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1.0 PROJECT BACKGROUND

The last decade has seen a surge in the expansion and rehabilitation of our road network. This has caused the emergence of greater transportation by road, the mass movement of goods and supplies across the country. The vehicles now being used to transport these goods, have been improved from the standard 18-wheeler trucks used in design of our roadways and the bridges by extension. As a result, some of our bridges have been overloaded beyond their designated allowable capacity, creating continuous stresses on the bridge structures.

With this, the peak traffic flows are not intense in these areas; however the frequency with which vehicles are impacting on this network is increased. There are 738 bridges on the NWA road network with an average age of 50 years. Most of the remainder of which were built prior to emancipation are still functional; but this condition is not desirable. However due to the scarcity of funds, they have been neglected, having less than design capacity.

By design definitions, the entire island of Jamaica is a coastal region; hence most if not all bridges will be affected by the saline conditions in the moisture from the sea. The structures most affected are steel in whole/part. These moist conditions are not desirable for these steel structures especially, due to the increased possibility for weathering and corrosion; concrete bridges are less susceptible. There are 33 steel truss bridges and 288 steel girder bridges in the current population, of which a number of them are under structural duress. The figure below provides a graphical representation of the bridge types that are on the NWA national network. Most of the Bailey Bridges on the Network has deteriorated, with many of the slabs shifting out of place and in some cases missing.

Figure 1.1 Distributions of Bridge Types on the National Network

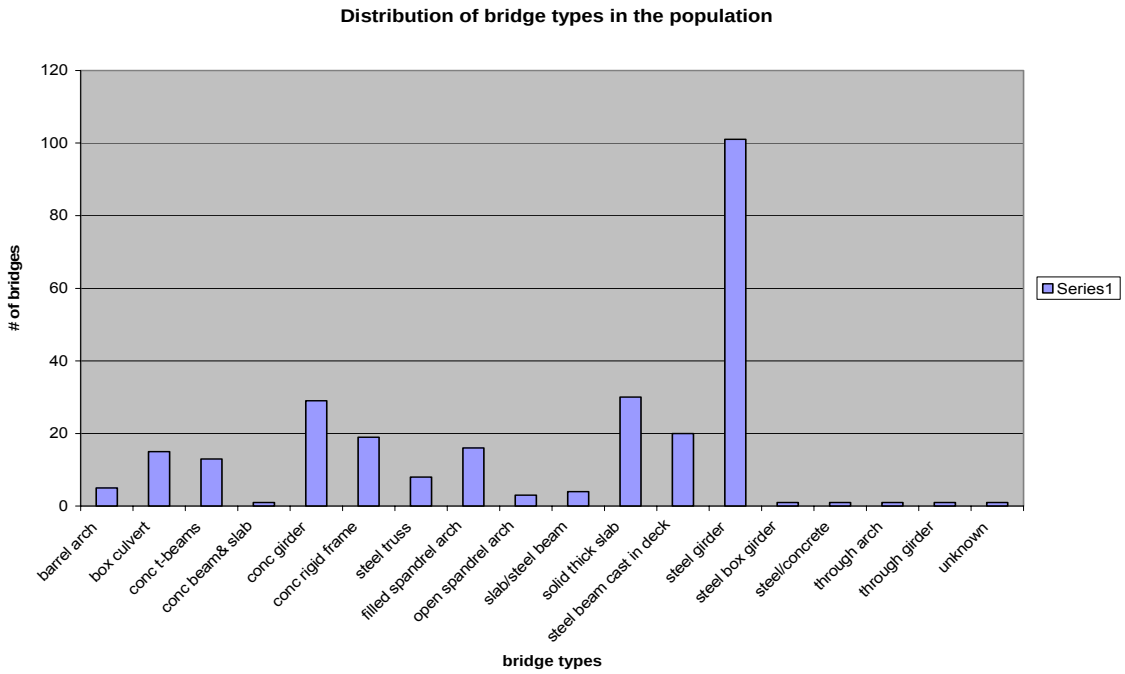

Figure 1.2: Typical Steel Girder (through) Bridge

Figure 1.3: Typical Steel truss Bridge

Figure 1: 4 Typical Timber Deck Bailey bridge

2.0 PROJECT DESCRIPTION

2.1 Bridge Structure

This project comprises the construction and replacement of approximately 43 Bridges Island wide. The bridges are of four (4) different forms namely, Compact 200 Bridges, Delta Bridges, Short Span Beam Bridges and Plate Girder Bridges, with spans that range from 12.191m to 39.622m, 48.766m, and 9.144m to 10.667m and 9.144m to 182.88m respectively. The short span beam bridge, delta and plate girders are two lanes bridges, while the compact 200 has both single and double lanes. Where foot walks are specified on compact bridges these will be of the cantilever type with a nominal width of 1.0 m, while on the delta, plate girder and short span beam bridges these will be internal to the main girders and have nominal width of 1.50m.

The bridges superstructure will be principally of a steel deck supplied with a Urethane and Bauxite surfacing however, there will be some plate girders with a reinforced concrete composite deck. All bridges structure will be supported on reinforced concrete abutment and center piers where necessary, with traditional mat or pile foundations.

2.2 Bridge Construction

2.2.1 Modular System:

The Compact 200 and Delta bridge systems are designed on the “unit construction” principle or a modular system. The basic unit of bridge being a 3.048m panel is easily transported to site and can be rapidly erected in only a few days by unskilled labor and requires minimal maintenance thereafter. Assembling a number of identical panels produces bridges of various lengths, in multiples of 3.048 m.

The two main girders of a “modular system” span between the abutments and foundations on each side of the water-way. For bridges of different spans, carrying different forms of loading, girders of various strengths are required. Owing to its modular system, the main girders are composed of a series of identical panels; the strength of the girders may be varied by varying the number of panels from which they are constructed. In its simplest form, the main girders consist of a single truss on either side of the bridge. Each truss is formed by pinning together end-to-end a number of identical unit panels. This construction is known as “**Single-Single**”. Adding a second and similar, truss either side of the bridge increases the strength of the main girders. This is called a “**Double-Single**” construction. Similarly a third and in some cases a fourth truss can be added to give “**Triple Single**” and “**Quadruple Single** construction”.

2.2.2 Basic Components of the Compact 200:

Each bay is composed of **Panels**, which form the main girders, **Transoms**, connected across the bottom chords of the panels to carry the roadway, **Rakers**, connected between panels and transoms to provide stability, and **Swaybraces** connected diagonally between the panel bottom chords to form, with the transoms a lateral bracing system. This is the basic system. **Bracing Frames** and **Tieplates** are used to connect together panels in multiple-truss side girders to form a complete bridge. To carry the road the steel panel decks are bolted to the transoms.

2.1.3 Launching of Modular System:

Bridging is supplied with a set of launching and erection equipment as well as spares. Launching and erection equipment is provided to "cantilever" launch the bridge. Bridging delivered contains all components needed to construct a launching nose, that is, panels and transoms, together with rollers, jacks and hand tools required to build, launch and jack down the bridges into their final position.

The basic principle of the Modular Bridge is that it is designed to be completely erected on rollers on one side of the gap to be bridged and then "launched" across, without requiring any temporary supports in the gap. This is achieved by building onto the front end of the bridge a temporary skeleton structure called the "Launching Nose" which is constructed from the same standard components as the bridge. The nose is built of such a length that when the whole structure is rolled forward, the tip of the nose lands on rollers on the far bank before the point of balance is reached. Once the bridge is in position across the gap the launching nose is dismantled, and the bridge jacked up off the rollers and lowered onto its permanent bearings on the abutments.

No piling will be done, as the foundations will be on spread footing. The abutments and foundations will be of reinforced concrete.

2.3 Short Span Beam Bridge:

These bridges are constructed using rolled universal steel beams with generally a steel strength grade of 355MPa. The structure consists of two main outer beams running parallel to the direction of the traffic and transom beams running transversely to the main beams. The beams are lifted by a crane or manually, depending on the length of the span and the weight and placed to span the gap; the transoms are then bolted to them. To carry the load, the steel panel decks are bolted to the transoms. Handrails are bolted to the top flange of the main beams. Finally, the main beams are bolted on bearings to the abutments.

All foundations will be on spread footing. The abutments and foundations will be of reinforced concrete.

2.4 Steel Plate Girder Bridge:

These bridges are constructed using shop welded plate girders. The construction will be of two types namely:

1. type one, similar to the short span beam bridge but of a longer span and
2. type two, with four (4) or more (even number of girders) main girders spanning parallel to the traffic flow

For the type two constructions, diaphragms and intermediate cross bracings are provided. To carry the load, either steel panel decks will be bolted to the transoms, or alternatively an in-situ deck will be constructed on the steel girders forming a composite action with the girders. The side walks/ footwalks will either be steel panel decks or will be formed out of concrete on either side of the bridge with a reinforced concrete short parapet wall on which the handrails are connected by bolting. Finally the main beams are bolted on bearings to the abutments.

The majority of the foundations will not require piling, however, their maybe a few requiring spread footings. The abutments and foundations will be of reinforced concrete.

2.5 Existing Bridge Structures

Where the bridges are existing and the new bridges are to be built on the existing alignment a detour will be constructed to allow for traffic diversion. The detour will be one of the following either (a) Bailey bridge built on gabion abutments or a Ford with concrete pipes to convey the water under the road in low tides. In the case where the existing abutment and foundation is adequate to carry the proposed bridges it will be made good and be utilized, however where they are in poor condition they will be replaced or repaired/reinforced.

Where the proposed bridges are to be built alongside the existing, the existing will continue to be used by traffic until the proposed is completed, at which stage it will be carefully demolished and removed from site. In both cases above, the public will be notified prior to the closure of the existing bridge and opening of the detour.

Table 2.1: Location and Status of Bridges

Bridge #	Bridge Name	Parish	Proposed Structure	Status/Existing Conditions	Map/ Plate
1`	Barham	Westmoreland	Two Lane Compact 200	This bridge is located in the district of Barham, spanning the upper reaches of the Cabarita River. Flows here are moderate and there appears to be a potential for scour. A through-girder type bridge is the existing structure on this site. The underside of the deck is severely corroded. The abutments appear to be in good condition, minor work may be needed on the concrete surfaces. Scour protection should be done here.	M ap #3 Plate #1
2	Bushy Park #3	St. Catherine	Delta 2-Lane	This multiple span, single lane, two small footwalks, pre-stressed concrete beam composite with double arch bridge is located in Bushy Park, 1 km off the Highway 2000, crossing the Colburns Gully in the parish of St. Catherine. The alignment of the bridge is poor and this area is susceptible to flooding during heavy rainfall. Scour protection will be required.	Map #9 Plate #2
3	Dry River Bridge	Portland	Single lane compact 200	This is a steel truss bridge located in the parish of Portland in the Seaman's Valley, just upstream of a confluence with the Rio Grande and Dry River (200 ft). The structural members, especially floor beams are very corroded and extensive section loss in some members. Wingwall appear to be scoured. Southeast wingwall needs refilling and tied back with the embankment. Bridge has a tendency to flood about 1 ft above the bridge deck. Residents say that flooding occurred in the past covering the bridge deck. Bailey footing to be placed on fill to approaches to tie in with existing roadway. Approximate baskets needed are 64 gabion baskets to retain fill. Preliminary height is at least 3 ft above current soffit level. A drain needs to be constructed on the Ginger House approach. River training will be necessary upstream of the bridge on the southwest bank. Immediately downstream, at the confluence, some river training is needed to prevent back water flow on the Dry River, hence the confluence needs to be properly and more formally defined.	Map #21 Plate #4
4	Dundee Bridge	Hanover	Single Lane Compact 200	A timber deck bailey bridge currently exists at this site. It is located in the parish of Hanover crossing a tributary into the Lucea East River. The embankment of the water course is very deep.	Map #1 Plate #5
5	Eden River	St. Mary	Two Lane Compact 200	Double span, steel girder bridge. Located in the parish of St. Mary crossing the Oracabessa River, approximately 60 ft from a three-way intersection. The pier is settling, as the foundation has been undermined and the deck is settling as a result. The bridge is located at a bend in the river and extensive bank protection would be necessary here to prevent further damage to the new	Map #13 Plate #6

Bridge #	Bridge Name	Parish	Proposed Structure	Status/Existing Conditions	Map/ Plate
				bridge when constructed (at least 250 ft along the upstream end). Bank and bridge abutment protection, about 250 ft upstream is necessary.	
7	Enfield	St. Mary	Single Lane Compact 200	Single span steel truss bridge located in the parish of St. Mary crossing the Dry River. The structural members, especially floor beams are very corroded and extensive section loss in some members. Bottom chord completely corroded; top chord shows no sign of buckling and corrosion not very extensive. Abutment and wing walls appear to be in fair condition. Water has never overtopped the bridge. The bridge is also located near a confluence in the river channel, hence the flood plain very wide. Construction of a gabion wall abutment (15 ft high). There is a possibility, to remove the bend near the bridge and smooth the curve to allow for safer approach to the bridge.	Map #14 Plate #7
8	Fontabelle #2	St. Mary	Two Lane Plate Girder	Single span concrete girder bridge. Located in the parish of St. Mary crossing the Brave River, around a very misaligned bend. The girders are in poor condition and the rebar is exposed in two. The headwalls of rubble stone in material are badly damaged and. Abutment and wingwalls appear to be in fair condition.	Map# 13 Plate #8
8	Simon Gutter (May River) Bridge	St. Mary	Short Span Beam Bridge	A steel beam cast in concrete arrangement. Located in the parish of St. Mary crossing the Simon Gutter River. The bridge is narrow and the guard rails are damaged and also missing. This small river enters the Dry River which is approximately 200 feet downstream.	Map #14 Plate #9
	Grosmond - Concrete	St. Elizabeth	Short Span Beam Bridge	This is a double lane two span concrete bridges located on the control section (Wilton to Union). The structure has shown damages in most of the sub structural members and replacement is critical.	Map# 04 Plate #9
10	Guanaboa Vale (Bamboo)	St. Catherine	Two lane Plate Girder	This through girder-type bridge is located in the district of Guanaboa Vale, crossing the World's End Gully .The alignment of the bridge is poor and a detailed hydraulic study has been done. For improvement work, the installation a double lane plate girder/Delta with two footwalks is recommended. Possible road alignment would have to be reviewed.	Map# 22 Plate #10
11	Harbour Head	St. Thomas	Single Lane Compact 200	This is a single lane through girder bridge located in the parish of St. Thomas. The structure is extensively damaged due to corrosion of sections of the structure. It is under weight restriction (12 tons) and improvement work is essential. The area is surrounded by wetland type vegetation and careful planning is necessary during the implementation of rehabilitation works.	Map #20 Plate #11
12	Hog Hole	St. Catherine	Single lane compact 200	This is an extensively damaged fording crossing the **Rio Doro** in the parish of St. Catherine adjacent United Estates farm on the	Map #12

Bridge #	Bridge Name	Parish	Proposed Structure	Status/Existing Conditions	Map/ Plate
				Riversdale main road. Install a single lane compact 200 bailey (100ft) without a foot walk. Approach road improvements would be necessary to tie in the existing road alignment. There is a quarry at the site and hence weight limit posting is necessary here.	Plate #12
13	Jacob	Portland	Single lane compact 200	Two span steel truss bridge. Located in the parish of Portland in the Seaman's Valley crossing Jacob's River (tributary) into the Rio Grande. The structural members, especially floor beams are very corroded and extensive section loss in some members. Abutment and wingwalls appear to be in good condition. Install a 100 feet, single lane compact 200 bailey with one foot walk. Approach fill retained by gabion works, 1 row (15 feet) and 2 rows (15 ft). Construction of approach roads.	Map #21 Plate #13
14	John's Hall #2	St. James	Short Span Beam	A steel beam cast in concrete arrangement. Located in the parish of St. James crossing the Sandy Gully River. The bridge is very narrow and located on the main road from Fairfield in the district John's Hall. The road adjacent to the bridge, which forms part of the embankment of the river, and is retained by a rubble masonry stone wall, has failed and is in urgent need of repair. Install a two lane quick bridge. Protection of the properties in the immediate vicinity of the bridge.	Map #2 Plate #15
15	John's Hall (New#1)	St. James	Short Span Beam	There is currently no existing bridge at this site; however there is a road deviation project with two bridges crossing the Sandy Gully River. It is downstream of Johns Hall #2 and upstream of the bridge in Hurlock. Install a two lane quick bridge. Protection of the properties in the immediate vicinity of the bridge.	Map #2 plate #14
16	John's Hall (New#2)	St. James	Short Span Beam	There is currently no existing bridge at this site; however there is a road deviation project which two bridges cross the Sandy Gully River. It is downstream of Johns Hall #2 and upstream of the bridge in Hurlock. Install a two lane quick bridge. Protection of the properties in the immediate vicinity of the bridge.	Map #2 Plate #14
17	Kings Valley Bridge	Westmoreland	Two Lane Plate Girder	A concrete rigid frame structure, replaced by a timber deck bailey bridge, spanning the New Savanna River in Albany (Delveland) Westmoreland. The timber deck has deteriorated and the bailey panels are severely corroded.	Map #3 Plate #16
18	Latium Bridge	St. James	Single Lane Compact 200	A steel beam cast in concrete arrangement, located in the parish of St. James crossing the Montego River; in the district of Latium (Latium Estate). The bridge pier has settled and the embankments in some places have been extensively eroded from previous heavy rainfall events. A lot of debris is evident at this site, which suggests that the current hydraulic height is insufficient. Need extensive embankment protection.	Map #2 Plate #17

Bridge #	Bridge Name	Parish	Proposed Structure	Status/Existing Conditions	Map/ Plate
19	Leith Hall	St. Thomas	Two Lane Quick Bridge	This narrow, simple span concrete girder bridge is located in Leith Hall, along the coast crossing the Sambo Bottom River in St. Thomas. Recent river training is evident and the gabion headwalls are exposed at road level. The girders are in poor condition, but the abutment and wingwalls appear to be in fair condition. The vertical alignment needs much improvement.	Map #20 Plate #18
20	Lime Bush	Portland	Single Lane Compact 200	Single span steel truss bridge. Located in the parish of Portland in Millsbank crossing a tributary to the Rio Grande (Quashie river). The structural members, especially floor beams are very corroded and extensive section loss in some members. Abutment and wingwalls appear to be in good condition. The alignment could be improved. Install a single lane compact 200 bailey without a foot walk. River training upstream. Need survey to capture the proposed alignment. Possibly, to jack/lift the bridge into place. Bush and excavate, fill, and reconstruct a new abutment with gabion works to facilitate the new alignment. Construction of approach roads; however, this may take some land acquisition as the alignment may encroach on the nearest land owner.	Map #21 Plate #19
21	Maggart Bridge	St. Mary	Two Lane Plate Girder	Single span solid thick slab bridge crossing a tributary to the **Rio Sambre River.** The bridge is located on a bend and the alignment needs upgrading. Abutment and wingwalls appear to be in good condition. Approach fill retained by gabion works, 1 row (15 feet) and 2 rows (15 ft). Construction of approach roads.	Map #15 Plate #20
22	May River Bridge	St. Mary	Short Span Beam Bridge	A steel beam cast in concrete arrangement. Located in the parish of St. Mary crossing the Simon Gutter River. The bridge is narrow and the guard rails are damaged and also missing. This small river enters the Dry River which is approximately 200 feet downstream. Install a two lane quick bridge (30 ft) without foot walks. Detour could take the form of pipe culverts and marl fill atop (on the way to Enfield Bridge). Note should be taken of the electrical pole which may have to be removed during construction.	Map # 14 Plate #21
23	Merrivale Gully	St. Andrew	Three Lane Plate Girder		Map #17 Plate #22
23	Nightingale (truss)	St. Catherine	Two Lane compact 200	Single span steel truss bridge crossing the **Colburns Gully**. The structural members are corroded and the tension members are buckling under load and strong winds. Abutment and wingwalls appear to be in fair condition. Install a double lane Compact 200 bailey (approx. 90 ft) with two foot walks. Improved vertical alignment and installation of gabions to retain the road fill. Detour should be at the entrance to Nightingale Grove before the	Map #09 Plate #23

Bridge #	Bridge Name	Parish	Proposed Structure	Status/Existing Conditions	Map/ Plate
				beginning of the Old Harbor By-Pass. Survey and borehole log is needed to ascertain soil type and the alignment.	
24	Pedro River Bridge	Clarendon	Two Lane Compact 200	This is a through girder-type bridge located almost at the border of ST. Ann and Clarendon, crossing the Pedro River. The Girders are in very poor condition, however the abutment are in reasonable good shape. Improvement maybe required for the alignment which is around a corner	Map #8 Plate #24
25	Red Hill's Over Pass	St. Andrew	Three Lane Plate Girder	This single span steel girder bridge spans the Red Hills Road in the vicinity of Calabar Mews, Zaidie Gardens and Dunrobin Avenue. Currently, five (5) girders on the north end of the bridge have been damaged from impacts from vehicles passing under. This new bridge would form the east bound lanes to the Washington Boulevard/Dunrobin Avenue road widening as an existing one for the west bound lanes have been recently constructed. No hydraulics is necessary as the bridge acts as an overpass to an existing road.	Map #17 Plate #25
26	Rosa Bridge	Clarendon	Short Span Beam bridge	This simple span steel girder bridge is located in Lower Chapelton along the control section (Chapelton – Danks), crossing a tributary which flows into the Rio Minho. The soil is very dry and there is evidence of limestone rock as the parent rock. Most of the soil material is dry and loose, characteristic of dry silty soil. The girders are in very poor condition and the eastern abutment has virtually failed. The handrails have been damaged. The bridge is on a very poor alignment in a "blind" corner. Install a quick bridge solution. Improved horizontal alignment and carry out a river training exercise both upstream and downstream..	Map #6 Plate #26
27	Salt Gully Bridge	St. Catherine	Single-Lane Compact	There is currently no structure here; it would be located across the Stony Gully in the parish of St. Catherine. This gully system fed by two other gullies; Fraser's and Church Pen Gullies. It is approximately 2 miles south of the Old Harbor By-Pass, in a westerly direction. The area is a haven for Crocodiles and is unsafe during construction in the mating season. Install a 120 feet, single lane compact 200. Detailed hydraulic analysis is necessary as this bridge is at the mouth of these gullies described above. Improvements to the approach roads, both to Old Harbor and to Bushy Park.	MAP #9 Plate #27
28	Sandy Gully Cassia Park	St. Andrew	Single Lane Compact 200	There exists a fording across the Sandy Gully through Cassia Park, which links to Red Hill's road near to the Overpass with Dunrobin Avenue. The invert of the gully is paved with rubble stone walls. Install a two lane plate girder bridge. Construction of bridge support systems. Improvement of the approaches and	Map #17 Plate #28

Bridge #	Bridge Name	Parish	Proposed Structure	Status/Existing Conditions	Map/ Plate
				checks for the pedestrian bridge.	
29	Sandy Gully (Queensborough)	St. Andrew	Two Lane Plate Girder	There is currently a fording along Molynes Road located in Queensborough crossing the Constant Spring gully. The invert of the gully is paved with rubble stone walls. Install a two lane plate girder bridge. Construction of bridge support systems. Improvement of the approaches and checks for the pedestrian bridge.	Map #17 Plate #29
30	Shooting River	St. Thomas	Single lane compact 200	Single lane Bailey bridge, with wooden deck crossing the **Shooting River**, just at an intersection and adjacent to the ramble bridge which crosses the Yallahs River. It is located approximately 500 ft from the confluence of the Yallahs River. The panels are moderately corroded and wooden deck which have deteriorated over time and was previously repaired. Abutment and wingwalls appear to be in fair condition; but it has to be widened by using gabion walls.	Map #19 Plate #30
31	Silent Hill Bridge	Clarendon	Single lane compact 200	There is no bridge at this site at the moment. The previous structure was destroyed years ago, preventing access to motor vehicles.	Map #5 Plate #31
32	Spring Field	Clarendon		This single span through girder-type bridge is located in the in the district of Springfield in southern Clarendon crossing the Hilliard's river which flows into the Milk River. The structural members are severely corroded and the bridge is located on a poor alignment. Install a double lane Compact 200 bailey (approx. 80 ft). Improved road horizontal alignment. The drawings and design for this bridge has been done under the CIDA programme, however review of this design will have to be done to accommodate the new solution.	Map #7 Plate #32
33	Spring Vale	St. Catherine	Two Lane Compact 200	This bailey bridge is atop a thick solid slab and was recently repainted. The deck is wooden and located in the fields of the Wakefield properties in the parish of St. Catherine, crossing the Giblatore River. It is located immediately after a bend and would need signs when the bridge is installed. Install a double lane compact 200 bailey (approx. 30 ft). Bailey footing to be placed on fill to approaches to tie in with existing roadway. To be placed on fill retained by gabion baskets.	Map #10 Plate #33
34	Stubbs Bridge	St. Catherine	Two Lane Plate Girder	This single span, two lanes, two footwalks, steel truss bridge is located immediately after a bend in the Rio Cobre, near Spanish Town. A large NWC water main is on the north footwalk. Install a double lane plate girder (approx. 105 ft), with two footwalks. Provisions would have to be made for the installation of the water main. Investigation and clarification of the width of the abutments to house this bridge as it is very high above the invert of the river.	Map #11 Plate #34

Bridge #	Bridge Name	Parish	Proposed Structure	Status/Existing Conditions	Map/ Plate
				A comprehensive river training plan would be necessary to protect the new bridge, as there is currently evidence of scour on the eastern abutment, resulting from the direction of flow through the old bridge and how it impacts the Stubbs bridge. Given the traffic situation with this bridge, the alternative route may be the Spanish Town By-Pass and this would have to be done after or prior to the improvements on the By-Pass.	
35	Temple Hall (Boswell Heights)	St. Andrew	Single lane compact 200	This is a fording that allows passage to motor vehicles across the Wag Water River when the water levels are low. The need for a bridge is critical as the is a growing community on the other side of the river.	Map #16 Plate #35
36	Vanity Fair	St. Catherine	Two Lane Plate Girder	This single span, two lanes, two footwalks, steel truss bridge is located in Linstead crossing the **Rio Magno Gully** in A large NWC water main under the footwalks. Install a double lane plate girder/delta, with two footwalks. Provisions would have to be made for the installation of the watermain. Some river training is necessary upstream. Given the traffic situation with this bridge, the alternative route would have to be through the Bog Walk main road or Barry to the main square.	Map #12 Plate #36
37	Wakefield	St. Catherine	Two Lane Compact 200	This bailey bridge is adjacent to the original solid thick slab bridge and was recently repainted. The deck is wooden and located in the fields of the Wakefield properties in the parish of St. Catherine; crossing the **Springvale River**. The invert to the underside of the bridge is shallow and would need to be elevated as the hydraulics would need improvement. Install a double lane compact 200 bailey (approx. 50 ft). Bailey footing to be placed on fill to approaches to tie in with existing roadway. To be placed on fill retained by gabion baskets.	Map #10 Plate #37
38	Wain Spring Bridge	Portland	Short Span Beam Bridge	Single span steel girder bridge located at Fellowship in the parish of Portland; crossing the Wain Spring. The steel girders are in relatively fair condition, however the alignment needs to be altered and the bridge width needs to be expanded. Abutment and wingwalls appear to be in good condition Install a 40 feet, two lane quick bridge with two foot walks. Widen channel upstream by 30 feet, may need to remove a large tree, girth 2.5 feet and two 8" girth trees.	Map #23 Plate #38
39	Ward River #1	St. Thomas	Short Span Beam	Sinple span steel girder bridge located along the coast near to the Leith Hall bridge in the Leith Hall community crossing the Ginger River. The girders are in reasonable repair; however the alignment of the bridge is poor and could be improved. Abutment and wingwalls appear to be in fair condition. Hydraulic analysis needed as realignment is proposed.	Map #20 Plate #

Bridge #	Bridge Name	Parish	Proposed Structure	Status/Existing Conditions	Map/ Plate
40	Yallahs River Bridge	St. Thomas	Two lane Plate Girder	A vented causeway about 350 ft and the collapse of the bailey bridge for 250 ft of the river crossing the **Yallahs River**. Install a 600ft two lane, two footwalk plate girder bridge solution, with multiple spans. Extensive river training is necessary here, as the immediate past has shown us that the river has a very intense erosive power and any structure which is installed here would need to be efficiently protected. Detailed hydraulic analysis is mandatory at this site and survey works.	Map# 18 Plate # 40
41	Unknown #3	St. Mary	Short Span Bean Bridge	Single concrete slab and Beam Bridge located in the parish of St. Mary crossing the Forked River, approximately 100 ft from a three-way intersection. This bridge is approximately 200 ft downstream of a confluence. The girders are in poor condition and would need extensive sandblast and painting. The rails are damaged; however, abutment and wing walls appear to be in fair condition.	Map #13 Plate #41
42	Unknown #4	St. Mary	Short Span Beam Bridge	Single concrete slab and Beam Bridge. Located in the parish of St. Mary crossing a tributary into the Oracabessa River, approximately 400 ft from a three-way intersection, to Lambkin Hill. The box culvert is very old and the headwalls are damaged. The bridge is very shallow and hydraulic improvements would have to be made.	Map #13 Plate #42

2.6 Construction Methodology

Table 2.2 Construction Methodology per Bridge Type

CONSTRUCTION METHODOLOGY	COMPACT 200	SHORT BEAM	DELTA	PLATE GIRDER
1. Setting up of site office and other construction support services	Y	Y	Y	Y
2. Construction of detour (Bailey bridge or Ford) and effect temporary road closure. Where a Bailey bridge is used, gabion baskets maybe used as protection for the foundations.	Y	Y	Y	Y
3. Where existing structures are to be removed, demolition of existing bridge structures (Superstructure and Abutments) and cart-away to storage or disposal site. Sediment control structures will be installed where required, to reduce the impact of sediments on water body.	Y	Y	Y	Y
4. Where spread footing is required. Excavation to the required levels for spread footing foundation, providing the necessary support for the sides of excavations and making provision for de-watering of excavation	Y	Y	Y	Y
5. Where existing structures are to remain. Repair/retrofit of existing abutments and make the necessary provisions to receive new superstructures. Sediment control structures will be installed where required, to reduce the impact of sediments on water body.	Y	Y	Y	Y
6. Excavation to the required levels for spread footing foundation, providing the necessary support for the sides of excavations and making provision for de-watering of excavation.	Y	Y	Y	Y
7. Installation of H steel piles foundation. Pile driving equipment and craneage will operate during daylight hours only. Before the piles are erected, properties adjacent to the work areas will be examined for their structural integrity.	-	-	-	Y
8. Construction of reinforced concrete spread footings, piers and abutments. Concrete will be delivered to the site by trucks and discharged using pumps.	Y	Y	Y	Y
9. Construction of “launching area” using a granular approach ramp.	Y	Y	Y	-

CONSTRUCTION METHODOLOGY	COMPACT 200	SHORT BEAM	DELTA	PLATE GIRDER
10. Delivery of structural steel "modular" bridge parts and short span beam bridge parts to site. The appropriate safety net put in place, to provide safety of workers and pedestrians as required.	Y	Y	Y	-
11. Delivery of structural steel girders to the site using police outriders (flashing lights), midnight to early morning or on a weekend. When steel girders are being off loaded, the entire road section will be closed including the detour, for at least two hours and the appropriate safety net put in place, to provide safety of workers and pedestrians	-	-	-	Y
12. Launching and installation of structural steel parts, to include steel deck units	Y	Y	Y	-
13. Launching and installation of structural steel girders, to include steel deck units. The steel girders will be special atmospheric resistance steel to BS EN 10155 with one coat prime or to BS EN 10025 with corrosion resistant protective finishes.	-	-	-	Y
14. Abutments will be protected using galvanized Reno mattresses and gabion baskets with rock fill where appropriate	Y	Y	Y	Y
15. Construction of concrete deck and asphalt surfacing and backfilling to abutments. During the backfilling exercise, there maybe temporary disruption of traffic.	Y	Y	Y	Y

3.0 PROJECT ENVIRONMENT

3.1 Noise and Vibrations:

Noise interferes with the perception of wanted sound and is likely to be physiologically harmful. Sound is usually applied to a form of energy that produces a sensation perceived by the sense of hearing in humans, while vibration is a no audible phenomena that are recognized by touch or feeling. Sound levels are measured by a logarithmic function of acoustic pressure a decibels (dB). Audible ranges of acoustic pressure are expressed as dB (A). Calm environments normally correspond to sound of 30 to 50 dB (A). Beyond 70 dB (A), sound becomes disruptive. Exposure to disruptive noise levels can affect human welfare both physiologically and psychologically. This exposure can be a source of annoyance, and may create communication problems leading to elevated stress levels. It may also be associated with behavioral and health effects. In addition, it may cause fatigue, temporary and permanent lessening of hearing acuity, sleep disorders and even contribute to learning disability in children. Vibrations from vehicular noise can have detrimental effects on structures in proximity to a construction site.

Noise level readings were taken by using an EXTECH 407735 Sound Level Meter. The meter was turned on and the response was set to slow, the weighting to A and the range to Lo. The calibrator was turned on for approximately 10 seconds to allow it to stabilize. The decibel range (dB) was set at 94dB and the adjusting screw adjusted until the meter reads 94 dB. The meters were calibrated each time they were turned off. If at the time of calibration the meter reading did not register 94dB, then the potentiometer (small hole with a screw on the left side of the meter) was adjusted.

A wind screen (sponge) was placed over the microphone to prevent measurement errors due to noise caused by wind blowing across the microphone. Records of the high and low dBA readings and the constant noise level at all stations were recorded.

Table 3.1 Baseline Noise Data and Vehicle per Day

Bridge #	Bridge Name	Parish	High dB(A)	Low dB(A)	Traffic Volume (VPD)	Regional Setting
1	Barham	Westmoreland	74	47	**1500**	Rural
2	Bushy Park #3	St. Catherine	70	50.4	**700**	Rural
3	Dry River Bridge	Portland	55	43	**55**	Rural
4	Dundee Bridge	Hanover	56	47	**497**	Rural
5	Eden River	St. Mary	75	55	**2458**	Rural
6	Enfield	St. Mary	67	52	**783**	Rural
7	Fontabelle #2	St. Mary	-	-	**1352**	Rural

Bridge #	Bridge Name	Parish	High dB(A)	Low dB(A)	Traffic Volume (VPD)	Regional Setting
8	Grosmond - Concrete	St. Elizabeth	72.1	53.9	**1992**	Rural
9	Guanaboa Vale (Bamboo)	St. Catherine	71.4	50.4	**6350**	Rural
10	Harbour Head	St. Thomas	-	-	**-**	Rural
11	Hog Hole	St. Catherine	64.5	66.5	**-**	Rural
12	Jacob	Portland	53.7	49.2	**20**	Rural
13	John's Hall #2	St. James	71.3	51.5	**120?**	Rural
14	John's Hall (New#1)	St. James	76.9	54.1	**120?**	Rural
15	John's Hall (New#2)	St. James	76.4	53.7	**120?**	Rural
16	Kings Valley Bridge	Westmoreland	69.6	53.3	**1284**	Rural
17	Latium Bridge	St. James	70.2	54.3	**133**	Rural
18	Leith Hall	St. Thomas	76.1	51.6	**2384**	Rural
19	Lime Bush	Portland	52.5	48.2	**90**	Rural
20	Maggart Bridge	St. Mary	69.8	55.1	**1057**	Rural
21	May River (Simon Gutter)	St. Mary	77.3	56	**783**	Rural
22	Merrivale Gully	St. Andrew	**68.0**	**60.5**	**5467**	Rural
23	Nightingale (truss)	St. Catherine	**67.2**	**60.4**	**450**	Rural
24	Pedro River Bridge	Clarendon	**45.2**	**39**	**427**	Rural
25	Red Hill's Over Pass	St. Andrew	**71.3**	**61.0**	**10,567**	Rural
26	Rosa Bridge	Clarendon	**62**	**43**	**4567**	Rural
27	Salt Gully Bridge	St. Catherine	**47.2**	**39.1**	**315**	Rural
28	Sandy Gully Cassia Park	St. Andrew	**74.8**	**50.0**	**11,170**	Urban
29	Sandy Gully (Queensborough)	St. Andrew	**72.1**	**55.9**	**9,000**	Urban
30	Sandy Gully (Truss)	-	**-**	**-**	**-**	-
31	Shooting River	St. Thomas	**-**	**-**	**267**	Rural
32	Silent Hill Bridge	Clarendon	**-**	**-**	**317**	Rural
33	Spring Field	Clarendon	**-**	**-**	**300**	Rural
34	Spring Vale	St. Catherine	**44.3**	**43.5**	**1,275**	Rural
35	Stubbs Bridge	St. Catherine	**-**	**-**	**450**	Urban
36	Temple Hall (Boswell Heights)	St. Andrew	**54.2**	**46.5**	**4,750?**	Rural
37	Vanity Fair	St. Catherine	**80**	77	**12,000**	Urban
38	Wakefield	St. Catherine	43.3	41.3	**1,275**	Rural
39	Wain Spring Bridge	Portland	56.0	71	**2,100**	Rural
40	Ward River #1	St. Thomas	-	-	**2,384**	Rural (HWY)
41	Yallahs River Bridge	St. Thomas	-	-	**8,530**	Rural (HWY)
42	Unknown #3	St. Mary	-	-	**1,352**	Rural
43	Unknown #4	St. Mary	-	-	**2,458**	Rural

3.2 Water Quality Assessment

3.2.1 Nitrogen

Nitrogen is one of the most abundant elements. About 80 percent of the air we breathe is nitrogen. It is found in the cells of all living things and is a major component of proteins. Inorganic nitrogen may exist in the Free State as a gas N2, or as nitrate NO3-, nitrite NO2-, or ammonia NH3+. Organic nitrogen is found in proteins and is continually recycled by plants and animals.

Nitrogen-containing compounds act as nutrients in streams and rivers. Nitrate reactions [NO3-] in fresh water can cause oxygen depletion. Thus, aquatic organisms depending on the supply of oxygen in the stream will die. The major routes of entry of nitrogen into bodies of water are municipal and industrial wastewater, septic tanks, feed lot discharges, animal wastes (including birds and fish) and discharges from car exhausts. Bacteria in water quickly convert nitrites [NO2-] to nitrates [NO3-].

Nitrites can produce a serious condition in fish called "brown blood disease." Nitrites also react directly with hemoglobin in human blood and other warm-blooded animals to produce methemoglobin. Methemoglobin destroys the ability of red blood cells to transport oxygen. This condition is especially serious in babies under three months of age. It causes a condition known as methemoglobinemia or "blue baby" disease. Water with nitrite levels exceeding 1.0 mg/l should not be used for feeding babies. Nitrite/nitrogen levels below 90 mg/l and nitrate levels below 0.5 mg/l seem to have no effect on warm water fish.

3.2.2 Dissolved Oxygen

Dissolved oxygen analysis measures the amount of gaseous oxygen (O2) dissolved in an aqueous solution. Oxygen gets into water by diffusion from the surrounding air, by aeration (rapid movement), and as a waste product of photosynthesis. Total dissolved gas concentrations in water should not exceed 110 percent. Concentrations above this level can be harmful to aquatic life. Fish in waters containing excessive dissolved gases may suffer from "gas bubble disease"; however, this is a very rare occurrence. Adequate dissolved oxygen is necessary for good water quality. Oxygen is a necessary element to all forms of life. Natural stream purification processes require adequate oxygen levels in order to provide for aerobic life forms. As dissolved oxygen levels in water drop below 5.0 mg/l, aquatic life is put under stress. Oxygen levels that remain below 1-2 mg/l for a few hours can result in large fish kills. The lower the concentration of dissolved O2, the greater the stress levels experienced by aquatic organisms.

3.2.3 Temperature

Human activities should not change water temperatures beyond natural seasonal fluctuations. To do so could disrupt aquatic ecosystems. Good temperatures are dependent on the type of stream you are monitoring. Lowland streams, known as "warm water" streams, are different from mountain or spring fed streams that are normally cool. In a warm water stream temperatures should not exceed 89 degrees (Fahrenheit) because high temperatures reduce available oxygen in the water.

3.2.4 pH

The pH value is a measure of the acidic or basic (alkaline) nature of a solution. The concentration of the hydrogen ion [H+] activity in a solution determines the pH. Mathematically this is expressed as: pH = - log [H+].
The pH value is the negative power to which 10 must be raised to equal the hydrogen ion concentration. A pH range of 6.0 to 9.0 appears to provide protection for the life of freshwater fish and bottom dwelling invertebrates.

The most significant environmental impact of pH involves synergistic effects. Synergy involves the combination of two or more substances which produce effects greater than their sum. This process is important in surface waters. Runoff from agricultural, domestic, and industrial areas may contain iron, aluminum, ammonia, mercury or other elements. The pH of the water will determine the toxic effects, if any, of these substances. For example, 4 mg/l of iron would not present a toxic effect at a pH of 4.8. However, as little as 0.9 mg/l of iron at a pH of 5.5 can cause fish to die.

3.2.5 Coliform (Bacteria)

Total coliform bacteria are a collection of relatively harmless microorganisms that live in large numbers in the intestines of man and warm- and cold-blooded animals. They aid in the digestion of food. A specific subgroup of this collection is the fecal coliform bacteria, the most common member being Escherichia coli. These organisms may be separated from the total coliform group by their ability to grow at elevated temperatures and are associated only with the fecal material of warm-blooded animals.

The presence of fecal coliform bacteria in aquatic environments indicates that the water has been contaminated with the fecal material of man or other animals. At the time this occurred, the source water may have been contaminated by pathogens or disease producing bacteria or viruses which can also exist in fecal material. Some waterborne pathogenic diseases include typhoid fever, viral and bacterial gastroenteritis and hepatitis A. The presence of fecal contamination is an indicator that a potential health risk exists for individuals exposed to this water. Fecal coliform bacteria may occur in ambient water as a result of the overflow of domestic sewage or nonpoint sources of human and animal waste.

3.2.6 Phosphorus

Phosphorus is one of the key elements necessary for growth of plants and animals. Phosphorus in elemental form is very toxic and is subject to bioaccumulation. Phosphates (PO_4) are formed from this element. Phosphates exist in three forms: orthophosphate, metaphosphate (or

polyphosphate) and organically bound phosphate. Each compound contains phosphorous in a different chemical formula. Ortho forms are produced by natural processes and are found in sewage. Poly forms are used for treating boiler waters and in detergents. In water, they change into the ortho form. Organic phosphates are important in nature. Their occurrence may result from the breakdown of organic pesticides which contain phosphates. They may exist in solution, as particles, loose fragments, or in the bodies of aquatic organisms.

Rainfall can cause varying amounts of phosphates to wash from farm soils into nearby waterways. Phosphate will stimulate the growth of plankton and aquatic plants which provide food for fish. This increased growth may cause an increase in the fish population and improve the overall water quality. However, if an excess of phosphate enters the waterway; algae and aquatic plants will grow wildly, choke up the waterway and use up large amounts of oxygen. This condition is known as eutrophication or over-fertilization of receiving waters. The rapid growth of aquatic vegetation can cause the death and decay of vegetation and aquatic life because of the decrease in dissolved oxygen levels. Phosphates are not toxic to people or animals unless they are present in very high levels. Digestive problems could occur from extremely high levels of phosphate.

3.2.7 Biochemical Oxygen Demand

Biochemical Oxygen Demand, or BOD, is a measure of the quantity of oxygen consumed bymicroorganisms during the decomposition of organic matter. BOD is the most commonly used parameter for determining the oxygen demand on the receiving water of a municipal or industrial discharge. BOD can also be used to evaluate the efficiency of treatment processes, and is an indirect measure of biodegradable organic compounds in water. Imagine a leaf falling into a stream. The leaf, which is composed of organic matter, is readily degraded by a variety of microorganisms inhabiting the stream. Aerobic (oxygen requiring) bacteria and fungi use oxygen as they break down the components of the leaf into simpler, more stable end products such as carbon dioxide, water, phosphate and nitrate. As oxygen is consumed by the organisms, the level of dissolved oxygen in the stream begins to decrease Water can hold only a limited supply of dissolved oxygen and it comes from only two sources- diffusion from the atmosphere at the air/water interface, and as a byproduct of photosynthesis. Photosynthetic organisms, such as plants and algae, produce oxygen when there is a sufficient light source. During times of insufficient light, these same organisms consume oxygen. These organisms are responsible for the diurnal (daily) cycle of dissolved oxygen levels in lakes and streams.

If elevated levels of BOD lower the concentration of dissolved oxygen in a water body, there is a potential for profound effects on the water body itself, and the resident aquatic life. When the dissolved oxygen concentration falls below 5 milligrams per liter (mg/l), species intolerant of low

oxygen levels become stressed. Eventually, species sensitive to low dissolved oxygen levels are replaced by species that are more tolerant of adverse conditions, significantly reducing the diversity of aquatic life in a given body of water. If dissolved oxygen levels fall below 2 mg/l for more than even a few hours, fish kills can result. At levels below 1 mg/l, anaerobic bacteria (which live in habitats devoid of oxygen) replace the aerobic bacteria. As the anaerobic bacteria break down organic matter, foul-smelling hydrogen sulfide can be produced.

3.2.8 Total Suspended Solids

Total suspended solids (TSS) include all particles suspended in water which will not pass through a filter. Suspended solids are present in sanitary wastewater and many types of industrial wastewater. There are also non-point sources of suspended solids, such as soil erosion from agricultural and construction sites.

As levels of TSS increase, a water body begins to lose its ability to support a diversity of aquatic life. Suspended solids absorb heat from sunlight, which increases water temperature and subsequently decreases levels of dissolved oxygen (warmer water holds less oxygen than cooler water). Some cold water species, such as trout and stoneflies, are especially sensitive to changes in dissolved oxygen. Photosynthesis also decreases, since less light penetrates the water. As less oxygen is produced by plants and algae, there is a further drop in dissolved oxygen levels.

For point sources, adequate treatment is necessary to insure that suspended solids are not present at levels of concern in waters of the state. Treatment typically consists of settling prior to discharge of the wastewater. Settling allows solids to sink to the bottom, where they can be removed. Some types of wastewaters, such as non-contact cooling water, are naturally low in suspended solids and do not require treatment.

For non-point sources, control measures should be implemented to reduce loadings of suspended solids to streams, rivers and lakes. **For construction sites, controls such as silt fences and sedimentation basins are designed to prevent eroding soils from reaching surface waters**. In urban areas, storm water retention ponds or a regular schedule of street sweeping may be effective in reducing the quantity of suspended solids in storm water run-off. Most people consider water with a TSS concentration less than 20 mg/l to be clear. Water with TSS levels between 40 and 80 mg/l tends to appear cloudy, while water with concentrations over 150 mg/l usually appears dirty. The nature of the particles that comprise the suspended solids may cause these numbers to vary.

3.2. Turbidity

Turbidity refers to how clear the water is. The greater the amount of total suspended solids (TSS) in the water, the murkier it appears and the higher the measured turbidity. The major source of turbidity in the open water zone of most lakes is typically phytoplankton, but closer to shore, particulates may also be clays and silts from shoreline erosion. Dredging operations, channelization, increased flow rates, floods, or even too many bottom-feeding fish (such as carp) may stir up bottom sediments and increase the cloudiness of the water.

High concentrations of particulate matter can modify light penetration, cause shallow lakes and bays to fill in faster, and smother benthic habitats - impacting both organisms and eggs. As particles of silt, clay, and other organic materials settle to the bottom, they can suffocate newly hatched larvae and fill in spaces between rocks which could have been used by aquatic organisms as habitat. Fine particulate material also can clog or damage sensitive gill structures, decrease their resistance to disease, prevent proper egg and larval development, and potentially interfere with particle feeding activities. If light penetration is reduced significantly, macrophyte growth may be decreased which would in turn impact the organisms dependent upon them for food and cover. Reduced photosynthesis can also result in a lower daytime release of oxygen into the water.

Table 3.2 Water Quality Baseline Data

Bridges	Parameters											
	Biochemical Oxygen Demand	Total Coliform	Fecal Coliform	Nitrates	Phosphates	pH	Temperature (oC)	Dissolved Oxygen	Turbidity	Total Suspended Solids	Lead	Oil & Grease
	NEPA STANDARDS											
	.8-1.7 mg/l	<1000 MPN	<10 MPN	.1-7.5 mg/l	.01-.8 mg/l	7-8.4	33°C	>4 mg/l	30 NTU	30 mg/l	0.1 mg/l	10 mg/l
Barham	9	244	70	3.5	0.05	7.3	27.2	3.5	24.3	11.6	-	1.5
Bushy Park #3	-	-	-	-	-	-	-	-	-	-	-	-
Dry River Bridge	3	100	<10	4.6	1.00	7.2	23.4	3.0	2.5	5.3	0	5.4
Dundee Bridge	9	500	<10	4.5	1.05	7.3	29.2	3.0	11.3	8.6	0	1.4
Eden River	5	1500	<10	3.7	0.40	7.1	23.6	2.6	9.0	4.0	0	7

Bridges	Parameters											
	Biochemical Oxygen Demand	Total Coliform	Fecal Coliform	Nitrates	Phosphates	pH	Temperature (oC)	Dissolved Oxygen	Turbidity	Total Suspended Solids	Lead	Oil & Grease
	NEPA STANDARDS											
	.8-1.7 mg/l	<1000 MPN	<10 MPN	.1-7.5 mg/l	.01-.8 mg/l	7-8.4	33°C	>4 mg/l	30 NTU	30 mg/l	0.1 mg/l	10 mg/l
Enfield	4.5	700	<10	2.9	0.35	7.3	24.4	2.8	6.0	7.0	0	5
Fontabelle #2	-	-	-	-	-	-	-	-	-	-	-	-
Grosmond - Concrete	1.2	800	<10	3.0	0.40	7.0	26.6	2.5	1.0	7.0	0	1.8
Guanaboa Vale (Bamboo)	-	-	-	-	-	-	-	-	-	-	-	-
Harbour Head		-	-	-	-	-	-	-	-	-	-	-
Hog Hole	4.0	200	25	5	0.90	7.1	28.3	3.0	3.1	7.6	0	3
Jacob	3.1	80	<10	4.5	.40	7.3	26.1	4.4	1.0	2.1	0	<1
John's Hall #2	17	1500	240	6.2	4.5	7.8	29.3	2.4	15	8.4	<1	4.6
John's Hall (New#1)	-	-	-	-	-	-	-	-	-	-	-	-
John's Hall (New#2)	-	-	-	-	-	-	-	-	-	-	-	-
Kings Valley (Delve) Bridge	8	350	35	3.53	.06	7.6	29.6	3.1	12.2	15	<1.0	<1
Latium Bridge	4.3	600	<10	3.8	1.2	7.9	29.4	3.2	17.2	11.5	<1	<1
Leith Hall	4.0	450	93	4.4	0.55	7.6	27.1	4.0	16.1	11	<1	<1
Lime Bush	3.2	80	<10	4.5	0.15	7.3	24.1	3.2	1.5	<1	<1	<1
Maggart Bridge	3.6	360	<10	3.2	1.2	7.5	28	2.9	10.0	12	<1	<1
May (Simon Gutter)Bridge	-	-	-	-	-	-	-	-	-	-	-	-
Merrivale Gully	-	-	-	-	-	-	-	-	-	-	-	-
Nightingale (truss)	2.4	350	60	3.1	1.2	7.6	28	2.4	1.6	5.2	<1	<1
Pedro River Bridge	1.2	300	<10	1.3	2.3	7.2	27	2.9	1.7	3.2	<1	<1
Red Hill's Over Pass	-	-	-	-	-	-	-	-	-	-	-	-
Rosa Bridge	-	-	-	-	-	-	-	-	-	-	-	-
Salt Gully Bridge	o	o	o	o	o	o	o	o	o	o	o	o
Sandy Gully Cassia Park	-	-	-	-	-	-	-	-	-	-	-	-
Sandy Gully Queensborough	-	-	-	-	-	-	-	-	-	-	-	-
Sandy Gully#3 Truss	o	o	o	o	o	o	o	o	o	o	o	o
Shooting River	-	-	-	-	-	-	-	-	-	-	-	-
Silent Hill Bridge	-	-	-	-	-	-	-	-	-	-	-	-
Springfield	-	-	-	-	-	-	-	-	-	-	-	-

Bridges	Parameters											
	Biochemical Oxygen Demand	Total Coliform	Fecal Coliform	Nitrates	Phosphates	pH	Temperature (oC)	Dissolved Oxygen	Turbidity	Total Suspended Solids	Lead	Oil & Grease
	NEPA STANDARDS											
	.8-1.7 mg/l	<1000 MPN	<10 MPN	.1-7.5 mg/l	.01-.8 mg/l	7-8.4	33°C	>4 mg/l	30 NTU	30 mg/l	0.1 mg/l	10 mg/l
Spring Vale	-	-	-	-	-	-	-	-	-	-	-	-
Stubbs Bridge	45	>2400	>2400	15.3	0.80	7.4	29.4	2.1	45	32	.13	8.1
Temple Hall Boswell Hghts.	3.4	120	40	3.4	0.33	7.3	28.4	3.2	2.0	4	<1	<!
Vanity Fair	-	-	-	-	-	-	-	-	-	-	-	-
Wakefield	-	-	-	-	-	-	-	-	-	-	-	-
Wain Spring Bridge	3.2	170	30	2.9	0.45	7.8	24.3	2.7	42	25	<1	<1
Ward River #1	-	-	-	-	-	-	-	-	-	-	-	-
Yallahs River Bridge	-	-	-	-	-	-	-	-	-	-	-	
Unknown #3	5.0	221	44	3.5	1.1	7,2	29.0	3.12	20	15	<1	<1
Unknown #4	-	-	-	-	-	-	-	-	-	-	-	-

3.3 Hydrological Evaluations

The accepted Jamaica criteria for the design storm is 1 in 50 year return frequency regardless of the priority of the highway with the provision that the new span is made to match the opening size of the existing structures over the same river, regardless of the return frequency. In Jamaica, it is understood that this approach has been modified in some instances by influence of the existing long-life structures whose opening are less than those found necessary by calculation for the replacement structures. The approach is acceptable considering that some of the existing structures have taken considerable maximum design flows over their 80 to 100 year life.

The Jamaican design approach to the development of time of concentration and peak flow development is based on the hydrograph method, similar to the SCS method in common use in Canada and USA. In Jamaica, under both Jamaica 1 and 2 formulae, a regressions approach to fit the unit graph indicates a fairly close fit during the rising concentration to the peak flow, but a variance during the recessions curve. A further difference during the SCS and both Jamaica 1 and 2 formulae lies in the time to peak, which is a larger value, increasing the volume of run-off and when the various coefficient are developed, increase in the peak flow.

When compared to the SCS approach, the discharge values of Jamaica 1 and 2 are more conservative. Although the formulation developed for peak flows by the Jamaica authorities was not completely verified, the answers obtained to both the times concentration and peak flow values agree within tolerable limits with those done by more conventional methods. In fact the use of Jamaica 2 formula generally provides flows in excess to that given by the SCS Hydro graph method. It would appear that Jamaica method is conservative and since it is familiar to the designers, should be retained.

Having determined the peak flow, the next step in the calculation is the determination of the size of opening required to pass the flow without detrimental effects of the river regime. The approach used with the Jamaica 2 formula is to determine the dominant flow which has been taken as 1 in 1.58 year return period. The "dominant flow" is found by projecting the various peak flow values determined for 25, 50 and 100 years return period on Grumbel logarithmic paper. A best fit line is applied and projected to intersect the 1.58 year line.

The Jamaica 2 method uses a drainage area, water shed length and height, curve number, roughness and 24 hour rainfall amounts to estimate return period flow rates. The drainage area and watershed length and height can be calculated from topographic maps (1:50,000 or 1:12,500 scales)

Curve numbers are calculated based on the land use and soil types. Determination of a representative curve number for each watershed for layer return periods has been shown to be insensitive to particular soil type and land use. Therefore the accepted structure of using a curve number 85 representing Jamaica saturated conditions was used for each watershed for the 25,50 and 100 years flow rate.

The roughness factor represents the resistance to overland flow due to different land use. The percentage land use for each watershed was determined from topographical map. The rainfall data was obtained from a table of return period rainfall amounts (maximum 24 hr. rainfall INS) published by the National Metrological Service and provided by the Ministry of Transport and Works.

The table below provides a summary of the hydraulic calculations for the bridges on the programme.

Table 3.3 Important Hydraulic Parameters for Bridges

Bridge #	Bridge Name	Drainage Area (Acres)	24 HR Rainfall Depth (mm)		Peak Discharge Jamaica 2 (m^3/s)		Design Flow (m^3/s)		Velocity Q_{50} (m^3/s)
			Q_{50}	Q_{100}	Q_{50}	Q_{100}	Q_{50}	Q_{100}	
1	Barham	14,715.4	258	290	458.89	534.61	458.89	534.61	6.09
2	Bushy Park #3	20,143.1	393	447	952.24	1103.2	952.24	1103.2	7.12
3	Dry River Bridge	3051.23	597	661	395.33	446.66	395.33	446.66	6.73
4	Dundee Bridge	5640	203	223.52	183	209.9	183	209.9	.371
5	Eden River	7706.05	316.9	356.1	579.1	681.78	579.1	681.78	7,08
6	Enfield	6075.6	409	456	471.9	539.96	471.9	539.96	
7	Fontabelle #2	1319.7	316.9	356.1	579.1	681.78	579.1	681.78	7.08
8	Grosmond - Concrete								
9	Guanaboa Vale (Bamboo)	7530	473	541	819.83	961.85	819.83	-	6.23
10	Harbour Head (Pedro River)	2328.90	491	556	225.86	262.12	225.86	262.12	4.94
11	Hog Hole	9770.16	346	391	514.16	628.13	514.16	628.13	5.97
12	Jacob	1008.77	597	661	176.23	189.80	176.23	189.80	6.14
13	John's Hall #2	1410.58	249	279.9	91.5	108.12	91.5	108.12	4.24
14	John's Hall (New#1)	1609	249	279.9	96	112.96	96	112.96	14.1
15	John's Hall (New#2)	1609	249	279.9	96	112.96	96	112.96	14.1
16	Kings Valley Bridge	2403.62	192	211	62.15	71.18	62.15	71.18	3.59
17	Latium Bridge	3716.32	214.44	236.9	133.6	154.72	133.6	154.72	
18	Leith Hall	578.9	490.9	556	80.5	92.5	80.5	92.5	4.95
19	Lime Bush	572.88	597	661	94.38	101.62	94.38	101.62	5.02
20	Maggart Bridge	1269.9	316	361.95	97.7	116.9	97.7	116.9	
21	May River Bridge	734.55	408.9	455	86.6	99.7	86.6	99.7	5.43
22	Merrivale Gully	-	-	-	-	-	-	-	-
23	Nightingale (truss)	19271.32	393	447	961.87	1115.4	961.87	1115.4	9.18
24	Pedro River Bridge	2291.57	305	341	163.68	192.82	163.68	192.82	6.39
25	Red Hill's Over Pass	-	-	-	-	-	-	-	-
26	Rosa Bridge	298.90	289	324	31.17	36.34	31.17	36.34	4.20
27	Salt Gully Bridge	5392.58	288	324	240.46	280.54	240.46	280.54	5.12
28	Sandy Gully Cassia Park	-	-	-	-	-	-	-	-
29	Sandy Gully Queensborough	-	-	-	-	-	-	-	-
30	Sandy Gully#3 Truss	-	-	-	-	-	-	-	-
31	Shooting River	1021.23	420	476	125.7	158.84	125.7	158.84	9.9
32	Silent Hill Bridge	398.53	352	398	48.22	56.81	48.22	56.81	4.74
33	Springfield	9200	307.4	345.44	273.37	315.29	273.37	315.29	0.325
34	Spring Vale	1419.76	388	441	156.17	183.05	156.17	183.05	4.73
35	Stubbs Bridge								
36	Temple Hall Boswell Hghts.	7024.06	480	549	617.62	725.36	617.62	725.36	8.29
37	Vanity Fair	19927.37	405	459	1146.6	1333.9	1146.6	1333.9	6.24
38	Wakefield	5865.84	371	421	367.22	429.80	367.22	429.80	5.60
39	Wain Spring Bridge	249.08	578	642	44.02	50.03	44.02	50.03	3.89
40	Ward River #1	1593.6	490.9	556	164.8	191.4	164.8	191.4	19.8
41	Yallahs River Bridge								
42	Unknown #3	1369	316.9	356.1	102.6	120.34	102.6	120.34	11.3
43	Unknown #4	6585	316.9	356.1	388.4	435.67	388.4	345.67	56

4.0 LEGISLATION:

4.1 Environmental Protection and Permitting

4.1.1 Natural Resources Conservation Authority (NRCA) Act

The NRCA Act is Jamaica's umbrella environmental law. The purpose of the Act is to provide for the management, conservation and protection of the natural resources of Jamaica.

The Act has established the Natural Resources Conservation Authority (NRCA), which has a number of powers including, inter alia:-

* Issuing of permits to persons responsible for undertaking any construction, enterprise or development of a prescribed category in a prescribed area

* Issuing licences for the discharge of trade or sewage effluent

* Requesting an Environmental Impact Assessment (EIA) from an applicant for a permit or the person responsible for undertaking any construction, enterprise or development
* Revocation or suspension of permits

* The Act also gave power of enforcement of the following environmental laws to the NRCA.

4.1.2 Environmental Review and Permitting Process (1997)

The Environmental Permit and License System (P&L), introduced in 1997, is a mechanism to ensure that all developments in Jamaica meet required standards in order to minimize negative environmental impacts. The P&L System is administered by NEPA, through the Applications Section (formerly the Permit and License Secretariat). Permits are required by persons undertaking new development which fall within a prescribed category. Under the NRCA Act of 1991, the NRCA is authorized to issue, suspend and revoke permits and licences if facilities are not in compliance with the environmental standards and conditions of approval stipulated. An applicant for a Permit or License must complete an application form as well as a Project Information Form (PIF) for submission to the NRCA/NEPA.

The main objectives of the Permit and License System are to:

- To ensure compliance with sections 9 & 12 of the NRCA Act, which gives the NRCA the right to issue permits for new developments and request EIA studies as required.

- To ensure the environmental issues are considered at the planning stage.
- Monitor waste discharge to the environment
- To ensure compliance with existing standards
- To ensure that production of goods and services are done in an environmentally friendly way
- To bring existing facilities into compliance with existing standards.

Table 4.1 Relevant Legislation:

LEGISLATION	PROJECT RELATED ISSUES
4.2.1Watershed Protection Act (1963) The Watersheds Protection Act of 1963 provides for the designation of watersheds for conservation purposes to reduce soil erosion, ensure regular flow in rivers and streams, and to maintain optimum levels of groundwater. This Act has been incorporated into the NRCA Act of 1991. More recently, the Natural Resources Conservation Authority in collaboration with the Ministry of Lands and the Environment (previously the Ministry of Environment and Housing) has produced a Watershed Policy for Jamaica (NRCA/MOEH, 1999) to assist in the management of Jamaica's watersheds. Management of the watersheds is done under Watershed Management Units. There are a total of 26 Watershed Management Units for the island.	1. Stream Bed modification 2. River Training Works 3. Bank Protection works
4.2.2 Flood Water Control Act: The Act designates specific persons who are given the responsibility to enter land I flood-water control area to: - Survey, measure, alter or regulate watercourses, maintain or build tools required to undertake flood control works. - Clean watercourse or banks of such and deposit where required.	1. River training works 2. Stream bed modification 3. Modifying water courses

LEGISLATION	PROJECT RELATED ISSUES
- Construct, improve, repair or maintain flood water control works.	
4.2.3 The Endangered Species Act (1999) This Act deals with restriction on trade in endangered species, regulation of trade in species specified in the schedule, suspension and revocation of permits or certificates, offences and penalties, and enforcement. Many species of reptile, amphibian and birds that are endemic to Jamaica but not previously listed under national protective legislation, or under international legislation, are listed in the Appendices of this Act.	1. Vegetation removal 2. Fauna disturbance and removal 3. Effects on habitat 4. Barriers to movement 5. Aquatic fauna 6. Wildlife corridors 7. Protection of sensitive areas
4.2.4 Water Resources Act (1995) The Water Resources Act of 1995 established the Water Resources Authority (WRA) and authorizes this Authority to regulate, allocate, conserve and manage the water resources of the island. The Authority is also responsible for water quality control and is required under **Section 4** of the Act to provide upon request to any department or agency of Government, technical assistance for any projects, programmes or activities relating to development, conservation and the use of water resources. It is the responsibility of the WRA as outlined in **Section 16** to prepare, for the approval of the Minister, a draft National Water Resources Master Plan for Jamaica. Areas to be covered in this Master Plan include objectives for the development, conservation and use of water resources in Jamaica with consideration being given to the protection and encouragement of economic activity, and the protection of the environment and the enhancement of environmental values. **Section 25** advises that the proposed user will still have to obtain	1. Abstraction of Water 2. Construction works in, around or adjacent to water resources (for domestic use).

LEGISLATION	PROJECT RELATED ISSUES
planning permission, if this is a requirement, under the Town and Country Planning Act. In addition, Section 21of the Act stipulates that if the water to be used will result in the discharge of effluents, an application for a license to discharge effluents will have to be made to the Natural Resources Conservation Authority or any other relevant body as indicated by the Minister. With regard to underground water, **Section 37** states that it is unlawful to allow this water to go to waste. However, if the underground water "interferes or threatens to interfere with the execution or operation of any underground works", it will not be unlawful to allow the water to go to waste in order to carry out the required works provided that there is no other reasonable method of disposing of the water. The Authority also has the power to determine the safe yield of aquifers **(Section 38**).	
4.2.5 Country Fires Act (1942) Section 4 of the Country Fires Act of 1942 prohibits the setting of fire to trash without prior notice being given to the nearest police station and the occupiers of all adjoining lands. In addition, a space of at least fifteen feet in width must be cleared around all trash to be burnt and all inflammable material removed from the area. Section 6 of the Act empowers the Minister to prohibit, as may be necessary, the setting of fire to trash without a permit. Offences against this Act include: * *Setting fire to trash between the hours of 6.00 p.m. and 6.00 a.m. (Section 5a);* * *Leaving open-air fires unattended before they have been completely extinguished (Section 5b);* * *Setting fires without a permit and contrary to the provisions outlined in* * *Section 6 (Section 8);* * *Negligent use or management of a fire, which could result in*	1. Burning of trash and other debris. 2. Fire management

LEGISLATION	PROJECT RELATED ISSUES
damage to property (Section 13a); * *Smoking a pipe, cigar or cigarette on the grounds of a plantation, which could result in damage to property (Section 13b)*	
4.2.6 Quarries Control Act (1983) The Quarries Control Act of 1983 established the Quarries Advisory Committee, which advises the Minister on general policy relating to quarries as well as on applications for licenses. The Act provides for the establishment of quarry zones, and controls licensing and operations of all quarries. The Minister may on the recommendation of the Quarries Advisory Committee declare as a specified area any area, in which quarry zones are to be established and establish quarry zones within any such specified area. **Section 5** of the Act states that; a licence is required for establishing or operating a quarry though this requirement may be waived by the Minister, if the mineral to be extracted is less than 100 cubic meters. Application procedures are outlined in **Section 8**. The prescribed form is to be filed with the Minister along with the prescribed fee and relevant particulars. The applicant is also required to place a notice in a prominent place at the proposed site for a period of at least 21 days starting from the date on which it was filed.	1. Sourcing of construction Materials. 2. Mining materials from river bed
4.2.7 Air Quality Standards The Federal Clean Air Acts, which came into force in the United States in 1990 established air quality standards for six pollutants: ozone (O_3), carbon monoxide (CO), sulfur dioxide (SO_2), nitrogen dioxide (NO_2), respirable particulate matter (PM_{10}) and lead (Pb). An allowable level for each of these pollutants has been set by the United States Environmental Protection Agency (US EPA) whose objective is to protect the public from exposure to dangerous levels. National standards, known as the National Ambient Air Quality Standards	1. Dust management. 2. Storing and stockpiling of construction materials. 3. Burning of trash 4. Exhaust fumes from

LEGISLATION	PROJECT RELATED ISSUES
(NAAQS), were established and they were categorized into two groups. In one group, there are the primary standards, designed to protect human health and in the other, there are the secondary standards designed to protect the environment and limit property damage.	equipment 5. Emission to the atmosphere 6. Land Clearing
4.2.8 Noise Standards Jamaica has a national noise guideline for environmental noise, which is similar to the World Health Organization guidelines, which is often used for benchmarking purposes.	1. Pile driving 2. Vehicular movements 3. Noise & Vibrations
4.2.9 Water Quality Regulation NRCA Act (1990) The NRCA has primary responsibility for control of pollution in Jamaica's environment, including pollution of water. National Standards exist for industrial and sewage discharge into rivers and streams. WHO Standards for drinking water are used and these are regulated by the National Water Commission. There are national standards for ambient water quality of riverine systems.	1. Erosion control 2. Flood control 3. Land clearing activities 4. Sediment control 5. Earthworks excavations cuts and fill.
4.2.10 The National Solid Waste Management Authority Act (2001) The National Solid Waste Management Authority Act (2001) is "an act to provide for the regulation and management of solid waste; to establish a body to be called the National Solid Waste Management Authority and for matters connected therewith or incidental thereto". The Solid Waste Management Authority (SWMA) is to take all steps as necessary for the effective management of solid waste in Jamaica in order to safeguard public health, ensure that waste is collected, sorted, transported, recycled, reused or disposed of, in an environmentally sound manner and to promote safety standards in relation to such waste. The SWMA also has responsibility for the promotion of public awareness of the importance of efficient solid waste management, to advise the Minister on matters of general policy and to perform other functions pertaining to solid waste management.	1. Solid waste management and disposal. 2. Construction camps, equipment storage,

LEGISLATION	PROJECT RELATED ISSUES
4.2.11 Jamaica National Heritage Trust Act (1985) The Jamaica National Heritage Trust Act of 1985 established the Jamaica National Heritage Trust (JNHT). The Trust's functions outlined in **Section 4** include the following responsibilities: *To promote the preservation of national monuments and anything designated as protected national heritage for the benefit of the Island;* *To carry out such development, as it considers necessary for the preservation of any national monument or anything designated as protected national heritage;* *To record any precious objects or works of art to be preserved and to identify and record any species of botanical or animal life to be protected.* **Section 17** states that it is an offence for any individual to: *Willfully deface, damage or destroy any national monument or protected national heritage or to deface, damage, destroy, conceal or remove any mark affixed to a national monument or protected national heritage;* *Alter any national monument or mark without the written permission of the Trust;* *Remove or cause to be removed any national monument or protected national heritage to a place outside of Jamaica.*	1. Demolition of existing bridges. 2. Cultural heritage structures 3. Siting of construction material and structures
4.2.12 Land Acquisition Act (1947) Section 3 of the Land Acquisition Act (1947) empowers any officer authorized by the Minister to enter and survey land in any locality that may be needed for any public purpose and may also involve:	1. Land acquisition 2. Relocation 3. Disposal of surplus

LEGISLATION	PROJECT RELATED ISSUES
Digging or boring into the sub-soil; Cutting down and clearing away any standing crop, fence, bush or woodland; Carrying out other acts necessary to ascertain that the land is suitable for the required purpose. The Minister is authorized under **Section 5** of the Act to make a public declaration under his signature if land is required for a public purpose provided that the compensation to be awarded for the land is to be paid out of the: Consolidated Fund or loan funds of the Government; Funds of any Parish Council, the Kingston and St. Andrew Corporation or the National Water Commission. Once the Commissioner enters into possession of any land under the provisions of this Act, the land is vested in the Commissioner of Lands and is held in trust for the Government of Jamaica in keeping with the details outlined in **Section 16**. The Commissioner shall provide the Registrar of Titles with a copy of every notice published as well as a plan of the land. The Commissioner will also make an application to the Registrar of Titles in order to bring the title of the land under the operation of the Registration of Titles Act.	land 4. Indigenous heritage
4.2.13 Mining Act (1947) It is the responsibility of the Commissioner of Mines to exercise general supervision over all prospecting and mining operations in the Island. **Section 8** of the Act identifies lands excluded from prospecting or mining. These include: *Land to be used for any public purpose (other than mining), for a burial ground or within 100 yards of such places;* * *Any area located within any town or village;* * *Land reserved for the purpose of a railway or situated within 100 yards of any railway (unless the railway is constructed by the mining lessee for use during operations);*	Sourcing materials for construction and backfilling.

LEGISLATION	PROJECT RELATED ISSUES
* *Any area, which is the site or is within 100 yards of any building, works, reservoir or dam or occupied by the Government or a public authority;* * *Any street road or highway or any land within 50 yards of the center line of a street, road or highway other than one constructed on the mining lease by the mining lessee;* * *Land within 100 yards of any building* * *Prospecting may proceed in these areas only with the consent of the Commissioner, or in the case of a building, the consent of its occupier.* *According to **Section 9** of the Act, the Minister may at any time, declare an area closed to prospecting and mining. This excludes any lands to which a lessee has rights under a licence or mining lease.*	
4.2.14 Biodiversity Convention The objectives of the Convention on Biological Diversity are "the conservation of biological diversity, sustainable use of its components and the fair equitable sharing of the benefits arising out of the utilization of genetic resources". The Convention acknowledges that the "conservation of biological diversity is a common concern of humankind and an integral part of the development process". In order to achieve its goals, the signatories are required to: * *Develop plans for protecting habitat and species.* * *Provide funds and technology to help developing countries provide protection.* * *Ensure commercial access to biological resources for development* * *Share revenues fairly among source countries and developers* * *Establish safe regulations and liability for risks associated with biotechnology development.* Jamaica's Green Paper Number 3/01, entitled Towards a National Strategy and Action Plan on Biological Diversity in Jamaica, speaks to	1. Effects on habitat 2. Barriers to movement 3. Aquatic fauna 4. Wildlife corridors 5. protection of sensitive areas

LEGISLATION	PROJECT RELATED ISSUES
Jamaica's continuing commitment to its obligations as a signatory to the Convention.	
4.2.15 Portland Bight Protected Area - Regulations 1999 **The Natural Resources Conservation Authority Act (1991) – The Natural Resources Conservation** These regulations apply within the area declared to be the Portland Bight Protected Area and apply in addition to any other regulations relating to the area. Offences listed include extraction or mining of minerals, pollution of water in rivers or streams, or deposit litter, rubbish or refuse. Licences for particular activities may be granted if application is made to the Protected Area Manager.	Construction of the Salt Gully Bridge Encroaching in the Habitat of crocodiles that are protected by Jamaican law (See section 4.2.3).
4.2.16 The Main Roads Act	
4.2.17 The Flood Water Control Act	

5.0 PROJECT IMPACTS (Identification and Mitigation)

5.1 Overview:

An environmental impact is defined as any change to an existing condition of the environment. For the purpose of this study, the impacts are categorized as minor negative, major negative, minor positive and major positive. To systemically identify the impacts associated with the proposed bridge rehabilitation programme, an impact matrix was constructed which arrayed the main project activities against the relevant environmental factors. This matrix is shown table 5.1.

5.1.1 Pre-Construction Impacts:

1. No widening or realignment of the carriage way outside of the existing right-of-way (ROW) will be required on most of the sites.
2. Replacement bridges will be constructed in most instances on the existing alignment and no realignment of approaches will be necessary.
3. Remedial works related to earthworks will adopt designs which do not involve new construction outside the existing ROW.

None of the direct or indirect potential impacts which are associated with land acquisition and displacement of population from housing, business premises or agricultural land will occur.

5.1.2 Construction Impacts:

The impacts associated with most of the areas where work is to take place are not in anyway adverse, because the activities will be confined to a narrow construction zone. However, control measures in the form of suitable environmental protection clauses will be included in the contracts.

The programme will not involve construction activities in areas which are designated environmentally sensitive. No major earthworks will be carried out in any of these areas and the potential for erosion will be significantly reduced. The improvement works at the Salt Gully Bridge will be analyzed in greater detail, because the project lies in a protected area.

No site clearance works will be needed in mangroves areas. Temporary Bailey bridge installation will not require any major earth works and as such the impact of these structures on the local flora will be minimal and temporary. In general, construction at locations with perennial streams

will take place within coffer dams and enforcement of the contract clause requiring coffer dam pumps to be treated in settling ponds before outfall downstream.

Activities and Associated Potential Impacts	Air		Water			Land			Flora & Fauna			Human Use						Quality of Life						Eval Env. Risk			Key to Signs / Comments
	Dust Level	Other Pollutant Levels	Surface Water Flows	Surface Water Quality	Ground Water Quality	Erosion & Siltation	Drainage Pattern	Slope Stability	Sensitive Habitat	Terrestrial Flora & Fauna	Aquatic Flora & Fauna	Infrastructure Service	Other Public Facilities	Agriculture & Forestry Aquaculture & Fisheries	Recreation	Industry & Commerce	Social Stability/Cohesion	Public Safety	Environmental Health	Noise & Vibration	Cultural Heritage	Landscape Quality	Non – significant	Minor	Significant	Comments
Workforce Deployment																										
Income generation in local economy																O								o		Temporary but locally significant
Increased pressure on public facilities																	x		X				x			Short Duration
Friction between Workers and locals													x					x						x		Possible if there is political divide
Deployment of Plant & Machinery																										
Overloading Road Structures/Pavement												x						x					x			Short term inconvenience to motorists
Induced Congestion and Safety Hazards																X		x						x		Mitigation by effective signaling
Aggregate & Material Extraction																										
Incremental land clearance	x					x				x				x								x	x			Where there is need for new sites
Extraction Process			x			x		x											X	x		x	x			Temporary duration
Pavement & Drainage Works																										
Disposal of surplus materials																						x		x		Disposal of old bridge material
Interference with traffic/ flow/road safety												x			x	X		X		x				x		Mitigation by effective signaling

Table 5.1 OVERALL ENVIRONMENTAL IMPACT MATRIX
Potentially Affected Components/Values

Key to Signs

x = Minor Negative Impact
X = Major Negative impact
o = Minor positive impact
O = Major Positive Impact

*** Degree of environmental Risk in outcome**

Table 5.1 OVERALL ENVIRONMENTAL IMPACT MATRIX Potentially Affected Components/Values

Key to Signs

x = Minor Negative Impact
X = Major Negative impact
o = Minor positive impact
O = Major Positive Impact

*** Degree of environmental Risk in outcome**

Activities and Associated Potential Impacts	Air		Water			Land			Flora & Fauna			Human Use						Quality of Life						Eval Env. Risk			Comments
	Dust Level	Other Pollutant Levels	Surface Water Flows	Surface Water Quality	Ground Water Quality	Erosion & Siltation	Drainage Pattern	Slope Stability	Sensitive Habitat	Terrestrial Flora & Fauna	Aquatic Flora & Fauna	Infrastructure Service	Other Public Facilities	Agriculture & Forestry Aquaculture & Fisheries	Recreation	Industry & Commerce	Social Stability/Cohesion	Public Safety	Environmental Health	Noise & Vibration	Cultural Heritage	Landscape Quality	Non – significant	Minor	Significant	
Pollution from asphalt and concrete		x	x		x						x				x	x				X							Temporary impacts possible
Waste Management																											
Restoration of solid waste, debris.												o	O			O	O		o	O	x		O			O	
Project Outcome/Operation Phase																											
Improvement to Bridge Structure			O	O			O	O	o			O	o	O	O	o	O	O	O	O			O			O	Benefits to commercial, agricultural and recreational uses.
Net improvement in transportation network/communication.												O	o	O	O	O	O	o	O	o						O	Security to movements and communication.
Restoration of productive economic activities												O	o	o		o	O									O	Improved access to farms and places of business.
Increases in land values from services provision												O	o	o		o	O	O	o	o					O		
Restoration/Enhancement of Recreational and Tourism values													o			O	O									O	

Wetlands and watercourses in general will be protected through the enforcement of construction contract clauses which will prohibit the location of certain facilities such as:

- Base camps and asphalt plants in or adjacent to wetlands;
- A requirement for effective precautions to be taken to minimize and contain spillages of polluting materials and for immediate clean-up measures to be taken in the event of spillages;
- All construction works within waterways and on banks to be undertaken behind coffer dams, with discharge from coffer dams pumps being treated before outfall downstream;
- The provision of enclosures to prevent lead-contaminating paint, removed during remedial works to bridge beams, falling into watercourses.

Bank protection works will comprise gabions which will naturally become covered with vegetation. In any case where bank works would result in unprotected slopes; the specifications will make provision for re-vegetation with suitable native species.

5.1.2.1 Construction wastes:

(1) Concrete Rubble and Earthworks

It is not expected that the works on the bridges will result in the generation of substantial volumes of construction wastes. Metal from the bridges will be stored for re-use and any sub-base material will be reworked, thus minimizing the need for disposal of waste. Excavation for new abutments and the removal of old abutments will be the only activity that will generate any significant amount of waste. This is unlikely to be very high, since the amounts are relatively small, ranging from 30 cubic meter to 80 cubic meter. Waste

Reduction in terms of incorporating rubble material into hard shoulders will be encouraged where possible.

Very little earthworks spoil is likely to be generated as a result of the bridge programme, in cases where embankments are affected; the material will be suitable to be incorporated in the remodeled embankments. Demolition waste in the form of concrete, steel beams and reinforcement will be generated. As indicated above these will deposited at the nearest approved solid waste site

(2) Hazardous Waste

The only form of hazardous waste that is likely to be generated by the project, is paint removed from steel bridge beams which, on account of the age of the structures, is likely to have a high lead content. The amount envisioned from this programme is expected to be small. Disposal

impact will be controlled by requiring all waste to be deposited of at the nearest approved site, and in accordance with the national Solid Waste Management Authority Guidelines.

5.1.2.2 Traffic Management:

During construction there will be the need for closure of most of the bridges, especially where construction will take place in the existing alignment. For these sites, diversion to detours, temporary Bailey bridges or culvert crossings will be the options pursued from a road safety, workforce safety and construction efficiency view point. At locations where there is adequate space adjacent to existing structures, temporary bridging will be installed. Under the terms of the contract, Contractors will be required to prepare traffic management plans before they commence work and to comply with these. These plans will be prepared for each bridge and will spell out in details the measures to be adopted to minimize interference with traffic flow caused by the execution of the works, and ensure the safety of both the workforce and road users. The plans will be discussed with the local authorities and any necessary remedial works to the diversion routes completed before the bridge is closed. The contractors are required to program their works so that any closures are for the minimum time possible in the circumstances. The traffic management changes will be published by the NWA as part of it's responsibilities under the Main Road's Act.

5.1.2.3 Extraction of Natural Resources:

It is considered most unlikely that contractors will have to open new working areas to meet their needs for aggregates and other materials. Consequently, the impacts associated with construction material extraction will be limited to marginal increases at the existing sites. With respect to haulage of materials most of the trucks are now more modern vehicles and more suited for long distances or the main thoroughfare. However, overloading will be carefully monitored, so that the safety of other road users is not compromised. Suitable clauses are included in the construction contracts to control haulage operations and so to minimize impacts.

5.1.3 Operational Impacts:

The key impact anticipated during the operational will generally be beneficial, these will include; improvement to local communities, access to markets, reduction in goods and passenger transport costs and improvement in drainage conditions. While there may be increases in traffic levels, the increase will unlikely to be high enough to have any negative impact on the communities. Project generated traffic levels are most unlikely to be sufficiently high to result in significant air pollution from vehicle exhausts, or the generation of noise at levels which will exceed the NEPA guidelines of 70 dBA. It is not considered that traffic speed will be raised as a result of the project works as the speeds are constrained by gradient and site distances.

5.2 Site Specific Impacts - Summary

BRIDGES	ENVIRONMENTAL FACTORS POTENTIALLY AFFECTED														
O - Major Positive o - Minor Positive X - Major Negative x- Minor Negative - No Impact	Land Use Planning	Aesthetics	Biological Resources	Agricultural Resources	Cultural Resources	Air Quality	Geology/Soils	Hydrology & water Quality	Mineral Resources	Noise	Recreation	Population & Housing	Transportation & Traffic	Mineral Resources	Hazard & Hazardous
Barham	-	O	x	O	-	-	-	X	-	x	-	O	O	-	-
Bushy Park #3	O	O	x	O	-	-	-	x	-	x	-	O	O	-	-
Dry River Bridge	O	O	o	O	-	-	-	x	-	x	o	O	O	-	-
Dundee Bridge	O	O	x	O	-	-	-	x	-	x	-	O	O	-	-
Eden River	O	O	x	O	-	-	-	x	-	x	o	O	O	-	-
Enfield	O	O	x	O	-	x	-	x	-	x	-	O	O	-	-
Fontabelle #2	O	O	x	O	-	x	-	x	-	x	-	O	O	-	-
Grosmond - Concrete	O	O	-	O	-	x	-	x	-	x	-	O	O	-	-
Guanaboa Vale (Bamboo)	O	O	-	O	-	x	-	-	-	x	-	O	O	-	-
Harbour Head	O	O	x	-	-	x	-	X	-	x	O	O	O	-	-
Hog Hole	O	O	x	O	-	-	-	x	-	x	-	O	O	-	-
Jacob	O	O	x	O	-	-	-	x	-	x	o	O	O	-	-
John's Hall #2	O	O	-	O	-	x	-	-	-	x	O	O	O	-	-
John's Hall (New#1)	O	O	-	O	-	x	-	-	O	x	O	O	O	O	-
John's Hall (New#2)	O	O	-	O	-	x	-	-	-	x	O	O	O	O	-
Kings Valley Bridge	O	O	-	O	-	x	-	x	-	x	O	O	O	-	-
Latium Bridge	O	O	-	O	-	x	-	x	-	x	O	O	O	O	-
Leith Hall	O	O	-	O	-	x	-	-	-	x	O	O	O	-	-
Lime Bush	O	O	x	O	-	x	-	x	-	x	O	O	O	-	-
Maggart Bridge	O	O	-	O	-	-	-	x	-	x	-	O	O	-	-
May River Bridge	O	O	-	O	-	x	-	-	-	x	-	O	O	-	-
Merrivale Gully	O	O	-	-	-	X	-	-	-	x	-	O	O	-	-
Nightingale (truss)	O	O	-	O	-	X	-	x	-	x	-	O	O	-	-
Pedro River Bridge	O	O	-	O	-	x	-	x	-x	x	-	O	O	-	-
Red Hill's Over Pass	O	O	-	-	-	X	-	-	-	x	-	O	O	-	-
Rosa Bridge	O	O	-	O	-	x	-	-	-	x	-	O	O	-	-
Salt Gully Bridge	O	O	X	O	-	-	-	x	-	x	X	O	O	-	-
Sandy Gully Cassia Park	O	O	-	-	-	X	-	-	-	x	-	O	O	-	-
Sandy Gully (Queensborough)	O	O	-	-	-	X	-	-	-	x	-	O	O	-	-
Shooting River	O	O	x	O	-	X	-	-	-	x	-	O	O	-	-
Silent Hill Bridge	O	O	x	O	-	-	-	x	-	x	x	O	O	-	-
Spring Field	O	O	-	O	-	-	-	x	-	x	-	O	O	-	-
Spring Vale	O	O	-	O	-	-	-	-	-	x	-	O	O	-	-
Stubbs Bridge	O	O	-	-	-	X	-	-	-	x	-	O	O	-	-
Temple Hall (Boswell Heights)	O	O	x	O	-	-	-	X	-	x	-	O	O	-	-
Vanity Fair	O	O	-	-	-	X	-	-	-	x	-	O	O	-	-
Wakefield	O	O	-	O	-	-	-	-	-	x	-	O	O	-	-
Wain Spring Bridge	O	O	-	O	-	-	-	x	-	x	O	O	O	-	-
Ward River #1	O	O	-	-	-	-	-	-	-	x	-	O	O	-	-
Yallahs River Bridge	O	O	-	O	-	x	-	-	O	x	O	O	O	O	-
Unknown #3	O	O	-	O	-	x	-	-	-	x	-	O	O	-	-
Unknown #4	O	O	-	O	-	x	-	-	-	x	-	O	O	-	-

Table 5.2Site Specific Impacts and Mitigation - Details

ACTIVITIES	IMPACTS	MITIGATION
Site Preparation and Construction		
1. Land Clearance **2. Vegetation Removal**	Soil investigations reveal that soil erosion and siltation of watercourses could have a negative impact on the flow regime and water quality within the river/gully associated with the bridge construction. This could lead to minor negative impacts such as declined water quality and water transparency, along with severe negative impacts such as flow impairment and localised upstream/downstream flooding (arising from the overtopping of the river/gully banks). It is imperative, therefore, that proper sediment management practices are implemented during site clearance, site preparation and the construction phase of the project.	**1.** Under no circumstance will top soil, sand, marl, silt, cut vegetation etc. be allowed to collect within the rivers and gullies to the extent that they impair surface water flow and provide the opportunity for overtopping and flooding. Coffer Dams will be used to control the movement on most of the work sites. **2.** Fine grained materials (sand, marl, etc.) will be stockpiled away from drainage channels and low berms will be placed around the piles which themselves will be covered with tarpaulin to prevent them from being eroded and washed away. **3.** Vegetation clearance, particularly on sections with grass and steep inclines, will be phased and cleared only as the need arises. This will help reduce the risk of soil erosion. Exposed areas will be re-vegetated and grassed as soon as possible after construction to reduce soil erosion and sediment runoff into the rivers and gullies. Installation of silt fences will required as part of the contract implementation and ill be included in the contract.
	The improper installation and construction of replacement bridges and temporary road traffic diversion bridges/fording has the potential of impacting negatively on the water flow regime within the river/gully in question. This could also lead to the type of overtopping and localized upstream/downstream flooding outlined in the preceding paragraph.	**1.** Replacement bridge and temporary road traffic diversion bridge/fording design and construction will take into account the impact of their installation and construction on the flow regime within the river/gully over a short- to long-term period. Appropriate mitigation measures and designs will be implemented to militate against overtopping, flooding and bank erosion arising from improper installation and construction of the bridge/temporary fording. Where possible (and practical) construction work on the bridges will be conducted during the dry season when the likelihood of heavy rainfall and increased surface water flow is minimal.
Noise Pollution	Site clearance and construction of the proposed development necessitates the use of heavy equipment to carryout the nature of the job. This equipment includes Front End loaders, backhoes, jackhammers etc.	1**.** Use equipment that has low noise emissions as stated by the manufacturers. **2.** Use equipment that is properly fitted with noise reduction devices such as mufflers. **3.** Operate noise-generating equipment during regular working hours (e.g. 7 am – 7 pm) to reduce the potential of creating a noise nuisance during the night. **4.** Construction workers operating equipment that generates noise should be equipped with noise protection. A guide is workers operating

ACTIVITIES	IMPACTS	MITIGATION
		equipment generating noise of ≥ 80 dBA (decibels) continuously for 8 hours or more should use ear muffs. Workers experiencing prolonged noise levels 70 - 80 dBA should wear earplugs.
Air Quality	Site preparation and construction has the potential to have a two-folded direct negative impact on air quality. The first impact is air pollution generated from the construction equipment and transportation. The second is from fugitive dust from cleared areas and raw materials stored on site. Fugitive dust has the potential to affect the health of construction workers, the resident population and the vegetation.	**1.** Access roads should be dampened every 4-6 hours or within reason to prevent a dust nuisance and on hotter days, this frequency should be increased. **2.** Minimize cleared areas to those that are needed to be used. 3. Cover or wet construction materials such as marl to prevent a dust nuisance. **4.** Where unavoidable, construction workers working in dusty areas should be provided and fitted with N95 respirators.
Solid Waste Generation	During this construction phase of the proposed project, solid waste generation may occur mainly from two points: 1. From the construction campsite. 2. From construction activities such as site clearance and excavation.	**1.** Skips and bins should be strategically placed within the campsite and construction site. **2.** The skips and bins at the construction campsite should be adequately designed and covered to prevent access by vermin and minimize odor. **3.** The skips and bins at the construction site should be adequately covered to prevent a dust nuisance. **4.** The skips and bins at both the construction campsite and construction site should be emptied regularly to prevent overfilling. **5.** Disposal of the contents of the skips and bins should be done at an approved disposal site.
Waste Water Generation and Disposal	With every construction site and campsite, there is the need to provide construction workers with showers and sanitary conveniences. The disposal of the wastewater generated at the construction campsite has the potential to have a minor negative impact on groundwater. No significant environmental impacts are expected from this activity.	**1**. Provide portable sanitary conveniences for the construction workers for control of sewage waste. A ratio of approximately 25 workers per chemical toilet should be used. **2.** For larger sites provision should be made for proper sanitary conveniences and showers or wash down areas for workers.
Storage of Materials and Equipment	Raw materials, for example sand and marl, used in the construction of the proposed development will be stored onsite. There will be a potential for them to become air or waterborne. Stored fuels and the repair of construction equipment has the potential to leak hydraulic fuels, oils etc.	**1.** Raw materials that generate dust should be covered or wet frequently to prevent them from becoming air or waterborne. **2.** Raw material should be placed on hardstands surrounded by berms. **3.** Equipment should be stored on impermeable hard stands surrounded by berms to contain any accidental surface runoff. **4.** Bulk storage of fuels and oils should be in clearly marked containers (tanks/drums etc.) indicating the type and quantity being stored. In addition, these containers should be surrounded

ACTIVITIES	IMPACTS	MITIGATION
		by berms to contain the volume being stored in case of accidental spillage.
Transportation of Raw Materials, equipment and Spoils	The transportation and use of heavy equipment and trucks is required during construction. Trucks will transport raw materials and heavy equipment. This has the potential to directly impact traffic flow along local roads and especially at the entrance to the construction site.	**1.** Adequate and appropriate road signs should be erected to warn road users of the construction activities. For example reduced speed near the construction site. **2**. Raw materials such as marl and sand should be adequately covered within the trucks to prevent any escaping into the air and along the roadway. **3.** The trucks should be parked on the proposed site until they are off loaded. **4.** Heavy equipment should be transported early morning (12 am – 5 am) with proper pilotage. **5.** The use of flagmen should be employed to regulate traffic flow.
Emergency Response	Construction of the proposed bridges has the potential for accidental injury. There maybe either minor or major accidents (See Appendix).	**1**. A lead person should be identified and appointed to be responsible for emergencies occurring on the site. This person should be clearly identified to he construction workers. **2.** The NWA Construction Management Team should have onsite first aid kits and arrange for a local nurse and/or doctor to be on call for the construction site. **3.** Make prior arrangements with local health care facilities such as health centers or the hospitals to accommodate any eventualities. **4.** Material Safety Data Sheets (MSDS) should be store onsite.
Workers Safety	Construction of a bridge entails workers being suspended in the construction process. This has the potential for increase construction accidents. Additionally, there will be some blasting in preparing some of the sites for the erection of a new bridge (See Appendix).	The provision of lifelines, personal safety nets or safety belts and scaffolding for the construction workers. Detail Guidelines are provided in the NWA ***Occupational Health and Safety Guidelines for Construction sites*****(**See Appendix*)*
Traffic Management	The construction of the new bridges will necessitate the re- routing of some vehicular and pedestrian traffic and introducing traffic delays thereby increasing in travel time. The re routing of vehicular traffic has the potential to lead to increase fares.	**1.** Ensure that the increase distances as a result of detours are kept to a minimum so as to reduce the cost of transportation. **2.** Place adequate and appropriate construction warning signs. **3.** Give adequate and ample notice of the pending road works and detours.
Demolition of Bridges	The removal of the temporary bridges (Baileys) erected for the construction exercise and the old bridges have the potential to impact negatively on the environment.	**1.** Follow the manufacturer's instruction for bridge removal. **2.** Necessary steps should be taken that stream flows and water quality are not negatively impacted.

ACTIVITIES	IMPACTS	MITIGATION
OPERATIONS		
Natural Hazards	Natural hazards such as flooding, hurricane and earthquake has the potential to impact negatively on the structural integrity of the bridges.	**1.** Ensure that the new structures can withstand hurricane and earthquake impacts. **2.** Ensure that the new structures are designed to withstand a 50 –100 year flood event. **3.** Bridge integrity inspections should be conducted every two (2) years by qualified personnel. **4.** Develop an emergency response plan for each bridge location.
Bridge Maintenance	Routine maintenance of the bridges is required to ensure the bridges integrity. This may entail sand blasting, scraping, painting and limiting the type of vehicular traffic using them.	**1.** The use of lead based paints should be prohibited. If this is unavoidable care should be taken to prevent inhalation by the persons applying the paint and to minimize the potential for the paint to enter the ecosystem. **2.** When sand blasting and scraping, collection mechanisms should be placed strategically to prevent the particulates from entering the waterways below. **3.** The load capacity of the bridges should be calculated and signs placed instructing that vehicles not meeting the criteria should not use the bridge.
Drainage , Flooding, Sub-surface and Overland Drainage	As is the case under the site preparation and construction phases of the project, siltation of watercourses (due to local and regional soil erosion and runoff during the operational phase of the project) could have a negative impact on the flow regime within the river/gully associated with the bridge in question. This could lead to severe negative impacts such as flow impairment and localised upstream/downstream flooding (arising from the overtopping of the river/gully banks). Increased stream flow is often a direct result of river/gully channelization and deepening and increased channel water flows are generally coupled with increased potentials for within-channel erosion and the associated transport of large volumes of silt downstream.	**1.** Proposed engineering works (particularly those proposing channel alterations) will seek to keep to a minimum changes in surface flows within the river and gully channels in question. These designs will minimize soil compaction (during the construction phase of the project) and ensure that post-project channel systems minimize within-channel soil erosion and can accommodate the projected volumes of increased surface water and bed material flow without increasing the risk of localized and regional upstream/downstream flooding. **2.** Maintenance of the river and gully channels will be a part of the routine annual maintenance works associated with the Bridge Management Programme maintenance plans for all the bridges proposed by the NWA. If required during this exercise, minor periodic removal of accumulated channel sediment will be undertaken to maintain the proposed channel design, and militate against the potential threat of future upstream/downstream flooding.

6.0 ENVIRONMENTAL MANAGEMENT GUIDELINES

6.1.0 General Requirements

Environmental management requirements during construction will be documented in the Environmental Management Plan (EMP). The Environmental Management Plan (EMP) is a method of ensuring that the measures identified and commitments made in the environmental assessment process are delivered in the construction and operational phases of the project.

It is also designed to assist in managing the environmental impacts. Project-specific EMP's will be prepared for all projects with significant environmental issues or impacts. These will then be responded to by the construction contractor in an Environmental Management Implementation Plan (EMIP).

The EMIP is a document that will be produced by the contractor, in accordance with EMP guidelines. It will detail how the contractor will implement and manage environmental aspects of the project. The contractor will outline mitigation measures that are required to be put in place for the duration of the Contract. The EMIP is expected to be a "live document" and is updated throughout the course of the contract.

6.1.1 Objective

To develop an Environmental Management Plan to reduce the adverse impact of construction activities on the environment.

6.1.2 Suggested measures

1. The agency's/company's environmental management policy and goals should be stated.

2. The EMP should be prepared for specific bridges (if more than bridge is being undertaken by the same contractor), or a complete site plan for individual bridges if only one site is involved;

3. The plan should, include detailed specifications on site-specific controls and include a general rehabilitation program in the plan;

4. The plan should support the measures in the plan on best practice (attached in the appendix);

5. The plan should be updated to meet new risks or where inspections, monitoring or audit reveal that measures are ineffective;

6. The plan must be updated achieve ongoing improvement.

Table 6.1 Details of Best Management Practices and Measures

ENVIRONMENTAL ISSUE	OBJECTIVES	ENVIRONMENTAL MANAGEMENT MEASURES TO BE TAKEN	CONSTRUCTION PRACTICE
1. Minimizing Erosion	**To minimize the quantity of soil lost during construction due to land-clearing.**	1. Schedule measures to avoid and reduce erosion by phasing the work program to minimize land disturbance in the planning and design stage. 2. Keep the areas of land cleared to a minimum, and the period of time areas remain cleared, to a minimum; 3. Base control measures to manage erosion on the vulnerability of cleared land to soil loss, paying particular attention to protecting slopes. 4. Mulch, roughen and seed cleared slopes and stockpiles where no works are planned for more than 28 days, with sterile grasses. 5. Keep vehicles to well-defined haul roads. 6. Rehabilitate cleared areas promptly.	1.Dewatering Operation 2. Material Storage and Spoils.
2. Stormwater Management	**To minimize the generation of contaminated stormwater**	1. Minimize the quantity of uncontaminated stormwater entering cleared areas. 2. Establish cut-off or intercept drains to redirect stormwater away from cleared areas and slopes to stable (vegetated) areas or effective treatment installations. 3. Reduce water velocities.	1. Dewatering Operation. 2. Vehicle Equipment Cleaning
3. Sediment Control	**To minimize the impact of contaminated.**	1. Install erosion and sediment control measures if possible before construction commences; 2. Identify drainage lines and install control measures to handle predicted stormwater and sediment loads generated in the mini-catchment;	1. Dewatering Operation. 2. Demolition of Bridges 3. Material Use.

ENVIRONMENTAL ISSUE	OBJECTIVES	ENVIRONMENTAL MANAGEMENT MEASURES TO BE TAKEN	CONSTRUCTION PRACTICE
		3. Design and install appropriate erosion and sediment run-off control measures appropriate to site conditions to handle a one-in-two-year storm event, for temporary structures, and a one-in-fifty year storm event, for permanent structures; 4. Establish an adequate inspection, maintenance and cleaning program for sediment run-off control structures; 5. Ensure that contingency plans are in place for unusual storm events; 6. Continually assess the effectiveness of sediment control measures and make necessary improvements.	4.Contaminated Soil
4. Air Quality	**To ensure there is no health risk or loss of amenity due to emission of dust to the environment.**	1. Implement a dust prevention strategy, developed at the project planning stage. 2. Take dust suppression measures, such as promptly watering exposed areas when visible dust is observed. 3. Install wind fences wherever appropriate. 4. Prevent the generation of dust in preference to applying dust suppression measures; 5. Ensure in the project schedule that the area of cleared land is minimized during the drier months of the year, when dust generation is at its greatest. 6. Pave and water haul roads. The frequency of watering will be determined by weather conditions and the erodibility of the soil. If additives in the water are used to increase its dust suppression properties, the chemical should have no adverse environmental impact on adjacent water bodies. 7. Water areas other than haul roads, if they are a source of dust; 8. Ensure that smooth surfaces are deep	1. Demolition of Bridges. 2. Material Transport. 3. Material Storage.

ENVIRONMENTAL ISSUE	OBJECTIVES	ENVIRONMENTAL MANAGEMENT MEASURES TO BE TAKEN	CONSTRUCTION PRACTICE
		ripped and left rough and cloddy to reduce the wind velocity at the soil surface; 9. Construct wind fences if this is appropriate for the site.	
5.Management of stockpiles and batters	**To manage soil stockpiles so that dust and sediment in run-off are minimized.**	1. Minimize the number of stockpiles, and the area and the time stockpiles are exposed. 2. Locate stockpiles away from drainage lines, at least 10 meters away from natural waterways and where they will be least susceptible to wind erosion. 3. Ensure that stockpiles and batters are designed with slopes no greater than 2:1 (horizontal/vertical). 4. Stabilize stockpiles and batters that will remain bare for more than 28 days by covering with mulch or anchored fabrics or seeding with sterile grass 5. Establish sediment controls around unstabilised stockpiles and batters. 6. Suppress dust on stockpiles and batters, as circumstances demand. 7. Locate stockpiles away from drainage lines to where they are protected from wind. 8. Minimize the number and size of stockpiles; 9. Keep topsoil separate from underburden when stockpiling soil; 10. Construct the stockpile with no slope greater than 2:1 (horizontal to vertical). A less steep slope may be required where the erosion risk is high. 11. Mulch, roughen and seed with sterile 12. Circle all unstabilised stockpiles and batters with silt fences or a drainage system that will collect and correctly dispose of contaminated water	1. Material Storage 2. Solid Waste Management 3. Concrete Waste Management 4. Contaminated soil management 5. Material Transport 6. Spill prevention and control 7. Material use 8. Storing fuels and chemicals

ENVIRONMENTAL ISSUE	OBJECTIVES	ENVIRONMENTAL MANAGEMENT MEASURES TO BE TAKEN	CONSTRUCTION PRACTICE
		13. Locate stockpiles within ten meters of a waterway only if no other alternatives exist. 14. Hand water or install temporary sprinklers to suppress dust from unstabilised stockpiles and batters. 15. Finish and contour any stockpiles located on a floodplain so as to minimize loss of material in a flood or rainfall event.	
6**. Working in Waterways, River Banks and Floodplains**	**To minimize stress on aquatic communities when working in a waterway**	1. Plan in-stream works so that the contact time is minimized. 2. Establish special practices so that impacts on the waterway and disturbance of its banks are minimized. 3. Stabilize banks and in stream structure so that they do not contribute to the sediment load. 4. Maintain minimum flows to ensure the viability of aquatic communities and ensure that there are no barriers to the passage of fish up and downstream. 5. Avoid times of the year when environmental damage is expected to be highest. 6. Construct in-stream crossings during low flows, designed to be stable under expected vehicle loads and flow regimes, which do not contribute to the sediment load in the stream; 7. Design crossings so that drainage off the crossing does not contribute sediment load to the stream. 8. Prepare a contingency plan for high-rain events; 9. Prepare a reinstatement plan if work in a stream is planned or the structure of a waterway will be altered. 10. Prior to works being undertaken on, near or within a waterway, a	1. Dewatering operation 2. Spill prevention control 3. Storing fuel and chemical 4. Hazardous Waste management

ENVIRONMENTAL ISSUE	OBJECTIVES	ENVIRONMENTAL MANAGEMENT MEASURES TO BE TAKEN	CONSTRUCTION PRACTICE
		reinstatement plan should be prepared and submitted to the Engineer for approval. The plan should include: * *Proposed changes to the waterway* * *The impact on adjacent vegetation* * *The type and form of flood protection works* * *Erosion and sediment run-off controls* * *Proposed methods for reinstatement of the waterway bed and banks* A re-vegetation plan addressing a period of no less than 12 months and including proposed species and locations, methods for weed control and ongoing maintenance until a satisfactory level of established plants is achieved.	
7. Noise and Vibrations	**To ensure nuisance from noise and vibration does not occur.**	1. Fit and maintain appropriate mufflers on earth-moving and other vehicles on the site. 2. Enclose noisy equipment; 3. Provide noise attenuation screens, where appropriate. 4. Where an activity is likely to cause a noise nuisance to nearby residents, restrict operating hours to between 7:00 a.m. and 6:00 p.m. weekdays and 7:00 a.m. to 1:00 pm Saturday, except where, for practical reasons, the activity is unavoidable. 5. Noise should not be above background levels inside any adjacent residence between 10:00 p.m. and 7:00 a.m. 6. Advise local residents when unavoidable out-of-hours work will occur. 7. Schedule deliveries to the site so that disruption to local amenity and traffic are 8. Minimized. 9. Conduct a study on the impact of ground vibration from construction	1. Dewatering Operation 2. Structure construction 3. Demolition of Bridges 4. Material transport 5. Paving Operation

ENVIRONMENTAL ISSUE	OBJECTIVES	ENVIRONMENTAL MANAGEMENT MEASURES TO BE TAKEN	CONSTRUCTION PRACTICE
		activities, where these operations occur within 50 metres of a building and take appropriate action; 10. Minimize air vibrations;	
8. Waste Minimization	**1. To minimize the waste load discharged to the environment.** **2. To ensure that all contaminated material uncovered on a construction site are excavated and disposed of in an environmentally responsible manner.** **3. To ensure that all litter is disposed of in a responsible manner, and is not released into the environment.**	1. Carry out a waste minimization assessment which examines opportunities for waste avoidance reduction, reuse and recycling; 2. Reduce wastes by selecting, in order of preference, avoidance, redu 3. Incorporate waste minimization targets and measures into the environmental management plan. 4. Assay material uncovered on-site prior to disposal. If the wastes include putrescible wastes, then also analyze leachate and landfill gases. 5. Excavate material in a manner which avoids off-site environmental problems. 6. Seal remaining contaminated material or wastes, where only part of the tip has been excavated, to ensure that there is no off-site effect now or in the future. 7. Transport odorous wastes in covered vehicles 8. Dispose of contaminated material in a landfill licensed to take the type of contaminated material or wastes uncovered. 9. Maintain a high quality of housekeeping and ensure that materials are not left where they can be washed or blown away to become litter. 10. Provide bins for construction workers and staff at locations where they consume food. 11. Conduct ongoing awareness with staff of the need to avoid littering;	1. Solid waste management 2. Hazardous waste management 3. Hazardous waste management 4. Material Management 5. Material use 6.

ENVIRONMENTAL ISSUE	OBJECTIVES	ENVIRONMENTAL MANAGEMENT MEASURES TO BE TAKEN	CONSTRUCTION PRACTICE
9. Storing Fuels and Chemicals	**To ensure that fuel and chemical storage is safe, and that any materials that escape do not cause environmental damage.**	1. Reducing the quantities of chemicals and fuel stored on-site to minimum practicable levels is desirable. 2. Infrequently used chemicals should be ordered just before they are needed. It may be possible to use a mini-tanker to refuel vehicles, instead of relying on a central fuelling point. 3. Installing bunds will prevent spilt fuel escaping and causing environmental damage. 4. Should a spill occur, then it is necessary to have a contingency plan in place to deal with the clean-up. It should consider issues such as cleaning up spilled material on the site, containing and cleaning up spills which have entered waterways, disposal or reuse of recovered residues, and contacting key company and government agency personnel to advise them of the emergency.	Contractor

7.0 ANALYSIS OF ALTERNATIVES

The analysis of alternatives in Environmental Assessments considers practicable strategies that will promote the elimination of negative environmental impacts identified. This section is a requirement of the National Environment and Planning Agency (NEPA), and is critical in consideration of the ideal development with minimal environmental disturbance.

This report has identified the major environmental impacts, noted in section 5 and detailed the environmental management guidelines in section 6...
The following alternatives have been identified. They are discussed in further detail below:

* The "No-Action" Alternative
* The proposed Development as described in the report

7.1 The "No-Action" Alternative

The "no action" alternative is required to ensure the consideration of the original environment without any development. This is necessary for the decision-makers in considering all possibilities.

The development will have a minimal effect on the physical environment. However, given the poor state of some of all the bridges and fording identified, they have the potential to impact negatively on public health, safety, commercial activity, social fabric and transportation.

7.2 The Proposed Development As Described In the Report

The impacts and mitigation measures for this alternative (Rehabilitation and construction of the 43 bridges) has been discussed in section 5 of this report. This alternative will have minimal impact on the physical environment and has considered the necessary measures to almost eliminate the identified issues of public health, safety and transportation (as outlined in section 6.

7.3 Overview of Alternative Analysis

Based on the above, the second alternative is the most preferred, given the importance of the bridges to the economic well being of the country.

SUMMARY AND CONCLUSION:

The Mabey Johnson Priority Bridges Programme is designed to rehabilitate at least 44 badly deteriorating bridges on the NWA national network. The work will involve primarily existing bridges structures or where fording exists, the work will take place in the same locations.

Having assessed the site conditions, there is no location where primary vegetation exists and the proposed works will not impact negatively on protected resources. Although some potential negative impacts have been identified for the project, the majority is short-term and relates mainly to site preparation and construction. Most of the negative impacts that have been identified can be successfully mitigated, given the guidelines provided in the appendices.

There are several positive impacts associated with the project. These include the improvement of access to remote, communities; improved efficiency in the movement of goods and services; support of new development and employment opportunities; improvement in the safety of the motoring public especially where the conditions on a number of the bridges have been deterioration over the past years.

Implementation, monitoring and enforcement of the mitigation measures that are recommended in the report and improved communication to the wider community, will ensure successful execution of this bridge program with minimum negative impact on the environment.