Targeted Environmental Assessment Temporary Sewage Treatment System Caracol Industrial Park (PIC) Northern Haiti

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REPORT

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1.0 INTRODUCTION

This document is prepared at the request of the Inter-American Development Bank and details the findings of a Targeted Environmental Assessment (EA) of the second temporary Wastewater Treatment System (WWTP#2) at the Caracol Industrial Park (PIC) in northern Haiti.

The report was prepared based on a site visit to the Caracol Industrial Park (PIC) on 06 December 2013 and subsequent review of several documents received from the IDB and UTE who are directly responsible for the implementation of the project. The conclusions are based on the Consultants' experience, site reconnaissance, the review of published and available maps; engineering drainage designs; topographic maps of the site; elevation data from Google Earth for areas near the site; other public domain data and available technical documents.

1.1 Consultants' Understanding of the Project

The Consultants understand that a temporary sewage treatment system was constructed by the project team to treat the sewage generated from the PIC while the permanent sewage treatment system was under construction. The temporary system was built to a handle a capacity of 130 m^3 of effluent per day. The permanent sewage treatment plant should be commissioned by the end of the first quarter of 2014.

Consequent to the fact that expansion of industrial activities at the Caracol Industrial Park (PIC) occurred at a faster pace than the construction progress of the permanent wastewater treatment system it was necessary to build a second temporary system with capacity to support the additional workers anticipated by December 2013. The second temporary system was built with a capacity of 250m^3 per day. The IDB has however set a cap of 150 m^3 as the maximum quantity of wastewater to be treated by the second temporary system. The septic system consists of a settling tank and drainage field and will work concurrently with the first temporary system to treat daily approximately 260 m^3 of domestic and commercial effluent.

The scope of the assessment will not include any intensive fieldwork as some data are already available. Geotechnical studies which were undertaken at the location of the proposed permanent wastewater treatment plant which provide a soil profile and results of recent permeability tests are available for review. It is understood that where data are not readily available and additional fieldwork is necessary, this should be indicated in the assessment.

Objective of the Consultancy

The Inter-American Development Bank (IDB) as part of their evaluation process have initiated this tender to determine if the project was designed and constructed with due consideration of the environment. The EA will examine the nature and extent of the Project's direct and indirect environmental and social risks and impacts, environmental setting of the project and the mitigation and management measures designed in the Project.

Project Constraints

The consultancy is of short duration with a short turnaround time, given that the commissioning of the wastewater treatment system is conditional to the outcome of this EA and approval by the Bank. The Consultants performed limited onsite investigations as most baseline and background information was provided by the IDB. Where there are technical or other limitations in the data provided, these are identified and the required project deliverable appropriately qualified.

1.2 Scope of Works

The scope of works as provided by the IDB for the targeted environmental assessment of a septic system currently being constructed at the Caracol Industrial Park (PIC) in northern Haiti are outlined below.

This is a standard environmental (risk) assessment for an onsite wastewater treatment system. International best practice should be applied e.g. US-EPA standards for siting, etc. (as referenced below). The EA should address at a minimum the following aspects (for further information please reference Onsite Wastewater Treatment Systems Manual EPA/625/R-00/008) or other suitable standards:

1. Design conditions and system selection
2. Design conditions and system performance
    a. Wastewater source considerations
    b. Regulatory requirements
    c. Receiver site suitability
3. Design boundaries and boundary loadings
4. Evaluating the Receiving Environment
    a. Reconnaissance survey
    b. Detailed evaluation
    c. Soil Profile
    d. Infiltration rate and hydraulic conductivity
    e. Characterizing groundwater table
5. Operation and maintenance requirements including emergency/ contingency plans in the event of system failure. The preparation of the EA shall include a site visit to better contextualize the environmental conditions where the septic system is being constructed and the existing information that will be used to prepare the EA.

2.0 APPROACH

A Charette style approach will be employed to allow for inter-disciplinary discussion among members of the core team on the observations and findings of the respective reviews. The team will identify any gaps that exist in the data provided as well as areas that may require further investigation. The environmental assessment will include, but not be limited to the following:

1) Desk Review - Review of all available environmental documentation for the site, including topographical maps, hydrogeological studies, engineering/technical drawings and site photographs, drainage plans, environmental permits and licences, plans for mitigation and monitoring of impacts and risks, and construction monitoring records to date.
2) Site Reconnaissance - The USEPA standards for onsite wastewater treatment systems provided by the Client informed the conduct of the site inspection and review of key physical, biological and social parameters.
3) Reporting – A final environmental assessment report was prepared as the final output of the reviews and investigations performed.

Data Collation and Interpretation

The assessment is based on the review of submitted material and engineering reports plus public documents available on the internet relating to the PIC property and on-site wastewater systems. The data and other sources of information collected are listed in Table 1.

Assessment Methodology and limitations

The assessment has been undertaken primarily based on the conclusions and test results of others and as such the findings of this report are contingent upon their validity. These data have been reviewed and interpretations made in the report are derived from the reports and the site visit of 06 Dec 2013.

The subsurface data reviewed from the abstraction well and associated piezometer are for the permanent WWTP site just over 1km southwest of WWTP#2. The data were used to infer static groundwater depths and hydrogeological parameters at the WWTP#2 site, but may not adequately represent the conditions at that site.

Table 1.0: Document Review

Topic	Source of Information
Wastewater Treatment Systems	A Guide To The Development of On-Site Sanitation, © WHO, 1992 pdf; *Onsite Wastewater Treatment Systems Manual* EPA/625/R-00/008 pdf; National Environment And Planning Agency Wastewater And Sludge Regulations, Jamaica. Effects Of Septic Systems On Ground Water Quality - Baxter, Minnesota By Ground Water Monitoring And Assessment Program (GWMAP)pdf; EPA Septic Tank Siting to Minimise Microbial Contamination of Groundwater and EPA- The Class V Underground Injection Control Study, Large Capacity Systems, pdf.
Geology Solid and Surficial	Carte Geologique D'Haiti, Feuille Nord-Est: Cap-Haitien, 1:250,000 (1989); Annexe 3_3 Étude geotechnique.pdf; Preliminary Hydrological Assessment for the Development of an Industrial Park in Haiti (2011); resultados geotecnicos 2.pdf;
Hydrogeology	Rapport final forages au PIC 14 Sept 2011.pdf; Carte Hydrogeologique de la Republique d'Haiti, North United Nations, Carte Hydrogeologique de la Republique d'Haiti, North 1:250,000, (http://maps.nypl.org/relief/maps/58); Preliminary Hydrological Assessment for the Development of an Industrial Park in Haiti (2011); L'Evaluation Des Ressources D'Eau D'Haiti, L'aout (1999); IDBDOCS-#38068491-v1-

	Contrat__Signe_avec__Ingeneria_Estrella_pour_la_construction_d_une_fosse_septique_au_PIC_pdf; Environ PIC Rapid Hydrogeological Assessment_Final.pdf
Other Documents & Drawings	Contrat construction d'une fosse septique au PIC.pdf; Annexe 3_4 Étude d'inontabilité v 2 aout 13.pdf; Environmental Vulnerability in Haiti: Findings & Recommendations (2007); IDBDOCS-#38157903-v3-Memorandum_of_Findings__Wastewater_Management_at_the_PIC (2).doc; norma tecnica 7229_93 da ABNT.pdf; PARQ-IE11006-1-44DD-0001_R15.dwg; PEST-IEH3027(1)-42DD-1_R00 PLAN DE DETAILS, FERRAILLAGE ET SEMELLE DE LA FOSSE SEPTIQUE.dwg; PLANTA GRAL_02-10-13.dwg; PLANTA Y SECS_02-10-13.dwg; PreBoard Condition DRA (HA-L1081).docx; SISTEMA DE TRATAMIENTO DE AGUAS RESIDUALES.dwg; TDR Environmental Analysis Haiti HA-L1076.doc; Progress on Water and Sanitation Issues in ***National Water and Sanitation Directorate (DINEPA),*** *June 1st, 2012*

3.0 SITE & VICINITY GENERAL CHARACTERISTICS

Figure 1: Location Map of the Caracol Industrial Park in Caracol, Northern Haiti taken from Wikipedia.

The municipality of Caracol consisting of approximately 6300 residents is considered one of the poorest fishing villages in Haiti. *The village of Caracol is located about 3 kilometers to the north of the PIC and is situated near to Jacquezy to the east and Madrasse to the west and approximately 35 - 40 km southeast of Cap-Haitian.*

The Caracol Industrial Park, the PIC, was built in 2012 on a square mile, 600 acre, 246 hectare greenfield site near Carocol. The number of workers in the PIC at December 6, 2013 is estimated to be approximately 2800.

The PIC is as described in the Disaster Risk Assessment (DRA) document PIC-HA-L1081, situated in the plains between the northern massif and the Atlantic Ocean. The PIC site is essentially flat with an elevation varying between 8 and 13 meters above sea level with a general slope of less than 0.5 percent toward the river. The site is bisected by the Trou-du-Nord River bordered by riparian vegetation; the river is believed to experience seasonal floods inundating its riparian habitats. The river empties into the Caracol Bay approximately 4 km downstream. There is a relationship between surface water, groundwater and the Caracol Bay, the extent of which has yet to be understood and will require further analysis. [Disaster Risk Assessment (DRA) document PIC-HA-L1081].

4.0 LEGISLATIVE FRAMEWORK

There are no clear wastewater legislations and regulations in Haiti governing the design, construction and operation of wastewater treatment facilities. The government implementing agency for the project the UTE located in the Ministry of Finance, utilize available international multilateral donor guidelines for wastewater quality parameters, namely, the IFC General EHS Guidelines, Section 1.3 Environmental: Wastewater and Ambient Water Quality. For the WTTP#2, the standards followed were those of the NBR 7229.
Literature research online identified the National Water and Sanitation Directorate (DINEPA) which was created in 2009 through the merger of several other agencies. The mandate of the DINEPA is to execute the government guidelines in the Water and Sanitation (WatSan) sector in the following areas:

- Development of the WatSan sector nationally
- Regulation of the WatSan sector
- Monitoring of stakeholders involved in the WatSan sector

The IDB assists DINEPA by administering a fund of the Spanish Agency for Development Corporations; there are several IDB projects in the water and sanitation sector being executed. The DINEPA is also currently assisted by the US Center for Disease Control (CDC) in capacity building. The CDC currently provides technical assistance to DINEPA in the following projects:

- Expansion of the Environmental Monitoring and Response in Port-au-Prince
- Development of a Household Water Treatment National Strategy to regular and promote this sector
- Development of DINEPA's Hygiene Promotion Strategy
- Workforce capacity at DINEPA by helping DINEPA to develop the training materials and funding part of the program.

5.0 DESIGN CONDITIONS AND SYSTEM SELECTION

The United States Environmental Protection Agency (EPA) Onsite Wastewater Treatment System (OWTS) Manual indicates that designs may vary according to the site and wastewater characteristics encountered. However, all designs should strive to incorporate the following basic requirements to achieve satisfactory long-term performance:

- Shallow placement of the infiltration surface (< 0.7m below final grade)
- Organic loading comparable to that of septic tank effluent at its recommended hydraulic loading rate

- Trench orientation parallel to surface contours
- Narrow trenches (< 1m wide)
- Timed dosing with peak flow storage
- Uniform application of wastewater over the infiltration surface
- Multiple cells to provide periodic resting, standby capacity, and space for future repairs or replacement

The location and setting of the site may result in the design engineer making some compromise based on a risk assessment. All effort should however be made to include as many of the basic requirements listed above to ensure system efficiency and performance with minimal impact on environmental health.

The waste water treatment option selected for the second temporary wastewater treatment plant (WWTP#2) is consistent with the practice for provisional sewage treatment. If the system selected is designed according to the above EPA minimum standards with due consideration for the environmental setting of the PIC, it should be appropriate for the identified purpose and period of operation.

The Septic system designed and built is specifically for short term use, possibly up to May 2014 and not for 'long term performance'. The Consultants took this information into consideration when reviewing the available project information and during their onsite investigation of the plant. Some deficiencies in the design and siting of WWTP#2 were identified. These are discussed in the following sections of the report.

5.1 WWTP#2 Design Criteria

A comparison of the EPA Onsite Wastewater Treatment System (OWTS) requirements with the design criteria for the WWTP#2 is given in the following sections.

1. Design population: 5,000 people
2. Design flows – (Q_p); 150 m^3/day
3. Loading Rate for Drainage gallery – 78 l/m^2/day

The EPA Onsite Manual specifies that:

- Septic Tank
    - A theoretical tank volume of 2 – 3 times the design daily flow is common for small septic tanks
    - Volume (V) = 1,125 + 0.75Q for large septic tanks between (6 and 57m^3) or (1,500 and 15,000
      gallons)
    - Multiple compartments preferred
- Tile Field
    - Loading Rate of 30 – 50 l/m^2/day

The actual designs/operational benchmark differ somewhat, with:

- Septic Tank
    - 250 m^3 divided into two parallel modules
    - Four compartments in series per module
- Tile Field
    - Loading Rate: 78 $l/m^2/day$ (based on 150 m^3/day volume)

5.1.1 The Septic Tank

The septic tank has been designed to 250 m^3 but will be effectively handling 150 m^3 of wastewater from the PIC. The ceiling of 150 m^3 allows the system to be closer aligned to the EPA guidance which suggests for improved performance the septic tank should be about 2-3 times the daily flow (for smaller tanks e.g. for single households). Where larger tanks are used (flows (Q) between 6 and 57m^3/day), the EPA Manual states that the septic tank volume (V) is calculated from; $V = 1,125 + 0.75Q$. There is no guidance related to septic tanks larger than 57m^3. In this case the use of the full volume does provide for a larger septic tank and the larger overall size is better, but the configuration of the 150 m^3 (40,000 gallons) is important.

The flow to the plant at the cap of 150 m^3 is therefore more than twice the maximum volume referenced in the design manual. This septic tank has been designed with two modules of equal capacity, which would be approximately 108 m^3 in each module. The contract states two or more compartments in series and whereas the two modules that are used do not violate any stated specification, four modules would have resulted in each module being below the maximum stated capacity, 57 m^3, in the EPA Manual. The use of multiple modules also reduces the flow rate through the septic tank which improves the treatment. Each module is correctly comprised of multiple compartments; best practice for septic tanks has two or more compartments. Admittedly the flow through the tank at 150 m^3/day will result in a greater retention time compared with that of 250 m^3. **The Consultants support conformance with the established cap of 150m^3 as above this volume the system moves further out of the realm of best practice for septic system designs.**

5.1.2 The Design Loading Rates

The loading rate of a drainage gallery is dependent upon the percolation rate of the soil. The percolation rate was determined by tests done near to and not on the location of the tile fields. It seems from the comments that the percolation rates varied significantly across the site. A single test was done at the actual location of the drainage gallery and while this showed good percolation a single test for a site this large was insufficient. The three excavations showed sandy soil down to the invert level of the drainage gallery as would have been seen during the excavation for the construction.

The recommended application rate for the identified soil and percolation rate is 30-50 $l/m^2/day$ and the applied design rate is an average of 78 $l/m^2/day$, approximately 60% higher than the upper recommended application limit. The justification for this accelerated volume is likely that the clogging of the base of the drainage gallery will not occur in the projected 6 months life of this system.

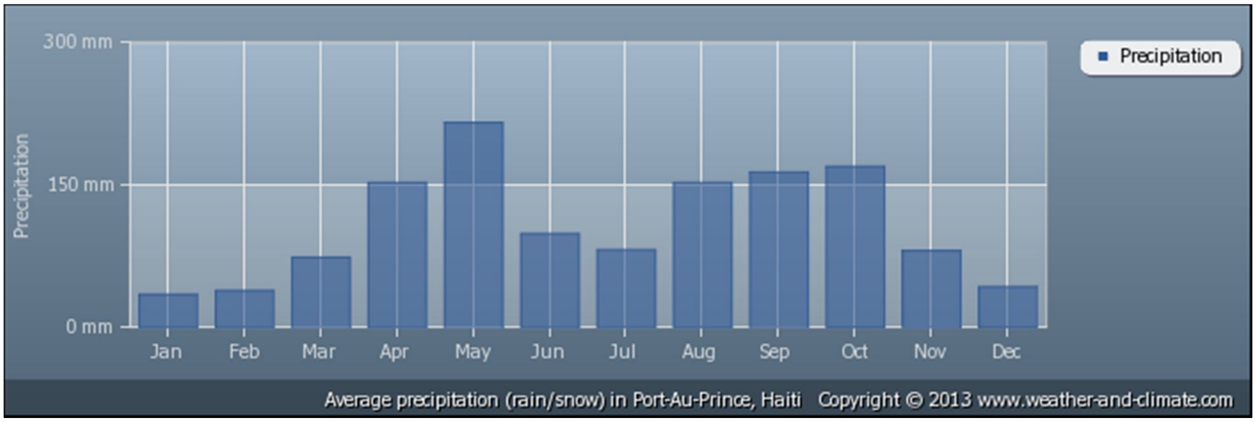
There is potential risk for overloading of the drainage gallery based on the following:

i. The percolation rate is based on limited testing
ii. At the higher application rate the accumulation of particulates on the base will be faster and the rate of percolation through the base will eventually slow down
iii. The actual volume of sewage is based on an estimated per capita rate and an estimated number of workers, it is possible to have a higher flow rate even with the established cap.
iv. Some of the literature describes saturation of the soil at the site and therefore during rainy periods infiltration may be inadequate.
v. In the dry period rapid percolation is not necessarily good as the soil provides some treatment but this is reduced if percolation is rapid.

5.1.3 Drainage Field Design

The design of septic systems is predicated on the fact that the septic tank and disposal system will only provide partial treatment. The ability of underlying soil in the drainage field to provide further attenuation of contaminants is therefore a critical consideration. Thus to effectively treat discharged effluent, the soil must have sufficient permeability and drainage characteristics to allow the effluent to infiltrate through the soil matrix. This allows further chemical processes to take place in order to remove pollutants such as nutrients. The soil must also contain sufficient ion exchange properties to permit the adsorption of microorganisms.
The design detail, as observed in the as built drawings, shows the designers opted for a bed system (single large excavation) than a trench system (each pipe laid in its own trench) both of which are acceptable however, in the bed system percolation is dependent almost solely on the base of the bed. In the trench system surface clogging and resultant loss of infiltrative capacity are less. The unsaturated zone below a wide surface due to the low oxygen diffusion rates very rapidly becomes anaerobic. Trenches will therefore perform better than beds, with narrower trenches (0.3 – 1.3 m) preferred [EPA OSWTS]. At the PIC the use of trenches instead of the four drainage beds would have been a more appropriate solution although it requires more surface area.

The flooding potential at this site is unknown. The two existing flood risk studies reviewed have conflicting conclusions. The Consultants are aware of another study that is being undertaken by the IDB however the findings will not be ready before June of 2014. How the system will behave during periods of heavy rainfall is unknown. The period November to March is usually a dry period in this part of the Caribbean with January and February having the lowest rainfall, however if the new permanent treatment system is not ready by March, 2014, one of the wet seasons begins in April and extends into June and the start of the hurricane season.



The performance of the system in such conditions is highly uncertain. This compounded by the signs onsite of restricted percolation in the immediate vicinity of infiltration pond for WWTP#1 and WWTP#2. The consultants therefore recommend the application of caution in the use of the system. The established cap of 150 m^3 for the WWTP#2 should therefore not be exceeded as the plant as designed is already at its maximum capacity at the drainage field.

The site geology and hydrogeology is discussed in greater detail in the following sections.

6.0 EVALUATING THE RECEIVING ENVIRONMENT

6.1 Geology & Hydrogeology of the Receiving Environment

6.1.1 Geology

The geology at the site is largely Quaternary Alluvium deposits from the Riviere Trou du Nord whose head-waters originates in the Cretaceous granodiorite massifs to the south. The geological map in Figure 2 shows the existing geology with the approximate site location. Alluvium consists of typically, gravels, sands, silty sands, clays and organic matter.

The on-site tests suggest that the upper 3m of the alluvium at the PIC consists of alternating layers of sandy clay loam, silty sand to gravelly sility clay with zones of high plastic clay between 1-2m below ground. This variability is typical of alluvial systems.

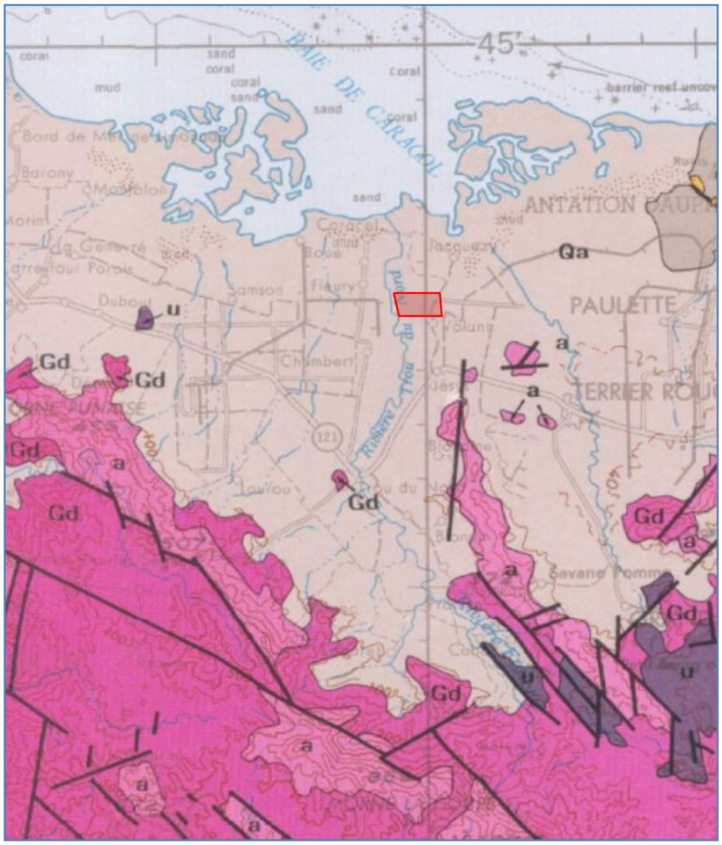


Figure 2 - Geology Map Showing Location of PIC (Red Polygon)

Table 2 below summarises the geology based on the seven manual wells undertaken by the Laboratoire National du Batiment et des Travaux Publics (LNBTP) at the PIC in April 2013. No groundwater was detected at manual well locations during this study.

TABLE 2 - SUMMARY OF SITE GEOLOGY IN THE UPPER 5M AT THE PIC (LNBTP, APRIL 2013). LOCATIONS OF THESE MANUAL WELLS ARE UNCERTAIN.

Well	Depth (m)	Thickness (m)	Geotechnical Description
P1	0.00 to 0.80	0.80	Sandy clay loam
	0.80 to 1.50	0.70	Little plastic silty clay
	1.50 to 3.00	1.50	Highly plastic clay
P2	0.06 to 0.60	0.60	Silty Sand
	0.60 to 1.60	1.00	Little plastic silty clay
	1.60 to 3.00	1.40	Little plastic silty clay
P3	0.00 to 0.70	0.70	Gravelly Silty Clay
	0.70 to 1.50	0.80	Silty Sand
	1.50 to 3.00	1.50	Clayey Sand

	Depth (m)	Thickness (m)	Geotechnical Description
P4	0.00 to 0.50	0.50	Silty Clay
	0.50 to 1.10	0.60	Sandy clay loam
	1.10 to 3.00	1.90	Highly plastic clay
P5	0.00 to 0.90	0.90	Silty Clay
	0.90 to 1.30	0.40	Silty Sand
	1.30 to 3.00	1.70	Clay loam
P6	0.00 to 0.90	0.90	Sandy clay loam
	0.90 to 3.00	2.10	Silty Clay
P7	0.00 to 1.40	1.40	Silty Clay
	1.40 to 2.00	0.60	Silty Sand
	2.00 to 3.00	1.00	Highly plastic clay

During the site reconnaissance on December 06, 2013 the surface soil encountered at the WWTP indicated a soil with moderate to large clay content at surface and extending to at least 3 m below soil surface as evidenced by the mechanical trial pit at WP13 (see Figure 3 and 4 below). Water was added into WP13 and the level of seepage observed. This was not a percolation test done to specifications, but simply an on-site observation of the behavior of introduced water on the soils in the unsaturated zone near the WWTP. Another trial pit WP14, advanced to approximately the same depth, 50 m to the south-west of WP13, and adjacent to the drainage field, penetrated silty clays, with silty clayey sand at the base (Figure 4). No water was introduced into this trial pit.

What is clear from these two tests is that sub-surface variability is quite significant across very short lateral distances. It further demonstrates the significance of the nature of the subsoils that lie at the base of each drainage gallery as their performance will depend largely on the ability of the soils beneath the drainage gallery to accept the generated effluent. The performance of the entire drainage gallery will be completely dependent on the receiving soils beneath each drainage gallery and less so on the granular backfill surrounding the perforated pipes. Consequently, the percolation tests done at the site should have been located within the boundaries of the existing four drainage galleries and tests constructed and tested no differently than how the excavation for the drainage gallery would be constructed. It should be pointed out that smearing of the soil surface during digging may cause artificially slow percolation rates.

The movement of subsurface aqueous contaminant plumes is controlled largely by soil type, soil layering, underlying geology, topography, and incident rainfall. The shape of the plume will depend on the soil and geological factors noted above, the uniformity of effluent distribution, the orientation of the WWTP with respect to principal groundwater flow and direction and the preferential flow that occurs in the unsaturated zone in pathways of higher permeability.

Figure 3 - Trial Pits: WP13 (Left) and WP14 (Right). No Groundwater Was Encountered In The Trial Pits.

FIGURE 4 - TRIAL PIT LOCATIONS ON 06 DEC 2013 (WP13 AND WP14). THE LOCATION OF THE WWTP#2 IS ALSO SHOWN BASED ON DRAWINGS SUBMITTED.

6.1.2 Hydrogeology

Earlier in September 2011 a hydrogeological investigation to inform the construction of a groundwater production well to supply the PIC was undertaken by Foratech Environment, SA. The production well and its adjacent peizometers were installed approximately 380m south-west of the proposed WWTP#2 and on the western side of the Riviere Trou du Nord. The ground elevation at those locations was recorded at 16m above sea-level and static groundwater level before pumping was recorded between 5.18m and 5.21m below ground surface at the piezometer locations P1 and P2 respectively (see Figure 5 below). Based on this it is likely that the static groundwater level at the proposed WWTP#2 on the eastern side of the river is likely to be within the same general depth of 5m below ground surface.

The preliminary hydrological assessment of the PIC report done by Environ Int'l Corp, indicate that there is a baseflow component to the Riviere Trou du Nord being contributed by groundwater and this was calculated at 0.57 m^3/s (50 L/s). Aquifer permeability was determined to be $1x10^{-3}$m/s at the production well.

Permeability tests done by the LNBTP in August 2013 within the upper 3m of the PIC site are listed below:

Table 3: Percolation/Permeability Tests done at the PIC, Locations Uncertain taken From LNBTP August 2013 Report

Test Location	Permeability Result (cm/s) [m/s]
PE1	$0.25x10^{-3}$ [$2.5x10^{-6}$]
PE2	$0.16x10^{-3}$ [$1.6x10^{-6}$]
PE3	$0.96x10^{-4}$ [$9.6x10^{-7}$]
PE4	$0.18x10^{-3}$ [$1.8x10^{-6}$]
PE5	$0.25x10^{-3}$ [$2.5x10^{-6}$]
PE6	$0.31x10^{-3}$ [$3.1x10^{-6}$]
AVERAGE	0.000208cm/s [$2.08x10^{-6}$]

The permeability results from these percolation tests are quite similar to that expected of the type of soils described by all the geotechnical reports reviewed by the consultants. Typically, for silty or clayey sands the permeability ranges between 10^{-6} to 10^{-9} m/s. The values as determined at the site are at the higher end of this range and suggestive of slightly permeable soils with zones for lower permeability as clay content increases.

Typically, the determining factor for drainage galleries is the surrounding soil's ability to accept water, not the pipe's ability to deliver water. From the drawings received the drainage gallery has several parallel 3" diameter perforated pipes installed across four (4) separate drainage galleries. Although the perforations, approximately 24 perforations per foot of pipe, in the pipe determine the allowable area at which the effluent can be released, it is ultimately the soil's ability to accept the effluent that is the determining factor in designing the WWTP drainage gallery.

A quick scoping exercise, considering a 75mm (3") diameter pipe installed in very permeable backfill envelope (permeability of 1"-2" granular backfill envelope estimated, K=1,000m/d=0.12 m/s=1.2cm/s) and groundwater 2m beneath the base of the perforated pipe. All similar conditions to that obtained from the site reports and drawings at the PIC. The 75mm (3") diameter pipe has approximately 24, 9.6mm (3/8") diameter holes per 31cm (foot) of pipe. Assuming that the pipe is full the rate of outfall from the pipe, Q_{pipe}, will be approximately 0.81 litres/s (12.8 gals/min) per 31cm (foot) of pipe. Using Darcy's Law to evaluate the flow thorough the receiving in-situ soil from the average of the permeability results from the site of 0.000208cm/s: Q_{soil}=3.68x10^{-6} liters/s (or 0.00006 gals/min) per 31 cm (foot) of soil along the pipe.

From this scoping calculation it is clear that the capacity of the receiving soils is at least five orders of magnitude less than the pipe full outflow per 31 cm (foot) of perforated pipe, i.e. $Q_{soil} << Q_{pipe}$. This exercise shows that the flow rate through the receiving soils is much less than the flow rate through the pipe perforations. It is important to note that any perforated pipe can only discharge water at the rate at which the surrounding soil will accept it.

The WWTP#2 drainage galleries will rely on the unsaturated zone for final polishing of the effluent before it enters the static groundwater beneath the site. Typically as the effluent enters the unsaturated zone at the base of the drainage galleries a biomat forms at this interface, most of the physical, chemical and biological treatment occurs in this biomat zone and the unsaturated zone above standing groundwater. This biomat zone becomes in effect a transitional zone where fluid flow changes from saturated (just above the biomat) to unsaturated flow (insitu soils beneath the biomat).

Based on the parameters derived from the other reports the time taken for effluent to travel from the base of the drainage galleries to arrive at groundwater under vertical migration occurs within as little as ten (10) days to as long as three (3) months depending on the vertical heterogeneity of the subsurface and the hydraulic gradient driving the flow and incident rainfall. In the unsaturated zone the effluent is under negative pressure resulting in capillary action and adsorptive forces occurring in the soil matrix. This is the most critical fluid transport zone because the air in the unsaturated zone allows the supply of oxygen to the microbes that grow on the surface of the soil particles. It is this

aerobic biological decomposition in the biomat and the unsaturated zone beneath that remove more than 90% of the BOD and suspended solids and 99% of the bacteria in normal subsurface infiltration systems.

However, if the soil is not able to accept the effluent flow then a "perched" saturated zone will occur above and just below the biomat leading to the occlusion of entrained air reaching deeper into the unsaturated zone and with time the effluent will become more and more anaerobic as the entrained oxygen is consumed by the microbes. This will lead to slower polishing of the effluent and more probable that a contaminant plume with higher contaminant concentrations arriving at standing groundwater than originally anticipated by the WWTP design.

On entering groundwater mixing is usually limited because groundwater flow is considered to be laminar and as such the plume can remain as a distinct body at the groundwater interface for some distance from the source. Using the permeability derived from the production pump tests, groundwater flowing to the river as base-flow could take from one (1) year up to thirty one (31) years to reach the river 300m away depending on the aquifer hydraulic gradient driving groundwater flow beneath the WWTP site. However, there is a risk of an accelerated flow path to the river by groundwater due to an increased hydraulic head caused by recharge from precipitation likely during the rainy season. This risk would be low during the dry season but may increase during the wet season and torrential downpours that last over three (3) days.

Figure 5 – Location of Production Well at the PIC in Relation to the WWTP 1km to the North-East. The Well is Approximately 380m from the Bank of the Riviere Trou Du Nord.

6.2 OBSERVATIONS ON SITE

The following observations were made during the onsite reconnaissance visit to the PIC on December 6, 2013.

A brief site walkover through areas that allowed foot-traffic was carried out on 06 December 2013 to confirm the engineering designs, environmental setting, hydrogeological environment, identify any surface water features, dominant soil types and other land use characteristics likely to influence hydrogeological processes.

The Consultants were first taken to the site of the first temporary wastewater (WWTP#1) treatment plant which is proximate and provides access to the site of the second temporary wastewater treatment system. The Scope of Works for the current assignment does not include a review of the operations of the WWTP#1, however the Consultants in recognizing that both temporary plants will be jointly operated to handle the wastewater generated at the PIC conducted a surficial review of WWTP#1. The monitoring plan and current monitoring data for WWTP#2 were not evaluated. The evaluation was limited to the visual conditions on site and the operational status of the plant.

At the time of the Consultant's visit WWTP#1 did not appear to be in operation. There was no apparent flow through the system and the mechanical parts were not running. Information provided by the IDB team on site suggested that the bacterial loading were at times noncompliant with USEPA sewage effluent standards likely due to the method used for chlorination.

Significant ponding was observed in the vicinity of both WWTP#1 and WWTP#2. Several stagnant surface ponds (Figures 6 - 12) of liquid were observed just west of the existing infiltration basin and extending approximately 100m east inside the north perimeter concrete wall. The source of the surface water/liquid was diverted treated effluent from the infiltration pond for WWTP #1.

Ponding was observed in four main areas:

1. Area of land between WWTP #1 and the associated infiltration pond (Figure 6)
2. Driveway between pond and perimeter wall (Figure 8)
3. Area of land adjacent to pond and inside the PIC perimeter fence (Figure 9)
4. Farm on neighboring property outside the PIC perimeter (Figure 10)

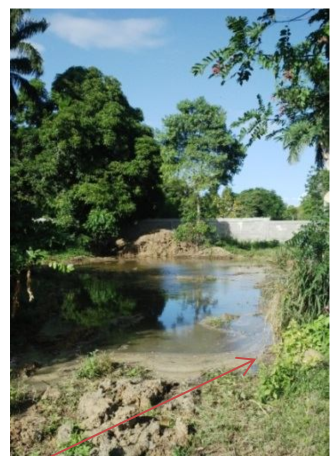


Figure 6: Showing ponding on land between pond and plant

Figure 7: Showing infiltration pond with fresh soil at edges

Figure 8: Ponding in the area of the driveway

Figure 9: Ponding inside of the PIC perimeter wall

Figure 10: showing ponding outside PIC perimeter fence

The evidence presented at the site suggested that these ponds inside the boundary wall have been present for at least a few continuous days to possibly weeks as the vegetation adjacent the ponds was verdant and lush. Further, evidence outside the northern boundary wall of the PIC suggests that the seepage there (Figure 10) has persisted for some considerable period of time. The seepage is limited to the areas in close proximity to the existing holding ponds and proposed WWTP drainage gallery. Based on the above evaluation, the capacity of the receiving soils to accept discharged water is likely to be exceeded and as a consequence the likely creation of a perched saturated zone above the pond/insitu soil zone. The possible explanation for the ponding/seepage at surface probably is likely caused by a laterally expanding perched groundwater mound emanating from the clarifying basin. As the water slowly percolates from the infiltration pond it creates a subsurface perched groundwater mound around the pond that will expand laterally as downward percolation is restricted.

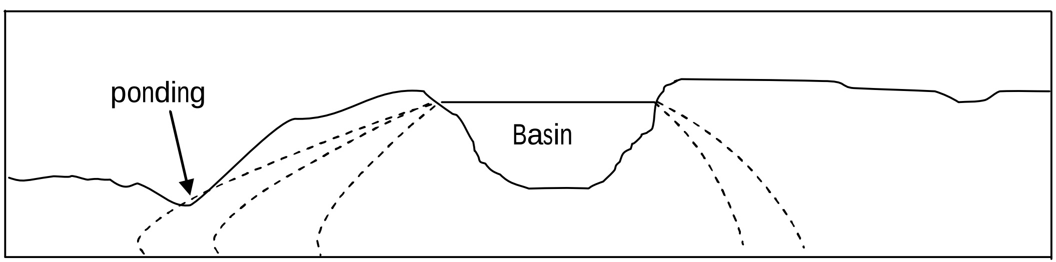


Figure 11 - Schematic Representation Of Possible Cause For Seepage North Of Clarifying Basin As The Perched Groundwater Envelope Expands From The Pond Intersects Ground Surface

As the perched groundwater mound expands from the pond and it intersects with any ground surface lower than the expanding mound the surface will become saturated and eventually surface ponding will occur. As the principal direction of subsurface flow would most likely be to the north, the presence of the ponds and surface seepage along the northern wall fits with this lateral expansion of the perched groundwater mound adjacent the infiltration basin. Figure 11 explains diagrammatically what is possibly occurring at the site. As more and more effluent is released to the infiltration pond and as downward percolation is restricted the pond will over-top occasionally and flow at surface and fill any low lying depressions as well. This is also likely to have occurred at the PIC.

Figure 12 - Observed surface ponding north of WWTP site on 06 December 2013. Photographs to the right of main image show images taken inside the PIC perimeter fence (bottom right image) and outside (top right image).

6.2.3 The Second Temporary Wastewater Treatment Plant (WWTP#2)

The second wastewater treatment plant had recently been completed and was being tested by the contractors Estrella at the time of the site visit. The test was not occurring as planned as the water used to fill the system was observed in seven (7) of the eight compartments. One compartment was empty.

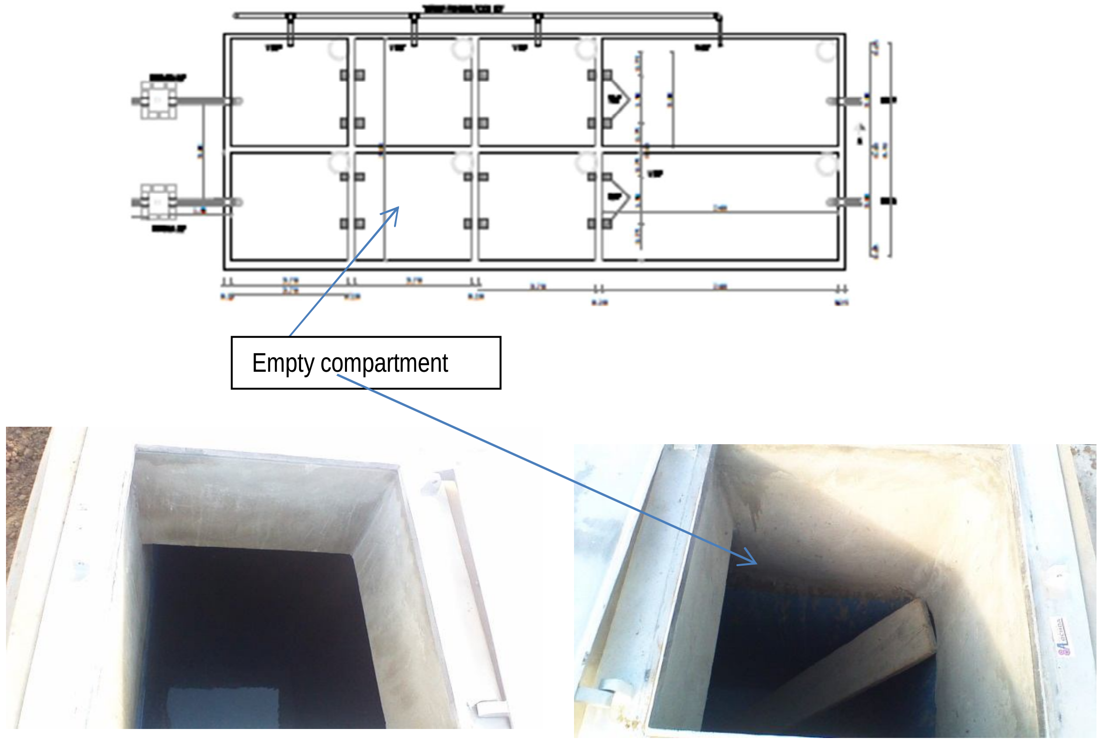


Figure 13: Septic tank at WWTP#2 with unfilled compartment

Figure 14: Showing completed drainage gallery viewed from the septic tank at WWTP#2

Figure 15: Views of the Septic Tank and Drainage Field at WWTP#2 during construction (IDB)

The drainage gallery site was very dusty, with significant amount of fugitive dusts. The workers on site were using their handkerchiefs to protect themselves from inhaling the particulates. The Consultant recommends wetting of the site to reduce fugitive dust levels. Workers should be provided with the necessary personal protective gear such as dust masks.

7.0 IMPACT ASSESSMENT AND MITIGATION

This section presents both a qualitative and quantitative analysis of the significant impacts as they pertain to the location, design, construct and environmental setting of the proposed WWTP#2. This analysis is detailed in Table 4 below.

The definition of the timeframe used in the table are provided as follows:

- Short term – during the life of the project (that is within three to six months)
- Medium term – beyond the life of the project (over six months) unless conditions change significantly during the life of the project
- Long Term – beyond the life of the project (over 12months)

Table 4 – Impact Matrix for WWTP#2 at the PIC, Haiti

Key issues	Potential Positive (P) or Adverse (A) Impact for the second temporary wastewater treatment plant (WWTP#2)
	WWTP#2 Design Considerations
Septic Tank	Septic tank design does not fully conform to the specifications of the EPA Onsite wastewater Treatment Standard. Nor standard practice in Jamaica. **Ranking: Adverse Impact long term** Mitigation: Impact does not require a system redesign/reconstruct. An effective daily maintenance programme is required to ensure the system operates optimally (see recommendations in Section 9.0).
Application rate	The recommended application rate for the identified soil and percolation rate is 30-50 l/m^2/day and the applied design rate is an average of 78/m^2/day, one and a half times the recommended rate. There is potential risk for overloading of the drainage gallery. At the higher application rate the accumulation of particulates on the base will be faster and the rate of percolation through the base will slow down. Some of the literature describes saturation of the soil at the site and therefore during rainy periods infiltration will be inadequate. In the dry period rapid percolation is not necessarily good as the soil provides some treatment but this is reduced if percolation is rapid. **Ranking: Adverse Impact medium to long term** Mitigation: 1. The use of the system should be limited to six months ***unless further onsite investigations prove the system is operating effectively over the short to medium term and there is no hindrance to percolation.*** 2. A soakaway pit could be added onsite to provide for any overflows. 3. Use of an effluent filter. 4 Chlorinate the effluent as a precaution since it is a well-known fact that septic systems do not treat pathogens. In the event that the drainage gallery is not functional the untreated pathogens will present a public health risk. 5. Strict monitoring of ground water levels.

Key issues	Potential Positive (P) or Adverse (A) Impact for the second temporary wastewater treatment plant (WWTP#2)
Drainage Gallery	The as built drawings show the designers opted for a bed system (four galleries) rather than a trench system (each pipe laid in its own trench) both of which are acceptable, however in the bed system percolation is dependent almost solely on the base of the bed. In the trench system surface clogging and resultant loss of infiltrative capacity are less. Trenches will therefore perform better than beds, with narrower trenches (0.3 – 1.3m) preferred [EPA OSWTS]. At the PIC the use of trenches instead of the four drainage beds would have been a more appropriate solution although it requires more surface area. **Ranking: Adverse Impact medium to long-term**. Mitigation: 1. The use of the system should be limited to six months ***unless further onsite investigations prove the system is operating effectively over the short to medium term and there is no hindrance to percolation.*** 2. A soakaway pit could be added onsite to provide for any overflows. 3. Use of an effluent filter. 4 Chlorinate the effluent as a precaution since it is a well-known fact that septic systems do not treat pathogens. In the event that the drainage gallery is not functional the untreated pathogens will present a public health risk. 5. Strict monitoring of ground water levels.
	Hydrogeological Issues
WWTP/natural soil interface	The proposed hydraulic loading design of the WWTP#2 is 30-50 litres/m^2/day. This hydraulic loading will exceed the infiltration capacity of the soils at the site based on the reports reviewed. The soils existing at the site are laterally and vertically heterogeneous and can be considered a fine sandy loam to fine sand with layers of silty clay and zones of high plastic clay. From the tests done by LNBTP the soils receiving capacity is unlikely to exceed 8-25 liters/m^2/day based on Tyler 2000[1]. At the stated loading rate the soil capacity will be exceeded leading to possible system failure. **Ranking: Adverse Impact and long-term**. Mitigation: If redesign to take into consideration a lower

[1] USEPA Onsite Wastewater Treatment Manual, p172

Key issues	Potential Positive (P) or Adverse (A) Impact for the second temporary wastewater treatment plant (WWTP#2)
	hydraulic loading cannot be accommodated, then the possibility exists to install piezometers that extend at least 1m below the drainage galleries – one up gradient (i.e. south side) and two down gradient (north side). The piezometer should be slotted from target depth up to 0.5m from surface and gravel packed from 0.5m below ground to hole target depth. Should groundwater be intercepted during drilling and it is not perched, then the piezometer should not be installed in a manner that allows it to act as a short circuit to groundwater. The piezometer base should be at least 2m above standing groundwater level. If groundwater is intersected by the boring then bentonite should be placed at the base of borehole and up to 2m above static groundwater. Then the piezometer can be installed ending with the 75mm bentonite layer above the gravel pack or slotted monitoring zone. These piezometers should be monitored periodically to see if a perched groundwater mound is developing down-gradient of the drainage galleries. If such a mound is detected then the WWTP#2 should be temporarily shut down until the perched groundwater levels decline to acceptable levels.
Soil layers in the unsaturated zone	From the site there appears to be approximately 2m of unsaturated soil beneath the base of the drainage galleries and likely standing groundwater level. What is unknown is what is considered high seasonal groundwater level at the site. A minimum of 90cm is required beneath the base of drainage gallery, however, the thickness of this unsaturated zone is very dependent on the overall permeability of the soils. This means that a quicker draining soil will need a larger amount of unsaturated soil between the base of the drainage gallery and the top of groundwater. As the soil and thickness of the unsaturated zone is unclear, it is difficult to state the type of impact without a characterisation of the subsoils. Based on the reported percolation rates, and provided there are no zones of high permeability, then 2m of unsaturated zone should provide sufficient retention at a loading rate between 8-25 l/m^2/day

Key issues	Potential Positive (P) or Adverse (A) Impact for the second temporary wastewater treatment plant (WWTP#2)
	Ranking: Adverse and long-term. Mitigation: Establish the soil profile from surface to standing groundwater at least at two locations within the footprint of the drainage galleries. As the drainage galleries are already installed for WWTP#2, borings about 1m down gradient from each gallery should be undertaken to evaluate the subsurface soils in the unsaturated zone. Percolation tests should be done at 1m intervals to standing groundwater. These tests should be used to help inform the sites hydraulic loading characteristics at each drainage gallery. Particular care should be taken in installing the boreholes. Borings that intersect groundwater should be filled with bentonite to at least 2m above static ground water before being back filled. And if these borings are later used to both test the unsaturated zone or for installation of the piezometer then they have to be constructed to ensure there is no inadvertent contamination of groundwater by setting up a short circuit to groundwater.
North Property Boundary Wall	The design criteria for WWTP#2 has to ensure that there is no perched groundwater created that intersects the ground surface. **Ranking: Adverse and short-term.** Mitigation: The installation of the piezometers between the drainage galleries and the northern wall would provide an observation platform and early warning system should there be system failure of WWTP#2. To promote evapotranspiration and soil dewatering, plants such as poplar, could be considered to promote phytopumping (Figure 16) in the areas between the infiltration pond and the northern boundary wall. Poplars can transpire between 0.1-1.1 m^3/day depending on maturity and species used. Alternatively, an interception trench can be installed and the migrating effluent, pumped from the interception trench back to the plant.
Other	

Key issues	Potential Positive (P) or Adverse (A) Impact for the second temporary wastewater treatment plant (WWTP#2)
Public Health	It is a well-known fact that contamination of domestic water sources can occur from raw sewage overflow, septic system failure, poor placement of drainage galleries, badly constructed percolation systems, leaking sewer lines, land application of sludge and partially treated waste water. Although sewage contain many types of contaminants. The greatest threats posed to water resources arise from contamination by pathogenic microorganisms. The presence of liquid ponds at the PIC and on neighboring lands is cause for concern. The neighboring farms are accessible to adults and children who were observed enroute to the river, as well as animals and birds that can also spread contaminants. **Ranking: Adverse immediate.** Mitigation: 1. Commission and begin use of the plant to treat the specified volume of 150 m³ of wastewater from the PIC.

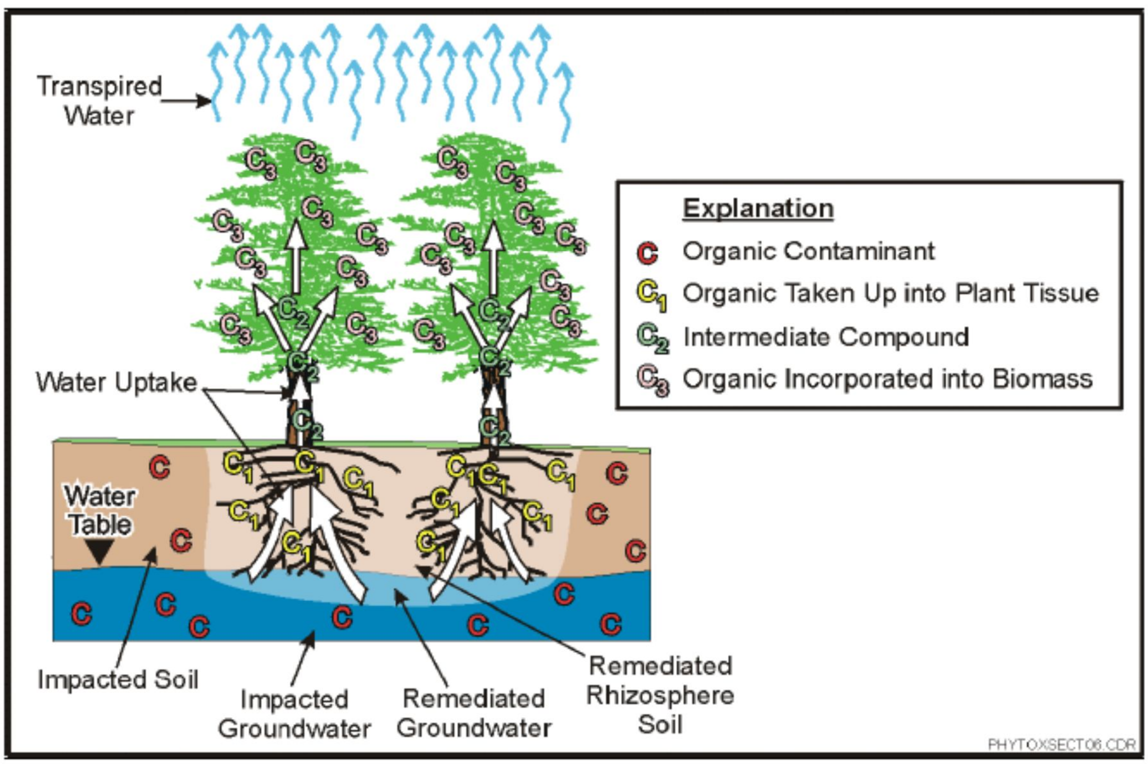


Figure 16: Phyto-Pumping and Contaminant Uptake by Poplars (Source Itrc, 2001)

8.0 CONCLUSIONS & RECOMMENDATIONS

8.1 CONCLUSIONS

The main conclusions arising from the environmental assessment of the second temporary WWTP are outlined:

1. The waste water treatment option selected for the second temporary wastewater treatment plant (WWTP#2) is consistent with the practice for provisional sewage treatment.

2. The system as designed just satisfies the requirements of the EPA OSWTP Manual guidelines and standard practice in Jamaica at the prescribed cap of 150m^3 per day. The consultants therefore recommend the application of caution in the use of the system. The established cap of 150 m^3 for the WWTP#2 should therefore not be exceeded as the plant as designed is already at its maximum capacity at the drainage field.

3. There are some deficiencies in the design of the system, the impacts outlined in Table 4 above are however primarily medium to long term (outside of the proposed life of the system. The short term impacts have clear mitigative measures that will reduce the impact to within acceptable levels and ensure the safe implementation of the sanitary solution.

4. The site surface seepage conditions identified during the site reconnaissance visit is likely due to the fluid from the infiltration pond flowing toward the river, the point of lowest hydraulic potential. The solid variability subsurface is possibly limiting the percolation pathways due to predominance of clayey soils resulting in effluent emerging or saturating the upper soils leading to ponding.

5. The physical characteristics of any site, including the PIC, has to take into consideration the location of the proposed system, the site specific geologic and hydrologic features in order to adequately determine the performance requirements and treatment needs for the site. In the case of the WWTP#2 the critical design boundaries are the drainage gallery/natural soil interface, the soil layers and thicknesses in the unsaturated zone above groundwater and the property boundary wall to the north. System failure occurs if any of these site boundary conditions is exceeded or not sufficient. System failure in the groundwater domain will result in excessive loading of contaminants to groundwater and a significant risk to public health.

6. Depending on the aquifer hydraulic gradient driving groundwater flow beneath the WWTP site from the permeability information derived from the production pump tests, groundwater flowing to the river as base-flow could take from one (1) year up to thirty one (31) years to reach the river 300m away. Great caution should be exercised as the hydraulic gradient isn't defined. There is also the risk of an accelerated flow path to the river by groundwater due to an increased hydraulic head caused by recharge from precipitation likely during the rainy season. This risk would be low during

the dry season but may increase during the wet season and torrential downpours that last over three (3) days.

7. As the flood risk potential at the site is not clearly defined the need to monitor flows to the plant and ground water levels are essential features of the management plan.

8. The use of the second temporary treatment system should only exceed six months if onsite tests prove the system is still operating optimally.

   The Consultants were asked to comment on the retention of the system after the commissioning of the permanent treatment plant. If the plant is to be retained best practice for temporary closure/abandonment should be utilized. This would include the emptying of the tanks by a licensed operator and removal of all solids. After this is done the tanks should be filled with debris free gravel to prevent collapse and also as a safety precaution. Disconnect power and cap influent ports. Maintain vegetative cover at the drainage field. Prior to future reuse the system must be re-commissioned as at initial commissioning and tested.

8.2 RECOMMENDATIONS

Based on the findings of the environmental assessment, the Consultant recommends the following pollution intervention strategies for the Clients consideration:

1. The management program proposed at Section 9.0 should be implemented at the temporary WWTP. This plan is predicated on the use of trained personnel which will be the deciding factor for system optimization.
2. Introduce a chlorination system which will reduce the public health risk associated with pathogenic contamination of ground water. This could be achieved by improving the current system that exists.
3. Install an effluent filter in the septic tank if it wasn't already included.
4. Phytopump by planting a row of poplar trees and other types of vegetation that establish a dense root mass and take up large quantities of water. Poplar trees when mature can transpire 114-1140 litres of water per day out of the ground. This could be used to control surface seepage. To promote evapotranspiration and soil dewatering, plants such as poplar, could be considered to promote phytopumping (Figure 16) in the areas between the infiltration pond and the northern boundary wall.
5. Restrict the use of WWTP#2 to six months unless it can be clearly demonstrated that percolation has not been compromised by the high application rate.
6. Install piezometers that extend at least 1m below the drainage galleries – one up gradient (i.e. south side) and two down gradient (north side). The piezometer should be slotted from target depth up to 0.5m from surface and gravel packed from 0.5m below ground to hole target depth. A 75mm bentonite layer should be installed above the gravel pack. These piezometers should be monitored periodically to see if a perched groundwater mound is developing down-gradient of the drainage

galleries. If such a mound is detected then the WWTP#2 should be temporarily shut down until the perched groundwater levels decline to acceptable levels.

7. Evaluation of contamination at the neighboring farms that are presently impacted by surface discharge of treated effluent. This remains a concern as effluent used for irrigation must meet more stringent standards than are required for the temporary systems at the PIC.

9.0 MAINTENANCE AND CONTINGENCY PLANNING

The objective of the maintenance and contingency program for the second temporary wastewater treatment plant (WWTP#2) at the PIC is to ensure sound environmental management practices in all aspects of the operation of the plant. Regular monitoring and reporting to key stakeholders at the IDB, UTE and PIC is a key requirement for success of the program.

9.1 MAINTENANCE PLAN

General Requirements

With the assistance of trained sanitary professionals ensure compliance with the requirements established by the EPA [NOWRA, 1999]:

- Performance requirements that protect human health and the environment.
- System management to maintain performance within the established performance requirements.
- Compliance monitoring and enforcement to ensure system performance is achieved and maintained.
- Technical guidelines for site evaluation, design, construction, and operation and acceptable prescriptive designs for specific site conditions and use.
- Education/training for all practitioners, planners, and owners.
- Certification/licensing for all practitioners to maintain standards of competence and conduct.
- Program reviews to identify knowledge gaps, implementation shortcomings, and necessary corrective actions.

Specific Requirements

All equipment on site must be operated in accordance with the suppliers' manual and bearing in mind the mitigative measures set out in this report (Table 4). The plant site must be kept orderly and cleaned weekly.

Septic Tanks

The primary treatment component of the WWTP is the septic tanks each with approximate capacity of 108 m^3. Septic tanks are anoxic system designed to settle out solids and reduce oxygen demand through anaerobic conditions. Inadequate maintenance of septic tanks is primary cause of system malfunction. Solids accumulate in the septic tanks and require removal periodically. Typically the tanks should be emptied by periodic pumping yearly. During tank cleaning one tank should be emptied every other month. **In the case of the WWTP#2 the tanks should be emptied at the end of the proposed six months unless site conditions prove the need for emptying earlier.**

- The distribution box to the septic tanks is to be inspected daily and cleared of any blockages.
- The filter on the outlet from the septic tank is to be inspected weekly and replaced as needed.
- The baffles should be checked when the tank is being inspected or pumped.
- Repair all physical damage immediately
- The effluent is to be sampled and tested monthly.
- An effluent filter in the outlet tee or in a separate chamber outside the tank helps retain solids in the tank and thus protects the drainage field. An effluent filter is easily cleaned by removing and rinsing it at regular intervals
- Prevent organic overload of the system by removing fabric, fibre (cellulose) wastes, from wastewater as these take a much longer time to degrade. Waste water with high organic loads such as high oil and grease levels may lead to system failure in a comparatively short time (few weeks to perhaps a few months).

Drainage Field

- The drainage field should be monitored to ensure that only grass is allowed to grow. Trees or shrubs should not be planted on the field as their roots may grow into distribution lines. Ensure grass is healthy.
- A root barrier such as copper sulfate may help control roots. Carefully select chemicals and follow the directions for application and safe handling.
- Too much soil should not be placed on top of the drainage field as this may restrict evapotranspiration. No more than 1 foot of soil cover.
- Prevent hydraulic overload by conserving water. Ensuring there are no leaking sanitary systems or significant additions of high volume water usage equipment. Install water-saving fixtures and appliances such as low-flow toilets.

Reporting

At least one operator is responsible for the day-to-day maintenance of the facility and mans the plant. The operator(s) at the plant must be experienced licensed sanitary professionals with a minimum of a secondary school education and must be trained as an operator by the equipment suppliers. As such at least two operators should be trained to maintain the system. Operators should be familiar with basic trouble shooing activities. The daily plant condition and monthly plant maintenance forms should be completed and submitted.

PIC		
CARACOL		
Daily Plant Condition Report Form		
Date:		**Staff schedule**
Insert 'Y' for yes or 'N' for no beside question if component is OK		
General description of plant		
OK		
Repairs required		**Report prepared by:**
Description		Name of Inspector / comments
Wet Well		
Pump flow rate		
OK		
Repairs required		
Pressure reading		
OK		
Repairs required		
Operator action, repair or changes required:		
Pumping equipment		
Operator action, repair or changes required:		
Septic Tank		
Operator action, repair or changes required:		
Drainage Field		
Operator action, repair or changes required:		
Chlorinator		
Chlorine regulator and scale OK		
Operator action, repair or changes required:		
Residual Chlorine Measurements		
Location 1		
Location 2		
Location 3		
Operator action, repair or changes required:		

Figure 17: Daily Plant Condition Report Form

Figure 18: Monthly Maintenance Form

PIC	
CARACOL	
MONTHLY SCHEDULED MAINTENANCE FORM	
Date:	**Report prepared by:**
Scheduled Inspections	
Description of equipment	**Serial number**
Parts to be replaced and date for scheduled replacement	
Regular maintenance Please list activity and dates to be carried out	

9.2 CONTINGENCY PLANNING

This section of the report documents the necessary actions required for effective contingency planning and safety.

Notification

In the event of a breakdown of the plant or any of its components, which is likely to affect the quality of the effluent discharged i.e. the effluent is not able to meet the discharge standard, the national water and Sanitation Directorate (DINEPA) should be notified within 24 hours by telephone, with a written notification within seven (7) days highlighting the nature of the incident/problem and action taken to address the problem.

The responsibility for notifying the relevant Agency lies with the Project Environmental/Sanitary Engineer. In the event of a natural disaster (hurricane, earthquake, etc) or plant malfunction, the details of the malfunction will be reported to the DINEPA, outlining the time period for which the plant will be out of service and the nature of the repairs to be carried out on the plant. The Project Environmental/Sanitary Engineer is also responsible for ensuring that the plant is brought back into good working order within a reasonable timeframe.

The following four situations have been identified as the major abnormal situations that the plant and its operators may have to face.

1. Plant Malfunction
2. Hurricane
3. Earthquake
4. Flash floods

The PIC emergency response plan will apply to the operations of this plant.

Plant Malfunction

- The sewage treatment plant is required to be monitored daily.
- The trash basket is to be inspected at the beginning of each shift and cleared daily. The waste collected in the basket is to be stored for collection and disposed at an approved solid waste disposal site.
- Pumps where they exist are to be started according to the directions in the Manufacturer’s manual.
- The pump operating curve and extracts from the operations and repair manual is to be on site in the operations booklet.
- The sewage flow meters are to be read daily at the same time, and the amount of sewage pumped is to be recorded.
- The distribution box to the septic tanks is to be inspected daily and cleared of any blockages.
- The filter on the outlet from the septic tank is to be inspected weekly and replaced as needed.
- The effluent is to be sampled and tested bimonthly.
- The septic tanks should be checked monthly to determine sludge thickness and emptied as required.

A plant malfunction report (sample shown at Figure 19) should be completed for each incident

Natural hazards

Hurricane and Earthquakes

In the event of a hurricane or other natural event the PIC Emergency Response Plan will be activated. During disasters with heavy continuous rainfall it may be necessary to close or reduce operations significantly at the plant. Due to the topography of the area in which the STP is located it is highly probable that the plant may intake storm water and may overflow.

If a tropical storm or hurricane is expected the operator will ensure all equipment is returned to the storage area and solid waste receptacles are emptied and secured. The buffer area surrounding the sewage treatment plant contains some trees however no adverse impact is expected from falling trees or branches. The flood risk potential at the site is unknown as such flood impacts are possible and should therefore be expected.

An alternate system such as a soakaway could be constructed to accept overflow from the system to mitigate possible flooding of the system. The system should be shut down if piezometer readings reveal high ground water levels.

The concrete structures including the lift stations and septic tanks should be designed to withstand earthquake forces. If an earthquake has occurred the lift station should be checked to ensure the pumps are properly seated. All manholes and distribution boxes should be inspected to determine if pipes have moved. If any damage has been sustained the Operator is to notify the UTE immediately.

Safety

Safety precautions must be adhered to by all personnel and visitors to the WWTP#2. These can be in the form of clearly marked signs throughout the plant site. Safety precautions should be discussed in relation to testing wastewater and other hazardous substances. First aid procedures for dealing with accidents involving personal injury should be available through adequate training and the maintaining of a first aid handbook and kit on site.

Rubber gloves must be worn with the direct handling of sewage or sludge and if there is direct contact hands must be washed and rinse in a bactericidal solution. Food and drinks should be kept in office areas and measures taken to prevent contamination.

Environmental Monitoring Considerations

The monitoring program will consist mainly of water quality monitoring. The WHO Sewage Effluent Standards should apply in absence of local standards. The final effluent discharge point to the environment is not accessible at WWTP#2. It is indicated in the literature that monitoring of groundwater will occur at a monitoring well located on the adjoining site.

Samples should be collected bimonthly according to standard sampling methodology and submitted to an accredited laboratory for analysis.

Figure 19: Malfunction Reporting Form

THIS FORM TO BE COMPLETED AND SENT TO THE UTE AND DINEPA WITHIN 24 HOURS OF MALFUNCTION	
PIC WWTP#2	**Process Type: Provisional Septic treatment system**
Caracol, north Haiti	
Malfunction Reporting Form	
Date of malfunction:	**Staff on duty at time of malfunction**
Time of malfunction:	
Date of report:	**Report prepared by:**
Description	
Nature of Malfunction	
Immediate actions	
Further actions required	
Plant restored to satisfactory operations	
Name of officer/s:	
Date and time:	
Send to:	
1) Manager:	
2) Responsible Government Agency	
Tel:	
Fax:	