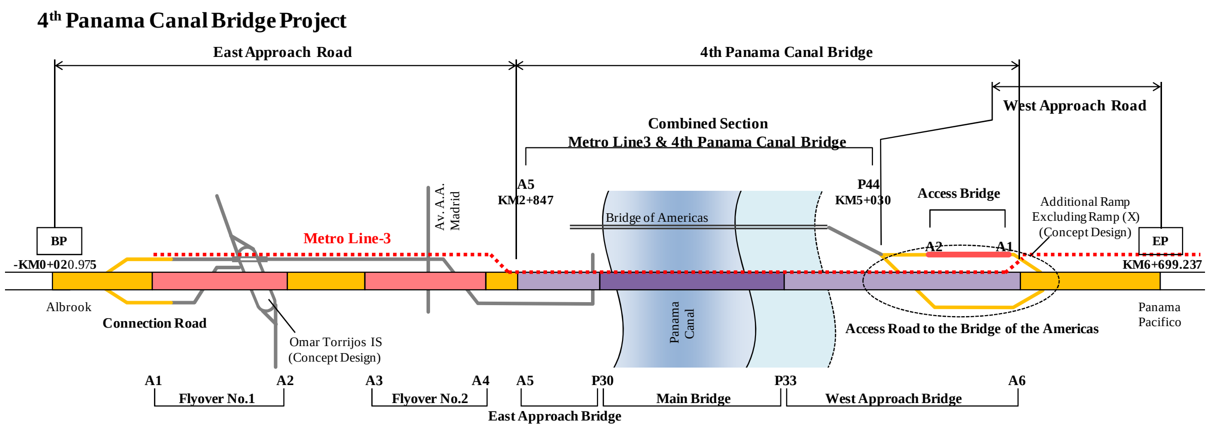
付属資料 7: 概算工事費積算内訳表
(第 4 パナマ運河橋)

7　概算工事費積算内訳表（第 4 パナマ運河橋）

概算工事費積算内訳表を添付する。
なお、資料は暫定的なものであり、今後の詳細検討において更新される。

7-1　主橋架設時に航路を利用できる場合

主橋架設時に航路を利用できる場合の概算工事費積算内訳表を次頁以降に記す。
なお、積算条件は下記に示すとおりである。



Cost Estimate Condition for Bridge Construction

Superstructure	Flyover No.1-1 PC I, L=270m							Flyover No.1-2 Metal Box, L=250m					
Substructure	A1	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	A2

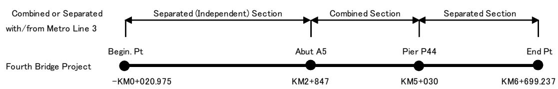
Superstructure	Flyover No.2-1 PC I, L=260m							Flyover No.2-2 Metal Box, L=480m						
Substructure	A3	P12	P13	P14	P15	P16	P17	P18	P19	P20	P21	P22	P23	A4

Superstructure	EAB No.1 Metal Box, L=533m							Main Bridge Arch, L=840m				WAB No.1 Metal Box, L=470m					WAB No.2 Metal Box, L=340m						WAB No.3 PC I, L=360m								
Substructure	A5	P24	P25	P26	P27	P28	P29	P30	P31	P32	P33	P34	P35	P36	P37	P38	P39	P40	P41	P42	P43	P44	P45	P46	P47	P48	P49	P50	P51	P52	A6

Superstructure	Access Bridge No.1 PC I, L=360m									Access Bridge No.2 PC I, L=400m										
Substructure	A1	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14	P15	P16	P17	P18	A2

EAB : East Approach Bridge
WAB : West Approach Bridge

Demarcation between Metro Line3 and 4th Panama Canal Bridge



Civil Works	Independent	Fourth Panama Canal Crossing Bridge Project	Independent
Civil Works（Rail, cats-walks）	Metro Line 3 Project		
Utilities	Independent		
Land Acquisition/Compensation	Fourth Panama Canal Crossing Bridge Project		
Public Utilities Underground Utilities	Fourth Panama Canal Crossing Bridge Project		

Cost Estimation for 4th Panama Canal Bridge Construction (Arch-rib Lifting Method)

Item No.	Description		Unit	Qty	Unit Rate (USD)	L/C (USD)	F/C ('1000 JPY)	Total ('000 JPY)
1	**Temporary Works (Preliminary Design)**					**93,355,850**	**2,383,144**	**11,690,722**
	Temporary yard	Rental, Preparation & Maintenance for Stock Yard. 270,000m2, including Transportation Material and Equipment from West Yard to East	Ls	1	92,268,000	73,814,400	1,839,824	9,199,120
	Temporary road	Access Road for Work	Ls	1	21,982,000	17,585,600	438,321	2,191,605
	Temporary Jetty	East and West Side Jetty and Embankment for P38 - P44	Ls	1	3,009,000	1,955,850	104,999	299,997
2	**East Approach Road (Preliminary Design)**					**101,913,173**	**7,715,357**	**17,876,100**
	Flyover No.1 (PC-I girder) (A1~P7)					17,425,404	906,322	2,643,635
	Superstructure					8,850,394	538,362	1,420,746
		Concrete (for main girder fck=40N/mm2)	m3	2,228	2,365	3,256,234	200,769	525,415
		Concrete (for situ in place fck=30N/mm2)	m3	1,660	885	1,027,748	44,058	146,524
		Concrete (for Barrier & Curb fck=24N/mm2)	m3	459	1,030	330,583	14,186	47,145
		Concrete (for PC panel fck=40N/mm2)	nos.	1,680	986	1,063,855	59,048	165,114
		Re-bar (SD345)	ton	882	2,243	1,349,968	62,603	197,195
		PC strand (12S15.2B)	ton	154	14,182	1,352,590	83,376	218,229
		Bearing	nos.	112	3,461	99,119	28,768	38,651
		Expansion Joint	m	44	8,411	93,767	27,213	36,561
		Pavement (for Vehicle)	m2	5,382	67	250,600	10,788	35,772
		Waterproofing	m2	5,382	19	25,931	7,554	10,139
	Substructure	A1~P6				8,575,010	367,961	1,222,889
		Concrete (fck=30N/mm2)	m3	4,416	852	2,629,760	112,732	374,919
		Formworks	m2	3,648	194	493,883	21,238	70,478
		Re-bar (SD345)	ton	690	2,563	1,236,225	53,042	176,294
		C.I.P pile (f=1500mm)	m	1,440	4,188	4,215,142	180,949	601,199
	Flyover No.1-2 (Box girder) (P7~A2)					13,108,792	1,265,124	2,572,070
	Superstructure					7,876,214	1,052,040	1,837,299
		Steel (for Vehicle)	kg	2,307,000	4.31	2,643,833	727,350	990,940
		Paint (for Vehicle)	m2	34,600	21	64,007	65,321	71,702
		Concrete (for Deck fck=24N/mm2)	m3	1,699	909	1,274,417	26,952	154,011
		Concrete (for Barrier & Curb fck=24N/mm2)	m3	637	785	412,665	8,727	49,870
		Bearing	nos.	48	10,318	24,764	46,911	49,380
		Expansion Joint	m	44	7,443	16,225	30,736	32,353
		Pavement (for Vehicle)	m2	4,850	71	244,006	9,937	34,264
		Waterproofing	m2	4,850	19	22,728	6,871	9,137
	Substructure	P7~A2				8,406,146	342,320	1,180,412
	For C.I.P pile	Concrete (fck=30N/mm2)	m3	5,249	852	3,173,569	129,236	445,641
		Formworks	m2	3,986	194	548,403	22,332	77,008
		Re-bar (SD345)	ton	692	2,563	1,259,089	51,273	176,805
		C.I.P pile (f=1500mm)	m	1,152	4,188	3,425,085	139,478	480,959
	Flyover No.2 -1 (PC-I girder) (A3~P18)					22,169,418	1,220,718	3,431,009
	Superstructure					11,419,832	758,920	1,897,477
		Concrete (for main girder fck=40N/mm2)	m3	2,786	2,617	4,215,479	306,595	726,878
		Concrete (for situ in place fck=30N/mm2)	m3	2,309	823	1,328,578	57,027	189,486
		Concrete (for Barrier & Curb fck=24N/mm2)	m3	442	1,030	318,339	13,661	45,399
		Concrete (for PC panel fck=40N/mm2)	nos.	2,240	955	1,369,646	76,650	213,204
		Re-bar (SD345)	ton	1,191	2,415	1,943,117	93,106	286,835
		PC strand (12S15.2B)	ton	193	14,824	1,653,765	120,246	285,127
		Bearing	nos.	140	3,461	123,899	35,961	48,313
		Expansion Joint	m	87	5,031	112,302	32,593	43,790
		Pavement (for Vehicle)	m2	6,942	67	323,238	13,914	46,141
		Waterproofing	m2	6,942	18	31,468	9,167	12,304
	Substructure	A3~P17				10,749,587	461,798	1,533,532
		Concrete (fck=30N/mm2)	m3	6,103	865	3,688,557	158,509	526,258
		Formworks	m2	4,838	199	671,896	29,053	96,041
		Re-bar (SD345)	ton	952	2,563	1,705,631	73,183	243,234
		C.I.P pile (f=1500mm)	m	1,600	4,188	4,683,502	201,054	667,999
	Flyover No.2-2 (Box girder) (P18~A4)					27,150,730	3,383,179	6,090,107
	Superstructure					10,798,241	2,470,016	3,546,600
		Steel (for Vehicle)	kg	6,176,000	4.32	6,157,257	2,044,755	2,658,634
		Paint (for Vehicle)	m2	92,645	21	171,386	174,903	191,990
		Concrete (for Deck fck=24N/mm2)	m3	4,225	909	3,169,166	67,023	382,989
		Concrete (for Barrier & Curb fck=24N/mm2)	m3	815	785	528,154	11,170	63,827
		Bearing	nos.	56	14,004	39,210	74,275	78,185
		Expansion Joint	m	59	9,569	28,229	53,475	56,289
		Pavement (for Vehicle)	m2	12,816	71	644,781	26,257	90,542
		Waterproofing	m2	12,816	19	60,058	18,157	24,144
	Substructure	P18~A4				16,352,489	913,164	2,543,507
	For C.I.P pile	Concrete (fck=30N/mm2)	m3	9,382	772	5,064,441	217,609	722,533
		Formworks	m2	7,271	208	1,058,209	45,280	150,783
		Re-bar (SD345)	ton	2,265	2,563	4,058,041	174,116	578,703
		C.I.P pile (f=1500mm)	m	2,016	4,188	5,901,193	253,330	841,679
		Top Beam (Steel)	kg	520,000	4.82	270,606	222,830	249,809

Item No.	Description		Unit	Qty	Unit Rate (USD)	L/C (USD)	F/C ('1000 JPY)	Total ('000 JPY)
	Road work					17,299,064	735,931	2,460,647
	Earth Works					2,872,742	117,154	403,567
		Clearing and Grubbing	m2	20,255	4	51,139	2,261	7,360
		Demolition of Pavement(Drainage Facility)	m2	21,940	10	149,340	6,499	21,388
		Embankment	m3	222,863	12	1,981,841	78,919	276,509
		Cutting	m3	10,328	27	191,578	8,267	27,367
		Slope Protection (Shotcreate)	m2	5,598	127	498,845	21,209	70,943
	Drainage Works	Side Ditch, Batch Basin, Drainage Pipe	Ls	1	722,667	504,951	21,706	72,050
	Pavement Works					6,245,084	267,938	890,573
		Asphalt Pavement (t=0.3)	m2	5,464	67	254,205	10,973	36,317
		Concrete Pavement (t=0.3)	m2	29,247	235	4,799,699	205,741	684,271
		Base Course (t=0.2)	m2	31,968	53	1,191,180	51,224	169,985
	Road Structure Works				-	6,813,742	292,258	971,588
		Retaining Wall (Terre Arme´e)	m2	10,780	904	6,813,742	292,258	971,588
	Road Furniture and Miscellaneous				-	862,544	36,874	122,870
		Guard Rail	m	3,428	128	307,248	13,114	43,747
		Concrete Barrier (Median)	m	1,607	468	525,418	22,527	74,911
		Road Marking	m2	2,213	14	22,349	910	3,138
		Road Sign	nos.	12	898	7,529	323	1,074
	Connection Road (East Side)					4,759,765	204,083	678,631
	Earth Works					147,496	6,364	21,069
		Clearing and Grubbing	m2	9,079	4	22,922	1,014	3,299
		Demolition of Pavement(Drainage Facility)	m2	2,312	10	15,737	685	2,254
		Embankment	m3	2,415	64	108,837	4,666	15,517
	Drainage Works	Concrete Curb, Catch Basin, Drainage Vertical Pipe	Ls	1	360,889	252,476	10,809	35,981
	Pavement Works					1,653,242	70,623	235,452
		Asphalt Pavement (t=0.3)	m2	2,400	67	111,657	4,820	15,952
		Concrete Pavement (t=0.3)	m2	7,200	235	1,181,586	50,649	168,453
		Base Course (t=0.2)	m2	9,600	53	359,999	15,154	51,046
	Structure Works					2,521,625	108,400	359,806
		Retaining Wall (Terre Arme´e)	m2	3,500	1,031	2,521,625	108,400	359,806
	Road Furniture and Miscellaneous					184,927	7,886	26,323
		Guard Rail (Side)	m	2,000	128	179,258	7,651	25,523
		Road Marking	m2	375	14	3,787	154	532
		Road Sign	nos.	3	898	1,882	81	269
3	**4th Panama Canal Bridge (Preliminary Design)**					**317,683,894**	**39,480,200**	**71,153,284**
	East Approach Bridge (Box girder) (A5~P30)					36,871,313	5,239,014	8,915,084
	Superstructure					13,395,007	3,495,893	4,831,375
		Steel (for Vehicle)	kg	6,302,000	4.34	5,791,111	2,147,373	2,724,747
		Steel (for Monorail)	kg	2,336,000	4.23	2,095,182	776,904	985,793
		Paint (for Vehicle)	m2	94,519	21	174,853	178,442	195,874
		Paint (for Monorail)	m2	35,034	21	64,809	66,139	72,601
		Concrete (for Deck fck=24N/mm2)	m3	4,692	909	3,519,461	74,431	425,322
		Concrete (for Barrier & Curb fck=24N/mm2)	m3	1,358	785	879,732	18,605	106,314
		Bearing	nos.	90	11,792	53,066	100,523	105,814
		Expansion Joint	m	118	7,443	43,912	83,183	87,561
		Pavement (for Vehicle)	m2	14,231	71	704,313	30,318	100,538
		Waterproofing	m2	14,231	19	68,567	19,974	26,810
	Substructure	A5~P29			-	23,476,306	1,743,121	4,083,709
	For C.I.P pile	Concrete (fck=30N/mm2)	m3	16,925	821	9,712,910	417,049	1,385,427
		Formworks	m2	17,507	221	2,715,059	115,198	385,889
		Re-bar (SD345)	ton	5,306	2,724	10,104,339	433,541	1,440,943
		Top Beam (Steel)	kg	1,814,000	5	943,998	777,333	871,450
	Main Bridge (Arch) (P30~P33)					122,019,415	24,052,974	36,218,310
	Superstructure					34,491,973	20,810,331	24,249,180
		Steel (for Vehicle)	kg	37,373,000	5.93	25,567,414	19,559,091	22,108,162
		Paint (for Vehicle)	m2	448,476	21	1,074,808	822,229	929,388
		Concrete (for Deck fck=24N/mm2)	m3	7,195	909	5,102,862	143,495	652,250
		Concrete (for Barrier & Curb fck=24N/mm2)	m3	1,945	785.12	1,259,822	26,643	152,248
		Bearing	nos.	4	109,453	21,891	41,467	43,650
		Expansion Joint	m	99	13,760	68,111	129,022	135,813
		Drainage	nos.	129	313	30,256	1,006	4,022
		Pavement (for Vehicle)	m2	22,428	71	1,127,783	46,008	158,448
		Pavement (for Pedestrian)	m2	3,360	50	118,331	4,819	16,616
		Waterproofing	m2	25,788	19	120,696	36,549	48,583
	Substructure	P30~P33			-	87,527,442	3,242,644	11,969,130
	For C.I.P pile	Concrete (fck=30N/mm2)	m3	48,179	684	26,300,117	663,605	3,285,726
		Formworks	m2	34,055	248	6,733,781	169,102	840,460
		Re-bar (SD345)	ton	15,900	2,526	32,032,665	811,261	4,004,917
		C.I.P pile (f=1800mm)	m	1,500	4,709	5,632,781	142,616	704,204
	For S.P.S.P (P32 only)	Steel pipe sheet pile (Exterior, SKY490, f=1500 x t25 mm)	kg	3,172,356	8	16,223,398	958,121	2,575,594
		Top Beam (Steel)	kg	1,162,000	5	604,700	497,939	558,228

Item No.	Description		Unit	Qty	Unit Rate (USD)	L/C (USD)	F/C ('1000 JPY)	Total ('000 JPY)
	West Approach Bridge (Box girder) (P33~P44)					116,882,919	8,815,501	20,468,728
	Superstructure					19,197,966	5,144,442	7,058,479
		Steel (for Vehicle)	kg	9,185,000	4.34	8,157,586	3,157,936	3,971,247
		Steel (for Monorail)	kg	3,395,000	4.30	2,988,966	1,157,078	1,455,078
		Paint (for Vehicle)	m2	137,771	21	254,865	260,096	285,506
		Paint (for Monorail)	m2	50,922	21	94,201	96,135	105,527
		Concrete (for Deck fck=24N/mm2)	m3	7,130	909	5,056,481	142,191	646,322
		Concrete (for Barrier & Curb fck=24N/mm2)	m3	2,064	785	1,336,928	28,274	161,566
		Bearing	nos.	130	10,318	67,070	127,050	133,737
		Expansion Joint	m	118	9,038	53,142	100,666	105,964
		Pavement (for Vehicle)	m2	21,627	71	1,087,505	44,365	152,789
		Waterproofing	m2	21,627	19	101,221	30,652	40,744
	Substructure	P34~P44			-	97,684,953	3,671,059	13,410,249
	For C.I.P pile	Concrete (fck=30N/mm2)	m3	34,944	931	25,951,214	654,801	3,242,137
		Formworks	m2	31,393	331	8,306,104	208,587	1,036,706
		Re-bar (SD345)	ton	11,532	2,487	22,868,129	579,159	2,859,112
		C.I.P pile (f=1800mm)	m	10,400	4,709	39,054,001	988,806	4,882,490
		Top Beam (Steel)	kg	2,893,000	5	1,505,505	1,239,705	1,389,804
	West Approach Bridge (PC-I girder) (P44~A6)					41,910,247	1,372,710	5,551,162
	Superstructure					14,538,696	681,429	2,130,937
		Concrete (for main girder fck=40N/mm2)	m3	3,582	2,006	4,785,053	239,403	716,473
		Concrete (for situ in place fck=30N/mm2)	m3	2,968	736	1,741,346	44,192	217,804
		Concrete (for Barrier & Curb fck=24N/mm2)	m3	612	908	281,944	27,284	55,394
		Concrete (for PC panel fck=40N/mm2)	nos	2,880	822	1,727,817	63,826	236,090
		Re-bar (SD345)	ton	1,457	2,483	2,804,354	81,171	360,765
		PC strand (12S15.2B)	ton	209	17,157	2,392,445	119,766	358,293
		Bearing	nos.	180	2,866	151,639	36,311	51,429
		Expansion Joint	m	87	5,811	149,114	35,708	50,575
		Pavement (for Vehicle)	m2	9,612	67	454,733	18,551	63,888
		Waterproofing	m2	11,412	18	50,251	15,217	20,227
	Substructure	P45~A6				27,345,548	690,129	3,416,480
		Concrete (fck=30N/mm2)	m3	12,524	656	6,555,829	165,452	819,068
		Formworks	m2	8,989	188	1,350,570	34,085	168,737
		Re-bar (SD345)	ton	3,027	2,340	5,651,573	142,631	706,093
		C.I.P pile (f=1800mm)	m	3,900	4,430	13,787,577	347,962	1,722,583
	Road Furniture and Miscellaneous				-	26,003	1,152	3,745
		Road Marking	m2	2,232	15	23,292	1,042	3,364
		Road Sign	nos.	4	954	2,711	110	381
4	**West Approach Road (Preliminary Design)**					**52,120,607**	**1,937,849**	**7,134,273**
	West Approach Road					18,870,853	761,067	2,642,491
	Earth Works					12,011,197	488,671	1,686,187
		Clearing and Grubbing	m2	50,476	4	130,246	5,355	18,341
		Demolition of Pavement(Drainage Facility)	m2	4,708	9	29,671	1,214	4,172
		Embankment	m3	274,890	61	11,851,280	482,102	1,663,675
	Drainage Works	Side Ditch, Catch Basin, Drainage Pipe	less	1	494,557	394,657	9,960	49,307
	Pavement Works			-		5,429,183	220,210	761,499
		Asphalt Pavement (t=0.3)	m2	4,450	67	210,487	8,592	29,578
		Concrete Pavement (t=0.3)	m2	23,824	235	3,966,178	161,965	557,393
		Base Course (t=0.2)	m2	28,274	53	1,075,424	43,122	150,342
		Side Walk	m2	2,995	81	177,094	6,530	24,187
	Road Furniture and Miscellaneous				-	1,035,817	42,226	145,497
		Guard Rail	m	2,618	128	238,036	9,678	33,410
		Fence	m	1,198	412	350,715	14,259	49,225
		Concrete Barrier (Median)	m	1,309	468	434,236	17,726	61,019
		Road Marking	m2	1,047	14	10,279	460	1,485
		Road Sign	nos.	4	898	2,551	104	358

Item No.	Description		Unit	Qty	Unit Rate (USD)	L/C (USD)	F/C ('1000 JPY)	Total ('000 JPY)
	Access Road to the Bridge of the Americas (Inbound and Outbound)					33,249,754	1,176,782	4,491,782
	Road work					4,886,757	196,796	684,006
	Earth Works					1,199,312	48,841	168,413
		Clearing and Grubbing	m2	30,976	4	79,929	3,286	11,255
		Demolition of Pavement(Drainage Facility)	m2	12,756	9	80,390	3,290	11,305
		Embankment	m3	218,000	7	1,038,993	42,266	145,853
	Drainage Works	Concrete Curb, Catch Basin, Drainage Pipe	less	1	164,852	131,552	3,320	16,436
	Pavement Works				-	3,555,893	144,635	499,157
		Asphalt Pavement (t=0.3)	m2	5,088	67	240,664	9,824	33,818
		Concrete Pavement (t=0.3)	m2	15,264	235	2,541,124	103,771	357,121
		Base Course (t=0.2)	m2	20,352	53	774,105	31,040	108,218
	Superstructure				-	12,240,593	566,914	1,787,301
		Concrete (for main girder fck=40N/mm2)	m3	3,025	2,107	4,315,470	205,103	635,355
		Concrete (for situ in place fck=30N/mm2)	m3	2,253	911	1,636,542	41,494	204,658
		Concrete (for Barrier & Curb fck=24N/mm2)	m3	646	727	138,025	33,040	46,801
		Concrete (for PC panel fck=40N/mm2)	nos.	2,280	839	1,398,513	51,312	190,743
		Re-bar (SD345)	ton	1,166	2,462	2,153,662	71,603	286,323
		PC strand (12S15.2B)	ton	209	15,212	2,157,315	102,575	317,659
		Bearing	nos.	152	2,866	128,048	30,663	43,429
		Expansion Joint	m	44	5,031	64,489	15,440	21,870
		Pavement (for Vehicle)	m2	4,806	67	227,366	9,275	31,944
		Waterproofing	m2	4,806	18	21,163	6,408	8,518
	Substructure	A1~A2			-	15,723,347	396,815	1,964,433
		Concrete (fck=30N/mm2)	m3	7,287	720	4,184,967	105,617	522,859
		Formworks	m2	6,193	195	965,635	24,370	120,644
		Re-bar (SD345)	ton	1,131	2,340	2,111,638	53,292	263,822
		C.I.P pile (f=1500mm)	m	2,532	4,188	8,461,107	213,536	1,057,108
	Road Furniture and Miscellaneous				-	399,057	16,256	56,042
		Guard Rail	m	4,240	128	385,512	15,674	54,109
		Road Marking	m2	795	14	7,805	349	1,127
		Road Sign	nos.	9	898	5,739	233	806
5	**Omar Torrijos Intersection (Concept Design incl. Cost No.1,7,8,9,11,12)**		Ls	1	196,900,000.0	**137,830,000**	**5,889,279**	**19,630,930**
6	**Additional Ramp-West Side (Concept Design incl. Cost No. 1,7,8,9,11,12)**		Ls	1	6,100,000.0	**4,270,000**	**182,451**	**608,170**

Item No.	Description		Unit	Qty	Unit Rate (USD)	L/C (USD)	F/C ('1000 JPY)	Total ('000 JPY)
7	**Utilities (Preliminary Design)**					**8,386,980**	**1,013,543**	**1,849,725**
	Electrical and Mechanical facilities					-	-	-
	Road Lighting					-	-	-
	-Include installation cost(20%)	Lamp(LED type)	set	1,102.0	3,600	-	395,530	395,530
		Cubicle for lighting(Outdoor type)	unit	3.0	36,000	-	10,768	10,768
	-Include construction cost(10%)	Pole(H=12.0m Straight type)	set	551.0	1,100	606,100	-	60,428
		Basis of pole	set	422.0	5,500	2,321,000	-	231,404
		Basis of cubicle	set	3.0	8,800	26,400	-	2,632
		Power cable	m	33,488.0	11	368,368	-	36,726
		Electrical Conduit	m	33,488.0	22	736,736	-	73,453
	Bridge Lighting					-	-	-
	-Include installation cost(20%)	Lamp(LED type)	set	352.0	3,600	-	126,340	126,340
	-Include construction cost(10%)	Pole(H=12.0m Straight type)	set	176.0	1,100	193,600	-	19,302
		Power cable	m	10,172.0	11	111,892	-	11,156
		Electrical Conduit	m	10,172.0	22	223,784	-	22,311
	Others Lighting					-	-	-
	-Include installation cost(20%)	Illumination lamp	set	848.0	2,400	-	202,909	202,909
		Cubicle for illumination lamp(Outdoor type)	set	1.0	36,000	-	3,589	3,589
	-Include installation cost(20%) and Spare parts(3.5%)	Floodlight(Light-up)	set	84.0	6,210	-	52,008	52,008
		Airplane Warning Light	set	1.0	24,840	-	2,477	2,477
		Marine Warning Light	set	4.0	24,840	-	9,906	9,906
		Solar cells for power supply control panel	unit	5.0	24,840	-	12,383	12,383
		Solar cells panel	set	5.0	12,420	-	6,191	6,191
		Control panel for airplane Warning Light and Marine Warning Light	unit	2.0	37,260	-	7,430	7,430
	-Include construction cost(10%)	Power cable	m	6,720.0	22	147,840	-	14,740
		Electrical Conduit	m	6,720.0	39	258,720	-	25,794
		Basis of cubicle	set	1.0	8,800	8,800	-	877
	Meteorological observatory facilities					-	-	-
	-Include installation cost(20%) and Spare parts(3.5%)	Variable Massaging Sigh board	set	2.0	149,040	-	29,719	29,719
		Operations panel for VMS	unit	2.0	37,260	-	7,430	7,430
		Meteorological observatory equipment	set	1.0	124,200	-	12,383	12,383
		Temperature meter	set	1.0	5,216	-	520	520
		Rain meter	set	1.0	5,216	-	520	520
		Visibility meter	set	1.0	62,100	-	6,191	6,191
		Anemometer	set	1.0	5,651	-	563	563
		Precipitation meter	set	1.0	10,681	-	1,065	1,065
		Connected to system of ATTT(Include fiber cable)	set	1.0	186,300	186,300	-	18,574
	-Include construction cost(10%)	Steel pole(H=7.2m)	set	2.0	8,800	17,600	-	1,755
		Steel pole(H=3m)	set	1.0	5,500	5,500	-	548
		Communication wire	m	840.0	17	13,860	-	1,382
		Cable rack	m	840.0	77	64,680	-	6,449
		Power cable	m	840.0	22	18,480	-	1,842
	Closed - circuit television(CCTV)					-	-	-
	-Include installation cost(20%)	CCTV camera	set	3.0	18,000	54,000	-	5,384
		CCTV device	unit	3.0	60,000	180,000	-	17,946
		Connected to system of ATTT(Include fiber cable)	set	1.0	180,000	180,000	-	17,946
	-Include construction cost(10%)	Steel pole(H=10m)	set	3.0	11,000	33,000	-	3,290
		Fiber optic	m	2,520.0	11	27,720	-	2,764
	Elevator facilities					-	-	-
	-Include installation cost(20%)	Elevator equipment	unit	2.0	150,000	-	29,910	29,910
		Drive unit	unit	2.0	120,000	-	23,928	23,928
		Shaft(Equipment)	set	2.0	300,000	-	59,820	59,820
		Operations panel	unit	2.0	60,000	-	11,964	11,964
	-Include construction cost(10%)	Cable and Plumbing	m	400.0	66	26,400	-	2,632
		Shaft(Civil)	set	2.0	1,100,000	2,200,000	-	219,340
	Utilities					-	-	-
	Water supply(IDAAN)					-	-	-
	-Include construction cost(10%)	PVC,18 inches	m	840.0	132	110,880	-	11,055
		Connection of bridges and earthwork	set	6.0	3,300	19,800	-	1,974
		Connected to existing pipe	set	2.0	5,500	11,000	-	1,097
		Water supply valve	set	2.0	8,800	17,600	-	1,755
		Flexible pipe	set	19.0	5,500	104,500	-	10,419
	Communication wire（Cable and Wireless,）					-	-	-
	-Include construction cost(10%)	HDPE,4 inches	m	840.0	33	27,720	-	2,764
		Connection of bridges and earthwork	set	6.0	2,200	13,200	-	1,316
		optical closure	set	2.0	2,200	4,400	-	439
	High-voltage line（GasFenosa）					-	-	-
	-Include construction cost(10%)	HDPE,6 inches	m	840.0	55	46,200	-	4,606
		Connection of bridges and earthwork	set	6.0	2,200	13,200	-	1,316
		Sleeve joint	set	2.0	3,850	7,700	-	768

Item No.	Description		Unit	Qty	Unit Rate (USD)	L/C (USD)	F/C ('1000 JPY)	Total ('000 JPY)
8	**Public Utilities Relocation (Preliminary Design)**				**-**	**15,370,640**	**-**	**1,532,453**
	Transmission line					-	-	-
	-Include construction cost and connected to existing(20%)	Transmission line relocation	set	1.0	1,596,000	1,596,000	-	159,121
		Transmission line tower removal	set	2.0	600,000	1,200,000	-	119,640
		Buried construction	m	160.0	6,000	960,000	-	95,712
		Power cable×3	m	480.0	48	23,040	-	2,297
		Electrical Conduit(φ130)× 6	m	960.0	120	115,200	-	11,485
		Joint	set	2.0	120,000	240,000	-	23,928
	Power line					-	-	-
	-Include construction cost and connected to existing(20%)	Power line relocation 01	set	63.0	6,000	378,000	-	37,687
		Power line relocation 02	set	33.0	6,000	198,000	-	19,741
		Power line relocation 03	set	25.0	6,000	150,000	-	14,955
		Power line relocation 04	set	22.0	6,000	132,000	-	13,160
		Power line relocation 05	set	55.0	6,000	330,000	-	32,901
		Power line relocation 06	set	26.0	6,000	156,000	-	15,553
		Power line relocation 07	set	50.0	6,000	300,000	-	29,910
		Power line relocation 08	set	38.0	6,000	228,000	-	22,732
		Power line relocation 09	set	84.0	6,000	504,000	-	50,249
		Power line relocation 10	set	51.0	6,000	306,000	-	30,508
		Power line relocation 11	set	80.0	6,000	480,000	-	47,856
		Power line relocation 12	set	20.0	6,000	120,000	-	11,964
		Power line relocation 13	set	150.0	6,000	900,000	-	89,730
	Water pipe and drainage					-	-	-
	-Include construction cost and connected to existing(20%)	Water pipe (Concrete protection) 01	set	20.0	6,000	120,000	-	11,964
		Water pipe (Concrete protection) 02	set	79.0	6,000	474,000	-	47,258
		Chill water pipe (Footing foundation) 03	set	15.0	9,600	144,000	-	14,357
		Water pipe (Relocation) 04	set	175.0	9,600	1,680,000	-	167,496
		Chill water pipe (Footing foundation) 05	set	11.0	3,600	39,600	-	3,948
		Chill water pipe (Footing foundation) 06	set	15.0	3,600	54,000	-	5,384
		Chill water pipe (Footing foundation) 07	set	12.0	3,600	43,200	-	4,307
		Water pipe (Relocation) 08	set	28.0	9,600	268,800	-	26,799
		Water pipe (Relocation) 09	set	103.0	9,600	988,800	-	98,583
		Water pipe (Concrete protection) 10	set	40.0	6,000	240,000	-	23,928
		Water pipe (Concrete protection) 11	set	38.0	6,000	228,000	-	22,732
		Water pipe (Concrete protection) 12	set	215.0	6,000	1,290,000	-	128,613
		Water supply valve	set	8.0	9,600	76,800	-	7,657
		Flexible pipe	set	8.0	6,000	48,000	-	4,786
	Communication wire					-	-	-
	-Include construction cost and connected to existing(20%)	Communication wire relocation 01	set	72.0	3,600	259,200	-	25,842
	Telecommunication building tower					-	-	-
	-Include construction cost(10%)	Improvement of tower	set	1.0	1,100,000	1,100,000	-	109,670

Item No.	Description		Unit	Qty	Unit Rate (USD)	L/C (USD)	F/C ('1000 JPY)	Total ('000 JPY)
9	**Environmental Mitigation and Monitoring (Preliminary Design)**					**2,021,453**	**0**	**201,539**
	Mitigation Plan					-	-	-
	Noise and Vibrations Control Program	Acoustic barriers barriers	km	6.75	9,500.00	64,125	-	6,393
	Soil Protection	Construction of containment barriers, ditches and sediment traps	km	6.75	16,000.00	108,000	-	10,768
	Surface Water Quality Control	Petroleum absorbers, dispersants, clean-up equipment and floating barriers	km	6.75	56,000.00	378,000	-	37,687
	Flora Protection	Tree and Grass Planting Plan in affected grassy areas (includes maintenance for 5 years)	ha	1.66	8,750.00	14,481	-	1,444
		Flora Rescue and Recovery Plan (forest and mangroves)	ha	2.88	350.00	1,007	0	100
		Reforestation Plan (forest and mangroves)	ha	2.88	7,700.00	22,161	0	2,209
	Fauna Protection	Placing signs in construction areas in stations and forest areas to instruct regarding good behavior toward fauna	sign	8.00	200.00	1,600	-	160
		Fauna Rescue and Relocation Plan (forest and mangrove sectors of the alignment)	ha	2.88	500.00	1,439	-	143
	Environmental Education Plan	Preparation and Execution of the Environmental Education Plan	worker	1,000.00	120.00	120,000	-	11,964
	Socio economic, Historical and Cultural	Disclosure of hiring policies for labor and employment opportunities for the local population	worker	1,000.00	33.00	33,000	-	3,290
		Notification to communities of the development of construction activities	location	3.00	900.00	2,700	-	269
		Placement of speed control signalization	sign	13.00	200.00	2,600	-	259
		Placement of warning and safety signalization in risk areas	area	6.00	3,800.00	22,800	-	2,273
	Environmental Supervisor	Salary	year	4.00	19,500.00	78,000	-	7,777
		Material and work equipment	year	4.00	2,400.00	9,600	-	957
	Social Aspects Manager	Salary	year	4.00	26,000.00	104,000	-	10,369
		Materials and work equipment	year	4.00	2,400.00	9,600	-	957
	Community Liaison Officer	Salary	year	4.00	19,550.00	78,200	-	7,797
		Materials and work equipment	year	4.00	3,000.00	12,000	-	1,196
	Environmental and Social Management Personnel Transportation	Vehicle's (4x4)	year	2.00	36,000.00	72,000	-	7,178
	Mitigation Plan					-	-	-
	Air Quality Monitoring	Quarterly monitoring of vehicular emissions	year	4.00	14,300.00	57,200	-	5,703
		Air quality monitoring before starting construction in Ancon Sector	year	3.00	1,000.00	3,000	-	299
		Quarterly air quality monitoring	year	4.00	29,400.00	117,600	-	11,725
	Noise Emissions Monitoring (Ambient and Occupational)	Quarterly occupational noise monitoring	year	4.00	28,600.00	114,400	-	11,406
		Baseline noise monitoring before construction in Ancon Sector	site	3.00	750.00	2,250	-	224
		Baseline noise monitoring before construction along the alignment.	site	8.00	750.00	6,000	-	598
		Quarterly noise monitoring	year	4.00	21,400.00	85,600	-	8,534
	Vibration Level Monitoring (Ambient and Occupational)	Quarterly full-body vibration monitoring	year	4.00	36,600.00	146,400	-	14,596
		Baseline ambient vibration monitoring before construction in Ancon sector and alignment	site	11.00	930.00	10,230	-	1,020
		Quarterly ambient vibration monitoring	year	4.00	29,400.00	117,600	-	11,725
		Monitoring in case of blasts	site	2.00	930.00	1,860	-	185
	Surface Water Quality Monitoring	Quarterly surface water quality monitoring	year	4.00	29,200.00	116,800	-	11,645
	Soil Quality Monitoring	Quarterly soil quality monitoring	year	4.00	11,800.00	47,200	-	4,706
	Land Subsidence Monitoring	Quarterly land subsidence monitoring	year	4.00	15,000.00	60,000	-	5,982
10	**Risk Cost (Preliminary Design and Concept Design)**		Ls	1	13,877,996.6	-	**1,383,636**	**1,383,636**
Total Construction Amount						**732,952,597**	**59,985,459**	**133,060,832**

Non Eligible Portion

11	**Environmental Compensation (Preliminary Design)**					**12,310**	**-**	**1,227**
	Environmental Compensation	Mangroves	ha	0.36	5,000.00	1,815	-	181
		Mature secondary forest	ha	1.67	5,000.00	8,340	-	831
		Intermediate secondary forest	ha	0.24	3,000.00	720	-	72
		Young secondary forest	ha	0.61	1,000.00	607	-	61
		Grassy plants	ha	1.66	500.00	828	-	83
12	**Land Acquisition & Resettlement (Preliminary Design)**					**5,301,056**	**-**	**528,515**
	Compensation for economic displacement		Ls	1	301,055.5	301,056	-	30,015
	Relocation of ACP structures		Ls	1	5,000,000.0	5,000,000	-	498,500

7-2　主橋架設時に航路を利用できない場合

主橋架設時に航路を利用できない場合の概算事業費は、主橋架設時に航路を利用できる場合に対して下記について変更した。

Cost Estimation for 4th Panama Canal Bridge Construction (Cable Erection Method)

Item No.	Description		Unit	Qty	Unit Rate (USD)	L/C (USD)	F/C ('1000 JPY)	Total ('000 JPY)
1	**Temporary Works (Preliminary Design)**					**100,872,751**	**2,570,503**	**12,627,516**
	Temporary yard	Rental, Preparation & Maintenance for Stock Yard. 270,000m2, including Transportation Material and Equipment from West Yard to East	Ls	1	101,664,126	81,331,301	2,027,183	10,135,913
	Temporary road	Access Road for Work	Ls	1	21,982,000	17,585,600	438,321	2,191,605
	Temporary Jetty	East and West Side Jetty and Embankment for P38 - P44	Ls	1	3,009,000	1,955,850	104,999	299,997
3	**4th Panama Canal Bridge (Preliminary Design)**					**321,418,407**	**42,337,105**	**74,382,521**
	Main Bridge (Arch) (P30~P33)					125,753,928	26,909,880	39,447,547
	Superstructure					38,226,486	23,667,236	27,478,417
		Steel (for Vehicle)	kg	37,373,000	6.80	29,301,927	22,415,997	25,337,399
		Paint (for Vehicle)	m2	448,476	21	1,074,808	822,229	929,388
		Concrete (for Deck fck=24N/mm2)	m3	7,195	909	5,102,862	143,495	652,250
		Concrete (for Barrier & Curb fck=24N/mm2)	m3	1,945	785.12	1,259,822	26,643	152,248
		Bearing	nos.	4	109,453	21,891	41,467	43,650
		Expansion Joint	m	99	13,760	68,111	129,022	135,813
		Drainage	nos.	129	313	30,256	1,006	4,022
		Pavement (for Vehicle)	m2	22,428	71	1,127,783	46,008	158,448
		Pavement (for Pedestrian)	m2	3,360	50	118,331	4,819	16,616
		Waterproofing	m2	25,788	19	120,696	36,549	48,583
9	**Environmental Mitigation and Monitoring (Preliminary Design)**					**2,310,003**	**0**	**230,307**
	Mitigation Plan					-	-	-
	Noise and Vibrations Control Program	Acoustic barriers barriers	km	6.75	9,500.00	64,125	-	6,393
	Soil Protection	Construction of containment barriers, ditches and sediment traps	km	6.75	16,000.00	108,000	-	10,768
	Surface Water Quality Control	Petroleum absorbers, dispersants, clean-up equipment and floating barriers	km	6.75	56,000.00	378,000	-	37,687
	Flora Protection	Tree and Grass Planting Plan in affected grassy areas (includes maintenance for 5 years)	ha	1.66	8,750.00	14,481	-	1,444
		Flora Rescue and Recovery Plan (forest and mangroves)	ha	2.88	350.00	1,007	0	100
		Reforestation Plan (forest and mangroves)	ha	2.88	7,700.00	22,161	0	2,209
	Fauna Protection	Placing signs in construction areas in stations and forest areas to instruct regarding good behavior toward fauna	sign	8.00	200.00	1,600	-	160
		Fauna Rescue and Relocation Plan (forest and mangrove sectors of the alignment)	ha	2.88	500.00	1,439	-	143
	Environmental Education Plan	Preparation and Execution of the Environmental Education Plan	worker	1,000.00	120.00	120,000	-	11,964
	Socio economic, Historical and Cultural	Disclosure of hiring policies for labor and employment opportunities for the local population	worker	1,000.00	33.00	33,000	-	3,290
		Notification to communities of the development of construction activities	location	3.00	900.00	2,700	-	269
		Placement of speed control signalization	sign	13.00	200.00	2,600	-	259
		Placement of warning and safety signalization in risk areas	area	6.00	3,800.00	22,800	-	2,273
	Environmental Supervisor	Salary	year	5.00	19,500.00	97,500	-	9,721
		Material and work equipment	year	5.00	2,400.00	12,000	-	1,196
	Social Aspects Manager	Salary	year	5.00	26,000.00	130,000	-	12,961
		Materials and work equipment	year	5.00	2,400.00	12,000	-	1,196
	Community Liaison Officer	Salary	year	5.00	19,550.00	97,750	-	9,746
		Materials and work equipment	year	5.00	3,000.00	15,000	-	1,496
	Environmental and Social Management Personnel Transportation	Vehicle's (4x4)	year	2.00	36,000.00	72,000	-	7,178
	Mitigation Plan					-	-	-
	Air Quality Monitoring	Quarterly monitoring of vehicular emissions	year	5.00	14,300.00	71,500	-	7,129
		Air quality monitoring before starting construction in Ancon Sector	year	3.00	1,000.00	3,000	-	299
		Quarterly air quality monitoring	year	5.00	29,400.00	147,000	-	14,656
	Noise Emissions Monitoring (Ambient and Occupational)	Quarterly occupational noise monitoring	year	5.00	28,600.00	143,000	-	14,257
		Baseline noise monitoring before construction in Ancon Sector	site	3.00	750.00	2,250	-	224
		Baseline noise monitoring before construction along the alignment.	site	8.00	750.00	6,000	-	598
		Quarterly noise monitoring	year	5.00	21,400.00	107,000	-	10,668
	Vibration Level Monitoring (Ambient and Occupational)	Quarterly full-body vibration monitoring	year	5.00	36,600.00	183,000	-	18,245
		Baseline ambient vibration monitoring before construction in Ancon sector and alignment	site	11.00	930.00	10,230	-	1,020
		Quarterly ambient vibration monitoring	year	5.00	29,400.00	147,000	-	14,656
		Monitoring in case of blasts	site	2.00	930.00	1,860	-	185
	Surface Water Quality Monitoring	Quarterly surface water quality monitoring	year	5.00	29,200.00	146,000	-	14,556
	Soil Quality Monitoring	Quarterly soil quality monitoring	year	5.00	11,800.00	59,000	-	5,882
	Land Subsidence Monitoring	Quarterly land subsidence monitoring	year	5.00	15,000.00	75,000	-	7,478
10	**Risk Cost (Preliminary Design and Concept Design)**		Ls	1	6,814,041.9	**-**	**679,360**	**679,360**
Total Construction Amount						**744,492,561**	**62,325,447**	**136,551,355**

付属資料 8: 概算運営維持管理費内訳表
(概略設計対象)
(第 4 パナマ運河橋)

付属資料 8　概算運営維持管理費内訳表（概略設計対象）（第 4 パナマ運河橋）

概算運営維持管理費積算内訳表を添付する。
なお、資料は暫定的なものであり、今後の詳細検討において更新される。

8-1　土木施設の概算維持管理費

Appendix 8　O&M Cost (Preliminary Design Section) (Civil Works)

Road	Category			Item	Specifications	Qty		Time		UnitRate				Amount	
						Qty	Unit (1 time)	Frequency (Year)	Times (100 Years)	F/C (JPY)	L/C (USD)	Equiv. in F/C (JPY)	Equiv. in L/C (USD)	Equiv. in F/C (JPY/100 Years)	Equiv. in L/C (USD/100 Years)
4th Panama Canal Bridge	Common			Repair of road marking		6,737	m	10	10	199	8	997	10	67,167,890	673,700
				Repair of road signs		6,737	m	10	10	4,985	200	24,925	250	1,679,197,250	16,842,500
	East Approach Bridge	Road		Pavement	Concrete	29,247	m2	30	3	2,592	104	12,961	130	1,137,211,101	11,406,330
				Pavement	Surface course, dense-grade asphalt	5,464	m2	10	10	1,336	54	6,680	67	364,995,200	3,660,880
				Repair of MSEW	MSEW	11,570	m2	50	2	-	200	19,940	200	461,411,600	4,628,000
				Repair of cut slope	Mortar spraying	5,598	m2	20	5	997	40	4,985	50	139,530,150	1,399,500
				Side ditch, catch pit		3,174	m	15	6	3,390	136	16,949	170	322,776,756	3,237,480
				Repair of guardrails	Flexible guard fence	3,428	m	10	10	399	16	1,994	20	68,354,320	685,600
		Flyover No.1	PC-I	Pavement	Surface course, dense-grade asphalt	5,238	m2	10	10	1,336	54	6,680	67	349,898,400	3,509,460
				Pavement	Binder course (modified asphalt), waterproofing	5,238	m2	30	3	1,595	64	7,976	80	125,334,864	1,257,120
				Catch pit	Steel	27	nos	50	2	98,703	110	109,670	1,100	5,922,180	59,400
				Repair of accessories (partial)	Cleaning, patching, repair	105	m2	5	20	1,994	80	9,970	100	20,889,144	209,520
				Repair of main girder (partial)	PC	524	m2	15	6	14,955	350	49,850	500	156,668,580	1,571,400
				Expansion joint	Steel	44	m	40	2	358,920	400	398,800	4,000	34,775,360	348,800
				Repair of substructure (partial)	RC	35	m2	10	10	9,970	400	49,850	500	17,447,500	175,000
			Steel Box	Pavement	Surface course, dense-grade asphalt	4,850	m2	10	10	1,336	54	6,680	67	323,980,000	3,249,500
				Pavement	Binder course (modified asphalt), waterproofing	4,850	m2	30	3	1,595	64	7,976	80	116,050,800	1,164,000
				Pavement	Sidewalk, asphalt	1,250	m2	30	3	798	32	3,988	40	14,955,000	150,000
				Catch pit	Steel	38	nos	50	2	98,703	110	109,670	1,100	8,225,250	82,500
				Repair of accessories (partial)	Cleaning, patching, repair	122	m2	5	20	1,994	80	9,970	100	24,326,800	244,000
				Re-painting	Weathering steel, equivalent to Class C-5	12,686	m2	40	2	9,870	11	10,967	110	278,261,304	2,790,986
				Re-painting (partial)	Equivalent to Classes C-5,D-5	300	m2	15	6	9,870	11	10,967	110	19,740,600	198,000
				Scaffolding for re-painting		4,850	m2	40	2	997	40	4,985	50	48,354,500	485,000
				Repair of deck slab (partial)	RC	305	m2	15	6	9,970	400	49,850	500	91,225,500	915,000
				Expansion joint	Steel	104	m	40	2	358,920	400	398,800	4,000	82,631,360	828,800
				Repair of substructure (partial)	RC	60	m2	10	10	34,895	150	49,850	500	29,910,000	300,000
		Flyover No.2	PC-I	Pavement	Surface course, dense-grade asphalt	6,942	m2	10	10	1,336	54	6,680	67	463,725,600	4,651,140
				Pavement	Binder course (modified asphalt), waterproofing	6,942	m2	30	3	1,595	64	7,976	80	166,108,176	1,666,080
				Catch pit	Steel	26	nos	50	2	98,703	110	109,670	1,100	5,702,840	57,200
				Repair of accessories (partial)	Cleaning, patching, repair	139	m2	5	20	1,994	80	9,970	100	27,684,696	277,680
				Repair of main girder (partial)	PC	694	m2	15	6	14,955	350	49,850	500	207,635,220	2,082,600
				Expansion joint	Steel	58	m	40	2	358,920	400	398,800	4,000	46,420,320	465,600
				Repair of substructure (partial)	RC	35	m2	10	10	9,970	400	49,850	500	17,447,500	175,000
			Steel Box	Pavement	Surface course, dense-grade asphalt	12,816	m2	10	10	1,336	54	6,680	67	856,108,800	8,586,720
				Pavement	Binder course (modified asphalt), waterproofing	12,816	m2	30	3	1,595	64	7,976	80	306,661,248	3,075,840
				Pavement	Sidewalk, asphalt	2,400	m2	30	3	798	32	3,988	40	28,713,600	288,000
				Catch pit	Steel	72	nos	50	2	98,703	110	109,670	1,100	15,792,480	158,400
				Repair of accessories (partial)	Cleaning, patching, repair	304	m2	5	20	1,994	80	9,970	100	60,681,408	608,640
				Re-painting	Weathering steel, equivalent to Class C-5	50,955	m2	40	2	9,870	11	10,967	110	1,117,641,487	11,210,845
				Re-painting (partial)	Equivalent to Classes C-5,D-5	300	m2	15	6	9,870	11	10,967	110	19,740,600	198,000
				Scaffolding for re-painting		12,816	m2	40	2	997	40	4,985	50	127,775,520	1,281,600
				Repair of deck slab (partial)	RC	761	m2	15	6	9,970	400	49,850	500	227,555,280	2,282,400
				Expansion joint	Steel	118	m	40	2	358,920	400	398,800	4,000	94,276,320	945,600
				Repair of substructure (partial)	RC	70	m2	10	10	34,895	150	49,850	500	34,895,000	350,000
	4th Panama Canal Bridge	East Approach Bridge	Steel Box	Pavement	Surface course, dense-grade asphalt	14,231	m2	10	10	1,336	54	6,680	67	950,637,480	9,534,837
				Pavement	Binder course (modified asphalt), waterproofing	14,231	m2	30	3	1,595	64	7,976	80	340,521,761	3,415,464
				Pavement	Sidewalk, asphalt	2,665	m2	30	3	798	32	3,988	40	31,884,060	319,800
				Catch pit	Steel	80	nos	50	2	98,703	110	109,670	1,100	17,536,233	175,890
				Repair of accessories (partial)	Cleaning, patching, repair	338	m2	5	20	1,994	80	9,970	100	67,381,647	675,844
				Re-painting	Weathering steel, equivalent to Class C-5	77,978	m2	40	2	9,870	11	10,967	110	1,710,379,322	17,155,259
				Re-painting (partial)	Equivalent to Classes C-5,D-5	300	m2	15	6	9,870	11	10,967	110	19,740,600	198,000
				Scaffolding for re-painting		14,231	m2	40	2	997	40	4,985	50	141,884,067	1,423,110
				Repair of deck slab (partial)	RC	845	m2	15	6	9,970	400	49,850	500	252,681,176	2,534,415
				Expansion joint	Steel	118	m	40	2	358,920	400	398,800	4,000	94,276,320	945,600
				Repair of substructure (partial)	RC	70	m2	10	10	34,895	150	49,850	500	34,895,000	350,000
		Main Bridge	Arch	Pavement	Surface course, dense-grade asphalt	22,428	m2	10	10	1,336	54	6,680	67	1,498,190,400	15,026,760
				Pavement	Binder course (modified asphalt), waterproofing	22,428	m2	30	3	1,595	64	7,976	80	536,657,184	5,382,720
				Pavement	Sidewalk, asphalt	3,360	m2	30	3	798	32	3,988	40	40,199,040	403,200
				Catch pit	Steel	126	nos	50	2	98,703	110	109,670	1,100	27,636,840	277,200
				Repair of accessories (partial)	Cleaning, patching, repair	516	m2	5	20	1,994	80	9,970	100	102,842,544	1,031,520
				Re-painting	Weathering steel, equivalent to Class C-5	243,650	m2	40	2	9,870	11	10,967	110	5,344,219,100	53,603,000
				Re-painting (partial)	Equivalent to Classes C-5,D-5	600	m2	15	6	9,870	11	10,967	110	39,481,200	396,000
				Scaffolding for re-painting		67,284	m2	40	2	997	40	4,985	50	670,821,480	6,728,400
				Repair of deck slab (partial)	RC	1,289	m2	15	6	14,955	350	49,850	500	385,659,540	3,868,200
				Expansion joint	Steel	118	m	40	2	358,920	400	398,800	4,000	94,276,320	945,600
				Repair of substructure (partial)	RC	30	m2	10	10	44,865	50	49,850	500	14,955,000	150,000
		West Approach Bridge	Steel Box	Pavement	Surface course, dense-grade asphalt	21,627	m2	10	10	1,336	54	6,680	67	1,444,683,600	14,490,090
				Pavement	Binder course (modified asphalt), waterproofing	21,627	m2	30	3	1,595	64	7,976	80	517,490,856	5,190,480
				Pavement	Sidewalk, asphalt	4,050	m2	30	3	798	32	3,988	40	48,454,200	486,000
				Catch pit	Steel	122	nos	50	2	98,703	110	109,670	1,100	26,649,810	267,300
				Repair of accessories (partial)	Cleaning, patching, repair	514	m2	5	20	1,994	80	9,970	100	102,399,876	1,027,080
				Re-painting	Weathering steel, equivalent to Class C-5	103,781	m2	40	2	9,870	11	10,967	110	2,276,335,744	22,831,853
				Re-painting (partial)	Equivalent to Classes C-5,D-5	300	m2	15	6	9,870	11	10,967	110	19,740,600	198,000
				Scaffolding for re-painting		21,627	m2	40	2	997	40	4,985	50	215,621,190	2,162,700
				Repair of deck slab (partial)	RC	1,284	m2	15	6	9,970	400	49,850	500	383,999,535	3,851,550
				Expansion joint	Steel	118	m	40	2	358,920	400	398,800	4,000	94,276,320	945,600
				Repair of substructure (partial)	RC	110	m2	10	10	34,895	150	49,850	500	54,835,000	550,000
			PC-I	Pavement	Surface course, dense-grade asphalt	9,612	m2	10	10	1,336	54	6,680	67	642,081,600	6,440,040
				Pavement	Binder course (modified asphalt), waterproofing	9,612	m2	30	3	1,595	64	7,976	80	229,995,936	2,306,880
				Catch pit	Steel	36	nos	50	2	98,703	110	109,670	1,100	7,896,240	79,200
				Repair of accessories (partial)	Cleaning, patching, repair	192	m2	5	20	1,994	80	9,970	100	38,332,656	384,480
				Repair of main girder (partial)	PC	961	m2	15	6	14,955	350	49,850	500	287,494,920	2,883,600
				Expansion joint	Steel	58	m	40	2	358,920	400	398,800	4,000	46,420,320	465,600
				Repair of substructure (partial)	RC	45	m2	10	10	9,970	400	49,850	500	22,432,500	225,000
	West Approach Bridge	Road		Pavement	Concrete	23,824	m2	30	3	2,592	104.00	12,961	130	926,348,592	9,291,360
				Pavement	Surface course, dense-grade asphalt	4,451	m2	10	10	1,336	53.60	6,680	67	297,326,800	2,982,170
				Repair of embankment slope	Mortar spraying	0	m2	20	5	399	16.00	1,994	20	0	0
				Side ditch, catch pit		1,309	m	15	6	3,390	136.00	16,949	170	133,117,446	1,335,180
				Repair of guardrails	Flexible guard fence	2,618	m	10	10	399	16.00	1,994	20	52,202,920	523,600
East Side Connection Road	Road			Pavement	Concrete	7,200	m2	30	3	2,592	104.00	12,961	130	279,957,600	2,808,000
				Pavement	Surface course, dense-grade asphalt	2,400	m2	10	10	1,336	53.60	6,680	67	160,320,000	1,608,000
				Repair of embankment slope	Mortar spraying	0	m2	20	5	399	16.00	1,994	20	0	0
				Side ditch, catch pit		1,020	m	15	6	3,390	136.00	16,949	170	103,727,880	1,040,400
				Repair of guardrails	Flexible guard fence	2,000	m	10	10	399	16.00	1,994	20	39,880,000	400,000
Access Road to the Bridge of the Americas	Common			Repair of road marking		1,582	m	10	10	199	8.00	997	10	15,772,540	158,200
				Repair of road signs		1,582	m	10	10	4,985	200.00	24,925	250	394,313,500	3,955,000
	Road			Pavement	Concrete	16,992	m2	30	3	2,592	104.00	12,961	130	660,699,936	6,626,880
				Pavement	Surface course, dense-grade asphalt	5,664	m2	10	10	1,336	53.60	6,680	67	378,355,200	3,794,880
				Repair of embankment slope	Mortar spraying	0	m2	20	5	399	16.00	1,994	20	0	0
				Side ditch, catch pit		2,360	m	15	6	3,390	136.00	16,949	170	239,997,840	2,407,200
				Repair of guardrails	Flexible guard fence	4,720	m	10	10	399	16.00	1,994	20	94,116,800	944,000
	Bridge		PC-I	Pavement	Surface course, dense-grade asphalt	7,372	m2	10	10	1,336	54	6,680	67	492,449,600	4,939,240
				Pavement	Binder course (modified asphalt), waterproofing	7,372	m2	30	3	1,595	64	7,976	80	176,397,216	1,769,280
				Catch pit	Steel	30	nos	50	2	98,703	110	109,670	1,100	6,667,936	66,880
				Repair of accessories (partial)	Cleaning, patching, repair	147	m2	5	20	1,994	80	9,970	100	29,399,536	294,880
				Repair of main girder (partial)	PC	737	m2	15	6	14,955	350	49,850	500	220,496,520	2,211,600
				Expansion joint	Steel	44	m	40	2	358,920	400	398,800	4,000	34,775,360	348,800
				Repair of substructure (partial)	RC	50	m2	10	10	9,970	400	49,850	500	24,925,000	250,000
Total														**33,450,952,943**	**335,514,843**

99.71　JPY/1USD

8-2　設備の概算維持管理費

Appendix 8　O&M Cost (Preliminary Design Section) (Electrical and Mechanical Facilities)

Road	Category	Item	Specifications	Qty		Time		Unit Rate				Amount	
				Qty	Unit (/1 time)	Frequency (Year)	Times (100 Years)	F/C (JPY)	L/C (USD)	Equiv. in F/C (JPY)	Equiv. in L/C (USD)	Equiv. in F/C (JPY/100 Years)	Equiv. in L/C (USD/100 Years)
4th Panama Canal Bridge/ East Side Connection Road/ Access Road to the Bridge of the Americas	Power Supply	Cubicle		3	unit	30	3	3,090,700		3,090,700	31,000	27,816,300	279,000
		Inspection	1 time/year	1	set	1	100		500	49,850	500	4,985,000	50,000
		Piping wiring		44,500	m	30	3		55	5,484	55	732,114,000	7,342,500
	Road Lighting	Lamp	LED	1,102	set	15	6	299,100		299,100	3,000	1,977,649,200	19,836,000
		Pole	h=12m	551	set	30	3		1,500	149,550	1,500	247,206,150	2,479,500
		Foundation of pole	Concrete	422	set	30	3		750	74,775	750	94,665,150	949,500
		Electric bill	1 time/year	1,102	set	1	100		37	3,689	37	406,527,800	4,077,400
		Inspection	2 times/year	2	set	1	100		3,306	299	3,306	59,800	661,200
	Road Lighting (Bridge)	Lamp	LED	352	set	15	6	299,100		299,100	3,000	631,699,200	6,336,000
		Pole	h=12m	176	set	30	3		1,500	149,550	1,500	78,962,400	792,000
		Electric bill	1 time/year	352	set	1	100		37	3,689	37	129,852,800	1,302,400
		Inspection	2 times/year	2	set	1	100		1,056	299	1,056	59,800	211,200
	Illumination	Floodlight	Including piping wiring	84	set	30	3	498,500		498,500	5,000	125,622,000	1,260,000
		Lamp	LED	848	set	15	6	199,400		199,400	2,000	1,014,547,200	10,176,000
		Inspection	2 times/year	2	set	1	100		2,000	199,400	2,000	39,880,000	400,000
		Piping wiring		6,720	m	30	3		55	5,484	55	110,557,440	1,108,800
	Airplane Warning Light	Airplane warning light	LED	1	set	15	6	1,994,000		1,994,000	20,000	11,964,000	120,000
		Solar cells for power supply	Including piping wiring	1	unit	20	5	9,970,000		9,970,000	100,000	49,850,000	500,000
		Solar cells panel		1	set	15	6	9,970,000		9,970,000	100,000	59,820,000	600,000
		Inspection	2 times/year	2	set	1	100		2,000	199,400	2,000	39,880,000	400,000
	Marine Warning Light	Marine warning light	LED	4	set	15	6	1,994,000		1,994,000	20,000	47,856,000	480,000
		Solar cells for power supply	Including piping wiring	1	unit	20	5	19,940,000		19,940,000	200,000	99,700,000	1,000,000
		Solar cells panel		4	set	15	6	9,970,000		9,970,000	100,000	239,280,000	2,400,000
		Inspection	2 times/year	2	set	1	100		2,000	199,400	2,000	39,880,000	400,000
	Variable Messege Signboard (VMS)	VMS	LED	2	set	15	6	15,952,000		15,952,000	160,000	191,424,000	1,920,000
		Operations panel		2	unit	15	6	498,500		498,500	5,000	5,982,000	60,000
		Pole	h=7m (steel pole), including piping wiring	2	set	30	3		5,000	498,500	5,000	2,991,000	30,000
		Inspection	2 times/year	2	set	1	100		3,000	299,100	3,000	59,820,000	600,000
	Meteorological Observation Facilities	Mo equipment		1	unit	15	6	9,970,000		9,970,000	100,000	59,820,000	600,000
		Pole	h=3m (steel pole)	1	set	30	3		2,000	199,400	2,000	598,200	6,000
		Temperature meter		1	set	15	6	418,740		418,740	4,200	2,512,440	25,200
		Rain meter		1	set	15	6	418,740		418,740	4,200	2,512,440	25,200
		Visibility meter		1	set	15	6	4,985,000		4,985,000	50,000	29,910,000	300,000
		Anemometer		1	set	15	6	453,635		453,635	4,550	2,721,810	27,300
		Precipitation meter		1	set	15	6	857,420		857,420	8,600	5,144,520	51,600
		Inspection	2 times/year	2	set	1	100		3,000	299,100	3,000	59,820,000	600,000
	Closed-circuit Television (CCTV)	CCTV camera		3	set	15	6	3,489,500		3,489,500	35,000	62,811,000	630,000
		CCTV device		3	unit	15	6	3,489,500		9,970,000	100,000	179,460,000	1,800,000
		Pole	h=10m (steel pole)	3	set	30	3		8,000	797,600	8,000	7,178,400	72,000
		Fiber optic		2,520	m	15	6		10	997	10	15,074,640	151,200
		Inspection	2 times/year	2	set	1	100		2,000	199,400	2,000	39,880,000	400,000
	Elevator Facilities	Elevator equipment		2	unit	20	5	19,940,000		19,940,000	200,000	199,400,000	2,000,000
		Drive unit		2	unit	20	5	9,970,000		9,970,000	100,000	99,700,000	1,000,000
		Shaft		2	unit	50	2	24,925,000		24,925,000	250,000	99,700,000	1,000,000
		Operations panel		2	unit	20	5	498,500		498,500	5,000	4,985,000	50,000
		Inspection	2 times/year	2	set	1	100		5,000	498,500	5,000	99,700,000	1,000,000
		Piping wiring		400	m	20	5		60	5,982	60	11,964,000	120,000
Total												7,453,543,690	75,630,000

99.71　JPY/1USD

付属資料 9: Pre-F/S レビュー・レポート(斜張橋)

パナマ国

パナマ首都圏都市交通（3 号線）整備事業準備調査

（第 4 パナマ運河橋整備事業）

Pre-F/S レビュー・レポート
（斜張橋）

2014 年 7 月

独立行政法人　国際協力機構

日本工営株式会社
株式会社トーニチコンサルタント
株式会社トステムズ
中南米工営株式会社

目次

第1章　概要

1.1　レビューの背景

国際協力機構との契約に基づき、日本工営～トーニチコンサルタント～トステムズ～中南米工営共同企業体(調査団)は、2013年6月下旬より、「パナマ首都圏都市交通(3号線)整備事業準備調査」(メトロ3号線調査)を実施している。

メトロ3号線整備事業は、路線にパナマ運河の渡河区間が含まれているが、同区間については、パナマ国運河庁が Pre-F/S 実施中の第 4 パナマ運河橋(道路・鉄道併用橋)を利用する計画としている。従って、メトロ3号線調査における同区間の調査の範囲は、パナマ国運河庁が実施中の Pre-F/S の確認、メトロ 3 号線整備事業からの要求事項の提示及び計画への反映に係る調整までとなっていた。

しかし、メトロ 3 号線調査開始後、パナマ政府から第 4 パナマ運河橋整備事業についても円借款案件として形成したい旨の意向が示されたため、2013 年 7 月 12 日、外務省ミッションとパナマ国メトロ庁長官が協議を行い、日本側も第 4 パナマ運河橋整備事業の調査を実施することが合意された。

上記より、2013 年 9 月 3 日、国際協力機構と調査団は、第 4 パナマ運河橋整備事業(本事業)を調査の範囲に追加した変更契約を締結し、第 4 パナマ運河橋調査(本調査)を開始した。

第 4 パナマ運河橋の主橋形式は、Pre-F/S では複合斜張橋、本調査ではアーチ橋をベースに調査を進めており、両者の概略設計結果を基に、最終的な主橋形式が決定される手筈となっている。

1.2　レビューの目的

本レビューは、Pre-F/S の複合斜張橋案と本調査のアーチ橋案の概略設計結果を比較する際、両者の比較条件が揃う様、Pre-F/S の複合斜張橋案の概略設計結果を検証することを目的とする。

1.3　レビューの対象物

本レビューは、現在、パナマ国運河庁が調査を実施している第 4 パナマ運河橋整備事業 Pre-F/S のドラフト・ファイナル・レポート(2013 年 11 月)を対象とした。

1.4　レビューの項目・結果

本レビューでは、以下の項目についてレビューを実施した。

- 計画・設計条件
- 標準横断
- 橋梁計画・設計
- 工事数量
- 施工計画
- 積算

表 1.1 にレビュー項目・結果(概要)を示す。

表 1.1　レビュー項目・結果(概要)

No.	項目			要確認事項の有無	比較検討上の取扱い	参照先(本レポート)
1	計画・設計条件	計画条件	地形条件	無		3.1.1
2			地質条件	無		3.1.2
3			航路条件	無		3.1.3
4			空域条件	無		3.1.4
5			交差条件	無		3.1.5
6			架設条件	有		3.1.6
7			メトロ 3 号線の配置位置	有		3.1.7
8		設計条件	Operational Category	有		3.2.1
9			設計耐用年数	有		3.2.2
10			設計活荷重	無		3.2.3
11			加速度応答スペクトル	無		3.2.4
12			設計風荷重	有		3.2.5
13			設計温度荷重	無		3.2.6
14	標準横断			有	1.5.2(1)参照	4
15	橋梁計画・設計	橋長及び支間割		有	1.5.2(2)参照	5.1
16		上部工	上部工形式	有		5.2.1
17			上部工解析・設計	有		5.2.2
18		下部・基礎工	下部・基礎工形式	有		5.3.1
19			下部・基礎工設計	有		5.3.2
20		付帯工	伸縮継手	有		5.4.1
21			支承	有		5.4.2
22			歩道	有		5.4.3
23			検査路	有		5.4.4
24	工事数量			有		6
25	施工計画	架設方法		有		7.2
26		施工期間		有		7.3
27	積算	初期建設費	積算方法	有		8.1.1
28			初期工事費	有	1.5.2(3), (4) 参照	8.1.2
29		維持管理費		有	1.5.2(5), (6) 参照	8.2

出典:調査団

1.5　まとめ

1.5.1 確認事項の有無

本レビューの結果、表 1.1 に示す項目について、パナマ国運河庁に確認が必要である。

1.5.2 本調査との比較における取扱い

本調査のアーチ橋案との比較に際しては、以下の取扱いが必要である。

(1) メトロ 3 号線のシステムについて、Pre-F/S はメトロリニア(幅員 9m)、本調査はモノレール(8.4m)としているが、比較の際はモノレールで統一し、Pre-F/S の幅員を-0.6m とする。

(2) 主橋の橋長について Pre-F/S 案は 1,118m、本調査案は 840m と異なるため、比較の際は 1,118m で統一し、本調査案の一部取付橋区間(278m)を含める。

(3) Pre-F/S の初期建設費は、メトロ 3 号線の軌道分が含まれ、道路の機電計画も異なるため、比較検討の際は土木工事費のみを対象とする。

(4) 上記(1)について、比較の際は Pre-F/S の初期建設費を幅員減の分(1.2%)を割引く。

(5) Pre-F/S の維持管理費に橋面舗装の基層・防水層改修が含まれていないため、比較検討の際は、本調査と同じ頻度・単価で算出した金額を Pre-F/S の維持管理費に追加する。

(6) 維持管理費は、JICA 提案として、割引率 4%で割掛けたコストに調整する。

第2章　　主橋計画の概要

2.1　計画位置

図 2.1 に主橋位置図を示す。

出典:Pre-F/S(ドラフト・ファイナル・レポート(2013 年 11 月))(運河庁)

図 2.1　主橋位置図

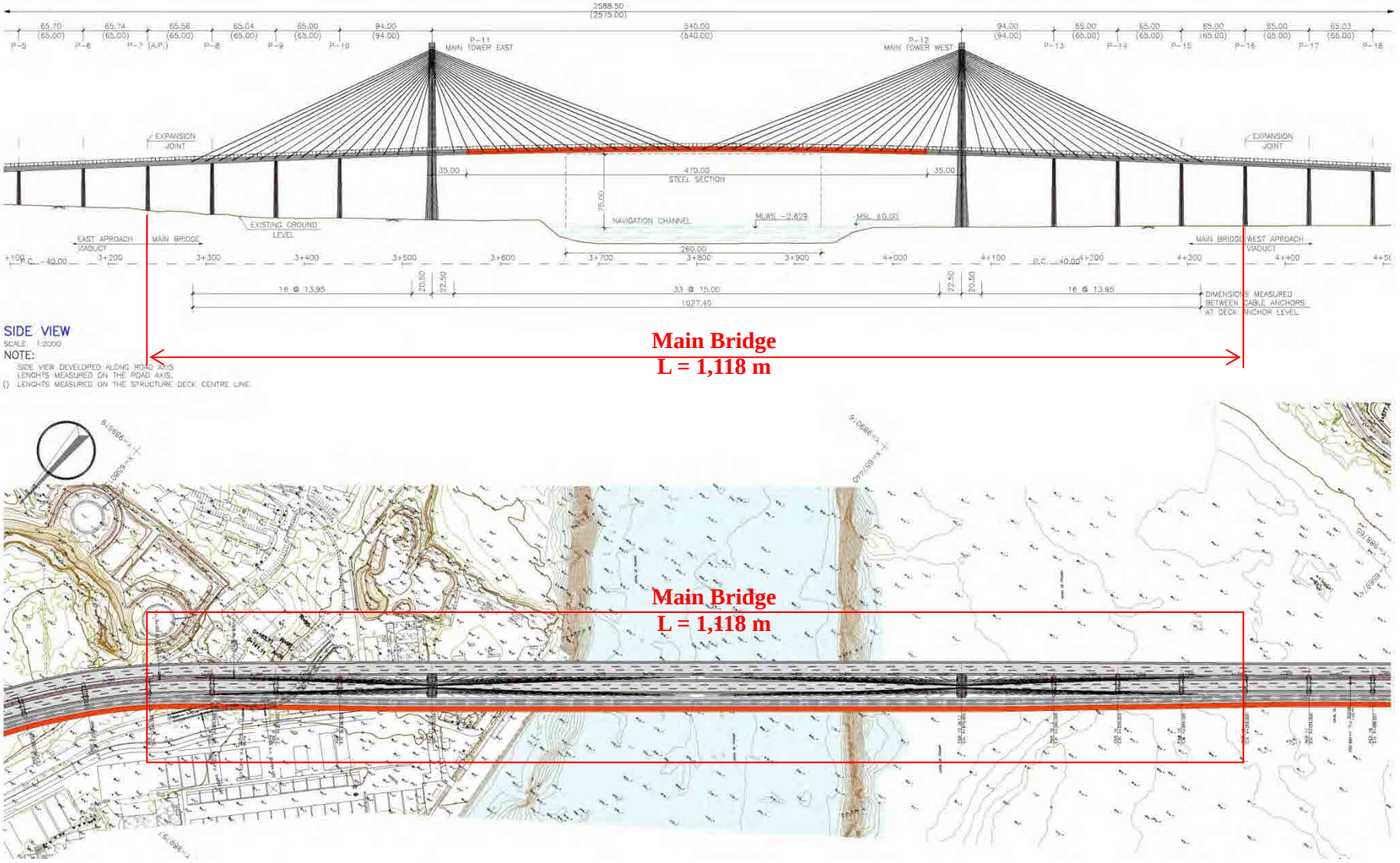
2.2　計画概要

表 2.1 に主橋計画概要、図 2.2 に主橋一般図を示す。

表 2.1　主橋計画概要

No.	項目		計画
1	起終点	起点	P7 橋脚
2		終点	P16 橋脚
3	橋長	橋長	1,118m
4	支間割	支間割	3@65m+94m+540m+94m+3@65m
5	横断構成	車線数	片側 3 車線
6		総幅員	54.3m
7		有効幅員	40.2m
8		幅員構成	4.5m+9.0m(メトロ)+1.2m+3@3.65m+1.2m+1.2m+3@3.65m+1.2m
9	橋梁構造	上部工	合成桁及びコンクリート桁斜張橋
10		下部工	Y 型 RC 橋脚
11		基礎工	直接基礎、杭基礎(φ2.25m)
12	施工計画	架設方法	片持式架設
13		施工工期	4 年
14	積算	初期建設費	USD 426 million(土木以外を含む)
15		維持管理費	DR=2.5% : USD 31 million (100 年、土木以外を含む) DR=5.0% : USD 14 million (同上)

出典:Pre-F/S(ドラフト・ファイナル・レポート(2013 年 11 月))(運河庁)



出典:Pre-F/S(ドラフト・ファイナル・レポート(2013 年 11 月))(運河庁)

図 2.2　主橋一般図

第3章　　計画・設計条件

3.1　計画条件

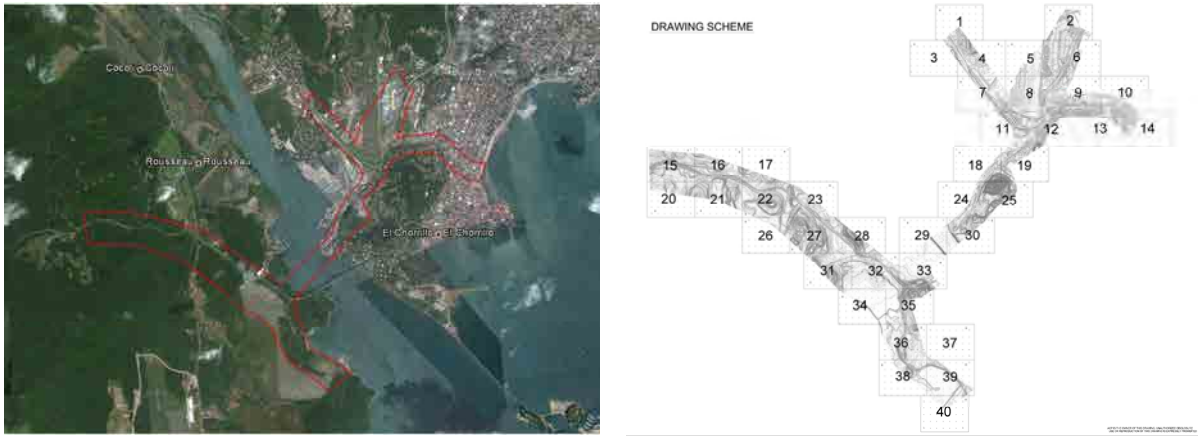
3.1.1 地形条件

(1) Pre-F/S の内容

日本の経済産業省と米国航空宇宙局は、共同で人工衛星搭載センサ「ASTER」を用いてASTER 全球3次元地形データの整備を進めている。上記の地形図のもととなるものは、これから取得したASTER-DRM をもとに次に示す仕様でデータ化したものである。

- 10m コンタ CAD/世界測地系(WGS84)/UTM(ユニバーサル横メルカトル図法)

Pre-F/S 本調査で使用した地形データを示す。



出典:Pre-F/S(ドラフト・ファイナル・レポート(2013 年 11 月))(運河庁)

図 3.1　Pre-F/S 調査で使用した地形データ

(2) コメント及び確認事項

予備設計時において上記地形図の精度を高めるために PTK-GPS による細部測量を実施されており、比較的精度は高いと考えられる。

(3) 本調査との比較における取扱い

本調査では Pre-F/S と同じ地形データを利用するため、比較の際は同条件として扱う。

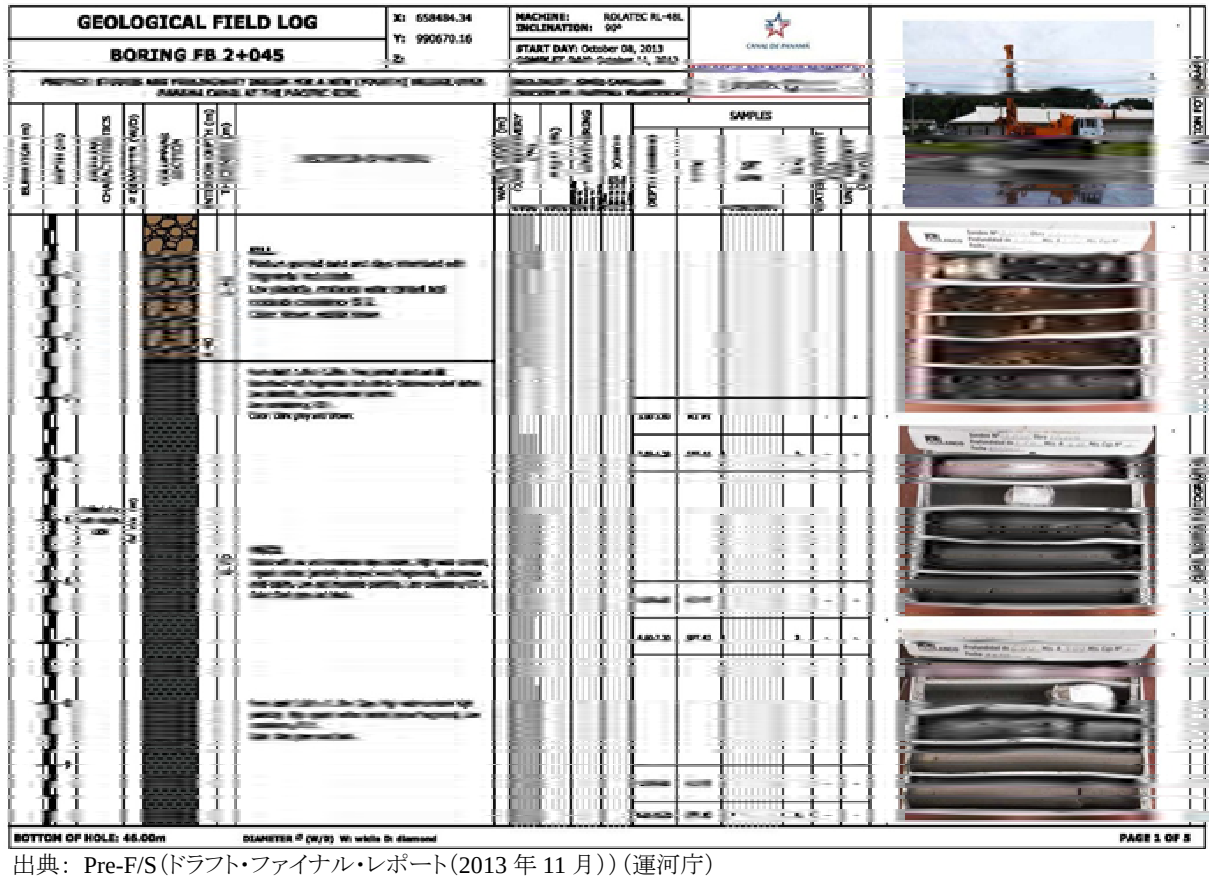
3.1.2 地質条件

(1) Pre-F/S の内容

ボーリング調査は、全部で 48 か所(本線橋:46 か所、西側連絡橋梁:2 か所)実施している。

(2) コメント及び確認事項

それぞれのボーリング柱状図には、コアの写真とともに地質状況が示されており、N値等も示されており、コンセプトデザイン時に用いていた既存の地質データに比べ精度が高いことが確認できる。



出典: Pre-F/S(ドラフト・ファイナル・レポート(2013 年 11 月))(運河庁)

図 3.2　ボーリング柱状図

(3) 本調査との比較における取扱い

本調査では Pre-F/S と同じ地質データを採用するため、比較の際は同条件として取り扱う。

3.1.3 航路条件

(1) Pre-F/S の内容

航路条件は、以下のとおりである。

【クリアランス】75m

【航路幅】224.8m (Current Navigational Prism Line)

260.09m (Future Navigational Prism Line)

(2) コメント及び確認事項

本設計では、ACP より以下の航路条件を提示された。

【クリアランス】75m

【航路幅】300.5m　(NEW PRISM LINE)

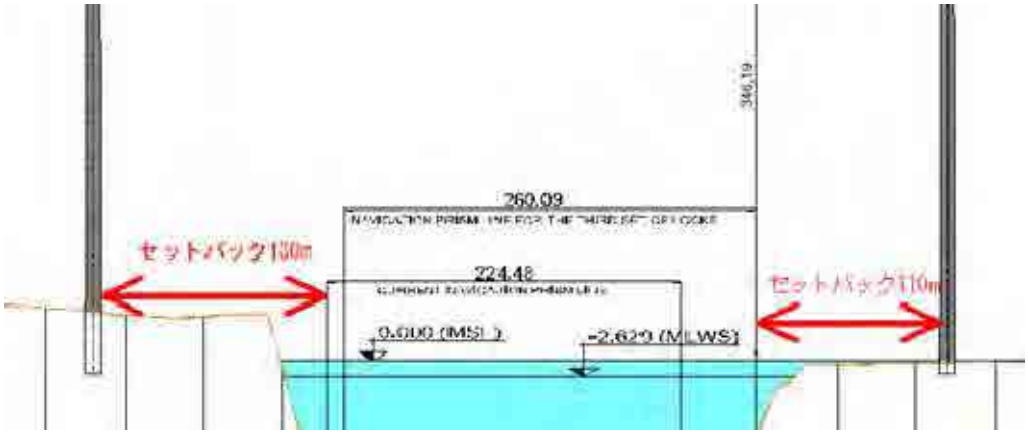
Pre-F/S では、関係機関と協議を重ね、第 4 パナマ運河橋主橋の橋脚位置の合意を取得している。橋脚位置は、パナマ運河の Prism Line から十分なセットバック量が確保されているため、本調査では、Pre-F/S の橋脚位置に沿い、主径間長を 540m とした。

なお、Prism Line が Pre-F/S と本調査で異なるため、セットバック量は若干異なるが、両者とも Pre-F/S の船舶衝突シミュレーションの結果(西側セットバック>100m)を満足している。

表 3.1　セットバック量の比較

	Pre-F/S	本調査
東側セットバック	130m	119m
西側セットバック	100m	120m

出典:本調査



出典:Pre-F/S(ドラフト・ファイナル・レポート(2013 年 11 月))(運河庁)

図 3.3　航路条件

(3) 本調査との比較における取扱い

本設計の中央支間は Pre-F/S の主塔間距離と同じ条件を採用しており、いずれも航路条件のセットバックは担保されている。従って比較の際は同条件として取り扱う。

3.1.4 空域条件

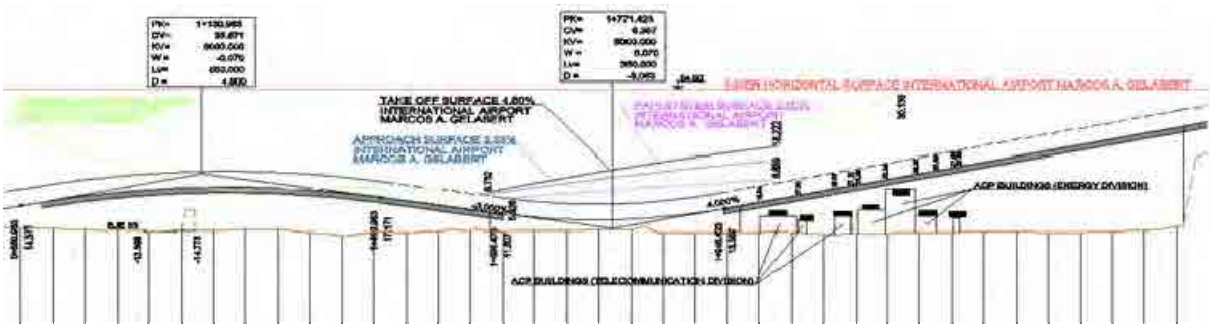
(1) Pre-F/S の内容

パナマ国航空庁(AAC)の空域の制限に準拠し、以下のとおりとしている。

表 3.2　制限表面条件

No.	項目	制限表面
1	水平表面	54.5m(半径 4km)
2	水平上面	129.5m
3	転移表面	14.3%
4	進入表面	3.3%
5	PAPI システム	2.0%

出典:パナマ国航空庁



出典:Pre-F/S(ドラフト・ファイナル・レポート(2013 年 11 月))(運河庁)

図 3.4　制限表面条件

(2) コメント及び確認事項

アルブルック国際空港の空域条件については、パナマ国航空庁の基準に準拠されている。運河の西側に位置するハワード空港については制約条件等を確認できなかったが、滑走路端からおよそ 4km の離隔を有している。

(3) 本調査との比較における取扱い

本調査は Pre-F/S と同じ空域条件により計画するため、比較の際は同条件として取り扱う。

3.1.5 交差条件

(1) Pre-F/S の内容

縦断のクリアランスについては、5.5m を確保している。

表 3.3　Pre-FS 縦断のクリアランス

VERTICAL PARAMETERS	DESIGN SPEED	
	100 km/h	90 km/h
Minimum gradient %	0.5	0.5
Maximum gradient %	5	5
Minimum sag vertical curve K	45	38
Minimum crest vertical curve K	52	39
Vertical clearance for roads (m)	5.5	5.5
Vertical clearance railway (m)	9.15	9.15
Minimun vertical clearance for Panama Canal (m) above mean low water springs (MLWS)	75	75

出典:Pre-F/S(ドラフト・ファイナル・レポート(2013 年 11 月))(運河庁)

(2) コメント及び確認事項

道路のクリアランスは、AASHTO の基準等での建築限界 4.9m に余裕を見込んだ値と推測できる。また、メトロについては、車両に必要なクリアランスを見込んでいる。

(3) 本調査との比較における取扱い

本調査の道路計画は、Pre-F/S と同じ AASHTO に基づいた最低限必要な建築限界(4.9m)に余裕を見込んだクリアランスを確保した計画としている。モノレールについても、最低限必要な建築限界に余裕を見込んだクリアランスを確保している。

主橋区間においては、いずれの案も橋面上に道路と軌道が配置されるため、比較の際は同条件として取り扱う。

3.1.6 架設条件

(1) Pre-F/S の内容

Pre-F/S における主橋の架設はメインケーブル利用した片持ち式架設工法であり、船舶への影響を避けたものとしている。

(2) コメント及び確認事項

片持ち式架設工法は水上における長大斜張橋としては多くの実績を有する一般的工法で、船舶への影響を最小とした妥当な架設計画である。本調査が提案するアーチ橋の架設工法については水上利用した架設も考えられるため、運河の航路利用について確認が必要である。

(3) 本調査との比較における取扱い

斜張橋の架設工法は橋梁形式に適した妥当な工法であると判断されるため、比較の際は Pre-F/S 案のとおり取り扱う。本調査の架設工法については、航路利用できる場合とできない場合について検討を行う。

3.1.7 メトロ 3 号線の配置位置

(1) Pre-F/S の内容

主橋区間におけるメトロは、北側に配置されている。当初は、中央配置を検討されていたが、アプローチ区間における影響を考慮して北側配置する計画とされている。

(2) コメント及び確認事項

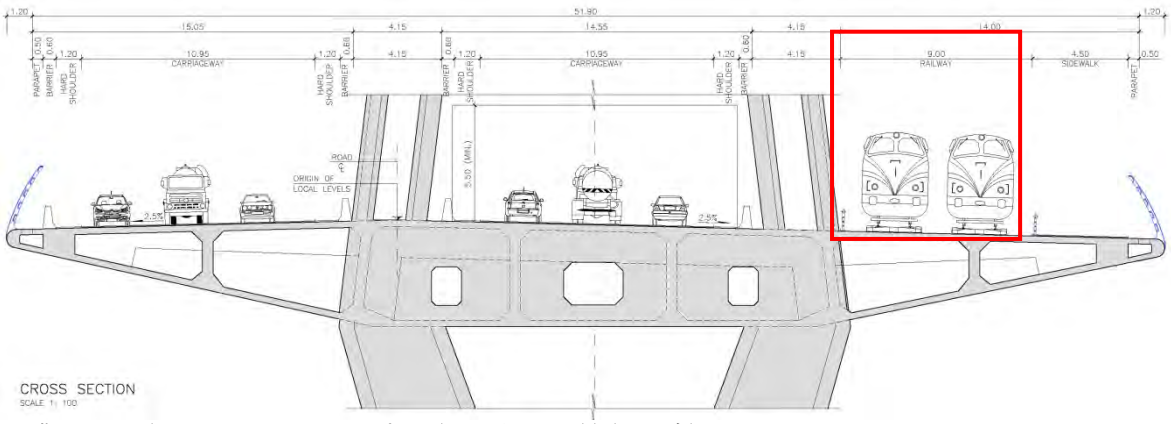
コンセプトデザインレポートの冒頭で、片側配置におけるアプローチ部でのメリットを以下のように述べている。

- 道路と鉄道との交差が生じないため、交差の際に生じる特別な構造的な対処は必要ない
- 道路部分を一つの橋脚に集約できるため、橋脚の数を 3 つから 2 つに減らせる
- 構造的に統一感が図れるため、景観的にも優れた構造となる

しかしながら、メトロの配置は、北側の配置となっているため、第 4 橋の両側メトロの駅が南側(Balboa, Panama Pacific に計画されているため、実際にはアプローチ部分で道路との交差が生じる。そのため、実際には、上記のような構造となる区間はあまり見られず、上部工は、1 及び 3 分離、また下部工は、1～3 分離の構造物となっている。

メトロと道路との一体化区間は、切土部から終点側の橋梁区間である。

メトロの幅員は、メンテナンス等を考慮して 9m としている。また、その外側には、歩道 4.0m が設置されている。



出典:Pre-F/S(ドラフト・ファイナル・レポート(2013 年 11 月))(運河庁)

図 3.5　主橋断面

(3) 本調査との比較における取扱い

本調査におけるモノレールの配置は、比較検討を行いメトロ庁との調整を踏まえて南側としている。軌道の配置は北側と南側とで異なるが、対象となる主橋区間では同じ橋面上に配置されているため、比較の際は同条件として取り扱う。

なお、軌道の占有幅については Pre-F/S 案のメトロリニアが 9m、本調査案のモノレールが 8.4m としているため、比較の際はモノレールで統一するために、Pre-F/S の幅員マイナス 0.6m の補正を加えるものとする。

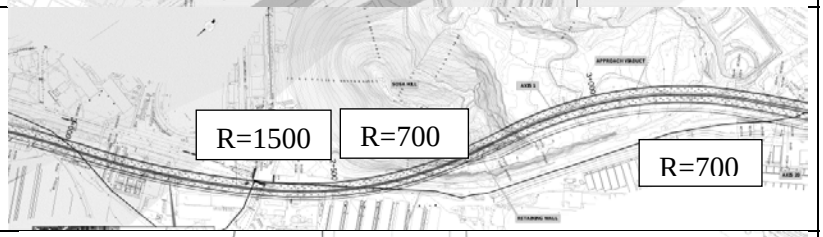
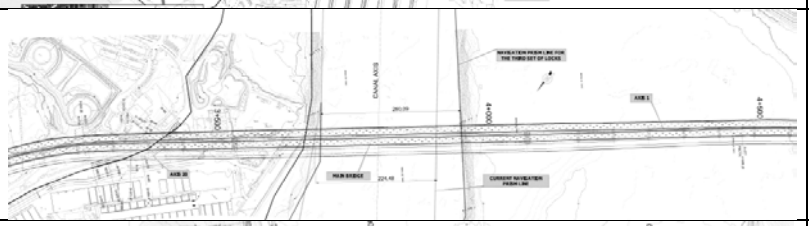
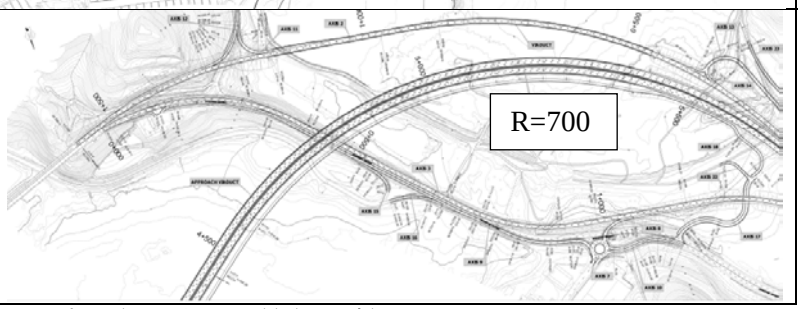
3.2　設計条件

3.2.1 線形計画

(1)　Pre-F/S の内容

道路の線形要素は、以下のとおりである。

表 3.4　Pre-FS 縦断のクリアランス

フライオーバー1	
フライオーバー2 東側アプローチ橋	
主橋	
西側アプローチ橋 アメリカ橋連絡橋	

出典:P re-F/S(ドラフト・ファイナル・レポート(2013 年 11 月))(運河庁)

(2)　コメント及び確認事項

道路区間の最小平面曲線半径は R=435m が採用されており、主橋区間については直線で計画されている。

(3)　本調査との比較における取扱い

本調査ではモノレール計画と空港の制限表面を考慮した線形計画を検討している。主橋区間の線形については Pre-F/S と同様に直線で桁下クリアランスは 75m の航路を確保しており同じ条件であるため、比較の際は同条件として取り扱う。

3.2.2 設計耐用年数

(1) Pre-F/S の内容

橋梁の設計耐用年数は、120 年を想定されている。また、各構成要素の耐用年数は以下に示すとおりである。

表 3.5 Pre-FS における各構成要素の設計耐用年数

Structural Component	Design Life [years]
Foundations	120
Piers	120
Concrete Deck	120
Bearings (minor components shall have service life of 20 years)	50
Movement Joint (minor components shall have service life of 20 years)	50
Parapets (metal parts only)	50
Parapets (concrete parts only)	120
Drainage System	20

出典:Pre-F/S(ドラフト・ファイナル・レポート(2013 年 11 月))(運河庁)

(2) コメント及び確認事項

AASHTO における設計耐用年数は 75 年、日本では 100 年である。Pre-F/S のおける設計耐用年数は 120 年としているが、実質的には、100 年で LCC を算定している。

(3) 本調査との比較における取扱い

本調査における設計耐用年数は Pre-F/S と同じ 100 年としているため、比較の際は同条件として取り扱う。

表 3.6 本調査における設計耐用年数

構造構成要素	設計耐用年数[年]
基礎	100
橋脚	100
床板	100
支承	100
伸縮装置	40
パラペット(鋼橋)	100
パラペット(コンクリート橋)	100
排水工	50

出典:調査団

3.2.3 設計活荷重

(1) Pre-F/S の内容

自動車の活荷重については、AASHTO に準拠し Hl-93 を用いている。

メトロの荷重については、Pre-F/S レポートのものが、EN 1991-2:2013(ユーロコード)のモデル SW/O の荷重を用いており、軌道桁の死荷重(44kN/m)、活荷重(66.5kN/m)となっている。

This load is defined in Clause 6.3.3. Of the aforementioned standard, and it is illustrated in Figure 10.54, where q_{vk} = 133kN/m, a = 15m and c = 5.3m (see EN 1991-2:2003, Table 6.1).

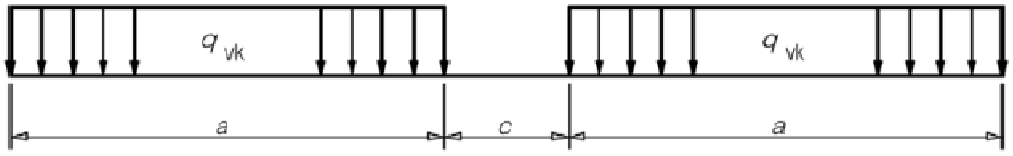


Figure 10.55 – Load Model SW/0 (from EN 1991-2:2003)

The characteristic value of q_{vk} given above is multiplied by a factor, α =0.5 , to account for light rail metro loading. This gives a classified vertical load of 66.5 kN/m which is applied to the structure.

出典:Pre-F/S(ドラフト・ファイナル・レポート(2013 年 11 月))(運河庁)

図 3.6　Pre-FS におけるメトロの設計荷重

(2) コメント及び確認事項

本調査では、メトロの荷重についてはモノレールを想定し、活荷重としており、Pre-F/S より重い荷重を想定している。

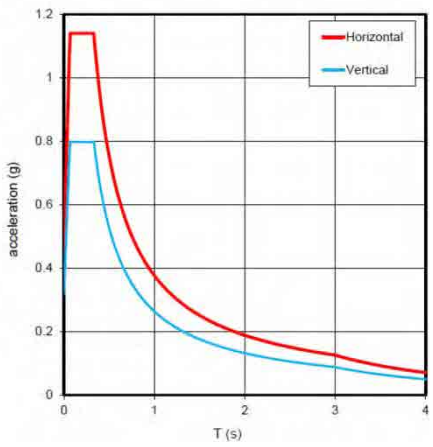
(3) 本調査との比較における取扱い

本調査での自動車荷重については、Pre-F/S と同様に HL-93 を採用している。メトロ荷重の差はあるものの死荷重を含めた主橋全体の荷重を考慮するとその差は微少と判断されるため、比較の際は同条件として取り扱う。

3.2.4 地震時荷重

(1) Pre-F/S の内容

- 加速度応答スペクトル: 再現期間：2475 年



出典:Pre-F/S(ドラフト・ファイナル・レポート(2013 年 11 月))(運河庁)

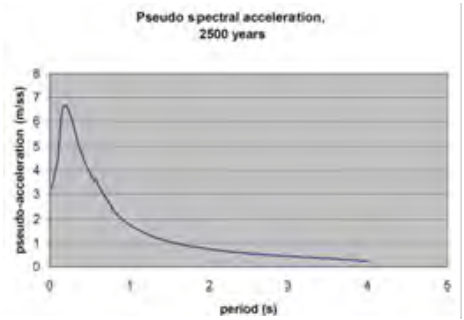
図 3.7　地震時応答スペクトル

(2) コメント及び確認事項

地震応答スペクトルは、Pre-F/S レポートのものが、ASCE(AMERICAN SOCIETY OF CIVILENGINEERS)でのスペクトル形状を用いている。しかしながら、これから地震時荷重をどうやって算定したかについてはレポートに記載されておらず、確認することができなかった。

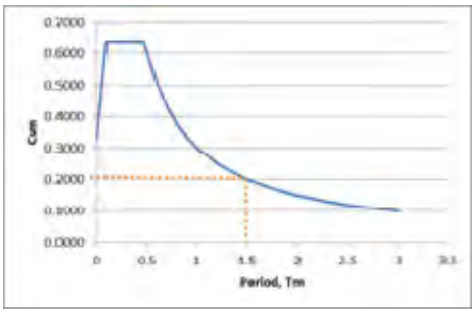
(3) 本調査との比較における取扱い

- 加速度応答スペクトル　再現期間:2500 年



出典:「SEISMIC HAZARD ASSESSMENT OF THE SECOND PANAMA CANAL CROSSING」

図 3.8　応答スペクトル



出典:調査団

図 3.9　設計地震荷重

本調査においては、第2橋(センテナリオ橋)を設計する際に行った調査(「SEISMIC HAZARD ASSESSMENT OF THE SECOND PANAMA CANAL CROSSING」)での調査結果を用いることで 運河庁(ACP)及びメトロ庁(SMP)と合意した。しかしながら、形状としては、両者とも似た形状を示している。設計水平震度については、Pre-F/S の地震荷重を分析し同等の地震荷重を採用しているため、比較の際は同条件として取り扱う。

3.2.5 設計風荷重

(1) Pre-F/S の内容

設計風速について、スペイン F/S は、実測データをもとにした 50 年確率での最大風速 86km/h を用いている。

86km/hr(実測値:50 年確率)

(2) コメント及び確認事項

Pre-F/S のレポートにおいて 50 年とした根拠は確認できなかったが、センテナリオ橋については、AASSTO に準拠した 100 年確率での風速値を用いている。Balboa FAA における 100 年確率の最大風速とパナマ独自の基準を比較した結果、パナマ独自の基準が上回っているため、本調査ではパナマ基準の 115km/hr を採用する。

表 3.7　設計風荷重

	実測値(Balboa FAA)		パナマの基準(REP)
	50 年確率	100 年確率	
設計風速	86km/hr	93.7km/hr	115km/hr

出典:本調査

(3) 本調査との比較における取扱い

本調査の風荷重強度は Pre-F/S よりもわずかに上回っているものの、風荷重が構造設計において卓越したものではなくその影響は微少と判断されるため、比較の際は同条件として取り扱う。

3.2.6 設計温度荷重

(1) Pre-F/S の内容

Balboa FAA での気象観測データを用いて温度荷重を以下のとおりとしている。

最大値　39.84℃

最低値　19.77°

ΔT=19.77

(2) コメント及び確認事項

最大値、最低値は、50 年確率での実測データに基づいた気温である。

(3) 本調査との比較における取扱い

本調査においては、1985 年～2012 年の気象観測データ(Balboa FAA)に基づき平均気温を 27℃とし、LRFD に準拠して±10℃の温度差を見込んだ最大・最小値を設定しており、Pre-F/S との差は同じ(Δt=20℃)である。従って、比較の際は同条件として取り扱う。

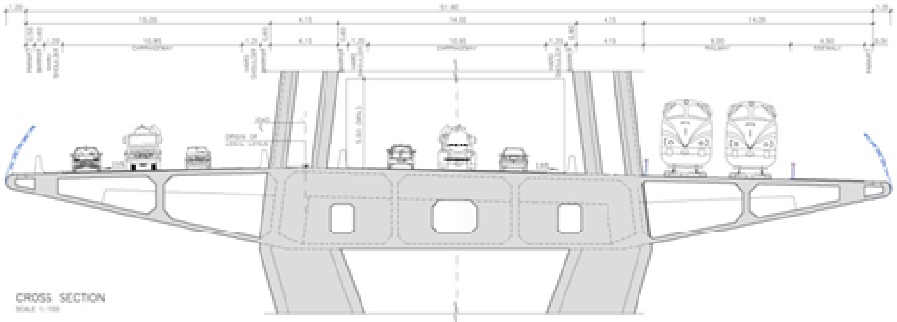
第4章　　横断構成

(1)　Pre-F/S の内容

表 4.1　横断構成要素

標準横断構成 Bridge Cross Section	Width
防風壁 Parapet Upstand/Wind Shield	1.70m
高欄 Barrier	0.60m
路肩 Hard Shoulder（Onside）	1.20m
車線 3no. Traffic Lanes	10.95m
路肩 Hard Shoulder（Offside）	1.20m
高欄 Barrier	0.60m
ケーブル及び塔 Cable Support Zone/Tower Leg Clearance Zone	Varies （1.38m to 4.15m）
高欄 Barrier	0.60m
路肩 Hard Shoulder（Onside）	1.20m
車線 3no. Traffic Lanes	10.95m
路肩 Hard Shoulder（Offside）	1.20m
高欄 Barrier	0.60m
ケーブル及び塔 Cable Support Zone/Tower Leg Clearance Zone	Varies （1.38m to 4.15m）
メトロ Trackway Transverse Clearance	9.00m
境界 Separation Barrier	0.50m
歩道 Sidewalk and Cycleway	4.00m
防風壁 Parapet Upstand/Wind Shield	1.70m
総幅 Total Width	48.0m～54.0m

出典：Pre-F/S（ドラフト・ファイナル・レポート（2013 年 11 月））（運河庁）



出典：Pre-F/S（ドラフト・ファイナル・レポート（2013 年 11 月））（運河庁）

図 4.1　主橋の標準断面

(2)　コメント及び確認事項

メトロの幅員は、9m であり、本調査の 8.4m と異なる。ケーブル及び主塔を設置するスペースについては、側径間の区間で 4.15～1.38 に擦り付けられ、擦り付けが終わったアプローチ橋の一般部での上下線間の離れは、1.0m としている。

(3)　本調査との比較における取扱い

メトロ 3 号線のシステムについて Pre-F/S はメトロリニアの幅員 9m としており、本調査ではモノレール 8.4m としている。比較においては同じシステム、幅員で比較することが妥当と判断し、モノレール幅で統一して Pre-F/S の幅員をマイナス 0.6m とする。

第5章　橋梁計画・設計

5.1　橋長及び支間割

(1)　Pre-F/S の内容

各橋梁の橋長、支間割は、以下に示すとおりである。

表 5.1　Pre-F/S における橋長及び支間割

名称	橋種	橋長	支間割
主橋(Main Bridge)	斜張橋	1118m	289m/540m/289m
東側アプローチ橋 (East Approach Bridge)	PC 箱桁	435m	65m/45m/32m
西側アプローチ橋 (West Approach Bridge)	PC 箱桁	1022m	65m/45m/32m
フライオーバー1(Bridge1)	PC 箱桁	709.2m(704.5m)	24.28m/60m
フライオーバー2(Bridge2)	PC 箱桁	768m(748m)	40m/42m/57m
西側アメリカ橋連絡橋(Bridge3)	PC 桁	721m	30m

出典:Pre-F/S(ドラフト・ファイナル・レポート(2013 年 11 月))(運河庁)

(2)　コメント及び確認事項

斜張橋の主塔間距離は、航路条件をもとに支間長を決めている。アプローチ橋梁やその他の橋梁についても、交差道路等を考慮した支間割となっている。主橋の支間割は 289m+540m+289m となっているが、これは鋼斜張橋の支間割であり、複合斜張橋の最適な支間割ではない。複合斜張橋の側径間:中央径間の最適比率は 0.3:1.0 である

(3)　本調査との比較における取扱い

本調査におけるアーチ中央径間は Pre-F/S と同様の航路条件をもとに設計されている。橋長及び支間割は以下に示すとおりである。主橋の橋長については、Pre-F/S 案が 1,118m、本調査案が 840m と異なるため、比較の際は 1,118m で統一し、本調査案の一部取付橋区間(278m)を含める。

表 5.2　本調査における橋長及び支間割

名称	橋種	橋長	支間割
主橋(Main Bridge)	アーチ	840m	150m/540m/150m
東側アプローチ橋 (East Approach Bridge)	鋼箱桁	533m	43m/60m/50m/90m/100m /100m/90m
西側アプローチ橋 (West Approach Bridge)	鋼箱桁 PC-I 桁	810m 360m	90m/100m@3/80m/60m@5/40m 40m@9
フライオーバー1 (Flyover1)	PC-I 桁 鋼箱桁	270m 250m	40m@2/30m/40@4 50m/60m@2/45m/35m
フライオーバー2 (Flyover2)	PC-I 桁 鋼箱桁	260m 480m	40m@5/30m@2 60m/90m@4/60m
西側アメリカ橋連絡橋 (Access Bridge)	PC-I 桁	760m	40m@9/40m@10

出典:本調査

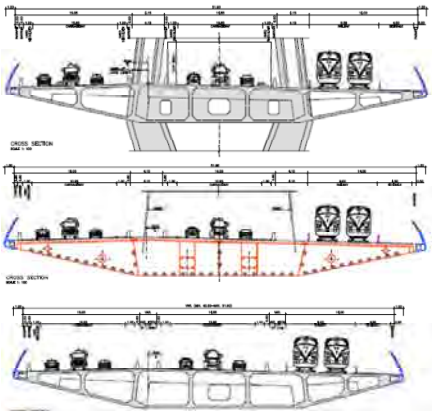
5.2　上部工設計

5.2.1 上部工形式

(1)　Pre-F/S の内容

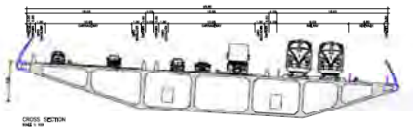
① 主橋(Main Bridge) 3+240.396～4+359.0

斜張橋の中央径間は 540m であり、そのうち 470m が合成桁斜張橋となっており、バックスパンの 578m(289m×2)と中央径間の両サイド 70m(35m×2)部分がコンクリート桁斜張橋となっている。



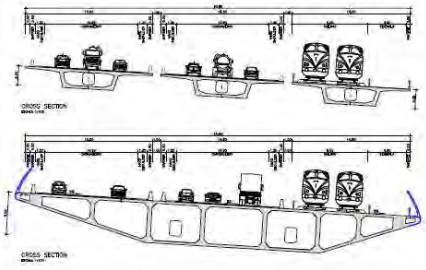
② 東側アプローチ橋(East Approach Viaduct) 2+801.345～3+240.396

東側のアプローチ橋梁は、R700 の曲線橋であり、上部工は、1Box のコンクリート箱桁(桁高 5m)が採用されている。



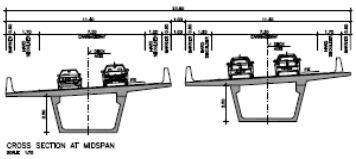
③ West Approach Viaduct 4+801.345～5+389.840

上部工の形状は、2 種類に分かれており、P26 より起点側のスパンが長くなる区間については、東側と同様に、桁高 5m のコンクリート箱桁(1Box)が採用されており、それより終点側のスパン割が短くなる区間については、桁高 2.25m のコンクリート箱桁が 3Box で計画されている。



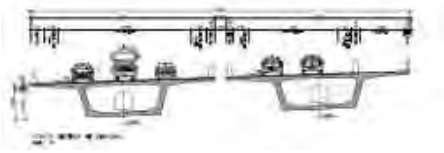
④ Viaduct 0+882 and 1+600

Omar インターチェンジを超える区間は、S字カーブの高架橋梁が 2 車線で計画されている。上部工は、コンクリートの連続 PC 箱桁が上下線それぞれで採用されている。桁の厚さは、P13 橋脚を境として、スパン長さが長くなる区間については、2.9m で、P13 橋脚より終点側のスパン長さが短くなる区間については、1.55m となっている。また、スパン割が 60m を超える区間については、桁厚を 2.9m～3.9m に変化させている。



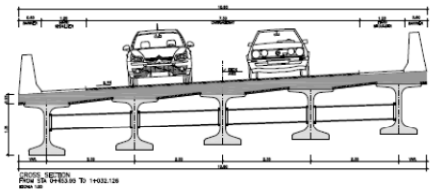
⑤ Viaduct 1+944 and 2+770

ルーズベルト通りの北側を通過する区間は、片側 3 車線の高架橋で計画されている。上部工形式は、Omar 交差点部と同じく、コンクリートの連続PC箱桁橋が採用されている。橋長は 708m で、スパン割は 24m～57m で計画されている。



⑥ Link Road　0+450～1+170

西側のアメリカ橋は、2 車線で計画されており、上部工は、コンクリートのプレキャスト桁が採用されている。橋長は、720m で、スパン長 30m である。



(2)　コメント及び確認事項

橋種類については、コンセプトデザインにもとづき主橋は鋼製斜張橋、アプローチ橋はすべてコンクリート橋梁形式であり、支間割に対して妥当な形式である。

(3)　本調査との比較における取扱い

主橋形式は Pre-F/S のとおりとするが、主橋の橋長が本調査案と異なるため、比較の際は Pre-F/S の 1,118m に統一し、本調査案の一部取付橋区間を含める。

表 5.3　本調査における上部工形式

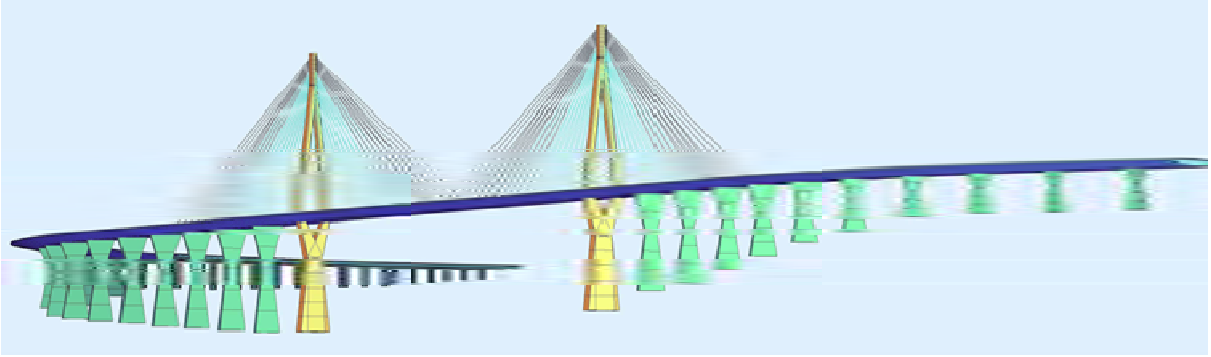
名称	Pre-F/S	本調査
主橋(Main Bridge)	斜張橋	アーチ橋
東側アプローチ橋 (East Approach Bridge)	PC 箱桁	鋼箱桁
西側アプローチ橋 (West Approach Bridge)	PC 箱桁	鋼箱桁 PC-I 桁
フライオーバー1	PC 箱桁	PC-I 桁 鋼箱桁
フライオーバー2	PC 箱桁	PC-I 桁 鋼箱桁
西側アメリカ橋連絡橋	PC 桁	PC-I 桁

出典:本調査

5.2.2 上部工解析・設計

(1) Pre-F/S の内容

全体モデルで解析が行われているが，モデル図・入力データのみが添付されている。



出典：Pre-F/S（ドラフト・ファイナル・レポート（2013 年 11 月））（運河庁）

図 5.1　構造設計モデル

(2) コメント及び確認事項

モデル図および入力データは確認されたが、解析結果および断面計算結果が添付されていないために確認できなかった。

(3) 本調査との比較における取扱い

Pre-F/S の構造解析は適切であると想定し、比較の際は同条件として取り扱う。

5.3　下部・基礎工設計

5.3.1 下部・基礎工形式

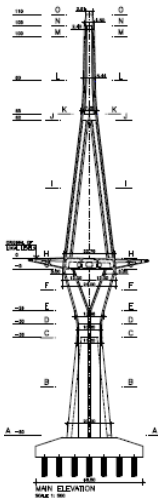
(1)　Pre-F/S の内容

① 主橋(Main Bridge) 3+240.396～4+359.0

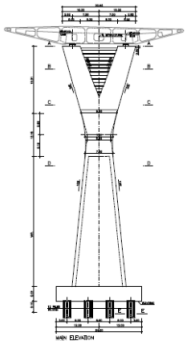
主塔高さは、路面から 150m であり、橋脚は、Y型形状の鉄筋コンクリートであり、基礎の天端から、路面までの高さは 80m である。

陸上側(東側)の主塔基礎は直接基礎、海上側(海側)は、φ2.25m の場所打ち杭を用いている

主塔



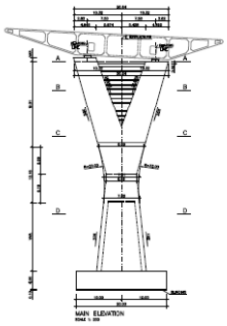
バックスパン橋脚



② 東側アプローチ橋(East Approach Viaduct) 2+801.345～3+240.396

橋脚は、鉄筋コンクリートのY型橋脚が採用されており、基礎形式は直接基礎を採用している。橋脚の高さが高いことから、Y 型の中空部分については、高さが 21m にも及ぶ。

一体型橋脚

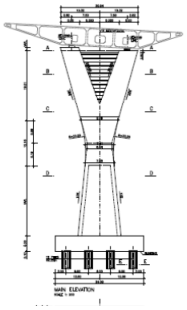


③ West Approach Viaduct 4+801.345～5+389.840

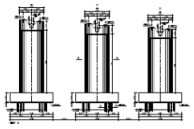
1Box 区間の形状は東側と同じY型橋脚であるが、基礎については杭基礎(φ2.25m)で計画されている。

3Box の区間については、3 つに橋脚を独立させ、それぞれの上部工を支えている。

一体型橋脚



独立型橋脚

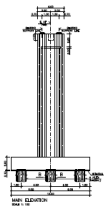


④ Viaduct 0+882and 1+600

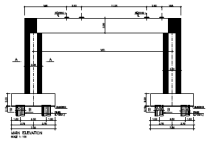
橋脚は、単柱式のものが採用されているが、水路などを跨ぐ箇所などにおいては、ポータルラーメン形式のものが採用されている。

基礎工については、杭基礎(φ1.5)が採用されている。

単柱式



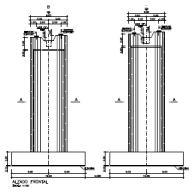
ラーメン型



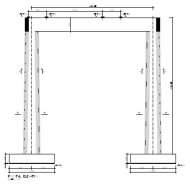
⑤ Viaduct 1+944 and 2+770

橋脚は、Flyover1 区間と同様に、単柱式のものとポータルラーメン式のものが採用されている。ラーメン式のものは、バルボア港の入口部の道路を跨ぐ箇所などで採用されている。基礎形式は、いずれも直接基礎を採用している。

独立

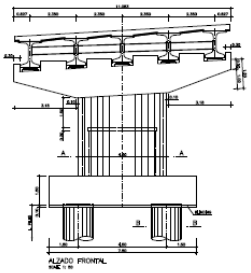


ラーメン型



⑥ Link Road 0+450～1+170

橋脚は張出し式が杭基礎(φ1.5m)で計画されている。



(2) コメント及び確認事項

基礎形式は主橋および西側アプローチ橋は杭基礎が採用され、東側アプローチ橋については直接基礎が採用されている。下部工形式は上部工形式と規模から妥当と考えられる。

(3) 本調査との比較における取扱い

下部工・基礎形式は妥当と判断し、比較の際は同条件として取り扱う。

表 5.4　本調査における下部工および基礎形式

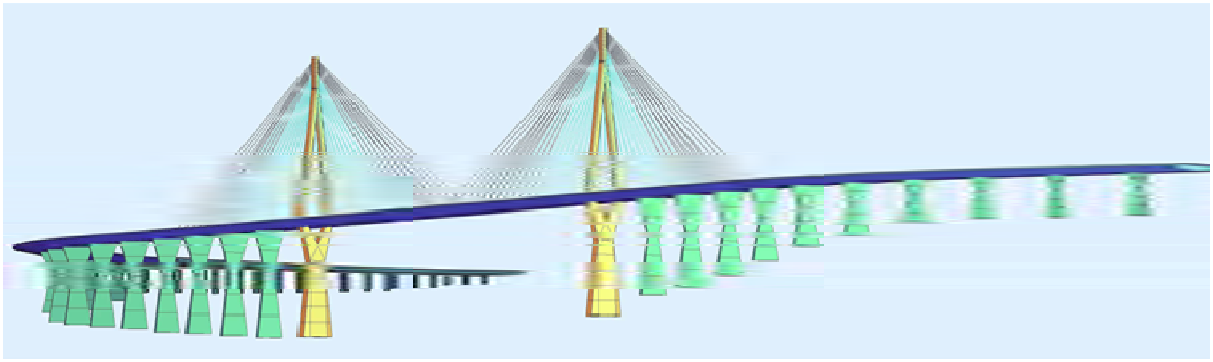
名称	Pre-F/S		本調査	
	橋脚	基礎	橋脚	基礎
主橋(Main Bridge)	ｺﾝｸﾘｰﾄ Y 型	杭基礎 (φ2.25)	ｺﾝｸﾘｰﾄ	直接基礎 鋼管矢板井筒基礎
東側アプローチ橋 (East Approach Bridge)	ｺﾝｸﾘｰﾄ Y 型	直接基礎	ｺﾝｸﾘｰﾄ門型	直接基礎
西側アプローチ橋 (West Approach Bridge)	ｺﾝｸﾘｰﾄ Y 型	杭基礎 (φ2.25)	ｺﾝｸﾘｰﾄ門型 張出し式	杭基礎 (φ1.8)
フライオーバー1	単柱式 ｺﾝｸﾘｰﾄ門型	杭基礎 (φ1.5)	張出し式 ｺﾝｸﾘｰﾄ門型	杭基礎 (φ1.5)
フライオーバー2	単柱式 ｺﾝｸﾘｰﾄ門型	杭基礎 (φ1.5)	張出し式 ｺﾝｸﾘｰﾄ門型	杭基礎 (φ1.5)
西側アメリカ橋連絡橋	張出し式	杭基礎 (φ1.5)	張出し式	杭基礎 (φ1.5)

出典:Pre-F/S(ドラフト・ファイナル・レポート(2013 年 11 月))(運河庁))

5.3.2 下部基礎工設計

(1) Pre-F/S の内容

全体モデルで解析が行われているが，モデル図・入力データのみが添付されている。



出典：Pre-F/S（ドラフト・ファイナル・レポート（2013 年 11 月））（運河庁）

図 5.2　構造設計モデル

(2) コメント及び確認事項

モデル図および入力データのみが添付されており，解析結果および断面計算結果が添付されていないため，検証ができない。

(3) 本調査との比較における取扱い

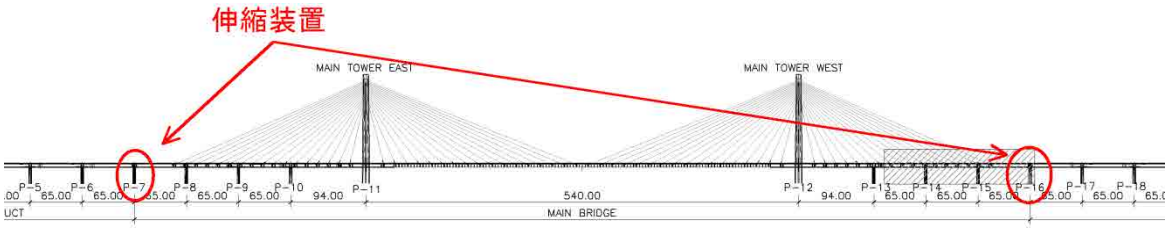
Pre-F/S は計画・設計条件から適切に解析がなされていると想定し、比較の際は同条件として取り扱う。

5.4　付帯工計画・設計

5.4.1 伸縮継手

(1)　Pre-F/S の内容

エクスパンションジョイントについては、P-7 橋脚と P-16 橋脚に設置する計画である。これについては、固有値解析の結果を踏まえジョイント長が 1500～3000mm 決められている。



出典:Pre-F/S(ドラフト・ファイナル・レポート(2013 年 11 月))(運河庁)

図 5.3　Pre-FS における伸縮継手の位置

表 5.5　Pre-FS における伸縮継手の計画

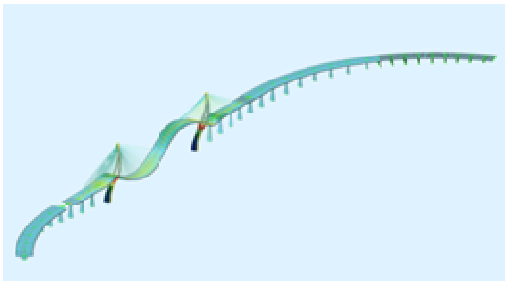
PRELIMINARY CONSTRUCTION COST ESTIMATE

Item	Unit	Quantity	Rate [$ / Unit]	Estimated Cost [$]
Substructure Sub-total				$166,500,697
Superstructure				
Bridge Deck				
Composite Deck	m^3	10,741	$668	$7,179,974
Concrete Deck	m^3	35,654	$991	$35,328,228
Formwork Deck				
Composite Deck - Exposed Surfaces	m^2	2,256	$150	$338,400
Concrete Deck - Exposed Surfaces	m^2	36,840	$150	$5,526,072
Concrete Deck - Hidden Surfaces	m^2	86,011	$100	$8,601,085
Reinforcement Deck				
Composite Deck	t	2,439	$2,950	$7,195,935
Concrete Deck	t	11,782	$2,950	$34,756,366
Prestressing Steel Concrete Deck	t	842	$16,400	$13,801,559
Composite Deck Structural Steel	t	9,757	$5,000	$48,786,000
Corrosion Protection of Steelwork	m^2	24,910	$100	$2,491,000
Cable Stays	t	1,972	$16,520	$32,580,979
Cable Stay Testing	Item	-	$750,000	$750,000
Expansion Joints (1500-3000mm)	m	104	$43,950	$4,562,010
Superstructure Sub-total				$201,897,608

出典:Pre-F/S(ドラフト・ファイナル・レポート(2013 年 11 月))(運河庁)

(2)　コメント及び確認事項

地震時においては、大きな変異が生じていると考えられる。



出典:Pre-F/S(ドラフト・ファイナル・レポート(2013 年 11 月))(運河庁)

図 5.4　固有値解析結果

移動量が大きいことで、モノレールが対応可能か確認する必要がある。もし，出来ない場合は変形を抑える工夫が必要となる。

(3)　本調査との比較における取扱い

伸縮装置の構造細目は不明であるが主構造に及ぼす影響は微少であるため、比較の際は同条件として取り扱う。

5.4.2 支承

(1) Pre-F/S の内容

使用する支承のタイプは，特に記述がない。

(2) コメント及び確認事項

支承は，斜張橋側径間の中間橋脚，取付橋の端部および PC-I 桁橋に使用されている。積算の際，どのタイプを想定したのか。

(3) 本調査との比較における取扱い

支承タイプは不明であるが設計に含まれていると想定し、比較の際は同条件として取り扱う。

5.4.3 歩道

(1) Pre-F/S の内容

Sta.2+50（Flyover2 の途中）～Sta.5+400（西側取付橋の終点）に渡り計画されている。

(2) コメント及び確認事項

歩道は，モノレールと隣接するまでは，車道に並列しており，モノレールと並列する際に，モノレールに隣接する計画となっている。モノレールが車道に並列する際，モノレールが歩道に交差することになり，交差する際の構造は不明である。

(3) 本調査との比較における取扱い

主橋区間における歩道配置は同じ条件であるため、比較の際は同条件として取り扱う。

5.4.4 検査路

(1) Pre-F/S の内容

斜張橋主塔内に検査用の階段を取り付けることにしている。また，その他の橋梁については，橋梁検査車により点検を行うと記述されている。

(2) コメント及び確認事項

取付橋も含め，橋種がすべてコンクリート橋のため，上部工に検査路を設けることは厳しいため妥当といえる。また，斜張橋中央径間の鋼補剛桁に関しては，補剛桁内部を利用することも可能である。

(3) 本調査との比較における取扱い

検査路の細目は不明であるが主構造におよぼす影響は微少と判断されるため、比較の際は同条件として取り扱う。

第6章 工事数量

(1) Pre-F/S の内容

工事数量は、道路区間と橋梁区間の大きく 2 つに分けて算定されている。

(2) コメント及び確認事項

詳細な数量算出根拠については不明である。

(3) 本調査との比較における取扱い

幅員は、Pre-F/S のメトロリニアの占有幅 9m、本調査のモノレールが 8.4m としているため、比較の際はモノレールで統一して Pre-F/S の幅員に 0.6m を減じた補正をする。

主橋の橋長については、Pre-F/S 案が 1,118m、本調査案が 840m と異なるため、比較の際は 1,118m で統一し、本調査案の取付橋区間(278m)を含めた比較とする。

第7章　施工計画

7.1　架設方法

(1)　Pre-F/S の内容

主橋メインスパンの上部工架設は、航路に影響しない主ケーブルを利用した片持ち式架設が採用されている。

また、アプローチ橋梁の上部工架設 については、送り出し工法が採用されている。メインスパンの桁架設は、アプローチ橋の桁架設の後に行われる。

(2)　コメント及び確認事項

斜張橋の架設工法は、構造規模からも実績があり妥当といえる。アプローチ橋に関しては、具体的な架設計画は確認できなかった。

(3)　本調査との比較における取扱い

主橋の架設方法は航路におよぼす影響が少なく問題ないと判断されるため、比較の際は Pre-F/S 案のとおり取り扱う。

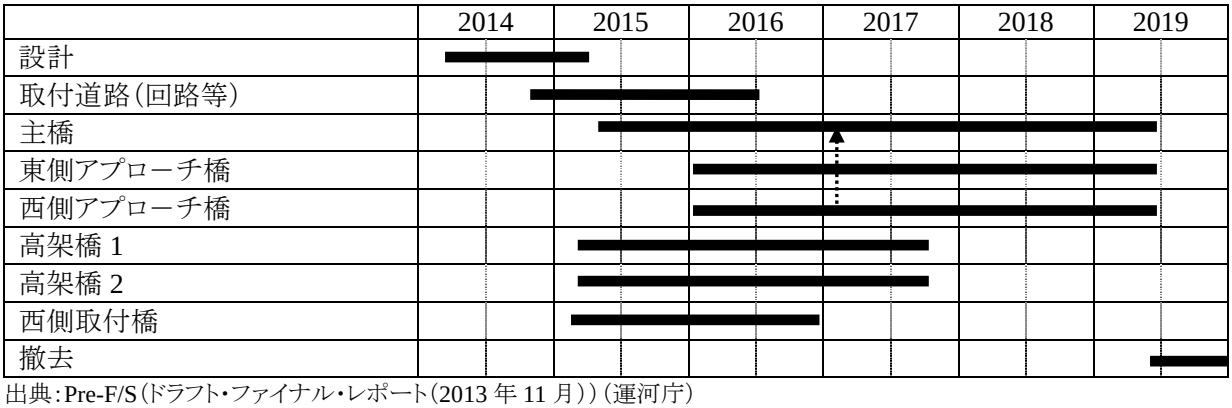
7.2　施工期間

(1)　Pre-F/S の内容

施工は、交通の迂回等を考慮しながら。路線全体を 5 段階に分け、約 5 年を要する。

主橋の建設には、4 ケ年を要する。

表 7.1　全体工程



出典:Pre-F/S(ドラフト・ファイナル・レポート(2013 年 11 月))(運河庁)

(2)　コメント及び確認事項

メインスパンの上部工架設は、27 日×18 ブロックで桁架設全工程を 1.5 年としている。

バックスパン部分については、スパンバイスパン工法を採用し、東側については、約 2 か月、また西側については、約 2 か月半の施工期間を要する。

(3)　本調査との比較における取扱い

主橋の比較において幅員の調整を行う必要があるが、施工工程におよぼす影響は微少と考えられるため、比較の際は Pre-F/S 案のとおり取り扱う。

第8章　積算

8.1　初期建設費

8.1.1 積算方法

(1) Pre-F/S の内容

単価設定は、第 3 橋梁と他の海上プロジェクトから設定しており，積み上げて設定してはいない。

架設機材が設定されない中で，どのように単価を設定したのか不明である。

単価について、各設計を比較すると以下のことが言える。

Pre-F/S レポートでは、コンセプトデザイン時に比べ、コンクリートの単価が下がっている（1,500$/m3→300$/m3）。逆に、鉄筋は、1700$/t→2,950$/t に上がってる。

材料調達，製作工場等の情報が無いため、何とも言えないところもあるが、鋼桁が 50 万円/t と非常に安価な金額が設定されている。

表 8.1　単価の比較

種類	単位	Pre-F/S	
		コンセプトデザイン	概略設計
鉄筋	t	$ 1,700	$2,950
コンクリート	m^3	$ 1,500	$300
鋼桁	t	$ 5,000	$5,000

出典：Pre-F/S（ドラフト・ファイナル・レポート（2013 年 11 月））（運河庁）

(2) コメント及び確認事項

単価設定根拠は確認できなかった。メトロ 3 号線のシステムは、Pre-F/S はメトロリニア（幅員 9m）、本調査はモノレール（8.4m）で異なる。また、主橋の橋長については、Pre-F/S 案は 1,118m、本調査案は 840m と異なる。

(3) 本調査との比較における取扱い

Pre-F/S の初期建設費は、メトロ 3 号線の軌道分が含まれ、道路の機電計画も異なるため、比較の際は土木工事費のみを対象とする。

8.1.2 初期工事費

(1) Pre-F/S の内容

工事費はコンセプトデザイン提出時よりも第 4 橋梁の初期コスト(主橋)が 100 億円増加している。理由としては、下部工の影響(特に杭)が大きい。

表 8.2　全体工事費

種類		単位	全体金額	ユニットコスト
道路		式	$35,095,177	
第 4 橋	主橋	〃	$425,759,347($326,498,413)	$7,552
	東側アプローチ	〃	$87,021,867($185,644,917)	$4,387
	西側アプローチ	〃	$231,482,014($204,601,040)	$5,799
	計	〃	$744,263,228	$6,409
東側高架橋 1		〃	$56,584,096	$3,321
西側高架橋 2		〃	$72,691,325	$3,186
西側連絡橋		〃	$25,492,020	$3,074
環境改善費(2%)			$18,682,517	
雑費(10%)			$93,412,585	
計			$1,046,220,949	
価格調整(2%)		〃	$20,924,419	
リスク対策(2%)		〃	$78,466,571	
工事費		〃	$1,145,611,939	

注記:( )内は、コンセプトデザイン時での工事費を示す。
出典:Pre-F/S(ドラフト・ファイナル・レポート(2013 年 11 月))(運河庁)

(2) コメント及び確認事項

上記金額のうち、土木工事費以外の金額は、以下のとおりとである。

表 8.3　メトロ工事費、および主橋の土木工事費以外の金額

Cost Items of Metro Line-3 and Other Than Civil Works	Cost ($)
Engineering and Construction Administration	15,124,924
Metro/LRT Overhead Line Equipment	111,800
Ballast, Sleepers&Track etc	72,670
Road Lighting	90,000
CCTV and Communication	47,629
Electrical System	3,120,814
Aviation Warning Light	20,000
Lighting Protection System	150,000
Navigation Cannel Lighting	30,000
Composite Deck Dehumidfer	100,000
Tower Dehumidefer	200,000
Total	19,067,837

出典:Pre-F/S(ドラフト・ファイナル・レポート(2013 年 11 月))(運河庁)

(3) 本調査との比較における取扱い

幅員については、Pre-F/S のメトロリニアが幅員 9m、本調査のモノレールが 8.4m としているため、比較の際はモノレールで統一し、Pre-F/S の幅員に 0.6m を減じた補正をする。比較の際は Pre-F/S の初期建設費に幅員増の分(1.2%)を割引く。

主橋の橋長については、Pre-F/S 案が 1,118m、本調査案が 840m と異なるため、比較の際は 1,118m で統一し、本調査案の取付橋区間(278m)を含める。

Pre-F/S 案における土木費のみの主橋コストは下表のとおりである。

表 8.4 Pre-F/S 案における主橋の修正済み初期工事費用

Main Bridge Cost (1+2)	**425,759,347 USD**
1. Main Bridge Cost (Civil Works)	406,691,510 USD
2. Items Other Than Civil Works (sum (a to k))	19,067,837 USD
a. Engineering and Construction Administration	15,124,924 USD
b. Metro/LRT Overhead Line Equipment	111,800 USD
c. Ballast, Sleepers&Track etc.	72,670 USD
d. Road Lighting	90,000 USD
e. CCTV and Communication	47,629 USD
f. Electrical System	3,120,814 USD
g. Aviation Warning Lights	20,000 USD
h. Lighting Protection System	150,000 USD
i. Navigation Channel Lighting	30,000 USD
j. Composite Deck Dehumidfer	100,000 USD
k. Tower Degumidifers	200,000 USD
Revised Initial Construction Cost (Civil Works of Main Bridge)	
USD406,691,510*(51.9m-0.6m)/51.9m=	401,989,874 USD

出典:本調査

8.2　維持管理費

(1)　Pre-F/S の内容

コスト算定期間は 100 年し、維持管理は，2.5%のディスカウントが入っているため，初期コスト比率が 10%程度になっている。

表 8.5　メンテナンスコスト

種類		単位	金額
第 4 橋	主橋	〃	$31,290,575(22,104,769)
	東側アプローチ	〃	$8,510,269(20,455,578)
	西側アプローチ	〃	$17,895,215(21,866,775)
東側高架橋 1		〃	$10,238,349
西側高架橋 2		〃	$11,127,546
西側連絡橋		〃	$5,324,114
計			$84,386,068

注記:( )内は、コンセプトデザイン時でのメンテナンスコストを示す。
出典:Pre-F/S(ドラフト・ファイナル・レポート(2013 年 11 月))(運河庁)

表 8.6　メンテナンスアイテム

Description	Unit	Unit Cost	Quantity	Item Cost
Preliminaries				
Safety Barriers	m	$190	4,474	$850,136
Drainage	m	$0.37	2,236	$820
Pavement	m^2	$4.50	993	$446,993
Metro/LRT CH	m	$50	2,236	$111,800
Ballast and Sleepers etc.	m^2	$0.80	10,062	$8,050
Road Signs / Markings	Item	-	-	$104,174
Road Lighting	no	$100	90	$9,000
Structural Concrete	-	-	-	$334,124
Steelwork	-	-	-	$241,484
Cable-stays	t	$16,520	1,972	$32,580,979
Bridge Bearings	no	$17,229	16	$275,664
Pedestrian Guardrails	m	$210	3,356	$704,718
Wind Barrier	m	$600	2,237	$1342,320
Bridge Expansion Joints	m	$43,950	104	$4,562,010
Aviation Warning Lights	Item	-	-	$20,000
Lightning Protection	Item	-	-	$150,000

出典:Pre-F/S(ドラフト・ファイナル・レポート(2013 年 11 月))(運河庁)

(2)　コメント及び確認事項

コンクリート補修および鋼材補修がまとめて計上されているため，内訳が不明である。また、維持管理費に橋面舗装の基層・防水層改修が含まれていない。

(3) 本調査との比較における取扱い

Pre-F/S の維持管理費に橋面舗装の基層・防水層改修が含まれていないため、比較検討の際は、本調査と同じ頻度・単価で算出した金額を Pre-F/S の維持管理費に追加する。また、維持管理費は、JICA 提案として割引率 4%で割掛けたコストに調整する。

Pre-F/S 案における土木(主橋)の維持管理費は下表のとおりである。

表 8.7　Pre-F/S 案における主橋の修正済み維持管理費用

Item	Unit	Unit Cost (USD)	Qty	Frequency (year)	Maintenance Cost (100 years) DR=0.00%	DR=2.5%	DR=5.0%
Maintenance Cost					**146,007,484**	**31,290,575**	**13,877,120**
C. Maintenance Cost (Civil Structures)					**143,378,924**	**30,345,170**	**13,386,025**
a. Safety Barriers	m	190	4,474	40	1,700,120	431,756	129,782
b. Drainage	m	0.37	2,236	1	82,732	32,777	18,772
c. Pavement	m3	450	993	10	4,468,500	1,464,701	697,918
d. Road Signs/Markings	item	-	-	15	625,044	207,604	93,721
e. Structural Concrete	-	-	-	1	33,412,400	13,357,938	7,650,118
f. Steelwork	-	-	-	1	24,148,400	1,930,852	1,105,803
g. Cable-stays	t	16,520	1,972	50	65,154,880	9,423,024	2,638,887
h. Bridge Bearings	no	17,229	16	40	551,328	140,001	42,083
i. Pedestrian Guardrails	m	210	3,356	40	1,409,520	357,903	107,583
j. Wind Barrier	m	600	2,237	40	2,684,400	681,720	204,919
k. Bridge Expansion Joints	m	43,950	104	40	9,141,600	2,316,894	696,439
D. Maintenance Cost (Other Than Civil Structures)					**2,628,560**	**945,405**	**491,095**
l. Road Lighting	no	100	90	1	900,000	359,810	206,064
m. Metro/LRT OH	m	50	2,236	40	223,600	73,138	28,506
n. Ballast and Sleepers etc.	m2	0.80	10,062	1	804,960	321,814	184,304
o. Aviation Warning Lights	item	-	-	20	100,000	28,642	11,695
p. Lighting Protection	item	-	-	25	600,000	162,001	60,526
Revised Maintenance Cost (Civil Structures)							
Pavement (Base and Waterproofing Layer) = (993m3/0.03m)*USD80/m2*3 times (frequency: 30 years)=						7,944,000	USD
Revised Maintenance Cost (DR=0%)=						151,322,924	USD

出典:本調査

付属資料 10: リスク分析レポート
(第 4 パナマ運河橋主橋)

Results of Risk Analysis

due to Closure of Pacific Approach Channel

for Erecting the Rib Arch Segment of the 4th Bridge over the Panama Canal

1. BACKGROUND:

The Secretaría del Metro de Panamá (SMP) is conducting a feasibility study for the construction of the 4th Bridge over the Panama Canal with technical assistance from a Japanese Survey Team financed by the Japan International Cooperation Agency (JICA).

The feasibility study for the 4th Bridge over the Panama Canal includes a section on the evaluation of alternative bridge types. Among the different bridge types evaluated, the Cable-stayed (refer to Figure #1) and Steel Arch (refer to Figure #2) stood out based on a multi-criteria analysis. One element which differentiates between these two bridge types is the level of interference with Panama Canal operations. If no interference with Canal operations is assumed, the Cable-stayed type bridge ranks above the Steel Arch type in the multi-criteria evaluation, based on lower cost, construction period and risk. Under this same prerequisite, the Steel Arch Bridge requires significant temporary works for assembling the arch which results in higher cost and longer construction period. The Steel Arch Bridge does offer some advantages over other bridge types by providing a more rigid structure and distinctive architectural features.

The JICA Survey Team conducting the feasibility study has proposed an alternative construction method for the Steel Arch Bridge that requires closure of the Pacific Approach navigational channel for a short period in order to erect the central rib arch segment of the bridge structure that would be prefabricated simultaneously with the rest of the on-site bridge structure. This construction method would eliminate the need for mayor temporary works reducing construction of the Steel Arch Bridge by 10 to 12 months and its cost. Under this premise, one element that needs to be evaluated and quantified is the impact of the Pacific Approach Channel closure upon the Panama Canal, the local ports and other primary elements of the container logistic system which might be impacted when the rib arch is assembled around year 2019.

The proposed erection method of the large rib arch segment of the bridge has no precedence. Consequently, the SMP in conjunction with the Autoridad del Canal de Panamá (ACP) conducted a risk analysis of the proposed Pacific Approach channel closure to identify associated risks, define mitigation measures & contingency plans and quantify the economic impact of such risks. The result of this risk analysis will be included as part of the feasibility study for the 4th Bridge over the Panama Canal.

Figure # 1 Cable-Stayed Bridge Type

Figure # 2 Steel Arch Bridge Type

2. IDENTIFICATION AND QUANTIFICATION OF RISKS:

The risk analysis performed by SMP and ACP involved several workshops, some in which members of the JICA Survey Team participated. From these workshops and other meetings with ACP personnel from operations, engineering and risk management, the different risks were identified. This process concluded with the identification of three (3) significant risks.

Risk #1: Closure of Pacific Approach Channel during the Erection of Rib Arch Segment:

To determine the probability and impact of the rib arch segment erection, the JICA Survey Team provided the list of work activities directly associated with the erection process which requires the closure of the Pacific Approach navigational channel. The SMP together with the ACP evaluated these work activities and established minimum and maximum times for the rib arch erection process, which resulted in a time range of navigational channel closure. The erection work activities and times are the following:

Step Number	Work Item	Min. Time	Maxi. Time
Step 1	Towing by tugboats	0.5 Hours	1.0 Hour
Step 2	Anchoring	1.0 Hour	2.0 Hours
Step 3	Setting of Hooks for Lifting	2.0 Hours	4.0 Hours
Step 4 ** Note 1*	Lifting Up of Arch Rib Segment	8.0 Hours	12.0 Hours
Step 5	**Temporary Fixing of Arch Rib Segment**	**1.0 Hour**	**3.0 Hours**
Step 6	Final Inspection	1.0 Hour	2.0 Hour
Channel Using Time Total		13.5 Hours	24.0 Hours

For the risk analysis of channel closure for erecting the rib arch segment, the maximum time was used for quantifying the impact of erecting the rib arch segment.

The scenario for the risk analysis corresponds to the year 2019 when the rib arch segment will be erected. In that year, the post-panamax locks (Third Set of Locks) will be fully operational and as would be ACP´s port of Corozal on the east bank of Balboa Reach. Traffic of post-panamax vessels is expected at 8 vessels per day and container movements at the three Pacific ports is projected at close to 20,000 TEU per day.

The 24-hour closure of the Pacific Approach channel of the Panama Canal would result in one full day of delayed transits, generating a queue (backlog) of between 20 to 30 transits above normal levels, of which 8 queued transits would be post-panamax. Also, loss of revenue from the Transit Reservation System would accrue to one full day. Such a relative small backlog will not result in any lost transits. However, in order to reduce the backlog of waiting vessels to normal levels, the ACP must operate at a level of capacity beyond normal for a period averaging 5 days. To achieve

this additional capacity on a daily basis, more pilot assignments are required, as are additional crews at the locks and extra towboat assignments and overtime. To mitigate the one-day impact of delayed transits, before the channel closure takes effect, between 3 to 4 transiting vessels could be anchored within Balboa Reach and Pacific Basin area. Also, to mitigate adverse effects from unfavorable meteorological phenomena, the ACP recommends to program the rib arch segment erection between the months of June and August.

To quantify the effects on port operations by the channel closure, a cursory evaluation was made to determine potential economic impact. The timing and day of the week selected for the rib arch segment erection could have considerable impact on the Pacific ports and the Panama Canal Railway; therefore, the day of the week selected for the erection operation is important. Since at this point such micro planning is not possible, for the analysis of ports and railway an average condition was considered. Most of the containership berthing at the Pacific ports are from Northbound (navigating from the Pacific coast to the Atlantic coast) transits moving through the Panama Canal, these ports would be impacted by the Pacific Approach channel closure. Berthing delays due to channel closure should result in idle berth space and resources, and a backlog of containers at the port yards resulting in double handling of some of these containers. No loss of revenue for the ports is expected. However, to normalize port operations, increased cost from overtime and additional container handling will be required. When taking into account mitigation measures for reducing impact to Pacific port operations, it is estimated that during the 24-hour channel closure, 75 percent of Pacific ports container movements will be delayed, or approximately 15,000 movements in a 24-hour span. The economic impact analysis for the ports does not consider penalties for late cargo delivery.

Most berths at the Atlantic ports are generated from Southbound transits through the Panama Canal with small portion from Northbound transits. An important portion of container movements in the Atlantic ports represent the repositioning of empty units. The effect on the Atlantic ports will be negligible (at less than 10 percent of container movements) since container vessel arriving from the Atlantic Ocean to the Atlantic ports are not impacted by the Pacific Approach channel closure.

Container transshipment movement using the Panama Canal Railway Company (PCRC) is expected at 18,000 containers per week for 2019. But considering that the Pacific ports container yards can stack more containers than the railroad can move in a single day, the PCRC operation would not be affected.

Direct economic compensation to affected key stakeholders is anticipated for the 24-hour channel closure. This economic compensation is summarized below and represents a rough approximation in order to establish cost values to include in the cost estimate of the Arch Bridge construction.

Impact	Stakeholder affected	Amount of Compensation
Loss of revenue from Transit Reservation System	ACP	US$731,022.00

Incremental transit capacity for 5 days to reduce backlog:	ACP	
- Pilot assignments	ACP	US$325,000.00
- Towboats	ACP	US$24,320.00
- Lock crews	ACP	US$55,000.00
- Contingency (10% of above)	ACP	US$40,750.00
Loss of Pacific Port berths	Pacific ports	US$650,000.00
Loss of Atlantic Port berths	Atlantic ports	US$65,000.00
Loss of container transshipment movements for PCRC	PCRC	US$0.00
Total Direct Compensation		US$1,891,092.00

Channel closure for erecting the rib arch segment will require contingency plans and special preventive measures, in addition to the equipment and resources required for executing the rib arch segment erection process that has been recommended by the JICA Survey Team. The additional resources and/or plans required for the erection of the rib arch segment are summarized as follows:

a. At least two standby generators to power the strand-jacks, one on each side of the main bridge support sections

b. Two spare (emergency) hydraulic jacks one on each side of the main bridge support sections in case of a hydraulic jack failure

c. Rental of the ACP´s floating crane Titan for a minimum period of 40 hours at a cost of US$110,000.00, for each erection plan occurrence.

d. At least two standby generators one for each of the two floating barges supporting the rib arch Segment to operate anchor mechanisms in case of failure of the on-board electrical power

e. At least two standby towboats in addition to those required to position the floating barges supporting the rib arch segment

f. All the equipment and resources required for floating and swinging out of the channel of the rib arch segment, within a period of 72 hours, if it happens to fall into the navigational channel (refer to Risk #3). This includes the use of ACP floating cranes plus additional back-up cranes and sufficient human resources to accomplish the rescue mission in case of an emergency. All cables used in the lifting and rescue operation shall have sufficient strength and an adequate safety factor in case of movements beyond those normally expected. The lifting operation must be halted if any malfunction occurs.

g. The temporary method of fixing the rib arch segment to the permanent structural elements on both sides of the bridge, upon lifting the rib arch, needs to be evaluated in more detail and redundancy methods need to be identified and incorporated to mitigate all risks associated with fixing of the rib arch segment to the rest of the bridge structure.

h. Given the significant and negative impact that failing to erect the rib arch segment properly would have on the operations of the Panama Canal, the Pacific ports and the Panama Canal Railway, especially if the rib arch segment falls into the navigational channel, it would be prudent to conduct one or more simulated lifts at the factory site where the rib arch segment is fabricated prior to its deployment to Panama. The test lift of the rib arch segment should be performed high enough and under similar conditions to permit the evaluation of all elements, procedures and equipment that will be involved in the erection process. Such test lift; however, could be performed on land and not necessarily over water. All costs associated with the test lift should be charged to the Arch Bridge project and included in its cost estimate.

i. All critical activities involving the lift of the Arch Bridge shall be scheduled during daylight hours and under favorable meteorological conditions during the months of June and August.

All associated cost and resources required for complying with contingency plans and measures listed in this document must be included in the construction cost of the Arch Bridge.

Risk #2: Short notice postponement of Pacific Approach Channel closure date:

This risk contemplates the possible postponement of the original scheduled date for the Pacific Approach channel closure for rib arch segment erection. The probability assigned to the risk of postponing the original scheduled date for the channel closure is considered moderate (at 50 percent) due to the many contingency plans and special requirements that must be in place before initiating the channel closure for erecting the rib arch segment.

This risk contemplates a change in the scheduled date within short notice of less than 12 hours. Because of the short notice, the ACP cannot offset the original impact of the closure of the channel; therefore, roughly 50 to 75 percent of the transits that could have navigated the Panama Canal on a normal day would be delayed causing an abnormal but small backlog in the neighborhood of 15 to 20 vessels. The ACP must reduce this backlog to normal levels before rescheduling the Pacific Approach Channel closure for erecting the rib arch segment. Consequently, the revenue of the Transit Reservation System from the original scheduled date will be loss plus that of the postponed closure. The incremental Canal capacity needed to reduce the resulting backlog with all its associated costs would be required for a period of 3 days. Some minor impact to Pacific and Atlantic ports, as well as for the PCRC may materialize if they are not able to reschedule ship berthing. However, the economic impact to ports and railroad was not considered for this risk.

Impact	Stakeholder affected	Amount of Compensation
Loss of revenue from Transit Reservation System	ACP	US$548,266.50
Incremental transit capacity for 3 days to reduce backlog:		

- Pilot assignments	ACP	US$195,000.00
- Lock crews	ACP	US$14,592.00
- Towboat	ACP	US$33,000.00
- Contingency (10% of above)	ACP	US$24,450.00
Loss of Pacific port berths	Pacific ports	n/a
Loss of Atlantic port berths	Atlantic ports	n/a
Loss of container transshipment movements for PCRC	PCRC	n/a
Total Direct Compensation		**US$815,308.50**

The economic consequence of this risk must be considered as part of the direct compensation package to the ACP by the contractor building the Arch Bridge.

Risk #3: Rib Arch Segment falling into the Pacific Approach channel causing an extended closure beyond the 24-hour period:

This risk considers the possibility that the rib arch segment being erected for the Arch Bridge fails and the rib arch structure falls into the Pacific Approach navigational channel blocking the transit of vessels in and out of the Panama Canal and the Pacific ports. Because of the many technical and safety requirements for the erection and fastening of the rib arch segment and the contingency plans contemplated to mitigate the impact of this risk, the likelihood of this risk materializing is considered low (below 10% probability); however, its impact on the Panama Canal, Pacific and Atlantic ports operations is considerable.

To quantify the impact of such risk, a preliminary analysis was conducted using the ACP´s computer simulation model for Canal Operations. ACP executed computer simulation runs for a 3-day closure, which indicated that the backlog of vessels awaiting to transit the Panama Canal would increase to levels between 80 to 95 vessels. Above the 100-vessel backlog with a heavy mix of post-Panamax vessels, it is possible for traffic diversion to take place, causing loss of transit revenue to the ACP. At this backlog level, it would take the ACP several weeks, working at full capacity with the post-panamax locks, to recover the queue of waiting vessels to normal levels. Any backlog that exceeds 100 vessels is considered unacceptable to the Panama Canal. Under high vessel traffic, a 3-day closure of the Panama Canal would produce backlogs nearing the threshold level of 100 waiting vessels. Consequently, the maximum period of channel closure shall not exceed 3 days.

Under the scenario of a maximum closure of 3 days, the JICA Survey Team presented a contingency plan to float and swing out-of-the-way the rib arch segment to open the navigational channel in a time period bellow 72 hours. The total buoyancy required to partially float the rib arch segment is estimated at 2,535 tons. The contingency plan proposed by the JICA Survey Team involves the use of buoyancy bags with floating capacity of 35 tons each. Therefore, for partially lifting the rib arch segment a total of 75 lift bags will be required. These air bags must be attached

underwater to the rib arch structure employing around 20 industrial divers. The process of attaching and inflating 75 lift bags is possible but impractical. In all, a total of 6 air compressors will be required to fill the floating bags. These air compressors must be outfitted on top of floating barges with portable generators. Also, at least 4 tow or pusher boats with on-board cranes will be required to move the barges with the air compressors and to attach the floating bags. Powerful towboats will be required for swinging out the rib arch segment to open the navigational channel for vessel traffic. In conclusion, the solution presented by the JICA Survey Team needs to be refined to develop a contingency plan that is more practical to execute and has higher potential for success within the 72-hour envelop available to retrieve the fallen rib arch segment.

All the equipment and resources required to execute the proposed contingency plan need to be estimated and costed, and added to the cost estimate of the project. In case of a fallen rib arch segment, the cost of remanufacturing the fallen arch structure plus the incurred delays must be quantified and added to the estimate of the project cost by way of a special purpose insurance policy.

The cost to principal stakeholder as a consequence of a 3-day channel closure involve the following:

a. Loss revenue from 3 days of the ACP´s Transit Reservation System.

b. Increased transit capacity of the Canal for a period of 19 days after the navigational channel is cleared and opened to reduce the accumulated backlog of transiting vessels. No loss in transit revenue was considered; although, if closure exceeds 3 days, loss of transit revenue is possible.

c. Mobilization and demobilization of salvage equipment in the region and daily operating cost of such equipment.

d. Increased cost due to idle (unproductive) berths and resources, additional port crews and overtime to load/unload backlog of berthing vessels accumulated due to channel closure, and the need for double handling of some container movements accumulated (transshipment) because of idle berthing space at the Pacific ports at 75% of daily container volume on the first day (similar to 24-hour closure) and 100% of container volumes for second and third days of closure.

e. Idle berth space at the Atlantic ports due to Northbound vessel delayed by channel closure in Pacific side and additional cost of overtime to handle containers delayed by closure of Pacific ports (that will be working overtime to makeup delays) at 10% of Pacific ports on first day and 25% on days two and three.

f. Cost of negotiated contract clauses with shippers on late delivery of cargo that is applicable to all ports is not considered, since it is assumed that berthing vessels trapped in the Canal´s transit backlog would be moved to Atlantic ports for berthing as soon as a slot is available and then returned to the Atlantic anchorage to await transit through the Panama Canal. The cost associated with these additional vessel movements is considered for the vessels delayed for as

many as 18 vessels (2 berths for 3 days of channel closure for the 3 Atlantic ports). The estimated cost of the 18 additional vessel movements to and from anchorages includes extra pilot assignments, channel fees, launches and towboats.

g. PCRC could mitigate impact by transferring empty containers and performing maintenance on railway track.

The above cost are summarized in the following table:

Impact	Stakeholder affected	Amount of Compensation
Loss of revenue from Transit Reservation System for 3 days	ACP	US$2,193,066.00
Incremental transit capacity for 19 days to reduce backlog:		
- Pilot assignments	ACP	US$1,235,000.00
- Lock crews	ACP	US$92,416.00
- Towboat	ACP	US$405,654.18
- Contingency (10% of above)	ACP	US$173,307.02
Mobilization and demobilization of salvage equipment	Subcontractors	US$750,000.00
Operation of salvage equipment	Subcontractors	US$300,000.00
Loss of Pacific port berths	Pacific ports	US$2,350,000.00
Loss of Atlantic port berths	Atlantic ports	US$500,000.00
Extra vessel movements in Atlantic from anchorage to ports and back	Pacific ports	US$88,000.00
Loss of container transshipment movements for PCRC	PCRC	n/a
Replacement of rib arch segment	Contractor	To be estimated by JICA Survey Team
Construction delays of 4th Bridge and star-up of Line 3 of the Metro	Government of Panama	To be estimated by JICA Survey Team
Total value of Compensation		**US$8,087,443.20**

Because the probability of the rib arch segment falling into the Pacific Approach channel is low, it is recommended that the economic compensation from such risk be covered by a special purpose insurance policy with the principal stakeholders (APC, Pacific and Atlantic ports) as beneficiaries. Additionally, since this insurance is unique in the sense that it is directly related to the construction methodology chosen for the Arch Bridge that requires the use of the navigational channel, it must also cover the cost of fabricating a new rib arch segment and the economic impact of delaying the execution of the 4th Bridge Project and postponement of the start of operations of Metro Line 3.

The cost of this special purpose insurance policy to cover the economic compensation to principal stakeholders and the cost of building a new rib arch segment and related implementation delay

costs could be in the neighborhood of 10 to 15% of the total insurance coverage. The cost of the insurance policy is a direct cost to the project. Additionally, the cost of the project shall borne the minimum deductible that must be covered by the contractor multiplied by the probability of occurrence of this risk. Giving that this is a unique risk, the cost of collateral, which may be demanded by the insurance company and/or its underwriters, should be quantified.

3. CONCLUSIONS:

The risk analysis conducted by the SMP and ACP to assess the impacts of channel closure for the erection of the rib arch segment of the 4th bridge over the Panama Canal identified and evaluated the following risks:

Risk	Event	Risk cause	Consequence	Probability	Impact	Recommended Mitigation
1	Erection of rib arch segment	24-hour closure of Pacific Approach Channel	Backlog of around 20 to 30 vessels and some berth losses at Pacific and Atlantic ports and backlog of container transshipment movements	100%	Low	- Redundancy of rib arch lifting and fixing method - Lifting of rib arch should take place between June and August when meteorological conditions are most favorable - Qualified personnel to execute the erection of the rib arch - Robust contracting clauses and requirements that the contractor must comply with - Simulation test of erection method at rib arch fabrication site - Contingency plan for a 72-hour removal of the fallen rib arch segment from channel - Full economic compensation to ACP, Pacific and Atlantic ports
2	Postponement of erection of rib arch segment	Reprogramming of 24-hour channel closure within short notice	Transit capacity for original closure not fully recovered, causing a low backlog and minor berth losses a Pacific and Atlantic ports	50%	Low	- Coordination of closure with sufficient lead-time between ACP, SMP, Contractor, port operators and railway operator - Full economic compensation to ACP, Pacific and Atlantic ports
3	Fall of rib arch segment into channel	Closure of navigational channel beyond 24-hours but not exceeding 72 hours	Major backlog of transiting vessels and losses for several days of berths at Pacific and Atlantic ports and container transshipment movements	10%	High	- All contractors risk insurance, civil responsibility and loss of revenue (refer to details in ACP Risk Evaluation) - Performance and payment bonds

						- Bank guarantees to insure payment of direct economic compensations - Robust contracting clauses and requirements that the contractor must comply with - Have in place a contingency plan with capability for retrieving the rib arch segment within a period of less than 72-hour - Redundancy systems and equipment available (standby) in case of mechanical and electrical failures that would delay the lifting and installation of the rib arch - Improve fallen rib arch segment retrieval method to add redundancy for critical tasks - Insurance must also cover cost of replacing the rib arch segment and the economic impact on project implementation and delay on startup of Metro Line 3

- A critical component of the proposed rib arch segment erection method are the contingency plans required to add redundancy to the erection processes and to generate the capability for retrieving the fallen rib arch segment from the navigational channel within the threshold of 3 days to resume normal navigation.
- Since the lift of the rib arch segment has no precedence, it is highly recommended to perform simulation tests of the erection plan at the rib arch fabrication site before transporting the rib arch to Panama.
- Means of economic compensation to ACP and Pacific and Atlantic ports are recommended in this risk analysis to cover cost incurred directly due to erection of rib arch segment closing the Pacific Approach navigational channel. Also, the insurance cost for replacing a damaged rib arch segment and for compensating delays caused by any accident must be quantified and included for the 4th Bridge Project and the startup of Line 3 of the Metro. These impacts must be included in the cost estimate of the 4th Bridge Project.
- The SMP must coordinate with ACP during the elaboration of terms and conditions of the solicitation documents for the 4th Bridge to insure clear establishment of the economic compensations to mayor affected stakeholders and the mechanisms to ensure payment to the ACP and ports.

- Finally, all cost associated with the rib arch bridge construction methodology, including associated costs, contingency plans and resources to execute the contingency plans listed in this document must be included in the cost estimate of the Arch Bridge over the Panama Canal. Also attributed and derived cost such as direct economic compensation, insurance policies and loss of revenue to affected stakeholders, plus the replacement of the rib arch and delays to 4th Bridge Project and Line 3 of the Metro must be accounted for.

付属資料 11:環境社会配慮

付属資料 11-1 フォーカス・グループ・ディスカッションの結果要約

(1) Focus Group Discussion with Women User of Public Transportation

[Women User of Public Transportation] February 17, 2014 16:00~17:30 Location: Specialized University of Las Americas Seven participants (Invited participants in the Albrook Bus Terminal)	 Source: URS Holdings, Inc.

Main opinions

- All participants agreed to the installation of the Metro Line 3. At the same time, they suggested that the route should reach until La Chorrera.
- They expressed a great dissatisfaction with the current transport system, buses and taxis, especially because of bad travel conditions (problem with safety, no seat, no air conditioning, long travel time, bad driving manner, etc.).
- They also pointed out that the *piratas*, “alternative transportation”, is important transportation which has more frequent services, with good conditions, and with short travel times. The problem is taht they do not have insurance to cover passengers, and the fee is quite high.
- They have willingness to pay from USD 0.25 (normal bus rate) to USD 1.50 (*piratas*, illegal bus rate) if the travel time is reduced and a good quality service is provided. For example, a lady who gains US$20 per day pays US$8 for transportation.
- They indicated that it is necessary of public education to build a culture oriented to care for these public goods.

(2) Focus Group Discussion with University Students

[University Students] February 18, 2014 14:30~16:10 Location: Specialized University of Las Americas Eight participants plus 15 observers (Selected by drawing)	 Source: URS Holdings, Inc

Main opinions

- The participants expected that the Metro Line 3 will be an efficient and well organized transportation system.
- They are worried about the disorder of the exiting transportation system.
- They emphasized the importance of educating school students to keeping the system in good condition.
- They insisted that it is very important to educate/guidance on how to use Metro.

(3) Focus Group Discussion with Community Leaders and Workers in Burunga, Arraijan

[Community leaders and workers in Burunga, Arraijan] February 20, 2014 17:00~18:30 Location: El Diamante, Burunga 10 participants	 Source: URS Holdings, Inc.

Main opinions

- Burunga workers consider that the Metro will be a viable alternative transportation that can help to improve transport in the area. For example, it takes around only 15 minutes without traffic jam, but it takes 1 hour to 1.5 hour with traffic from Albrook to Burunga.
- They are aware of their responsibility in the invasion of RoW.

(4) Summary of Focus Group Discussion with Transportation Sector

[Transportation Sector] March 17, 2014 10:00~11:30 Location: Panama International Maritime University (La Boca) Six participants (Four taxi drivers, one administrator of Bus Association, one *pirata*, *"alternative transportation"*, driver)	 Source: JICA Study Team

Main opinions

- The participants have strong perception for transportation system, because it is they who have been providing services for a long time.
- They agreed with the Metro Line 3 Project, but at the same time, they do not want to leave the current transportation system.
- They strongly recommended improving the internal routes in Arraijan. It is required to pave existing small roads.
- They emphasized the necessity to integrate all transportation sectors.

Source: Elaborated by the JICA Study Team based on URS Holdings, Inc. (2014)

付属資料 11-2 ルート選定代替案比較 - 環境社会配慮の側面より

Ref	Issue	Autopista Route		Panamericana Route	
		Advantages	***Disadvantages***	***Advantages***	***Disadvantages***
1	Land acquisition and resettlement	• Resettlement unlikely			• Resettlement is quite likely, particularly for associated infrastructure • Compensation for lost business premises etc is likely to be high
2	Local economy, employment and livelihoods	• Business generation is likely to occur around stations and other infrastructure • May better serve future needs?	• Will not serve the existing community as well, and fewer passengers are likely if this route is selected (initially)	• Will better serve the existing community, and more passengers are likely if this route is selected • Business generation is likely to occur around stations and other infrastructure • Existing businesses are likely to benefit • The service will be most beneficial to existing settlements in the project area	• Construction process may adversely affect local businesses • Some businesses may be permanently affected by the project
3	Land use and local resources usage	• More space is available for working areas • Greater opportunity for land use planning • This route option could allow for advanced integrated town planning, though it is unlikely	• The number of new feeder roads required, as well as the establishment of stations in relatively uninhabited areas means that significant development at these sites is to be expected	• Less space is available for working areas • Less opportunity for land use planning	• Possible perception that the project is serving current needs without considering future land development
4	Social capital and Local organizations	• Unknown	• Unknown	• Unknown	• Unknown
5	Existing infrastructure and public services	• Likely to be few conflicts with existing services such as water and electricity supply	• Possibilities for new services/systems could be seen as an advantageous opportunity	• Existing infrastructure and services is already in place and could potentially be adapted as needed	• Likely to be many conflicts with existing services such as water and electricity supply
6	Ethnic minorities and indigenous community	• Unlikely to be much difference	• Unlikely to be much difference	• Unlikely to be much difference	• Unlikely to be much difference
7	Unbalanced distribution of benefits and damages	• Unlikely to be much difference	• Unlikely to be much difference	• Unlikely to be much difference	• Unlikely to be much difference
8	Local conflicts caused by common interests	• Unknown	• Unknown	• Unknown	• Unknown
9	Cultural heritage	• Unknown	• Unknown	• Unknown	• Unknown
10	Right of water use	• Unlikely to be much difference	• Unlikely to be much difference	• Unlikely to be much difference	• Unlikely to be much difference
11	Infectious diseases such as HIV/AIDS	• Unlikely to be much difference	• Unlikely to be much difference	• Unlikely to be much difference	• Unlikely to be much difference
12	Safety		• Likely to be high risk of workers accident	• Unlikely to be much difference	• Likely to be high risk of accidents involving the public
13	Topography and geography	• Likely to be less civil works.			• The volume of civil works for construction of stations is likely to be bigger.
14	Underground water	• Unknown	• Unknown	• Unknown	• Unknown
15	Soil erosion		• Soil erosion is likely to be increased	• Soil erosion is likely to be less	
16	Hydrology	• Unlikely to be much difference	• Unlikely to be much difference	• Unlikely to be much difference	• Unlikely to be much difference
17	Flora, fauna and biodiversity		• Risk of adverse impacts is slightly higher	• Possibility of redeveloping brownfield land for depots etc could reduce impacts	
18	Landscape	• Unlikely to be much difference	• Unlikely to be much difference	• Unlikely to be much difference	• Unlikely to be much difference
19	Protected Natural Areas (PNAs)	• No PAs near route	• No PAs near route	• No PAs near route	• No PAs near route
20	Global warming	• Unlikely to be much difference	• Unlikely to be much difference	• Unlikely to be much difference	• Unlikely to be much difference
21	Air pollution	• Construction related air quality impacts are likely to be less significant due to lack of sensitive receptors	• Operational air quality impacts are likely to be more significant due to the expected increased need of feeder buses	• Operational air quality impacts are likely to be less significant	• Construction related air quality impacts are likely to be more significant due to sensitive receptors
22	Water pollution	• Unlikely to be much difference	• Unlikely to be much difference	• Unlikely to be much difference	• Unlikely to be much difference
23	Soil pollution	• Unlikely to be much difference	• Unlikely to be much difference	• Unlikely to be much difference	• Unlikely to be much difference
24	Waste management	• Waste management during both construction and operation is likely to be easier to manage and control	• New collection routes will be required during operation	• Existing collection routes can be modified (if they exist)	
25	Noise and vibration	• Both construction and operational noise and vibration impacts are likely to be lower			• Both construction and operational noise and vibration impacts are likely to be higher
26	Land subsidence	• Unknown	• Unknown	• Unknown	• Unknown
27	Offensive odors	• Unlikely to be much difference	• Unlikely to be much difference	• Unlikely to be much difference	• Unlikely to be much difference
28	Traffic	• Disruption during construction likely to be less significant • Accidents likely to be fewer	• Any accidents could be more serious	• Any accidents likely to be less serious	• Disruption during construction likely to be more significant • More accidents likely

Source: JICA Study Team

付属資料 11-3 システム代替案比較 - 環境社会配慮の側面より

Ref	System	Advantages	Disadvantages
1	Automated Guideway Transit (AGT)	• Running performance for hill-climbing and small curvature, Low noise and vibration	• Electric consumption is larger than the system which is using steel wheel. • Basically, slab structure which gives large impact to the landscape is installed
2	Monorail	• Ditto • Generally, transport capacity is larger than that of AGT. • Since no slab structure is installed, impact to the city landscape is low.	• Electric consumption is larger than the system which is using steel wheel.
3	Linear metro	• Hill-climbing performance, and lower noise from steel wheel than MRT. • R.O.W is smaller than that of MRT.	• Basically, slab structure which gives large impact to the landscape is installed
4	Urban Railway / MRT	• Large transport capacity, Large number of manufacturer in the world. • Low electric consumption per transport capacity	• Basically, slab structure which gives large impact to the landscape is installed • Bigger noise and vibration compared with other system. • Flexibility of an alignment is lower than that of other system. And this system can't adapt to small curvature and steep gradient. It may cause land acquisitions.
5	LRT (Tramway with segregated RoW)	• Low construction cost when it is constructed at grade.	• Since R.O.W is installed in road space, this system gives large impact to road traffic.

Ref	System	Construction									Operation	
		Needs tunnel?	*Construction period below, at or above average?*	*Nature of line – raised or ground level?*	*Civil works requirement below, at or above average?*	*Overhead line?*	*Number of required substations*	*Difference in working area required during construction?*	*Earthworks requirement below, at or above average?*	*Piling / dewatering requirement below, at or above average?*	*Safety*	*Noise/ vibration*
1	Automated Guideway Transit (AGT)	No Applicable maximum gradient is 6%	Average	Raised	Average	Side	Various kind of voltage	Average	Average	Average	Secured by ATP (Automatic train protection)	Lower Because of rubber tire
2	Monorail	No Ditto	Below	Raised	Below	Side	DC1500V or DC750V	Smaller	Below	Below No slab structure	Secured by ATP (Automatic train protection)	Lower Because of rubber tire
3	Linear metro	No Ditto	Average MRT + Reaction plate installation	Raised or Ground level	Average	Overhead	DC1500V	Average	Average	Average	Secured by ATP (Automatic train protection)	Lower Because of bogie with steering system
4	Urban Railway / MRT	Yes Applicable maximum gradient is 3.5%	Above	Raised or Ground level	Above	Overhead	Various kind of voltage	Larger Because of large structure	Above	Above Axle load of train and dead load of structure are heavy	Secured by ATP (Automatic train protection)	Average
5	LRT (Tramway with segregated RoW)	Yes Ditto	Below Because of at grade	Ground level	Below Because of at grade	Overhead	Various kind of voltage	Larger Because of ground level	Below Because of at grade	Below Because of at grade	Secured by driver	Lower Because of steel wheel of sandwich structure with rubber
	The System of Metro Line 1, elevated section		**Average**		**Average**			**Average**	**Average**	**Average**		**Average**

Note:
Regarding Construction period, Civil works requirement, Difference in working area, Earthworks requirement and Piling dewatering requirement, the system of Metro Line 1 was considered to be an "Average" and each system was compared.
AGT, Linear metro, MRT and HSST have slab structure in superstructure. In this table, adoption of U-shape slab structure which is used in Line-1 was assumed.
LRT can be installed as a Raised line. However, LRT in this table is assumed as at grade.
Number of required substations is depending on voltage of the system. Since some systems are adopting various kind of voltage, please ask this question to an electric specialist.
Source: JICA Study Team

付属資料 11-4 ベースライン調査次に確認された陸上植物種

Family	Scientific Name	Vernacular Name	IUCN Red List	Panamanian Law (Resolution AG-0051)
Acanthaceae	*Aphelandra scabra*	-	-	VU
Adiantaceae	*Adiantun lunulatum*	Walking Maidenhair Fern	-	-
Anacardiaceae	*Anacardium excelsum*	Wild Cashew	-	-
	Anacardium occidentale	Cashew	-	-
	Astronium graveolens	Glassywood	-	VU
	Spondias mombin	Hog Plum	-	-
Annonanceae	*Annona purpurea*	Soncoya	-	-
	Xylopia frutescens	-	-	-
	Guatteria sp.	-	-	-
	Porcelia magnifructa	-	-	-
Apocynaceae	*Thevetia peruviana*	Yellow Oleander	-	-
Araceae	*Dieffenbachia sp.*	-	-	-
	Rodospatha sp.	-	-	-
	Philodendron sp.	-	-	-
	Monstera sp.	-	-	-
Araliaceae	*Schefflera morototoni*	Morototo	-	-
	Dendropanax arboreus	-	-	-
Arecaceae	*Attalea butyracea*	Yagua Palm	-	-
	Bactris cf.coloniata	Uvito Palm	VU	VU
	Desmoncus orthacanthos	-	-	-
	Elaeis oleifera	American Oil Palm	-	-
	Oenocarpus mapora	Don Pedrito's Palm	-	-
	Roystonea regia	Cuban Royal Palm	-	-
	Chryosophila warscewiczii	-	-	-
	Cryosophila warscewiczii	-	-	-
Asteraceae	*Delilia biflora*	-	-	-
	Mikania sp.	-	-	-
	Vernonanthura patens	Salvión	-	-
Bignoniaceae	*Arrabidaea sp.*	-	-	-
	Tecoma stans	Yellow Trumpetbush	-	-
	Tabebuia guayacan	Guayacan Trumpet Tree	-	VU
	Tabebuia rosea		-	VU
Bombacaceae	*Ochroma pyramidale*	Balsa	-	-
	Pseudobombax septenatum	-	-	-
Boraginaceae	*Cordia alliodora*	Spanish Elm	-	-
	Cordia panamensis	Guacalmanono	-	-
Bromeliaceae	*Bromelia pinguin*	Penguin	-	-
Burseraceae	*Bursera simarouba*	Copperwood	-	-
	Protium panamense	Jennywood	NT	-
Cactaceae	*Epiphyllum phyllanthus*	-	LC	VU
Capparaceae	*Capparis cf. frondosa*	-	-	-
	Cleome sp.	-	-	-
Caricaceae	*Vasconcellea cauliflora*	Carica	-	-
Cecropiaceae	*Cecropia sp.*	-	-	-
	Cecropia peltata	-	-	-
Chrysobalanaceae	*Hirtella americana*	Pigeon Plum	-	-
	Hirtella racemosa	-	-	-
Clusiaceae	*Vismia billbergiana*	Sangrillo	-	-
Cochlospermaceae	*Cochlospermum vitifolium*	-	-	-
Combretaceae	*Laguncularia racemosa*	White Mangrove	LC	EN

Family	Scientific Name	Vernacular Name	IUCN Red List	Panamanian Law (Resolution AG-0051)
	Terminalia oblonga	-	-	VU
	Terminalia amazonia	-	-	VU
Convolvulaceae	*Ipomoea sp.*	-	-	-
Costaceae	*Costus villosissimus*	Porcupine Ginger	-	-
Cyatheaceae	*Cyathea petiolata*	-	-	VU
Cychlanthaceae	*Carludovica palmata*	Panama Hat Plant	-	-
Cucurbitaceae	*Gurania makoyana*	-	-	-
Dilleniaceae	*Curatella americana*	Sandpaper tree	-	-
Euphorbiaceae	*Acalypha diversifolia*	-	-	-
	Acalypha macrostachya	-	-	-
	Croton schiedeanus	Coegalasapi	-	-
	Sapium glandulosum	Gumtree	-	-
Fabaceae-Caesalpinioideae	*Andira inermis*	Cabbage bark tree	-	-
	Cassia sp.	Cassia	-	-
	Copaifera aromatica	-	-	-
	Hymenaea courbaril	Jatobá	-	-
	Peltophorum pterocarpum	Copperpod	-	-
	Swartzia simplex	-	-	-
Fabaceae-Mimosoideae	*Acacia collinsii*	Bull Horn Acacia	-	-
	Cojoba rufescens	Coral Snake tree	-	-
	Leucaena multicapitula	Frijolillo	-	-
	Enterolobium cyclocarpum	Elephant Ear Tree	-	-
	Inga sp.	-	-	-
	Pithecellobium unguis-cati	-	-	-
	Zygia longifolium	Sota caballo	-	-
	Pseudosamanea guachapele	Guachapele	-	-
	Samanea saman			
Fabaceae-Papilionoideae	*Andira inermis*	-	-	-
	Flemingia strobilifera	-	-	-
Flacourtiaceae	*Hasseltia floribunda*	-	-	-
	Casearia sp.	-	-	-
	Lacistema aggregatum	Cemp wood tree	-	-
	Lindackeria laurina	-	-	-
	Zuelania guidonia	Cagajón	-	-
Gesneriaceae	*Codonanthe sp.*	-	-	-
Haemadoraceae	*Xiphidium caeruleum*	-	-	-
Heliconiaceae	*Heliconia latispatha*	Lobster claw Heliconia	-	-
	Heliconia platystachys	Sexy Orange Heliconia	-	-
Lauraceae	*Cinnamomum triplinerve*	-	-	-
	Ocotea sp.	-	-	-
	Nectandra sp.	-	-	-
Lecythidaceae	*Gustavia superva*	Membrillo	-	-
Loganiaceae	*Strychnos sp.*	-	-	-
Loranthaceae	*Phoradendron piperoides*	-	-	-
Marantaceae	*Ischnosiphon sp.*	-	-	-
Malvaceae	*Sida sp.*	Mallow	-	-
	Taliparitiliaceum var. pernambucensis			
Melastomataceae	*Miconia impetiolaris*	Mule's Ear Miconia	-	-
	Miconia argentea	-	-	-
	Mouriri myrtilloides	-	-	-
	Miconia elata	-	-	-
Meliaceae	*Trichilia sp.*	-	-	-

Family	Scientific Name	Vernacular Name	IUCN Red List	Panamanian Law (Resolution AG-0051)
	Cedrela odorata	Spanish Cedar	VU	VU
	Guarea sp.	-	-	-
	Guarea multiflora	-	-	-
Moraceae	*Ficus insipida*	-	-	-
	Ficus obtusifolia	Strangler Fig	-	-
	Castilla elastica	Panama Rubber Tree	-	-
Muntingiaceae	*Muntingia calabura*	Panama berry	-	-
Myristicaceae	*Virola sebifera*	Red Ucuuba	-	-
Myrsinaceae	*Ardisia sp.*	Coralberry	-	-
	Alibertia edulis	Puruí	-	-
Myrtaceae	*Eugenia sp.*	-	-	-
Nyctaginaceae	*Guapira costaricana*	-	-	-
Orchidaceae	*Epidendrum sp.*	-	-	VU
	Coryanthes sp.	-	-	-
Passifloraceae	*Passiflora vitifolia*	Passiflora	-	-
	Passiflora biflora	Two-flowered passion flower	-	-
Pellicieraceae	*Pelliciera rhizophorae*	Tea Mangrove	VU	EN
Piperaceae	*Piper reticulatum*	-	-	-
	Piper marginatum	Marigold pepper	-	-
	Piper culebranum	-	-	-
	Piper aequale	-	-	-
Poaceae	*Saccharum spontaneum*	Kans Grass	-	-
	Panicum maximum	Guinea grass	-	-
	Panicum pilosum	-	-	-
	Pharus latifolius	-	-	-
	Chusquea simpliciflora	-	-	-
	Rottboellia conchinchinensis	-	-	-
Polygonaceae	*Triplaris cumingiana*	Ant tree	-	-
	Coccoloba sp.	-	-	VU
	Coccoloba Caracasana	-	-	-
	Coccoloba manzanillensis	-	-	-
Rhamnaceae	*Gouania sp.*	-	-	-
Rhizophoraceae	*Rhizophora mangle*	Red Mangrove	LC	EN
	Cassipourea elliptica	Goat wood	-	-
Rubiaceae	*Alseis blackiana*	-	-	-
	Calycophyllum candidissimum	Harino o alazano	-	-
	Faramea occiddentalis	-	-	-
	Genipa americana	Genipapo	-	-
	Macrocnemum roseum	-	-	-
	Palicourea guianensis	Recadito	-	-
	Pittoniotis trichantha	Aguacatillo	-	-
	Posoqueria latifolia	Needle-flower Tree	-	-
	Psychotria carthagenensis	Amyruca	-	-
	Psychotria horizontalis	-	-	-
	Psychotria micrantha	-	-	-
	Psychotria sp.1	-	-	-
Sapindaceae	*Allophylus occidentalis*	-	-	-
	Cupania rufescens	-	-	-
	Cupania scrobiculata	Gorgojero	-	-
	Matayba glaberrima	-	-	-

Family	Scientific Name	Vernacular Name	IUCN Red List	Panamanian Law (Resolution AG-0051)
	Matayba scrobiculata	-	-	-
	Sapindus saponaria	Wingleaf soapberry	-	-
	Serjania sp.	-	-	-
Solanaceae	*Solanum sp.*	-	-	-
Sapotaceae	*Chrysophyllum cainito*	Star Apple	-	-
	Pouteria sp.	-	-	-
Scrophulariaceae	*Scoparia dulcis*	Goatweed	-	-
Siparunaceae	*Siparuna pauciflora*	-	-	-
Sterculiaceae	*Guazuma ulmifolia*	Guácima	-	-
	Herrania purpurea	-	-	-
	Sterculia apetala	Panama tree	-	-
Tectariaceae	*Cyclopeltis semicordata*	-	-	-
	Tectaria incisa	-	-	-
Thelypteraceae	*Thelypteris poiteana*	-	-	-
Tiliaceae	*Luehea seemannii*	-	-	-
	Apeiba tibourbou	-	-	-
Verbenaceae	*Tectona grandis*	Teak	-	-
	Aegiphila sp.	-	-	-
Vitaceae	*Cissus sp.*	-	-	-

Source: Prepared by JICA Study Team based on URS Holdings, Inc. (2014)

付属資料 11-5 ベースライン調査時に確認された陸上動物種

Family Name	Scientific Name	Vernacular name	IUCN Red List	Panamanian Law (Resolution AG-0051)
Mammals				
Agoutidae	*Agouti paca*	Spotted Paca	-	VU
Cebidae	*Saguinus geoffroyi*	Geoffroy's Tamarin	-	VU
Dasypodidae	Dasypus novemcinctus	Nine-banded Armadillo	-	-
Dasyproctidae	*Dasyprocta punctata*	Central American Agouti	-	-
Didelphidae	*Didelphis marsupialis*	Black-eared Opossum	-	-
Echimyidae	*Proechimys semispinosus*	Tome's Spiny Rat	-	-
Leporidae	Sylvilagus brasiliensis	Tapeti/ Forest Rabbit	-	-
Muridae	*Sigmodon hirsutus*	Southern Cotton Rat	-	-
Phyllostomidae	*Glossophaga soricina*	Pallas's Long-tongued Bat	-	-
	Carollia perspicillata	Seba's Short-tailed Bat	-	-
	Uroderma bilobatum	Tent-making Bat	-	-
	Artibeus jamaicensis	Jamaican Fruit-eating Bat	-	-
	Platyrrhinus helleri	Heller's Broad-nosed Bat	-	-
Procyonidaqe	*Nasua narica*	White-nosed Coati	-	-
	Procyon sp.	-	-	-
Sciuridae	*Sciurus granatensis*	Red-tailed Squirrel	-	-
Birds				
Alcedinidae	*Chloroceryle americana*	Green Kingfisher	-	-
Ardeidae	*Tigrisoma mexicanum*	Bare-throated Tiger-heron	-	-
	Ardea alba	Great Egret	-	-
	Egretta caerulea	Little Blue Heron	-	-
Cathartidae	*Coragyps atratus*	Black Vulture	-	-
	Cathartes aura	Turkey Vulture	-	-
Charadriidae	*Charadrius wilsonia*	Wilson's Plover	-	-
Columbidae	*Columba cayennensis*	Pale-vented Pigeon	-	VU
	Columbina talpacoti	Ruddy Ground-dove	-	-
	Leptotila verreauxi	White-tipped Dove	-	-
	Patagioenas cayennensis	Pale-vented pigeon	-	-
Cracidae	*Ortalis cinereiceps*	Grey-headed Chachalaca	-	-
Cuculidae	*Crotophaga ani*	Smooth-billed Ani	-	-
Emberizidae	*Volatinia jacarina*	Blue-black Grassquit	-	-
Falconidae	*Milvago chimachima*	Yellow-headed Caracara	-	-
Fregatidae	*Fregata magnificens*	Magnificent Frigatebird	-	-
Icteridae	*Quiscalus mexicanus*	Great-tailed Grackle	-	-
Laridae	*Larus Sp.*	Seagull	-	-
Pelecanidae	*Pelecanus occidentalis*	Brown Pelican	-	-
Phalacrocoracidae	*Phalacrocorax brasilianus*	Neotropic Cormorant	-	-
Picidae	*Melanerpes rubricapillus*	Red-crowned Woodpecker	-	-
Psittacidae	*Amazona autumnalis*	Red-lored Amazon	-	VU
	Amazona ochrocephala	Yellow-crowned Amazon	-	VU
Strigidae	*Otus choliba*	Tropical Screech-owl	-	-
Sulidae	*Sula leucogaster*	Brown Booby	-	-
Thraupidae	*Ramphocelus dimidiatus*	Crimson-backed	-	-
	Thraupis episcopus	Blue-grey Tanager	-	-
Trochilidae	*Phaethornis anthophilus*	Pale-bellied Hermit	-	-
Tyrannidae	*Tyrannus melancholicus*	Tropical Kingbird	-	-

Family Name	Scientific Name	Vernacular name	IUCN Red List	Panamanian Law (Resolution AG-0051)
	Myiocetetes cayanensis			
Reptiles				
Alligatoridae	*Crocodylus acutus*	American Crocodile	VU	EN
Boidae	*Boa constrictor*	Boa constrictor	-	VU
Colubridae	*Oxybelis fulgidus*	Green vine snake	-	-
Corytophanidae	*Basiliscus basiliscus*	Common basilisk	-	-
Gekkonidae	*Gonatodes albogularis*	Yellow-headed gecko	-	-
Gymnophthal-midae	*Leposoma southi*	Northern Spectacled Lizard	-	-
Iguanidae	*Iguana iguana*	Green Iguana	-	VU
Polychrotidae	*Anolis limifrons*	Slender Anole	-	-
	Anolis tropidogaster	Tropical Anole	-	-
	Anolis lionotus	Lion Anole	-	-
Scincidae	*Mabuya unimarginata*	Central American Mabuya	-	-
Teiidae	*Ameiva ameiva*	Giant Ameiva	-	-
Amphibians				
Bufonidae	*Chaunus marinus*	Cane toad	-	-
	Rhaebo haematiticus	Truando Toad	-	-
Centrolenidae	*Teratohyla spinosa*	Spiny Cochran frog	-	-
Dendrobatidae	*Dendrobates auratus*	Green And Black Poison Frog	-	VU
Eleutherodac-tylidae	*Silverstoneia flotator*	Rainforest Rocket Frog	-	-
	Diasporus diastema	Common Tink frog	-	-
	Diasporus vocator	Agua Buena Robber Frog	-	-
Hylidae	*Smilisca phaeota*	Masked Tree Frog	-	-
	Smilisca sordida	Veragua cross-banded tree frog	-	-
Leiuperidae	*Engystomops pustulosus*	Tungara Frog, Túngara Frog	-	-
Leptodactylidae	*Leptodactylus savagei*	Savage's Thin-toed Frog	-	-
	Leptodactylus fragilis	American White Lipped Frog	-	-

Source: Prepared by JICA Study Team based on URS Holdings, Inc. (2014)

付属資料 11-6 ベースライン調査時に確認された水生動物種

Family Name	Scientific Name	Vernacular name
Fish		
Atherinidae	*Atherinella panamensis*	Panama Silverside
	Melaniris pachylepis	Thick scale Silverside
Carangidae	*Caranx caninus*	Crevalle Jack
	Oligoplites altus	Longjaw Leatherjacket
Clupeidae	*Lile stolifera*	Pacific Piquitinga
Engraulidae	*Anchoa argentivittata*	Silverstripe Anchovy
	Anchoa panamensis	Panama Anchovy
Gerreidae	*Diapterus peruvianus*	Peruvian Mojarra
Haemulidae	*Anisotremus dovii*	Spotted head Sargo
Mugilidae	*Mugil curema*	Silver Mullet
Scianidae	*Cynoscion squamipinnis*	Scalyfin Corvina
Tetraodontidae	*Sphoeroides annulatus*	Bullseye Puffer
Bivalves		
Arcidae	*Anadara concinna*	-
	Anadara grandis	Mangrove Cockle
Cardiidae	*Laevicardium elenense*	-
	Trachycardium elenense	-
	Trigoniocarda obovalis	-
	Trigoniocardia granifera	-
Corbulidae	*Caryocorbula nasuta*	-
Mactridae	*Mactra fonsecana*	-
	Mulinia pallida	-
Solecurtidae	*Tagelus sp.*	-
Tellinidae	*Macoma siliqua*	-
	Psammotreta aurora	-
	Tellina eburnea	-
	Tellina inaequistriata	-
	Tellina rubescens	-
Veneridae	*Dosinia dunkeri*	-
	Protothaca aspérrima	-
Echinoderms		
Cidaridae	*Eucidaris thouarsii*	Slate Pencil Urchin
Brissidae	*Brissus obesus*	-
	Metala nobilis	-
Clypeasteridaae	*Clypeaster rotundus*	-
Cynoglossidae	*Symphurus elongatus*	-
Schizasteridae	*Agassizia scrobiculata*	-
Scutellidae	*Encope micropora*	-
	Mellita longifissa	-
Diadematidae	*Diadema mexicanum*	-
Echinometridae	*Echinometra vanbrunti*	-
Toxopneustidae	*Toxopneustes roseus*	-
	Tripneustes depresus	White Sea Urchin
Gastropods		
Buccinidae	*Phos fusoides*	-
Calyptraea	*Calyptraea conica*	Chinese Hat Snail
	Calyptraea mamillaris	-

Family Name	Scientific Name	Vernacular name
	Crepidula onyx	Onyx slippersnail
	Crucibulum spinosum	Spiny Cup-and-Saucer Snail
Cancellariidae	*Cancellaria albida*	-
Columbellidae	*Cosmioconcha modeta*	-
Conidae	*Conus fergusoni*	-
	Conus gradatus	-
	Conus patricius	Patrician Cone
Melongenidae	*Melongena sp.*	-
Nactidae	*Natica elenae*	-
	Polinices uber	-
Nassariidae	*Strombina recurva*	-
Neritidae	*Nerita funiculata*	-
Terebridae	*Terebra formosa*	-
Crustaceans		
Ocypodidae	*Uca sp.*	Fiddler Crab
Balanidae	*Balanus sp.*	Barnacle
Calappidae	*Hepatus kossmanni*	-
	Raninoides benedicti	-
Stelleroidea		
Ophiotrichidae	*Ophiothrix spiculata*	Brittle Star
Linckiidae	*Pharia pyramidata*	Yellow Spotted Star

Source: Prepared by JICA Study Team based on URS Holdings, Inc. (2014)

付属資料 11-7 メトロ 3 号線事業 EMP に関する概算コスト

(1) Construction Phase

USD

Environmental Management Plan	Description	Unit Cost	Unit	Quantity	Costs	Sub Total
Mitigation Programs						
Climate, Air, Noise and Vibrations Quality Control Program						251,750.00
	Installation of acoustic barriers	9,500	km	26.5	251,750.00	
Soil Protection						930,150.00
	Construction of containment barriers, ditches and sediment traps	16,000	km	26.5	424,000.00	
	Setup of drainage works	19,100	km	26.5	506,150.00	
Surface Water Quality Control						380,275.00
	Petroleum absorbers and floating barriers	9,550	km	26.5	253,075.00	
	Oil traps in drains	4,800	km	26.5	127,200.00	
Flora Protection						482,210.50
	Tree and Grass Planting Plan in affected grassy areas (includes maintenance for 5 years)	8,750	ha	14	122,500.00	
	Flora Rescue and Recovery Plan (forest, mangroves and plantations throughout the alignment)	350	ha	28	9,800.00	
	Reforestation Plan (forest, mangroves and plantations sectors of the alignment)	7,700	ha	28	215,600.00	
	Environmental Compensation:					
	Mature secondary forest	5,000	ha	24.146	120,730.00	
	Intermediate secondary forest	3,000	ha	1.501	4,503.00	
	Young secondary forest	1,000	ha	1.873	1,873.00	
	Grassy plants	500	ha	14.409	7,204.50	
Fauna Protection						14,116.00
	Placing signs in construction areas in stations and forest areas to instruct regarding good behavior toward fauna	200	sign	36	7,200.00	
	Fauna Rescue and Relocation Plan (forest and mangrove sectors of the alignment)	247	ha	28	6,916.00	
Environmental Education Plan						120,000.00
	Preparation and Execution of the Environmental Education Plan	120	worker	1000	120,000.00	
Socio economic, Historical and Cultural						111,200.00
	Disclosure of hiring policies for labor and employment opportunities for the local population	33	worker	1000	33,000.00	
	Notification to communities of the development of construction	300	locations	20	6,000.00	

Environmental Management Plan	Description	Unit Cost	Unit	Quantity	Costs	Sub Total
	activities					
	Placement of warning and safety signalization in risk areas	3,800	area	19	72,200.00	
Environmental Supervisor						98,550.00
	Salary	19,500	year	4.5	87,750.00	
	Material and work equipment	2,400	year	4.5	10,800.00	
Social Aspects Manager						127,800.00
	Salary	26,000	year	4.5	117,000.00	
	Materials and work equipment	2,400	year	4.5	10,800.00	
Community Liaison Officer						101,475.00
	Salary	19,550	year	4.5	87,975.00	
	Materials and work equipment	3,000	year	4.5	13,500.00	
Environmental and Social Management Personnel Transportation						72,000.00
	Vehicle's (4x4)	36,000	veh.	2	72,000.00	
				Subtotal		2,689,526.50
Monitoring Plan						
Air Quality Monitoring						199,650.00
	Quarterly monitoring of vehicular emissions	14,300	year	4.5	64,350.00	
	Air quality monitoring before starting construction in Ancon Sector.	1,000	site	3	3,000.00	
	Quarterly air quality monitoring - Construction.	29,400	year	4.5	132,300.00	
Noise Emissions Monitoring (Ambient and Occupational)						233,250.00
	Quarterly occupational noise monitoring - Construction.	28,600	year	4.5	128,700.00	
	Baseline noise monitoring before construction in Ancon Sector.	750	site	3	2,250.00	
	Baseline noise monitoring before construction along the alignment.	750	site	8	6,000.00	
	Quarterly noise monitoring - Construction.	21,400	year	4.5	96,300.00	
Vibration Level Monitoring (Ambient and Occupational)						309,090.00
	Quarterly full-body vibration monitoring - Construction.	36,600	year	4.5	164,700.00	
	Baseline ambient vibration monitoring before construction in Ancon sector and alignment.	930	site	11	10,230.00	
	Quarterly ambient vibration monitoring - Construction.	29,400	year	4.5	132,300.00	
	Monitoring in case of blasts - Construction	930	site	2	1,860.00	
Surface Water Quality Monitoring						131,400.00
	Quarterly surface water quality monitoring– Construction.	29,200	year	4.5	131,400.00	
Soil Quality Monitoring						53,100.00
	Quarterly soil quality monitoring - Construction.	11,800	year	4.5	53,100.00	

Environmental Management Plan	Description	Unit Cost	Unit	Quantity	Costs	Sub Total
				Subtotal		926,490.00
				Total		3,616,016.50

Source: URS Holdings, Inc. (2014)

(2) Operation Phase

USD

Monitoring Plan	Description	Unit Cost	Unit	Quantity	Costs	Sub Total
Air Quality Monitoring						30,000.00
	Biannual air quality monitoring – Year 1 Operation.	15,000	year	1	15,000.00	
	Annual air quality monitoring – Year 2 and 3 Operation.	7,500	year	2	15,000.00	
Noise Emissions Monitoring (Ambient and Occupational)						22,000.00
	Biannual noise monitoring – Year 1 Operation.	11,000	year	1	11,000.00	
	Annual noise monitoring – Year 2 and 3 Operation.	5,500	year	2	11,000.00	
Vibration Level Monitoring (Ambient and Occupational)						22,500.00
	Annual ambient vibration monitoring - Operation.	7,500	year	3	22,500.00	
Surface Water Quality Monitoring						29,200.00
	Biannual surface water quality monitoring– Year 1 Operation.	14,600	year	1	14,600.00	
	Annual surface water quality monitoring– Year 2 and 3 Operation.	7,300	year	2	14,600.00	
Soil Quality Monitoring						12,400.00
	Biannual soil quality monitoring – Year 1 Operation.	6,200	year	1	6,200.00	
	Biannual soil quality monitoring – Year 2 and 3 Operation.	3,100	year	2	6,200.00	
Waste water monitoring						54,900.00
	Biannual monitoring of wastewater effluent at stations and at Depot area– Year 1 Operation.	27,450	year	1	27,450.00	
	Annual monitoring of wastewater effluent at stations and in Depot area (1 site) – Year 2 and 3 Operation	13,725	year	2	27,450.00	
				Total		171,000.00

Source: Prepared by JICA Study Team based on URS Holdings, Inc. (2014)

付属資料 11-8 第 4 パナマ橋事業 EMP に関する概算コスト

(1) Construction Phase

USD

Environmental Management Plan	Description	Unit Cost	Unit	Quantity	Costs	Sub Total
Mitigation Plan						
Noise and Vibrations Control Program						64,125.00
	Acoustic barriers barriers	9,500	km	6.75	64,125.00	
Soil Protection						108,000.00
	Construction of containment barriers, ditches and sediment traps	16,000	km	6.75	108,000.00	
Surface Water Quality Control						378,000.00
	Petroleum absorbers, dispersants, clean-up equipment and floating barriers	56,000	km	6.75	378,000.00	
Flora Protection						49,958.65
	Tree and Grass Planting Plan in affected grassy areas (includes maintenance for 5 years)	8,750	ha	1.655	14,481.25	
	Flora Rescue and Recovery Plan (forest and mangroves)	350	ha	2.878	1,007.30	
	Reforestation Plan (forest and mangroves)	7,700	ha	2.878	22,160.60	
	Environmental Compensation: o Mangroves	5,000	ha	0.363	1,815.00	
	o Mature secondary forest	5,000	ha	1.668	8,340.00	
	o Intermediate secondary forest	3,000	ha	0.240	720.00	
	o Young secondary forest	1,000	ha	0.607	607.00	
	o Grassy plants	500	ha	1.655	827.50	
Fauna Protection						123,039.00
	Placing signs in construction areas in stations and forest areas to instruct regarding good behavior toward fauna	200	sign	8	1,600.00	
	Fauna Rescue and Relocation Plan (forest and mangrove sectors of the alignment)	500	ha	2.878	1,439.00	
Environmental Education Plan	Preparation and Execution of the Environmental Education Plan	120	worker	1000	120,000.00	
Socio economic, Historical and Cultural						61,100.00
	Disclosure of hiring policies for labor and employment opportunities for the local population	33	worker	1000	33,000.00	
	Notification to communities of the development of construction activities	900	location	3	2,700.00	
	Placement of speed control signalization	200	sign	13	2,600.00	
	Placement of warning and safety signalization in risk areas	3,800	area	6	22,800.00	
Environmental Supervisor						87,600.00
	Salary	19,500	year	4	78,000.00	

Environmental Management Plan	Description	Unit Cost	Unit	Quantity	Costs	Sub Total
	Material and work equipment	2,400	year	4	9,600.00	
Social Aspects Manager						113,600.00
	Salary	26,000	year	4	104,000.00	
	Materials and work equipment	2,400	year	4	9,600.00	
Community Liaison Officer						90,200.00
	Salary	19,550	year	4	78,200.00	
	Materials and work equipment	3,000	year	4	12,000.00	
Environmental and Social Management Personnel Transportation						72,000.00
	Vehicle's (4x4)	36,000	vehicle	2	72,000.00	
				Subtotal		1,147,622.65
Monitoring Plan						
Air Quality Monitoring						177,800.00
	Quarterly monitoring of vehicular emissions	14,300	year	4	57,200.00	
	Air quality monitoring before starting construction in Ancon Sector	1,000	year	3	3,000.00	
	Quarterly air quality monitoring	29,400	year	4	117,600.00	
Noise Emissions Monitoring (Ambient and Occupational)						208,250.00
	Quarterly occupational noise monitoring	28,600	year	4	114,400.00	
	Baseline noise monitoring before construction in Ancon Sector	750	site	3	2,250.00	
	Baseline noise monitoring before construction along the alignment.	750	site	8	6,000.00	
	Quarterly noise monitoring	21,400	year	4	85,600.00	
Vibration Level Monitoring (Ambient and Occupational)						276,090.00
	Quarterly full-body vibration monitoring	36,600	year	4	146,400.00	
	Baseline ambient vibration monitoring before construction in Ancon sector and alignment	930	site	11	10,230.00	
	Quarterly ambient vibration monitoring	29,400	year	4	117,600.00	
	Monitoring in case of blasts	930	site	2	1,860.00	
Surface Water Quality Monitoring						116,800.00
	Quarterly surface water quality monitoring	29,200	year	4	116,800.00	
Soil Quality Monitoring						47,200.00
	Quarterly soil quality monitoring	11,800	year	4	47,200.00	
Land Subsidence Monitoring						60,000.00
	Quarterly land subsidence monitoring	15,000	year	4	60,000.00	
				Subtotal		886,140.00
				Total		2,033,762.65

Source: URS Holdings, Inc. (2014)

(2) Operation Phase

USD

Monitoring Plan	Description	Unit Cost	Unit	Quantity	Cost	Sub Total
Air Quality Monitoring						30,000.00
	Biannual air quality monitoring – Year 1 Operation.	15,000	year	1	15,000.00	
	Annual air quality monitoring – Year 2 and 3 Operation.	7,500	year	2	15,000.00	
Noise Emissions Monitoring (Ambient and Occupational)						22,000.00
	Biannual noise monitoring – Year 1 Operation.	11,000	year	1	11,000.00	
	Annual noise monitoring – Year 2 and 3 Operation.	5,500	year	2	11,000.00	
Vibration Level Monitoring (Ambient and Occupational)						22,500.00
	Annual ambient vibration monitoring	7,500	year	3	22,500.00	
Surface Water Quality Monitoring						29,200.00
	Biannual surface water quality monitoring– Year 1 Operation.	14,600	year	1	14,600.00	
	Annual surface water quality monitoring– Year 2 and 3 Operation.	7,300	year	2	14,600.00	
Soil Quality Monitoring						67,300.00
	Biannual soil quality monitoring – Year 1 Operation.	6,200	year	1	6,200.00	
	Biannual soil quality monitoring – Year 2 and 3 Operation.	3,100	year	2	6,200.00	
Waste water monitoring						54,900.00
	Biannual monitoring of wastewater effluent at stations and at Depot area– Year 1 Operation.	27,450	year	1	27,450.00	
	Annual monitoring of wastewater effluent at stations and in Depot area (1 site) – Year 2 and 3 Operation	13,725	year	2	27,450.00	
Total						225,900.00

Source: Prepared by JICA Study Team based on URS Holdings, Inc. (2014)

付属資料 11-9 メトロ 3 号線事業及び第 4 パナマ運河橋事業のモニタリング計画

Monitoring Plan	Monitoring Activity	Parameters	Implementation Period	Q*	BA*	A*	T*	O*	Responsible for Implementation
Monitoring of Air Quality	**Monitoring of Vehicle Emissions**								
	Measurement of vehicle emissions (quarterly monitoring/ 10 vehicles/ 5 years)	Emissions parameters defined in current regulations	Construction	**X**					Owner
	Monitoring of Ambient Air Quality								
	Monitoring of the air quality in the Ancón area (3 sites/ 1 measurement)	$PM_{10,}$ NO_2, SO_2, CO, CO_2 and O_3	Before beginning construction					**X**	Owner
	Monitoring of the air quality in recipients near the project (8 sites / 5 year)	$PM_{10,}$ NO_2, SO_2, CO, CO_2 and O_3	Construction	**X**					Owner
	Monitoring of the air quality in recipients near the project (8 sites / 1 year)	$PM_{10,}$ NO_2, SO_2, CO, CO_2 and O_3	Operation 1st year		**X**				Owner
	Monitoring of the air quality in sensible receptors near the project (8 sites / 2 years)	$PM_{10,}$ NO_2, SO_2, CO, CO_2 and O_3	Operation 2nd and 3rd years			**X**			Owner
Monitoring of Occupational Noise	**Monitoring of Noise in a Work Environment**								
	Dosimeters (10 workers per sector/ 5 sectors/ 5 years)	VdB	Construction	**X**					Owner
Monitoring of Ambient Noise	**Monitoring of Ambient Noise**								
	Monitoring of ambient noise in Ancón area (3 sites / 1 measurement)	Lmax, Lmin, Leq. Daily and nightly (dBA)	Before beginning construction					**X**	Owner
	Monitoring of ambient noise in sensible receptors near the project (8 sites / 5 years)	Lmax, Lmin, Leq. Daily and nightly (dBA)	Construction	**X**					Owner
	Monitoring of ambient noise in sensible receptors near the project (8 sites / 1 year)	Lmax, Lmin, Leq. Daily and nightly (dBA)	Operation 1st year		**X**				Owner
	Monitoring of ambient noise in sensible receptors near the project (8 sites / 2 years)	Lmax, Lmin, Leq. Daily and nightly (dBA)	Operation 2nd and 3rd years			**X**			Owner
t r u c t	**Monitoring of Ambient Vibration Levels**								

Monitoring Plan	Monitoring Activity	Parameters	Implementation Period	Q*	BA*	A*	T*	O*	Responsible for Implementation
	Inspections of existing structures along the alignment to verify their current condition, up to a radius of 200 meters. In the zones where blasting must be applied, the radius must be expanded up to 1,000 meters.	Presence of fissures, cracks or damages in general to the walls, floors, ceiling or beams	Before beginning construction					**X**	Owner
	Monitoring of baseline vibrations in Ancón (3 sites) and alignment (8 sites). One time measurement.	Peak Particle Velocity (mm/s)	Before site preparation					**X**	Owner
	Monitoring of ambient vibration along the alignment. (8 sites / 5 years)	Peak Particle Velocity (mm/s)	Construction	**X**					Owner
	Monitoring of ambient vibration. Exclusively in event of blasting. (2 sites / blasting)	Peak Particle Velocity (mm/s)	Construction. During blasting					**X**	Owner
	Structural integrity inspections after the use of blasting, up to 1,000 meters from the blasting site.	Presence of fissures, cracks or damages in general to the walls, floors, ceiling or beams	Construction. After blasting					**X**	Owner
	Monitoring of ambient vibration along the alignment. (8 sites / 1 year)	Peak Particle Velocity (mm/s)	Operation 1st year		**X**				Owner
	Monitoring of ambient vibration along the alignment. (10 sites /2 years)	Peak Particle Velocity (mm/s)	Operation 2nd and 3rd years			**X**			Owner
Monitoring of Occupational Vibrations	**Monitoring of Ambient Vibration Levels in Work Environments**								
	Monitoring of complete body vibration. (10 workers per sector/ 5 sectors***/ 5 years)	VdB	Construction	**X**					Owner
Monitoring of Surface Water Quality	**Monitoring of Surface Water Quality**								
	Monitoring of surface water quality (4 water courses, up and downstream the project). In other words, 2 samples per water course, in total 8 samples). (5 years)	pH, dissolved oxygen, turbidity, biochemical oxygen demand, fecal coliforms, oils and greases, metals and detergents	Construction	**X**					Owner

Monitoring Plan	Monitoring Activity	Parameters	Implementation Period	Q*	BA*	A*	T*	O*	Responsible for Implementation
	Monitoring of surface water quality (4 water courses, up and downstream the project). In other words, 2 samples per water course, in total 8 samples). (1 year)	pH, dissolved oxygen, turbidity, biochemical oxygen demand, fecal coliforms, oils and greases, metals and detergents	Operation 1st year		**X**				Owner
	Monitoring of surface water quality (4 water courses, up and downstream the project). In other words, 2 samples per water course, in total 8 samples). (2 years)	pH, dissolved oxygen, turbidity, biochemical oxygen demand, fecal coliforms, oils and greases, metals and detergents	Operation 2nd and 3rd years			**X**			Owner
Monitoring of Waste Waters	**Monitoring of Waste Water Quality**								
	Monitoring of waste waters from metro station's bathrooms (14 samples) and Depot area and equipment yard (1 sample). (1 year)	Parameters defined in current regulations, depending on the discharge point	Operation 1st year		**X**				Owner
	Monitoring of waste waters from metro station's bathrooms (14 samples) and Depot area and equipment yard (1 sample). (2 years)	Parameters defined in current regulations, depending on the discharge point	Operation 2nd and 3rd years			**X**			Owner
Monitoring of Soil Quality	**Monitoring of Soil Quality**								
	Monitoring of soil quality in areas used as fuel depots, workshops and equipment yards. (4 sites / 5 years)	Heavy metals, Hydrocarbons, Organic material, Dehydrogenase Microbial Activity	Construction	**X**					Owner
	Monitoring of soil quality in areas used as fuel depots, workshops and equipment yards. (4 sites / 1 year)	Heavy metals, Hydrocarbons, Organic material, Dehydrogenase Microbial Activity	Operation 1st year		**X**				Owner

Monitoring Plan	Monitoring Activity	Parameters	Implementation Period	Q*	BA*	A*	T*	O*	Responsible for Implementation
	Monitoring of soil quality in areas used as fuel depots, workshops and equipment yards. (4 sites / 2 years)	Heavy metals, Hydrocarbons, Organic material, Dehydrogenase Microbial Activity	Operation 2nd and 3rd years			**X**			Owner
Monitoring of Subsidence	Monitoring of the subsidence in Omar-Torrijos Interchange by visual check and measurement (only for the Fourth Panama Canal Bridge Project)	Meters	Construction	**X**					Owner
Reports**	**Follow-Up**								
	Biannual compliance reports		Construction		**X**				Owner
	Annual compliance reports		Operation (for the first 3 years)			**X**			Owner

*:Q-quarterly; BA-biannual; A-annual; T-every two years; y O-once.
**: Proposed frequencies must be adjusted to what has been established by the ANAM.
***: Number of sectors for programming and management cost calculation. Once the activities are programmed, an adjustment may be required.
Source: URS Holdings, Inc. (2014)

付属資料 11-10 環境管理計画モニタリングフォーム

Monitoring format of General Site Visit

Date:		Name and signiture:	
Weather:			
General observation in the field			
Problems	Measures taken	Actual situation (still in process to resolve or resolved)	Action to be taken

Monitoring format of Ambient Quality (Construction phase)

Air quality

Item	Unit	Measured value (mean)	Measured value (Max.)	Country's Standards	Standards for Contract	Referred International Standards	Proposed Measurement Point	Frequency
PM_{10}	$\mu g/m^3N$			50/year 150/24 hours			McDonalds (Balboa), ACP Building 731 (Balboa), ACP Building 910 (La Boca), SENAN (Rodman), Delta station (Arraijan), Residential Arboleda (Caceres), Global Bank (Arraijan), Gas Station Puma (Parque Oeste)	Quarterly
NO_2	$\mu g/m^3N$			100/year 150/24 hours				
SO_2	$\mu g/m^3N$			80/year 365/24 hours				
CO	$\mu g/m^3N$			10,000/8hours 30,000/1hour				
O_3	$\mu g/m^3N$			157/8hours 235/1hour				

Noise

Item	Unit	Measured value	Country's Standards		Standards for Contract	Referred International Standards	Proposed Measurement Point	Frequency
			Day	Night				
Noise Level Lmax. (day and night)	dB		-	-			National Police (Albrook), ACP Building 729 (Balboa), PIPSA(La Boca), SENAN (Rodman), Super Xtra (Arraijan), Residential Arboleda (Caceres), Supermarket Rey (Vista Alegre), Cemetery Colina de la Paz	Quarterly
Noise Level Lmin. (day and night)	dB		-	-				
Noise Level Leq. (day and night)	dB		60	50				

Vibration

Item	Unit	Measured value	Country's Standards	Standards for Contract	Referred International Standards	Proposed Measurement Point	Frequency
Peak Particle Velocity	mm/s		50			National Police (Albrook), ACP Building 729 (Balboa), PIPSA(La Boca), SENAN (Rodman), Super Xtra (Arraijan), Residential Arboleda (Caceres), Supermarket Rey (Vista Alegre), Cemetery Colina de la Paz	Semiannually

Surface water quality

Item	Unit	Measured value (mean)	Measured value (Max.)	Country's Standards	Standards for Contract	Referred International Standards	Proposed Measurement Point	Frequency
pH							Velasquez River, Aguacate River, One stream without name (Valle Hermos, Nuevo Arraijan), River Cope	Quarterly
Dissolved Oxygen (DO)	mg/l			>5.0				
Turbidity	NTU			<100				
Biochemical Oxygen Demand (BOD)	mg/l			<5.0				
Fecal Coliforms	UFC/100ml			<1000				
Oils & greases								
Metals								
Detergents								

Soil quality

Item	Unit	Measured value (mean)	Measured value (Max.)	Country's Standards	Standards for Contract	Referred International Standards	Proposed Measurement Point	Frequency
Heavy metals							Area of fuel tank, workshops, and yard	Quarterly
Hydrocarbons								
Organic material								
Dehydrogenase Microbial Activity								

Monitoring format of Ambient Quality (Operation phase)

Air quality

Item	Unit	Measured value (mean)	Measured value (Max.)	Country's Standards	Standards for Contract	Referred International Standards	Proposed Measurement Point	Frequency
PM_{10}	$\mu g/m^3N$			50/year 150/24 hours			McDonalds (Balboa), ACP Building 731 (Balboa), ACP Building 910 (La Boca), SENAN (Rodman), Delta station (Arraijan), Residential Arboleda (Caceres), Global Bank (Arraijan), Gas Station Puma (Parque Oeste)	Semiannually in the 1st year, and annually in the 2nd and 3rd year
NO_2	$\mu g/m^3N$			100/year 150/24 hours				
SO_2	$\mu g/m^3N$			80/year 365/24 hours				
CO	$\mu g/m^3N$			10,000/8hours 30,000/1hour				
O_3	$\mu g/m^3N$			157/8hours 235/1hour				

Noise

Item	Unit	Measured value	Country's Standards		Standards for Contract	Referred International Standards	Proposed Measurement Point	Frequency
			Day	Night				
Noise Level Lmax. (day and night)	dB		-	-			National Police (Albrook), ACP Building 729 (Balboa), PIPSA(La Boca), SENAN (Rodman), Super Xtra (Arraijan), Residential Arboleda (Caceres), Supermarket Rey (Vista Alegre), Cemetery Colina de la Paz	Semiannually in the 1st year, and annually in the 2nd and 3rd year
Noise Level Lmin. (day and night)	dB		-	-				
Noise Level Leq. (day and night)	dB		60	50				

Surface water quality

Item	Unit	Measured value (mean)	Measured value (Max.)	Country's Standards	Standards for Contract	Referred International Standards	Proposed Measurement Point	Frequency
pH							Velasquez River, Aguacate River, One stream without name (Valle Hermos, Nuevo Arraijan), River Cope	Semiannually in the 1st year, and annually in the 2nd and 3rd year
Dissolved Oxygen (DO)	mg/l			>5.0				
Turbidity	NTU			<100				
Biochemical Oxygen Demand (BOD)	mg/l			<5.0				
Fecal Coliforms	UFC/100ml			<1000				

Item	Unit	Measured value (mean)	Measured value (Max.)	Country's Standards	Standards for Contract	Referred International Standards	Proposed Measurement Point	Frequency
Oils & greases								
Metals								
Detergents								

Soil quality

Item	Unit	Measured value (mean)	Measured value (Max.)	Country's Standards	Standards for Contract	Referred International Standards	Proposed Measurement Point	Frequency
Heavy metals							Area of fuel tank, workshops, and yard	Semiannually in the 1st year, and annually in the 2nd and 3rd year
Hydrocarbons								
Organic material								
Dehydrogenase Microbial Activity								

Note: "Item", "Proposed measurement point", and "Frequency" will be fixed based in the requirements of ANAM and the results of monitoring.

付属資料 11-11 住民移転計画履行確認モニタリングフォーム案

Date	Name
General observation in the field	
Results of interview with PAPs	

Problems, complains	Measures taken	Actual situation (still in process to resolve or resolved)	Action to be taken

Progress of activities

Activities	Total	Unit	Progress in quantity		Progress in %		Expected date of completion	Responsible organization
			During the week	Till	During the week	Till		
Preparation of MINI RAP								
Employment of consultants		M/M						
Update of Strategic RAP								
Implementation of census to PAPs								
Property assess								
Approval of MINI RAP by SMP								
Finalization of PAPs List		No. Of PAPs						
Progress of compensation payment		No. Of HHs						
Balboa								
Loma Coba								
Arraijan								
Nuevo Chorrillo								
Biquez								
Vista Alegre								
Nuevo Arraijan								
San Bernardino								
Hato Montana								
Progress of land acquisition		m2						
Arraijan								
Nuevo Chorillo								
Biquez								
Vista Alegre								
Hato Montana								
Progress of resplacement		No. Of HHs						
Nuevo Chorrillo								
Biquez								
Hato Montana								
Progress of economic displacement		No. Of HHs						
Balboa								
Loma Coba								
Arraijan								
Nuevo Chorrillo								
Biquez								
Vista Alegre								
Nuevo Arraijan								
San Bernardino								
Hato Montana								

付属資料 11-12 JICA 環境チェックリスト（メトロ 3 号線事業及び第 4 パナマ運河橋事業）[1]

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
1 Permits and Explanation	(1) EIA and Environmental Permits	(a) Have EIA reports been already prepared in official process? (b) Have EIA reports been approved by authorities of the host country's government? (c) Have EIA reports been unconditionally approved? If conditions are imposed on the approval of EIA reports, are the conditions satisfied? (d) In addition to the above approvals, have other required environmental permits been obtained from the appropriate regulatory authorities of the host country's government?	(a) Y (b) N (c) N (d) N	(a) The EIA reports will be submitted to ANAM on August in 2014, and the approval will be issued within around three months after submission. One EIA report was prepared for the Metro Line 3 Project, and another for the Fourth Panama Canal Bridge Project including the improvement work of Omar-Torrijos Intersection. (b) The reports will be in the process of inspection by ANAM. (c) The reports will be in the process of inspection by ANAM. (d) The various other required permits (for example tree clearance, payment for mangrove cut, permit for explosion, permit for discharge of used and waste water, permit of water use, permit for excavation and landfill, permit for solid waste disposal, permit for hazardous wastes management, permit of work in the Canal Area by ACP, etc.) cannot be applied for before the EIAs are approved via ANAM's resolution. The ANAM resolution will include a number of conditions and permits that must be fulfilled by the promoter.
	(2) Explanation to the Local Stakeholders	(a) Have contents of the Project and the potential impacts been adequately explained to the local stakeholders based on appropriate procedures, including information disclosure? Is understanding obtained from the local stakeholders? (b) Have the comments from the stakeholders (such as local residents) been reflected in the Project design?	(a) Y (b) Y	(a) Numerous public consultation meetings, stakeholder meetings and focus group discussions were held (see Table 19.2), exceeding the local procedures and rules. The general consensus among civil society, local populations and even affected people, is that the projects will bring significant positive impacts, and as such there is widescale support obtained from local stakeholders. Final information disclosure will be carried out by ANAM following approval of the EIA reports. (b) The line 3 project basic design fully reflects the opinions of PAPs and other local stakeholders. For example, the overall routing was shifted from the "Autopista" alignment to the "Panamericana" alignment, stations, bus stops and other project features were added or moved according to popular request.
	(3) Examination of Alternatives	(a) Have alternative plans of the Project been examined with social and environmental considerations?	(a) Y	(a) Project alternatives have been evaluated to a significant extent, including social and environmental considerations at all times. Alternatives for the Metro Line 3 project included routing alternatives, and technology alternatives, and for the Fourth Panama Canal Bridge project, routing alternatives were considered alongside bridge type. A tunnel alternative was also studied. For both the Metro Line 3 and Fourth Panama Canal Bridge projects, the "no project" alternative was also studied.
2 Pollution Control	(1) Air Quality	(a) Is there a possibility that air pollutants emitted from the Project related sources, such as vehicles traffic will affect ambient air quality? Does ambient air quality comply with the country's air quality standards? Are any mitigating measures taken? (b) Where industrial areas already exist near the route, is there a possibility that the Project will make air pollution worse?	(a) Y (b) N	(a) The construction of the project will of course generate air pollutants such as SOx, NOx, CO and PM10 however this impact will be minor, temporary, and easily mitigated for via standard mitigation measures proposed in the EIAs. The operation of both projects will have significant positive impacts on air quality. The Metro Line 3 monorail will be run on clean energy and will therefore offset / reduce air pollution that would have been generated by vehicular traffic. Likewise, although the new Fourth Panama Canal Bridge will cause a local reduction in air quality, it will cause an overall improvement in air quality and pollutant levels by reducing journey lengths and journey times. Panama has no ambient air quality standard (one is currently under preparation) however provisional limits are available. Most of the survey results are below the likely eventual standards, however several readings exceeded the provisional limits. (b) There is no industrial area near the route.
	(2) Water Quality	(a) Is there a likelihood that soil runoff from the bare lands resulting from earthmoving activities, such as cutting and filling will cause water quality degradation in downstream water areas? (b) Is there a likelihood that the project will contaminate water sources, such as groundwater? (c) Do effluents from various facilities, such as parking areas/service areas comply with the country's effluent standards and ambient water quality standards? Is there a possibility that the effluents will cause areas not to comply with the country's ambient water quality standards?	(a) Y (b) N (c) Y	(a) Water quality degradation during ground clearance activities is likely due to the high rainfall in Panama and the slopes in the forest section of Metro Line 3. However, the increased sediment level in runoff water will be a fairly insignificant increase in most water bodies, which already have high TSS levels. b) It is fairly unlikely that construction or operation of the project will contaminate groundwater. (c) Panama does not have comprehensive water quality standards in place that could be exceeded by the projects' operational effluents. Nevertheless, operational effluents will be carefully collected and treated prior to discharge, so negative impacts are not expected.
	(3) Wastes	(a) Will waste generated from the Project facilities, such as stations and depot, be properly treated and disposed of in accordance with the country's regulations?	(a) Y	(a) Solid waste management will be one of the design features to be considered during detailed design for the projects, but will be required to be in accordance with the relevant legislation (Executive Decree 34 of 2007). During construction, contractors will also be bound to carrying out their work in accordance with Panamanian Laws, as well as international standards, via the Waste Management Plan that forms part of the overall Environmental Management Plan.

[1] This table is a version created by combining tables 8 (rail) and 12 (bridges) from the JICA Website.

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
	(4) Noise and Vibration	(a) Do noise and vibrations from the vehicle and train traffic comply with the country's standards?	(a) N	(a) The baseline surveys determined that background noise levels are already in excess of the legal limits as defined in Panamanian law at all locations where readings were taken, and at all times. The construction and operation of the new metro line and bridge will add to the already high background noise levels, but the noise increase will be restricted to the immediate project vicinity. Detailed design should include consideration for operational noise reduction. Conversely, as the metro system will offset expected increase in car numbers and traffic problems, vehicular noise will be reduced, or at least noise increase will be prevented. There is no national standard for vibrations in Panama, but the EIA determined that the negative impacts due to vibration were likely to be low to moderate.
	(5) Subsidence	(a) In the case of extraction of a large volume of groundwater, is there likelihood that the extraction of groundwater will cause subsidence (especially in case of Undergrounds/Subways)?	(a) N	(a) The metro system will be entirely above ground, and there will therefore be no significant tunneling or underground excavations. Dewatering will be required during construction at certain locations (e.g. bridge and rail support piling) but, considering the fairly low volumes and considering the ground conditions, subsidence is very unlikely, and was not considered a significant impact by the EIA studies.
3 Natural Environment	(1) Protected Areas	(a) Is the Project site located in protected areas designated by the country's laws or international treaties and conventions? Is there a possibility that the Project will affect the protected areas?	(a) N	(a) There is no protected area in/around the Project site, and it is extremely unlikely that the projects will affect protected areas.
	(2) Ecosystem	(a) Does the Project site encompass primeval forests, tropical rain forests, ecologically valuable habitats (e.g., coral reefs, mangroves, or tidal flats)? (b) Does the Project site encompass the protected habitats of endangered species designated by the country's laws or international treaties and conventions? (c) If significant ecological impacts are anticipated, are adequate protection measures taken to reduce the impacts on the ecosystem? (d) Are adequate protection measures taken to prevent impacts, such as disruption of migration routes, habitat fragmentation, and traffic accident of wildlife and livestock? (e) Is there a likelihood that installation of railroads, bridges and access roads will cause impacts, such as destruction of forest, poaching, desertification, reduction in wetland areas, and disturbance of ecosystems due to introduction of exotic (non-native invasive) species and pests? Are adequate measures for preventing such impacts considered? (f) In cases the Project site is located at undeveloped areas, is there a likelihood that the new development will result in extensive loss of natural environments?	(a) Y (b) N (c) N/A (d) N/A (e) N (f) N	(a) The Metro Line 3 project passes through a significant area of mainly mature secondary tropical rain forest, however, as the line runs alongside the road for the majority of the alignment, a relatively small amount of clearance is required. For the same reason, the impacts of forest clearance alongside a highly disturbed area are clearly much less significant than if the clearance were occurring in an undisturbed location. The Fourth Panama Canal Bridge project element passes through a small area of mangroves on the western banks of the Canal. A Special Mangrove Management Plan has been developed as part of the EIA for the Fourth Panama Canal Bridge, to ensure that construction impacts are minimized. It should be noted that academic and NGO opinion is that the area of mangrove to be cleared during construction of the bridge is likely to regenerate fairly rapidly. Both the forest and mangrove areas to be cleared will be offset through ANAM's forestry offset program. (b) The project sites do not encompass any protected habitats, but does encompass habitats of endangered species designated by both Panamanian law and international conventions. Despite this, the EIA studies determined that the projects will not cause significant habitat loss, nor will it have effects on the protected species. (c) Severe impacts on the ecosystem are not foreseen. (d) Due to the fact that the alignment of the Metro Line 3 project is largely alongside the existing road, and due to the fact that the entire alignment is raised above ground, no impacts are expected on animal migration, severance, or habitat fragmentation. As a result, no protection measures are required. (e) No introduction of exotic species is expected. (f) The majority of the project site is not located in undeveloped areas, and passes through existing urban areas. The section that passes through forest will not result in extensive loss of natural environments due to the proximity of the alignment to the existing road, the raised nature of the alignment, and the fairly small amount of clearance required. Offset and regeneration will also take place.
	(3) Hydrology	(a) Is there a likelihood that alteration of topographic features and installation of structures, such as tunnels will adversely affect surface water and groundwater flows?	(a) N	(a) The surface water flow is unlikely to be significantly affected by the presence or operation of the project, however they may be a slight increase in runoff. The construction of the project has some potential to affect surface water and groundwater flows, but the affects, if any, will be minor, and can be fairly easily mitigated.
	(4) Topography and Geology	(a) Is there any soft ground on the route that may cause slope failures or landslides? Are adequate measures considered to prevent slope failures or landslides, and where are such needed? (b) Is there a likelihood that civil works, such as cutting and filling will cause slope failures or landslides? Are adequate measures considered to prevent slope failures or landslides? (c) Is there a likelihood that soil runoff will result from cut and fill areas, waste soil disposal sites, and borrow sites? Are adequate measures taken to prevent soil runoff?	(a) N (b) Y (c) Y	(a) The project is in a high risk area for landlsides. Although soft ground does exist in places alongside the alignment of the Metro Line 3 Project, due to the fact that the majority of the alignment is alongside or in the centre of a paved road, slope failures and landslides are not expected. (b) It is possible that cut and fill and other construction activities may cause slope failures and landslides, however it is farily unlikely, particularly when the recommended mitigation measures are implemented via the Environmental Management Plan. (c) Soil runoff is highly likely during construction, due to the nature of the terrain and the climate in Panama. Runoff will be mitigated for via the Environmental Management Plan. Example mitigation measures include installation of silt fences.
4 Social Environment	(1) Resettlement	(a) Is involuntary resettlement caused by project implementation? If involuntary resettlement is caused, are efforts made to minimize the impacts caused by resettlement? (b) Is adequate explanation on compensation and resettlement assistance given	(a)Y (b)Y (c)Y (d)Y	(a) Resettlement will be required for five families. The alignment was determined minimizing relocation of inhabitants. (b) All PAPs have been involved in the community participation activities during the feasibility study. (c) The RAP in accordance with the World Bank OP 4.12 was elaborated based on the census and socioeconomic

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
		to affected people prior to resettlement? (c) Is the resettlement plan, including compensation with full replacement costs, restoration of livelihoods and living standards developed based on socioeconomic studies on resettlement? (d) Are the compensations going to be paid prior to the resettlement? (e) Are the compensation policies prepared in document? (f) Does the resettlement plan pay particular attention to vulnerable groups or people, including women, children, the elderly, people below the poverty line, ethnic minorities, and indigenous peoples? (g) Are agreements with the affected people obtained prior to resettlement? (h) Is the organizational framework established to properly implement resettlement? Are the capacity and budget secured to implement the plan? (i) Are any plans developed to monitor the impacts of resettlement? (j) Is the grievance redress mechanism established?	(e)Y (f)Y (g)Y (h)Y (i)Y (j)Y	study of PAPs carried out on February to April of 2014. (d) The Strategic RAP determines the compensation is paid prior to resettlement. (e) The Strategic RAP determines the compensation policies. (f) The Strategic RAP describes the livelihood conditions of vulnerable groups and people. Special attention will be paid for vulnerable people. (g) The Strategic RAP determines that the SMP should obtain the agreements with the PAPs prior to resettlement. (h) SMP has a unit for resettlement and land acquisition. They have a successful experience in the Metro Line 1 Project. (i) A monitoring plan was elaborated out as a part of the Strategic RAP. (j) SMP will open the offices to conduct the grievance redress in the project area.
	(2) Living and Livelihood	(a) Where railways, bridges and access roads are newly installed, is there a likelihood that the Project will affect the existing means of transportation and the associated workers? Is there a likelihood that the Project will cause significant impacts, such as extensive alteration of existing land uses, changes in sources of livelihood, or unemployment? Are adequate measures considered for preventing these impacts? (b) Is there any likelihood that the Project will adversely affect the living conditions of the inhabitants other than the target population? Are adequate measures considered to reduce the impacts, if necessary? (c) Is there any likelihood that diseases, including infectious diseases, such as HIV will be brought due to immigration of workers associated with the Project? Are adequate considerations given to public health, if necessary? (d) Is there any likelihood that the project will adversely affect road traffic in the surrounding areas (e.g., increase of traffic congestion and traffic accidents)? (e) Is there any likelihood that railways, bridges or access roads will impede the movement of inhabitants? (f) Is there any likelihood that structures associated with roads (such as bridges) will cause sun shading and radio interference?	(a) N (b) N (c) N (d) Y (e) N (f) Y	(a) Any severe impacts are not foreseen. The railways will go along the existing highway. (b) Any severe impacts are not foreseen. The project will have positive impact on the quality of life in the project area. (c) Any severe impacts are not foreseen in the environmental management plan with regards to awareness training for the workers. (d) The traffic congestion can occur during site preparation and construction, which can be minimized by controlling the working time. However, during the operation stage, situation is expected to improve. (e) Any revere impacts are not foreseen. (f) The columns of railway and of access road to the bridge probably will cause sun shading and radio interference. However, the most section of Metro Line 3 Project will go in the medium of the exiting highway, and the impact will be minimized.
4 Social Environment	(3) Heritage	(a) Is there a likelihood that the Project will damage the local archeological, historical, cultural, and religious heritage? Are adequate measures considered to protect these sites in accordance with the country's laws?	(a) N	(a) As the projects pass along fairly highly disturbed areas, and as the baseline surveys found little evidence of archaeological interest, it is not considered likely that the projects will damage local archaeological or historical resources. Likewise, the projects do not pass in proximity to any cultural or religious facilities or sites. Considerable effort was made during the EIA studies to uncover any evidence of such resources, in excess of the legal requirements. During construction, a Chance Find Procedure will be implemented to ensure that in the unlikely event of a discovery, the incident be correctly handled.
	(4) Landscape	(a) Is there a likelihood that the Project will adversely affect the local landscape? Are necessary measures taken?	(a) N	(a) The EIA assessment determined that the existing landscapes are “average”. Many of the sections of the projects are highly disturbed due to anthropogenic activity, and even the relatively unpopulated forested area to the West of the Canal already includes the highway. No specific measures are required for landscape mitigation during construction, however sympathetic architecture for stations, substations, and other infrastructure should be employed.
	(5) Ethnic Minorities and Indigenous Peoples	(a) Are considerations given to reduce impacts on the culture and lifestyle of ethnic minorities and indigenous peoples? (b) Are all of the rights of ethnic minorities and indigenous peoples in relation to land and resources to be respected?	(a) N (b) N	(a) There is neither ethnic minorities nor traditional indigenous community in/around the Project area. (b) There is neither ethnic minorities nor traditional indigenous community in/around the Project area.
	(6) Working Conditions	(a) Is the Project proponent not violating any laws and ordinances associated with the working conditions of the country which the Project proponent should observe in the Project? (b) Are tangible safety considerations in place for individuals involved in the	(a) N (b) Y (c) Y	(a) The Project will take place in accordance with the national laws and ordinances about the working conditions (b) SMP will obligate consultants and contractors to provide safety considerations for their workers. (c) SMP will obligate consultants and contractors to implement safety and health program for their workers.

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
		Project, such as the installation of safety equipment which prevents industrial accidents, and management of hazardous materials? (c) Are intangible measures being planned and implemented for individuals involved in the Project, such as the establishment of a safety and health program, and safety training (including traffic safety and public health) for workers, etc.? (d) Are appropriate measures being taken to ensure that security guards involved in the Project not to violate safety of other individuals involved, or local residents?	(d) Y	(d) SMP will obligate consultants and contractors to consider security guards for the workers.
5 Others	(1) Impacts during Construction	(a) Are adequate measures considered to reduce impacts during construction (e.g., noise, vibrations, turbid water, dust, exhaust gases, and wastes)? (b) If construction activities adversely affect the natural environment (ecosystem), are adequate measures considered to reduce impacts? (c) If construction activities adversely affect the social environment, are adequate measures considered to reduce impacts?	(a) Y (b) Y (c) Y	(a) The Environmental Management Plan, which includes a number of specific sub-plans such as a waste management plan and a flora and fauna protection plan, proposes a large number of effective mitigation measures to remove or reduce negative impacts during construction. Examples include restrictions on working hours and locations, and use of modern machinery to reduce noise and emissions, use of dust suppression equipment and regular damping to reduce dust generation, installation of silt fences and settling tanks to reduce runoff sediment loads, strict controls on waste management and storage and use of hazardous liquids, to prevent soil and water contamination, and extensive measures to prevent harm to workers or the general public. (b) The Environmental Management Plan outlines measures to reduce the negative impact of the required forest clearance, as well as proposing offset measures. (c) The RAP as well as the Environmental Management Plan is prepared to reduce impacts on social environment during construction, which will include among other measures the deployment of a full time Community Liaison Officer, regular meetings with the local communities, and implementation of a Grievance Redress Mechanism.
	(2) Monitoring	(a) Does the proponent develop and implement monitoring program for the environmental items that are considered to have potential impacts? (b) What are the items, methods and frequencies of the monitoring program? (c) Does the proponent establish an adequate monitoring framework (organization, personnel, equipment, and adequate budget to sustain the monitoring framework)? (d) Are any regulatory requirements pertaining to the monitoring report system identified, such as the format and frequency of reports from the proponent to the regulatory authorities?	(a) Y (b) Y (c) Y (d) Y	(a) The proponent develops and implements the monitoring program In accordance with the Environmental Management Plan, with the support of ANAM and other related agencies. (b) The items, methods and frequencies of the monitoring program of air quality, noise and vibration are explained in 19.7.6 of this Report. (c) In accordance with the Environmental Management Plan as well as the national regulation of ANAM, SMP will establish adequate monitoring framework. (d) The proponent should periodically submit the monitoring reports to ANAM.

Source: JICA Study Team