	Environmental damage thateven after mitigative action will take days to weeks to regain pre–event conditions. *Spills, regardless of size, have migrated off–site.*
		High	Environmental damage that may require extensive mitigative action or may be of long term duration before recovery. *Pit containing oil is present. Contaminants appear to have migrated out of the pit. Spills appear to impact groundwater.*

PART 7 - SURFACE WATERS

7.1 INTRODUCTION

The effluent and surface waters associated with PETROECUADOR-TEXACO oil field in the Oriente region were characterized and assessed as part of the overall environmental audit. The assessment was based on field data collected in June 1993.

The principal objectives were to characterize and assess the effluents and surface waters and to provide an environmental baseline to which future water quality changes can be compared. More specifically, the objectives were as follows:

1. characterize the effluents (produced water and sanitary) associated with the petroleum activities;
2. characterize the rivers receiving the effluents;
3. assess the quality of the effluents and rivers according to their respective water quality criteria; and
4. provide a comparative analysis of river water quality upstream and downstream of effluent discharge points, and between reaches in a stream and among streams as they pertain to influences from the petroleum operations, other anthropogenic activities and/or natural processes.

7.2 METHODOLOGY

The surface water field sampling program was conducted during June 8 - 16, 1993. A total of 39 effluent and stream samples were collected which represented 10 oilfields in the concession area. The oilfields included in the study were Shushufindi, Agua Rico, Sacha, Yuca, Cononaco, Auca, Lago Agrio, Atacapi, Parahuacu, and Guanta. Sampling at Culebra, Yulebra and Auca Sur was not conducted because they have no direct releases to the environment.

Of the total (39) samples collected, 17 were produced water effluents and one was a sanitary effluent. The effluents were sampled from outlet pipes or from outlets draining final treatment ponds. In the both cases, the samples reflect the final effluent entering the receiving streams or land.

A total of 21 samples were collected from streams and rivers. Streams receiving an effluent, were sampled upstream and downstream from the discharge point where access to the stream was available. The distances from the effluent discharge point varied widely and was determined by access to the stream. Some other rivers, which did not receive effluent were sampled for comparative analysis and because of their regional importance.

At sampling sites downstream of the effluent discharge points, the samples were collected from the mixing zone, a zone before the concentration of the effluent becomes homogenous across the width of the river channel. Because most of the streams receiving effluent were generally < 10 m wide, it was assumed that the effluent mixed rapidly and that its concentration became homogeneous within 5 km downstream of the discharge point.

Water samples were obtained from a depth of about 20 cm below surface in order to avoid surface debris. The water samples were preserved (as required), kept cool and dark until their transport to the laboratory in Edmonton, Alberta.

The water quality of the effluents and rivers were assessed using parameters and their respective criteria established by the Environmental Audit Technical Committee. The water quality assessment was based solely on field data obtained during the June sampling because no historical data were found.

7.3 REGIONAL CHARACTERISTICS OF STREAMS AND WATER USERS

The study area is located at the base of the Andes Mountains in the Northern Oriente region of Ecuador. The region, comprised mainly of jungle, is located about 300 m above sea level within the upper Amazon drainage basin and annually receives between 2000 and 4000 mm of rainfall.

The rivers generally flow from west to east. The size of rivers in the study area range widely. Rio Napo and Rio Agua Rico are the largest rivers. Rio Eno, Rio Tiputini and Rio Shiripuro are about 30 m wide. Most of the other rivers sampled were < 10 m wide. These rivers provide a wide range of domestic and industrial uses, they include: habitat for terrestrial and aquatic wildlife, drinking, stock watering, fishing, bathing, washing (clothing and automobiles, etc.), receiving of effluents from petroleum operations and abatoirs, water withdrawals for industry and transportation.

7.4 EFFLUENTS AND RIVERS IN THE SHUSHUFINDI FIELD

7.4.1 Effluents

The quality of the effluents originating from the South, North and Southwest (sites E2, E11, and E12) production facilities in the Shushufindi field are generally similar (Figure 6-1 and Tables 7-1 and 7-2). The produced waters have a near neutral (field) pH, warm temperatures

TABLE 7-1

Summary of Effluent Sample Sources and Receiving River/Land in the PETROECUADOR-TEXACO Oriente Oil Fields.

Oilfield/Production Station	Sample Source	Receiving River or Land
Shusufindi Cental	Rio Shushufindi, 500 m downstream of discharge point	forest/Rio Shushufindi
Shushufindi North	from final pond	small stream
Shushufindi South	from drainage ditch about 50 m from discharge point into Rio Niutshinac	Rio Niutshinac
Shushufindi Southwest	from outlet of the third pond	wetland/forest
Agua Rico Central	outlet pipe	forest
Sacha North-2	outlet pipe	cultivated field/Rio Jivino Rojo
Sacha North	outlet pipe	Rio Plandayacu
Sacha Central	drainage ditch	drainage ditch/Rio Quincha Ya Cu/Rio Blanco
Sacha Central	drainage ditch - sewage effluent	forest/Rio Quincha Ya Cu/Rio Blanco
Sacha South	outlet pipe	forest/Rio Huamayacu
Yuca Central	outlet pipe	plantations/Laguna Taracoa
Cononaco Central	final pond - outlet	forest/Rio Shiripuro
Auca Central	outlet pipe	No Name River(a)
Auca South	final pond - outlet	No Name River(b)/Rio Tiputini
Lago Agrio Central	from drainage ditch located about 5 m from discharge pipe	Rio Teteye
Lago Agrio North	outlet pipe	No Name River(c)/Rio Teteye
Atacapi Central	final pond - outlet	wetland/forest
Parahuacu Central	outlet pipe	wetland/forest
Guanta Central	final pond - outlet	wetland forest

TABLE 7-2

Summary of Effluent Quality Data for the PETROECUADOR-TEXACO Oriente Oil Fields, June 1993

Site Parameter	Water Quality Criteria	Shushufindi			Agua Rico	Sacha				
		South E2	North E11	South/West E12	Central E9	North #2 E13	North E15	Central E19	Sewage E20	South E21
Temperature (°C)		30.0	38.0	36.0	33.0	34.0	40.0	34.0	26.0	39.0
pH-field (units)	5.5-9.5	7.16	7.36	7.28	6.89	7.6	7.4	7.5	6.8	7.1
pH (units)	5.5-9.5	6.53	6.3	6.1	6.70	6.55	6.35	6.45	6.23	3.22
Specific Conductance-field (mS/cm)		>50.0	39.0	>50.0	>50.0	7.0	10.0	14.0	0.80	7.5
Specific Conductance (mS/cm)		57.2	30.3	65.3	67.3	6.2	8.4	14.2	0.5	6.2
Colour (truce)		17	50	11	20	2	2	9	<1	21
Chloride, Diss.	2500	20000	11200	28200	32600	1580	2400	4540	113	1630
Hardness, T. as ($CaC0_3$)		5241	6523	3580	7961	866	606	950	79	478
Total Suspended Solids (TSS)	40	2150	540	1100	365	442	120	320	164	324
Total Dissolved Solids (.45 μm) (TDS)	5000	39100	20200	49700	55400	3130	4540	8180	356	3240
TPH (C5-C30)	25	3.6	5.4	4.1	7.5	1.0	4.7	1.9	<0.2	8.7
Sulphide	1.0	8.1	3.2	2.9	3.6	1.5	2.6	0.7	0.3	2.0
Phosphorus, T. as P	2	0.16	0.35	0.19	0.1	0.02	0.21	0.25	0.11	0.80

Notes: Water Quality Criteria for effluent taken from the criteria, all values are reported in mg/L unless otherwise stated; T - Total; TPH - Total Petroleum Hydrocarbons; P - Phosphorus; Diss. - Dissolved; E - Effluent

TABLE 7-2 (CONCLUDED)

Site Parameter	Water Quality Criteria	Yuca	Cononaco	Auca		Lago Agrio		Atacapi	Parahuacu	Guanta
		Central E22	Central E23	Central E25	South E27	Central E31	North E34	Central E37	Central E38	Central 39
Temperature (°C)		32.0	48.0	43.0	39.0	26.0	33.0	33.0	35.0	32
pH-field (units)	5.5-9.5	6.7	8.1	7.3	7.4	7.1	7.3	0.74	6.4	6.3
pH (units)	5.5-9.5	6.61	7.2	6.52	7.13	7.07	6.50	5.5	4.8	4.44
Specific Conductance-field (mS/cm)		>50.0	4.0	13.0	46.0	1.75	18.5	>50.0	19.5	>50.0
Specific Conductance (mS/cm)		75.1	2.8	10.9	37.8	1.6	16	160	16.5	103
Colour (truce)		9	4	<1	17	11	30	32	24	23
Chloride, Diss.	2500	30400	670	3270	13700	418	5130	88000	6020	48900
Hardness, T. as (CaC0$_3$)		6645	115	481	2477	237	2170	32830	2386	17492
Total Suspended Solids (TSS)	40	808	124	310	756	168	1270	11000	818	4470
Total Dissolved Solids (.45 μm) (TDS)	5000	52700	1510	5790	24100	1020	10200	147000	10300	82400
TPH (C5-C30)	25	2.2	3.6	5.9	2.6	0.5	21	1.0	4.1	3.0
Sulphide	1.0	7.8	1.4	4.5	5.3	1.3	1.7	10.2	5.9	7.0
Phosphorus, T. as P	2.0	0.59	0.53	0.12	0.50	0.50	0.84	0.74	0.15	0.16

Notes: Water Quality Criteria for effluent taken from the criteria, all values are reported in mg/L unless otherwise stated; T - Total; TPH - Total Petroleum Hydrocarbons; P - Phosphorus; Diss. - Dissolved; E - Effluent and are characteristically high in concentrations of total suspended solids (TSS), total dissolved solids (TDS), and sulphide.

The TDS concentrations, as high as 49700 mg/L (site E12), are between four and ten times higher than the water quality criteria of 5000 mg/L. The chloride concentrations, a major contributor to the high TDS levels, exceed its criteria by an equal amount. The high concentrations of TDS are also reflected in the high levels of specific conductance and total hardness (sum of calcium and magnesium ions). Water with TDS levels ranging from 10,000 to 100,000 mg/L and a total hardness of >180 mg/L are considered saline and very hard (McNeely et al. 1979). Concentrations of TSS and sulphate also exceed their respective water quality criteria while levels of phosphorous are within the limit. The effluent had an odour similar to that of hydrogen sulphide.

7.4.2 Rio Niutshinac, Rio Shushufindi, and Rio Eno

Rio Niutshinac, Rio Shushufindi and Rio Eno are the main rivers directly or potentially associated with the South, North and Southwest production facilities in the Shushufindi field (Figure 6-1 and Table 7-3). The three rivers are important to aquatic life, are extensively used for domestic purposes and some receive effluents directly from the petroleum operations (Photo 7-1). The following describe the most important changes in the water quality of the rivers resulting from the effluent discharge.

7.4.2.1 Rio Niutshinac

Rio Niutshinac receives effluent (produced water) from the Shushufindi Southwest production facility. The effluent flows along an oil stained drainage ditch before it enters the river at site E2 (Photo 7-2). Although the river water quality at upstream (site R1U) and downstream sites (R3D and R4D) is generally similar in terms of temperature, near neutral pH, low turbidity levels and colour, other parameters reveal some important differences. Concentrations of TSS, TDS and total petroleum hydrocarbons (TPH) are higher at site R3d by about 65, 4 and 3 times, respectively, than those recorded at the background site (R1U) located about 500 m upstream of the effluent discharge site. These differences are likely the result of input at site E2 since these parameters are found in high concentrations in the effluent.

The ionic characteristics of the Rio Niutshinac have also changed, from a calcium bicarbonate type of water at site R1U to a sodium chloride type of water at sites R3d and R4d. The ionic dominance was altered from: cations $Ca^{++} > Mg^{++} > Na^{+} > K^{+}$; anions $HCO_3^{-} > SO_4^{=} > Cl^{-}$ at the background site to: cations $Na^{+} > Ca^{++} > Mg^{++} > K^{+}$; anions $Cl^{-} > HCO_3^{-} > SO_4^{=} >$ at the two downstream sites. The total hardness of the water changed from soft to a moderately soft state downstream of the effluent discharge. Waters with a total hardness of 91 to 120 mg/L are considered moderately soft (McNeely et al. 1979). Total alkalinity levels are within a moderate range. Waters with a total alkalinity concentration of <24 mg/L are susceptible to

TABLE 7.3

Summary of Water Quality Data for Rivers in the PETROECUADOR-TEXACO Orient Oilfields - June 1993

Site Parameter	Water Quality Criteria		Shushufindi							Agua Rico	Sacha	
	Drinking	Aquatic Life	R1U	R3d	R4d	R5U	R6d	R7d	R8U	R10d	R14d	R16d
Temperature (°C)			24.0	23.0	24.0	25.0	25.0	24.0	24.0	22.0	23.0	23.5
pH-field (units)	6.0-9.0	4.0-9.0	6.55	6.04	7.30	5.86	5.93	6.22	6.53	7.04	7.31	7.19
pH (units)	6.0-9.0	4.0-9.0	7.61	7.01	7.10	7.16	7.07	7.16	7.27	7.63	7.18	7.22
Specific Conductance-field (mS/cm)			0.23	0.85	0.70	0.20	0.23	0.29	0.30	0.16	0.26	0.29
Specific Conductance (mS/cm)			0.11	0.64	0.65	0.08	0.07	0.08	0.09	0.11	0.096	0.15
Dissolved Oxygen (field)		>5.0	See Notes									
Turbidity NTU	100		11	6.4	16	2.1	8	39	21	100	19	9.3
Colour (true)	20		16	5	12	20	17	21	19	7	13	19
Calcium, Diss.	75	75	8	17	20	5.2	4.8	5.2	5.4	13	5.0	8.3
Magnesium, Diss.	50	50	3.9	6.2	7.3	2.5	2.3	2.5	2.7	1.2	2.5	2.9
Potassium, Diss.			1.4	3.9	3.9	1.3	1.3	1.5	1.6	1.3	1.9	2.4
Sodium, Diss.			5	82	80	4	3	2	4	2	3	8
Iron, T.	0.3	0.3	1	1.3	1.4	1	1.2	1.4	1.4	1.2	0.1	0.1
Manganese, Diss	0.5	0.1	<0.05	<0.05	<0.05	<0.05	,0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Bicarbonate, Diss.	100		57	63	62	43	37	39	45	48	37	50
Carbonate, Diss.	50		<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Chloride, Diss.	250	1000	0.8	150	155	0.7	0.9	0.6	0.8	2.5	1.1	9.0
Sulphate, Diss.	500	500	1.5	0.9	3.7	0.6	0.6	1.6	1.1	5.1	0.7	0.6
Alkalinity, T. as (CaC0$_3$)	250		47	52	50	35	30	32	37	40	30	41
Hardness, T. as (CaC0$_3$)	250		36	68	80	23	21	23	25	37	23	33
Total Suspended Solids (TSS)	Absent		27	65	210	105	16	60	410	260	168	276
Total Dissolved Solids (.45 μm) (TDS)	1000		92	365	368	77	80	83	73	77	84	93
TPH (C5-C30)	1.0	1.0	0.9	2.4	1.7	2.7	3.9	3.1	3.3	2.5	0.3	0.4
Ionic Balance			0.985	0.951	0.947	0.912	0.919	0.856	0.902	0.900	0.973	0.978

<u>Notes</u>: Water quality criteria for surface waters taken from the contract document; all values are reported in mg/L unless otherwise stated; T - Total; TPH - Total Petroleum Hydrocarbons; P - Phosphorus; Diss. - Dissolved/ R - River; U - Upstream (control) site; d - downstream of effluent discharge point.

Dissolved oxygen concentrations in rivers and streams ranged from 4.0 to 6.0 mg/L in June 1993 (personal communication with Roy Roberts of Fugro McClelland).

TABLE 7.3 (CONCLUDED)

Site Parameter	Water Quality Criteria		Sacha		Cononaco	Auca				Lago Agrio			
	Drinking	Aquatic Life	R17U	R18U	R34U	R26d	R28U	R29d	R30U	R32d	R33U	R35U	R36d
Temperature (°C)			23.5	24.0	25.0	24.5	24.0	26.5	23.5	25.0	21.0	24.0	25.0
pH-field (units)	6.0-9.0	4.0-9.0	7.03	6.78	7.40	6.91	6.93	7.33	7.80	7.05	7.80	6.18	5.94
pH (units)	6.0-9.0	4.0-9.0	7.19	7.39	7.17	6.74	6.93	7.12	6.70	7.00	7.29	7.58	7.53
Specific Conductance-field (mS/cm)			0.27	0.32	0.20	0.68	0.14	5.80	0.13	0.20	0.15	0.17	1.25
Specific Conductance (mS/cm)			0.11	0.16	0.05	0.62	0.04	5.04	0.02	0.12	0.10	0.09	1.23
Dissolved Oxygen (field)		>5.0					See Notes						
Turbidity NTU	100		8.4	2.1	17	2.1	4.2	4.2	6.5	70	40	6.9	7.8
Colour (true)	20		20	15	5	3	17	14	5	13	7	16	20
Calcium, Diss.	75	75	6.8	9.6	3.3	9.8	2.1	64	0.8	8.7	10	6.8	56
Magnesium, Diss.	50	50	2.8	4.5	2.0	1.9	0.8	10	0.5	3.3	1.2	3.0	5.3
Potassium, Diss.			1.8	1.9	1.1	2.4	1.6	24	0.5	32.	1.1	1.7	18
Sodium, Diss.			4	5	3	89	2	895	2	5	2	4	142
Iron, T.	0.3	0.3	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Manganese, Diss	0.5	0.1	<0.05	<0.05	<0.05	<0.05	,0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Bicarbonate, Diss.	100		47	70	29	23	17	56	10	49	38	49	116
Carbonate, Diss.	50		<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Chloride, Diss.	250	1000	1.0	0.8	0.9	154	0.5	1600	0.2	2.2	1.4	1.4	378
Sulphate, Diss.	500	500	0.5	0.5	0.5	0.6	0.4	1.6	0.5	1.0	3.7	0.6	6.6
Alkalinity, T. as $(CaC0_3)$	250		39	57	24	19	15	46	8	40	31	40	95
Hardness, T. as $(CaC0_3)$	250		29	43	16	32	9	201	4	35	30	29	162
Total Suspended Solids (TSS)	Absent		152	152	156	140	88	216	168	152	200	104	200
Total Dissolved Solids (.45 μm) (TDS)	1000		83	100	63	360	57	2800	15	88	77	93	732
TPH (C5-C30)	1.0	1.0	0.3	<0.2	0.2	0.4	0.4	0.3	0.3	0.5	0.4	0.5	0.2
Ionic Balance			0.976	0.945	0.954	0.967	0.991	0.945	1.005	1.134	0.964	0.940	0.999

__Notes__: Water quality criteria for surface waters taken from the contract document; all values are reported in mg/L unless otherwise stated; T - Total; TPH - Total Petroleum Hydrocarbons; P - Phosphorus; Diss. - Dissolved/ R - River; U - Upstream (control) site; d - downstream of effluent discharge point.

Dissolved oxygen concentrations in rivers and streams ranged from 4.0 to 6.0 mg/L in June 1993 (personal communication with Roy Roberts of Fugro McClelland).

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Photo 7-1 River Rio Niutshinac at site R3d showing typical stream morphology and water use in the study area.

Photo 7-2 Produced water from the southwest production station flowing along an oil stained drainage channel before it enters Rio Niutshinac at site E2.

alterations in pH which consequently may have a serious impact on aquatic life (CCREM 1987). Although the levels of TDS and associated constituents are within the water quality criteria, the aquatic flora and fauna tolerant of increased salinity are probably favoured and a shift in the biological community can result.

The concentration of TPH showed about a threefold increase at site R3d as compared to the background site. Concentrations at both downstream sites exceed the water quality criteria for drinking and aquatic life of 1.0 mg/L.

Concentrations of iron at sites upstream and downstream of the effluent discharge exceed the water quality criteria for drinking and aquatic life. Levels of TSS at the downstream sites exceed the criteria for drinking water.

7.4.2.2 Rio Shushufindi

Available data suggests that water quality of Rio Shushufindi upstream (site R5U) and downstream (site R6d) of Shushufindi Central production facility is similar and shows no significant influence from the operation of the facility. The waters at both sites have an identical temperature (25.0°C) near neutral pH, moderate turbidity and low to moderate levels of alkalinity. The concentrations of TDS and major ions indicate the water is of the calcium bicarbonate type. The ionic species according to their dominance are: cations $Ca^{++} > Mg^{++} > Na^{+} > K^{+}$; anions $HCO_3^{-} > Cl^{-} > SO_4^{=}$. The water is considered very soft and because of the low alkalinity, it has a low capacity to neutralize an acid.

The concentrations of iron, TSS, and TPH exceed the water quality criteria for drinking water. The inputs of iron and TSS are probably from natural sources. The source of TPH is unknown.

7.4.2.3 Rio Eno

The water quality of Rio Eno upstream (site R8U) and downstream (site R7d) is similar and exhibits no influence from Shushufindi North, the nearest production facility. It should be noted that the hydraulic connection between the small creek that receives the effluent from the facility and Rio Eno could not be determined. The water quality of Rio Eno is similar to that of Rio Shushufindi. The water is of the calcium bicarbonate type, has a near neutral pH, moderately turbid, soft, low in TDS, and has a moderate to high level of TSS. The concentrations of iron, TSS and TPH exceed the water quality criteria for drinking water. The TPH levels also exceed the criteria for the protection of aquatic life. The elevated levels of these parameters probably originate from other anthropogenic sources. The laboratory test for TPH excludes naturally occurring hydrocarbons.

7.5 EFFLUENT IN THE AGUA RICO FIELD

The effluent in the Agua Rico field originates from the Agua Rico Central production facility (Figure 6-1, Tables 7-1 and 7-2). The produced water at site E9 has a near neutral pH, warm temperature and is saline and very hard. The TDS concentration was higher than those recorded in the Shushufindi field. Concentrations of chloride (32600 mg/L), TSS (365 mg/L), TDS (55400 mg/L), and sulphide exceed the water quality criteria of 2500, 40, 5000 and 1.0 mg/L, respectively. The effluent from the Agua Rico field was discharged into the forest with no direct connection to a receiving stream. The effluent has had a notable effect on the forest. The vegetation adjacent to the discharge was dead or yellowed (Photo 7-3).

7.6 EFFLUENTS AND RIVERS IN THE SACHA FIELD

7.6.1 Effluents

The effluents from the Sacha field comprise produced waters from Sacha #2 North, Sacha North, Sacha Central and Sacha South and sewage effluent from Sacha Central facilities (Figure 6-1 and Tables 7-1 and 7-2). The produced waters exhibit a similar quality. They are warm, particularly at site E15 and have a near neutral pH. As compared to those in the Shushufindi field, the effluents have similar TPH levels, notably lower concentrations of TSS and sulphide and the TDS levels are about 10 times lower. In terms of fresh water, the effluents are considered fresh and very hard (McNeely et al. 1979). The concentrations of chloride and TDS at site E19 and some of the sulphide and phosphorous levels at the other sites exceed the water quality criteria.

The sewage effluent at site E20 has a near neutral pH and relative to the produced waters has low concentrations of TDS and total hardness and similar levels of suspended solids. Only the TSS level exceeded the water quality criteria.

7.6.2 Rio Jivino Rojo, Rio Plandayacu and Rio Blanco

Rio Jivino Rojo, Rio Plandayacu and Rio Blanco are the main rivers directly associated with the production facilities in the Sacha field. These rivers are important to aquatic life and for domestic uses.

7.6.2.1 Rio Jivino Rojo

Rio Jivino Rojo receives effluent indirectly from the Sacha North #2 facility. The effluent from site E13 flows along a ditch through a cultivated field and potentially into the river (Figure 6-1). A river sample upstream of the effluent discharge point could not be obtained. The data suggest that the river downstream of the effluent discharge point (site R14d) is unaffected (Table 7-3).

The water has a neutral pH, is of the calcium bicarbonate type with low levels of TDS, total hardness and alkalinity, similar to those levels at the upstream river sites in the Shushufindi field. The TPH concentration (0.3 mg/L) is low. Only the TSS level (168 mg/L) exceeded the water quality criteria for drinking.

7.6.2.2 Rio Plandayacu

Rio Plandayacu receives effluent from the Sacha North facility (site E15). In general, the water quality of Rio Plandayacu is similar to that of Rio Jivino Rojo. The water upstream (site R17U) and downstream (R15d) of the effluent discharge point are similar except for the slightly elevated levels of calcium, sodium and chloride found at the downstream site. Because a high concentration of these parameters is characteristic of the effluent, the higher levels found in the river are probably the result of loading from the effluent. The changes in water quality are slight. Only the level of TSS exceeded the water quality criteria for drinking.

7.6.2.3 Rio Blanco

Rio Blanco may receive effluents (produced water and sewage) indirectly from the Sacha Central production facility (sites E19 and E20). The effluent from site E19 flows along a drainage ditch into the forest and may eventually reach the Rio Quincha Ya Cu/Rio Blanco. The ditch immediately downstream of site E19 also contained a significant amount of oily wastes (Photo 7-4). Because a direct connection between the effluents and the river was unlikely, the sampling of the river was limited to the upstream site (R18U).

The water quality of Rio Blanco at site R18U is similar to that reported for the upstream site on Rio Plandayacu. The water has a near neutral pH, is of the calcium bicarbonate type with low levels of TDS, chloride, total hardness and alkalinity. The TPH concentration (<0.2 mg/L) is low. Only the TSS concentration (152 mg/L) exceeded the water quality criteria for drinking water. Available data provides evidence that the discharge from the production station has no apparent influence on the water quality of the river.

7.7 EFFLUENT IN THE YUCA FIELD

In the Yuca field, the effluent originates from the Yuca Central (site E22) production facility (Figure 6-1). The effluent flows along a small and poorly defined stream, through plantations, and may eventually discharge into Laguna Taracoa, a distance of about three kilometres (Table 7-1). Because the stream contains mainly produced water, the sampling was limited to the effluent discharge site.

Photo 7-3 Vegetation showing stress due to the effluent discharged from the Agua Rico Central Production station (site E9).

Photo 7-4 A drainage ditch containing oily wastes and produced water released from the Sacha Central production station (site E19).

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The quality of the effluent resembles those found in the Shushufindi and Agua Rico fields (Table 7-2). The produced water has a near neutral pH, it is saline, very hard, with high concentrations of TDS, TSS, chloride and sulphide. The concentrations of chloride, TSS, TDS, and sulphide substantially exceed the water quality criteria.

7.8 EFFLUENT AND RIVER IN THE CONONACO FIELD

7.8.1 Effluent

In the Cononaco field, effluent from the Cononaco Central production station (site E23) was discharged directly into the forest. The effluent has had notable effects on the forest. The vegetation in the immediate area of the discharge was dead or yellowed.

The quality of the effluent is notably different than those previously described. The produced water is very warm (48.0°C), slightly alkaline, moderately soft, and relatively low in concentrations of TDS, TSS and chloride (Table 7-2). Concentrations of TSS and sulphide exceed the water quality criteria.

7.8.2 Rio Shiripuro

Because the forest receives the effluent and the distance between the effluent discharge point and Rio Shiripuro is about one and one-half kilometres, a direct hydraulic connection between the effluent and the river is unlikely (Figure 6-1 and Table 7-2). The quality of the river was addressed because it is important for drinking and other domestic uses.

The river is alkaline, of the calcium bicarbonate type, with a moderate level of TSS (Table 7.3). As compared to the upstream sites on the other rivers previously described, Rio Shiripuro has low concentrations of TDS and the water is very soft. The total alkalinity concentration of 24 mg/L is considered low. Water with a total alkalinity concentration of <24 mg/L are susceptible to alterations in pH and consequently may have a serious impact on aquatic life (CCREM 1987). Only the concentration of TSS (156 mg/L) exceeded the water quality criteria (for drinking). The effluent from the production station had no apparent influence on the water quality of Rio Shiripuro.

7.9 EFFLUENTS AND RIVERS IN THE AUCA FIELDS

7.9.1 Effluents

In the Auca field, produced water effluents are released from the Auca Central (site E25) and Auca South (site E27) production stations (Figure 6-1). The produced waters are very warm, particularly at site E25 (43.0°C), have a near neutral pH, but are dissimilar with respect to TSS and some dissolved parameters (Table 7-2). The level of TSS at site E27 is more than twice that found at site E25. More importantly, the TDS at site E27 is about four times higher. Water with TDS levels < 1000 mg/L are considered fresh, while those with levels between 10,000 and 100,000 mg/L are saline (McNeely et al. 1979). At both sites, the concentrations of TSS, TDS, chloride, and sulphide exceed the water quality criteria.

7.9.2 No Name River(a), No Name River(b) and Rio Tiputini

7.9.2.1 No Name River(a)

No Name River(a) receives produced water effluent from the Auca Central station (site E25). As compared to streams in other fields, the water quality of the river at site R26d, downstream of the effluent discharge is similar. It has a near neutral pH, is soft, and has low levels of total alkalinity and TPH (Table 7-3). However, by the same comparison, the concentrations of TDS and some major ions are elevated. The most revealing is that the water is of the sodium chloride type as compared to the calcium bicarbonate type which is characteristic of upstream sites in other rivers. The water upstream of the effluent discharge is probably of the calcium bicarbonate type and the change at the downstream site is likely the result of effluent discharge from Auca Central, since the effluent has a high concentration of chloride. It should be recognized that the river is about 1.5 m wide and <0.5 m deep and because of its low flow rate, the water quality can be easily influenced by the effluent. Only the level of TSS exceeded the water quality criteria.

7.9.2.2 No Name River (b)

No Name River(b), approximately 1.5 m wide and 0.5 m deep, receives produced water effluent from the Auca South station (site E27). The effluent flows along a poorly defined stream for about 0.25 km and then enters the river about 50 m upstream of site R29d (Photos 7-5 and 7-6). At the upstream (R28U) and downstream (R29d) sites the river had a near neutral pH, and low levels of TPH but most of the other parameters showed a notable difference. The most important differences are that the water type changed from a calcium bicarbonate to a sodium chloride, very soft to very hard and from fresh to slightly saline condition. The elevated levels of particularly sodium, chloride and TDS are likely the result of effluent discharge from Auca South. High concentrations of chloride and TDS are characteristic of the effluent. Because the river is small and has a low flow, its water quality can be significantly influenced by the effluent. Levels of TSS and TDS exceed the drinking water quality criteria.

Photo 7-5 Effluent from Auca South station entering a poorly defined stream before discharging into No Name River(b) about 50 m upstream of site R29d.

Photo 7-6 No Name River(b) at site R29d.

7.9.2.3 Rio Tiputini

Although Rio Tiputini does not directly receive effluent, the water quality was verified because it is a source of drinking water and provides other domestic uses and aquatic habitat. As compared to upstream sites on other rivers, the river has a similar pH (near neutral) and TPH but some important differences are evident. Rio Tiputini has a sodium bicarbonate type of water which is unlike that at the upstream sites of other rivers which have calcium bicarbonate waters. In addition, the concentrations of TDS (15 mg/L), total hardness (4 mg/L) and total alkalinity (8 mg/L) are the lowest found in the entire study area. The water is very soft and very susceptible to alterations in pH. Only the level of TSS exceeded the water quality criteria. The water quality of Rio Tiputini is probably characteristic of natural conditions in the drainage area.

7.10 EFFLUENTS AND RIVERS IN THE LAGO AGRIO FIELD

7.10.1 Effluents

In the Lago Agrio field, produced water effluents are released from the Lago Agrio Central (site E31) and Lago Agrio North (site E34) production stations (Figure 6-1 and Table 7-1). The effluents have a similar pH (near neutral), both exhibit high concentrations of sulphide but the North station effluent is considered saline and very hard (Table 7-2). In addition, the effluent at site E34 contained the highest concentration of TPH (21 mg/L) found in the entire study area. Concentrations of chloride, TSS, TDS and sulphide at the North station exceed the water quality criteria, while only TSS and sulphide levels at the Central station exceed the criteria.

7.10.2 Rio Teteye and No Name River(c)

7.10.2.1 Rio Teteye

Rio Teteye receives effluent from Lago Agrio Central and Lago Agrio North stations indirectly form drainage ditches and No Name River(c), respectively (Figure 6-1). The water quality in Rio Teteye at site R43d is similar to that found at the upstream site R35U. Our data indicates significant influence on water quality from the effluent discharged from the Central station (Table 7-3). The waters are soft, have a near neutral pH, of the calcium bicarbonate type and exhibit moderate concentrations of alkalinity and TDS. The concentrations of TSS at both sites exceed the water quality criteria.

7.10.2.2 No Name River(c)

No Name River(c) receives effluent directly from the North station (site E34). The effluent flows along a small stream before entering the river (Photo 7-7). At site R36d, downstream of the effluent discharge, the water is moderately soft, has a near neutral pH, and is of the sodium bicarbonate type. The higher concentrations of TDS and most of the major ions, as compared to site R25U suggests some influence of the effluent. Effects of the effluent can be appreciated because the river at this site is shallow, <2 m wide and is located about 1.0 km from the station. Only the TSS concentration exceeded the water quality criteria.

7.11 EFFLUENTS IN THE ATACAPI, PARAHUACU AND GUANTA FIELDS AND RIO AGUA RICO

7.11.1 Effluents

Effluents from the Central stations in the Atacapi, Parahuacu and Guanta fields are released directly into wetland/forest areas (Figure 6-1, Table 7-1 and Photo 7-8). The effluents have near neutral pH and the sites at Atacapa and Guanta reveal the highest concentrations of TDS, total hardness, chloride and TSS found in the study area. The Atacapi site showed the highest level (10.2 mg/L) of sulphide. With a TDS of 147,000 mg/L, the effluent from the Atacapi site is considered a brine (McNeely et al. 1979). The concentrations of chloride, TSS, TDS and sulphide at all three sites exceed the water quality criteria.

7.11.2 Rio Agua Rico

Rio Agua Rico drains the Lago Agrio, Atacapi, Parahuacu and Guanta fields and after Rio Napo, it is the second largest river in the study area (Figure 6-1). The river water quality at sites R33U and R10d is similar (Table 7-3). It has a neutral pH, is of the calcium bicarbonate type, soft, with notably higher levels of turbidity, TSS and TPH at the downstream site. Such increases of these parameters can be expected through natural occurrence. The levels of TSS at both sites exceed the water quality criteria; TPH exceeded the criteria value at site R10d.

7.12 SUMMARY OF IMPACTS

The surface water sampling program was conducted during June 8 - 16, 1993. A total of 17 produced water effluents and 21 river water samples were collected which represent 10 oilfields. The characterization and assessments were based solely on field data collected for parameters and water quality criteria established by the Environmental Audit Technical Committee.

The study revealed that the water quality of effluents vary widely and the effluent discharges have influenced the water quality of some rivers. The produced waters generally have a near neutral pH, warm temperatures and are characteristically high in concentrations of total suspended solids, total dissolved solids, total hardness, chloride and sulphide. All total suspended solids values exceeded the water quality criteria. The salinity ranged from fresh found at Lago Agrio Central to a brine at Atacapi Central. Most of the total dissolved solids values exceeded the water quality criteria. Chloride concentrations, a major constituent of total dissolved solids, frequently exceed the criteria. Except for two, all remaining sulphide concentrations exceed the criteria. All concentrations of total petroleum hydrocarbons (TPH) and phosphorous in the effluents were within their respective criteria.

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Photo 7-7 Produced water from the Lago Agrio North station flowing into the forest immediately downstream of the outlet (site E34) before entering No Name River(c)

Photo 7-8 Produced water discharged to a wetland/forest at the Atacapi Central station and typical for the Central stations at Parabuacu and Guanta

The effluent discharges have influenced the water quality of five rivers. The most important changes were found at: Rio Niutshinac, No Name River(a), No Name River(b) and No Name River(c). At the upstream sampling sites on these rivers, the waters had a near neutral pH, low levels of turbidity, total suspended solids, total dissolved solids, chloride and the waters were of the calcium bicarbonate type. Levels of total suspended solids occasionally exceeded the water quality criteria. At the downstream sites, the water quality showed important changes. Most revealing was that the water changed from a calcium bicarbonate to a sodium chloride type. At No Name River(c) the change was to a sodium bicarbonate. Due to the effluent, the water showed elevated levels of total suspended solids, total dissolved solids, most major ions, particularly sodium and chloride and increased hardness. Consequently, levels of total suspended solids, total dissolved solids, total petroleum hydrocarbons and chloride occasionally exceeded the water quality criteria.

The impacts of effluent discharge on the water quality and aquatic life of the receiving streams and rivers are summarized in Table 7-4. The impacts on water quality were evaluated by comparing the water quality analyses with the water quality criteria for drinking and aquatic life. Impacts on vegetation were based solely on observation. Impacts were rated high, medium and low according to the scoring system given in Table 6-4.

The effluents changed the water quality of some streams so that water quality for drinking and aquatic life was affected. The impacts ranged from none to moderate and were mainly the result of increased salinity and changes to the water from a calcium bicarbonate to sodium chloride type.

7.13 REFERENCES

Canadian Council of Resource and Environment Ministers (CCREM). 1987. Canadian water quality guidelines. prep. by Task Force on Water Quality Guidelines.

McNeeley, R.N., V.P. Neimanis, and L. Dwyer. 1979. Water quality sourcebook, a guide to water quality parameters. Inland water Directorate, Environment Canada, Ottawa, Ont. 88 pp.

TABLE 7-4

Summary of Impacts on Water Quality

Oilfield/Production Station	Receiving River or Land	Impacts on Water Quality and Vegetation
Shushufindi Central	forest/Rio Shushufindi	no apparent impact on Rio Shushufindi
Shushufindi North	small stream	stream has limited uses, impact is minimal to low; no impact on Rio Eno
Shushufindi South	Rio Niutshinac	low impact on drinking water and low to moderate impact on aquatic life of Rio Niutshinac due to increased salinity
Shushufindi Southwest	wetland/forest	no visible impact on vegetation; no impact on streams
Agua Rico Central	forest	moderate to high impact on vegetation adjacent to discharge; no impact on streams
Sacha North-2	cultivated field/Rio Jivino Rojo	no apparent impact on vegetation; no impact on streams
Sacha North	Rio Plandayacu	no impact on drinking water, low impact on aquatic life due to increased salinity
Sacha Central	drainage ditch/Rio Quincha Ya Cu/Rio Blanco	low to moderate impact on drinking water and aquatic life in Rio Blanco
Sacha Central	forest/Rio Quincha Ya Cu/Rio Blanco	no apparent impact on vegetation or streams
Sacha South	forest/Rio Huamayacu	no visible impact on vegetation
Yuca Central	plantations/Leguma Taracoa	no visible impact on vegetation
Cononaco Central	forest/Rio Shiriparo	no apparent impact on vegetation on Rio Shiripuro
Auca Centra	No Name River(a)	low impact on drinking water; moderate impact on aquatic life due to change in water type
Auca South	No Name River(b)/Rio Tiputini	low impact on drinking water; moderate impact on aquatic life due to change in water type; no impact on Rio Tiputini
Lago Agrio Central	Rio Teteye	no apparent impact on Rio Teteye
Lago Agrio North	No Name River(c)/Rio Teteye	low impact on drinking water; low impact on aquatic life due to change in water type; no impact on Rio Teteye
Atacapi Central	wetland/forest	no apparent impact on vegetation
Parahuaou Central	wetland/forest	no apparent impact on vegetation
Guanta Central	wetland/forest	no visible impact on vegetation

PART 8 - SUBSURFACE SOILS AND GROUNDWATER

This section of the report provides a discussion of the goals, methods and results of a broad-based investigation of subsurface soils and groundwater within the PETROECUADOR-TEXACO Consortium Oil Fields.

8.1 INTRODUCTION

The results of the Phase I Assessment indicated that the greatest potential for significant subsurface contamination appeared to exist at the production stations and well sites, particularly in the areas of pits, ponds and sumps. A large number of soil samples were collected during the Phase I Audit, primarily in order to determine what concentrations of assessment criteria constituents could be found at the margins of these features. During the Phase II subsurface investigation, our primary goal was to determine if there was evidence that these constituents had migrated through subsurface soils and groundwater, in a manner that might affect recommendations made in the Environmental Management Plan.

The specific goals of the Phase II subsurface investigation were:

- to determine the concentrations and distribution of assessment criteria constituents within subsurface soils and groundwater in the Assessment Area; and
- to develop an understanding of the potential for contaminant migration in the subsurface through a regional evaluation.

Our strategy for selecting the Phase II exploration sites was based partly upon our review of preliminary results of the Phase I Audit, and upon our understanding of the distribution of subsurface soil types and groundwater throughout the study area. Rather than attempting to explore each of the well sites (approximately 325) and production stations (22) throughout the Assessment Area, we focused instead upon defining how contaminants have migrated (and could be expected to migrate) through the subsurfaces of areas with similar hydrogeologic conditions. In other words, well sites and production stations were explored not only to determine their specific subsurface conditions, but also in order to predict subsurface conditions at other, unexplored sites in similar geologic settings. Aquifer testing was carried out at four separate locations in order to broadly define hydrogeologic conditions and groundwater migration rates throughout the study area.

8.2 REGIONAL GEOLOGY AND HYDROGEOLOGY

In the upland areas south of the Rio Napo, and in the Gaunta and Lago Agrio Oil Field areas, the soils consist of red to reddish brown, stiff, kaolinitic clays (Atas del Mundo, 1982). Because of the high rainfall, the soil horizon has been profoundly leached and depleted in base metals (calcium, magnesium, sodium, and potassium) and silica; it has been enriched in iron and aluminium. The soils in the lowland alluvial flood plains between the Rio Napo and the Rio Aguarico developed on sediments recently derived from the Andes. These alluvial soils are typically poorly-drained and not as deeply weathered as the soil horizons on the hills.

Shallow groundwater occurs within unconfined and perched conditions within the Oriente Basin. Hand dug domestic water wells are common, particularly south of the Aguarico River and north of the Napo River. These water wells are generally less than five meters in depth. Springs are common in upland areas to the south of the Napo River, and north of the Napo River in the Lago Agrio and Guanta Field areas. These springs are partly controlled by perched aquifers, fractures and faults. Because of the occurrence of clayey soils of low permeability in the Study Area, the rate of recharge to the shallow aquifers is relatively low to moderate, and surface runoff to rivers is high. Typically, streams in humid tropical regions receive groundwater discharge, and the water table slopes towards the streams. Most vertical and lateral groundwater flow occurs along fractures within the clay or within silt or sand units.

8.3 METHODOLOGY

Our field explorations were carried out between June 8 and June 18, 1993, and consisted of collecting soil and groundwater samples from test pits, hand auger borings, springs and domestic water wells. Test pit excavations and hand auger borings were located near mud pits on the well sites and adjacent to the production water ponds and discharge points at the production stations. Groundwater samples were collected from domestic water wells and springs near production facilities and well sites, to screen for evidence of the subsurface migration of contaminants on the first occurring water table. The following sections describe exploration methods and sample handling procedures.

8.3.1 Soil Sampling Procedures

Subsurface investigations were conducted at production ponds in 13 of the larger stations located in the Sacha, Shushufindi, Lago Agrio, Auca, Guanta and Cononaco fields. We also explored 18 representative well sites within Lago Agrio, Sacha, Shushufindi, Aguarico, Auca and Cononaco fields. The excavation of test pits was accomplished using a rubber-tire backhoe at Shushufindi and Lago Agrio Fields (Photo 8-1), and with a trackhoe at Sacha Field. Subsurface sampling at Auca, Cononaco and Guanta Fields was carried out using stainless steel hand augers.

Test pit excavations generally ranged from 2.5 to 5.0 meters in depth. The locations of these test pits were selected in order to determine if there was evidence of migration of contaminants away from pits, ponds, sumps or other "high-risk" features. Soil samples were collected directly from excavations through the use of backhoe and trackhoe buckets, or from decontaminated Dutch-head hand augers. In order to eliminate the possibility of cross-contamination, hand augers were decontaminated between sampling episodes, and no samples were collected from soils that had been in contact with the internal surfaces of the buckets. As each bucket of soil (to be sampled) was removed from an excavation, a hand trowel was used to scrape away soils, in order to reach soil samples near the center of the bucket.

At most of the 31 subsurface exploration sites, test pit or hand-auger locations were sampled close to and at successive distances from "high risk" features such as mud pits. At most exploration sites, two or three test pits were excavated at successive distances from the "high risk" features. As an example, two test pits were excavated at the Aguarico Well 9. The first test pit was excavated to a depth of three meters, within a few meters of the northern margin of the large mud pit located at the site. Soil samples were collected at several intervals, following a visual inspection and logging of soil types. The second test pit was then excavated several tens of meters to the north, in order to determine if oil from the mud pit had migrated a significant distance through the subsurface soils or groundwater.

The process of collecting subsurface soils through test pit excavations, provided the basis of our characterization of shallow subsurface soils at each field. Samples were observed and classified in the field by two or more geologists. Representative portions of each sample were collected, placed in airtight, Teflon-sealed containers and transported on ice to the HBT AGRA laboratory in Edmonton, Alberta, Canada. All excavations were backfilled following test pit excavation and sampling. Geologic test pit and boring logs appear in Appendix H.

Petroleum-like odors, as noted on the test pit logs, are subjective information gathered or detected at the time of sampling. Detection of petroleum odors is partly dependent on the sensitivity of the person classifying the sample, as well as on other factors, including air and sample temperature, wind velocity, the length of time the sample is out of the excavation and product degradation. Because these constraints are not readily quantifiable, and no test standards exist, these observations should be considered as general subjective information.

8.3.2 Groundwater Sampling Procedures

Groundwater samples were collected from a total of 29 sites. These samples were taken directly from test pits, from hand auger borings using disposable bailers or other suitable decontaminated containers, from water wells and from springs. During test pit sampling, if a sufficient volume of groundwater was found to recharge an excavation, the water sample was collected directly into a water sample bottle attached to a rod. If only a small quantity of water infiltrated the excavation, the groundwater was collected with a decontaminated plastic bucket which was lowered into the excavation with a rope. Samples collected from hand auger borings were collected with disposable bailers through slotted PVC pipe. Samples collected from springs and seeps were collected, when possible, directly from the point of discharge.

Each groundwater sample was inspected following collection and then immediately tested in the field for pH and specific conductance, using a Hydac Digital Conductance, Temperature and pH Tester. The samples were transported under chain-of-custody procedures to the HBT AGRA lab in Edmonton, Alberta, Canada.

8.3.3 Aquifer Testing Procedures

Rising head tests were conducted on piezometers located at the Shushufindi Central Production Station, Sacha Well 103, Sacha South Production Station and Auca Central Production Station. The purpose of the aquifer testing was to determine the hydraulic conductivity near the top of the first-occurring water table at these sites. Hydraulic conductivity is the rate of flow of water through a permeable medium.

The piezometers were installed in a two inch diameter hand auger boring. The slotted interval for each piezometer was 0.3 meters in length (Photo 8-2). The annulus between the hand auger boring and the PVC casing was less than one centimeter, and it was not possible to place a sand filter pack in this small annular space. A nylon stocking was used to cover the slotted interval of the casing to act as a filter (Photo 8-3).

The static water level in each well was measured prior to the start of each rising head test. Each test was performed by rapidly bailing water from the well with a bailer, and then closely monitoring the groundwater recovery for one-half hour to two hours. Water levels were measured with a steel tape coated with water-sensitive paste (Kolor Kut). The rising head test data were analyzed using the Hvorslev model for a well point in a uniform aquifer.

8.3.4 Laboratory Analysis of Soil and Water Samples

In accordance with the Final Assessment Criteria, soil samples collected during the Phase II subsurface investigation were tested for oil and grease by IR (USEPA Test Method 413.2). Inorganic constituents in soils, including heavy metals, were tested in the soil samples collected during the Phase I Assessment, and are discussed in Section 6.0 of this report.

Groundwater samples were analyzed for oil and grease (O&G) by U.S. EPA Test Method 413.2; groundwater samples were also tested for inorganic chemicals including calcium, chloride, iron, manganese, magnesium, sulfate, total dissolved solids, carbonate, bicarbonate, total hardness, total alkalinity, and pH; and for physical characteristics such as color, turbidity and specific

Photo 8-1 Backhoe used to excavate test pits at Shushufindi Field.

Photo 8-2 A slotted interval of 0.3 meters was cut in the PVC prior to installing the piezometer.

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conductance. Groundwater samples collected from test pits were tested primarily for O&G, since groundwater in the test pits was characterized by very high turbidity. Clays in tropical soils typically have high concentrations of iron and manganese, and groundwater samples with high concentrations of suspended clays may not be representative of dissolved concentrations of these constituents. In order to obtain more representative samples with low turbidity, inorganic constituents and other parameters were evaluated in samples from monitoring wells, domestic water wells and from springs located on or near well sites and production stations.

Groundwater samples were tested for O&G to screen for the presence of dissolved or suspended petroleum hydrocarbons. If a measurable thickness of free phase petroleum were identified during our subsurface investigation, a water sample was not collected or tested. A heavy petroleum sheen was identified on the surface of the water in Test Pit No. 1 of SSF-STC. Therefore, contamination of groundwater was noted at the site, but a groundwater sample was not collected or tested. Only one other test pit yielded evidence of free-phase petroleum hydrocarbons on the surface of the water table. This test pit was at Well Site 9 (Aguarico Field) and was excavated less than two meters from the margin of the mud pit, which contained a layer of oil on its surface.

It should be noted that while our field sampling procedures were designed to eliminate the risk of cross-contamination of samples, low levels of O&G (less than 1.0 ppm) can sometimes be introduced during field sampling or laboratory analysis. Nonpolar biogenic organic compounds other than petroleum hydrocarbons, such as humic or tannic acids, can be detected by the IR instrument during analysis. In other words, decaying vegetation can contribute to the presence of oil and grease in surface water or groundwater.

8.4 SUBSURFACE CONDITIONS

This section of the report provides qualitative information about soil types identified throughout the Study Area; the results of our aquifer testing are also included. As discussed in Section 8.1, our approach to the subsurface investigation was based upon defining widespread subsurface soil and groundwater conditions, and then conducting explorations for contaminants at select sites in order to predict how petroleum hydrocarbons and other potential contaminants could be expected to migrate through the subsurface. Quantitative results and our summary of impacts to the subsurface are presented in Sections 8.5 and 8.6.

Approximately one-half meter of sand and gravel fill was found to cover the native soils at all the well sites in the Study Area. The gravel fill is typically spread over timbers, originally used to create a foundation. Clay fill material was encountered at the Lago Agrio Central and North production stations adjacent to the production station ponds. Native soils encountered throughout most of the Study Area consists of silty clay with discontinuous lenses of sand or silt. Shallow groundwater above three to five meters of depth was often found throughout the Study Area, though sometimes this water was perched on stiff soils underlying the fill materials. The subsurface conditions at each of the fields are discussed in the following sections, 8.4.1 through 8.4.7.

8.4.1 Shushufindi Field

Soils in the Shushufindi field area primarily consist of brown or reddish brown, stiff silty clay. In exploration test pits, the clay was found to occur from the base of fill to the total depths of the test pits at Shushufindi South Station, Well B66, Well B71, Well B57, Well A13, and Well A67. At Shushufindi Central Station, North Station, Southeast Station and Well A43, well sorted, fine to medium grained sand was encountered beneath the clay at depths of 0.9 to 3.1 meters below ground surface. The sand is locally cemented by iron, forming a hard pan layer between 0.5 and 1.5 meters thick. Iron concretions also occur within the unconsolidated sand or silt.

Shallow groundwater occurrence in the area of Shushufindi Field is sporadic, and appears to be partly controlled by topography. Groundwater was encountered in the test pit excavations at three out of ten sites. A water bearing sand was found between 2.0 and 3.6 metres at Central Station and at 3.0 meters at Southeast Station. Fractured clay also yielded groundwater at 1.0 meters of depth, in a test pit excavated at South Station. Surface water perched within the permeable sand and gravel fill, infiltrated the test pits excavated at Well B66, Well B71 and Well A67. Shallow domestic water wells near North Station, South Station, Southeast Station, and Well A43 were found to be less than four meters in depth.

A rising head slug test conducted on a piezometer installed within the silty sand at Central Station yielded a moderate hydraulic conductivity of 0.35 meter/day. This conductivity is consistent with the intrinsic permeability of a silty sand, which suggests that the shallow aquifer at Central Station is behaving as a uniform porous medium.

Visual or olfactory evidence of petroleum contamination was encountered at Central Station, North Station, Southeast Station and Well B57. Crude oil was noted in fractures and relict root channels at North Station and Well B57. A measurable layer of petroleum hydrocarbons was observed on the surface of the groundwater in the test pit located approximately 25 meters from the production ponds at Central Station (Photo 8-4). A discussion of test results for all soil and groundwater samples collected during our investigation is included in Section 8.5.

8.4.2 Aguarico Field

Soils in the vicinity of the Aguarico Field consist of stiff, brown or gray silty clay. A fine to medium grained sand was encountered beneath the clay at Aguarico Wells 3 and 10. The sand at Well 10 is laterally discontinuous and interfingers with silt.

Photo 8-3 A nylon stocking was used to cover the slotted interval of the PVC pipe to act as a filter.

Photo 8-4 Petroleum hydrocarbon layer on the groundwater encountered in testpit TP1 at Shushufindi Central Station.

Groundwater was encountered at Aguarico Field between 0.84 and 3.0 meters below ground surface in water bearing sands, silts or fractured clays. It should be noted that Aguarico Station and some of the upland well sites have deeper groundwater.

Crude oil was noted in fractures within the clay at Well 3, and free phase petroleum hydrocarbons were identified on the groundwater at Wells 3 and 9.

8.4.3 Sacha Field

Soils at Sacha Field consist of silty clay with discontinuous layers of silt or fine sand. The shallow silt and sand layers range in thickness from 0.5 meters to at least 2.0 meters.

Groundwater was encountered in the more permeable sand, silt and fractured clays at Central Station, North #1 Station, South Station, Well 103 and Well 94. No groundwater was observed above the total depth of the test pit (3.5 meters) at Well 75 . Rising head slug tests were conducted at Well 103 and South Station. The moderate to low hydraulic conductivities at Well 103 and South Station were 0.037 meters/day and 0.0092 meters/day, respectively. The conductivity at South Station appears to fall at the upper end of the range of typical hydraulic conductivities for silty clay (between 10^{-5} meters/day and 0.009 meters/day).

Crude oil was identified in fractures and relict root channels in a test pit located near the production water discharge pond at North #1 Station (Photo 8-5).

8.4.4 Auca Field

The soils in the Auca Field area are stiff, reddish brown to red, silty or sandy clay. Exposures on road cuts indicate that the red clay abruptly changes color to light gray at three to four meters below ground surface (Photo 8-6).

Perched groundwater was encountered in borings on a slope below the production ponds at Central Station and South Station. The groundwater occurs in a fine sand which overlies a less permeable clay. This groundwater appears to be seepage originating from production ponds which are situated up-slope from the borings (Photos 8-7 and 8-8). A rising head slug test conducted on a piezometer installed at the Auca Central Production Station indicated a moderate hydraulic conductivity of 0.01 meters/day. A major source of domestic water in the area is springs controlled by fractures within the clay or perched aquifers.

No visual evidence of significant petroleum contamination was noted in the hand auger borings near the production ponds at Central Station or South Station. Petroleum was observed on the ground surface near the production pond at Central Station.

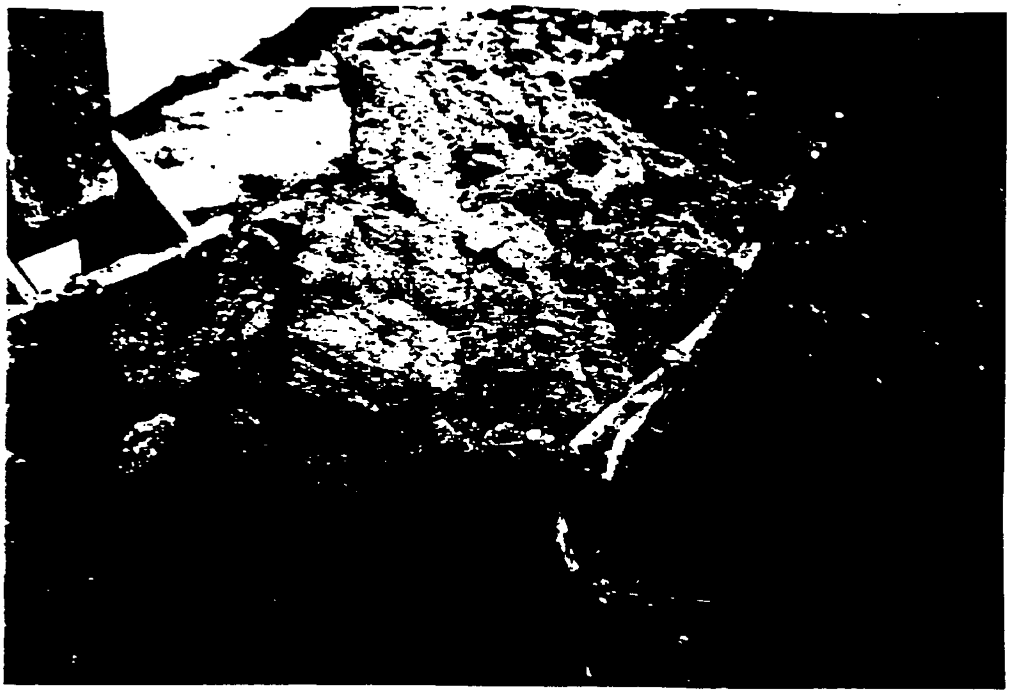

Photo 8-5 Crude oil in soil excavated near production pond at Sacha North #1 Station (TP1).

Photo 8-6 Soil profile exposed in cliff near Auca Central Station.

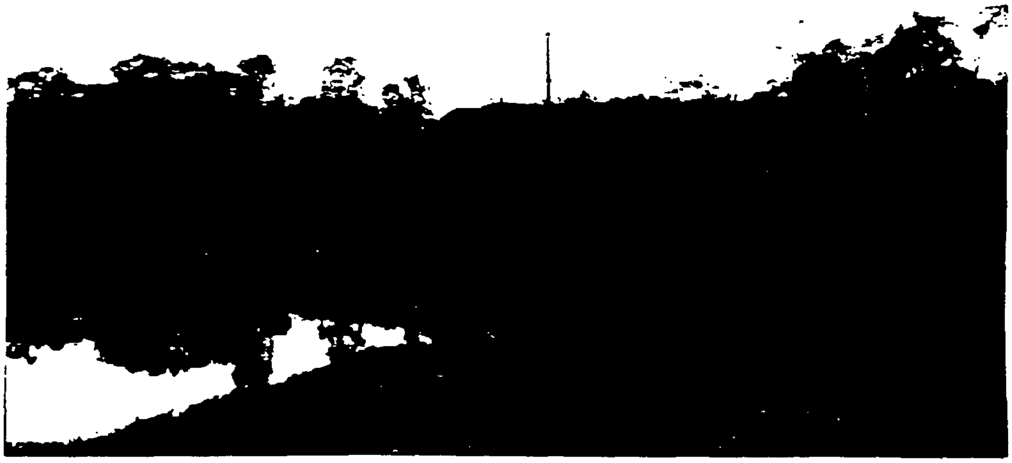

Photo 8-7 Production pond at Auca South Station located on bluff adjacent to flare stack. Produced water is seeping at the base of the bluff.

Photo 8-8 Production water seep located at toe of the slope below a pond at Auca Central Station. The location of a piezometer is indicated on the photo.

8.4.5 Cononaco Field

Soil encountered in hand auger borings at Central Station, and also observed in local road cuts, consist of reddish brown to red clay. No other soil types were identified during our investigation.

Groundwater was not encountered above 3.0 meters in the hand auger borings near the production pond at Central Station. As with Auca Field, springs in the vicinity are controlled by fractures and are often perched.

No visible evidence of contamination was noted in the subsurface soils near the production pond at the Central Station.

8.4.6 Lago Agrio Field

Undisturbed soils in the Lago Agrio Field consist of reddish brown, red or gray silty clay, with interbedded clayey silt or clayey sand layers which range in thickness from 0.1 to 1.0 meters. Clay fill was noted near the production ponds at Central Station and North Station.

Groundwater was encountered at 1.2 meters below ground surface at Well 32, and at 2.8 meters at North Station. No groundwater was noted in the test pit (4.5 meters total depth) at Well 1, nor in the hand auger borings (2.4 meters total depth) located near the production pond at Central Station.

No significant visual evidence of petroleum hydrocarbon contamination was noted in the test pits or borings at Central Station, North Station, Well 1 or at Well 32.

8.4.7 Guanta Field

Soils in the vicinity of the produced water pond at the Central Station are composed of medium stiff, brown silty clays. Saturated soils were encountered at 2.4 meters below grade in a hand auger boring. No visual evidence of contamination was noted in the boring.

8.5 QUANTITATIVE ANALYSIS

Test results for petroleum hydrocarbons in both soil and groundwater are summarized in Table 8-1. Groundwater test results for organic and inorganic parameters for samples collected from monitoring wells, domestic water wells and springs are presented in Tables 8-2 and 8-3. Laboratory reports and chain-of-custody records are included in Appendix G. Test results are discussed in the following sections.

TABLE 8-1

Soil and Groundwater Hydrocarbon Test Results for Test Pits and Borings Located on Well Sites and Production Stations PETROECUADOR-TEXACO Consortium

Site	Sample Name	Soil Sample		Water Sample
		Depth (m)	Oil and Grease (µg/g dry wt)	Oil and Grease (mg/L)
Shushufindi Field				
Central Station	TP2/4M	2.4	170	<0.2
	TP3/4M	2.4	220	<0.2
North Station	TP1	2.6	31	
	TP2	2	1100	
Southeast Station	TP1			0.5
	TP2			<0.2
	TP3			<0.2
South Station	TP1	3.5	1800	
Well Site A43	TP1	3	99	
	TP2	2	140	
Well Site B66	TP1		82	1
Well Site B71	TP1	2.7	260	0.5
	TP2	1.2	510	
Well Site B57	TP1	2.7	150	
	TP2	2.7	17000	
Well Site A13	TP1	3	42	
Well Site A67	TP1	3.6	410	
Aguarico Field				
Well Site 3	TP1	2	1700	67
	TP2			8.3
Well Site 9	TP1	3	63	
	TP2	1	100	0.6
Well Site 10	TP1			
	TP2	3	140	
	TP3			0.9
Sacha Field				
Central Station	TP1	3.4	150	
	TP2			0.6
	TP3	5	75	

TABLE 8-1 (CONT'D)

Site	Sample Name	Soil Sample		Water Sample
		Depth (m)	Oil and Grease (μg/g dry wt)	Oil and Grease (mg/L)
South Station	TP1			<0.2
	TP2	1	4100	
North #1 Station	TP1	3.5	2800	
	TP2			<0.2
Well Site 94	BH1			<0.2
Well Site 75	TP1	1	130	
Well Site 103	BH1	3.2	170	0.2
<u>Auca Field</u>				
Central Station	MW1			1
	BH2	3.2	200	
	BH3	1.5	670	
South Station	BH1	2.2	370	
	SS2	0.3	120	
Well Site 7	SS1	1	140	
	SS2	0.6	53	
<u>Cononaco Field</u>				
Central Station	BH1	0.8	160	
	BH2	2.8	130	
<u>Lago Agrio Field</u>				
Central Station	BH1	Composite	460	
	BH2	1	3100	
North Station	TP1	4.5	47	
	TP2	3.2	99	
Well Site 1	TP1	1.9	86	
Well Site 32	TP1	3.0	82	
<u>Guanta Field</u>				
Central Station	BH1	2.4	260	

TABLE 8-2

Analytical Results for Groundwater Collected from Monitoring Well and Production Pond Seeps PETROECUADOR-TEXACO Consortium

Analytical Parameter	Units	Proposed Criteria mg/L	Site				
			Auca South Station	Auca Central Station	Shushufindi Central Station	Sacha Well Site 103	Sacha Well Site 94
Sample Name			AU-STS-SS1	AU-STC-MW1	SSF-STS-MW1	SA-103-MW1	SA-94-BH1
Source			Seep Near Production Pond	Monitoring Well Near Production Pond	Monitoring Well Near Production Pond	Monitoring Well Near Mud Pit	Monitoring Well on Well Site
Calcium	mg/L	100	236*	15.6	25.8	NT	NT
Magnesium	mg/L	50	66.5*	5	15.1	NT	NT
Potassium	mg/L	NA	101	2.9	1.1	NT	NT
Sodium	mg/L	NA	6755	270	20.9	NT	NT
Iron	mg/L	0.3	32.4*	28.7*	10.1*	NT	NT
Manganese	mg/L	0.05	4*	10.3*	0.69	NT	NT
Bicarbonate	mg/L	NA	74	82	47	NT	NT
Carbonate	mg/L	NA	<1	<1	<1	NT	NT
Chloride	mg/L	250	13800	490	135	NT	NT
Sulphate	mg/L	250	1.7	2.7	1.3	NT	NT
Lab Conductivity	mS/cm	N1	29	1.585	0.577	NT	NT
Field Conductivity	mS/cm				1	NT	NT
Lab pH		7.5	7.11	6.35	6.88	NT	NT

▨ = Exceeds Proposed Assessment Criteria
NT = Not Tested
* = High Concentration Probably Due to High Turbidity

TABLE 8-2 (CONT'D)

Analytical Parameter	Units	Proposed Criteria mg/L	Site				
			Auca South Station	Auca Central Station	Shushufindi Central Station	Sacha Well Site 103	Sacha Well Site 94
Field pH					7.4	NT	NT
Color		15	3	500	33	NT	NT
Turbidity	NTU	5	88800	1800	2600	NT	NT
Total Alkalinity	mg/L	250	60	68	39	NT	NT
Total Hardness	mg/L	NA	863.139	59.5432	126.6044	NT	NT
Total Dissolved Solids	mg/L	850	22345	1965	750	NT	NT
Oil and Grease	mg/L	0.1		1.0	NT	0.2	<0.2

▨ = Exceeds Proposed Assessment Criteria
NT = Not Tested
* = High Concentration Probably Due to High Turbidity

TABLE 8-3

Analytical Test Results for Groundwater Collected from Water Wells and Springs PETROECUADOR-TEXACO Consortium

Field			Aguarico			Auca		Cononaco	Lago Agrio			
Analytical Parameter	Units	Proposed Criteria mg/L	Well Site #3	Well Site #9	Well Site #10	South Station	Central Station	Station	North Station	Well Site #20	Well Site #21	Well Site #26
Sample Name			AG3-WW	AG9-WW	AG-10-WW	AU-STS-SS1	AU-STC-WW	CON-STC-WW	LA-STN-WW1	LA20-SS	LA21-SS	LA26-SS
Source			Water Well	Water Well	Water Well	Spring	Spring	Spring	Water Well	Spring	Spring	Spring
Location			Adjacent to well site	200 meters west of well site	Adjacent to well site	50 meters north of station	Adjacent to north boundary of station	50 meters west of station	Adjacent to west boundary of station	200 meters north of well site #20	100 meters north of well site #20	50 meters south of well site #26
Calcium	mg/L	100	6.4	7.8	NT	3.3	2	3.4	23.9	6.9	6.9	1.8
Magnesium	mg/L	50	2.2	0.9	NT	1.1	<0.1	0.9	2.3	2.1	2.4	0.6
Potassium	mg/L	NA	1.4	1	NT	<0.1	0.8	1.2	4.2	1.6	0.8	<0.1
Sodium	mg/L	NA	2.1	1.9	NT	4.6	3.7	3.2	11.9	4.2	5.3	2.2
Iron	mg/L	0.3	0.1	0.2	NT	0.1	0.12	1.51	0.1	1.31	0.1	0.11
Manganese	mg/L	0.05	<0.05	<0.05	NT	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Bicarbonate	mg/L	NA	26	35	NT	36	19	35	95	51	50	16
Carbonate	mg/L	NA	<1	<1	NT	<1	<1	<1	<1	<1	<1	<1
Chloride	mg/L	250	1.8	1	NT	0.5	2.1	0.5	11	1.4	1.3	0.62
Sulphate	mg/L	250	5.5	1.5	NT	0.1	1.2	1.2	2.6	0.24	1.1	1.2
Lab Conductivity	mS/cm	NA	0.076	0.062	NT	0.04	0.029	0.037	0.186	0.064	0.075	0.023
Field Conductivity	mS/cm		NA	NA	NT	0.05	NA	0.044	0.24	NA	0.094	0.04
Lab pH		7.5	6.63	6.93	NT	7.03	6.05	6.5	7.08	7.26	6.72	6.75
Field pH			NA	NA	NT	6.5	NA	6.3	6.3	NA	5.8	7
Color		15	NA	1	NT	5	1	1	1	23	2	1
Turbidity	NTU	5	13	12	NT	3.3	2.6	5.3	5.5	7.8	3.1	5.8
Total Alkalinity	mg/L	250	23	29	NT	30	16	29	78	42	41	13
Total Hardness	mg/L	NA	25	23.1828	NT	12.7699	4.994	16.752	59.1497	25.8771	27.1125	6.9654
Total Dissolved Solids	mg/L	850	1.95	140	NT	860	275	265	420	460	315	250
Oil and Grease	mg/L	0.1	NT	<0.2	<0.2	0.3	0.75	NT	0.4	0.3	0.3	0.2

▨ = Exceeds Proposed Assessment Criteria
NT = Not Tested
NA = Not Available

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TABLE 8-3 (CONT'D)

Field			Sacha					Shushufindi Field						
Analytical Parameter	Units	Proposed Criteria mg/L	North #1 Station	South Station	Well Site #94	Well Site #100	Well Site #90	South Station	North Station	Well Site #A43	Well Site #13	Well Site #6	Southeast Station
Sample Name			SA-STN1-WW	SA-STS-WW	SA94-WW	SA100-WW	SA90-WW	SSF-STS-WW	SSF-STN-WW1	SSF-A43-WW1	SSF-13-SS	SSF-09-WW	SSF-STSW-WW1
Source			Water Well	Water Well	Water Well	Water Well	Water Well	Water Well	Water Well	Water Well	Spring	Water Well	Water Well
Location			75 meters west of station	300 meters south of station near Pueblo San Carlos	500 meters east of well site	75 meters east of well site	Adjacent to well site	Adjacent to well site	Adjacent to well site	Adjacent to well site	Adjacent to well site	Adjacent to well site	250 meters north of station
Calcium	mg/L	100	7.9	8.1	11.5	13.5	4.4	5.6	7.8	6.5	NT	NT	NT
Magnesium	mg/L	50	2.2	2.6	7.3	3.1	1.4	3.1	3.8	4.5	NT	NT	NT
Potassium	mg/L	NA	1.5	1.2	26.9	2	1.3	1.4	1.2	1.3	NT	NT	NT
Sodium	mg/L	NA	3.3	3.8	19.7	5.8	5.2	2.8	5.3	4.4	NT	NT	NT
Iron	mg/L	0.3	<0.05	<0.05	0.13	0.17	0.16	0.3	<0.05	<0.05	NT	NT	NT
Manganese	mg/L	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.58	<0.05	<0.05	NT	NT	NT
Bicarbonate	mg/L	NA	41	44	147	62	35	44	72	14	NT	NT	NT
Carbonate	mg/L	NA	<1	<1	<1	<1	<1	<1	<1	<1	NT	NT	NT
Chloride	mg/L	250	2.5	3.8	23	24	2.5	1.4	7	7.2	NT	NT	NT
Sulphate	mg/L	250	2.4	1.3	3.1	2.4	2.7	0.9	1.4	1	NT	NT	NT
Lab Conductivity	mS/cm	NA	0.095	0.106	0.236	0.161	0.81	0.078	0.115	0.121	NT	NT	NT
Field Conductivity	mS/cm		0.138	0.149	0.15	0.23	0.102	1.05	0.358	NA	NT	NT	1.65
Lab pH		7.5	6.6	6.46	6.89	6.9	6.5	6.92	6.8	6.32	NT	NT	NT
Field pH			5.9	5.5	6.1	6	5.6	6.5	6.5	NA	NT	NT	6.3
Color		15	1	2	3	1	1	NA	1	3	NT	NT	NT
Turbidity	NTU	5	1.4	4.4	3.4	3.9	5.3	10	1.1	1.4	NT	NT	NT
Total Alkalinity	mg/L	250	34	36	121	51	29	36	59	12	NT	NT	NT
Total Hardness	mg/L	NA	28.7859	30.9325	58.7769	46.4753	16.752	26.749	35.125	34.7615	NT	NT	NT
Total Dissolved Solids	mg/L	850	440	335	370	250	265	60	225	165	NT	NT	NT
Oil and Grease	mg/L	0.1	<0.2	<0.2	<0.2	0.6	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0.5

▨ = Exceeds Proposed Assessment Criteria
NT = Not Tested
NA = Not Available

TABLE 8-3 (CONT'D)

Field			Background Samples		
Analytical Parameter	**Units**	**Proposed Criteria mg/L**	**Villa**	**Culebra**	**Eno**
Sample Name					
Source			**Spring**	**Spring**	**Water Well**
Location			**5.7 kilometers south of Auca Sur #1**	**9.2 kilometers south of Rio Napo**	**3 kilometers south of Eno**
Calcium	mg/L	100	<0.1	0.8	7.3
Magnesium	mg/L	50	<0.1	0.5	3.4
Potassium	mg/L	NA	0.9	<0.1	1.2
Sodium	mg/L	NA	1.7	1.3	4.9
Iron	mg/L	0.3	<0.05	0.26	0.29
Manganese	mg/L	0.05	<0.05	<0.05	<0.05
Bicarbonate	mg/L	NA	9	9	46
Carbonate	mg/L	NA	<1	<1	<1
Chloride	mg/L	250	0.38	0.6	3.6
Sulphate	mg/L	250	0.2	2.7	3.1
Lab Conductivity	mS/cm	NA	0.014	0.014	0.083
Field Conductivity	mS/cm		0.037	0.023	0.088
Lab pH		7.5	5.85	5.98	6.69
Field pH			5.1	5.3	6.1
Color		15	1	2	2
Turbidity	NTU	5	1.9	13	15
Total Alkalinity	mg/L	250	7	7	38
Total Hardness	mg/L	NA	<6	4.0566	32.2293
Total Dissolved Solids	mg/L	850	430	150	190
Oil and Grease	mg/L	0.1	<0.2	0.67	0.98

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▨	= Exceeds Proposed Assessment Criteria
NT	= Not Tested
NA	= Not Available

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8.5.1 Shushufindi Field

A total of 14 subsurface soil samples were collected within Shushufindi Field. Concentrations were found to range from 31 μg/g (ppm) to 17,000 ppm. Concentrations of O&G in 13 of the samples were measured at less than 5,000 ppm. Moderately elevated concentrations of O&G were detected at North Station (1,100 ppm at 2.0 meters in test pit TP2) and at South Station (1,800 ppm at 3.5 meters in TP1). As mentioned in section 8.4.1, crude oil was noted in the fractures and root channels in soils excavated near the production pond at the North Station. Only one soil sample collected from the subsurface of Shushufindi Field exceeded the assessment criterion of 5,000 ppm (O&G). A concentration of O&G at 17,000 ppm was detected at 2.7 meters below ground surface in test pit TP2. Groundwater was not encountered in the test pit excavated at this well site.

A total of 14 groundwater samples were collected within Shushufindi Field. These included seven groundwater samples from test pits, one sample from a monitoring well, one sample from a spring, and five samples from domestic water wells. Of these samples, 13 were tested for O&G. Concentrations were below the detection limit of 0.2 mg/l in nine groundwater samples. Three samples yielded concentrations of 0.5 mg/l and one sample (TP1 at Well Site B66) contained a concentration of 1.0 mg/l.

As discussed above, free phase petroleum hydrocarbons were encountered in the groundwater in a test pit (TP1) at Shushufindi Central Station. This test pit is located 25 meters from the nearest production pond. Groundwater samples collected from the two other test pits, located over 50 meters from the production ponds, contained concentrations of O&G below detection limits.

Of the 14 Shushufindi groundwater samples, four were tested for inorganics and other drinking-water parameters. Mildly elevated concentrations of iron and manganese were detected in a domestic water well near South Station, and in a monitoring well sample installed near the production pond at Central Station. The concentrations of these metals in these groundwater samples may be partly due to the high turbidity of the samples.

8.5.2 Aguarico Field

A total of four subsurface soil samples were collected from this field. Concentrations of O&G ranged from 63 to 1,700 ppm, all beneath the assessment criteria.

Eight groundwater samples were also collected within the field. Of the seven samples tested for O&G, two (both from water wells) were below the detection limit of 0.2 mg/l, two yielded concentrations less than 1.0 mg/l, and three were greater than 1.0 mg/l. One sample (TP1 from Well Site 3) was significantly elevated at 67 mg/l. Crude oil was noted in one of the three test pits at Well 9. Levels of O&G in the other test pit (TP2) at Well 9 was less than 1.0 ppm.

Water samples collected from domestic water wells located near the well sites yielded no evidence of significant levels of petroleum hydrocarbon or inorganic chemicals.

8.5.3 Sacha Field

Six subsurface soil samples were collected from Sacha Field. Concentrations of O&G ranged from 75 ppm to 4,100 ppm (all beneath the assessment criterion of 5,000 ppm). Elevated levels of O&G were detected in the soils at 3.5 meters near the production pond at North #1 Station (2,800 ppm) and at 1.0 meters in TP2 at South Station (4,100 ppm). At North #1 Station, oil was identified within fractures. The relatively low level (2,800 ppm) of O&G detected in the sample may be explained by a heterogeneous distribution of the oil in the soil.

Twelve groundwater samples were collected from Sacha Field. Concentrations of O&G were below the detection limit in eight of the 10 samples. Detectable levels of O&G were present in the groundwater sample collected from a test pit at Central Station (0.6 mg/l), in a domestic water well near Well Site 100 (0.6 mg/l) and in a monitoring well at Well Site 103 (0.2 mg/l). Levels of inorganic chemicals of all five water samples collected from wells in the Sacha Field area, were below assessment criteria levels. However, elevated chloride values were found in well site 94 (23 mg/l) and well site 100 (24 mg/l).

8.5.4 Auca Field

Six subsurface soil samples were collected within Auca Field. Concentrations of O&G ranged from 82 ppm to 670 ppm in the samples tested.

Three groundwater samples from Auca Field were tested. Levels of O&G in the groundwater samples collected from springs, seeps, and the monitoring wells at Central Station were all equal to or less than 1.0 ppm. Water samples collected from a monitoring well near the production pond at Central Station and from a seep near a production pond at South Station, yielded elevated concentrations of chlorides, with a high specific conductance.

8.5.5 Cononaco Field

Two subsurface soil samples were collected at Central Station in Cononaco Field. Test results for the two soil samples were 130 ppm and 160 ppm (O&G).

A spring sample was collected from the field, and it yielded an elevated concentration of iron (1.51 ppm). All other parameters were below the assessment criteria concentrations.

8.5.6 Lago Agrio Field

Six subsurface soil samples were collected at Lago Agrio Field. Concentrations of O&G were found to range from 47 ppm to 3,100 ppm. The highest concentration of petroleum hydrocarbons was identified in a soil sample collected near the production pond at Central Station (O&G at 3,100 ppm), 1.0 meter below ground surface. An organic, peat-like streak was noted in the sand fill at this depth, and the occurrence of a relict topsoil horizon in the fill may account for the elevated O&G concentration.

Four groundwater samples were collected within Lago Agrio Field. Concentrations of O&G in the groundwater samples were all above the assessment criterion of 0.1 mg/l, but were less than 1.0 mg/l.

8.5.7 Guanta Field

An O&G concentration of 260 ppm was detected in a subsurface soil sample at 2.4 meters near the production station pond.

8.5.8 Background Groundwater Samples

In order to establish the background concentrations of the assessment parameters used for the study, groundwater samples were collected from three domestic water wells and springs located far from production stations and well sites. Samples were collected from a spring located 5.7 kilometers south of Auca Sur #1, from a spring 9.2 kilometers south of the Rio Napo and from a domestic water well located 3 kilometers south of the pueblo Eno.

All three background groundwater samples were tested for the presence of O&G. One yielded a concentration below the detection limit of 0.2 mg/l. The other two samples contained concentrations of 0.67 mg/l and 0.98 mg/l, both above the assessment criterion of 0.1 mg/l. The elevated O&G levels in these samples are likely due to biogenic organics. Concentrations of the inorganic constituents in all three samples were within the assessment criteria standards, except for elevated turbidity in one spring sample and one water well sample.

8.6 SUMMARY OF IMPACTS TO THE SUBSURFACE

Through our visual observation of near surface soils and groundwater, testing of the upper water table aquifer and analysis of subsurface soil and groundwater samples through chemical testing, we have been able to identify and rate environmental impacts to the subsurface, for locations throughout the Study Area. A description of the scoring system used to rate environmental impacts is given in Table 6-4. Exploration sites with no evidence of subsurface contamination or oil-filled pits/ponds have been rated as "low". Sites with oil-filled pits/ponds, yet no evidence of significant subsurface contamination have been rated as "medium", and sites that

TABLE 8-4

Summary of Site Conditions and Impact Rating of Site
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Site	Type of Soil	Groundwater Occurrence and Depth Encountered	Visual Evidence of Petroleum	Analytical Test Evidence	Impact Rating*
Aguarico Field					
Well 3	Clay overlying sand @ 2.4 m	2.6 to 2.7 m	Petroleum on groundwater		High
Well 9	Clay	2.5 m	Petroleum on groundwater	67 ppm O&G in water	High
Well 10	Clay overlying sand and silt	1.75 to 2.5 m	No evidence		Medium
Auca Field					
Central Station	Clayey sand	Seepage from pond	No evidence	13,800 ppm chloride in water	High
South Station	Silty sand or sandy clay	Seepage from pond	No evidence	490 ppm chloride in water	Medium
Well 7	Clay	No groundwater encountered	No evidence		Low
Cononaco Field					
Station	Clay	No groundwater encountered	No evidence		Medium
Guanta Field					
Station	Clay	2.5 m	No evidence		Medium
Lago Agrio Field					
Central Station	Clay fill	No groundwater encountered	No evidence	3,100 ppm O&G in organic rich soil @ 1 m	Medium
North Station	Clay and sand fill	2.8 to 3.0 m	No evidence		Medium
Well 1	Clay	No groundwater encountered	No evidence		Low
Well 32	Clay	1.2 m	No evidence		Low
Sacha Field					
Central Station	Clay overlying sand @ 1 m or clay with no underlying sand	3 to 3.4 m	No evidence		Medium

* Basis of rating is discussed in Section 8.6.
** Perched water encountered in 0.5 meter thick sandy gravel fill which covered all well sites.

TABLE 8-4 (CONT'D)

Site	Type of Soil	Groundwater Occurrence and Depth Encountered	Visual Evidence of Petroleum	Analytical Test Evidence	Impact Rating*
South Station	Clay	No groundwater encountered	Petroleum odour noted in sand	4,100 ppm O&G in soil @ 4 m	Medium
North #1 Station	Clay overlying sand @ 4.3 m	4.5 m	Oil in sand	2,800 ppm O&G in soil @ 3.5 m	High
Well 75	Clay with interbedded soil	No groundwater encountered	No evidence		Medium
Well 94	Clay with interbedded silt	Perched groundwater in fill**	No evidence		Low
Sacha Field					
Well 103	Clay overlying sand @ 2.7 m	2.9 m	No evidence		Medium
Shushufindi Field					
Central Station	Clay overlying sand @ 0.9 to 1.9 m	2 to 3.6 m	Petroleum on groundwater		High
North Station	Clay overlying sand or clay with no underlying sand	No groundwater encountered	Oil in sand	1,100 ppm O&G in soil @ 2 m	High
Southeast Station	Clay overlying sand @ 3 m	3 m	Petroleum odour in soil		Medium
South Station	Clay	1 m	Petroleum odour in soil	1,800 ppm O&G in sand @ 3.5 m	Medium
Well A43	Clay overlying sand @ 2.0 m	No groundwater encountered	No evidence		Medium
Well B66	Clay	Perched groundwater in fill**	No evidence		Medium
Well B71	Clay	Perched groundwater in fill**	No evidence		Medium
Well B57	Clay	No groundwater encountered	Oil in sand	17,000 ppm O&G in soil @ 2.7 m	High
Well A13	Clay	No groundwater encountered	No evidence		Medium
Well A67	Clay	Perched groundwater in fill**	No evidence		Low

* Basis of rating is discussed in Section 8.6.

** Perched water encountered in 0.5 meter thick sandy gravel fill which covered all well sites.

have displayed evidence of contaminant migration in subsurface soils and/or groundwater have been rated as "high". The results of our rating are presented in Table 8-4.

Based on the results of our investigation, we have found little evidence of significant subsurface contaminant migration beyond the boundaries of the production stations and well sites. At most sites there was little evidence of contamination migrating beyond the margins of the "high risk" features such as mud pits and ponds. Seven of the sites investigated (25%) displayed evidence of contaminant migration in subsurface soils. Three exploration sites (Shushufindi-Central Station, and Aguarico Well Sites 3 and 9) were characterized by oil on the surface of the water table in excavations close to oily, open pits. In each case, contamination was found to diminish within a few tens of meters.

Vertical and lateral migration of contaminants in the subsurface generally was found to be limited by the low to moderate hydraulic conductivity of the upper water table aquifers, the low permeability of the clays commonly encountered throughout the Study Area and by the relatively low mobility of crude oil through the area's subsurface. At most exploration locations, the vertical migration of petroleum was found to be limited to fractures or root channels within clay soils. The greatest migration of oil through the subsurface was evident at sites with more permeable sand lenses or beds underlying the clay.

In general, we found concentrations of most organic and inorganic constituents in groundwater samples from domestic water wells and springs located within the Study Area, to be near or below the assessment criteria standards. The concentrations of O&G in domestic water wells, monitoring wells and spring samples located near oil wells and production stations, were found to be below the detection limit of 0.2 mg/kg at 12 sites and mildly elevated (equal to or less than 1.0 mg/l) in 10 others. Concentrations of O&G in water samples near well sites do not appear to vary significantly from background samples collected far from oil production sites.

8.7 REFERENCES

Atlas del Mundo, 1982. Atlas del Ecuador. Out of Paris, le edicion J.A.

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PART 9 - SUMMARY OF ENVIRONMENTAL LIABILITIES

9.1 INTRODUCTION

The site assessment (Part 6), surface water investigations (Part 7) and subsurface soil and groundwater investigations (Part 8) identified and described environmental liabilities within the concession area. The following sections provide a prioritized ranking of these liabilities based on nature of the contamination and an assessment of environmental and human health risk.

9.2 PRIORITIZED RANKING OF ENVIRONMENTAL LIABILITIES

Before recommendations for further assessment and mitigation can be made, a prioritized ranking of environmental liabilities needs to be completed. This ranking was based on the environmental risk potential of each site. The environmental risk potential identifies those sites where the environmental liabilities are more likely to cause impacts to the environment or present the greatest health risk. The environmental risk potential was therefore used as a means to provide a relative ranking of sites. Sites exhibiting high risk potential should be remediated before sites which have been categorized as having a low risk potential.

To determine the environmental risk potential for each site, a contaminant impact rating and a site sensitivity rating were first developed. The contaminant rating and site sensitivity rating for each site were then given a score. The environmental risk potential was then calculated as the sum of the contaminant rating score and the site sensitivity rating score.

9.2.1 Contaminant Rating

The contaminant rating considers the nature of the contamination and its potential to impact off-site resources. The results of this assessment are discussed in Sections 6.5, 7.11.3 and 8.6. The results are summarized in Table 9-1 for the well site liabilities and Table 9-2 for the production station liabilities.

9.2.2 Site Sensitivity Rating

The site sensitivity rating considers receptors (human and environment) and contaminant exposure pathways such as streams and groundwater. The parameters which were used to determine site sensitivity included proximity to dwellings, proximity to surface water contamination of groundwater and nature of adjacent land use. The scoring method used to determine site sensitivity rankings of "high", "moderate" or low are provided at the base of Tables 9-1 and 9-2. Sites rated as having a high sensitivity are situated within 100 metres of a dwelling and/or surface water. The lands adjacent to highly sensitive sites are usually used

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for agricultural purposes. Sites rated as being moderately sensitive are usually situated within 300 metres of a dwelling or surface water. Low sensitive sites are located adjacent to land which is not used for agricultural purposes, or dwellings or surface water was not located within 300 metres of the site.

9.2.3 Environmental Risk Potential

The environmental risk potential was determined for each site by summation of the contaminant rating score and the site sensitivity rating score. The scoring system used is described at the base of Tables 9-1 and 9-2. An overall score of 4-6 was categorized as a high risk potential, a score of 7-9 as moderate risk potential and a score of 10-13 as low risk potential.

The results of this assessment are summarized in Table 9-1 for well site liabilities and Table 9-2 for production station liabilities.

Where risk potential is considered high, action is required (although action may consist of further assessment). Where risk potential is considered medium, action is likely required. Where risk potential is considered low, action is not likely required.

Table 9 – 1
Well Site Environmental Risk Potential

Assessed Site		Contaminant Rating (a)		Proximity to : (b)		Land Use	Site Sensitivity Rating (c)	Environmental Risk Potential (d)
				Dwelling	Water			
		Shading of "High" ratings provided for clarity only.						
LA	1	Medium	=2	300	180	Mixed	7 =Moderate	9 =Moderate
LA	2	Low	=4	350	300	Grazing	7 =Moderate	11 =Low
LA	5	Low	=4	40	300	Mixed	5 =High	9 =Moderate
LA	6	–	=99	100	100	Grazing	4 =High	103 =None
LA	8	Low	=4	300	300	None	9 =Low	13 =Low
LA	9	–	=99	150	300	Grazing	6 =Moderate	105 =None
LA	10	Medium	=2	50	15	Mixed	3 =High	5 =High
LA	11B	Low	=4	20	5	Mixed	3 =High	7 =Moderate
LA	12	Low	=4	375	300	Mixed	7 =Moderate	11 =Low
LA	17	–	=99	500	300	Mixed	7 =Moderate	106 =None
LA	19	–	=99	15	300	Mixed	5 =High	104 =None
LA	20	Low	=4	70	300	Grazing	5 =High	9 =Moderate
LA	21	Low	=4	70	25	Mixed	3 =High	7 =Moderate
LA	26	Medium	=2	5	25	Mixed	3 =High	5 =High
LA	29	Low	=4	20	100	Mixed	4 =High	8 =Moderate
LA	32	Low	=4	300	10	Grazing	5 =High	9 =Moderate
LA	33	Low	=4	50	50	Mixed	3 =High	7 =Moderate
LA	34	Low	=4	150	300	Mixed	6 =Moderate	10 =Low
LA	35	Low	=4	350	70	Grazing	6 =Moderate	10 =Low
PH	2	Medium	=2	100	25	None	5 =High	7 =Moderate
PH	5	Medium	=2	300	20	None	7 =Moderate	9 =Moderate
AT	1	Low	=4	350	300	None	9 =Low	13 =Low
AT	2	Medium	=2	200	100	None	7 =Moderate	9 =Moderate
AT	3	Low	=4	350	100	None	8 =Low	12 =Low
GU	1	High	=1	20	1	Mixed	3 =High	4 =High
GU	3	High	=1	100	10	Grazing	3 =High	4 =High
GU	5	High	=1	100	1	Grazing	3 =High	4 =High
GU	8	Medium	=2	20	1	Mixed	3 =High	5 =High
AG	AG3	High	=1	20	300	Mixed	5 =High	6 =High
AG	AG6	High	=1	200	200	Mixed	6 =Moderate	7 =Moderate
AG	AG8	High	=1	200	300	Grazing	6 =Moderate	7 =Moderate
AG	AG9	High	=1	150	100	Plantation	5 =High	6 =High
AG	AG10	Medium	=2	20	30	Grazing	3 =High	5 =High
SSF	B57	High	=1	300	300	Mixed	7 =Moderate	8 =Moderate
SSF	B59	High	=1	150	300	Grazing	6 =Moderate	7 =Moderate
SSF	61	High	=1	300	300	Plantation	7 =Moderate	8 =Moderate
SSF	B63	High	=1	100	10	Plantation	3 =High	4 =High
SSF	B64	High	=1	20	1	Mixed	3 =High	4 =High
SSF	A65	Low	=4	100	300	None	7 =Moderate	11 =Low
SSF	B66	High	=1	50	15	Mixed	3 =High	4 =High
SSF	A67	Medium	=2	300	300	Mixed	7 =Moderate	9 =Moderate
SSF	68	High	=1	300	40	Grazing	5 =High	6 =High
SSF	69	Low	=4	300	20	Grazing	5 =High	9 =Moderate
SSF	71	Medium	=2	300	20	Mixed	5 =High	7 =Moderate
SSF	WIW2	–	=99	350	300	Mixed	7 =Moderate	106 =None
SSF	WIW4	–	=99	50	300	Mixed	5 =High	104 =None
SSF	WIW7	–	=99	100	200	Mixed	5 =High	104 =None
SSF	A1	High	=1	30	70	Mixed	4 =High	5 =High
SSF	A7	High	=1	300	300	Grazing	7 =Moderate	8 =Moderate
SSF	A9	Low	=4	20	300	None	7 =Moderate	11 =Low
SSF	A10	Low	=4	50	20	Grazing	3 =High	7 =Moderate

Table 9 – 1
Well Site Environmental Risk Potential

Assessed Site		Contaminant Rating (a)		Proximity to : (b)		Land Use	Site Sensitivity Rating (c)	Environmental Risk Potential (d)
				Dwelling	Water			
SSF	A13	High	=1	40	50	Mixed	3 =High	4 =High
SSF	B15	High	=1	350	1	None	7 =Moderate	8 =Moderate
SSF	B16	High	=1	300	300	None	9 =Low	10 =Low
SSF	A20	Medium	=2	150	300	None	8 =Low	10 =Low
SSF	A22B	Medium	=2	350	200	None	9 =Low	11 =Low
SSF	A24	High	=1	10	20	Mixed	3 =High	4 =High
SSF	A26	Low	=4	50	25	Mixed	3 =High	7 =Moderate
SSF	A30	High	=1	20	50	Mixed	3 =High	4 =High
SSF	B31	Medium	=2	200	1	None	6 =Moderate	8 =Moderate
SSF	A33	Medium	=2	5	70	Mixed	4 =High	6 =High
SSF	A34	–	=99	300	300	None	9 =Low	108 =None
SSF	B36	High	=1	300	10	Mixed	5 =High	6 =High
SSF	A38	High	=1	20	40	Mixed	3 =High	4 =High
SSF	A43	High	=1	1	300	Mixed	5 =High	6 =High
SSF	6B	High	=1	75	300	Plantation	5 =High	6 =High
SSF	A45	Medium	=2	150	300	Grazing	6 =Moderate	8 =Moderate
SSF	A45B	Medium	=2	200	300	NA	8 =Low	10 =Low
SSF	46	Medium	=2	300	200	Mixed	7 =Moderate	9 =Moderate
SSF	B49	High	=1	150	300	Grazing	6 =Moderate	7 =Moderate
SSF	A50	–	=99	30	50	Grazing	3 =High	102 =None
SSF	B51	Medium	=2	20	50	Mixed	3 =High	5 =High
SSF	B52	Medium	=2	300	150	Mixed	6 =Moderate	8 =Moderate
SSF	B55	High	=1	70	300	Mixed	5 =High	6 =High
SA	WIW1	Low	=4	25	300	Plantation	5 =High	9 =Moderate
SA	WIW2	Medium	=2	50	100	Mixed	4 =High	6 =High
SA	WIW3	–	=99	50	300	Plantation	5 =High	104 =None
SA	WIW4	Medium	=2	300	300	None	9 =Low	11 =Low
SA	WIW5	High	=1	50	300	Mixed	5 =High	6 =High
SA	WIW6	Medium	=2	350	300	None	9 =Low	11 =Low
SA	1	Medium	=2	25	50	None	5 =High	7 =Moderate
SA	2	–	=99	50	300	Mixed	5 =High	104 =None
SA	8	High	=1	15	300	Plantation	5 =High	6 =High
SA	9	Low	=4	100	50	Mixed	3 =High	7 =Moderate
SA	11	Medium	=2	20	300	Plantation	5 =High	7 =Moderate
SA	12	High	=1	10	20	Mixed	3 =High	4 =High
SA	13	Low	=4	350	300	Grazing	7 =Moderate	11 =Low
SA	16	High	=1	5	40	Plantation	3 =High	4 =High
SA	18	High	=1	50	300	Plantation	5 =High	6 =High
SA	19	High	=1	100	100	Plantation	4 =High	5 =High
SA	20	High	=1	30	50	Mixed	3 =High	4 =High
SA	21	Medium	=2	350	300	Plantation	7 =Moderate	9 =Moderate
SA	25	High	=1	25	100	Mixed	4 =High	5 =High
SA	27	Medium	=2	20	300	Mixed	5 =High	7 =Moderate
SA	28	Medium	=2	300	100	Grazing	6 =Moderate	8 =Moderate
SA	32	Medium	=2	350	300	None	9 =Low	11 =Low
SA	33	High	=1	350	300	Mixed	7 =Moderate	8 =Moderate
SA	34	Medium	=2	5	300	Mixed	5 =High	7 =Moderate
SA	35	Low	=4	5	300	None	7 =Moderate	11 =Low
SA	36	Medium	=2	350	300	None	9 =Low	11 =Low
SA	43	High	=1	350	300	Plantation	7 =Moderate	8 =Moderate
SA	44	Medium	=2	350	300	None	9 =Low	11 =Low

Shading of "High" ratings provided for clarity only.

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Table 9 – 1
Well Site Environmental Risk Potential

Assessed Site		Contaminant Rating (a)		Proximity to : (b)		Land Use	Site Sensitivity Rating (c)	Environmental Risk Potential (d)
				Dwelling	Water			

Shading of "High" ratings provided for clarity only.

SA	46	Medium	=2	60	20	Mixed	3 =High	5 =High
SA	54	Medium	=2	350	200	None	9 =Low	11 =Low
SA	55	Medium	=2	100	300	Plantation	5 =High	7 =Moderate
SA	56	–	=99	300	300	Plantation	7 =Moderate	106 =None
SA	58	High	=1	50	300	Plantation	5 =High	6 =High
SA	59	High	=1	100	300	NA	7 =Moderate	8 =Moderate
SA	60	High	=1	200	200	Mixed	6 =Moderate	7 =Moderate
SA	72	Medium	=2	300	300	Mixed	7 =Moderate	9 =Moderate
SA	73	Low	=4	200	300	None	8 =Low	12 =Low
SA	74	High	=1	300	300	Mixed	7 =Moderate	8 =Moderate
SA	75	Medium	=2	350	300	Plantation	7 =Moderate	9 =Moderate
SA	77	Medium	=2	300	40	Mixed	5 =High	7 =Moderate
SA	78	High	=1	20	1	Grazing	3 =High	4 =High
SA	81	Medium	=2	200	300	None	8 =Low	10 =Low
SA	84	Low	=4	300	150	Plantation	6 =Moderate	10 =Low
SA	85	Medium	=2	20	10	Mixed	3 =High	5 =High
SA	86	Medium	=2	350	100	None	8 =Low	10 =Low
SA	91	Medium	=2	350	300	None	9 =Low	11 =Low
SA	93	High	=1	1	100	Mixed	4 =High	5 =High
SA	94	Medium	=2	350	10	Grazing	5 =High	7 =Moderate
SA	95	High	=1	200	300	Mixed	6 =Moderate	7 =Moderate
SA	97	High	=1	300	10	Grazing	5 =High	6 =High
SA	100	High	=1	350	300	Plantation	7 =Moderate	8 =Moderate
SA	103	High	=1	300	10	Mixed	5 =High	6 =High
SA	104	Medium	=2	300	300	Plantation	7 =Moderate	9 =Moderate
SA	107	High	=1	1	100	Mixed	4 =High	5 =High
SA	109	High	=1	350	300	None	9 =Low	10 =Low
SA	110	Low	=4	50	300	Plantation	5 =High	9 =Moderate
SA	111	Medium	=2	350	40	None	7 =Moderate	9 =Moderate
SA	113	Medium	=2	300	300	None	9 =Low	11 =Low
CU	2	High	=1	300	1	None	7 =Moderate	8 =Moderate
YB	2	High	=1	300	1	None	7 =Moderate	8 =Moderate
YU	4	High	=1	200	300	Grazing	6 =Moderate	7 =Moderate
YU	6	–	=99	200	300	None	8 =Low	107 =None
YU	5	Medium	=2	150	300	Mixed	6 =Moderate	8 =Moderate
YU	12	High	=1	300	100	None	8 =Low	9 =Moderate
YUS	1	Low	=4	1	30	Plantation	3 =High	7 =Moderate
AU	1	High	=1	300	50	Plantation	5 =High	6 =High
AU	4	High	=1	200	300	Plantation	6 =Moderate	7 =Moderate
AU	6	High	=1	300	300	None	9 =Low	10 =Low
AU	7	Medium	=2	350	1	None	7 =Moderate	9 =Moderate
AU	9	Medium	=2	200	300	None	8 =Low	10 =Low
AU	11	High	=1	20	100	Mixed	4 =High	5 =High
AU	12	High	=1	10	30	Plantation	3 =High	4 =High
AU	15	High	=1	200	500	None	8 =Low	9 =Moderate
AU	16	High	=1	300	100	Plantation	6 =Moderate	7 =Moderate
AU	17	High	=1	300	100	Plantation	6 =Moderate	7 =Moderate
AU	18	Low	=4	300	300	None	9 =Low	13 =Low
AU	19B	High	=1	300	300	Grazing	7 =Moderate	8 =Moderate
AU	21	High	=1	300	100	None	8 =Low	9 =Moderate
AU	24	High	=1	100	100	Mixed	4 =High	5 =High

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Table 9 – 1
Well Site Environmental Risk Potential

Assessed Site		Contaminant Rating (a)		Proximity to : (b)		Land Use	Site Sensitivity Rating (c)	Environmental Risk Potential (d)
				Dwelling	Water			
AUS	1	Low	=4	50	50	Plantation	3 =High	7 =Moderate
RM	1	Medium	=2	350	300	None	9 =Low	11 =Low
CN	1	High	=1	50	300	Plantation	5 =High	6 =High
CN	2	High	=1	10	300	Plantation	5 =High	6 =High
CN	3	–	=99	1	10	Plantation	3 =High	102 =None
CN	8	–	=99	300	5	None	7 =Moderate	106 =None
CN	11	Medium	=2	300	300	None	9 =Low	11 =Low
CN	12	Medium	=2	300	300	None	9 =Low	11 =Low
DU	1	–		20	20	None	5 =High	104 =None

Shading of "High" ratings provided for clarity only.

(a) Contaminant impact rating detail provided on Table 6 – 6.

If rated as "High" score = 1
If rated as "Medium" score = 2
If rated as "Low" score = 4
If rated as "None" score = 99

(b) Some adjustments to the data were required to facilitate calculations. These adjustments include:

- Distance to dwelling identified as >200 metres in Table E – 1 have been adjusted to 300 metres.
- Distance to dwelling identified as NA in Table E – 1 have been adjusted to 400 metres.
- Distance to water identified as >200 metres or NA in Table E – 1 have been adjusted to 300 metres.

(c) Site sensitivity scored as follows:

Proximity to Dwelling	If =<100 metres; Score = 1 If >100 and =<200 metres; Score = 2 If >200 metres; Score = 3
Proximity to Water	If =<50 metres; Score = 1 If >50 and =<150 metres; Score = 2 If >150 metres; Score = 3
Land Use	If Plantation, Grazing or Mixed Score = 1 If None Score = 3
Final Scoring	Sum of the above scores. Low Risk = Scores of 8 or 9. Moderate Risk = Scores of 6 or 7. High Risk = Scores of 3, 4 or 5.

(d) Environmental risk potential calculated as follows:

Sum of contamination impact score (1, 2, 4 or 99) and site sensitivity score (3,4,5,6,7, 8 or 9) result in a score used to estimate environmental risk potential.

- "High" risk potential = if sum of scores is 4,5, or 6.
- "Moderate" risk potential = if sum of scores is 7, 8 or 9.
- "Low" risk potential = if sum of scores is 10, 11, 12 or 13.
- "None" risk potential = if sum of scores is >100.

Table 9 – 2
Environmental Risk Potential for Production Stations

		Contaminant	Proximity to : (b)		Land	Site Sensitivity	Environmental
Station	Spill Source	Rating (a)	Dwelling	Water	Use	Rating (c)	Risk Potential (d)

Shading of "High" ratings provided for clarity only.

Guanta	Wash Tank	Medium =2	20	1	Plantation	3 =High	5 =High
	Fuel Tank (Diesel)	Low =4					7 =Moderate
	Pump/Compressor	Medium =2					5 =High
	Flare Line	Medium =2					5 =High
	Flare Stack	Low =4					7 =Moderate
	Separation Pits	High =1					4 =High
Aguarico	Separator	Low =4	200	20	Forestry	6 =Moderate	10 =Low
	Wash Tank	Medium =2					8 =Moderate
	Surge Tank	Low =4					10 =Low
	Lined Sump	Medium =2					8 =Moderate
	Flare Stack N.	Low =4					10 =Low
	Flare Stack S.	Medium =2					8 =Moderate
	Pit	Medium =2					8 =Moderate
Shushufindi Central	Separator	Medium =2	20	10	Mixed	3 =High	5 =High
	Vehicle Maintenance	High =1					4 =High
	Wash Tank	Low =4					7 =Moderate
	Surge Tank	Low =4					7 =Moderate
	Chemical Tank	High =1					4 =High
	Fuel Tank (Diesel)	High =1					4 =High
	Fuel Tank (Diesel)	High =1					4 =High
	Fuel Tank (Jet)	High =1					4 =High
	Pump/Compressor	High =1					4 =High
	Flare Stack	Low =4					7 =Moderate
	Separation Pits	Medium =2					5 =High
Shushufindi North	Wash Tank	Medium =2	20	20	Plantation	3 =High	5 =High
	Surge Tank	Medium =2					5 =High
	Chemical Tank	Medium =2					5 =High
	Pump/Compressor	Medium =2					5 =High
	Gas Vent	High =1					4 =High
	Flare Stack	Medium =2					5 =High
	Separation Pits	High =1					4 =High

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Table 9 – 2
Environmental Risk Potential for Production Stations

Shading of "High" ratings provided for clarity only.

Station	Spill Source	Contaminant Rating (a)	Proximity to : (b)		Land Use	Site Sensitivity Rating (c)	Environmental Risk Potential (d)
			Dwelling	Water			
Lago Agrio Central	Separator	Low =4	100	100	Industry	5 =High	9 =Moderate
	Wash Tank	Low =4					9 =Moderate
	Surge Tank	Low =4					9 =Moderate
	Chemical Tank	Low =4					9 =Moderate
	Fuel Tank (Diesel)	Low =4					9 =Moderate
	Fuel Tank (Gas)	Low =4					9 =Moderate
	Fuel Tank (Jet)	Low =4					9 =Moderate
	Pump/Compressor	Low =4					9 =Moderate
	Lined Sump	Low =4					9 =Moderate
	Vehicle Maintenance	Medium =2					7 =Moderate
	Flare Stack	Low =4					9 =Moderate
	Waste Pit	High =1					6 =High
	Separation Pits	High =1					6 =High
Lago Agrio North	Separator	Low =4	50	250	Plantation	5 =High	9 =Moderate
	Surge Tank	Low =4					9 =Moderate
	Wash Tank	Low =4					9 =Moderate
	Pump/Compressor	Low =4					9 =Moderate
	Flare Stack	Low =4					9 =Moderate
	Separation Pits	High =1					6 =High
Parahuacu	Well Site	Medium =2	100	1	Forestry	5 =High	7 =Moderate
	Surge Tank	Low =4					9 =Moderate
	Separator	Low =4					9 =Moderate
	Pump/Compressor	Low =4					9 =Moderate
	Flare Line	High =1					6 =High
	Flare Stack	Low =4					9 =Moderate
	Separation Pits	High =1					6 =High
Atacapi	Separator	Low =4	300	50	Mixed	5 =High	9 =Moderate
	Separation Pits	High =1					6 =High

Table 9 – 2
Environmental Risk Potential for Production Stations

Shading of "High" ratings provided for clarity only.

Station	Spill Source	Contaminant	Proximity to : (b)		Land	Site Sensitivity	Environmental
		Rating (a)	Dwelling	Water	Use	Rating (c)	Risk Potential (d)
Shushufindi South	Pipeline	Low =4	300	300	Plantation	7 =Moderate	11 =Low
	Separator	Low =4					11 =Low
	Wash Tank	Low =4					11 =Low
	Surge Tank	Low =4					11 =Low
	Pump/Compressor	High =1					8 =Moderate
	Lined Sump	High =1					8 =Moderate
	Flare Stack	Low =4					11 =Low
	Separation Pits	High =1					8 =Moderate
Shushufindi Southwest	Separator	Low =4	100	10	Mixed	3 =High	7 =Moderate
	Wash Tank	Medium =2					5 =High
	Chemical Tank	Medium =2					5 =High
	Fuel Tank (Diesel)	Low =4					7 =Moderate
	Pump/Compressor	Low =4					7 =Moderate
	Lined Sump	Medium =2					5 =High
	Flare Stack	Low =4					7 =Moderate
	Off-Site Waste Pit	High =1					4 =High
	Separation Pits	High =1					4 =High
Shushufindi Water Inj.	Pump/Compressor	High =1	250	10	Grazing	4 =High	5 =High
Sacha Central	Vehicle Maintenance	Low =4	50	700	Mixed	5 =High	9 =Moderate
	Separator	Low =4					9 =Moderate
	Wash Tanks (2)	Medium =2					7 =Moderate
	Surge Tank	High =1					6 =High
	Chemical Storage	High =1					6 =High
	Fuel Tank (Diesel)	Low =4					9 =Moderate
	Fuel Tank (Diesel)	Medium =2					7 =Moderate
	Pump/Compressor	Low =4					9 =Moderate
	Flare Stack	Low =4					9 =Moderate
	Separation Pits	High =1					6 =High
Sacha North # 1	Separator	Low =4	40	20	Plantation	3 =High	7 =Moderate
	Wash Tank	Low =4					7 =Moderate

Table 9 – 2
Environmental Risk Potential for Production Stations

Station	Spill Source	Contaminant Rating (a)	Proximity to : (b) Dwelling	Proximity to : (b) Water	Land Use	Site Sensitivity Rating (c)	Environmental Risk Potential (d)
		Shading of "High" ratings provided for clarity only.					
	Fuel Tank (Diesel)	Low =4					7 =Moderate
	Flare Stack	Low =4					7 =Moderate
	Separation Pits	Medium =2					5 =High
Sacha North # 2	Separator	Low =4	50	150	Mixed	4 =High	8 =Moderate
	Wash Tank	Low =4					8 =Moderate
	Surge Tank	Low =4					8 =Moderate
	Pump/Compressor	Low =4					8 =Moderate
	Flare Stack	Low =4					8 =Moderate
	Separation Pits	High =1					5 =High
Sacha South	Separator	Low =4	10	10	Mixed	3 =High	7 =Moderate
	Wash Tank	High =1					4 =High
	Surge Tank	High =1					4 =High
	Pump/Compressor	Low =4					7 =Moderate
	Flare Stack	Low =4					7 =Moderate
	Separation Pits	High =1					4 =High
Culebra	Pipeline	Low =4	20	300	Plantation	5 =High	9 =Moderate
	Wash Tank	Low =4					9 =Moderate
	Fuel Tank (Diesel)	Low =4					9 =Moderate
	Pump/Compressor	Low =4					9 =Moderate
	Former Pit	Low =4					9 =Moderate
Yulebra	Wash Tank	Low =4	800	30	Mixed	5 =High	9 =Moderate
	Fuel Tank (Diesel)	Low =4					9 =Moderate
	Pump/Compressor	Medium =2					7 =Moderate
	Lined Sump	Low =4					9 =Moderate
	Flare Stack	Low =4					9 =Moderate
	Pit	High =1					6 =High

Table 9 – 2
Environmental Risk Potential for Production Stations

Station	Spill Source	Contaminant Rating (a)	Proximity to : (b)		Land Use	Site Sensitivity Rating (c)	Environmental Risk Potential (d)
			Dwelling	Water			
Yuca	Separator	Low =4	300	100	Forestry	7 =Moderate	11 =Low
	Wash Tank	Low =4					11 =Low
	Surge Tank	Low =4					11 =Low
	Chemical Tank	Low =4					11 =Low
	Fuel Tank (Diesel)	Low =4					11 =Low
	Fuel Tank (Jet)	Low =4					11 =Low
	Pump/Compressor	Low =4					11 =Low
	Lined Sump	Medium =2					9 =Moderate
	Flare Stack	Low =4					11 =Low
	Separation Pits	High =1					8 =Moderate
Auca Central	Vehicle Maintenance	Medium =2	100	100	Mixed	3 =High	5 =High
	Separator	Low =4					7 =Moderate
	Fuel Tank (Diesel)	Low =4					7 =Moderate
	Pump/Compressor	Low =4					7 =Moderate
	Generator	Low =4					7 =Moderate
	Sumps	Medium =2					5 =High
	Flare Stack	Low =4					7 =Moderate
	Separation Pits	High =1					4 =High
Auca South	Pipeline	Low =4	200	50	Forestry	6 =Moderate	10 =Low
	Separator	Medium =2					8 =Moderate
	Wash Tank	Medium =2					8 =Moderate
	Pump/Compressor	Medium =2					8 =Moderate
	Generator	Low =4					10 =Low
	Flare Stack	Low =4					10 =Low
	Separation Pits	High =1					7 =Moderate
Auca Sur	Fuel Tank (Diesel)	Medium =2	50	20	Plantation	3 =High	5 =High
	Pump/Compressor	Medium =2					5 =High
	Generator	Medium =2					5 =High
	Pit	High =1					4 =High

Shading of "High" ratings provided for clarity only.

Table 9 – 2
Environmental Risk Potential for Production Stations

Station	Spill Source	Contaminant Rating (a)	Proximity to : (b) Dwelling	Water	Land Use	Site Sensitivity Rating (c)	Environmental Risk Potential (d)
Cononaco	Lined Sump	Medium =2	20	300	Plantation	5 =High	7 =Moderate
	Flare Stack	Low =4					9 =Moderate
	Separation Pit	High =1					6 =High
Dureno	Surge Tank	Low =4	20	20	Forestry	5 =High	9 =Moderate
	Lined Sump	Low =4					9 =Moderate
	Flare Stack	Low =4					9 =Moderate
	Separation Pit	High =1					6 =High

Shading of "High" ratings provided for clarity only.

(a) Contaminant impact rating detail provided on Table 6 – 7.

If rated as "High" score = 1
If rated as "Medium" score = 2
If rated as "Low" score = 4
If rated as "None" score = 99

(b) Some adjustments to the data were required to facilitate calculations. These adjustments include:

- Distance to dwelling identified as >200 metres in Table E–2 (Volume I) have been adjusted to 300 metres.
- Distance to dwelling identified as NA in Table E–2 (Volume I) have been adjusted to 400 metres.
- Distance to water identified as >200 metres or NA in Table E–2 (Volume I) have been adjusted to 300 metres.

(c) Site sensitivity scored as follows:

<u>Proximity to Dwelling</u>
If =< 100 metres; Score = 1
If > 100 and =<200 metres; Score = 2
If >200 metres; Score = 3

<u>Proximity to Water</u>
If =<50 metres; Score = 1
If >50 and =< 150 metres; Score = 2
If > 150 metres; Score = 3

<u>Land Use</u>
If Plantation, Grazing or Mixed Score = 1
If None Score = 3

<u>Final Scoring</u>
Sum of the above scores.
Low Risk = Scores of 8 or 9.
Moderate Risk = Scores of 6 or 7.
High Risk = Scores of 3, 4 or 5.

(d) Environmental risk potential calculated as follows: Sum of contamination impact score (1, 2, 4 or 99) and site sensitivity score (3,4,5,6,7, 8 or 9) result in a score used to estimate environmental risk potential.

- "High" risk potential = if sum of scores is 4,5, or 6.
- "Moderate" risk potential = if sum of scores is 7, 8 or 9.
- "Low" risk potential = if sum of scores is 10, 11, 12 or 13.
- "None" risk potential = if sum of scores is > 100.

DRAFT

PART 10 - CONCLUSIONS AND RECOMMENDATIONS

This section provides recommendations for assessment and remediation required at each of the assessed sites within the Concession oil fields. A summary of the recommended actions is given in Table 10-1 for the well sites and Table 10-2 for production stations. A rating scale of 1 or 2 has been used to prioritize mitigation actions with the highest priority corresponding to a rating of 1.

The following is a summary of the recommended actions for each of the main types of environmental liabilities identified during the site assessment studies and the facility audit. The recommendations relating to present operational practices are based on the need for the oil field operations to comply with current Ecuadorian Law and conform to current international practices.

10.1 CONCLUSIONS AND RECOMMENDATIONS FROM THE SITE ASSESSMENTS

All of the twenty-two production stations and 163 (50%) of the well sites in the concession oil fields were assessed. The following conclusions and recommendations relate to these sites investigated.

10.1.1 Well Site Assessment Recommendations

Contamination observed at assessed well sites was generally attributable to one or more of the following: spills resulting from workovers, spills occurring during drilling activities, spills associated with flowlines, contamination resulting from oil applications to the well site pad, disposal of solid domestic waste, spills resulting from leaks at meter stations, spills resulting from siphoned discharge from well site pits, contaminant migration from pits and disposal of filters in pits.

The following are specific recommendations arising from the well site assessment.

Well Sites

- The extent of contamination within the large stained areas should be confirmed by further assessment particularly at sites where spills have migrated off-site or impacted surface waters (Table 10-1).

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Table 10 – 1
Prioritized Ranking of Recommended Actions for Assessed Well Sites

Assessed Site		Further Assessment (a)	Remediation (b)
LA	1	Yes	Yes (2)
LA	2	–	–
LA	5	–	Yes (2)
LA	6	–	–
LA	8	–	–
LA	9	–	–
LA	10	Yes	Yes (1)
LA	11B	–	Yes (2)
LA	12	–	–
LA	17	–	–
LA	19	–	–
LA	20	–	Yes (2)
LA	21	–	Yes (2)
LA	26	Yes	Yes (1)
LA	29	–	Yes (2)
LA	32	–	Yes (2)
LA	33	–	Yes (2)
LA	34	–	–
LA	35	–	–
PH	2	Yes	Yes (2)
PH	5	Yes	Yes (2)
AT	1	–	–
AT	2	Yes	Yes (2)
AT	3	–	–
GU	1	Yes	Yes (1)
GU	3	Yes	Yes (1)
GU	5	Yes	Yes (1)
GU	8	Yes	Yes (1)
AG	AG3	Yes	Yes (1)
AG	AG6	Yes	Yes (2)
AG	AG8	Yes	Yes (2)
AG	AG9	Yes	Yes (1)
AG	AG10	Yes	Yes (1)
SSF	B57	Yes	Yes (2)
SSF	B59	Yes	Yes (2)
SSF	61	Yes	Yes (2)
SSF	B63	Yes	Yes (1)
SSF	B64	Yes	Yes (1)
SSF	A65	–	–
SSF	B66	Yes	Yes (1)
SSF	A67	Yes	Yes (2)
SSF	68	Yes	Yes (1)
SSF	69	–	Yes (2)
SSF	71	Yes	Yes (2)
SSF	WIW2	–	–
SSF	WIW4	–	–
SSF	WIW7	–	–

Table 10 – 1
Prioritized Ranking of Recommended Actions for Assessed Well Sites

Assessed Site		Further Assessment (a)	Remediation (b)
SSF	A1	Yes	Yes (1)
SSF	A7	Yes	Yes (2)
SSF	A9	–	–
SSF	A10	–	Yes (2)
SSF	A13	Yes	Yes (1)
SSF	B15	Yes	Yes (2)
SSF	B16	Yes	–
SSF	A20	Yes	–
SSF	A22B	Yes	–
SSF	A24	Yes	Yes (1)
SSF	A26	–	Yes (2)
SSF	A30	Yes	Yes (1)
SSF	B31	Yes	Yes (2)
SSF	A33	Yes	Yes (1)
SSF	A34	–	–
SSF	B36	Yes	Yes (1)
SSF	A38	Yes	Yes (1)
SSF	A43	Yes	Yes (1)
SSF	6B	Yes	Yes (1)
SSF	A45	Yes	Yes (2)
SSF	A45B	Yes	–
SSF	46	Yes	Yes (2)
SSF	B49	Yes	Yes (2)
SSF	A50	–	–
SSF	B51	Yes	Yes (1)
SSF	B52	Yes	Yes (2)
SSF	B55	Yes	Yes (1)
SA	WIW1	–	Yes (2)
SA	WIW2	Yes	Yes (1)
SA	WIW3	–	–
SA	WIW4	Yes	–
SA	WIW5	Yes	Yes (1)
SA	WIW6	Yes	–
SA	1	Yes	Yes (2)
SA	2	–	–
SA	8	Yes	Yes (1)
SA	9	–	Yes (2)
SA	11	Yes	Yes (2)
SA	12	Yes	Yes (1)
SA	13	–	–
SA	16	Yes	Yes (1)
SA	18	Yes	Yes (1)
SA	19	Yes	Yes (1)
SA	20	Yes	Yes (1)
SA	21	Yes	Yes (2)
SA	25	Yes	Yes (1)
SA	27	Yes	Yes (2)

Table 10 – 1
Prioritized Ranking of Recommended Actions for Assessed Well Sites

Assessed Site		Further Assessment (a)	Remediation (b)
SA	28	Yes	Yes (2)
SA	32	Yes	–
SA	33	Yes	Yes (2)
SA	34	Yes	Yes (2)
SA	35	–	–
SA	36	Yes	–
SA	43	Yes	Yes (2)
SA	44	Yes	–
SA	46	Yes	Yes (1)
SA	54	Yes	–
SA	55	Yes	Yes (2)
SA	56	–	–
SA	58	Yes	Yes (1)
SA	59	Yes	Yes (2)
SA	60	Yes	Yes (2)
SA	72	Yes	Yes (2)
SA	73	–	–
SA	74	Yes	Yes (2)
SA	75	Yes	Yes (2)
SA	77	Yes	Yes (2)
SA	78	Yes	Yes (1)
SA	81	Yes	–
SA	84	–	–
SA	85	Yes	Yes (1)
SA	86	Yes	–
SA	91	Yes	–
SA	93	Yes	Yes (1)
SA	94	Yes	Yes (2)
SA	95	Yes	Yes (2)
SA	97	Yes	Yes (1)
SA	100	Yes	Yes (2)
SA	103	Yes	Yes (1)
SA	104	Yes	Yes (2)
SA	107	Yes	Yes (1)
SA	109	Yes	–
SA	110	–	Yes (2)
SA	111	Yes	Yes (2)
SA	113	Yes	–
CU	2	Yes	Yes (2)
YB	2	Yes	Yes (2)
YU	4	Yes	Yes (2)
YU	6	–	–
YU	5	Yes	Yes (2)
YU	12	Yes	Yes (2)
YUS	1	–	Yes (2)
AU	1	Yes	Yes (1)
AU	4	Yes	Yes (2)

Table 10 – 1
Prioritized Ranking of Recommended Actions for Assessed Well Sites

Assessed Site		Further Assessment (a)	Remediation (b)
AU	6	Yes	–
AU	7	Yes	Yes (2)
AU	9	Yes	–
AU	11	Yes	Yes (1)
AU	12	Yes	Yes (1)
AU	15	Yes	Yes (2)
AU	16	Yes	Yes (2)
AU	17	Yes	Yes (2)
AU	18	–	–
AU	19B	Yes	Yes (2)
AU	21	Yes	Yes (2)
AU	24	Yes	Yes (1)
AUS	1	–	Yes (2)
RM	1	Yes	–
CN	1	Yes	Yes (1)
CN	2	Yes	Yes (1)
CN	3	–	–
CN	8	–	–
CN	11	Yes	–
CN	12	Yes	–
DU	1	–	–

(a) Further assessment is recommended at sites which have been rated as having "medium" or "high" contaminant impact. The extent of contamination may require further definition at these well sites prior to implementation of remediation.

(b) The priority for remediation has been identified as 1 if the environmental risk potential has been rated as "high" or 2 if the environmental risk potential has been rated as "medium". A description of remediation methods is given in the Environmental Management Plan (Volume II).

Table 10 – 2
Prioritized Ranking of Recommended Actions for Production Stations

Station	Spill Source	Further Assessment (a)	Remediation (b)
Lago Agrio Central	Separator	–	Yes (2)
	Wash Tank	–	Yes (2)
	Surge Tank	–	Yes (2)
	Chemical Tank	–	Yes (2)
	Fuel Tank (Diesel)	–	Yes (2)
	Fuel Tank (Gas)	–	Yes (2)
	Fuel Tank (Jet)	–	Yes (2)
	Pump/Compressor	–	Yes (2)
	Lined Sump	–	Yes (2)
	Vehicle Maintenance	Yes	Yes (2)
	Flare Stack	–	Yes (2)
	Waste Pit	Yes	Yes (1)
	Separation Pits	Yes	Yes (1)
Lago Agrio North	Separator	–	Yes (2)
	Surge Tank	–	Yes (2)
	Wash Tank	–	Yes (2)
	Pump/Compressor	–	Yes (2)
	Flare Stack	–	Yes (2)
	Separation Pits	Yes	Yes (1)
Parahuacu	Well Site	Yes	Yes (2)
	Surge Tank	–	Yes (2)
	Separator	–	Yes (2)
	Pump/Compressor	–	Yes (2)
	Flare Line	Yes	Yes (1)
	Flare Stack	–	Yes (2)
	Separation Pits	Yes	Yes (1)
Atacapi	Separator	–	Yes (2)
	Separation Pits	Yes	Yes (1)
Guanta	Wash Tank	Yes	Yes (1)
	Fuel Tank (Diesel)	–	Yes (2)
	Pump/Compressor	Yes	Yes (1)
	Flare Line	Yes	Yes (1)
	Flare Stack	–	Yes (2)
	Separation Pits	Yes	Yes (1)
Aguarico	Separator	–	–
	Wash Tank	Yes	Yes (2)
	Surge Tank	–	–
	Lined Sump	Yes	Yes (2)
	Flare Stack N.	–	–
	Flare Stack S.	Yes	Yes (2)
	Pit	Yes	Yes (2)

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Table 10 – 2
Prioritized Ranking of Recommended Actions for Production Stations

Station	Spill Source	Further Assessment (a)	Remediation (b)
Shushufindi Central	Separator	Yes	Yes (1)
	Vehicle Maintenance	Yes	Yes (1)
	Wash Tank	–	Yes (2)
	Surge Tank	–	Yes (2)
	Chemical Tank	Yes	Yes (1)
	Fuel Tank (Diesel)	Yes	Yes (1)
	Fuel Tank (Diesel)	Yes	Yes (1)
	Fuel Tank (Jet)	Yes	Yes (1)
	Pump/Compressor	Yes	Yes (1)
	Flare Stack	–	Yes (2)
	Separation Pits	Yes	Yes (1)
Shushufindi North	Wash Tank	Yes	Yes (1)
	Surge Tank	Yes	Yes (1)
	Chemical Tank	Yes	Yes (1)
	Pump/Compressor	Yes	Yes (1)
	Gas Vent	Yes	Yes (1)
	Flare Stack	Yes	Yes (1)
	Separation Pits	Yes	Yes (1)
Shushufindi South	Pipeline	–	–
	Separator	–	–
	Wash Tank	–	–
	Surge Tank	–	–
	Pump/Compressor	Yes	Yes (2)
	Lined Sump	Yes	Yes (2)
	Flare Stack	–	–
	Separation Pits	Yes	Yes (2)
Shushufindi Southwest	Separator	–	Yes (2)
	Wash Tank	Yes	Yes (1)
	Chemical Tank	Yes	Yes (1)
	Fuel Tank (Diesel)	–	Yes (2)
	Pump/Compressor	–	Yes (2)
	Lined Sump	Yes	Yes (1)
	Flare Stack	–	Yes (2)
	Off–Site Waste Pit	Yes	Yes (1)
	Separation Pits	Yes	Yes (1)
Shushufindi Water Inj.	Pump/Compressor	Yes	Yes (1)
			Yes (1)

Table 10 – 2
Prioritized Ranking of Recommended Actions for Production Stations

Station	Spill Source	Further Assessment (a)	Remediation (b)
Sacha Central	Vehicle Maintenance	–	Yes (2)
	Separator	–	Yes (2)
	Wash Tanks (2)	Yes	Yes (2)
	Surge Tank	Yes	Yes (1)
	Chemical Storage	Yes	Yes (1)
	Fuel Tank (Diesel)	–	Yes (2)
	Fuel Tank (Diesel)	Yes	Yes (2)
	Pump/Compressor	–	Yes (2)
	Flare Stack	–	Yes (2)
	Separation Pits	Yes	Yes (1)
Sacha North # 1	Separator	–	Yes (2)
	Wash Tank	–	Yes (2)
	Fuel Tank (Diesel)	–	Yes (2)
	Flare Stack	–	Yes (2)
	Separation Pits	Yes	Yes (1)
Sacha North # 2	Separator	–	Yes (2)
	Wash Tank	–	Yes (2)
	Surge Tank	–	Yes (2)
	Pump/Compressor	–	Yes (2)
	Flare Stack	–	Yes (2)
	Separation Pits	Yes	Yes (1)
Sacha South	Separator	–	Yes (2)
	Wash Tank	Yes	Yes (1)
	Surge Tank	Yes	Yes (1)
	Pump/Compressor	–	Yes (2)
	Flare Stack	–	Yes (2)
	Separation Pits	Yes	Yes (1)
Culebra	Pipeline	–	Yes (2)
	Wash Tank	–	Yes (2)
	Fuel Tank (Diesel)	–	Yes (2)
	Pump/Compressor	–	Yes (2)
	Former Pit	–	Yes (2)
Yulebra	Wash Tank	–	Yes (2)
	Fuel Tank (Diesel)	–	Yes (2)
	Pump/Compressor	Yes	Yes (2)
	Lined Sump	–	Yes (2)
	Flare Stack	–	Yes (2)
	Pit	Yes	Yes (1)

Table 10 – 2
Prioritized Ranking of Recommended Actions for Production Stations

Station	Spill Source	Further Assessment (a)	Remediation (b)
Yuca	Separator	–	–
	Wash Tank	–	–
	Surge Tank	–	–
	Chemical Tank	–	–
	Fuel Tank (Diesel)	–	–
	Fuel Tank (Jet)	–	–
	Pump/Compressor	–	–
	Lined Sump	Yes	Yes (2)
	Flare Stack	–	–
	Separation Pits	Yes	Yes (2)
Auca Central	Vehicle Maintenance	Yes	Yes (1)
	Separator	–	Yes (2)
	Fuel Tank (Diesel)	–	Yes (2)
	Pump/Compressor	–	Yes (2)
	Generator	–	Yes (2)
	Sumps	Yes	Yes (1)
	Flare Stack	–	Yes (2)
	Separation Pits	Yes	Yes (1)
Auca South	Pipeline	–	–
	Separator	Yes	Yes (2)
	Wash Tank	Yes	Yes (2)
	Pump/Compressor	Yes	Yes (2)
	Generator	–	–
	Flare Stack	–	–
	Separation Pits	Yes	Yes (2)
Auca Sur	Fuel Tank (Diesel)	Yes	Yes (1)
	Pump/Compressor	Yes	Yes (1)
	Generator	Yes	Yes (1)
	Pit	Yes	Yes (1)
Cononaco	Lined Sump	Yes	Yes (2)
	Flare Stack	–	Yes (2)
	Separation Pit	Yes	Yes (1)
Dureno	Surge Tank	–	Yes (2)
	Lined Sump	–	Yes (2)
	Flare Stack	–	Yes (2)
	Separation Pit	Yes	Yes (1)

(a) Further assessment is recommended at sites which have been rated as having "medium" or "high" contaminant impact. The extent of contamination may require further definition at these well sites prior to implementation of remediation.

(b) The priority for remediation has been identified as 1 if the environmental risk potential has been rated as "high" or 2 if the environmental risk potential has been rated as "medium". A description of remediation methods is given in the Environmental Management Plan (Volume II).

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Well Site Pits

- Pits should be monitored on a regular basis to ensure that there is sufficient free board, to ensure siphons are working correctly and to document any evidence of seepage and soils outside the pits.
- A large number of pits have been closed. Improper closure at some sites has resulted in contamination of soil and often unstable surfaces. It is recommended that all well site pits be properly remediated and closed as soon as is practically possible.

Solid Waste

- Solid waste (primarily domestic garbage) found at numerous well sites should be assessed and cleaned up.

10.1.2 Production Station Assessment Recommendations

Contamination of soil at production stations was usually associated with one or more of the following: used oil discharge to sumps or drains which ultimately discharge to off-site areas, process area spills, flare system failures/spills, tank related spills, disposal of tank bottoms, subsurface contaminant migration from separation pits, direct discharge to the environment of oily produced water, and fuel and chemical spills.

The following are specific recommendations arising from the production station assessments:

- Most of the production station pits are currently in use. Those that are not in use should be properly closed. Those that are currently in use should be phased out and ultimately closed. This will necessitate the prior implementation of other means of produced water disposal (e.g., deep well injection).
- Used oil recycling programs should be implemented and the practice of directly discharging these wastes to the environment should be discontinued.
- Flare systems should be upgraded and properly maintained.
- Further assessment is required to more accurately define the extent of contamination below produced water discharge areas at the production stations, and at other spill sites (Table 10-2).

10.2 CONCLUSIONS AND RECOMMENDATIONS FROM FACILITY AUDIT

The following are specific recommendations arising from the facility audit.

Air Emissions

- An air quality monitoring program should be established for the incinerator at Lago Agrio.
- An air quality monitoring program should be introduced for the flare stacks that is in conformance with Ecuadorian regulatory requirements.

Water/Waste Water Discharge

- Effluent from septic tanks should be tested prior to discharge.

Waste Handling, Storage, Transportation and Disposal

- A waste management program should be introduced which includes the following elements:

  - designation of personnel responsible for waste management
  - assessment of wastes for potential minimization, reuse or recycling
  - periodic audit of operations to determine methods to minimize or eliminate wastes
  - a waste recording system to monitor progress with waste minimization

- A hazardous materials inventory list should be made at each production station.
- A Workplace Hazardous Material Information System (WHMIS) should be introduced for all hazardous chemicals and substances. This should include proper chemical labelling, and material safety data sheets containing information on safe use and disposal.

Use/Disposal of Produced Gas

- A knockout tank system to remove fluids from flare lines should be installed at the production stations to minimize sprays and reduce the fire hazard.

Containment and Control of Crude Oil Spills

- A spill contingency plan should be developed for all facilities. Training programs should be conducted and response capabilities should be tested by means of mock drills.

Noise

- A noise monitoring program should be introduced that is in conformance with regulatory requirements.

Disposal of Produced Water

- Produced water should be tested on a regular basis prior to discharge.
- The feasibility of disposal of produced water by deep well injection or other means should be evaluated for all Concession oil fields.

Disposal of Tank Bottoms and Residual Oil

- Tank bottoms and residual oil should be sampled and analyzed prior to disposal.
- Disposal of tank bottoms and residual oil onto roads should only be undertaken where these wastes meet appropriate disposal criteria (see Appendix I for example of disposal criteria).
- Disposal should only be done when roads are dry, at a specified application rate (see Appendix I) and where there is no possibility of direct runoff to creeks and streams.
- Alternate disposal methods for tank bottoms and residual oil should be investigated.

Well Site Management

- The practice of burying drilling sumps without assessment, treatment and remediation should be discontinued.
- Well site inspection programs should be undertaken on a regular basis.
- Erosion control measures need to be implemented at some well sites.
- A waste management program needs to be introduced.

Pipeline Management

- A pipeline inspection program using standard reporting procedures should be undertaken on a regular basis.
- Priority risk areas based on land use and sensitivity of receptors (i.e., stream crossings) need to be identified and protection measures implemented.

PART 11 - CLOSURE

- The services performed and outlined herein were based in part, upon visual observations of the sites and attendant structures. Our opinion cannot be extended to portions of the site which were unavailable for direct observations at the time of our observations.

- Our observations relating to hazardous and toxic materials in the environment at the site are described in this report. Where testing was performed, it was executed in accordance with our contract for these services. The testing and analyses of only those compounds or materials specified in our contract for services was performed.

- The conclusions presented herein are based solely upon the scope of services described in our contract and the time and budgetary constraints imposed by the contract.

- The site history research performed herein relies on information supplied by others. No attempt has been made to independently verify the accuracy of such information, unless specifically noted in our report.

- The conclusions of this report are based, in part, on the information provided by others and any testing and analyses described in the report. The possibility remains that unexpected environmental conditions may be encountered at locations not explored. Should such an event occur, HBT AGRA should be notified in order that we may determine if modifications to our conclusions are necessary.

- This report has been prepared in accordance with generally accepted environmental study and/or engineering practices. No other warranties, either expressed or implied, are made as to the professional services provided under the terms of our contract and included in this report.

APPENDIX A

SUMMARY OF PRE-ASSESSMENT FINDINGS

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AGRA
Earth & Environmental Group

Table A – 1
Summary of Pre–Assessment Findings – Production Data

Site Identification	Description of Production Stations and Well Sites

Field	Well	Milestone Dates									Cumulative Production *		
Number	Status	Spud			Completion			Production			Oil	Gas	Water
		MM	DD	YY	MM	DD	YY	MM	DD	YY	Barrels	Cubic Feet	Barrels

Producing = P
Abandoned = A
Water Inj. = W

☐ Blank if not available
☐ Assumed date

* to June 10, 1990

Lago Agrio

Estacion Central													
Estacion Norte													
1	P	2	16	67	4	8	67	5		72	8,360,166	2,180,255	3,846,582
2	P	5	17	67	6	30	67	5		72	5,085,269	866,666	1,599,510
3	P	10	1	67	11	15	67	9		72	1,292,778	206,306	629,793
4	P	1	5	68	2	17	68	9		72	1,441,668	281,909	3,031,537
5	P	2	6	70	3	21	70	9		72	10,689	1,433	2,339
6	P	3	23	70	5	1	70	5		72	11,325,853	1,883,694	4,777,251
7	A	1	30	70	3	19	70	6		72	2,000,322	343,792	343,792
8	P	3	14	70	5	16	70	5		72	3,489,293	562,257	212,199
9	P	3	28	70	6	3	70	5		72	903,243	54,438	204,615
9B	P	2	21	76	3	26	76	2		82	404,110	17,163	129,444
10	P	6	23	70	7	23	70	5		72	2,089,158	311,817	444,623
11B	P	4	12	76	5	10	76	6		76	4,978,739	3,400,645	959,272
12	P	7	25	70	8	25	70	5		72	8,261,657	1,796,574	6,790,672
13	P	8	7	70	9	9	70	10		72	2,436,072	398,695	810,683
14	P	5	19	70	6	21	70	6		72	1,613,970	279,916	507,623
15	P	7	19	70	8	5	70	5		72	1,101,314	215,855	263,396
16	A	8	27	70	9	24	70	5		72	950,285	136,490	15,640
16B	P	7	16	85	9	26	85	10		85	502,743	85,704	392,060
17	P	9	14	70	10	12	70	5		72	2,869,618	66,983	3,124,221
18	P	9	27	70	10	29	70	5		72	15,855,338	3,133,006	12,894,906
19	A	11	2	70	12	4	70						
20	P	12	28	70	2	2	71	6		72	685,526	92,266	178,078
21	P	10	16	70	11	15	70	5		72	2,423,746	446,792	576,726
22	P	11	18	70	12	2	70	5		72	2,903,060	740,559	765,323
23	P	1	10	71	2	26	71	5		72	5,418,192	1,332,204	6,304,188
24	P	12	7	70	1	7	71	5		72	12,269,350	2,946,448	7,766,260
25	P	2	3	71	3	2	71	6		72	883,480	228,106	18,092
26	P	6	23	73	7	11	73	7		73	6,059,025	972,606	1,049,067
27	P	7	15	77	8	13	77	8		77	1,386,233	317,628	404,960
28	P	2	28	79	2	26	79	3		79	145,047	38,542	325,297
29	P	9	2	81	10	14	81	1		83	954,126	399,349	1,285,216
30	P	1	15	82	2	12	82	2		82	2,017,914	666,771	523,009
31	P	2	15	82	3	11	82	3		82	333,068	119,926	302,087
32	P	1	31	83	2	21	83	3		83	1,501,262	239,456	62,562
33	P	2	27	82	8	10	82	8		82	3,796,368	345,778	48,339
34	P	8	11	80	9	16	80	12		86	777,248	113,456	71,690
35	P	12	4	87	12	28	87	2		92	120,129	16,901	177,700

Count	37
Percent	11.4

	36	36	36
Field Production	116,646,055	25,240,386	60,838,752
Concession percentage	8.5	10.1	16.2

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Table A – 1
Summary of Pre–Assessment Findings – Production Data

Site Identification	Description of Production Stations and Well Sites

Field Number	Well Status	Milestone Dates									Cumulative Production *		
		Spud			Completion			Production			Oil	Gas	Water
		MM	DD	YY	MM	DD	YY	MM	DD	YY	Barrels	Cubic Feet	Barrels

Producing = P
Abandoned = A
Water Inj. = W

☐ Blank if not available
☐ Assumed date

* to June 10, 1990

Parahuacu

Estacion													
1	P	10	4	68	11	17	68	12		78	3,838,958	765,967	9,288
2	P	4	11	78	5	21	78	12		80	1,021,944	19,504	85,162
3	P	7	23	78	9	1	78	12		78	617,600	148,398	8,468
4	P	10	20	78	11	22	78	12		78	503,116	98,942	9,819
5	P	7	23	79	10	25	79	7		80	1,011,733	358,752	19,772

Count	5		5	5	5
Percent	1.5	Field Production	6,993,351	1,391,563	132,509
		Concession percentage	0.5	0.6	0.0

Atacapi

Estacion													
1	P	2	6	68	9	20	68	12		78	4,813,977	559,364	1,289,940
2	P	5	28	78	6	8	78	1		79	3,121,640	8,049,448	1,283,404
3	P	9	12	78	10	13	78	12		78	418,949	225,700	7,881
4	P	3	6	79	3	24	79	7		80	4,311,137	767,171	1,007,753
5	P	4	3	79	4	22	79	2		81	289,783	63,196	11,334
6	P	11	7	81	11	22	81						

Count	6		5	5	5
Percent	1.8	Field Production	12,955,486	9,664,879	3,600,312
		Concession percentage	0.9	3.9	1.0

Guanta

Estacion Guanta													
1	P	12	15	85	2	11	86	3		86	1,199,081	163,738	15,007
2	P	5	23	86	6	17	86	7		86	1,357,718	289,213	8,052
3	P	9	19	86	10	12	86	11		86	859,703	146,854	55,423
4	P	12	3	86	12	22	86	1		87	1,051,798	152,812	112,681
5	P	1	5	87	2	10	87	8		87	1,077,603	126,611	5,826
6	P	2	12	87	3	9	87	8		87	703,573	117,067	3,766
7	P	3	19	87	4	14	87	8		87	981,042	107,089	125,350
8	P	4	29	87	5	18	87	9		87	886,764	82,368	197,050
9	P	10	29	87	11	21	87	12		87	483,527	111,054	2,690

Count	9		9	9	9
Percent	2.8	Field Production	8,600,809	1,296,806	525,845
		Concession percentage	0.6	0.5	0.1

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Table A – 1
Summary of Pre–Assessment Findings – Production Data

Site Identification	Description of Production Stations and Well Sites

Field Number	Well Status	Milestone Dates									Cumulative Production *		
		Spud			Completion			Production			Oil	Gas	Water
		MM	DD	YY	MM	DD	YY	MM	DD	YY	Barrels	Cubic Feet	Barrels

Producing = P
Abandoned = A
Water Inj. = W

☐ Blank if not available
☐ Assumed date

* to June 10, 1990

Aguarico

Field Number	Well Status	Spud MM	Spud DD	Spud YY	Completion MM	Completion DD	Completion YY	Production MM	Production DD	Production YY	Oil Barrels	Gas Cubic Feet	Water Barrels
Estacion													
AG1	P	3	4	69	4	1	69	2		74	11,695,699	3,133,783	931,476
AG2	P	7	18	70	8	8	70	2		74	1,806,721	669,284	866,159
Ag3	P	7	30	73	8	25	73	12		75	5,529,412	1,374,369	1,244,636
AG4	P	6	25	74	7	19	74	10		75	730,071	173,898	73,775
AG5	P	9	24	73	10	9	73	2		74	7,641,120	1,724,618	694,210
AG6	P	3	2	74	3	18	74	4		74	429,756	92,761	3,416
AG7	P	8	11	73	8	28	73	1		74	1,787,314	452,745	497,362
AG8	P	8	30	73	9	14	73	1		74	1,382,050	390,135	526,594
AG9	P	2	21	74	3	2	74	4		74	8,315,760	2,096,544	1,878,167
AG10	P	1	22	80	2	7	80	8		80	7,279,359	1,543,597	2,469,301

Count	10		10	10	10
Percent	3.1	Field Production	46,597,262	11,651,734	9,185,096
		Concession percentage	3.4	4.7	2.4

Shushufindi

Field Number	Well Status	Spud MM	Spud DD	Spud YY	Completion MM	Completion DD	Completion YY	Production MM	Production DD	Production YY	Oil Barrels	Gas Cubic Feet	Water Barrels
Estacion Norte													
Estacion													
Estacion Sur–O													
Estacion Central													
B56	P	6	7	77	6	21	77	7		77	7,529,057	1,742,551	1,454,133
B57	P	8	24	75	9	26	75	11		75	7,342,327	1,596,287	1,062,520
B59	P	11	5	75	11	29	75	2		76	7,846,930	1,756,877	1,225,098
61	P	10	22	77	11	5	77	11		77	8,700,160	2,013,210	3,573,824
B62	P	2	25	85	3	25	85	4		85	3,641,367	825,616	410,294
B63	P	6	28	85	7	19	85	8		85	4,460,182	1,197,641	34,739
B64	P	11	18	85	12	16	85	1		86	2,058,436	551,077	316,845
A65	P	7	28	85	8	20	85	9		85	4,410,806	1,349,720	1,193,782
B66	P	12	31	85	2	6	86	3		86	1,289,128	445,021	5,026
A67	P	6	21	86	7	9	86	8		86	3,754,762	1,147,107	176,518
68	P	5	18	88	6	25	88	7		88	1,314,113	573,321	54,863
69	P	6	27	88	7	16	88	8		88	968,031	243,389	471,680
70	P	5	17	70	14	8	70	7		90			
71	P	11	23	90	12	16	90	1		91			
WIW1	W	5	6	83	5	27	83						
WIW2	W	6	1	83	6	23	83						
WIW3	W	6	30	83	7	20	83						
WIW4	W	7	23	83	8	3	83						
WIW5	W						84						

Table A – 1
Summary of Pre–Assessment Findings – Production Data

Producing = P
Abandoned = A
Water Inj. = W

☐ Blank if not available
☐ Assumed date

* to June 10, 1990

Site Identification		Description of Production Stations and Well Sites												
Field	Well	Milestone Dates									Cumulative Production *		
Number	Status	Spud			Completion			Production			Oil	Gas	Water
		MM	DD	YY	MM	DD	YY	MM	DD	YY	Barrels	Cubic Feet	Barrels
WIW6	W						84						
WIW7	W						84						
WIW8	W						84						
A1	P	4	12	68	1	13	69	9		72	22,562,991	4,999,344	107,671
A2	P	10	16	69	11	7	69	9		72	10,628,527	2,838,729	1,786,118
A3	P	11	20	69	1	37	70	9		72	9,039,353	9,071,504	37,486
A4	P	4	18	70	5	5	70	9		72	3,197,284	792,466	70,875
A5	P	2	12	72	2	26	72	7		72	13,639,677	3,256,405	886,434
A6	A	1	31	79	2	10	79	9		72	7,326,313	1,645,387	41,797
A7	P	8	11	72	8	28	72	9		72	17,465,764	4,300,139	2,457,485
A8	P	3	5	72	3	21	72	7		72	14,623,934	3,229,436	8,556,072
A9	P	6	18	72	6	29	72	7		72	15,925,255	3,972,712	920,111
A10	P	4	18	72	5	4	72	7		72	14,544,169	3,083,172	454,947
A11	P	7	1	72	7	20	72	7		72	10,976,896	2,065,602	982,140
A12	P	6	8	72	6	25	72	7		72	17,125,494	3,560,934	15,616
A13	P	5	9	72	5	28	72	8		72	82,651,186	2,112,533	1,353,641
B14	P	7	23	72	8	7	72	11		72	14,025,235	3,538,451	110,338
B15	P	7	19	72	8	15	72	6		74	9,514,227	1,585,916	17,561
B15B	P	3	3	81	3	31	81	4		81	2,612,201	464,268	316,363
B16	P	1	11	73	1	26	73	2		73	11,539,477	2,431,470	761,153
A17	P	8	13	72	8	29	72	10		72	10,267,482	2,376,878	1,305,494
A18	P	1	25	73	2	16	73	3		73	4,870,084	1,060,881	257,369
A19	P	3	6	74	3	24	73	4		73	19,003,398	3,998,700	55,131
A20	P	1	10	73	1	28	73	2		73	26,241,921	5,082,589	1,120,525
A21	P	1	23	73	2	20	73	3		73	5,979,570	1,315,856	785,109
A22	A	12	29	72	1	14	73				617,728	178,065	1,134
A22B	P	5	8	77	5	28	77	6		77	15,822,924	2,831,429	41,660
A23	P	10	20	72	11	15	72	11		72	15,568,100	3,776,180	301,421
A24	P	9	27	72	10	9	72	10		72	18,861,323	3,876,778	3,800,487
A25	P	2	22	73	3	10	73	2		73	1,832,136	354,168	612,006
A26	P	9	1	72	9	17	72	10		72	14,233,278	3,131,658	1,325,697
A27	P	6	25	73	7	14	73	8		73	3,673,508	852,947	241,170
A28	P	3	29	73	4	17	73	4		74	18,958,046	3,873,827	39,714
A29	P	4	28	73	5	17	73	5		73	12,574,617	2,657,847	1,634,710
A30	P	12	1	72	12	18	72	1		73	3,498,739	1,158,619	1,618,627
B31	P	4	7	73	4	24	73	8		84	4,013,123	1,174,423	978,689
B32	P	5	11	73	5	28	73	4		73	104,625	36,497	955
A33	P	7	8	73	7	24	73	8		73	59,269	13,712	3,273
A34	A	5	27	73	6	13	73	6		73	27,964	6,643	135
A35	P	5	26	74	6	15	74	10		75	8,905,595	1,720,418	1,396,479
B36	P	11	22	73	12	9	73	11		73	21,334,236	6,541,871	1,638,677
A38	P	12	29	73	1	15	74	1		76	27,530	15,199	14,862

Table A – 1
Summary of Pre–Assessment Findings – Production Data

Site Identification	Description of Production Stations and Well Sites

Producing = P
Abandoned = A
Water Inj. = W

☐ Blank if not available
☐ Assumed date

* to June 10, 1990

Field	Well	Milestone Dates									Cumulative Production *		
Number	Status	Spud			Completion			Production			Oil	Gas	Water
		MM	DD	YY	MM	DD	YY	MM	DD	YY	Barrels	Cubic Feet	Barrels
A39	P	5	18	74	7	26	74	10		75	3,505,368	782,831	1,793,985
A41	P	9	11	73	9	27	73	10		73	1,598,530	306,777	12,853
A42	A	10	23	73	11	8	73	10		73	10,505,870	2,186,271	43,178
A42B	P	4	1	85	4	19	85	5		85	3,017,064	357,626	585,560
A43	P	12	18	73	1	6	74	1	22	74	15,099,713	3,120,567	1,253,191
A44	P	11	16	74	3	3	74	5		74	4,448,466	1,323,412	36,475
6B	P	1	30	81	2	23	81	3		81	18,095,511	5,418,000	1,930,476
A45	P	11	17	73	12	4	73	1		74	12,024,814	3,591,897	1,031,760
A45B	P	9	3	86	9	14	86	9		86	2,738,816	1,035,404	231,111
46	P						74	3		74	5,015,978	982,032	258,133
A48	P	4	15	74	5	2	74	2		86	916,438	329,102	240,865
B49	P	3	23	74	4	15	74	4	25	74	9,042,060	2,040,004	757,022
A50	P	8	24	77	9	22	77	11		75	229,541	31,180	14,603
B51	P	8	10	74	9	9	74	9		74	9,315,390	1,985,523	660,821
B52	P	4	8	75	4	30	75	5		75	8,833,274	2,250,540	1,600,281
B53	P	5	5	75	5	18	75	7		81	8,209,946	2,447,311	1,037,692
B54	P	6	15	75	5	11	75	7		75	9,925,556	1,674,485	309,185
B55	P	7	25	75	8	21	75	9		82	61,431	14,567	2,377

Count	79
Percent	24.3

	Oil	Gas	Water
	69	69	69
Field Production	659,772,244	142,302,999	57,828,022
Concession percentage	47.9	57.2	15.4

Sacha

Field Number	Well Status	Spud MM	Spud DD	Spud YY	Completion MM	Completion DD	Completion YY	Production MM	Production DD	Production YY	Oil	Gas	Water
Estacion Sur													
Estacion Central													
Estacion Norte													
Estacion Norte 2													
WIW1	W						84						
WIW2	W						84						
WIW3	W						84						
WIW4	W						84						
WIW5	W						84						
WIW6	W						84						
1	P	1	21	69	2	18	69	7	15	72	6,808,055	92,850	6,149,130
2	P	7	21	69	8	31	69	8	15	73	2,513,853	83,404	112,327
3	P	9	4	69	10	11	69	7	15	72	3,091,904	3,512,162	3,512,162
4	A	5	14	70	6	6	70	8	15	72	902,126	7,232	1,002,748
6	P	4	23	71	5	24	71	6	15	72	1,646,522	117,560	117,560
7	P	4	30	71	5	16	71	7	27	72	6,872,363	7,368,815	7,368,815
8	P	3	19	71	4	10	71	7	29	72	5,847,133	338,242	5,284,955
9	P	3	21	71	4	12	71	6	15	72	7,104,311	224,224	8,882,109
10	P	5	23	71	6	7	71	4		75	1,034,434	188,239	962,210

Table A – 1
Summary of Pre–Assessment Findings – Production Data

Producing = P
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☐ Blank if not available
☐ Assumed date

* to June 10, 1990

Site Identification	Description of Production Stations and Well Sites												
Field	Well	Milestone Dates									Cumulative Production *		
Number	Status	Spud			Completion			Production			Oil	Gas	Water
		MM	DD	YY	MM	DD	YY	MM	DD	YY	Barrels	Cubic Feet	Barrels
11	P	5	29	71	6	18	71	6		72	3,376,553	93,493	2,334,633
12	P	4	28	71	5	17	71	6		72	4,327,496	207,415	2,109,152
13	P	3	31	71	4	19	71	6		72	3,539,408	40,429	1,633,469
14	P	5	27	71	6	18	71	6		72	4,284,374	44,494	4,767,599
15	P	6	14	71	7	1	71	6		72	133,360	848,517	103,691
16	P	6	23	71	7	17	71	6		72	2,230,445	412,585	1,135,009
17	P	7	29	71	8	24	71	6		72	3,804,965	538,583	1,058,542
18	P	7	9	71	8	5	71	6		72	6,777,466	54,165	6,784,762
19	P	7	20	71	8	13	71	6		72	4,021,893	627,198	408,101
20	P	7	2	71	7	26	71	6		72	5,615,650	1,300,025	646,091
21	P	9	21	71	10	5	71	6		72	3,196,853	47,556	2,857,207
22	P	8	25	71	9	19	71	6		72	3,408,435	80,752	2,398,905
23	P	8	17	71	9	5	71	6		72	4,693,346	148,762	969,061
24	P	9	17	71	10	9	71	6		72	768,048	41,010	396,615
25	P	8	27	71	9	14	71	6		72	8,966,699	526,478	4,373,021
26	P	11	11	71	12	2	71	7		72	8,435,943	168,274	4,458,070
27	P	9	21	71	8	9	71	6		72	10,575,509	259,446	2,008,485
28	P	12	8	71	12	29	71	6		72	11,026,862	2,610,034	547,365
29	P	10	15	71	11	8	71	6		72	4,947,373	410,404	2,409,700
30	P	10	12	71	11	2	71	6		72	6,892,589	74,350	5,890,258
31	P	11	14	71	12	1	71	6		72	1,865,994	53,156	1,834,332
32	P	12	15	72	1	4	72	10		72	3,214,778	150,082	2,177,916
33	P	11	9	71	12	1	71	6		72	4,166,003	853,649	1,293,311
34	P	12	4	71	12	21	71	6		72	14,969,044	2,603,791	6,528,487
35	P	10	12	71	11	5	71	4		73	4,174,537	81,094	4,564,136
36	P	12	28	71	1	15	72	7		72	10,412,545	2,581,926	405,041
37	P	1	3	72	1	26	72	6		72	7,401,696	1,656,495	161,539
38	P	1	10	72	1	27	72	10		72	1,449,157	1,899,570	1,899,570
39	P	1	21	72	3	5	72	6		72	3,995,275	950,019	431,302
40	P	2	6	72	2	24	72	6		72	7,225,878	216,400	2,521,452
41	P	11	18	72	12	18	72	12		72	3,403,875	635,640	567,356
42	P	3	14	72	4	1	72	6		72	6,440,538	8,111	5,497,758
43	P	4	7	72	4	29	72	8		72	7,208,553	210,285	7,261,999
44	P	5	24	72	6	11	72	9		72	2,031,922	373,805	373,805
45	P	3	7	72	4	2	72	6		72	1,191,509	29,169	144,321
46	P	6	16	72	7	4	72	2		75	2,261,694	22,523	83,705
47	P	5	7	72	5	25	72	9		72	6,498,735	94,742	6,215,396
48	W	6	18	72	7	5	72	8	6	72	7,620	61	233
49	P	2	6	73	2	24	73	5		73	3,790,393	205,423	3,947,847
50	P	2	20	73	3	20	73	4		73	5,662,806	1,116,983	499,773
51	P	3	7	73	3	25	73	2		75	4,880,535	601,135	790,132
52	P	3	23	73	4	8	73	4		73	4,267,152	46,153	3,411,594
53	P	4	6	73	4	21	73	5		73	3,297,553	701,275	27,552
54	P	5	1	73	5	16	73	12		76	3,771,115	1,023,076	88,491
55	P	4	25	73	5	10	73	5		73	8,002,619	2,070,688	747,434

Table A – 1

Summary of Pre–Assessment Findings – Production Data

Site Identification	Description of Production Stations and Well Sites

Producing = P
Abandoned = A
Water Inj. = W

☐ Blank if not available
☐ Assumed date

* to June 10, 1990

Field	Well	Milestone Dates									Cumulative Production *		
Number	Status	Spud			Completion			Production			Oil	Gas	Water
		MM	DD	YY	MM	DD	YY	MM	DD	YY	Barrels	Cubic Feet	Barrels
56	P	5	19	73	6	2	73	12		76	2,199,614	552,862	14,487
57	A	6	7	73	6	22	73	6	29	73	96,371	16,342	11,897
58	P	5	27	73	6	11	73	10		73	2,857,402	54,934	1,683,077
59	P	8	16	73	8	28	73	11		74	6,543,197	1,660,379	648,812
60	P	7	2	73	7	16	73	9		73	1,758,565	104,090	2,046,125
61	P	7	27	73	8	11	73	9		73	891,200	113,790	4,569,369
62	P	9	17	73	10	21	73	2		74	61,911	7,072	4,985
63	P	10	7	73	10	24	73	11		73	1,359,961	19,367	1,762,753
64	P	8	19	73	9	4	73	9		73	3,704,968	139,863	4,899,962
65	P	9	9	73	9	23	73	10		73	2,724,753	50,280	3,050,068
66	A	7	19	73	8	2	73	9		73	2,250,109	521,753	138,049
67	P	11	5	73	11	20	73	12		73	1,268,755	20,221	742,965
68	P	11	29	73	12	13	73	1		74	2,537,375	258,087	1,353,340
69	A	12	25	73	1	9	74	1	14	74	0	0	0
70	P	1	18	74	2	3	74	2		74	7,416,072	65,434	13,232,699
71	?	6	14	74	8	2	74	8		75			
72	P	3	18	74	4	12	74	4		74	6,274,479	61,211	3,572,885
73	P	2	12	74	4	23	74	4		74	5,378,959	43,859	4,883,149
74	P	5	3	74	5	20	74	6		74	4,310,409	245,629	3,602,642
75	P	5	1	74	5	27	74	6		74	4,131,693	66,518	1,507,184
76	A	1	28	77	2	21	77				0	0	0
77	P	6	11	76	6	24	76	7		76	3,228,388	267,172	1,435,547
78	P	7	7	76	7	29	76	8		76	2,881,975	39,805	1,461,271
79	A	2	25	77	3	12	77				0	0	0
80	P	8	1	76	8	28	76	8		76	4,069,211	128,114	4,005,343
81	P	9	1	76	9	19	76	9		76	2,728,826	31,850	1,856,465
82	P	9	22	76	10	5	76	11		76	6,413,401	76,269	3,701,201
83	P	10	14	76	11	8	76	11		76	6,280,792	67,574	3,105,121
84	P	12	8	76	12	26	76	1		77	2,658,936	273,393	2,962,516
85	P	11	12	76	12	4	76	12		76	3,440,107	106,623	2,890,915
86	P	10	31	79	12	21	79	8		80	3,878,107	908,481	46,274
87	P	12	24	79	1	15	80	1		80	3,548,762	40,792	1,998,956
88	P	7	2	80	7	23	80	7		80	2,358,898	22,354	1,591,763
89	P	4	4	72	6	16	78	7		78	1,953,334	120,873	436,575
90	P	6	7	79	7	3	79	7		80	2,621,494	646,382	27,356
91	P	7	27	80	8	19	80	8		80	2,298,812	344,399	1,099,599
92	P	9	20	80	10	10	80	10		80	2,112,704	18,157	404,696
93	P	8	24	80	9	15	80	9		80	1,851,237	298,252	609,734
94	P	4	8	81	5	2	81	9		83	205,016	1,628	55,690
95	P	5	14	81	6	8	81	9		81	237,111	2,568	225,779
96	P	8	3	81	8	25	81	9		81	1,857,063	81,173	663,005
97	P	10	7	81	10	28	81	11		81	1,634,163	13,809	1,030,556
98	P	12	5	81	1	7	82	1		82	2,321,831	25,551	598,603
99	P	6	10	82	7	8	82	7		82	1,818,070	62,258	24,005
100	P	3	7	83	3	31	83	7		83	2,437,674	28,022	953,425

CONFIDENTIAL
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Table A – 1
Summary of Pre–Assessment Findings – Production Data

Site Identification	Description of Production Stations and Well Sites

Field	Well	Milestone Dates									Cumulative Production *		
Number	Status	Spud			Completion			Production			Oil	Gas	Water
		MM	DD	YY	MM	DD	YY	MM	DD	YY	Barrels	Cubic Feet	Barrels

Producing = P
Abandoned = A
Water Inj. = W

☐ Blank if not available
☐ Assumed date

* to June 10, 1990

101	P	12	19	82	1	19	83	1		83	1,858,525	14,798	230,211
102	P	4	5	83	5	1	83	5		83	2,037,174	434,767	219,216
103	P	10	31	85	11	21	85	12		85	1,009,686	6,201	506,350
104	P	2	13	86	4	2	86	4		86	612,921	10,564	518,478
106	P	4	20	86	6	14	86	6		86	931,888	19,760	852,005
107	P	10	31	86	12	12	86	1		87	611,973	27,489	8,092
108	P	6	4	87	7	2	87	9		87	922,533	4,984	118,433
109	P	7	3	87	8	14	87	9		87	719,794	9,631	330,891
110	P	10	1	87	11	10	87	11		87	766,873	6,102	142,855
111	P	2	13	88	3	17	88	3		88	767,451	18,156	10,480
112	P	3	18	88	4	15	88	4		88	573,087	3,836	537,775
113	P	4	16	88	5	16	88	6		88	777,785	178,810	128,789
114	P	9	3	90	10	10	90	10		90			
115	P	7	8	90	8	11	90	10		90			
116	P	11	17	90	12	13	90	12		90			

Count	120		110	110	110
Percent	36.9	Field Production	388,626,889	47,054,237	214,668,652
		Concession percentage	28.2	18.9	57.0

Culebra

Estacion													
1	P	11	8	73	11	30	73	3		81	2,337,102	201,165	399,792
2	P	8	18	77	8	25	77	10		87	452,752	55,272	163,672

Count	2		2	2	2
Percent	0.6	Field Production	2,789,854	256,437	563,464
		Concession percentage	0.2	0.1	0.1

Yulebra

Estacion													
1	P	5	5	80	5	24	80	2		81	2,707,609	351,069	86,621
2	P	5	1	85	5	21	85	6		85	656,237	5,222	11,050
3	P	1	9	88	2	11	85	3		88	552,266	47,272	1,439

Count	3		3	3	3
Percent	0.9	Field Production	3,916,112	403,563	99,110
		Concession percentage	0.3	0.2	0.0

Yuca

Estacion													
1	P	10	31	70	11	23	70	12		80	1,151,170	75,028	45,183
2B	P	5	1	79	6	10	79	12		80	1,654,821	190,622	603,441

Table A – 1

Summary of Pre–Assessment Findings – Production Data

Site Identification	Description of Production Stations and Well Sites

Field Number	Well Status	Milestone Dates									Cumulative Production *		
		Spud			Completion			Production			Oil	Gas	Water
		MM	DD	YY	MM	DD	YY	MM	DD	YY	Barrels	Cubic Feet	Barrels

Producing = P
Abandoned = A
Water Inj. = W

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* to June 10, 1990

3	P	0	30	79	8	31	79	1		81	397,253	43,666	245,053
4	P	9	5	79	11	2	79	12		80	814,840	79,969	196,760
5	P	10	9	79	11	8	79	1		81	771,660	69,650	1,221,821
6	P	12	31	79	2	3	80						
9	P	0	21	80	11	7	80	4		81	2,135,493	296,823	64,010
10	P	6	23	81	7	26	81				6,068,691	575,706	924,124
12	A	3	30	80	4	28	80	12		80	0	0	0

Count	9		8	8	8
Percent	2.8	Field Production	12,993,928	1,331,464	3,300,392
		Concession percentage	0.9	0.5	0.9

Yuca Sur

1	P	11	17	79	12	24	79	1		86	1,280,969	98,885	1,252,506

Count	1		1	1	1
Percent	0.3	Field Production	1,280,969	98,885	1,252,506
		Concession percentage	0.1	0.0	0.3

Auca

Estacion Sur													
Estacion Central													
1	P	2	15	70	3	29	70	4		75	4,511,395	25,719	359,869
2	P	6	18	70	8	3	70	4		75	764,769	12,558	294,029
3	P	10	2	70	11	12	70	5		76	4,097,170	384,873	290,729
4	P	12	22	73	1	20	74	5		86	431,998	116,216	12,339
5	P	1	27	74	2	16	74	4		75	915,306	14,755	1,446,525
6	P	2	24	74	3	14	74	4		75	2,202,261	8,834	1,824,207
7	P	10	20	74	11	23	74	4		76	4,093,182	30,820	223,644
8	P	4	13	74	5	1	74	4		75	1,528,216	97,867	284,341
9	P	5	20	74	6	9	74	4		75	4,228,668	114,304	2,245,873
10	P	11	1	74	12	5	74	11		77	723,389	119,294	653,430
11	P	6	28	74	7	26	74	4		75	4,962,226	360,576	573,583
12	P	6	8	74	7	8	74	4		76	4,219,491	406,946	1,195,415
13	P	7	29	74	8	24	74	4		76	4,107,226	360,576	573,583
14	P	8	28	74	10	29	74	4		76	4,032,218	369,933	2,207,504
15	P	7	1	78	8	9	74	8		78	4,349,489	236,047	1,890,655
16	P	11	3	74	12	13	74	4		76	8,772,331	1,136,560	470,963
17	P	1	19	75	2	19	75	9		75	1,692,964	345,472	1,051,297
18	P	12	16	74	1	14	75	4		76	7,725,908	1,077,300	351,307
19	A	9	25	78	12	7	78				0	0	0
19B	P	3	20	79	4	19	79	9		80	641,620	59,797	14,257
20	P	2	14	80	3	23	80	3		81	1,526,690	220,949	194,898
21	P						76	5		76	7,642,184	1,015,524	1,154,574
22	P	1	11	78	2	13	78	6		78	5,747,245	838,279	397,592
23	A	8	21	78	9	16	78				0	0	0

Table A – 1
Summary of Pre–Assessment Findings – Production Data

Site Identification	Description of Production Stations and Well Sites

Field	Well	Milestone Dates									Cumulative Production *		
Number	Status	Spud			Completion			Production			Oil	Gas	Water
		MM	DD	YY	MM	DD	YY	MM	DD	YY	Barrels	Cubic Feet	Barrels

Producing = P
Abandoned = A
Water Inj. = W

☐ Blank if not available
☐ Assumed date

* to June 10, 1990

24	P	3	28	82	5	23	82	6		82	1,165,702	11,050	131,593
25	P	7	30	90	8	28	90	9		90			
26	P	9	29	90	10	22	90	11		90			

Count	27		25	25	25
Percent	8.3	Field Production	80,061,648	7,364,249	17,842,207
		Concession percentage	5.8	3.0	4.7

Auca Sur

Estacion													
1	P	11	29	80	12	24	80	9		91	1,147,540	41,277	1,332,914
2	P	6	15	85	8	26	85	8		85	591,109	64,310	204,816

Count	2		2	2	2
Percent	0.6	Field Production	1,738,649	105,587	1,537,730
		Concession percentage	0.1	0.0	0.4

Rumiyacu

1		8	22	82	11	28	82	10		83	184,939	320	26,663

Count	1		1	1	1
Percent	0.3	Field Production	184,939	320	26,663
		Concession percentage	0.0	0.0	0.0

Cononaco

Estacion Central													
1	P	10	30	72	11	27	72	10		83	4,654,669	66,775	52,058
2	P	11	11	83	12	21	83	12		83	5,386,819	72,042	1,177,736
3	P	2	14	84	3	21	84	3		84	4,200,397	33,434	658,892
4	P	7	11	84	8	11	84	9		84	1,736,408	12,416	60,913
6	P	1	9	84	2	5	84	6		84	335,970	21,832	18,790
7	P	3	31	84	5	6	84	5		84	4,968,465	34,259	396,922
8	P	5	14	84	7	4	84	7		84	3,786,277	24,697	969,191
9	P	9	3	84	10	8	84	10		84	1,484,498	10,359	268,318
10	P	12	3	84	1	5	85	1		85	2,466,273	18,805	1,087,172
11	P	1	11	85	2	11	85	2		85	2,805,054	16,568	101,318
12	P	9	14	85	10	4	85	10		85	1,271,707	10,140	230,189
13	P	1	14	91	2	27	91	3		91			
14	P	2	23	91	3	3	91	3		91			

Count	13		11	11	11
Percent	4.0	Field Production	33,096,537	321,327	5,021,499
		Concession percentage	2.4	0.1	1.3

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Table A – 1

Summary of Pre–Assessment Findings – Production Data

Site Identification	Description of Production Stations and Well Sites

Field Number	Well Status	Milestone Dates									Cumulative Production *		
		Spud			Completion			Production			Oil	Gas	Water
		MM	DD	YY	MM	DD	YY	MM	DD	YY	Barrels	Cubic Feet	Barrels

Producing = P
Abandoned = A
Water Inj. = W

☐ Blank if not available
☐ Assumed date

* to June 10, 1990

Dureno

Field Number	Well Status	Spud MM	Spud DD	Spud YY	Completion MM	Completion DD	Completion YY	Production MM	Production DD	Production YY	Oil Barrels	Gas Cubic Feet	Water Barrels
1	P	6	7	69	7	15	69	9		84	1,306,174	373,733	285,954

Count	1
Percent	0.3

	1	1	1
Field Production	1,306,174	373,733	285,954
Concession percentage	0.1	0.2	0.1

Project Summary

Stations	22
Wells	325
Project	347

Number of wells having production data.	298	298	298
Total production of all fields.	1,377,580,906	248,858,169	376,708,713

Project %	100.0

Percent of wells with production data.	92	92	92

Table A – 2
Summary of Pre–Assessment Findings – Environmental Data

Producing =
Abandoned =
Water Inj. =

See footnote for heading definitions.

See spill record for detail.
Totals exclude stations.

	Site Identification	Data From Ecuadorian Dept. of National Hydrocarbons (Data collected in 1987)									Wellsite Workovers				Spill Record (1973–90 Spills)	
	Field	Data	Site Condition			Adjacent Land Use				Pit Size	90	91	92	93	Number	Volume
	Number	Available	1	2	3	1	2	3	4	m2	Number by year.				of Spills	Barrels
	Lago Agrio															
	Estacion Central														16	1214
	Estacion Norte														1	50
	1	1	1			1				225					1	50
	2	1	1						1	400	1				1	30
	3	1	1						1	900						
	4	1	1			1				375					2	4
	5	1		1		1				200						
	6	1			1			1		144						
	7	1		1				1							1	15
	8	1	1			1				420					2	103
	9															
	9B	1		1		1				240						
	10	1			1	1				225			1			
	11B	1			1	1				378	1				1	25
	12	1	1			1				150	1		1			
	13	1	1						1	144	1				1	45
	14	1		1		1				200	1					
	15	1			1				1	225					1	15
	16	1			1	1				1200						
	16B															
	17	1	1			1				330					1	15
	18	1	1			1				225						
	19	1		1			1									
	20	1	1			1				200					1	50
	21	1	1						1	600	1				2	45
	22	1		1					1	225						
	23	1	1			1				784	1				2	63
	24	1	1						1	400		1	1		1	3
	25														1	80
	26	1	1						1	270	1				2	40
	27	1		1		1				300	1					
	28	1			1	1										
	29	1	1			1				225						
	30	1	1			1				378						
	31	1			1	1				225	1					
	32	1		1		1				100	1					
	33															
	34															
	35															
Count	37	31	16	8	7	20	1	2	8	28	11	1	3	0	15	583
Percent	11.4	100	52	26	23	65	3	6	26	90	30	3	8	0		

Percent of Total

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Table A – 2
Summary of Pre–Assessment Findings – Environmental Data

Producing =
Abandoned =
Water Inj. =

See footnote for heading definitions.

See spill record for detail.
Totals exclude stations.

Site Identification		Data From Ecuadorian Dept. of National Hydrocarbons (Data collected in 1987)									Wellsite Workovers				Spill Record (1973–90 Spills)	
Field		Data	Site Condition			Adjacent Land Use				Pit Size	90	91	92	93	Number	Volume
	Number	Available	1	2	3	1	2	3	4	m2	Number by year.				of Spills	Barrels
Parahuacu																
	Estacion															
	1														1	4500
	2												2			
	3															
	4										1				1	20
	5											1			1	16
Count	5	0	0	0	0	0	0	0	0	0	1	1	1	0	3	4536
Percent	1.5	0	0	0	0	0	0	0	0	0	20	20	20	0		
Atacapi																
	Estacion															
	1	1		1					1	352						
	2	1	1						1	240	1				1	40
	3	1			1				1	128						
	4	1			1				1	625	1	1				
	5	1			1				1	378						
	6															
Count	6	5	1	1	3	0	0	0	5	5	2	1	0	0	1	40
Percent	1.8	100	20	20	60	0	0	0	100	100	33	17	0	0		
Guanta																
	Estacion Guanta															
	1												1		1	450
	2															
	3										1					
	4										1					
	5												1			
	6										1					
	7										2					
	8										1					
	9															
Count	9	0	0	0	0	0	0	0	0	0	5	0	2	0	1	450
Percent	2.8	0	0	0	0	0	0	0	0	0	56	0	22	0		

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Table A – 2
Summary of Pre–Assessment Findings – Environmental Data

Producing =
Abandoned =
Water Inj. =

See footnote for heading definitions.

See spill record for detail.
Totals exclude stations.

	Site Identification	Data From Ecuadorian Dept. of National Hydrocarbons (Data collected in 1987)									Wellsite Workovers				Spill Record (1973–90 Spills)	
	Field	Data	Site Condition			Adjacent Land Use				Pit Size	90	91	92	93	Number	Volume
	Number	Available	1	2	3	1	2	3	4	m2	Number by year.				of Spills	Barrels
	Aguarico															
	Estacion															
	AG1	1			1		1			100		1	---		1	250
	AG2	1			1		1			64	1		---			
	Ag3	1	1			1				100						
	AG4														2	204
	AG5															
	AG6	1	1				1			225						
	AG7	1		1			1			100						
	AG8	1		1				1		150					1	3
	AG9	1		1				1		64	1				1	5
	AG10	1	1					1		1000						
Count	10	8	3	3	2	1	4	3	0	8	2	1	0	0	4	462
Percent	3.1	100	38	38	25	13	50	38	0	100	20	10	0	0		
	Shushufindi															
	Estacion Norte														1	40
	Estacion															
	Estacion Sur–O															
	Estacion Central														5	515
	B56	1		1				1		1000			1			
	B57	1		1				1		900	1					
	B59	1			1	1				100	1	1				
	61	1		1			1			64		1				
	B62	1		1		1				36						
	B63	1		1		1				800			1			
	B64	1	1				1			100					1	60
	A65	1	1				1			100	1		1			
	B66	1			1	1				900						
	A67															
	68										1					
	69												1			
	70										1					
	71										1	1				
	WIW1															
	WIW2															
	WIW3															
	WIW4															
	WIW5															

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Table A – 2
Summary of Pre–Assessment Findings – Environmental Data

Site Identification	Data From Ecuadorian Dept. of National Hydrocarbons (Data collected in 1987)									Wellsite Workovers				Spill Record (1973–90 Spills)	
Field	Data	Site Condition			Adjacent Land Use				Pit Size	90	91	92	93	Number	Volume
Number	Available	1	2	3	1	2	3	4	m2	Number by year.				of Spills	Barrels
WIW6															
WIW7															
WIW8															
A1	1		1			1			100			1			
A2	1		1			1			100						
A3	1	1						1	100						
A4															
A5	1	1				1				1					
A6	1		1			1			64						
A7	1		1			1			200						
A8	1	1				1			64	1		1		1	30
A9	1		1				1		80						
A10	1	1				1			225						
A11	1			1		1			100						
A12	1		1		1				80						
A13	1	1				1			100						
B14	1		1		1				180		1				
B15	1		1		1				400						
B15B	1		1		1				500						
B16	1		1		1				120						
A17	1	1						1	80						
A18															
A19	1		1				1		100						
A20	1	1			1				64			1		1	1
A21											1			1	500
A22	1	1			1				64			1			
A22B											1	2			
A23	1		1			1			80						
A24	1	1					1		64	1		1			
A25	1		1				1				1				
A26	1		1				1		100				1	1	10
A27	1			1			1		64	1					
A28	1	1			1				64						
A29	1			1	1				64						
A30	1			1		1			100						
B31	1		1		1					2		2			
B32															
A33															
A34															
A35	1		1			1				1					
B36	1	1						1	100	1		1			
A38															

Producing =
Abandoned =
Water Inj. =

See footnote for heading definitions.

See spill record for detail.
Totals exclude stations.

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Table A – 2
Summary of Pre–Assessment Findings – Environmental Data

Producing =
Abandoned =
Water Inj. =

See footnote for heading definitions.

See spill record for detail.
Totals exclude stations.

	Site Identification	Data From Ecuadorian Dept. of National Hydrocarbons (Data collected in 1987)									Wellsite Workovers				Spill Record (1973–90 Spills)	
	Field	Data	Site Condition			Adjacent Land Use				Pit Size	90	91	92	93	Number	Volume
	Number	Available	1	2	3	1	2	3	4	m2	Number by year.				of Spills	Barrels
	A39															
	A41	1		1				1		64						
	A42															
	A42B	1		1			1			100						
	A43	1		1				1		64						
	A44	1			1		1			80		1				
	6B															
	A45	1			1		1			64						
	A45B															
	46	1		1			1			80			1			
	A48										1					
	B49	1		1			1			64						
	A50															
	B51	1			1		1			100					1	6
	B52	1			1	1				100						
	B53	1		1					1	80	1					
	B54	1	1			1				64			1			
	B55															
Count	79	51	14	27	10	16	21	10	4	47	15	8	14	1	6	607
Percent	24.3	100	27	53	20	31	41	20	8	92	19	10	18	1		

Sacha

Estacion Sur														4	1065
Estacion Central														13	554
Estacion Norte														4	60
Estacion Norte 2															
WIW1															
WIW2															
WIW3															
WIW4															
WIW5															
WIW6															
1	1		1			1								1	60
2	1			1		1			64					5	101
3	1	1						1	64						
4	1		1			1			60					1	30
6	1	1				1			64						
7														6	150
8	1		1			1			1000					1	5
9	1	1				1								2	180
10	1			1		1			64	1				3	58

Table A – 2
Summary of Pre–Assessment Findings – Environmental Data

Producing =
Abandoned =
Water Inj. =

See footnote for heading definitions.

See spill record for detail.
Totals exclude stations.

Site Identification	Data From Ecuadorian Dept. of National Hydrocarbons (Data collected in 1987)									Wellsite Workovers				Spill Record (1973 –90 Spills)	
Field	Data	Site Condition			Adjacent Land Use				Pit Size	90	91	92	93	Number	Volume
Number	Available	1	2	3	1	2	3	4	m2	Number by year.				of Spills	Barrels
11	1	1			1				64						
12	1	1				1			80						
13														9	517
14	1	1				1			100					1	4
15	1	1				1			64					7	115
16	1	1				1			100					3	18
17	1		1			1			100					4	327
18															
19	1	1				1								5	263
20														6	78
21	1	1				1			64					2	40
22	1	1				1			64	1				1	12
23										1					
24	1	1				1			64					2	35
25	1			1		1			64					2	8
26	1			1		1			64	1				2	7
27	1			1		1									
28	1		1		1				100	2				1	30
29	1	1				1				1					
30	1		1			1			64	1					
31	1	1			1									3	23
32	1		1			1			100					1	228
33	1	1				1			100				1		
34	1	1				1			64					2	43
35	1	1						1	64					2	33
36	1	1				1			64					1	10
37	1		1			1								1	15
38	1	1				1			36						
39	1	1				1			64						
40	1			1			1		64					1	30
41										1				1	200
42	1			1		1									
43										1					
44	1		1			1			600						
45	1			1		1			80		1			1	15
46	1	1				1			64					1	50
47	1	1			1										
48	1	1			1				64						
49	1	1				1			1000	1				1	40
50															
51	1	1				1			64					1	50
52	1	1				1			1000	1					
53	1	1				1			36						
54	1	1				1								1	40
55	1	1				1								2	70

Table A – 2
Summary of Pre–Assessment Findings – Environmental Data

Site Identification	Data From Ecuadorian Dept. of National Hydrocarbons (Data collected in 1987)									Wellsite Workovers				Spill Record (1973–90 Spills)	
Field	Data	Site Condition			Adjacent Land Use				Pit Size	90	91	92	93	Number	Volume
Number	Available	1	2	3	1	2	3	4	m2	Number by year.				of Spills	Barrels
56	1	1				1			64	1				1	50
57														1	8
58	1	1			1				36					4	50
59	1	1				1									
60	1	1				1			400					5	142
61	1	1			1									1	1
62	1	1				1								2	270
63	1	1				1			36					2	80
64	1		1		1				1500	1				1	5
65	1	1				1			36			1			
66	1	1				1			400						
67	1	1				1			64					1	2
68															
69															
70	1	1				1			1000	1					
71	1	1				1			100						
72	1	1				1			1500						
73	1	1				1			1000						
74	1	1			1				900	1				1	50
75														1	50
76															
77	1	1				1			1000					1	10
78	1	1			1										
79															
80	1	1				1			1500	1				5	95
81														1	200
82	1		1					1	1000						
83															
84															
85															
86															
87	1		1			1			1000	1					
88	1	1			1				1000	1					
89	1	1				1			1000					2	250
90														1	300
91	1		1		1				80						
92										1					
93	1	1				1									
94	1	1				1			100						
95	1	1				1									
96															
97										1					
98	1		1			1			1000						
99	1	1			1				2500						
100	1	1				1			1500						

See spill record for detail.
Totals exclude stations.

Producing =
Abandoned =
Water Inj. =

See footnote for heading definitions.

Table A – 2
Summary of Pre–Assessment Findings – Environmental Data

See footnote for heading definitions.

See spill record for detail.
Totals exclude stations.

Producing =
Abandoned =
Water Inj. =

Site Identification		Data From Ecuadorian Dept. of National Hydrocarbons (Data collected in 1987)									Wellsite Workovers				Spill Record (1973–90 Spills)	
Field		Data	Site Condition			Adjacent Land Use				Pit Size	90	91	92	93	Number	Volume
	Number	Available	1	2	3	1	2	3	4	m2	Number by year.				of Spills	Barrels
	101															
	102															
	103	1	1			1				2500						
	104	1	1				1			2500	1					
	106															
	107															
	108															
	109															
	110										1					
	111															
	112															
	113															
	114										1					
	115										1					
	116										1					
Count	120	78	56	14	8	14	60	1	3	61	25	1	1	1	50	4448
Percent	36.9	100	72	18	10	18	77	1	4	78	21	1	1	1		

Culebra

	Estacion															
	1														1	40
	2											1				
Count	2	0	0	0	0	0	0	0	0	0	0	1	0	0	1	40
Percent	0.6	0	0	0	0	0	0	0	0	0	0	50	0	0		

Yulebra

	Estacion															
	1															
	2										1					
	3															
Count	3	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Percent	0.9	0	0	0	0	0	0	0	0	0	33	0	0	0		

Yuca

	Estacion														1	40
	1														2	580
	2B										1					

Table A – 2
Summary of Pre–Assessment Findings – Environmental Data

Producing =
Abandoned =
Water Inj. =

See footnote for heading definitions.

See spill record for detail.
Totals exclude stations.

Site Identification		Data From Ecuadorian Dept. of National Hydrocarbons (Data collected in 1987)									Wellsite Workovers				Spill Record (1973–90 Spills)	
Field		Data	Site Condition			Adjacent Land Use				Pit Size	90	91	92	93	Number	Volume
	Number	Available	1	2	3	1	2	3	4	m2	Number by year.				of Spills	Barrels
	24	1							1							
	25										1					
	26										1					
Count	27	18	6	5	2	0	0	0	18	11	6	1	1	1	10	1464
Percent	8.3	100	33	28	11	0	0	0	100	61	22	4	4	4		
Auca Sur																
	Estacion															
	1															
	2															
Count	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Percent	0.6	0	0	0	0	0	0	0	0	0	0	0	0	0		
Rumiyacu																
	1															
Count	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Percent	0.3	0	0	0	0	0	0	0	0	0	0	0	0	0		
Cononaco																
	Estacion Central															
	1	1	1			1				120						
	2	1	1				1			80	1				1	500
	3	1	1						1							
	4	1	1				1			1296						
	6	1			1	1				36						
	7	1	1			1				40						
	8	1	1						1	80						
	9	1		1			1			120						
	10	1	1						1	60						
	11	1	1						1	60						
	12	1	1						1	80	1					
	13											1				
	14											1				
Count	13	11	9	1	1	3	3	0	5	10	2	2	0	0	1	500
Percent	4.0	100	82	9	9	27	27	0	45	91	15	15	0	0		

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Table A - 2
Summary of Pre-Assessment Findings - Environmental Data

Site Identification		Data From Ecuadorian Dept. of National Hydrocarbons (Data collected in 1987)									Wellsite Workovers				Spill Record (1973-90 Spills)	
Field		Data	Site Condition			Adjacent Land Use				Pit Size	90	91	92	93	Number	Volume
	Number	Available	1	2	3	1	2	3	4	m2	Number by year.				of Spills	Barrels

Producing =
Abandoned =
Water Inj. =

See footnote for heading definitions.

See spill record for detail.
Totals exclude stations.

	3															
	4															
	5															
	6															
	9															
	10															
	12															
Count	9	0	0	0	0	0	0	0	0	0	1	0	0	0	1	580
Percent	2.8	0	0	0	0	0	0	0	0	0	11	0	0	0		

Yuca Sur

	1															
Count	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Percent	0.3	0	0	0	0	0	0	0	0	0	0	0	0	0		

Auca

	Estacion Sur														3	115
	Estacion Central														10	342
	1	1		1					1	400					2	1005
	2	1			1				1	100			1		2	10
	3	1	1						1	100						
	4	1		1					1	400	1					
	5	1		1					1	200						
	6	1			1				1	100					1	15
	7	1	1						1	1600						
	8														2	225
	9															
	10	1		1					1	200	1					
	11	1	1						1	80						
	12	1	1						1						1	7
	13	1	1						1	80	1				1	30
	14	1	1						1	100	1				1	80
	15	1							1							
	16														1	30
	17													1	1	12
	18	1							1							
	19															
	19B															
	20	1							1			1			1	50
	21	1							1							
	22	1		1					1							
	23															

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Table A – 2
Summary of Pre–Assessment Findings – Environmental Data

Site Identification		Data From Ecuadorian Dept. of National Hydrocarbons (Data collected in 1987)									Wellsite Workovers				Spill Record (1973–90 Spills)	
Field	Number	Data Available	Site Condition			Adjacent Land Use				Pit Size	90	91	92	93	Number of Spills	Volume Barrels
			1	2	3	1	2	3	4	m2	Number by year.					
Dureno																
	1															
Count	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Percent	0.3	0	0	0	0	0	0	0	0	0	0	0	0	0		

Producing =
Abandoned =
Water Inj. =

See footnote for heading definitions.

See spill record for detail.
Totals exclude stations.

Project Summary

Stations	22	Total wellsites with DNH data – by data parameter.									Workover Sites by				Spill Sites	
Wells	325	202	105	59	33	54	89	16	43	170	71	17	22	3	93	13710
Project	347															
		Extracted from percentage of wells with DNH data (202).									Percent of total wellsites (325).					
Project %	100.0	100	52	29	16	27	44	8	21	84	22	5	7	1	29	

Site Condition

1 =	No spills evident, site levelled and gravelled, drainage system in place.
2 =	Oil stain around wellhead, site levelled, sand covering existing spills.
3 =	Extensive spills on wellsite, evidence of spills off–site.

Adjacent Land Use

1 =	Virgin or secondary growth forest.
2 =	Virgin forest and plantation.
3 =	Virgin forest, plantation, rivers, streams and natural depressions.
4 =	Virgin forest, rivers and streams.

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Table A – 3
Spill Record

Note : Records were obtained from Department of National Hydrocarbons and PETROECUADOR files.

Field/Area	Location	Spill Date			Volume (Barrels)			Spill	Material or	Natural	Comments
Ordered Alphabetically	Ordered Numerically	MM	DD	YY	Gross	Recovered	Net	Location	Equipment Used In Cleanup	Resource Affected by Spill	Area Affected or Cause of Spill
Aguarico	1	8	16	89	250	0	250	Flowline	Sand	Soil	Sabotage
Aguarico	4	4	30	77	4	0	4	Pit Failure	Not Available	Soil	None
Aguarico	4	6	7	77	8						
Aguarico	4	4	11	80	200	0	200	Flowline	Burnt	Soil	1 Ha
Aguarico	8	5	2	77	3	0	3	Flowline	Sand	Water/Soil	Entered Stream
Aguarico	9	11	10	75	5	5	0	Flowline	Vacuum Truck	Soil	Grader Cut Flowline
Aguarico	25	6	16	77	100						Oil Filtration From Pit to Stream
Total		7			570						
Aguarico River		6	23	76	610	498	112	Tank	Not Available	Water/Soil	Tank Overflow Into River – Diesel Fuel
Aguarico River		7	5	79	4,725	0	4725	Pipeline	Dispersion	Water	Entered River
Aguarico River		6	8	87	100	0	100	Rio Aguarico	None	Not Known	Trunk Line
Total		3			5,435						
Atacapi	2	5	22	89	40	Shading in this area indicates that additional data is currently not available. Totals for recovered spill and net spill are therefore not calculated.					
Total		1			40						
Auca	Central Sta.	5	5	76	3	0	3	Tank	Not Available	Soil	Check Valve failure
Auca	Central Sta.	2	13	84	100	80	20	Flowline	Burnt/Buried	Water	Into Small Stream
Auca	Central Sta.	2	13	84	100						
Auca	Central Sta.	10	2	84	10	0	10	Flowline	Burnt	Water	50 m2
Auca	Central Sta.	6	9	85	49						
Auca	Central Sta.	3	11	89	50	35	15	Flowline	Vacuum Truck	Water/Soil	Flowed Into Lake at Camp
Auca	Central Sta.	12	16	89	12	0	12	Flowline	Burnt/Absorbants	Soil	Unable to Recover
Auca	Central Sta.	2	11	90	5						
Auca	Central Sta.	2	24	90	1						
Auca	Central Sta.	2	25	90	12						

Table A – 3
Spill Record

Field/Area	Location	Spill Date			Volume (Barrels)			Spill	Material or	Natural	Comments
Ordered Alphabetically	Ordered Numerically	MM	DD	YY	Gross	Recovered	Net	Location	Equipment Used In Cleanup	Resource Affected by Spill	Area Affected or Cause of Spill
Auca	South Sta.	11	9	76	5	0	5	Valve Failure	Sand	Soil	None
Auca	1	11	18	82	1,000	0	1000	Trunk Line	Burnt	Soil	Line Break
Auca	1	10	12	89	5						
Auca	2	2	4	77	6	0	6	Flowline	Sand	Soil	Platform
Auca	2	2	24	90	4	2	2	Flowline	Absorbents	Land/Soil	Part of Plantation
Auca	6	3	29	90	15						
Auca	8	9	2	81	25	0	25	Pit	None	Soil	None
Auca	8	4	28	84	200	150	50	Trunk Line	Existing Soil	Soil	50 m2
Auca	12	9	15	89	7	3	4	Flowline	Sand	Soil	Line Accidently Opened
Auca	13	10	3	82	30	0	30	Flowline	Burnt	Water	Flowed Into Rio Tiputini
Auca	14	2	6	78	80	0	80	Pit Failure	Burnt	Water/Soil	Entered Small Streams
Auca	16	11	27	77	30	0	30	Pit Failure	Burnt	Water/Soil	Entered Small Stream
Auca	17	2	25	90	12						
Auca	20	1	30	90	50	0	50	Flowline	Burnt	Water/Soil	Burnt Coffee Plantation, Entered Stream
Total		24			1,811						
Auca Sur	Sta.	11	3	84	60						
Auca Sur	Sta.	2	15	90	50	35	15	Flowline	Vacuum Truck/Sand	Water/Soil	Flowed Into Lake at Camp
Auca Sur	3	11	3	84	36						
Total		3			146						
Cononaco	2	3	7	84	500	0	500	Pit Erosion	Burnt	Water/Soil	Oil Into Rio Snirypono
Total		1			500						
Culebra	1	10	21	84	40						
Total		1			40						

Note : Records were obtained from Department of National Hydrocarbons and PETROECUADOR files.

Table A – 3
Spill Record

Field/Area	Location	Spill Date			Volume (Barrels)			Spill	Material or	Natural	Comments
Ordered Alphabetically	Ordered Numerically	MM	DD	YY	Gross	Recovered	Net	Location	Equipment Used In Cleanup	Resource Affected by Spill	Area Affected or Cause of Spill
Guanta	4	1	25	87	450						
Total		1			450						
Lago Agrio	Central Sta.	4	3	75	4	0	4	Pit Drainage	Not Available	Soil	Workers Opened Pit Drainage
Lago Agrio	Central Sta.	12	12	75	30						
Lago Agrio	Central Sta.	4	5	76	6	0	6	Flowline	Not Available	Soil	Damaged Valve
Lago Agrio	Central Sta.	5	12	76	27	0	27	Tank	Not Available	Soil	Valve left Open While Filling – Diesel Fuel
Lago Agrio	Central Sta.	6	17	76	41						
Lago Agrio	Central Sta.	8	14	77	2	0	2	Pump Failure	Sand	Soil	100 m2
Lago Agrio	Central Sta.	9	8	79	5						
Lago Agrio	Central Sta.	11	17	79	9	8	1	Pump House	Existing Soil	Soil	7 m2
Lago Agrio	2	10	22	76	30	0	30	Valve Failure	Not Available	Soil/Vegetation	Valve failure on Tank
Lago Agrio	4	8	23	77	3	1.5	1.5	Flowline	Existing Soil/Sand	Soil	20 m2
Lago Agrio	4	10	3	77	1	0	1	Flowline	Existing Soil/Sand	Soil	20 m2
Lago Agrio	7	1	6	77	15	0	15	Pit Failure	Not Available	Water/Soil	Overflow From Rain
Lago Agrio	7	12	24	76	15						
Lago Agrio	8	10	26	76	3	0	3	Flowline	Not Available	Soil	Corrosion
Lago Agrio	8	4		77							Pit Full of Oil – Water Overflowing During Rain
Lago Agrio	11	5	18	76	25	0	25	Flowline	Existing Soil/Sand	Soil	Grader Cut Flowline
Lago Agrio	11B	4		77							Platform Covered With Oil
Lago Agrio	13	3	24	78	45	0	45	Tank	Existing Soil	Soil	Accidental Valve Opening
Lago Agrio	15	10	8	76	15	0	15	Pit	Pit Filled	Soil	Filtration From Pit
Lago Agrio	15	4		77							Pit Full of Oil – Water Overflowing During Rain
Lago Agrio	17	7	27	79	15	0	15	Flowline	Not Available	Soil	Plantations & Farms
Lago Agrio	17	4		77							
Lago Agrio	21	5	2	79	25	18	7	Wellhead	Gravel/Existing Soil	Water/Soil	Entered Stream
Lago Agrio	23	9	8	79	3	0	3	Flowline	Existing Soil	Water/Soil	Entered Small Stream
Lago Agrio	24	10	29	77	3	1	2	Valve Failure	Existing Soil/Sand	Soil	200 m2 on Platform

Note : Records were obtained from Department of National Hydrocarbons and PETROECUADOR files.

Table A – 3
Spill Record

Note : Records were obtained from Department of National Hydrocarbons and PETROECUADOR files.

Field/Area	Location	Spill Date			Volume (Barrels)			Spill Location	Material or Equipment Used In Cleanup	Natural Resource Affected by Spill	Comments
Ordered Alphabetically	Ordered Numerically	MM	DD	YY	Gross	Recovered	Net				Area Affected or Cause of Spill
Lago Agrio	25	6	7	77	80	0	80	Pit Failure	Sand	Soil	Unused Pits
Lago Agrio	Central Sta.	8	6	82	60	0	60	Pit	Burnt	Soil	Around wash Tank
Lago Agrio	Central Sta.	12	19	82	10	5	5	Flowline	Existing Soil	Soil	300 m2
Lago Agrio	Central Sta.	10	31	83	800	0	800	Pit	None	None	Into Pit
Lago Agrio	Central Sta.	12	21	87	40						
Lago Agrio	Central Sta.	4	3	88	50						
Lago Agrio	Central Sta.	3	21	89	10	5	5	Flowline	Existing Soil	Soil	300 m2
Lago Agrio	Central Sta.	3	25	90	60	40	20	Flowline	Vacuum Truck	Soil	200 m2
Lago Agrio	Central Sta.	3	29	90	60	40	20	Flowline	Vacuum Truck	Soil	200 m2
Lago Agrio	North Sta.	5	20	81	50	0	50	Pit Failure	Burnt	Water/Soil	Entered Rio Te Te Ye
Lago Agrio	North Sta.	?			5	0	5	Flowline	Existing Soil	Soil	300 Lined ? Metres
Lago Agrio	1	1	9	82	50	20	30	Flowline	Burnt	Water/Soil	600 m2, Flowed Into Stream
Lago Agrio	8	1	21	81	100	0	100	Trunk Line	Burnt	Soil	1 Ha
Lago Agrio	18	4		77							Pit Full of Oil – Water Overflowing During Rain
Lago Agrio	20	2	24	90	50						
Lago Agrio	21	6	5	81	20	0	20	Wellhead	Existing Soil	Soil	Half of Location
Lago Agrio	22	4		77							Platform & Surroundings Covered With Oil
Lago Agrio	23	8	17	86	60	35	25	Flowline	Vacuum Truck	Soil	200 m2
Lago Agrio	26	9	9	86	20						
Lago Agrio	26	4		77							'Considerable Spill'
Lago Agrio	26	9	29	86	20	0	20	Road Access	Existing Soil	Land/Soil	1 Ha
Total		46			1,867						
Parahuaca	Sta.	11	24	81	200	200	0	Tank	Vacuum Truck	None	None
Parahuaca	1	4	6	79	4,500	2300	2200	Flowline	Existing Soil	Water/Soil	Entered Streams – 4 kms
Parahuaca	4	1	24	88	20						
Parahuaca	5	1	16	81	16	0	16	Not Available	Existing Soil/Sand	Soil	100 m2
Total		4			4,736						

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Table A – 3
Spill Record

Field/Area Ordered Alphabetically	Location Ordered Numerically	Spill Date			Volume (Barrels)			Spill Location	Material or Equipment Used In Cleanup	Natural Resource Affected by Spill	Comments
		MM	DD	YY	Gross	Recovered	Net				Area Affected or Cause of Spill
Sacha	Central Sta.	8	7	73	8						
Sacha	Central Sta.	12	14	75	130	0	130	Trunk Line	Not Available	Soil	Corrosion
Sacha	Central Sta.	12	9	76	1	0	1	Flowline	Not Available	Soil	Corrosion
Sacha	Central Sta.	12	29	76	5	0	5	Flowline	Not Available	Soil	Corrosion
Sacha	Central Sta.	12	26	77	5	0	5	Flowline	Not Available	Water/Soil	Corrosion
Sacha	Central Sta.	7	2	80	80	0	80	Pit Failure	Burnt	Soil	Burnt Corn Field
Sacha	Central Sta.	5	11	81	15						
Sacha	Central Sta.	7	27	81	50						
Sacha	Central Sta.	9	14	83	60	60	0	Trunk Line	Vacuum Truck	None	None
Sacha	Central Sta.	11	6	83	30	20	10	Flowline	Burnt	Soil	50 m2
Sacha	Central Sta.	6	22	88	10						
Sacha	Central Sta.	2	21	89	80	0	80	Pit Failure	Burnt	Soil	Burnt Corn Field
Sacha	Central Sta.	4	28	90	80	0	80	Pit Failure	Burnt	Soil	Burnt Corn Field
Sacha	North Sta.	7	6	73	5	0	5	Flowline	Not Available	Soil	Corrosion
Sacha	North Sta.	2	6	76	5	0	5	Flowline	Not Available	Soil	Corrosion
Sacha	North Sta.	1	19	77	Indeterminate						
Sacha	North Sta.	6	19	80	50	0	50	Pit Failure.	Burnt	Water/Soil	Entered Rio Jiuino
Sacha	South Sta.	3	20	76	200	0	200	Pit Failure	Not Available	Water/Soil/Vegetation	Pit Overflow Into Stream – 4 Kms
Sacha	South Sta.	12	21	77	15	10	5	Tank	Existing Soil/Sand	Soil/Vegetation	50 m2
Sacha	South Sta.	7	24	79	800	300	500	Pump House	Burnt/Existing Soil	Water/Soil	Entered Stream – 100 m2
Sacha	South Sta.	7	27	81	50						
Sacha	Flow Line ?	6	12	81	30						
Sacha	1	1	1	88	60						
Sacha	2	9	5	73	20						
Sacha	2	9	20	73	3						
Sacha	2	11	8	75	6	2	4	Flowline	Vacuum Truck	Soil	Unknown cause
Sacha	2	1	26	77	22						
Sacha	2	6	19	80	50						
Sacha	4	12	28	78	30						

Note : Records were obtained from Department of National Hydrocarbons and PETROECUADOR files.

Table A – 3
Spill Record

Field/Area	Location	Spill Date			Volume (Barrels)			Spill	Material or	Natural	Comments
Ordered Alphabetically	Ordered Numerically	MM	DD	YY	Gross	Recovered	Net	Location	Equipment Used in Cleanup	Resource Affected by Spill	Area Affected or Cause of Spill
Sacha	7	7	13	75	15	0	15	Flowline	Not Available	Soil	Corrosion
Sacha	7	7	19	75	10	0	10	Flowline	Not Available	Soil/Vegetation	Normal Repair But Vac Truck Broken
Sacha	7	5	18	76	5	0	5	Flowline	Sand	Soil	Corrosion
Sacha	7	5	19	76	10	0	10	Flowline	Not Available	Soil	Corrosion, Mainly Water
Sacha	7	6	13	76	100	0	100	Flowline	Not Available	Soil	Flowline Explosion
Sacha	7	12	9	77	10	8	2	Flowline	Existing Soil/Sand	Soil	100 m2 on Roadway
Sacha	8	12	8	74	5						
Sacha	9	3	19	79	30	20	10	Flowline	Existing Soil	Soil	200 m2
Sacha	9	7	12	79	150	0	150	Pit Failure	Burnt	Water/Soil	Entered Stream
Sacha	10	7	10	73	6						
Sacha	10	7	6	76	12	0	12	Flowline	Not Available	Soil	Corrosion
Sacha	10	3	19	79	40						
Sacha	13	8	4	73	220						
Sacha	13	8	11	73	8	0	8	Valve Failure	Sand	Soil	Somebody Opened Valve
Sacha	13	8	17	73	15						
Sacha	13	7	18	75	60						
Sacha	13	10	10	75	3	0	3	Flowline	Not Available	Soil	Corrosion
Sacha	13	10	30	75	1	0	1	Flowline	Not Available	Soil	Corrosion
Sacha	13	11	7	76	8	0	8	Valve Failure	Sand	Soil	Somebody Opened Valve
Sacha	13	4	17	78	2	0	2	Flowline	Existing Soil	Soil/Vegetation	9 m2
Sacha	13	12	11	87	200						
Sacha	14	2	19	76	4	0	4	Flowline	Not Available	Soil	Corrosion
Sacha	15	5	12	76	2	0	2	Flowline	Not Available	Soil	Corrosion
Sacha	15	8	1	76	1	0	1	Flowline	Sand	Soil	Corrosion
Sacha	15	10	3	76	5	0	5	Wellhead	Not Available	Soil/Vegetation	Nipple Failure
Sacha	15	1	22	78	4	0	4	Valve Failure	Existing Soil/Sand	Soil/Vegetation	40 m2
Sacha	15	1	22	78	5	0	5	Wellhead	Not Available	Soil/Vegetation	Nipple Failure
Sacha	15	12	21	78	60						
Sacha	15	3	19	79	40	0	40	Flowline	Sand	Soil	On Platform
Sacha	16	9	16	75	6	0	6	Flowline	Not Available	Soil	Corrosion

Note : Records were obtained from Department of National Hydrocarbons and PETROECUADOR files.

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Table A – 3
Spill Record

Note : Records were obtained from Department of National Hydrocarbons and PETROECUADOR files.

Field/Area	Location	Spill Date			Volume (Barrels)			Spill	Material or	Natural	Comments
Ordered Alphabetically	Ordered Numerically	MM	DD	YY	Gross	Recovered	Net	Location	Equipment Used in Cleanup	Resource Affected by Spill	Area Affected or Cause of Spill
Sacha	16	3	9	77	2	0	2	Flowline	Not Available	Soil	Corrosion
Sacha	16	6	4	77	10	0	10	Flowline	Sand	Soil	None
Sacha	17	5	31	75	10	0	10	Flowline	Not Available	Soil	Corrosion
Sacha	17	11	12	75	15	0	15	Manifold	Not Available	Soil	Corrosion
Sacha	17	5	14	76	2	0	2	Flowline	Not Available	Soil	Corrosion
Sacha	17	7			1	0	1	Flowline	Not Available	Soil	Corrosion
Sacha	17	10	22	86	300						
Sacha	19	7	30	73	30						
Sacha	19	11	4	76	3	0	3	Tank	Not Available	Soil	Tank Failure
Sacha	19	11	9	76	40	0	40	Valve Failure	Not Available	Soil	On Platform
Sacha	19	11	8	84	130						
Sacha	19	1	24	85	60						
Sacha	20	7	29	75	40	0	40	Flowline	Not Available	Soil/Vegetation	Heavy Equipment Accident
Sacha	20	9	1	75	15	0	15	Manifold	Not Available	Soil/Vegetation	Corrosion
Sacha	20	11	22	75	2	0	2	Flowline	Not Available	Soil	Corrosion
Sacha	20	12	11	75	1	0	1	Flowline	Not Available	Soil	Corrosion
Sacha	20	5	19	76	10	0	10	Flowline	Sand	Soil	Corrosion
Sacha	20	3	3	77	10	0	10	Flowline	Not Available	Soil	None
Sacha	21	5	13	76	20	0	20	Trunk Line	Sand	Soil	Corrosion – 5 to 6 day Leak
Sacha	21	9	24	76	20	0	20	Flowline	Not Available	Soil	Corrosion
Sacha	22	1	26	77	12	0	12	Valve Failure	Sand	Water/Soil	Entered Small Stream
Sacha	24	12	2	74	15						
Sacha	24	5	13	76	20	0	20	Flowline	Not Available	Soil	Corrosion
Sacha	25	6	29	75	6	0	6	Wellhead	Not Available	Soil	Nipple Failure
Sacha	25	8	19	75	2	0	2	Wellhead	Not Available	Soil	Nipple Failure
Sacha	26	8	22	75	2	0	2	Flowline	Not Available	Soil	Corrosion
Sacha	26	9	8	75	5	0	5	Flowline	Not Available	Soil	Corrosion
Sacha	28	10	1	79	30						
Sacha	31	12	13	74	20						
Sacha	31	10	30	75	2	0	2	Flowline	Not Available	Soil	Corrosion

Table A – 3
Spill Record

Note : Records were obtained from Department of National Hydrocarbons and PETROECUADOR files.

Field/Area	Location	Spill Date			Volume (Barrels)			Spill	Material or	Natural	Comments
Ordered Alphabetically	Ordered Numerically	MM	DD	YY	Gross	Recovered	Net	Location	Equipment Used in Cleanup	Resource Affected by Spill	Area Affected or Cause of Spill
Sacha	31	12	21	76	1	0	1	Flowline	Not Available	Soil	Corrosion
Sacha	31	?			8	0	8	Flowline	Vacuum Truck	Soil	Corrosion
Sacha	32	4	13	89	228	135	93	Flowline	Sand	Soil	300 m2, Someone Stole Part of Line
Sacha	34	9	30	75	3	0	3	Wellhead	Not Available	Soil	Corrosion
Sacha	34	5	3	90	40	0	40	Flowline	Burnt	Land	Heavy Equipment Accident
Sacha	35	12	8	74	3						
Sacha	35	12	6	75	30						
Sacha	36	9	17	77	10	3	7	Valve Failure	Sand	Soil	16 m2 on Platform
Sacha	37	2	26	76	15	5	10	Pit Failure	Vacuum Truck	Soil	Pit Overflow
Sacha	40	12	15	77	30	0	30	Wellhead	Burnt/Sand	Soil	On Platform
Sacha	41	10	5	77	200	180	20	Pit Failure	Burnt	Water/Soil	Entered Small Stream
Sacha	45	6	3	75	15	0	15	Pit Failure	Not Available	Water/Soil/Vegetation	1 Ha, Entered River
Sacha	46	1	11	81	50	0	50	Flowline	Burnt	Water/Soil	Entered Stream
Sacha	49	4	14	77	40	40	0	Flowline	Not Available	Soil	Line Corrosion
Sacha	51	12	15	74	50						
Sacha	54	3	26	81	40	0	40	Flowline	Burnt/Existing Soil	Water/Soil	1 Ha, Entered Adjacent Rio
Sacha	55	11	6	76	20	0	20	Filtration From F	Sand	Soil/Vegetation	Filtration From Pit
Sacha	55	3	14	83	50	0	50		Existing Soil	50 m2	
Sacha	56	12	17	76	50	0	50	Pit Failure	Not Available	Water/Soil	Entered Stream Through Filtration
Sacha	57	9	25	75	8						
Sacha	58	2	19	76	10	0	10	Flowline	Not Available	Soil/Vegetation	Corrosion
Sacha	58	2	19	76	30	0	30	Flowline	Not Available	Soil	Corrosion
Sacha	58	6	30	76	5	0	5	Flowline	Burnt/Existing Soil/Sa	Soil	60 m2
Sacha	58	10	6	77	5	0	5	Flowline	Not Available	Soil	Corrosion
Sacha	60	5	19	76	20	0	20	Flowline	Not Available	Soil	Corrosion
Sacha	60	5	19	76	20	0	20	Flowline	Vacuum Truck	Water/Soil	Entered River
Sacha	60	8	16	76	2	0	2	Flowline	Not Available	Soil	Corrosion
Sacha	60	12	20	76	80	0	80	Trunk Line	Not Available	Water/Soil/Vegetation	Corrosion, Entered Stream
Sacha	60	1	19	77	20	0	20	Flowline	Not Available	Soil	Corrosion
Sacha	60	1	21	77	20	0	20	Flowline	Not Available	Water	Entered River

Table A – 3
Spill Record

Field/Area	Location	Spill Date			Volume (Barrels)			Spill	Material or	Natural	Comments
Ordered Alphabetically	Ordered Numerically	MM	DD	YY	Gross	Recovered	Net	Location	Equipment Used In Cleanup	Resource Affected by Spill	Area Affected or Cause of Spill

<u>Note : Records were obtained from Department of National Hydrocarbons and PETROECUADOR files.</u>

Sacha	61	8	2	76	1	0	1	Choke Failure	Not Available	Soil	Nipple failure
Sacha	62	4	21	79	110	0	110	Not Available	Sand	Soil	Burnt Plantation – 1 Ha
Sacha	62	4	21	79	160	0	160	Pit Failure	Sand	Soil	1 Ha
Sacha	63	5	15	77	20						
Sacha	63	2	1	87	60	0	60	Flowline	None	Soil	100 m2
Sacha	64	12	25	77	5	3	2	Valve Failure	Sand	Soil	100 m2 on Platform
Sacha	67	9	19	73	2						
Sacha	74	4	10	78	50	40	10	Flowline	Burnt/Existing Soil	Soil/Vegetation	Around Platform
Sacha	75	12	8	87	50						
Sacha	77	5	28	81	10	0	10	Flowline	Existing Soil	Soil	100 m2
Sacha	80	2	14	79	20	0	20	Flowline	Burnt	Land/Soil	2000 m2
Sacha	80	9	5	79	20	0	20	Flowline	Burnt	Soil	None
Sacha	80	9	12	79	15	0	15	Flowline	Burnt	Water/Soil	Entered Small Stream
Sacha	80	9	22	79	10						
Sacha	80	10	4	79	30	0	30	Flowline	Not Available	Water/Soil	Entered Samll Stream
Sacha	81	6	18	85	200	0	200	Flowline	Burnt	Water/Soil	0.5 Ha
Sacha	89	1	3	79	100	50	50	Flowline	Existing Soil	Land/Soil	100 m2
Sacha	89	8	19	80	150	120	30	Flowline	Existing Soil	Soil	250 m2
Sacha	90	3	14	83	300	0	300	Flowline	Existing Soil	Land/Soil	1 Ha
<u>Total</u>		138			6,188						
Shushufindi	10,11,31	12	7	82	650	650	0	Access Road	Vacuum Truck	Soil	100 m2
Shushufindi	Central Sta.	4	4	76	7						
Shushufindi	Central Sta.	3	21	77	3	0	3	Tank	Not Available	Soil	Tank Overflow
Shushufindi	Central Sta.	11	14	77	150	145	5	Tank	Existing Soil/Sand	Soil	500 m2 – Dyke Damaged
Shushufindi	Central Sta.	2	10	78	15	0	15	Tank	Existing Soil	Soil	40 m2
Shushufindi	Central Sta.	12	4	86	327	222	105	Turbine House	Vacuum Truck	None	None
Shushufindi	Station	7			20	0	20	Tank	Not Available	Soil	Tank Dyke Failure
Shushufindi	North Sta.	4	23	89	40	36	4	Flowline	Sand	Soil	500 m2

Table A – 3
Spill Record

Field/Area	Location	Spill Date			Volume (Barrels)			Spill	Material or	Natural	Comments
Ordered Alphabetically	Ordered Numerically	MM	DD	YY	Gross	Recovered	Net	Location	Equipment Used In Cleanup	Resource Affected by Spill	Area Affected or Cause of Spill
Note : Records were obtained from Department of National Hydrocarbons and PETROECUADOR files.											
Shushufindi	South Sta.	?			10	0	10	Tank	Not Available	Soil	Did Not Turn Pump Off
Shushufindi	8	10	8	77	30	25	5	Flowline	Vacuum Truck	Soil	20 m2
Shushufindi	20	6	27	76	1	0	1	Trunk Line	Vacuum Truck	Soil	Truck Hit Pipeline
Shushufindi	21	7	11	77	500	0	500	Choke Failure	Sand	Soil	Platform Area
Shushufindi	26	10	19	75	10	0	10	Flowline	Not Available	Soil	Line Test
Shushufindi	51	6	16	77	6	0	6	Pit Failure	Not Available	Soil	None
Shushufindi	57	?	.		6	0	6	Tank	Pushed Into Sump	Soil	Discharge Hose Dropped Off Tank
Shushufindi	64	4	5	78	60	48	12	Flowline	Sand	Soil	0.1 Ha
Total		16			1,835						
Yuca	Sta.	4	14	89	40						
Yuca	1	5	25	80	540	285	255	Not Available	Existing Soil	Water/Soil	200 m2
Yuca	1	4	14	89	40	20	20	Flowline	Sand/Burnt	Soil	200 m2
Total		3			620						
Yuca Sur	1	6	17	89	10						
Total		1			10						
Yuca Town		1	13	90	30						
Yuca Town		7	20	90	15						
Total		2			45						
Grand Total		251			24,293	NA	NA				

[redacted]

APPENDIX B

FACILITY AUDIT PROTOCOLS

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Earth & Environmental Group

PRIVILEGED AND CONFIDENTIAL
WORK PRODUCT

PETROECUADOR-TEXACO SITE ASSESSMENT AND FACILITY AUDIT

INTERNATIONAL ENVIRONMENTAL AUDIT PROTOCOL AND FIELD NOTES

Facility: ______________________________

Location: ______________________________

Date Audited: ______________________________

PREPARED FOR:

PETROECUADOR-TEXACO CONSORTIUM

PREPARED BY:

HBT AGRA Ltd.

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PET 040887

CONFIDENTIALITY STATEMENT

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The information contained in this document is confidential and proprietary in nature, and is to be used in conjunction with other facts and data for the sole purpose of providing advice concerning potential environmental liabilities.

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APPENDIX A ENVIRONMENTAL AUDIT FINDINGS FORM

APPENDIX B MASTER AUDIT CHECKLIST

PART A PRODUCTION FACILITY MANAGEMENT

1. GENERAL INFORMATION

1.1	Facility Name:	
1.2	Field Name:	
1.3	Mailing Address:	
1.4	Telephone:	
1.5	Telex / TWX / Fax:	
1.6	Dates Audited:	
1.7	Auditors/Affiliation:	
1.6	Facility Manager:	Current:
		Pre 1990:
1.7	Individual(s) Responsible for Health, Safety & Environmental Affairs:	Current:
		Pre 1990:
1.8	Audit Contact:	Current:
		Pre 1990:
1.9	Individuals consulted as part of this facility audit process, including their affiliation, titles, and subject matter discussed:	

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SUMMARY OF ATTACHMENTS OBTAINED

- Site layout map with buildings, storage tanks, chemical and waste storage areas identified.

  Yes ☐ No ☐

- Area map (municipality or local area) showing site location and proximity to towns, rivers, residences, etc.

  Yes ☐ No ☐

- Photographs - general photographs of site and detailed photographs illustrating potential concerns.

  Yes ☐ No ☐

(as available)

- Site history (previous activities of environmental concern)
- Bulk and Drum Chemical Storage Inventory
- (Copies of Environmental, Health and Safety Permits)
- Documentation of Emergency Prevention/Response Plan
- Copy of Company Environmental Policy

List of Interviews

- Site and corporate personnel
- Local, regional or national authorities

2. FACILITY DESCRIPTION

2.1	Total Site Area:	Current:
		Pre 1990:
2.2	Describe the Following:	
	Volume of Oil and Gas Processed at this facility:	Current:
		Pre-1990:
	Pocess to refine raw product:	Current:
		Pre-1990:
	Types of chemicals used in the refining process:	Current:
		Pre-1990:
	Chemical Storage area configuration	Current:
		Pre-1990:
	Number of underground storage tanks, volume and contents:	Current:
		Pre-1990:

CA1069639

2.	**FACILITY DESCRIPTION**	
	Oil sludge waste treatment method	Current:
		Pre-1990:
	Sewage Treatment:	Current:
		Pre-1990:
	Product Storage Tanks and areas:	Current:
		Pre-1990:
	Other (treater, line pigging areas, compressors etc.)	Current:
		Pre-1990:
2.3	List Chemicals used:	Current:
		Pre-1990:
2.4	Briefly describe operations, where applicable: Production Processes, Transport, Power Source	Current:
		Pre-1990:

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2.	FACILITY DESCRIPTION	
2.5	Is sewage effluent: a) sent to a municipal system; or b) treated on-site?	Current:
		Pre-1990:
2.6	When sewage effluent was treated on-site, was the treatment consistent with regulatory and company standards?	Current:
		Pre-1990:
2.7	Are all waste oils and toxic wastes disposed of via appropriate practices, or to approved facilities?	Current:
		Pre-1990:
2.8	Is landfilled solid waste disposed of on-site or at off-site dumps?	Current:
		Pre-1990:
2.9	Are solid camp wastes incinerated?	Current:
		Pre-1990:

3. SITE HISTORY

3.1 List any changes, refitting, or additions to the operations and product handling at the facility since to 1990.

____

____

____

3.2 Trace the history of the site and plant facility prior to 1990. Include dates, occupants, uses, and known or suspected environmental problems, including spills, former lagoons, tank storage areas, etc.

Section of the Facility	Type of Change or Addition to the Process	Dates	Environmental Concerns
eg. Sulphur Extraction	Sour Gas Processes	1970 to 1973	

3.3 Describe plant construction and reclamation practices and any alterations to site topography since 1990.

____

____

____

3.4 Provide a site map and any historical or current aerial photographs which depict the site and its surroundings.

3.5 Describe the age and use of any current or previously existing structures on site.

Building Name or Description	Dates Built and Demolished	Function

3.6 Describe previous site use(s) of any chemicals, pesticides or hazardous substances.

Chemical	Amount Used	Type of Process

3.7 Include/review floor plans of any historical operations and structures, underground storage tanks for sewers, floor drains, chemical storage, water wells, cisterns, and piping to lagoons etc.

4.	SITE CHARACTERISTICS	
4.1	Describe Area Topography	
4.2	Describe Area Meteorology	
	- Direction of prevailing wind - dry season, monsoon	
	- Air temperature (maximum / minimum)	
	- Annual mean precipitation	
	- Is the area subject to periodic climatic inversions?	
	- Is the area known for air pollution?	
	- Is the area subject to earthquakes, hurricanes, tornadoes, or any unusual weather patterns?	
4.3	Adjacent Land Uses - Describe surrounding land usage (urban, suburban, industrial, rural).	Current:
		Pre-1990:
	- Identify neighbouring facilities and type of industries within a two kilometre radius (eg. plantation)	Current:
		Pre-1990:

	- State size and locations of nearest residential communities, upwind and downwind.	Current:
		Pre-1990:
	- Locations of any schools, hospitals, child care facilities, churches, railway stations, nursing or convalescent homes within 5 kilometres of the facility.	Current:
		Pre-1990:
	- Locations of any parks, natural areas, wetlands, or critical habitats within 5 kilometres of the facility.	Current:
		Pre-1990:
	- Locations of nearest police, fire and emergency response teams.	Current:
		Pre-1990:
	- Location of nearby conservation areas including heritage sites.	Current:
		Pre-1990:
4.4	Soils/Geology	
	- Is the facility located on or near an active volcanic area?	
	- Has there been any seismic activity in the area in the last 100 years?	

	- Describe on-site soils. Have borings ever been made? Give date and results if available.	
	- Has fill ever been brought to the site? Describe fill operations (including source of fill brought to the site and fill location as well as fate of fill removed from site) etc.	
	- Define and describe site geology from the surface down to bed-rock.	
	- Have soil and/or groundwater samples ever been taken by the plant or by the Authorities?	Current:
		Pre-1990:
	- Are you aware of any surface or subsurface soil contamination in the immediate area?	Current:
		Pre-1990:
4.5	Groundwater/Hydrogeology	
	- Depth to and direction of flow of groundwater.	
	- Depth to and direction of flow in usable uppermost aquifer.	
	- Location, number, and use of any on-site water wells.	
	- Depths and pumping rates?	
	- Analytical data?	

	- Are water wells cased? To what depth?	
	- Describe groundwater use within a 5 kilometre radius of facility (municipal or residential drinking water; irrigation for food/non-food crops; stock watering; commercial or industrial; not used).	
	- Location, direction, population served, and aquifer depth of nearest downgradient private and/or municipal wells.	
	- To where does groundwater discharge ie, stream, wetland, etc.?	
	- State any known or suspected local, off-site groundwater contamination?	

Have any of the above groundwater characteristics changed since 1990?

4.6	Surface Water	
	- Is the site located in a flood plain? Any flooding ever recorded? Results? Actions taken?	
	- Are there any critical habitat on site or in proximity?	
	- Identify (name, location, and distance) of all surface water bodies within three miles of the facility.	
	- Identify any discharges (known or suspected) to surface water from the property/facility.	Current:
		Pre-1990:
	- Location(s) of ditches, dry stream beds, storm sewers, cuts, or swales within 500 feet of the site and which might receive plant runoff.	Current:
		Pre-1990:
	- Are any surface water bodies contaminated by any source in the area?	Current:
		Pre-1990:
	- How is rainwater/storm water handled on site, and where does it flow to?	Current:
		Pre-1990:

5.	AIR EMISSIONS	
5.1	Identify any National atmospheric emission laws or regulations applicable to this facility. Collect copies of permits.	Current:
		Pre-1990:
5.2	Identify notification requirements for reporting abnormal (routine or sudden) emissions.	Current:
		Pre-1990:
5.3	Total number of plant emission sources (stacks and vents) exhausting to the atmosphere. Note history of changes to emission sources.	Current:
		Pre-1990:
5.4	Describe frequency and scope of any air emission monitoring programs, whether required by law or voluntary. Review.	Current:
		Pre-1990:
5.5	Has the facility been in compliance with permissible emission standards?	Current:
		Pre-1990:
5.6	Presence of detectable odours, solid particulates, liquid droplets or mist in air: - within buildings	Current:
		Pre-1990:

	- outside buildings, but within plant property limits	Current:
		Pre-1990:
	- outside plant property	Current:
		Pre-1990:
5.7	Distance, location in relation to site, and nature of other area sources of air pollution.	Current:
		Pre-1990:
5.8	Nature and frequency of neighbour complaints;	Current:
		Pre-1990:
	- plant action in response	Current:
		Pre-1990:
5.9	Has the plant had standardized response procedures to accidental releases and to neighbour complaints?	Current:
		Pre-1990:
5.10	History of any abnormal emission incidents?	Current:
		Pre-1990:

5.11	Nature of any fugitive emissions on site and steps taken to control same.	Current:
		Pre-1990:
5.12	List all air pollution violation notices, such as warnings (verbal or written), citations, fines, or informal meetings, and/or enforcement action proceedings taken against this facility in the last three years, the reason(s) for each, and their current status.	Current:
		Pre-1990:

5.13 List all regulatory agencies with which the plant deals on air pollution matters. Attach copies of permits.

Name of Agency	**Address**	**Contact Person**	**Telephone**

6. WATER / WASTEWATER DISCHARGES

6.1	Describe all sources of process, and potable water use. Do quality data exist for these sources? Review.	Current:
		Pre-1990:
6.2	Identify source of plant drinking water.	Current:
		Pre-1990:
6.3	Describe any drinking water contamination in past or present.	Current:
		Pre-1990:
	Does plant drinking water meet national standards? UNEP standards?	Current:
		Pre-1990:
6.4	Describe all sources and volumes of wastewater.	Current:
		Pre-1990:
6.5	Review available wastewater quality data.	Current:
		Pre-1990:

6.6	Is the wastewater collection system combined (process + sanitary + storm)?	Current:
		Pre-1990:
	- Continuous	Current:
		Pre-1990:
	- Batch	Current:
		Pre-1990:
	- Both	Current:
		Pre-1990:
6.7	Provide and describe the results of any bioassay testing of wastewater for toxicity.	Current:
		Pre-1990:
6.8	Does waste water from floor washings and liquids collected from spills and leaks in plant buildings (around pumps, vessels, etc.), flow through the waste water treatment and disposal system?	Current:
		Pre-1990:

6.9	Does runoff water from non-process areas collected in drains, ditches, troughs and other run-off collection systems flow into a tank or ponds?	Current:
		Pre-1990:
6.10	Are evaporation ponds, lagoons or other waste water impoundments, lined with impervious material (clay, PVC, concrete etc.) to prevent groundwater contamination?	Current:
		Pre-1990:
6.11	Are records kept of the location and contents of each above ground and underground waste water storage vessel, lagoon or pond?	Current:
		Pre-1990:
6.12	Is plant sewage treated or disposed of in a manner that does not contaminate surface water or groundwater?	Current:
		Pre-1990:
6.13	Are the waste waters from cooling tower blowdown or boilers treated and disposed of by environmentally safe methods?	Current:
		Pre-1990:
6.14	Treated/untreated wastewater outfalls discharge to:	
	- Stream or river	Current:
		Pre-1990:

	- Storage (no discharge)	Current:
		Pre-1990:
	- Septic tank	Current:
		Pre-1990:
	- Storm sewer	Current:
		Pre-1990:
	- Other	Current:
		Pre-1990:
6.15	Has wastewater ever been discharged to on-site lagoons, leach fields, septic systems, spray irrigation, etc.? Have any of these systems ever been drained or filled? With what frequency? If drained, what was fate of sludges or other solids removed?	Current:
		Pre-1990:
6.16	List all water discharge violation notices, such as warnings (verbal or written), citings, fines, or informal meetings, and/or enforcement action proceedings, taken against this facility, the reason(s) for each, and their current status.	Current:
		Pre-1990:

Discharge to Treatment Plant via Sewer

6.17	Location of wastewater treatment facility:	Current:
		Pre-1990:
	- Design capacity	Current:
		Pre-1990:
	- History of plant	Current:
		Pre-1990:
6.18	Inspection history of facility by government authorities.	Current:
		Pre-1990:
6.19	Plant waste water effluent permits: - Regulatory agency	Current:
		Pre-1990:
	- Date(s)- issued	Current:
		Pre-1990:

	- Expiration	Current:
		Pre-1990:
6.20	Design capacity of pretreatment plant:	Current:
		Pre-1990:
	- History	Current:
		Pre-1990:
	- Type of pretreatment	Current:
		Pre-1990:
	- Plant designer	Current:
		Pre-1990:
6.21	Who performs required monitoring analysis?	Current:
		Pre-1990:
6.22	Who has responsibility for record keeping?	Current:
		Pre-1990:

6.23	Has or does wastewater from adjoining sources (including neighbours) flow into facility sewer system(s)?	Current:
		Pre-1990:
6.24	If 'yes', were or are there actual or potential non-compliance problems?	Current:
		Pre-1990:
6.25	Fate of pretreatment residues.	Current:
		Pre-1990:

6.26 List all regulatory agencies with which the plant deals on wastewater issues. Attach copies of permits.

Name of Agency	Address	Contact Person	Telephone

7. WASTE HANDLING, STORAGE, TRANSPORTATION, AND DISPOSAL

7.1 Identify any National/ Region laws or regulations which address the handling and storage, transportation and disposal of hazardous and non-hazardous waste.

____

____

____

7.2 List all regulatory agencies with whom the plant has dealt regarding wastes.

Name of Agency	Address	Contact Person	Telephone

Hazardous Waste Generation		
7.3	Identify present and past generation of hazardous waste streams. Detail waste sources and volumes.	Current:
		Pre-1990:
7.4	Is the plant registered with a generator number? If so, identify.	Current:
		Pre-1990:
7.5	Has there been a waste analysis plan in effect, including sampling/analyses prior to storage and disposal?	Current:
		Pre-1990:
7.6	Has the plant ever treated, stored, or disposed of hazardous waste on site ? Describe. Has it been licensed to do so?	Current:
		Pre-1990:
7.7	Is a waste manifest tracking system (consignment note) in effect on site? Describe.	Current:
		Pre-1990:
Hazardous Waste Storage		
7.8	Review hazardous waste storage with respect to storage design, waste compatibility, secondary containment structures, drum condition, labelling, aisle space and length of time in storage.	Current:
		Pre-1990:

7.9	How have wastes been transported to and from the drums or tanks?	Current:
		Pre-1990:
7.10	Describe storm drains, bunds, or secondary containment in transfer area.	Current:
		Pre-1990:
Hazardous Waste Disposal		
7.11	Provide a list of all hazardous waste disposed of by the plant, including demulsifiers, corrosion inhibitors etc.	Current:
		Pre-1990:
7.12	As far as possible, identify all hazardous waste disposal facilities ever used by the plant. Are these facilities licensed ? Have the facilities been visited to verify waste disposal practices ?	Current:
		Pre-1990:
7.13	Describe any hazardous waste disposal on-site. Include on-site lagoons, landfills, land treatment systems, incinerators or other treatment systems.	Current:
		Pre-1990:
7.14	Do these disposal methods meet any standards or requirements ? National standards ? UNEP standards ?	Current:
		Pre-1990:

7.15	Describe the process of shipping wastes off-site. Are company-owned vehicles used? Are they licensed to haul hazardous wastes ?	Current:
		Pre-1990:
7.16	Does any waste in any form leave the site which could be traced by labels or other method to the plant ?	Current:
		Pre-1990:
7.17	Are any waste materials recycled or reused on site ? Describe all such processes.	Current:
		Pre-1990:
7.18	Are there any "cleaner production" or pollution prevention/waste minimization plans ? Describe.	Current:
		Pre-1990:
7.19	Indicate procedures for disposal of empty chemical containers (eg. 55 gallon drums).	Current:
		Pre-1990:
Specific Hazardous Wastes		
7.20	List sources, volumes produced, handling and storage procedures, and disposal fate of waste oil (lubrication, hydraulic, vacuum, generator, cutting, etc.) generated at the plant.	Current:
		Pre-1990:

7.21	Fate of process wastes: liquids, solids, and sludges.	Current:
		Pre-1990:
Nonhazardous Waste		
7.22	Indicate sources, and volumes of non-hazardous wastes, including general trash (kitchen wastes, paper, wood, oil rags, plastic wraps, food left-overs, etc) and processing related wastes.	Current:
		Pre-1990:
7.23	Indicate storage procedures of non-hazardous wastes.	Current:
		Pre-1990:
7.24	Indicate disposal procedures of non-hazardous wastes including use of incinerators and procedures for disposal of resulting ash.	Current:
		Pre-1990:

8. MATERIAL HANDLING AND STORAGE

8.1	Are material inventory lists, including quantities and locations available? How often are these inventories updated?	Current:
		Pre-1990:
8.2	Has the plant produced a separate hazardous substance inventory? (Please attach.)	Current:
		Pre-1990:
8.3	Identify hazardous or toxic materials or wastes stored or used on site. Identify maximum quantities on site and used or stored on the site in the past.	Current:
		Pre-1990:
8.4	Have there ever been any incidents or accidents (spills, fires, injuries, etc.) involving any of these materials?	Current:
		Pre-1990:
8.5	How are materials received (barge, truck, etc.) and stored on site (drums, tanks, cylinders)?	Current:
		Pre-1990:
8.6	Does the company transport these materials directly or through contractors/suppliers?	Current:
		Pre-1990:

8.7	Have incompatible materials been segregated and labelled?	Current:
		Pre-1990:
8.8	Describe any hazardous material storage and handling management and training plans. Attach Table of Contents from spill contingency plans, if available.	Current:
		Pre-1990:
8.9	Describe the condition of drums and drum storage area: - condition of drums (corrosion, etc.)	Current:
		Pre-1990:
	- stacking height, storage racks	Current:
		Pre-1990:
	- presence of absorbents, spill kits, etc.	Current:
		Pre-1990:

9.	**STORAGE TANKS**	
9.1	Describe any National / Regional laws or regulations in effect governing the use/regulation of underground / above-ground storage tanks. Are these regulated under fire regulations ?	Current:
		Pre-1990:
9.2	Describe waste materials stored in tanks or cisterns; tank design and capacity, tank materials, tank age, leak detection systems or ground water monitoring systems employed.	Current:
		Pre-1990:
9.3	Do the tanks meet any design requirements? Describe.	Current:
		Pre-1990:
9.4	Any tank integrity or leak detection tests or inventory control records for these tanks?	Current:
		Pre-1990:
9.5	Obtain copies of any up-to-date tank layout plans, including:	
	- Existing Tanks	Current:
		Pre-1990:
	- Removed Tanks	Current:
		Pre-1990:

	- Abandoned Tanks (including tanks no longer in use and/or filled in place)	Current:
		Pre-1990:
	- Connecting Pipelines and Pipe Pits	Current:
		Pre-1990:
9.6	Obtain a tank inventory.	Current:
		Pre-1990:
9.7	Do the tank basins meet any design requirements? - size of tank basins - drain valves of tank basins - dam walls.	Current:
		Pre-1990:
9.8	Are tank structures designed in accordance with any applicable regulations?	Current:
		Pre-1990:

10.	**USE/DISPOSAL OF PRODUCED GAS**	
10.1	Describe the produced gas gathering system.	Current:
		Pre-1990:
10.2	Is gas flared at any wellsites?	Current:
		Pre-1990:
10.3	Is gas flared at any of the production stations?	Current:
		Pre-1990:
10.4	Are knockout tanks in place to collect condensate? How is the condensate handled?	Current:
		Pre-1990:
10.5	Is gas vented at any of the wellsites, or production stations?	Current:
		Pre-1990:
10.6	Are flare pits in use at wellsites or production stations?	Current:
		Pre-1990:

CA1069668

10.7	Is produced gas used in any way or is it always flared or vented?	Current:
		Pre-1990:
10.8	Is gas disposed of in accordance with any applicable regulations?	Current:
		Pre-1990:

10.9 List all regulatory agencies with whom the plant has dealt regarding produced gas.

Name of Agency	Address	Contact Person	Telephone

11. CONTAINMENT AND CONTROL OF CRUDE OIL SPILLS

11.1	Do on-site spill prevention and control methods and equipment provide: (1) Leak prevention in storage and transfer facilities?	Current:
		Pre-1990:
	(2) Primary containment (tanks, sumps, dykes, drainage)?	Current:
		Pre-1990:
	(3) Secondary containment (ditches, lagoon, pits)?	Current:
		Pre-1990:
	(4) Emergency containment (sandbags, pumps, absorbents)?	Current:
		Pre-1990:
	(5) Safety valve and rupture disk discharge systems?	Current:
		Pre-1990:
	(6) Emergency venting, purging and bypass systems?	Current:
		Pre-1990:

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11.2	Are frequent formal surveys made to identify the need for spill prevention control methods and equipment?	Current:
		Pre-1990:
11.3	Have any of the survey results been implemented?	Current:
		Pre-1990:
11.4	Have devices been installed to detect losses, leaks and/or spills from any above ground or underground installations?	Current:
		Pre-1990:
11.5	Is the level of emergency planning consistent with the degree of risk or possible environmental impairment?	Current:
		Pre-1990:
11.6	Is the response capability sufficient to handle anticipated spills, releases, or other incidents?	Current:
		Pre-1990:
11.7	Is there a spill response plan for this facility?	Current:
		Pre-1990:
11.8	Is a copy of the spill plan available on-site, and are personnel familiar with the plan and procedures?	Current:
		Pre-1990:

11.9	Does the spill response plan include specific responsibilities for response and control activities?	Current:
		Pre-1990:
12.0	Do company personnel and contractors participate in training or drills to improve the response efficiency of company and mutual aid organizations?	Current:
		Pre-1990:
12.1	If deficiencies were noted, or recommendations made arising out of an exercise, were they corrected or implemented?	Current:
		Pre-1990:
12.2	Is there a designated spokesperson, trained for emergency response situations, to respond to regulatory agencies, the media and the public?	Current:
		Pre-1990:
12.3	Are details of previous spills and other related data relative to product storage and transfer sites available for use in planning for future facility decommissioning?	Current:
		Pre-1990:
12.4	Have spill response plans been prepared for the route of products moved by road?	Current:
		Pre-1990:

12.	RADIOACTIVE MATERIALS	
12.1	Identify types, quantities, and use (e.g. tracer, laser, etc.) of ionizing and non-ionizing radiation sources on-site.	Current:
		Pre-1990:
12.2	Describe training programmes in effect for handling, storage and disposal of radioactive materials. Does this include employee exposure monitoring?	Current:
		Pre-1990:
12.3	Identify quantities and waste types generated on-site which contain radioactive materials.	Current:
		Pre-1990:
12.4	Are radioactive materials disposed of on-site? Detail disposal methods, containment etc.	Current:
		Pre-1990:
12.5	Are records kept on-site of radioactive materials in use, stored or disposed of on-site? For how-long?	Current:
		Pre-1990:
12.6	For off-site disposal of radioactive materials, identify transporter, disposal facility and final disposition of materials.	Current:
		Pre-1990:

12.7	Are records kept of off-site disposal and transport of facility radioactive materials? For how long?	Current:
		Pre-1990:
12.8	Are all radioactive materials and radiation-producing equipment licensed and/or registered with the appropriate regulatory agency?	Current:
		Pre-1990:
12.9	Have all radioactive materials been disposed of in accordance with any applicable regulations?	Current:
		Pre-1990:

12.10 List all regulatory agencies with whom the plant has dealt regarding radioactive materials.

Name of Agency	Address	Contact Person	Telephone

13.	NOISE	
13.1	What are the local noise levels that must be met? - During the day? - At night?	Current:
		Pre-1990:
13.2	Does the facility meet its noise level requirements?	Current:
		Pre-1990:
	- Describe any areas of non-compliance.	Current:
		Pre-1990:
	- What equipment is the cause ?	Current:
		Pre-1990:
	- What remedial actions have been or are planned to be undertaken ?	Current:
		Pre-1990:
13.3	Does the facility have an up-to-date noise contour map?	Current:
		Pre-1990:

	- How frequently are measurements taken?	Current:
		Pre-1990:
13.4	Are noise complaints received from the public?	Current:
		Pre-1990:
	- If so, how many per year?	Current:
		Pre-1990:
	- How are these handled ?	Current:
		Pre-1990:
13.5	Is the facility operating in compliance within accepted regulations regarding noise levels at the workplace ?	Current:
		Pre-1990:

13.6 List all regulatory agencies with whom the plant has dealt regarding noise.

Name of Agency	Address	Contact Person	Telephone

14. DISPOSAL OF PRODUCED WATER

14.1	Is produced water routinely analyzed prior to disposal?	Current:
		Pre-1990:
14.2	Produced water outfalls discharge to:	
	- stream, river, lake	Current:
		Pre-1990:
	- disposal well	Current:
		Pre-1990:
	- other (ie. lagoons)	Current:
		Pre-1990:
14.7	List all water discharge violation notices, such as warnings (verbal or written), citings, fines, or informal meetings, and/or enforcement action proceedings, taken against this facility, the reason(s) for each, and their current status.	Current:
		Pre-1990:
14.8	Is produced water disposed of in accordance with any applicable regulations?	Current:
		Pre-1990:

14.8 List all regulatory agencies with which the plant deals on produced water. Attach copies of permits.

Name of Agency	Address	Contact Person	Telephone

15. DISPOSAL OF TANK BOTTOMS AND RESIDUAL OIL

15.1	Are tank bottoms analysed prior to disposal?	Current:
		Pre-1990:
15.2	Are tank bottoms treated before disposal?	Current:
		Pre-1990:
15.3	Are records kept on the volume of tank bottoms?	Current:
		Pre-1990:
15.4	How are tank bottoms disposed?	Current:
		Pre-1990:
15.5	Have tank bottoms been disposed of in accordance with any applicable regulations?	Current:
		Pre-1990:

15.6 List all regulatory agencies with whom the plant has dealt regarding tank bottoms.

Name of Agency	Address	Contact Person	Telephone

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PART B WELL SITE MANAGEMENT

1.0	Describe any erosion control programs implemented.	Current:
		Pre-1990:
1.1	Describe any vegetation management/control program implemented.	Current:
		Pre-1990:
1.2	Are mechanical methods of weed control attempted before using chemical methods?	Current:
		Pre-1990:
1.3	What reclamation/revegetation programs have been implemented?	Current:
		Pre-1990:
1.4	Are there monitoring programs to detect spills or leaks?	Current:
		Pre-1990:
1.5	Are wellheads and exposed casing marked and protected against accidental impact?	Current:
		Pre-1990:

1.6	Have spill prevention measures been implemented?	Current:
		Pre-1990:
1.7	Are the cellars covered with grates to contain small spills from the wellhead?	Current:
		Pre-1990:
1.8	Have leases been cleared of debris, used buildings and equipment?	Current:
		Pre-1990:
1.9	Are suspended well sites monitored in the same fashion as operating wells.	Current:
		Pre-1990:
1.20	Are efforts made to minimize lease size while accommodating workover and maintenance requirements?	Current:
		Pre-1990:
1.21	How are flare pits maintained?	Current:
		Pre-1990:
1.22	Has odour been a problem at any wellheads, have remedial measures been taken?	Current:
		Pre-1990:

1.23	Workover and Completion Wastes (A) Were all workover and completion wastes stored in segregated tanks?	Current:
		Pre-1990:
	(B) Were salt solutions sent for disposal by: deep well disposal; approved road spraying; pumping off lease; burial or spread on lease?	Current:
		Pre-1990:
	(C) Were oil/oil water emulsions disposed by: salvaging oil; downhole disposal; oil reclaimers; pumping off lease; burial or spread on lease?	Current:
		Pre-1990:
	(D) Were frac sands and components buried or spread on the surface of the lease?	Current:
		Pre-1990:
	(E) Was acid water disposal by: neutralization/downhole disposal; neutralizing/ vaporation; pumping off-lease; burial on-lease; or, directing to sump?	Current:
		Pre-1990:
1.24	Were environmentally safe drilling products used in the program?	Current:
		Pre-1990:
1.25	Were efforts made to conserve or recycle water?	Current:
		Pre-1990:

1.26	Were waste streams segregated before going to the main sump?	Current:
		Pre-1990:
1.27	Were measures taken to protect surface waters, freshwater horizons and mineral resources from contamination?	Current:
		Pre-1990:

PART C PIPELINE MANAGEMENT

1.1	Describe any erosion control programs implemented,	Current:
		Pre-1990:
1.2	Describe any vegetation management/control programs implemented.	Current:
		Pre-1990:
1.3	Are mechanical methods of weed control attempted before using chemical methods?	Current:
		Pre-1990:
1.4	Is brush control practiced on all flow, injection and group lines?	Current:
		Pre-1990:
1.5	What reclamation/revegetation programs have been implemented?	Current:
		Pre-1990:
1.6	Is there a monitoring program at flowlines to detect spills or leaks?	Current:
		Pre-1990:

1.7	Are there remote detection systems in place to detect spills and leaks from flowlines?	Current:
		Pre-1990:
1.8	Are spill events assessed in an effort to design remedial measures?	Current:
		Pre-1990:
1.9	Are suspended flowlines monitored in the same fashion as the operating flowlines?	Current:
		Pre-1990:

APPENDIX C

SELECTION OF WELL SITES, FLOWLINES, PIPELINES AND PRODUCTION FACILITIES

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AGRA
Earth & Environmental Group

Table C – 1
Random Selection of Well Sites and Flowlines For Phase I Assessment

Field	Well Site Identification	Well Site Selection	Flowline Selection
	1	Indicates site selected	
Lago Agrio	1	1	1
	2	1	
	3		
	4		
	5	1	
	6	1	1
	7		
	8	1	1
	9	1	
	9B		
	10	1	
	11B	1	
	12	1	
	13		
	14		
	15		
	16		
	16B		
	17	1	1
	18		
	19	1	
	20	1	
	21	1	
	22		
	23		
	24		
	25		
	26	1	
	27		
	28		
	29	1	1
	30		
	31		
	32	1	
	33	1	1
	34	1	1
	35	1	
Total	37	19	7
Percent	100	51	19
Parahuacu	1		
	2	1	
	3		
	4		
	5	1	1
Total	5	2	1
Percent	100	40	20

Table C – 1
Random Selection of Well Sites and Flowlines For Phase I Assessment

Field	Well Site Identification	Well Site Selection	Flowline Selection
	1	Indicates site selected	
Atacapi	1	1	1
	2	1	
	3	1	
	4		
	5		
	6		
Total	6	3	1
Percent	100	50	17
Guanta	1	1	
	2		
	3	1	1
	4		
	5	1	1
	6		
	7		
	8	1	
	9		
Total	9	4	2
Percent	100	44	22
Aguarico	AG1		
	AG2		
	AG3	1	
	AG4		
	AG5		
	AG6	1	
	AG7		
	AG8	1	1
	AG9	1	
	AG10	1	1
Total	10	5	2
Percent	100	50	20
Shushufindi	B56		
	B57	1	1
	B59	1	
	61	1	1
	B62		
	B63	1	
	B64	1	1
	A65	1	1
	B66	1	
	A67	1	
	68	1	
	69		
	70		

Table C – 1
Random Selection of Well Sites and Flowlines For Phase I Assessment

Field	Well Site Identification	Well Site Selection	Flowline Selection
	1	Indicates site selected	
Shushufindi continued	71	1	
	WIW1		
	WIW2	1	
	WIW3		
	WIW4	1	1
	WIW5		
	WIW6		
	WIW7	1	
	WIW8		
	A1	1	
	A2		
	A3		
	A4		
	A5		
	A6		
	A7	1	1
	A8		
	A9	1	
	A10	1	
	A11		
	A12		
	A13	1	1
	B14		
	B15	1	1
	B15B		
	B16	1	
	A17		
	A18		
	A19		
	A20	1	
	A21		
	A22		
	A22B	1	
	A23		
	A24	1	1
	A25		
	A26	1	
	A27		
	A28		
	A29		
	A30	1	1
	B31	1	
	B32		
	A33	1	
	A34	1	1
	A35		
	B36	1	
	A38	1	1

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Table C – 1
Random Selection of Well Sites and Flowlines For Phase I Assessment

Field	Well Site Identification	Well Site Selection	Flowline Selection
	1	Indicates site selected	
Shushufindi continued	A39		
	A41		
	A42		
	A42B		
	A43	1	
	A44		
	6B	1	
	A45	1	
	A45B	1	
	46	1	1
	A48		
	B49	1	
	A50	1	1
	B51	1	1
	B52	1	
	B53		
	B54		
	B55	1	
Total	79	40	15
Percent	100	51	19
Sacha	WIW1	1	
	WIW2	1	
	WIW3		
	WIW4	1	
	WIW5	1	1
	WIW6	1	
	1	1	
	2	1	
	3		
	4	1	
	6		
	7		
	8	1	
	9	1	
	10		
	11	1	1
	12	1	
	13		
	14		
	15		
	16	1	
	17		
	18	1	
	19	1	
	20	1	1
	21	1	
	22		

Table C – 1
Random Selection of Well Sites and Flowlines
For Phase I Assessment

Field	Well Site Identification	Well Site Selection	Flowline Selection
	1	Indicates site selected	
Sacha continued	23		
	24		
	25	1	1
	26		
	27	1	
	28	1	
	29		
	30		
	31		
	32	1	
	33	1	1
	34		
	35	1	1
	36	1	
	37		
	38		
	39		
	40	1	
	41		
	42	0	
	43	1	
	44	1	
	45		
	46	1	1
	47		
	48	1	1
	49		
	50		
	51		
	52		
	53		
	54	1	
	55	1	
	56	1	1
	57		
	58	1	1
	59	1	1
	60	1	
	61		
	62		
	63		
	64		
	65		
	66		
	67		
	68		
	69		
	70		

Table C – 1
Random Selection of Well Sites and Flowlines
For Phase I Assessment

Field	Well Site Identification	Well Site Selection	Flowline Selection
	1	Indicates site selected	
Sacha continued	71		
	72	1	
	73	1	1
	74	1	1
	75	1	
	76	1	
	77	1	
	78	1	
	79		
	80		
	81	1	1
	82		
	83		
	84	1	1
	85	1	
	86	1	
	87		
	88		
	89		
	90	1	1
	91	1	1
	92		
	93	1	
	94	1	
	95	1	1
	96		
	97	1	
	98		
	99		
	100	1	1
	101		
	102		
	103	1	
	104	1	
	106		
	107	1	1
	108		
	109	1	
	110	1	1
	111	1	
	112		
	113	1	1
	114		
	115		
	116		
Total	120	60	22
Percent	100	50	18

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Table C – 1
Random Selection of Well Sites and Flowlines For Phase I Assessment

Field	Well Site Identification	Well Site Selection	Flowline Selection
	1	Indicates site selected	
Culebra	1		
	2	1	1
Total	2	1	1
Percent	100	50	50
Yulebra	1		
	2	1	1
	3		
	3	1	1
		33	33
Yuca	1		
	2B		
	3		
	4	1	1
	5		
	6	1	
	9	1	
	10		
	12	1	1
Total	9	4	2
Percent	100	44	22
Yuca Sur	1	1	1
Total	1	1	1
Percent	100	100	100
Auca	1	1	
	2		
	3		
	4	1	1
	5		
	6	1	1
	7	1	
	8		
	9	1	
	10		
	11	1	
	12	1	1
	13		
	14		
	15	1	
	16	1	1
	17	1	
	18	1	1
	19		
	19B	1	

Table C – 1
Random Selection of Well Sites and Flowlines For Phase I Assessment

Field	Well Site Identification	Well Site Selection	Flowline Selection
	1	Indicates site selected	
Auca continued	20		
	21	1	
	22		
	23		
	24	1	
	25		
	26		
Total	27	14	5
Percent	100	52	19
Auca Sur	1	1	1
	2		
Total	2	1	1
Percent	100	50	50
Rumiyacu	1	1	1
Total	1	1	1
Percent	100	100	100
Cononaco	1	1	
	2	1	
	3	1	1
	4		
	6		
	7		
	8	1	1
	9		
	10		
	11	1	
	12	1	1
	13		
	14		
Total	13	6	3
Percent	100	46	23
Dureno	1	1	1
Total	1	1	1
Percent	100	100	100
Project Totals			
Total	325	163	66
Percent	100	50	20

Table C – 2
Random Selection of Secondary Pipeline Segments For Phase I Assessment

Pipeline Corridor		Total Length (Km)	Assessed Length (20%) (Km)	Number of Assessed Segments	Length of Assessed Segment (Km)	Location of Randomly Selected Segments							
Beginning	End					Segment 1		Segment 2		Segment 3		Segment 4	
						Begin	End	Begin	End	Begin	End	Begin	End
Atacapi Station	Guanta Juntion	13	2.5	1	2.5	4.9	7.4						
Guanta Juntion	Lago Agrio Station	12	2.5	1	2.5	5.7	8.2						
Lago Agrio Station	Shushufindi Juntion	29	6.0	2	3.0	17.4	20.4	11.0	14.0				
Shushufindi Juntion	Shushufindi Station	20	4.0	2	2.0	5.9	7.9	3.0	5.0				
Shushufindi Station	Aguarico Station	13	3.0	1	3.0	11.3	14.3						
Shushufindi Juntion	Yulebra Juntion	35	7.0	3	2.3	28.7	31.0	8.7	11.0	32.1	34.4		
Yulebra Juntion	Yuca Station	16	3.0	1	3.0	15.8	18.8						
Yulebra Juntion	Cononaco Station	50	10.0	4	2.5	45.8	48.3	48.9	51.4	5.1	7.6	13.7	16.2

Start at beginning of corridor. All distances are in kilometres.

Totals	188	38	15

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Table C – 3

Production Stations Requiring Phase I Assessment

Field	Station
Lago Agrio	Central Production Station North Production Station
Parahuacu	Production Station
Atacapi	Production Station
Guanta	Production Station
Aguarico	Production Station
Shushufindi	Central Production Station North Production Station South Production Station Southwest Production Station Water Injection Station
Sacha	Central Production Station North # 1 Production Station North # 2 Production Station South Production Station
Culebra	Production Station
Yulebra	Production Station
Yuca	Production Station
Yuca Sur	
Auca	Central Production Station South Production Station
Auca Sur	Production Station
Rumiyacu	
Cononaco	Production Station
Dureno	Production Station
Project Total	23

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Table C – 4
Development History, Workover Record and Spill Record For Well Sites and Flowlines Subject to Phase I Assessment

Assessed Well Site		Assessed Flowline	Well Site – Milestone Dates Spud/Completion/Production						Wellsite Workovers	Spill Record 1973–1990	
			MM	YY	MM	YY	MM	YY	Post 1990 (Number)	Number of Spills	Volume (Barrels)
LA	1	1	2	67	4	67	5	72		1	50
LA	2		5	67	6	67	5	72	1	1	30
LA	5		2	70	3	70	9	72			
LA	6	1	3	70	5	70	5	72			
LA	8	1	3	70	5	70	5	72		2	103
LA	9		3	70	6	70	5	72			
LA	10		6	70	7	70	5	72	1		
LA	11B		4	76	5	76	6	76	1	1	25
LA	12		7	70	8	70	5	72	2		
LA	17	1	9	70	10	70	5	72		1	15
LA	18		11	70	12	70					
LA	20		12	70	2	71	6	72		1	50
LA	21		10	70	11	70	5	72	1	2	45
LA	26		6	73	7	73	7	73	1	2	40
LA	29	1	9	81	10	81	1	83			
LA	32		1	83	2	83	3	83	1		
LA	33	1	2	82	8	82	8	82			
LA	34	1	8	80	9	80	12	86			
LA	35		12	87	12	87	2	92			
PH	2		4	78	5	78	12	80	2		
PH	5	1	7	79	10	79	7	80	1	1	16
AT	1	1	2	68	9	68	12	78			
AT	2		5	78	6	78	1	79	1	1	40
AT	3		9	78	10	78	12	78			

▨ Indicates well sites and flowlines selected for assessment.

Table C – 4
Development History, Workover Record and Spill Record For Well Sites and Flowlines Subject to Phase I Assessment

▨ Indicates well sites and flowlines selected for assessment.

Assessed Well Site		Assessed Flowline	Well Site – Milestone Dates Spud/Completion/Production						Wellsite Workovers	Spill Record 1973–1990	
			MM	YY	MM	YY	MM	YY	Post 1990 (Number)	Number of Spills	Volume (Barrels)
GU	[illegible]		12	85	2	86	3	86	1	1	450
GU	3	1	9	86	10	86	11	86	1		
GU	5	1	1	87	2	87	8	87	1		
GU	8		4	87	5	87	9	87	1		
AG	AG3		7	73	8	73	12	75			
AG	AG6		3	74	3	74	4	74			
AG	AG1		8	73	9	73	1	74		1	3
AG	AG9		2	74	3	74	4	74	1	1	5
AG	AG10	1	1	80	2	80	8	80			
SSF	B57	1	8	75	9	75	11	75	1		
SSF	B59		11	75	11	75	2	76	2		
SSF	[illegible]	1	10	77	11	77	11	77	1		
SSF	B63		6	85	7	85	8	85	1		
SSF	B64	1	11	85	12	85	1	86		1	60
SSF	A65	1	7	85	8	85	9	85	2		
SSF	B66		12	85	2	86	3	86			
SSF	AB7		6	86	7	86	8	86			
SSF	68		5	88	6	88	7	88	1		
SSF	69		6	88	7	88	8	88	1		
SSF	71		11	90	12	90	1	91	2		
SSF	WIW2		6	83	6	83					
SSF	WIW4	1	7	83	8	83					
SSF	WIW7					84					
SSF	A1		4	68	1	69	9	72	1		

Table C – 4
Development History, Workover Record and Spill Record For Well Sites and Flowlines Subject to Phase I Assessment

▨ Indicates well sites and flowlines selected for assessment.

Assessed Well Site		Assessed Flowline	Well Site – Milestone Dates Spud/Completion/Production						Wellsite Workovers	Spill Record 1973–1990	
			MM	YY	MM	YY	MM	YY	Post 1990 (Number)	Number of Spills	Volume (Barrels)
SSF	A7	1	8	72	8	72	9	72			
SSF	A9		6	72	6	72	7	72			
SSF	A10		4	72	5	72	7	72			
SSF	A13	1	5	72	5	72	8	72			
SSF	B15	1	7	72	8	72	6	74			
SSF	B16		1	73	1	73	2	73			
SSF	A20		1	73	1	73	2	73	1	1	1
SSF	A22B		5	77	5	77	6	77	3		
SSF	A24	1	9	72	10	72	10	72	2		
SSF	A26		9	72	9	72	10	72	1	1	10
SSF	A30	1	12	72	12	72	1	73			
SSF	B31		4	73	4	73	8	84	4		
SSF	A33		7	73	7	73	8	73			
SSF	A34	1	5	73	6	73	6	73			
SSF	B36		11	73	12	73	11	73	2		
SSF	A38	1	12	73	1	74	1	76			
SSF	A43		12	73	1	74	1	74			
SSF	6B		1	81	2	81	3	81			
SSF	A45		11	73	12	73	1	74			
SSF	A45B		9	86	9	86	9	86			
SSF	46	1				74	3	74	1		
SSF	B49		3	74	4	74	4	74			
SSF	A50	1	8	77	9	77	11	75			
SSF	B51	1	8	74	9	74	9	74		1	6

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Table C – 4
Development History, Workover Record and Spill Record For Well Sites and Flowlines Subject to Phase I Assessment

▨ Indicates well sites and flowlines selected for assessment.

Assessed Well Site		Assessed Flowline	Well Site – Milestone Dates Spud/Completion/Production						Wellsite Workovers	Spill Record 1973–1990	
			MM	YY	MM	YY	MM	YY	Post 1990 (Number)	Number of Spills	Volume (Barrels)
SSF	B62		4	75	4	75	5	75			
SSF	B65		7	75	8	75	9	82			
SA	WIW1					84					
SA	WIW2					84					
SA	WIW3		1	77	2	77					
SA	WIW4					84					
SA	WIW5	[illegible]				84					
SA	WIW6					84					
SA	[illegible]		1	69	2	69	7	72		1	60
SA	2		7	69	8	69	8	73		5	101
SA	8		3	71	4	71	7	72		1	5
SA	9		3	71	4	71	6	72		2	180
SA	11	[illegible]	5	71	6	71	6	72			
SA	12		4	71	5	71	6	72			
SA	13	[illegible]	3	31	71	4	19	71		9	517
SA	16		6	71	7	71	6	72		3	18
SA	18		7	71	8	71	6	72			
SA	19		7	71	8	71	6	72		5	263
SA	20	[illegible]	7	71	7	71	6	72		6	78
SA	21		9	71	10	71	6	72		2	40
SA	25	[illegible]	8	71	9	71	6	72		2	8
SA	27		9	71	8	71	6	72			
SA	28		12	71	12	71	6	72	2	1	30
SA	32		12	72	1	72	10	72		1	228

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Table C – 4
Development History, Workover Record and Spill Record For Well Sites and Flowlines Subject to Phase I Assessment

▨ Indicates well sites and flowlines selected for assessment.

Assessed Well Site		Assessed Flowline	Well Site – Milestone Dates Spud/Completion/Production						Wellsite Workovers	Spill Record 1973–1990	
			MM	YY	MM	YY	MM	YY	Post 1990 (Number)	Number of Spills	Volume (Barrels)
SA	33	1	11	71	12	71	6	72	1		
SA	34	1	12	71	12	71	6	72		2	43
SA	35	1	10	71	11	71	4	73		2	33
SA	36		12	71	1	72	7	72		1	10
SA	40		2	72	2	72	6	72		1	30
SA	43		4	72	4	72	8	72	1		
SA	44		5	72	6	72	9	72			
SA	46	1	6	72	7	72	2	75		1	50
SA	54		5	73	5	73	12	76		1	40
SA	55		4	73	5	73	5	73		2	70
SA	56	1	5	73	6	73	12	76	1	1	50
SA	58	1	5	73	6	73	10	73		4	50
SA	59	1	8	73	8	73	11	74			
SA	60		7	73	7	73	9	73		5	142
SA	72		3	74	4	74	4	74			
SA	73	1	2	74	4	74	4	74			
SA	74	1	5	74	5	74	6	74	1	1	50
SA	75		5	74	5	74	6	74		1	50
SA	77		6	76	6	76	7	76		1	10
SA	78		7	76	7	76	8	76			
SA	81	1	9	76	9	76	9	76		1	200
SA	84	1	12	76	12	76	1	77			
SA	85		11	76	12	76	12	76			
SA	86		10	79	12	79	8	80			

Table C – 4
Development History, Workover Record and Spill Record For Well Sites and Flowlines Subject to Phase I Assessment

▩ Indicates well sites and flowlines selected for assessment.

Assessed Well Site		Assessed Flowline	Well Site – Milestone Dates Spud/Completion/Production						Wellsite Workovers	Spill Record 1973–1990	
			MM	YY	MM	YY	MM	YY	Post 1990 (Number)	Number of Spills	Volume (Barrels)
SA	91	[illegible]	7	80	8	80	8	80			
SA	93		8	80	9	80	9	80			
SA	94		4	81	5	81	9	83			
SA	95	[illegible]	5	81	6	81	9	81			
SA	97		10	81	10	81	11	81	1		
SA	100	[illegible]	3	83	3	83	7	83			
SA	103		10	85	11	85	12	85			
SA	104		2	86	4	86	4	86	1		
SA	107	[illegible]	10	86	12	86	1	87			
SA	109		7	87	8	87	9	87			
SA	110	[illegible]	10	87	11	87	11	87	1		
SA	111		2	88	3	88	3	88			
SA	113	[illegible]	4	88	5	88	6	88			
CU	2	[illegible]	8	77	8	77	10	87	1		
YB	2	[illegible]	5	85	5	85	6	85	1		
YU	4	[illegible]	9	79	11	79	12	80			
YU	6		12	79	2	80					
YU	5		10	79	11	80	1	81			
YU	12	[illegible]	3	80	4	80	12	80			
YUS	1	[illegible]	11	79	12	79	1	86			
AU	1		2	70	3	70	4	75		2	1005
AU	4	[illegible]	12	73	1	74	5	86	1		
AU	6	[illegible]	2	74	3	74	4	75		1	15
AU	7		10	74	11	74	4	76			

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APPENDIX D

FIELD DATA RECORDING SHEETS FOR PRODUCTION FACILITIES, WELL SITES AND PIPELINES

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AGRA
Earth & Environmental Group

HBT AGRA Limited
Engineering & Environmental Services

PHASE I SITE RECONNAISSANCE FACILITY AND WELLSITE DATA SHEET

ASSESSMENT DATE: ____________________ ASSESSMENT PERSONNEL: ____________________

____

____

LOCATION

FIELD: ____________________

SITE NUMBER: ____________________
(Use field abbreviation and wellsite number)

SITE NAME: ____________________

AGE AND STATUS

SPUD DATE: ______________ COMPLETION DATE: ______________ PRODUCTION DATE: ______________

JUNE 1990 STATUS: PRODUCING ☐ ABANDONED ☐

CURRENT STATUS: PRODUCING ☐ ABANDONED ☐

PRODUCTION STATION CONSTRUCTION DATE: ____________________

AVAILABLE ENVIRONMENTAL DOCUMENTATION

PRE-AUDIT QUESTIONNAIRE: ☐ YES ☐ NO

IS SITE SPECIFIC DETAIL AVAILABLE? ☐ YES ☐ NO
If YES provide a brief summary below and address environmental issues on data sheets

____

____

____

SPILL RECORDS ☐ YES ☐ NO
If YES refer to spill record and record current evidence of spill on data sheets

PAST REMEDIAL ACTION: ☐ YES ☐ NO
If YES provide details

____

____

____

HAVE HISTORIC AIR PHOTOS BEEN ACQUIRED FOR THIS SITE? ☐ YES ☐ NO

HAS A SITE PLAN BEEN ACQUIRED? ☐ YES ☐ NO

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Engineering & Environmental Services

SITE NUMBER ________

SITE INFRASTRUCTURE

INCLUDE PAST AND PRESENT INSTALLATIONS AND INDICATE THEIR STATUS BY:

A - Active; B - In place but out of use C - Removed Leave blank if not present
U - Underground

	NUMBER /STATUS	EVIDENCE OF ENVIRONMENTAL DAMAGE			
		ON-SITE		OFF-SITE	
		Yes	No	Yes	No
FLARE PIT	______/______	☐	☐	☐	☐
DRILL SUMP WORKOVER PIT	______/______	☐	☐	☐	☐
WASTE PIT	______/______	☐	☐	☐	☐
STORAGE TANK	______/______	☐	☐	☐	☐
KNOCKOUT TANK	______/______	☐	☐	☐	☐
FUEL TANK	______/______	☐	☐	☐	☐
POPTANK	______/______	☐	☐	☐	☐
WELL HEAD	______/______	☐	☐	☐	☐
FLARE STACK	______/______	☐	☐	☐	☐
SEPARATOR	______/______	☐	☐	☐	☐
TREATOR	______/______	☐	☐	☐	☐
PUMP	______/______	☐	☐	☐	☐
HEATER	______/______	☐	☐	☐	☐
PRODUCT LOADOUT	______/______	☐	☐	☐	☐
CHEMICALS	______/______	☐	☐	☐	☐
CHEMICAL LOADOUT	______/______	☐	☐	☐	☐
TRANSFORMER	______/______	☐	☐	☐	☐
PIPELINE	______/______	☐	☐	☐	☐
OTHER ____________	______/______	☐	☐	☐	☐

If YES for any of the above provide detail on attached data sheets

WASTE MATERIALS PRESENT ON SITE

	PRESENT		DISPOSED OF ON SITE	
	Yes	No	Yes	No
DRILL MUD	☐	☐	☐	☐
WASTE OIL	☐	☐	☐	☐
TANK BOTTOMS	☐	☐	☐	☐
PRODUCED WATER	☐	☐	☐	☐
PRODUCED FLUIDS	☐	☐	☐	☐
FILTERS	☐	☐	☐	☐
SEWAGE	☐	☐	☐	☐
DOMESTIC GARBAGE	☐	☐	☐	☐
CONTAMINATED SOIL____________	☐	☐	☐	☐
SCRAP METAL	☐	☐	☐	☐
OTHER ________________	☐	☐	☐	☐

If YES for any of the above provide detail on attached data sheets

HBT AGRA Limited
Engineering & Environmental Services

SITE NUMBER ________

GENERAL SITE DESCRIPTION

ELEV. PAD: ________ metres

PAD MATERIAL: ________

BERMED: ☐ YES ☐ NO

BERM MATERIAL: ________

DRAINAGE: ________

IS A DRAINAGE DITCH PRESENT? ☐ YES ☐ NO

AREA DRAINED ________

EROSION: ________

EROSION CONTROL: ________

ESTIMATED CURRENT DISTURBED AREA ________ hectares

VEGETATION ON WELLSITE PAD: ________

VEGETATION CONTROL METHOD: ☐ MANUALLY CUT OTHER: ________

ESTIMATED DEPTH TO GROUNDWATER ________ m

TOPOGRAPHY:

☐ LEVEL to GENTLY SLOPING (0-5°)
☐ MODERATE to STRONGLY SLOPING (6 - 17°)
☐ VERY STRONGLY TO STEEPLY SLOPI (17 TO >45°)

WELLSITE POSITION ON SLOPE: ☐ CREST ☐ UPPER ☐ MIDDLE ☐ LOWER ☐ TOE ☐ DEPRESSIC

ADJACENT LANDUSE

DISTANCES ARE MEASURED FROM THE NEAREST SITE BOUNDARY. DISTANCES ARE ESTIMATED.

DISTANCE TO NEAREST WATER WELL ________ m ☐ > 200m ☐ UNKNOWN

DISTANCE TO NEAREST RESIDENCE ________ m ☐ > 200m ☐ UNKNOWN

DISTANCE TO NEAREST SURFACE WATER ________ m ☐ > 200m ☐ UNKNOWN

DISTANCE TO NEAREST WETLAND ________ m ☐ > 200m ☐ UNKNOWN

IS THE LAND ADJACENT THE SITE USED FOR AGRICULTURAL PURPOSES? ☐ YES ☐ NO

AGRICULTURAL LAND USE: CULTIVATED ☐ GRAZING ☐
PLANTATION ☐ OTHER ☐ ________

HAS ADJACENT LAND BEEN IMPACTED BY OILFIELD ACTIVITIES? ☐ YES ☐ NO

(if YES provide detail on attached data sheets.)

NATIVE VEGETATION: ☐ YOUNG SECONDARY FOREST ☐ SECONDARY FOREST ☐ MATURE RAIN FOREST

____

SIZE OF CLEARING (surrounding well site or production facilities as a result of oil field development) ________ ha

☐ DEFORESTATION BY COLONIZERS

____

EXTENT OF FOREST REGENERATION WITHIN ORIGINAL CLEARED AREA ________ %

____

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Engineering & Environmental Services

HYDROCARBON ODOUR KEY
None = N
Faint = F
Distinct = D
Strong = S

SITE NUMBER ____________

SAMPLE SUMMARY

SAMPLE IDENTIFICATION

LOCATION	SAMPLE NUMBER	INTERVAL (cm)		DESCRIPTION	
		FROM	TO	TEXTURE	HYDROCARBON ODOUR
SOIL					
WATER					

PHOTOGRAPHIC RECORD

PHOTO NUMBER		DESCRIPTION	DIRECTION Looking N, S, E, W			
ROLL	PHOTO		N	S	E	W
			☐	☐	☐	☐
			☐	☐	☐	☐
			☐	☐	☐	☐
			☐	☐	☐	☐
			☐	☐	☐	☐
			☐	☐	☐	☐

APPENDIX E

PHYSICAL IMPACTS RECORDED FOR ASSESSED WELL SITES AND PRODUCTION STATIONS

AGRA
Earth & Environmental Group

Table E – 1
Physical Impacts, Topography and Adjacent Land Use Recorded For Assessed Well Sites

Assessed Well Site		Currently Disturbed Area	Topography (Slope)			Proximity to :		Adjacent Land Use	Erosion Present
			Gentle 0 – 5	Mod. 6 – 17	Strong 17 – 45	Res.	Creek/ River		
		(m2)	Position on Slope			Estimated (m)		(Type)	Yes or No
LA	1	7,150	Mid	–	–	>200	180	Mixed	No
LA	2	7,200	Mid	–	–	350	300	Grazing	No
LA	5	3,420	Mid	–	–	40	NA	Mixed	No
LA	6	4,950	–	Mid	–	100	100	Grazing	No
LA	8	3,400	Mid	–	–	>200	NA	None	No
LA	9	9,350	Mid	–	–	150	NA	Grazing	No
LA	10	4,500	Mid	–	–	50	15	Mixed	No
LA	11B	12,852	Mid	–	–	20	5	Mixed	No
LA	12	6,900	Mid	–	–	375	NA	Mixed	No
LA	17	7,150	Mid	–	–	500	NA	Mixed	No
LA	19	1,250	Mid	–	–	15	NA	Mixed	No
LA	20	2,730	Mid	–	–	70	NA	Grazing	No
LA	21	4,845	Mid	–	–	70	25	Mixed	No
LA	26	4,700	–	Crest	–	5	25	Mixed	Yes
LA	29	7,875	Mid	–	–	20	100	Mixed	No
LA	32	6,300	Mid	–	–	300	10	Grazing	No
LA	33	7,700	Mid	–	–	50	50	Mixed	No
LA	34	8,190	Mid	–	–	150	NA	Mixed	No
LA	35	7,920	Mid	–	–	NA	70	Grazing	No
PH	2	2,400	Lower	–	–	100	25	None	No
PH	5	4,000	–	–	Crest	>200	20	None	Yes
AT	1	12,600	–	–	Crest	NA	NA	None	Yes
AT	2	4,500	–	–	Mid	200	100	None	No
AT	3	5,200	–	–	Crest	NA	100	None	Yes
GU	1	11,500	Mid	–	–	20	1	Mixed	No
GU	3	8,100	–	Mid	–	100	10	Grazing	No
GU	5	19,500	–	–	Crest	100	1	Grazing	Yes
GU	8	5,000	Mid	–	–	20	1	Mixed	No
AG	AG3	6,780	Mid	–	–	20	NA	Mixed	No
AG	AG6	11,400	–	–	Crest	200	200	Mixed	No
AG	AG8	9,025	Mid	–	–	200	NA	Grazing	No
AG	AG9	7,000	Mid	–	–	150	100	Plantation	No
AG	AG10	11,625	Mid	–	–	20	30	Grazing	No
SSF	B57	7,900	Mid	–	–	>200	>200	Mixed	No
SSF	B59	4,800	Mid	–	–	150	NA	Grazing	No
SSF	61	14,275	Mid	–	–	>200	NA	Plantation	No
SSF	B63	10,750	–	Crest	–	100	10	Plantation	No
SSF	B64	12,000	–	–	Crest	20	1	Mixed	Yes
SSF	A65	NA	Mid	–	–	100	NA	None	No
SSF	B66	12,600	–	Toe	–	50	15	Mixed	No
SSF	A67	5,200	Mid	–	–	>200	>200	Mixed	No

Table E – 1
Physical Impacts, Topography and Adjacent Land Use Recorded For Assessed Well Sites

Assessed Well Site		Currently Disturbed Area	Topography (Slope)			Proximity to :		Adjacent Land Use	Erosion Present
			Gentle 0 – 5	Mod. 6 – 17	Strong 17 – 45	Res.	Creek/ River		
		(m2)	Position on Slope			Estimated (m)		(Type)	Yes or No
SSF	68	10,200	Mid	–	–	>200	40	Grazing	Yes
SSF	69	7,496	Mid	–	–	>200	20	Grazing	No
SSF	71	19,425	Mid	–	–	>200	20	Mixed	No
SSF	WIW2	6,900	Mid	–	–	NA	NA	Mixed	No
SSF	WIW4	9,000	Mid	–	–	50	NA	Mixed	No
SSF	WIW7	5,200	–	Mid	–	100	200	Mixed	No
SSF	A1	4,750	–	–	Crest	30	70	Mixed	No
SSF	A7	5,160	Mid	–	–	>200	>200	Grazing	No
SSF	A9	1,950	Mid	–	–	20	NA	None	No
SSF	A10	7,800	Mid	–	–	50	20	Grazing	No
SSF	A13	6,500	Mid	–	–	40	50	Mixed	No
SSF	B15	4,200	–	Lower	–	NA	1	None	No
SSF	B16	NA	–	–	Crest	>200	NA	None	No
SSF	A20	5,750	Mid	–	–	150	NA	None	No
SSF	A22B	7,200	Mid	–	–	NA	200	None	No
SSF	A24	3,600	Mid	–	–	10	20	Mixed	No
SSF	A26	3,600	Mid	–	–	50	25	Mixed	No
SSF	A30	3,800	Crest	–	–	20	50	Mixed	No
SSF	B31	5,500	–	Mid	–	200	1	None	No
SSF	A33	6,500	Mid	–	–	5	70	Mixed	No
SSF	A34	NA	Mid	–	–	>200	>200	None	No
SSF	B36	4,900	–	Mid	–	>200	10	Mixed	No
SSF	A38	4,400	Mid	–	–	20	40	Mixed	No
SSF	A43	6,500	Mid	–	–	1	NA	Mixed	No
SSF	6B	8,000	Mid	–	–	75	>200	Plantation	No
SSF	A45	4,675	Mid	–	–	150	NA	Grazing	No
SSF	A45B	9,300	Mid	–	–	200	NA	NA	No
SSF	46	5,500	Mid	–	–	>200	200	Mixed	No
SSF	B49	8,025	Mid	–	–	150	NA	Grazing	No
SSF	A50	2,160	Mid	–	–	30	50	Grazing	No
SSF	B51	3,600	Mid	–	–	20	50	Mixed	No
SSF	B52	6,900	Mid	–	–	>200	150	Mixed	No
SSF	B55	23,000	Mid	–	–	70	>200	Mixed	No
SA	WIW1	1,000	Mid	–	–	25	NA	Plantation	No
SA	WIW2	3,300	–	Mid	–	50	100	Mixed	No
SA	WIW3	NA	Mid	–	–	50	NA	Plantation	No
SA	WIW4	3,600	Mid	–	–	300	NA	None	No
SA	WIW5	3,200	Mid	–	–	50	NA	Mixed	No
SA	WIW6	7,400	Mid	–	–	NA	NA	None	No
SA	1	3,025	Mid	–	–	25	50	None	No
SA	2	2,745	Mid	–	–	50	NA	Mixed	No

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Table E – 1
Physical Impacts, Topography and Adjacent Land Use Recorded For Assessed Well Sites

Assessed Well Site		Currently Disturbed Area	Topography (Slope)			Proximity to :		Adjacent Land Use	Erosion Present
			Gentle 0 – 5	Mod. 6 – 17	Strong 17 – 45	Res.	Creek/ River		
		(m2)	Position on Slope			Estimated (m)		(Type)	Yes or No
SA	8	3,300	Upper	–	–	15	NA	Plantation	No
SA	9	2,000	Mid	–	–	100	50	Mixed	Yes
SA	11	4,000	Mid	–	–	20	NA	Plantation	No
SA	12	7,200	Mid	–	–	10	20	Mixed	No
SA	13	3,200	Mid	–	–	NA	>200	Grazing	No
SA	16	4,500	Upper	–	–	5	40	Plantation	No
SA	18	2,500	Mid	–	–	50	NA	Plantation	No
SA	19	1,000	Mid	–	–	100	100	Plantation	No
SA	20	1,500	–	Mid	–	30	50	Mixed	No
SA	21	5,750	Upper	–	–	NA	NA	Plantation	No
SA	25	5,000	Mid	–	–	25	100	Mixed	No
SA	27	5,500	Mid	–	–	20	NA	Mixed	No
SA	28	4,500	Mid	–	–	>200	100	Grazing	No
SA	32	4,100	–	Mid	–	NA	NA	None	No
SA	33	3,200	Mid	–	–	NA	NA	Mixed	No
SA	34	4,500	Mid	–	–	5	NA	Mixed	No
SA	35	1,000	Mid	–	–	5	NA	None	No
SA	36	12,750	Mid	–	–	NA	NA	None	No
SA	40	1,000	Mid	–	–	NA	NA	None	No
SA	43	700	Mid	–	–	NA	>200	Plantation	No
SA	44	2,625	Mid	–	–	NA	NA	None	No
SA	46	6,600	Mid	–	–	60	20	Mixed	No
SA	54	1,150	Mid	–	–	NA	200	None	No
SA	55	1,225	Mid	–	–	100	300	Plantation	No
SA	56	1,200	Mid	–	–	>200	NA	Plantation	No
SA	58	5,400	Mid	–	–	50	NA	Plantation	No
SA	59	NA	Mid	–	–	100	NA	NA	No
SA	60	4,500	Mid	–	–	200	200	Mixed	No
SA	72	6,600	Mid	–	–	>200	>200	Mixed	No
SA	73	NA	Mid	–	–	200	NA	None	No
SA	74	5,625	Mid	–	–	>200	NA	Mixed	No
SA	75	3,825	Mid	–	–	NA	NA	Plantation	No
SA	77	7,700	Upper	–	–	>200	40	Mixed	No
SA	78	4,240	Mid	–	–	20	1	Grazing	No
SA	81	11,400	Mid	–	–	200	NA	None	No
SA	84	8,380	Mid	–	–	>200	150	Plantation	No
SA	85	6,000	Upper	–	–	20	10	Mixed	No
SA	86	2,650	–	Mid	–	NA	100	None	No
SA	91	8,700	Mid	–	–	NA	NA	None	No
SA	93	6,850	–	–	Crest	1	100	Mixed	No
SA	94	8,234	Upper	–	–	NA	10	Grazing	No

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Table E – 1
Physical Impacts, Topography and Adjacent Land Use Recorded For Assessed Well Sites

Assessed Well Site		Currently Disturbed Area	Topography (Slope)			Proximity to :		Adjacent Land Use	Erosion Present
			Gentle 0 – 5	Mod. 6 – 17	Strong 17 – 45	Res.	Creek/ River		
		(m2)	Position on Slope			Estimated (m)		(Type)	Yes or No
SA	95	7,800	Mid	–	–	200	NA	Mixed	No
SA	97	5,225	Mid	–	–	>200	10	Grazing	No
SA	100	5,400	Mid	–	–	NA	NA	Plantation	No
SA	103	6,000	Mid	–	–	>200	10	Mixed	No
SA	104	8,825	Mid	–	–	>200	NA	Plantation	No
SA	107	12,000	Mid	–	–	1	100	Mixed	No
SA	109	7,200	Mid	–	–	NA	NA	None	No
SA	110	6,000	Mid	–	–	50	NA	Plantation	No
SA	111	9,600	–	–	Crest	NA	40	None	No
SA	113	5,550	Mid	–	–	>200	NA	None	No
CU	2	6,600	–	Mid	–	>200	1	None	Yes
YB	2	8,400	–	Mid	–	>200	1	None	Yes
YU	4	6,300	–	Crest	–	200	NA	Grazing	No
YU	6	5,000	–	Mid	–	200	NA	None	No
YU	5	7,200	–	Crest	–	150	NA	Mixed	No
YU	12	6,000	Mid	–	–	>200	100	None	No
YUS	1	14,000	–	Upper	–	1	30	Plantation	Yes
AU	1	5,000	–	–	Crest	>200	50	Plantation	No
AU	4	6,000	–	Upper	–	200	NA	Plantation	No
AU	6	6,000	–	Upper	–	>200	NA	None	No
AU	7	6,000	Lower	–	–	NA	1	None	No
AU	9	6,900	–	Crest	–	200	>200	None	No
AU	11	6,000	–	Mid	–	20	100	Mixed	No
AU	12	5,000	Mid	–	–	10	30	Plantation	No
AU	15	6,000	–	Mid	–	200	500	None	No
AU	16	6,600	–	Upper	–	>200	100	Plantation	No
AU	17	5,000	–	Crest	–	>200	100	Plantation	No
AU	18	7,150	–	Mid	–	>200	NA	None	No
AU	19B	6,000	–	Upper	–	>200	>200	Grazing	Yes
AU	21	6,050	–	Mid	–	>200	100	None	No
AU	24	14,400	–	Mid	–	100	100	Mixed	Yes
AUS	1	NA	Mid	–	–	50	50	Plantation	No
RM	1	4,900	–	Upper	–	NA	NA	None	No
CN	1	6,900	–	Mid	–	50	NA	Plantation	
CN	2	10,500	Mid	–	–	10	NA	Plantation	No
CN	3	7,700	Mid	–	–	1	10	Plantation	No
CN	8	10,400	Lower	–	–	>200	5	None	No
CN	11	9,600	–	–	Crest	>200	>200	None	Yes
CN	12	10,400	–	–	Crest	>200	>200	None	Yes
DU	1	5,800	–	–	Crest	20	20	None	No

Table E – 2
Physical Impacts, Topography and Adjacent Land Use Recorded For Production Stations

Production Station		Currently Disturbed Area (ha)	Topography (Slope) Gentle 0 – 5	Mod. 6 – 17	Strong 17 – 45	Proximity to : Res.	Creek/ River	Adjacent Land Use (b)	Erosion Present (c)
			Position on Slope			Estimated (m)		(Type)	Yes or No
Lago Agrio	Central	80	Mid	–	–	100	100	Industry	No
	North	10	Mid	–	–	50	250	Plantation	No
Parahuacu		6	Crest	–	–	100	0	Forestry	No
Atacapi		3	–	Crest	–	300	50	Mixed	Yes
Guanta		8	Mid	–	–	20	1	Plantation	No
Aguarico		6	–	Upper	–	200	20	Forestry	Yes
Shushufindi	Central	50	Mid	–	–	20	10	Mixed	No
	North	13	Mid	–	–	20	20	Plantation	No
	South	15	Mid	–	–	300	300	Plantation	No
	Southwest	16	Mid	–	–	100	10	Mixed	No
	Water Inj.		–	–	Crest	250	10	Grazing	No
Sacha	Central	47	Mid	–	–	50	700	Mixed	No
	North # 1	20	Mid	–	–	40	20	Plantation	No
	North # 2	9	Mid	–	–	50	150	Mixed	No
	South	5	Mid	–	–	10	10	Mixed	No

Table E – 2
Physical Impacts, Topography and Adjacent Land Use Recorded For Production Stations

Production Station		Currently Disturbed Area (ha)	Topography (Slope)			Proximity to :		Adjacent Land Use (b)	Erosion Present (c)
			Gentle 0 – 5	Mod. 6 – 17	Strong 17 – 45	Res.	Creek/ River		
			Position on Slope			Estimated (m)		(Type)	Yes or No
Culebra		2	–	Upper	–	20	NA	Plantation	No
Yulebra		3	Upper	–	–	800	30	Mixed	No
Yuca		12	–	Upper	–	300	100	Forestry	Yes
Auca	Central	30	–	Upper	–		100	Mixed	Yes
	South	9	–	Crest	–	200	50	Forestry	Yes
Auca Sur		2	Mid	–	–	50	20	Plantation	Yes
Cononaco		8	Upper	–	–	20	NA	Plantation	No
Dureno		1	–	–	Crest	20	20	Forestry	Yes

(a) Excludes marginal regeneration adjacent site boundaries.

(b) Agricultural types (ie. plantation and grazing) noted when immediately adjacent site boundaries.

(c) Where erosion impact is present, details are provided in Table 6 – .

APPENDIX F

CONTAMINANT OBSERVATIONS FOR ASSESSED WELL SITES, PRODUCTION STATIONS AND SECONDARY PIPELINES

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Table F – 1
Summary of Contaminant Observations For Assessed Well Sites

Assessed Site		Produced Fluid Spills From:					Solid Waste Present		Refined Product Spills			Pits		
		Well	Flowline	Pump	Tank	Flare	Ind.	Dom.	Oil	Chem.	Fuel	#1	#2	#3
LA	1	Yes	No	Yes	–	–	–	–	–	–	–	–	–	–
LA	2	Yes	No	–	–	–	Yes	–	Yes	No	–	No	No	–
LA	5	Yes	No	–	–	–	–	Yes	–	–	–	–	–	–
LA	6	No	No	–	–	–	–	–	–	–	–	–	–	–
LA	8	Yes	No	–	–	–	–	Yes	–	–	–	–	–	–
LA	9	No	No	–	Yes	–	–	–	–	–	–	–	–	–
LA	10	Yes	Yes	–	–	–	Yes	–	–	–	–	No	–	–
LA	11B	Yes	Yes	–	–	–	–	–	–	–	–	No	–	–
LA	12	Yes	Yes	–	–	–	Yes	–	Yes	–	–	–	–	–
LA	17	No	No	–	–	–	–	–	–	–	–	–	–	–
LA	19	No	No	–	–	–	–	–	–	–	–	–	–	–
LA	20	Yes	No	–	–	–	–	–	–	–	–	–	–	–
LA	21	Yes	No	–	–	–	Yes	–	Yes	–	–	–	–	–
LA	26	Yes	No	–	–	–	–	–	–	No	–	–	–	–
LA	29	Yes	Yes	–	–	–	–	–	–	No	–	–	–	–
LA	32	Yes	No	–	–	–	–	–	–	–	–	–	–	–
LA	33	Yes	No	–	–	–	–	–	–	–	–	–	–	–
LA	34	Yes	No	–	–	–	–	–	–	–	–	–	–	–
LA	35	Yes	No	–	–	–	–	–	–	–	–	–	–	–
PH	2	Yes	No	–	–	–	–	–	–	–	–	–	–	–
PH	5	Yes	No	–	–	–	Yes	–	–	–	–	–	–	–
AT	1	No	Yes	Yes	–	–	–	–	–	No	–	No	No	–
AT	2	No	No	Yes	–	–	–	–	–	No	–	Yes	–	–

Yes A spill has been identified.
▨ Yes The spill has migrated off the well site or contaminants have migrated beyond the confines of the pit.
No A spill has not been identified.
– The feature is not present on the site.
Ind. = Industrial, Dom. = Domestic
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Table F – 1

Summary of Contaminant Observations For Assessed Well Sites

Assessed Site		Produced Fluid Spills From:					Solid Waste Present		Refined Product Spills			Pits		
		Well	Flowline	Pump	Tank	Flare	Ind.	Dom.	Oil	Chem.	Fuel	#1	#2	#3
AT	3	Yes	No	–	–	–	–	–	–	–	–	☐ No	–	–
GU	1	Yes	No	–	–	–	Yes	–	▨ Yes	No	–	▨ Yes	▨ Yes	–
GU	3	No	No	–	–	–	Yes	–	–	–	–	▨ Yes	–	–
GU	5	No	No	▨ Yes	▨ Yes	Yes	Yes	–	▨ Yes	–	Yes	▨ Yes	–	–
GU	8	▨ Yes	▨ Yes	–	–	–	–	–	–	–	–	–	–	–
AG	AG3	Yes	No	–	–	–	Yes	–	Yes	–	–	▨ Yes	–	–
AG	AG6	No	No	–	–	–	–	–	–	–	–	▨ Yes	▨ Yes	–
AG	AG8	No	No	–	–	–	–	–	–	–	–	▨ Yes	–	–
AG	AG9	Yes	Yes	–	–	–	Yes	–	Yes	–	–	▨ Yes	–	–
AG	AG10	Yes	No	–	–	–	–	–	–	No	–	▨ Yes	Yes	–
SSF	B57	Yes	No	–	–	–	Yes	–	Yes	Yes	–	▨ Yes	–	–
SSF	B59	Yes	No	–	–	–	–	–	–	Yes	–	▨ Yes	–	–
SSF	61	Yes	No	–	–	–	–	–	–	No	–	▨ Yes	Yes	–
SSF	B63	Yes	No	–	–	–	Yes	–	Yes	–	–	▨ Yes	▨ Yes	–
SSF	B64	Yes	No	–	–	–	–	Yes	–	–	–	▨ Yes	–	–
SSF	A65	Yes	No	–	–	–	–	–	–	–	–	–	–	–
SSF	B66	Yes	No	–	–	–	–	–	–	–	–	▨ Yes	–	–
SSF	A67	Yes	No	–	–	–	Yes	–	Yes	No	–	Yes	No	–
SSF	68	Yes	No	–	–	–	–	–	–	No	–	▨ Yes	–	–
SSF	69	Yes	Yes	–	–	–	–	–	–	No	–	No	No	–
SSF	71	Yes	▨ Yes	–	–	–	–	–	–	–	–	Yes	No	No
SSF	WIW2	No	No	–	–	–	–	–	–	–	–	No	–	–
SSF	WIW4	No	No	–	–	–	–	Yes	–	–	–	No	–	–

Yes — A spill has been identified.
▨ Yes — The spill has migrated off the well site or contaminants have migrated beyond the confines of the pit.
No — A spill has not been identified.
– — The feature is not present on the site.
Ind. = Industrial, Dom. = Domestic
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Table F – 1
Summary of Contaminant Observations For Assessed Well Sites

Assessed Site		Produced Fluid Spills From:					Solid Waste Present		Refined Product Spills			Pits		
		Well	Flowline	Pump	Tank	Flare	Ind.	Dom.	Oil	Chem.	Fuel	#1	#2	#3
SSF	WIW7	No	No	–	–	–	–	–	–	–	–	No	–	–
SSF	A1	Yes	No	–	–	–	–	–	–	–	–	Yes	–	–
SSF	A7	Yes	No	–	–	–	–	–	–	–	–	Yes	–	–
SSF	A9	Yes	No	–	–	–	–	–	–	No	–	–	–	–
SSF	A10	Yes	No	–	–	–	–	Yes	–	–	–	–	–	–
SSF	A13	Yes	Yes	Yes	–	–	–	–	–	No	–	Yes	No	–
SSF	B15	Yes	No	–	–	–	–	Yes	–	–	–	Yes	–	–
SSF	B16	No	No	–	–	–	–	Yes	–	–	–	Yes	–	–
SSF	A20	Yes	No	–	–	–	Yes	–	Yes	No	–	Yes	–	–
SSF	A22B	Yes	Yes	–	–	–	–	–	–	Yes	–	Yes	–	–
SSF	A24	Yes	Yes	–	–	–	–	–	–	No	–	Yes	–	–
SSF	A26	Yes	No	–	–	–	–	–	–	–	–	–	–	–
SSF	A30	No	No	–	–	–	–	–	–	–	–	Yes	Yes	Yes
SSF	B31	Yes	No	–	–	–	Yes	Yes	Yes	No	–	Yes	–	–
SSF	A33	No	No	–	–	–	–	–	–	–	–	Yes	–	–
SSF	A34	–	–	–	–	–	–	–	–	–	–	–	–	–
SSF	B36	Yes	No	–	–	–	Yes	–	Yes	No	–	Yes	–	–
SSF	A38	Yes	No	–	–	–	–	–	–	–	–	Yes	–	–
SSF	A43	Yes	No	–	–	–	–	–	–	–	–	Yes	Yes	–
SSF	6B	Yes	Yes	–	–	–	–	–	–	No	–	Yes	–	–
SSF	A45	Yes	Yes	Yes	–	–	–	Yes	–	–	–	No	–	–
SSF	A45B	Yes	Yes	–	–	–	–	–	–	No	–	Yes	No	–
SSF	46	Yes	No	–	Yes	–	Yes	Yes	Yes	–	Yes	Yes	–	–

Yes A spill has been identified.
Yes The spill has migrated off the well site or contaminants have migrated beyond the confines of the pit.
No A spill has not been identified.
– The feature is not present on the site.
Ind. = Industrial, Dom. = Domestic
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Table F – 1
Summary of Contaminant Observations For Assessed Well Sites

Assessed Site		Produced Fluid Spills From:					Solid Waste Present		Refined Product Spills			Pits		
		Well	Flowline	Pump	Tank	Flare	Ind.	Dom.	Oil	Chem.	Fuel	#1	#2	#3
SSF	B49	Yes	No	–	–	–	–	–	–	–	–	Yes	Yes	–
SSF	A50	No	No	–	–	–	–	–	–	–	–	–	–	–
SSF	B51	Yes	No	–	–	–	–	–	–	–	–	Yes	–	–
SSF	B52	Yes	Yes	–	–	–	–	–	–	No	–	–	–	–
SSF	B55	No	No	–	–	–	–	–	–	–	–	Yes	–	–
SA	WIW1	No	No	–	–	–	–	–	–	–	–	–	–	–
SA	WIW2	Yes	No	–	–	–	–	–	–	–	–	Yes	Yes	–
SA	WIW3	No	No	–	–	–	–	–	–	–	–	No	–	–
SA	WIW4	No	No	–	–	–	Yes	–	–	–	–	Yes	–	–
SA	WIW5	No	No	–	–	–	–	–	–	–	–	Yes	–	–
SA	WIW6	No	No	–	–	–	–	–	–	–	–	Yes	Yes	–
SA	1	Yes	No	–	–	–	Yes	–	Yes	–	–	–	–	–
SA	2	No	No	–	–	–	–	–	–	No	–	No	–	–
SA	8	Yes	Yes	–	–	–	–	–	–	–	–	Yes	–	–
SA	9	Yes	No	–	–	–	–	–	–	–	–	–	–	–
SA	11	Yes	No	–	–	–	–	–	–	–	–	Yes	–	–
SA	12	Yes	No	–	–	–	–	–	–	–	–	Yes	–	–
SA	13	Yes	Yes	–	–	–	–	–	–	–	–	No	No	–
SA	16	Yes	No	–	–	–	–	–	–	–	–	Yes	–	–
SA	18	Yes	Yes	–	–	–	–	–	–	–	–	Yes	–	–
SA	19	Yes	No	–	–	–	–	–	–	–	–	Yes	–	–
SA	20	Yes	No	–	–	–	–	–	–	–	–	Yes	–	–
SA	21	Yes	Yes	–	–	–	–	–	–	–	–	Yes	Yes	–

Yes — A spill has been identified.
▨ Yes — The spill has migrated off the well site or contaminants have migrated beyond the confines of the pit.
No — A spill has not been identified.
– — The feature is not present on the site.
Ind. = Industrial, Dom. = Domestic
☐ — Covered Pit

Table F – 1

Summary of Contaminant Observations For Assessed Well Sites

Assessed Site	Produced Fluid Spills From:					Solid Waste Present		Refined Product Spills			Pits		
	Well	Flowline	Pump	Tank	Flare	Ind.	Dom.	Oil	Chem.	Fuel	#1	#2	#3
SA 25	▨ Yes	No	–	–	–	–	–	–	–	–	▨ Yes	–	–
SA 27	▨ Yes	No	–	–	–	–	–	–	–	–	–	–	–
SA 28	Yes	▨ Yes	–	–	–	Yes	–	–	–	–	–	–	–
SA 32	Yes	No	–	–	–	Yes	–	–	No	–	Yes	No	–
SA 33	Yes	No	–	–	–	–	–	–	–	–	Yes	▨ Yes	–
SA 34	Yes	▨ Yes	–	–	–	–	–	–	–	–	–	–	–
SA 35	Yes	No	–	–	–	–	–	–	–	–	–	–	–
SA 36	Yes	▨ Yes	Yes	Yes	–	–	–	Yes	Yes	Yes	Yes	–	–
SA 40	No	No	–	–	–	–	Yes	–	–	–	–	–	–
SA 43	Yes	No	–	–	–	–	–	–	–	–	▨ Yes	–	–
SA 44	No	No	–	–	–	–	–	–	No	–	Yes	–	–
SA 46	Yes	▨ Yes	–	–	–	–	–	–	–	–	Yes	☐ No	–
SA 54	Yes	No	–	–	–	–	–	–	–	–	Yes	–	–
SA 55	▨ Yes	No	–	–	–	–	–	–	–	–	Yes	–	–
SA 56	No	No	–	–	–	–	–	–	–	–	–	–	–
SA 58	▨ Yes	No	–	–	–	–	–	–	No	–	▨ Yes	Yes	–
SA 59	Yes	Yes	–	–	–	–	–	–	–	–	▨ Yes	–	–
SA 60	Yes	No	–	–	–	–	–	–	–	–	▨ Yes	–	–
SA 72	Yes	No	–	–	–	–	–	–	–	–	Yes	No	–
SA 73	Yes	–	–	–	–	–	–	–	–	–	–	–	–
SA 74	Yes	No	–	–	–	–	–	–	–	–	▨ Yes	–	–
SA 75	Yes	No	–	–	–	–	–	–	–	–	Yes	No	–
SA 77	Yes	No	–	–	–	–	Yes	–	–	–	Yes	–	–

Yes A spill has been identified.
▨ Yes The spill has migrated off the well site or contaminants have migrated beyond the confines of the pit.
No A spill has not been identified.
– The feature is not present on the site.
Ind. = Industrial, Dom. = Domestic
☐ Covered Pit

Table F – 1
Summary of Contaminant Observations For Assessed Well Sites

Yes A spill has been identified.

Yes The spill has migrated off the well site or contaminants have migrated beyond the confines of the pit.

No A spill has not been identified.

– The feature is not present on the site.

Ind. = Industrial, Dom. = Domestic

☐ Covered Pit

Assessed Site	Produced Fluid Spills From:					Solid Waste Present		Refined Product Spills			Pits		
	Well	Flowline	Pump	Tank	Flare	Ind.	Dom.	Oil	Chem.	Fuel	#1	#2	#3
SA 78	Yes	Yes	–	–	–	Yes	–	–	–	–	Yes	–	–
SA 81	Yes	No	–	–	–	–	Yes	–	–	–	Yes	–	–
SA 84	Yes	Yes	–	–	–	–	–	–	–	–	Yes	No	–
SA 85	Yes	No	–	–	–	Yes	–	–	–	–	Yes	–	–
SA 86	Yes	No	–	–	–	–	–	–	–	–	Yes	No	–
SA 91	No	No	–	–	–	–	–	–	–	–	Yes	No	–
SA 93	Yes	Yes	–	–	–	–	–	–	–	–	Yes	–	–
SA 94	Yes	No	–	–	–	Yes	Yes	–	–	–	Yes	Yes	–
SA 95	Yes	No	–	–	–	–	–	–	–	–	Yes	Yes	No
SA 97	Yes	Yes	–	–	–	–	–	–	–	–	Yes	–	–
SA 100	Yes	No	–	–	–	–	–	–	–	–	Yes	–	–
SA 103	Yes	No	–	–	–	Yes	Yes	–	–	–	Yes	No	–
SA 104	Yes	No	–	–	–	–	–	–	–	–	Yes	–	–
SA 107	Yes	Yes	–	–	–	–	–	–	–	–	Yes	–	–
SA 109	Yes	No	–	–	–	–	–	–	–	–	Yes	No	–
SA 110	Yes	No	–	–	–	–	–	–	–	–	Yes	–	–
SA 111	Yes	No	–	–	–	–	–	–	–	–	Yes	–	–
SA 113	Yes	–	–	–	–	–	–	–	–	–	Yes	–	–
CU 2	Yes	No	–	–	–	Yes	–	Yes	–	–	Yes	–	–
YB 2	No	No	–	–	–	Yes	–	Yes	–	Yes	Yes	–	–
YU 4	Yes	Yes	–	–	–	–	–	–	–	–	Yes	–	–
YU 6	–	–	–	–	–	–	Yes	–	–	–	No	–	–
YU 5	Yes	No	–	Yes	–	Yes	–	Yes	–	–	Yes	Yes	Yes

Table F – 1
Summary of Contaminant Observations For Assessed Well Sites

Yes — A spill has been identified.

▨ Yes — The spill has migrated off the well site or contaminants have migrated beyond the confines of the pit.

No — A spill has not been identified.

– — The feature is not present on the site.

Ind. = Industrial, Dom. = Domestic

☐ — Covered Pit

Assessed Site		Produced Fluid Spills From:					Solid Waste Present		Refined Product Spills			Pits		
		Well	Flowline	Pump	Tank	Flare	Ind.	Dom.	Oil	Chem.	Fuel	#1	#2	#3
YU	12	Yes	▨ Yes	–	–	–	–	–	–	Yes	–	▨ Yes	–	–
YUS	1	Yes	No	–	–	–	–	–	–	Yes	–	▨ Yes	–	–
AU	1	Yes	No	–	–	–	–	–	–	–	–	▨ Yes	–	–
AU	4	Yes	No	Yes	Yes	No	Yes	–	▨ Yes	No	▨ Yes	▨ Yes	–	–
AU	6	▨ Yes	No	–	–	–	Yes	–	Yes	–	–	▨ Yes	–	–
AU	7	▨ Yes	No	–	–	–	–	–	–	–	–	☐ No	–	–
AU	9	No	Yes	–	–	–	–	–	–	No	–	☐ No	–	–
AU	11	Yes	Yes	–	–	–	–	–	–	No	–	▨ Yes	–	–
AU	12	Yes	Yes	–	–	–	–	–	–	–	–	▨ Yes	–	–
AU	15	Yes	Yes	–	–	–	–	–	–	Yes	–	▨ Yes	–	–
AU	16	Yes	No	–	–	–	–	–	–	–	–	▨ Yes	–	–
AU	17	Yes	Yes	–	–	–	–	Yes	–	–	–	▨ Yes	Yes	–
AU	18	Yes	Yes	–	–	–	–	–	–	–	–	–	–	–
AU	19B	Yes	Yes	–	–	–	–	–	–	–	–	▨ Yes	–	–
AU	21	Yes	Yes	–	–	–	Yes	–	–	–	–	▨ Yes	–	–
AU	24	No	No	–	–	–	–	Yes	–	–	–	▨ Yes	No	–
AUS	1	Yes	Yes	Yes	Yes	No	–	–	▨ Yes	–	▨ Yes	▨ Yes	☐ No	Yes
RM	1	Yes	No	–	–	–	–	–	–	–	–	Yes	–	–
CN	1	Yes	No	–	–	–	–	Yes	–	–	–	▨ Yes	–	–
CN	2	No	No	–	–	–	–	–	–	–	–	▨ Yes	–	–
CN	3	No	No	–	–	–	–	–	–	–	–	No	–	–
CN	8	No	No	–	–	–	–	–	–	–	–	No	–	–
CN	11	▨ Yes	No	–	–	–	–	–	–	–	–	–	–	–

Table F – 1
Summary of Contaminant Observations For Assessed Well Sites

Yes A spill has been identified.

Yes The spill has migrated off the well site or contaminants have migrated beyond the confines of the pit.

No A spill has not been identified.

– The feature is not present on the site.

Ind. = Industrial, Dom. = Domestic

☐ Covered Pit

Assessed Site		Produced Fluid Spills From:					Solid Waste Present		Refined Product Spills			Pits		
		Well	Flowline	Pump	Tank	Flare	Ind.	Dom.	Oil	Chem.	Fuel	#1	#2	#3
CN	12	Yes	No	–	–	–	Yes	Yes	Yes	–	–	Yes	–	–
DU	1	No	No	Yes	Yes	Yes	–	–	–	–	–	Yes	–	–
Sites Total (All Conditions)	Yes	126	41	10	8	2	32	20	23	7	6	107	17	3
Total No		35	118	0	0	2	0	0	0	27	0	18	19	2
Total –		2	4	153	155	159	131	143	140	129	157	38	127	158
Totals		163	163	163	163	163	163	163	163	163	163	163	163	163
Total	Yes	109	28	6	6	1	32	20	16	7	3	39	9	2
Total	Yes	17	13	4	2	1	–	–	7	0	3	36	6	1
Total	Yes	–	–	–	–	–	–	–	–	–	–	31	2	0
Total	No	–	–	–	–	–	–	–	–	–	–	10	3	0

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Table F – 2

Description of Produced Fluid Spills Identified For Well Sites, Flowlines, Pumps, Tanks and Flares

Assessed Site		Well Site Spills			Flowline Spills			Pump Spills			Tank Spills			Flare Spills		
		Estimated Spill Dimensions (Area in square metres, Depth in metres, Volume in cubic metres)														
		Area	Depth	Vol.	Area	Depth	Vol.	Area	Depth	Vol.	Area	Depth	Vol.	Area	Depth	Vol.
LA	1	10	0.1	1				25	0.1	2.5						
LA	2	20	0.1	2												
LA	5	10	0.3	3												
LA	8	20	0.1	2												
LA	10	50	0.1	5	50	0.1	5									
LA	11B	10	0.1	1	10	0.1	1									
LA	12	15	0.1	1.5	15	0.1	1.5									
LA	20	15	0.1	1.5												
LA	21	100	0.2	20												
LA	26	40	0.1	4												
LA	29	250	0.2	50	250	0.2	50									
LA	32	15	0.1	1.5												
LA	33	25	0.2	5												
LA	34	200	0.1	20												
LA	35	15	0.1	1.5												
PH	2	900	0.3	270												
PH	5	50	0.5	25												
AT	1				10	0.2	2	35	0.3	10.5						
AT	2							100	0.3	30						
AT	3	100	0.1	10												
GU	1	50	0.2	10												
GU	5							100	0.5	50	50	0.2	10	25	0.5	12.5
GU	8	1000	0.1	100	50	0.2	10									

▨ The spill has migrated off the well site.

☐ The spill has affected water.

Table F – 2

Description of Produced Fluid Spills Identified For Well Sites, Flowlines, Pumps, Tanks and Flares

▨ The spill has migrated off the well site. ☐ The spill has affected water.

Assessed Site		Well Site Spills			Flowline Spills			Pump Spills			Tank Spills			Flare Spills		
		Estimated Spill Dimensions (Area in square metres, Depth in metres, Volume in cubic metres)														
		Area	Depth	Vol.	Area	Depth	Vol.	Area	Depth	Vol.	Area	Depth	Vol.	Area	Depth	Vol.
AG	AG3	100	0.5	50												
AG	AG9	40	0.2	8	40	0.2	8									
AG	AG10	80	0.2	16												
SSF	B57	50	0.5	25												
SSF	B59	40	0.2	8												
SSF	61	5	0.2	1												
SSF	B63	10	0.5	5												
SSF	B64	10	0.1	1												
SSF	A65	250	0.2	50												
SSF	B66	10	0.1	1												
SSF	A67	10	0.1	1												
SSF	68	50	0.2	10												
SSF	69	15	0.2	3	15	0.2	3									
SSF	71	20	0.2	4	2000	0.5	1000									
SSF	A1	10	0.2	2												
SSF	A7	20	0.2	4												
SSF	A9	10	0.1	1												
SSF	A10	400	0.1	40												
SSF	A13	15	0.2	3	10	0.1	1	20	0.2	4						
SSF	B15	5	0.1	0.5												
SSF	A20	20	0.2	4												
SSF	A22	4	0.5	2	4	0.5	2									
SSF	A24	25	0.2	5	25	0.2	5									

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Table F – 2

Description of Produced Fluid Spills Identified For Well Sites, Flowlines, Pumps, Tanks and Flares

Estimated Spill Dimensions (Area in square metres, Depth in metres, Volume in cubic metres)

▨ The spill has migrated off the well site. ☐ The spill has affected water.

Assessed Site		Well Site Spills			Flowline Spills			Pump Spills			Tank Spills			Flare Spills		
		Area	Depth	Vol.	Area	Depth	Vol.	Area	Depth	Vol.	Area	Depth	Vol.	Area	Depth	Vol.
SSF	A26	60	0.3	18												
SSF	B31	50	0.1	5												
SSF	B36	500	0.3	150												
SSF	A38	300	0.2	60												
SSF	A43	200	0.2	40												
SSF	6B	100	0.5	50	50	0.5	25									
SSF	A45	5	0.1	0.5	100	0.3	30	100	0.3	30						
SSF	A45B	10	0.2	2	10	0.2	2									
SSF	46	500	0.3	150							100	0.3	30			
SSF	B49	5	0.2	1												
SSF	B51	200	0.2	40												
SSF	B52	40	0.2	8	50	0.3	15									
SA	WIW2	100	0.2	20												
SA	1	1000	0.3	300												
SA	8	40	0.2	8	40	0.2	8									
SA	9	15	0.2	3												
SA	11	250	0.3	75												
SA	12	50	0.2	10												
SA	13	100	0.2	20												
SA	16	25	0.2	5												
SA	18	50	0.2	10	25	0.2	5									
SA	19	20	0.1	2												
SA	20	150	0.2	30												

Table F – 2

Description of Produced Fluid Spills Identified For Well Sites, Flowlines, Pumps, Tanks and Flares

▨ The spill has migrated off the well site. ☐ The spill has affected water.

Assessed Site		Well Site Spills			Flowline Spills			Pump Spills			Tank Spills			Flare Spills		
		Estimated Spill Dimensions (Area in square metres, Depth in metres, Volume in cubic metres)														
		Area	Depth	Vol.	Area	Depth	Vol.	Area	Depth	Vol.	Area	Depth	Vol.	Area	Depth	Vol.
SA	21	15	0.3	4.5	15	0.3	4.5									
SA	25	200	0.2	40												
SA	27	200	0.2	40												
SA	28	100	0.2	20	500	0.2	100									
SA	32	150	0.5	75												
SA	33	400	0.2	80												
SA	34	100	0.2	20	100	0.2	20									
SA	35	10	0.2	2												
SA	36	80	0.2	16	100	0.2	20	100	0.2	20	15	0.5	7.5			
SA	43	200	0.2	40												
SA	46	20	0.2	4	80	0.3	24									
SA	54	15	0.3	4.5												
SA	55	500	0.3	150												
SA	58	200	0.3	60												
SA	59	25	0.2	5	150	0.1	15									
SA	60	300	0.2	60												
SA	72	150	0.3	45												
SA	73	500	0.2	100												
SA	74	60	0.5	30												
SA	75	150	0.3	45												
SA	77	10	0.2	2												
SA	78	250	0.5	125	250	0.5	125									
SA	81	100	0.2	20												

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Table F – 2

Description of Produced Fluid Spills Identified For Well Sites, Flowlines, Pumps, Tanks and Flares

Estimated Spill Dimensions (Area in square metres, Depth in metres, Volume in cubic metres)

▨ The spill has migrated off the well site. ☐ The spill has affected water.

Assessed Site		Well Site Spills			Flowline Spills			Pump Spills			Tank Spills			Flare Spills		
		Area	Depth	Vol.	Area	Depth	Vol.	Area	Depth	Vol.	Area	Depth	Vol.	Area	Depth	Vol.
SA	84	25	0.2	5	25	0.2	5									
SA	85	150	0.2	30												
SA	86	200	0.3	60												
SA	93	25	0.3	7.5	25	0.3	7.5									
SA	94	300	0.2	60												
SA	95	100	0.2	20												
SA	97	20	0.1	2	500	0.2	100									
SA	100	100	0.1	10												
SA	103	200	0.2	40												
SA	104	200	0.1	20												
SA	107	100	0.5	50												
SA	109	200	0.2	40												
SA	110	20	0.2	4												
SA	111	100	0.2	20												
SA	113	15	0.2	3												
CU	2	175	0.1	17.5												
YU	4	10	0.2	2	1200	1.5	1800									
YU	5	100	1	100							20	0.5	10			
YU	12	10	0.5	5	25	0.5	12.5									
YUS	1	200	0.2	40												
AU	1	6	0.5	3												
AU	4	40	0.5	20												
AU	6	600	0.2	100							25	0.5	12.5			

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Table F – 2

Description of Produced Fluid Spills Identified For Well Sites, Flowlines, Pumps, Tanks and Flares

▨ The spill has migrated off the well site. ☐ The spill has affected water.

Assessed Site		Well Site Spills			Flowline Spills			Pump Spills			Tank Spills			Flare Spills		
		Estimated Spill Dimensions (Area in square metres, Depth in metres, Volume in cubic metres)														
		Area	Depth	Vol.	Area	Depth	Vol.	Area	Depth	Vol.	Area	Depth	Vol.	Area	Depth	Vol.
AU	7	50	0.5	25												
AU	9				20	0.2	4									
AU	11	50	0.3	15	40	0.3	12									
AU	12	50	0.3	15	30	0.3	9									
AU	15	40	0.5	20	15	0.2	3									
AU	16	10	0.2	2												
AU	17	60	0.5	30	10	0.5	5									
AU	18	10	0.5	5	10	0.5	5									
AU	19B	60	0.5	30	20	0.5	10									
AU	21	100	0.2	20	10	0.5	5									
AUS	1	10	0.2	2	10	0.2	2	(a)			(a)					
RM	1	75	0.1	7.5												
CN	1	10	0.3	3												
CN	11	200	0.1	20												
CN	12	200	0.2	40												
DU	1							(a)			(a)			(a)		
Totals (Rounded)				3,700			3,500			150			70			10

(a) Spill characterized in Table F – 7 (Description of Contamination at Production Stations)
Well sites AUS1 and DU1 are located at production stations.

Note : Estimates of spill area, depth and volume are based on a very limited amount of data.
More reliable estimates cannot be prepared without additional field data.

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Table F – 3
Description of Refined Product Spills Identified For Well Sites

Assessed Site		Used Oil			Chemicals			Fuel		
		Estimated Spill Dimensions (Area in square metres, Depth in metres, Volume in cubic metres)								
		Area	Depth	Vol.	Area	Depth	Vol.	Area	Depth	Vol.
LA	2	15	0.3	4.5						
LA	12	4	1	4						
LA	21	2	1	2						
GU	1	50	1	50						
GU	5	100	0.5	50				20	1	20
AG	AG3	2	1	2						
SSF	B59				10	0.1	1			
SSF	B63	5	0.5	2.5						
SSF	A20	4	0.2	0.8						
SSF	A22B				5	0.1	0.5			
SSF	B36	25	1	25						
SSF	46	50	0.3	15				50	0.3	15
SA	1	100	0.5	50						
SA	36	100	0.5	50	20	0.5	10	80	0.5	40
CU	2	4	0.3	1.2						
YB	2	250	0.3	75				150	1.5	225
YU	5	150	0.3	45						
YU	12				10	1	10			
YUS	1				5	1	5			

Yes The spill has migrated off the site. ☐ The spill has affected water.

Table F – 3

Description of Refined Product Spills Identified For Well Sites

Assessed Site		Used Oil			Chemicals			Fuel		
		Estimated Spill Dimensions (Area in square metres, Depth in metres, Volume in cubic metres)								
		Area	Depth	Vol.	Area	Depth	Vol.	Area	Depth	Vol.
AU	4	80	0.5	40				200	0.5	100
AU	6	15	0.5	7.5						
AU	15				15	0.5	7.5			
AUS	1	(a)						(a)		
Totals (Rounded)				400			30			400

▨ Yes The spill has migrated off the site.

☐ The spill has affected water.

(a) Spill characterized in Table F – 7 (Description of Contamination at Production Stations)
Well site AUS1 is located at a production station.

Filters are present in pits at well sites AG9, SSFB57, SSFA67, SSFB31, and CN12 however, the presence of used oil has not been assumed.

Note : Estimates of spill area, depth and volume are based on a very limited amount of data.
More reliable estimates cannot be prepared without additional field data.

Table F – 4
Description of Solid Waste Present at Well Sites

Assessed Site		Description of Industrial Waste Located on the Site	Description of Domestic Waste Located on the Site
LA	2	Several used oil filters and associated oil spill.	
LA	5		One small mound of domestic garbage.
LA	8		One pile of garbage including broken concrete and pipe.
LA	10		One small mound of domestic garbage.
LA	12	Oily soil (approx. 3 m3) pile on site.	
LA	21	Oily soil and refuse (approx. 3 m3) pile on site.	
PH	5	Metalic debris and oily soil mound present (5 m3).	
GU	1	Filters & oil in 2 m2 pit – oil migrating out of pit.	
GU	3	Filters & oily soil dumped beside site (10 m3).	
GU	5	Filters & used oil dumped adjacent pumps.	
AG	AG3	Metalic debris and filters present.	
AG	AG9	Metalic debris and filters dumped into pit.	
SSF	B57	Filters dumped into pit.	
SSF	B63	Filters dumped into pit and on edge of site.	
SSF	B64		Site used as landfill. Very large volume of waste present.
SSF	A67	Metalic debris and filters dumped into pit.	
SSF	WIW4		One small mound of domestic garbage.
SSF	A10		Some garbage from adjacent community centre.
SSF	B15		Site used as landfill. Large volume of waste present.
SSF	B16		Site used as landfill. Very large volume of waste present.
SSF	A20	Filters dumped on well site.	
SSF	B31	Metalic debris and filters dumped into pit.	Small amount of domestic garbage present.
SSF	B36	Metallic debris, filters and waste soil dumped (25 m3).	
SSF	A45		Garbage present in a 4 m2 pit.
SSF	46	Filters & used oil dumped adjacent pumps.	Garbage recently covered at edge of site.

Table F – 4
Description of Solid Waste Present at Well Sites

Assessed Site		Description of Industrial Waste Located on the Site	Description of Domestic Waste Located on the Site
SA	WIW4	Metal and plastic debris on site. (Small amount)	
SA	1	Scrap metal and construction debris dumped.	
SA	28	Metalic debris and filters at edge of site. (2 m3)	
SA	32	Oily soil mound (15 m3) present on site.	
SA	40		Several truckloads of garbage dumped on pad.
SA	77		Small amount of domestic garbage present.
SA	78	Large tank dumped into pit.	
SA	81		Domestic garbage present in oil pit.
SA	85	Steel cable present on site.	
SA	94	Metallic debris dumped into oil pit.	Domestic garbage present (30 m3).
SA	103	Domestic and industrial waste combined. Drums, filters, waste soil, wood and paper (40 m3).	
CU	2	Several filters dumped.	
YB	2	Filters & used oil dumped adjacent pumps.	
YU	6		Domestic garbage covers 400 m2. Dump area overgrown.
YU	5	Dumped drums and waste oil flow off site 20 m.	
AU	4	Filters & used oil dumped adjacent pumps.	
AU	6	Filters & used oil dumped adjacent pumps.	
AU	17		Domestic garbage present at two locations (50 m3).
AU	21	Scrap pipe on site.	
AU	24		Domestic garbage present (20 m3). Mainly wood.
CN	1		Small amount of domestic garbage and metal on slope.
CN	12	Filters and wood dumped into oil pit.	Domestic garbage dumped down slope (several loads).

Table F – 5

Description of Contamination Associated With Well Site Pits

Assessed Site	Pit Status	Estimated Dimensions Area (m2)	Thickness (m) Oil	Thickness (m) Water	Freeboard (m)	Berm Present Yes/No	Oil Condition Fluid/Tar	Siphon Found Yes/No	Seepage Found Yes/No	Discharge to Stream Yes/No	Comments
LA 1	–										
LA 2	No	1,500	0	0		No		No	No	No	Area revegetated
LA 2	No	150	0	1.5		No		No	No	No	Dense vegetation around pit.
LA 5	–										
LA 6	–										
LA 8	–										
LA 9	–										
LA 10	No	NA	0	0		No		No	No	No	Area revegetated
LA 11B	No	NA	0	0		No		No	No	No	Area revegetated
LA 12	–										
LA 17	–										
LA 19	–										
LA 20	–										
LA 21	–										
LA 26	–										
LA 29	–										
LA 32	–										
LA 33	–										
LA 34	–										
LA 35	–										

☐ Covered Pit	Yes	Oily wastes are present in the pit.	No	Oily wastes were not identified.
	▨ Yes	Contaminants have migrated beyond the confines of the pit.	–	Evidence of a pit was not found on the site.
			NA	Not Available

Table F – 5

Description of Contamination Associated With Well Site Pits

Assessed Site		Pit Status	Estimated Dimensions				Berm Present	Oil Condition	Siphon Found	Seepage Found	Discharge to Stream	Comments
			Area	Thickness (m)		Freeboard						
			(m2)	Oil	Water	(m)	Yes/No	Fluid/Tar	Yes/No	Yes/No	Yes/No	

☐ Covered Pit

Yes Oily wastes are present in the pit.

Yes Contaminants have migrated beyond the confines of the pit.

No Oily wastes were not identified.

– Evidence of a pit was not found on the site.

NA Not Available

PH	2	–										
PH	5	–										
AT	1	No	400	0	0		No		No	No	No	Recently covered.
AT	1	No	400	0	0		No		No	No	No	Recently covered.
AT	2	Yes	60	0	0.5	1.5	Yes		No	No	No	Not in use
AT	3	No	NA	0	0		No		No	No	No	Identified by colonizer.
GU	1	Yes	3,200	0.01	2	1	Yes	Fluid	Yes	No	Yes	Dense vegetation around pit.
GU	1	Yes	2	0.5	1.5	0.3	No	Fluid	No	Yes	Yes	Filters in pit.
GU	3	Yes	484	0.3	1.2	0.75	Yes	Fluid	Yes	No	Yes	Recent oil input
GU	5	Yes	3,200	0	0		No		No	Yes	Yes	Recently covered.
GU	8	–										
AG	AG3	Yes	120	0.05	1.5	0.25	Yes	Tar	No	Yes	No	Dense vegetation around pit.
AG	AG6	Yes	600	0	0		No	Tar	No	Yes	Yes	Recently covered.
AG	AG6	Yes	600	0	0		No	Tar	No	Yes	Yes	Recently covered.
AG	AG8	Yes	225	0.03	1.5	0.1	Yes	Tar	No	Yes	No	Pit has overflowed.
AG	AG9	Yes	1,600	0.01	2	0.5	Yes	Fluid	No	Yes	No	Dense vegetation around pit.
AG	AG10	Yes	2,700	0.01	2	0.1	No	Tar	No	Yes	No	Dense vegetation around pit.
AG	AG10	Yes	50	0.05	2.5	0.25	No	Tar	No	No	No	Pipe from flowline to pit.
SSF	B57	Yes	2,500	0.05	2	0.1	No	Fluid	No	Yes	NA	Dense vegetation around pit.
SSF	B59	Yes	225	0.15	1.5	0.2	No	Fluid	No	Yes	No	Pit has overflowed.

Table F – 5

Description of Contamination Associated With Well Site Pits

☐ Covered Pit

Yes — Oily wastes are present in the pit.

▨ Yes — Contaminants have migrated beyond the confines of the pit.

No — Oily wastes were not identified.

– — Evidence of a pit was not found on the site.

NA — Not Available

Assessed Site	Pit Status	Estimated Dimensions				Berm Present	Oil Condition	Siphon Found	Seepage Found	Discharge to Stream	Comments
		Area	Thickness (m)		Freeboard						
		(m2)	Oil	Water	(m)	Yes/No	Fluid/Tar	Yes/No	Yes/No	Yes/No	
SSF 61	▨ Yes	2,550	0.15	1.5	0.2	No	Fluid	No	▨ Yes	No	Dense vegetation around pit.
SSF 61	Yes	64	0.1	0	1	No	Tar	No	No	No	Dense vegetation around pit.
SSF B63	▨ Yes	324	0.01	1	0.3	Yes	Fluid	No	▨ Yes	No	Grass around pit.
SSF B63	▨ Yes	3,150	0.02	2	0.5	Yes	Fluid	No	No	▨ Yes	Grass around pit.
SSF B64	▨ Yes	3,300	0	0		No	Tar	No	▨ Yes	▨ Yes	Oil in stream = 1800 m2.
SSF A65	–										
SSF B66	▨ Yes	2,600	0.03	2	2	Yes	Fluid	▨ Yes	▨ Yes	▨ Yes	Grass around pit.
SSF A67	Yes	500	0.02	1.5	0.3	Yes	Fluid	No	No	No	Grass around pit.
SSF A67	No	100	0	0	1.5	No		No	No	No	Pit is empty.
SSF 68	▨ Yes	NA	0	0		No		No	▨ Yes	▨ Yes	Area reforested.
SSF 69	No	800	0	1.5		No		No	No	No	No visible contamination.
SSF 69	No	96	0	1.5		No		No	No	No	No visible contamination.
SSF 71	Yes	2,590	0.02	1.5	0.5	No	Fluid	No	No	No	Oil on 30% of surface.
SSF 71	No	2,590	0	2	0.5	No		No	No	No	Unknown use.
SSF 71	No	2,590	0	2	0.5	No		No	No	No	Unknown use.
SSF WIW2	No	216	0	2	0.1	No		No	No	No	Unknow use.
SSF WIW4	No	2,400	0	2	0.1	No		No	No	No	Unknow use.
SSF WIW7	No	170	0	2	0.1	No		No	No	No	Unknow use.
SSF A1	▨ Yes	600	0	0		No		No	▨ Yes	No	Location not confirmed.
SSF A7	▨ Yes	225	0.05	1	0.1	No	Tar	No	▨ Yes	No	Adjacent oil seep area.

Table F – 5
Description of Contamination Associated With Well Site Pits

Assessed Site		Pit Status	Estimated Dimensions				Berm	Oil	Siphon	Seepage	Discharge	Comments
			Area	Thickness (m)		Freeboard	Present	Condition	Found	Found	to Stream	
			(m2)	Oil	Water	(m)	Yes/No	Fluid/Tar	Yes/No	Yes/No	Yes/No	

☐ Covered Pit

Yes Oily wastes are present in the pit.

Yes Contaminants have migrated beyond the confines of the pit.

No Oily wastes were not identified.

– Evidence of a pit was not found on the site.

NA Not Available

SSF	A9	–										
SSF	A10	–										
SSF	A13	Yes	300	0.15	2	0.5	No	Fluid	Yes	Yes	Yes	Dense vegetation around pit.
SSF	A13	No	400	0	1.5		No		No	No	No	Unknown use.
SSF	B15	Yes	1,125	0.02	1	0.2	No	Fluid	No	NA	Yes	Possible oil filled depression.
SSF	B16	Yes	1,000	0.02	1	0.2	No	Fluid	No	NA	Yes	Downslope discharge.
SSF	A20	Yes	300	0.04	2	1	No	Fluid	No	No	No	Oily vegetation in pit.
SSF	A22B	Yes	120	0.05	NA	0.1	No	Tar	No	No	No	Oily vegetation in pit.
SSF	A24	Yes	150	0.05	1	0.1	No	Tar	No	Yes	No	Oily vegetation in pit.
SSF	A26	–										
SSF	A30	Yes	450	0.5	NA	NA	No	Tar	No	No	No	Oily vegetation in pit.
SSF	A30	Yes	480	0.5	NA	0.1	NA	Tar	No	Yes	Yes	Oily vegetation in pit.
SSF	A30	Yes	225	0.5	NA	0.1	NA	Tar	No	Yes	Yes	Oily vegetation in pit.
SSF	B31	Yes	595	0.5	0.1	0.5	No	Tar	No	No	No	Dense vegetation around pit.
SSF	A33	Yes	1,200	0.25	NA	1	No	Tar	No	No	No	Vegetation growing on oil.
SSF	A34	–										
SSF	B36	Yes	NA	0	0		No		No	Yes	No	Area revegetated.
SSF	A38	Yes	300	0.15	NA	0	No	Tar	No	Yes	Yes	Oil seeping into wetland.
SSF	A43	Yes	1,750	0	0		No		No	Yes	No	Area covered with grasses.
SSF	A43	Yes	64	0	0		No		No	Yes	No	Pit filled with wood chips.

CONFIDENTIAL TREATMENT REQUESTED
SDNY - 04 CIV 8378

Table F – 5
Description of Contamination Associated With Well Site Pits

Assessed Site	Pit Status	Estimated Dimensions Area (m2)	Thickness (m) Oil	Thickness (m) Water	Freeboard (m)	Berm Present Yes/No	Oil Condition Fluid/Tar	Siphon Found Yes/No	Seepage Found Yes/No	Discharge to Stream Yes/No	Comments
SSF 6B	Yes	64	0	0		No		No	Yes	No	Oil seep in plantation.
SSF A45	No	4	0	0		No		No	No	No	Contains domestic waste.
SSF A45B	Yes	1,500	0.02	1.5	0.1	No	Fluid	No	No	No	Grass around pit. Oil overflow.
SSF A45B	No	120	0	0		No		No	No	No	Pit is empty – grass inside.
SSF 46	Yes	324	0.05	0	4	Yes	Fluid	No	No	No	Dense vegetation around pit.
SSF B49	Yes	880	0.05	1.5	1	Yes	Tar	No	No	No	Pasture on two sides.
SSF B49	Yes	100	0.5	0.5	1	Yes	Fluid	No	Yes	No	Dense vegetation around pit.
SSF A50	–										
SSF B51	Yes	64	0.1	2	0.3	No	Fluid	No	No	No	Grass around pit.
SSF B52	–										
SSF B55	Yes	1,200	0	0		No	Fluid	No	Yes	No	Oily soil mound adjacent pit.
SA WIW1	–										
SA WIW2	Yes	625	0.5	0.5	0.5	No	Tar	No	No	No	Tar overgrown with vegetation.
SA WIW2	Yes	750	0.5	0.5	0.5	No	Tar	No	No	No	Tar overgrown with vegetation.
SA WIW3	No	800	0	2	NA	NA		No	No	No	Aquatic vegetation in pit.
SA WIW4	Yes	1,200	0.05	1.5	NA	No	Tar	No	No	No	Dense vegetation around pit.
SA WIW5	Yes	NA	NA	0				No	Yes	No	Grass over former pit area.
SA WIW6	Yes	3,150	0.05	1	0.5	No	Tar	No	No	No	
SA WIW6	Yes	12	0.03	2	0.5	No	Fluid	No	No	No	Dense vegetation around pit.
SA 1	–										

☐ Covered Pit
Yes Oily wastes are present in the pit.
▨ Yes Contaminants have migrated beyond the confines of the pit.
No Oily wastes were not identified.
– Evidence of a pit was not found on the site.
NA Not Available

CONFIDENTIAL
PET 040992

Table F – 5
Description of Contamination Associated With Well Site Pits

Assessed Site	Pit Status	Estimated Dimensions				Berm Present	Oil Condition	Siphon Found	Seepage Found	Discharge to Stream	Comments
		Area	Thickness (m)		Freeboard						
		(m2)	Oil	Water	(m)	Yes/No	Fluid/Tar	Yes/No	Yes/No	Yes/No	

☐ Covered Pit

Yes — Oily wastes are present in the pit.

▨ Yes — Contaminants have migrated beyond the confines of the pit.

No — Oily wastes were not identified.

– — Evidence of a pit was not found on the site.

NA — Not Available

Assessed Site	Pit Status	Area (m2)	Oil (m)	Water (m)	Freeboard (m)	Berm Present	Oil Condition	Siphon Found	Seepage Found	Discharge to Stream	Comments
SA 2	No	400	0	0				No	No	No	
SA 8	Yes	900				NA		No	Yes	No	Vegetation over former pit area.
SA 9	–										
SA 11	Yes	64	1	1	1	No	Fluid	No	No	No	Dense vegetation around pit.
SA 12	Yes	400				NA		No	Yes	No	Vegetation over former pit area.
SA 13	No	NA						No	No	No	Vegetation over former pit area.
SA 13	No	NA						No	No	No	Vegetation over former pit area.
SA 16	Yes	100				NA		No	Yes	No	Grass over former pit area.
SA 18	Yes	NA				NA		No	Yes	No	Vegetation around former pit.
SA 19	Yes	375	0.05	1	NA	No	Tar	No	Yes	Yes	Possible discharge area.
SA 20	Yes	6	0.01	1	0	No	Fluid	No	Yes	Yes	Dense vegetation around pit.
SA 21	Yes	100	0.05	2	1	Yes	Tar	No	No	No	Dense vegetation around pit.
SA 21	Yes	100	0.05	0	0.5	No	Fluid	No	Yes	No	Vegetation inside pit area.
SA 25	Yes	100							Yes	No	Pit undergoing burial.
SA 27	–										
SA 28	–										
SA 32	Yes	2,500	0.1	2	1	Yes	Fluid	No	No	No	Dense vegetation around pit.
SA 32	No	500	0	2				No	No	No	Aquatic vegetation in pit.
SA 33	Yes	150	0.5	1.5	1	Yes	Fluid	No	No	No	Dense vegetation around pit.
SA 33	Yes	16	0.02	2	0.5	No	Fluid	No	Yes	Yes	Vegetation around pit area.

Table F – 5
Description of Contamination Associated With Well Site Pits

Assessed Site	Pit Status	Estimated Dimensions				Berm Present	Oil Condition	Siphon Found	Seepage Found	Discharge to Stream	Comments
		Area	Thickness (m)		Freeboard						
		(m2)	Oil	Water	(m)	Yes/No	Fluid/Tar	Yes/No	Yes/No	Yes/No	
SA 34	–										
SA 35	–										
SA 36	Yes	NA	NA	NA	NA	NA	Fluid	No	No	No	Pit not accessible – tall grass.
SA 43	▨ Yes	NA				NA		No	▨ Yes	No	Former pit area is vegetated.
SA 44	Yes	750	NA	NA	0.5	Yes	Tar	No	No	No	Dense vegetation around pit.
SA 46	Yes	144	0.05	0	2	Yes	Tar	No	No	No	Pit filled with cut trees.
SA 46	☐ No	NA						No	No	No	Former pit area vegetated.
SA 54	Yes	150	0.05	0	1	Yes	Tar	No	No	No	Dense vegetation around pit.
SA 55	Yes	25	0.05	0	2	No	Tar	No	No	No	Dense vegetation around pit.
SA 56	–										
SA 58	▨ Yes	96	0.05	1	1	No	Tar	No	▨ Yes	No	Dead vegetation in pit.
SA 58	Yes	700	0.05	1.5	1	Yes	Tar	No	No	No	Plantation adjacent pit.
SA 59	▨ Yes	300	0.05	1	0.3	No	Tar	▨ Yes	▨ Yes	No	Grass growing into pit.
SA 60	▨ Yes	750	0.02	1	0.1	No	Fluid	No	▨ Yes	▨ Yes	Grass around pit.
SA 72	Yes	1,500	0.02	2	1	No	Tar	No	No	No	Vegetation on oil layer.
SA 72	No	100	0	0	2	No		No	No	No	Trees growing in pit.
SA 73	–										
SA 74	▨ Yes	750	0.1	2	1	Yes	Fluid	▨ Yes	▨ Yes	No	Tall grass adjacent pit.
SA 75	Yes	1,500	0.05	1	1	No	Tar	No	No	No	Dead vegetation in pit.
SA 75	No	225				No		No	No	No	Pit is empty.

☐ Covered Pit	Yes	Oily wastes are present in the pit.	No	Oily wastes were not identified.
	▨ Yes	Contaminants have migrated beyond the confines of the pit.	–	Evidence of a pit was not found on the site.
			NA	Not Available

Table F – 5
Description of Contamination Associated With Well Site Pits

Assessed Site		Pit Status	Estimated Dimensions				Berm Present	Oil Condition	Siphon Found	Seepage Found	Discharge to Stream	Comments
			Area	Thickness (m)		Freeboard						
			(m2)	Oil	Water	(m)	Yes/No	Fluid/Tar	Yes/No	Yes/No	Yes/No	

☐ Covered Pit

Yes Oily wastes are present in the pit.

▨ Yes Contaminants have migrated beyond the confines of the pit.

No Oily wastes were not identified.

– Evidence of a pit was not found on the site.

NA Not Available

SA	77	Yes	300	0.1	1.5	0.5	Yes	Fluid	No	No	No	Grass around pit.
SA	78	Yes	600	0.05	1	0.1	No	Fluid	No	Yes	Yes	Grass around pit.
SA	81	Yes	4,800	0.15	1.5	0.5	No	Fluid	No	No	No	Dense vegetation around pit.
SA	84	Yes	2,100	0.01	2	0.5	No	Fluid	No	No	No	Plantation adjacent pit.
SA	84	No	300	0	0	2	No		No	No	No	Pit is empty.
SA	85	Yes	100	Film	1.5	0.1	No	Fluid	No	No	No	Grass around pit.
SA	86	Yes	600	0.02	1	1	Yes	Fluid	No	No	No	Dense vegetation around pit.
SA	86	No	400	0	1.5	1	No		No	No	No	Dense vegetation around pit.
SA	91	Yes	450	0.01	3	3	No	Fluid	No	No	No	Dense vegetation around pit.
SA	91	No	3,200	0	1.5	0.5	No		No	No	No	Grass/bamboo adjacent pit.
SA	93	Yes	450		0.1	0.1	No	Tar	No	Yes	No	Grass growing over former pit.
SA	94	Yes	3,600	0.05	2	0.1	No	Fluid	No	No	No	Dense vegetation around pit.
SA	94	Yes	384	0.05	1	1	Yes	Fluid	No	No	No	Grass around pit.
SA	95	Yes	1,900	0.15	NA	0.1	No	Tar	No	Yes	No	Dead vegetation in pit.
SA	95	Yes	400	NA	NA	0.1	Yes	Tar	No	Yes	No	Pit contains wood cuttings.
SA	95	No	400	0			No		No	No	No	Cleared area around pit.
SA	97	Yes	2,800	Film	0.2			Fluid	No	Yes	Yes	Former pit in wetland area.
SA	100	Yes	800						No	Yes	No	Grass growing over former pit.
SA	103	Yes	1,600	0.2	2	0.5	Yes	Fluid	Yes	Yes	Yes	Tall grass adjacent pit.
SA	103	No	100	0	2	1	Yes		No	No	No	Plantation adjacent pit.

[redacted]

Table F – 5
Description of Contamination Associated With Well Site Pits

Assessed Site	Pit Status	Estimated Dimensions				Berm Present	Oil Condition	Siphon Found	Seepage Found	Discharge to Stream	Comments
		Area	Thickness (m)		Freeboard						
		(m2)	Oil	Water	(m)	Yes/No	Fluid/Tar	Yes/No	Yes/No	Yes/No	

☐ Covered Pit — Yes: Oily wastes are present in the pit. — No: Oily wastes were not identified.

▨ Yes: Contaminants have migrated beyond the confines of the pit. — –: Evidence of a pit was not found on the site.

NA: Not Available

SA 104	Yes	1,125	0.1	2	0.5	No	Fluid	No	No	No	Tall grass adjacent pit.
SA 107	▨ Yes	1,200	0.05	1	0.1	No	Fluid	No	▨ Yes	No	Cut trees dumped into pit.
SA 109	▨ Yes	1,250	0.1	1.5	1	Yes	Fluid	No	▨ Yes	No	Grass around pit.
SA 109	No	225	0	1	1	No		No	No	No	Dense vegetation around pit.
SA 110	Yes	1,500	0.05	1.5	1	Yes	Fluid	No	No	No	Vegetation around pit.
SA 111	Yes	900	0.1	1.5	0.5	Yes	Fluid	▨ Yes	No	No	Grass around pit.
SA 113	Yes	1,500	0.05	0.1	0.1	No		No	No	No	Grass and trees growing in pit.
CU 2	▨ Yes	1,150				No		No	▨ Yes	▨ Yes	Sparse grass over former pit.
YB 2	▨ Yes	125	0.01	2.5	1.5	No	Fluid	▨ Yes	▨ Yes	▨ Yes	Tall grass adjacent pit.
YU 4	▨ Yes	225	0.1	2	1	Yes	Fluid	▨ Yes	▨ Yes	▨ Yes	Tall grass adjacent pit.
YU 6	☐ No	400	0	0		No		No	No	No	Garbage in pit.
YU 5	Yes	90	0.005	1.5	1	Yes	Fluid	No	No	No	Dense vegetation adjacent pit.
YU 5	Yes	120	0.05	2	1	Yes	Tar	▨ Yes	No	No	Plantation adjacent pit.
YU 5	Yes	60	0.01	1	1	No	Fluid	No	No	No	Dense vegetation adjacent pit.
YU 12	▨ Yes	144	0.05	2.5	0.5	Yes	Fluid	▨ Yes	▨ Yes	No	Dense vegetation adjacent pit.
YUS 1	▨ Yes	400						No	▨ Yes	No	No vegetation adjacent pit.
AU 1	▨ Yes	100						No	▨ Yes	No	Grass on former pit area.
AU 4	▨ Yes	400							▨ Yes	No	Grass on former pit area.
AU 6	▨ Yes	100						No	▨ Yes	No	Grass on former pit area.
AU 7	☐ No	1,250						No	No	No	Located in low wetland area.

Table F – 5
Description of Contamination Associated With Well Site Pits

Assessed Site	Pit Status	Estimated Dimensions				Berm Present	Oil Condition	Siphon Found	Seepage Found	Discharge to Stream	Comments
		Area (m2)	Thickness (m) Oil	Thickness (m) Water	Freeboard (m)	Yes/No	Fluid/Tar	Yes/No	Yes/No	Yes/No	
AU 9	No	64						No	No	No	Grass on former pit area.
AU 11	Yes	100	0.01	2	0.3	Yes	Fluid	Yes	Yes	Yes	Tall grass adjacent pit.
AU 12	Yes	100						No	Yes	No	Grass on former pit area.
AU 15	Yes	150						No	Yes	No	Grass on former pit area.
AU 16	Yes	150						No	Yes	No	Grass on former pit area.
AU 17	Yes	64	0.05	1.5	1	Yes	Fluid	Yes	Yes	Yes	Grass adjacent pit .
AU 17	Yes	1	0.5	0	0.1	No	Fluid	No	No	No	Temporary pit below flowline.
AU 18	–										
AU 19B	Yes	150						No	Yes	No	No vegetation over former pit.
AU 21	Yes	100						No	Yes	No	Sparse grass on former pit area.
AU 24	Yes	150						No	Yes	No	Grass on former pit area.
AU 24	No	1,200	0	2	1	Yes		No	No	No	Unknown usage.
AUS 1	Yes	(a)									
AUS 1	No	(a)									
AUS 1	Yes	(a)									
RM 1	Yes	225	0.01	1.5	0.5	Yes	Fluid	No	No	No	Organic scum on water.
CN 1	Yes	120							Yes	No	Orchard adjacent former pit.
CN 2	Yes	450						No	Yes	No	Former pit adjacent plantation.
CN 3	No	150	0	2	1	Yes		No	No	No	Grass adjacent pit.
CN 8	No	80	0	0	2	Yes		No	No	No	Grass growing in pit.

☐ Covered Pit	Yes	Oily wastes are present in the pit.	No	Oily wastes were not identified.
	▨ Yes	Contaminants have migrated beyond the confines of the pit.	–	Evidence of a pit was not found on the site.
			NA	Not Available

Table F – 5

Description of Contamination Associated With Well Site Pits

Assessed Site	Pit Status	Estimated Dimensions				Berm Present	Oil Condition	Siphon Found	Seepage Found	Discharge to Stream	Comments
		Area	Thickness (m)		Freeboard						
		(m2)	Oil	Water	(m)	Yes/No	Fluid/Tar	Yes/No	Yes/No	Yes/No	
CN 11	–										
CN 12	Yes	300	0.3	2	0.5	Yes	Fluid	No	No	No	Dense vegetation on one side.
DU 1	▨ Yes	(a)									

☐ Covered Pit

Yes Oily wastes are present in the pit.

▨ Yes Contaminants have migrated beyond the confines of the pit.

No Oily wastes were not identified.

– Evidence of a pit was not found on the site.

NA Not Available

Total (All Conditions)	Yes	126	Open pits or closed pits with evidence of oil in the pit and/or evidence of oil migrating beyond the confines of the pit.
Total (All Conditions)	No	39	Open or closed pits with no evidence of oil accumulation.
Total	–	37	Evidence of open or closed pits not found.
Total Records		202	
Total	Yes	50	Oil wastes are cofined in the pit.
Total	▨ Yes	43	Oil waste present in an open pit with evidence that oil has migrated beyond the confines of the pit.
Total	▨ Yes	33	Oil waste present in a covered pit and/or oil waste present beyond the confines of a former pit.
Total	☐ No	13	No evidence of oil within the confines of a covered pit or beyond the confines of a covered pit.
Total	No	26	No evidence of oil in an open pit or beyond the confines of an open pit.

Note : Estimates of area and depth are based on a limited amount of data.
More reliable estimates cannot be prepared without additional field data.

Table F – 6
Description of Contamination Associated With Assessed Flowlines

Assessed Flowline		Evidence of Spill Yes / No	Description of Spill	Spill Location (a)	Vegetation Regeneration Within Corridor	Comments
LA	1	No			Yes	
LA	6	No			Yes	
LA	8	No			Yes	
LA	17	Yes	Line repair (b) spill affecting soil and water.	East of North Station access road.	Yes	Six flowlines cross the stream at this location.
LA	29	No			Yes	
LA	33	Yes	Line repair spill affecting soil and water.	Near well site LA10	Yes	Two flowlines in the corridor at spill location.
LA	34	No			Yes	
PH	5	No			Yes	Flowline has no supports over some of route.
AT	1	No			Yes	Flowline has no supports over most of route.
GU	3	No			Yes	Flowline has no supports over some of route.
GU	5	No			Exposed soil.	Flowline has no supports over most of route.
AG	AG8	No				Rent clearing along portion of route.
AG	AG10	No			Yes	
SSF	B57	No			Yes	
SSF	61	No			Yes	
SSF	B64	No			Yes	Stream sedimentation from well site construction.
SSF	A65	No			No	Well site located at Central Station.
SSF	WIW4	No			Yes	
SSF	A7	No			Yes	
SSF	A13	No			Yes	
SSF	B15	No			Yes	
SSF	B16	Yes	Line repair spill affecting soil. (50 m2)	200 m south of production station.	Yes	Eleven flowlines in the corridor at spill location.
SSF	A24	No			Yes	Flowline removed. Supports still in place.
SSF	A30	Yes	Line repair resulted in small spill.	50 metres east of A34 access road.		
SSF	A34	Yes	Line removal resulted in small spill.	Along access road to well site.	Yes	Flowline has been removed.
SSF	A38	No			Yes	
SSF	46	No			Yes	Up to twelve flowlines in corridor.
SSF	A50	No			Yes	Flowline removed. Supports still in place.
SSF	B51	No			Yes	Up to nine flowlines in corridor.
SA	WIW5	NA			Yes	No road access to corridor.
SA	11	No			Yes	Up to nine flowlines in corridor.
SA	13	Yes	Open valve resulted in 4 m2 spill.	At junction to main road.	Yes	Up to nine flowlines in corridor.
SA	20	Yes	Open valve resulted in 6 m2 spill.	At junction to main road.	Yes	Up to nine flowlines in corridor.
SA	25	No			Yes	Up to twelve flowlines in corridor.
SA	33	NA			Yes	No road access to corridor.
SA	35	No			Yes	Portions of the flowline are underground.
SA	46	Yes	2 m2 pit below flowline contains oil.		Yes	Recent repair to flowline.
SA	56	No			Yes	Up to five flowlines in corridor.

Table F – 6
Description of Contamination Associated With Assessed Flowlines

Assessed Flowline		Evidence of Spill Yes / No	Description of Spill	Spill Location (a)	Vegetation Regeneration Within Corridor	Comments
SA	58	NA			Yes	No road access to corridor.
SA	59	No			Yes	Up to twelve flowlines in corridor.
SA	73	No			No	Well site located at production station.
SA	74	No			Yes	
SA	81	No			Yes	Poor pipeline support at stream crossing.
SA	84	Yes	Repair resulted in 30 m2 spill below line.	At access road junction.	Yes	Two pipes joined at spill location.
SA	91	No			Yes	No road access to much of corridor.
SA	95	No			Yes	Flowline disconnected from wellhead.
SA	100	No			Yes	Up to five flowlines in corridor.
SA	107	No			Yes	Up to twelve flowlines in corridor.
SA	110	No			Yes	
SA	113	No			Yes	Flowline removed.
CU	2	No			Yes	
YB	2	No			Yes	
YU	4	No			Yes	Two flowlines in corridor.
YU	12	No			Yes	Up to three flowlines in corridor.
YUS	1	No			Yes	Two flowlines in corridor.
AU	4	Yes	Spill has flowed downslope.	At access road to well site AU5.	Yes	
AU	6	No			Yes	Two flowlines in corridor.
AU	12	No			No	Up to seven flowlines in corridor.
AU	16	No			Yes	Two flowlines in corridor.
AU	18	No			Yes	Two flowlines in corridor.
AUS	1	Yes	Spill affects land and water (60 m2).	At access road to well site AU15.		
RM	1	No			Yes	Flowline removed.
CN	3	No			Yes	
CN	8	No			Yes	Flowline is underground.
CN	12	No			Yes	Flowline removed.
DU	1	No			No	Wellsite is located at production station.

Total Spills 11

(a) The flowline was assessed from the well site boundary to the production station boundary.

(b) Observed pipeline repair method involves several steps.
1. A pit is dug below the section of pipe requiring repair.
2. The pipe is cut and the contents released to the pit.
3. A vacuum truck removes and disposes the fluid from the pit.
4. The damaged section of pipe is removed.
5. A new section of pipe is welded in place.

Table F – 7
Description of Contamination at Production Stations

Station	Spill Source (a)	Spill Type (b)	Estimated Dimensions (c)		Description of On–Site Spill	Description of Off–Site Spill
			Area (m2)	Depth		
Lago Agrio Central	Separator	PF	NA	NA	Surficial staining adjacent equipment area.	None
	Wash Tank	PF	NA	0.3	Small spills confined inside bermed area.	None
	Surge Tank	PF	NA	0.3	Small spills confined inside bermed area.	None
	Chemical Tank		Small	NA	Small spills confined to area below tanks.	None
	Fuel Tank	Diesel	100	Variable	Spills appear to be confined inside bermed areas.	None
		Gasoline	100	Variable	Spills appear to be confined inside bermed areas.	None
		Jet Fuel	100	Variable	Spills appear to be confined inside bermed areas.	None
	Pump/Compressor	PF	250	NA	Surficial staining adjacent equipment area.	None
	Lined Sump	PF,UO	Large	NA	Periodic sump overflow and drain to ditches.	Ditch drains to separation pit.
	Vehicle Maintenance	UO	Large	NA	Used oil and wash water discharge to ditch.	Ditch drains to low area off–site.
	Flare Stack	PF	400	NA	Surficial spills at the base of three flare stacks.	Spills enter separation pit.
	Pit	PF,UO	200	NA	Overflow discharges to channel.	Overflow collects in low off–site area.
		PF	Very Large	NA		Widespread contamination of land below discharge.
Lago Agrio North	Separator	PF	100	0.1	Numerous small spills covered with sand.	None
	Surge Tank	PF	20	0.3	Spills located below surface piping.	None
	Wash Tank	PF	50	0.3	Spills located near drain and inlet pipe.	None
	Pump/Compressor	PF	100	0.3	Oil spill around equipment.	None
	Flare Stack	PF	20	0.1	Surficial stains at base of stacks.	None
	Pit	PF	Very Large		None	Contamination appears confined to the channel and banks of channel below the discharge pipe.
	Industrial Solid Waste				Incinerated on site.	None
	Domestic Solid Waste				Incinerated on site.	None
Parahuacu	Well Site	Mud	3000	1	Large barren area with no vegetation growth.	Spill merged with produced water discharge.
	Surge Tank	PF	100	0.8	Oily sand throughout much of tank area.	None
	Separator	PF	–	–	Small spills are routinely covered with sand.	None
	~~Pump/Compressor~~	UO	–	–	~~Small spills adjacent equipment.~~	None
	Flare Line	PF	200	–	Spill below flare line enters drainage ditch.	Spill enters wetland adjacent flare line.
	Flare Stack	PF	NA	–	Spills enter separation pit.	
	Pit	PF	Very Large	–	None	Widespread contamination of land below discharge.

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Table F – 7
Description of Contamination at Production Stations

Station	Spill Source (a)	Spill Type (b)	Estimated Dimensions (c)		Description of On-Site Spill	Description of Off-Site Spill
			Area (m2)	Depth		
Atacapi	Separator	PF	200	0.3	Small spills are routinely covered with sand.	None
	Pit		Large		Contamination in channel on eroding slope.	Widespread contamination of land below discharge.
Guanta	Wash Tank	PF	500	0.3	Spills around tanks and beyond berm.	Spills ultimately merge at pit discharge area.
	Surge Tank	PF	500	0.3		
	Fuel Tank	Diesel	200	0.5	Spills around tanks and beyond berm.	None
	Pump/Compressor	UO	300	0.3	Numerous spills around pumps and sumps.	Sump discharge to ditch and ultimately merges
	Lined Sump				Associated with pump spills.	with pit discharge.
	Flare Line	PF			Fluids spill from line into ditch.	Spill merges with pit discharge.
	Flare Stack	PF	50	0.1	Fluids flow to separation pit.	Pit discharge to off-site land and water.
	Pit	PF	Very Large	NA		Widespread contamination of land.
	Note: All spills flow to produced water separation pit area and discharge to off-site land at that point.					
Aguarico	Separator	PF	20	0.3	Surficial spills throughout area.	
	Wash Tank	PF	NA	NA	Surficial spills throughout bermed area.	Spills have entered off-site wetland via drain pipes.
	Surge Tank	PF	80	0.1	Surficial spills throughout bermed area.	None
	Lined Sump	UO	200	0.2	Surficial spills on roadway.	Spills have entered off-site wetland.
	Flare Stack N.	PF	50		Surficial spills under stack.	
	Flare Stack S.	PF	NA	NA	Spills in former pit area.	Pit below flare is destroyed. Spills spread out.
	Pit	PF	NA	NA	Pit bottom is stained.	Pit is breached or destroyed. Spills spread out.
Shushufindi Central	Separator	PF	NA	NA	Surface oil stains around equipment.	Waste discharge to pipe and ditch which drains to off-site location.
	Vehicle Maintenance	UO	Large	NA	Wash water drains into central drain system.	Drain system discharges off-site near runway.
	Wash Tank	PF	200	0.5	Oil saturated the gravel and sand layer.	Drainage ditch adjacent berm contains oil.
	Surge Tank	PF	100	0.2	Surficial spills throughout bermed area.	Drainage ditch adjacent berm contains oil.
	Chemical Tank	Methanol		1	Groundwater appeared to be contaminated. The tank is near the Jet Fuel tank.	None.
	Fuel Tank	Diesel	200	1	Groundwater appeared to be contaminated.	None.
	Fuel Tank	Diesel	200	1	Groundwater appeared to be contaminated.	None.
		Jet Fuel			Groundwater appeared to be contaminated.	None.
	Pump/Compressor	PF	NA	NA	Surface oil stains around equipment.	Waste discharge or spill has flowed off-site via pipe

Table F – 7
Description of Contamination at Production Stations

Station	Spill Source (a)	Spill Type (b)	Estimated Dimensions (c)		Description of On–Site Spill	Description of Off–Site Spill
			Area (m2)	Depth		
						and ditch. The oily outflow has covered a very large area off–site. Separator drainage is via same ditch.
	Lined Sump					
	Flare Stack	PF	NA	NA	Only visual evidence of spills. The operator warned against entry to area due to sporadic large bursts of flame and uncombusted gases. Small spills under each of the nine flare stacks.	None
	Pit	PF	Large	2	Subsurface migration of contaminants adjacent at least one of the seven pits.	Discharge of produced water to bog and stream. Abundant vegetation in bog area.
	Industrial Solid Waste				Scrap metal, pipe and melted flare stacks are located in the area adjacent the separation pits.	None
	Hazardous Waste				About 50 drums located within concrete pit. The pit has been recently constructed.	None
	Domestic Waste				Recently constructed composting facility on site.	None
Shushufindi North	Wash Tank	PF	500	0.3	Oily soil throughout bermed area. The tank ruptured resulting in large spill. The spill entered an on site ditch.	The ditch flows to the separation pit which discharges waste to off–site river.
	Surge Tank	PF	100	0.3	Spill has entered drain and ditch outside berm.	As above.
	Chemical Tank	Methanol	20	0.5	Spill appears confined to narrow path.	Spill has flowed down slope and off–site.
	Pump/Compressor	UO	400	0.3	Used oil dumped into ditch adjacent pumps.	Used oil flows through culvert and into plantation.
		UO	50	0.3	Used oil has overflowed the adjacent sump.	Spill has flowed down slope and off–site. Spill merges with spill from methanol tank.
	Gas Vent	PF	100	0.5	Oily waste has collected below the vent. Emmissions appear to impact adjacent banana trees.	Oily waste has migrated downslope and entered river. The spill merges with pit discharge.
	Flare Stack	PF	2500	NA	Surficial spills in area around vertical stacks. Horizontal flares discharge fluids to separation pit.	None. Bullets of oil emmitted from flares into wetland.
	Pit	PF	Very Large	NA	Two pits have overflowed. Spill has moved down slope.	Discharge and overflows into wetland and river. Oil in soil, groundwater and surface water. Oil seeps on river bank. Contamination is widespread.

Table F – 7
Description of Contamination at Production Stations

Station	Spill Source (a)	Spill Type (b)	Estimated Dimensions (c)		Description of On–Site Spill	Description of Off–Site Spill
			Area (m2)	Depth		
Shushufindi South	Pipeline	PF	100	0.5	Spill under produced water line near pits.	None
	Separator	PF	NA	NA	Surficial spills throughout process area.	None
	Wash Tank	PF	20	0.5	Spills appear confined to areas below valves.	None
	Surge Tank	PF	20	0.5	Spills appear confined to areas below valves.	None
	Chemical Tank					
	Pump/Compressor	PF	NA	NA	Surficial spills throughout process area.	Oil change to engines resulted in very large oil spill to sump and ditch which drains to nearby river. The spill has collected in the lowland adjacent the river.
	Lined Sump	PF, UO				Sumps drain to off–site ditch. Ditch drains to river.
	Flare Stack	PF			Small surficial spills under 10 flare stacks.	None
	Pit	PF	Very Large	0.3	Spill outside of pit berm may result from overflow or dumping wastes into pit.	Contamination appears confined to the channel and banks of channel below the discharge pipe.
Shushufindi Southwest	Separator	PF			Surficial spills covered with sand.	None
	Wash Tank	PF	500	0.3	Oil on surface and in ditch inside bermed area. Sand over oily soil throughout bermed area.	Drain pipe spills to sump and then to off–site stream. Stream contains oil.
	Chemical Tank	NA	100	1	Soil has solvent odour adjacent tanks. Odour persists downslope to sump.	Sump and ditch discharge to off–site stream.
	Fuel Tank	Diesel	100	0.5	The spill has migrated out of the bermed area.	None
	Pump/Compressor	UO	300	NA	Surficial stains around equipment.	Sumps drain to ditch and to off–site stream.
	Lined Sump				Sumps are located on–site.	Sumps drain to ditch and to off–site stream.
	Flare Stack	PF	NA	NA	Horizontal flares knockout to separation pit. Surficial spills under vertical flares.	Pit discharges to off–site channel.
	Pit	PF	2000	NA	None	The pit is located near well site SSF23. It appears to have been used for tank bottoms. The discharge channel from the separation pit may have flowed through the pit some time ago. The pit contains a very large volume of oily sludge.
	Pit	PF	Very Large	NA	None	Contamination appears confined to the channel and banks of channel below the discharge pipe.
	Note: All process area wastes appear to discharge to a small off–site stream. The stream contains oily sediment. Oil floats on the surface of the water.					
Shushufindi Water Inj.	Pump/Compressor	UO	Very Large	NA	Surficial used oil spills around pump area.	Continuous discharge of used oil to stream adjacent the site. The stream contains oily sediment.

Table F – 7
Description of Contamination at Production Stations

Station	Spill Source (a)	Spill Type (b)	Estimated Dimensions (c)		Description of On–Site Spill	Description of Off–Site Spill
			Area (m2)	Depth		
						Oil floats on the water. Contamination appears confined to the channel and banks of channel below the discharge point. Channel enters a river some distance away.
Sacha Central	Vehicle Maintenance	UO	1000	NA	Used oil flows in ditch below flowlines. Wash water runs freely around the maintenance area.	None.
	Separator				Surficial spills around equipment.	None.
	Wash Tanks (2)	PF	Large	NA	Spills inside the bermed area. Oily fluid from gas line drips out of bottom of line. Water discharged inside tank area periodically.	Spill entered drainage ditch adjacent tanks. Ditch flows to separation pit discharge area and off–site.
	Surge Tank	PF	Large	NA	Oily soil around entire tank. Ditch contains free oil.	Oily waste is discharged via ditch to plantation area.
	Chemical Storage		Large	NA	Numerous filled drums on pipe racks. A large number of spills have occurred throughout compound. Several of the drums leak. Overturned drums and free oil on surface in several areas.	Bananas and corn adjacent compound appear normal.
	Fuel Tank	Diesel	500	1	Fuel spills inside and outside the bermed area.	None.
		Diesel	1500	1	Fuel spills inside and outside the bermed area.	Spills enter ditch adjacent plantation via drain.
	Pump/Compressor	UO	NA	NA	Used oil spills around compressor facility. Waste is pumped to the wash tank.	None.
	Flare Line					
	Flare Stack	PF	1500	NA	Spills at base of three flare stacks.	None.
	Pit	PF	Very Large	NA	Waste discharge to onsite ditch. Waste appears confined to ditch. Evidence of migration of oil into soil adjacent pits. Surface spills at edge of one of three pits.	Widespread contamination of soil and water at discharge point. Flow enters plantation area. Wastes appear confined to channel.
	Industrial Solid Waste					
	Domestic Solid Waste					

Table F – 7
Description of Contamination at Production Stations

Station	Spill Source (a)	Spill Type (b)	Estimated Dimensions (c)		Description of On–Site Spill	Description of Off–Site Spill
			Area (m2)	Depth		
Sacha North # 1	Separator	PF	200	2	Sump overflow results in spill to adjacent ditch. Groundwater has oil layer.	None.
	Wash Tank	PF	NA	NA	Small spills appear confined to bermed area.	None.
	Fuel Tank	Diesel	200	1	Spills inside and outside tank berm area.	None.
	Flare Stack	PF	500	NA	Surficial spills at base of three stacks.	Spills enter separation pit.
	Pit	PF	Large	NA	Surficial spills around oil recovery tank.	Oily soil and water below discharge pipe. Discharge has been discontinued.
Sacha North # 2	Separator	PF	100		Surficial spills around equipment.	Sump contents to underground pipe and off–site discharge.
	Wash Tank	PF	1000	NA	Spills inside bermed area have been collected in a ditch. Sandy soil to at least 3 metres.	Ditch enters sump which drains off–site.
	Surge Tank	PF	400	NA	Spills inside bermed area have been collected in a ditch. Sandy soil to at least 3 metres.	Ditch enters sump which drains off–site.
	Pump/Compressor	PF	100		Surficial spills around equipment.	Sump contents to underground pipe and off–site discharge.
	Flare Stack	PF	NA	NA	Small surficial spills below one of two stacks.	None.
	Pit	PF	Very Large	NA	High heat area. Sandy soils. Vegetation to edge of two pits. Possible seepage.	Discharge of waste to stream which flows through farmyard. Waste appears confined to channel.
Sacha South	Separator	PF	150	NA	Surficial spills around equipment.	Sump enters subsurface drainage system. Discharge point unknown.
	Wash Tank	PF	1000	1.5	Oil on shallow groundwater within bermed area. Oil in ditch outside bermed area.	Ditch enters subsurface drainage system. Discharge point unknown.
	Surge Tank	PF	1000	1.5	Oil on shallow groundwater within bermed area.	Ditch enters subsurface drainage system. Discharge point unknown.
	Pump/Compressor	PF	150	NA	Surficial spills around equipment.	Sump enters subsurface drainage system.
	Flare Stack	PF	500	NA	Surficial spills under each of five stacks.	None.
	Pit	PF	Very Large	NA		Oily sediment and water below discharge pipe. Wastes appear confined to stream channel. Stream flows through plantation.

Table F – 7
Description of Contamination at Production Stations

Station	Spill Source	Spill	Estimated Dimensions (c)		Description of On–Site Spill	Description of Off–Site Spill
	(a)	Type (b)	Area (m2)	Depth		
Culebra	Pipeline	PF	50	0.3	Spills under secondary pipeline adjacent site.	None.
	Wash Tank	PF	NA	NA	Spills from unbermed tank appear confined to site.	None.
	Fuel Tank	Diesel	20	1	Surficial spill outside bermed area.	None.
	Pump/Compressor	UO	50	0.3	Spills around equipment appear confined to site.	None.
	Flare Stack					
	Pit	PF	NA	NA	Pit covered in 1992. Unable to investigate due to extreme heat and danger near flare stack.	Vegetation in the area appears normal.
Yulebra	Wash Tank	PF	Small	NA	Small spills are confined to area inside the berm.	NA
	Fuel Tank	Diesel	20	1	Small spills are confined to area inside the berm.	None.
	Pump/Compressor	PF	Large	NA	Area adjacent equipment has surficial spills. Spills have entered and on–site ditch.	Spills have flowed via the ditch to an off–site wetland.
	Lined Sump	PF	NA	NA	Sump has overflowed and stained soil adjacent the sump.	None
	Flare Stack				Emitting black smoke during assessment.	
	Pit	PF	Very Large	NA	Produced fluids have been siphoned to on–site ditch. Pump spills have entered the same ditch.	Spills have flowed via the ditch to an off–site wetland.
Yuca	Separator	PF	100		Surficial spills around the manifold.	None.
	Wash Tank	PF	50	NA	Surficial spills confined to bermed area.	
	Surge Tank	PF	200	0.3	Surficial spills around tank and pipes. Temporary bermed area contains oily water.	None.
	Chemical Tank	NA	50	0.3	Spills around the unbermed tank.	None.
	Fuel Tank	Diesel	100	0.3	Spills inside and outside the bermed area.	None.
		Jet Fuel	50	NA	Spills around the unbermed tank.	None.
	Pump/Compressor	PF	100	NA	Surficial spills adjacent equipment.	Sump adjacent pumps has overflowed and spilled into off–site area. Spill appears confined to path.
	Lined Sump	PF	Large	NA	Overflow around sump area believed connected to the separators. Connected via underground pipe.	Overflow has flowed downslope and off–site. Overflow is through fenced area into the jungle.
	Flare Stack	PF	100	NA	Flare stack fluids flow into separator pit. Area below two flares is stained.	Discharge to off–site via pit siphon.
	Pit	PF	Very Large	NA		Discharged fluid appears confined to narrow channel.
	Industrial Solid Waste				Used drums at several locations. Some discarded pipe.	None

Table F – 7
Description of Contamination at Production Stations

Station	Spill Source	Spill	Estimated Dimensions (c)		Description of On–Site Spill	Description of Off–Site Spill
	(a)	Type (b)	Area (m2)	Depth		
Auca Central	Vehicle Maintenance	UO	200	0.3	Used oil and wash water stains around building.	Waste fluids enter ditch and flow off–site.
	Separator	PF	NA	NA	Surficial spills around equipment.	None.
	Fuel Tank	Diesel	100	0.5	Spills inside bermed area and at fill station. Spill has discharged via drain in berm.	None.
	Pump/Compressor	UO	100	0.3	Oil changes have resulted in spills adjacent equipment and around sump.	None.
	Generator	UO	100	0.3	Oil changes have resulted in spills.	Spills flow down slope towards road.
	Sumps	PF,UO	Large	NA	Process area drains to subsurface pipe system.	Sumps appear to drain via subsurface pipe to off–site stream. The stream contains oily waste.
	Flare Stack	PF	200	0.3	Spills below each of three stacks. Spills enter separation pit.	Separation pit discharges wastes off–site. Much black smoke emmitted from horizontal flare during spill event while on–site.
	Pit	PF	Large	NA	A large amount of exposed oily sludge is present. A large water pond located on the site has a slight hydrocarbon sheen on water surface.	Waste is discharged to off–site stream.
	Domestic Solid Waste					
Auca South	Pipeline	PF	40	0.3	Spill below flowlines entering the station.	None.
	Separator	PF	200	0.3	Separator sump has overflowed.	Overflow has spilled down slope and moved off–site..
	Wash Tank	PF	NA	NA		Pooled oily water in off–site wetland east of the wash tank. The source of the spill could be the tank.
	Pump/Compressor	PF	140	0.3	Pindo field transfer pump spill around pumps. Spills around pumps and pump sump.	Spill has flowed downslope and off–site. Pump sump drains downslope to off–site area.
	Lined Sump					
	Generator	UO	50	0.3	Used oil present on surface around equipment.	Discharge is to produced water separation pit.
	Flare Stack	PF	100		Surficial spills at base of two stacks.	Spills discharge to produced water separation pit.
	Pit	PF	Very Large			Oil in stream below discharge pipe. Oil in soil below discharge pipe.
Auca Sur	Fuel Tank	Diesel	Large	1	Spill inside and outside of bermed area.	Spill has entered ditch and collects in wetland.
	Pump/Compressor	PF	Large	NA	Spill around equipment and sump.	Spill has entered ditch and collects in low area.
	Generator	UO	Large	NA	Spill around equipment from oil changes.	Spill has flowed into low area with diesel spill.
	Pit	PF	Very Large	NA	Oil seepage to surface from former pit.	Pit fluids discharged to off–site area. Vegetation is oil stained to a height of 0.5 metres.

Table F – 7
Description of Contamination at Production Stations

Station	Spill Source (a)	Spill Type (b)	Estimated Dimensions (c)		Description of On–Site Spill	Description of Off–Site Spill
			Area (m2)	Depth		
Cononaco	Lined Sump	PF	NA	NA	Sump overflow enters on–site ditch.	Off–site drainage ditch contains pooled oil.
	Flare Stack	PF	NA	NA	Spills at base of two stacks appear surficial.	Stack fluids discharge to adjacent separation pit.
	Pit	PF	Very Large	NA	Spills around skimmed oil holding tank adjacent pit.	Discharge to off–site channel. Oil in soil and water.
Dureno	Surge Tank	PF	20	0.1	Spill located around edge of tank.	None
	Lined Sump	PF	20	NA	Sump has overflowed causing surficial stain.	Small spill downslope to jungle. Confined to path.
	Flare Stack	PF	100	0.1	Most of spill confined to stack pad.	Small spill downslope to jungle. Dead trees near flare stack. Possible heat damage.
	Pit	PF	Very Large	NA	None	Discharge is downslope to jungle and stream.

(a) Information not provided unless a spill has been identified.

(b) PF = Produced fluids containing oil and water. UO = Used oil

(c) Dimensions have been visually estimated. Depth estimated using limited hand operated auger investigations and knowledge of soil types. Estimates of spill area and depth are based on a very limited amount of data. More reliable estimates cannot be prepared without additional field data.

(d) NA = Not available. Usually not available due to limited information and/or safety concerns related to obtaining information.

Table F – 8
Condition of Tank Berms and Flare Stacks at Production Stations

Production Station		Product Storage Tank Berms (a)					Flare Stacks (b)				Comments
		No.	Area (m2)	Depth (m)	Berm Condition	Drain Control	No. Hor.	No. Vert.	Complete Combustion	Stack Condition	
Lago Agrio	Central	2	4,800	1.5	Good	Yes	0	4	Yes	Good	Condensate knockout to pit.
	North	2	7,150	1.2	Good	Yes	0	3	Yes	Good	Condensate knockout to pit.
Parahuacu		2	2,925	1.5	Good	Yes	0	2	No	Good	Condensate knockout to pit. Some smoke emitted.
Atacapi		2	1,200	1.5	Good	NA	0	3	Yes	Good	Condensate knockout to pit.
Guanta		3	2,301	1.2	Good	Yes	0	2	Yes	Good	Condensate spills to surface.
Aguarico		2	7,400	1.2	Poor	Yes	1	2	No	Poor	Condensate spills to surface.
Shushufindi	Central	3	36,150	1.3	Good	Yes	0	8	No	Good	Condensate spills to surface.
	North	2	13,000	1	Poor	Yes		2	Yes	Good	Condensate spills to surface.
							1		No	Poor	Condensate knockout to pit.
	South	2	14,400	1.5	Good	Yes	0	9	No	Poor	Condensate knockout to pit.
	Southwest	2	6,500	1	Poor (surge)	Yes		2	Yes	Good	Condensate spills to surface.
					Good (wash)	Yes	1		No	Poor	Condensate knockout to pit.
	Water Inj.	Not Present					0	0			
Sacha	Central	3	44,800	1.3	Good	Yes	0	3	Yes	Good	Condensate spills to surface.
	North # 1	2	28,000	1.3	Good	Yes	0	3	No	Good	Condensate spills to surface.
	North # 2	2	5,000	1.2	Good	Yes	0	2	Yes	Good	Condensate spills to surface.
	South	2	6,250	1.2	Poor	Yes	0	5	Yes	Good	Condensate spills to surface.
Culebra		Not Present					0	1	Yes	Good	Condensate spills to surface.
Yulebra		Not Present					0	1	No	NA	Condensate spills to surface.

Table F – 8
Condition of Tank Berms and Flare Stacks at Production Stations

Production Station		Product Storage Tank Berms (a)					Flare Stacks (b)				
		No.	Area (m2)	Depth (m)	Berm Condition	Drain Control	No. Hor.	No. Vert.	Complete Combustion	Stack Condition	Comments
Yuca		2	10,400	2	Poor	Yes		0	3	Poor	Condensate spills to pit.
Auca	Central	3	15,850	2	Poor	Yes	0	3	No	Poor	Condensate knockout to pit. Large burn event while on site.
	South	2	9,450	2	Good	Yes	0	3	Yes	Good	Condensate knockout to pit.
Auca Sur		Not Present					0	1	Not Lit	Good	Condensate spills to surface.
Cononaco		2	8,000	1.5	Good	Yes	0	2	Yes	Good	Condensate knockout to pit.
Dureno		Not Present					0	2	Yes	Good	Condensate knockout to pit. Some vegetation damage due to heat.

(a) Berm area is the combined estimated area within wash tank and surge tank berms.
Condition of berm is noted as good if asphalt cover is intact and no breaches are present.
Condition of berm is noted as poor when breaches are present or asphalt cover is in poor condition.
Drain control is noted as present if drains are present and equiped with shutoff valves.

(b) Hor. = Horizontal flare stack. Horizontal stacks vent only at separation pits.
Vert. = Vertical flare stack.
Complete combustion of gases is noted as "no" if smoke was emitted from the stack at any time during the assessment.
Condition of the flare stacks was noted as poor if they were not vertical, appeared bent or appeared burnt (ie. ragged metal).

Table F – 9
Description of Contamination Associated With Production Station Pits

Pit No.	Pit Status	Pit Use	Sep. Stage #	Estimated Dimensions Area (m2)	Thickness (m) Oil	Water	Oily Sludge Yes/No	Free Board (m)	Over-flow Yes/No	Berm Yes/No	Ditch Yes/No	Siphon Yes/No	Seep Yes/No	Discharge to Pit Yes/No	Stream Yes/No	Comments
Lago Agrio Central																
1	Open	Separation	1	600	1	0.5	Yes	1	No	Yes	Yes	No	No	Yes	No	Input = Oily waste from off-site via truck &
2	Open	Separation	2	150	0.1	1.5	Yes	1	No	Yes	Yes	No	No	Yes	No	produced water from station.
3	Open	Separation	3	150	Film	1.5	Yes	1	No	Yes	Yes	No	No	No	Yes	Extensive contamination below discharge.
4	Open	Haz Waste		NA												Under construction.
5	Open	Separation	1		0											Under construction. Concrete lined.
6	Open	Waste		16	0.05	1	Yes	0.5	Yes	Yes	Yes	Yes	No	No	Yes	Overflow to wetland.
Lago Agrio North																
1	Open	Separation	1	100	0.01	1.5	No	0.5	No	Yes	No	Yes	No	Yes	No	Concrete lined. Input = off-site oily waste
2	Open	Separation	2	100	0	1.5	No	0.5	No	Yes	No	Yes	No	No	Yes	and produced water from production station.
3	Open	Separation	1	200	0	1.5	Yes	1	No	Yes	No	Yes	No	Yes	No	
4	Open	Separation	2	225	0.01	1.5	Yes	1	No	Yes	No	Yes	No	No	Yes	Extensive contamination below discharge.
Parahuacu																
1	Open	Separation	Final	1575	0.02	2.5	Yes	1	No	Yes	No	Yes	No	No	Yes	Adjacent water pond not connected. Extensive contamination below discharge.
Atacapi																
1	Open	Separation	1	560	0.03	2.5	Yes	0.75	No	Yes	No	Yes	No	Yes	No	The pits are located adjacent a steep slope.
2	Open	Separation	2	270	Film	1.5	Yes	0.75	No	Yes	Yes	No	No	Yes	No	
3	Open	Separation	Final	400	Film	1.5	Yes	0.5	No	Yes	No	Yes	No	No	Yes	Extensive contamination below discharge.
Guanta																
1	Open	Separation	1	1444	0.02	2	Yes	0.75	No	Yes	No	Yes	No	Pit 2	No	Film in Pit #3 is reddish brown.
2	Open	Separation	2	400	0.01	2	Yes	0.75	No	Yes	No	Yes	No	Pit 3	No	
3	Open	Separation	Final	400	Film	2	Yes	0.75	No	Yes	No	Yes	No	No	Yes	Extensive contamination below discharge.
4	Open	Gas Vent		64	0	1.5	No	1	No	Yes	No	No	No	No	No	Berm is vegetated to water level.

Yes = Produced fluids have been discharged to the environment or seepage has been identified.

Table F – 9

Description of Contamination Associated With Production Station Pits

Pit No.	Pit Status	Pit Use	Sep. Stage #	Estimated Dimensions Area (m2)	Thickness (m) Oil	Thickness (m) Water	Oily Sludge Yes/No	Free Board (m)	Over-flow Yes/No	Berm Yes/No	Ditch Yes/No	Siphon Yes/No	Seep Yes/No	Discharge to Pit Yes/No	Discharge Stream Yes/No	Comments
Aguarico																
1	Open	Unknown		NA	0	1.5	No	NA	No	Yes	No	Yes	No	No	Yes	Extensive erosion below discharge.
2	Open	Separation		700	Film	0.1	No	2	No	Yes	No	No	No	No	No	Pit recently constructed.
3	Breached	Not in use	1	NA	NA	0	Yes	0	Yes	No	No	No	No	No	Yes	Severe damage around possible pits 3 and 4.
4	Breached	Not in use	1	NA	NA	0	Yes	0	Yes	No	No	No	No	No	Yes	Possibly former discharge without seperation. Extensive contamination below discharge.
Shushufindi Central																
1	Open	Off-site oil	1	693	0.5	2.5	Yes	0.5	No	Yes	No	Yes	Yes	Yes	No	Input = Oily waste from off-site via truck.
2	Open	Separation	2	147	0.5	1.5	Yes	0.2	No	Yes	No	Yes	Yes	Yes	No	Pit 1 separation.
3	Open	Separation	1	1056	0.2	2	Yes	0.5	No	Yes	Yes	No	No	Yes	No	Input = Produced water from station.
4	Open	Oil Storage		342	1.5	3	Yes	1	Yes	Yes	No	Yes	Yes	No	No	Recovered oil from pit 3 pumped to station.
5	Open	Separation	2	480	Film	3	Yes	0.5	No	Yes	Yes	No	No	Yes	No	
6	Open	Separation	3	340	0.1	2	Yes	0.5	No	Yes	Yes	No	No	Yes	No	
7	Open	Oil recovery		4	0	0	Yes	2	No	Yes	No	No	No	No	No	Small oil recovery pit.
8	Open	Separation	4	1598	Film	3	Yes	0.5	No	Yes	No	Yes	No	No	Yes	Direct discharge to wetland. Discharge area does not appear to be severly contaminated. Continuous mechanical oil recovery in practice.
9	Open	Gas Vent		300	0.02	2	Yes	1	No	Yes	No	No	No	No	No	Located at end of vent line.
Shushufindi North																
1	Open	Flare		928	NA	0	No	1	Yes	Yes	No	No	Yes	No	No	Large spill beyond pit area.
2	Open	Separation	1	144	0.01	1.5	Yes	0.3	Yes	Yes	No	Yes	No	Yes	Yes	Water boiling hot / oil burning.
3	Open	Separation	2	144	Film	1.5	Yes	0.5	Yes	Yes	Yes	No	No	Yes	Yes	
4	Open	Separation	3	400	0	1.5	Yes	1	No	Yes	No	No	No	No	Yes	Extensive contamination below discharge. Discharge to stream.
5	Open	Unknown		1200	0.05	1	Yes	0	Yes	No	No	No	Yes	No	Yes	

Yes (shaded): Produced fluids have been discharged to the environment or seepage has been identified.

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Table F – 9
Description of Contamination Associated With Production Station Pits

Pit No.	Pit Status	Pit Use	Sep. Stage #	Estimated Dimensions			Oily Sludge	Free Board	Over-flow	Berm	Ditch	Siphon	Seep	Discharge		Comments
				Area (m2)	Thickness (m)									to Pit	Stream	
					Oil	Water	Yes/No	(m)	Yes/No	Yes/No	Yes/No	Yes/No	Yes/No	Yes/No	Yes/No	
Shushufindi South																
1	Open	Separation	1	625	Film	1.5	Yes	0.5	No	Yes	Yes	No	No	Yes	No	
2	Open	Separation	2	625	Film	1.5	Yes	0.5	Yes	Yes	Yes	No	No	Yes	No	
3	Open	Separation	3	625	0.01	1.5	Yes	0.5	No	Yes	No	Yes	No	Yes	No	
4	Open	Separation	4	1089	Film	1.5	Yes	0.5	No	Yes	No	Yes	No	Yes	No	
5	Open	Separation	5	1089	Film	1.5	Yes	1	No	Yes	Yes	Yes	No	No	Yes	
6	Open	Separation		4	0	0	No	2	No	No	No	No	No	No	No	Beside pit #3. No water migration from pit #3 Extensive contamination below discharge.
7	Open	Flaring		625	NA	0	Yes	1	Yes	No	Yes	No	No	Yes	Yes	Proximity to flare prevented further appraisal.
8	Open	Unknown		800	NA	0	Yes	5	Yes	No	No	No	No	No	Yes	Near well site SSF 23. Former waste dump.
Shushufindi Southwest																
1	Open	Separation	1	3500	0.05	2	Yes	0.3	No	Yes	No	Yes	No	Yes	No	Flare condensate discharge to pit #1.
2	Open	Separation	2	1800	0.05	2	Yes	0.5	No	Yes	Yes	No	No	Yes	No	The oil in Pit #2 is tar–like.
3	Open	Separation	NA	1400	0	0	No	2	No	Yes	No	No	No	No	No	Pit #3 usage is not known.
4	Open	Separation	Final	2250	Film	2	Yes	1.5	No	Yes	Yes	Yes	No	No	Yes	Pit #4 discharge to channel, then stream. Extensive contamination below discharge.
Water Inj.																No pits found.
Sacha Central																
1	Open	Separation	1	702	0.1	2	Yes	1	No	Yes	No	Yes	No	Yes	No	Input = Produced water from station.
2	Open	Separation	2	100	0.1	2	Yes	1	Yes	Yes	No	Yes	No	Yes	No	Oil to sump and overflow ditch.
3	Open	Separation	3	100	0.1	2	Yes	1	No	Yes	No	Yes	No	No	Yes	Extensive contamination below discharge.
4	Open															Not in use. Under construction.
Sacha North #1																
1	Open	Separation	1	1800	0.1	1.5	Yes	1	No	No	No	Yes	No	No	Yes	Extensive contamination below discharge. Oil recovery during assessment No discharge during assessment
2	Open	Separation	1,2,3	NA	NA	1.5	No	0.75	No	Yes	No	Yes	No	No	Yes	New Installation.
3	Covered	Workover		NA	0	0	No		No		No	No	No	No	No	Covered in 1992.
4	Open	Gas Vent		100	0	2	No	1	No	Yes	No	No	No	No	No	Presence of gas prevented further appraisal.

▨ Yes — Produced fluids have been discharged to the environment or seepage has been identified.

Table F – 9
Description of Contamination Associated With Production Station Pits

Pit No.	Pit Status	Pit Use	Sep. Stage #	Estimated Dimensions Area (m2)	Thickness (m) Oil	Thickness (m) Water	Oily Sludge Yes/No	Free Board (m)	Over–flow Yes/No	Berm Yes/No	Ditch Yes/No	Siphon Yes/No	Seep Yes/No	Discharge to Pit Yes/No	Discharge Stream Yes/No	Comments
Sacha North #2																
1	Open	Separation	1	625	0.01	2	Yes	1	No	Yes	No	Yes	Yes	Yes	No	Both pits constructed in sandy soil.
2	Open	Separation	2	625	Film	2	Yes	1	No	Yes	No	Yes	No	No	Yes	Extensive contamination below discharge. Extreme heat from adjacent flares.
Sacha South																
1	Open	Separation	1	64	1	0.5	Yes	0.75	No	Yes	No	Yes	No	Yes	No	Both pits are reportedly present over a
2	Open	Separation	2	64	0.02	1.5	Yes	0.75	No	Yes	Yes	Yes	No	No	Yes	former pit (now covered). Discharge to stream discontinued in 1992.
3	Open	Gas Vent		100	0	1.5	No	1	No	Yes	No	No	No	No	No	Empty drums in pit.
4	Open	Gas Vent		100	0	1.5	No	1	No	Yes	No	No	No	No	No	
5	Open	Separation	1,2,3	NA	NA	1.5	No	0.75	No	Yes	No	Yes	No	No	Yes	Extensive contamination below discharge.
Culebra																
1	Closed	Unknown		NA					NA				NA			Not investigated due to safety concerns. Extreme heat from flare stack. Pit covered in 1992.
Yulebra																
1	Open	Unknown	1	150	0.1	1.5	Yes	0.75	No	Yes	No	Yes	No	No	Yes	Possible former separation pit. Extensive contamination below discharge.
'uca																
1	Open	Separation	1	1050	0.05	2.5	Yes	0.5	No	No	No	Yes	No	No	Yes	Input = Oily waste from well sites. Extensive contamination below discharge.

▨ Yes Produced fluids have been discharged to the environment or seepage has been identified.

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PET 041015

Table F – 9
Description of Contamination Associated With Production Station Pits

Pit No.	Pit Status	Pit Use	Sep. Stage #	Estimated Dimensions Area (m2)	Thickness (m) Oil	Thickness (m) Water	Oily Sludge Yes/No	Free Board (m)	Over-flow Yes/No	Berm Yes/No	Ditch Yes/No	Siphon Yes/No	Seep Yes/No	Discharge to Pit Yes/No	Discharge Stream Yes/No	Comments
Auca Central																
1	Open	Separation	1	400	0.1	1.5	Yes	1	No	Yes	No	Yes	No	Yes	No	Input = Oily waste from well sites. Input = Produced water from station.
2	Open	Separation	2	1200	Film	1.5	Yes	1	No	Yes	No	Yes	No	No	▨ Yes	Extensive contamination below discharge.
3	Open	Sewage	5 lagoons	NA	0		No								▨ Yes	
Auca South																
1	Open	Separation	1	150	0.01	1.5	Yes	0.5	No	Yes	Yes	No	No	Yes	No	Pits vulnerable to erosion damage.
2	Open	Separation	2	150	Film	1.5	Yes	0.2	No	Yes	No	Yes	No	No	▨ Yes	Tar-like oil patches in pit. Extensive contamination below discharge.
3	Open	Sewage	2 lagoons	100												Reportedly out of use.
Auca Sur																
1	Closed	Separation	1	400							Yes	No	No	No	▨ Yes	Produced water piped to Auca Central.
2	Closed	Workover		150							No	No	▨ Yes	No	No	Large off-site overflow and contamination. Pits 1 & 2 covered in 1993.
3	Open	Used Oil		2	1	0	Yes	0.5	Yes	No	No	No	▨ Yes	No	No	Overflow to wetland.
Cononaco																
1	Open	Separation	1	1500	0.05	3	Yes	1	No	Yes	No	Yes	No	No	▨ Yes	Extensive contamination below discharge.
Dureno																
1	Open	Separation	1	625	0.01	2.5	Yes	0.75	No	Yes	No	Yes	No	No	▨ Yes	Extensive contamination below discharge.

▨ Yes Produced fluids have been discharged to the environment or seepage has been identified.

Note : Estimates of area and depth are based on a limited amount of data. More reliable estimates cannot be prepared without additional field data.

Table F – 10
Description of Contamination Along Assessed Segments of Secondary Pipeline

Secondary Pipeline Corridor		Assessed Segment Number	Assessed Length (Km)	Description of Spill and Comments
Beginning	End			
Atacapi Station	Guanta Juntion	1	2.5	No spills observed along assessed segment.
Guanta Juntion	Lago Agrio Station	1	2.5	No spills observed along assessed segment.
Lago Agrio Station	Shushufindi Juntion	1	3.0	No spills observed along assessed segment.
		2	3.0	No spills observed along assessed segment.
Shushufindi Juntion	Shushufindi Station	1	2.0	No spills observed along assessed segment.
		2	2.0	No spills observed along assessed segment.
Shushufindi Station	Aguarico Station	1	3.0	Small 2 m2 spill below valve noted. Located between well sites SSF A9 and SSF B64.
Shushufindi Juntion	Yulebra Juntion	1	2.3	No spills observed along assessed segment.
		2	2.3	No spills observed along assessed segment.
		3	2.3	No spills observed along assessed segment.
Yulebra Juntion	Yuca Station	1	3.0	No spills observed along assessed segment.
Yulebra Juntion	Cononaco Station	1	2.5	No spills observed along assessed segment.
		2	2.5	No spills observed along assessed segment.
		3	2.5	No spills observed along assessed segment.
		4	2.5	No spills observed along assessed segment.
	Total	15	38	

HBT AGRA Limited
Engineering & Environmental Services

SITE NUMBER ____________

SITE SKETCH

N

LEGEND

⊗[1]	Sample locations	Ⓣ	Tank
X	Auger hole observations	⬬	Spill
Ⓦ	Well head	P	Pit
———	Above ground feature	B	Building
- - - -	Below ground feature	⬭	Depression
⌐┅┅┅	Berm	⬭	Mound
⟶	Drainage direction	┬┬┬┬┬	Slope
⌂	Residence	— – ——	Well Site Boundary
═	Roadway		
〰	Stream		

HAVE ADDITIONAL SKETCHES BEEN DRAWN FOR THIS SITE?

☐ YES ☐ NO NUMBER__________

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SITE NUMBER ____________

PITS

TYPE OF PIT: ☐ FLARE PIT ☐ WASTE PIT ☐ DRILL SUMP/WORKOVER PIT ☐ OTHER

PIT CONTENTS: ☐ PRODUCED FLUIDS ☐ WATER ☐ DRILL MUD ☐ OTHER ____________

PIT DIMENSIONS: LENGTH ________ m WIDTH ________ m DEPTH ________ m

PIT BOTTOM RELATIVE ELEVATION
AT GRADE ________
BELOW GRADE ________ m
ABOVE GRADE ________ m

PIT USAGE: ☐ IN USE ☐ OUT OF USE ☐ UNKNOWN

IS THE PIT BERMED? ☐ YES ☐ NO

CONDITION OF BERM /CONSTRUCTION DETAILS ____________

WAS THE SUBSURFACE ADJACENT TO THE PIT PROBED WITH A HAND AUGER? ☐ YES ☐ NO

DEPTH OF AUGER PENETRATION ________ m DISTANCE FROM PIT ________ m

DESCRIPTION OF SOIL MATERIALS ADJACENT THE PIT: ____________

EVIDENCE OF SPILLS/OVERFLOW: ____________

ESTIMATED SPILL AREA ____________ m^2 (include all spills)

IS MORE THAN ONE SPILL AREA PRESENT? ☐ YES ☐ NO NUMBER OF SPILL AREAS ________

ESTIMATED AVERAGE CONTAMINATED THICKNESS WITHIN SPILL AREA ____________ m

HAVE ALL SPILLS BEEN RECORDED ON THE SKETCH MAP? ☐ YES ☐ NO

HAS THE SPILL MIGRATED BEYOND THE WELLSITE BOUNDARY? ☐ YES ☐ NO

HAS THE SPILL ENTERED A WATER COURSE? ☐ YES ☐ NO

If YES provide details ____________

WERE SOIL OR SLUDGE SAMPLES OBTAINED? ☐ YES ☐ NO If YES see attached Sample Summary

PIT ABANDONMENT DETAIL: ____________

DESCRIPTION OF VEGETATION ADJACENT THE PIT: ____________

OTHER INFORMATION AND OBSERVATIONS: ____________

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Engineering & Environmental Services

SITE NUMBER ________

STORAGE TANK

TANK TYPE: ☐ PRODUCT STORAGE TANK ☐ CHEMICAL TANK
☐ POP TANK ☐ KNOCKOUT TANK
☐ FUEL TANK

TANK VOLUME ____________________

TANK CONTENTS ____________________

IS THE TANK LOCATED ABOVE GROUND OR UNDERGROUND? ____________

IS THE TANK WITHIN A BERMED AREA? ____________________

BERM DIMENSIONS: LENGTH ________m WIDTH ________m HEIGHT ________m

BERM BOTTOM RELATIVE ELEVATION: AT GRADE ________
BELOW GRADE ________m
ABOVE GRADE ________

CONDITION OF BERM/CONSTRUCTION DETAILS: ____________________

____

WAS THE SUBSURFACE PROBED WITH A HAND OPERATED AUGER? ☐ YES ☐ NO

DEPTH OF PENETRATION ________m

DESCRIPTION OF SOILS IN AND AROUND THE TANK AREA ____________________

____

____

EVIDENCE OF SPILLS: ____________________

ESTIMATED SPILL AREA: ________________ m^2 (include all spills)

IS MORE THAT ONE SPILL AREA PRESENT? ☐ YES ☐ NO NUMBER OF SPILLS ________

ESTIMATED AVERAGE CONTAMINATED THICKNESS WITHIN SPILL AREA ________m

HAVE ALL SPILLS BEEN RECORDED ON THE SKETCH MAP? ☐ YES ☐ NO

HAVE SPILLS MIGRATED BEYOND THE BERMED AREA? ☐ YES ☐ NO

HAS THE SPILL ENTERED A WATER COURSE? ☐ YES ☐ NO
If YES prodive details

____

____

WERE SOIL SAMPLES OBTAINED? ☐ YES ☐ NO If YES see attached sample summary

ABANDONMENT DETAIL: ____________________

____

____

TANK AREA - OTHER INFORMATION & OBSERVATIONS: ____________________

____

____

____

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SITE NUMBER ________

WELLHEAD

POWER SOURCE: ☐ PROPANE ☐ GAS/DIESEL ☐ ELECTRIC

ARE TRANSFORMERS IN USE ON THE WELLSITE? ☐ YES ☐ NO

CHEMICALS CURRENTLY IN USE AT WELLHEAD: ________________

WAS THE SUBSURFACE PROBED WITH A HAND OPERATED AUGER? ☐ YES ☐ NO

DEPTH OF PENETRATION ________m

DESCRIPTION OF SOIL MATERIALS ADJACENT THE WELLHEAD: ________________

ESTIMATED SPILL AREA: ________________m2 (include all spills)

ESTIMATED AVERAGE CONTAMINATED THICKNESS: ________________m

IS MORE THAN ONE SPILL PRESENT? ☐ YES ☐ NO NUMBER OF SPILL AREAS ________

HAVE ALL SPILLS BEEN RECORDED ON THE SKETCH MAP? ☐ YES ☐ NO

HAVE SPILLS ORIGINATING FROM THE WELLHEAD MIGRATED BEYOND THE WELLSITE BOUNDARY? ☐ YES ☐ NO

HAS THE SPILL ENTERED A WATER COURSE? ☐ YES ☐ NO
If YES provide detail

WERE SAMPLES OBTAINED? ☐ YES ☐ NO
(If YES see attached sample summary)

WELL HEAD AREA - OTHER INFORMATION AND OBSERVATIONS:

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PET 041021

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SITE NUMBER ________

PROCESS EQUIPMENT

EQUIPMENT TYPE: ☐ FLARE STACK ☐ COMPRESSOR ☐ OTHER
☐ SEPARATOR ☐ HEATER
☐ TREATER ☐ PUMP

WAS THE SUBSURFACE PROBED WITH A HAND OPERATED AUGER? ☐ YES ☐ NO

DEPTH OF PENETRATION _____m

DESCRIPTION OF SOIL MATERIALS ADJACENT THE PROCESS AREA: ____________________

____

____

ESTIMATED SPILL AREA: ____________________m2 **(include all spills)**

ESTIMATED AVERAGE CONTAMINATED THICKNESS: ____________________m

IS MORE THAN ONE SPILL AREA PRESENT? ☐ YES ☐ NO NUMBER OF SPILL AREAS ________

HAVE ALL SPILLS BEEN RECORDED ON THE SKETCH MAP? ☐ YES ☐ NO

HAVE SPILLS MIGRATED BEYOND THE SITE BOUNDARY? ☐ YES ☐ NO

HAS THE SPILL ENTERED A WATER COURSE? ☐ YES ☐ NO
If YES provide details

____

____

____

WERE SAMPLES OBTAINED? ☐ YES ☐ NO
(If YES see attached sample summary)

HAVE AIR EMISSIONS IMPACTED SURROUNDING VEGETATION ☐ YES ☐ NO

EXTENT OF AFFECTED AREA ____________m2

PROCESS AREA - OTHER INFORMATION AND OBSERVATIONS

____

____

____

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PET 041022

WASTES

WHAT TYPE OF WASTE MATERIALS ARE GENERATED ON THE SITE?

DRILL MUD

WASTE OIL

TANK BOTTOMS

PRODUCED WATER

FILTERS TYPE ____________

USED OIL

SEWAGE

DOMESTIC TYPE ____________

GAS

CHEMICALS TYPE ____________

OTHER ________________________

ARE ANY OF THE ABOVE WASTE S DISPOSED OF AT THE WELL SITE? ☐ YES ☐ NO TYPES __________

DESCRIBE HOW THE ABOVE WASTES (if any) ARE REMOVED FROM THE SITE. ____________________

HAVE ANY OF THE ABOVE WASTES BEEN SPILLED ON THE SITE? ☐ YES ☐ NO
(If YES proved details)

HAS THE SPILL BEEN CHARACTERIZED ELSEWHERE ON THE DATA SHEETS ☐ YES ☐ NO

SITE PHOTOGRAPHS

4 X 6 PHOTO

DESCRIPTION:

4 X 6 PHOTO

DESCRIPTION:

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HBT AGRA Limited
Engineering & Environmental Services

PHASE I SITE RECONNAISSANCE PIPELINE DATA SHEET

INSPECTED LOCATION:

ASSESSMENT DATE: ____________

ASSESSMENT PERSONNEL: ________

FIELD NAME ______________________________

WELLSITE # ____________________

SEGMENT FROM ______________________________

TO ______________________________

APPROXIMATE LENGTH ______________________________ KM

SPECIFIC LOCATION

DISTANCE FROM ______________________________ KM

DIRECTION ______________________________

PIPELINE DETAIL:

☐ FLOWLINE ☐ SECONDARY PIPELINE

NUMBER OF PIPELINES IN CORRIDOR ____________ WIDTH OF CORRIDOR ____________ m

DIAMETER OF PIPELINES IN CORRIDOR ____________ REGENERATION WITHIN CORRIDOR: ☐ YES ☐ NO

PIPELINE CONTENTS
- ☐ PRODUCED FLUIDS
- ☐ OIL
- ☐ PRODUCED WATER

IS THE PIPELINE ABOVE OR BELOW GROUND? ☐ ABOVE ☐ BELOW

ARE REPAIR SLEEVES VISIBLE ALONG THIS PORTION OF THE PIPELINE ☐ YES ☐ NO NUMBER _____

SPILL DETAIL:

IS A SPILL EVIDENT AT THIS LOCATION OR OVER THIS SEGMENT OF PIPELINE ☐ YES ☐ NO

HAS A SPILL BEEN PREVIOUSLY DOCUMENTED ☐ YES ☐ NO ☐ UNKNOWN

(If YES provide detail)

____

____

ESTIMATED SIZE OF SPILL ____________ m2

ESTIMATED CONTAMINATED THICKNESS ____________ m

HAS THE SPILL AFFECTED AGRICULTURAL LAND? ☐ YES ☐ NO

HAS THE SPILL ENTERED A WATER COURSE ☐ YES ☐ NO

HAS A SAMPLE BEEN OBTAINED ☐ YES ☐ NO

HAS A SKETCH MAP BEEN DRAWN? ☐ YES ☐ NO

HYDROCARBON ODOUR KEY

None = N
Faint = F
Distinct = D
Strong = S

LOCATION	SAMPLE NUMBER	INTERVAL FROM	TO	TEXTURE	DESCRIPTION HYDROCARBON ODOUR

PHOTO NUMBER

ROLL	PHOTO	DESCRIPTION

OTHER INFORMATION AND OBSERVATIONS

____

____

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PET 041025

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SITE SKETCH

N

LEGEND

⊗	Sample locations	Ⓣ	Tank
⊗	Auger hole observations		Spill
Ⓦ	Well head	[P]	Pit
———	Above ground feature	[B]	Building
- - - -	Below ground feature		Marsh
	Berm		Depression
➔	Drainage direction		Mound
⌂	Residence	┬┬┬┬┬	Slope
═══	Roadway	—— – ——	Well Boundary
⌃⌃⌃⌃	Stream		

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APPENDIX G

SAMPLE SUMMARY AND ANALYTICAL RESULTS

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PET 041027

AGRA
Earth & Environmental Group

Table G – 1

Phase I Sample Summary and Analytical Request

Sample Identification					Interval		Hydro-carbon	Sample	Sampled	Analytical Request – Soil												Water
										Hydrocarbons		Heavy Metals					Other Inorganics				EC	See
Field	Site	#	Form	Type	(cm)		Odour	Matrix	Area	O&G	BTEX	ICPM	As	Hg	Se	Sn	S	Bromide	Cyanide	Flouride	pH	Note
AU	24	1	2347	S	90	120	F	Red / Grey Clay	Adjacent Former Pit	1												
AUS	BG	1	2344	S			N		Background Soil	1											1	
AUS	STN1	1	2346	S	100	120	F	Red Clay	Former Pit	1											1	
AUS	1	2	2346	S	10	40	S	Red Clay	Process Area	1												
CN	BG	1	2344	S			N		Background Soil	1		1									1	
CN	STN	1	2345	W				Water	Produced Water Pit													1
CN	1	1	2345	S	100	120	S	Red Clay	Former Pit	1		1									1	
CN	2	1	2345	S	160	200	D	Silty Clay	Former Pit	1												
CN	11	1	2345	S	0	30	D	Red Clay	Drainage Ditch	1												
CN	12	1	2346	S			S	Sludge	Pit Sludge	1												
CU	BG	1	2344	S			N		Background Soil	1												
CU	STN	1	2345	S	0	30	S	Sandy Gravel	Crude Tank	1												
CU	STN	2	2345	S	0	25	S	Sandy Gravel	Off–Site	1												
CU	2	1	2345	S	0	10	D	Sand / Pebbles	Well Pad	1											1	
DU	1	1	2260	S	0	10	S	Clay	Produced Water Pit	1												
DU	1	2	2260	S	0	10	S	Burnt Clay	Flare Stack	1		1									1	
DU	1	3	2260	W				Water	Pit Water													1
GU	BG	1	2341	S	15	25	N	Red Clay	Background Soil	1		1	1	1	1	1	1			1	1	
GU	ST	1	2341	S	0	50	F	Clay	Pit Discharge	1												
GU	ST	2	2341	S			S	Sludge	Pond / Flare Line	1												
GU	ST	3	2341	S	0	20	S	Clay / Sand	Diesel Tank	1												
GU	ST	4	2341	S	0	20	F	Clay	Sump Drain	1												
GU	ST	5	2341	W			F	Water	Produced Water Pit													1
GU	ST	6	2341	S	0	20	S	Clay / Sand	Crude Tank Drain	1												
GU	1	1	2258	W			S	Water	Pit Water													1
GU	1	2	2258	S	0	40	F	Clay	Pit Discharge	1												

▨ 1 Indicates analyses requested

Table G – 1
Phase I Sample Summary and Analytical Request

Sample Identification					Interval		Hydro–carbon	Sample	Sampled	Analytical Request – Soil												Water
										Hydrocarbons		Heavy Metals					Other Inorganics				EC	See
Field	Site	#	Form	Type	(cm)		Odour	Matrix	Area	O&G	BTEX	ICPM	As	Hg	Se	Sn	S	Bromide	Cyanide	Flouride	pH	Note
AG	ST	1	2337	S=Soil	0	20	S=Strong	Silty Clay	Flare Stack	1												
AG	ST	2	2337	S	0	30	S	Sand	Sump Discharge	1												
AG	ST	3	2337	S	0	30	S	Sand	Crude Tank	1												
AG	ST	4	2337	S	0	30	S	Silty Clay	Produced Water Discharge	1												
AG	3	1	2337	S	0	20	S	Clay / Organics	Pit Discharge	1												
AG	3	2	2337	S	0	5	S	Sand	Well Pad	1												
AG	6	1	2337	S	NA	NA	NA	NA	Pit Discharge	1											1	
AG	8	1	2337	S	0	120	D=Distinct	Clay	Pit Discharge	1												
AG	10	1	2337	S	0	30	D	Clay	Adjacent Pit	1												
AGSSF	BG	1	2337	S	0	20	N=None	Silty Brown Clay	Road cut near well SSF76	1		1									1	
AT	BG	1	2259	S	0	20	N	Red Clay	Road cut near station	1											1	
AT	ST	1	2259	S	0	10	D	Sand	Process Area	1												
AT	ST	2	2259	S			S	Sludge	Pit Sludge	1												
AT	ST	2	2259	W=H2O			D	Water	Produced Water Pit													1
AT	ST	3	2259	S	0	10	S	Clay	Water Discharge	1												
AT	1	1	2259	S	150	190	F=Faint	Clay	Former Pit	1												
AT	2	1	2259	S			S	Sludge	Pit	1												
AT	2	2	2259	S	0	20	D	Clay	Sump Overflow	1												
AU	19/19B	1	2347	S	90	120	S	Sandy Clay	Former Pit	1												
AU	BG	1	2344	S			N		Background Soil	1		1									1	
AU	STN	1	2347	W				Water	Produced Water Pit													1
AU	1	1	2347	S	90	120	S	Silty Clay	Adjacent Former Pit	1												
AU	1	2	2347	S	90	120	F	Silty Clay	Adjacent Former Pit	1												
AU	4	1	2347	S	140	180	S	Clay / Sand	Former Pit	1												
AU	11	1	2345	W				Water	Pond / Depression													1
AU	17	1	2347	S	70	110	S	Clay / Sand	Adjacent Pit	1												

▨ 1 Indicates analyses requested

Table G – 1

Phase I Sample Summary and Analytical Request

Sample Identification					Interval		Hydro-carbon	Sample	Sampled	Analytical Request – Soil												Water
										Hydrocarbons		Heavy Metals					Other Inorganics				EC	See
Field	Site	#	Form	Type	(cm)		Odour	Matrix	Area	O&G	BTEX	ICPM	As	Hg	Se	Sn	S	Bromide	Cyanide	Flouride	pH	Note
GU	3	1	2258	S	0	100	N	Clay	Off–Site Stream	1												
GU	3	2	2258	S	0	30	D	Silt / Sand	Dumped Soil	1		1		1							1	
GU	5	1	2258	S	0	20	S	Clay	Pump / Off–Site	1												
GU	5	2	2258	S	0	100	N	Burnt Clay	Flare Stack	1												
GU	8	1	2258	S	0	20	S	Clay	Drainage Ditch	1												
GU	8	2	2258	S	0	20	F	Clay	Off–Site	1												
LA	11B	1	2256	S	0	20	F	Sand	Well Pad	1												
LA	FL17	1	2257	S			S	Sludge	Creek Below Flowline	1												
LA	STC	1	2257	S	0	5	F	Sand	Crude Tank	1												
LA	STC	2	2257	S	0	5	N	Sand / Tar	Fuel Tanks	1												
LA	STC	3	2257	S	0	20	D	Sand	Process Area	1												
LA	STC	4	2257	W			D	Water	Waste Pit													1
LA	STC	5	2258	S	0	5	F	Sand / Gravel	Diesel Tank	1												
LA	STC	6	2258	S	20	40	D	Sand	Crude Tank	1												
LA	STC	7	2258	S	0	5	F	Sand / Silt	Crude Tank	1												
LA	STC	8	2258	W			S	Water	Produced Water Pit													1
LA	STC	9	2260	S			S	Sludge	Produced Water Pit	1		1	1	1	1	1	1	1	1	1	1	
LA	STN	1	2257	S	0	20	F	Sand / Tar	Crude Tank	1												
LA	STN	2	2257	S			S	Sludge	Pit	1	1	1									1	
LA	STN	2	2257	W			S	Water	Produced Water Pit													1
LA	STN	3	2257	S	0	20	S	Silty Clay	Pit Discharge	1												
LA	1	1	2256	S	0	30	F	Silty Clay	Pump	1												
LA	5	1	2256	S	0	30	F	Sand / Gravel	Well Pad	1												
LA	10	1	2256	S	0	30	D	Silty Sand	Flowline	1												
LA	10	2	2256	S	20	50	N	Sandy Clay	Well Pad – Background	1											1	
LA	12	1	2256	S	0	30	F	Sandy Silt	Well Pad	1												

1 Indicates analyses requested

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Phase I Sample Summary and Analytical Request

CONFIDENTIAL
PET 041031

1 Indicates analyses requested

Sample Identification					Interval		Hydro–carbon	Sample	Sampled	Analytical Request – Soil												Water
										Hydrocarbons		Heavy Metals					Other Inorganics				EC	See
Field	Site	#	Form	Type	(cm)		Odour	Matrix	Area	O&G	BTEX	ICPM	As	Hg	Se	Sn	S	Bromide	Cyanide	Flouride	pH	Note
LA	21	1	2256	S	0	20	S	Sandy Gravel	Well Pad – Flowline	1												
LA	26	1	2256	S	0	20	N	Silty Clay	Off–Site	1												
LA	26	2	2256	S	0	20	N	Silty Clay	Off–Site	1												
LA	26	3	2256	S	0	15	S	Sandy Clay	Well Pad – Flowline	1												
LA	29	1	2256	S	0	20	D	Sandy Silt	Flowline	1												
LA	29	2	2256	S	10	20	D	Sandy Silt	Well Pad	1		1									1	
LA	34	1	2257	S	0	20	D	Silty Clay	Well Pad	1												
LA	35	1	2257	S	70	100	N	Sandy Silt	Well Pad – Flowline	1												
PH	BG	1	2260	S	15	25	N	Red Clay	Road cut near station	1											1	
PH	ST	1	2259	S	0	20	S	Clay	Produced Water Discharge	1												
PH	ST	2	2259	S	0	20	S	Clay	Flare Line	1												
PH	ST	3	2259	S	0	50	F	Mud – Bentonite	Drill Mud Discharge	1		1	1	1	1	1	1	1	1	1	1	
PH	ST	4	2259	S	0	30	D	Sand	Crude Tank	1												
PH	2	1	2259	S	0	10	D	Sand	Well Pad	1												
PH	2	2	2260	S	0	20	S	Sandy Clay	Off–Site	1											1	
PH	5	1	2260	S	0	20	S	Sand	Off–Site Spill	1												
RM	BG	1	2344	S			N		Background Soil	1		1									1	
RM	1	1	2347	S	0	15	D	Sandy Gravel	Well Pad	1												
RM	1	2	2345	W				Water	Pit Water												1	1
SA	BG	Sa	2343	S			N	Sand	Road cut near well SA27			1									1	
SA	BG	1	2344	S			N		Background Soil	1		1									1	
SA	BG	2	2350	S			N		Background Soil	1		1									1	
SA	FL84	1	2342	S	NA	NA	NA	NA	Below Pipeline	1												
SA	STC	1	2351	S	10	30	S	Silty Clay	Crude Tank / Flare Line	1												
SA	STC	2	2350	S	0	20	S	Clay	Site Drainage	1	1	1	1	1	1	1	1	1	1	1	1	
SA	STC	2	2351	S	10	30	S	Silty Clay	Crude Tank Drain	1											1	

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Phase I Sample Summary and Analytical Request

1 Indicates analyses requested

Sample Identification					Interval		Hydro-carbon	Sample	Sampled	Analytical Request – Soil												Water
										Hydrocarbons		Heavy Metals					Other Inorganics				EC	See
Field	Site	#	Form	Type	(cm)		Odour	Matrix	Area	O&G	BTEX	ICPM	As	Hg	Se	Sn	S	Bromide	Cyanide	Flouride	pH	Note
SA	STC	3	2351	S	0	100	D	Clay	Adjacent Pit	1												
SA	STC	4	2350	S	0	20	S	Silty Clay	Diesel Tank Drain / Site Drain	1												
SA	STN1	1	2351	S	150	200	D	Sandy Silt	Process Area	1		1									1	
SA	STN1	2	2351	S	10	30	S	Sand / Clay	Diesel Tank	1												
SA	STN1	3	2351	S	0	20	S	Clay / Sludge	Water Discharge Area	1												
SA	STN1	4	2350	S	0	20	S	Silty Clay	Process Area Drain	1												
SA	STN2	1	2350	S	100	200	D	Sand	Crude Tank	1												
SA	STN2	2	2350	S			S	Sediment/Sludge	Water/Waste Discharge Area	1	1	1	1	1	1	1	1	1	1	1	1	
SA	STS	1	2351	S	0	20	S	Clay	Tank Drainage Ditch	1												
SA	STS	2	2351	S	0	30	S	Sand / Clay	Crude Tank	1												
SA	STS	3	2351	S			S	Sediment	Water/Waste Discharge Area	1											1	
SA	WW6	1	2350	S	0	30	S	Silty Clay	Adjacent Pit	1												
SA	1	2	2342	S	0	20	D	Sand	Site Drainage	1												
SA	8	1	2346	S	70	120	D	Brown Clay	Adjacent Former Pit	1												
SA	9	1	2343	S	0	20	D	Silty Sand	Site Drainage	1												
SA	12	1	2346	S	70	120	D	Brown Clay	Former Pit	1											1	
SA	16	1	2346	S	0	60	S	Sandy Brown Clay	Adjacent Former Pit	1												
SA	20	1	2343	S	0	20	F	Silty Clay	Well Pad	1												
SA	21	1	2346	S	0	120	S	Brown Clay	Drained Pit	1												
SA	25	1	2343	S	0	30	D	Clay	Well Pad	1												
SA	25	2	2343	S	0	20	D	Clay	Adjacent Pit	1												
SA	27	1	2342	S	0	30	S	Sandy Clay	Well Pad	1												
SA	28	1	2342	S	0	30	D	Clay	Off-Site Depression	1												
SA	34	1	2343	S	0	20	S	Silty Clay	Meter Station	1												
SA	35	1	2342	S	50	60	F	Sand	Well Pad	1												
SA	36	1	2343	S	20	30	S	Sandy Organics	Flowline	1												

Table G – 1
Phase I Sample Summary and Analytical Request

Sample Identification					Interval		Hydro-carbon	Sample	Sampled	Analytical Request – Soil												Water
										Hydrocarbons		Heavy Metals					Other Inorganics				EC	See
Field	Site	#	Form	Type	(cm)		Odour	Matrix	Area	O&G	BTEX	ICPM	As	Hg	Se	Sn	S	Bromide	Cyanide	Flouride	pH	Note
SA	STC	3	2351	S	0	100	D	Clay	Adjacent Pit	1												
SA	STC	4	2350	S	0	20	S	Silty Clay	Diesel Tank Drain / Site Drain	1												
SA	STN1	1	2351	S	150	200	D	Sandy Silt	Process Area	1		1									1	
SA	STN1	2	2351	S	10	30	S	Sand / Clay	Diesel Tank	1												
SA	STN1	3	2351	S	0	20	S	Clay / Sludge	Water Discharge Area	1												
SA	STN1	4	2350	S	0	20	S	Silty Clay	Process Area Drain	1												
SA	STN2	1	2350	S	100	200	D	Sand	Crude Tank	1												
SA	STN2	2	2350	S			S	Sediment/Sludge	Water/Waste Discharge Area	1	1	1	1	1	1	1	1	1	1	1	1	
SA	STS	1	2351	S	0	20	S	Clay	Tank Drainage Ditch	1												
SA	STS	2	2351	S	0	30	S	Sand / Clay	Crude Tank	1												
SA	STS	3	2351	S			S	Sediment	Water/Waste Discharge Area	1											1	
SA	WW8	1	2350	S	0	30	S	Silty Clay	Adjacent Pit	1												
SA	1	2	2342	S	0	20	D	Sand	Site Drainage	1												
SA	8	1	2346	S	70	120	D	Brown Clay	Adjacent Former Pit	1												
SA	9	1	2343	S	0	20	D	Silty Sand	Site Drainage	1												
SA	12	1	2346	S	70	120	D	Brown Clay	Former Pit	1											1	
SA	16	1	2346	S	0	80	S	Sandy Brown Clay	Adjacent Former Pit	1												
SA	20	1	2343	S	0	20	F	Silty Clay	Well Pad	1												
SA	21	1	2346	S	0	120	S	Brown Clay	Drained Pit	1												
SA	25	1	2343	S	0	30	D	Clay	Well Pad	1												
SA	25	2	2343	S	0	20	D	Clay	Adjacent Pit	1												
SA	27	1	2342	S	0	30	S	Sandy Clay	Well Pad	1												
SA	28	1	2342	S	0	30	D	Clay	Off–Site Depression	1												
SA	34	1	2343	S	0	20	S	Silty Clay	Meter Station	1												
SA	35	1	2342	S	50	60	F	Sand	Well Pad	1												
SA	36	1	2343	S	20	30	S	Sandy Organics	Flowline	1												

▨ 1 Indicates analyses requested

Table G – 1

Phase I Sample Summary and Analytical Request

Sample Identification					Interval		Hydro-carbon	Sample	Sampled	Analytical Request – Soil												Water
										Hydrocarbons		Heavy Metals					Other Inorganics				EC	See
Field	Site	#	Form	Type	(cm)		Odour	Matrix	Area	O&G	BTEX	ICPM	As	Hg	Se	Sn	S	Bromide	Cyanide	Flouride	pH	Note
SA	36	2	2343	S	20	30	D	Sand	Chemical Tanks	1	1											
SA	36	3	2343	S	0	20	S	Sand	Diesel Tank	1												
SA	43	1	2343	S	60	70	S	Sand	Former Pit	1												
SA	46	1	2343	S	60	70	F	Clay	Suspect Pit	1												
SA	72	1	2350	S	50	70	D	Clay	Pit	1												
SA	74	1	2346	S	80	120	D	Brown Clay	Pit Discharge	1												
SA	77	1	2344	S	0	40	N	Brown Clay	Barren Area	1												
SA	78	1	2342	S	0	30	F	Clay	Pit Discharge	1												
SA	86	1	2342	S	NA	NA	NA	NA	Site Drainage	1												
SA	93	1	2350	S	0	50	F	Clay	Pit Discharge	1												
SA	93	2	2350	S	0	20	S	Clay	Drainage Ditch	1												
SA	94	1	2342	S	0	30	D	Clay	Pit	1												
SA	94	2	2342	W			S	Water	Pit Water													1
SA	94	3	2342	S			S	Sludge	Pit	1												
SA	97	1	2342	S	0	20	D	Clay / Organics	Off–Site / Meter	1												
SA	100	1	2343	S	0	20	S	Clay	Former Pit	1												
SA	109	1	2346	S	80	100	S	Brown Clay	Adjacent Pit	1												
SSF	A1	1	2338	S	10	30	D	Clay	Suspect Pit	1												
SSF	A24	1	2330	S	90	10	F	Clay	Adjacent Pit	1												
SSF	A43	1	2339	S	80	100	S	Clay	Adjacent Pit	1												
SSF	A43	2	2339	S	0	50	D	Clay	Former Pit	1												
SSF	A45B	1	2330	S	60	70	S	Clay / Organics	Pit Discharge	1												
SSF	A68	1	2330	S	90	100	F	Silty Clay	Near Stream	1												
SSF	A68	2	2330	S	60	70	D	Silty Clay	Former Pit	1												
SSF	A68	3	2330	S	20	30	F	Silty Clay	Former Pit	1												
SSF	B31	1	2330	S	0	45	S	Silt / Clay	Filter Dump Pit	1		1	1	1	1	1	1	1	1	1	1	

▨ 1 Indicates analyses requested

Table G – 1

Phase I Sample Summary and Analytical Request

Sample Identification					Interval		Hydro–carbon	Sample	Sampled	Analytical Request – Soil												Water
										Hydrocarbons		Heavy Metals					Other Inorganics				EC	See
Field	Site	#	Form	Type	(cm)		Odour	Matrix	Area	O&G	BTEX	ICPM	As	Hg	Se	Sn	S	Bromide	Cyanide	Flouride	pH	Note

1 Indicates analyses requested

SSF	B36	1	2983	S	0	20	D	Clay	Former Pit	1												
SSF	B36	2	2339	S	0	20	F	Sand	Filter / Waste Pit	1												
SSF	B52	1	2330	S	0	10	F	Silty Sand	Flowline	1												
SSF	B57	1	2340	S	50	100	S	Silty Clay	Adjacent Pit	1												
SSF	B59	1	2330	S	0	20	D	Clay	Pit Discharge	1												
SSF	B63	1	2330	S	0	50	S	Clay	Pit	1												
SSF	B64	1	2339	S	50	60	S	Clay	Former Pit	1											1	
SSF	B66	1	2339	S	0	50	S	Clay	Pit Discharge	1		1	1	1	1	1	1	1	1	1	1	
SSF	FL13	BG	2330	S	0	20	S	Clay	Background – 1.4 km	1											1	
SSF	FLA6	1	2330	S						1												
SSF	SP1	1	2330	S	0	20	D	Clay	Below Pipeline Valve	1												
SSF	SP1	2	2338	S	0	20	D	Clay	Below Pipeline	1												
SSF	STC	1	2338	S	180	200	D	Silty Clay	Adjacent Pit	1		1										
SSF	STC	2	2338	S	90	100	F	Clay	Crude Tank	1												
SSF	STC	3	2339	S	0	20	F	Clay	Crude Tank	1												
SSF	STC	4	2339	S	90	100	D	Clay	Fuel Tanks	1	1											
SSF	STC	5	2438	S	60	70	D	Silty Clay	Diesel Tank	1												
SSF	STN	1	2338	S	0	20	D	Silty Clay	Adjacent Depression	1												
SSF	STN	2	2338	S	0	20	D	Brown Clay	Pit Discharge	1												
SSF	STN	3	2338	S	0	20	S	Clay	Off–Site Discharge	1												
SSF	STN	4	2338	S	0	20	S	Sand	Tank Area Drain	1												
SSF	STS	1	2338	S	10	30	F	Clay	Discharge Channel	1												
SSF	STS	2	2338	S	0	30	D	Sand / Clay / Grav	Crude Tank	1												
SSF	STS	3	2338	S	0	30	S	Sand / Clay	Diesel Tank	1	1											
SSF	STS	4	2351	S	0	20	S	Silt	Waste Pit Sludge near SSF23	1	1	1	1	1	1	1	1	1	1	1	1	
SSF	STSW	1	2339	S	0	50	S	Sandy Clay	Crude Tank Drain	1												

Methodologies, Method Detection Limits (MDL) and description

Temperature (EPA 170.1)

Temperature measurements were made with a mercury-filled centigrade thermometer.

pH (EPA 150.1)

The pH of a sample is determined electrometrically using a combination electrode.

Specific Conductance (Conductivity) (EPA 120.1)

The specific conductance of a sample is measured by use of a self-contained Wheatstone bridge type meter (YSI Model 34). Samples are preferably analyzed at 25°C. If not, temperature corrections are made and results are reported at 25°C.

Turbidity (EPA 180.1)

The method is based upon a comparison of the intensity of light scattered by a sample under defined conditions with the intensity of light scattered by a reference suspension in a spectrophotometer at 540 nm. Readings are reported in NTU units.

Calcium (Dissolved) (EPA 215.1, MDL 0.1 mg/L)

Sample is filtered through 0.45 μm membrane filter and acidified with 1:1 nitric acid to a pH of <2. Filtered, acidified sample mixed with lanthanum chloride solution and analyzed by atomic absorption spectrophotometer at 422.7 nm.

Magnesium (Dissolved) (EPA 242.1, MDL 0.1 mg/L)

Sample is filtered through 0.45 μm membrane filter and acidified with 1:1 nitric acid to a pH of <2. Filtered, acidified sample analyzed by atomic absorption spectrophotometer at 285.2 nm.

Potassium (Dissolved) EPA 258.1, MDL 0.1 mg/L)

Sample is filtered through 0.45 μm membrane filter and acidified with 1:1 nitric acid to a pH of <2. Filtered, acidified sample analyzed by atomic absorption spectrophotometer at 265.9 nm.

Sodium (Dissolved) (EPA 273.1, MDL 0.1 mg/L)

Sample is filtered through 0.45 μm membrane filter and acidified with 1:1 nitric acid to a pH of <2. Filtered, acidified sample analyzed by atomic absorption spectrophotometer at 589.6 nm.

Iron (Total) (EPA 236.2, MDL 1 mg/L)

Unfiltered water sample digested vigourously with conc. HNO_3. Filtered, acidified sample analyzed by atomic absorption spectrophotometer at 248.3 nm.

Manganese (Dissolved) (EPA 243.1, MDL 0.1 mg/L)

Sample is filtered through 0.45 μm membrane filter and acidified with 1:1 nitric acid to a pH of <2. Filtered, acidified sample analyzed by atomic absorption spectrophotometer at 279.5 nm.

Chloride, Nitrate, Nitrite, Sulphate (EPA 300, MDL 0.1, 0.05, 0.05, 0.01 mg/L, respectively)

The method is based on the separation of these anions on an analytical ion exchange column using high performance liquid chromatograph. Detection of the anions in the mobile phase with an electrochemical detector. The chromatogram is plotted on a printer/plotter and areas are determined electronically and compared to standards.

Chloride (Brine waters) (APHA 4500-Cl^- D)

Chloride is determined by potentiomentric titration with ion selective electrode solution.

Bicarbonate/Carbonate (EPA 310.1, MDL 1 mg/L)

Bicarbonate and/or carbonate is determined in water samples from the appropriate alkalinity relationship using phenolphthalein and total alkalinity concentrations.

Alkalinity (EPA 310.1, MDL 1 mg/L)

An unfiltered sample is titrated to an electrometrically determined end point of pH 4.5 and 8.3. The sample must not be filtered, diluted, concentrated or altered in any way.

Hardness (EPA 130.2, MDL 6 mg/L)

Hardness is obtained by calculation based on the calcium and magnesium ions concentration in the sample.

$$Hardness\ (mg/L) = (Ca\ (mg/L)\ X\ 2.497) + (Mg\ (mg/L)\ X\ 4.118)$$

Total Dissolved Solids Filterable (1.8 μm, 0.45 μm) (EPA 160.1, MDL 2 mg/L)

A well-mixed sample is filtered through a standard glass fibre filter (1.5 μm, 0.45 μm). The filtrate is evaporated and dried to a constant weight at 180°C.

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Total Suspended Solid (Residue, Non-Filtrable) (EPA 160.2, MDL 2 mg/L)

A well-mixed sample is filtered through a glass fibre filter (1.5 µm), and the residue retained on the filter is dried to a constant weight at 103-105°C.

Total Petroleum Hydrocarbons, Total Recoverable (EPA 418, MDL 0.2 mg/L)

The sample is acidified to pH <2 and serially extracted with fluorocarbon-113 in a separatory funnel. The solvent is evaporated from the extract and the residue weighed. Interferences are removed with silica gel absorbent. Infrared analysis of the extract is performed by direct comparison with standards.

Color (APHA 2120B, MDL 1 mg/L)

True Color is determined by visual comparison of the sample with known concentrations of colored solutions. The colored solutions are prepared with varying ratios of chloroplatinate and cobaltous chloride. Values were reported in True Color Units.

Sulphite (EPA 376.1, MDL 0.2 mg/L)

A sample is acified with sulfuric acid and titrated with a standardized potassium iodide-iodate solution in the presence of a starch indicator.

Phosphorus, Total (EPA 365.2, MDL 0.01 mg/L)

Ammonium molybdate and stannous chloride react in an acid medium with dilute solutions of phosphorus. Molybdophosphoric acid is formed and reduced by stannous chloride to form molybdenum blue which is read at 690 nm in a spectrophotometer. The color is proportional to the phosphorus concentration.

Only orthophosphate forms a blue color in this test. Polyphosphates (and some organic phosphorus compounds) may be converted to the orthophosphate form by sulphuric acid hydrolysis. Organic phosphorus compounds may be converted to the orthophosphate form by persulphate digestion.

APHA Standard Methods for the Examination of Water and Wastewater, American Public Health Association, 17th ed. 1991.

EPA, 1983. Methods for Chemical Analysis of Water and Wastes. United States Environmental Protection Agency, Environmental Monitoring and Support Laboratory, Cincinati, OH 45268.

HBT AGRA Limited
Engineering & Environmental Services

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Soil

Methodologies, Method Detection Limits (MDL) and description

Total Petroleum hydrocarbons by IR (EPA 413.2, MDL 20 µ g/g)

Wet soil samples are extracted with Freon (1,1,1,-trichloro, 2,2,2-trifluoroethane), dried over sodium sulphate. A single wavelength infrared spectrometer is used to determined the concentration of petroleum hydrocarbons in soil samples. A mixture of hydrocarbons is used as calibration standard.

BTEX (EPA 5030/8020, MDL 0.005 µg/g)

Benzene, toluene, ethylbenzene, and xylenes (BTEX) are liberated from the soil samples in aqueous media using an automated headspace autosampler and a gas chromatograph equipped with a capillary column and a photoionization detector (PID). The organics are volatilized into a capillary column for separation and quantified using the PID.

Metals Sample preparation (EPA 3050)

A representative soil sample (1-2 g, wet weight) is digested in nitric acid and hydrogen peroxide. The digestate is then refluxed with either nitric acid or hydrochloric acid for ICP or AAS, respectively.

ICP (APHA)

Soil extracts are analyzed for metals by ICP.

Arsenic (EPA 7061, MDL 0.003 µg/g)

Samples are digested with nitric/sulphuric acid. Next, the arsenic in the digestate is converted to a gaseous hydride with sodium borohydride and is swept into an argon-hydrogen flame located in the optical path.

Antimony (EPA 7741 MDL 0.003 µg/g)

Samples are prepared according to the nitric/sulphuric acid digestion procedure. Antimony in the digestate is reduced with sodium borohydride and the volatile hydride is swept into a argon-hydrogen flame located in the optical path of an AAS.

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Mercury (EPA 7471 MDL 0.003 µg/g)

Samples are digested with aqua regia to reduce mercery to the elemental state. The extract is aerated from solution in a closed system. The mercury vapor passes through a cell positioned in the light path of a flameless AAS.

Selenium (EPA 7741 MDL 0.003 µg/g)

Samples are prepared according to the nitric/sulphuric acid digestion procedure. Selenium in the digestate is reduced with sodium borohydride to a volatile hydride and is swept into a argon-hydrogen flame located in the optical path of an AAS.

Sulfur (EPA 9010, MDL 20 µg/g)

Dried and ground sample digested in the microwave followed by analysis using ICP.

Bromide (Soluble) (APHA 4110B, MDL 8 µg/g)

Dried and ground sample digested (boiled for one hour with distilled water) following analysis using Ion Chromatography.

Cyanide (Total) (EPA 9012, MDL 0.025 µg/g)

Dried and ground sample distilled and analyzed colorimetrically using isonicotinic acid and barbutric acid.

Fluoride (Total) (APHA 4500, MDL 10 µg/g)

Dried and ground sample fused with a mixture of sodium carbonate and potassium carbonate followed by analysis using the TISAB method and fluoride electrode.

Soluble salts in 1:2 soil:water mixtures (McKeague 3.22)

200 mL of distilled water is added to 100 g of air dried soil. The mixture is shaken on a mechanical shaker for one hour. Cations and anions are analyzed by AAS and ion exchange chromatography, respectively.

Moisture Content (McKeague 2.411)

A moist soil sample, 10 g or more, is weighed and air dried at 105°C to a constant weight. The percentage water by weight is calculated as follow:

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Saturated Paste

$$P_w = 100\ X \left[\frac{\textit{Weight of moist soil}}{\textit{Weight of oven-dry soil}} - 1 \right]$$

Soil Moisture Content

$$P_w = 100\ X \left[\frac{\textit{Weight of moist soil - Weight of oven dry soil}}{\textit{Weight of oven dry soil}} \right]$$

pH/Conductivity in 1:2 soil:water mixtures (McKeague 4.12)

A 15 g soil sample is mechanically shaken for 30 minutes with 30 mL distilled water. The pH and conductivity of the suspension is measured with either a pH strip or pH electrode and conductivity meter.

References

EPA, 1986. SW-846 Third Edition. Test Methods for Evaluating Solid Waste. United States Environmental Protection Agency. Office of Solid Waste and Emergency Response, Washington, DC 20460

McKeague, J.A. 1978. Manual on Soil Sampling and Methods of Analysis, Can. Soil Sci. Ottawa.

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SDNY - 04 CIV 8378

HBT AGRA Limited

Analytical Chemistry Laboratory
WATER QUALITY CONTROL STANDARD
PRELIMINARY RESULTS

File# EC17086/17118

Date: 5-Aug-93

Project# Ecuador

Date	ANALYTICAL PARAMETERS	Units	APHA Method	MDL	Analyzed Value Run 1	Analyzed Value Run 2	Analyzed Value Run 3	Analyzed Value Run 4	Advisory Range	Certified Value	ERA lot no.
25-Jun	Calcium	mg/L	3500Ca-b	<0.1	81.4	79.7	82.2	81	71-95	83	9943
7-Jul	Calcium	mg/L	3500Ca-b	<0.1	85.0	82.5	80.3		71-93	82	9947
25-Jun	Magnesium	mg/L	3500Mg-b	<0.1	9.8	9.9			9.0-13	10.0	9943
6-Jul	Magnesium	mg/L	3500Mg-b	<0.1	10.9	11.0	11.0	9.6	9.0-13	10	9943
24-Jun	Potassium	mg/L	3500K-b	<0.1	160				157-212	184	9945
Jun 24-Jul 6	Potassium	mg/L	3500K-b	<0.1	200	218	206	211	175-237	206	9948
26-Jun	Sodium	mg/L	3500Na-b	<0.1	210	216			174-235	204	9945
26-Jun	Sodium	mg/L	3500Na-b	<0.1	276	274	280		222-300	261	9948
15-Jul	Sodium	mg/L	3500Na-b	<0.1	260	257			222-300	261	9948
26-Jun	Iron	mg/L	3500Fe-b	<0.05	0.515	0.511	0.531	0.519	0.430-0.620	0.525	9946
5-Jul	Iron	mg/L	3500Fe-b	<0.05	0.514	0.550	0.553		0.430-0.620	0.525	9946
26-Jun	Manganese	mg/L	3500Mn-b	<0.05	0.103	0.106	0.110	0.106	0.083-0.119	0.101	9946
5-Jul	Manganese	mg/L	3500Mn-b	<0.05	0.106	0.110	0.101		0.083-0.119	0.101	9946
16-Jul	Chloride	mg/L	4500Cl-b	<1	100				98-112	105	9949
Jun 25-29	Chloride	mg/L	4500Cl-f	<0.1	102	107	107	104	98-112	105	9949
Jul 6-12	Chloride	mg/L	4500Cl-f	<0.1	108	106	104	102	98-112	105	9949
Jun 25-29	Sulphate	mg/L	4500SO4--b	<0.1	284	303	301	297	251-333	292	9949
Jul 6-12	Sulphate	mg/L	4500SO4--b	<0.1	304	296	298	293	251-333	292	9949
25-Jun	Conductivity @ 25°C	mS/cm	2510		1.453				1.250-1.690	1.470	9949
5-Jul	Conductivity @ 25°C	mS/cm	2510		1.516	1.510	1.514	1.510	1.250-1.690	1.470	9949
25-Jun	pH @ 25°C		4500H		9.13				8.9-9.3	9.1	9949
5-Jul	pH @ 25°C		4500H		9.05	9.07	9.09	9.15	8.9-9.3	9.1	9949
11-Jul	Phosphorus- total as P	mg/L	4500P-d	<0.01	4.29	4.19			3.5-4.8	4.16	9943
11-Jul	Phosphorus- total as P	mg/L	4500P-d	<0.01	6.63				5.2-6.9	6.04	9947
Jun 25-Jul 5	Total Alkalinity (as CaCO3)	mg/L	2320	<1	173	182	181	179	158-196	177	9949
25-Jun	Total Hardness (as CaCO3) (calc)	mg/L	2340-b	<8	244	240			211-286	248	9943
28-Jun	Total Dissolved Solids @ 180°C	mg/L	2540-c	<2	1128	1160	1160		1010-1310	1160	9949
14-Jul	Total Dissolved Solids @ 180°C	mg/L	2540-c	<2	1162	1152			1010-1310	1160	9949
18-Jul	Total Dissolved Solids @ 180°C	mg/L	2540-c	<2	1248				1150-1490	1320	9948
Jul 9-14	Total Petroleum Hydrocarbons (IR)	mg/L	5520-f	<0.1	1400	1300	910	1000	620-1800	1380	93008 #2

* modified method

APHA - Standard methods for the Examination of Water and Wastewaters. 1989. 17th Ed. American Public Health Association.

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Senior Analyst: Marie England

Manager:

HBT AGRA Limited

Analytical Chemistry Laboratory
WATER QUALITY CONTROL STANDARD
PRELIMINARY RESULTS

File No.: EC17119
Project No.: Ecuador

Date	ANALYTICAL PARAMETERS	Units	APHA Method	MDL	Analyzed Value				Advisory Range	Certified Value	ERA Lot no.
					Run 1	Run 2	Run 3	Run 4			
18-Jul	Calcium	mg/L	3500Ca-b	<1	81.0	79.0	83.1	83.1	71-93	82.0	9947
18-Jul	Magnesium	mg/L	3500Mg-b	<1	19.7	19.8	20.0		17-23	19.8	9947
18-Jul	Potassium	mg/L	3500K-b	<1	218	212	212		175-237	206	9948
14-Jul	Sodium	mg/L	3500Na-b	<1	263	258	254		222-300	261	9948
13-Jul	Iron	mg/L	3500Fe-b	<0.05	0.500	0.527	0.546	0.526	0.430-0.620	0.525	9946
14-Jul	Manganese	mg/L	3500Mn-b	<0.05	0.103	0.098			0.083-0.119	0.101	9946
Jul 6-12	Chloride	mg/L	4500Cl-f	<0.1	108	108	104	102	98-112	105	9949
Jul 6-17	Sulphate	mg/L	4500SO4-b	<0.1	304	296	296	293	251-333	292	9949
5-Jul	Conductivity @ 25°C	mS/cm	2510	--	1.516	1.51	1.514	1.51	1.250-1.690	1.47	9949
5-Jul	pH @ 25°C	--	4500H	--	9.06	9.07	9.09	9.16	8.9-9.3	9.1	9949
11-Jul	Phosphorus- total as P	mg/L	4500P-d	<0.01	4.19				3.5-4.8	4.16	9943
5-Jul	Total Alkalinity (as CaCO3)	mg/L	2320	<1	182	181	179		158-196	177	9949
18-Jul	Total Hardness (as CaCO3) (calc)	mg/L	2340-b	<6	283	279	290		246-326	286	9947
14-Jul	Total Dissolved Solids @ 180°C	mg/L	2540-c	<2	1162	1152			1010-1310	1160	9949
Jul 7-8	Total Petroleum Hydrocarbons (IR)	mg/L	5520-f	<0.1	1000	1600			620-1600	1380	93008-2

* modified method

APHA - Standard methods for the Examination of Water and Wastewaters. 1989. 17th Ed. American Public Health Association.

Senior Analyst: Marie England

Manager:

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PET 041043

HBT AGRA Limited

Analytical Chemistry Laboratory
WATER QUALITY CONTROL STANDARD
PRELIMINARY RESULTS

File No: EC17040
Project No.: Ecuador

Date	ANALYTICAL PARAMETERS	Units	Method	MDL	Analyzed Values			Range	Certified Value	ERA lot no.
					Run 1	Run 2	Run 3			
28-Jul	Arsenic	mg/L	EPA 3050/7061	<0.0005	0.090			0.088-0.167	0.105	9945
28-Jul	Arsenic	mg/L	EPA 3050/7061	<0.0005	0.122	0.119		0.094-0.150	0.125	9946
28-Jul	Mercury	mg/L	EPA 3050/7471	<0.0005	0.0036			0.0022-0.0041	0.00325	9946
26-Jul	Mercury	mg/L	EPA 3050/7471	<0.0005	0.0077			0.0036-0.0088	0.00667	9944
26-Jul	Mercury	mg/L	EPA 3050/7471	<0.0005	0.013			N/A	0.017 ug/g	CANMET SO-3
27-Jul	Selenium	mg/L	EPA 3050/774	<0.0005	0.109	0.095	0.098	0.089-0.150	0.119	9946
30-Jul	Tin	mg/L	EPA 3050/7870	<5	25.7			N/A	25.0	LAB STD
30-Jul	Tin	mg/L	EPA 3050/7870	<5	50.1			N/A	50.0	LAB STD
30-Jul	Tin	mg/L	EPA 3050/7870	<5	130			N/A	100.0	LAB STD
16-Jul	Chloride	mg/L	APHA4500Cl-b	<1	100			98-112	105	9949
3-Aug	Chloride	mg/L	APHA 4500Cl-f	<0.1	104			98-112	105	9949
14-Jul	pH	--	APHA 4500H	--	9.06			8.9-9.3	9.1	9949
11-Jul	Phosphorus- total as P	mg/L	APHA 4500P-d	<0.01	3.56			3.5-4.8	4.16	9943
11-Jul	Phosphorus- total as P	mg/L	APHA 4500P-d	<0.01	5.68			4.5-6.1	5.33	9947
16-Jul	Total Dissolved Solids @ 180°C	mg/L	APHA 2540-c	<2	1160			1010-1310	1160	9949
Jul 6-7	Total Petroleum Hydrocarbons (IR)	mg/L	APHA 5520-f	<0.0	1000	1800		620-1780	1380	93008#2

* modified method

APHA - Standard methods for the Examination of Water and Wastewaters. 1989. 17th Ed. American Public Health Association.

EPA - U.S. Environemental Protection Agency, 1986. Test Methods for Evaluation of Solid Waste 3rd Ed. Office of Solid Waste Emergency Response, U.S. Environmental Protection Agency, Washington, D.C.

Senior Analyst: Marie England

Manager:

HBT AGRA Limited

Analytical Chemistry Laboratory
WATER QUALITY CONTROL STANDARD
SUMMARY RESULTS

File No.: EC17085
Project No.: Ecuador

Date	ANALYTICAL PARAMETERS	Units	APHA Method	MDL	Analyzed Values					Advisory Range	Certified Value	ERA lot no.
					Run 1	Run 2	Run 3	Run 4	Run 5			
18-Jul	Calcium	mg/L	3500Ca-b	<1	81.5	79.4				71-93	82.0	9947
18-Jul	Magnesium	mg/L	3500Mg-b	<1	20.3	19.7				17-23	19.8	9947
16-Jul	Potassium	mg/L	3500K-b	<1	222	218				175-237	206	9948
14-Jul	Sodium	mg/L	3500Na-b	<1	273	267	263			222-300	261	9948
13-Jul	Iron	mg/L	3500Fe-b	<0.05	0.528	0.535				0.430-0.620	0.525	9946
14-Jul	Manganese	mg/L	3500Mn-b	<0.05	0.103	0.098				0.083-0.119	0.101	9946
Jul 13-16	Chloride	mg/L	4500Cl-f	<0.1	104	105	106	107		98-112	105	9949
Jul 17-19	Chloride	mg/L	4500Cl-f	<0.1	105	106	107			98-112	105	9949
Jul 13-16	Sulphate	mg/L	4500SO4-b	<0.1	288	293	302	297		251-333	292	9949
Jul 17-19	Sulphate	mg/L	4500SO4-b	<0.1	303	296	303			251-333	292	9949
5-Jul	Conductivity @ 25°C	mS/cm	2510	--	1.516	1.51	1.514	1.51		1.250-1.690	1.47	9949
14-Jul	pH	--	4500H	--	9.15	9.12	9.15	9.16	9.10	8.9-9.3	9.1	9949
14-Jul	Total Alkalinity (as CaCO3)	mg/L	2320	<1	182	185	183	188	185	158-198	177	9949
18-Jul	Total Hardness (as CaCO3) (calc)	mg/L	2340-b	<6	287	279				246-326	286	9947
16-Jul	Total Dissolved Solids @ 180°C	mg/L	2540-c	<2	1070					1010-1310	1160	9949
Jul 15-16	Total Petroleum Hydrocarbons (IR)	mg/L	5520-f	<0.1	1100	1200				620-1800	1380	93008-2

* modified method

APHA - Standard methods for the Examination of Water and Wastewaters. 1989. 17th Ed. American Public Health Association.

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Senior Analyst: Marie England

Manager:

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TECHNICAL REPORT

PETROECUADOR - TEXACO
Environmental Assesment

Sample Description Descripción de Muestras			Water Analysis Analisis de Agua (1)						
Field Campo	Site Sitio	No. Numero	(4500H) pH @ 25°C pH a 25°C	(4500P-B/D) Phosphate Total Fosfato Total (<1 mg/L)	(4500Cl-F) Chloride Cloruro (<0.1 mg/L)	(2540-D) TSS @ 105°C SS (total) a 105°C (<2 mg/L)	(2540-C) TDS @ 180°C STS a 180°C (<2 mg/L)	(4500S-E) Sulphide Sulfuro (<0.1 mg/L)	(5520-F) TPH by IR THP por IR (<0.1 mg/L)
AT	ST	2	6.39	0.01	71,100*	3,076	140,000	0.3	12
AU	11	1	6.92	0.03	0.70	15	35	0.3	1.1
CN	STN	1	7.71	0.04	678*	<2	1,440	<0.1	680
DU	1	3	7.57	0.05	12,700*	520	20,000	2.0	53
GU	ST	5	6.56	0.04	47,000*	2,120	81,000	1.5	4.6
GU	1	1	6.31	0.16	1.3	88	164	1.1	130
LA	STC	8	7.56	0.24	5,390*	1,804	10,200	3.0	91
LA	STN	2	7.46	0.24	4,440*	496	9,000	4.3	6800
RM	1	2	6.04	0.03	0.6	4	48	0.4	0.6
SA	94	2	6.05	0.12	5.0	76	44	2.1	34

(1) - Method: APHA; *- 4500Cl-B, Method Detection Limit <1

APHA - Standard method for the Examinaiton of Water and Wastewater, 1989. 17th Ed. American Public Health Association.
TSS - Total Suspended Solids
TDS - Total Dissolved Solids
TPH - Total Petroleum Hydrocarbons

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HBT AGRA Limited
Engineering & Environmental Services

TECHNICAL REPORT

HBT AGRA Limited
Calgary, Alberta

Date Received: June 28/93
Date Sampled: N/A
Date of Report: July 31/93

SOIL ANALYSIS

Attention: Chris Wenzel

Project No.: CC00222.453

File No.: EC00561U17040

Analyst	Date of Analysis	Pametamters	EPA Method	Lab. No.	8030-93	8090-93	8088-93	8080-93	8130-93	8124-93	8103-93	8135-93
				Sample I.D.	LA STN 2	SA STC 2	SA STN2 2	SA 36 2	SSF STC 4	SSF STS 3	SSF STS 4	SSF STSW 4
				Surrogate Recovery(%)	102	85	88	116	132	92	63	93
				MDL	µg/g dry wt.							
BC	12/7/93	Benzene	5030/8020	0.005	1.6	0.049	<0.005	0.18	7.7	0.011	22	0.11
BC	12/7/93	Toluene	5030/8020	0.005	0.52	0.074	0.009	0.30	7.1	0.045	34	<0.005
BC	12/7/93	Ethylbenzene	5030/8020	0.005	0.88	0.13	0.016	0.13	14	0.056	10	0.14
BC	12/7/93	Xylenes	5030/8020	0.005	4.3	0.50	0.048	1.3	15	0.42	52	1.0
BC	12/7/93	Moisture	%		53.5	50.3	28.2	15.1	33.0	15.9	30.7	56.8

MDL - Method Detection Limit

Report reviewed by: Marie England

Marie England
QA/QC Compliance
Environmental Services

Raynald LeBlanc, M. Sc.
Manager
Environmental Services

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PET 041047

** All Samples Will Be Disposed After 30 Days Following Analysis. Please Contact The Lab If You Require Additional Sample Storage Time
(Samples Deemed Hazardous Will Be Returned To The Client At Their Own Expense Or Disposal Will Be Arranged) **

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HBT AGRA Limited
Engineering & Environmental Services

TECHNICAL REPORT

HBT AGRA Limited
Calgary, Alberta

Date Received: June 28/93
Date Sampled: N/A
Date of Report: July 31/93
Page 1 of 2

SOIL ANALYSIS

Attention: Chris Wenzel

Project No.: CE00222.453

File No.: EC00561U17040

Analyst	Date of Analysis	Sample Description			Lab. No.	Parameters Electrical Conductivity McKeague 4.12
		Field	Site	No.		(mS/cm)
PF	22/7/93	AG	6	1	7977-93	0.06
PF	22/7/93	AGSSFN	BG	1	7982-93	0.03
PF	22/7/93	AT	BG	1	8002-93	0.02
PF	22/7/93	AU	BG	1	7946-93	0.01
PF	22/7/93	AUS	STN1	1	7968-93	0.02
PF	22/7/93	AUS	BG	1	7945-93	0.01
PF	22/7/93	CN	1	1	7858-93	0.02
PF	22/7/93	CN	BG	1	7943-93	0.10
PF	22/7/93	CU	2	1	7957-93	0.21
PF	22/7/93	DU	1	2	8012-93	2.43
PF	22/7/93	GU	3	2	8045-93	0.10
PF	22/7/93	GU	BG	1	8051-93	0.03
PF	22/7/93	LA	STN	2	8030-93	1.59
PF	22/7/93	LA	10	2	8018-93	0.19
PF	22/7/93	LA	29	2	8026-93	0.13
PF	22/7/93	PH	ST	3	8005-93	0.02
PF	22/7/93	PH	2	2	8008-93	0.24
PF	22/7/93	PH	BG	1	8010-93	0.02
PF	22/7/93	RM	BG	1	7948-93	0.01

MDL - **Method Detection Limit**
McKeague - **J.A. 1978 - Manual on Soil Sampling and Method of Analyses. Can. Soc. Sci. Ottawa.**

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AGRA
Earth & Environmental Group

HBT AGRA Limited
Engineering & Environmental Services

TECHNICAL REPORT

HBT AGRA Limited
Calgary, Alberta

Date Received: June 28/93
Date Sampled: N/A
Date of Report: July 31/93
Page 2 of 2

SOIL ANALYSIS

Attention: Chris Wenzel

Project No.: CE00220

File No.: EC00561U17040

Analyst	Date of Analysis	Sample Description			Lab. No.	Parameters Electrical Conductivity McKeague 4.12
		Field	Site	No.		(mS/cm)
PF	22/7/93	SA	STC	2	8090-93	0.58
PF	22/7/93	SA	STC	3	8099-93	0.20
PF	22/7/93	SA	STN1	1	8086-93	0.03
PF	22/7/93	SA	STN2	2	8089-93	3.16
PF	22/7/93	SA	12	1	7964-93	0.03
PF	22/7/93	SA	BG	Sa	8077-93	0.02
PF	22/7/93	SA	BG	1	7944-93	0.06
PF	22/7/93	SA	BG	2	8093-93	0.03
PF	22/7/93	SSF	STS	4	8103-93	1.10
PF	22/7/93	SSF	B64	1	8139-93	0.06
PF	22/7/93	SSF	B66	1	8138-93	0.26
PF	22/7/93	SSF	FL13	BG	8107-93	0.02
PF	22/7/93	SSF	B31	1	8115-93	4.20
PF	22/7/93	YB	2	1	7972-93	0.07
PF	22/7/93	YUS	BG	1	7947-93	0.03

MDL - Method Detection Limit
McKeague - J.A. 1978 - Manual on Soil Sampling and Method of Analyses. Can. Soc. Sci. Ottawa.

Report reviewed by:

Brenda Chomin

Brenda Chomin
QA/QC Compliance
Environmental Services

Raynald LeBlanc, M. Sc.
Manager
Environmental Services

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** All Samples Will Be Disposed After 30 Days Following Analysis. Please Contact The Lab If You Require Additional Sample Storage Time. Samples Deemed Hazardous Will Be Returned To The Client At Their Own Expense Or Disposal Will Be Arranged. **

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Table G – 2
Analytical Results for Soils; Oil and Grease

Sample Description					Hydrocarbons
Field	Site	No.	Odour	Sampled Area	Oil and Grease by IR (µg/g dry wt)
				Criterion	5,000
AG	ST	1	S = Strong	Flare Stack	260,000
AG	ST	2	S	Sump Discharge	20,000
AG	ST	3	S	Crude Tank	42,000
AG	ST	4	S	Produced Water Discharge	3,700
AG	3	1	S	Pit Discharge	33,000
AG	3	2	S	Well Pad	44,000
AG	6	1	D = Distinct	Pit Discharge	2,800
AG	8	1	D	Pit Discharge	5,500
AG	10	1	D	Adjacent Pit	360
AT	ST	1	D	Process Area	13,000
AT	ST	3	S	Water Discharge	6,200
AT	1	1	F = Faint	Former Pit	1,100
AT	2	1	S	Pit	58,000
AT	2	2	D	Sump Overflow	7,200
AU	STN	1	S	Pit Sludge	880,000
AU	1	1	S	Adjacent Former Pit	750
AU	1	2	F	Adjacent Former Pit	3,700
AU	4	1	S	Former Pit	6,300
AU	17	1	S	Adjacent Pit	69,000
AU	19/19B	1	S	Former Pit	1,100
AU	24	1	F	Adjacent Former Pit	2,600
AUS	STN1	1	F	Former Pit	420
AUS	1	2	S	Process Area	16,000
CN	1	1	S	Former Pit	59,000
CN	2	1	D	Former Pit	2,200
CN	11	1	D	Drainage Ditch	950
CN	12	1	S	Pit Sludge	430,000
CU	STN	1	S	Crude Tank	86,000
CU	STN	2	S	Off–Site	8,300
CU	2	1	D	Well Pad	7,000
DU	1	1	S	Produced Water Discharge	10,000
DU	1	2	S	Flare Stack	270,000
GU	ST	1	F	Pit Discharge	6,700
GU	ST	2	S	Pond / Flare Line	930
GU	ST	3	S	Diesel Tank	48,000
GU	ST	4	F	Sump Drain	2,600
GU	ST	6	S	Crude Tank Drain	10,000
GU	1	2	F	Pit Discharge	770
GU	3	1	N = None	Off–Site Stream	990
GU	3	2	D	Dumped Soil	60,000
GU	5	1	S	Pump / Off–Site	120,000

Indicates parameter level exceeding criterion. ☐

Table G – 2
Analytical Results for Soils; Oil and Grease

Sample Description					Hydrocarbons
Field	Site	No.	Odour	Sampled Area	Oil and Grease by IR (µg/g dry wt)
				Criterion	5,000
				Indicates parameter level exceeding criterion.	☐
GU	5	2	N	Flare Stack	270
GU	8	1	S	Drainage Ditch	73,000
GU	8	2	F	Off-Site	11,000
LA	FL17	1	S	Creek Below Flowline	12,000
LA	STC	1	F	Crude Tank	1,500
LA	STC	2	D	Fuel Tanks	21,000
LA	STC	3	D	Process Area	2,000
LA	STC	5	F	Diesel Tank	17,000
LA	STC	6	D	Crude Tank	5,800
LA	STC	7	F	Crude Tank	280
LA	STN	1	F	Crude Tank	72,000
LA	STN	2	S	Pit	210,000
LA	STN	3	S	Pit Discharge	26,000
LA	1	1	F	Pump	12,000
LA	5	1	F	Well Pad	3,000
LA	10	1	D	Flowline	16,000
LA	10	2	N	Well Pad	4,500
LA	11B	1	F	Well Pad	550
LA	12	1	F	Well Pad	3,600
LA	21	1	S	Well Pad – Flowline	140,000
LA	26	1	N	Off-Site	3,400
LA	26	2	N	Off-Site	590
LA	26	3	S	Well Pad – Flowline	51,000
LA	29	1	D	Flowline	1,600
LA	29	2	D	Well Pad	19,000
LA	34	1	D	Well Pad	1,500
LA	35	1	N	Well Pad – Flowline	100
PH	ST	1	S	Discharge Area	390
PH	ST	2	S	Flare Line	120,000
PH	ST	3	F	Drill Mud Discharge	100
PH	ST	4	D	Crude Tank	29,000
PH	2	1	D	Well Pad	55,000
PH	2	2	S	Off-Site	21,000
PH	5	1	S	Off-Site Spill	42,000
RM	1	1	D	Well Pad	2,500
SA	FL84	1	NA	Below Pipeline	240,000
SA	STC	1	S	Crude Tank / Flare Line	11,000
SA	STC	2	S	Crude Tank Drain	130,000
SA	STC	3	D	Adjacent Pit	8,700
SA	STC	4	S	Diesel Tank Drain / Site Drain	72,000
SA	STN1	1	D	Process Area	530
SA	STN1	2	S	Diesel Tank	9,300

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Table G – 2
Analytical Results for Soils; Oil and Grease

Sample Description					Hydrocarbons
Field	Site	No.	Odour	Sampled Area	Oil and Grease by IR (µg/g dry wt)
				Criterion	5,000
SA	STN1	3	S	Water Discharge Area	6,200
SA	STN1	4	S	Process Area Drain	3,100
SA	STN2	1	D	Crude Tank	3,300
SA	STN2	2	S	Water/Waste Discharge Area	2,800
SA	STS	1	S	Tank Drainage Ditch	21,000
SA	WW6	1	S	Adjacent Pit	230,000
SA	1	1	S	Site Drainage	1,600
SA	1	2	D	Site Drainage	35,000
SA	8	1	D	Adjacent Former Pit	1,000
SA	9	1	D	Site Drainage	2,600
SA	12	1	D	Former Pit	1,900
SA	16	1	S	Adjacent Former Pit	7,700
SA	20	1	F	Well Pad	11,000
SA	21	1	S	Drained Pit	39,000
SA	25	1	D	Well Pad	140,000
SA	25	2	D	Adjacent Pit	2,700
SA	27	1	S	Well Pad	73,000
SA	28	1	D	Off-Site Depression	99,000
SA	34	1	S	Meter Station	230,000
SA	35	1	F	Well Pad	92,000
SA	36	1	S	Flowline	150,000
SA	36	2	D	Chemical Tanks	21,000
SA	36	3	S	Diesel Tank	44,000
SA	43	1	S	Former Pit	9,500
SA	46	1	F	Suspect Pit	740
SA	72	1	D	Pit	280
SA	77	1	N	Barren Area	460
SA	78	1	F	Pit Discharge	2,200
SA	86	1	NA	Site Drainage	270,000
SA	93	1	F	Pit Discharge	1,200
SA	93	2	S	Drainage Ditch	31,000
SA	94	1	D	Pit	530,000
SA	94	3	S	Pit	760,000
SA	97	1	D	Off-Site / Meter	290,000
SA	100	1	S	Former Pit	20,000
SA	109	1	S	Adjacent Pit	2,300
SSF	STC	1	D	Adjacent Pit	2,700
SSF	STC	2	F	Crude Tank	2,400
SSF	STC	2	F	Crude Tank	690
SSF	STC	3	D	Fuel Tanks	210
SSF	STC	4	D	Fuel Tanks	23,000
SSF	STC	5		Diesel Tank	420

Indicates parameter level exceeding criterion. ☐

Table G – 2
Analytical Results for Soils; Oil and Grease

Sample Description					Hydrocarbons
Field	Site	No.	Odour	Sampled Area	Oil and Grease by IR (µg/g dry wt)
				Criterion	5,000
				Indicates parameter level exceeding criterion.	☐
SSF	STN	1	D	Adjacent Depression	6,800
SSF	STN	2	D	Pit Discharge	180
SSF	STN	3	S	Off–Site Discharge	2,100
SSF	STN	4	S	Tank Area Drain	23,000
SSF	STS	1	F	Discharge Channel	200
SSF	STS	2	D	Crude Tank	2,100
SSF	STS	3	S	Diesel Tank	6,100
SSF	STS	4	S	Waste Pit Sludge near SSF23	480,000
SSF	STSW	1	S	Crude Tank Drain	51,000
SSF	STSW	2	D	Process Area Drain	990
SSF	STSW	3	S	Chemical Tanks	4,200
SSF	STSW	4	S	Discharge Channel	8,300
SSF	WF	1	D	Stream	230,000
SSF	A1	1	D	Suspect Pit	3,400
SSF	A24	1	F	Adjacent Pit	5,900
SSF	A43	1	S	Adjacent Pit	23,000
SSF	A43	2	D	Former Pit	14,000
SSF	A68	2	D	Former Pit	1,500
SSF	A68	1	F	Near Stream	94
SSF	A68	3	F	Former Pit	1,700
SSF	A45B	1	S	Pit Discharge	140,000
SSF	B36	1	D	Former Pit	1,500
SSF	B52	1	F	Flowline	20,000
SSF	B57	1	S	Adjacent Pit	4,000
SSF	B59	1	D	Pit Discharge	230,000
SSF	B63	1	S	Pit	77,000
SSF	B64	1	S	Former Pit	4,100
SSF	B66	1	S	Pit Discharge	110,000
SSF	SP1	1	D	Below Pipeline Valve	170
SSF	SP1	2	D	Below Pipeline	44,000
SSF	6	1	S	Oil Seep	140,000
SSF	13	1	F	Chemicals / Pump Drain	5,400
SSF	31	1	S	Filter Dump Pit	190,000
SSF	FLA6	1	F	Flowline	230
YB	1	1	S	Unknown	1,400
YB	2	1	S	Adjacent Pit	11,000
YUS	1	1	S	Former Generator Area	700
YUS	1	2	D	Former Process Area	900
YUS	1	3	S	Former Pit Discharge	74
YUS	1	4	F	Former Process Area	460

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Table G – 2
Analytical Results for Soils; Oil and Grease

Sample Description					Hydrocarbons
Field	Site	No.	Odour	Sampled Area	Oil and Grease by IR (µg/g dry wt)
				Criterion	**5,000**

Indicates parameter level exceeding criterion. ☐

Background Soils

AGSSFN	BG	1	N	Background Soil	110
AT	BG	1	N	Background Soil	340
AU	BG	1	N	Background Soil	170
AUS	BG	1	N	Background Soil	170
CN	BG	1	N	Background Soil	190
CU	BG	1	N	Background Soil	35
GU	BG	1	N	Background Soil	450
PH	BG	1	N	Background Soil	110
RM	BG	1	N	Background Soil	450
SA	BG	Sa	N	Background Soil	23
SA	BG	1	N	Background Soil	50
SA	BG	2	N	Background Soil	140
SSF	FL13	BG	N	Background Soil	830
YUS	BG	1	N	Background Soil	150

Table G – 3
Analytical Results for Soils; pH

Sample Description				pH
Field	Site	No.	Area Sampled	
			Adjusted Criterion	4.5 – 7.5
			Indicates parameter level exceeding criterion.	☐
AG	6	1	Pit Discharge	5.3
AUS	STN1	1	Former Pit	5.4
CN	1	1	Former Pit	5.3
CU	2	1	Well Pad	7.3
DU	1	2	Flare Stack	4.6
GU	3	2	Dumped Soil	7.2
LA	29	2	Well Pad	6.9
LA	10	2	Well Pad	4.9
LA	STN	2	Pit	7.8
PH	ST	3	Drill Mud Discharge	4.9
PH	2	2	Off–Site	7.8
SA	STC	2	Crude Tank Drain	6.3
SA	STC	3	Adjacent Pit	6.3
SA	STN1	1	Process Area	5.8
SA	STN2	2	Water/Waste Discharge Area	7.3
SA	12	1	Former Pit	5.6
SSF	STS	4	Waste Pit Sludge near SSF23	7.9
SSF	B64	1	Former Pit	5.5
SSF	B66	1	Pit Discharge	6.6
SSF	31	1	Filter Dump Pit	8.1
YB	2	1	Adjacent Pit	5.5

Background Soils

AGSSFN	BG	1	Background Soil	6.0
AT	BG	1	Background Soil	5.1
AU	BG	1	Background Soil	5.0
AUS	BG	1	Background Soil	5.2
CN	BG	1	Background Soil	7.5
GU	BG	1	Background Soil	4.8
PH	BG	1	Background Soil	4.9
RM	BG	1	Background Soil	5.2
SA	BG	Sa	Background Soil	5.8
SA	BG	1	Background Soil	7.2
SA	BG	2	Background Soil	5.7
SSF	FL13	BG	Background Soil	5.2
YUS	BG	1	Background Soil	4.8

Table G – 4

Analytical Results for Soils; Metals

Sample Description				Heavy Metals												
Field	Site	No.	Sampled Area	<0.003 As	<0.003 Hg	<0.003 Se	<5 Sn	<0.5 Ba	<0.5 Cd	<1 Cr	<5 Co	<1 Cu	<5 Pb	<5 Mo	<5 Ni	<1 Zn
				All results in (μg/g).												
			Criteria	40	10	10	50	2000	20	1000	300	500	1000	40	500	1500
CN	1	1	Former Pit	–	–	–	–	140	2.0	130	12	50	79	<5	49	53
DU	1	2	Flare Stack	–	–	–	–	69	<0.5	13	<5	212	570	<5	83	315
GU	3	2	Dumped Soil	–	<0.003	–	–	61	<0.5	15	<5	7	72	<5	8	27
GU	8	2	Off–site Seep	–	–	–	–	79	<0.5	12	<5	12	26	<5	12	51
LA	STN	2	Pit	0.010	0.043	0.028	15.9	159	<0.5	22	12	50	55	<5	18	84
LA	29	2	Well Pad	–	–	–	–	775	<0.5	11	6	24	49	<5	9	57
PH	ST	3	Drill Mud Discharge	<0.003	0.184	0.072	28.4	64	<0.5	17	<5	7	71	<5	8	28
SA	STC	2	Site Drainage	0.005	0.038	0.114	54.0	370	<0.5	25	25	57	83	<5	25	132
SA	STN1	1	Waste Discharge	–	–	–	–	560	<0.1	14	20	44	51	<5	13	67
SA	STN2	2	Filter Dump Pit	0.005	0.052	0.020	<5	160	<0.5	17	12	27	28	<5	15	48
SSF	B66	1	Pit Discharge	0.01	0.022	0.173	40.1	800	<0.5	28	21	59	56	<5	25	76
SSF	STC	1	Adjacent Pit	–	–	–	–	740	<0.5	27	24	80	83	<5	22	87
SSF	STS	4	Waste Pit Sludge	0.007	0.288	0.020	13.2	210	<0.5	10	6	30	63	<5	22	87
SSF	STSW	2	Process Area Drain	–	–	–	–	480	<0.5	73	33	71	66	<5	37	97
SSF	31	1	Filter Dump Pit	0.006	<0.003	0.024	9.18	200	<0.5	18	15	111	560	<5	25	714
YB	2	1	Adjacent Pit	–	–	–	–	240	<0.5	13	11	14	35	<5	17	68
Background Soils																
AGSSF	BG	1	Background Soil	–	–	–	–	1190	<0.5	27	24	63	78	<5	22	71
AU	BG	1	Background Soil	–	–	–	–	105	<0.5	96	12	82	61	<5	45	36
CN	BG	1	Background Soil	–	–	–	–	172	<0.5	23	<5	27	35	<5	14	51
GU	BG	1	Background Soil	0.017	0.050	0.027	<5	59	<0.5	12	3	11	9	<5	11	53
RM	BG	1	Background Soil	–	–	–	–	89	1.0	105	11	31	63	<5	32	45
SA	BG	Sa	Background Soil	–	–	–	–	58	<05	5	<5	9	13	<5	10	45
SA	BG	1	Background Soil	–	–	–	–	81	<0.5	7	<5	9	11	<5	11	53
SA	BG	2	Background Soil	–	–	–	–	1,030	1.0	26	30	77	81	<5	19	86
YUS	BG	1	Background Soil	–	–	–	–	71	1.0	23	<5	13	49	<5	11	51

Indicates parameter level exceeding criterion. ☐

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Table G – 5
Analytical Results for Soils; Metals

Sample Description														
Field	Site	No.	Sampled Area	<5 Al	<0.1 Be	<5 Ca	<1 Fe	<5 Mg	<5 Mn	<5 P	<5 K	<5 Na	<10 Tl	<5 V
			Canadian Criteria	–	4	–	–	–	–	–	–	–	–	200
			Indicates parameter level exceeding criterion.	☐										
CN	1	1	Former Pit	80,300	<0.1	190	51,330	345	120	240	160	33	21	145
DU	1	2	Flare Stack	7,390	<0.1	5080	15,490	870	91	980	520	1,320	16.0	170
GU	3	2	Dumped Soil	660,900	<0.1	57	6,720	190	11	41	190	21	<10	<5
GU	8	2	Off–site Seep	22,850	<0.1	35	11,630	2,560	50	132	603	22	<10	42
LA	STN	2	Pit	445,300	<0.1	7730	30,840	5,400	330	720	1,700	1,690	14	67
LA	29	2	Well Pad	120,300	<0.1	4190	14,790	5,640	220	580	1,500	520	<10	43
PH	ST	3	Drill Mud Discharge	692,900	<0.1	55	7,210	200	11	44	160	23	<10	42
SA	STC	2	Site Drainage	76,700	<0.1	3,050	32,470	3,400	260	1,560	802	1,230	132	136
SA	STN1	1	Waste Discharge	56,670	<0.1	1,100	28,260	1,810	525	680	830	270	98	110
SA	STN2	2	Filter Dump Pit	28,490	3.0	12,240	21,350	4,390	200	1,030	530	189	23	81
SSF	B66	1	Pit Discharge	56,040	<0.1	1,370	33,290	3,590	430	550	644	200	29	135
SSF	STC	1	Adjacent Pit	100,400	<0.1	1,070	42,480	2,770	540	1,220	834	585	23	135
SSF	STS	4	Waste Pit Sludge	7,600	<0.1	52,470	22,230	1,190	230	240	270	4,900	36	49
SSF	STSW	2	Process Area Drain	80,030	<0.1	1,590	44,460	3,410	655	1,940	860	785	41	160
SSF	31	1	Filter Dump Pit	220,900	<0.1	36,120	57,550	4,770	390	590	830	1,440	52	60
YB	2	1	Adjacent Pit	23,660	<0.1	2,170	21,360	3,570	830	230	932	49	45	47

Background Soils

Field	Site	No.	Sampled Area	<5 Al	<0.1 Be	<5 Ca	<1 Fe	<5 Mg	<5 Mn	<5 P	<5 K	<5 Na	<10 Tl	<5 V
AGSSF	BG	1	Background Soil	93,520	<0.1	1400	35,960	2,390	730	684	632	115	30	110
AU	BG	1	Background Soil	53,520	<0.1	61	48,540	585	270	291	186	29	35	170
CN	BG	1	Background Soil	22,050	<0.1	3,235	154	3,570	101	113	1,410	178	<10	41
GU	BG	1	Background Soil	14,800	0.1	63	12,500	938	50	96	270	<50	<10	42
RM	BG	1	Background Soil	62,610	<0.1	90	46,320	452	210	237	231	24	25	125
SA	BG	Sa	Background Soil	8,080	<0.1	930	9,820	1,550	130	196	363	8	<10	30
SA	BG	1	Background Soil	9,280	<0.1	1,680	100	2,140	116	194	505	19	<10	32
SA	BG	2	Background Soil	99,050	<0.1	750	41,750	2,610	1,210	1,220	700	140	162	140
YUS	BG	1	Background Soil	47,610	<0.1	107	27,130	1,950	93	167	805	35	19	74

Table G – 6

Analytical Results for Soils; Cyanide, Sulphur, Bromide and Flouride

Sample Description				Other Inorganics				
Field	Site	No.	Sampled Area	Total Cyanide	Free Cyanide	Sulphur	Bromide	Fluoride
				(mg/Kg)				
			Criteria	500	10	2,000	50	2,000
PH	ST	3	Drill Mud Discharge	< 0.025	–	407	< 8	96
SSF	B66	1	Pit Discharge	0.028	–	3,227	< 8	136
SA	STN2	2	Water/Waste Discharge Area	0.051	–	3,703	< 8	660
SSF	STS	4	Waste Pit Sludge near SSF23	0.062	–	12,315	< 8	92
SSF	31	1	Filter Dump Pit	0.073	–	35,750	< 8	160
SA	STC	2	Crude Tank Drain	0.37	–	4,593	< 8	152
GU	8	2	Off-Site	–	–	1,233	–	–
LA	STN	2	Pit Sludge	0.047	0.54	319	< 8	168

Indicates parameter level exceeding criterion. ☐

Background Soil

GU	BG	1	Background Soil	–	–	< 20	–	1.5

Table G – 7
Analytical Results for Soils; Electrical Conductivity

Sample Identification					Electrical Conductivity
Field	Site	No.	Odour	Sampled Area	(mS/cm)
				Canadian Soil Quality Criteria	2
				Indicates parameter level exceeding criterion.	☐
AG	6	1	NA	Pit Discharge	0.06
AUS	STN1	1	F	Former Pit	0.02
CN	1	1	S	Former Pit	0.02
CU	2	1	D	Well Pad	0.21
DU	1	2	S	Flare Stack	2.43
GU	3	2	D	Dumped Soil	0.1
LA	10	2	N	Well Pad	0.19
LA	29	2	D	Well Pad	0.18
LA	STN	2	S	Pit	1.59
PH	2	2	S	Off–Site	0.24
PH	ST	3	F	Drill Mud Discharge	0.02
SA	12	1	D	Former Pit	0.03
SA	STC	2	S	Site Drainage	0.58
SA	STC	3	S	Adjacent Pit	0.2
SA	STN1	1	D	Process Area	0.03
SA	STS	3	S	Water/Waste Discharge Area	3.16
SSF	B31	1	S	Filter Dump Pit	4.2
SSF	B64	1	S	Former Pit	0.06
SSF	B66	1	S	Pit Discharge	0.26
SSF	STS	4	S	Waste Pit Sludge near SSF23	1.1
YB	2	1	S	Adjacent Pit	0.07
Background Soil					
AGSSF	BG	1	N	Road cut near well SSF76	0.03
AT	BG	1	N	Road cut near station	0.02
AU	BG	1	N	Background Soil	0.01
AUS	BG	1	N	Background Soil	0.01
CN	BG	1	N	Background Soil	0.1
GU	BG	1	N	Background Soil	0.03
PH	BG	1	N	Road cut near station	0.02
RM	BG	1	N	Background Soil	0.01
SA	BG	Sa	N	Road cut near well SA27	0.02
SA	BG	1	N	Background Soil	0.06
SA	BG	2	N	Background Soil	0.03
SSF	FL13	BG1	S	Background – 1.4 km	0.02
YUS	BG	1	N	Background Soil	0.03

Table G – 8

Analytical Results for Soils; Benzene, Toluene, Ethylbenzene and Xylene

Sample Identification					Hydrocarbons			
Field	Site	No.	Odour	Sampled Area	Benzene	Toluene	Ethylbenzene	Xylenes
					(ug/g dry weight)			
				Canadian Soil Quality Criteria	**0.5**	**3**	**5**	**5**
LA	STN	2	S	Pit	1.6	0.52	0.88	4.3
SA	36	2	D	Chemical Tanks	0.18	0.3	0.13	1.3
SA	STC	2	S	Site Drainage	0.049	0.074	0.13	0.5
SA	STN2	2	S	Water/Waste Discharge Area	<0.005	0.09	0.016	0.048
SSF	STC	4	D	Fuel Tanks	7.7	7.1	14	15
SSF	STS	3	S	Diesel Tank	0.011	0.045	0.056	0.42
SSF	STS	4	S	Waste Pit Sludge near SSF23	22	34	10	52
SSF	STSW	4	S	Discharge Channel	0.11	<0.005	0.14	1

Indicates parameter level exceeding criterion. ☐

Table G – 9
Analytical Results for Pit Water Samples

Sample Description				Water Analysis						
Field	Site	No.	Sampled Area	(4500H) pH @ 25°C	(4500P-B/D) Phosphate Total (<1 mg/L)	(4500Cl-F) Chloride (<0.1 mg/L)	(2540-D) TSS @ 105°C (<2 mg/L)	(2540-C) TDS @ 180°C (<2 mg/L)	(4500S-E) Sulphide (<0.1 mg/L)	(5520-F) TPH by IR (<0.1 mg/L)
			Criteria	5.5 – 9.5	2	2,500	40	5,000	1	25
AT	ST	2	Produced Water Pit	6.39	0.01	71,100	3,076	140,000	0.3	12
AU	11	1	Pond / Depression	6.92	0.03	0.7	15	35	0.3	1.1
CN	STN	1	Produced Water Pit	7.71	0.04	678	<2	1,440	<0.1	680
DU	1	3	Produced Water Pit	7.57	0.05	12,700	520	20,000	2.0	53
GU	ST	5	Produced Water Pit	6.56	0.04	47,000	2,120	81,000	1.5	4.6
GU	1	1	Pit Water	6.31	0.16	1.3	88	164	1.1	130
LA	STC	8	Produced Water Pit	7.56	0.24	5,390	1,804	10,200	3.0	91
LA	STN	2	Produced Water Pit	7.46	0.24	4,440	496	9,000	4.3	6,800
RM	1	2	Pit Water	6.04	0.03	0.6	4	48	0.4	0.6
SA	94	2	Pit Water	6.05	0.12	5.0	76	44	2.1	34

☐ Indicates parameter level exceeding criterion.

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Sample Description Descripción de Muestras			Hydrocarbons Hidrocarbones (1)		Conventional Convensional (2)	Other Inorganics Otros Inorganicos (3)				
Field Campo	Site Sitio	No. Numero	Oil & Grease by IR Aceite y Grasa por IR (µg/g dry wt)	Moisture Humedad (%)	pH	Cyanide, Free Cianuro, Libre (mg/Kg)	Cyanide, Total Cianuro, Total	Sulphur Azufre	Bromide Bromuro	Fluoride Fluoruro
AG	ST	1	260,000	38.0	–	–	–	–	–	–
AG	ST	2	20,000	3.6	–	–	–	–	–	–
AG	ST	3	42,000	9.2	–	–	–	–	–	–
AG	ST	4	3,700	33.5	–	–	–	–	–	–
AG	3	1	33,000	35.0	–	–	–	–	–	–
AG	3	2	44,000	6.6	–	–	–	–	–	–
AG	6	1	2,800	32.5	5.3	–	–	–	–	–
AG	8	1	5,500	19.0	–	–	–	–	–	–
AG	10	1	360	34.1	–	–	–	–	–	–
AGSSFN	BG	1	110	33.1	6.0	–	–	–	–	–
AT	ST	1	13,000	7.8	–	–	–	–	–	–
AT	ST	3	6,200	49.2	–	–	–	–	–	–
AT	1	1	1,100	37.6	–	–	–	–	–	–
AT	2	1	58,000	73.3	–	–	–	–	–	–
AT	2	2	7,200	34.7	–	–	–	–	–	–
AT	BG	1	340	31.3	5.1	–	–	–	–	–
AU	STN	1	880,000	8.6	–	–	–	–	–	–
AU	1	1	750	18.6	–	–	–	–	–	–
AU	1	2	3,700	25.7	–	–	–	–	–	–
AU	4	1	6,300	30.9	–	–	–	–	–	–
AU	17	1	69,000	27.0	–	–	–	–	–	–
AU	19/19B	1	1,100	31.0	–	–	–	–	–	–
AU	24	1	2,600	22.8	–	–	–	–	–	–
AU	BG	1	170	35.0	5.0	–	–	–	–	–
AUS	STN1	1	420	29.7	5.4	–	–	–	–	–
AUS	1	2	16,000	30.6	–	–	–	–	–	–
AUS	BG	1	170	27.7	5.2	–	–	–	–	–
CN	1	1	59,000	45.7	5.3	–	–	–	–	–
CN	2	1	2,200	40.5	–	–	–	–	–	–
CN	11	1	950	41.9	–	–	–	–	–	–
CN	12	1	430,000	39.5	–	–	–	–	–	–
CN	BG	1	190	14.8	7.5	–	–	–	–	–
CU	STN	1	86,000	15.6	–	–	–	–	–	–
CU	STN	2	8,300	10.1	–	–	–	–	–	–
CU	2	1	7,000	7.7	7.3	–	–	–	–	–
CU	BG	1	35	15.3	–	–	–	–	–	–
DU	1	1	10,000	46.0	–	–	–	–	–	–
DU	1	2	270,000	31.2	4.6	–	–	–	–	–
GU	ST	1	6,700	51.3	–	–	–	–	–	–
GU	ST	2	930	47.5	–	–	–	–	–	–
GU	ST	3	48,000	22.3	–	–	–	–	–	–

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(1) - Method: EPA 418.1 , Method Detection Limit <20
(2) - Method: McKeague 4.12
(3) - Method: Cyanide - APHA 4500, Method Detection Limit <0.025; Sulphur - EPA 3050, Method Detection Limit <20; Bromide - APHA 4500, Method Detection Limit <8;
Fluoride - Fusion, Method Detection Limit <40

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* Analyses Performed by Norwest Labs.

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Environmental Assesment

Sample Description Descripción de Muestras			Hydrocarbons Hidrocarbones (1)		Conventional Convencional (2)	Other Inorganics Otros Inorganicos (3)				
Field Campo	Site Sitio	No. Numero	Oil & Grease by IR Aceite y Grasa por IR (µg/g dry wt)	Moisture Humedad (%)	pH	Cyanide, Free Cianuro, Libre (mg/Kg)	Cyanide, Total Cianuro, Total (mg/Kg)	Sulphur Azufre (mg/Kg)	Bromide Bromuro (mg/Kg)	Fluoride Fluoruro (mg/Kg)
GU	ST	4	2,600	42.3	–	–	–	–	–	–
GU	ST	6	10,000	19.4	–	–	–	–	–	–
GU	1	2	770	37.6	–	–	–	–	–	–
GU	3	1	990	38.5	–	–	–	–	–	–
GU	3	2	60,000	8.1	7.2	–	–	–	–	–
GU	5	1	120,000	20.3	–	–	–	–	–	–
GU	5	2	270	30.9	–	–	–	–	–	–
GU	8	1	73,000	40.5	–	–	–	–	–	–
GU	8	2	11,000	36.1	–	–	–	1233	–	–
GU	8	3	2,100	42.6	–	–	–	–	–	–
GU	BG	1	450	19.2	4.8	–	–	<20*	–	1.5*
LA	FL17	1	12,000	39.0	–	–	–	–	–	–
LA	STC	1	1,500	18.5	–	–	–	–	–	–
LA	STC	2	21,000	12.0	–	–	–	–	–	–
LA	STC	3	2,000	25.1	–	–	–	–	–	–
LA	STC	4	110,000	68.2	–	–	–	–	–	–
LA	STC	5	17,000	19.9	–	–	–	–	–	–
LA	STC	6	5,800	27.0	–	–	–	–	–	–
LA	STC	7	280	23.8	–	–	–	–	–	–
LA	STN	1	72,000	18.3	–	–	–	–	–	–
LA	STN	2 (sed.)	29,000	53.5	7.8	–	–	–	–	–
LA	STN	2	210,000	54.4	–	0.54	0.047	319	<8	168
LA	STN	3	26,000	49.0	–	–	–	–	–	–
LA	1	1	12,000	22.2	–	–	–	–	–	–
LA	5	1	3,000	24.0	–	–	–	–	–	–
LA	10	1	16,000	27.4	–	–	–	–	–	–
LA	10	2	4,500	35.3	4.9	–	–	–	–	–
LA	11B	1	550	15.8	–	–	–	–	–	–
LA	12	1	3,600	24.9	–	–	–	–	–	–
LA	21	1	140,000	25.3	–	–	–	–	–	–
LA	26	1	3,400	29.7	–	–	–	–	–	–
LA	26	2	590	21.3	–	–	–	–	–	–
LA	26	3	51,000	7.7	–	–	–	–	–	–
LA	29	1	1,600	10.6	–	–	–	–	–	–
LA	29	2	19,000	9.0	6.9	–	–	–	–	–
LA	34	1	1,500	22.5	–	–	–	–	–	–
LA	35	1	100	34.8	–	–	–	–	–	–
PH	ST	1	390	26.7	–	–	–	–	–	–
PH	ST	2	120,000	22.2	–	–	–	–	–	–
PH	ST	3	100	20.7	4.9	–	<0.025	407	<8	96
PH	ST	4	29,000	24.4	–	–	–	–	–	–

(1) - Method: EPA 418.1 , Method Detection Limit <20
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Fluoride - Fusion, Method Detection Limit <40

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Sample Description Descripción de Muestras			Hydrocarbons Hidrocarbones (1)		Conventional Convensional (2)	Other Inorganics Otros Inorganicos (3)				
Field Campo	Site Sitio	No. Numero	Oil & Grease by IR Aceite y Grasa por IR (µg/g dry wt)	Moisture Humedad (%)	pH	Cyanide, Free Cianuro, Libre	Cyanide, Total Cianuro, Total	Sulphur Azufre	Bromide Bromuro	Fluoride Fluoruro
						(mg/Kg)				
PH	2	1	55,000	8.2	–	–	–	–	–	–
PH	2	2	21,000	22.8	7.8	–	–	–	–	–
PH	5	1	42,000	25.8	–	–	–	–	–	–
PH	BG	1	110	34.9	4.9	–	–	–	–	–
RM	1	1 (dup. 1)	2,500	26.7	–	–	–	–	–	–
RM	1	1 (dup. 2)	2,700	21.5	–	–	–	–	–	–
RM	BG	1	450	24.7	5.2	–	–	–	–	–
SA	FL84	1	240,000	31.7	–	–	–	–	–	–
SA	STC	1	11,000	33.3	–	–	–	–	–	–
SA	STC	2	130,000	50.2	6.3	–	0.37	4,593	<8	152
SA	STC	3	8,700	33.4	6.3	–	–	–	–	–
SA	STC	4	72,000	27.5	–	–	–	–	–	–
SA	STN1	1	530	33.3	5.8	–	–	–	–	–
SA	STN1	2	9,300	20.0	–	–	–	–	–	–
SA	STN1	3	6,200	38.7	–	–	–	–	–	–
SA	STN1	4	3,100	36.8	–	–	–	–	–	–
SA	STN2	1	3,300	29.5	–	–	–	–	–	–
SA	STN2	2	2,800	37.5	7.3	–	0.051	3,703	<8	660
SA	STS	1	21,000	36.9	–	–	–	–	–	–
SA	WW6	1	230,000	23.1	–	–	–	–	–	–
SA	1	1	1,600	41.3	–	–	–	–	–	–
SA	1	2	35,000	23.9	–	–	–	–	–	–
SA	8	1	1,000	37.0	–	–	–	–	–	–
SA	9	1	2,600	17.7	–	–	–	–	–	–
SA	12	1	1,900	42.8	5.6	–	–	–	–	–
SA	16	1	7,700	31.9	–	–	–	–	–	–
SA	20	1	11,000	20.7	–	–	–	–	–	–
SA	21	1	39,000	36.9	–	–	–	–	–	–
SA	25	1	140,000	24.5	–	–	–	–	–	–
SA	25	2	2,700	40.5	–	–	–	–	–	–
SA	27	1	73,000	23.3	–	–	–	–	–	–
SA	28	1	99,000	39.8	–	–	–	–	–	–
SA	34	1	230,000	31.2	–	–	–	–	–	–
SA	35	1	92,000	25.5	–	–	–	–	–	–
SA	36	1	150,000	21.9	–	–	–	–	–	–
SA	36	2	21,000	15.1	–	–	–	–	–	–
SA	36	3	44,000	15.9	–	–	–	–	–	–
SA	43	1	9,500	40.0	–	–	–	–	–	–
SA	46	1	740	35.9	–	–	–	–	–	–
SA	72	1	280	21.0	–	–	–	–	–	–
SA	77	1	460	35.9	–	–	–	–	–	–

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Fluoride - Fusion, Method Detection Limit <40

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Sample Description Descripción de Muestras			Hydrocarbons Hidrocarbones (1)		Conventional Convensional (2)	Other Inorganics Otros Inorganicos (3)				
Field Campo	Site Sitio	No. Numero	Oil & Grease by IR Aceite y Grasa por IR (µg/g dry wt)	Moisture Humedad (%)	pH	Cyanide, Free Cianuro, Libre	Cyanide, Total Cianuro, Total	Sulphur Azufre	Bromide Bromuro	Fluoride Fluoruro
						(mg/Kg)				
SA	78	1	2,200	33.1	–	–	–	–	–	–
SA	86	1	270,000	64.9	–	–	–	–	–	–
SA	93	1	1,200	33.6	–	–	–	–	–	–
SA	93	2	31,000	49.2	–	–	–	–	–	–
SA	94	1	530,000	57.9	–	–	–	–	–	–
SA	94	3	760,000	36.8	–	–	–	–	–	–
SA	97	1	290,000	16.0	–	–	–	–	–	–
SA	100	1	20,000	35.5	–	–	–	–	–	–
SA	109	1	2,300	34.2	–	–	–	–	–	–
SA	BG	Sa	23	13.6	5.8	–	–	–	–	–
SA	BG	1	50	12.3	7.2	–	–	–	–	–
SA	BG	2	140	26.3	5.7	–	–	–	–	–
SSF	STC	1	2,700	38.0	–	–	–	–	–	–
SSF	STC	2	2,400	20.4	–	–	–	–	–	–
SSF	STC	3	210	35.3	–	–	–	–	–	–
SSF	STC	4	23,000	33.0	–	–	–	–	–	–
SSF	STC	5	420	31.2	–	–	–	–	–	–
SSF	STN	1	6,800	37.6	–	–	–	–	–	–
SSF	STN	2	180	36.1	–	–	–	–	–	–
SSF	STN	3	2,100	45.2	–	–	–	–	–	–
SSF	STN	4	23,000	27.6	–	–	–	–	–	–
SSF	STS	1	200	36.7	–	–	–	–	–	–
SSF	STS	2	2,100	14.5	–	–	–	–	–	–
SSF	STS	3	6,100	15.9	–	–	–	–	–	–
SSF	STS	4	480,000	24.8	7.9	–	0.062	12315	<8	92
SSF	STSW	1	51,000	25.0	–	–	–	–	–	–
SSF	STSW	2	990	35.5	–	–	–	–	–	–
SSF	STSW	3	4,200	31.2	–	–	–	–	–	–
SSF	STSW	4	8,300	56.8	–	–	–	–	–	–
SSF	WF	1	230,000	51.1	–	–	–	–	–	–
SSF	A1	1	3,400	23.3	–	–	–	–	–	–
SSF	A24	1	5,900	35.1	–	–	–	–	–	–
SSF	A43	1	23,000	36.9	–	–	–	–	–	–
SSF	A43	2	14,000	42.8	–	–	–	–	–	–
SSF	A68	1	94	39.4	–	–	–	–	–	–
SSF	A68	2	1,500	45.6	–	–	–	–	–	–
SSF	A6B	3	1,700	45.6	–	–	–	–	–	–
SSF	A45B	1	140,000	26.8	–	–	–	–	–	–
SSF	B36	1	1,500	18.3	–	–	–	–	–	–
SSF	B52	1	20,000	20.9	–	–	–	–	–	–
SSF	B57	1	4,000	43.4	–	–	–	–	–	–

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Field Campo	Site Sitio	No. Numero	Oil & Grease by IR Aceite y Grasa por IR (µg/g dry wt)	Moisture Humedad (%)	pH	Cyanide, Free Cianuro, Libre (mg/Kg)	Cyanide, Total Cianuro, Total (mg/Kg)	Sulphur Azufre (mg/Kg)	Bromide Bromuro (mg/Kg)	Fluoride Fluoruro (mg/Kg)
SSF	B59	1	230,000	64.1	–	–	–	–	–	–
SSF	B63	1	77,000	25.8	–	–	–	–	–	–
SSF	B64	1	4,100	33.8	5.5	–	–	–	–	–
SSF	B66	1	110,000	31.6	6.6	–	0.028	3227	<8	136
SSF	SP1	1	170	22.9	–	–	–	–	–	–
SSF	SP1	2	44,000	31.8	–	–	–	–	–	–
SSF	6	1	140,000	29.9	–	–	–	–	–	–
SSF	13	1	5,400	27.6	–	–	–	–	–	–
SSF	B31	1	190,000	20.5	8.1	–	0.073	35,750	<8	160
SSF	FLA6	1	230	31.8	–	–	–	–	–	–
SSF	FL13	BG	830	29.9	5.2	–	–	–	–	–
YB	1	1	1,400	24.7	–	–	–	–	–	–
YB	2	1	11,000	23.0	5.5	–	–	–	–	–
YUS	1	1	500	27.2	–	–	–	–	–	–
YUS	1	1	700	26.6	–	–	–	–	–	–
YUS	1	2	900	23.3	–	–	–	–	–	–
YUS	1	3	74	25.3	–	–	–	–	–	–
YUS	1	4	460	25.1	–	–	–	–	–	–
YUS	BG	1	150	25.0	4.8	–	–	–	–	–

(1) - Method: EPA 418.1 , Method Detection Limit <20
(2) - Method: McKeague 4.12
(3) - Method: Cyanide - APHA 4500, Method Detection Limit <0.025; Sulphur - EPA 3050, Method Detection Limit <20; Bromide - APHA 4500, Method Detection Limit <8;
Fluoride - Fusion, Method Detection Limit <40

EPA - U.S. Environmental Protection Agency, 1986. Test Methods for Evaluation of Solid Waste 3rd Ed. Office of Solid Waste Emergency Response, U.S. Environmental Protection Agency, Washington, D.C.
McKeague - J.A. 1978 - Manual on Soil Sampling and Method of Analyses. Can. Soc. Sci. Ottawa.
APHA - Standard method for the Examination of Water and Wastewater, 1989. 17th Ed. American Public Health Association
* Analysis Performed by Norwest Labs.

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TECHNICAL REPORT

PETROECUADOR - TEXACO
Environmental Assesment

Sample Description Descripción de Muestras			Heavy Metals Metales Pesados (1)																						
Field Campo	Site Sitio	No. Numero	<0.003 Ar (µg/g)	<0.003 Hg (µg/g)	<0.003 Se (µg/g)	<5 Sn (µg/g)	<5 Al (µg/g)	<0.5 Ba (µg/g)	<0.1 Be (µg/g)	<0.5 Cd (µg/g)	<5 Ca (µg/g)	<1 Cr (µg/g)	<5 Co (µg/g)	<1 Cu (µg/g)	<1 Fe (µg/g)	<5 Pb (µg/g)	<5 Mg (µg/g)	<5 Mn (µg/g)	<5 Mo (µg/g)	<5 Ni (µg/g)	<5 P (µg/g)	<5 K (µg/g)	<5 Na (µg/g)	<10 Tl (µg/g)	<5 V (µg/g)	<1 Zn (µg/g)
AGSSFN	BG	1	–	–	–	–	93,520	1190	<0.1	<0.5	1400	27	24	63	35,960	78	2,390	730	<5	22	684	632	115	30	110	71
AU	BG	1	–	–	–	–	53,520	105	<0.1	<0.5	61	96	12	82	48,540	61	585	270	<5	45	291	186	29	35	170	36
CN	1	1	–	–	–	–	80,300	140	<0.1	2.0	190	130	12	50	51,330	79	345	120	<5	49	240	160	33	21	145	53
CN	BG	1	–	–	–	–	22,050	172	<0.1	<0.5	3,235	23	<5	27	154	35	3,570	101	<5	14	113	1,410	178	<10	41	51
DU	1	2	–	–	–	–	7,390	69	<0.1	<0.5	5080	13	<5	212	15,490	570	870	91	<5	83	980	520	1,320	16.0	170	315
GU	3	2	–	<0.003	–	–	660,900	61	<0.1	<0.5	57.00	15	<5	7	6,720	72	190	11	<5	8	41	190	21	<10	<5	27
GU	8	2	–	–	–	–	22,850	79	<0.1	<0.5	35	12	<5	12	11,630	26	2,560	50	<5	12	132	603	22	<10	42	51
GU	BG	1	0.017	0.050	0.027	<5	14,800*	59.1*	0.1*	<0.5*	63*	12.4*	3*	11.3*	12,500*	9*	938*	50.4*	<5*	11*	96*	270*	<50*	<10*	41.8*	53.5*
LA	STN	2	0.010	0.043	0.028	15.9	445,300	159	<0.1	<0.5	7730	22	12	50	30,840	55	5,400	330	<5	18	720	1,700	1,690	14	67	84
LA	29	2	–	–	–	–	120,300	775	<0.1	<0.5	4190	11	6	24	14,790	49	5,640	220	<5	9	580	1,500	520	<10	43	57
PH	ST	3	<0.003	0.184	0.072	28.4	692,900	64	<0.1	<0.5	55.00	17	<5	7	7,210	71	200	11	<5	8	44	160	23	<10	42	28
RM	BG	1	–	–	–	–	62,610	89	<0.1	1.0	90	105	11	31	46,320	63	452	210	<5	32	237	231	24	25	125	45
SA	STC	2	0.005	0.038	0.114	54.0	76,700	370	<0.1	<0.5	3,050	25	25	57	52,470	83	3,400	260	<5	25	1,560	802	1,230	132	136	132
SA	STN1	1	–	–	–	–	56,670	560	<0.1	<0.5	1,100	14	20	44	28,260	51	1,810	525	<5	13	680	830	270	98	110	67
SA	STN2	3	0.005	0.052	0.020	<5	28,490	160	3.0	<0.5	12,240	17	12	27	21,350	28	4,390	200	<5	15	1,030	530	189	23	81	48
SA	BG	Sa	–	–	–	–	8,080	58	<0.1	<05	930	5	<5	9	9,820	13	1,550	130	<5	10	196	363	8	<10	30	45
SA	BG	1	–	–	–	–	9,280	81	<0.1	<0.5	1,680	7	<5	9	100	11	2,140	116	<5	11	194	505	19	<10	32	53
SA	BG	2	–	–	–	–	99,050	1,030	<0.1	1.0	750	26	30	77	41,750	81	2,610	1,210	<5	19	1,220	700	140	162	140	86
SSF	STC	1	–	–	–	–	100,400	740	<0.1	<0.5	1,070	27	24	80	42,480	83	2,770	540	<5	22	1,220	834	585	23	135	87
SSF	STS	4	0.007	0.288	0.020	13.2	7,600	210	<0.1	<0.5	52,470	10	6	30	22,230	63	1,190	230	<5	22	240	270	4,900	36	49	87
SSF	STSW	2	–	–	–	–	80,030	480	<0.1	<0.5	1,590	73	33	71	44,460	66	3,410	655	<5	37	1,940	860	785	41	160	97
SSF	B66	1	0.010	0.022	0.173	40.1	56,040	800	<0.1	<0.5	1,370	28	21	59	33,290	56	3,590	430	<5	25	550	644	200	29	135	76
SSF	B31	1	0.006	<0.003	0.024	9.18	220,900	200	<0.1	<0.5	36,120	18	15	111	57,550	560	4,770	390	<5	25	590	830	1,440	52	60	714
YB	2	1	–	–	–	–	23,660	240	<0.1	<0.5	2,170	13	11	14	21,360	35	3,570	130	<5	17	230	932	49	45	47	68
YUS	BG	1	–	–	–	–	47,610	71	<0.1	1.0	107	23	<5	13	27,130	49	1,950	93	<5	11	167	805	35	19	74	51

(1) - Method: EPA 3050

EPA - U.S. Environmental Protection Agency, 1986 Test Methods for Evaluation of Solid Waste 3rd Ed. Office of Solid Waste Emergency Response, U.S. Environmental Protection Agency, Washington, D.C.

* Analysis Performed by Norwest Labs.

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** All Samples Will Be Disposed After 30 Days Following Analysis. Please Contact The Lab If You Require Additional Sample Storage Time (Samples Deemed Hazardous Will Be Returned To The Client At Their Own Expense Or Disposal Will Be Arranged) **

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TECHNICAL REPORT

PETROECUADOR - TEXACO
Environmental Assesment

Sample Description Descripción de Muestras			Hydrocarbons Hidrocarbones (1)	
Field Campo	Site Sitio	No. Numero	Oil & Grease by IR Aceite y Grasa por IR (ug/g dry wt)	Moisture Humedad (%)
AU	STC	BH3	670	24.5
AU	STC	BH2	200	26.5
LA	1	TP1	86	26.5
GU	STC	BH1	260	32.9
LA	32	TP1	82	38.6
LA	STN	TP2	99	34.7
LA	STN	TP1	47	32.6
AU	STS	BH1	370	18.3
AU	STS	SS2	120	25.0
AU	7	SS1	140	27.9
AU	7	SS2	53	20.1
CON	STC	BH1	160	27.7
CON	STC	BH2	130	28.4
LA	STC	BH1	460	34.8
LA	STC	BH2	3100	24.0
SSF	STC	TP2/4M	170	27.8
SSF	STC	TP3/4M	220	42.3
SSF	STN	TP2	1100	38.9
SSF	STN	TP1	31	20.5
SSF	B66	TP1	82	42.5
SSF	A43	TP1	99	36.3
SSF	A43	TP2	140	35.2
SSF	S7	TP2	17000	37.0
SSF	S7	TP1	150	42.5
SSF	71	TP1	260	39.6
SSF	71	TP2	510	38.5
AG	9	TP2	100	38.5
AG	9	TP1	63	27.7
AG	3	TP1	1700	26.9
AG	10	TP2	140	56.1
SSF	13	TP1	42	17.9
SSF	67	TP1	410	56.0
SSF	STS	TP1	1800	48.1
SA	STC	TP1	150	43.4
SA	STC	STP3	75	34.6
SA	STS	TP2	4100	22.2
SA	75	TP1	130	38.9
SA	103	TP1	170	35.7
SA	STN1	TP1	2800	39.1

1 - Method: EPA 418.1 , Method Detection Limit <20

EPA - U.S. Environmental Protection Agency, 1986. Test Methods for Evaluation of Solid Waste 3rd Ed. Office of Solid Waste Emergency Response, U.S. Environmental Protection Agency, Washington, D.C.

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** All Samples Will Be Disposed After 30 Days Following Analysis. Please Contact The Lab If You Require Additional Sample Storage Time (Samples Deemed Hazardous Will Be Returned To The Client At Their Own Expense Or Disposal Will Be Arranged). **

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TECHNICAL REPORT

PETROECUADOR - TEXACO
Environmental Assessment

Sample Description Descripción de Muestras			Hydrocarbons[1] Hidrocarburos
Field Campo	Site Sitio	No. Numero	Oil and Grease by IR Aceite y Grasa por IR (mg/L)
SSF	STC	TP2	<0.2
SSF	STC	TP3	<0.2
SSF	B66	TP1	1.0
SSF	A43	WW1	<0.2
SSF	STN	WW1	<0.2
SSF	71	TP1	0.5
AG	9	TP2	0.6
AG	3	TP2	8.3
AG	3	TP1	67
AG	3	WW	–
AG	9	WW	<0.2
AG	10	WW	<0.2
AG	10	TP1	1.1
AG	10	TP3	0.9
SA	STC	TP2	0.6
SA	STS	TP1	<0.2
SA	STN1	TP2	<0.2
SSF	13	SS	<0.2
SSF	STS	WW	<0.2
SSF	STSW	TP1	0.5
SSF	STSW	TP2	<0.2
SSF	STSW	TP3	<0.2
SSF	STSW	WW	<0.2
SSF	O6	WW	<0.2

1 - Method: EPA 413.1 , Method Detection Limit <0.2
2 - Method: McKeague 4.12

EPA - U.S. Environmental Protection Agency, 1986. Test Methods for Evaluation of Solid Waste 3rd Ed. Office of Solid Waste Emergency Response, U.S. Environmental Protection Agency, Washington, D.C.
McKeague - J.A. 1978 - Manual on Soil Sampling and Method of Analyses. Can. Soc. Sci. Ottawa.

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TECHNICAL REPORT

PETROECUADOR - TEXACO

Environmental Assement

Page 1 of 3

Field	Campo	AU	AU	AU	AU	AG	AG	AG	AG	AG	AG	AG	AG	CON	LA	LA
Site	Sitio	STS	STS	STC	STS	3	3	3	9	9	10	10	10	STG	STN	20
Number	Numero	SS1	MW1	WW	WW1	TP1	TP2	WW	TP2	WW	TP1	TP3	WW	WW	WW1	55
Parameter	Parametros															
pH (units)	pH (unidades)	7.11	6.35	6.05	7.03	–	–	6.63	–	6.93	–	–	–	6.99	7.08	7.26
Specific Conductance (mS/cm)	Conducto Especifico (mS/cm)	29	1.585	0.03	0.04	–	–	0.08	–	0.06	–	–	–	0.04	0.19	0.07
Turbidity NTU	Turbieza NTU	88800	1800	2.6	3.3	–	–	13	–	12	–	–	–	85	5.5	7.8
Colour (true)	Color (verdadero)	3	500	1	5	–	–	–	–	1	–	–	–	25	1	23
Calcium, Diss.	Calcio, Dis.	236	15.6	2.0	3.3	–	–	6.4	–	7.8	–	–	–	3.4	23.9	6.9
Magnesium, Diss.	Magnesio, Dis.	66.5	5.0	<0.1	1.1	–	–	2.2	–	0.9	–	–	–	0.9	2.3	2.1
Potassium, Diss.	Potasio, Dis.	101	2.9	0.8	<0.1	–	–	1.4	–	1	–	–	–	1.2	4.2	1.6
Sodium, Diss.	Sodio, Dis.	6755	270	3.7	4.6	–	–	2.1	–	1.9	–	–	–	3.2	11.9	4.2
Iron, T.	Hierro, T.	32.4	28.7	0.12	0.1	–	–	0.1	–	0.2	–	–	–	1.51	0.10	1.31
Manganese, Diss.	Manganesio, Dis.	4	10.3	<0.05	<0.05	–	–	<0.05	–	<0.05	–	–	–	<0.05	<0.05	<0.05
Bicarbonate, Diss.	Bicarbonato, Dis.	74	82	19	36	–	–	28	–	35	–	–	–	25	95	51
Carbonate, Diss.	Carbonato, Dis.	<1	<1	<1	<1	–	–	<1	–	<1	–	–	–	<1	<1	<1
Chloride, Diss.	Clorudos, Dis.	13800	490	2.1	0.5	–	–	1.8	–	1	–	–	–	0.5	11	1.4
Sulphate, Diss.	Sulfato, Dis.	1.7	2.7	1.2	0.1	–	–	5.5	–	1.5	–	–	–	1.2	2.6	0.24
Oil and Grease by IR	Aceite y Grasa por IR	–	1.0	0.5	0.3	67	8.3	–	0.6	<0.2	1.1	0.9	<0.2	–	0.4	0.3
Alkalinity, T. as (CaCO3)	Alcalinidad, T. (CaCO3)	60	68	16	30	–	–	23	–	29	–	–	–	21	78	42
Hardness, T. as (CaCO3)	Dureza, T. (CaCO3)	863	60	5	13	–	–	25	–	23	–	–	–	12	69	26
Total Dissolved Solids (.45μm)	Solidos Totales Disueltos (.45μm)	22345	1965	275	860	–	–	1.95	–	140	–	–	–	135	420	460
Balance	Balance	0.81	0.95	0.72	0.76	–	–	1.01	–	0.91	–	–	–	1.04	1.05	0.89

Notes: All values are reported in mg/L unless otherwise stated; T. - total; Diss. - Dissolved.

Notas: Todas las unidades son reportadas en mg/L a menos de ser indicado diferente; T - total; Dis. - Disuelto.

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PETROECUADOR - TEXACO

Field	Campo	LA	LA	SA	SA	SA	SA	SA	SA	SA	SA	SA	SSF	SSF	SSF	SSF
Site	Sitio	21	26	STC	STN1	STN1	STS	STS	90	94	100	103	STC	STC	STC	STN
Number	Numero	55	55	TP2	TP2	WW	TP1	WW	WW	WW	WW	MW1	MW1	TP2	TP3	WW1
Parameter	Parametros															
pH (units)	pH (unidades)	6.72	6.75	–	–	6.6	–	6.46	6.5	6.89	6.9	–	6.88	–	–	680
Specific Conductance (mS/cm)	Conducto Especifico (mS/cm)	0.08	0.02	–	–	0.10	–	0.11	0.081	0.24	0.16	–	0.58	–	–	0.12
Turbidity NTU	Turbiem NTU	3.1	5.8	–	–	1.4	–	4.4	5.3	3.4	3.9	–	2600	–	–	1.1
Colour (true)	Color (verdadero)	2	1	–	–	1	–	2	1	3	1	–	33	–	–	1
Calcium, Diss.	Calcio, Dis.	6.9	1.8	–	–	7.9	–	8.1	4.4	11.5	13.5	–	25.8	–	–	7.8
Magnesium, Diss.	Magnesio, Dis.	2.4	0.6	–	–	2.2	–	2.6	1.4	7.3	3.1	–	15.1	–	–	3.8
Potassium, Diss.	Potasio, Dis.	0.8	<0.1	–	–	1.5	–	1.2	1.3	26.9	2	–	1.1	–	–	1.2
Sodium, Diss.	Sodio, Dis.	5.3	2.2	–	–	3.3	–	3.8	5.2	19.7	5.8	–	20.9	–	–	5.3
Iron, T.	Hierro, T.	0.10	0.11	–	–	<0.05	–	<0.05	0.16	0.13	0.17	–	10.1	–	–	<0.05
Manganese, Diss.	Manganesio, Dis.	<0.05	<0.05	–	–	<0.05	–	<0.05	<0.05	<0.05	<0.05	–	0.69	–	–	<0.05
Bicarbonate, Diss.	Bicarbonato, Dis.	50	16	–	–	41	–	44	35	147	62	–	47	–	–	72
Carbonate, Diss.	Carbonato, Dis.	<1	<1	–	–	<1	–	<1	<1	<1	<1	–	<1	–	–	<1
Chloride, Diss.	Clorudos, Dis.	1.3	0.62	–	–	2.5	–	3.8	2.5	23	24	–	135	–	–	7
Sulphate, Diss.	Sulfato, Dis.	1.1	1.2	–	–	2.4	–	1.3	2.7	3.1	2.4	–	1.3	–	–	1.4
Oil and Grease by IR	Aceite y Grasa por IR	0.3	0.2	0.6	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0.6	0.2	–	<0.2	<0.2	<0.2
Alkalinity, T. as (CaCO3)	Alcalinidad, T. (CaCO3)	41	13	–	–	34	–	36	29	121	51	–	39	–	–	59
Hardness, T. as (CaCO3)	Dureza, T. (CaCO3)	27	7	–	–	29	–	31	17	59	46	–	127	–	–	35
Total Dissolved Solids (.45µm)	Solidos Totales Disueltos (.45µm)	315	250	–	–	440	–	335	265	370	250	–	750	–	–	225
Balance	Balance	0.91	0.79	–	–	0.96	–	0.95	0.86	0.87	0.71	–	0.84	–	–	0.68

Notes: All values are reported in mg/L unless otherwise stated; T. - total; Diss. - Dissolved.

Notas: Todas las unidades son reportadas en mg/L a menos de ser indicado diferente; T - total; Dis. - Disuelto.

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HBT AGRA Limited
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TECHNICAL REPORT

PETROECUADOR - TEXACO

Field	Campo	SSF	SSF	SSF	SSF	SSF	SSF	SSF	SSF	SSF	SSF	Villa Hermosa	Culebra	Eno
Site Number	Sitio Numero	SSTSW TP1	STS TP3	STS WW	STSW TP2	STSW WW	A43 WW1	B66 TP1	6 WW	13 SS	71 TP1			
Parameter	Parametros													
pH (units)	pH (unidades)	–	–	6.92	–	–	6.32	–	–	–	–	5.85	5.98	6.69
Specific Conductance (mS/cm)	Conducto Especifico (mS/cm)	–	–	0.08	–	–	0.12	–	–	–	–	0.01	0.01	0.08
Turbidity NTU	Turbieza NTU	–	–	10	–	–	1.4	–	–	–	–	1.9	13	15
Colour (true)	Color (verdadero)	–	–	–	–	–	3	–	–	–	–	1	2	2
Calcium, Diss.	Calcio, Dis.	–	–	5.6	–	–	6.5	–	–	–	–	<0.1	0.8	7.3
Magnesium, Diss.	Magnesio, Dis.	–	–	3.1	–	–	4.5	–	–	–	–	<0.1	0.5	3.4
Potassium, Diss.	Potasio, Dis.	–	–	1.4	–	–	1.3	–	–	–	–	0.9	<0.1	1.2
Sodium, Diss.	Sodio, Dis.	–	–	2.8	–	–	4.4	–	–	–	–	1.7	1.3	4.9
Iron, T.	Hierro, T.	–	–	0.3	–	–	<0.05	–	–	–	–	<0.05	0.26	0.29
Manganese, Diss.	Manganesio, Dis.	–	–	0.58	–	–	<0.05	–	–	–	–	<0.05	<0.05	<0.05
Bicarbonate, Diss.	Bicarbonato, Dis.	–	–	44	–	–	14	–	–	–	–	9	9	46
Carbonate, Diss.	Carbonato, Dis.	–	–	<1	–	–	<1	–	–	–	–	<1	<1	<1
Chloride, Diss.	Cloruros, Dis.	–	–	1.4	–	–	7.2	–	–	–	–	0.38	0.6	3.6
Sulphate, Diss.	Sulfato, Dis.	–	–	0.9	–	–	1	–	–	–	–	0.2	2.7	3.1
Oil and Grease by IR	Aceite y Grasa por IR	0.5	<0.2	<0.2	<0.2	<0.2	<0.2	1.0	<0.2	<0.2	0.5	1040	0.3	0.5
Alkalinity, T. as (CaCO3)	Alcalinidad, T. (CaCO3)	–	–	36	–	–	12	–	–	–	–	7	7	38
Hardness, T. as (CaCO3)	Dureza, T. (CaCO3)	–	–	27	–	–	35	–	–	–	–	<6	4	32
Total Dissolved Solids (.45μm)	Solidos Totales Disueltos (.45μm)	–	–	60	–	–	165	–	–	–	–	430	150	190
Balance	Balance	–	–	0.93	–	–	2.28	–	–	–	–	0.60	0.67	0.98

Notes: All values are reported in mg/L unless otherwise stated; T. - total; Diss. - Dissolved.

Notas: Todas las unidades son reportadas en mg/L a menos de ser indicado diferente; T - total; Dis. - Disuelto.

Report reviewed by: Marie England
Marie England
QA/QC Compliance
Environmental Services

for Raynald LeBlanc, M. Sc.
Manager
Environmental Services

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All Samples Will Be Disposed After 30 Days Following Analysis. Please Contact The Lab If You Require Additional Sample Storage Time (Samples Deemed Hazardous Will Be Returned To The Client At Their Own Expense Or Disposal Will Be Arranged)

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TECHNICAL REPORT

Table 7.3. Summary of water quality data for rivers and streams in the Petroecuador - Texaco Oriente Oilfields, June 1993.

		Water Quality Criteria Criterio de Cualidad de Agua		Shushufindi							Agua Rico	Secha	
		Drinking	Aquatic Life	R1U	R3d	R4d	R5U	R6d	R7d	R8U	R10d	R14d	R16d
Site Parameter	Sitio Parametros	Bebido	Vida Aquatica										
Temperature (°C)	Temperatura (°C)			24.0	23.0	24.0	25.0	25.0	24.0	24.0	22.0	23.0	23.5
pH-field (units)	pH-campo (unidades)	6.0-9.0	4.0-9.0	6.55	6.04	7.30	5.86	5.93	6.22	6.53	7.04	7.31	7.19
pH (units)	pH (unidades)	6.0-9.0	4.0-9.0	7.61	7.01	7.10	7.16	7.07	7.16	7.27	7.63	7.18	7.22
Specific Conductance-field (mS/cm)	Conducto Especifico-campo (mS/cm)			0.23	0.85	0.70	0.20	0.23	0.29	0.30	0.30	0.26	0.29
Specific Conductance (mS/cm)	Conducto Especifico (mS/cm)			0.11	0.64	0.65	0.08	0.07	0.08	0.09	0.11	0.096	0.15
Dissolved Oxygen (field)	Oxigeno Disuelto		>5.0						See Notes				
Turbidity NTU	Turbieza NTU	100		11	6.4	16	2.1	8	39	21	100	19	9.3
Colour (true)	Color (verdadero)	20		16	5	12	20	17	21	19	7	13	19
Calcium, Diss.	Calcio, Dis.	75	75	8	17	20	5.2	4.8	5.2	5.4	13	5.0	8.3
Magnesium, Diss.	Magnesio, Dis.	50	50	3.9	6.2	7.2	2.5	2.3	2.5	2.7	1.2	2.5	2.9
Potassium, Diss.	Potasio, Dis.			1.4	3.9	3.9	1.3	1.3	1.5	1.6	1.3	1.9	2.4
Sodium, Diss.	Sodio, Dis.			5	82	80	4	3	2	4	2	3	8
Iron, T.	Hierro, T.	0.3	0.3	1	1.3	1.4	1	1.2	1.4	1.4	1.2	0.1	0.1
Manganese, Diss.	Manganesio, Dis.	0.5	0.1	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Bicarbonate, Diss.	Bicarbonato, Dis.	100		57	63	62	43	37	39	45	48	37	50
Carbonate, Diss.	Carbonato, Dis.	50		<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Chloride, Diss.	Clorudos, Dis.	250	1000	0.8	150	155	0.7	0.9	0.6	0.8	2.5	1.1	9.0
Sulphate, Diss.	Sulfato, Dis.	500	500	1.5	0.9	3.7	0.6	0.6	1.6	1.1	5.1	0.7	0.6
Alkalinity, T. as (CaCO3)	Alcalinidad, T. (CaCO3)	250		47	52	50	35	30	32	37	40	30	41
Hardness, T. as (CaCO3)	Dureza, T. (CaCO3)	250		36	68	80	23	21	23	25	37	23	33
Total Suspended Solids	Solidos Suspendidos (total)	Absent		27	65	210	105	16	60	410	260	168	276
Total Dissolved Solids (.45µm)	Solidos Totales Disueltos (.45µm)	1000		92	365	368	77	80	83	73	77	84	93
TPH (C5-C30)	THP (C5-C30)	1.0	1.0	0.9	2.4	1.7	2.7	3.9	3.1	3.3	2.5	0.3	0.4
Ionic Balance	Balance de Iones			0.985	0.951	0.947	0.912	0.919	0.856	0.902	0.900	0.973	0.978

Notes: Water Quality Criteria for surface waters taken from the contract document; all values are reported in mg/L unless otherwise stated; T. - total; TPH - Total Petroleum Hydrocarbons; Diss. - Dissolved; R - River; U - Upstream (control) site; d - downstream of effluent discharge point.

Dissolved oxygen concentrations in rivers and streams ranged from 4.0 to 6.0 mg/L in June (personal communication with Roy Roberts of Fugro McClelland).

Notas: Criterio de Cualidad de Agua para las aguas del superficio sacados de los documentos del contrato; todas las unidades son reportadas en mg/L a menos de ser indicado diferente; T-Total; THP-Total del Hidocaburo de Petroleo; Dis.-Disuleto; R-Rio; U- Agua arriva (control) sitio; d- Agua abajo del punto de descarga del efluente.

Las concentraciónes del Oxigeno Disuelto en los rios y arroyos fluctúa de 4.0 a 6.0 mg/L en Junio (comunicación personal con Roy Roberts de Fugro McClelland).

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Table 7.3 Cont'd. Summary of water quality data for rivers and streams in the Petroecuador - Texaco Oriente Oilfields, June 1993.

Page 2 of 2

		Water Quality Criteria Critterio de Cualidad de Agua		Sacha		Cononaco	Auca	Auca			Lago Agrio			
Site Parameter	Sitio Parametros	Drinking Bebido	Aquatic Life Vida Aquatica	R17U	R18U	R24U	R26d	R28U	R29d	R30U	R32d	R33U	R35U	R36d
Temperature (°C)	Temperatura (°C)			23.5	24.0	25.0	24.5	24.0	26.5	23.5	25.0	21.0	24.0	25.0
pH-field (units)	pH-campo (unidades)	6.0-9.0	4.0-9.0	7.03	6.78	7.40	6.91	6.93	7.33	7.80	7.05	7.80	6.18	5.94
pH (units)	pH (unidades)	6.0-9.0	4.0-9.0	7.19	7.39	7.17	6.74	6.93	7.12	6.70	7.00	7.29	7.58	7.53
Specific Conductance-field (mS/cm)	Conducto Especifico-campo (mS/cm)			0.27	0.32	0.20	0.68	0.14	0.58	0.13	0.20	0.15	0.17	1.25
Specific Conductance (mS/cm)	Conducto Especifico (mS/cm)			0.11	0.16	0.05	0.62	0.04	5.04	0.02	0.12	0.10	0.09	1.23
Dissolved Oxygen (field)	Oxigeno Disuelto		>5.0						See Notes					
Turbidity NTU	Turbieza NTU	100		8.4	2.1	17	2.1	4.2	4.2	6.5	70	40	6.9	7.8
Colour (true)	Color (verdadero)	20		20	15	5	3	17	14	5	13	7	16	20
Calcium, Diss.	Calcio, Dis.	75	75	6.8	9.6	3.3	9.8	2.1	64	0.8	8.7	10	6.8	56
Magnesium, Diss.	Magnesio, Dis.	50	50	2.8	4.5	2.0	1.9	0.8	10	0.5	3.3	1.2	3.0	5.3
Potassium, Diss.	Potasio, Dis.			1.8	1.9	1.1	2.4	1.6	24	0.5	3.2	1.1	1.7	18
Sodium, Diss.	Sodio, Dis.			4	5	3	89	2	895	2	5	2	4	142
Iron, T.	Hierro, T.	0.3	0.3	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	<0.1	0.2	0.1
Manganese, Diss.	Manganeso, Dis.	0.5	0.1	<0.05	<0.05	<0.05	<0.05	<0.05	0.059	<0.05	<0.05	<0.05	<0.05	<0.05
Bicarbonate, Diss.	Bicarbonato, Dis.	100		47	70	29	23	17	56	10	49	38	49	116
Carbonate, Diss.	Carbonato, Dis.	50		<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Chloride, Diss.	Clorudos, Dis.	250	1000	1.0	0.8	0.9	154	0.5	1600	0.2	2.2	1.4	1.4	278
Sulphate, Diss.	Sulfato, Dis.	500	500	0.5	0.5	0.5	0.6	0.4	1.6	0.5	1.0	3.7	0.6	6.6
Alkalinity, T. as (CaCO3)	Alcalinidad, T. (CaCO3)	250		39	57	24	19	15	46	8	40	31	40	95
Hardness, T. as (CaCO3)	Dureza, T. (CaCO3)	250		29	43	16	32	9	201	4	35	30	29	162
Total Suspended Solids	Solidos Suspendidos (total)	Absent		152	152	156	140	88	216	168	152	200	104	200
Total Dissolved Solids (.45µm)	Solidos Totales Disueltos (.45µm)	1000		83	100	63	360	57	2800	15	88	77	93	732
TPH (C5-C30)	THP (C5-C30)	1.0	1.0	0.3	<0.2	0.2	0.4	0.4	0.3	0.3	0.5	0.4	0.5	0.2
Ionic Balance	Balance de Iones			0.976	0.945	0.954	0.967	0.991	0.945	1.005	1.134	0.964	0.940	0.999

Notes: Water Quality Criteria for surface waters taken from the contract document; all values are reported in mg/L unless otherwise stated; T. - total; TPH - Total Petroleum Hydrocarbons; Diss. - Dissolved; R - River; U - Upstream (control) site; d - downstream of effluent discharge point.

Dissolved oxygen concentrations in rivers and streams ranged from 4.0 to 6.0 mg/L in June (personal communication with Roy Roberts of Fugro McClelland).

Notas: Criterio de Cualidad de Agua para las aguas del superficio sacados de los documentos del contrato; todas las unidades son reportadas en mg/L a menos de ser indicado diferente; T-Total; THP-Total del Hidocaburo de Petroleo; Dis.-Disuleto; R-Rio; U- Agua arriva (control) sitio; d- Agua abajo del punto de descarga del effuente.

Las concentraciónes del Oxigeno Disuelto en los rios y arroyos fluctúa de 4.0 a 6.0 mg/L en Junio (comunicación personal con Roy Roberts de Fugro McClelland).

Report reviewed by: Marie England

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APPENDIX H

GEOLOGIC TEST PIT AND BORING LOGS

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TEST PIT LOGS

Depth (meters)	Materials Encountered
Shushufindi Estacion Central (SSF-STC)	
Test Pit No. 1	
0 - 1.4	Stiff, moist, moderately plastic, dark brown, silty CLAY. Carbon layer at 0.3 meters. color change to mottled dark brown and gray at 0.6 meters.
1.4 - 3.7	Stiff, moist, gray, silty SAND with strong petroleum odor.
3.7 - 3.8	Medium dense, saturated, gray, fine to medium grained, well sorted, SAND. Groundwater with heavy sheen infiltrating into test pit at 3.6 meters.
Test Pit No. 2	
0 - 0.9	Loose, moist, gray, medium grained SAND with Gravel and Cobbles.
0.9 - 1.5	Hard, damp, reddish brown, cemented fine to medium grained SAND.
1.5 - 3.2	Medium dense, moist to wet, unconsolidated fine to medium SAND. Sand becomes coarser at 2.1 meters. Groundwater infiltrating test pit at 2.7 meters. Slight sheen noted on the groundwater. Soil sample SSF-STC-TP2 collected at 2.4 meters. Water sample SSF-STC-TP2 collected from excavation.
Test Pit No. 3	
0 - 1.5	Medium stiff, moist, brown, plastic silty CLAY. Color change to dark brown at 1.1 meters.
1.5 - 1.9	Medium stiff, wet, dark brown, silty CLAY with sand.
1.9 - 2.3	Medium dense, saturated, fine to medium grained, silty SAND. Groundwater infiltrating test pit at 2.0 meters. No sheen or product noted on groundwater. Soil sample SSF-STC-TP3 collected at 2.4 meters. Water sample SSF-STC-TP2 collected from test pit.
Peizometer MW-1	
0 - 1.5	Medium stiff, moist, brown, plastic silty CLAY. Color change to dark brown at 1.0 meters.
1.5 - 1.9	Medium stiff, wet, dark brown, silty CLAY with sand.

1.9 - 2.0	Medium dense, saturated, silty SAND. Static water level in Peizometer at 0.942 meters from top of casing. Two inch PVC pipe used for casing. Casing slotted from 1.7 to 2.0 meters. No sand or gravel filter pack used. Water sample SSF-STC-MW1 collected from peizometer.

Shushufindi Estacion Norte (SSF-STN)

Test Pit No. 1

0 - 2.0	Stiff, damp, dark brown, Clayey SILT. Low plasticity.
2.0 - 2.6	Ferruginous hard pan layer. Hard, damp, reddish brown, cemented sandy SILT. The hard pan layer is fractured.
2.6 - 2.8	Unconsolidated dense, gray, fine grained SAND. No groundwater encountered. Sample SSF-STN-TP1 collected at 2.6 meters.

Test Pit No. 2

0 - 0.3	Stiff, reddish brown, damp to moist, silt CLAY.
0.3 - 2.8	Stiff, gray, fractured CLAY. Crude oil contamination noted at 0.3 meters. Globules of oil concentrated in fractures and root holes. Soil sample SSF-STN-TP2 collected from test pit at 2.0 meters.

Shushufindi Estacion Sur (SSF-STS)

Test Pit No. 1

0 - 0.35	Medium grained SAND and GRAVEL. Perched groundwater at 0.35 meters.
0.35 - 3.5	Stiff, black, plastic, silty CLAY. Color changes to brown at 0.7 meters. Soil sample SSF-STS-TP1 collected at 3.5 meters.

Shushufindi Estacion Sur-Oeste (SSF-STSW)

Test Pit No. 1

0 - 0.05	Black Tar.
0.05 - 2.1	Brown, moderately plastic, silty CLAY.
2.1 - 3.1	Brown, moist, sandy SILT.
3.1 - 3.6	Gray, wet, silty SAND. Groundwater level at 3.24 meters below ground surface. Water sample SSF-STSW-TP1 collected from test pit.

Test Pit No. 2

0 - 2.0	Brown, moderately plastic, silty CLAY.
2.0 - 3.0	Mottled brown, plastic, clayey SILT with iron concretions.

3.0 - 3.6	Brown, wet, silty SAND. Groundwater encountered in test pit. Water sample SSF-STSW-TP2 collected from test pit.

Test Pit No. 3

0 - 0.3	Medium sand and gravel FILL.
0.3 - 3.0	Reddish brown silty CLAY. Visibly contaminated soil noted between 1.0 and 3.0 meters. Water sample SSF-STSW-TP3 collected from test pit.

Shushufindi Pozo A43
Test Pit No. 1

0 - 0.46	Medium Sand and Gravel FILL.
0.46 - 0.84	Gray SAND with petroleum odor.
0.84 - 1.7	Reddish brown, silty CLAY.
1.7 - 3.24	Ferruginous hard pan. Hard, moist to wet, cemented fine SAND. No groundwater infiltrated test pit. Soil sample SSF-43-TP1 collected at 3.04 meters.

Test Pit No. 2

0 - 0.9	Medium sand and gravel FILL.
0.9 - 2.0	Moist, reddish brown, silty CLAY. Soil sample SSF-43-TP2 collected at 2.0 meters.
2.0 - 2.4	Ferruginous hard pan. Hard cemented fine to medium grained SAND.

Shushufindi Pozo B66
Test Pit No. 1

0 - 0.6	Medium Sand and Gravel FILL. Perched groundwater in fill.
0.6 - 2.7	Stiff, moist, reddish brown silty CLAY. Becomes mottled reddish brown and greenish brown with greater depth in test pit. Water sample SSF-66-TP1 collected from test pit.

Test Pit No. 2

0 - 0.27	Wet, sandy gravel FILL.
0.27 - 1.6	Stiff, damp, reddish brown, plastic silty CLAY. Color changes to gray at 1.2 meters.
1.6 - 3.0	Reddish brown CLAY.

Shushufindi Pozo B71

Test Pit No. 1

0 - 0.58	Medium Sand and Gravel FILL. Perched groundwater in fill.
0.58 - 2.7	Medium stiff to stiff, moist, plastic, reddish brown silty CLAY. Soil sample SSF-71-TP1 collected at 2.7 meters. Crude oil in fractures in clay above 1.6 meters. Color changes to mottled brown at 2.6 meters.

Test Pit No. 2

0 - 0.38	Silty sand, FILL.
0.38 - 2.0	Reddish brown, fractured silty CLAY. Becomes less plastic with greater depth. Soil sample SFF-71-TP2 collected at 1.2 meters. Water sample collected from test pit.

Shushufindi Pozo B57

Test Pit No. 1

0 - 0.4	Medium silty sand FILL.
0.4 - 0.5	Medium SAND with gravel and cobbles. Petroleum odor noted.
0.5 - 2.7	Stiff, silty CLAY with crude oil in fractures. Iron concretions at 2.6 meters. Soil sample SSF-57-TP1 collected at 2.7 meters.

Test Pit No. 2

0 - 0.34	Medium sand with gravel and cobbles, FILL.
0.34 - 3.0	Dark gray silty CLAY with very strong petroleum odor. Soil sample SSF-57-TP2 collected at 2.7 meters.

Test Pit No. 3

0 - 0.33	Medium sand with gravel, FILL.
0.33 - 3.0	Reddish brown silty CLAY. Crude oil noted in fractures in the clay below 1.0 meters.

Shushufindi Pozo A13

Test Pit No. 1

0 - 0.4	Fine to medium sand and gravel FILL. Wood debris at base of fill. Perched groundwater in fill at 0.1 meters.
0.4 - 3.0	Mottled red and gray, very stiff, damp, low plasticity, silty CLAY. Soil sample SSF-13-TP1 collected at 3.0 meters.

Test Pit No. 2

0 - 0.5	Medium sand and gravel FILL
0.4 - 3.1	Mottled red and gray, very stiff, moist to very moist, moderate plasticity, silty CLAY.
3.1 - 3.5	Mottled brown, stiff, wet, plastic, CLAY.

Shushufindi Pozo A67
Test Pit No. 1

0 - 0.5	Medium sand and gravel FILL. Perched groundwater in fill.
0.5 - 3.6	Black, moist, low plasticity, silty CLAY. Color changes to brown at 0.9 meters. Soil sample SSF-67-TP1 collected at 3.6 meters.

Test Pit No. 2

0 - 0.5	Medium sand and gravel FILL. Perched groundwater in fill.
0.5 - 3.5	Brown to light brown silty CLAY. Pebbles within the clay at 3.0 meters.

Test Pit No. 3

0 - 0.4	Medium sand and gravel FILL. Wood debris at base of fill. Perched groundwater in fill.
0.4 - 3.4	Black silty CLAY. Color changes to brown at 1.3 meters.

Agua Rico Pozo 3
Test Pit No. 1

0 - 0.36	Medium sand and gravel FILL. Perched groundwater in fill. Petroleum sheen on the groundwater.
0.36 - 2.38	Dark brown, silty CLAY. Petroleum odor noted in soil at 2.0 meters. Soil sample AG9-TP1 collected at 2.0 meters.
2.38 - 2.6	Ferruginous hard pan. Hard, cemented fine SAND.
2.6 - 2.7	Unconsolidated, fine to medium grained SAND. Slight petroleum odor noted in sand. Water sample AG9-TP1 collected from test pit.

Test Pit No. 2

0 - 0.35	Sandy gravel FILL.
0.35 - 1.0	Brown to gray silty CLAY. Groundwater with a heavy sheen encountered at 0.84 meters. Water sample AG9-TP2 collected from test pit.

Test Pit No. 3

0 - 0.37	Sand and gravel FILL.
0.37 - 2.5	Dark gray silty CLAY with a strong petroleum odor and visible crude oil in fractures. Oil flowing into hole at 1.8 meters.

Agua Rico Pozo 9
Test Pit No. 1

0 - 0.5	Fine sand and gravel FILL.
0.5 - 2.0	Brown silty CLAY. Evidence of petroleum contamination noted in soil. Groundwater infiltrated test pit at 2.5 meters. Heavy sheen noted on groundwater.
2.0 - 3.0	Mottled brown clayey SILT. Soil sample AG-9-TP1 collected at 3.0 meters.

Test Pit No. 2

0 - 0.58	Sandy gravel FILL. Logs at base of fill.
0.58 - 2.7	Dark brown silty CLAY. Color change to light brown at 1.84 meters. Collected soil sample AG9-TP2 at 1.0 meter. Groundwater infiltrated test pit. Water sample AG9-TP2 collected from test pit.

Agua Rico Pozo 10
Test Pit No. 1

0 - 0.26	Medium sand and gravel FILL.
0.26 - 2.54	Brown silty CLAY. Color change to light brown at 1.06 meters.
2.54 - 2.7	Unconsolidated, well sorted, medium grained SAND. Groundwater infiltrated test pit at 2.54 meters. Water Sample AG10-TP1 collected from test pit.

Test Pit No. 2

0 - 0.4	Sandy gravel FILL.
0.4 - 1.0	Brown silty CLAY.
1.0 - 3.0	Brown, wet, clayey SILT with fine sand layers. Groundwater infiltrating test pit at 2.0 meters.
3.0 - 3.1	Mottled brown, saturated SILT. Soil sample AG-10-TP2 collected at 3.0 meters.

Test Pit No. 3

0 - 0.4	Sand and gravel FILL
0.4 - 1.75	Brown, very plastic silty CLAY. Groundwater infiltrating the cavity at 1.75 meters at a fast rate.
1.75 - 2.7	Sandy SILT with Clay.
2.7 - 3.0	Brown SILT. Groundwater infiltrating from multiple zones within silt. Water sample AG10-TP3 collected from test pit.

Sacha Estacion Central

Test Pit No. 1

0 - 0.5	Organic rich, dark brown top soil.
0.5 - 1.3	Dark brown silty CLAY.
1.3 - 2.3	Ferruginous hard pan. Reddish brown, hard, cemented fine sand.
2.3 - 4.4	Gray, unconsolidated, saturated, medium grained SAND. A small quantity of groundwater infiltrating test pit at 3.4 meters.

Test Pit No. 2

0 - 0.3	Organic rich, dark brown topsoil.
0.3 - 0.4	Medium SAND with cobbles.
0.4 - 1.1	Dark reddish brown, moist to wet, silty CLAY.
1.1 - 1.8	Ferruginous hard pan. Hard cemented fine SAND. Water sample SA-STC-TP2 collected from test pit.
1.8 - 3.8	Gray, unconsolidated, saturated, medium grained SAND. Groundwater encountered at 2.9 meters.

Test Pit No. 3

0 - 0.6	Dark brown silty CLAY.
0.6 - 1.2	Ferruginous hard pan.
1.2 - 3.0	Gray medium grained SAND.
3.0 - 4.5	Reddish brown, wet, plastic, fine sandy CLAY with weathered rock fragments.

4.5 - 5.0	Reddish brown, cemented medium SAND. No groundwater encountered in test pit. Soil sample SA-STC-TP3 collected at 5.0 meters.

Sacha Estacion Sur
Test Pit No. 1

0 - 1.6	Brown, moist, plastic, silty CLAY. Becomes saturated at 1.0 meters. Water infiltrating the test pit at a fast rate.
1.6 - 3.8	Mottled reddish brown and gray silty CLAY. Water sample SA-STS-TP1 collected from test pit.

Test Pit No. 2

0 - 0.2	Black silty CLAY with cobbles. Petroleum odor noted in soil.
0.2 - 3.0	Reddish brown silty CLAY. Color change to dark grayish brown at 1.5 meters. Collected soil sample SA-STS-TP2 at 1.0 meter.

Peizometer MW-1

0 - 1.6	Brown, moist, stiff, CLAY. Becomes wet at 0.8 meters and becomes saturated at 1.5 meters. Color change to mottled reddish brown and gray 1.6 meters. Static water level in Peizometer at 0.600 meters from bottom of peizometer. Two inch PVC pipe used for casing. Casing slotted from 1.3 to 1.6 meters. No sand or gravel filter pack used. Water sample SA-STS-MW1 collected from peizometer.

Sacha Estacion Norte 1
Test Pit No. 1

0 - 2.2	Dark gray to black silty CLAY. Medium sand FILL and discarded drum in portion of the test pit.
2.2 - 4.6	Brown, moist silty CLAY. Crude oil noted in fractures and root holes between 3.2 and 4.6 meters. No groundwater encountered in test pit. Soil sample SA-STN1-TP1 collected at 3.5 meters.

Test Pit No. 2

0 - 0.3	Topsoil.
0.3 - 0.4	Sandy Silt with blocky texture.
0.4 - 0.8	Dark gray silty SAND.
0.8 - 3.15	Brown, moist, moderately plastic, fine sandy CLAY.
3.15 - 4.3	Dark reddish brown silty CLAY.

4.3 - 4.8	Mottled reddish brown and gray silty fine SAND. Water infiltrating test pit at 4.5 meters. Water sample SA-STN1-TP2 collected from test pit.

Sacha Pozo 75
Test Pit No. 1

0 - 0.4	Fine grained sand FILL with petroleum odor. Logs at the base of fill.
0.4 - 1.9	Dark grayish brown, stiff, plastic, moist silty CLAY. Color changes to reddish brown at 0.8 meters. Soil sample SA-75-TP1 collected at 1.0 meter.
1.9 - 3.3	Cemented fine SAND.
3.3 - 3.5	Reddish brown silty CLAY

Sacha Pozo 94
Hand Auger Boring BH-1

0 - 0.3	Sand and gravel FILL
0.3 - 0.6	Gray medium sand FILL. Perched groundwater within fill.
0.6 - 1.5	Dark brown silty CLAY.
1.5 - 1.7	Dark gray saturated SILT.
1.7 - 3.2	Light brown silty CLAY. Water sample SA94-BH1 collected from boring.

Sacha Pozo 103
Peizometer MW-1

0 - 2.7	Reddish brown, moist to wet, plastic, silty CLAY. Color changes to dark brown at 1.0 meters.
2.7 - 3.2	Dark gray, saturated, medium grained silty SAND. Static water level in Peizometer at 0.275 from bottom of peizometer. Two inch PVC pipe used for casing. Casing slotted from 2.9 to 3.2 meters. No sand or gravel filter pack used. Water sample SA103-MW1 collected from peizometer.

Auca Estacion Central
Peizometer MW-1

0 - 0.1	Grayish brown, fine SAND.
0.1 - 1.2	Reddish brown silty CLAY. Becomes saturated at 0.2 meters. Static water level in Peizometer at 0.890 from bottom of peizometer. Two inch PVC pipe used for casing. Casing slotted from 0.9 to 1.2 meters. No sand or gravel filter pack used. Water sample AU-STC-MW1 collected from peizometer.

Hand Auger Boring BH-2

0 - 2.7	Mottled red and gray, moist sandy clay FILL. Soil sample AU-STC-BH2 collected at 2.5 meters.
2.7 - 3.2	Gray, moist clayey sand FILL. No groundwater encountered. Soil sample AU-STC-BH2 collected at 3.2 meters.

Hand Auger Boring BH-3

0 - 0.8	Dark red and gray, moist silty CLAY.
0.8 - 1.2	Gray, sandy CLAY. Becomes wet at 1.0 meters.
1.2 - 1.6	Reddish brown silty CLAY. Soil sample AU-STC-BH3 collected at 1.5 meters.

Auca Estasion Sur
Hand Auger Boring BH-1

0 - 2.2	Light red and gray, moist, silty SAND. Moderate petroleum odor noted. Color change to yellowish brown at 0.7 meters. Soil sample AU-STS-BH1 collected at 2.2 meters.
2.2 - 2.3	Reddish brown, moist, silty SAND with clay.

Hand Auger Boring BH-2

0 - 0.3	Red, saturated, CLAY. Water flowing from seep in embankment.
0.3 - 0.5	Moist, gray sandy CLAY. Soil sample AU-STS-SS1 collect at 0.3 meters. Water sample AU-STS-SS1 collected from seep near boring.

Auca Pozo 7
Soil Profile in Trench

0 - 0.6	Black, sandy gravel FILL. Hydrocarbon odor noted in fill.
0.6 - 1.0	Reddish brown and gray silty CLAY. Soil sample AU-7-SS1 collected at 1.0 meters, sample AU-7-SS2 collected at 0.6 meters just below contact with fill.

Cononaco Estacion Central
Hand Auger Boring BH-1

0 - 0.3	Light brown clayey SAND.
0.3 - 0.9	Mottled light brown and gray, plastic, moist to wet sandy CLAY. Soil sample CON-STC-BH1 collected at 0.8 feet. Refusal at 0.9 feet.

Hand Auger Boring BH-2

0 - 3.0	Reddish brown, moist, moderately plastic silty CLAY. Soil sample CON-STC-BH2 collected at 2.8 meters.

Lago Agrio Estacion Central
Hand Auger Boring BH-1

0 - 0.75	Mottled dark brown and red, stiff, plastic, damp to moist silty Clay FILL
0.75 - 2.2	Gray Sandy clay FILL
2.2 - 2.4	Buried top soil horizon. Mat of roots, decayed grass, and wood debris encountered. Refusal at 2.4 feet. Composite soil sample LA-STC-BH1 collected from between 0.75 and 2.4 meters.

Hand Auger Boring BH-2

0 - 0.1	Dark gray medium SAND.
0.1 - 0.7	Red, moist, plastic silty clay FILL
0.7 - 2.2	Gray fine grained silty sand FILL Black ash streaks within sand. Soil sample LA-STC-BH2 collected at 1.0 meter.
2.2 - 2.3	Sandy SILT with clay.

Lago Agrio Estacion Norte
Test Pit No. 1

0 - 0.3	Gray medium sand with cobbles - FILL Logs at the base of fill.
0.3 - 1.5	Reddish brown to gray silty CLAY. Black organic or oily layer at 0.75 meters.
1.5 - 2.55	Gray, cemented, medium grained silty SAND. Silty clay layers in sand between 1.7 and 2.55 meters.
2.55 - 4.5	Reddish brown, plastic, moist, silty CLAY. Thin lense of petroleum hydrocarbon contamination at 2.8 meters. Color change to dark brown at 4.1 meters. Soil sample LA-STN-TP1 collected at 4.5 meters. Groundwater seeping into test pit at 2.8 meters.

Test Pit No. 2

0 - 3.2	Reddish brown silty clay FILL Color change to dark brown at 0.45 meters and dark yellowish brown at 2.0 meters. Tree trunks and roots noted at between 2.0 and 3.2 meters. Groundwater encountered at 3.0 meters. Soil sample LA-STN-TP2 collected at 3.2 meters.

Lago Agrio Pozo 1
Test Pit No. 1

0 - 0.3	Gray medium grained sand with cobbles - FILL.
0.3 - 1.0	Gray fine SAND
1.0 - 1.8	Reddish brown and gray silty CLAY with blocky structure.
1.8 - 1.9	Gray, saturated clayey SILT. This soil horizon yielded a small quantity of perched groundwater.
1.9 - 4.0	Very dark brown, plastic, moist, silty CLAY. Reddish brown layer between 2.5 and 3.0 meters. Soil sample LA-1-TP1 collected at 1.9 meters.

Lago Agrio Pozo 32
Test Pit No. 1

0 - 0.5	Gray medium grained sand with cobbles - FILL.
0.5 - 1.2	Reddish brown, plastic, moist, silty CLAY.
1.2 - 1.6	Dark brown, organic rich, saturated clayey SILT.
1.6 - 2.3	Brown, saturated, moderately plastic silty CLAY. Soil sample LA-32-TP1 collected at 3.0 meters. Groundwater collected from test pit.

Guanta Estasion
Hand Auger Boring No. 1

0 - 2.4	Medium stiff to soft, damp to saturated, brown silty CLAY. Groundwater encountered at 2.4 meters. Soil sample GU-STC-BH1 collected at 2.4 meters.

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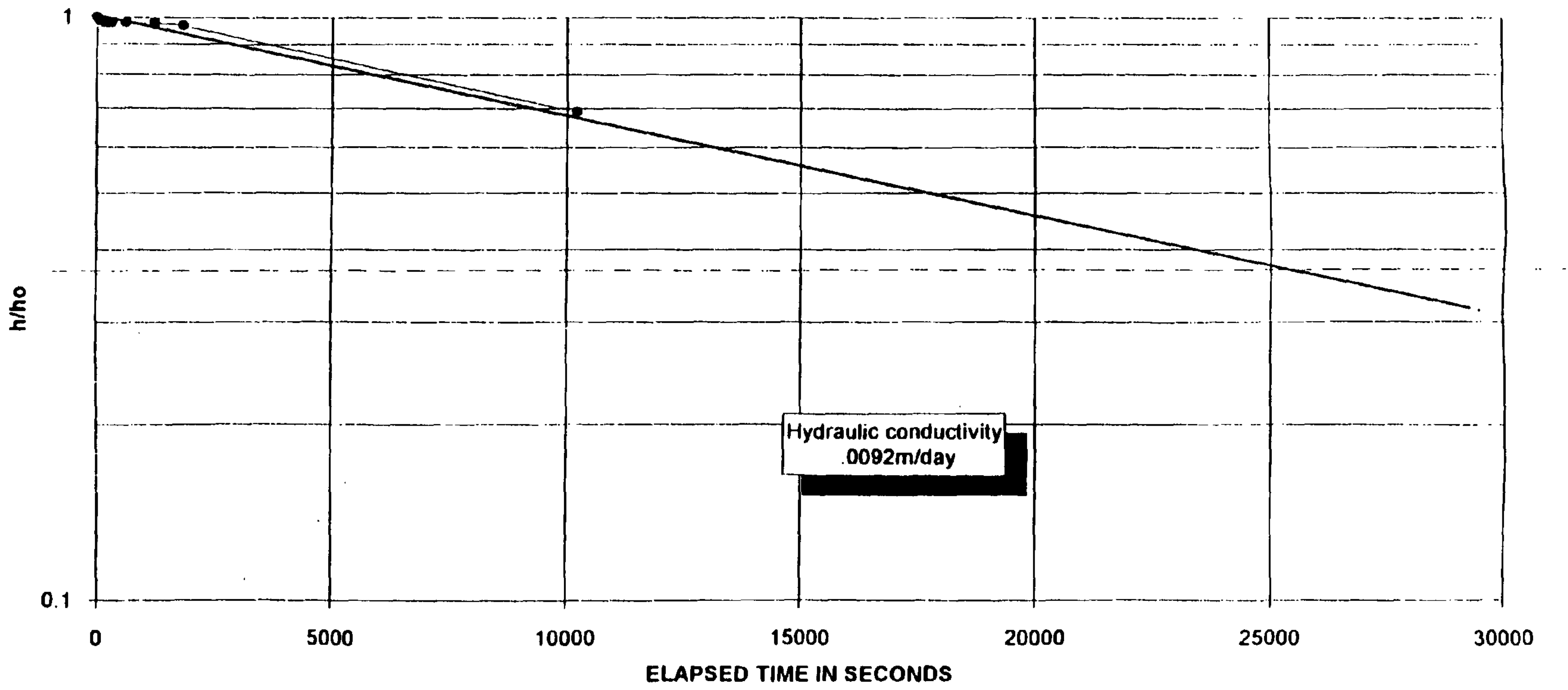
RISING HEAD TEST IN MW-1, SACHA ESTACION SUR



Revised 8/13/93
6287MTRC XLS Chart 1

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PET 041088

CA1069835

Shusufindi Estacion Central
MW-1
Slug Test

Elapsed Time	Depth to Water (measured from bottom of casing - meters)	Change in Water Level h (meters)	h/ho
	0.942		
30	0.36	0.582	1
80	0.412	0.53	0.91
120	0.452	0.49	0.84
180	0.49	0.452	0.78
240	0.531	0.411	0.71
300	0.56	0.382	0.66
600	0.7	0.242	0.42
900	0.785	0.157	0.27
1200	0.85	0.092	0.16
1800	0.91	0.032	0.05

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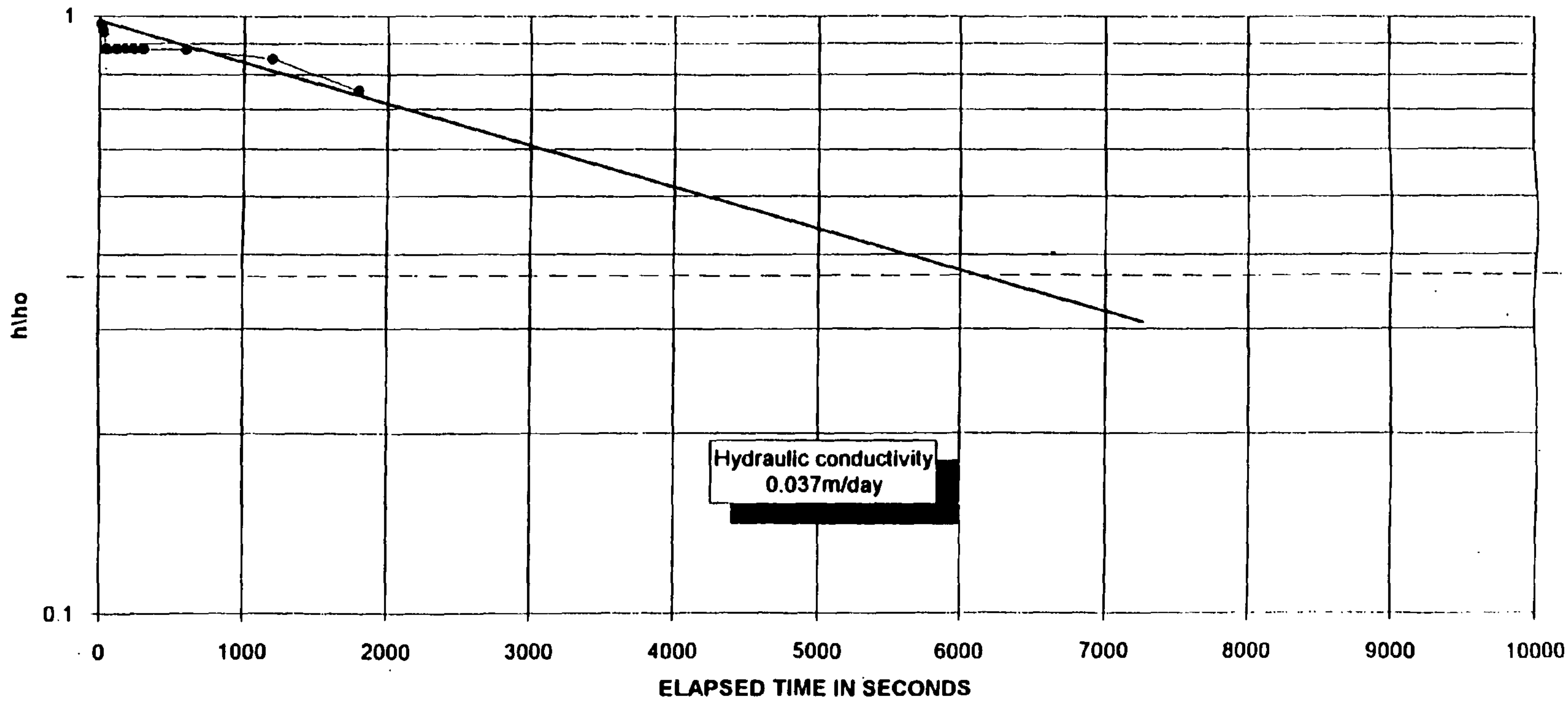
RISING HEAD TEST IN MW-1, SACHA POZO 103



Revised 8/13/93
6287MTRC XLS Chart 5

Sacha Pozo 103
MW-1
Slug Test

Elapsed Time	Depth to Water (measured from bottom of casing - meters)	Change in Water Level h (meters)	h/ho
	0.275		
0	0.11	0.165	
15	0.115	0.16	0.97
30	0.12	0.155	0.94
45	0.13	0.145	0.88
60	0.13	0.145	0.88
120	0.13	0.145	0.88
180	0.13	0.145	0.88
240	0.13	0.145	0.88
300	0.13	0.145	0.88
600	0.13	0.145	0.88
1200	0.135	0.14	0.85
1800	0.152	0.123	0.75
3540	0.282	0	

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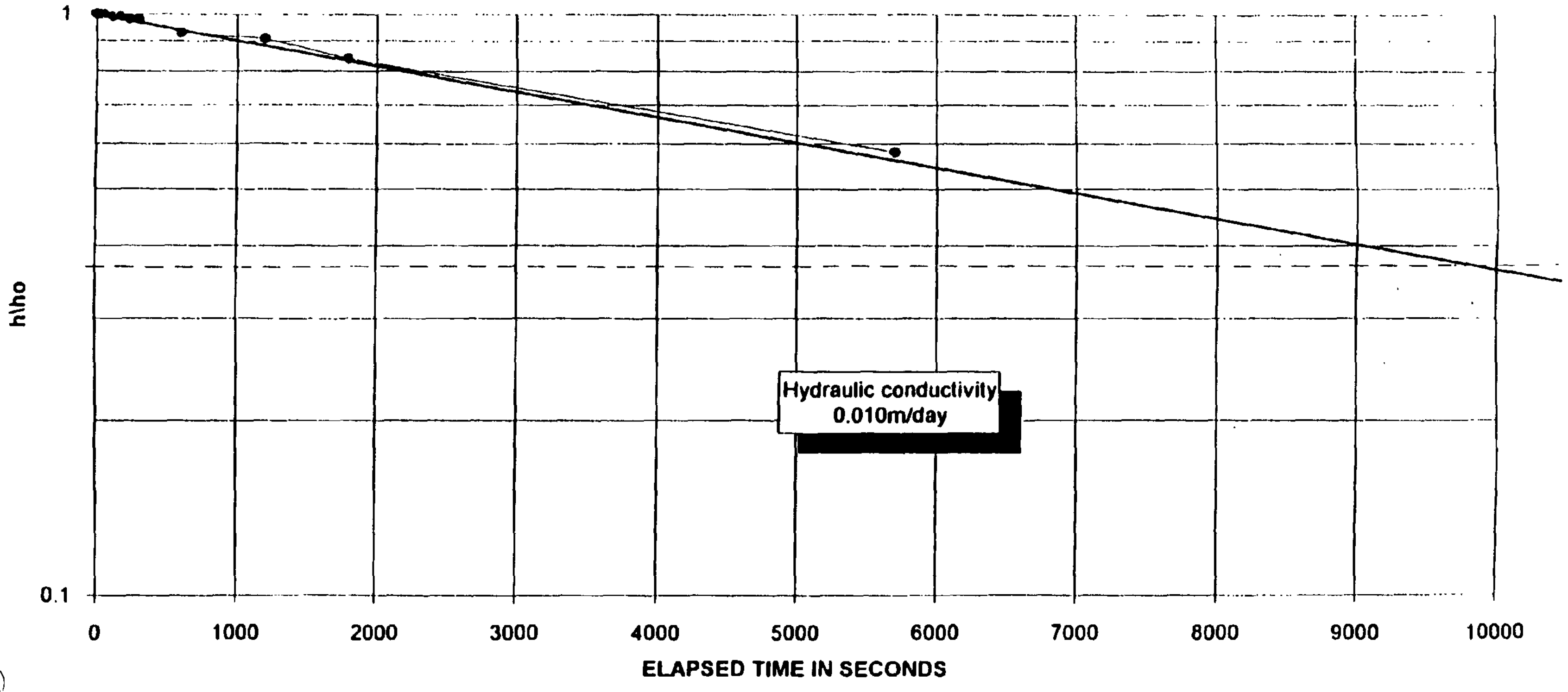
RISING HEAD TEST IN MW-1, AUCA ESTACION



Hydraulic conductivity
0.010m/day

Revised 8/13/03
8287MTRC KLS Chart 4

Auca Estacion
MW-1
Slug Test

Elapsed Time	Depth to Water (measured from bottom of casing - meters)	Change in Water Level h (meters)	h/ho
	0.89		
0	0.6	0.29	1
15	0.6	0.29	1
30	0.6	0.29	1
45	0.6	0.29	1
60	0.6	0.29	1
120	0.603	0.287	0.99
180	0.604	0.286	0.99
240	0.605	0.285	0.98
300	0.605	0.285	0.98
600	0.62	0.27	0.93
1200	0.626	0.264	0.91
1800	0.645	0.245	0.84
5700	0.722	0.168	0.58
23400	0.925	0	

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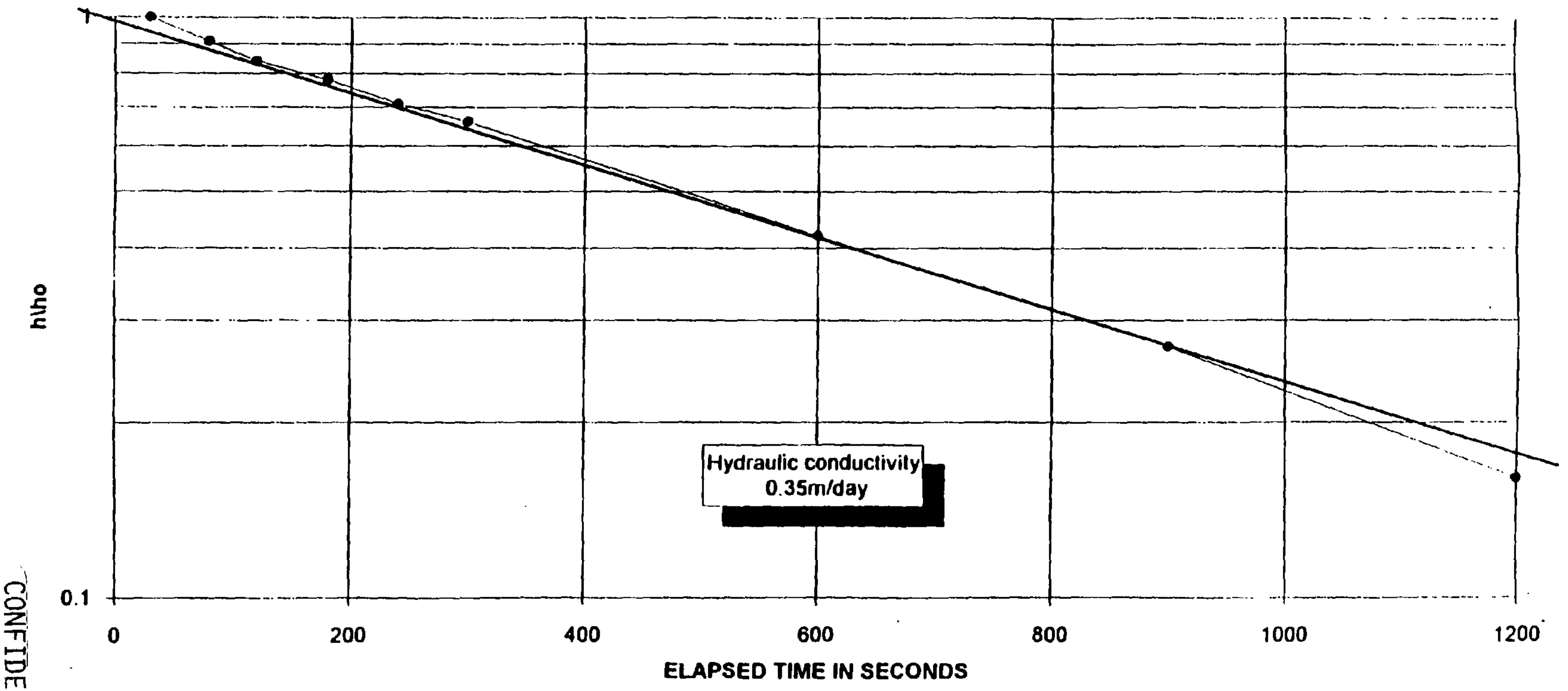
RISING HEAD TEST IN MW-1, SHUSUFINDI ESTACION CENTRAL



Revised 8/13/03
8287MTRC XLS Chart 3

Sacha Estacion SU5
MW-1
Slug Test

Elapsed Time	Depth to Water (measured from bottom of casing - meters)	Change in Water Level h (meters)	h/ho
	0.6		
0	0.12	0.48	1
15	0.121	0.479	1
30	0.122	0.478	1
45	0.124	0.476	0.99
60	0.126	0.474	0.99
120	0.128	0.472	0.98
180	0.13	0.47	0.98
240	0.13	0.47	0.98
300	0.131	0.469	0.98
600	0.132	0.468	0.98
1200	0.132	0.468	0.98
1800	0.133	0.467	0.97
10200	0.265	0.335	0.69

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6287MTRC XLS

APPENDIX I

RECOMMENDED DISPOSAL CRITERIA FOR OILY WASTES

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RECOMMENDED DISPOSAL CRITERIA FOR OILY WASTES

Oily waste material and fluids may be applied to road surfaces if the following characterization criteria can be met and alternate practical technologies are not readily available.

No free water.

The hydrocarbon content must be equal to or greater than 5 percent as a calculated mix. The oil should be of a relatively high density.

pH ≥ 6.

Total salts:
- Na ≤ 5 500 kg/ha,
- chloride ≤ 7 000 kg/ha.

Total metals:
- Cd ≤ 1.6 kg/ha,
- Hg ≤ 1.0 kg/ha,
- Pb ≤ 200 kg/ha,
- Ni ≤ 100 kg/ha,
- V ≤ 150 kg/ha,
- B ≤ 20 kg/ha.

Other data required in the analysis but which are not part of the criteria are specific conductance and density of sample.

The material must not contain halogenated hydrocarbons, hazardous chemicals, refined or lube oils or deleterious substances such as filters, rags, vegetation or other debris.

The maximum depth of application of material is limited to the smallest of the "Calculated Application Depths" determined for all parameters using the following formula:

$$d(cm) = \frac{Lx10^4}{DxC}$$

where: d = depth (cm) - calculated.
L = loading rate (kg/ha) - specified in sections 2.4 and 2.5 for each parameter.
D = density of sample (kg/m³) - determined by laboratory.
C = concentration (mg/kg) - determined by laboratory.

Source: ERCB General Bulletin GB92-10

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APPENDIX J

PHASE I ASSESSMENT PHOTOGRAPHS

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LIST OF PHOTOS

Photo J-1	Reproduction of 1:60,000 scale airphoto showing surface disturbances related to oil field development. Production stations (Sacha Central and North #1), well sites, access roads and agricultural land use are present.
Photo J-2	Erosion at well site CN11.
Photo J-3	Erosion at former pit location adjacent well site GU5.
Photo J-4	Flowlines and roads are often present in the same corridor throughout the concession.
Photo J-5	Many of the well sites in the concession are equipped with a transformer, flowline and meter station. Corrosion inhibiters are often injected at the well site.
Photo J-6	Numerous flowlines from nearby well sites converge at the Lago Agrio North production station.
Photo J-7	Produced fluid spill has stained the pad at well site GU8. Dwellings are often located adjacent well sites.
Photo J-8	Flowline related spill at well site AU5. Sand has been used to cover a portion of the spill.
Photo J-9	Used oil and filters have been discarded at a number of well sites.
Photo J-10	Domestic solid waste has been discarded at a number of well sites.
Photo J-11	Oil has been released to a stream during pit closure at well site SSFB64.
Photo J-12	Oil seep from covered pit at well site GU5.
Photo J-13	Oil and water containing pit at well site SSFB66.
Photo J-14	Discharge of oily waters from pit at well site SSFB66.
Photo J-15	Separators and process area sump at the Atacapi Production Station. Spills are typically covered with sand.
Photo J-16	Bermed surge tank at the Sacha North #2 Production Station.
Photo J-17	Pumping equipment is present at all production stations.
Photo J-18	A pump workover at the Shushufindi South Production Station resulted in used oil being discharged to a nearby river.
Photo J-19	Used oil spill adjacent the generator located at the Auca Sur Production Station.
Photo J-20	Flare failure at the Auca Central Production Station.
Photo J-21	Used oil spill below flowlines located adjacent the vehicle maintenance yard at the Sacha Central Production Station.
Photo J-22	Spilled oil adjacent the chemical storage yard at the Sacha Production Station.
Photo J-23	Oil skimming on produced water pit at the Sacha North #1 Production Station.
Photo J-24	Oil and water containing pit at the Parahuacu Production Station.
Photo J-25	Oily produced water discharge stream through farmyard adjacent Sacha North #2 Production Station.
Photo J-26	Produced water separation pits at Sacha Central Production Station.
Photo J-27	Dwelling located on secondary pipeline corridor.
Photo J-28	Road application of oil in the Sacha field.

Photo J-1: Reproduction of 1:60,000 scale airphoto showing surface disturbances related to oil field development. Production stations (Sacha Central and North #1), well sites, access roads and agricultural land use are present.

Photo J-2: Erosion at well site CN11.

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Photo J-3: Erosion at former pit location adjacent well site GU5.

Photo J-4: Flowlines and roads are often present in the same corridor throughout the concession.

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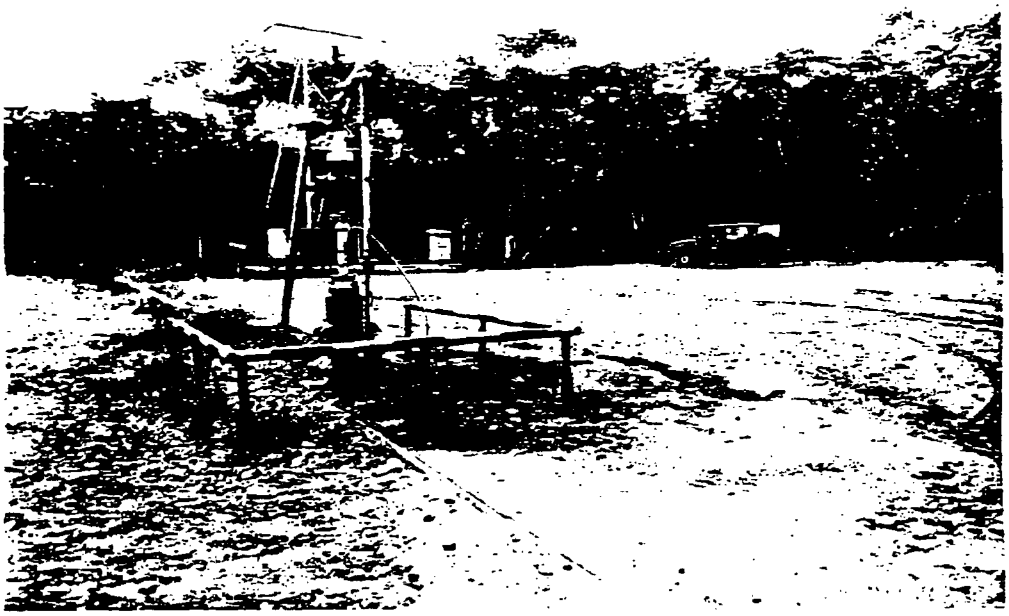

Photo J-5: Many of the well sites in the concession are equipped with a transformer, flowline and meter station. Corrosion inhibiters are often injected at the well site.

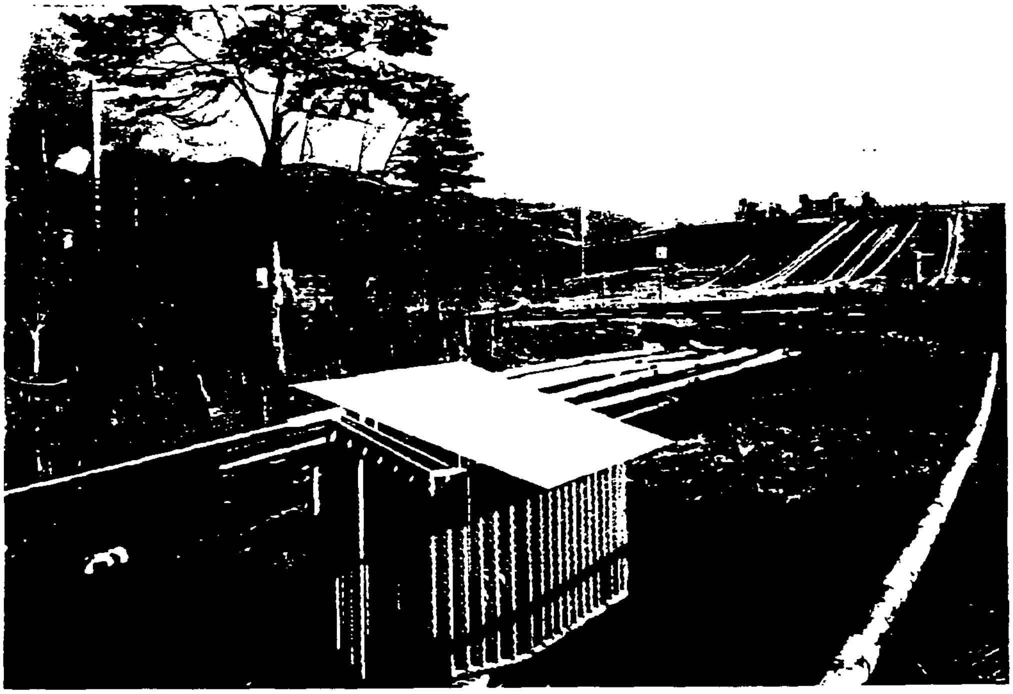

Photo J-6: Numerous flowlines from nearby well sites converge at the Lago Agrio North production station.

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Photo J-7: Produced fluid spill has stained the pad at well site GU8. Dwellings are often located adjacent well sites.

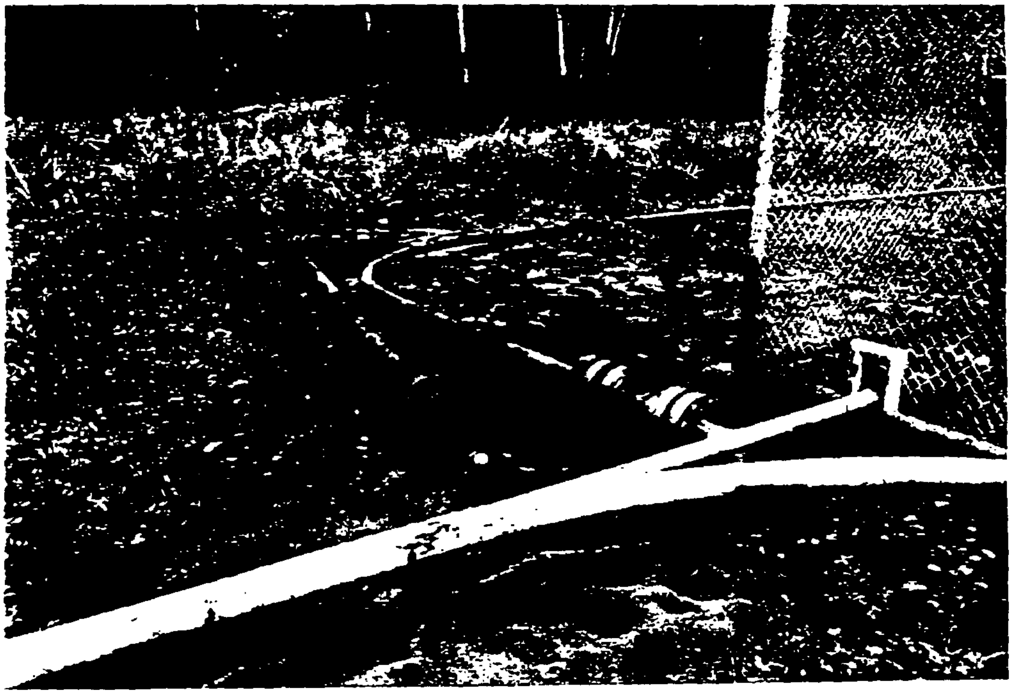

Photo J-8: Flowline related spill at well site AU5. Sand has been used to cover a portion of the spill.

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Photo J-9: Used oil and filters have been discarded at a number of well sites.

Photo J-10: Domestic solid waste has been discarded at a number of well sites.

Photo J-11: Oil has been released to a stream during pit closure at well site SSFB64.

Photo J-12: Oil seep from covered pit at well site GU5.

Photo J-13: Oil and water containing pit at well site SSFB66.

Photo J-14: Discharge of oily waters from pit at well site SSFB66.

Photo J-15: Separators and process area sump at the Atacapi Production Station. Spills are typically covered with sand.

Photo J-16: Bermed surge tank at the Sacha North #2 Production Station.

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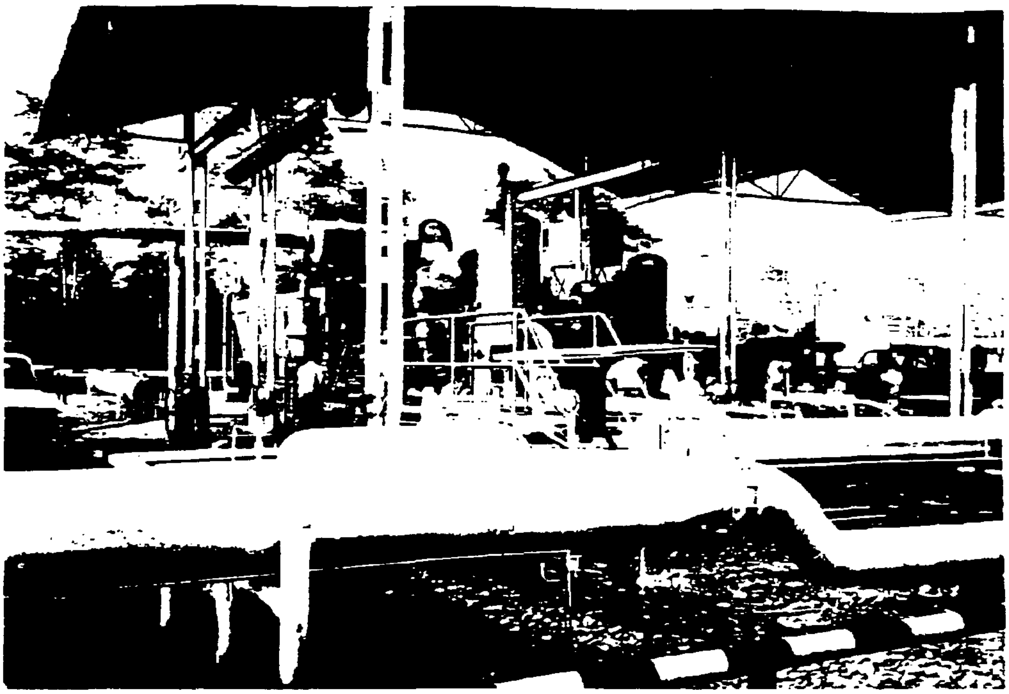

Photo J-17: Pumping equipment is present at all production stations.

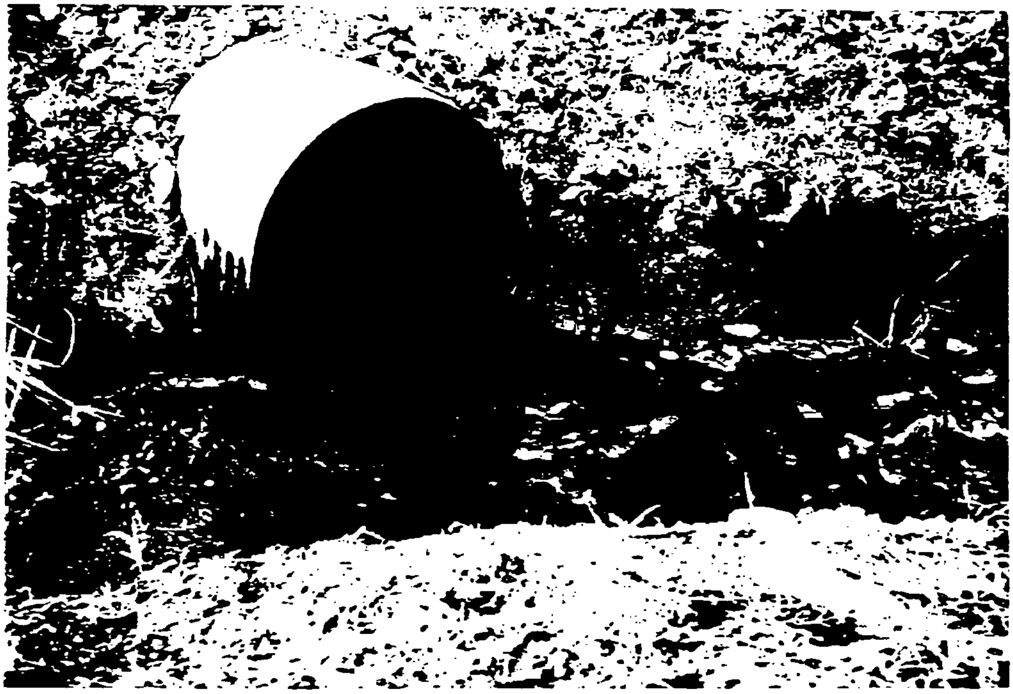

Photo J-18: A pump workover at the Shushufindi South Production Station resulted in used oil being discharged to a nearby river.

Photo J-19: Used oil spill adjacent the generator located at the Auca Sur Production Station.

Photo J-20: Flare failure at the Auca Central Production Station.

Photo J-21: Used oil spill below flowlines located adjacent the vehicle maintenance yard at the Sacha Central Production Station.

Photo J-22: Spilled oil adjacent the chemical storage yard at the Sacha Production Station.

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Photo J-23: Oil skimming on produced water pit at the Sacha North #1 Production Station.

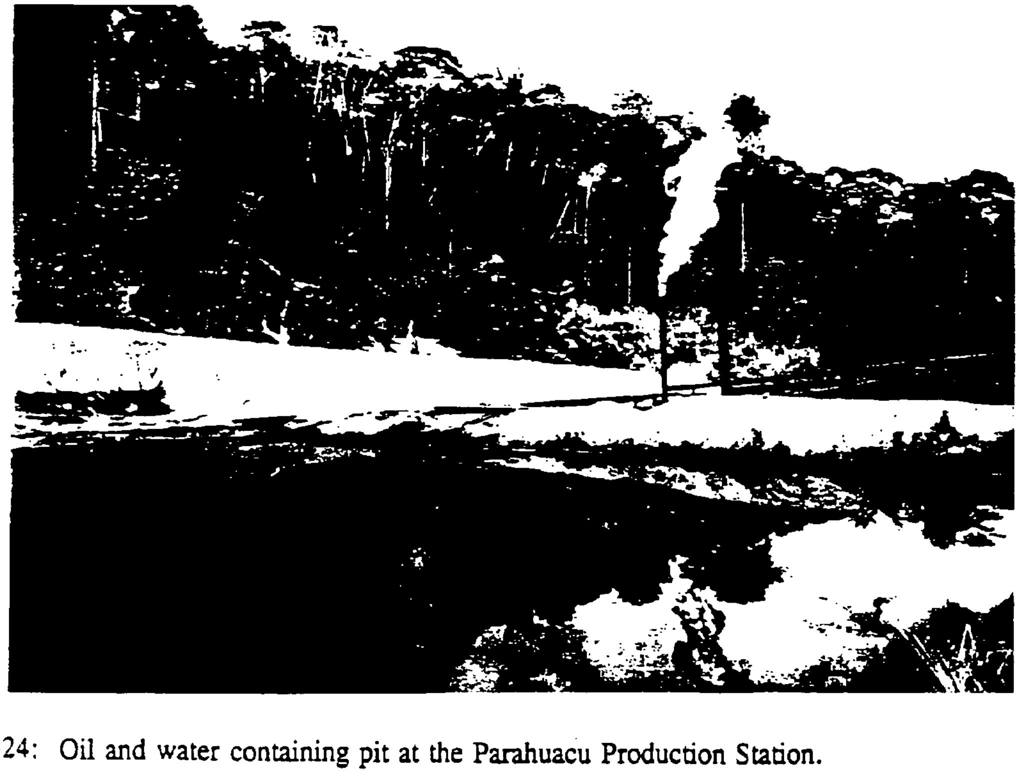

Photo J-24: Oil and water containing pit at the Parahuacu Production Station.

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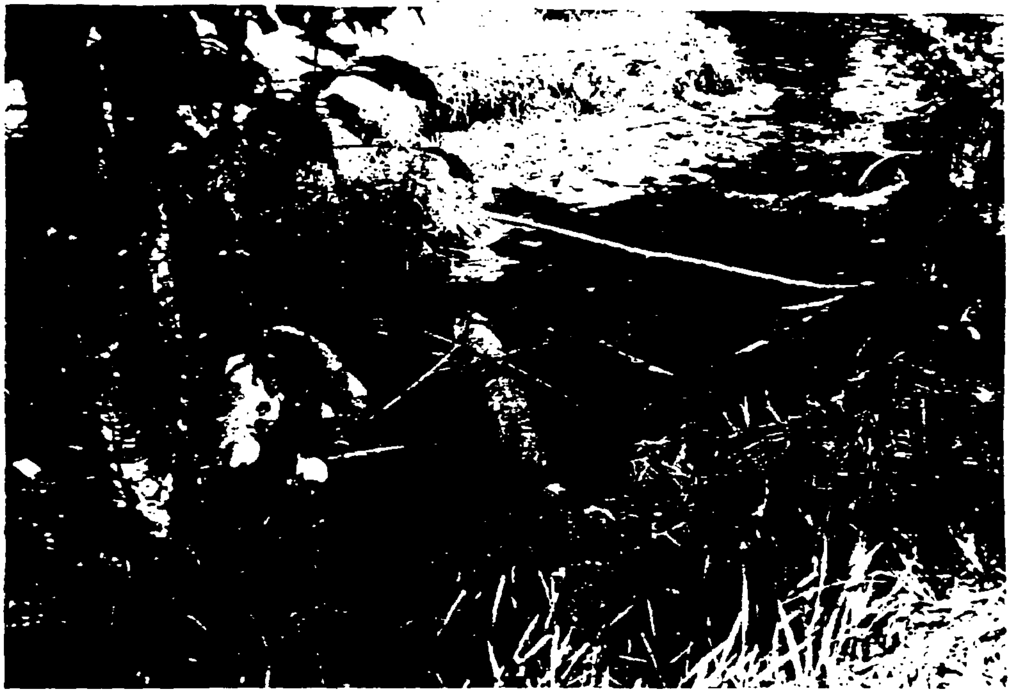

Photo J-25: Oily produced water discharge stream through farmyard adjacent Sacha North #2 Production Station.

Photo J-26: Produced water separation pits at Sacha Central Production Station.

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Photo J-27: Dwelling located on secondary pipeline corridor.

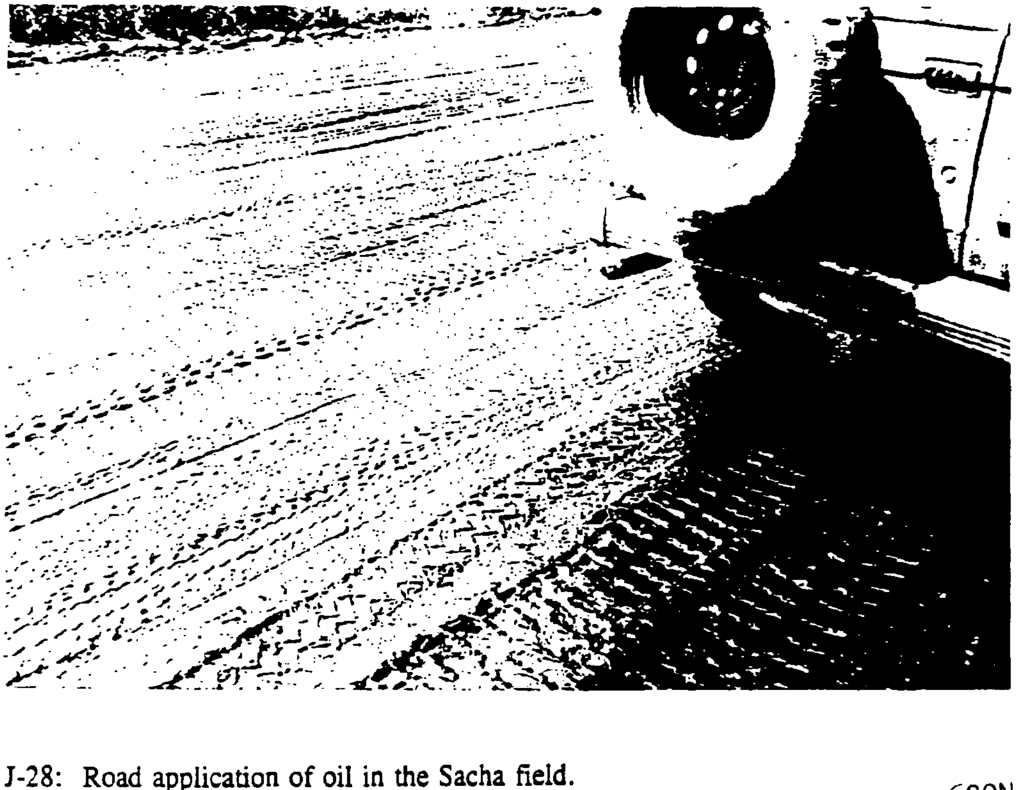

Photo J-28: Road application of oil in the Sacha field.

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