STATEMENT OF BASIS/PROPOSED FINAL REMEDY DECISION
Area of Concern (AOC) #2

REGION II
VID 980536080

HOVENSA L. L. C.

Christiansted, St. Croix, USVI
February 14, 2008

Facility/Unit Type: **Active Petroleum Refinery**
Contaminants: **Dissolved-phase hydrocarbons**
Media: **AOC 2 - Areas where Dissolved-phase hydrocarbon (DPH) plumes are located (site-wide)**
Remedy: **Total Fluid Recovery, Vacuum Enhanced Recovery, Air Sparging and Monitored Natural Attenuation**

FACILITY DESCRIPTION

In 1999, in the renewed RCRA Part B Permit, the United States Environmental Protection Agency (EPA) designated several Areas of Concern (AOCs) for purposes of conducting corrective action for groundwater at HOVENSA. Area of Concern 2 includes areas where dissolved-phase hydrocarbon (DPH) exists. This Statement of Basis describes the status of the Area of Concern 2 areas at the site.

The HOVENSA refinery is situated on approximately 1,500 acres located on the south central coast of St. Croix. Oil refining, chemical processing, storage, and handling activities have been conducted at the site for over 40 years by HOVENSA and its predecessor HOVIC. During that time, process-derived wastes were managed in surface impoundments or treated in landfarms. Historic operations at the refinery, including storage and handling activities, have resulted in impacts to soil and groundwater.

St. Croix has a semi-arid tropical climate typical of Caribbean islands. The mean monthly temperature ranges from 76 to 82 degrees Fahrenheit. Annual rainfall averages 39 inches per year with a standard deviation of 13.5 inches per year. Most of the precipitation occurs during two seasonal periods, in May and June, and September through November.

In the area of the Refinery, limestone, lagoonal clay and fill compose the near surface lithologic units. In the northern portion of the facility, limestone predominates, while lagoonal clay overlain by fill material is common in the southern portion of the facility. The fill covers the majority of the site and is present as a thin layer in the northern portion of the Refinery. It occurs above the water table in most areas where the lagoonal clay is absent. Where the fill is absent, the Kingshill limestone constitutes the surface material.

The reported depth to groundwater ranges from 6 feet to over 100 feet across the site. Groundwater beneath the site is not potable and is not utilized for drinking or domestic purposes. In particular, the Kingshill limestone is characterized by high levels of sodium and chloride. The site abuts the Caribbean Sea along the south shoreline. In this area the shoreline is primarily used for shipping and commercial purposes.

The site is located in the Southern Industrial Complex and the shoreline near the HOVENSA facility is used as an industrial park. This is in accordance with the policies of the Virgin Islands Industrial Act of 1963. Light industrial zones are adjacent to the central heavy-industry area. Presently, most of the land surrounding the industrial area is characterized by unimproved shrub thickets and grasslands. Adjacent properties include industrial/commercial land with residential areas along the perimeter to the north and northeast.

Under the 1965 Agreement between the Virgin Islands Government and HOVIC, as amended, the use of the site as an oil refinery is deemed to comply with zoning and land use law. The Legislature and the Governor confirmed the use of the refinery site again in 1998 with approval of the creation of the joint venture between HOVIC and Petróleos de Venezuela S.A. (PDVSA) V.I. The long term use and the future of the site as a refinery are stipulated in the 1998 Amendment Agreement, which will remain in place ensuring use of the site as a refinery until year 2022.

PRIOR INVESTIGATIONS AND OTHER ACTIONS

In 1982, HOVIC discovered phase separated hydrocarbon (PSH) in the subsurface below the gasoline blending area. HOVIC conducted an initial investigation and began PSH delineation and recovery operations under its Hydrocarbon Recovery Project (HRP).

Since then, HOVIC/HOVENSA, in coordination with the United States Environmental Protection Agency (EPA), has implemented the Hydrocarbon Recovery Project as an Interim Corrective Measure (ICM) to mitigate the risk to the environment and human health arising from the presence of Phase Separated Hydrocarbon (PSH) on the groundwater table and the associated dissolved-phase hydrocarbon plumes in the groundwater, and to prevent those plumes from migrating into Limetree Bay, Krause Lagoon, or the Caribbean Sea. The goals of the ICM/HRP program are 1) Source Identification, 2) Containment, and 3) recovery of the Phase Separated Hydrocarbon and associated dissolved-phase hydrocarbon plumes. The program was incorporated into the RCRA Part B Permit in November 1, 1999, and is ongoing.

Also, as part of the ICM, investigations and evaluations have been performed to establish hydraulic control, such that any off-site migration of the PSH on the groundwater table and the associated dissolved-phase hydrocarbon plumes was stopped and existing plumes would be contained on-site at the facility. Further evaluations have been implemented as part of the Corrective Measures Study (CMS) required under the 1999 RCRA Permit, so as to identify all remaining areas of dissolved-phase hydrocarbon plumes requiring remedial measures, and to determine the proposed final remedy for those areas.

A Corrective Measures Study (CMS) has been performed for the AOCs at the site, and has been approved by EPA. The CMS identified 45 Potential Remedial Areas ("PRAs") within AOC #2, where dissolved organic or inorganic (metals) hazardous constituents were present in the groundwater at concentrations exceeding Risk Based Concentration/Action Levels. The 45 identified PRAs then underwent further evaluation to determine if, under current site usage, they posed an unacceptable risk to human health and/or the environment.

The evaluation included a tiered risk assessment to determine further action. Final tier site-specific evaluations used the industrial value for total carcinogenic risk of 1E-04 (1 in 10,000 chance of contracting cancer) in industrial areas, 1E-06 (1 in 1,000,000 chance of contracting cancer) in residential areas, and used a Hazard Quotient of 1.0 across both residential and industrial areas. Potential Remedial Areas (PRAs) determined to require further action from site-specific evaluations were selected as remedial action areas (RAAs). The final Corrective Measures Study report was approved by EPA on May 30, 2006. A total of 45 PRAs were identified for evaluation under the Corrective Measures Studies analyses for Area of Concern 2. Results of the analyses indicated that four of the 45 identified "Potential Remedial Areas" for AOC #2 pose potentially unacceptable risks under current site usage conditions, and are therefore classified as "Remedial Action Areas".

As a part of the Corrective Measures Study, an Ecological Risk Assessment was also conducted to evaluate whether unacceptable impacts to ecological receptors and/or the environment result from the Constituents of Potential Environmental Concern associated with Area of Concern 2. This Ecological Risk Assessment was approved by EPA on June 7, 2004. Results of this analysis were incorporated into the final Corrective Measures Study report for Area of Concern 2.

EXPOSURE PATHWAYS

Possible pathways for human exposure were evaluated for the dissolved-phase contaminants in the groundwater (Area of Concern #2) at HOVENSA. Potential exposure paths evaluated include via indoor air, outdoor air, groundwater, and tap water. Exposure via tap water was considered to not constitute a viable pathway, as groundwater is not used for "tap water" for either drinking or other domestic purposes (such as for washing) at, or down-gradient of, the HOVENSA facility.

Potential receptor populations include on-site residents, workers, construction workers and trespassers. However, trespasser exposure was determined to be precluded by physical access restrictions, including fencing and security. The potential exposure routes evaluated for on-site residents, workers, and construction workers include inhalation, ingestion, and direct/dermal contact; however, due to the depth of groundwater and excavation controls, inhalation (of volatile constituents) was determined to constitute the only complete exposure pathway. That exposure pathway was quantitatively evaluated in the Corrective Measures Study to determine the areas constituting the Remedial Action Areas (RAAs).

An Ecological Risk Assessment was also conducted as part of the Corrective Measures Study, and it determined that no unacceptable ecological impacts were indicated as a result of contaminants in the groundwater. Although the exposure pathway via discharge of contaminated groundwater to the adjacent surface waters for aquatic organisms and habitats is considered complete, no Constituents of Potential Environmental Concern (COPECs) were indicated to be present in the

surface waters at concentrations above accepted ecological benchmarks, in areas where groundwater discharge to surface water can occur. Potential pathways for terrestrial organism (such as crabs) exposure to COPECs in the groundwater via direct uptake and ingestion were evaluated. However, since the site is industrial and most of the refinery area is paved, incidental ingestion of soil by terrestrial organisms (such as crabs) and exposure to the COPEC constituents by higher organisms (such as birds) in the food chain are not considered significant pathways under current site usage conditions.

The Least Tern (*Sterna antillarum antillarum*), a locally listed endangered species, is the only endangered species indicated to inhabit the refinery property. However, other habitats are indicated to occur in the vicinity of the facility in the off-site areas. Threatened and endangered species listed for St. Croix near HOVENSA include eleven animal and 3 plant species as federal threatened or endangered species. Among these fourteen species, four species are threatened; they are green sea turtle (*Chelonia mydas*), loggerhead sea turtle (*Caretta caretta*), the least bittern (Lxobrychus exilis), and the roseate tern (*Sterna dougallii dougallii*). The remaining ten species are listed as endangered species; St. Croix ground lizard (*Ameiva polops*), brown pelican (*Pelecanus occidentalis*), peregrine falcon (*Falco peregrinus*), hawksbill sea turtle (*Eretmochelys imbricate*), leatherback sea turtle (*Dermochelys coriacea*), Caribbean monk seal (*Monachus tropicalis*), finback whale(*Balaenoptera physalus*), sperm whale (*Physeter catodon*), VI tree boa (Epicrates monensisgranti), and plants (specifically for St. Croix) including *Catesbaea melanocarp,* and Vahl's Boxwood (Buxus vahlii), and lignum vitae (Guajacum officinale). In addition to the federally listed plants, twelve species are locally listed for St. Croix. However, only one plant, Lignum vitae (Guajacum officinale) has been identified in the vicinity of HOVENSA.

CONTAMINATION DETECTED AND CLEANUP GOALS

Goals are presented for constituents that have been observed at the site and are indicated to potentially pose an unacceptable risk level from Corrective Measures Study and Corrective Measures Implementation evaluations. Other constituents have been determined not to pose an unacceptable risk at this time.

Media	Estimated volume	Contaminant	Maximum Detected Concentration* (mg/l)	Action Level** (mg/l)	Cleanup Goals***	Point of Compliance for Action Level or Cleanup Goal
Groundwater	None given	Chloroform	0.62	0.00016	No exceedance of CMS Risk Based Site-specific Target Level ("SSTL")	DISSOLVED CONSTITUENT NETWORK WELLS[2]
		1,2-Dichloroethane	0.0838	0.005	No exceedance of CMS Risk Based Site-specific Target Level ("SSTL")	DISSOLVED CONSTITUENT NETWORK WELLS[2]
		1,4-Dioxane	5.1	0.006	No exceedance of CMS Risk Based Site-specific Target Level ("SSTL")	DISSOLVED CONSTITUENT NETWORK WELLS[2]
		Benzenethiol	0.14	0.00006	No exceedance of CMS Risk Based Site-specific Target Level ("SSTL")	DISSOLVED CONSTITUENT NETWORK WELLS[2]

Media	Estimated volume	Contaminant	Maximum Detected Concentration* (mg/l)	Action Level** (mg/l)	Cleanup Goals***	Point of Compliance for Action Level or Cleanup Goal
		Bis(2-ethylhexyl)phthalate	0.048	0.0048	No exceedance of CMS Risk Based Site-specific Target Level ("SSTL")	DISSOLVED CONSTITUENT NETWORK WELLS[2]
		Benzene	456	0.005	between 6.4 mg/l in industrial areas; to 0.26 mg/l in on-site residential areas	See Tables 9.1 and 9.2 of Feb. 2008 CMI Work Plan
		Ethylbenzene	13.9	0.7	No exceedance of CMS Risk Based Site-specific Target Level ("SSTL")	DISSOLVED CONSTITUENT NETWORK WELLS[2]
		Toluene	129	1.0	No exceedance of CMS Risk Based Site-specific Target Level ("SSTL")	DISSOLVED CONSTITUENT NETWORK WELLS[2]
		Xylenes	145	10.0	between 50.7 mg/l in industrial areas; to 10.0 mg/l in site boundary areas.	See Tables 9.1 and 9.2 of Feb 2008 CMI Work Plan
		Naphthalene	1.06	0.0065	No exceedance of CMS Risk Based Site-specific Target Level ("SSTL")	DISSOLVED CONSTITUENT NETWORK WELLS[2]
		Vinyl Chloride	0.0396	0.002	No exceedance of CMS Risk Based Site-specific Target Level ("SSTL")	DISSOLVED CONSTITUENT NETWORK WELLS[2]
		Antimony	0.0682	0.006	None - NV[1]	DISSOLVED CONSTITUENT NETWORK WELLS[2]
		Arsenic	0.183	0.01	None - NV[1]	DISSOLVED CONSTITUENT NETWORK WELLS[2]
		Beryllium	0.0897	0.004	None - NV[1]	DISSOLVED CONSTITUENT NETWORK WELLS[2]
		Cadmium	0.0883	0.005	None - NV[1]	DISSOLVED CONSTITUENT NETWORK WELLS[2]

Media	Estimated volume	Contaminant	Maximum Detected Concentration* (mg/l)	Action Level** (mg/l)	Cleanup Goals***	Point of Compliance for Action Level or Cleanup Goal
		Cobalt	402	0.73	None - NV[1]	DISSOLVED CONSTITUENT NETWORK WELLS[2]
		Lead	0.27	0.015	None- NV[1]	DISSOLVED CONSTITUENT NETWORK WELLS[2]
		Mercury	0.0061	0.002	None - NV[1]	DISSOLVED CONSTITUENT NETWORK WELLS[2]
		Nickel	20.4	0.73	None - NV[1]	DISSOLVED CONSTITUENT NETWORK WELLS[2]
		Selenium	0.702	0.050	None - NV[1]	DISSOLVED CONSTITUENT NETWORK WELLS[2]
		Vanadium	2.48	0.256	None - NV[1]	DISSOLVED CONSTITUENT NETWORK WELLS[2]

* taken between August 1989 to December 2005
** Residential risk based concentration (RBC) - see Table 2.1 from February 2008 Corrective Measures Implementation Workplan .
*** for Remedial Action Area Clean-up goals - see Tables 9.1 and 9.2 from the February 2008 Corrective Measures Implementation Workplan. For CMS Risk Based Site-specific Target Levels ("SSTL") see Tables 5.67 through 5.77 of May 2006 Final Corrective Measures Study Report.
[1] NV – Not volatile (no complete exposure pathways)
[2] DISSOLVED CONSTITUENT NETWORK WELLS – per Condition III.A.4 of RCRA Permit

SELECTED REMEDY

The proposed remedies selected by the Corrective Measures Implementation (CMI) workplan to address dissolved-phase hydrocarbon constituents in the groundwater include: Total Fluids Recovery, Vacuum Enhanced Recovery , Air Sparging, and Monitored Natural Attenuation (MNA).

Total Fluids Recovery creates a cone of depression in the water table in order to induce a potentiometric gradient toward the extraction system and draw impacted groundwater towards the recovery well via a single down-hole pump. At the well, groundwater impacted with Dissolved-phase Hydrocarbon is extracted and pumped to the onsite treatment system. This technology is particularly applicable because it produces hydraulic control and containment of Dissolved-phase Hydrocarbon plumes. Total Fluid Recovery is primarily effective in high permeability areas.

Vacuum Enhanced Recovery uses one pump to recover vapor (From Phase Separated Hydrocarbon and Dissolved-phase Hydrocarbon), Phase Separated Hydrocarbon, and water. Vacuum Enhanced Recovery extracts Phase Separated Hydrocarbon from the water table and capillary fringe. In addition, Vacuum Enhanced Recovery acts to remediate Dissolved-phase Hydrocarbon and enhance bioremediation by drawing air through the unsaturated zone. Vacuum Enhanced Recovery is less effective in low permeability soils than in high permeability soils, but is likely more effective than TFR in low permeability areas.

Air sparging involves the reduction of petroleum constituent concentrations by injecting air into groundwater. Injected air moves both horizontally and vertically in the aquifer. This approach removes constituents dissolved in groundwater or adsorbed to aquifer material principally though volatilization. In addition, the air sparging adds oxygen to the aquifer promoting aerobic degradation.

These remedial technologies were indicated to be applicable at the site and have a proven track record of effectiveness as part of the Hydrocarbon Recovery

Project ICM. Total Fluid Recovery technologies are indicated to be effective for Dissolved-phase Hydrocarbon in areas where permeability is great enough to recover total fluids efficiently. Vacuum Enhanced Recovery is effective in both low permeability zones and areas with minimal fluid availability, as well as in areas of high permeability and high fluid availability. Vacuum Enhanced Recovery may also involve the use of Vacuum Trucks to supplement activities in localized areas.

Monitored Natural Attenuation encompasses all in situ processes within the aquifer that decrease dissolved concentrations, and must include an ongoing program for monitoring the concentrations of the dissolved hazardous constituents in the groundwater. The natural attenuation processes may include dilution, dispersion, volatilization, biodegradation, adsorption, and chemical interaction with aquifer materials. Of these natural processes, biodegradation is considered the most important for organic constituents dissolved in the groundwater at the HOVENSA site. Monitored Natural Attenuation at HOVENSA is considered a secondary remedy, while the cleanup goals are achieved primarily through active remediation systems, including Total Fluids Recovery, Vacuum Enhanced Recovery, and/or Air Sparging.

Currently, the identified Remedial Action Areas are undergoing remediation by using methods described above. These activities will be maintained until the clean-up criteria are satisfied, as discussed in the February 2008 Corrective Measures Implementation (CMI) work plan. In addition, groundwater monitoring will continue at the dissolved constituent monitoring well network around the perimeter of the HOVENSA facility, to confirm that should any unforeseen, future offsite migration of PSH and/or dissolved constituent plumes occur, it will be detected and addressed.

The costs to complete the corrective measures remedies associated with Areas of Concern 1, 2 & 3 at the HOVENSA Refinery is estimated to be $28,050,000 in present day costs. It is assumed that the site will remain an industrial facility for the next 30 years, and the final corrective measures remedies will be completed within the 30 year timeframe.

It should also be noted that the Remedial Action Areas and the recommended remedies and clean-up goals discussed in this Statement of Basis are based on current site-usage as an industrial facility. If the site ceases to be utilized as a petroleum refinery, additional corrective measures may be necessary to achieve an acceptable, i.e., unrestricted site clean-up.

INNOVATIVE TECHNOLOGIES CONSIDERED

Vacuum enhanced recovery, air sparging.

PUBLIC PARTICIPATION

A public meeting to discuss this proposed remedy decision is scheduled to be held on March 12, 2008 in St. Croix.

NEXT STEPS

Implement the February 2008 Corrective Measures Implementation Work Plan, and continue semiannual monitoring and reporting. Perform assessment of remedial operations for defined Remedial Action Areas on an annual basis to ensure continued progress towards the specified clean-up goals. Perform a review of the risk assessment every five years to determine if any conditions have changed warranting that a revised risk assessment be performed.

KEY WORDS
Groundwater, Dissolved-phase Hydrocarbon, Inhalation, Refinery, Organics, Monitoring, Recovery, Vacuum Enhanced Recovery, Air Sparging, Volatile organic Compounds, Area of Concern 2, AOC 2, Natural Attenuation

CONTACT
Timothy Gordon
U.S. Environmental Protection Agency (EPA), Region 2
Gordon.timothy@epa.gov
(212) 637-4167