6. Environmental Permit

PERMIT NUMBER: EPA/EP/ESIA-RAP/001-1212
ISSUED DATE: 06/12/12
EXPIRATION DATE: 05/12/14

E N V I R O N M E N T A L P E R M I T

1.0 CONTACT	:	Hon. Edsel Edward Smith **ASSISTANT MINISTER FOR LANNING** Ministry of Public Works Monrovia, Liberia TEL: (00231) 04-914 012 Email: edselsmith@gmail.com
2.0 PROPONENT	:	Ministry of Public Works Lynch Street Monrovia, Liberia
3.0 PROJECT *LOCATION*	:	Somalia Drive -Red Light Montserrado County
4.0 ***TYPE OF WORK***	:	***ROAD RECONSTRUCTION***

In pursuance of the Environment Protection & Management Law of Liberia, 2003 Part III Sections 8 (1), 11 (1) 13 and on the basis of the submitted Environmental and Social Impact Assessment (ESIA); Preparatory Survey and Resettlement Action Plan, this permit is issued, authorizing the Ministry of Public Works of the Government of Liberia to commence road reconstruction works between the Freeport of Monrovia, Monrovia City through Somalia Drive up to Red-Light, City of Paynesville, Montserrado County.

5.0 *CONDITIONS OF PERMIT*

5.1 Permit does not cover Forest Reserves, Wildlife Reserves or Natural heritage area;

6.0 *COMMITMENT TO PROJECT SPECIFICATIONS*
Comply with all specifications in Environmental and Social Impact Assessment (ESIA); Preparatory Survey and Resettlement Action Plan

6.1 *COMPLY WITH THE FOLLOWING GENERAL MEASURES:*

a. Adhere to terms and conditions of the submitted Resettlement Action Plan that identified Project Affected Persons (PAPs) within the Ministry of Public Works approved Right-of-Way, baseline and census of PAPs and

b. their communities, institutional and implementation framework, schedule of implementation and grievance procedures before effectuating resettlement
c. Demolition of any private asset along the road should only be executed after due compensation to PAPs in accordance with the RAP;
d. Put in place dust mitigation measures as follows: water sprinkler system for dust mitigation on access road and other operating areas; cover trucks conveying spoil materials to prevent spills during haulage; fit crushers with dust suppression equipment
e. Avoid pollution of surface water bodies in proximity to site
f. Put in place measures to reduce noise including equipment maintenance, locate heavy equipment and operations away from any sensitive receptors: humans and water sources of communities/settlements
g. Ensure that acquisition of private asset (quarries, borrow pits etc) are consistent with due process that guarantees the right and entitlements of property owner;
h. Put in place measures for continuous engagement with project communities with respect to operational issues that impact community activities; including recording of grievances and measures to correct them
i. Ensure that a comprehensive health and safety management system including training and inductions, supply of personal protective equipment, emergency preparedness etc
j. Present a monthly environmental monitoring report to the EPA on existing environmental conditions in the project area and measures taken to ensure compliance to EMP

6.2 *NOTIFICATIONS OF CHANGES*

Notify EPA of any major changes in the planned development contrary to the information provided in the ESIA, Survey and Resettlement Action Plan.

6.3 *TRANSFERABILITY*: this permit is not transferable, *except authorized and approved by the EPA.*

AV

6.4 *VALIDITY PERIOD*

This Permit is valid for two years commencing 06th December to 2012 to 05th December, 2014 renewable under new terms and conditions

6.5 *NOTWITHSTANDING THIS PERMIT*, the road rehabilitation is subject to other relevant regulations and permits pertaining to the sector and must be observed.

FAILURE TO COMPLY WITH OR OBSERVE ALL THE PERMIT CONDITIONS ABOVE MAY WARRANT THE REVOCATION OF THIS PERMIT.

Anyaa Vohiri 6/12/12
Anyaa Vohiri **DATE**
EXECUTIVE DIRECTOR

7. Design Data
7-1 Geological Survey Result

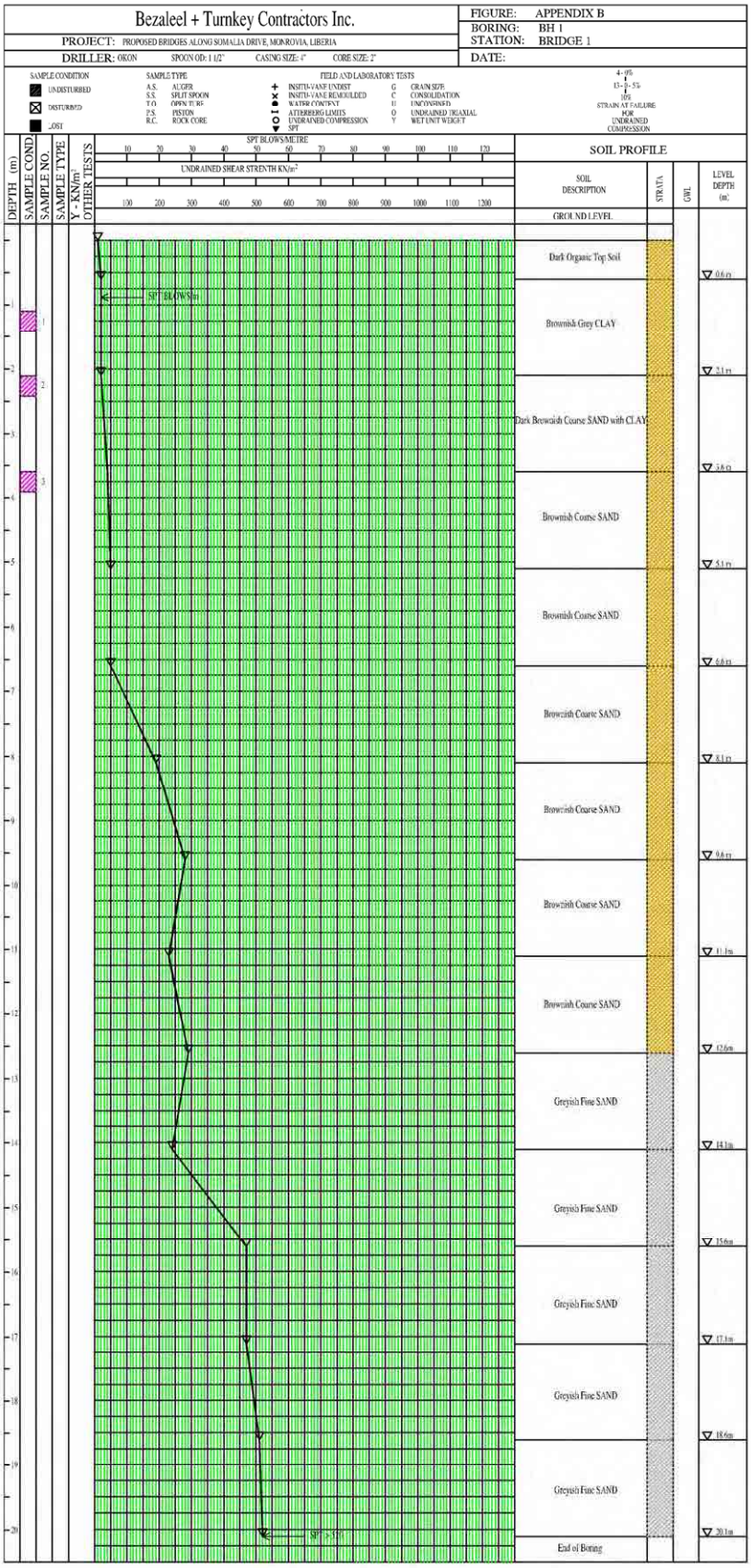
1) SPT

Table 1.1: Ultimate Bearing Capacity Pressures

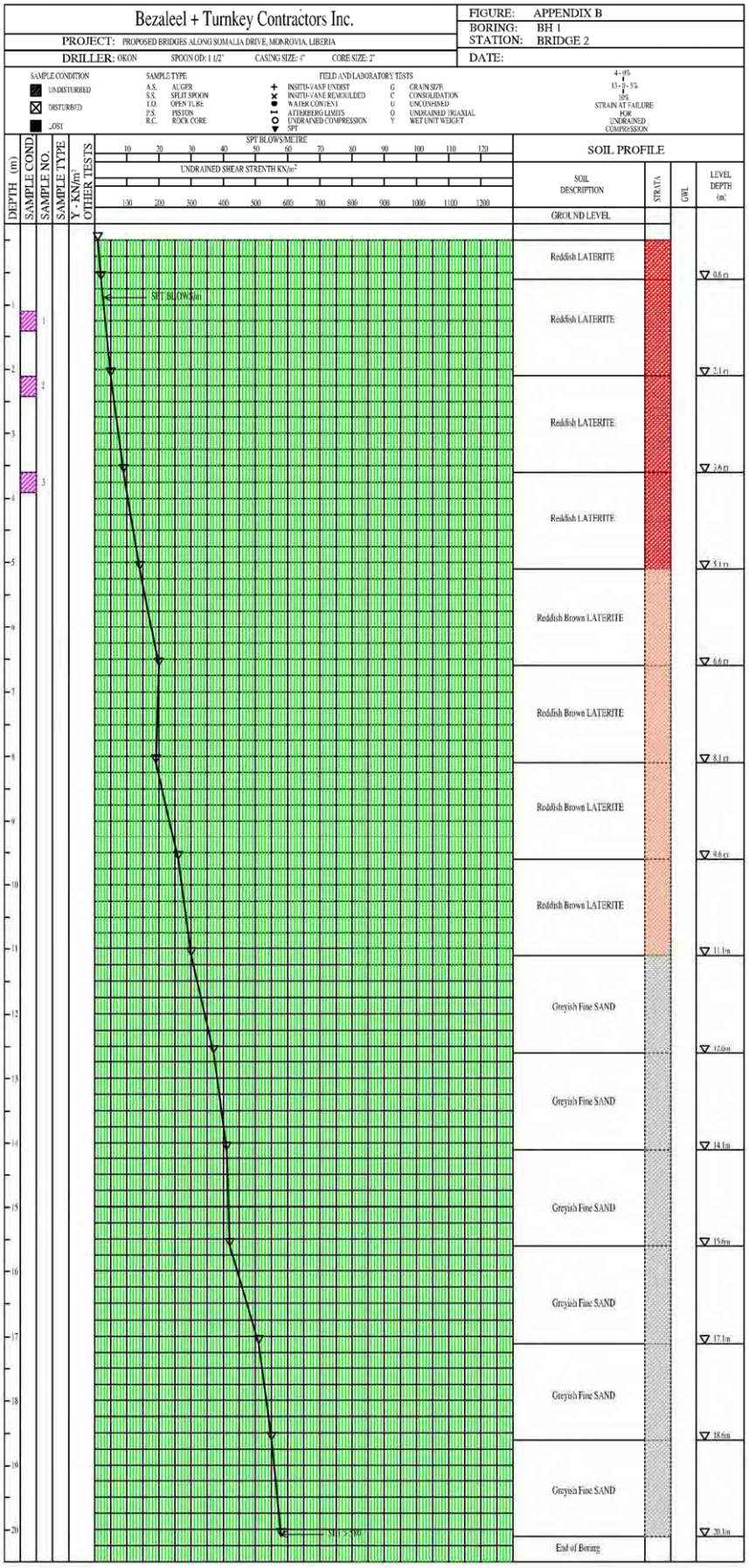
Depth (m)	Boring Locations							
	Bearing Capacity Values (kN/m^2)				SPT N-Values			
	Bridge #1		Bridge #2		Bridge #1		Bridge #2	
	BH1 Abutment A	BH2 Abutment B	BH1 Abutment A	BH2 Abutment B	BH1 Abutment A	BH2 Abutment B	BH1 Abutment A	BH2 Abutment B
0.0-0.6	20	20	20	60	2	2	2	6
1.5-2.1	20	50	50	90	2	5	5	9
3.0-3.6	40	40	90	90	4	4	9	9
4.5-5.1	50	70	140	130	5	7	14	13
6.0-6.6	50	80	200	150	5	8	20	15
7.5-8.1	190	110	190	190	19	11	19	19
9.0-9.6	280	140	260	230	28	14	26	23
10.5 – 11.1	230	220	300	320	23	22	30	32
12.0-12.6	290	320	370	360	29	32	37	36
13.5-14.1	240	400	410	360	24	40	41	36
15.0-15.6	470	430	420	370	47	43	42	37
16.5 – 17.1	470	470	510	460	47	47	51	46
18.0-18.6	510	490	550	520	51	49	55	52
19.5 – 20.1	520	520	580	550	52	52	58	55

2)

i)Bridge-1,BH-1

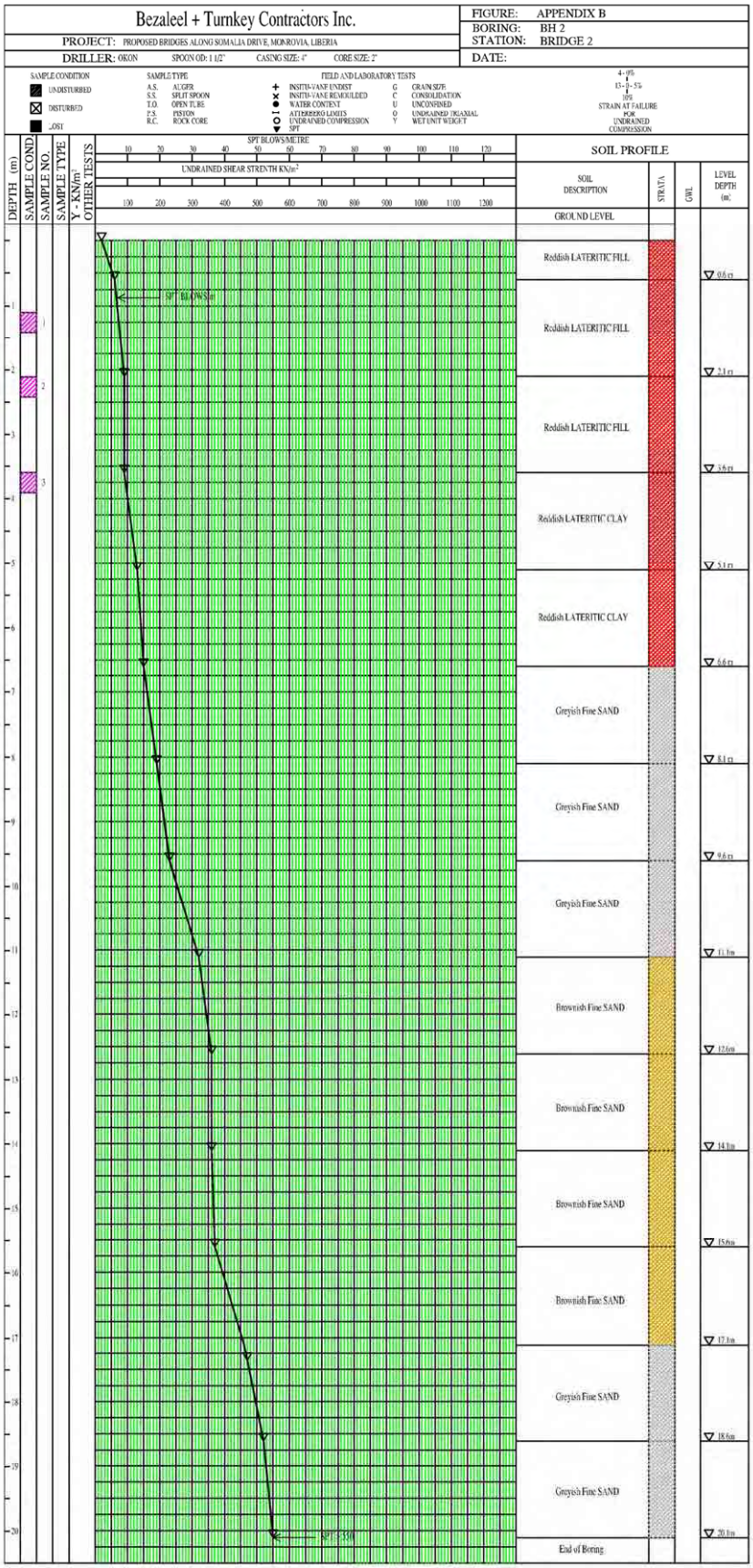


ii) Bridge-1,BH-2



iii) Bridge-2,BH-1

iv) Bridge-2,BH-21



DETAILED LABORATORY TEST RESULTS FOR BRIDGE 1

Borehole	Sample	Sample	Description of	INDEX PROPERTIES				PARTICLE SIZE ANALYSIS										Direct Shear Strength		TRIAXIAL Shear Strength parameters		Bulk Density	Specific	Consolidation	
No.	No.	Depth (m)	Sample	EMC (%)	LL (%)	PL (%)	PI (%)	5 (5mm)	#7 (3.35mm)	#10 (2mm)	#14 (1.18mm)	#25 (600μm)	#36 (425μm)	#52 (300μm)	#72 (212μm)	#100 (150μm)	#200 (75μm)	C KN/m^2	ø	C KN/m^2	ø	kN/m^3	Gravity	Cv m^2/yrs	Mv m^2/KN
BH1	2	2.1	Brownish Grey Clay	23	50	31	19	-	-	97.60	90.11	80.39	64.28	61.39	56.4	50.99	44.68	-	-	32	17	18.61	2.86	$2.84x10^{-2}$	$1.46x10^{-4}$
BH1	3	3.6	Dark Brown coarse SAND mix with clay	15	Non - plastic			99.03	96.97	91.07	56.77	26.73	23.00	19.70	18.97	16.77	14.43	0	32	-	-	17.91	2.55	-	-
BH1	4	5.1	Brownish coarse SAND	12	Non - plastic			-	97.91	93.61	60.23	52.15	40.15	36.45	11.39	5.28	3.61	0	29	-	-	17.27	2.53	-	-
BH1	7	9.6	Brownish medium grained SAND	5	Non - plastic			-	99.70	99.00	57.20	17.77	11.00	4.30	3.40	2.03	1.20	0	30	-	-	17.86	2.55	-	-
BH1	9	12.6	Brownish medium grained SAND	9	Non - plastic			-	99.46	89.11	55.68	21.39	15.19	7.68	5.19	3.61	2.69	0	31	-	-	17.59	2.51	-	-
BH1	10	14.1	Greyish medium dense fine SAND	13	Non - plastic			-	-	98.11	80.15	70.91	61.45	22.39	17.41	16.15	5.78	1	29	-	-	18.21	2.60	-	-
BH1	11	15.6	Greyish fine grained SAND	11	Non - plastic			-	-	99.00	84.69	73.41	56.29	19.61	13.48	10.61	7.15	1	25	-	-	18.00	2.67	-	-
BH1	12	17.1	Greyish fine grained SAND	18	Non - plastic			-	-	-	97.78	79.46	62.96	30.47	12.97	9.65	3.15	0	28	-	-	17.61	2.75	-	-
BH1	14	20.1	Greyish fine grained SAND	17	Non - plastic			-	-	99.81	82.25	80.02	54.71	22.26	18.90	12.85	11.30	0	34	-	-	17.56	2.69	-	-
BH2	3	3.6	Greyish Brown stiff CLAY	16	46	29	17	-	-	96.15	86.17	73.36	70.59	64.28	60.35	52.61	48.76	-	-	36	18	18.97	2.84	$3.96x10^{-2}$	$3.68x10^{-4}$
BH2	5	6.6	Greyish coarse grained SAND	23	Non - plastic			-	97.61	89.76	79.41	50.61	39.11	24.83	17.85	11.69	7.41	0	31	-	-	18.61	2.51	-	-
BH2	7	9.6	Greyish loose coarse grained SAND	23	Non - plastic			-	98.14	95.06	85.42	48.87	37.62	21.72	19.47	13.31	7.88	0	27	-	-	17.50	2.74	-	-
BH2	8	11.1	Greyish loose coarse grained SAND	11	Non - plastic			-	99.98	89.61	83.11	52.68	39.41	34.15	28.51	11.61	5.41	0	30	-	-	17.69	2.50	-	-
BH2	9	12.6	Greyish dense coarse grained SAND	15	Non - plastic			-	98.46	92.39	87.15	75.26	63.15	47.98	21.96	18.15	7.26	0	32	-	-	17.79	2.53	-	-
BH2	11	15.6	Greyish dense fine grained SAND	17	Non - plastic			-	-	99.2	90.61	86.00	71.45	32.41	18.76	10.47	6.34	1	30	-	-	17.48	2.52	-	-

DETAILED LABORATORY TEST RESULTS FOR BRIDGE 1

Borehole	Sample	Sample	Description of	INDEX PROPERTIES				PARTICLE SIZE ANALYSIS										Direct Shear Strength		TRIAXIAL Shear Strength parameters		Bulk Density	Specific	Consolidation	
No.	No.	Depth (m)	Sample	EMC (%)	LL (%)	PL (%)	PI (%)	5 (5mm)	#.7 (3.35mm)	#.10 (2mm)	#.14 (1.18mm)	#.25 (600μm)	#.36 (425μm)	#.52 (300μm)	#.72 (212μm)	#.100 (150μm)	#.200 (75μm)	C KN/m^2	ø	C KN/m^2	ø	kN/m^3	Gravity	Cv m^2/yrs	Mv m^2/KN
BH2	13	18.6	Greyish very dense fine grained SAND	20	Non - plastic			-	-	-	99.09	92.46	79.86	44.71	15.91	8.63	3.49	1	27	-	-	17.61	2.60	-	-

DETAILED LABORATORY TEST RESULTS FOR BRIDGE 2

Borehole No.	Sample No.	Sample Depth (m)	Description of Sample	INDEX PROPERTIES				PARTICLE SIZE ANALYSIS										Direct Shear Strength		TRIAXIAL Shear Strength parameters		Bulk Density kN/m³	Specific Gravity	Consolidation	
				EMC (%)	LL (%)	PL (%)	PI (%)	5 (5mm)	#.7 (3.35mm)	#.10 (2mm)	#.14 (1.18mm)	#.25 (600μm)	#.36 (425μm)	#.52 (300μm)	#.72 (212μm)	#.100 (150μm)	#.200 (75μm)	C KN/m²	ø	C KN/m²	ø			Cv m²/yrs	Mv m²/KN
BH1	2	2.1	Reddish Pebbly LATERITE	15	Non - plastic			64.50	49.10	40.90	30.47	21.50	18.23	13.17	12.07	8.77	5.63	10	21	-	-	15.98	2.58	-	-
BH1	4	5.1	Reddish Pebbly LATERITE	14	Non - plastic			71.96	48.79	42.80	29.38	24.96	18.20	14.96	12.89	9.78	3.89	14	26	-	-	15.87	2.59	-	-
BH1	5	6.6	Reddish Brown LATERITE	16	30	14	16	98.23	95.67	89.37	67.4	51.47	45.63	34.53	32.10	22.93	14.97	18	23	-	-	16.40	2.61	$1.46x10^{-3}$	$4.96x10^{-5}$
BH1	6	8.1	Reddish Brown LATERITE	18	32	13	19	99.14	94.40	90.89	69.34	53.56	45.78	39.79	33.40	26.19	18.38	-	-	16	22	16.26	2.64	$2.87x10^{-3}$	$3.96x10^{-5}$
BH1	8	11.1	Reddish Brown LATERITE	19	30	16	14	98.20	95.40	82.60	73.95	49.76	43.29	41.00	33.89	24.67	17.96	-	-	18	23	16.57	2.66	$4.40x10^{-3}$	$5.40x10^{-5}$
BH1	9	12.6	Greyish dense fine grained SAND	18	Non - plastic			-	99.78	87.96	85.60	74.89	45.80	38.4	19.87	16.78	10.89	1	28	-	-	17.10	2.68	-	-
BH1	11	15.6	Greyish dense fine grained SAND	22	Non - plastic			-	98.69	91.78	88.9	62.87	38.76	29.40	19.38	10.96	9.86	0	31	-	-	17.26	2.70	-	-
BH1	13	18.6	Greyish dense fine grained SAND	19	Non - plastic			-	99.48	99.18	96.81	87.40	59.38	26.78	17.03	15.89	14.96	0	30	-	-	17.49	2.69	-	-
BH1	14	20.1	Greyish very dense fine grained SAND	20	Non - plastic			-	-	99.40	89.80	67.48	48.96	20.84	14.36	12.89	10.00	1	29	-	-	17.60	2.71	-	-
BH2	3	3.6	Reddish LATERITE(fill material)	14	30	11	19	88.90	81.78	73.80	67.96	53.97	45.78	41.76	38.67	31.46	20.46	18	24	-	-	16.40	2.60	-	-
BH2	4	5.1	Reddish Lateritic CLAY	16	38	16	22	-	98.67	94.40	90.70	83.96	79.60	63.39	54.96	44.87	34.96	-	-	28	19	17.98	2.69	$1.36x10^{-3}$	$3.84x10^{-5}$
BH2	5	6.6	Reddish Lateritic CLAY	24	36	18	19	-	-	98.90	88.96	74.49	57.96	52.38	44.49	38.87	36.19	-	-	26	17	18.01	2.72	$1.40x10^{-2}$	$6.87x10^{-4}$
BH2	6	8.1	Greyish fine grained SAND	12	Non - plastic			-	-	98.10	87.40	69.78	58.89	33.19	27.44	20.89	13.45	2	28	-	-	16.96	2.60	-	-
BH2	8	11.1	Greyish fine grained SAND	10	Non - plastic			-	-	97.40	88.40	74.96	70.89	30.97	23.67	19.49	12.60	0	30	-	-	17.01	2.64	-	-
BH2	9	12.6	Brownish dense fine grained SAND	14	Non - plastic			-	-	99.8	92.88	90.40	67.96	39.48	27.96	19.49	14.38	2	29	-	-	16.87	2.67	-	-

DETAILED LABORATORY TEST RESULTS FOR BRIDGE 2

Borehole	Sample	Sample	Description of	INDEX PROPERTIES				PARTICLE SIZE ANALYSIS										Direct Shear Strength		TRIAXIAL Shear Strength parameters		Bulk Density	Specific	Consolidation	
No.	No.	Depth (m)	Sample	EMC (%)	LL (%)	PL (%)	PI (%)	5 (5mm)	#.7 (3.35mm)	#.10 (2mm)	#.14 (1.18mm)	#.25 (600μm)	#.36 (425μm)	#.52 (300μm)	#.72 (212μm)	#.100 (150μm)	#.200 (75μm)	C KN/m^2	ø	C KN/m^2	ø	kN/m^3	Gravity	Cv m^2/yrs	Mv m^2/KN
BH2	12	17.1	Brownish dense fine grained SAND	18	Non - plastic			-	99.50	99.43	98.37	85.40	70.40	31.13	26.43	17.03	16.40	0	30	-	-	17.10	2.69	-	-
BH2	14	20.1	Greyish very dense fine grained SAND	20	Non - plastic			-	-	-	99.63	60.50	45.83	22.27	19.33	10.53	8.73	1	29	-	-	17.29	2.70	-	-

The Preparatory Survey on the Project for Reconstruction of Somalia Drive in Monronia

(Road Side Traffic Counts)

Road Name: Somalia Drive

Date: 2011/3/12

Location / Point A: Stockton Bridge

Surveyed by: Taye, Konah and Kaba, Turay,Kun & Lardeindee

Direction / From: Free Port ; To: Red Light Jct.

Supervised by: Milton S. Pajibo & Emmanuel King

Key Map

No。	1	2	3	4	5	6	7	8	9	10
Category / Hours	Sedan / Wagon / Pich-up	Taxi	Mini Bus	Large Bus	Light Truck (2-Axle)	Heavy Truck (> 2-Axle)	Trailor (Artuculated Truck)	Motorbike	Bicycle	Pedestrian
8:00 ~ 9:00	143	347	46	14	11	24	7	630	0	333
9:00 ~ 10:00	130	347	62	8	11	11	4	601	6	107
10:00 ~ 11:00	137	377	64	17	22	43	9	566	6	120
11:00 ~ 12:00	60	60	18	110	10	110	20	110	3	60
12:00 ~ 13:00	210	200	64	160	30	160	27	170	0	210
13:00 ~ 14:00	160	160	90	10	37	41	12	180	0	60
14:00 ~ 15:00	140	216	61	7	22	20	9	344	1	130
15:00 ~ 16:00	179	185	78	130	26	76	50	365	0	208
16:00 ~ 17:00	120	70	38	240	21	180	140	330	0	120
17:00 ~ 18:00	213	480	155	84	46	63	30	390	2	356
18:00 ~ 19:00	120	210	45	410	12	270	190	410	3	120
19:00 ~ 20:00	163	231	86	420	20	210	180	450	0	250
20:00 ~ 21:00	75	260	171	120	20	11	108	300	0	230
21:00 ~ 22:00	68	220	70	200	23	90	7	480	3	77
22:00 ~ 23:00	29	164	34	0	9	0	2	320	0	35
23:00 ~ 0:00	9	15	5	3	0	0	0	58	1	7
0:00 ~ 1:00	19	16	0	0	2	2	1	60	0	1
1:00 ~ 2:00	9	2	1	0	0	0	0	15	0	2
2:00 ~ 3:00	5	0	3	0	0	0	0	3	0	1
3:00 ~ 4:00	3	1	0	0	0	2	0	5	0	0
4:00 ~ 5:00	4	3	0	0	0	1	0	2	0	3
5:00 ~ 6:00	18	34	27	7	4	10	5	21	1	30
6:00 ~ 7:00	69	282	112	20	22	45	4	140	40	160
7:00 ~ 8:00	128	380	76	37	10	39	8	610	4	285
Peak Hour Traffic	213	480	171	420	46	270	190	630	40	356
24-hr Traffic Total	2211	4260	1306	1997	358	1408	813	6560	70	2905
Peak Hour Ratio	0.096336	0.113	0.1309	0.210315	0.128492	0.191761	0.2337023	0.09604	0.571	0.122547

The Preparatory Survey on the Project for Reconstruction of Somalia Drive in Monrovia

(Road Side Traffic Counts)

Road Name: Somalia Drive Date: 2012/3/12

Location / Point A: Stockton Bridge Surveyed by: Blayon, Johnson, Ssonie, Turay, Harris & Dennis

Direction / From: Redoight To: Freeport Supervised by: Sawoh Lassana & Emmanuel King

Key Map

No。	1	2	3	4	5	6	7	8	9	10
Category / Hours	Sedan / Wagon / Pich-up	Taxi	Mini Bus	Large Bus	Light Truck (2-Axle)	Heavy Truck (> 2-Axle)	Trailor (Artuculated Truck)	Motorbike	Bicycle	Pedestrian
8:00 ~ 9:00	104	830	319	20	86	11	_	650	3	380
9:00 ~ 10:00	88	800	466	118	170	32	2	571	3	290
10:00 ~ 11:00	119	190	80	11	22	28	5	362	7	560
11:00 ~ 12:00	40	60	33	4	20	11	21	40	4	60
12:00 ~ 13:00	80	330	152	70	36	113	0	260	1	170
13:00 ~ 14:00	110	40	40	0	29	5	0	140	0	110
14:00 ~ 15:00	90	200	94	5	20	24	3	230	0	90
15:00 ~ 16:00	213	324	157	14	40	20	4	130	3	280
16:00 ~ 17:00	105	270	140	19	30	27	7	320	0	200
17:00 ~ 18:00	90	330	142	17	21	20	5	20	0	0
18:00 ~ 19:00	88	320	214	26	38	21	2	580	0	0
19:00 ~ 20:00	80	280	160	23	36	22	5	475	1	110
20:00 ~ 21:00	11	190	150	240	50	0	0	420	0	180
21:00 ~ 22:00	50	370	190	10	37	10	1	297	0	120
22:00 ~ 23:00	4	100	70	7	50	10	1	160	1	120
23:00 ~ 0:00	31	60	60	1	48	2	_	63	2	38
0:00 ~ 1:00	33	41	50			3		66		32
1:00 ~ 2:00	5	4	10	1	_	3	_	25	_	13
2:00 ~ 3:00	4	4	10	_	_	4	1	4	1	9
3:00 ~ 4:00	4	6	10	_	_	_	_	2	_	1
4:00 ~ 5:00	3	4	10	_	_	_	1	2	_	3
5:00 ~ 6:00	12	20	20	8	_	2	3	25	_	36
6:00 ~ 7:00	29	160	160	20	_	18	1	84	2	223
7:00 ~ 8:00	140	430	270	8	50	4		561	6	457
Peak Hour Traffic	213	830	466	240	170	113	21	650	7	560
24-hr Traffic Total	1533	5363	3007	622	783	390	62	5487	34	3482
Peak Hour Ratio	0.138943	0.155	0.155	0.385852	0.217114	0.289744	0.3387097	0.11846	0.206	0.160827

The Preparatory Survey on the Project for Reconstruction of Somalia Drive in Monrovia

(Road Side Traffic Counts)

Road Name: Somalia Drive Date: 2012/3/12

Location / Point B:Double Bridge Surveyed by: Morris, Nyandibo,Turay, Nyenpan, Swen

Direction / From: Free Port To: Red Light Jct. Supervised by: Othello Horrace

Key Map

No。	1	2	3	4	5	6	7	8	9	10
Category / Hours	Sedan / Wagon / Pich-up	Taxi	Mini Bus	Large Bus	Light Truck (2-Axle)	Heavy Truck (> 2-Axle)	Trailor (Artuculated Truck)	Motorbike	Bicycle	Pedestrian
8:00 ~ 9:00	43	410	154	14	4	23	6	248	1	136
9:00 ~ 10:00	86	384	115	0	11	0	0	240	0	108
10:00 ~ 11:00	125	422	142	7	30	26	6	203	0	341
11:00 ~ 12:00	90	190	130	34	17	3	160	2	90	
12:00 ~ 13:00	130	311	56	7	22	29	4	250	4	130
13:00 ~ 14:00	110	300	71	4	16	42	6	189	1	191
14:00 ~ 15:00	60	240	90	4	27	30	10	133	2	60
15:00 ~ 16:00	80	245	109	9	21	15	4	196	3	80
16:00 ~ 17:00	80	312	65	5	40	32	6	194	3	80
17:00 ~ 18:00	112	201	70	7	24	26	5	220	0	100
18:00 ~ 19:00	90	290	57	3	31	33	13	211	2	90
19:00 ~ 20:00	110	266	50	3	18	20	9	144	1	139
20:00 ~ 21:00	60	211	31	23	17	12	3	260	0	90
21:00 ~ 22:00	70	145	18	20	8	11	3	145	0	60
22:00 ~ 23:00	44	83	9	14	7	4	0	87	1	50
23:00 ~ 0:00	11	30	2	2	2	10	2	104	0	23
0:00 ~ 1:00	13	9	5	0	1	0	0	25	0	4
1:00 ~ 2:00	2	4	0	0	2	0	0	9	0	2
2:00 ~ 3:00	1	2	0	0	0	0	0	3	0	3
3:00 ~ 4:00	3	1	0	0	0	0	0	2	0	1
4:00 ~ 5:00	3	5	0	0	0	5	1	4	0	2
5:00 ~ 6:00	16	68	17	9	3	4	0	13	0	12
6:00 ~ 7:00	63	260	73	24	3	31	0	80	1	70
7:00 ~ 8:00	135	411	120	25	7	23	2	225	5	160
Peak Hour Traffic	135	422	154	34	40	42	160	260	90	341
24-hr Traffic Total	1537	4800	1384	214	311	379	240	3187	114	1932
Peak Hour Ratio	0.087833	0.088	0.1113	0.158879	0.128617	0.110818	0.6666667	0.08158	0.789	0.176501

The Preparatory Survey on the Project for Reconstruction of Somalia Drive in Monrovia

(Road Side Traffic Counts)

Road Name: Somalia Drive

Date: 2012/3/12

Location / Point B: Double Bridge

Surveyed by: Kongoison, Jallah, Zarr, Varflay, Taweh & Harris

Direction / From: Redlight To: Freeport

Supervised by: Tee-Jem Mitchell & McArthur Ballah

Key Map

No。	1	2	3	4	5	6	7	8	9	10
Category / Hours	Sedan / Wagon / Pich-up	Taxi	Mini Bus	Large Bus	Light Truck (2-Axle)	Heavy Truck (> 2-Axle)	Trailor (Artuculated Truck)	Motorbike	Bicycle	Pedestrian
8:00 ~ 9:00	90	316	51	6	4	17	5	324	3	360
9:00 ~ 10:00	94	390	69	5	5	25	3	285	1	190
10:00 ~ 11:00	140	240	51	22	2	31	4	237	2	220
11:00 ~ 12:00	88	215	45	24	10	51	4	204	1	130
12:00 ~ 13:00	132	310	75	8	22	49	5	240	3	160
13:00 ~ 14:00	126	210	73	14	21	50	10	210	1	156
14:00 ~ 15:00	126	60	56	7	16	50	2	227	1	141
15:00 ~ 16:00	111	240	70	14	23	13	4	236	1	119
16:00 ~ 17:00	166	210	62	8	17	33	4	190	2	164
17:00 ~ 18:00	139	320	111	16	57	24	5	327	4	157
18:00 ~ 19:00	145	280	104	24	47	19	7	242	0	129
19:00 ~ 20:00	121	74	56	10	22	20	2	282	2	203
20:00 ~ 21:00	140	165	16	30	16	22	4	282	3	172
21:00 ~ 22:00	91	65	32	40	15	8	3	190	1	84
22:00 ~ 23:00	78	40	16	30	0	4	2	132	0	46
23:00 ~ 0:00	35	29	6	0	4	3	0	95	1	19
0:00 ~ 1:00	10	21	2	1	2	1	0	30	0	7
1:00 ~ 2:00	4	3	1	1	0	2	0	11	0	6
2:00 ~ 3:00	4	1	1	0	0	1	0	6	0	1
3:00 ~ 4:00	2	2	0	0	0	1	0	3	0	1
4:00 ~ 5:00	2	3	1	0	0	0	0	1	0	10
5:00 ~ 6:00	20	34	27	7	2	4	4	10	0	20
6:00 ~ 7:00	23	146	72	13	7	20	4	67	0	105
7:00 ~ 8:00	79	259	55	6	1	26	5	321	4	387
Peak Hour Traffic	166	390	111	40	57	51	10	327	4	387
24-hr Traffic Total	1966	3633	1052	286	293	474	77	4152	30	2987
Peak Hour Ratio	0.084435	0.107	0.1055	0.13986	0.194539	0.107595	0.1298701	0.07876	0.133	0.129561

The Preparatory Survey on the Project for Reconstruction of Somalia Drive in Monrovia

(Road Side Traffic Counts)

Road Name: Somalia Drive

Date: March 12,2012

Location / Direction / From: Free Port J. To: Red Light Jct.

Point C: Barnersville Jct.

Surveyed by: Kaba, Paye, Tugbe, Browne, Keller & Wilson

Supervised by: Walter Stevens & Catherine Worgee

Key Map

No。	1	2	3	4	5	6	7	8	9	10
Category / Hours	Sedan / Wagon / Pich-up	Taxi	Mini Bus	Large Bus	Light Truck (2-Axle)	Heavy Truck (> 2-Axle)	Trailor (Artuculated Truck)	Motorbike	Bicycle	Pedestrian
8:00 ~ 9:00	110	450	227	25	8	19	6	744	0	127
9:00 ~ 10:00	90	320	102	0	0	0	0	752	0	70
10:00 ~ 11:00	125	194	52	53	15	78	4	698	0	100
11:00 ~ 12:00	107	237	63	7	31	32	3	198	1	110
12:00 ~ 13:00	129	269	80	10	24	34	4	278	1	242
13:00 ~ 14:00	132	321	91	14	12	41	5	273	1	185
14:00 ~ 15:00	94	351	82	5	20	33	4	274	0	107
15:00 ~ 16:00	131	390	76	6	18	28	8	336	2	146
16:00 ~ 17:00	110	308	60	16	21	28	6	304	2	152
17:00 ~ 18:00	98	340	50	4	14	32	5	170	1	190
18:00 ~ 19:00	180	320	57	15	15	26	7	480	1	248
19:00 ~ 20:00	138	240	50	17	5	21	8	480	1	373
20:00 ~ 21:00	186	256	35	27	4	16	3	370	0	295
21:00 ~ 22:00	135	73	12	20	5	12	3	290	1	126
22:00 ~ 23:00	198	110	10	0	2	4	0	250	1	100
23:00 ~ 0:00	30	97	14	4	7	4	0	134	0	26
0:00 ~ 1:00	20	21	0	3	1	0	3	164	0	17
1:00 ~ 2:00	6	6	1	0	2	1	0	46	0	9
2:00 ~ 3:00	3	8	0	0	0	1	1	40	0	1
3:00 ~ 4:00	5	5	3	0	1	0	0	23	0	0
4:00 ~ 5:00	2	17	8	2	0	4	2	24	0	24
5:00 ~ 6:00	2	80	57	16	8	12	8	104	0	14
6:00 ~ 7:00	60	154	100	33	25	29	4	189	0	80
7:00 ~ 8:00	87	55	265	19	63	18	2	312	2	115
Peak Hour Traffic	198	450	265	53	63	78	8	752	2	373
24-hr Traffic Total	2178	4622	1495	296	301	473	86	6933	14	2857
Peak Hour Ratio	0.090909	0.097	0.1773	0.179054	0.209302	0.164905	0.0930233	0.10847	0.143	0.130557

The Preparatory Survey on the Project for Reconstruction of Somalia Drive in Monrovia

(Road Side Traffic Counts)

Road Name: Somalia Drive

Date: March 12,2012

Location / Point C: Barnersville Jct.

Surveyed by: Lewis,Natt, Matico, Kerkula, Worgee & Inepo

Direction / From: Red light To: Freeport

Supervised by: G. Isaac Doe & Catherine Worgee

Key Map

No。	1	2	3	4	5	6	7	8	9	10
Category / Hours	Sedan / Wagon / Pich-up	Taxi	Mini Bus	Large Bus	Light Truck (2-Axle)	Heavy Truck (> 2-Axle)	Trailor (Artuculated Truck)	Motorbike	Bicycle	Pedestrian
8:00 ~ 9:00	117	330	115	7	19	24	5	569	4	152
9:00 ~ 10:00	117	370	230	0	65	18	0	352	0	164
10:00 ~ 11:00	104	270	140	0	18	17	3	403	3	144
11:00 ~ 12:00	330	309	69	12	23	49	5	300	133	118
12:00 ~ 13:00	234	277	47	0	17	38	1	332	5	137
13:00 ~ 14:00	157	190	86	7	18	33	4	280	1	112
14:00 ~ 15:00	230	116	100	15	25	32	6	310	3	186
15:00 ~ 16:00	227	182	91	22	25	29	5	322	2	89
16:00 ~ 17:00	200	124	55	13	9	41	9	199	1	167
17:00 ~ 18:00	200	202	106	25	20	53	8	250	5	73
18:00 ~ 19:00	197	159	80	27	29	38	5	350	4	104
19:00 ~ 20:00	149	140	50	28	15	46	2	290	0	110
20:00 ~ 21:00	110	186	35	20	11	16	4	314	0	110
21:00 ~ 22:00	170	130	15	18	2	16	3	229	1	114
22:00 ~ 23:00	132	76	5	3	2	8	2	190	2	115
23:00 ~ 0:00	37	34	5	0	3	1	0	101	0	50
0:00 ~ 1:00	23	20	2	1	3	2	1	70	0	27
1:00 ~ 2:00	5	7	1	1	2	1	1	16	0	7
2:00 ~ 3:00	6	5	2	0	3	1	1	4	0	3
3:00 ~ 4:00	7	1	20	0	0	0	0	6	0	3
4:00 ~ 5:00	11	9	2	0	0	0	0	5	0	17
5:00 ~ 6:00	30	35	34	3	3	6	2	16	0	25
6:00 ~ 7:00	90	277	110	15	41	13	5	168	3	90
7:00 ~ 8:00	80	289	151	3	26	9	5	296	6	150
Peak Hour Traffic	330	370	230	28	65	53	9	569	133	186
24-hr Traffic Total	2963	3738	1551	220	379	491	77	5372	173	2267
Peak Hour Ratio	0.111374	0.099	0.1483	0.127273	0.171504	0.107943	0.1168831	0.10592	0.769	0.082047

The Preparatory Survey on the Project for Reconstruction of Somalia Drive in Monrovia

(Road Side Traffic Counts)

Road Name: Somalia Drive

Date: 2012/3/16

Location / Point A: Stockton Bridge

Surveyed by: Taye, Konah and Kaba, Turay,Kun & Lardeindee

Direction / From: Free Port ; To: Red Light Jct.

Supervised by: Milton S. Pajibo & Emmanuel King

Key Map

No。	1	2	3	4	5	6	7	8	9	10
Category / Hours	Sedan / Wagon / Pich-up	Taxi	Mini Bus	Large Bus	Light Truck (2-Axle)	Heavy Truck (> 2-Axle)	Trailor (Artuculated Truck)	Motorbike	Bicycle	Pedestrian
8:00 ~ 9:00	67	198	77	196	17	9	5	490	0	280
9:00 ~ 10:00	99	270	126	21	19	13	6	480	0	166
10:00 ~ 11:00	147	310	97	12	30	43	14	425	5	220
11:00 ~ 12:00	137	170	75	7	36	35	16	300	0	140
12:00 ~ 13:00	110	310	101	8	34	55	23	378	7	100
13:00 ~ 14:00	130	248	105	4	32	28	12	370	0	137
14:00 ~ 15:00	190	380	169	110	32	123	125	190	0	170
15:00 ~ 16:00	220	330	144	25	30	30	15	400	2	150
16:00 ~ 17:00	210	332	90	22	44	40	20	380	0	150
17:00 ~ 18:00	277	290	73	17	19	40	10	380	1	392
18:00 ~ 19:00	116	202	66	16	8	5	1	380	4	200
19:00 ~ 20:00	105	260	150	190	20	110	70	380	2	160
20:00 ~ 21:00	41	160	121	12	80	8	3	70	1	300
21:00 ~ 22:00	133	620	240	45	140	18	11	396	0	470
22:00 ~ 23:00	170	510	420	10	120	10	2	260	0	74
23:00 ~ 0:00	52	130	130	2	0	0	0	90	6	84
0:00 ~ 1:00	20	11	10	0	0	0	0	20	0	20
1:00 ~ 2:00	2	8	1	0	0	0	0	40	0	16
2:00 ~ 3:00	4	2	1	2	0	1	0	6	0	20
3:00 ~ 4:00	10	3	2	2	0	1	2	8	0	10
4:00 ~ 5:00	10	5	10	22	0	10	5	10	0	20
5:00 ~ 6:00	16	35	50	2	0	0	0	90	0	43
6:00 ~ 7:00	13	30	30	20	0	12	5	100	7	210
7:00 ~ 8:00	20	690	330	13	110	6	2	166	2	330
Peak Hour Traffic	277	690	420	196	140	123	125	490	7	470
24-hr Traffic Total	2299	5504	2618	758	771	597	347	5809	37	3862
Peak Hour Ratio	0.120487	0.125	0.1604	0.258575	0.181582	0.20603	0.3602305	0.08435	0.189	0.121699

The Preparatory Survey on the Project for Reconstruction of Somalia Drive in Monrovia

(Road Side Traffic Counts)

Road Name: Somalia Drive

Date: March 16,2012

Location / Point A: Stockton Bridge

Surveyed by: Blayon, Johnson, Ssonie, Turay, Harris & Dennis

Direction / From: Redlight To: Freeport

Supervised by: Sawoh Lassana & Emmanuel King

Key Map

No。	1	2	3	4	5	6	7	8	9	10
Category / Hours	Sedan / Wagon / Pich-up	Taxi	Mini Bus	Large Bus	Light Truck (2-Axle)	Heavy Truck (> 2-Axle)	Trailor (Artuculated Truck)	Motorbike	Bicycle	Pedestrian
8:00 ~ 9:00	175	140	102	41	30	46	10	667	2	400
9:00 ~ 10:00	200	440	200	22	6	40	7	600	6	327
10:00 ~ 11:00	150	340	117	17	2	44	9	480	0	230
11:00 ~ 12:00	153	220	230	23	33	27	10	495	3	370
12:00 ~ 13:00	170	264	114	3	22	29	16	382	10	240
13:00 ~ 14:00	186	230	80	6	0	25	7	390	0	340
14:00 ~ 15:00	200	258	190	4	58	43	6	360	6	200
15:00 ~ 16:00	210	160	121	18	61	25	7	370	0	210
16:00 ~ 17:00	210	83	40	10	7	8	5	400	5	280
17:00 ~ 18:00	160	210	21	9	12	22	5	520	0	160
18:00 ~ 19:00	230	225	190	7	21	7	0	710	0	430
19:00 ~ 20:00	118	60	18	5	3	7	1	280	1	430
20:00 ~ 21:00	42	109	31	8	5	5	0	280	0	75
21:00 ~ 22:00	64	176	21	3	13	34	16	672	3	76
22:00 ~ 23:00	22	98	11	7	2	8	2	249	0	3
23:00 ~ 0:00	28	72	1	0	2	0	0	140	1	14
0:00 ~ 1:00	10	12	1	0	0	0	0	2	0	24
1:00 ~ 2:00	6	8	0	0	0	0	0	12	0	0
2:00 ~ 3:00	5	3	0	0	2	0	0	8	0	0
3:00 ~ 4:00	5	4	0	0	2	1	0	8	0	4
4:00 ~ 5:00	9	13	0	0	0	0	0	11	1	28
5:00 ~ 6:00	30	28	14	2	1	20	7	16	0	60
6:00 ~ 7:00	38	165	106	15	34	25	0	150	3	165
7:00 ~ 8:00	53	264	77	29	19	81	6	464	6	140
Peak Hour Traffic	230	440	230	41	61	81	16	710	10	430
24-hr Traffic Total	2474	3582	1685	229	335	497	114	7666	47	4206
Peak Hour Ratio	0.092967	0.123	0.1365	0.179039	0.18209	0.162978	0.1403509	0.09262	0.213	0.102235

The Preparatory Survey on the Project for Reconstruction of Somalia Drive in Monrovia

(Road Side Traffic Counts)

Road Name: Somalia Drive

Date: 2012/3/16

Location / Direction / From: Free Port / Point B:Double Bridge To: Red Light Jct.

Surveyed by: Kaba, Paye, Tugbe, Browne, Keller & Wilson

Supervised by: Walter Stevens & Catherine Worgee

Key Map

No。	1	2	3	4	5	6	7	8	9	10
Category / Hours	Sedan / Wagon / Pich-up	Taxi	Mini Bus	Large Bus	Light Truck (2-Axle)	Heavy Truck (> 2-Axle)	Trailor (Artuculated Truck)	Motorbike	Bicycle	Pedestrian
8:00 ~ 9:00	100	410	100	13	14	34	12	252	3	130
9:00 ~ 10:00	80	361	104	7	23	22	8	130	1	87
10:00 ~ 11:00	156	307	92	8	22	25	5	172	4	154
11:00 ~ 12:00	104	300	68	3	35	30	19	188	2	230
12:00 ~ 13:00	108	267	86	5	26	34	10	167	1	140
13:00 ~ 14:00	83	303	88	1	35	46	13	169	3	90
14:00 ~ 15:00	90	335	71	8	38	48	9	161	2	120
15:00 ~ 16:00	86	226	59	7	24	29	7	120	2	95
16:00 ~ 17:00	90	310	68	3	27	38	8	207	4	74
17:00 ~ 18:00	93	310	52	10	24	26	9	260	1	110
18:00 ~ 19:00	127	306	70	22	32	42	3	265	3	150
19:00 ~ 20:00	194	215	43	3	14	11	6	200	1	157
20:00 ~ 21:00	120	186	102	13	71	7	7	201	0	130
21:00 ~ 22:00	87	166	31	16	8	23	9	190	2	72
22:00 ~ 23:00	70	97	13	0	6	0	1	146	1	62
23:00 ~ 0:00	62	54	12	1	5	1	1	93	0	47
0:00 ~ 1:00	50	27	7	0	3	0	0	35	0	10
1:00 ~ 2:00	15	9	1	0	0	1	0	19	0	7
2:00 ~ 3:00	6	4	1	0	0	2	0	12	0	0
3:00 ~ 4:00	2	2	0	0	0	0	0	5	0	1
4:00 ~ 5:00	8	6	2	0	0	6	0	15	0	0
5:00 ~ 6:00	13	57	12	3	1	4	1	10	0	7
6:00 ~ 7:00	126	260	93	16	5	19	11	72	3	78
7:00 ~ 8:00	274	367	129	15	7	38	1	180	1	
Peak Hour Traffic	274	410	129	22	71	48	19	265	4	230
24-hr Traffic Total	2144	4885	1304	154	420	486	140	3269	34	1951
Peak Hour Ratio	0.1278	0.08	0.099	0.1429	0.16905	0.09877	0.13571	0.0811	0.12	0.11789

The Preparatory Survey on the Project for Reconstruction of Somalia Drive in Monrovia

(Road Side Traffic Counts)

Road Name: Somalia Drive

Date: March 16,2012

Location / Point B:Double Bridge

Surveyed by: Lewis,Natt, Matico, Kerkula, Worgee & Inepo

Direction / From: Red light To: Freeport

Supervised by: G. Isaac Doe & Catherine Worgee

Key Map

No。	1	2	3	4	5	6	7	8	9	10
Category / Hours	Sedan / Wagon / Pich-up	Taxi	Mini Bus	Large Bus	Light Truck (2-Axle)	Heavy Truck (> 2-Axle)	Trailor (Artuculated Truck)	Motorbike	Bicycle	Pedestrian
8:00 ~ 9:00	76	310	60	6	12	9	9	301	10	172
9:00 ~ 10:00	95	325	73	4	18	46	1	259	0	190
10:00 ~ 11:00	110	277	63	8	7	8	8	247	2	110
11:00 ~ 12:00	160	278	68	9	9	7	7	212	0	42
12:00 ~ 13:00	56	172	51	11	13	12	6	244	4	120
13:00 ~ 14:00	22	157	47	5	15	5	0	219	6	197
14:00 ~ 15:00	62	277	54	3	26	12	0	284	3	119
15:00 ~ 16:00	53	304	74	6	22	4	2	184	3	79
16:00 ~ 17:00	101	309	64	9	29	12	6	217	1	107
17:00 ~ 18:00	82	371	75	11	46	8	1	254	1	90
18:00 ~ 19:00	148	334	112	14	67	14	3	357	1	150
19:00 ~ 20:00	133	343	113	16	47	9	6	304	1	118
20:00 ~ 21:00	138	221	101	5	10	17	3	227	0	91
21:00 ~ 22:00	140	210	44	6	7	18	4	234	1	109
22:00 ~ 23:00	90	145	30	0	2	0	1	215	0	110
23:00 ~ 0:00	60	71	10	4	2	1	0	101	0	50
0:00 ~ 1:00	25	19	2	0	1	3	0	33	0	14
1:00 ~ 2:00	12	14	2	0	1	1	0	12	0	2
2:00 ~ 3:00	5	5	0	0	1	1	0	8	0	1
3:00 ~ 4:00	3	4	2	0	0	0	0	1	0	0
4:00 ~ 5:00	5	5	1	1	0	0	0	0	0	6
5:00 ~ 6:00	10	32	19	0	1	1	3	11	1	10
6:00 ~ 7:00	40	150	76	42	4	42	16	66	0	120
7:00 ~ 8:00	220	322	80	4	1	26	18	317	3	310
Peak Hour Traffic	220	371	113	42	67	46	18	357	10	310
24-hr Traffic Total	1846	4655	1221	164	341	256	94	4307	37	2317
Peak Hour Ratio	0.119177	0.08	0.0925	0.256098	0.196481	0.179688	0.1914894	0.08289	0.27	0.133794

The Preparatory Survey on the Project for Reconstruction of Somalia Drive in Monrovia

(Road Side Traffic Counts)

Road Name: Somalia Drive

Date: 2012/3/16

Location / Direction / From: Point C: Bardnersville To: Free Port Red Light Jct.

Surveyed by: Kaba, Paye, Tugbe, Browne, Keller & Wilson

Supervised by: Walter Stevens & Catherine Worgee

Key Map

No。	1	2	3	4	5	6	7	8	9	10
Category / Hours	Sedan / Wagon / Pich-up	Taxi	Mini Bus	Large Bus	Light Truck (2-Axle)	Heavy Truck (> 2-Axle)	Trailor (Artuculated Truck)	Motorbike	Bicycle	Pedestrian
8:00 ~ 9:00	37	250	72	4	7	9	0	298	0	112
9:00 ~ 10:00	87	347	116	8	13	13	2	438	3	155
10:00 ~ 11:00	104	359	87	4	13	16	4	457	2	197
11:00 ~ 12:00	61	328	64	2	27	31	3	356	3	247
12:00 ~ 13:00	102	364	85	8	20	21	7	398	0	219
13:00 ~ 14:00	108	359	83	7	15	39	5	294	3	166
14:00 ~ 15:00	111	336	74	4	13	28	8	304	1	158
15:00 ~ 16:00	138	349	83	4	20	32	10	302	3	201
16:00 ~ 17:00	115	360	66	9	20	26	8	355	2	228
17:00 ~ 18:00	109	357	64	20	21	32	10	43	1	256
18:00 ~ 19:00	80	317	65	16	10	20	3	594	1	339
19:00 ~ 20:00	57	191	21	10	7	11	0	751	0	353
20:00 ~ 21:00	90	170	110	12	29	5	1	78	0	80
21:00 ~ 22:00	90	140	60	30	47	6	3	200	0	80
22:00 ~ 23:00	100	262	70	13	24	3	1	240	0	68
23:00 ~ 0:00	60	120	13	0	12	1	0	180	0	35
0:00 ~ 1:00	8	46	0	0	0	4	0	118	0	0
1:00 ~ 2:00	6	46	12	0	0	1	1	68	0	0
2:00 ~ 3:00	2	27	8	0	0	0	1	48	0	0
3:00 ~ 4:00	10	22	4	0	0	1	0	42	0	0
4:00 ~ 5:00	15	19	2	0	0	0	0	46	0	10
5:00 ~ 6:00	27	55	22	2	0	5	2	158	0	17
6:00 ~ 7:00	35	144	78	17	12	26	2	238	0	39
7:00 ~ 8:00	100	317	30	15	16	26	1	620	0	80
Peak Hour Traffic	138	364	116	30	47	39	10	751	3	353
24-hr Traffic Total	1652	5285	1289	185	326	356	72	6626	19	3040
Peak Hour Ratio	0.083535	0.069	0.09	0.162162	0.144172	0.109551	0.1388889	0.11334	0.158	0.116118

The Preparatory Survey on the Project for Reconstruction of Somalia Drive in Monrovia

(Road Side Traffic Counts)

Road Name: Somalia Drive

Date: 2012/3/16

Location / Point C:Bardnersville

Surveyed by: Lewis,Natt, Matico, Kerkula, Worgee & Inepo

Direction / From: Redlight To: Freeport

Supervised by: G. Isaac Doe & Catherine Worgee

Key Map

No。	1	2	3	4	5	6	7	8	9	10
Category / Hours	Sedan / Wagon / Pich-up	Taxi	Mini Bus	Large Bus	Light Truck (2-Axle)	Heavy Truck (> 2-Axle)	Trailor (Artuculated Truck)	Motorbike	Bicycle	Pedestrian
8:00 ~ 9:00	180	250	55	13	13	38	4	709	7	161
9:00 ~ 10:00	132	287	66	10	8	32	2	492	6	151
10:00 ~ 11:00	110	216	65	16	9	30	3	463	15	183
11:00 ~ 12:00	175	228	65	10	4	30	12	475	25	218
12:00 ~ 13:00	130	186	57	7	9	37	10	386	6	170
13:00 ~ 14:00	100	235	63	6	4	22	2	313	15	138
14:00 ~ 15:00	112	204	69	5	12	38	1	337	17	80
15:00 ~ 16:00	90	179	66	16	6	26	4	391	13	82
16:00 ~ 17:00	150	228	70	15	4	40	4	433	15	120
17:00 ~ 18:00	85	250	99	21	13	51	4	530	0	80
18:00 ~ 19:00	104	230	69	23	6	26	4	592	5	110
19:00 ~ 20:00	85	194	41	14	12	18	7	467	0	142
20:00 ~ 21:00	33	90	32	1	9	2	0	446	0	40
21:00 ~ 22:00	78	211	38	0	10	8	2	294	1	110
22:00 ~ 23:00	34	155	67	0	10	7	3	254	0	90
23:00 ~ 0:00	38	78	5	0	1	3	0	122	0	53
0:00 ~ 1:00	18	22	3	2	1	0	0	77	0	23
1:00 ~ 2:00	11	12	2	0	2	0	0	33	0	26
2:00 ~ 3:00	7	5	0	0	0	0	0	8	0	15
3:00 ~ 4:00	6	3	2	0	1	0	0	7	0	14
4:00 ~ 5:00	4	4	1	0	2	0	0	14	0	16
5:00 ~ 6:00	7	40	27	0	1	6	2	28	0	10
6:00 ~ 7:00	30	178	110	11	25	16	2	109	1	48
7:00 ~ 8:00	51	300	120	10	17	20	8	220	1	44
Peak Hour Traffic	180	300	120	23	25	51	12	709	25	218
24-hr Traffic Total	1770	3785	1192	180	179	450	74	7200	127	2124
Peak Hour Ratio	0.101695	0.079	0.1007	0.127778	0.139665	0.113333	0.1621622	0.09847	0.197	0.102637

Table 2: Distribution of distresses on Pavement

Section Chainage	Concentration of Distresses According to Type and Severity (%)														
	Rutting (Average Depth, mm)			Potholes (Average Depth, mm)			Cracks (mean width, mm)			Corrugation (% of road way)			Patching (% Area per station)		
	6-13	13-18	18+	0-25	25-50	50+	1-6	6-12	12+	1-25	25-75	75+	1-5	6-25	25+
0+000 - 0+500	√										√		√		
0+500 - 1+000	√						√			√				√	
1+000 - 1+250		√											√		
1+250 - 1+500		√					√			√				√	
1+500 - 2+000	√						√			√				√	
2+000 - 2+500	√									√				√	
2+500 - 3+000	√												√		
3+000 - 3+500	√												√		
3+500 - 4+000	√			√							√			√	
4+000 - 4+500			√				√				√				√
4+500 - 5+000	√									√			√		
5+000 - 5+500	√									√					

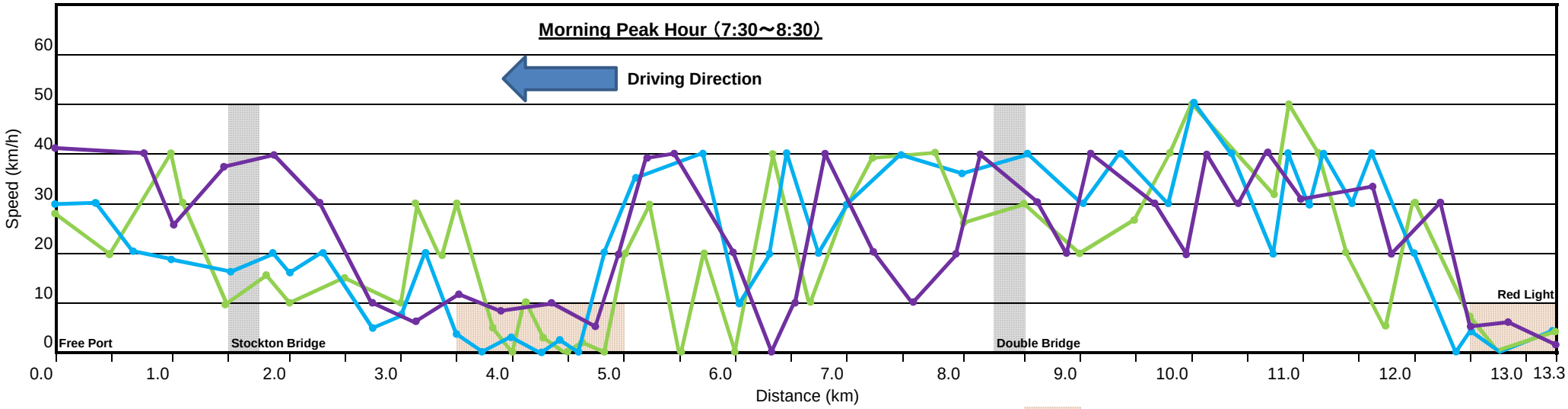
Table 2: Distribution of distresses on Pavement

Section Chainage	Concentration of Distresses According to Type and Severity (%)														
	Rutting (Average Depth, mm)			Potholes (Average Depth, mm)			Cracks (mean width, mm)			Corrugation (% of road way)			Patching (% Area per station)		
	6-13	13-18	18+	0-25	25-50	50+	1-6	6-12	12+	1-25	25-75	75+	1-5	6-25	25+
5+500 - 6+000	√												√		
6+000 - 6+500	√									√					
6+500 - 7+000	√						√			√					
7+000 - 7+500	√														
7+500 - 8+000	√														
8+000 - 8+500															
8+500 - 9+000	√												√		
9+000 - 9+500	√									√					
9+500 - 10+000	√						√			√			√		
10+000 - 10+500	√						√						√		

Table 2: Distribution of distresses on Pavement

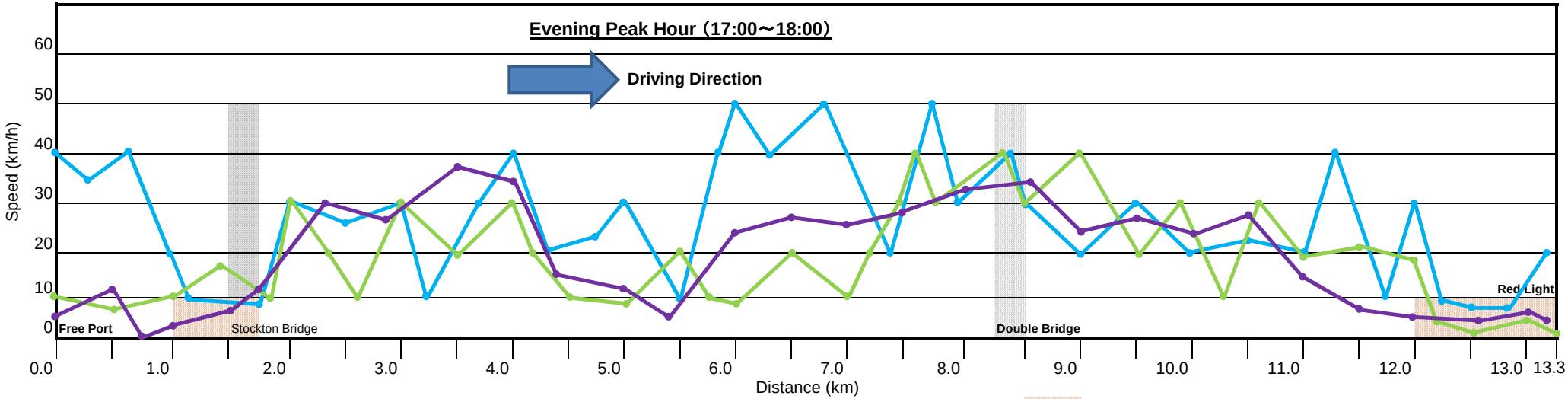
Section Chainage	Concentration of Distresses According to Type and Severity (%)														
	Rutting (Average Depth, mm)			Potholes (Average Depth, mm)			Cracks (mean width, mm)			Corrugation (% of road way)			Patching (% Area per station)		
	6-13	13-18	18+	0-25	25-50	50+	1-6	6-12	12+	1-25	25-75	75+	1-5	6-25	25+
10+500 - 11+000	√						√			√			√		
11+000 - 11+500	√						√			√			√		
11+500 - 12+000	√									√			√		
12+000 - 12+500	√						√			√			√		
12+500 - 13+000		√					√			√					

Morning Peak Hour（7:30～8:30）



8/February	62 minutes/13.3km	Average Speed	12.9	km/h
9/February	74 minutes/13.3km	Average Speed	10.8	km/h
10/February	61 minutes/13.3km	Average Speed	13.1	km/h
Average	66 minutes/13.3km	Average Speed	12.1	km/h

Evening Peak Hour（17:00～18:00）



8/February	45 minutes/13.3km	Average Speed	17.7	km/h
9/February	52 minutes/13.3km	Average Speed	15.3	km/h
10/February	57 minutes/13.3km	Average Speed	14.0	km/h
Average	51 minutes/13.3km	Average Speed	15.6	km/h

7-5 Pavement Structure Design

Calculation of Traffic Load

	1	2	3	4	5	6	7	8	9	10	
2009	Sedan / Wagon / Pich-up	Taxi	Mini Bus	Large Bus	Light Truck (2-Axle)	Heavy Truck (> 2-Axle)	Trailor (Artuculated Truck)	Motorbike	Bicycle	Pedestrian	
Stokton Br	15825	14384	4148	441	253	342	216	4447	34		40056
Double Br	9532	12471	5589	3502	2977	1842	911	2125	333		38949
Bardnesvill	3645	4972	1933	532	422	745	77	4630	84		16956
2012											
Stokton Br	4656	9354	4308	1072	1123	989	348	12761	94	7227	34611
Double Br	3746	8986	2480	409	682	797	207	7457	67	4593	24764
Bardnesvill	4281	8715	2763	440	670	885	154	13065	33	5144	30973

Stokton Br	growth rat		ESAL	0.74	1	2.048	4.4	5.6		
2013	1.078			4644	1155	1210	1066	375		
2014	1.078			5006	1245	1304	1149	404		
2015	1.065			5331	1325	1388	1223	430		
2016	1.065			5677	1411	1478	1302	457		
2017	1.065			6046	1502	1574	1386	486		
2018	1.065			6438	1599	1676	1476	517		
2019	1.065			6856	1702	1784	1571	550		
2020	1.05			7198	1787	1873	1649	577		
2021	1.05			7557	1876	1966	1731	605		
2022	1.05			7934	1969	2064	1817	635		
2023	1.05			8330	2067	2167	1907	666		
2024	1.05			8746	2170	2275	2002	699		
2025	1.05			9183	2278	2388	2102	733	Average No. of Large Vehicle	6047.4
		10yr		54734	18361	39413	74549	33180	w_{18}=	4.019E+07

Double Br	growth rat		ESAL	0.74	1	2.048	4.4	5.6		
2013	1.078			2673	440	735	859	223		
2014	1.078			2881	474	792	926	240		
2015	1.065			3068	504	843	986	255		
2016	1.065			3267	536	897	1050	271		
2017	1.065			3479	570	955	1118	288		
2018	1.065			3705	607	1017	1190	306		
2019	1.065			3945	646	1083	1267	325		
2020	1.05			4142	678	1137	1330	341		
2021	1.05			4349	711	1193	1396	358		
2022	1.05			4566	746	1252	1465	375		
2023	1.05			4794	783	1314	1538	393		
2024	1.05			5033	822	1379	1614	412		
2025	1.05			5284	863	1447	1694	432	Average No. of Large Vehicle	3579.9
		10yr		31497	6962	23908	60112	19605	w_{18}=	2.593E+07

Subgrade Evaluation with CBR test result

1	0+000	22		
2	0+500	18		
3	1+000	38		
4	1+250	10		
5	1+500	40	n=12	g (12,0.05)=0.376
6	2+000	30	min	0.066667 < 0.376 OK
7	2+500	19	max	0.0625 < 0.376 OK
8	3+000	8	Average	21.75
9	3+500	21	Standard deviaton	9.88226
10	4+000	22	CBR=	11.8677 **say 12**
11	4+500	15		
12	5+000	18		
13	5+500	41		
14	6+000	14	n=9,8	g (9,0.05)=0.437,0.468
15	6+500	16	min	0.166667 < 0.468 OK
16	7+000	9	max	0.625 > 0.437 OUT
17	7+500	11		0.166667 < 0.468 OK
18	8+000	21	Average	14.625
19	8+500	18	Standard deviaton	4.62717
20	9+000	19	CBR=	9.99783 **say 10**
21	9+500	9		
22	10+000	10	n=7	g (7,0.05)=0.507
23	10+500	29	min	0.142857 < 0.507 OK
24	11+000	19	max	0.321429 < 0.507 OK
25	11+500	38	Average	20.1429
26	12+000	14	Standard deviaton	9.85611
27	12+500	16	CBR=	10.2867 **say 10**
28	13+000	15		

Design of Pavement structure

10 years	~5+000	~13+000
W_{18}=(cumulative 18kipESAL)	4.019E+07	2.593E+07
R=(Reliability)	0.9	0.9
z_R=(Standard Deviation)	-1.282	-1.282
S_0=(total standard deviation)	0.45	0.45
p0=(Initial service index)	4.2	4.2
pt=(final service index)	2.5	2.5
ΔPSI=(gap of service index)	1.7	1.7
CBR=	12	10
M_R=(Resilient coefficient)	18000	15000
SN=	4.51	4.50

~5+000	layer coefficient	thickness (cm)	thickness (inch)	drainage coefficient	SN
Surface AC 350,000psi	0.390	5	1.969	-	0.768
Binder AC 350,000psi	0.390	10	3.937	-	1.535
Base CBR=80	0.135	20	7.874	1.000	1.063
Subbase CBR=30	0.108	30	11.811	1.000	1.276
		t=65cm		Total	4.642

~13+000	layer coefficient	thickness (cm)	thickness (inch)	drainage coefficient	SN
Surface AC 350,000psi	0.390	5	1.969	-	0.768
Binder AC 350,000psi	0.390	10	3.937	-	1.535
Base CBR=80	0.135	20	7.874	1.000	1.063
Subbase CBR=30	0.108	30	11.811	1.000	1.276
		t=65cm		Total	4.642

7-6 Free Port Junction Traffic Analysis

Results of Intersection Analysis

Inflow Direction	A	A	B	B	C	C
Outflow Direction	Through and Left-turn	Through	Left-turn	Right-turn	Through	Through and Right-turn
Number of Lanes	1	1	1	1	1	1
Ideal Saturation Flow Rate(One Lane)	2000	2000	1800	1800	2000	2000
Lane Width(m)	3	3	3	3	3	3
Adjustment Factor for Lane Width	1	1	1		1	1
Approach Grade(%)	0	0	0		0	0
Adjustment Factor for Approach Grade	1	1	1		1	1
Heavy Vehicle Ratio(%)	0	0	0		0	0
Adjustment Factor for Heavy Vehicles	1	1	1		1	1
Timing(sec)	50	50	36		50	50
Cycle Time(sec)	90	90	90		90	90
Right Turns Ratio(%)	0	0			0	0
Pedestrian Flows(peds/cycle)						
Reduction for Pedestrian						
Pedestrian Green Time(sec)						
Right Turn Equivalence						
Adjustment Factor for Right Turn and Through						
Adjustment Factor for Right Turn Lane						
Left Turns Ratio(%)	40.57	0	100		0	0
Traffic Volume of Opposing Lane	763		0			
Probability of Left Turns	0.47		1			
Pass Flow during Yellow Phase(veh/cycle)	2		2			
Left Turn Equivalence	2.41					
Adjustment Factor for Left Turn and Through	0.64					
Left Turn Phase			no exclusive			
Adjustment Factor for Bus Blockage	1	1	1		1	1
Saturation Flow(veh/h)	1274	2000	3600	1800	2000	1500
Design Hourly Volume(veh/h)		1326	1428	794		1386
Normalized Traffic Rate		0.405	0.352	0.441		0.396
Capacity(veh/h)		1820	1680	1800		1946
Necessary Phase Rate						
Phase 1		0.405		0.245		0.396
Phase 2			0.352	0.196		
Degree of Saturation of Intersection			0.757			
Cycle Time(sec)			90			

Results of Intersection Analysis

Inflow Direction	A	A	B	B	C	C
Outflow Direction	Through and Left-turn	Through	Left-turn	Right-turn	Through	Through and Right-turn
Number of Lanes	1	2	2	1	2	1
Ideal Saturation Flow Rate(One Lane)	2000	2000	1800	1800	2000	2000
Lane Width(m)	3	3	3	3	3	3
Adjustment Factor for Lane Width	1	1	1	1	1	1
Approach Grade(%)	0	0	0	0	0	0
Adjustment Factor for Approach Grade	1	1	1	1	1	1
Heavy Vehicle Ratio(%)	0	0	0	0	0	0
Adjustment Factor for Heavy Vehicles	1	1	1	1	1	1
Timing(sec)	50	50	40	90	50	50
Cycle Time(sec)	90	90		90	90	90
Right Turns Ratio(%)	0	0		0	0	100
Pedestrian Flows(peds/cycle)				0		0
Reduction for Pedestrian				0		0
Pedestrian Green Time(sec)				0		0
Right Turn Equivalence			90	1		0
Adjustment Factor for Right Turn and Through						0.75
Adjustment Factor for Right Turn Lane						
Left Turns Ratio(%)	60.86	0	100		0	0
Traffic Volume of Opposing Lane Direction(veh/h)	762		0			
Probability of Left Turns	0.47		1			
Pass Flow during Yellow Phase(veh/cycle)	2		2			
Left Turn Equivalence	2.24					
Adjustment Factor for Left Turn and Through	0.57					
Left Turn Phase			no exclusive			
Adjustment Factor for Bus Blockage	1	1	1	1	1	1
Saturation Flow(veh/h)	1139	4000	3600	1800	4000	1500
Design Hourly Volume(veh/h)		1326	1428	794		1386
Normalized Traffic Rate		0.258	0.352	0.441		0.252
Capacity(veh/h)		2856	1680	1800		3057
Necessary Phase Rate						
Phase 1		0.258		0.245		0.252
Phase 2			0.352	0.196		
Degree of Saturation of Intersection			0.610			
Cycle Time(sec)			90			

Flow Calculation

Rational: Q=(1/(3.6*10^6))*C*I*a　　Q=A・V

discharge coefficient(AC)	0.9	Manning: V=(1/n)・R^(2/3)・i^(1/2)	
rainfall intensity(3yr return period)	100mm/h	roughness coefficient:(concrete)	0.015
catchment width	17.7m	effective depth	0.8

Median Drain

No.	Median Drain Station	Length (m)	Slope (%)	elevation start	elevation end	U-Ditch Station	U-Ditch Outlet	discharge (m3/s)	Capacity depth (m)	Capacity width (m)	Capacity section area:A (m2)	Capacity Hydraulic radius:R (m)	Capacity velocity (m/s)	Capacity capacity (m3/s)	judge
1	0+225 ～ 0+360	135	0.059	1.350	1.406	pipe	crown slope	0.060	0.50	2.214	0.168	0.152	0.461	0.078	OK
2	0+360 ～ 0+640	280	0.030	1.782	1.697		0+640 inner wetland	0.124	0.90	0.500	0.450	0.196	0.391	0.176	OK
3	0+640 ～ 0+730	90	0.112	2.196	2.263		0+640 inner wetland	0.040	0.40	0.500	0.200	0.154	0.641	0.128	OK
4	0+730 ～ 0+900	170	0.076	2.278	2.149		0+905 inner wetland	0.075	0.50	0.500	0.250	0.167	0.556	0.139	OK
	0+900 1+025	125	0.737	2.249	3.170			0.144	0.40	0.500	0.200	0.154	1.643	0.329	OK
	1+025 1+225	200	0.400	3.170	3.818			0.089	0.40	0.500	0.200	0.154	1.211	0.242	OK
5	0+900 ～ 1+225	325	0.483	2.249	3.818		0+905 inner wetland	0.144	0.40	0.500	0.200	0.154	1.330	0.266	OK
6	1+225 ～ 1+380	155	0.039	3.896	3.850		Stokton river	0.069	0.45	0.500	0.225	0.161	0.389	0.088	OK
7	1+462 1+539	77	0.032	4.040	4.065		Stokton river	0.034	0.40	0.500	0.200	0.154	0.345	0.069	OK
	1+539 1+600	61	0.865	3.733	3.465			0.027	0.40	0.500	0.200	0.154	1.780	0.356	OK
	1+600 1+825	225	0.424	3.465	2.510			0.127	0.40	0.500	0.200	0.154	1.247	0.249	OK
	1+825 1+900	75	0.311	2.510	2.277			0.160	0.40	0.500	0.200	0.154	1.067	0.213	OK
8	1+539 ～ 1+900	361	0.403	3.733	2.277		1+900 inner wetland	0.160	0.40	0.500	0.200	0.154	1.216	0.243	OK
	1+900 1+975	75	0.120	2.277	2.367			0.127	0.50	0.500	0.250	0.167	0.699	0.175	OK
	1+975 2+100	125	0.154	2.367	2.560			0.094	0.40	0.500	0.200	0.154	0.752	0.150	OK
	2+100 2+187	87	0.102	2.560	2.620			0.038	0.40	0.500	0.200	0.154	0.610	0.122	OK
9	1+900 ～ 2+187	287	0.191	2.277	2.620		1+900 inner wetland	0.127	0.40	0.500	0.200	0.154	0.837	0.167	OK
10	2+187 ～ 2+328	141	0.035	2.649	2.600		2+328 pipe culvert	0.062	0.45	0.500	0.225	0.161	0.367	0.083	OK
	2+328 2+385	57	0.047	2.302	2.329			0.109	0.60	0.500	0.300	0.176	0.456	0.137	OK
	2+385 2+425	40	0.195	2.329	2.407			0.084	0.40	0.500	0.200	0.154	0.845	0.169	OK
	2+425 2+575	150	0.442	2.407	3.070			0.066	0.40	0.500	0.200	0.154	1.273	0.255	OK
11	2+328 ～ 2+575	247	0.372	2.152	3.070		2+328 pipe culvert	0.109	0.85	0.500	0.425	0.193	1.358	0.577	OK
	2+575 2+725	150	0.153	3.070	2.840			0.066	0.40	0.500	0.200	0.154	0.750	0.150	OK
	2+725 2+775	50	0.100	2.840	2.790			0.089	0.40	0.500	0.200	0.154	0.605	0.121	OK
	2+775 2+825	50	0.400	2.790	2.590			0.111	0.40	0.500	0.200	0.154	1.211	0.242	OK
	2+825 3+000	175	0.129	2.590	2.365			0.144	0.65	0.500	0.325	0.181	0.764	0.248	OK
12	2+575 ～ 3+000	425	0.166	3.070	2.365		3+000 inner wetland	0.188	0.65	0.500	0.325	0.181	0.867	0.282	OK
13	3+000 ～ 3+125	125	0.226	2.615	2.333		3+125 inner wetland	0.055	0.40	0.500	0.200	0.154	0.909	0.182	OK
	3+125 3+163	38	0.297	2.233	2.346			0.195	0.50	0.500	0.250	0.167	1.101	0.275	OK
	3+163 3+200	37	0.424	2.346	2.503			0.178	0.40	0.500	0.200	0.154	1.247	0.249	OK
	3+200 3+275	75	0.665	2.503	3.002			0.162	0.40	0.500	0.200	0.154	1.561	0.312	OK
	3+275 3+325	50	0.472	3.002	3.238			0.129	0.40	0.500	0.200	0.154	1.315	0.263	OK
	3+325 3+450	125	0.226	3.288	3.570			0.107	0.40	0.500	0.200	0.154	0.909	0.182	OK
	3+450 3+566	116	0.086	3.570	3.670			0.051	0.40	0.500	0.200	0.154	0.562	0.112	OK
14	3+125 ～ 3+566	441	0.326	2.233	3.670		3+125 inner wetland	0.195	0.50	0.500	0.250	0.167	1.153	0.288	OK

No.	Median Drain			Slope (%)	elevation		U-Ditch		discharge (m3/s)	Capacity						judge
	Station		Length (m)		start	end	Station	Outlet		depth (m)	width (m)	section area:A (m2)	Hydraulic radius:R (m)	velocity (m/s)	capacity (m3/s)	
	3+566	3+675	109	0.382	3.629	3.327			0.048	0.40	0.500	0.200	0.154	1.183	0.237	OK
	3+675	3+725	50	0.320	3.327	3.167			0.070	0.40	0.500	0.200	0.154	1.083	0.217	OK
	3+725	3+925	200	0.152	3.167	2.863			0.159	0.55	0.500	0.275	0.172	0.803	0.221	OK
15	3+566 ～	3+925	359	0.213	3.629	2.863		3+925 inner wetland	0.159	0.55	0.500	0.275	0.172	0.952	0.262	OK
	3+925	4+030	105	0.098	2.763	2.866			0.163	0.65	0.500	0.325	0.181	0.667	0.217	OK
	4+030	4+060	30	0.197	2.866	2.925	pipe		0.117	0.50	2.214	0.168	0.152	0.842	0.142	OK
	4+060	4+200	140	0.290	3.325	3.731			0.104	0.40	0.500	0.200	0.154	1.031	0.206	OK
	4+200	4+217	17	0.100	3.731	3.748			0.042	0.40	0.500	0.200	0.154	0.605	0.121	OK
	4+217	4+294	77	0.025	3.748	3.767			0.034	0.40	0.500	0.200	0.154	0.301	0.060	OK
16	3+925 ～	4+294	369	0.272	2.763	3.767		3+925 inner wetland	0.163	0.75	0.500	0.375	0.188	1.139	0.427	OK
	4+294	4+450	156	0.143	3.616	3.536			0.069	0.40	0.500	0.200	0.154	0.723	0.145	OK
	4+450	4+500	50	0.432	3.536	3.320			0.091	0.40	0.500	0.200	0.154	1.258	0.252	OK
	4+500	4+630	130	0.124	3.320	3.159			0.149	0.55	0.500	0.275	0.172	0.725	0.199	OK
17	4+294 ～	4+630	336	0.148	3.616	3.119		4+630 box culvert	0.149	0.55	0.500	0.275	0.172	0.793	0.218	OK
	4+630	4+750	120	0.132	3.159	3.317			0.153	0.55	0.500	0.275	0.172	0.748	0.206	OK
	4+750	4+975	225	0.272	3.317	3.928			0.100	0.40	0.500	0.200	0.154	0.997	0.199	OK
18	4+630 ～	4+975	345	0.223	3.159	3.928		4+630 box culvert	0.153	0.55	0.500	0.275	0.172	0.973	0.268	OK
	4+975	5+134	159	0.157	3.828	4.077			0.144	0.50	0.500	0.250	0.167	0.799	0.200	OK
	5+134	5+164	30	0.313	4.077	4.171	pipe		0.073	0.40	2.214	0.108	0.122	0.916	0.099	OK
	5+164	5+275	111	0.222	4.521	4.767			0.060	0.40	2.214	0.108	0.122	0.771	0.083	OK
	5+275	5+300	25	0.168	4.767	4.809			0.011	0.40	0.500	0.200	0.154	0.785	0.157	OK
19	4+975 ～	5+300	325	0.331	3.733	4.809		4+975 pipe culvert	0.144	0.75	0.500	0.375	0.188	1.257	0.471	OK
	5+300	5+355	55	0.116	4.809	4.745			0.024	0.40	0.500	0.200	0.154	0.653	0.131	OK
	5+355	5+516	161	0.221	4.745	4.389			0.096	0.40	0.500	0.200	0.154	0.900	0.180	OK
	5+516	5+555	39	2.644	4.389	3.358			0.113	0.40	0.500	0.200	0.154	3.112	0.622	OK
20	5+300 ～	5+555	255	0.177	4.809	4.358		5+555 pipe culvert	0.113	0.40	0.500	0.200	0.154	0.805	0.161	OK
	5+555	5+750	195	0.321	4.358	4.984			0.119	0.40	0.500	0.200	0.154	1.085	0.217	OK
	5+750	5+825	75	0.127	4.984	5.079			0.033	0.40	0.500	0.200	0.154	0.681	0.136	OK
21	5+555 ～	5+825	270	0.267	4.358	5.079		5+555 pipe culvert	0.119	0.40	0.500	0.200	0.154	0.989	0.198	OK
22	5+825	5+975	150	0.079	5.079	4.960			0.066	0.40	0.500	0.200	0.154	0.539	0.108	OK
	5+975	6+135	160	0.221	4.960	4.607		6+135 box culvert	0.137	0.40	0.500	0.200	0.154	0.899	0.180	OK
23	6+135 ～	6+175	40	0.032	4.607	4.620		6+135 box culvert	0.018	0.30	0.500	0.150	0.136	0.318	0.048	OK
	6+175	6+400	225	0.180	4.250	4.025			0.100	0.40	0.500	0.200	0.154	0.812	0.162	OK
	6+400	6+491	91	0.152	4.025	3.887			0.140	0.46	0.500	0.230	0.162	0.771	0.177	OK
	6+491	6+521	30	0.050	3.167	3.152	pipe		0.153	0.70	2.214	0.330	0.213	0.532	0.175	OK
	6+521	6+560	39	0.026	3.152	3.142			0.170	1.05	0.500	0.525	0.202	0.367	0.193	OK
24	6+175 ～	6+560	385	0.287	4.250	3.145		6+560 pipe culvert	0.170	1.05	0.500	0.525	0.202	1.229	0.645	OK
	6+560	6+675	115	0.385	3.792	4.235			0.136	0.40	0.500	0.200	0.154	1.188	0.238	OK
	6+675	6+725	50	1.342	4.235	4.906			0.085	0.40	0.500	0.200	0.154	2.217	0.443	OK
	6+725	6+868	143	0.584	4.906	5.157			0.063	0.40	0.500	0.200	0.154	1.462	0.292	OK
25	6+560 ～	6+868	308	0.443	3.792	5.157		6+560 pipe culvert	0.136	0.40	0.500	0.200	0.154	1.274	0.255	OK
26	6+868 ～	6+925	57	0.011	5.621	5.615		6+925 inner wetland	0.025	0.40	0.500	0.200	0.154	0.196	0.039	OK

No.	Median Drain		Length (m)	Slope (%)	elevation		U-Ditch		discharge (m3/s)	Capacity						judge
	Station				start	end	Station	Outlet		depth (m)	width (m)	section area:A (m2)	Hydraulic radius:R (m)	velocity (m/s)	capacity (m3/s)	
	6+925	7+025	100	0.609	5.915	6.524			0.097	0.40	0.500	0.200	0.154	1.494	0.299	OK
	7+025	7+088	63	0.089	6.524	6.580			0.053	0.40	0.500	0.200	0.154	0.571	0.114	OK
	7+088	7+118	30	0.347	6.580	6.684	pipe		0.025	0.40	2.214	0.108	0.122	0.964	0.104	OK
	7+118	7+145	27	0.107	7.034	7.063			0.012	0.40	0.500	0.200	0.154	0.627	0.125	OK
27	6+925 ～	7+145	220	0.285	4.090	7.063		6+925 inner wetland	0.097	0.40	0.500	0.200	0.154	1.022	0.204	OK
	7+145	7+333	188	0.304	7.023	6.542			0.083	0.40	0.500	0.200	0.154	1.056	0.211	OK
	7+333	7+433	100	0.255	6.092	5.837	pipe		0.127	0.50	2.214	0.168	0.152	0.959	0.162	OK
	7+433	7+575	142	0.104	5.837	5.689			0.190	0.65	2.214	0.285	0.198	0.730	0.208	OK
	7+575	7+750	175	0.245	5.689	5.260			0.268	0.65	2.214	0.285	0.198	1.120	0.319	OK
	7+750	7+840	90	0.334	5.260	4.959			0.308	0.65	0.500	0.325	0.181	1.232	0.400	OK
28	7+145 ～	7+840	695	0.297	7.023	4.959		7+840 pipe culvert	0.308	0.65	0.500	0.325	0.181	1.161	0.377	OK
29	7+840 ～	7+902	62	0.239	5.209	5.061		7+902 pipe culvert	0.027	0.40	0.500	0.200	0.154	0.935	0.187	OK
30	7+902 ～	7+966	64	0.009	4.911	4.917		7+902 pipe culvert	0.028	0.40	0.500	0.200	0.154	0.185	0.037	OK
	7+966	8+200	234	0.178	4.608	4.370			0.104	0.40	0.500	0.200	0.154	0.807	0.161	OK
	8+200	8+229	29	0.238	4.370	4.301			0.116	0.55	0.500	0.275	0.172	1.005	0.276	OK
31	7+966 ～	8+229	263	0.117	4.608	4.301		double br	0.116	0.55	0.500	0.275	0.172	0.704	0.194	OK
	8+280	8+325	45	0.302	4.358	4.494			0.204	0.50	0.500	0.250	0.167	1.110	0.277	OK
	8+325	8+475	150	0.551	4.494	5.320			0.184	0.40	0.500	0.200	0.154	1.420	0.284	OK
	8+475	8+741	266	0.336	5.320	7.220			0.118	0.40	0.500	0.200	0.154	1.110	0.222	OK
32	8+280 ～	8+741	461	0.336	4.358	7.220		double br	0.204	0.60	0.500	0.300	0.176	1.216	0.365	OK
33	8+741 ～	8+803	62	0.697	7.220	7.443		8+741 pipe culvert	0.027	0.40	0.500	0.200	0.154	1.598	0.320	OK
	8+803	8+900	97	0.081	7.587	7.508			0.043	0.40	0.500	0.200	0.154	0.546	0.109	OK
	8+900	8+975	75	0.597	7.508	7.060			0.076	0.40	0.500	0.200	0.154	1.479	0.296	OK
	8+975	9+150	175	0.798	7.060	5.663			0.077	0.40	0.500	0.200	0.154	1.710	0.342	OK
34	8+803 ～	9+150	347	0.554	7.587	5.663		9+150 inner culvert	0.154	0.40	0.500	0.200	0.154	1.425	0.285	OK
	9+150	9+245	95	0.798	5.663	4.905			0.042	0.40	0.500	0.200	0.154	1.710	0.342	OK
	9+245	9+275	30	0.800	4.555	4.315	pipe		0.055	0.40	2.214	0.108	0.122	1.464	0.158	OK
	9+275	9+325	50	0.098	4.315	4.266			0.077	0.40	0.500	0.200	0.154	0.599	0.120	OK
	9+325	9+400	75	0.791	4.266	3.673			0.111	0.40	0.500	0.200	0.154	1.702	0.340	OK
	9+400	9+456	56	0.288	3.673	3.512			0.135	0.40	0.500	0.200	0.154	1.026	0.205	OK
	9+456	9+545	89	0.064	3.512	3.455			0.175	1.05	0.500	0.525	0.202	0.581	0.305	OK
35	9+150 ～	9+545	395	0.560	5.663	3.450		9+545 box culvert	0.175	1.05	0.500	0.525	0.202	1.717	0.902	OK
36	9+545 ～	9+825	280	0.996	4.105	6.895		9+545 box culvert	0.124	0.40	0.500	0.200	0.154	1.911	0.382	OK
	9+825	9+915	90	0.628	6.895	7.460			0.102	0.40	0.500	0.200	0.154	1.517	0.303	OK
	9+915	9+945	30	1.000	7.460	7.760	pipe		0.062	0.40	2.214	0.108	0.122	1.637	0.176	OK
	9+945	10+055	110	0.977	8.110	9.185			0.049	0.40	0.500	0.200	0.154	1.892	0.378	OK
37	9+825 ～	10+055	230	0.996	6.895	9.185		9+825 pipe culvert	0.102	0.40	0.500	0.200	0.154	1.910	0.382	OK
	10+055	10+200	145	0.988	9.185	10.618			0.108	0.40	0.500	0.200	0.154	1.903	0.381	OK
	10+200	10+264	64	0.497	10.618	10.936			0.044	0.40	0.500	0.200	0.154	1.349	0.270	OK
	10+264	10+300	36	0.144	10.936	10.988			0.016	0.40	0.500	0.200	0.154	0.727	0.145	OK
38	10+055 ～	10+300	245	0.736	9.185	10.988		10+055 pipe culvert	0.108	0.40	0.500	0.200	0.154	1.642	0.328	OK

No.	Median Drain			Slope (%)	elevation		U-Ditch		discharge (m3/s)	Capacity						judge
	Station		Length (m)		start	end	Station	Outlet		depth (m)	width (m)	section area:A (m2)	Hydraulic radius:R (m)	velocity (m/s)	capacity (m3/s)	
	10+300	10+350	50	0.156	10.988	10.910			0.022	0.40	0.500	0.200	0.154	0.756	0.151	OK
	10+350	10+395	45	0.458	10.910	10.704			0.042	0.40	0.500	0.200	0.154	1.295	0.259	OK
39	10+300 ～	10+395	95	0.299	10.988	10.704		10+395 pipe culvert	0.042	0.40	0.500	0.200	0.154	1.047	0.209	OK
	10+395	10+428	33	0.612	10.704	10.502			0.015	0.40	0.500	0.200	0.154	1.498	0.300	OK
	10+428	10+567	139	1.074	10.502	9.009			0.076	0.40	0.500	0.200	0.154	1.984	0.397	OK
	10+567	10+667	100	1.102	8.659	7.557	pipe		0.120	0.40	2.214	0.108	0.122	1.718	0.185	OK
	10+667	10+718	51	0.412	7.557	7.347			0.143	0.40	0.500	0.200	0.154	1.228	0.246	OK
	10+718	10+830	112	1.094	7.347	6.122			0.192	0.40	0.500	0.200	0.154	2.002	0.400	OK
40	10+395 ～	10+830	435	1.053	10.704	6.122		10+830 pipe culvert	0.192	0.40	0.500	0.200	0.154	1.964	0.393	OK
	10+830	10+925	95	1.114	6.122	5.064			0.042	0.40	0.500	0.200	0.154	2.020	0.404	OK
	10+925	10+975	50	0.804	5.064	4.662			0.064	0.40	0.500	0.200	0.154	1.716	0.343	OK
	10+975	11+017	42	0.210	4.662	4.574			0.083	0.40	0.500	0.200	0.154	0.876	0.175	OK
	11+017	11+135	118	0.044	4.574	4.522			0.135	1.55	0.500	0.775	0.215	0.503	0.390	OK
41	10+830 ～	11+135	305	0.508	6.072	4.522		11+135 pipe culvert	0.135	1.55	0.500	0.775	0.215	1.707	1.323	OK
	11+135	11+230	95	0.877	5.484	6.317			0.142	0.40	0.500	0.200	0.154	1.792	0.358	OK
	11+230	11+250	20	1.345	6.317	6.586	pipe		0.100	0.40	2.214	0.108	0.122	1.898	0.205	OK
	11+250	11+275	25	1.920	6.586	7.066	pipe		0.091	0.40	2.214	0.108	0.122	2.268	0.244	OK
	11+275	11+325	50	2.548	7.066	8.340	pipe		0.080	0.40	2.214	0.108	0.122	2.613	0.282	OK
	11+325	11+330	5	1.000	8.340	8.390	pipe		0.058	0.40	2.214	0.108	0.122	1.637	0.176	OK
	11+330	11+455	125	1.229	8.740	10.276			0.055	0.40	0.500	0.200	0.154	2.122	0.424	OK
42	11+135 ～	11+455	320	1.498	5.484	10.276		11+135 pipe culvert	0.142	0.40	0.500	0.200	0.154	2.342	0.468	OK
	11+455	11+500	45	1.156	10.276	10.796			0.080	0.40	0.500	0.200	0.154	2.058	0.412	OK
	11+500	11+550	50	0.836	10.796	11.214			0.060	0.40	0.500	0.200	0.154	1.750	0.350	OK
	11+550	11+600	50	0.442	11.214	11.435			0.038	0.40	0.500	0.200	0.154	1.273	0.255	OK
	11+600	11+636	36	0.103	11.435	11.472			0.016	0.40	0.500	0.200	0.154	0.614	0.123	OK
43	11+455 ～	11+636	181	0.661	10.276	11.472		11+455 pipe culvert	0.080	0.40	0.500	0.200	0.154	1.556	0.311	OK
44	11+636 ～	11+713	77	0.013	11.312	11.322		11+636 pipe culvert	0.034	0.50	0.500	0.250	0.167	0.230	0.058	OK
45	11+713 ～	11+930	217	0.204	10.963	10.871		11+930 pipe culvert	0.096	0.40	0.500	0.200	0.154	0.865	0.173	OK
	11+930	12+052	122	0.207	10.571	10.824			0.164	0.50	0.500	0.250	0.167	0.919	0.230	OK
	12+052	12+193	141	0.659	10.824	11.753			0.110	0.40	0.500	0.200	0.154	1.554	0.311	OK
	12+193	12+223	30	1.053	11.753	12.069	pipe		0.048	0.40	2.214	0.108	0.122	1.680	0.181	OK
	12+223	12+265	42	1.552	12.069	12.721			0.035	0.40	0.500	0.200	0.154	2.385	0.477	OK
	12+265	12+301	36	0.150	12.721	12.775			0.016	0.40	0.500	0.200	0.154	0.741	0.148	OK
46	11+930 ～	12+301	371	0.204	10.350	12.775		11+930 pipe culvert	0.164	0.50	0.500	0.250	0.167	0.913	0.228	OK
	12+301	12+350	49	0.467	12.775	12.546			0.022	0.40	0.500	0.200	0.154	1.309	0.262	OK
	12+350	12+381	31	1.048	12.546	12.221			0.035	0.40	0.500	0.200	0.154	1.960	0.392	OK
	12+381	12+525	144	1.272	12.221	10.389			0.099	0.40	0.500	0.200	0.154	2.159	0.432	OK
	12+525	12+550	25	0.916	10.389	10.160			0.110	0.40	0.500	0.200	0.154	1.832	0.366	OK
	12+550	12+575	25	0.372	10.160	10.067			0.121	0.40	0.500	0.200	0.154	1.167	0.233	OK
47	12+301 ～	12+575	274	0.988	12.775	10.067		12+575 inner wetland	0.121	0.40	0.500	0.200	0.154	1.903	0.381	OK

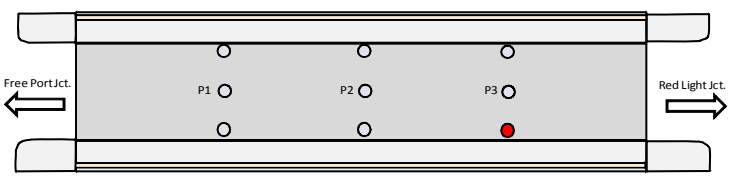
No.	Median Drain			Slope (%)	elevation		U-Ditch		discharge (m3/s)	Capacity						judge
	Station		Length (m)		start	end	Station	Outlet		depth (m)	width (m)	section area:A (m2)	Hydraulic radius:R (m)	velocity (m/s)	capacity (m3/s)	
	12+575	12+601	26	0.177	10.067	10.113			0.115	0.40	0.500	0.200	0.154	0.805	0.161	OK
	12+601	12+625	24	0.717	10.113	10.285			0.103	0.40	0.500	0.200	0.154	1.620	0.324	OK
	12+625	12+650	25	1.248	10.285	10.597			0.092	0.40	0.500	0.200	0.154	2.138	0.428	OK
	12+650	12+675	25	1.788	10.597	11.044			0.081	0.40	0.500	0.200	0.154	2.559	0.512	OK
	12+675	12+775	100	2.186	11.044	13.230			0.070	0.40	0.500	0.200	0.154	2.830	0.566	OK
	12+775	12+834	59	2.097	13.230	14.467			0.026	0.40	0.500	0.200	0.154	2.772	0.554	OK
48	12+575 ～	12+834	259	1.699	10.067	14.467		12+575 inner wetland	0.115	0.40	0.500	0.200	0.154	2.495	0.499	OK
	12+834	12+864	30	2.097	14.117	14.746	pipe		0.162	0.40	2.214	0.108	0.122	2.370	0.255	OK
	12+864	12+925	61	2.021	15.096	16.329			0.149	0.40	0.500	0.200	0.154	2.721	0.544	OK
	12+925	12+964	39	1.559	16.329	16.937			0.122	0.40	0.500	0.200	0.154	2.390	0.478	OK
	12+964	13+075	111	0.850	16.937	17.880			0.104	0.40	0.500	0.200	0.154	1.764	0.353	OK
	13+075	13+200	125	0.504	17.880	18.510			0.055	0.40	0.500	0.200	0.154	1.359	0.272	OK
49	12+834 ～	13+200	366	1.200	14.117	18.510		12+834 inner wetland	0.162	0.40	0.500	0.200	0.154	2.097	0.419	OK
										diameter (m)	θ (rad)	section area:A (m2)	Hydraulic radius:R (m)	velocity (m/s)	capacity (m3/s)	
				0.263			0+640	0+640 inner wetland	0.164	0.50	2.214	0.168	0.152	0.974	0.164	OK
				0.470			0+905	0+905 inner wetland	0.219	0.50	2.214	0.168	0.152	1.302	0.219	OK
				0.805			1+900	1+900 inner wetland	0.287	0.50	2.214	0.168	0.152	1.704	0.287	OK
				0.350			3+000	3+000 inner wetland	0.188	0.50	2.214	0.168	0.152	1.124	0.189	OK
				0.614			3+125	3+125 inner wetland	0.250	0.50	2.214	0.168	0.152	1.488	0.251	OK
				1.016			3+925	3+925 inner wetland	0.322	0.50	2.214	0.168	0.152	1.915	0.322	OK
				0.150			6+925	6+925 inner wetland	0.123	0.50	2.214	0.168	0.152	0.736	0.124	OK
				0.232			9+150	9+150 inner wetland	0.154	0.50	2.214	0.168	0.152	0.915	0.154	OK
				0.545			12+575	12+575 inner wetland	0.236	0.50	2.214	0.168	0.152	1.402	0.236	OK
				0.260			12+834	12+834 inner wetland	0.162	0.50	2.214	0.168	0.152	0.969	0.163	OK

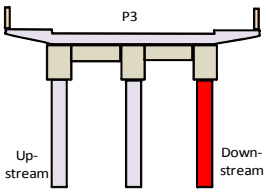
Appendix 1 Visual Inspection result

STOCKTON BRIDGE

Road	:	**Smalia Drive (appx. 1.5km from Free Port Jct.)**
Super Str.	:	**RC Girder (Rigid Type)**
		L= 15.5m+21.3m+21.3m+15.5m = 73.6m
Pier Type	:	**Columned Pile (D=760 X 3)**
Fundation	:	**(Supposed to be) Pile fundation**
Condition	:	**Passable (2-lane)**
Width	:	**W=11.0m**
		=0.9m + 9.2m + 0.9m
H.W.L.	:	**1.3m below from bottom of Girder at Pier**
Judgement	:	**Reconstruction**
		There is serious damage at Pier 3
		Needs urgent repair (See next page)
Others	:	**No Data for this Bridge (Refer next next page)**
		(Drawing, Soil Investigation, Design Calculation
		Constructed before in 1974.

Problem Column





Stanley Consultants INC.

December 6, 2011

Atty. Samuel Kofi Woods, II, Minister
Ministry of Public Works
Lynch Street South
Monrovia, Liberia

Attention: Edsel Smith

Dear Sirs

Subject: **Cost Estimate - Reprographics**
Records for Somalia Drive (Formerly Monrovia By-Pass)
MPW REF.#: SKW-M/MPW-R1./0300/'11

This letter is a followup to correspondence dated September 19, 2011 and September 28, 2011 requesting record drawings and documents relating to Somalia Drive (formerly Monrovia By-Pass) Improvements. We understand that the Government of Liberia (GOL) needs to supply the Japan International Cooperation Agency (JICA) with available information to enable them to implement the Somalia Drive Improvement Project.

After an exhaustive search by personnel in our archives group, we found about 500 pages of relevant documents relating to the design and construction supervision of highway improvements completed in the 1970s for Somalia Drive. These documents include the highway drawings shown in the attached indexes. We did not find any engineering reports, i.e., geotechnical investigations.

Please note that Stanley Consultants does not have record drawings of the bridges on this corridor According to Jim McLellan, Resident Engineer, Stanley Consultants, the bridges were already constructed when he arrived in Monrovia in 1974 to begin the supervision of construction for Somalia Drive. Jim was the Resident Engineer on our project from 1974-1978 and returned to Monrovia to build the Bomi Hills Road, 1984-1988. We checked with other Stanley members who worked in Liberia in the 1970s and 1980s It is our understanding that an Italian company, Vianini Construction Corp. (now Vianini Lavori SpA), constructed the bridges on Somalia Drive in the 1960s, before the highway was paved from Freeport to Red Light. Vianini and its related company, Porto Torre, constructed a number of works in Liberia in the 1960s - the Temple of Justice, the Lofa River Bridge, and Monrovia to Totota Highway. We hope this information is useful to you. http://www.vianinigroup.it/index_eng.php

Our estimate is $2,794 to retrieve, print, and scan the documents requested. This cost includes the 28 hours spent to date by our records personnel to locate and identify this information. We would also provide you with electronic copies on a CD-ROM. Instructions for payment are shown on the following page

Sincerely,
Stanley Consultants, Inc.

Tshaka E. Dennis, PE
Vice President

Attachments

Stanley Building · 225 Iowa Avenue · Muscatine, IA 52761-3764 · phone 563 264 6600 · fax 563 264 6658
www.stanleyconsultants.com

Stockton Bridge Photo

Photo 1

Photo 2

Photo 3

Photo 4

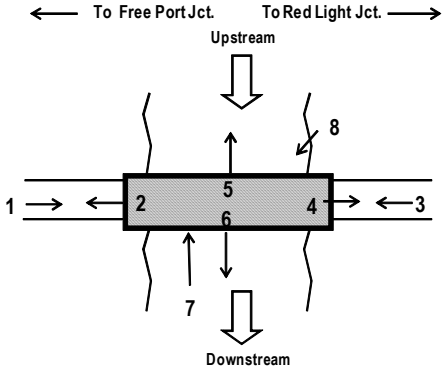


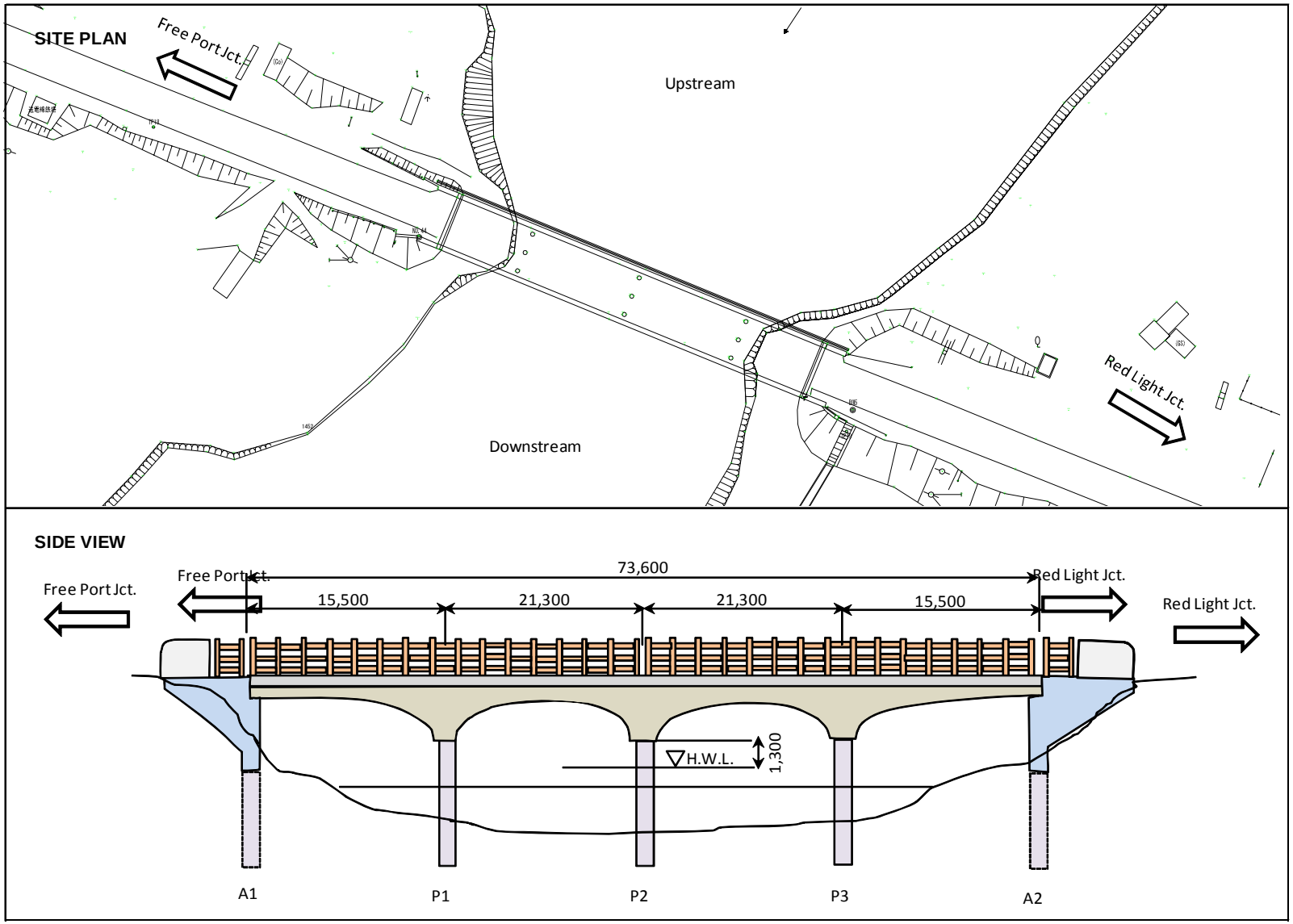
Photo 5

Photo 6

Photo 7

Photo 8

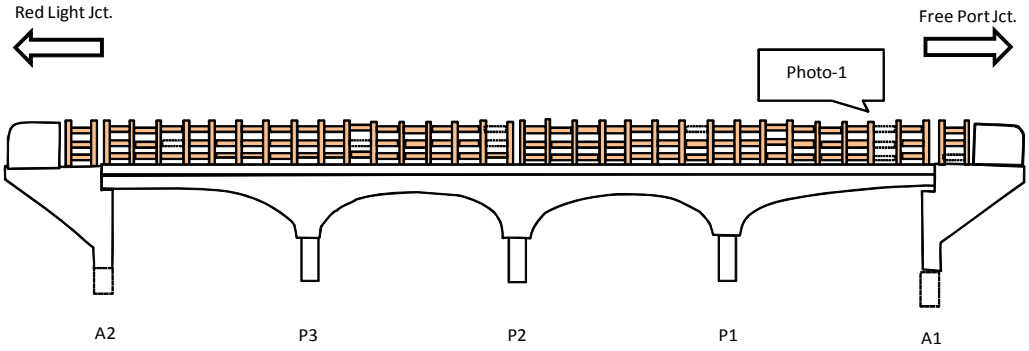
Bridge Name : Stockton Bridge



Stockton Bridge Inspection Sheet (1/6)

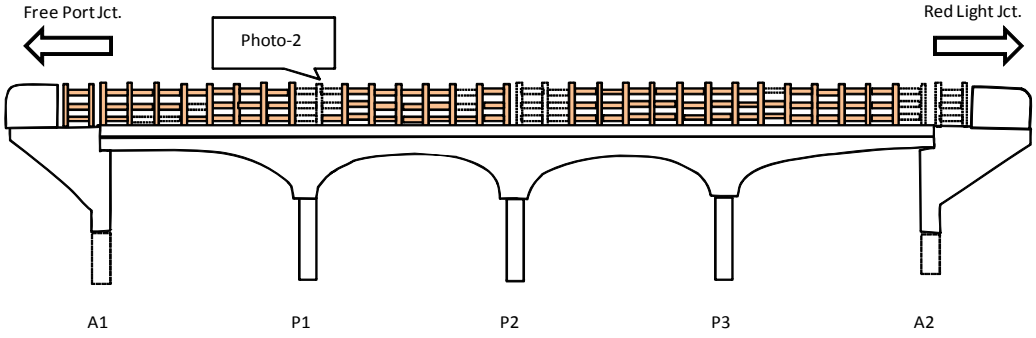
1. Railing

1-1 Upstream side



* 9 pipes are missing.

1-2 Downstream side



* 22 pipes and 6 posts are missing.

* Note: ▭ : missing pipe

▯ : missing post

* Status of Railing :
  31 hirizontal pipes and 6 poles are missing.

Photo-1 Missing Pipe (Upstream side)

Photo-2 Missing Pipe & Pole (Downstream side)

Stockton Bridge Inspection Sheet (2/6)

2. Slab

2-1 Surface

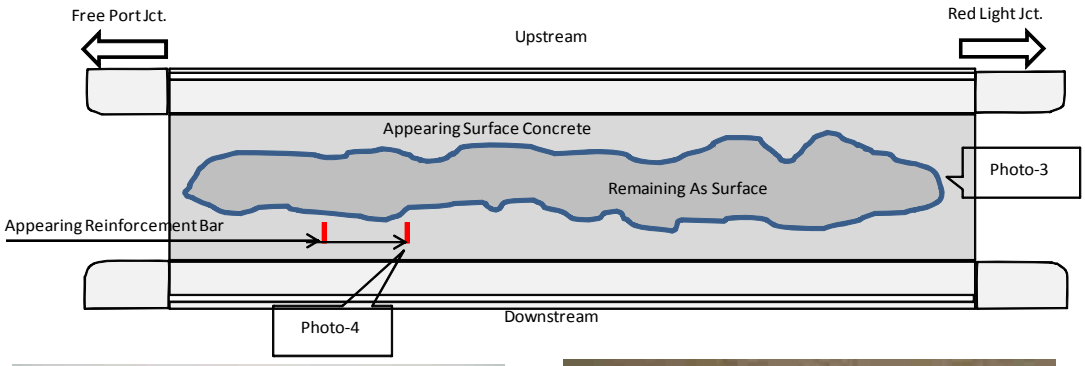


Photo-3 Condition of Surface

Photo-4 Appearing Reinforcement Bar

2-2 Bottom

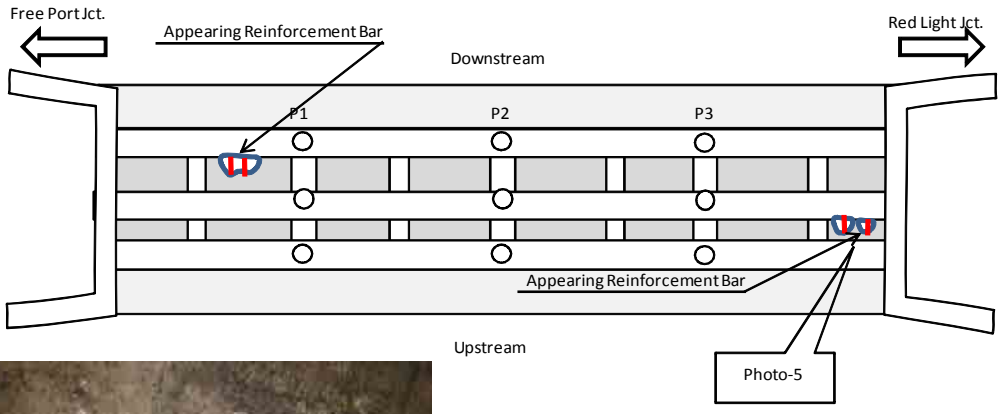


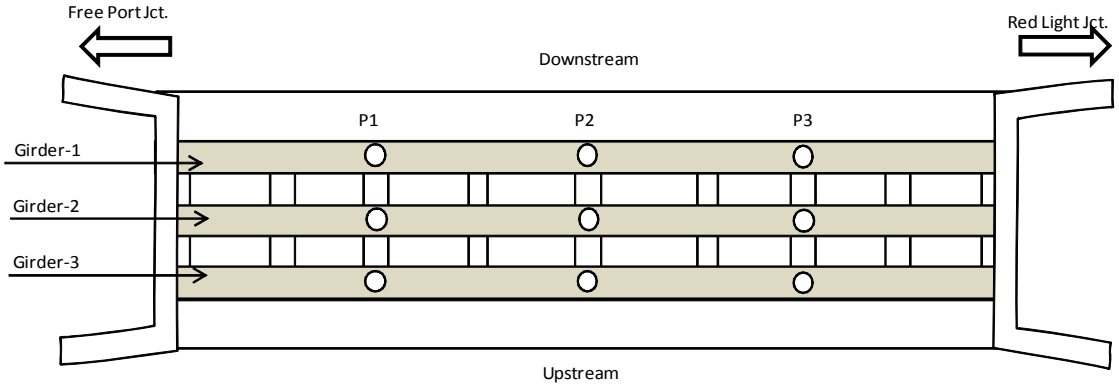
Photo-5 Appearing Reinforcement Bar

* Status of Slab :
Surface : Exfoliated As Surface.
Appearing Reinforcement bar.
Bottom : There ar 2 lacking concrete portions.

Stockton Bridge Inspection Sheet (3/6)

3. Main Girder

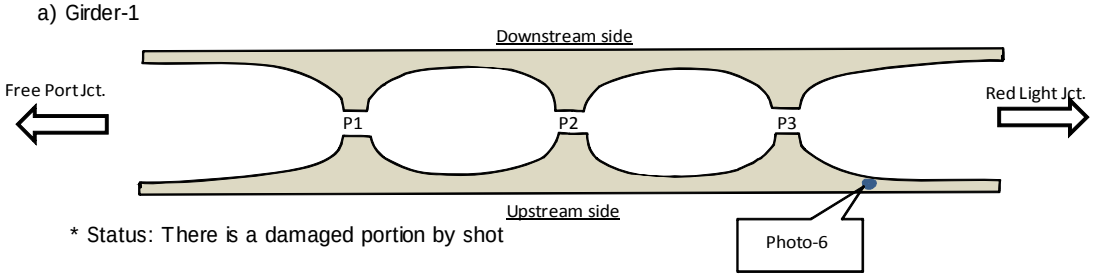
3.1. Bottom of Girder



* Status: No Problem

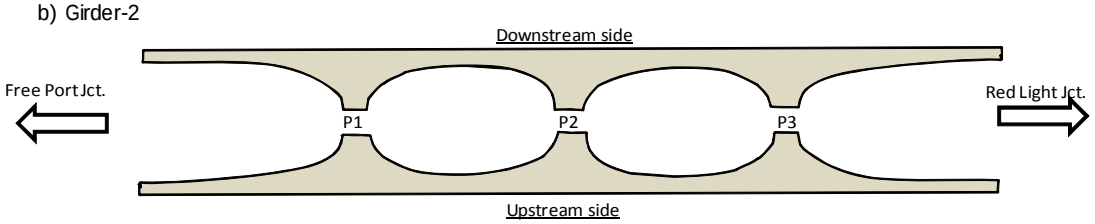
3.2. Side of Girder

a) Girder-1



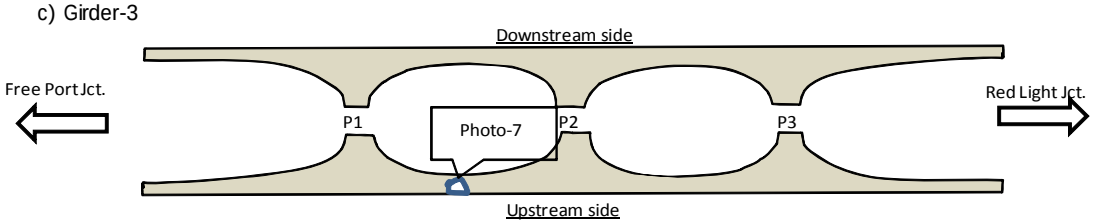
* Status: There is a damaged portion by shot

b) Girder-2



* Status: No Problem

c) Girder-3



* Status: There is a damaged portion by shot

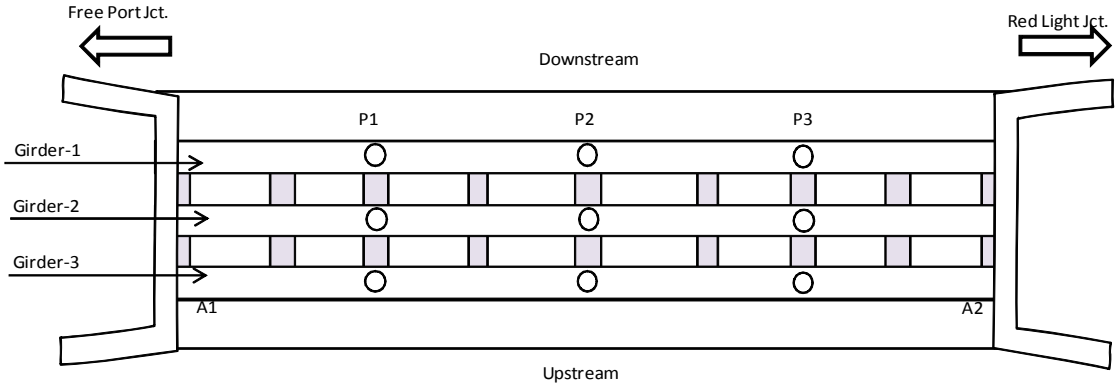
Photo-6 Damage by Shot

Photo-7 Damage by Shot

Stockton Bridge Inspection Sheet (4/6)

4. Horizontal Girder

4.1 Bottom of Girder



* Status: No Problem

4.2. Side of Girder

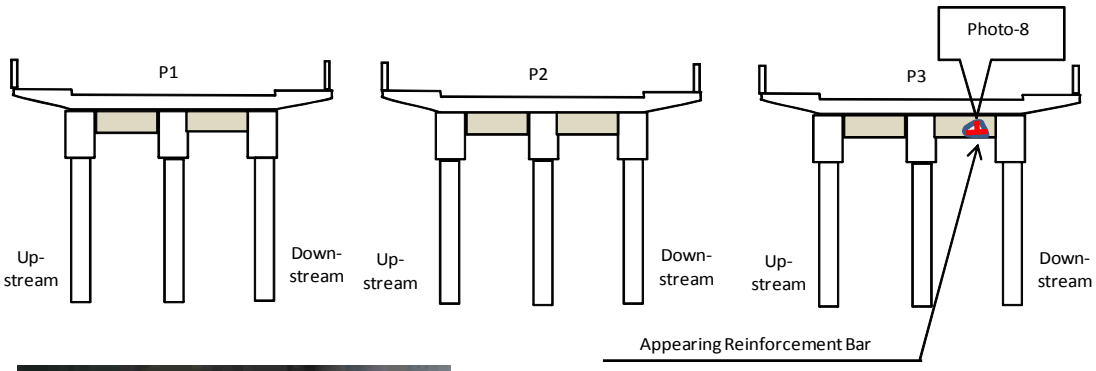
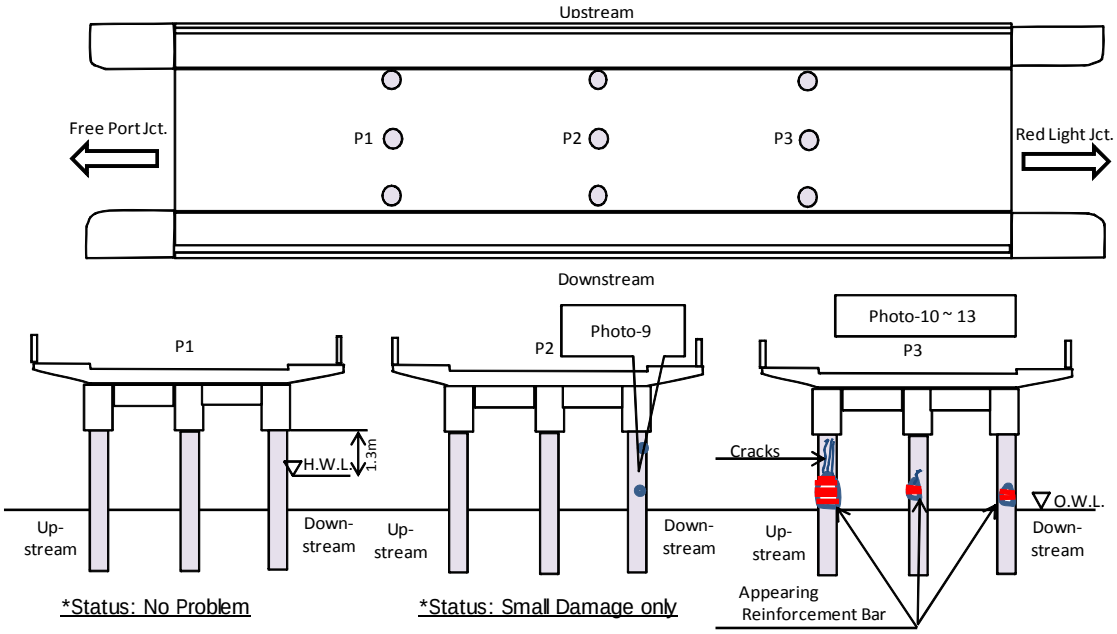


Photo-8 Appearing Reinforcement Bar

Status: There is a lacking concrete portion at P-3.

Stockton Bridge Inspection Sheet (5/6) ***Status: Serious Problem at Pier 3!!**

5. Pier



*Status: No Problem

*Status: Small Damage only

Photo-9 Damage by Shot (P-2)

Photo-10 Damage of P-3, Upstream side

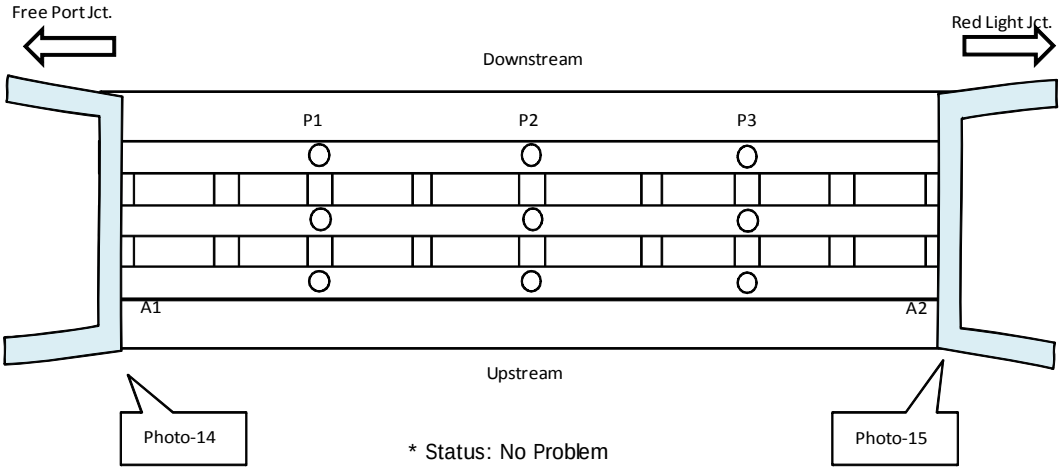
Photo-11 Damage of P-3, Center

Photo-12 P-3, Downstream side (Upper)

Photo-13 P-3, Downstream side (Lower)

Stockton Bridge Inspection Sheet (6/6)

6. Abutment & Bearing



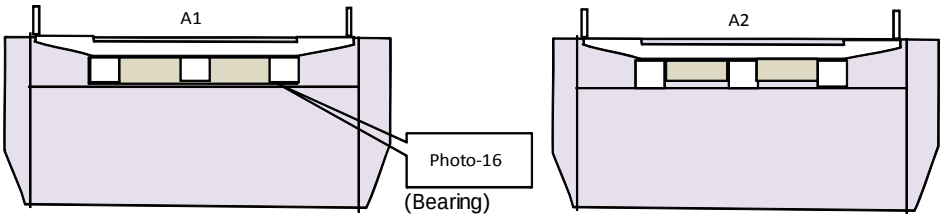


Photo-14 Abutment 1 (Free Port Jct. side)

Photo-15 Abutment 1 (Free Port Jct. side)

Photo-16 Bearing

DOUBLE BRIDGE

Road	:	**Smalia Drive (appx. 8.3km from Free Port Jct.)**
Super Str.	:	**RC Box Girder**
		L= 25.0m+25.0m = 50.0m
Pier Type	:	**Wall**
Fundation	:	**(Supposed to be) Direct fundation**
Condition	:	**Passable (2-lane)**
Width	:	**W=11.0m**
		=1.1m + 7.3m + 0.7m
H.W.L.	:	**1.5m below from bottom of Girder**
Judgement	:	**Keep Existing with repairment**
		There are small damages to be repaired
Others	:	**No Data for this Bridge**
		(Drawing, Soil Investigation, Design Calculation)
		Constructed before in 1974.

Double Bridge Photo

Photo 1

Photo 2

Photo 3

Photo 4

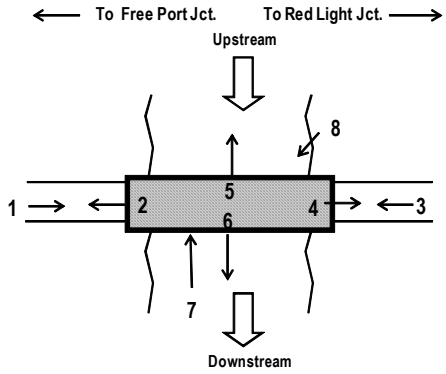


Photo 5

Photo 6

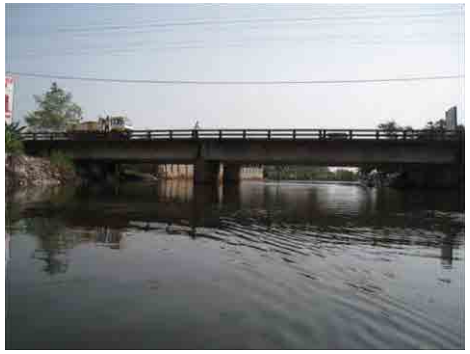
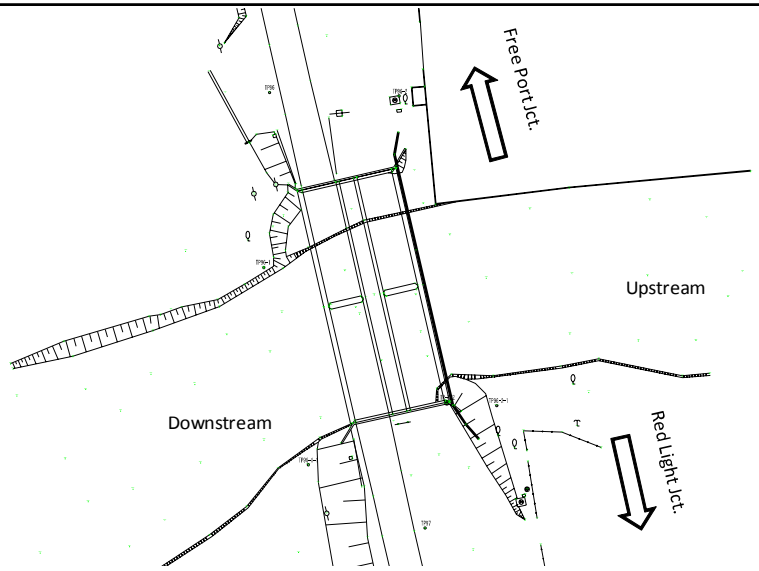


Photo 7

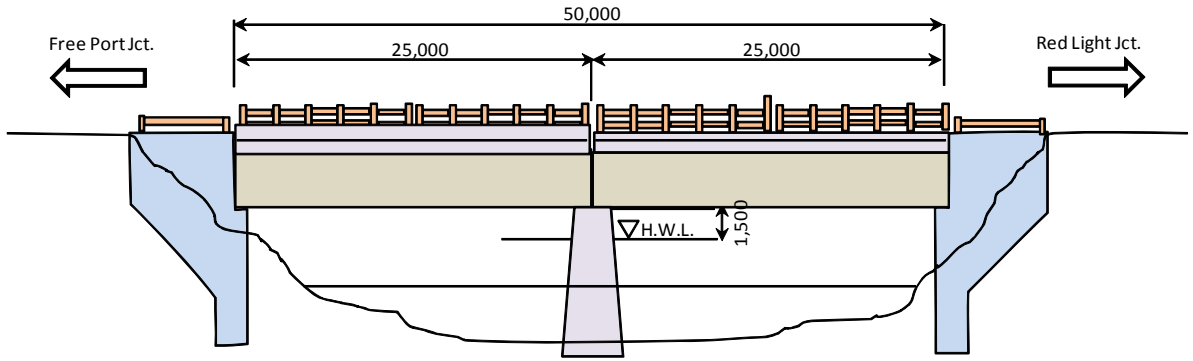
Photo 8

Bridge Name : Double Bridge

SITE PLAN

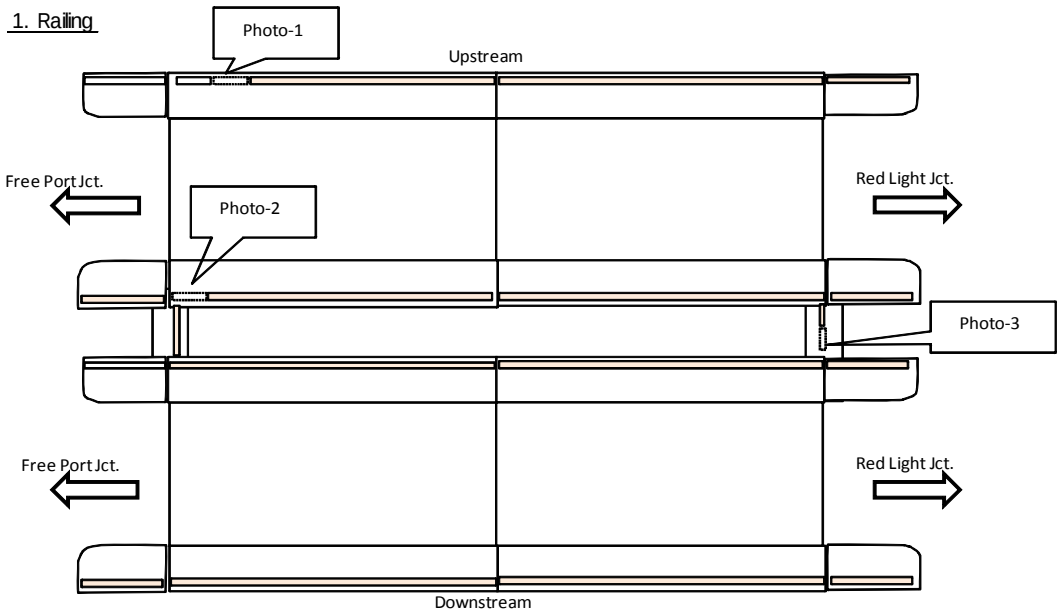


SIDE VIEW



Double Bridge Inspection Sheet (1/6)

1. Railing



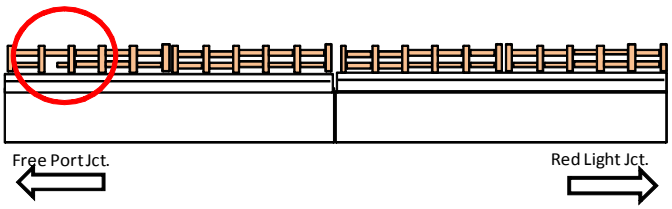


Photo-1 Broken Railing

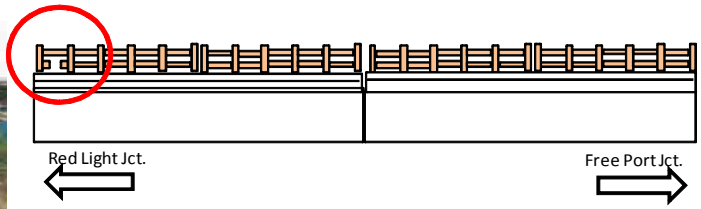


Photo-2 Broken Railing

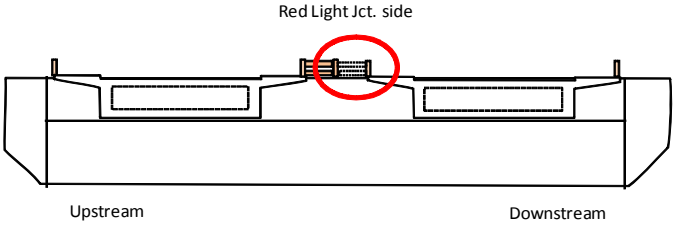


Photo-2 Broken Railing

*Status of Railing: 4 horizontal beam are missing at 3 portions.

Double Bridge Inspection Sheet (2/6)

2. Slab (Surface of RC Box Girder)

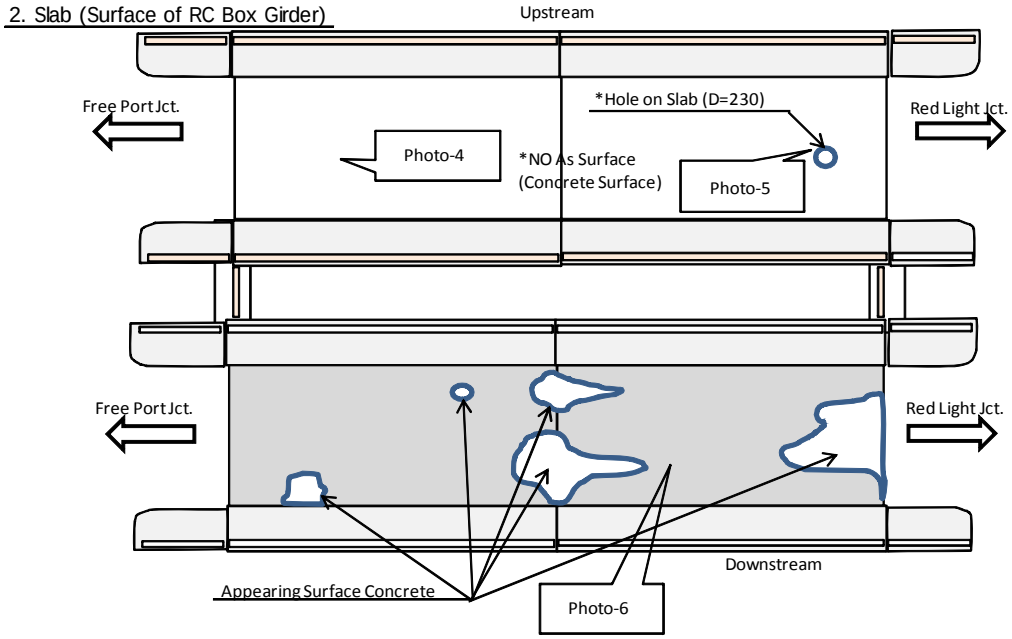


Photo-4 Hole on Slab (D=230mm)

Photo-5 Condition of Surface (Upstream side)

Photo-6 Condition of Surface (Downstream side)

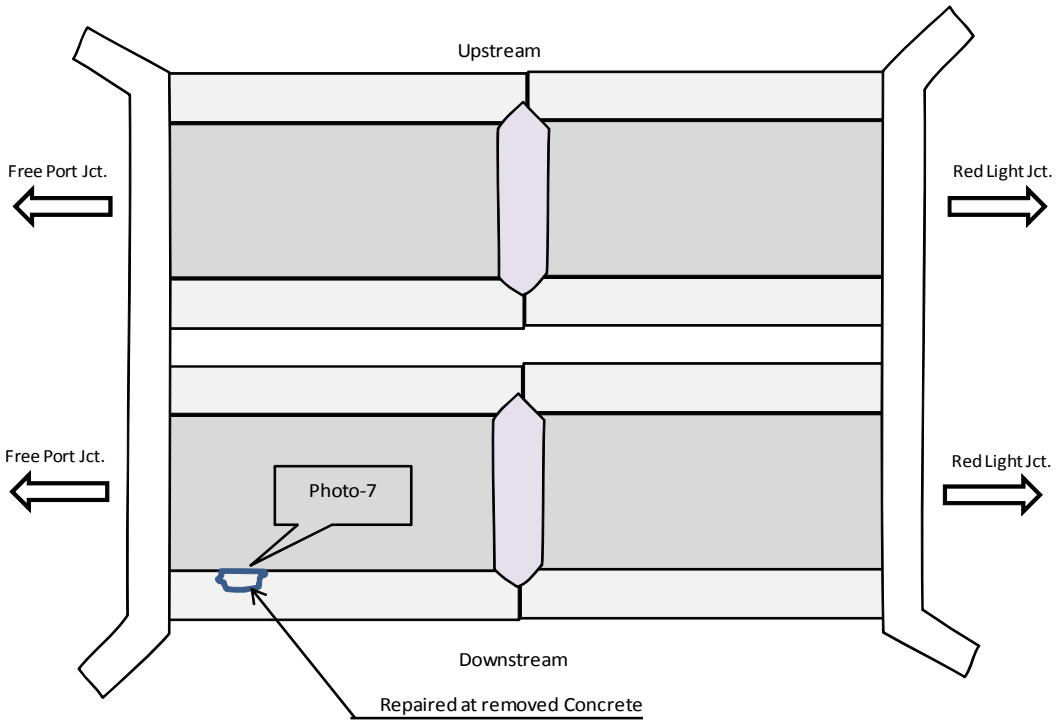
*Status of Slab:

No As Surface with 1 hole (D=230mm)
at Upstream side Bridge

Exfoliated As Surface at Downstream side Bridge

Double Bridge Inspection Sheet (3/6)

3. Slab (Bottom of RC Box Girder)



*Status of Slab: No Problem

Photo-7 Repaired Portion

Double Bridge Inspection Sheet (4/6)

4. Wall (Side Wall of RC Box Girder)

4. 1. North Side Bridge (Planned Widening Side)

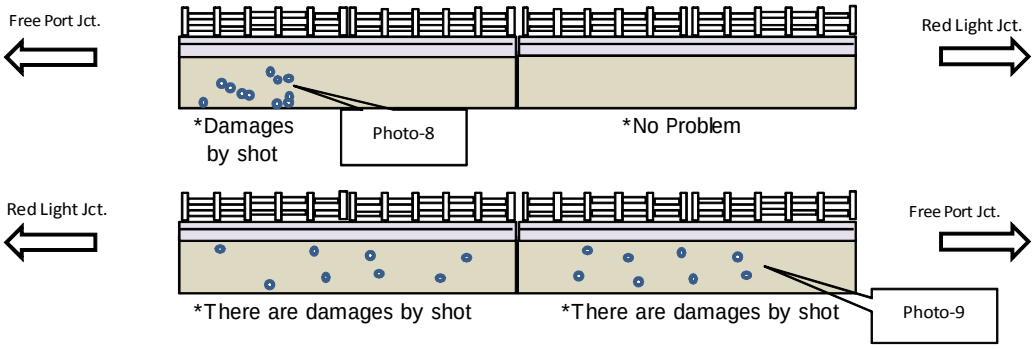
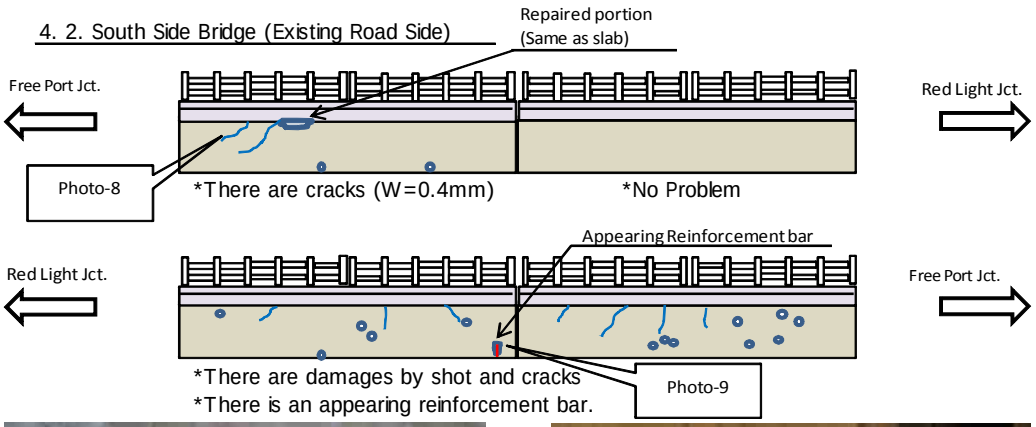


Photo-8 Damages by shot

Photo-9 Damages by shot

4. 2. South Side Bridge (Existing Road Side)



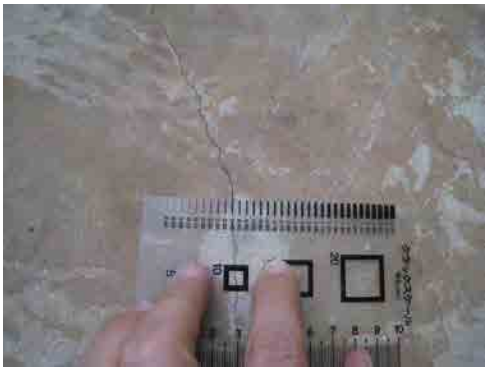
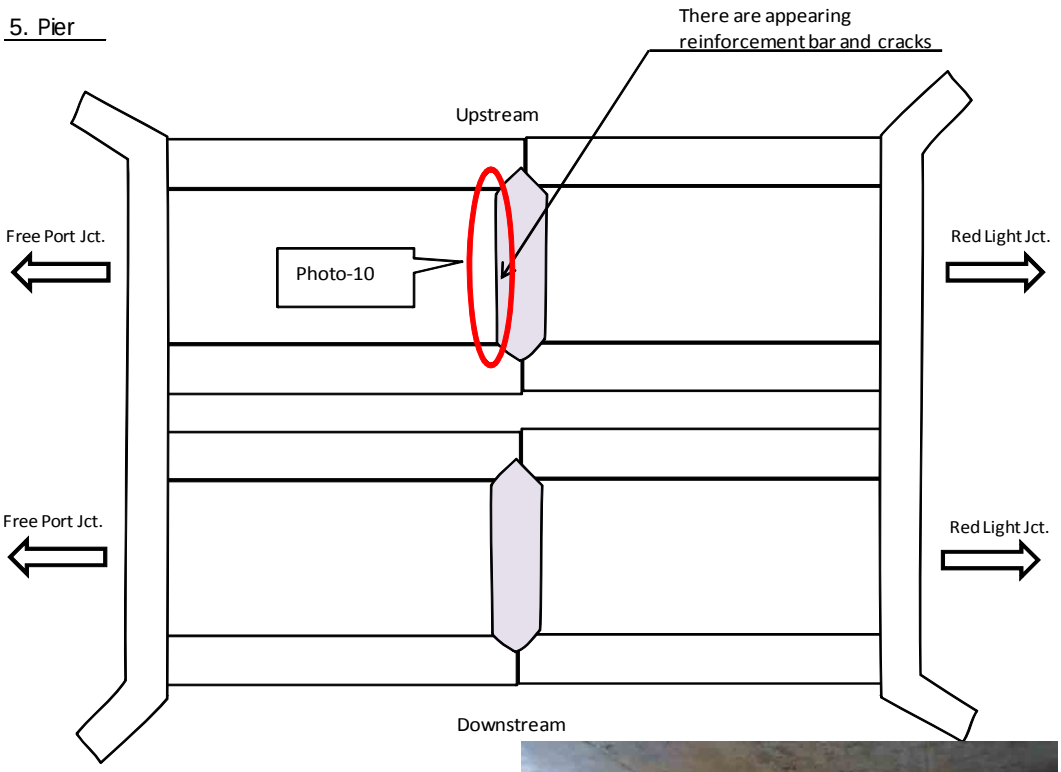


Photo-8 Crack Width (W=0.4mm)

Photo-9 Appering Reinforcement bar

Double Bridge Inspection Sheet (5/6)

5. Pier



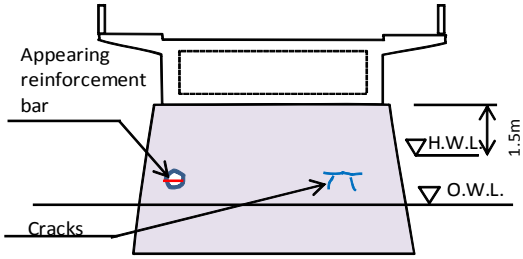


Photo-10 Status of Abutment (North Br., Free port sid

*Status of Piear:

There is an appearing reinforcement bar portion and some cracks at Free port side of North Bridge

Double Bridge Inspection Sheet (6/6)

6. Abutment and bearing

6.1. Abutment

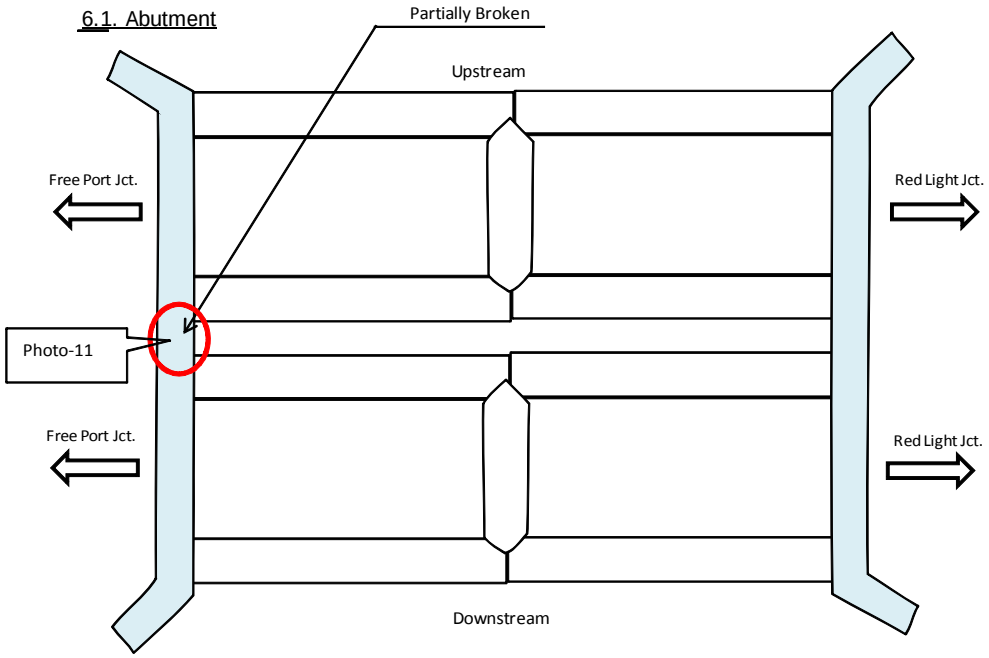
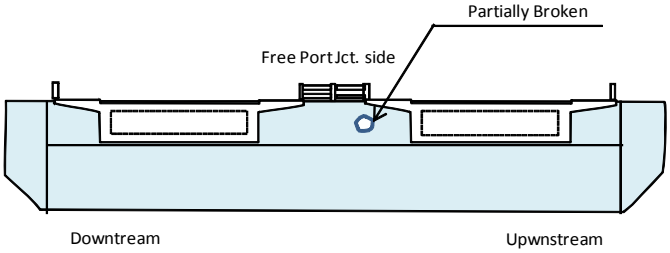


Photo-11 Broken Abutment (Free port side)



*Status of Slab:

Partially Broken at Free Port side between bridges

6.2. Bearing

Photo-12 Bearing Pad

*Status of Bearing:

All Bearing Pads are so old.

Appendix2 Nondestructive test result for Double bridge

A. Neutralization Test

<<Outline of the test>>

Concrete is originally alkaline property then becomes neutral property in a long term. Neutralization of concrete occurs from the surface to inside. The problem by the neutralization is re-bars inside rust in this condition. And the week tension strength occures crack and finally the concrete is broken.

Photo 1- Phenolphthalein solution

Photo 2 Test result at slab

The neutralization haven't been occurred because color of edge is red.

<<Test method>>

1) Chipping, cleaning at the target portion for the test.

2 Sprinkling Phenolphthalein solution (1%) at the exposed surface.

(Red color: alkaline property, no color; neutral property)

3) Measuring the depth from surface to neutral area.

<<Test result>>

Table 1- Neutralization test result

Measured Place	Neutralization Depth (cm)	Estimated age (Year)*)
Slab	0.0	0.00
Abutment	0.2	0.29
Girder	0.3	0.65
Pier	0.2	0.29

*)Eatimated age is calculated by following formula

In case water-cement ratio is more than 60 %

$$t = \frac{7.2}{R^2(4.6w - 1.76)^2} x^2$$

w: water-cement ratio

x: Neutralization depth (cm)

t: Estimated age (year)

R: neutralization rate (=1, Portland cement)

<<Consideration>>

All estimated year became less than 1 year, therefore the newtralization is not occurred at the Double bridge. High quality concrete seems to be used at the Double bridge because of this test result.

B. X-ray test

<< Outline of the test >>

Not only the location and alignment of the re-cars, but also the void in the concrete is of re-bars, but also the void are inspected by X-ray. The purpose of this test is to confirm shoddy construction at the blind area.

Photo 3- X-ray measuring device

Photo-4measurement situation

<<Test Result>>

Table 2- X-ray Test result (At Northern bridge)

Measured place			Depth of re-bar (cm)	Pith of main re-bar (cm)*1)	Void
Box Girder	Top	Cross-section	6.0	15.5	None
		Axial direction	7.5	45.0	None
	Side	Cross-section	4.0	20.0	None
		Axial direction	7.0	36.0	None
	Bottom	Cross-section	4.5	19.5	None
		Axial direction	5.0	42.0	None
Abut-ment	Axial direction		4.5	30.0	None
Pier	Axial direction		4.5	50.0	None

Table 3- X-ray Test result(At Southern bridge)

Measured place			Depth of re-bar (cm)	Pith of main re-bar (cm)*1)	Void
Box Girder	Top	Cross-section	12.5※2)	15.0	None
		Axial direction	13.0※2)	41.0	None
	Side	Cross-section	4.0	17.0	None
		Axial direction	7.0	37.0	None
	Bottom	Cross-section	3.5	20.0	None
		Axial direction	4.0	41.0	None
Abut-ment	Axial direction			29.5	無し
Pier	Axial direction			50.0	無し

*1) Result of Pitch of re-bar is average of testing at several portions.

*2) Northern bridge has no pavement and southern bridge has As pavement, therefore the difference of the depth of re-bar comes from the thickness of As pavement.

<<Consideration>>

Applicable alignment of re-bars and no void in the concrete were confirmed by the X-ray test.

It is difficult to judge that the alignment is adequate or not because there are no drawing or no design calculation documents, and this test cannot confirm the diameter of the re-bar. But the alignments of re-bars between Northern bridge (not yet open) and southern bridge (already open) has almost no difference, therefore it seems no problem to open the northern bridge.

C. Schmidt hammer test

<< Outline of the test >>

Schmidt hammer can measure and estimate the strength of existing concrete by the resistance force when the head of metal is pushed to the concrete structure.

Photo 5- Schmidt hammer

Photo-6 Measuring situation

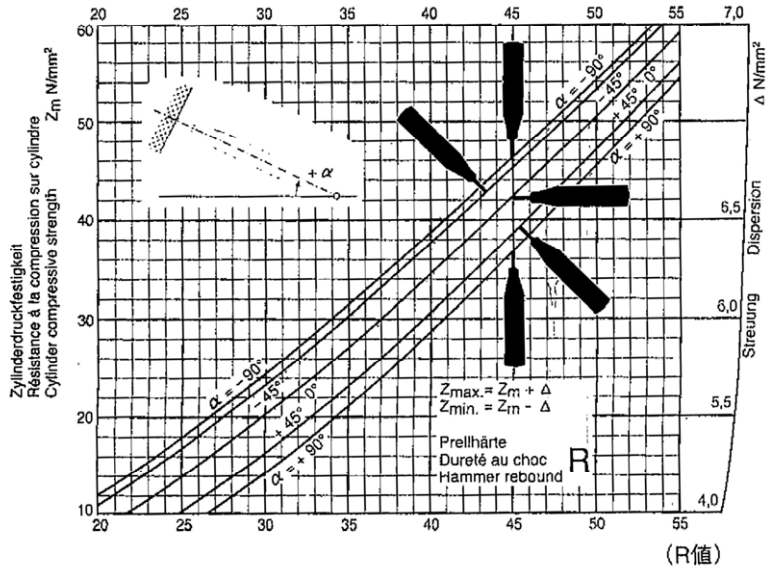
<<Test result>>

Table 4- Schmidt hammer test result

Measured Place	Measured DIrection	Measured value by Schmidt Hammer (Average)	Estimated strength of concrete*) (N/mm^2)
Girder (Top)	Top to bottom	46.2	40.0
Girder (Side)	Side to side	50.0	50.5
Girder (Bottom)	Bottom to top	49.3	44.5
Abut-ment	Side to side	49.2	50.0
Pier	※Impossible to measure by standing on the boat		

*) The strength of the concrete is calculated by following formula.

Conversion curve between Resistance force(R value) and strength of concrete



<<Consideration>>

Design strength of the concrete is commonly 21 ~ 24N/mm2. Therefore this result shows that the strength of existing Double bridge has twice of design strength. It is confirmed that there is no deterioration by poor quality control or circumstance for a long period.

<<Attachent>>

1) Detail of X-ray test result

Table 5- Superstructure at northern bridge (1/2)

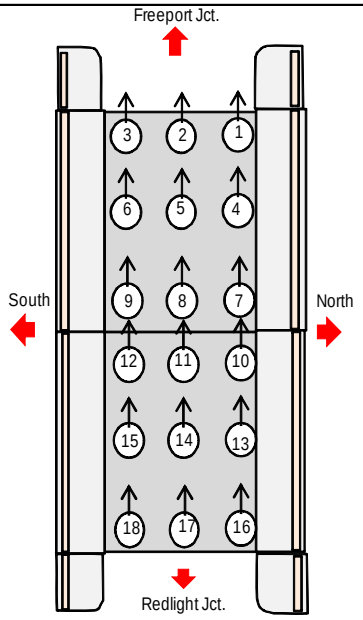
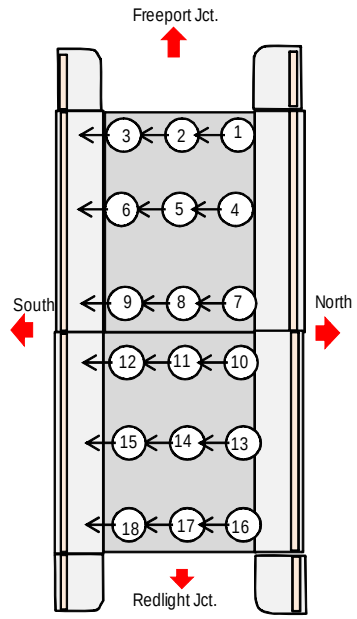
Location	Measured Direction	NO.	Main-Re-bar		Air Void	Drawing
			Covering Depth (cm)	Spearing pitch (cm)		
North Bridge (Upstream side) Surface	Section	1	6.0	14.0	None	
		2	6.0	15.5	None	
		3	6.0	16.0	None	
		4	5.5	15.0	None	
		5	6.0	15.5	None	
		6	6.0	14.5	None	
		7	6.0	15.0	None	
		8	6.5	17.0	None	
		9	6.0	15.0	None	
		10	6.0	16.0	None	
		11	6.0	16.5	None	
		12	6.0	16.0	None	
		13	6.0	16.0	None	
		14	5.5	14.5	None	
		15	6.5	18.0	None	
		16	6.0	14.5	None	
		17	6.0	15.5	None	
		18	6.0	15.5	None	
		Ave	**6.0**	**15.6**	**-**	
	Distribution	1	8.0	47.5	None	
		2	7.5	46.5	None	
		3	8.0	47.5	None	
		4	7.5	44.0	None	
		5	7.0	46.0	None	
		6	7.5	44.5	None	
		7	8.0	45.0	None	
		8	6.5	46.5	None	
		9	7.0	43.5	None	
		10	7.0	45.5	None	
		11	7.5	45.0	None	
		12	8.0	44.5	None	
		13	7.5	45.0	None	
		14	7.0	44.5	None	
		15	6.5	44.5	None	
		16	7.5	42.5	None	
		17	7.5	45.5	None	
		18	8.0	43.5	None	
		Ave	**7.4**	**45.1**	**-**	

Table 6- Superstructure at northern bridge (2/2)

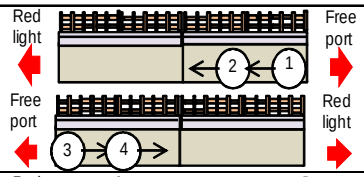
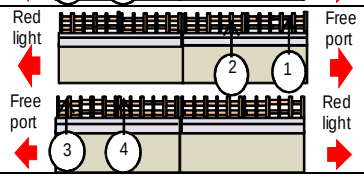
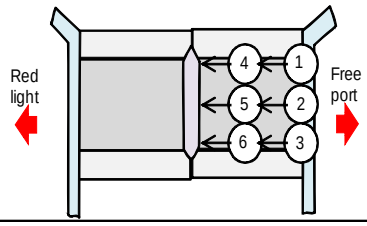
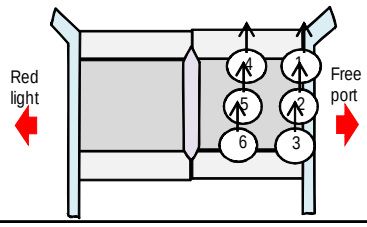
Location	Measured Direction	NO.	Main-Re-bar		Air Void	Drawing
			Covering Depth (cm)	Spearing pitch (cm)		
North Bridge (Upstream side) Side	Section	1	4.0	21.5	None	
		2	4.5	21.0	None	
		3	4.0	18.5	None	
		4	4.0	18.0	None	
		Ave	**4.1**	**19.8**	**-**	
	Distribution	1	7.5	36.0	None	
		2	7.0	36.0	None	
		3	7.0	37.0	None	
		4	7.0	35.5	None	
		Ave	**7.1**	**36.1**	**-**	
North Bridge (Upstream side) Bottom	Section	1	4.5	18.5	None	
		2	4.5	19.0	None	
		3	4.5	19.0	None	
		4	4.0	20.5	None	
		5	4.5	20.0	None	
		6	4.5	19.5	None	
		Ave	**4.4**	**19.4**	**-**	
	Distribution	1	5.5	43.5	None	
		2	5.0	44.5	None	
		3	5.0	45.0	None	
		4	5.0	38.0	None	
		5	4.5	39.0	None	
		6	5.0	40.5	None	
		Ave	**5.0**	**41.8**	**-**	

Table 7- Superstructure at southern bridge (1/2)

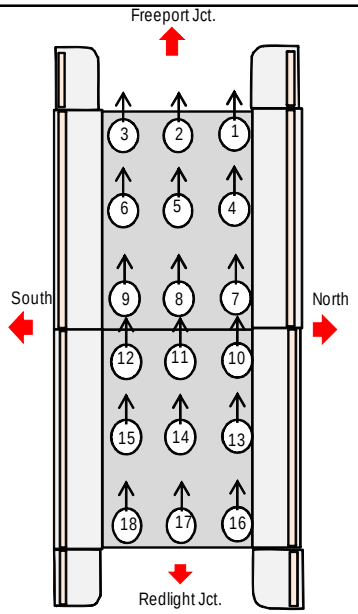
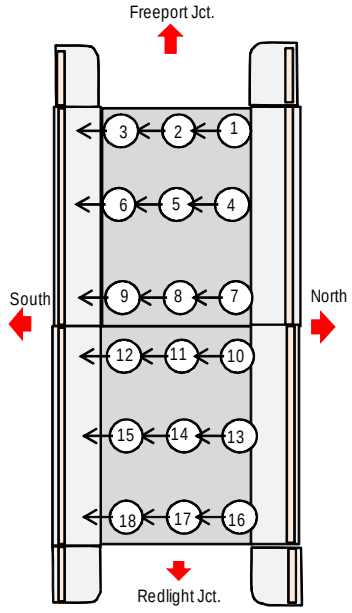
Location	Measured Direction	NO.	Main-Re-bar		Air Void	Drawing
			Covering Depth (cm)	Spearing pitch (cm)		
South Bridge (Downstream side) Surface	Section	1	12.0	15.5	None	
		2	12.0	15.5	None	
		3	12.5	15.5	None	
		4	12.5	15.0	None	
		5	13.0	15.5	None	
		6	13.0	15.0	None	
		7	12.5	15.0	None	
		8	12.5	16.0	None	
		9	13.0	15.0	None	
		10	13.5	15.0	None	
		11	13.5	15.5	None	
		12	13.0	15.5	None	
		13	12.5	15.5	None	
		14	12.5	14.5	None	
		15	12.0	15.0	None	
		16	12.0	14.0	None	
		17	12.0	15.0	None	
		18	12.5	15.0	None	
		Ave	**12.6**	**15.2**	**-**	
	Distribution	1	12.5	41.5	None	
		2	12.5	40.5	None	
		3	12.0	41.5	None	
		4	12.5	41.0	None	
		5	13.0	40.5	None	
		6	12.5	41.5	None	
		7	13.0	42.5	None	
		8	13.0	41.0	None	
		9	13.5	39.5	None	
		10	13.5	40.5	None	
		11	12.5	40.5	None	
		12	13.0	40.5	None	
		13	13.0	41.5	None	
		14	13.0	44.5	None	
		15	12.5	42.0	None	
		16	13.5	41.0	None	
		17	13.0	39.5	None	
		18	13.5	42.0	None	
		Ave	**12.9**	**41.2**	**-**	

Table 8- Superstructure at southern bridge (2/2)

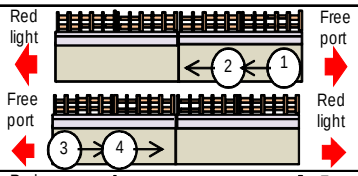
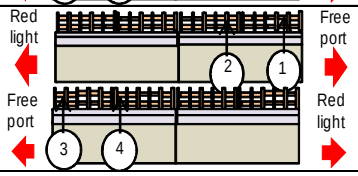
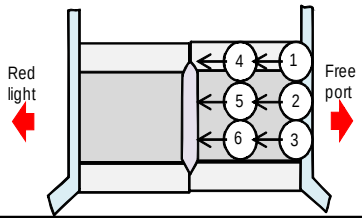
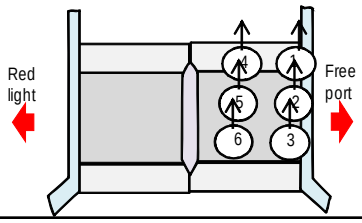
Location	Measured Direction	NO.	Main-Re-bar		Air Void	Drawing
			Covering Depth (cm)	Spearing pitch (cm)		
South Bridge (Downstream side) Side	Section	1	4.0	17.5	None	
		2	4.5	17.5	None	
		3	4.0	16.5	None	
		4	4.0	17.0	None	
		Ave	**4.1**	**17.1**	**-**	
	Distribution	1	7.5	37.0	None	
		2	7.0	37.0	None	
		3	7.0	37.0	None	
		4	7.0	36.0	None	
		Ave	**7.1**	**36.8**	**-**	
South Bridge (Downstream side) Bottom	Section	1	4.0	21.0	None	
		2	3.0	20.5	None	
		3	3.5	20.0	None	
		4	3.5	19.5	None	
		5	3.5	20.0	None	
		6	3.5	19.5	None	
		Ave	**3.5**	**20.1**	**-**	
	Distribution	1	5.0	41.0	None	
		2	4.5	42.5	None	
		3	5.0	41.0	None	
		4	3.5	39.5	None	
		5	3.0	39.5	None	
		6	3.5	41.0	None	
		Ave	**4.1**	**40.8**	**-**	

Table 9- Abutment at northern bridge

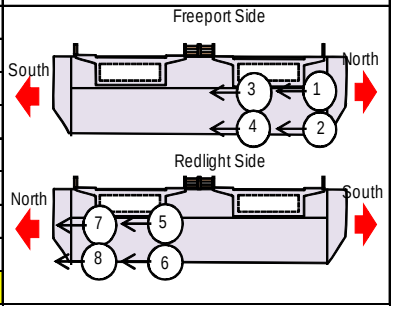
Location	Measured Direction	NO.	Main-Re-bar		Air Void	Drawing
			Covering Depth (cm)	Spearing pitch (cm)		
North Brige (Upstream side) Abutment	Section	1	4.0	29.5	None	
		2	4.5	30.5	None	
		3	4.0	31.0	None	
		4	5.0	29.5	None	
		5	4.5	29.5	None	
		6	4.0	29.5	None	
		7	4.5	29.0	None	
		8	4.5	29.5	None	
		Ave	**4.4**	**29.8**	**-**	

Table 10- Abutment at southern bridge

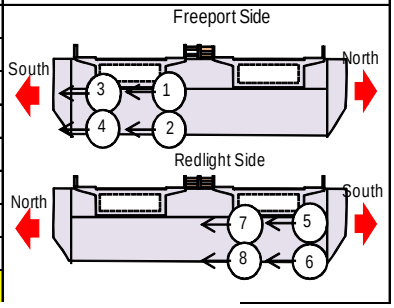
Location	Measured Direction	NO.	Main-Re-bar		Air Void	Drawing
			Covering Depth (cm)	Spearing pitch (cm)		
South Brige (Downstream side) Abutment	Section	1	3.5	29.5	None	
		2	4.5	28.5	None	
		3	4.0	30.0	None	
		4	4.5	29.5	None	
		5	4.5	29.5	None	
		6	4.0	29.5	None	
		7	4.0	29.0	None	
		8	4.0	30.5	None	
		Ave	**4.1**	**29.5**	**-**	

Table 11- Pier at northern bridge

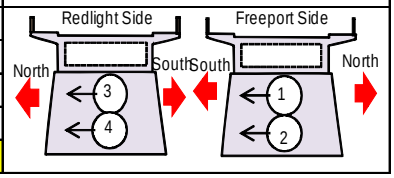
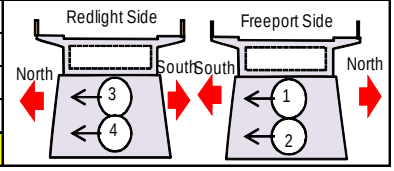
Location	Measured Direction	NO.	Main-Re-bar		Air Void	Drawing
			Covering Depth (cm)	Spearing pitch (cm)		
North Brige (Upstream side) Pier	Section	1	4.5	53.0	None	
		2	4.0	49.0	None	
		3	4.0	45.0	None	
		4	5.0	52.0	None	
		Ave	**4.4**	**49.8**	**-**	

Table 12- Pier at southern bridge

Location	Measured Direction	NO.	Main-Re-bar		Air Void	Drawing
			Covering Depth (cm)	Spearing pitch (cm)		
South Brige (Downstream side) Pier	Section	1	5.0	51.5	None	
		2	4.5	49.0	None	
		3	4.5	46.0	None	
		4	4.0	53.5	None	
		Ave	**4.5**	**50.0**	**-**	

2) Detail of Schmidt hammer test result

Method of measurement by Schmidt hammer test is as following;

1) Measure 20 times per 1 portion

2) Calculate average these data

3) Exclude the value more than 20% or less than 20% from average as abnormal value

4) Calculate average remaining values (final test result)

Table 13- Schmidt hammer test result

		Girder			Abutment
		Surface	Side	Bottom	
Measured Value	1	53	56	49	51
	2	51	52	56	38
	3	33	58	63	49
	4	39	44	40	48
	5	44	44	44	61
	6	42	63	44	44
	7	35	46	51	50
	8	53	49	35	47
	9	45	51	53	62
	10	47	55	52	44
	11	62	53	48	48
	12	43	39	45	48
	13	45	49	60	53
	14	59	44	47	49
	15	47	50	49	53
	16	52	55	56	47
	17	40	47	57	51
	18	43	41	48	53
	19	44	51	50	39
	20	51	55	39	52
	Ave.	46.4	50.1	49.3	49.4
Upper range (Ave.+20%)		55.7	60.1	59.2	59.2
Lower range (Ave.-20%)		37.1	40.1	39.4	39.5
Ave. of White cell		**46.2**	**50.0**	**49.3**	**49.2**

* Out of range: it should be excluded as outlier