



Environment, Rural Development and Disaster Risk Management Division

CSD/RND

Updating and Detailed Designs of Flood Control Works in Belize City

Final Report

September 2017

**CHENTEC**  
MILE 1 ½ GEORGE PRICE HWY, BELIZE CITY, BELIZE

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## 1 Introduction

Belize City, Belize is a coastal metropolis situated on a small peninsula protruding into the Caribbean Sea. The city was positioned on the estuary of the Belize River because it provided the British settlers with the distinct advantage of a natural sea outlet for the stockpiling and exporting of logwood and mahogany wood. However, being situated in swampy low lying areas has rendered the area a challenge with respect to drainage design and provision of adequate drainage infrastructure. Throughout the years there have been numerous flooding events, many stem from localised flooding from heavy rainfall, storm surge from a tropical cyclone and/or the river overflowing its banks.

In an effort to alleviate flooding, past administrations have constructed drainage canals throughout the city as far back as the 1800's. Today the city is traversed with canals of varying sizes, usefulness, states of completion and working conditions. In recent years (<5 years), the Government of Belize and the Inter-American Development Bank have collaborated on the Flood Mitigation Infrastructure Project which resulted in the construction of two (2) new canals just north of the city centre and the rehabilitation (cleaning, reinforcing, lining) of some existing canals.

The second phase of this flood mitigation project seeks to design and construct infrastructure that will ameliorate the effect of flooding events being experienced by the most vulnerable residents and commercial businesses within the city – the Southside area. The plan is to address the conditions and hydraulic functioning of two (2) major drainage canals in the Southside section of the city, namely **Collet** and **East** (Southside) canals. The ultimate goal is to rehabilitate, clean and build infrastructure along these canals in question that will allow for more effective and efficient drainage of the project area.

The main design concept involves creating a canal system that can be isolated from the sea and the river (Haulover Creek) through the use of gates (locks) when the need arises. This isolation will be created when the respective locks are closed. This will enable the pumping of the closed canal system – effectively lowering the water level in the canals. In doing so, stormwater from the surrounding area will enter the canals at a faster rate and thus reducing the incidence of flooding in the area resulting from localised extreme rainstorm events.

This proposed project comprises of key infrastructure in the form of:

1. Pump Station at the Collet Canal outlet to the sea;
2. Gate 1 at the Collet Canal outlet to the sea;
3. Gate 2 at the confluence of Collet Canal with Haulover Creek;
4. Gate 3 at the confluence of East Canal with Haulover Creek;
5. Gate 4 at the confluence of Collet Canal and West Canal;
6. Dredging and repair of linings for both canals;
7. Rehabilitation and connection of side drains that empty into the canal system;
8. Constriction of canal lining for Collet Canal from Kut Ave. to sea outfall;

9. Provision of operating manuals and procedures for the proper functioning and maintenance of the proposed infrastructure.

Figure below shows the relative position of the key infrastructure to the project. Maps in Annex 3 also gives more detail on the proposed works.



Figure 1: Key drainage infrastructure locations.

Some of the other benefits of the proposed infrastructure includes providing operational flexibility to open and close the locks depending on the existing hydraulic situation such as high tide or storm surge. It will also potentially facilitate the requisite maintenance works on the canal system by lowering water levels to enable easier cleaning.

On an environmental note, the proposed infrastructure will potentially improve the quality of water in the canal system thereby eliminating the persistent foul smells that are synonymous with the canals. It should also result in the enhancement of the aquatic habitat and a possible increase in fish populations. And most importantly, the improvement in the health and sanitation conditions of the canals and surrounding areas.

## 2 Proposed Infrastructure

### 2.1 Pumps

Currently, the proposed design states that the pump station will furnish an array of Archimedes pumps (screw type). The preliminary design parameters are as follows: -

- Peak Discharge: 6 m<sup>3</sup>/s [95,100 GPM]
- Head (Lift): 3 m [9.8 ft.]
- Required Power: 235 kW [315 Hp]

Screw pumps are designed to lift water to low heads (1m – 12m) and can pump up to 12 m<sup>3</sup>/s [190,000 GPM]. The technology dates back to the third century BC. The distinct advantages of screw pumps are its effectiveness when pumping debris-laden water. The main components are a screw, trough and a driver (motor) that spins the screw. The main applications are in drainage water pumping stations and water treatment plants. It is also known for its reduced damage to aquatic life when compared to a conventional centrifugal pump.

#### 2.1.1 Pumping Considerations

- a) In order to reduce the size and subsequent cost of the pumping system, it should be considered to lower the lift height from 3m to 2m. Note that the tidal range in Belize is only 0.3m [1 ft.].
- b) Pumps will be electrically driven and as such a backup generator system should be supplied and installed to provide power to the pumps due extreme weather events when grid power is not available.
- c) All metal components of the pumps should be manufactured from either Stainless Steel Type 316 and/or Aluminium.
- d) The outlet side of the pump system should be equipped with a settling basin that will allow the settling of some debris and heavier sediments before it enters the sea. This basin should be design to allow for easy cleaning

Estimated cost for the supply and installation of the pump system is **US\$ 1.4 million**

## 2.2 Hydraulic Gates

Hydraulic gates (locks) will be placed at four (4) locations throughout the canal system. A lock is a closure device in which a “leaf” is moved across the fluid flow to control the flow of water. Sluice gates that move vertically with motorised operation and manual over-ride will be supplied and installed. The advantages of this type of gate are its simple operation and minimal maintenance requirements<sup>1</sup>. Total estimated cost for gates is **US\$ 1,072,950.00**

## 2.3 Canal Dredging

Dredging of the canals is the exercise of removing, transporting and safely disposing of the significant amount of silt and debris that has built-up the canal system over many years. This build-up in certain sections of the canal system accounts for more than 80% of the total canal depth. This build-up is seen as the single largest factor that impairs hydraulic capacity and subsequently results in flooding of the surrounding area.

Based on an initial survey of the sediment levels, there is approximately **9,300 cubic meters** [12,163 yd<sup>3</sup>] or 1,200 truckloads of settled material that must be dredged. See Annex 2 for sediment volume estimate. The estimated cost of dredging both canal is **US\$ 862,850.00**.

Dredging Considerations:

1. Location of the dumped material. The distance from the excavated site weighs heavily on costs.
2. Method of extraction. Currently the option that is most suitable for the location is the use of excavators, plus additional manual labour to clean and repair channel sections.

## 2.4 Side Street Drain Rehabilitation

In order for this project to be beneficial to its stakeholders, there is the need to rehabilitate and in some cases construct new side drains along critical streets that run perpendicular to the canal system. It is universally acknowledged that a large problem with the drainage infrastructure in Belize City is the lack of connectivity of street drains to outlet infrastructure (canals, river and sea). There are known sections of the City that become inundated with flood waters which are less than 10 m away from the canal.

Under this pilot project the main streets that will benefit from drainage rehabilitation are Orange Street, King Street and Dean Street - these have a total length of 2,400 m [7,870 ft.]. Note that the proposed drainage system for these street will take an unorthodox approach to street drainage.

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<sup>1</sup> Erbisti, Paulo, Design of Hydraulic Gates, 2<sup>nd</sup> Ed., CRC Press, 2014, pg. 30.

The conventional way for draining streets and surrounding environs has always centred on the use of concrete box drains situated under sidewalks.

When functioning properly, the main advantages of this method are its inherent space saving design and the fact that stormwater flows away from the streets and sidewalks with little or no ponding. However, in a situation with minimal slopes, inconsistent maintenance and cleaning sidewalk drains becomes blocked with garbage and silt rendering them useless. This is the case with the majority of drains in Belize City.

The solution being proposed under this flood mitigation project is the use of surface drainage paths in the form of **swales** and **curb and gutter** elements. While there will be some pooling of stormwater during a rainstorm event, this pooling will flow off quickly towards the canals. For proper functioning these drainage elements must have the correct slope towards respective canals with adequately sized and placed outlets.

Major works for this aspect of the project will include: -

- Raising some sections of streets;
- Repairing sidewalks;
- Installing swales along streets;
- Constructing outlet culverts.

The estimated cost for the above works is **US\$ 448,625.00**

## 2.5 Canal Lining

The Collet Canal has concrete lining from the Conch Shell Bay Fish Market near the inlet at Haulover Creek up to the intersection with Kut Avenue. The remainder of the canal, from Kut Avenue to the sea outlet is unlined. There are asphalt paved streets on both sides of the Canal, but there is no canal edge or wall that separates the canal from the adjacent streets. The new lining of the Collet Canal would provide additional stability and confinement to the canal. The canal lining wall would prevent the canal's earthen banks from erosion which has the potential of undermining adjacent streets.

The length of the Collet Canal from Kut Avenue to the Yarborough Bridge is approximately 290 m [1,280 ft.]. The estimated cost for this aspect of the project is **US\$ 836,650.00**

Project Cost Summary: -

ITEM	SECTION	ESTIMATED COST (US\$)
<b>1.0</b>	Preliminaries	\$ 47,400.00
<b>2.0</b>	Pump Station	\$ 1,398,000.00
<b>3.0</b>	Sluice Gates	\$ 1,072,950.00
<b>4.0</b>	Dredging	\$ 862,850.00
<b>5.0</b>	Street Drains	\$ 448,625.00
<b>6.0</b>	Canal Lining	\$ 836,650.00
<b>7.0</b>	Contingency (10%)	\$ 466,647.50
<b>8.0</b>	<b>TOTAL</b>	<b>\$ 5,133,122.50</b>

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### 3 Bills of Quantities

The following preliminary Bills of Quantities provides more detail for the above costing: -

#### 3.1.1 Preliminaries

Item	Description	Qty	Unit	Rate (\$/unit)	Amount (US\$)
	Notes:				
a	Cost of preliminaries that are not fixed shall be value related and paid based on progress off the project.				
b	Rates to include for all equipment, plant, tools, labor, materials and associated activities required to complete the entire job as shown, specified and instructed by the BWS Engineer				
1.1	Allow for Insurances to minimum limits stated in the bidding document	1.00	LS	\$ 25,000.00	\$ 25,000.00
1.2	Allow for Performance security (10% of contract price)	1.00	LS	\$ 4,500.00	\$ 4,500.00
1.3	Allow for Mobilization and Demobilization including providing setting out, signs and safety barriers during works	1.00	LS	\$ 4,000.00	\$ 4,000.00
1.4	Allow for site clearance and preparation prior to commencement and after project completion	1.00	LS	\$ 3,500.00	\$ 3,500.00
1.5	Allow for all temporary structures and its maintenence such as 10'x10' clear internal space site office, temporary storage facilities, work sheds, work benches, sanitary facilities, site security, accommodations for security, site staff etc. as required including the dismantling, clearing away and make good on completion of the project	1.00	LS	\$ 2,500.00	\$ 2,500.00
1.6	Allow for the cost of utility services over the construction of the project including electricity, water, etc. As required including connection fees and charges during the construction phase and to clear away and make good on completion of the project	1.00	LS	\$ 900.00	\$ 900.00
1.7	Allow for provision of PPE (Personal Protective Equipment) as required for all work men and visitors.	1.00	LS	\$ 750.00	\$ 1,500.00
1.8	Provide for testing of concrete used in the works, both slump and cube tests. Slump: 2 per set, one before placing and other during placing. Cube: 4 specimen per set; two are to be tested at 7 days and two at 28 days.	1.00	Set	\$ 1,500.00	\$ 1,500.00
1.9	Allow for other specified testing such as sieve analysis, compaction percentage etc.	1.00	PS	\$ 4,000.00	\$ 4,000.00
				Total	\$ 47,400.00

### 3.1.2 Pumping Station

Item	Description	Qty	Unit	Rate (\$/unit)	Amount (US\$)
2.00	Supply and install Archimedes Screw Pumps. Stainless Steel. Concrete embedded. Discharge, Q = 2 m^3/s, Head, H = 3m. Electric motor driven.	3	No.	\$ 235,000.00	\$ 705,000.00
3.00	Civil Works: entry and exit channels, sedimentation basin, pump housing, mechanical and electrical.	1	LS	\$ 485,000.00	\$ 485,000.00
4.00	Supply and install standby diesel generator.	1	No.	\$ 208,000.00	\$ 208,000.00
5.00	Total				\$ 1,398,000.00

### 3.1.3 Sluice Gates

Item	Description	Qty	Unit	Rate (\$/unit)	Amount (US\$)
<b>1.00 GATE 1 and GATE 2</b>					
1.01	Supply and installation of Sluice Gate as required. W: 3080mm x H: 2440mm. See Specifications below.	2	No.	\$ 168,000.00	\$ 336,000.00
1.02	Supply and install Trash Screen (25mm gap) on both side of the gate. Stainless Steel Type 316.	4	No.	\$ 15,000.00	\$ 60,000.00
1.03	Manual cleaning with a 45 degree slope.	1	LS	\$ 70,000.00	\$ 70,000.00
<b>3.00 GATE 3</b>					
3.01	Supply and installation of Sluice Gate as required. W: 2440mm x H: 1070mm. See Specifications below.	1	No.	\$ 105,000.00	\$ 105,000.00
3.02	Supply and install Trash Screen (25mm gap) on both side of the gate. Stainless Steel Type 316.	2	No.	\$ 15,000.00	\$ 30,000.00
3.03	Manual cleaning with a 45 degree slope.	1	LS	\$ 35,000.00	\$ 35,000.00
<b>4.00 GATE 4</b>					
4.01	Supply and installation of Sluice Gate as required. W: 3080mm x H: 2440mm. See Specifications below.	1	No.	\$ 105,000.00	\$ 105,000.00
4.02	Supply and install Trash Screen (25mm gap) on both side of the gate. Stainless Steel Type 316.	2	No.	\$ 15,000.00	\$ 30,000.00
4.03	Manual cleaning with a 45 degree slope.	1	LS	\$ 105,000.00	\$ 105,000.00
<b>5.00 MISCELLANEOUS</b>					
5.01	Provide spare electrical actuators for all gates.	4	No.	\$ 8,500.00	\$ 34,000.00
5.02	Provide a Portable Gas Motor Driver Actuator that can be used to open and close gates when grid power is lost. See specifications.	2	No.	\$ 4,500.00	\$ 9,000.00
5.03	Supply and install Ultrasonic water level sensors. Two each at Gates 1, 2 and 3. See specifications.	6	No.	\$ 3,575.00	\$ 21,450.00
5.04	Supply and install SCADA system with all necessary hardware and software with the ability to monitor and control gates and pumping stations.	1	LS	\$ 125,000.00	\$ 125,000.00
5.05	Supply and install professional weather station. Solar powered. Sensors: Rainfall rate, wind, temperature, atmospheric pressure, data logger.	1	No.	\$ 7,500.00	\$ 7,500.00
				<b>TOTAL</b>	<b>\$ 1,072,950.00</b>

### 3.1.4 Dredging

<b>Item</b>	<b>Description</b>	<b>Qty</b>	<b>Unit</b>	<b>Rate (\$/unit)</b>	<b>Amount (US\$)</b>
1.00	Isolation				
	Supply and install suitable fill material (clay) to isolate 50m [160ft.] sections of the canal for cleaning.	1200	CM	\$ 50.00	\$ 60,000.00
2.00	Pumping				
	Provide and use 6" diesel trash pump to drawdown isolated canal sections	1	LS	\$ 75,000.00	\$ 75,000.00
3.00	Excavation				
	Provide and use excavator with a 4 ft. wide bucket (minimum) to remove debris.	9300	CM	\$ 16.50	\$ 153,450.00
4.00	Trucking				
	Provide and use suitable trucks with properly sealed beds (minimize spillage).	9300	CM	\$ 5.50	\$ 51,150.00
5.00	Disposal				
	Dispose of excavated material in an appropriate and environmentally safe manner.				
	5 mile radius of excavation point	9300	CM	\$ 2.50	\$ 23,250.00
	15 mile radius of excavation point	9300	CM	\$ -	
	30 mile radius of excavation point	9300	CM	\$ -	
	Over 30 miles	9300	CM	\$ -	
6.00	Supply materials (concrete, BRC mesh etc.) to repair sections of the concrete canal. Repair spalling, fill ruts, scrap and remove foreign matter including barnacles.	1	LS	\$ 150,000.00	\$ 150,000.00
7.00	Purchase and supply a 1,200 gallon capacity Vacuum Truck. 20 GPM @2500PSI,	1	No.	\$ 350,000.00	\$ 350,000.00
				Total	\$ 862,850.00

### 3.1.5 Street Drainage

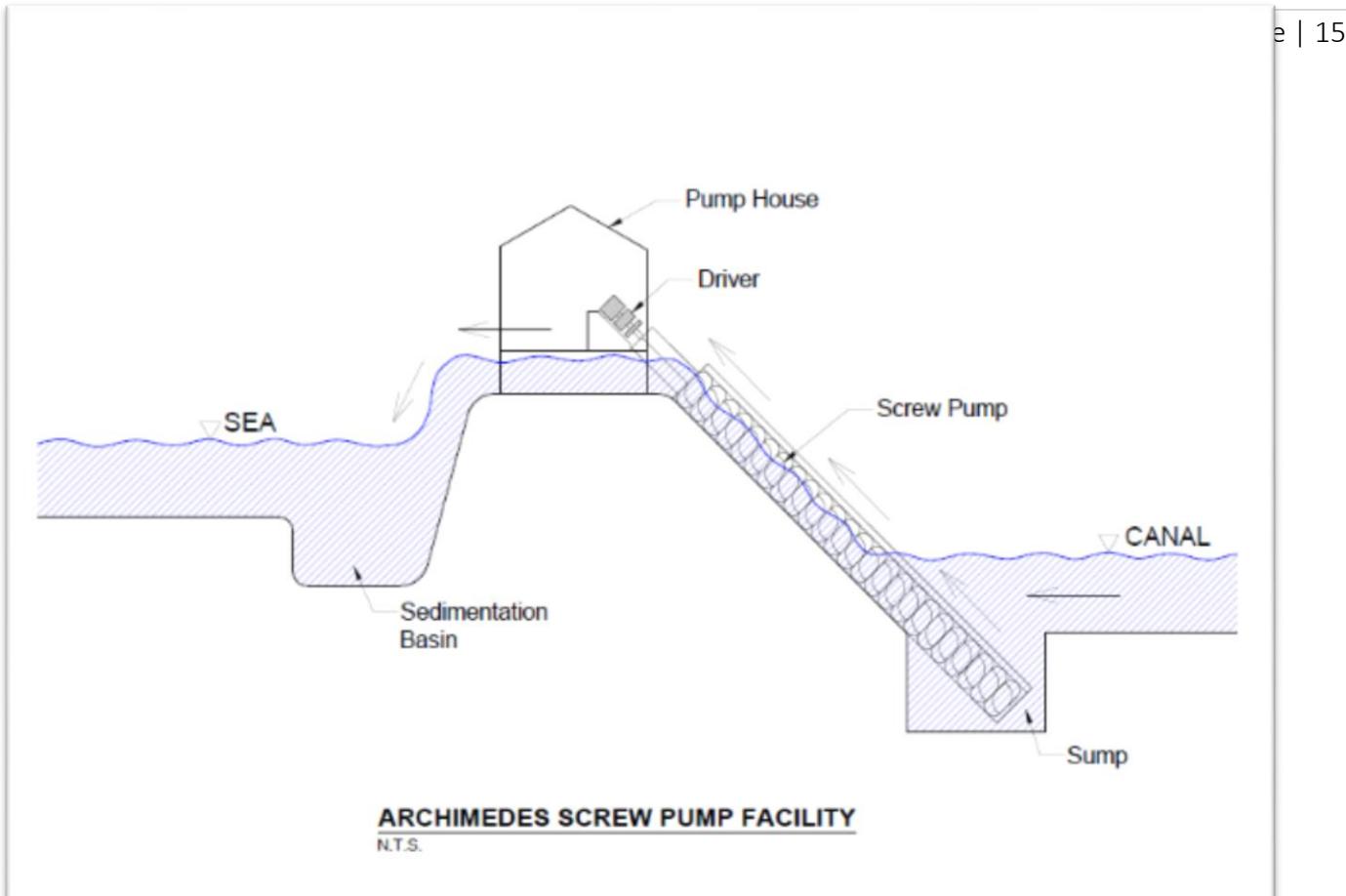
<b>Item</b>	<b>Description</b>	<b>Qty</b>	<b>Unit</b>	<b>Rate (\$/unit)</b>	<b>Amount (US\$)</b>
1.00	Clear site appropriately of all bush, shrub, grass, garbage and trees in a manner that the works can be completed properly and dispose at adequate location.	2400	m	\$ 2.25	\$ 5,400.00
2.00	Cut and remove section of curb and gutters along roadway. 300 mm in width.	4800	m	\$ 19.50	\$ 93,600.00
2.01	Supply and install granular compacted fill at the correct levels as indicated by drawings.	250	cm	\$ 15.50	\$ 3,875.00
2.02	Supply and install 4500 psi (min) reinforced swale (W: 300mm) with correct slope towards canals as indicated by drawings.	250	cm	\$ 535.00	\$ 133,750.00
3.00	Supply and install RC box culvert W: 900mm x H: 450mm x L: 15 m with appropriate angled wingwalls and clean-outs as detailed by drawings.	12	No.	\$ 7,250.00	\$ 87,000.00
4.00	Provide all labour and material to make repairs to existing sidewalks. Restore edges, cover existing manholes, widen, chamfer vertical edges where necessary.	1	LS	\$ 125,000.00	\$ 125,000.00
				Total	\$ 448,625.00

### 3.1.6 Canal Lining

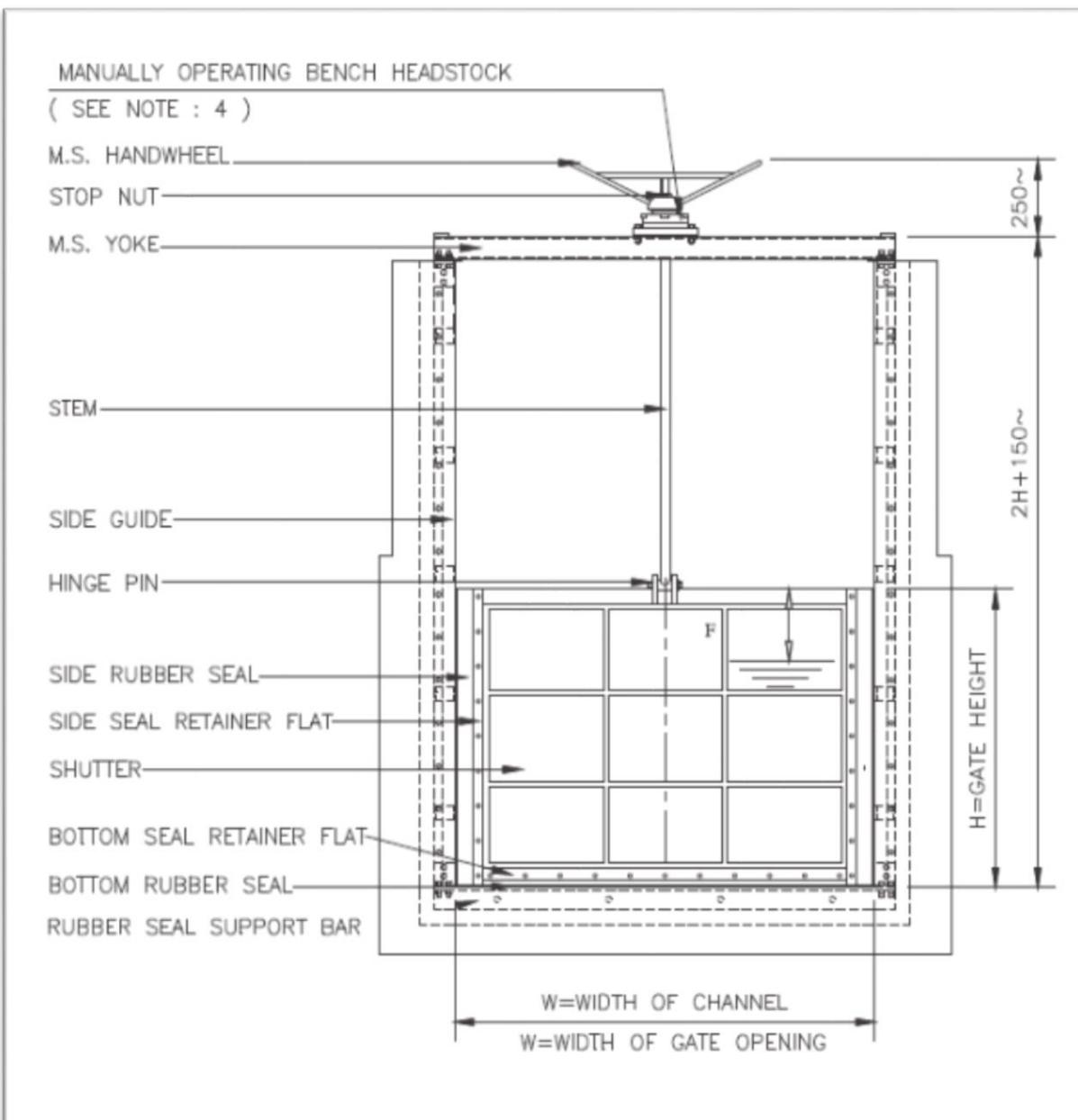
Item	Description	Qty	Unit	Rate (\$/unit)	Amount (US\$)
1.00	Excavation				
	Clearing existing open earthen canal , allow for widen where necessary min. width 4.0m, clearing canal bed of debris, waste and any obstruction. Allow for carting all debris off site to assigned location by Engineering Supervisor.	2,610.00	cm	\$ 18.50	\$ 48,285.00
2.00	Piling				
	Provide, install and cut 300mm concrete prestressed <b>Piles</b> to bed rock or to 40ton refusal (ENR) as specified in drawing. Piles to be placed with a tolerance of +/- 25mm horizontal displacement.	135	No.	\$ 975.00	\$ 131,625.00
3.00	Slabs				
	Provide all labour and materials to construct and install prefabricated <b>Vertical Slab</b> (1525mm x 3658mm) as shown in drawing.	135	No.	\$ 815.00	\$ 110,025.00
4.00	Capping beam				
	Provide all labour and materials to construct and install prefabricated <b>Capping Beam</b> as shown in drawing.	590	m	\$ 295.00	\$ 174,050.00
5.00	Safety Rails				
	Provide all labour and materials to construct and install prefabricated <b>Safety Rails</b> as shown in drawing.	590	m	\$ 225.00	\$ 132,750.00
6.00	Backfilling				
	Provide granular fill and allow for placing, compaction and shaping as deem necessary. Compaction not to exceed layer of 150mm.	2655	cm	\$ 85.00	\$ 225,675.00
7.00	Provide and install material to chip seal (two layers) backfilled area above item.	890	sm	\$ 16.00	\$ 14,240.00
				<b>Total</b>	<b>\$ 836,650.00</b>

## 4 Drawings/Sketches

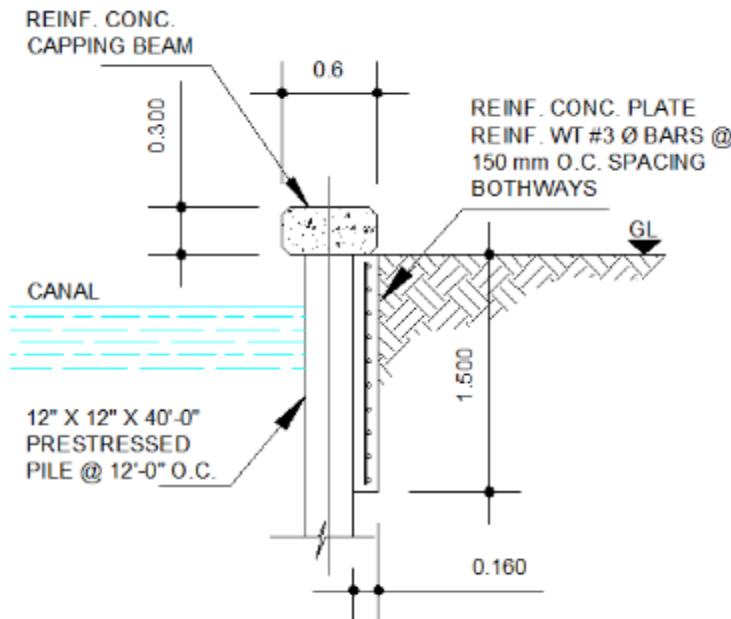
### 4.1 Pumping Station



## 4.2 Sluice Gates

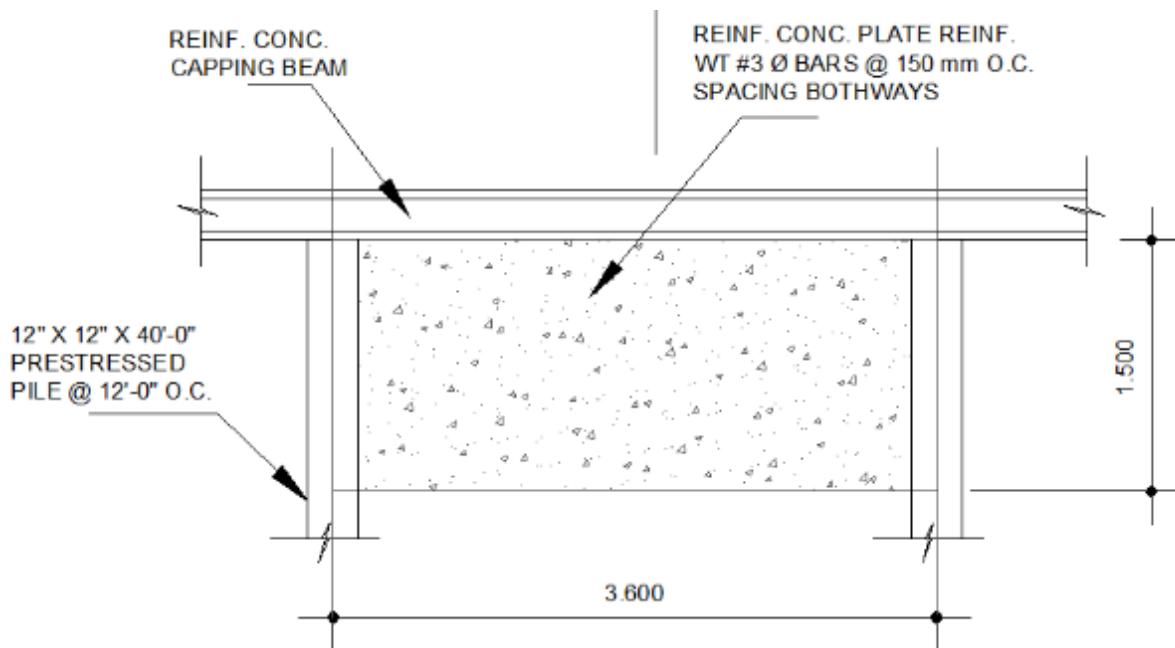


### 4.3 Retaining Wall



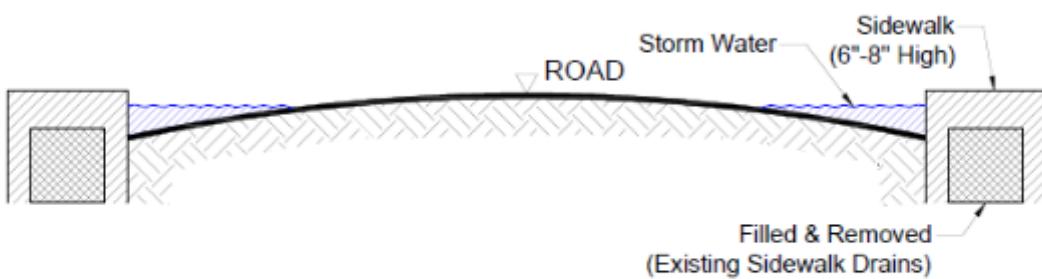
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**RETAINING WALL DESING SECTION**



**RETAINING WALL SIDE VIEW**

#### 4.4 Street Drainage



#### **CURB & GUTTER DRAINS**

N.T.S.

## 5 Annex 1 – Equipment Documentation

*See Attached Files*

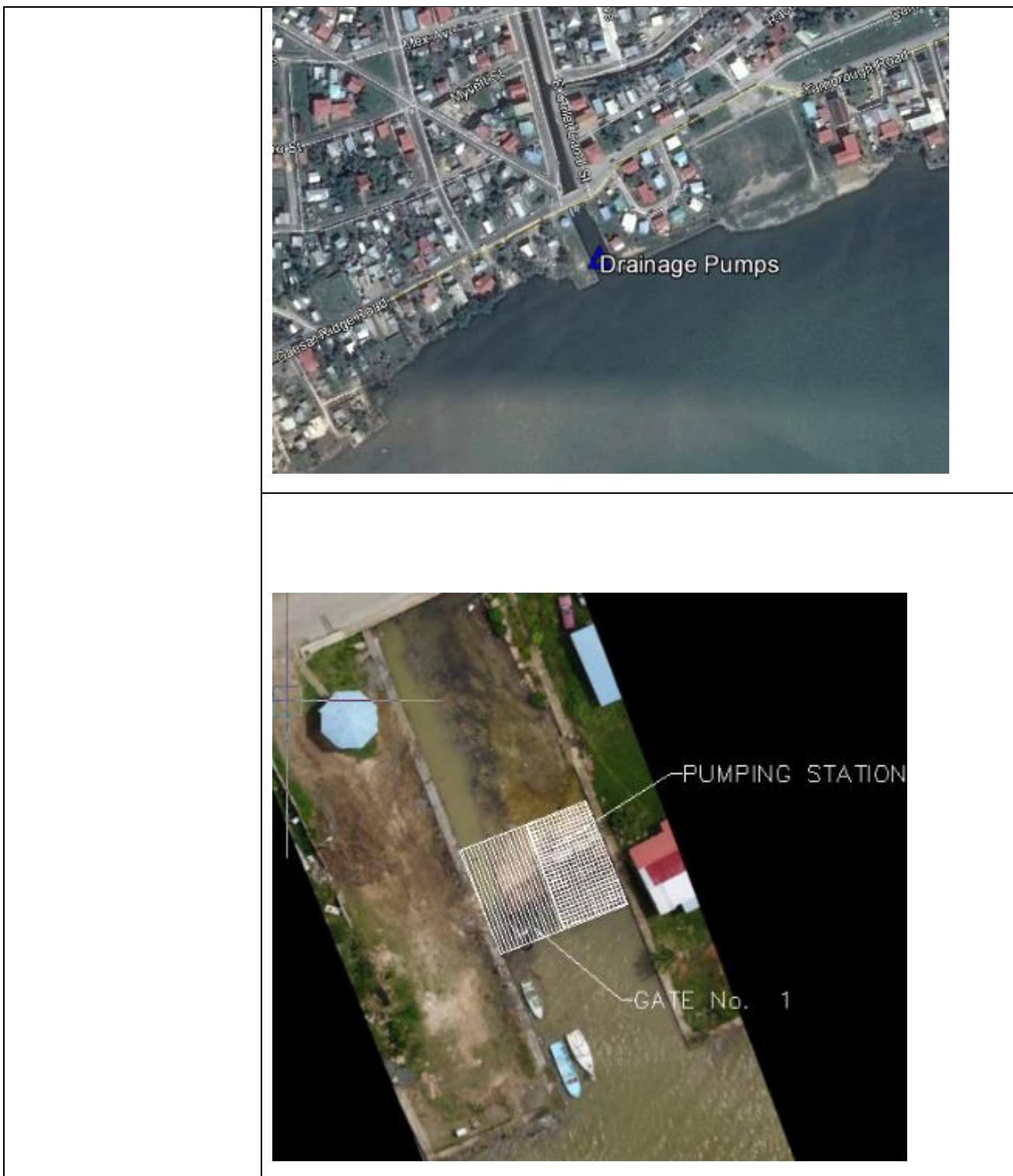
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## 6 Annex 2 – Data Sheets

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Component	<b>Drainage Pump – Archimedes Screw Type.</b>
Objectives	<p>The primary objective of these pumps is to transfer stormwater from the closed canal system of Collet and East Canals to the sea. The purpose of this is to reduce the incidence of flooding within the catchment area. Other secondary objectives include:</p> <ol style="list-style-type: none"><li>1. Pumping water through the canal system to improve circulation and consequently water quality;</li><li>2. Drawing down water levels during maintenance procedures such as routine cleaning.</li></ol>
	<p>This component will have the ability to reduce the effects of surface water flooding, river flooding and storm surge flood of the sub-catchment area.</p> <p>.</p>
Location	<p>The single pump station is to be located at the sea outfall of Collet Canal in the Yarbrough area of Belize City.</p> <p>XY Coordinates (WGS84): 373377 E, 1933734 N.</p>



Picture Example	
Beneficiaries	<p>The areas of the city to benefit from an improved drainage system include all the sub-catchment areas to the east and west pf both canal systems. Currently, the total catchment area is estimated to be 175 ac [71 ha].</p> <p>This area is a mixture of middle to low income residences (75%) and small to medium retail commercial (25%). There are no industries in this beneficiary area.</p>
Description of Intervention	<p>The objective of the drainage pumps is lower the water levels in the canal system (Collet and East Canals) to facilitate improved drainage of the catchment area.</p> <p>The scope of the project covers approximately 71 ha. Of land on the Southside of Belize City. The area will improve drainage for sections of Queen Square, Mesopotamia and Albert constituencies. The focus is on the Collet and East canal systems measuring a total length of 2.6 km.</p> <p>The screw type pump system being recommended has a design life span of 30 years.</p> <p>Flood risk types that are intended to be mitigated by this component includes surface water (pluvial) flooding form local heavy rainfall events. The gates will be closed and the pumps turned-on to evacuate the system. A fall in water level in the closed canal system will result in an increase in flow of storm water from the sub-catchments towards the canals. This effect will see a reduction flooding of the project area.</p> <p>Also, the component in combination with gates will mitigate against river (fluvial) flooding. Closed gates will stop river waters from entering the system. Pumps will be turned on if necessary to keep water levels in the canals at a prescribed level.</p>

	<p>There is also the possibility of the component assisting in the reduction of coastal flooding arising from a storm surge event (tropical cyclone). The gates will be open to allow the storm surge waters to naturally exit the system. However, this exit process can be enhanced by turning on the pumps.</p>
	<p>Schematic:</p> <p style="text-align: center;"><b>ARCHIMEDES SCREW PUMP FACILITY</b> N.T.S.</p>
	<p>Preliminary estimates indicate a required pumping rate of <math>6 \text{ m}^3/\text{s}</math>. It is suggested that three (3) screws be installed each with a capacity of <math>2 \text{ m}^3/\text{s}</math>.</p> <p>The area in which the pumps will be install has soils with very low bearing capacity. Hence the super structure must be placed on a piled foundation. The screw pump provider will be consulted on the best layout for the pump/gate system. All the structural members of the infrastructure (piles, plie caps, beams, slabs, walls and roof) will be constructed on site. The pumps, motors and electrical system will be procured and installed on site.</p> <p>Some of the main considerations during the construction process are ensuring that the canal system operates as per normal with the tidal, mitigating inconveniences to be experienced by neighbouring residents (noise, dust, traffic increase) and erosion control.</p>
Project Indicators	<p>The project will be designated a success when the pump system is able to operate reliably and provide the intended reduction in flood in the sub-catchment area.</p>

	<p>At a maximum pump rate of 6 m<sup>3</sup>/s, the pumps should be able to drawdown (3 ft.) water levels in the canal system with 1 hour of operation. Once the side drain connectivity is in place, flooding in the most at risk areas will be reduced and in some cases eliminated.</p>
Budget	The approximate capital budget for this pump system is US\$1.4 million.
Management Model	<p>The pumps along with gates will be under custody of the Belize City Council (BCC). Direct responsibility will fall on the City Engineer and his or her deputies.</p> <p>It is recommended that the pumps as well as the gates have the ability to be operated remotely. Each gate will have an ultra-sonic water level sensor and a Closed Circuit Camera System.</p> <p>The procedure for turning on pumps and closing the gates will be guided by the water level reading being transmitted to a central point. The City Engineer will close the gates and turn on the pumps when water levels have reached the prescribed critical level. The camera system will allow the operator to quickly determine if the gates are closed properly – debris has not blocked the gates, and also the ability to determine if the pumps are operational.</p>
Implementation Schedule	The expected time for implementation of this aspect of the project is the Third quarter of 2018.

INTER-AMERICAN DEVELOPMENT BANK

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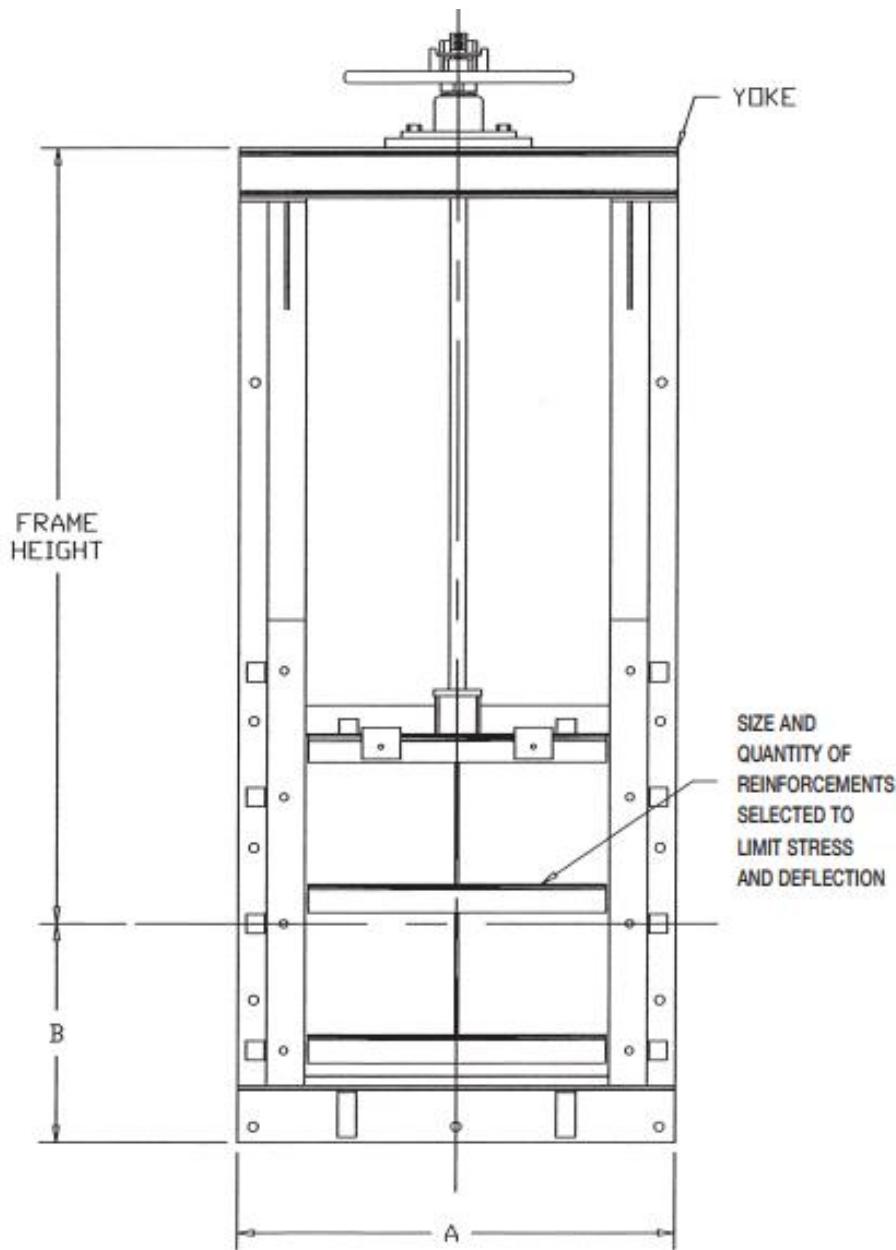
DATA SHEET: No. 002

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Component	<b>Hydraulic Gates – Sluice Gates: GATE 1</b>
Objectives	<p>The primary objective of Gate 1 is to close the outfall of Collet Canal to the sea. The Gate will form part of a four (4) gate locking system that when closed has the ability to isolate the Collet and East Canals from the sea and Haulover Creek. This isolation will provide operators with the opportunity to lower water levels in the canals via a pumping station which should result in reduced flooding of the sub-catchment area of the City.</p> <p>This component will have the ability to reduce the effects of surface water flooding, river flooding and storm surge flood of the sub-catchment area. .</p>
Location	<p>Gate 1 will be located next the pumping station at the Collet Canal sea outfall in the Yarbrough area of Belize City.</p> <p>XY Coordinates (WGS84): 373379 E, 1933734 N.</p>



Schematic



Picture Example	
Beneficiaries	<p>The areas of the city to benefit from an improved drainage system include all the sub-catchment areas to the east and west of both canal systems. Currently, the total catchment area is estimated to be 175 ac [71 ha].</p> <p>This area is a mixture of middle to low income residences (75%) and small to medium retail commercial (25%). There are no industries in this beneficiary area.</p>
Description of Intervention	The objective of Gate 1 is to close Collet Canal's sea outfall. It is one of four (4) gates to be installed for this proposed project. When close the gates will hydraulically isolate the canals so that they can be pumped.

	<p>At this point, the project is recommending sluice (vertical sliding) gates as the mechanism option for the closure of the canal system.</p> <p>A sluice gate is a barrier (“leaf”) sliding in grooves that are set in the sides of the canal. Sluice gates commonly control water levels and flow rates in rivers and canals. The sluice gates have a design life of approximately 25 years. Usually, a mechanism drives the sluice up or down. They may be hand-operated (manual), or it may be electrically or hydraulically powered.</p> <p>Flood risk types that are intended to be mitigated by this component includes surface water (pluvial) flooding from local heavy rainfall events. The gates will be closed and the pumps turned-on to evacuate the system. A fall in water level in the closed canal system will result in an increase in flow of storm water from the sub-catchments towards the canals. This effect will see a reduction flooding of the project area.</p> <p>Also, gates will mitigate against river (fluvial) flooding. Closed gates will stop river waters from entering the system. Pumps will be turned on if necessary to keep water levels in the canals at a prescribed level.</p>
	<p>Gate 1 will be largest of all four gates with a span of approximately 30 ft. Gates will be constructed with stainless steel. Electric actuators will have a manual override function and will have the ability to be remotely operated.</p> <p>The area in which the Gate 1 will be installed has soils with very low bearing capacity. Hence the gate’s super structure must be placed on a piled foundation. The gate fabricator/provider will be consulted on the best layout. All components of the gates such as framing, leaf, actuators etc. will be procured internationally.</p> <p>Some of the main considerations during the construction process are ensuring that the canal system operates as per normal with the tidal, mitigating inconveniences to be experienced by neighbouring residents (noise, dust, traffic increase) and erosion control.</p>
Project Indicators	The project will be designated a success when the gate is able to operate reliably and provide the intended reduction in flooding in the sub-catchment area.

	Specifically, the gates should be able to effectively isolate the canal system hydraulically from the sea, river and West Canal. That is, there should be no perceptible leakage of water when the gates are closed.
Budget	The approximate capital budget for Gate 1 is US\$ 233,000.00
Management Model	<p>The gates will be managed by the Belize City Council (BCC). Direct responsibility will fall on the City Engineer.</p> <p>It is recommended that the gates have the ability to be operated remotely. Each gate will have an ultra-sonic water level sensor (on both sides of the gate) and a Closed Circuit Camera System installed on them.</p> <p>The closure of the gates will be guided by the water level reading being transmitted to a central point. The City Engineer will close the gates and turn on the pumps when water levels have reached a prescribed critical level. The camera system will allow the operator to quickly see if the gates are closed properly and that the pumps are operational.</p>
Implementation Schedule	The expected time for implementation of this aspect of the project is the third quarter of 2018.

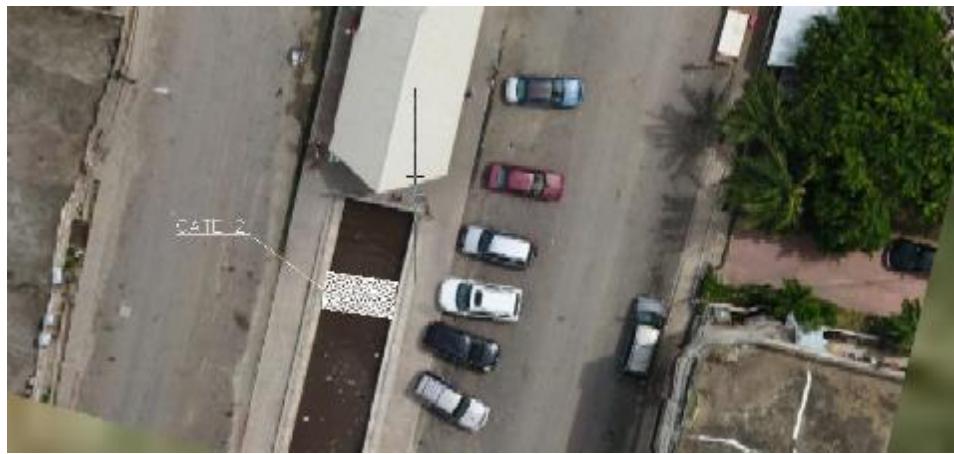
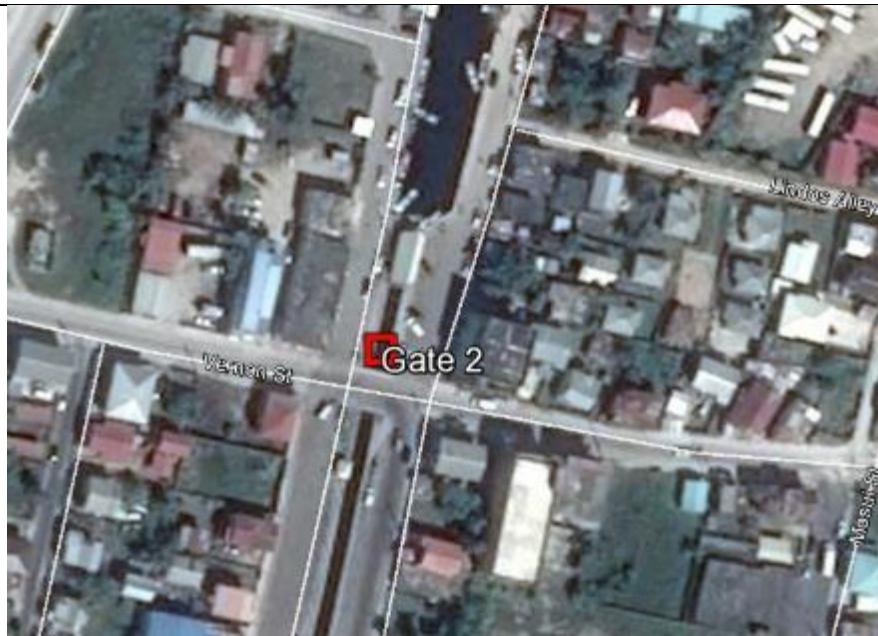
INTER-AMERICAN DEVELOPMENT BANK

Updating and Detailed Designs of Flood Control Works in Belize City

DATA SHEET: No. 003

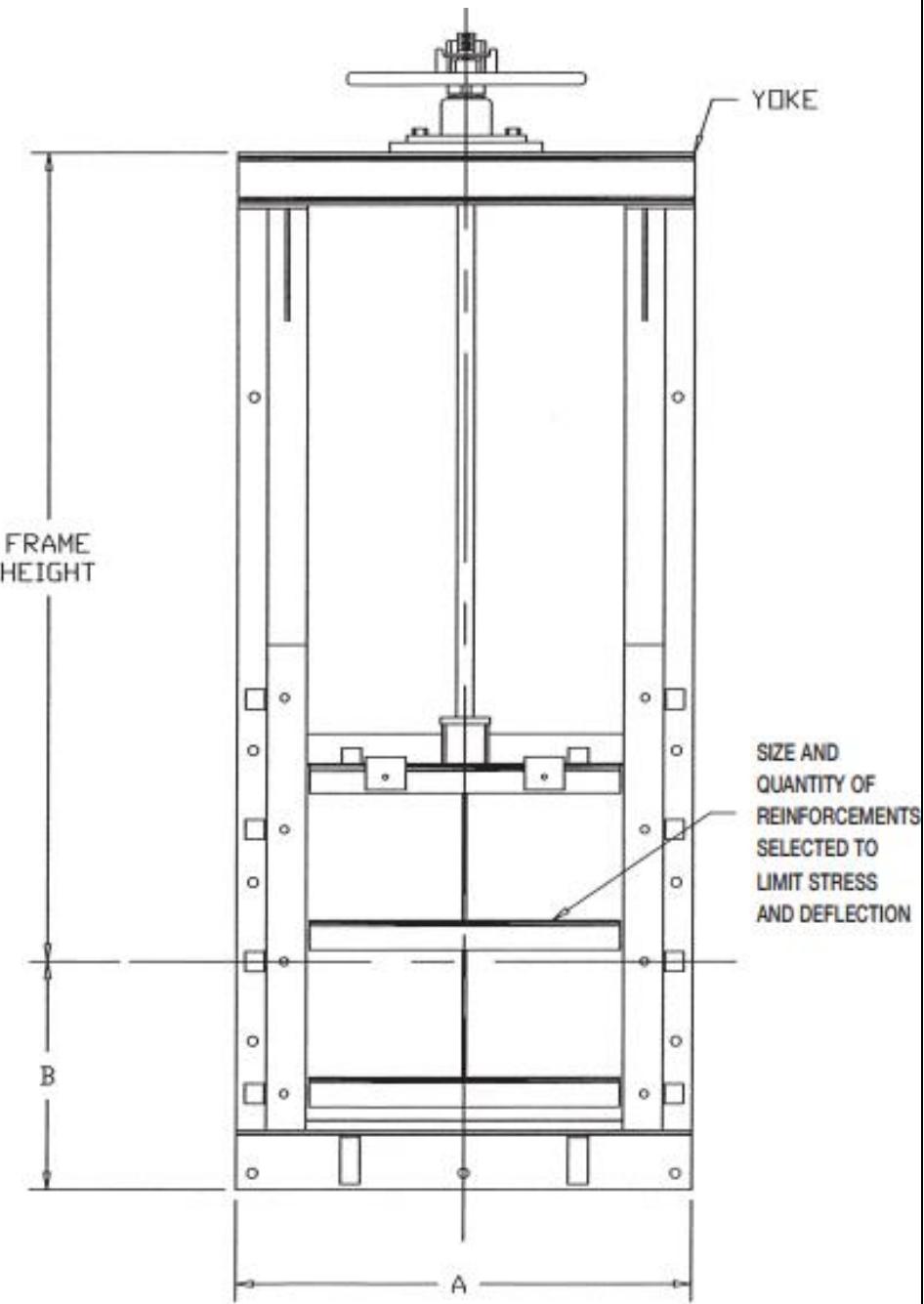
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Component	<b>Hydraulic Gates – Sluice Gates: GATE 2</b>
Objectives	<p>The primary objective of <b>Gate 2</b> is to close the outfall of Collet Canal to Haulover Creek. The Gate will form part of a four (4) gate locking system that when closed has the ability to isolate the Collet and East Canals from the sea and Haulover Creek. This isolation will provide operators with the opportunity to lower water levels in the canals via a pumping station which should result in reduced flooding of the sub-catchment area of the City.</p> <p>This component will have the ability to reduce the effects of surface water flooding, river flooding and storm surge flood of the sub-catchment area.</p> <p>.</p>
Location	<p>Gate 2 will be located in the lined section of the canal near the Vernon Street Bridge (Pound yard Bridge).</p> <p>XY Coordinates (WGS84): 373434.00 m E, 1934907.00 m N</p>



*Figure 2: This location is near the Conch Shell Bay fish market building.*

Schematic



Picture Example	
Beneficiaries	<p>The areas of the city to benefit from an improved drainage system include all the sub-catchment areas to the east and west of both canal systems. Currently, the total catchment area is estimated to be 175 ac [71 ha].</p> <p>This area is a mixture of middle to low income residences (75%) and small to medium retail commercial (25%). There are no industries in this beneficiary area.</p>
Description of Intervention	<p>The objective of Gate 2 is to close Collet Canal's river outfall. It is one of four (4) gates to be installed for this proposed project. When required, the gates will close and hydraulically isolate the canals so that they can be pumped.</p>

	<p>At this point, the project is recommending sluice (vertical sliding) gates as the mechanism option for the closure of the canal system.</p> <p>A sluice gate is a barrier ("leaf") sliding in grooves that are set in the sides of the canal. Sluice gates commonly control water levels and flow rates in rivers and canals. The sluice gates have a design life of approximately 25 years. Usually, a mechanism drives the sluice up or down. They may be hand-operated (manual), or it may be electrically or hydraulically powered.</p> <p>Flood risk types that are intended to be mitigated by this component includes surface water (pluvial) flooding from local heavy rainfall events. The gates will be closed and the pumps turned-on to evacuate the system. A fall in water level in the closed canal system will result in an increase in flow of storm water from the sub-catchments towards the canals. This effect will see a reduction flooding of the project area.</p> <p>Also, gates will mitigate against river (fluvial) flooding. Closed gates will stop river waters from entering the system. Pumps will be turned on if necessary to keep water levels in the canals at a prescribed level.</p>
	<p>Gate 2 will have a span of approximately 15 ft. Gates will be constructed with stainless steel. Electric actuators will have a manual override function and will have the ability to be remotely operated.</p> <p>Gate 2 will be installed in the concrete lined canal between the Conch Shell Bay building and the Vernon Street bridge. It is envisioned that the sluice-gate structure will be able to be supported by the existing canal lining. Further investigations in the design and bearing capacity of the concrete lining need to take place. If the lining cannot support the weight of the sluice gate, additional foundation support will be necessary. The gate fabricator/provider will be consulted on the best layout. All components of the gates such as framing, leaf, actuators etc. will be procured internationally.</p> <p>Some of the main considerations during the construction process are ensuring that the canal system operates as per normal with the tidal, mitigating inconveniences to be experienced by neighbouring residents (noise, dust, traffic increase) and erosion control.</p>
Project Indicators	The project will be designated a success when the gate is able to operate reliably and provide the intended reduction in flooding in the sub-catchment area.

	Specifically, the gates should be able to effectively isolate the canal system hydraulically from the sea, river and West Canal. That is, there should be no perceptible leakage of water when the gates are closed.
Budget	The approximate capital budget for Gate 2 is US\$ 233,000.00
Management Model	<p>The gates will be managed by the Belize City Council (BCC). Direct responsibility will fall on the City Engineer.</p> <p>It is recommended that the gates have the ability to be operated remotely. Each gate will have an ultra-sonic water level sensor (on both sides of the gate) and a Closed Circuit Camera System installed on them.</p> <p>The closure the gates will be guided by the water level reading being transmitted to a central point. The City Engineer will close the gates and turn on the pumps when water levels have reached a prescribed critical level. The camera system will allow the operator to quickly see if the gates are closed properly and that the pumps are operational.</p>
Implementation Schedule	The expected time for implementation of this aspect of the project is the third quarter of 2018.

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Component	<b>Hydraulic Gates – Sluice Gates: GATE 3</b>
Objectives	<p>The primary objective of <b>Gate 3</b> is to close the outfall of East Canal and Haulover Creek. The Gate will form part of a four (4) gate locking system that when closed, has the ability to isolate the Collet and East Canals from the sea and Haulover Creek. This isolation will provide operators with the opportunity to lower water levels in the canals via a pumping station which should result in reduced flooding of the sub-catchment area of the City.</p> <p>This component will have the ability to reduce the effects of surface water flooding, river flooding and storm surge flood of the sub-catchment area.</p> <p>.</p>
Location	<p>Gate 3 will be located in the lined section of East Canal near the intersection of Regent Street West and East Canal Street.</p> <p>XY Coordinates (WGS84): 373845.52 m E, 1934812.14 m N</p>

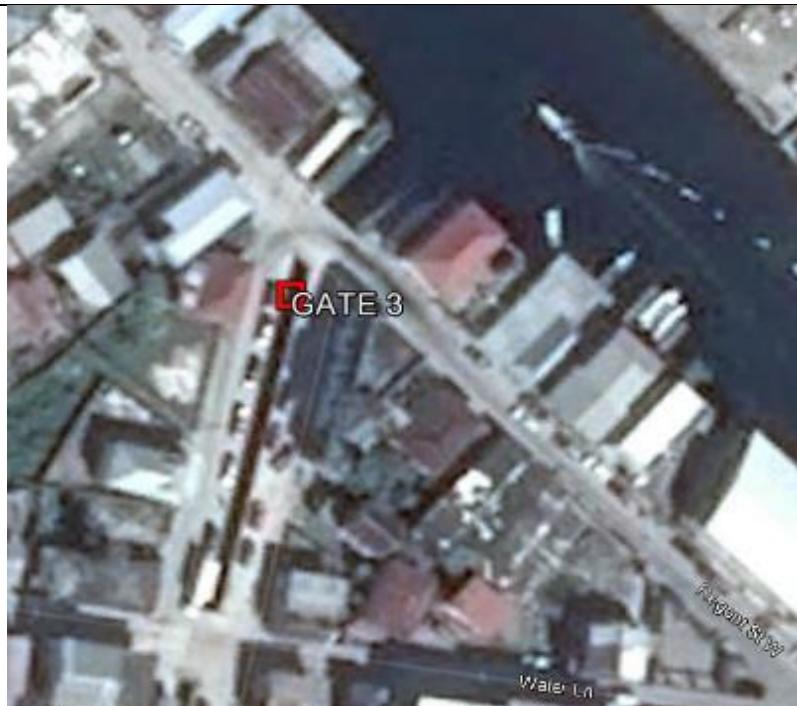
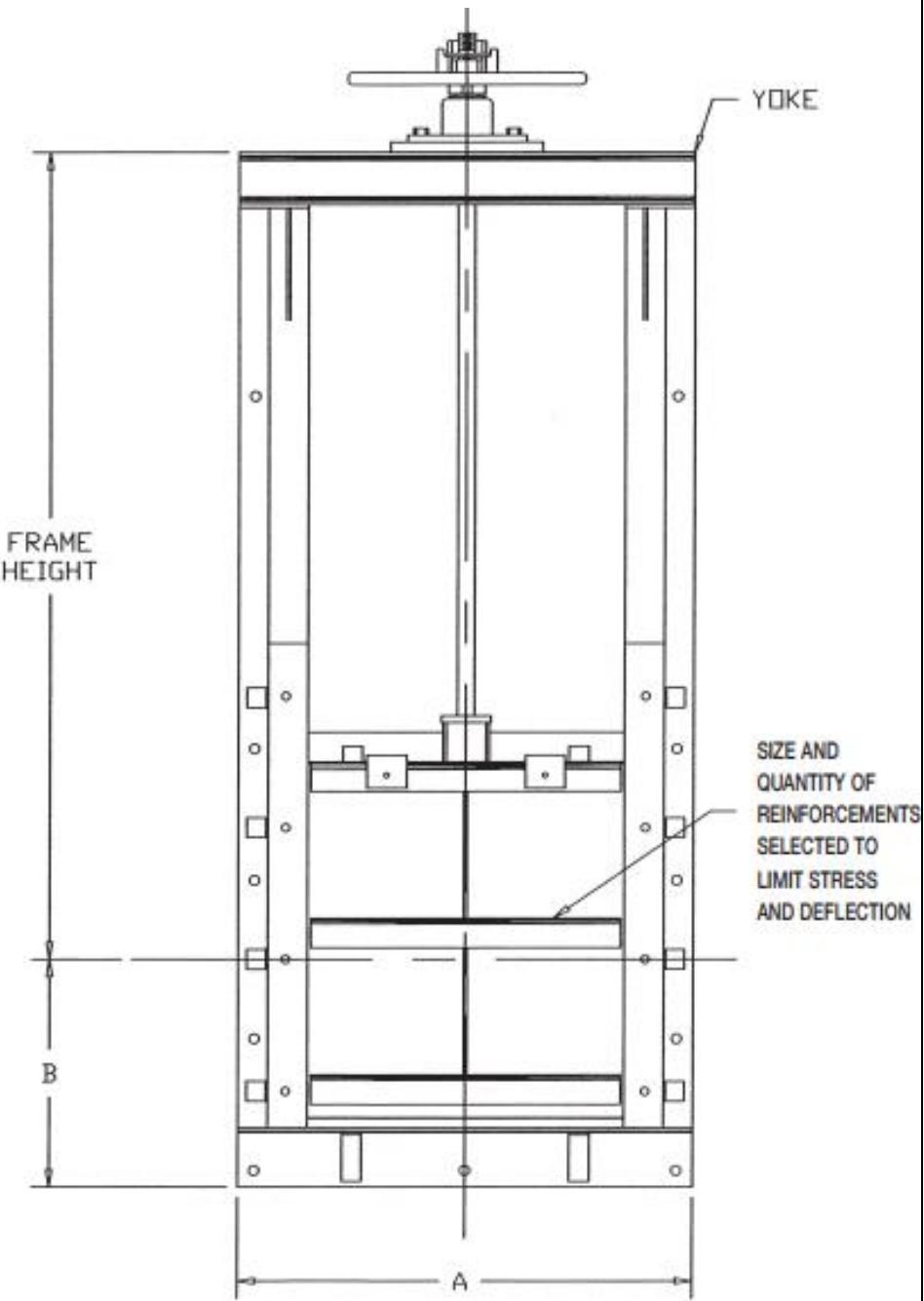


Figure 3: At the intersection of Regent St West and East Canal Street.

Schematic



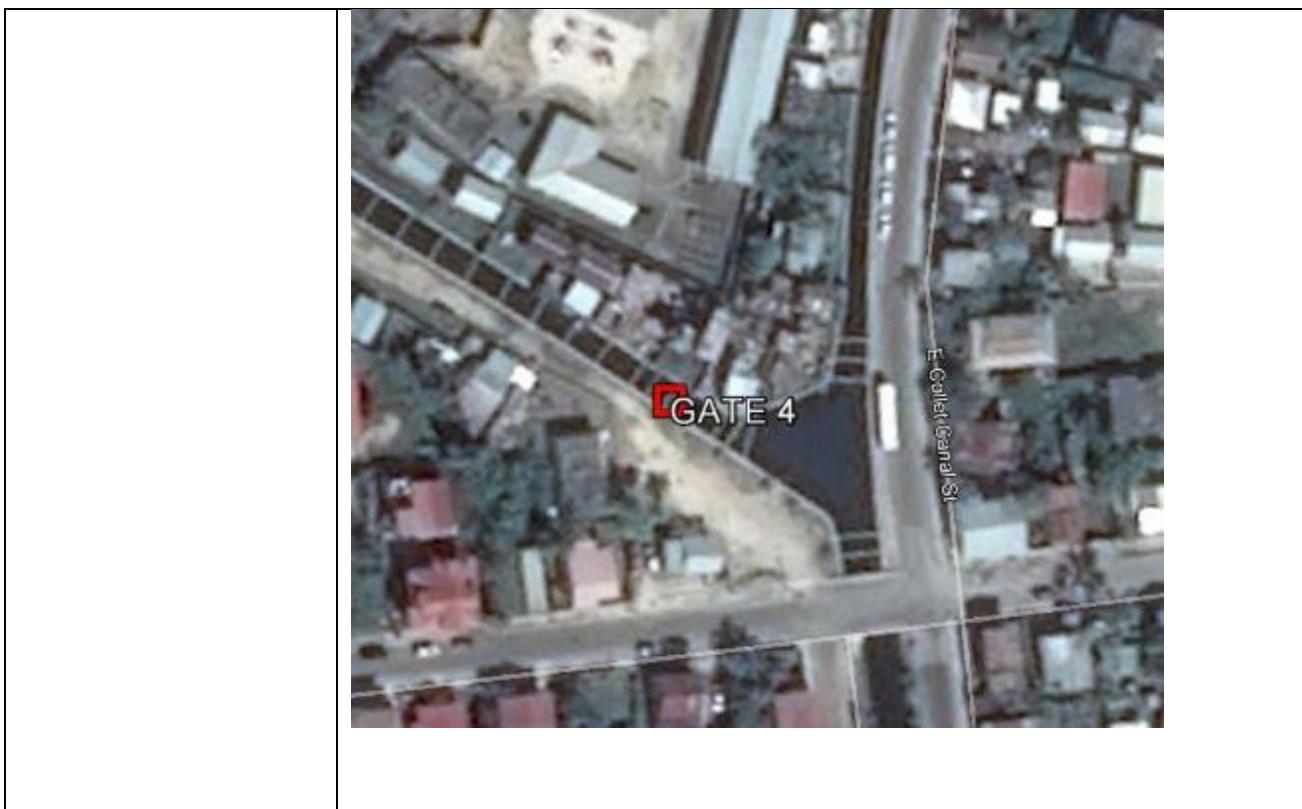
Picture Example	
Beneficiaries	<p>The areas of the city to benefit from an improved drainage system include all the sub-catchment areas to the east and west of both canal systems. Currently, the total catchment area is estimated to be 175 ac [71 ha].</p> <p>This area is a mixture of middle to low income residences (75%) and small to medium retail commercial (25%). There are no industries in this beneficiary area.</p>
Description of Intervention	<p>The objective of Gate 3 is to close East Canal's river outfall. It is one of four (4) gates to be installed for this proposed project. When required, the gates will close and hydraulically isolate the canals so that they can be pumped.</p> <p>At this point, the project is recommending sluice (vertical sliding) gates as the option for the closure of the canal system.</p>

	<p>A sluice gate is a barrier ("leaf") sliding in grooves that are set in the sides of the canal. Sluice gates commonly control water levels and flow rates in rivers and canals. The sluice gates have a design life of approximately 25 years. Usually, a mechanism drives the sluice up or down. They may be hand-operated (manual), or it may be electrically or hydraulically powered.</p> <p>Flood risk types that are intended to be mitigated by this component includes surface water (pluvial) flooding from local heavy rainfall events. The gates will be closed and the pumps turned-on to evacuate the system. A fall in water level in the closed canal system will result in an increase in flow of storm water from the sub-catchments towards the canals. This effect will see a reduction flooding of the project area.</p> <p>Also, gates will mitigate against river (fluvial) flooding. Closed gates will stop river waters from entering the system. Pumps will be turned on if necessary to keep water levels in the canals at a prescribed level.</p>
	<p>Gate 3 will have a span of approximately 10 ft. Gates will be constructed with stainless steel. Electric actuators will have a manual override function and will have the ability to be remotely operated.</p> <p>Gate 3 will be installed in the East Canal concrete lining. It is envisioned that the sluice-gate structure can be supported by the existing canal lining. Further investigations of the design and bearing capacity of the concrete lining needs to take place. If the lining cannot support the weight of the sluice gate, additional foundation support will be necessary. The gate fabricator/provider will be consulted on the best layout. All components of the gates such as framing, leaf, actuators etc. will be procured internationally.</p> <p>Some of the main considerations during the construction process are ensuring that the canal system operates as per normal with the tidal, mitigating inconveniences to be experienced by neighbouring residents (noise, dust, traffic increase) and erosion control.</p>
Project Indicators	<p>The project will be designated a success when the gate is able to operate reliably and provide the intended reduction in flooding in the sub-catchment area.</p> <p>Specifically, the gates should be able to effectively isolate the canal system hydraulically from the sea, river and West Canal. That is, there should be no perceptible leakage of water when the gates are closed.</p>

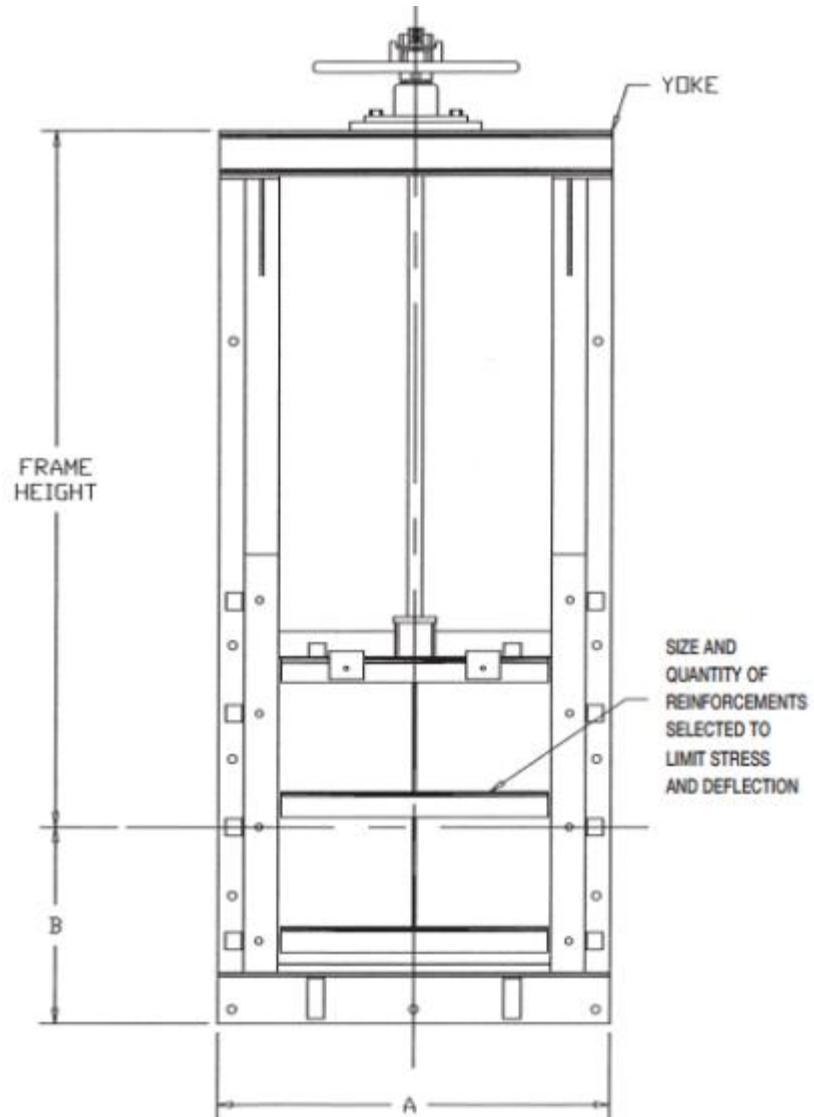
Budget	The approximate capital budget for Gate 3 is US\$ 170,000.00
Management Model	<p>The gates will be managed by the Belize City Council (BCC). Direct responsibility will fall on the City Engineer.</p> <p>It is recommended that the gates have the ability to be operated remotely. Each gate will have an ultra-sonic water level sensor (on both sides of the gate) and a Closed Circuit Camera System installed on them.</p> <p>The closure the gates will be guided by the water level reading being transmitted to a central point. The City Engineer will close the gates and turn on the pumps when water levels have reached a prescribed critical level. The camera system will allow the operator to quickly see if the gates are closed properly and that the pumps are operational.</p>
Implementation Schedule	The expected time for implementation of this aspect of the project is the third quarter of 2018.

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Component	<b>Hydraulic Gates – Sluice Gates: GATE 4</b>
Objectives	<p><b>Gate 4</b> will be installed on West Canal (South Creek). The Gate will form part of a four (4) gate locking system that when closed, has the ability to isolate the Collet and East Canals from the sea, Haulover Creek and West Canal. This isolation will provide operators with the opportunity to lower water levels in the project canals via a pumping station which should result in reduced flooding of the contributing sub-catchment areas of the City.</p> <p>This component will have the ability to reduce the effects of surface water flooding, river flooding and storm surge flood of the sub-catchment area.</p> <p>.</p>
Location	<p>Gate 4 will be located in the lined section of West Canal near the confluence with Collet Canal at the road intersection of Kut Avenue and East Collet Canal Street.</p> <p>XY Coordinates (WGS84): 373240.02 m E, 1934108.42 m N</p>



Schematic



Picture Example	
Beneficiaries	<p>The areas of the city to benefit from an improved drainage system include all the sub-catchment areas to the east and west of both canal systems. Currently, the total catchment area is estimated to be 175 ac [71 ha].</p> <p>This area is a mixture of middle to low income residences (75%) and small to medium retail commercial (25%). There are no industries in this beneficiary area.</p>
Description of Intervention	<p>The objective of Gate 4 is to close off West canal from Collet Canal when necessary. It is one of four (4) gates to be installed for this proposed project. When required the gates will close and hydraulically isolate the canals so that they can be pumped.</p> <p>At this point, the project is recommending sluice (vertical sliding) gates as the option for the closure of the canal system.</p>

	<p>A sluice gate is a barrier ("leaf") sliding in grooves that are set in the sides of the canal. Sluice gates commonly control water levels and flow rates in rivers and canals. The sluice gates have a design life of approximately 25 years. Usually, a mechanism drives the sluice up or down. They may be hand-operated (manual), or it may be electrically or hydraulically powered.</p> <p>Flood risk types that are intended to be mitigated by this component includes surface water (pluvial) flooding from local heavy rainfall events. The gates will be closed and the pumps turned-on to evacuate the system. A fall in water level in the closed canal system will result in an increase in flow of storm water from the sub-catchments towards the canals. This effect will see a reduction flooding of the project area.</p> <p>Also, gates will mitigate against river (fluvial) flooding. Closed gates will stop river waters from entering the system. Pumps will be turned on if necessary to keep water levels in the canals at a prescribed level.</p>
	<p>Gate 4 will have a span of approximately 15 ft. Gates will be constructed with stainless steel. Electric actuators will have a manual override function and will have the ability to be remotely operated.</p> <p>Gate 4 will be installed on West Canal near the confluence with Collet Canal at the road intersection of Kut Avenue and East Collet Canal Street. It is envisioned that the sluice-gate structure can be supported by the existing canal lining. Further investigations of the design and bearing capacity of the concrete lining needs to take place. If the lining cannot support the weight of the sluice gate, additional foundation support will be necessary. The gate fabricator/provider will be consulted on the best layout. All components of the gates such as framing, leaf, actuators etc. will be procured internationally.</p> <p>Some of the main considerations during the construction process are ensuring that the canal system operates as per normal with the tidal, mitigating inconveniences to be experienced by neighbouring residents (noise, dust, traffic increase) and erosion control.</p>
Project Indicators	The project will be designated a success when the gate is able to operate reliably and provide the intended reduction in flooding in the sub-catchment area.

	Specifically, the gates should be able to effectively isolate the canal system hydraulically from the sea, river and West Canal. That is, there should be no perceptible leakage of water when the gates are closed.
Budget	The approximate capital budget for Gate 4 is US\$ 240,000.00
Management Model	<p>The gates will be managed by the Belize City Council (BCC). Direct responsibility will fall on the City Engineer.</p> <p>It is recommended that the gates have the ability to be operated remotely. Each gate will have an ultra-sonic water level sensor (on both sides of the gate) and a Closed Circuit Camera System installed on them.</p> <p>The closure the gates will be guided by the water level reading being transmitted to a central point. The City Engineer will close the gates and turn on the pumps when water levels have reached a prescribed critical level. The camera system will allow the operator to quickly see if the gates are closed properly and that the pumps are operational.</p>
Implementation Schedule	The expected time for implementation of this aspect of the project is the third quarter of 2018.

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Component	<b>Dredging Works</b>
Objectives	<p>The primary objective of dredging is to clean the canal system of all foreign matter. This includes, silt, sand, rocks, garbage, rotting matter et. Anything that is reducing the flow (hydraulic) capacity of the canal system must be extracted and disposed of in a responsible manner.</p> <p>This component will have the ability to reduce the effects of surface water flooding, river flooding and storm surge flood of the sub-catchment area. The dredged canals will have greater stormwater carrying capacity which will reduce flooding in the area.</p>
Location	<p>Dredging works will be conducted on both Collet and East Canals.</p> <p>Collet Canal's length: 4,500 ft. [1,380 m]</p> <p>East Canal's length: 3,880 ft. [1,182 m]</p>



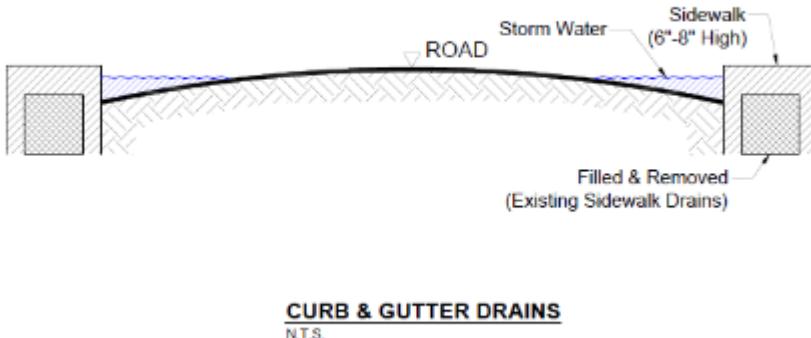
Figure 4: Collet Canal: Purple. East Canal: Orange.

Beneficiaries	<p>The areas of the city to benefit from an improved drainage system include all the sub-catchment areas to the east and west pf both canal systems. Currently, the total catchment area is estimated to be 175 ac [71 ha].</p> <p>This area is a mixture of middle to low income residences (75%) and small to medium retail commercial (25%). There are no industries in this beneficiary area.</p>
Description of Intervention	<p>Dredging of the canals is the exercise of removing, transporting and safely disposing of the significant amount of silt and debris that has built-up the canal system over many years. The dredged canals will have greater stormwater carrying capacity and will result in reduced flooding in the area.</p> <p>Current estimates of the volume of material to be dredged is some 12,163 cubic yards or 1,200 truckloads.</p> <p>There are two main considerations for dredging:</p> <ol style="list-style-type: none"><li>1. Disposal Location: material requires testing before disposal location can be determined.</li></ol>

	2. Method of extraction: based on a number of factors such as size and accessibility, it is recommended that an excavator be used.
Project Indicators	The dredging aspect of the project will be deemed a success when all the built-up material from both canals is safely and effectively removed, and disposed of in a location in which environmental risks are low.
Budget	The approximate capital budget for dredging is US\$ 862, 850.00
Management Model	Dredging will occur using backhoe or excavator buckets. The plan is to block sections of the canal, dewater, then begin the process of removing debris. Blocking (plugging) can be done with 2 – 3 truckloads of clay. Once the section is cleaned, the clay plug is removed and moved to another section.  Cleaning of the canals will include the removal of all foreign matter from the base and sides of the structure such as barnacles. The dredging contractor will be asked to execute minor repair works to all structurally damaged sections of the canals. Repairs will generally include concrete path work for chipped or spalling concrete surfaces.
Implementation Schedule	The expected time for implementation of this aspect of the project is the first quarter of 2018.

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Component	<h2>Street Drainage</h2>
Objectives	<p>The primary objective of the street rehabilitation component is to improve the side street drainage system that connects to the canals in question. The rehabilitation and upgrading of critical side street drains will result in the stormwater effectively draining towards the canals.</p> <p>This component will have the ability to reduce the effects of surface water flooding as a result of extreme rainfall events.</p>
Location	<p>Initially the main streets that were under consideration for side drain rehabilitation were Orange Street, King Street and Dean Street. These have a total length of 2,400 m [7,870 ft.]. See figure below.</p> 

Beneficiaries	<p>The areas of the city to benefit from an improved drainage system include all the sub-catchment areas to the east and west pf both canal systems. Currently, the total catchment area is estimated to be 175 ac [71 ha].</p> <p>This area is a mixture of middle to low income residences (75%) and small to medium retail commercial (25%). There are no industries in this beneficiary area.</p>
Description of Intervention	<p>The existing type of side drains are concrete lined box-shaped conduits covered under the sidewalk. The majority of these are blocked with silt and garbage and hence not effective as drainage conduits.</p> <p>The new proposal for side drains it to construct surface drains in the form of shallow swales and kerb and gutters. This surface drainage system will essentially result in the entire road as being the drainage conduit. Note that with the canal system in full operation with gates and pumps, stormwater from an extreme event may pond temporarily on the roads. However, drawdown should be fair rapid (&lt; 15 mins) once the pumps begin to operate. The main advantages of this surface drainage concept is the ability for the streets (which effectively is also the drain) to be cleaned on a routine basis (weekly). Other benefits of this system include a reduction in cost of construction and the removal of the unsightly and potential health hazards stagnant drains currently pose.</p> <p>As it relates to drainage in Belize City, this component seeks to address the situation that exists where many drains have no outlet and/or are not connected to each other (the lack of connectivity). The newly constructed surface drains will all have an outlet (canals).</p>
Schematic	 <p style="text-align: center;"><b>CURB &amp; GUTTER DRAINS</b> N.T.S.</p>

Project Indicators	This component will be deemed a success when all the recommended side drainage are rehabilitated. Additionally, inundation on major streets like King St. and Dean Street will be eliminated.
Budget	The approximate capital budget for street rehabilitation is US\$ 448,625.00
Management Model	<p>The execution of this component will require significant collaboration between the project principals and the Belize City Council. Most of this type of work will involve the use of manual labour, which should provide temporary jobs for willing inner city youth.</p> <p>The construction works will result in inconveniences being experienced by motorists, business owners and residents (noise and dust pollution).</p>
Implementation Schedule	The expected time for implementation of this aspect of the project is the first quarter of 2018.

INTER-AMERICAN DEVELOPMENT BANK
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DATA SHEET: No. 008

Component	<b>Lining of Collet Canal</b>
Objectives	The primary objective of lining the Collet Canal is for erosion control and containment of the water in the canal from the Canal Intersection at Kut Avenue to Yarborough Bridge. Lining the Collet Canal will also improve the aesthetics of the proposed area of the Collet Canal.
Location	The Collet Canal has concrete lining from the inlet at Haulover Creek until the intersection with Kut Avenue. The remainder of the canal, from Kut Avenue to the outlet to the Caribbean Sea, is unlined and therefore the banks are earthen. There are asphalt paved streets on both sides of the Canal, but there is no canal edge or wall that separates the canal from the adjacent streets. The new lining of the Collet Canal, shown in the figure below, would provide additional stability and confinement to the canal. The canal lining wall would prevent the canal's earthen banks from eroding under the streets. The length of the Collet Canal from Kut Avenue to the Yarborough bridge is approximately 1,000 feet, therefore to line both sides of the canal, the resulting length of lining needed is approximately 2,000 feet.

	
Beneficiaries	The canal lining could provide safety for drivers and pedestrians on West and East Collet Canal Streets.
Description of Intervention	The lining will be done with the use of pre-stressed concrete piles, a reinforced concrete plate (slab), and a reinforced concrete capping beam. The pre-stressed concrete piles will be placed at increments of 12 feet on each side of the canal. At this increment, the total amount of piles to be placed will be approximately 170. The reinforced concrete plate is placed behind the piles followed by the reinforced concrete capping beam to tie all the members together.

<p><b>Schematic</b></p>	<p>12' X 12' X 40'-0" PRESTRESSED PILE @ 12'-0" O.C.</p> <p>REINF. CONC. PLATE REINF. W/ 45 # BARS @ 150 mm O.C. SPACING</p> <p>3.000</p> <p><b>RETAINING WALL PLAN VIEW</b> SCALE: 1:50</p> <p>REINF. CONC. CAPPING BEAM</p> <p>REINF. CONC. PLATE REINF. W/ 45 # BARS @ 150 mm O.C. SPACING BOTHWAYS</p> <p>CANAL</p> <p>12' X 12' X 40'-0" PRESTRESSED PILE @ 12'-0" O.C.</p> <p>10.160</p> <p><b>RETAINING WALL DESIGN SECTION</b> SCALE: 1:50</p> <p>REINF. CONC. CAPPING BEAM</p> <p>REINF. CONC. PLATE REINF. W/ 45 # BARS @ 150 mm O.C. SPACING BOTHWAYS</p> <p>12' X 12' X 40'-0" PRESTRESSED PILE @ 12'-0" O.C.</p> <p>3.000</p> <p><b>RETAINING WALL SIDE VIEW</b> SCALE: 1:50</p>
<b>Project Indicators</b>	<p>This component will be deemed a success when successfully completed, improves the aesthetics of the surrounding community, provides erosion protection for the banks of the canal and containment of water within the canals.</p>
<b>Budget</b>	<p>The approximate capital budget for Collet Canal lining is US\$ 836,650.00</p>
<b>Management Model</b>	<p>Construction management will involve collaboration between the contractor and the City Council. The components such as piles and slabs will be precast members to be supplied by contractor. However, the capping beam will be done in-situ – which can provide temporary employment for willing and able inner city youths.</p> <p>The construction works will result in inconveniences being experienced by motorists, business owners and residents (noise and dust pollution).</p>
<b>Implementation Schedule</b>	<p>The expected time for implementation of this aspect of the project is the first quarter of 2018.</p>