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# NEW HARBOUR II & III PROPOSED HOUSING SUB-DIVISION, ST. CATHERINE



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Potential Hydrological Impacts

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# New Harbour II & III Proposed Housing Sub-division, St. Catherine

## POTENTIAL HYDROLOGICAL IMPACTS

### INTRODUCTION AND SCOPE

This hydrological constraints assessment considers the general effects of the proposed surface water drainage solutions and sewage treatment solutions for New Harbour II and III subdivisions only. The study is mainly concerned with immediate site conditions, but a 500m buffer around the site was also considered. The assessment techniques used were aimed at identifying any hydrological constraints, including areas in which development should be avoided and areas in which the proposed drainage or sewage activities may result in negative impacts on the physical environment. Where appropriate, mitigation countermeasures will be outlined. The conclusions are based on a review of the published maps, WRA records<sup>1</sup>, engineering drainage designs, topographic maps of developments and areas near the site and other public domain data and technical documents available.

### DATA COLLATION AND INTERPRETATION

The assessment is based on the review of published material plus engineering reports relating to the Whim property and New Harbour property. The data and other sources of information collected are listed in Table 1.

A brief site walkover through areas that allowed foot-traffic was carried out on 15 June 2009 to confirm the hydrological environment, identify any surface water features, dominant soil types and other land use characteristics likely to influence hydrological processes. The micro dam areas to the east were heavily overgrown and not accessible without clearing. An aerial overview was done on 18 June 2009 to assist in appreciating the larger regional hydrology and fly-over of inaccessible areas that are critical to the study area, such as the confluence of the Frasers, Stony and Church Pen Gullies and the lower catchment of the Bowers Gully.

Topic	Source of Information
<b>Geology</b> Solid and Surficial	Mines and Geology Division, Sheet 20, Old Harbour 1:50,000
<b>Hydrological Reports</b>	Whims Housing Project Development, Engineering Hydrology, Drainage Study and Flood mapping, Fluid Systems, Feb 2009; Overall Drainage Plan Map, FCS, June 2009; GDL WHIM Housing Design, AF Consultants, June 25 2009; New Harbour I EIA, ESL 2006. Marine Shrimp Farms Expansion EIA, Brampton Farms (NEPA internet document), GDL WHIM Housing Development Water Supply Designs, June 28 2009
<b>Flooding</b>	ODPEM Report on New Harbour I, 2006

TABLE 1 - SOURCES OF GEOLOGICAL AND HYDROLOGICAL INFORMATION

## ASSESSMENT METHODOLOGY AND LIMITATIONS

The assessment has been undertaken primarily based on the conclusions of others and are contingent upon their validity. These data have been reviewed and interpretations made in the report. Some of these data are preliminary "screening" opinions, and should be confirmed with intrusive and detailed quantitative analyses if more specific predictions are necessary.

## BASELINE

This section describes the existing hydrological conditions at the proposed site and surroundings up to 500m from the proposed sites.

### Climate

The meteorological station nearest to the study area is located at Old Harbour (E237808, N142991), approximately 2km north of the site. Monthly mean maximum temperature at Bodles for the period 1987 - 2005, ranges from 18°C in the cooler months to 34°C in warmer months. Monthly mean minimum temperatures for the same period range from 16°C in February to 21°C in July.

The Meteorological Service of Jamaica 30-year long-term mean monthly rainfall (1951 – 1981) for Old Harbour, St. Catherine ranges between 41 – 213mm. The highest rainfalls are recorded in May and October of each year.

The information indicates that the site has two distinct wet periods, where soils moisture content will be high and a following period when soil moisture condition will be low.

## TOPOGRAPHY AND SURFACE HYDROLOGY

Largely, the site slopes towards the southeast away from Highway 2000 with the largest elevation change being approximately 10-14m. From aerial photographs the east-west elevation changes are of a similar order of magnitude with a gentle slope toward the east. Overall the site is flat with very little original vegetation and is left mostly fallow, however, the most recent land-use maps (1998) classifying the site as “plantation and uncultivated fields”.

The nearest, named surface watercourses are the Frasers Gully, which lies to the east of the site, and Bowers Gully, which lies to the west. On-site a tributary of the Frasers Gully traverses the northeastern third off the previous New Harbour I (NH I) and runs through the northern portion of New Harbour III (NH III). As the tributary exits NH II, it joins the Frasers Gully beneath the proposed sewage treatment plant. Further east both gullies join a third gully, the Stony Gully. A further 300m south-east these gullies join the Church Pen Gully forming one gully system prior to discharging to Old Harbour Bay some 1.5km further south. On the “Whim” side, the location of New Harbour II (NH II), there is presently the Whims Gully that begins in the southern zones of the Old Harbour Town and continues southward following the Old Harbour Bay main road before exiting at Old Harbour Bay as the Old Harbour Bay Gully. See Figure 1 for pictorial overview of the above description. Overall three gullies materially affect the proposed development.

A brief review of the existing drainage channels suggest that moderate to large flows should be anticipated during heavy rainfall in each gully. No flooding has been noted on the site via the WRA. However, it should not be assumed that flooding does not occur as these flood reports are sample biased towards areas with large human populations. Residents along Thompson Pen Road, 1km south of the site, have experience continual heavy flooding. As recently as May-September 2002 Thompson Pen Lane has been severely flooded by heavy rains that affected Jamaica. It is estimated that that rainfall event represented a 1:25yr rainfall event<sup>ii</sup>. Thompson Pen Lane and much of the lower coastal regions of Old Harbour Bay are susceptible to severe flooding due to soils (low permeability clays), topography (flat between 0-1m asl) and numerous surface water systems from the hinterland discharging to the coast.

## PROPOSED DRAINAGE MODIFICATIONS AND IMPACTS

### **The Whim Property (New Harbour II)**

It is proposed that the surface drains currently existing on the Whim side of the property will be rerouted to the Bowers Gully (see Figure 1). This will include both the western boundary drain (which will be extended to meet the upgraded mid-property drain) and mid-property/central drain (which will be upgraded and lined with concrete). The only portion of the property drainage what will continue as currently exists is the southern tip of NH II. This continues along the Whim Gully and at the junction with the Old Harbour Main Road will be routed to an existing drainage channel that slopes east toward the lower reach of the Frasers Gully into Daggars Bay (Figure 1). This will continue to ensure that post-development surface flows are kept out of Old Harbour Bay with the majority of the flow being directed to Bowers Gully and a small proportion to the Frasers Gully via the new drainage upgrade channel installed by the NWA.

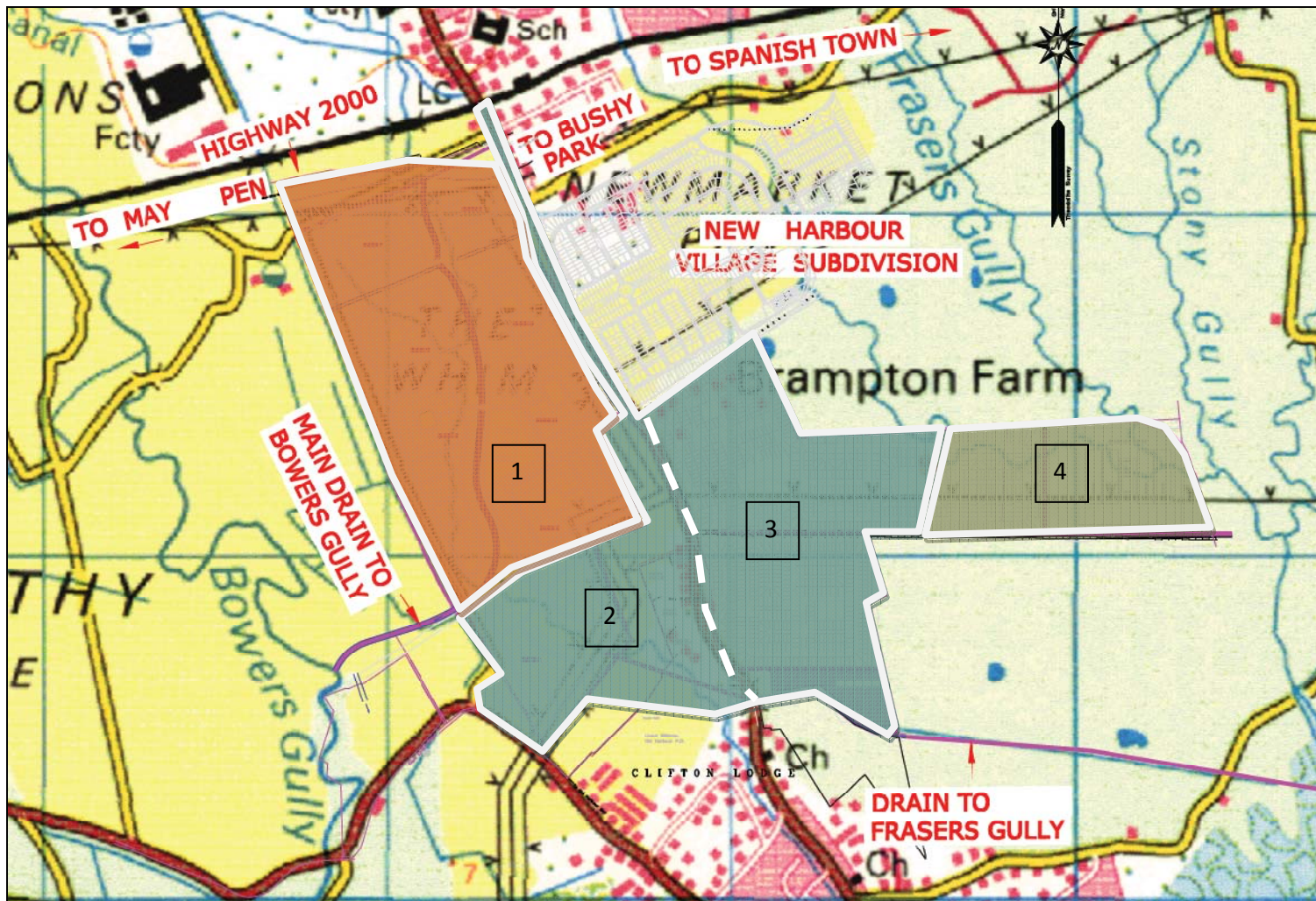


FIGURE 1 – SITE SUB-DIVISION LAYOUT AND LOCATION IN RELATION TO OVERALL SURFACE WATER FEATURES. AREAS 1. AND 2. CONTRIBUTE TO OLD HARBOUR TOWN GULLY PRE-DEVELOPMENT SCENARIO. POST-DEVELOPMENT SCENARIO 1. WILL BE ROUTED TO BOWERS GULLY VIA MAIN DRAIN. 2 AND 3 WILL DRAIN TO FRASERS GULLY VIA EARTH CHANNEL BETWEEN FISH PONDS. AREA 4, WHICH INCLUDES THE STP WILL FLOW TO FRASERS GULLY.

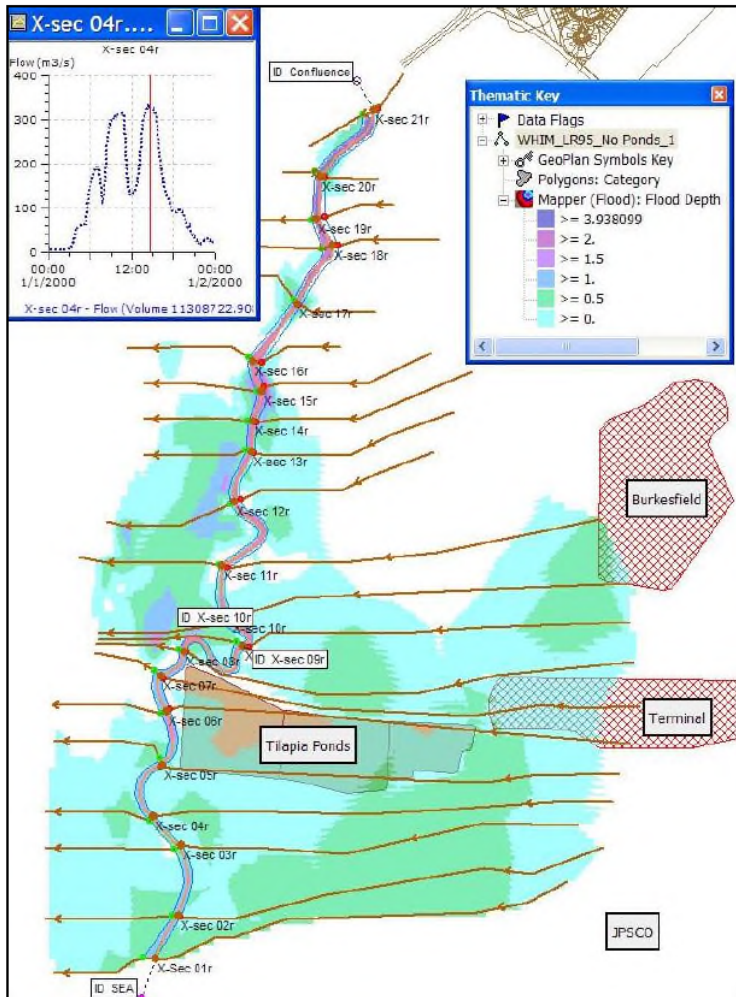
This new NWA drainage infrastructure development was carried out to alleviate the recurrent flooding problem that exists in Old Harbour Bay during heavy rainfall. The overall development drainage design for NH II will ensure that no additional surface flows are directed toward Old Harbour Bay in keeping with the NWA drainage developments. Central drain within the property will be designed for 1:25yr flows with 25% freeboard as required. Roadways and minor drains will be designed to 1:10yr event.

The predicted predevelopment flow along Bowers Gully is estimated to be between 340 – 360 m<sup>3</sup>/s for the 1:100yr return period<sup>iii</sup>. Modeling has predicted that the additional flows to Bowers Gully will be increased by approximately 3% below the confluence of the proposed mid-drain and the gully channel. The small increase is due in large part to the time shift between the arrival of the separate flood waves that will emerge from the proposed development and the larger, upper catchment of the Bowers Gully. It is predicted that the surface water from the proposed post-development scenario, 55 m<sup>3</sup>/s (1:100yr), will arrive at the confluence some 2.5hrs earlier than the predicted flows from the upper catchment of Bowers Gully resulting in only a marginal 3% increase in flows along Bowers Gully. The depth of water predicted at the central drain, which will be reinforced with appropriate energy dissipaters to reduce erosion, is approximately 1.95m and the proposed depth of the channel will be 2.5m. Flooding impacts will remain as they have always been in the past along the lower reaches of the Bowers Gully mainly because of the time shift in the discharge hydrographs from the upper and lower catchments. Flood modeling supports anecdotal evidence that dwellings at Burkesfield and Terminal experience flooding on the order of 0.4m (predicted) and 0.5m (anecdotal)<sup>iii</sup>. This flooding occurs mainly due to river bank modification (tilapia ponds that restrict overbank flows and storage) and the extremely gentle slopes in the lower catchment that facilitate ponding. The computed inundation map (Figure 2) shows that both Burkesfield and Terminal experience a maximum of 0.4m water depths during significant rainfall events. This will remain the same even post-development due to the time difference in the arrival of the flood hydrographs from the upper and lower catchments. In order to alleviate the flooding experienced by the communities (and this is outside the scope of the developers) both the removal of the tilapia ponds and the construction of a 1m bund along the western most boundaries of the communities should significantly reduce their current flooding issues. Generated flows from Block A, Figure 3, continue to discharge to the south, however not through the town. The flows here will be significantly reduced on the order of 75%, and will also be routed through detention features incorporated into the overall drainage design for NH II and within the JPS Reserve. The detention feature will see the installation of earth embankments that are perpendicular to flow direction with outflow pipes across the embankments. These structures will act as surface water detention features that will further control the rate of discharge and amount of the predicted runoff from Block A and will be released to a newly constructed drain that crosses the main road and flows into the lower reaches of the Brampton Farms lands into Frasers Gully.

Overall the Whim development will not adversely increase the level of downstream flooding already experienced in the lower reaches of the Bowers Gully catchment by existing residents. However, as the Bowers Gully catchment is large (4074 ha) it would be reasonable for the local government/parish council and the regional planning agency to install restricted development orders for the lower catchment of the



Bowers Gully to ensure that the flood plains remain available for overtopping as development is expected to increase in the upper catchment.



**FIGURE 3 - FLOOD INUNDATION MAPPING FOR THE WHIM PROPERTY (NEW HARBOUR II). A 1M ENBANKMENT AT THE EASTERN EDGE OF THE FISH PONDS, AND THE REMOVAL OF THE FISH PONDS, WOULD ALLEVIATE FLOODING IN THE COMMUNITIES.**



**FIGURE 2 - PROPOSED WHIM DEVELOPMENT LAYOUT. BLOCK A WILL DISCHARGE TO THE SOUTH FLOWING OLD HARBOUR MAIN ROAD GULLY. THIS FLOW WILL BE REDUCE BY SOME 75% OVER PRE-DEVELOPMENT FLOWS AND WILL NOT INCREASE THE FLOOD RISK IN THE TOWN.**

### **The Brampton Farms Property (New Harbour III)**

It is proposed that the unnamed gully and its confluence with the Frasers Gully be relocated north of the property boundary outside of the footprint of the proposed sewage treatment plant (STP) for NH II and III. The relocation will be coupled with the lifting of the land surface of NH III to a 6.5m asl which is presumed to be adequate for the 1:25yr flood stages along the Frasers Gully. Approximately 33% of NH III (East Brampton Farms, 27 ha) will be routed to the Stony/Fraser Gully confluence. It is understood from the drainage reports that the remaining 77% of NH III and southern portions of NH II (presumably Block A) will be combined and routed along the newly constructed earth drain that discharges to Dagger Bay via the Salinas (Figure 4). Pre-development discharge is estimated to be 66 m<sup>3</sup>/s (1:25yr); however, this includes a significant portion of the Whim property (Figure 1, Area 1). Post-development, a substantial portion of the Whim property area will be routed through the created central drain to Bowers Gully, with only a thin sliver alongside the main road, the southern end of the property and the portions of NH III highlighted in Figure 1, being directed beneath the main road toward Frasers Gully via the earth drain (Figure 4) that separates the shrimp ponds. The post development runoff is estimated to be 35 m<sup>3</sup>/s (1:25yr), which will be routed along the earth drain shown in Figure 4. This means that the Old Harbour Town will see a significant reduction in the flows that once was routed through the town from the Whim property. This new earth drain will be evaluated by the design engineers to estimate if the projected flows plus freeboard, can be safely accommodated. The installing of appropriate erosion control measures along its length to ensure no adverse erosion or under mining of the banks will also be evaluated along the drain.

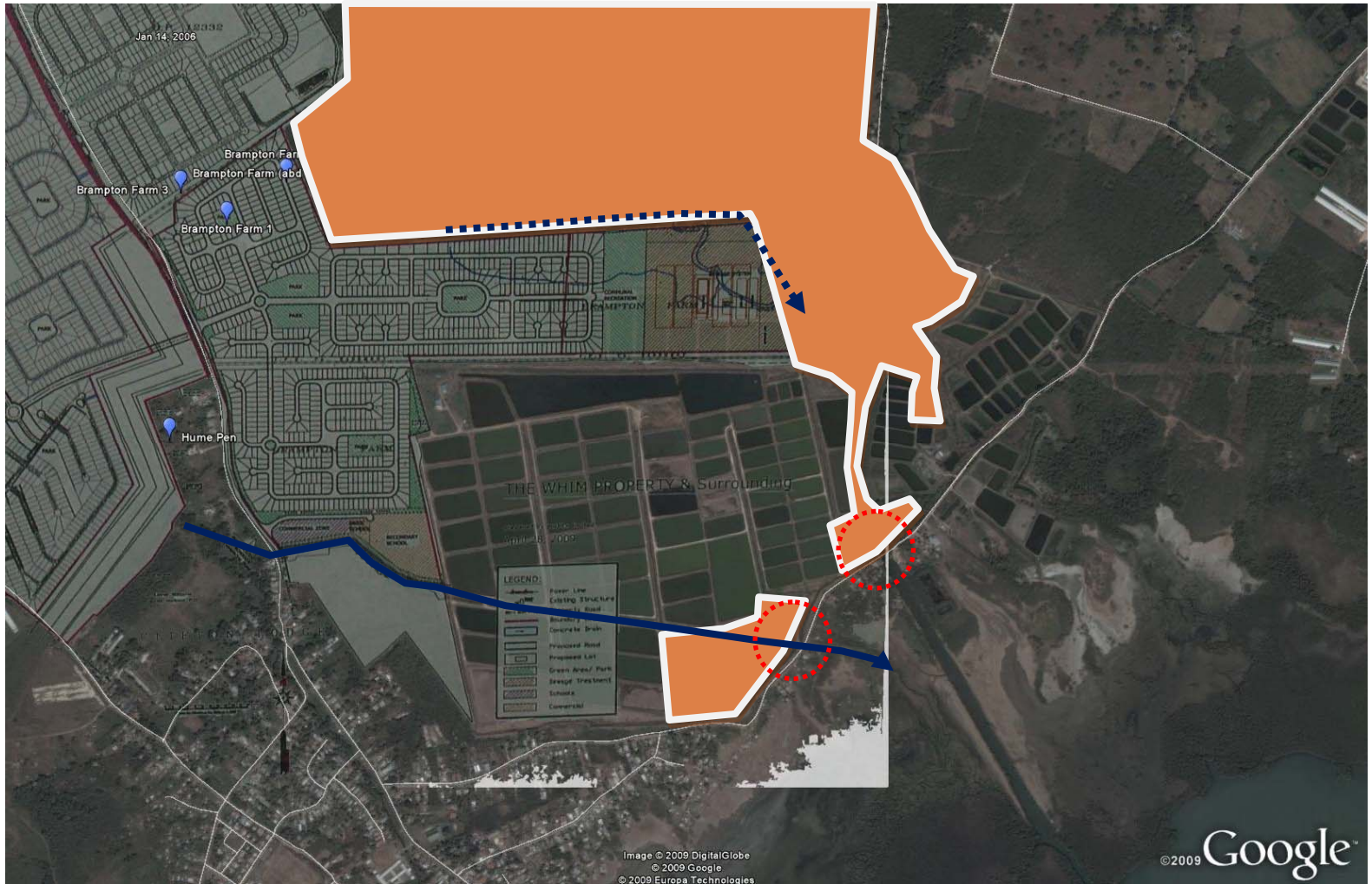


**FIGURE 4 - NEWLY CONSTRUCTED EARTH DRAIN THAT FLOWS TOWARD FRASERS GULLY (PHOTO LOOKING EAST)**

Flows from the eastern portion of NH III and the STP are projected to be about  $13 \text{ m}^3/\text{s}$  (1:25yr) and this will only marginally increase the overall flows into Frasers Gully. Preliminary calculations, pre-development and post-development, for the reach of Frasers Gully that will accept the discharge is approximately  $220 \text{ m}^3/\text{s}$  (1:25yr) and  $223 \text{ m}^3/\text{s}$ , respectively<sup>iv</sup>. This is likely due to a time shift in the arrival of the hydrographs from the development first then from the upper catchment sometime afterwards.

Flooding offsite is highly probable in the low lying areas identified in Figure 5 during significant rainfall events. The fish/shrimp ponds have been elevated to around 6m asl and these have no records of flooding during recent significant rainfall events. Given that the design documents have indicated that the NH III sub-division will be protected by a peripheral earth berm 6.5m high along the north and east of the property, clear long-term site management plan will have to be developed to ensure that these peripheral berms are maintained over the long-term to ensure the integrity of these earth berms in the future. Further south, the zones of highest flood risks are the locations highlighted in by dashed circles in Figure 5. These locations are currently prone to flooding and the additional flows from the development are likely to slightly increase the flood levels experienced in these areas. To reduce this flood risk the appropriate hydraulic analysis, including tidal effect, is understood to be underway to establish whether the existing structures are adequate, especially at the culverted crossing with parochial road. The Salinas south of the crossings will experience flooding due to their slope and low soil permeability but this is the natural function of the lands to accommodate flood waters. Development orders will have to be installed to restrict and if necessary remove any dwellings located in these flood prone areas both on the Bowers Gully and Frasers Gully. A gully cleaning exercise should be undertaken to ensure that the proposed routes for the surface runoff have sufficient carrying capacity along its length.

The ODPEM has also indicated that designs should consider land use changes in the upper catchment of Fraser Gully (Marlie Mount and Claremont) to ensure that inevitable changes to the upper catchment are not restricted by designs in the lower catchment<sup>v</sup>.



**FIGURE 5 - SURFACE WATER ROUTING AND POTENTIAL AREAS FOR FLOODING POST-DEVELOPMENT. THE DASHED BLUE LINE SHOWS THE POST-DEVELOPMENT RELOCATION OF THE UNNAMED TRIBUTARY THAT INTERCEPTS FRASERS GULLY. THE SOLID BLUE LINE SHOWS THE EARTH DRAIN LEADING TO THE BAY THROUGH THE FISH/SHRIMP PONDS. THE ORANGE POLYGONS INDICATE THE LOW LYING AREAS THAT ARE SUSCEPTIBLE TO FLOODING DURING SUSTAINED HEAVY RAINFALL. THE FISH PONDS ARE ELEVATED TO APPROXIMATELY 6M ASL AND IT IS PROPOSED TO CONSTRUCT A BERM 6.5M ASL ALONG THE NORTH AND EAST OF THE PROPERTY. RED DASHED CIRCLES AT THE INTERSECTION OF THE ROAD WAY AND THE WATER COURSES ARE AREAS CONTINUE TO HAVE INCREASED FLOOD RISK DUE TO THE POST-DEVELOPMENT DRAINAGE ARRANGEMENTS. THESE AREA ALREADY HAVE EXISTING FLOODING ISSUES, BUT IT IS PROBABLE THAT THE SOUTHERN MOST CROSSING MAY BE INADEQUATE TO ACCOMMODATE THE ANTICIPATED FLOWS ALONG THAT EARTH DRAIN. FLOODING OF THE LOWER SALINAS IS ALSO EXPECTED GIVEN THE SHALLOW SLOPES AND TIDAL INFLUENCE. NORTH TO TOP OF PAGE.**

## PROPOSED SEWAGE TREATMENT PLANT

The proposed STP will discharge  $0.05 \text{ m}^3/\text{s}$  (793 gpm). It is unclear if the surface water and the STP streams will be mixed before discharge to the gully. The previous New Harbour I (95% complete) also discharges to the same gully system. Post-development, two additional sub-divisions will discharge to the same gully system. It is understood that secondary/tertiary treatment is proposed.

The proposed sites will be serviced by a package sewage treatment plants (PTP). PTPs are, in effect, small scale sewage treatment works and can produce effluent of a similar standard to full scale works. Most package plants require electric power to operate and all will require regular maintenance and de-sludging in accordance with the manufacturer's instructions in order to ensure that the system operates effectively and the effluent complies with the consent discharge conditions. A maintenance agreement with a suitable contractor may be useful, and the installation of an alarm to warn of power or plant failure is recommended. The proposed PTP will provide secondary/tertiary treated effluent discharge which will be directed to the Frasers Gully watercourse at its egress from the east of the site. The effluent limits are not available but it is understood that the effluent water should be within the NEPA Sewage Effluent Standard limits.

Given that the discharge constituents will be additive into any water body, there is the possibility that although each STP will meet the NEPA sewage effluent standard on its own merit, the combined discharge of each STP into the single gully system may cause exceedances of Jamaican Ambient Water Quality Standards for Freshwater downstream and possibly the Sewage Effluent Standards, especially during low flow conditions in the dry season. Monitoring of the downstream waters will be required during low flow periods to ascertain the degree of change to the water chemistry post-development to ensure a policy of no deterioration of the estuary waters. However, given that there are ongoing industrial discharges from several properties (shrimp ponds) that have adjusted the ambient freshwater quality, it would be reasonable to allow for not more than a 10% change in receiving water quality unless there is insignificant environmental change as a consequence (particularly for bacteriological parameters in coastal waters in the Portland Blight area).

Avenues should be considered for effluent discharge re-use for non-potable activities such as greening of adjacent green spaces.

## PROPOSED WATER DEMAND

The proposed water demand for the site is approximately  $3,302 \text{ m}^3/\text{d}$  based on 2,353 housing solutions being proposed and including factors for leaks etc. Currently, the water supply solution being considered is groundwater abstraction from WICHONS Rodons Well in St. Catherine. The WRA has provided a licence (No. A2088/46) to abstract no more than  $4,360 \text{ m}^3/\text{d}$  for domestic purpose from the aquifer. Monthly reporting of the abstracted amount is also required as a condition of licence, limit of 250 mg/l chloride, pumping levels (pump setting) must be above sea-level and twice yearly (April and November) water

quality reports are the stipulated conditions of the licence. Provided the main stipulation that pump levels must be above sea-level and that the abstraction amounts are limited to 4,360 m<sup>3</sup>/day, it is unlikely that degradation of water quality will occur in the medium term.

The aquifer is able to supply the amounts specified to meet the demands of the site. Any increase in demand should be followed by a complete aquifer and well test analysis to ensure that additional amounts can be abstracted without deterioration of water quality.

## QUALITATIVE IMPACT ASSESSMENT

In this section a qualitative impact assessment of the proposed development evaluated against the site’s present hydrological baseline is presented in Table 2.

Key issues	Potential Positive (P) or Adverse (A) Impact on Proposed Development
<b>Surface runoff/Flooding</b>	<p>There is existing flooding along the lower reaches of the Bower and Fraser Gullies. Post development flood risk will increase slightly in proportion to the increase in surface flows which are not significant. Along Bowers Gully a 1m berm would be required to alleviate flooding in Terminal and Burkesfield. Along Fraser Gully a 6.5m peripheral north and east berm will be required to reduce the flood risk inside the post-development NH III property. Development orders required to limit downstream development of informal dwellings on estuaries of both gullies. All major water course crossings should conform to 1:100yr event with appropriate free board. Major and minor internal drains should be designed to 1:25yr and 1:5yr with 25% freeboard.</p> <p><b>Ranking: Adverse Impact (A) and long-term</b>, if appropriate mitigative countermeasures are not established to minimize any identified flood risk. With appropriate flood and erosion control measures the risk is low.</p>
<b>Sewage Treatment Plant (STP)</b>	<p>The location of two STPs on the Fraser Gully may increase ambient water quality to above the standards even though each STP meets the sewage effluent standards due to a multiplier effect in the receiving water course. The receiving water course already receives nutrient-rich pond water and is likely already polluted. No more than a 10% change in the receiving water body</p>

Key issues	Potential Positive (P) or Adverse (A) Impact on Proposed Development
	should be allowed downstream. <b>Ranking: Adverse and long-term.</b> But STP maintenance and water quality monitoring can reduce the long-term impacts significantly.

TABLE 2 – QUALITATIVE IMPACT ASSESSMENT FOR NEW HARBOUR II AND III



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<sup>i</sup> WRA data, July 2006

<sup>ii</sup> [http://www.nrca.org/eias/StCatherine/Brampton/EIA\\_MarineShrimpFarm\\_Brampton.pdf](http://www.nrca.org/eias/StCatherine/Brampton/EIA_MarineShrimpFarm_Brampton.pdf) , accessed July 02, 2009

<sup>iii</sup> Fluid Systems, Engineering Hydrology, Drainage Study and Flood Mapping, Whims Housing Development, Feb. 2009

<sup>iv</sup> Foreman, Chung & Sykes, New Harbour III Regional Drainage Report (Draft), July 2009

<sup>v</sup> ODPEM, New Harbour Village Review Report, June 2006