FIELD REPORT

ENVIRONMENTAL ASSESSMENT OF SOLID WASTE EMERGENCY PROGRAM FOR PORT-AU-PRINCE, HAITI

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WASH Field Report No. 423
August 1993

WATER AND SANITATION for HEALTH PROJECT

Sponsored by the U.S. Agency for International Development
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Prepared for the USAID Mission to Haiti,
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by

Kevin Murray

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RELATED WASH REPORTS

Reflections on a Long-term Program for the Management and Collection of Solid Waste in the Metropolitan Zone of Port-au-Prince. June 1991. WASH Field Report No. 337. Prepared by Philip Roark, Mito Bessalel, Frantz Benoit, Emanual Fexil, Eddy Jeune, and Ronald Turin. (Also available in French).

Market Survey of Solid Waste Management, Port-au-Prince, September 10-28, 1990 (Vol. I & II). February 1991. WASH Field Report No. 319. Prepared by Philip Roark, Menajem Bessalel, David Dalmat, and Kevin Murray. (Also available in French).

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EXECUTIVE SUMMARY

Port-au-Prince generates approximately 1,100 tons of solid waste a day, much of which is dumped in the streets, canals, and ravines throughout the city. This improper disposal has serious implications for the health of the city, diminishing the ability of the population to function efficiently; chokes the drainage canals, causing erosion and sedimentation, and deterioration of the road network from the overflow during heavy rain; hampers productivity; and hastens destruction of the drainage canals.

These conditions are the basis of a plan, developed under the direction of USAID by the Cooperative Housing Foundation (CHF) and the Water and Sanitation for Health Project (WASH), for the emergency cleanup of solid wastes in the hardest hit areas of Port-au-Prince. The three elements of the plan are: collecting and transporting randomly discharged waste materials to designated disposal sites; removing waste materials and accumulated sediments from the drainage canals and using the sediments as cover material at these disposal sites; and disposing of the collected wastes and sediments at the Truittier or Titanyn landfills. The plan recommended an environmental assessment (EA) of these cleanup activities before they were implemented.

This report presents the results of the EA, which discusses the environmental effects of the proposed emergency cleanup measures and evaluates these measures in the context of: avoiding or minimizing adverse effects; enhancing the quality of the environment so that the expected benefits can be weighed against any adverse human impacts; identifying any irreversible commitment of resources; and suggesting potential mitigation measures.

The EA concludes that any of the proposed alternatives will be an improvement on current conditions but that some have certain advantages over others.

Waste removal will reduce public health hazards, improve air quality and surface water quality, and ease traffic congestion. The impacts on the environment will be short-term. Collection and transportation will raise dust and odors, but these can be controlled by specific operational procedures.

The removal of sediments from the drainage canals and their use as landfill cover will provide a dual benefit - restoring the function of the drainage canals for the movement of stormwater, and eliminating the need to excavate and apply soil to cover the landfills. The effect of these measures on the environment will be minimal. Dust will be generated during collection, and the sediments could affect groundwater at the disposal sites. Both impacts can be moderated. Specific operational procedures can minimize the generation of dust, and monitoring wells and a sediment testing program can track the potential contamination of the groundwater.

The Truittier site is an acceptable location for the short-term disposal of solid wastes. It is isolated, the groundwater there is saline and thus unfit for drinking and agriculture, and regional data indicate that the movement of groundwater is away from potable water wells and towards the Bay of Port-au-Prince. Surface water is unlikely to be contaminated by landfill activities because of the distance between the site and water bodies (the Bay and river).

However, the site does pose some problems. Collection vehicles, although barely adding to the traffic, will generate dust because of the condition of the access road. This can be reduced by upgrading and improving the maintenance of the road. In the long term, however, leachate from the landfill could contaminate potable water supplies, because even though groundwater movement appears to be away from the wells, continued pumping of nearby commercial potable water wells could reverse this direction. This possibility should be monitored by continual sampling of the wells.

The Titanyn site has a greater likelihood of causing short- and long-term environmental degradation. It has good access and is isolated, but it is near a saltwater marsh with a thriving wildlife population. The groundwater is saline and shows no evidence of pollutants from past landfill operations. Yet, since the groundwater is close to the surface and moves in the direction of the marsh, future landfill activities could be detrimental to the marsh. Before this site is used, it will be necessary to assemble more data on the magnitude of potential damage by the landfill. A clay liner should also be installed at the site to prevent the seepage of contaminants into the groundwater.

A third choice is the no-action alternative that would continue the current collection and disposal arrangements, using LaSaline as the disposal site. The discharged materials would continue to cause traffic congestion, infrastructure breakdown, disease, odors, noise, dust, and surface water pollution. However, with some improvements to the site and disposal operations, the use of LaSaline offers several benefits. Its proximity to the point of generation reduces many of the adverse impacts associated with Truittier. The access road is well paved and can handle heavy traffic. Adjacent land use is primarily industrial and commercial. The site is degraded to the point at which additional waste materials will make little difference. Using the site will obviate the need to develop either Truittier or Titanyn and the attendant likelihood of contamination. The short-term disposal operation could be coordinated with a plan for the eventual closure of the site and developing it for some other use. Mitigation measures for La Saline would include: building a paved service road at the site; constructing a barrier between the site and Nationale 1; ceasing operations in the area adjacent to Nationale 1 and moving them to the rear of the site; constructing a transfer station to reduce traffic at the site; and generally improving landfill operations.

Chapter 1

BACKGROUND AND PURPOSE

The daily quantity of solid wastes generated in Port-au-Prince in 1991 was estimated at 1,100 tons, 14 percent of which was collected by the city and a small quantity by private companies, leaving the bulk to accumulate wherever it was dumped.

A small portion of the waste is disposed of in designated landfills in Truittier or Titanyn. The rest is discarded at the La Saline site in downtown Port-au-Prince, and in the streets, drainage canals, and ravines in various sections of the city.

This improper disposal of large quantities of waste materials has serious implications for the health of the city, disproportionately affecting lower-income groups and diminishing the ability of the population to function efficiently. The garbage in the streets finds its way into the drainage canals, preventing them from serving the purpose for which they were designed. The resultant overflow during periods of heavy rain causes erosion and sedimentation that have accelerated the deterioration of the road network and exacerbated traffic congestion.

These conditions were the basis of a USAID request to the Cooperative Housing Foundation (CHF) and the Water and Sanitation for Health (WASH) Project to draw up a plan for a labor-intensive, solid waste cleanup in Port-au-Prince as a continuation of the assistance WASH has provided to the solid waste sector in Haiti since 1989. The report by CHF/WASH concluded that one of Port-au-Prince's many difficulties is the "vast solid waste accumulation, presenting serious health hazards to its residents." The report proposed an emergency cleanup plan in the hardest hit areas, and recommended an environmental assessment (EA) before it was implemented.

This report presents the results of the EA conducted over a two-week period in Port-au-Prince. From existing sources and studies, field staff developed information on the potential impact of the project on land use, site access, traffic, dust, odors, groundwater, surface water/wetlands, and health. The staff also conducted on-site surveys, measured canal sediments, did traffic counts, and installed monitoring wells at potential disposal sites. Monitoring well data were analyzed at laboratories in Haiti and the United States.

The EA discusses the environmental effects of the proposed emergency cleanup measures and weighs the expected benefits against any adverse human impacts or any irreversible commitment of resources. The EA is based on the requirements of 22 CFR Ch. II Part 216 - Environmental Requirements.

The assessment provides background information, a description of the affected environment, and an evaluation of the proposed measures and a no-action altemative, and suggests mitigation measures.

Chapter 2

DESCRIPTION OF PROJECT ALTERNATIVES

This section compares the proposed **action** with a **no action** alternative. The proposed action calls for collecting and transporting randomly discharged waste materials to designated disposal sites; removing waste materials and accumulated sediments from the drainage canals and using the sediments as cover material at the disposal sites; and disposing of the collected wastes and sediments at the Truittier or Titanyn landfills. The **no action** alternative requires no collection of wastes from the random discharge areas; no removal of accumulated wastes and sediments from the drainage canals; and continued disposal of collected materials at the La Saline site.

2.1 Proposed Action

2.1.1 Collection and Transportation of Waste Materials

Randomly discharged waste materials will be collected, transported, and disposed of at designated landfills.

2.1.2 Collection of Sediments from Drainage Canals

Waste materials and accumulated sediments in the canals will be removed and disposed of at designated sites. The sediments will be used as cover material at these sites.

2.1.3 Disposal of Waste Materials at Truittier Landfill

The landfill will be used as a disposal site for collected waste materials and be upgraded to mitigate potential environmental impacts.

2.1.4 Disposal of Waste Materials at Titanyn Landfill

The landfill will be used as a disposal site for collected waste materials and be upgraded to mitigate potential environmental impacts.

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2.2 No-Action Alternative

2.2.1 Collection and Transportation of Waste Materials

Randomly discharged waste materials will be allowed to accumulate until municipal crews have the opportunity to collect and transport them to designated sites.

2.2.2 Collection of Sediments from Drainage Canals

Waste materials and accumulated sediments in the canals will not be removed. Cover material for the designated waste disposal sites will be obtained from other sources.

2.2.3 Continued Disposal of Waste Materials at La Saline

The site will continue to be used for disposal of waste materials collected by the public and private sectors.

Chapter 3

DESCRIPTION OF THE AFFECTED ENVIRONMENT

3.1 Collection and Transportation of Waste Materials

Site Description

Numerous makeshift sites throughout Port-au-Prince are currently used for the disposal of residential and commercial wastes awaiting collection by municipal crews. The sites evaluated were considered the worst at the time the EA was conducted and were located primarily in Croix de Bossales, Carrefour, Cite Soleil, and Marche de la Saline (see Figure 1). Approximately 190,000 m3 of waste accumulate at any one time.

Land Use

All sites evaluated were in densely populated residential areas with scattered small businesses.

Site Access

Access was generally poor, along roads only 6 meters wide. Residences and businesses were located within 3 to 5 meters of the sites.

Traffic

Traffic surveys counted 95 to 110 vehicles per hour during peak periods on the most heavily traveled roads. This dropped to 50 to 60 vehicles per hour during nonpeak periods.

All roads were in poor condition. Approximately 90 percent of the roads were paved but were badly pitted, slowing traffic to 16-32 kilometers per hour. The unpaved roads had a gravel base.

Dust

At all the sites, dried discharge and dust from the road base were raised by wind and passing vehicles.

Odors

Odors were evident within 6 meters of the sites, which were visited on clear days with moderate winds and temperatures in the upper nineties. They were less prevalent at sites with old waste and were assumed to come from rotting materials and stagnant water.

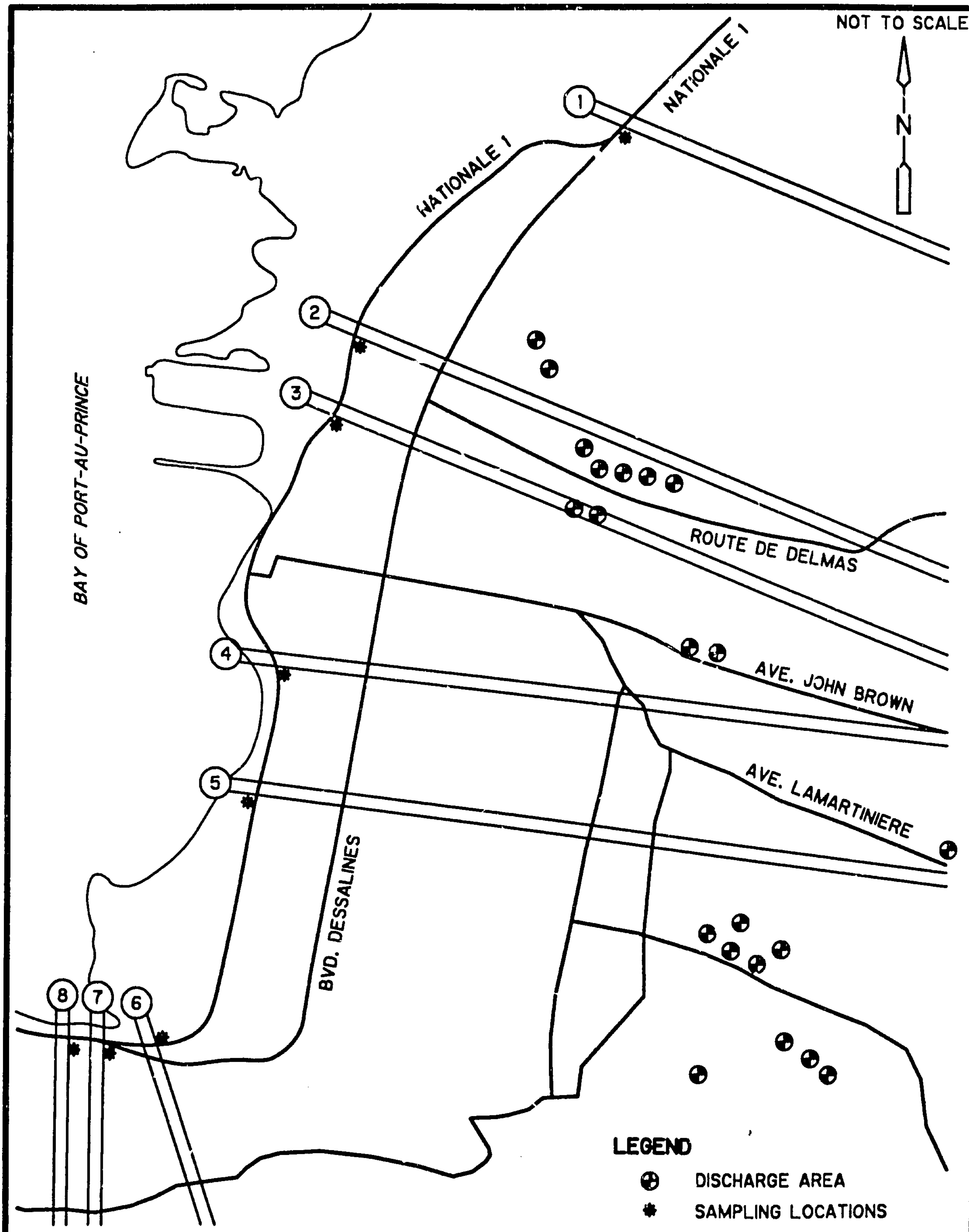

FIGURE 1

APPROXIMATE LOCATION
DRAINAGE CANALS AND DISCHARGE AREAS
PORT-AU-PRINCE, HAITI

Groundwater

No groundwater data were available for the discharge sites.

Surface Water/Wetlands

No natural surface water bodies or wetlands were found at any of the sites. However, there were drainage canals adjacent to many of the sites, and since these discharge untreated water into the Bay of Port-au-Prince, they are considered surface water bodies for purposes of this study.

Health

No data on health were available for the sites visited, but it can be assumed that they share the problems typical of Port-au-Prince.

3.2 Collection of Sediments from Drainage Canals

Site Description

Eight canals measuring approximately 24 kilometers provide stormwater drainage for the study area. They run down ravines and terminate in the Bay of Port-au-Prince. They are narrowest and deepest at the point of origin (approximately 3 to 4 meters wide and 7 to 9 meters deep) and widest and shallowest at the point of discharge (approximately 6 meters wide and 2 to 3 meters deep). Access at the upper elevations is difficult. Large quantities of waste discharges and minimal quantities of sediment were found at roadway crossings. The greatest quantities of sediment were found close to the point of discharge.

Since all sections of the canals were not easily accessible, the estimate of sediments that could be recovered and used for landfill cover was based on the quantity excavated from a one-half kilometer section of each canal, roughly from the downtown area to the Bay. The total quantity of sediment was determined by measuring individual piles recently removed from 6-meter lengths of 4 of the 8 canals. Each pile was approximately 3,236 cubic meters. According to the foreman overseeing the cleanup, this represented 6 months of buildup. As such, the total quantity of material that could be collected from a one-half kilometer section of the 8 canals in 6 months was estimated at 1,709,089 cubic meters. The locations of the canals are shown in Figure 1.

A sieve analysis of the material from two of the canals indicated that 85 percent, or approximately 1,452,725 cubic meters, of sediment would be suitable as landfill cover

Land Use

The land use opposite the drainage ditches is primarily residential, with scattered businesses.

Site Access

Access generally is poor. Over 65 percent of the drainage ways are difficult to reach because of their depth from the roadway which increases the farther they are from the ocean. Furthermore, over 65 percent of the canals are not adjacent to roads and thus road crossings are limited.

Traffic

Traffic surveys counted 95 to 110 vehicles per hour on the most heavily traveled roads during peak periods and 50 to 60 vehicles per hour during nonpeak periods. The less traveled roads have approximately the same use during peak hours, but considerably less during nonpeak hours.

Although 95 percent of the roads adjacent to or intersecting the canals are paved, they are in poor condition. Travel speeds range from 16 - 20 kilometers per hour.

Dust

The constant flow of water through the canals appears to keep down the dust. Observations were made at the beginning of the dry season.

Odors

Odors were perceptible at 60 percent of the canals from distances that depended on the observation point. Odors were most obvious at the shallow canals closest to the road. Observations were made on clear days with moderate winds and temperatures in the upper nineties (°F). The materials observed were both old and new.

Groundwater

No groundwater information was available.

Surface Water/Wetlands

Although no samples were taken from the canals, the absence of fish, the odors, and the general appearance and color of the water suggested they were severely polluted. No wetlands were found along the ditches.

Health

No health statistics were available for these locations, but it can be assumed they have problems typical of Port-au-Prince.

3.3 Disposal of Waste Materials at Truittier Landfill

Site Description

The Truittier landfill, a disposal site for waste materials from the city and surrounding communities, is located to the west of Nationale 1 and north of downtown Port-au-Prince. It is surrounded by sugarcane fields and abandoned farms and is approximately 1 kilometer from the Bay of Port-au-Prince. A drainage ditch along the southern boundary flows into the ocean. The east-west access road originates at Nationale 1 and terminates at a small village adjacent to the landfill.

Although the site is supposedly active, not many waste materials appear to have been deposited for one or two years. Except for some large metal items and broken glass, the materials at the dump were covered with soil and overgrown with vegetation. The site gave the impression of a closed landfill.

Land Use

Immediately east and south of the site is a sugarcane field. The site access road is also to the east. Further to the east and parallel to the access road are approximately 170 residential dwellings and businesses, the nearest approximately .9 kilometer from the site.

Several potable water supply companies that draw their water from wells are also located along the access road. The closest is approximately 1 to 1.2 kilometers from the landfill.

Immediately to the north of the site is a sugarcane field. Adjacent to it and approximately .25 kilometers from the site is a village of approximately 300 residents. To the west of the site are a sugarcane field and the Bay. To the south are sugarcane fields. There are two irrigation wells used by local residents for potable water, one on the southeastern corner of the site, and the other approximately .8 kilometer from the site near the access road.

Site Access

Travel time from Nationale 1 to the site is approximately 20 minutes for a passenger vehicle. This was recorded during the dry season when traffic is heavy because of the movement of water supply trucks.

Traffic

Approximately 81 vehicles per hour use the access road during the morning and early afternoon rush periods. Traffic decreases in the middle of the afternoon and the evening.

The road is approximately 9 meters wide and in poor condition, with numerous holes that are often filled with water. A drainage canal runs along its length.

Dust

Dust generated by passing vehicles and pedestrian traffic is dense enough to limit visibility. (This observation was made during the dry season.)

Odors

Odors were minimal because of the age of the landfill.

Groundwater

The geologic formations of the greater Port-au-Prince area consist of cretaceous basalt, tertiary limestone, and alluvial deposits. Existing reports and boring log data generated as part of this study indicate the landfill site consists primarily of alluvial deposits of sand, gravel, and clay. The boring logs from this study and from existing irrigation wells are provided in Appendix A. A limestone aquifer and an alluvial aquifer are the primary water-bearing channels at the landfill site. The alluvial aquifer is continuous and represents the region's most important water source, supplying the irrigation wells adjacent to the site. Recharge is primarily from surface water. There is evidence that the landfill is on the edge of a freshwater lens.

Regional groundwater flow is reported to be to the west towards the Bay of Port-au-Prince. Data on groundwater flow around the landfill are not available.

A review of the geology of the site and of monitoring well data and discussions with farm managers provided convincing evidence of saltwater intrusion. Fault zones occur on an east-west orientation to the site, which would favor landward penetration of saltwater. Farm managers reported that when potable water wells are pumping at maximum capacity, the irrigation wells dry up or produce brackish water. Local residents using the irrigation well to the southeast for potable water confirmed the periodic presence of brackish water. Groundwater testing as part of this study identified high specific conductivity, an indication of the presence of saltwater.

Groundwater was sampled from five wells adjacent to the site (see Figure 2). Wells 1, 2, and 4 were drilled as part of this project for the specific purpose of monitoring on-site groundwater. Wells 3 and 5 are irrigation wells used by local residents as sources of potable water.

Well 1 is on the western boundary of the site between the landfill and the ocean. Well 2 is on the northern boundary. Well 3 is on the southeastern corner. Well 4 is on the eastern

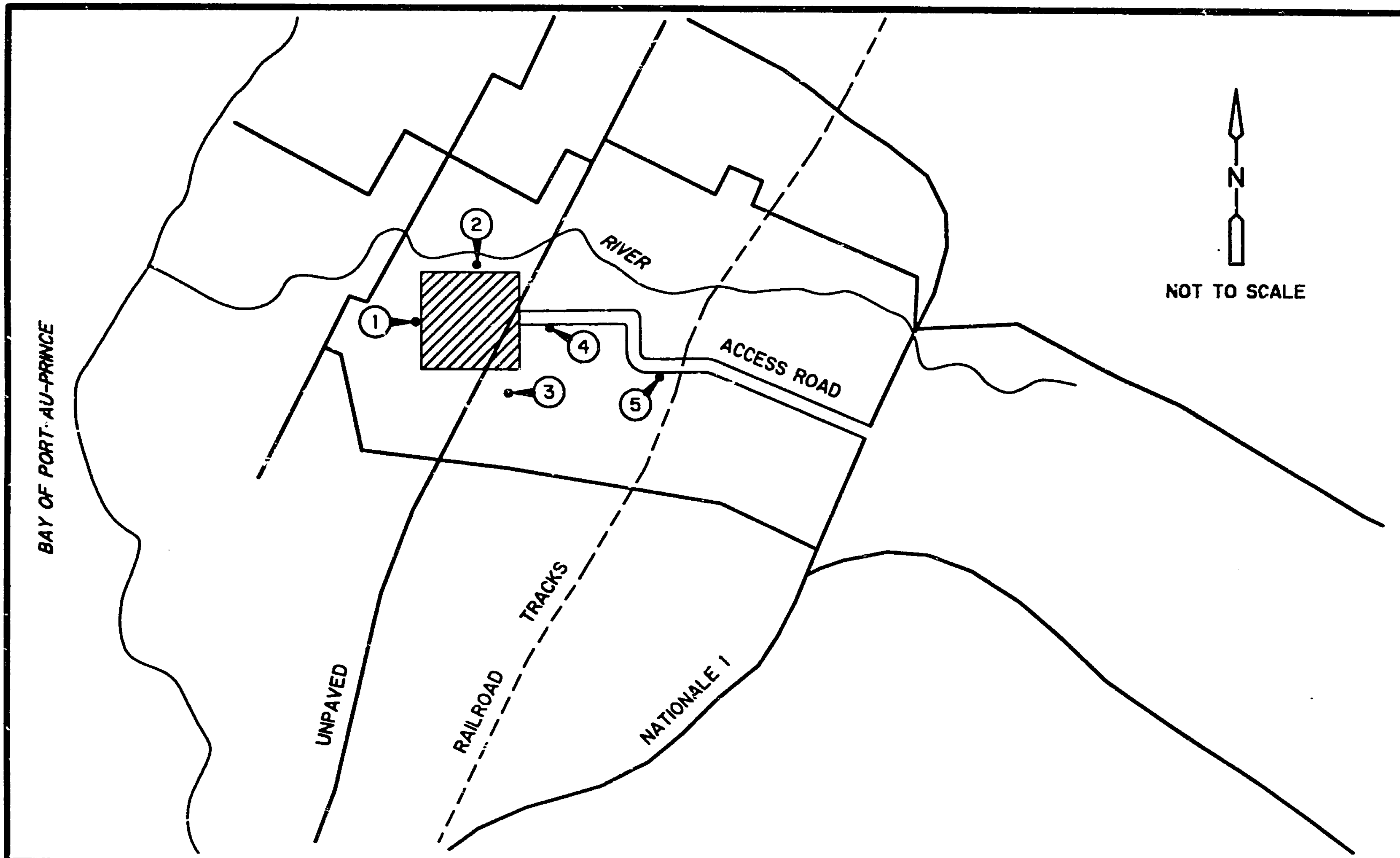

FIGURE 2

MONITORING WELL LOCATIONS
TRUITTIER LANDFILL
PORT-AU-PRINCE, HAITI

boundary. Well 5 is approximately .8 kilometer east of the site adjacent to the access road. Detailed data on each well are provided in Appendix B.

Samples from each well were tested for depth to groundwater, specific conductivity, and temperature. Standard USEPA tests were conducted for priority pollutants, nonpriority pollutants, and metals. The samples were collected, placed in coolers with ice, and shipped within 24 hours to a laboratory in the United States.

Depth to groundwater ranges from 2.4 to 3.6 meters. Specific conductivity ranges from 448 to 9,010. The highest conductivity was recorded at Well 1, the well nearest to the ocean; the lowest conductivity was recorded at Well 5, the well farthest from the ocean. The pH is consistent, ranging from 6.2 to 6.9.

The laboratory results indicate that the only priority pollutant in the groundwater at the site is toluene, which comes from gasoline or other petroleum products. Toluene is present in Wells 1 and 2, which are located downgradient from the landfill, at parts per billion (ppb) levels of 22 and 32, respectively. This is well below the USEPA drinking water standard of 1,000 ppb for this compound. No toluene was found in Wells 3, 4 and 5.

Nonpriority pollutants were found in Wells 1 and 2 and to a lesser extent in Well 3, but it is difficult to determine whether they come from the landfill or from saltwater intrusion. The typical nitrate-nitrite landfill leachates are present only in trace amounts. Leachates such as ammonia, sulfate, chloride, and total dissolved solids, and high conductivity could as well be attributed to saltwater. No evidence of nonpriority pollutants was found in Wells 4 and 5.

The full laboratory results are provided in Appendix B.

In summary, it appears the site consists primarily of alluvial deposits of sand, gravel, and clay, and groundwater movement is from east to west towards the ocean. There is evidence that the site is on the edge of a freshwater lens into which saltwater has intruded. The groundwater at the site is affected by the landfill and by saltwater intrusion. The upgradient wells are free from pollutants typical of landfill operations.

Surface Water/Wetlands

A river approximately .8 kilometer from the northern boundary of the site drains the alluvial plain and discharges into the Bay of Port-au-Prince.

There are no wetlands at the site.

Health

No data were available on the health of local residents, but the groundwater tests suggest they may be drinking water with trace quantities of pollutants.

3.4 Disposal of Waste Materials at Titanyn Landfill

Site Description

The Titanyn landfill is an active disposal site 20 kilometers northwest of Port-au-Prince and adjacent to Nationale 1. It is bordered by the Bay of Port-au-Prince and surrounded by abandoned fields. Although the site is active, it did not appear to be much used currently.

Land Use

East and west of the site are open fields with scrub vegetation typical of dry environments. To the north are the access road and more open fields. To the south is the Bay of Port-au-Prince. The nearest residence along the access road is about 1.6 kilometers from the site.

Trucks must use Nationale 1 to reach the site. Between the turnoff road to the Truittier site and the Titanyn access road are approximately 500 residential dwellings and businesses.

Site Access

The approach to the site is good as Nationale 1 is well paved, but the access road from Nationale 1 is in poor shape. There is no direct turnoff, and the road has a gravel base. Randomly discharged materials on the road hamper access.

Traffic

Approximately 75 vehicles per hour pass the site during peak travel times. Conditions on Nationale 1 are excellent. Average vehicle speed is 96 kilometers per hour. On the access road, vehicle speed is under 8 kilometers per hour.

Dust

Dust is a problem on the site because of a lack of moisture and a covering for waste materials.

Odors

Onsite odors from decaying waste materials were noticeable.

Groundwater

The geologic formations of the area consist of cretaceous basalt, tertiary limestone, and alluvial deposits. Existing reports and boring log data generated as part of this study indicate the landfill site consists primarily of alluvial deposits. The boring logs from this study are provided in Appendix C.

An alluvial aquifer is the primary water-bearing channel at the landfill site and is recharged from surface water. Regional groundwater flow is reported to be to the south towards the Bay. Data on groundwater flow around the landfill are not available.

The location of the site suggests that the groundwater is heavily influenced by the salinity of the Bay. Furthermore, residents of the nearest village pointed out that there were no farms in the area because of a lack of potable water. People appeared to be filling water containers from a pipe, which on closer inspection proved to be a hole in a main water line running along the coast.

A monitoring well at the southeastern corner of the site was drilled and sampled by the Haitian subcontractor, to whom standard sampling procedures were explained. In-field testing covered depth to groundwater and specific conductivity. Laboratory tests were conducted for priority and nonpriority pollutants.

Groundwater was within 1.5 meters of the surface. Specific conductivity was 16,820. Temperature and pH were not recorded but the latter was assumed to be near 7.

The laboratory tests provided no indication of priority pollutants and only trace levels of non-priority pollutants. The nonpriority pollutants could be attributed to either landfill leachate or the natural saline condition of the groundwater.

The test results are provided in Appendix D.

In summary, it appears the site consists primarily of alluvial deposits of sand and clay, and groundwater movement is from north to south towards the Bay of Port-au-Prince. There is evidence that the groundwater is saline.

Surface Water/Wetlands

The site is adjacent to the Bay of Port-au-Prince. The zone between the landfill and the Bay is a saltwater marsh or wetland, where cranes and other birds were observed. There were physical indications that the wetland is affected by the landfill.

Health

No information was available on the health of area residents.

3.5 Disposal of Waste Materials at La Saline

Site Description

La Saline is a discharge area in downtown Port-au-Prince adjacent to the harbour where most of the city's waste materials are disposed of (see Figure 3). Although it has an operations crew responsible for day-to-day management of the site, the equipment and staff are insufficient for the quantities of materials received. Furthermore, there is no evidence of a management plan.

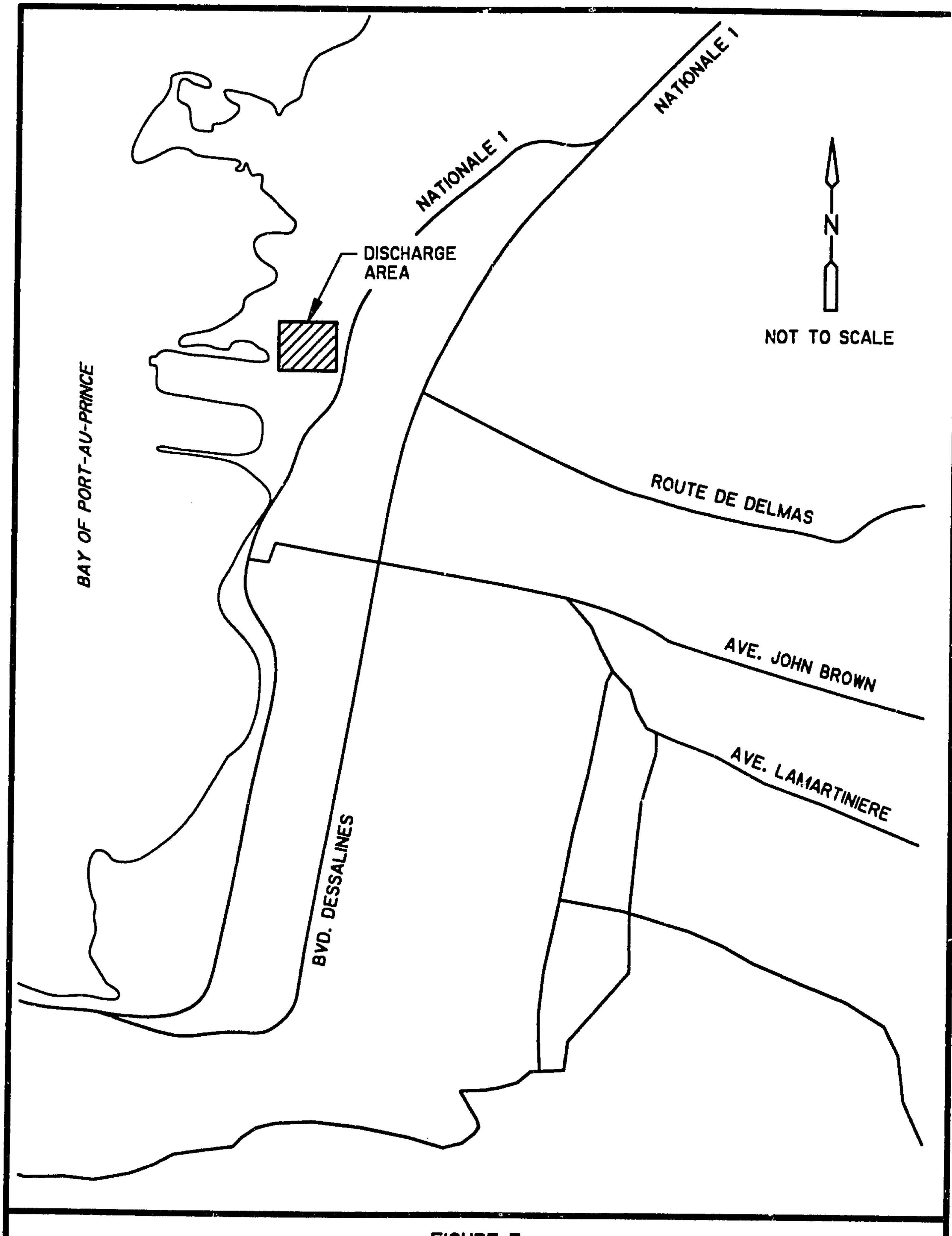

FIGURE 3

APPRCXIMATE LOCATION
LA SALINE DISCHARGE AREA
PORT-AU-PRINCE, HAITI

Materials are randomly discharged, so that the staff responsible for spreading and covering them can reach only about one-third by the end of the day. The rest remains uncovered and in piles, some of which are burned in the open.

Land Use

The site is in a densely settled area. The central market of Port-au-Prince is to the east, warehouses are to the south, a military prison is to the north, and the Bay is to the west.

Site Access

Primary access is from Nationale 1. A small dirt road runs along the north of the site.

Traffic

Traffic is heavy. Over 95 vehicles per hour were counted during the peak hours and 40-50 vehicles per hour during nonpeak hours. The section of Nationale 1 adjacent to the site is over 14 meters wide.

Dust

Dust is a major problem at the site and is generated by the spreading and covering of discharged materials, uncovered waste piles, and trucks entering and exiting the site and bringing in trash from the streets on their wheels.

Odors

Odors were noticeable within 15 meters of the edge of the discharge area.

Groundwater

No monitoring wells were drilled at this site, but observations of seepage made at the drainage canals on both sides of the landfill suggested that groundwater is severely affected. It is assumed that groundwater in areas adjacent to the site is also contaminated. The likely sources of contamination are the market, roadside auto and bicycle repair shops, a gas station, general runoff, etc.

Surface Water/Wetlands

The nearest surface water bodies are the drainage canals and the Bay of Port-au-Prince. The canals are stagnant and polluted, and the absence of marine life and the color of the water in the Bay indicate it is severely polluted as well.

Health

No data are available on health conditions in the area, but it can be assumed that airborne pollutants, vermin, and direct contact with the waste materials pose serious hazards.

Chapter 4

ENVIRONMENTAL CONSEQUENCES

This chapter discusses the potential environmental consequences of the action and no action alternatives to the natural and human environment with reference to:

- their direct and indirect effects on land use, the quality of life, and the environment;
- their depletion of natural resources and their potential for conservation;
- the relationship between short-term use of the environment and long-term productivity;
- any irreversible commitment of resources should the proposal be implemented; and
- potential mitigation measures.

4.1 Action Alternatives

4.1.1 Collection and Transportation of Waste Materials

Action

Randomly discharged waste materials will be collected from selected neighborhoods and disposed of in designated areas.

Direct and indirect effects on land use, the quality of life, and the environment

Land Use

All these locations are densely populated residential and small business neighborhoods within 3 to 5 meters of the discharge areas. The collection of waste materials will improve land use, freeing the space for other purposes, and improve the quality of life for residents.

Site Access

Access roads are only 6 meters wide, often narrowed to less than 4.6 meters by piles of accumulated garbage. The removal of these obstructions will improve access greatly.

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Traffic

Waste collection vehicles will make an insignificant addition to the traffic but will improve the traffic flow by clearing away garbage that forces reduced speeds and frequent stops and starts.

Dust

The removal of waste materials will generate more dust initially but in the long term will greatly reduce this vexing problem.

Odors

Similarly, garbage collection will increase unpleasant odors to begin with but will eliminate this objectionable feature once it is done regularly.

Groundwater

No groundwater data were available for these discharge locations, but it can be assumed that leachate and runoff from the discharges are seeping through. Waste collection will remove these groundwater contaminants.

Surface Water/Wetlands

There are no natural surface water bodies at any of the locations, but drainage canals near many of the sites carry storm runoff contaminated by the discharged piles into the Bay of Port-au-Prince.

The discharged materials consist of organics and inorganics. Both are known to contribute contaminants to surface water. Since runoff from the materials enters the canals, the collection of these waste materials will remove one source of pollution in the Bay.

No wetland areas were identified.

Health

No health information was available for these specific locations. However, for purposes of this study it can be assumed they have problems typical of Port-au-Prince.

Health hazards associated with solid waste include inhalation of contaminated dust, ingestion of contaminated materials, and the spread of disease by vermin foraging in the waste materials. The removal of waste will eliminate these hazards.

Depletion of natural resources and potential for conservation

The collection and transportation of waste materials will not deplete natural resources and have no potential for conservation.

Relationship between short-term use of the environment and long-term productivity

Regular collection of waste materials for a specified period will enhance the long-term productivity of the sites.

Irreversible commitment of resources should the proposal be implemented

There is no irreversible commitment of resources to this project.

Potential mitigation measures

Measures to minimize the adverse effects of collection would include:

- collecting wastes during nonpeak travel hours so as not to disrupt traffic;
- using manual labor instead of machines and using water trucks to wet the piles in order to control airborne dust;
- providing larger disposal containers in order to reduce litter, odors, and dust.

4.1.2 Collection of Sediments from Drainage Canals

Action

Waste and accumulated sediments in the canals will be disposed of in designated locations and the sediments will be used as cover material at these disposal sites.

Direct and indirect effects on land use, the quality of life, and the environment.

Land Use

The land opposite the drainage ditches is occupied by residences and small businesses. The removal of the materials will allow the canals to function as designed and will benefit the people living nearby.

Site Access

The removal of materials will have no impact on site access, which is constrained by the design of the canals and urban development.

Traffic

The trucks hauling the sediments to the landfills will only briefly slow traffic and increase the number of vehicles on the access roads.

Dust

The collection of materials will create a problem only during the dry season, when the sediments have dried out, but even this will be an improvement over the current situation. Some dust will also be generated when materials are off-loaded at the landfill sites.

Odors

There will be odors when the sediments are disturbed during the removal process, but this will be preferable to having odors 24 hours a day as at present.

Groundwater

The removal of the sediments will not entirely prevent the contaminants in stagnant water from entering the groundwater but should significantly reduce this. However, when the sediments are used as cover material, rainwater can leach the harmful materials from them into the groundwater.

Surface Water/Wetlands

The removal of the sediments will improve the quality of water in the canals by removing the obstructions that cause stagnation and prevent the free flow of stormwater into the Bay. This will reduce the contamination from contact with the discharged materials. However, contaminants from the sediments used as landfill cover could runoff into surface water bodies.

Health

The contaminants in the sediments are an obvious health risk and are spread by scavengers rummaging through the sediments and raising a dust when they are dry. Removing the sediments will remove the reason for scavaging.

Depletion of natural resources and potential for conservation

Collecting the sediments will not deplete natural resources, and using them as landfill cover can be considered a conservation measure since they will replace soil that would have to be brought in.

Relationship between short-term use of the environment and long-term productivity

Removing the sediments and using them as landfill cover should continue so as to prevent the canals from again becoming blocked and to avoid the need to excavate soil for landfill cover.

Irreversible commitment of resources should the proposal be implemented

This action requires no irreversible commitment of resources.

Potential mitigation measures

Measures to minimize any adverse effects of collection include:

- removing sediments during nonpeak travel hours in order not to disrupt traffic;
- using manual labor instead of machines and using water trucks to wet down the sediments to reduce dust and odors.

No special measures are necessary when spreading the sediments on the landfills. However, they should be analyzed periodically for metals before use to prevent contamination of the groundwater.

4.1.3 Disposal of Waste Materials at Truittier Landfill

Action

The landfill will be used for disposal of collected waste materials.

Direct and indirect effects on land use, the quality of life, and the environment

Land Use

Both active and inactive sugarcane fields surround the site. The access road is to the east, and parallel to it are about 170 dwellings and businesses. The nearest residence along the access road is approximately .9 kilometer from the site, and there is a village of about 300 residents approximately .25 kilometer from the site.

There are several potable water supply companies along the access road that draw their water from onsite wells. The closest company is a little more than 1 kilometer from the landfill site. There are two irrigation wells near the site used by residents for potable water, and several hand pump wells along the access road.

The use of this site for the disposal of solid waste will affect people near the access road, creating increased traffic, dust, noise, and odors. The collection vehicles will be in and out of the site 6 days a week.

Site Access

Current travel time from Nationale 1 to the site is approximately 20 minutes for a passenger vehicle. The roadway has numerous potholes that slow traffic. Bringing in 24 collection vehicles per day will further degrade the road base and make the road impassable in the section leading up to the water companies. After that section, the vehicles will have minimal impact on the road.

Traffic

Although the 9 meters-wide access road is in poor condition, the addition of 3 collection vehicles per hour, even during the morning and early afternoon rush periods when 81 vehicles per hour use it, will have a minimal impact.

Dust

Dust generated by vehicles and pedestrians on the access road is excessive, but the addition of 3 vehicles per hour will not increase this measurably. Dust from landfilling will have no impact on the closest resident.

Odors

Odors are not excessive because of the age of the landfill. But even the odors from new materials will have little effect because the closest residence is 1 kilometer away. Odors from the vehicles approaching the landfill can be mitigated.

Groundwater

The site can be used for the disposal of solid wastes without any harmful impact on groundwater. Available information indicates that groundwater movement in the alluvial plain is from east to west towards the ocean, so that pollutants from the landfill should move toward the Bay and have no effect on the potable water wells. Furthermore, the data from upgradient wells show no impact from pollutants typical of landfill operations, and it can be assumed these pollutants either remain onsite or move towards the Bay. However, since this assumption is based on regional data, the possibility of site-specific variations should be investigated.

A further argument for using the site as a landfill is that the groundwater at the site is already affected by the landfill and/or by saltwater intrusion, making the site unsuitable for any other use.

Surface Water/Wetlands

There is a river approximately .8 kilometer from the northern boundary of the site that drains the alluvial plain and discharges into the Bay of Port-au-Prince. There are no wetlands.

Since the movement of groundwater is towards the Bay, leachate from the landfill could adversely affect the waters of both the river and the Bay. However, the distance from the landfill should mitigate this impact. Furthermore, since the Bay is already contaminated, discharges from the landfill will not add much.

Health

Since groundwater data indicate that residents drinking water from Well 3 could be ingesting trace quantities of pollutants, the development of the landfill could exacerbate this problem.

Depletion of natural resources and potential for conservation

Since the site is already used as a landfill, no natural resources will be depleted. There is no potential for conservation because the alternatives are also in use as landfills.

However, composting of solid wastes would reduce the need for extensive use of the site and, if this was done elsewhere, would reduce the effects of traffic and dust on the nearby residences.

Relationship between short-term use of the environment and long-term productivity

Because of onsite contamination and the extent of suspected saltwater intrusion, short-term use will not affect the long-term productivity of the site. If the adjacent potable water wells continue to pump at current rates, saltwater intrusion may extend further inland and render the land of minimal value for agricultural or residential development.

However, if saltwater intrusion is isolated, contaminants from the landfill could affect the adjacent potable water wells. This could occur if the withdrawal of water from the commercial potable water wells were to reverse the flow of groundwater in the direction of the well fields, or if investigation showed that local and regional groundwater conditions were different.

Irreversible commitment of resources should the proposal be implemented

Since the site is already used for disposal of wastes, there is no irreversible commitment of resources attendant on this action.

Potential mitigation measures

Measures to minimize adverse impacts include:

- improving the access road to the site;
- applying water to the access road during operations in order to control dust;
- limiting truck traffic to nonpeak travel times;
- continuously monitoring Wells 1,2,3,4, and 5 adjacent to the site;
- installing additional monitoring wells to gain more information on local groundwater conditions and the movement of contaminants;
- obtaining permission to monitor groundwater quality at the commercial potable water wells;
- monitoring the continued intrusion of saltwater;
- providing adequate cover for the materials each day;

- developing alternative disposal facilities to minimize impact on the site;
- developing a landfill operations plan in order to minimize offsite impacts;
- considering the placement of a clay liner prior to landfilling;
- considering the development of one or more transfer stations to reduce the number of trucks coming to the site.

4.1.4 Disposal of Waste Materials at Titanyn Landfill

Action

The existing landfill will be used for disposal of collected waste materials.

Direct and indirect effects on land use, the quality of life, and the environment

Land Use

The land surrounding the site has no settlements or active farms. However, to reach the site, trucks must use Nationale 1, along which there is residential, commercial, and industrial development. Between the turnoff to the Truittier site and the Titanyn access road, there are about 500 dwellings and businesses. However, the addition of 3 trucks per hour will have a minimal impact on land use.

Site Access

Nationale 1 has an adequate road base that can handle large vehicles, but the access road from Nationale 1 is in poor shape. There is no direct turnoff, and the road has a gravel base.

Site access poses no perceivable environmental problems. However, there is a potential for collisions between entering and exiting vehicles and normal traffic on Nationale 1, and the access road would have to be improved to handle truck traffic.

Traffic

The addition of 3 trucks per hour to the approximately 75 vehicles per hour that pass the access road during peak periods will not alter existing traffic conditions.

Dust

Dust is a problem on the site but will not affect the nearest residence, which is sufficiently distant from daily site activities.

Odors

Again, because the nearest residence is far enough, odors generated by landfilling activities will not affect land use.

Groundwater

The data indicate that landfilling activities will not affect the quality of groundwater, which is largely saline and thus unsuitable as a source of potable water. Furthermore, there are no potable water wells that could be affected by contaminants typical of landfill operations since the nearest is over 1 kilometer from the site and is upgradient from it.

Surface Water/Wetlands

The site is adjacent to the Bay of Port-au-Prince. The zone between the landfill and the Bay is a saltwater marsh or wetland.

The proximity of the marsh, the direction of groundwater flow from the landfill to the marsh, and the presence of wildlife would suggest that landfill activities would have a harmful effect on the marsh. However, the monitoring well data provide inconclusive evidence of the impact of present landfill activities. The fact that they give no indication of the presence of contaminants typical of solid waste can be attributed to the high level of salinity in the groundwater, as well as to the minimal use of the site recently. Therefore, it would be advisable to install more monitoring wells to gather data before using the site as a long-term landfill.

Health

The distance of the site from the nearest residence makes it unlikely that landfilling activities will be a health hazard.

Depletion of natural resources and potential for conservation

Since the site is already used as a landfill, no natural resources will be depleted. There is no potential for conservation because the alternatives are also in use as landfills.

Relationship between short-term use of the environment and long-term productivity

The short-term use of the site could affect the long-term productivity of the adjacent wetlands. However, if the landfill operations are contained by the application of a clay liner under the disposal area, contaminants from the landfill could be prevented from reaching the wetlands.

Irreversible commitment of resources should the proposal be implemented

The contamination of the saltwater marsh and wetlands by landfill operations would be an irreversible commitment of resources.

Potential mitigation measures

Measures to minimize adverse impacts include:

- improving the access road to the site;
- continuously monitoring groundwater from Well 6 adjacent to the site;
- installing additional monitoring wells on the marsh side of the site to gather more groundwater data before using the site as a landfill;
- implementing a water quality testing program on the marsh for information on existing conditions;
- installing a clay liner under the disposal area to prevent contamination of the marsh;
- providing adequate cover daily for the waste materials brought in;
- developing an operations plan to maximize the use of the landfill.

4.2 No-Action Alternative

4.2.1 Collection and Transportation of Waste Materials

No Action

Randomly discharged waste materials will be left where they are.

Direct and indirect effects on land use, the quality of life, and the environment

Land Use

Leaving the discharged materials where they are subjects the residential and small business dwellers of these densely populated areas to the vermin, odors, dust, and contaminated runoff from solid waste and their attendant health hazards, and reduces whatever opportunities there might be for new development.

Site Access

Already poorly served by roads no more than 6 meters wide, often narrowed to less than 4.6 meters by piles of garbage, these neighborhoods become established as permanent discharge sites and the problem of access for residences and businesses grows more acute.

Traffic

Uncollected garbage on the streets impedes the free flow of traffic, causing congestion and often traffic standstills. No increase in the present average speed of 16-32 kilometers per hour can be expected with the continued discharge of waste materials on the streets.

Dust

Airbome dust blown by the wind and passing vehicles from dried discharge and the road base is a major cause of pollution and respiratory ailments.

Odors

Waste materials left uncollected will continue to produce offensive odors because the longer they are allowed to pile up the more likely they are to become anaerobic, which is when they release the most objectionable odors.

Groundwater

The failure to collect waste materials will further the degradation of the groundwater. Since it is assumed the groundwater flows into the Bay and also recharges the municipal wells, the water quality of both the Bay and wells can only get worse.

Surface Water/Wetlands

The drainage canals will continue to discharge water contaminated by waste materials into the Bay of Port-au-Prince, fouling the water quality of the Bay still further.

Health

The inhalation of contaminated dust, ingestion of contaminated food and the spread of disease by vermin foraging in the waste materials will grow worse if these materials remain on the streets.

Depletion of natural resources and potential for conservation

Leaving waste materials uncollected will not deplete natural resources nor offer any potential for conservation.

Relationship between short-term use of the environment and long-term productivity

Uncollected garbage will have a serious impact on the quality of life, the environment, and long-term productivity, affecting public health, traffic, the life of the drainage canals, and business development.

Irreversible commitment of resources should the proposal be implemented

There is no irreversible commitment of resources if waste is not collected.

Potential mitigation measures

Measures to mitigate the consequences of not collecting waste include:

- providing more enclosed garbage containers;
- providing more trucks and labor to improve present operations;
- wetting the garbage to control dust;
- providing a full-time maintenance staff at major discharge areas;
- implementing waste reduction measures in order to minimize waste generation;
- developing small-scale disposal facilities at various locations.

4.2.2 Collection of Sediments from Drainage Canals

No Action

Waste materials and accumulated sediments will not be collected from the canals, and the sediments will not be used as daily cover at the landfill.

Direct and indirect effects on land use, the quality of life, and the environment

Land Use

Allowing waste materials and sediments to accumulate will continue the obstruction of drainage canals, causing them to overflow during the rainy season and produce erosion and flooding in addition to objectionable odors. During the dry season these materials are blown about by the wind. At all times they have an adverse effect on land use.

Site Access

The removal of materials will have no negative impact on site access, which is restricted by the design of the canals and urban development.

Traffic

Since no additional vehicles will be involved, not removing the sediments will have no impact on traffic conditions.

Dust

Leaving the sediments where they are will mean the generation of dust and air pollution during the dry season.

Odors

If left in place the waste materials will continue to generate odors, although not to the extent that these are present in the discharge areas because of the nature of the materials and the depth of the canals. However, the more these materials are allowed to build up, the greater will be the odor problems.

Groundwater

Since it is assumed that stormwater infiltrates into the groundwater, contaminants in the canals are continuing to leach into the groundwater and to contaminate the Bay and potable wells.

Surface Water/Wetlands

Unremoved sediments will continue to pollute the surface water and to obstruct the stormwater flow, causing stagnation and the leaching of contaminants into the groundwater.

Health

Leaving the sediments untouched encourages scavengers to rummage through them and to raise polluted dust as the sediments dry. This dust is a public health hazard.

Depletion of natural resources and potential for conservation

Uncollected sediments deplete resources through erosion and sedimentation of the Bay and contamination of the groundwater. Furthermore, uncollected sediments will require the use of other materials for landfill cover.

Relationship between short-term use of the environment and long-term productivity

The short-term use is leaving the sediments in place and using soil as landfill cover, neither of which enhances long-term productivity. Uncollected sediments will hasten the destruction of the canals, erosion, groundwater contamination, and depletion of cover material.

Irreversible commitment of resources should the proposal be implemented

The use of soil in lieu of canal sediments as landfill cover would be an irreversible commitment of a resource.

Potential mitigation measures

Measures to minimize the consequences of not collecting sediments include:

- fencing in the canals to prevent unauthorized scavenging;
- using compost in place of sediment as landfill cover;

- reducing the quantities of required cover material by developing alternative disposal methods; and
- developing a successful collection program.

4.2.3 Disposal of Waste Materials at La Saline

No Action

The disposal site will continue to be used.

Land Use

Because severe environmental degradation has already taken place, a short-term disposal program would not have a marked effect on the adjacent land, currently occupied by the central market, a gas station, and vendors of all types.

Site Access

Nationale 1, which approaches the site, is 14 meters wide and adequately maintained. The site is also accessible from two directions, which reduces the impact on any one intersection or roadway. However, the two roads leading from Nationale 1 into the site are unsuitable for the volume of traffic handled.

Traffic

The section of Nationale 1 approaching the site is 14 meters wide. As such, the addition of three collection trucks per hour will have minimal impact on the roadway.

Dust

Dust is a major problem already, and the short-term use of the site will hardly aggravate existing conditions. The dust generated by three more vehicles per hour will hardly be noticed.

Odors

The odor level is already high enough that the quantity of materials expected to be disposed of by the short-term use of the site will produce no measurable change.

Groundwater

Based on the quantities of material the landfill currently receives, the short-term use of the site will have no measurable impact on groundwater that from observations is already severely contaminated.

Surface Water/Wetlands

Based on the quantities of material the landfill currently receives and observations of the quality of the stormwater entering the water body, the short-term use of the site will have no measurable impact on surface water that is heavily polluted.

Health

Airborne pollutants, vermin, and direct contact with the waste materials are already a serious threat to public health. The increased quantity of waste from short-term use of the site will not greatly exacerbate these conditions.

Depletion of natural resources and potential for conservation

Since the site is currently used as a landfill, no natural resources will be depleted. There is no potential for conservation because the alternatives are also in use as landfills. However, this site would have even less potential for conservation than the alternatives because of the quantities of waste it receives. Composting would reduce the need for extensive use of the site and, if this was done elsewhere, would reduce the ancillary effects on traffic and dust.

Relationship between short-term use of the environment and long-term productivity

Because of current onsite contamination, the short-term use will not contribute greatly to further degradation that will preclude any future productive development of the site.

Irreversible commitment of resources should the proposal be implemented

Since the site is currently used for disposal of waste materials, there is no irreversible commitment of resources in this action.

Potential mitigation measures

Mitigation measures necessary to minimize impacts include the following:

- paving the access road to the site;
- watering the access road during operations to control dust;
- drilling monitoring wells around the perimeter of the site;
- developing a landfill operations plan to minimize offsite impacts;
- building a temporary wall between Nationale 1 and the landfill to minimize offsite impacts;
- discontinuing operations near Nationale 1, covering this section with soil and vegetation, and moving operations to the back of the site;
- installing a litter fence around the perimeter of the site;
- washing down all vehicles as they exit the site;

- developing alternative disposal facilities to reduce the quantities of materials delivered to the site;

- considering the construction of a transfer station to further reduce truck traffic to the site.

Chapter 5

MITIGATION MEASURES

5.1 Action Alternatives

5.1.1 Collection and Transportation of Waste Materials

Randomly discharged waste materials will be collected, transported, and disposed of in designated landfills.

Mitigation measures include:

- collecting the materials during nonpeak and evening hours to minimize traffic disruption;
- using manual labor instead of machines for collection to minimize dust and odors;
- using water trucks to wet the garbage piles to control airborne dust;
- providing larger garbage containers to minimize litter, odors, and dust.

5.1.2 Collection of Sediments from Drainage Canals

Waste materials and accumulated sediments in the canals will be removed and disposed of in designated landfills, and the sediments will be used as daily cover material at these sites.

Mitigation measures include:

- removing the sediments during nonpeak and evening hours to minimize traffic disruption;
- using manual labor instead of machines for collection to minimize dust;
- using water trucks to wet down the sediments to minimize dust.

5.1.3 Disposal of Waste Materials at Truittier Landfill

The existing landfill will be upgraded to reduce potential environmental impacts.

Mitigation measures include:

- improving the access road to the site;
- watering the access road during operations to control dust;

- limiting truck traffic to nonpeak and evening hours;
- continuously monitoring Wells 1,2,3,4, and 5 adjacent to the site;
- drilling additional monitoring wells to gather more data on groundwater conditions and the movement of contaminants;
- obtaining permission to monitor the groundwater quality of the commercial potable wells;
- monitoring the continued intrusion of saltwater into the site;
- providing adequate material to cover the materials every day;
- developing alternative disposal facilities to ease pressure on the site;
- developing an integrated solid waste management plan to minimize impacts on existing facilities and improve operations;
- developing a landfill operations plan to minimize offsite impacts;
- considering the placement of a clay liner prior to landfilling;
- considering the construction of one or more transfer stations to reduce truck traffic at the site.

5.1.4 Disposal of Waste Materials at Titanyn Landfill

The existing landfill will be upgraded to reduce potential environmental impacts.

Mitigation measures include:

- improving the access road to the site;
- continuously monitoring Well 6 adjacent to the site;
- drilling additional monitoring wells along the saltwater marsh before using the site for landfilling to gain a better understanding of the potential impacts of the landfill on the marsh;
- implementing a water quality testing program on the marsh for information on existing conditions;
- installing a clay liner under the deposit area to prevent contamination of the marsh;
- providing adequate cover for the materials every day;
- developing a landfill operations plan to maximize the use of the landfill;

- developing alternative disposal facilities to ease pressure on the site;
- developing an integrated solid waste management plan to minimize impacts on existing facilities and improve operations.

5.2 No-Action Alternatives

5.2.1 Collection and Transportation of Waste Materials

Randomly discharged waste materials will be left where they are until municipal crews have the opportunity to collect and transport them to designated sites.

Mitigation measures include:

- providing additional closed garbage containers for depositing waste materials;
- providing additional trucks and labor to improve operations;
- periodically wetting accumulated garbage to control dust;
- providing a full-time maintenance staff at the major discharge areas;
- implementing waste reduction measures to minimize waste generation;
- developing small-scale disposal facilities at various locations throughout the area; and
- developing an integrated solid waste management plan to improve operations.

5.2.2 Collection of Sediments from Drainage Canals

Waste materials and accumulated sediments in the canals will not be removed. Daily cover material for the designated waste disposal sites will be obtained from other sources.

Mitigation measures include:

- fencing in the canals to prevent unauthorized disposal of waste materials;
- using compost in place of sediment as landfill cover;
- providing more trucks and labor to improve operations;
- reducing the quantities of needed cover material by developing alternative disposal methods;
- developing an integrated solid waste management plan to improve operations.

5.2.3 Continued Disposal of Waste Materials at La Saline

The site will continue to be used for disposal of waste materials collected by the public and private sectors.

Mitigation measures include:

- paving the access road to the site;
- wetting the access road during operations to control dust;
- drilling monitoring wells around the perimeter of the site;
- developing a landfill operations plan to minimize offsite impacts;
- building a temporary wall between Nationale 1 and the landfill to minimize offsite impacts;
- discontinuing operations in the area immediately adjacent to Nationale 1, covering it with soil and vegetation, and moving operations to the back of the site;
- installing a litter fence around the perimeter of the site;
- using a water truck to wash down all vehicles as they exit the site;
- developing an integrated solid waste management plan to improve operations.
- developing alternative disposal facilities to reduce the quantities of materials delivered to the site;
- considering the construction of a transfer station to further reduce truck traffic at the site.

Chapter 6

CONCLUSIONS AND RECOMMENDATIONS

The CHF/WASH emergency cleanup plan has three elements: the collection and transportation of randomly discharged waste materials to designated disposal sites; the removal of waste materials and accumulated sediments from the drainage canals and the use of these sediments as daily cover material at these disposal sites; and the disposal of collected wastes and sediments at the Truittier or Titanyn landfills.

6.1 Collection and Transportation

The EA concludes that the collection and transportation of discharged wastes and canal sediments will clearly improve existing conditions by

- reducing the health hazards associated with decomposing waste;
- removing the source of offensive odors;
- preventing groundwater and surface water contamination by leachates;
- reducing traffic congestion;
- eliminating the need for residents to dispose of wastes in the drainage canals;
- restoring the function of the drainage canals by removing obstacles to the movement of stormwater;
- using the canal sediments instead of soil for daily landfill cover.

The effect of these collection and transportation activities on the environment will be minimal. They will generate some dust and odors, and the canal sediments could affect groundwater at the disposal sites. However, wetting the waste materials during collection will hold down the dust, and using manual labor instead of mechanized equipment will do the same and also minimize odors. A groundwater monitoring program should be able to track possible contamination by the sediments.

6.2 Truittier Disposal Site

There are advantages and disadvantages to using Truittier as a landfill. The site is isolated, and the groundwater, being saline, is unsuitable for drinking or agriculture. Furthermore, regional data indicate that the movement of groundwater is away from potable water wells and towards the Bay of Port-au-Prince. Surface water is unlikely to be contaminated by landfill activities because of the distance between the site and the Bay.

However, on the negative side, the collection vehicles, although barely adding to the traffic, will generate dust because of the condition of the access road. This can be reduced by upgrading and improving the maintenance of the road. In the long term, however, leachate from the landfill could contaminate potable water supplies, because even though groundwater movement appears to be away from the wells, continued pumping of nearby commercial potable water wells could reverse this direction. This possibility should be monitored by continuous sampling of the wells.

6.3 Titanyn Disposal Site

The Titanyn site has a greater probability of causing short- and long-term environmental degradation. Although Titanyn has adequate access and is isolated, the site is near a saltwater marsh with a thriving wildlife population. The groundwater is saline and shows no evidence of pollutants from past landfill operations. Yet, since the groundwater is close to the surface and moves in the direction of the marsh, future landfill activities could prove detrimental to the marsh. Before this site is used, it will be necessary to assemble more data on the magnitude of potential damage by the landfill. A clay liner should also be installed at the site to prevent the seepage of contaminants into the groundwater.

6.4 La Saline Alternative

A no-action altemative is to continue using La Saline for the disposal of waste materials. Although it is clear the site must eventually be closed down, it provides several short-term benefits. Its proximity to the point of generation reduces many of the adverse impacts associated with Truittier. The access road is well paved and can handle heavy traffic. Adjacent land use is primarily industrial and commercial. The site is degraded to the point at which additional waste materials will make little difference. Using the site will obviate the need to develop Truittier or Titanyn, and will avoid the possible contamination of groundwater at one and surface water at the other.

Furthermore, since closing down La Saline requires the use of final cover materials, the sediments from the drainage canals collected as part of the recommended activities could be used for this purpose over the short term. The collection and disposal operation could be coordinated with the plan for closing down the site and developing it for a new long-term use. Mitigation measures for La Saline before project initiation would include: building a paved service road at the site; constructing a barrier between the site and Nationale 1; and ceasing operations in the area adjacent to Nationale 1 and moving them to the rear of the site.

6.5 Additional Short- and Long-Term Disposal Considerations

Using the three sites (Titanyn, Truittier, and La Saline) either in combination or singly will have similar impacts on traffic, groundwater and surface water contamination, odors, dust, and noise. Therefore, an implementation program should contain elements applicable to all three: the construction of transfer stations; the continued testing of on-site groundwater monitoring wells and surface water; the development of a long-term comprehensive solid waste management plan and collection program; and improved onsite landfill operations.

A transfer station linked to the use of Truittier or Titanyn would enable the transfer of waste materials from small collection vehicles to large trucks and would reduce traffic, dust, and noise at the site. La Saline would be an appropriate location for the transfer station after landfill operations cease. The station can be designed to control any potential offsite impacts.

Ground and surface water monitoring should continue at both Truittier and Titanyn throughout the short-term and long-term programs to provide information on the impact of waste disposal as well as to determine the potential for long-term use of the sites. Should Truittier or Titanyn be used for short-term disposal, monitoring of the existing wells should start immediately.

A long-term comprehensive solid waste management plan should serve several purposes. It should identify alternative methods of disposal such as composting, recycling, and waste reduction that will eliminate the need for La Saline, Truittier, or Titanyn. It should ensure that waste materials are collected and transported to the designated disposal sites. It should seek collection and disposal methods and collection routes that reduce noise, dust, and odors typical of these activities.

A landfill operations plan suitable for all three sites should include traffic control, directions for depositing waste materials, litter and dust control, the application of cover material, staffing, and final closure.

6.6 Recommended Actions

Based on the foregoing considerations, the following actions are recommended:

1. Implement the waste materials and canal sediments collection program proposed in the CHF/WASH report.

2. Develop a long-term solid waste management plan for Port-au-Prince that includes: collection and disposal alternatives to eliminate the need for landfilling; collection methods that maximize the efficiency of collection vehicles; and the best use of available local resources. Earlier WASH reports have described such a management plan.

3. Use La Saline for the short-term disposal of waste materials and upgrade operations with additional equipment, training of personnel, and an operations plan.

4. Begin the closure of the La Saline site and consider other purposes it can serve in the long term, using the waste materials and sediments collected during the emergency program proposed by CHF/WASH.

5. Prepare for long-term disposal of solid wastes at Truittier by continued monitoring of on-site wells, and by developing an alternative access to the site (this could be the existing railroad) or upgrading the existing road.

6. Use Titanyn as the last disposal alternative for the collected materials.

7. Upgrade the present collection program before using any of the three sites to ensure the long-term feasibility of the selected site.

8. Consider using La Saline as a transfer station for the materials going to Truittier.

9. Develop a generic plan that will improve day-to-day operations at all three sites.

APPENDIXES

SAVANNAH LABORATORIES
& ENVIRONMENTAL SERVICES, INC.

414 SW 12th Avenue • Deerfield Beach, Florida 33442 • (305) 421-7400 • Fax (305) 421-2584

LOG NO: D3-22023

Received: 11 JUN 93

Mr. Kevin Murray
Camp, Dresser & McKee Inc.
The Sears Tower, Suite 450
Chicago, IL 60606-6306

Project: Haiti Forotech
Sampled By: Client

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , LIQUID SAMPLES	DATE SAMPLED
22023-1	MW-1	06-10-93
22023-2	MW-2	06-10-93
22023-3	MW-3	06-10-93
22023-4	MW-4	06-10-93
22023-5	MW-5	06-10-93

PARAMETER	22023-1	22023-2	22023-3	22023-4	22023-5
Priority Pollutant Volatiles					
Acrolein, ug/l	<100	<100	<100	<100	<100
Acrylonitrile, ug/l	<100	<100	<100	<100	<100
Benzene, ug/l	<1.0	<1.0	<1.0	<1.0	<1.0
Bromoform, ug/l	<5.0	<5.0	<5.0	<5.0	<5.0
Carbon tetrachloride, ug/l	<5.0	<5.0	<5.0	<5.0	<5.0
Chlorobenzene, ug/l	<5.0	<5.0	<5.0	<5.0	<5.0
Chlorodibromomethane, ug/l	<5.0	<5.0	<5.0	<5.0	<5.0
Chloroethane, ug/l	<10	<10	<10	<10	<10
2-Chloroethylvinyl Ether, ug/l	<50J	<50J	<50J	<50J	<50J
Chloroform, ug/l	<5.0	<5.0	<5.0	<5.0	<5.0
Dichlorobromomethane, ug/l	<5.0	<5.0	<5.0	<5.0	<5.0
1,1-Dichloroethane, ug/l	<5.0	<5.0	<5.0	<5.0	<5.0
1,2-Dichloroethane, ug/l	<5.0	<5.0	<5.0	<5.0	<5.0
1,1-Dichloroethene, ug/l	<5.0	<5.0	<5.0	<5.0	<5.0
1,2-Dichloropropane, ug/l	<5.0	<5.0	<5.0	<5.0	<5.0
1,3-Dichloropropylene, ug/l	<5.0	<5.0	<5.0	<5.0	<5.0
Ethylbenzene, ug/l	<5.0	<5.0	<5.0	<5.0	<5.0
Methyl Bromide, ug/l	<10	<10	<10	<10	<10
Methyl Chloride, ug/l	<10	<10	<10	<10	<10
Methylene chloride, ug/l	<5.0	<5.0	<5.0	<5.0	<5.0
1,1,2,2-Tetrachloroethane, ug/l	<5.0	<5.0	<5.0	<5.0	<5.0

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Project: Haiti Forotech
Sampled By: Client

REPORT OF RESULTS

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22023-1	MW-1	06-10-93
22023-2	MW-2	06-10-93
22023-3	MW-3	06-10-93
22023-4	MW-4	06-10-93
22023-5	MW-5	06-10-93

PARAMETER	22023-1	22023-2	22023-3	22023-4	22023-5
Tetrachloroethene, ug/l	<5.0	<5.0	<5.0	<5.0	<5.0
Toluene, ug/l	22	32	<5.0	<5.0	<5.0
Trans-1,2-Dichloroethene, ug/l	<5.0	<5.0	<5.0	<5.0	<5.0
1,1,1-Trichloroethane, ug/l	<5.0	<5.0	<5.0	<5.0	<5.0
1,1,2-Trichloroethane, ug/l	<5.0	<5.0	<5.0	<5.0	<5.0
Trichloroethene, ug/l	<5.0	<5.0	<5.0	<5.0	<5.0
Vinyl chloride, ug/l	<10	<10	<10	<10	<10
Date Analyzed	06.15.93	06.15.93	06.15.93	06.15.93	06.15.93
Method Number	EPA 8240	EPA 8240	EPA 8240	EPA 8240	EPA 8240
Dilution factor	1	1	1	1	1

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22023-2	MW-2	06-10-93
22023-3	MW-3	06-10-93
22023-4	MW-4	06-10-93
22023-5	MW-5	06-10-93

PARAMETER	22023-1	22023-2	22023-3	22023-4	22023-5
PP Base Neutral Extractables					
Acenaphthene, ug/l	<10	<10	<10	<10	<10
Acenaphthylene, ug/l	<10	<10	<10	<10	<10
Anthracene, ug/l	<10	<10	<10	<10	<10
Benzidine, ug/l	<80	<80	<80	<80	<80
Benzo(a)anthracene, ug/l	<10	<10	<10	<10	<10
Benzo(a)pyrene, ug/l	<10	<10	<10	<10	<10
3,4-Benzofluoranthene, ug/l	<10	<10	<10	<10	<10
Benzo(g,h,i)perylene, ug/l	<10	<10	<10	<10	<10
Benzo(k)fluoranthene, ug/l	<10	<10	<10	<10	<10
Bis(2-Chloroethoxy)methane, ug/l	<10	<10	<10	<10	<10
Bis(2-Chloroethyl)ether, ug/l	<10	<10	<10	<10	<10
Bis(2-chloroisopropyl)ether, ug/l	<10	<10	<10	<10	<10
Bis(2-Ethylhexyl)phthalate, ug/l	<10	<10	<10	<10	<10
4-Bromophenyl-phenyl-ether, ug/l	<10	<10	<10	<10	<10
Butylbenzylphthalate, ug/l	<10	<10	<10	<10	<10
2-Chloronaphthalene, ug/l	<10	<10	<10	<10	<10
4-Chlorophenyl-phenyl ether, ug/l	<10	<10	<10	<10	<10
Chrysene, ug/l	<10	<10	<10	<10	<10
Dibenz(a,h)anthracene, ug/l	<10	<10	<10	<10	<10
1,2-Dichlorobenzene, ug/l	<10	<10	<10	<10	<10
1,3-Dichlorobenzene, ug/l	<10	<10	<10	<10	<10

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22023-2	MW-2	06-10-93
22023-3	MW-3	06-10-93
22023-4	MW-4	06-10-93
22023-5	MW-5	06-10-93

PARAMETER	22023-1	22023-2	22023-3	22023-4	22023-5
1,4-Dichlorobenzene, ug/l	<10	<10	<10	<10	<10
3,3'-Dichlorobenzidine, ug/l	<20	<20	<20	<20	<20
Diethylphthalate, ug/l	<10	<10	<10	<10	<10
Dimethylphthalate, ug/l	<10	<10	<10	<10	<10
Di-n-butylphthalate, ug/l	<10	<10	<10	<10	<10
2,4-Dinitrotoluene, ug/l	<10	<10	<10	<10	<10
2,6-Dinitrotoluene, ug/l	<10	<10	<10	<10	<10
Di-n-octylphthalate, ug/l	<10	<10	<10	<10	<10
1,2-Diphenylhydrazine, ug/l	<10	<10	<10	<10	<10
Fluoranthene, ug/l	<10	<10	<10	<10	<10
Fluorene, ug/l	<10	<10	<10	<10	<10
Hexachlorobenzene, ug/l	<10	<10	<10	<10	<10
Hexachlorobutadiene, ug/l	<10	<10	<10	<10	<10
Hexachlorocyclopentadiene, ug/l	<10	<10	<10	<10	<10
Hexachloroethane, ug/l	<10	<10	<10	<10	<10
Indeno (1,2,3-cd)pyrene, ug/l	<10	<10	<10	<10	<10
Isophorone, ug/l	<10	<10	<10	<10	<10
Naphthalene, ug/l	<10	<10	<10	<10	<10
Nitrobenzene, ug/l	<10	<10	<10	<10	<10
N-Nitrosodimethylamine, ug/l	<10	<10	<10	<10	<10
N-Nitrosodi-N-Propylamine, ug/l	<10	<10	<10	<10	<10
N-Nitrosodiphenylamine/diphenylamine, ug/l	<10	<10	<10	<10	<10

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22023-2	MW-2	06-10-93
22023-3	MW-3	06-10-93
22023-4	MW-4	06-10-93
22023-5	MW-5	06-10-93

PARAMETER	22023-1	22023-2	22023-3	22023-4	22023-5
Phenanthrene, ug/l	<10	<10	<10	<10	<10
Pyrene, ug/l	<10	<10	<10	<10	<10
1,2,4-Trichlorobenzene, ug/l	<10	<10	<10	<10	<10
Date Extracted	06.14.93	06.14.93	06.14.93	06.14.93	06.14.93
Date Analyzed	06.16.93	06.16.93	06.16.93	06.16.93	06.16.93
Method Number	EPA 8270	EPA 8270	EPA 8270	EPA 8270	EPA 8270
Dilution factor	1	1	1	1	1
Priority Pollutant Acid Extractables					
2-Chlorophenol, ug/l	<10	<10	<10	<10	<10
2,4-Dichlorophenol, ug/l	<10	<10	<10	<10	<10
2,4-Dimethylphenol, ug/l	<10	<10	<10	<10	<10
4,6-Dinitro-2-methylphenol, ug/l	<50	<50	<50	<50	<50
2,4-Dinitrophenol, ug/l	<50	<50	<50	<50	<50
2-Nitrophenol, ug/l	<10	<10	<10	<10	<10
4-Nitrophenol, ug/l	<50	<50	<50	<50	<50
P-Chloro-m-cresol, ug/l	<10	<10	<10	<10	<10
Pentachlorophenol, ug/l	<50	<50	<50	<50	<50
Phenol, ug/l	<10	<10	<10	<10	<10
2,4,6-Trichlorophenol, ug/l	<10	<10	<10	<10	<10
Date Extracted	06.14.93	06.14.93	06.14.93	06.14.93	06.14.93
Date Analyzed	06.16.93	06.16.93	06.16.93	06.16.93	06.16.93
Method Number	EPA 8270	EPA 8270	EPA 8270	EPA 8270	EPA 8270
Dilution factor	1	1	1	1	1

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22023-2	MW-2	06-10-93
22023-3	MW-3	06-10-93
22023-4	MW-4	06-10-93
22023-5	MW-5	06-10-93

PARAMETER	22023-1	22023-2	22023-3	22023-4	22023-5
Priority Pollutant Pesticides/PCB's					
Aldrin, ug/l	<0.050	<0.050	<0.050	<0.050	<0.050
Alpha-BHC, ug/l	<0.050	<0.050	<0.050	<0.050	<0.050
Beta-BHC, ug/l	<0.050	<0.050	<0.050	<0.050	<0.050
Gamma-BHC, ug/l	<0.050	<0.050	<0.050	<0.050	<0.050
Delta-BHC, ug/l	<0.050	<0.050	<0.050	<0.050	<0.050
Chlordane, ug/l	<0.50	<0.50	<0.50	<0.50	<0.50
4,4'-DDT, ug/l	<0.10	<0.10	<0.10	<0.10	<0.10
4,4'-DDE, ug/l	<0.10	<0.10	<0.10	<0.10	<0.10
4,4'-DDD, ug/l	<0.10	<0.10	<0.10	<0.10	<0.10
Dieldrin, ug/l	<0.10	<0.10	<0.10	<0.10	<0.10
Alpha-Endosulfan, ug/l	<0.050	<0.050	<0.050	<0.050	<0.050
Beta-Endosulfan, ug/l	<0.10	<0.10	<0.10	<0.10	<0.10
Endosulfan sulfate, ug/l	<0.10	<0.10	<0.10	<0.10	<0.10
Endrin, ug/l	<0.10	<0 10	<0.10	<0.10	<0.10
Endrin Aldehyde, ug/l	<0.10	<0.10	<0.10	<0.10	<0.10
Heptachlor, ug/l	<0.050	<0.050	<0.050	<0.050	<0.050
Heptachlor epoxide, ug/l	<0.050	<0.050	<0.050	<0.050	<0.050
Aroclor-1242, ug/l	<1.0	<1.0	<1.0	<1.0	<1.0
Aroclor-1254, ug/l	<1.0	<1.0	<1.0	<1.0	<1.0
Aroclor-1221, ug/l	<2.0	<2.0	<2.0	<2.0	<2.0
Aroclor-1232, ug/l	<1.0	<1.0	<1.0	<1.0	<1.0

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REPORT OF RESULTS

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22023-1	MW-1	06-10-93
22023-2	MW-2	06-10-93
22023-3	MW-3	06-10-93
22023-4	MW-4	06-10-93
22023-5	MW-5	06-10-93

PARAMETER	22023-1	22023-2	22023-3	22023-4	22023-5
Aroclor-1248, ug/l	<1.0	<1.0	<1.0	<1.0	<1.0
Aroclor-1260, ug/l	<1.0	<1.0	<1.0	<1.0	<1.0
Aroclor-1016, ug/l	<1.0	<1.0	<1.0	<1.0	<1.0
Toxaphene, ug/l	<5.0	<5.0	<5.0	<5.0	<5.0
Date Extracted	06.14.93	06.14.93	06.14.93	06.14.93	06.14.93
Date Analyzed	06.23.93	06.23.93	06.23.93	06.23.93	06.23.93
Method Number	EPA 608	EPA 608	EPA 608	EPA 608	EPA 608
Dilution factor	1	1	1	1	1
Antimony, mg/l	<0.050	<0.050	<0.050	<0.050	<0.050
Arsenic, mg/l	0.024	<0 010	<0.010	<0.010	<0.010
Beryllium, mg/l	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Cadmium, mg/l	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Chromium, mg/l	0.30	0.028	<0.010	0.031	<0.010
Copper, mg/l	0.79	<0.025	<0.025	<0.025	<0.025
Lead, mg/l	0.028	0.012	0.011	<0.0050	<0.0050
Mercury, mg/l	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020
Nickel, mg/l	0.30	0.041	<0.040	<0.040	<0.040
Selenium, mg/l	<0.010	<0.010	<0.010	<0.010	<0.010
Silver, mg/l	<0.010	<0.010	<0.010	<0.010	<0.010
Thallium, mg/l	<0.010	<0.010	<0.010	<0.010	<0.010
Zinc, mg/l	0.48	<0.020	0.049	<0.020	<0.020

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22023-2	MW-2	06-10-93
22023-3	MW-3	06-10-93
22023-4	MW-4	06-10-93
22023-5	MW-5	06-10-93

PARAMETER	22023-1	22023-2	22023-3	22023-4	22023-5
Chemical Oxygen Demand					
Chemical Oxygen Demand, mg/l	120	100	82	48	<20
Date Analyzed	06.14.93	06.14.93	06.14.93	06.14.93	06.14.93
Method Number	EPA 410.4	EPA 410.4	EPA 410.4	EPA 410.4	EPA 410.4
Phenolics, Total Recoverable					
Phenolics, Total Recoverable, mg/l	<0.010	<0.010	<0.010	<0.010	<0.010
Date Analyzed	06.23.93	06.23.93	06.23.93	06.23.93	06.23.93
Method Number	EPA 420.1	EPA 420.1	EPA 420.1	EPA 420.1	EPA 420.1

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LOG NO	SAMPLE DESCRIPTION , QC REPORT FOR LIQUID SAMPLES
22023-6	Lab Blank
22023-7	Accuracy - % Recovery (Mean)
22023-8	Precision - Relative % Difference
22023-9	Detection Limit

PARAMETER	22023-6	22023-7	22023-8	22023-9
Priority Pollutant Volatiles				
Acrolein, ug/l	<100	---	---	100
Acrylonitrile, ug/l	<100	---	---	100
Benzene, ug/l	<1.0	116 %	1.7 %	1.0
Bromoform, ug/l	<5.0	---	---	5.0
Carbon tetrachloride, ug/l	<5.0	---	---	5.0
Chlorobenzene, ug/l	<5.0	118 %	3.4 %	5.0
Chlorodibromomethane, ug/l	<5.0	---	---	5.0
Chloroethane, ug/l	<10	---	---	10
2-Chloroethylvinyl Ether, ug/l	<50J	---	---	50J
Chloroform, ug/l	<5.0	---	---	5.0
Dichlorobromomethane, ug/l	<5.0	---	---	5.0
1,1-Dichloroethane, ug/l	<5.0	---	---	5.0
1,2-Dichloroethane, ug/l	<5.0	---	---	5.0
1,1-Dichloroethene, ug/l	<5.0	108 %	6.5 %	5.0
1,2-Dichloropropane, ug/l	<5.0	---	---	5.0
1,3-Dichloropropylene, ug/l	<5.0	---	---	5.0
Ethylbenzene, ug/l	<5.0	---	---	5.0
Methyl Bromide, ug/l	<10	---	---	10
Methyl Chloride, ug/l	<10	---	---	10
Methylene chloride, ug/l	<5.0	---	---	5.0
1,1,2,2-Tetrachloroethane, ug/l	<5.0	---	---	5.0
Tetrachloroethene, ug/l	<5.0	---	---	5.0

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22023-6	Lab Blank
22023-7	Accuracy - % Recovery (Mean)
22023-8	Precision - Relative % Difference
22023-9	Detection Limit

PARAMETER	22023-6	22023-7	22023-8	22023-9
Toluene, ug/l	<5.0	122 %	1.6 %	5.0
Trans-1,2-Dichloroethene, ug/l	<5.0	---	---	5.0
1,1,1-Trichloroethane, ug/l	<5.0	---	---	5.0
1,1,2-Trichloroethane, ug/l	<5.0	---	---	5.0
Trichloroethene, ug/l	<5.0	94 %	17 %	5.0
Vinyl chloride, ug/l	<10	---	---	10
Date Analyzed	06.15.93	---	---	---
Method Number	EPA 8240	---	---	---

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LOG NO: D3-22023

Received: 11 JUN 93

Mr. Kevin Murray
Camp, Dresser & McKee Inc.
The Sears Tower, Suite 450
Chicago, IL 60606-6306

Project: Haiti Forotech
Sampled By: Client

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , QC REPORT FOR LIQUID SAMPLES
22023-6	Lab Blank
22023-7	Accuracy - % Recovery (Mean)
22023-8	Precision - Relative % Difference
22023-9	Detection Limit

PARAMETER	22023-6	22023-7	22023-8	22023-9
PP Base Neutral Extractables				
Acenaphthene, ug/l	<10	72 %	5.6 %	10
Acenaphthylene, ug/l	<10	---	---	10
Anthracene, ug/l	<10	---	---	10
Benzidine, ug/l	<80	---	---	80
Benzo(a)anthracene, ug/l	<10	---	---	10
Benzo(a)pyrene, ug/l	<10	---	---	10
3,4-Benzofluoranthene, ug/l	<10	---	---	10
Benzo(g,h,i)perylene, ug/l	<10	---	---	10
Benzo(k)fluoranthene, ug/l	<10	---	---	10
Bis(2-Chloroethoxy)methane, ug/l	<10	---	---	10
Bis(2-Chloroethyl)ether, ug/l	<10	---	---	10
Bis(2-chloroisopropyl)ether, ug/l	<10	---	---	10
Bis(2-Ethylhexyl)phthalate, ug/l	<10	---	---	10
4-Bromophenyl-phenyl-ether, ug/l	<10	---	---	10
Butylbenzylphthalate, ug/l	<10	---	---	10
2-Chloronaphthalene, ug/l	<10	---	---	10
4-Chlorophenyl-phenyl ether, ug/l	<10	---	---	10
Chrysene, ug/l	<10	---	---	10
Dibenz(a,h)anthracene, ug/l	<10	---	---	10
1,2-Dichlorobenzene, ug/l	<10	---	---	10
1,3-Dichlorobenzene, ug/l	<10	---	---	10
1,4-Dichlorobenzene, ug/l	<10	54 %	1.9 %	10

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22023-6	Lab Blank
22023-7	Accuracy - % Recovery (Mean)
22023-8	Precision - Relative % Difference
22023-9	Detection Limit

PARAMETER	22023-6	22023-7	22023-8	22023-9
Priority Pollutant Acid Extractables				
2-Chlorophenol, ug/l	<10	63 %	1.6 %	10
2,4-Dichlorophenol, ug/l	<10	---	---	10
2,4-Dimethylphenol, ug/l	<10	---	---	10
4,6-Dinitro-2-methylphenol, ug/l	<50	---	---	50
2,4-Dinitrophenol, ug/l	<50	---	---	50
2-Nitrophenol, ug/l	<10	---	---	10
4-Nitrophenol, ug/l	<50	40 %	37 %	50
P-Chloro-m-cresol, ug/l	<10	67 %	1.5 %	10
Pentachlorophenol, ug/l	<50	63 %	9.5 %	50
Phenol, ug/l	<10	32 %	19 %	10
2,4,6-Trichlorophenol, ug/l	<10	---	---	10
Date Extracted	06.14.93	---	---	---
Date Analyzed	06.16.93	---	---	---
Method Number	EPA 8270	---	---	---

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REPORT OF RESULTS

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22023-6	Lab Blank
22023-7	Accuracy - % Recovery (Mean)
22023-8	Precision - Relative % Difference
22023-9	Detection Limit

PARAMETER	22023-6	22023-7	22023-8	22023-9
Priority Pollutant Pesticides/PCB's				
Aldrin, ug/l	<0.050	70 %	7.1 %	0.050
Alpha-BHC, ug/l	<0.050	---	---	0.050
Beta-BHC, ug/l	<0.050	---	---	0.050
Gamma-BHC, ug/l	<0.050	100 %	2.0 %	0.050
Delta-BHC, ug/l	<0.050	---	---	0.050
Chlordane, ug/l	<0.50	---	---	0.50
4,4'-DDT, ug/l	<0.10	112 %	22 %	0.10
4,4'-DDE, ug/l	<0.10	---	---	0.10
4,4'-DDD, ug/l	<0.10	---	---	0.10
Dieldrin, ug/l	<0.10	88 %	8.0 %	0.10
Alpha-Endosulfan, ug/l	<0.050	---	---	0.050
Beta-Endosulfan, ug/l	<0.10	---	---	0.10
Endosulfan sulfate, ug/l	<0.10	---	---	0.10
Endrin, ug/l	<0.10	90 %	12.0 %	0.10
Endrin Aldehyde, ug/l	<0.10	---	---	0.10
Heptachlor, ug/l	<0.050	65 %	0 %	0.050
Heptachlor epoxide, ug/l	<0.050	---	---	0.050
Aroclor-1242, ug/l	<1.0	---	---	1.0
Aroclor-1254, ug/l	<1.0	---	---	1.0
Aroclor-1221, ug/l	<2.0	---	---	2.0
Aroclor-1232, ug/l	<1.0	---	---	1.0
Aroclor-1248, ug/l	<1.0	---	---	1.0

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REPORT OF RESULTS

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22023-6	Lab Blank
22023-7	Accuracy - % Recovery (Mean)
22023-8	Precision - Relative % Difference
22023-9	Detection Limit

PARAMETER	22023-6	22023-7	22023-8	22023-9
Aroclor-1260, ug/l	<1.0	---	---	1.0
Aroclor-1016, ug/l	<1.0	---	---	1.0
Toxaphene, ug/l	<5.0	---	---	5.0
Date Extracted	06.14.93	---	---	---
Date Analyzed	06.23.93	---	---	---
Method Number	EPA 608	---	---	---
Antimony, mg/l	<0.050	98 %	1.0 %	0.050
Arsenic, mg/l	<0.010	107 %	9.3 %	0.010
Beryllium, mg/l	<0.0050	100 %	0 %	0.0050
Cadmium, mg/l	<0.0050	94 %	0 %	0.0050
Chromium, mg/l	<0.010	106 %	0.94 %	0.010
Copper, mg/l	<0.025	103 %	0 %	0.025
Lead, mg/l	<0.0050	107 %	1.9 %	0.0050
Mercury, mg/l	<0.00020	101 %	0 %	0.00020
Nickel, mg/l	<0.040	104 %	0.96 %	0.040
Selenium, mg/l	<0.010	99 %	2.0 %	0.010
Silver, mg/l	<0.010	98 %	1.0 %	0.010
Thallium, mg/l	<0.010	100 %	0 %	0.010
Zinc, mg/l	<0.020	98 %	1.0 %	0.020
Chemical Oxygen Demand				
Chemical Oxygen Demand, mg/l	<20	92 %	1.1 %	20
Date Analyzed	06.14.93	---	---	---
Method Number	EPA 410.4	---	---	---

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Project: Haiti Forotech
Sampled By: Client

REPORT OF RESULTS

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22023-6	Lab Blank
22023-7	Accuracy - % Recovery (Mean)
22023-8	Precision - Relative % Difference
22023-9	Detection Limit

PARAMETER	22023-6	22023-7	22023-8	22023-9
Phenolics, Total Recoverable				
Phenolics, Total Recoverable, mg/l	<0.010	105 %	1.9 %	0.010
Date Analyzed	06.23.93	---	---	---
Method Number	EPA 420.1	---	---	---

Method References: EPA 40 CFR Part 136, EPA 600/4-79-020 and EPA SW-846. J - Estimated Value.

Paul Canevaro

E T C H A

ETUDE ET TRAITEMENT EN CHIMIE APPLIQUEE
Port-au-Prince, Haiti
Tel: 46-4304

RESULTATS DE L'ANALYSE DES ECHANTILLONS D'EAU PRELEVES SUR LES FORAGES DE TRUITIER ET TITANYEN

HAITI

JUL 07 '93 06:0[illegible] CDM/WASH PROJECT P.6

COMPTE-RENDU DE FORAGE

HAITI-FORATECH

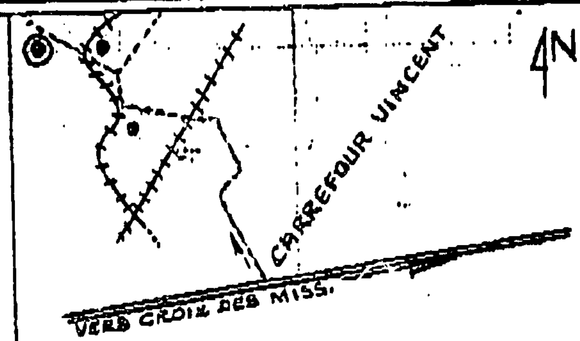
N° IRE
1

TYPE et NOM du POINT d'EAU	PIEZOMETRE WASH	DATES des TRAVAUX	du 4-6-93 au 5-6-93	PROFONDEUR TOTALE DU FORAGE	20 m
N° REF. DOSSIER	HF/1793/590				
MAITRE D'OEUVRE	WASH	ENTREPRISE et Chef de chantier	HAITI-FORATECH PIERRE ARLANDE		
BUT du FORAGE (utilisations)	ETUDE ET CONTROLE POLLUTION	AUTORISATION DE FORAGE	N°:	Date :	

LOCALISATION

LIEU-DIT	TRUITIER	
VILLAGE		
COMMUNE	DELMAS	
DEPARTEMENT	OUEST	
BASSIN HYDROGRAPHIQUE	RIVIERE GRISE	
CARTE TOPOGRAPHIQUE — Nom	CRX DES MISSIONS	ALTITUDE
CARTE TOPOGRAPHIQUE — Numéro	5771 IV NE	m
CARTE TOPOGRAPHIQUE — Echelle	1/25 .000 ème	d'après :
COORDONNEES (en km et mètres)	X (Ouest)	Y (Nord)

PLAN D'ACCES



Indiquer repères, distances et orientations.

APPAREILLAGES DE FORAGE UTILISES	DESCRIPTION DE L'ACCES
FAILING CF-15	SUIVRE LE MEME PARCOURT QUE CELUI DU # 2
METHODE DE FORAGE	A 150 M DE CELUI-CI TRAVERSER UN RAVIN A GAUCHE
ROTATION A CIRCULATION DIRECTE	SITE SITUE A 60m DU RAVIN

OPERATIONS DE FORAGE ET DE CAPTAGE

FORAGE

Diamètres successifs (mm)	250
Cotes par rapport au sol (m) de	0
à	20
Longueurs (m)	20
Outils de forage utilisés	DRAG BIT

ALESAGES

Diamètres successifs (mm)	
Cotes par rapport au sol (m) de	
à	
Longueurs (m)	
Type d'aléseur utilisé	

TUBAGES

Caractéristiques	PVC SCH40
Diamètres successifs (mm)	102
Cotes par rapport au sol (m) de	0
à	20
Longueurs (m)	20

CREPINES

Caractéristiques	FENTES VERTICALES
Diamètres successifs (mm)	120
Cotes par rapport au sol (m) de	8
à	20
Longueurs (m)	12

ESPACE ANNULAIRE

	Massif filtrant	Cimentation	Autres
Caractéristiques	GRAVIER ARRONDI	SOCLE EN BETON	BOUCHON SCELLE
Cotes par rapport au sol (m) de	0		
à	20		
Longueurs (m)	20		
Volumes (m3)	1		

DEVELOPPEMENT

Méthode et appareillage	AIR LIFT COMPRESSEUR LEROY
Durée totale (h)	2
Eau claire obtenue ?	OUI
Conductivité (ppm/ mhos.cm)	début / fin
Débit (l/s) - méth. mesure	
Rabattement mesuré (m)	
Mesure remontée niv. eau ?	

AUTRES OPERATIONS	INCIDENTS
Carottage électr./mécan. an. granulo., traitements..	Ex: pertes de boue, d'outil, coincements..

N° IRE 1

Coupe géologique

Profondeur en mètres: 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30, 32, 34, 36, 38, 40, 42, 44, 46, 48, 50, 52, 54, 56, 58, 60, 62, 64, 66, 68, 70, 72, 74, 76, 78, 80, 82, 84, 86, 88, 90

ARGILE SABLEUSE

SABLE ARGILEUX

ARGILE SABLEUSE

Observations

(vitesse d'avancement, pertes de boue, venues d'eau, etc...)

Coupe technique

Ø8-1/2"

Profondeur en pieds: 10, 20, 30, 40, 50, 60, 70, 80, 90, 100, 110, 120, 130, 140, 150, 160, 170, 180, 190, 200, 210, 220, 230, 240, 250, 260, 270, 280, 290

COMPTE-RENDU DE FORAGE

HAITI-FORATECH

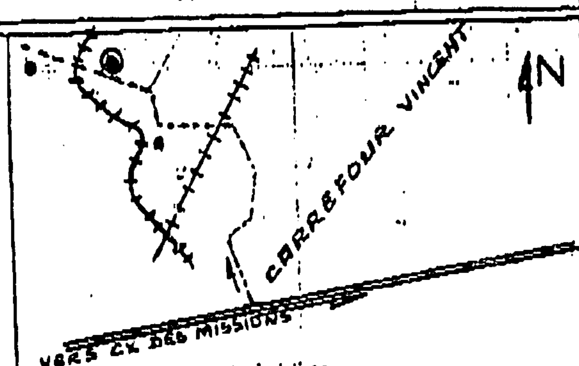
N° IRE 2

TYPE et NOM du POINT d'EAU	PIEZOMETRE WASH	DATES des TRAVAUX	du 3-6-93 au 3-6-93	PROFONDEUR TOTALE du FORAGE	20 m
N° REF. DOSSIER	HF/1793/590				
MAITRE D'OEUVRE	WASH	ENTREPRISE et Chef de chantier	HAITI-FORATECH PIERRE ARLANDE		
BUT du FORAGE (utilisations)	ETUDE ET CONTRO-LE POLLUTION	AUTORISATION DE FORAGE	N°:	Date :	

LOCALISATION

LIEU-DIT		
VILLAGE		
COMMUNE	DELMAS	
DEPARTEMENT	OUEST	
BASSIN HYDROGRAPHIQUE	RIVIERE GRISE	
CARTE TOPOGRAPHIQUE – Nom	CRX DES MISSIONS	ALTITUDE
Numéro	5771 IV NE	m
Echelle	1/25 .000 ème	d'après :
COORDONNEES (en km et mètres)	X (Ouest)	Y (Nord)

PLAN D'ACCES



Indiquer repères, distances et orientations.

APPAREILLAGES DE FORAGE UTILISES	DESCRIPTION DE L'ACCES
FAILING CF-15	
METHODE DE FORAGE	
ROTATION A CIRCULATION DIRECTE	

OPERATIONS DE FORAGE ET DE CAPTAGE

FORAGE

Diamètres successifs (mm)	250
Cotes par rapport au sol (m) de	0
à	20
Longueurs (m)	20
Outils de forage utilisés	DRAG BIT

ALESAGES

Diamètres successifs (mm)	
Cotes par rapport au sol (m) de	
à	
Longueurs (m)	
Type d'aléseur utilisé	

TUBAGES

Caractéristiques	PVC SCH40
Diamètres successifs (mm)	120
Cotes par rapport au sol (m) de	0
à	20
Longueurs (m)	20

CREPINES

Caractéristiques	FENTES
Diamètres successifs (mm)	120
Cotes par rapport au sol (m) de	8
à	20
Longueurs (m)	12

ESPACE ANNULAIRE

	Massif filtrant	Cimentation	Autres
Caractéristiques	GRAVIER ARRONDI	SCELLE EN BETON	BOUCHON SCELLE
Cotes par rapport au sol (m) de	0		
à	20		
Longueurs (m)	20		
Volumes (m3)	1 m3		

DEVELOPPEMENT

Méthode et appareillage	AIR LIFT COMPRESSEUR LEROY
Durée totale (h)	2
Eau claire obtenue ?	OUI
Conductivité (ppm/ mhos.cm)	début __ fin __
Débit (l/s) - méth.mesure	
Rabattement mesuré (m)	
Mesure remontée niv. eau ?	

AUTRES OPERATIONS	INCIDENTS
Carottage électr./mécan. an.granulo., traitements..	Ex: pertes de boue, d'outil, coincements..

N° IRE 2

PROFONDEUR en mètres	Coupe géologique	Observations (vitesse d'avancement, pertes de boue, venues d'eau, etc...)	Coupe technique	PROFONDEUR en pieds
2 – 4	ARGILE SABLEUSE		NS ≈ 10'	10
6 – 10	SABLE ARGILEUX			20 – 30
12 – 20	ARGILE + SABLE			40 – 60

Profondeur (mètres): 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30, 32, 34, 36, 38, 40, 42, 44, 46, 48, 50, 52, 54, 56, 58, 60, 62, 64, 66, 68, 70, 72, 74, 76, 78, 80, 82, 84, 86, 88, 90

Profondeur (pieds): 10, 20, 30, 40, 50, 60, 70, 80, 90, 100, 110, 120, 130, 140, 150, 160, 170, 180, 190, 200, 210, 220, 230, 240, 250, 260, 270, 280, 290

COMPTE-RENDU DE FORAGE

HAITI-FORATECH

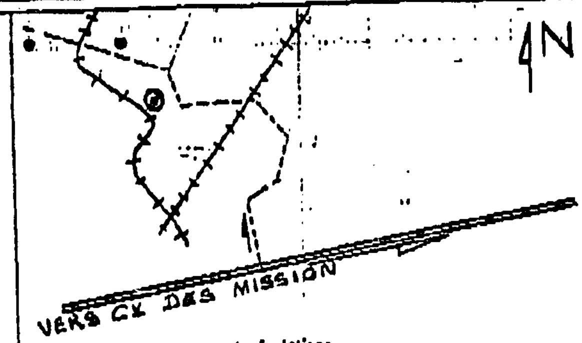
N° IRE: 3

TYPE et NOM du POINT d'EAU	PIEZOMETRE WASH	DATES des TRAVAUX	du 7-6-93 / au 7-6-93	PROFONDEUR TOTALE du FORAGE: 20 m.	N° REF. DOSSIER: HF/1793/590
MAITRE D'OEUVRE	WASH	ENTREPRISE et Chef de chantier	HAITI-FORATECH / PIERRE ARLANDE		
BUT du FORAGE (utilisations)	ETUDE ET CONTRO-LE POLLUTION	AUTORISATION DE FORAGE	N°:	Date :	

LOCALISATION

LIEU-DIT	MENELAS/TRUTIER	
VILLAGE	MENELAS	
COMMUNE	DELMAS	
DEPARTEMENT	OUEST	
BASSIN HYDROGRAPHIQUE	RIVIERE GRISE	
CARTE TOPOGRAPHIQUE – Nom		ALTITUDE: m d'après :
CARTE TOPOGRAPHIQUE – Numéro		
CARTE TOPOGRAPHIQUE – Echelle	1/25000 ème	
COORDONNEES (en km et mètres)	X (Ouest):	Y (Nord):

PLAN D'ACCES



Indiquer repères, distances et orientations.

APPAREILLAGES DE FORAGE UTILISES

FAILING CF-15

METHODE DE FORAGE

ROTATION A CIRCULATION DIRECTE

DESCRIPTION DE L'ACCES

PRENDRE LA ROUTE NATIONALE VERS CROIX DES MISSIONS TOURNER A GAUCHE (CARREFOUR VINCENT) TRAVERSER LES RAILS DE LA HASCO - SITE A ENVIRON UN METRE DE LA ROUTE

OPERATIONS DE FORAGE ET DE CAPTAGE

FORAGE	Diamètres successifs (mm)	250
	Cotes par rapport au sol (m) – de	0
	Cotes par rapport au sol (m) – à	20
	Longueurs (m)	20
	Outils de forage utilisés	DRAG BIT
ALESAGES	Diamètres successifs (mm)	
	Cotes par rapport au sol (m) – de	
	Cotes par rapport au sol (m) – à	
	Longueurs (m)	
	Type d'aléseur utilisé	
TUBAGES	Caractéristiques	PVC SCH40
	Diamètres successifs (mm)	102
	Cotes par rapport au sol (m) – de	0
	Cotes par rapport au sol (m) – à	20
	Longueurs (m)	20
CREPINES	Caractéristiques	FENTES VERTICALES
	Diamètres successifs (mm)	102
	Cotes par rapport au sol (m) – de	8
	Cotes par rapport au sol (m) – à	20
	Longueurs (m)	12

ESPACE ANNULAIRE	Massif filtrant	Cimentation	Autres
Caractéristiques	GRAVIER ARRONDI	SOCLE EN BETON	BOUCHON SCELLE
Cotes par rapport au sol (m) – de	0		
Cotes par rapport au sol (m) – à	20		
Longueurs (m)	20		
Volumes (m3)	1m3		

DEVELOPPEMENT	
Méthode et appareillage	AIR LIFT / AIR COMPRIME LEROY
Durée totale (h)	2 — Eau claire obtenue ? OUI
Conductivité (ppm/ mhos.cm)	début – fin
Débit (l/s) – méth. mesure	
Rabattement mesuré (m)	
Mesure remontée niv. eau ?	

AUTRES OPERATIONS	INCIDENTS
Carottage électr./mécan. an.granulo., traitements..	Ex:pertes de boue, d'outil, coincements..

PROFONDEUR en mètres	N° IRE 3 — Coupe géologique	Observations (vitesse d'avancement, pertes de boue, venues d'eau, etc...)	Coupe technique	PROFONDEUR en pieds
0–4	ARGILE + SABLE NOIR		PLEINS — CREPINES; NS = 12'	0–10
4–10	SABLE FIN NOIR			10–30
10–20	GRAVIER COQUILLE			30–60

Profondeur en mètres: 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30, 32, 34, 36, 38, 40, 42, 44, 46, 48, 50, 52, 54, 56, 58, 60, 62, 64, 66, 68, 70, 72, 74, 76, 78, 80, 82, 84, 86, 88, 90

Profondeur en pieds: 10, 20, 30, 40, 50, 60, 70, 80, 90, 100, 110, 120, 130, 140, 150, 160, 170, 180, 190, 200, 210, 220, 230, 240, 250, 260, 270, 280, 290

COMPTE-RENDU DE FORAGE

HAITI-FORATECH

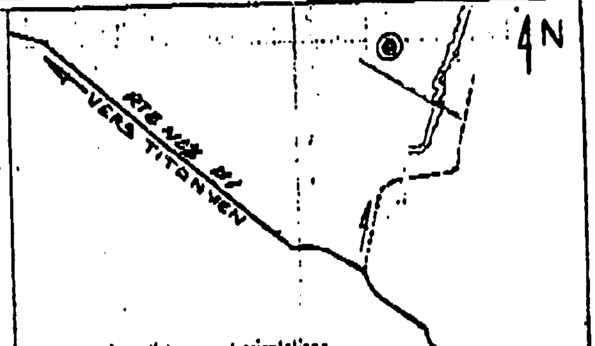
N° IRE
4

TYPE et NOM du POINT d'EAU	PIEZOMETRE WASH	DATES des TRAVAUX	du 11-6-93 / au 11-6-93	PROFONDEUR TOTALE du FORAGE	20 m	N° REF. DOSSIER HF/17937590
MAITRE D'ŒUVRE	WASH	ENTREPRISE et Chef de chantier	HAITI-FORATECH PIERRE ARLANDE			
BUT du FORAGE (utilisations)	ETUDE ET CONTROLE POLLUTION	AUTORISATION DE FORAGE	N°:	Date :		

LOCALISATION

LIEU-DIT		
VILLAGE	SOURCES PUANTES/TITANYEN	
COMMUNE		
DEPARTEMENT	OUEST	
BASSIN HYDROGRAPHIQUE		
CARTE TOPOGRAPHIQUE — Nom	SOURCE MATELAS	ALTITUDE
CARTE TOPOGRAPHIQUE — Numéro	5772 III SE	m d'après :
CARTE TOPOGRAPHIQUE — Echelle	1/25 .000 ème	
COORDONNEES (en km et mètres)	X (Ouest):	Y (Nord):

PLAN D'ACCES



Indiquer repères, distances et orientations.

APPAREILLAGES DE FORAGE UTILISES	DESCRIPTION DE L'ACCES
FAILING CF-15	PRENDRE LA ROUTE NLE NO 1 EN DIRECTION DE TITANYEN JUSTE A QUELQUES METRES
METHODE DE FORAGE	DE SOURCE PUANTE, TOURNER A GAUCHE
ROTATION CIRCULATION DIRECTE	SITE SITUE A 600M DE LA ROUTE NLE

OPERATIONS DE FORAGE ET DE CAPTAGE

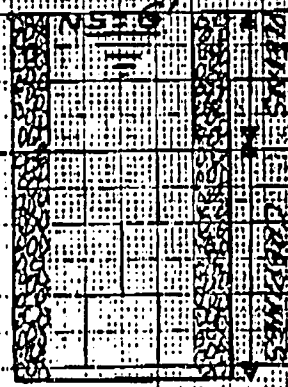
FORAGE — Diamètres successifs (mm)	250	
Cotes par rapport au sol (m) — de	0	
Cotes par rapport au sol (m) — à	20	
Longueurs (m)	20	
Outils de forage utilisés	DRAG BIT	
ALESAGES — Diamètres successifs (mm)		
Cotes par rapport au sol (m) — de		
Cotes par rapport au sol (m) — à		
Longueurs (m)		
Type d'aléseur utilisé		
TUBAGES — Caractéristiques	PVC SCH40	
Diamètres successifs (mm)	100	
Cotes par rapport au sol (m) — de	0	
Cotes par rapport au sol (m) — à	20	
Longueurs (m)	20	
CREPINES — Caractéristiques	FENTES	
Diamètres successifs (mm)	102	
Cotes par rapport au sol (m) — de	8	
Cotes par rapport au sol (m) — à	20	
Longueurs (m)	12	

ESPACE ANNULAIRE	Massif filtrant	Cimentation	Autres
Caractéristiques	GRAVIER ARRONDI	SOCLE EN BETON	BOUCHON SCELLE
Cotes par rapport au sol (m) — de			
Cotes par rapport au sol (m) — à			
Longueurs (m)			
Volumes (m3)			

DEVELOPPEMENT			
Méthode et appareillage	AIR LIFT COMPRESSEUR LEROY		
Durée totale (h)	2	Eau claire obtenue ?	OUI
Conductivité (ppm/ mhos.cm)	début	fin	
Débit (l/s) - méth.mesure			
Rabattement mesuré (m)			
Mesure remontée niv. eau ?			

AUTRES OPERATIONS	INCIDENTS
Carottage électr./mécan. an.granulo., traitements..	Ex:pertes de boue, d'outil, coincements...

Profondeur en mètres	N° IRE 4 — Coupe géologique	Observations (vitesse d'avancement, pertes de boue, venues d'eau, etc...)	Coupe technique	Profondeur en pieds
0–2	SABLE GROSSIER (Sand)			10
2–10	GRAVIER + ARGILE GRISE (Clay)			20, 30
10–15	GRAVIER + SABLE MOY.			40, 50
15–20	GRAVIER + ARGILE			60



Profondeur en mètres: 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30, 32, 34, 36, 38, 40, 42, 44, 46, 48, 50, 52, 54, 56, 58, 60, 62, 64, 66, 68, 70, 72, 74, 76, 78, 80, 82, 84, 86, 88, 90

Profondeur en pieds: 10, 20, 30, 40, 50, 60, 70, 80, 90, 100, 110, 120, 130, 140, 150, 160, 170, 180, 190, 200, 210, 220, 230, 240, 250, 260, 270, 280, 290

E T C H A

ÉTUDE ET TRAITEMENT EN CHIMIE APPLIQUÉE

RÉSULTATS D'ANALYSE DE L'EAU

Pour le compte de: HAÏTI FORATEC

\# Dossier: 4-1/160693-HF

ECHANTILLONS:	Puits 1	Puits 2	Puits 3	Puits 4
<u>ALCALINITÉ:</u>				
Hydroxyde (meq/l)	0	0	0	0
Carbonatée(meq/l)	4.4	4.0	2.0	0
Bicarbonatée(meq/l)	11.5	8.4	14.2	9.6
Totale(ppm CaCO3)	795	620	810	480
Calcium(ppm)	46	12	21	558
Magnésium(ppm)	54	8.69	9.2	472
Fer(ppm)	0>Fe<0.25	0<Fe<0.25	0<Fe<0.25	0<Fe<0.025
Manganèse(ppm)	____	____	____	____
Zinc(ppm)	0<Zn<0.25	Trace	0<Zn<0.25	Trace
Cuivre(ppm)	0<Cu<0.05	0<Cu<0.05	0<Cu<0.05	0<Cu<0.05
Chrome(ppm)	Trace	Trace	Trace	Trace
Chlore résiduel(ppm)	____	____	____	____
Oxygène dissout(ppm)	Trace	Trace	Trace	Trace

REMARQUES:

Les caractéristiques physico-chimiques de ces échantillons indiquent une pollution certaine de l'eau des puits: en plus de la turbidité, de la couleur, et de la salinité qui sont relativement élevées, la concentration en ions ammonium et la quantité négligeable d'oxygène dissout sont des indices particuliers de cette pollution. Il faut également souligner que l'eau de ces échantillons dégage une odeur nettement désagréable - (Dégradation de matières organiques) -

Il serait intéressant d'effectuer périodiquement d'autres analyses, afin de confirmer et de préciser ces résultats, et pour suivre l'évolution de cette pollution.

Il serait recommandé d'efffectuer une comparaison avec l'eau de quelques puits forrés dans la même zone

Port-au-Prince, Haïti, le 24 juin 1993

Joselyne Saint-Léger
Chimiste

E T C H A

ETUDE ET TRAITEMENT EN CHIMIE APPLIQUÉE

RESULTATS D'ANALYSE DE L'EAU

Pour le compte de: HAÏTI FORATEC

Dossier: 4-1/160693-HF

ÉCHANTILLONS:	Puits 1	Puits 2	Puits 3	Puits 4
Date de prélèvement	16/06/1993	16/06/1993	16/06/1993	16/06/1993
Date de réception	16/06/1993	16/06/1993	16/06/1993	16/06/1993
DETERMINATIONS				
A - ORGANOLEPTIQUES:				
Turbidité(°Formz.)	<500	<500	<500	<500
Couleur(°Pt)	100	80	30	30
Goût	Salé	+	Salé	Salé
Odeur	+	+	+	+
Tempé.(°C)-(Analyse)	29	29	29	29
B - PHYSICO-CHIMIQUES:				
pH	8.82	8.85	8.64	7.59
pHs	6.17	6.87	6.53	5.34
Conductivité(uOhm/cm)	5 630	1 240	2 640	16 820
TDS(ppm)	3 940	970	1 840	11 790
Nitrates(ppm)	Trace	Trace	Trace	Trace
Nitrites(ppm)	Trace	Trace	Trace	Trace
Ammonium(ppm)	4.3	0.3	0.5	15
Phosphates(ppm)	1.5	1.6	1.6	1.8
Chromate (ppm)	Trace	Trace	Trace	Trace
Cyanure(ppm)	0.08	0.05	0.05	0.02
Silice(ppm)	53	35	40	90
Sulfates(ppm)	1 670	73	350	1 938
Sulfure(ppm)	Trace	Trace	Trace	Trace
Fluor(ppm)	____	____	____	____
Chlorures(ppm)	1 630	128	390	13 372
NaCl(ppm)	2 690	211	644	22 064
DURETÉ:				
Totale(ppm CaCO3)	335	66	91	3 330
Carbonatée(ppm CaCO3)	335	66	91	480
Non Carbonatée(")	0	0	0	2 850

Port-au-Prince, Haïti, le 24 juin 1993

Josselyne Saint-Léger
Chimiste

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