

***DATA BOOK D***  
***PROCESS CALCULATION SHEET AND B/Q***  
***OF STF<sub>s</sub>***

## Process Calculation Sheet of Priority STFs

**Remark:**

*(1) This process calculation sheet presents the results of selected optional processes as well as not selected ones.*

1. Design Basis
2. Grit Chamber
3. Influent Pump
4. RAFA Reactor
5. Bio-Filter
6. B/F Recirculation Pump
7. Sedimentation Tank
8. Aerated Lagoon
9. Aerator for Aerated Lagoon
10. Polishing Pond
11. Sludge Generation
12. Sludge Thickener
13. Sludge Digester
14. Sludge Dehydrator
15. Sludge Drying Bed
16. B/F Recirculation Tank
17. Disinfection Tank
18. Transfer Pump
19. Transfer Tank
20. Treated Sewage Discharge Pipe

## DESIGN BASIS

The following figures, which have been formulated in the Sewerage Planning, are adopted for this preliminary design:

Design Parameters	Units	Systems						
		CONCEICAO	JANGA	CABANGA	BOA VIAGEM	CORDEIRO	PRAZERES	CURCURANA
<b>Sewage Flow in 2020</b>								
Daily maximum flow	(m <sup>3</sup> /d)	14,900	73,585	66,374	31,337	22,245	38,219	28,762
Daily average flow	(m <sup>3</sup> /d)	13,135	64,464	57,381	27,087	19,308	32,677	24,795
Hourly maximum flow	(m <sup>3</sup> /d)	20,508	102,382	93,791	44,408	31,091	53,937	40,638
<b>Capacity of Existing Treatment Facilities</b>								
Daily maximum flow	(m <sup>3</sup> /d)	-	39,200	80,000	-	-	-	-
Daily average flow	(m <sup>3</sup> /d)	-	34,341	69,161	-	-	-	-
Hourly maximum flow	(m <sup>3</sup> /d)	-	54,541	#####	-	-	-	-
<b>Sewage Flows for Expansion or New Installation</b>								
Daily maximum flow	(m <sup>3</sup> /d)	14,900	34,385	66,374	31,337	22,245	38,219	28,762
Daily average flow	(m <sup>3</sup> /d)	13,135	30,123	57,381	27,087	19,308	32,677	24,795
Hourly maximum flow	(m <sup>3</sup> /d)	20,508	47,841	93,791	44,408	31,091	53,937	40,638
<b>Influent Sewage Qualities</b>								
BOD	(mg/l)	257	271	304	315	305	386	327
SS (Suspended Solids)	(mg/l)	285	301	338	350	339	429	363
<b>Treated Sewage Qualities</b>								
Overall removal rate	(%)	90	90	90	90	90	90	90
BOD	(mg/l)	26	27	30	32	31	39	33
SS (Suspended Solids)	(mg/l)	29	30	34	35	34	43	36
<b>Train number of facilities</b>		2	3	3	3	2	3	2

**Remark:**

- (1) In the Cabanga STF (Sewage Treatment Facilities), the existing influent system containing influent pumps, grit chambers and sludge treatment-related facilities will be continued to be used after the expansion.
- (2) In the Janga STF, the existing treatment facilities will work as another trains, separately with the STF to be expanded.

## GRIT CHAMBER

**Base Sewage Flow:**

Hourly maximum flow ( $Q_{hmax}$ , m<sup>3</sup>/d)

**Design Criteria:**

The following design criteria are applied to remove sand particles with larger than 0.15 mm diameter:

- Water surface loading rate ( $L_s$ ): 1,300 (m/d)
- Critical horizontal velocity ( $V_c$ ): 0.12 (m/sec)
- Detention time ( $T_d$ ): 40 (sec)

**Calculation Equation:**

Water surface area =  $Q_{hmax} \times 1/L_s$  (m<sup>2</sup>)  
 Vertical section area =  $Q_{hmax} \times 1/V_c$  (m<sup>2</sup>)  
 Volume =  $Q_{hmax} \times T_d \times 86400$  (m<sup>3</sup>)

**Calculation Results:**

Design Parameters		Units	Systems						
			CONCEICAO	JANGA	CABANGA	BOA VIAGEM	CORDEIRO	PRAZERES	CURCURANA
Unit numbers			2	3	2	3	2	3	2
Required figures / train	Water surface	m <sup>2</sup>	7.9	12.3	36.1	11.4	12.0	13.8	15.6
	Vertical section	m <sup>2</sup>	1.0	1.5	4.5	1.4	1.5	1.7	2.0
	Volume	m <sup>3</sup>	4.7	7.4	21.7	6.9	7.2	8.3	9.4
Actual dimensions / train	Width	m	2.0	2.0	8.75	2.0	2.0	2.0	2.0
	Length	m	5.0	7.0	8.75	7.0	6.0	7.0	8.0
	Depth	m	0.5	0.8	0.6	0.8	0.8	1.0	1.0
	Depth of sand pit	m	0.3	0.3	0.15	0.3	0.3	0.3	0.3
Actual figures / train	Water surface	m <sup>2</sup>	10.0	14.0	76.6	14.0	12.0	14.0	16.0
	Vertical section	m <sup>2</sup>	1.0	1.6	4.9	1.6	1.6	2.0	2.0
	Volume	m <sup>3</sup>	5.0	11.2	42.9	11.2	9.6	14.0	16.0

**Remarks:**

(1) The existing grit chambers in the Cabanga STF will be used after rehabilitated.

Results	OK	OK	OK	OK	OK	OK	OK
---------	----	----	----	----	----	----	----

## INFLUENT PUMP

**Base Sewage Flow:**

Hourly maximum flow ( $Q_{hmax}$ , m<sup>3</sup>/d)

**Design Criteria:**

The following criteria are applied:

- Suction side velocity ( $V_s$ ): 2.0 (m/sec)

**Calculation Equation:**

Diameter of suction pipe =  $146 \times (Q_{hmax}/V_s)^{0.5}$  (mm)

Shaft power =  $0.163 \times Q_{hmax}/N_{pump} \times H_{total} \times 1/\eta_{pump} \times 1/1440$  (kw)

**Where:**

$N_{pump}$  : Quantity of duty pump (-)

$H_{total}$  : Total pump head (m)

$\eta_{pump}$  : Pump efficiency (-)

**Calculation Results:**

Design Parameters		Units	Systems						
			CONCEICAO	JANGA	CABANGA	BOA VIAGEM	CORDEIRO	PRAZERES	CURCURANA
Quantities of pumps	Duty	-	2	3	4	3	2	3	2
	Stand-by	-	1	1	1	1	1	1	1
Conditions	Total head	m	16	13	10	16	16	16	16
	Pump efficiency	%	75	80	80	75	75	75	75
Required figures / unit	Discharge	m <sup>3</sup> /min	7.1	11.1	16.3	10.3	10.8	12.5	14.1
	Diameter of suction pipe	mm	275	344	417	331	339	365	388
	Shaft power	kw	24.8	29.3	33.2	35.7	37.5	43.4	49.1
Actual figures / unit	Type of pump		Mixed flow	Mixed flow	Centrifugal	Mixed flow	Mixed flow	Mixed flow	Mixed flow
	Discharge	m <sup>3</sup> /min	7.2	11.5	26.4	11.0	11.0	13.0	14.5
	Diameter of suction pipe	mm	300	350	500	350	350	400	400
	Motor rated power	CV	40	50	75	60	75	75	75

**Remarks:**

(1) The existing influent pumps in the Cabanga STF will be used after rehabilitated.

Results	OK	OK	OK	OK	OK	OK	OK
---------	----	----	----	----	----	----	----

## RAFA REACTOR

### Base Sewage Flow:

Daily maximum flow ( $Q_{d,max}$ ,  $m^3/d$ )

### Design Criteria:

The following criteria are applied:

- Hydraulic detention time ( $T_{RAFA}$ ): 7.0 (h)
- Unit volume of RAFA reactors for Cabanga 150 ( $m^3$ )
- Unit volume of RAFA reactors for other STFs 125 ( $m^3$ )  
(5.0 mW x 5.0 mL x 6.0 mH for the Cabanga Station,  
5.0 mW x 5.0 mL x 5.0 mH for other STFs)

### Calculation Equation:

- Required Quantities of RAFA reactors =  $Q_{d,max} \times T_{RAFA} \times 1/24 \times 1/125$  (unit)

### Calculation Results:

Design Parameters	Units	Systems						
		CONCEICAO	JANGA	CABANGA	BOA VIAGEM	CORDEIRO	PRAZERES	CURCURANA
Train numbers	-	4	4	8	4	4	6	6
Total required volume	$m^3$	4,346	10,029	19,359	9,140	6,488	11,147	8,389
Required quantities	unit/train	8.7	20.1	19.4	18.3	13.0	14.9	11.2
Actual quantities	unit/train	9	21	17	20	13	16	12
Total numbers of RAFA	units	36	84	136	80	52	96	72
Total actual volume	$m^3$	4,500	10,500	20,400	10,000	6,500	12,000	9,000

Results	OK	OK	OK	OK	OK	OK	OK
---------	----	----	----	----	----	----	----

## BIO-FILTER

**Base Sewage Flow:**

Daily maximum flow ( $Q_{dmax}$ , m<sup>3</sup>/d)

**Design Criteria:**

The following criteria are applied:

- BOD loading rate ( $L_{BF}$ ): 0.75 (kg-BOD/m<sup>3</sup>.d)
- Height of bio-filters ( $H_{BF}$ ): 2.0 (m)

**Calculation Equation:**

- Required horizontal area of bio-filter =  $Q_{dmax} \times T-BOD_{inf, BF} / 1000 \times 1/L_{BF} \times 1/H_{BF}$  (m<sup>2</sup>)

**Where:**

T-BOD<sub>inf, BF</sub> : Total-BOD of influent to bio-filters (mg/l)

**Calculation Results:**

Design Parameters		Units	Systems						
			CONCEICAO	JANGA	CABANGA	BOA VIAGEM	CORDEIRO	PRAZERES	CURCURANA
Unit numbers		-	2	3	3	3	2	3	2
Required horizontal area / unit		m <sup>2</sup>	319	517	1,121	548	565	820	784
Actual figures / unit	Diameter	m	21.0	26.0	39.0	27.0	27.0	33.0	32.0
	Height	m	2.0	2.0	2.0	2.0	2.0	2.0	2.0
	Horizontal area	m <sup>2</sup>	346	531	1,194	572	572	855	804

Results	OK	OK	OK	OK	OK	OK	OK
---------	----	----	----	----	----	----	----

## RECIRCULATION PUMP FOR BIO-FILTER

### Base Sewage Flow:

Daily maximum flow ( $Q_{dmax}$ , m<sup>3</sup>/d)

### Design Criteria:

The following criteria are applied:

- Recirculation rate ( $R_{BF}$ )                      2.0                      (-)
- Suction side velocity ( $V_s$ ):                      2.0                      (m/sec)

### Calculation Equation:

Required Discharge =  $Q_{dmax} \times R_{BF} \times 1/1440$  (m<sup>3</sup>/min)

Shaft power =  $0.163 \times Q_{hmax} / N_{pump} \times H_{total} \times 1 / \eta_{pump} \times 1/1440$  (kw)

Diameter of suction pip =  $146 \times (Q_{hmax} / V_s)^{0.5}$  (mm)

### Where:

$N_{pump}$  : Quantity of duty pump (-)

$H_{total}$  : Total pump head (m)

$\eta_{pump}$  : Pump efficiency (-)

### Calculation Results:

Design Parameters		Units	Systems						
			CONCEICAO	JANGA	CABANGA	BOA VIAGEM	CORDEIRO	PRAZERES	CURCURANA
Quantities of pumps	Duty	-	2	3	6	3	2	3	2
	Stand-by	-	1	1	1	1	1	1	1
Conditions / unit	Total head	m	8	8	8	8	8	8	8
	Pump efficiency	%	80	77	80	80	80	80	80
Required figures / unit	Discharge	m <sup>3</sup> /min	10.3	15.9	15.4	14.5	15.4	17.7	20.0
	Diameter of suction pipe	mm	332	412	405	393	406	434	461
	Shaft power	kw	16.9	27.0	25.0	23.6	25.2	28.8	32.6
Actual figures / unit	Type of pump		Mixed flow	Mixed flow	Mixed flow	Mixed flow	Mixed flow	Mixed flow	Mixed flow
	Discharge	m <sup>3</sup> /min	11.0	16.0	16.0	15.0	16.0	18.0	20.5
	Diameter of suction pipe	mm	350	450	450	400	450	450	500
	Motor rated power	CV	30	45	40	45	40	45	50

### Reference:

Grand total of duty recirculation pump	kw	60	135	240	135	80	135	100
Grand total of aerator	kw	22	59	113	56	33	83	55



## SEDIMENTATION TANK

### Base Sewage Flow:

Daily maximum flow ( $Q_{dmax}$ ,  $m^3/d$ )

### Design Criteria:

The following criteria are applied:

- Water surface loading rate ( $L_{ST}$ ): 24.0 ( $m^3/m^2.d$ )
- Hydraulic retention time ( $T_{ST}$ ): 2.5 (h)
- Weir overflow rate ( $WO_{ST}$ ): 150 ( $m^3/m.d$ )

### Calculation Equation:

- Required water surface =  $Q_{dmax} \times 1/L_{ST}$  ( $m^2$ )
- Required volume =  $Q_{dmax} \times T_{ST} \times 1/24$  ( $m^3$ )
- Required weir length =  $Q_{dmax} \times 1/WO_{ST}$  (m)

### Calculation Results:

Design Parameters		Units	Systems						
			CONCEICAO	JANGA	CABANGA	BOA VIAGEM	CORDEIRO	PRAZERES	CURCURANA
Unit numbers		-	2	3	4	3	2	3	2
Required figures / unit	Water surface	$m^2$	310	478	691	435	463	531	599
	Water volume	$m^3$	776	1,194	1,728	1,088	1,159	1,327	1,498
	Weir length	m	50	76	111	70	74	85	96
Actual dimensions / unit	Diameter	m	20	25	-	24	25	27	28
	Width	m	-	-	12	-	-	-	-
	Length	m	-	-	60	-	-	-	-
	Water depth	m	3.0	3.0	3.0	3.0	3.0	3.0	3.0
	Weir length	m	60	90	90	80	80	90	100
Actual figures / unit	Water surface	$m^2$	314	491	720	452	491	572	615
	Water volume	$m^3$	942	1,472	2,160	1,356	1,472	1,717	1,846

Water surface  
Water volume

Results	OK	OK	OK	OK	OK	OK	OK	OK
Results	OK	OK	OK	OK	OK	OK	OK	OK

## AERATED LAGOON

**Base Sewage Flow:**

Daily maximum flow ( $Q_{dmax}$ , m<sup>3</sup>/d)

**Design Criteria:**

The following criteria are applied:

- Hydraulic retention time ( $T_{AL}$ ): 1.0 (d)
- Water depth ( $H_{AL}$ ): 3.8 (m)
- Slope of embankment: 2 : 1 (-)
- Free board of embankment 0.5 (m)

**Calculation Equation:**

- Required volume  $= Q_{dmax} \times T_{AL}$  (m<sup>3</sup>)

**Calculation Results:**

Design Parameters		Units	Systems						
			CONCEICAO	JANGA	CABANGA	BOA VIAGEM	CORDEIRO	PRAZERES	CURCURANA
Unit numbers		-	2	4	3	3	2	3	2
Required figures / unit	Volume	m <sup>3</sup>	7,450	8,596	22,125	10,446	11,123	12,740	14,381
	Water surface at the median	m <sup>2</sup>	1,961	2,262	5,822	2,749	2,927	3,353	3,784
Actual dimensions / unit	Width	m	32	50	51	49	38	39	50
	Length	m	100	66	160	86	120	130	115
	Depth	m	4.3	4.3	4.3	4.3	4.3	4.3	4.3
Actual volume / unit		m <sup>3</sup>	7,695	8,659	23,661	11,439	11,914	13,451	16,181

Results	OK	OK	OK	OK	OK	OK	OK
---------	----	----	----	----	----	----	----

## AERATOR FOR AERATED LAGOONS

### Base Sewage Flow:

Daily maximum flow ( $Q_{dmax}$ , m<sup>3</sup>/d)

### Design Criteria:

The following criteria are applied:

	Submersible aerator	
- Type of an aerator:	75	(%)
- BOD removal rate in RAFA reactors ( $\eta_{RAFA}$ ):	60	(%)
- BOD removal rate in aerated lagoons ( $\eta_{A/L}$ ):	35	(mg/l)
- Cell concentration in aerated lagoons ( $X_{A/L}$ ):	1.0	(kg-O <sub>2</sub> /kwh)
- Aerator efficiency at the standard state ( $N_0$ ):	0.9	(-)
- Oxygen transfer rate in sewage ( $\alpha$ ):	28	(°C)
- Sewage temperature (t):	0.9	(-)
- Oxygen saturation ration ( $\beta$ ):	7.6	(mg/l)
- Oxygen saturation conc. at 28°C ( $C_s'$ ):	9.1	(mg/l)
- Oxygen saturation conc. at 20°C ( $C_s$ ):	0.5	(mg/l)
- DO concentration in aerated lagoons ( $C_L$ ):		

### Calculation Equation:

Required oxygen ( $R_{O_2}$ )  
 $= 1.5/1000 \times (T-BOD_{inf,A/L} - F-BOD_{eff,A/L})Q_{dmax} - 1.42/1000 \times X_{A/L}Q_{dmax}$  (kg/d)

Influent BOD of aerated lagoons ( $T-BOD_{inf,A/L}$ )  
 $= T-BOD_{inf,RAFA}(1 - \eta_{RAFA}/100)$  (mg/l)

Effluent BOD of aerated lagoons ( $F-BOD_{eff,A/L}$ )  
 $= T-BOD_{inf,A/L}(1 - \eta_{A/L}/100)$  (mg/l)

Aerator efficiency at the actual state ( $N$ )  
 $= N_0 \times \alpha (1.024^{t-20}) (\beta C_s' - C_L)/C_s$  (kg-O<sub>2</sub>/kwh)

### Where:

$X_{A/L}$  : Cell concentration in aerated lagoons (mg/l)

### Calculation Results:

Design Parameters	Units	Systems							
		CONCEICAO	JANGA	CABANGA	BOA VIAGEM	CORDEIRO	PRAZERES	CURCURANA	
Train number	-	2	4	3	3	2	3	2	
Influent T-BOD of RAFA	mg/l	257	271	304	315	305	386	327	
Influent T-BOD of aerated lagoons	mg/l	64	68	76	79	76	97	82	
Effluent F-BOD of aerated lagoons	mg/l	26	27	30	32	31	39	33	
Cell concentration in aerated lagoons	mg/l	25	27	29	29	31	37	29	
$N/N_0$	-	0.76	0.76	0.76	0.76	0.76	0.76	0.76	
Required oxygen /	Oxygen consumption	kg/d	166	199	592	308	272	445	457
	Oxygen supply at actual state	kg/h	6.9	8.3	24.7	12.8	11.3	18.6	19.0
	Aerator capacity at standard state	kw	9.1	10.9	32.5	16.9	15.0	24.5	25.1
Actual Figure /	Quantities of aerators	-	3	4	5	5	3	5	5
	Unit rated power of aerators	kw	3.7	3.7	7.5	3.7	5.5	5.5	5.5
	Total rated power of aerators /train	kw	11.1	14.8	37.5	18.5	16.5	27.5	27.5
<b>Grand total of aerators</b>	<b>kw</b>	<b>22.2</b>	<b>59.2</b>	<b>112.5</b>	<b>55.5</b>	<b>33.0</b>	<b>82.5</b>	<b>55.0</b>	

Results	OK	OK	OK	OK	OK	OK	OK
---------	----	----	----	----	----	----	----

## POLISHING POND

**Base Sewage Flow:**

Daily maximum flow ( $Q_{dmax}$ , m<sup>3</sup>/d)

**Design Criteria:**

The following criteria are applied:

- Hydraulic retention time ( $T_{P/P}$ ): 1.5 (d)
- Water depth ( $H_{P/P}$ ): 3.6 (m)
- Slope of embankment: 2:1 (-)
- Free board of embankment 0.7 (m)

**Calculation Equation:**

- Required volume =  $Q_{dmax} \times T_{P/P}$  (m<sup>3</sup>)

**Calculation Results:**

Design Parameters		Units	Systems						
			CONCEICAO	JANGA	CABANGA	BOA VIAGEM	CORDEIRO	PRAZERES	CURCURANA
Unit numbers			2	4	3	3	2	3	2
Required figures / unit	Volume	m <sup>3</sup>	11,175	12,894	33,187	15,669	16,684	19,110	21,572
	Water surface at the median	m <sup>2</sup>	3,104	3,582	9,219	4,352	4,634	5,308	5,992
Actual dimensions / unit	Width	m	32	50	51	49	38	39	50
	Length	m	152	100	235	125	180	200	166
	Depth	m	4.3	4.3	4.3	4.3	4.3	4.3	4.3
Actual volume/unit		m <sup>3</sup>	11,246	12,960	33,210	16,146	17,136	19,836	22,464

Results	OK	OK	OK	OK	OK	OK	OK
---------	----	----	----	----	----	----	----

## SLUDGE GENERATION

### Base Sewage Flow:

Daily average flow ( $Q_{avg}$ , m<sup>3</sup>/d)

### Design Criteria:

The following criteria are applied:

#### Around RAFA reactors:

- Fixed SS ratio of influent ( $R_{fix,SS}$ ): 30 (%)
- Total SS of RAFA effluent ( $T-SS_{eff, RAFA}$ ): =  $250/T_{RAFA} + 10$  (mg/l)
- BOD removal rate ( $\eta_{RAFA}$ ): 75 (%)
- Cell generation rate ( $r_{RAFA}$ ): 15 (% of removed BOD)

#### Around bio-filters:

- Sludge generation rate for Influent T-SS ( $Y_{B/F}$ ): 80 (%)

#### Around lagoon system:

- BOD removal rate ( $\eta_{lagoon}$ ): 60 (%)
- Digestion rate of volatile sludge ( $r_{digestion, lagoon}$ ): 70 (%)

#### Around existing oxidation ditches in the Janga STF:

- Sludge generation rate for influent T-SS ( $r_{O/D}$ ): 75 (%)

### Calculation Equation:

#### Around RAFA reactors:

- Effluent Total BOD ( $T-BOD_{eff, RAFA}$ ) =  $T-BOD_{inf, RAFA} \times (1 - \eta_{RAFA}/100)$  (mg/l)
- Cell Yield ( $Y_{RAFA}$ ) =  $(T-BOD_{inf} - T-BOD_{eff}) \times r_{RAFA}/100$  (mg/l)
- Generated Sludge from RAFA reactors =  $(R_{fix,SS} + Y_{RAFA} - T-SS_{eff, RAFA})/1000 \times Q_{dave}$  (kg-DS/d)

#### Around a bio-filter:

- Generated sludge from bio-filters =  $T-SS_{eff, RAFA}/1000 \times Y_{B/F}/100 \times Q_{dave}$  (kg-DS/d)

#### Around lagoon system:

- Soluble BOD of effluent ( $S-BOD_{effluent, lagoon}$ ) =  $T-BOD_{eff, RAFA} (1 - \eta_{lagoon}/100)$  (mg/l)
- Cell generation ( $X$ ) =  $0.65 (T-BOD_{eff, RAFA} - S-BOD_{eff, lagoon}) / (1 + 0.07T_{lagoon})$  (mg/l)
- Sludge generation in lagoon system ( $C_{sludge, lagoon}$ ) =  $X + T-SS_{eff, RAFA} \times R_{fix,SS}/100$  (mg/l)
- Generated sludge from lagoons =  $(X (1 - r_{digestion, lagoon}/100) - T-SS_{eff, RAFA} \times R_{fix,SS}) \times Q_{dave}$  (kg-DS/d)

#### Around existing oxidation ditches in the Janga STF:

- Generated sludge from existing oxidation ditches: =  $Q_{dave} \times T-SS_{inf}/1000 \times r_{O/D}/100$  (kg-DS/d)

### Where:

- $T_{RAFA}$  : Hydraulic retention time in RAFA reactors (h)
- $T-BOD_{inf, RAFA}$  : Total BOD of RAFA influent (mg/l)
- $T-SS_{inf}$  : Influent Total Suspended Solids (mg/l)

### Calculation Results:

Design Parameters	Units	Sub-Systems							
		CONCEICAO	JANGA	CABANGA	BOA VIAGEM	CORDEIRO	PRAZERES	CURCURANA	
Around RAFA reactors	Influent Total SS	mg/l	257	271	304	315	305	386	327
	Influent Fixed SS	mg/l	77	81	91	95	92	116	98
	Influent Total BOD	mg/l	285	301	338	350	339	429	363
	Effluent Total BOD	mg/l	71	75	85	88	85	107	91
	Hydraulic retention time	h	7.0	7.0	7.0	7.0	7.0	7.0	7.0
	Effluent Total SS	mg/l	46	46	46	46	46	46	46
	Cell yield	mg/l	32	34	38	39	38	48	41
Generated sludge from RAFA	kg-DS/d	833	2,088	4,792	2,388	1,620	3,867	2,311	
Generated sludge from bio-filters	kg-DS/d	480	1,102	2,099	991	706	1,195	907	
Around lagoon system	Effluent soluble BOD	mg/l	29	30	34	35	34	43	36
	Cell generation	mg/l	26	27	31	32	31	39	33
	Sludge generation in lagoon	mg/l	40	41	45	46	45	53	47
	Generated sludge from lagoons	kg-DS/d	282	661	1,317	631	444	831	586
Generated from existing facilities	kg-DS/d	-	7,745	-	-	-	-	-	

### Overall Sludge Generation Rate

Sludge generation rate in RAFA + B/F (= Genrated DS/Influent T-SS)	(-)	0.39	0.39	0.40	0.40	0.40	0.40	0.40
Sludge generation rate in RAFA + Lagoon (= Genrated DS/Influent T-SS including lagoons sludge)	(-)	0.33	0.34	0.35	0.35	0.35	0.37	0.36
Sludge generation rate in RAFA + Lagoon (= Genrated DS/Influent T-SS excluding lagoon sludge)	(-)	0.25	0.26	0.27	0.28	0.28	0.31	0.29



## SLUDGE DIGESTER

### Base Sewage Flow:

Daily average flow ( $Q_{daveg}$ , m<sup>3</sup>/d)

### Design Criteria:

The following criteria are applied:

- Volatile sludge portion ( $R_{volatile}$ ): 70.0 (%)
- Hydraulic retention time ( $T_{digester}$ ): 20.0 (d)
- Digestion rate ( $r_{digestion}$ ): 50.0 (%)
- Concentration of influent sludge ( $C_{inf}$ ): 3.5 (%)
- Concentration of digested sludge ( $C_{eff}$ ): 3.5 (%)
- Digestion gas generation rate ( $r_{gas}$ ): 0.4 (nm<sup>3</sup>/kg-removed Sludge)

### Calculation Equation:

- Required digester volume =  $Q_{inf} \times T_{digester}$  (m<sup>3</sup>)
- Digested dry solid flow  
=  $Q_{inf} \times C_{inf}/100 \{R_{volatile}/100 \times (1-r_{digestion}/100) + (1 - R_{volatile}/100)\}$  (kg-DS/d)
- Digestion gas flow =  $Q_{inf} \times C_{inf}/100 \times R_{volatile}/100 \times r_{digestion}/100 \times r_{gas}$  (nm<sup>3</sup>/d)

### Calculation Results (In the case of RAFA + Bio-Filter):

Design Parameters		Units	CABANGA Systems	Remarks
Unit number		-	1	One unit of 2 units will be used as sludge a separation and storage tank.
Required volume		m <sup>3</sup>	3,937	
Actual dimensions	Diameter	m	25.0	
	Height	m	8.2	
Actual volume		m <sup>3</sup>	4,115	
Digested dry sludge flow		kg-DS/d	4,479	
Digested wet sludge flow		m <sup>3</sup> /d	118	
Digestion gas flow		nm <sup>3</sup> /d	965	

### Existing Digester:

Q'ty: 2

Dimension Straight Height	8.23 m	
Water depth	7.16 m	(Straight Part)
Bottom height	2.9 m	
Top height	3.05	

### Existing Gas Holder

Q'ty: 1

Diameter:	10.0 m
Height	5.0 m

## SLUDGE DEHYDRATOR

### Base Sewage Flow:

Daily average flow ( $Q_{daveg}$ , m<sup>3</sup>/d)

### Design Criteria:

The following criteria are applied:

- Operation hours ( $T_{dehydrator}$ ): 8 (h/d)
- Filtration rate ( $r_{dehydrator}$ ): 130 (kg-DS/m.h)
- Dosing rate of polymer coagulant ( $r_{polymer}$ ): 0.7 (% for dry solid)
- Water content of dehydrated sludge ( $C_{cake}$ ): 80 (%)

### Calculation Equation:

- Required belt width  $= Q_{inf} \times C_{inf}/100 \times 1/T_{dehydrator} \times 1/r_{dehydrator}$  (m)
- Injected polymer coagulant  $= Q_{inf} \times C_{inf}/100 \times r_{polymer}/100 \times 1000$  (kg/d)
- Dehydrated sludge quantity  $= Q_{inf} \times C_{inf}/100 \times 1/(1 - C_{cake}/100)$  (Wet-ton/d)

### Where:

- $Q_{inf}$ : Influent sludge flow (m<sup>3</sup>/d)
- $C_{inf}$ : Influent sludge concentration (%)

### Calculation Results:

Design Parameters	Units	Systems				
		CABANGA	BOA VIAGEM		CORDEIRO	
			In case of RAFA + Bio-Filter	In case of RAFA + Lagoon	In case of RAFA + Bio-Filter	In case of RAFA + Lagoon
Unit numbers	-	2	2	2	2	2
Required filter belt width / unit	m	2.2	1.6	1.1	1.1	0.8
Actual filter belt width / unit	m	2.5	2.0	1.5	1.5	1.0
Injected polymer coagulant	kg/d	31.4	23.7	16.7	16.3	11.3
Dehydrated sludge quantity	Wet-ton/d	22.4	16.9	11.9	11.6	8.1

### Remark:

- (1) The dehydrators in the Janga STF treats the sludge generated the existing STF, together.

Influent sludge	kg-DS/d	4,479	3,379	2,388	2,327	1,620
-----------------	---------	-------	-------	-------	-------	-------

Results	OK	OK	OK	OK	OK
---------	----	----	----	----	----



## SLUDGE DRYING BED

### Base Sewage Flow:

Daily average flow ( $Q_{daveg}$ , m<sup>3</sup>/d)

### Design Criteria:

The following criteria are applied:

- Drying rate ( $r_{drying}$ ): 1.3 (kg-DS/m<sup>2</sup>.d)
- Water content of dried sludge ( $C_{cake}$ ): 60 (%)
- Unit area of drying bed ( $A_{dry}$ ): 150 (m<sup>2</sup>)  
(10mW x 15mL.)

### Calculation Equation:

- Required quantities of beds =  $Q_{inf} \times C_{inf}/100 \times 1/r_{drying} \times 1/A_{dry}$  (unit)
- Dried sludge quantity =  $Q_{inf} \times C_{inf}/100 \times 1/(1 - C_{cake}/100)$  (Wet-ton/d)

### Where:

- $Q_{inf}$ : Influent sludge flow (m<sup>3</sup>/d)
- $C_{inf}$ : Influent sludge concentration (%)

### Calculation Results:

Design Parameters	Units	Systems							
		CONCEICAO	JANGA	BOA VIAGEM		CORDEIRO		PRAZERES	CURCURANA
				In case of RAFA + Bio-Filter	In case of RAFA + Lagoon	In case of RAFA + Bio-Filter	In case of RAFA + Lagoon		
Required numbers of beds	units	4.3	50.4	17.3	12.2	11.9	8.3	19.8	11.9
Required drying area	m <sup>2</sup>	641	7,563	2,599	1,837	1,790	1,246	2,975	1,778
Actual numbers of beds	units	6	56 = 8 x 7	20	15	15	10	24 = 2 x 12	14 = 2 x 7
Actual drying area	m <sup>2</sup>	900	8,400	3,000	2,250	2,250	1,500	3,600	2,100
Dried sludge quantity	Wet-ton/d	2.1	24.6	8.4	6.0	5.8	4.1	9.7	5.8

### Remark:

- (1) The drying beds in the Janga STF treats the sludge generated the existing STF, together.

Results	OK	OK	OK	OK	OK	OK	OK	OK
---------	----	----	----	----	----	----	----	----

Influent sludge	kg-DS/d	833	9,832	3,379	2,388	2,327	1,620	3,867	2,311
-----------------	---------	-----	-------	-------	-------	-------	-------	-------	-------

## BF RECIRCULATION TANK

**Base Sewage Flow:**

Daily maximum flow ( $Q_{dmax}$ , m<sup>3</sup>/d)

**Design Criteria:**

The following criteria are applied:

- Hydraulic retention time ( $T_{R/T}$ ): 2.0 (min)
- Water depth ( $H_{R/T}$ ): 2.5 (m)

**Calculation Equation:**

- Required volume =  $Q_{dmax} \times T_{R/T}$  (m<sup>3</sup>)

**Calculation Results:**

Design Parameters		Units	Systems						
			CONCEICAO	JANGA	CABANGA	BOA VIAGEM	CORDEIRO	PRAZERES	CURCURANA
Unit numbers		-	1	1	1	1	1	1	1
Required figures		m <sup>3</sup>	21	48	92	44	31	53	40
Actual dimensions	Width	m	3	3	3	3	3	3	3
	Length	m	6	10	13	8	6	10	6
	Depth	m	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Actual volume		m <sup>3</sup>	45	75	98	60	45	75	45

Train number of facilities	2	3	3	3	2	3	2
----------------------------	---	---	---	---	---	---	---

## DISINFECTION TANK

**Base Sewage Flow:**

Daily maximum flow ( $Q_{dmax}$ , m<sup>3</sup>/d)

**Design Criteria:**

The following criteria are applied:

- Hydraulaic retention time ( $T_{D/T}$ ): 3.0 (min)
- Water depth ( $H_{D/T}$ ): 2.5 (m)

**Calculation Equation:**

- Required volume =  $Q_{dmax} \times T_{D/T}$  (m<sup>3</sup>)

**Calculation Results:**

Design Parameters		Units	Systems						
			CONCEICAO	JANGA	CABANGA	BOA VIAGEM	CORDEIRO	PRAZERES	CURCURANA
Unit numbers		-	1	1	1	1	1	1	1
Required figures		m <sup>3</sup>	31	72	138	65	46	80	60
Actual dimensions	Width	m	3	4	5	3	3	4	3
	Length	m	6	10	12	10	8	10	10
	Depth	m	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Actual volume		m <sup>3</sup>	45	88	150	75	60	100	75

Train number of facilities	2	3	3	3	2	3	2
----------------------------	---	---	---	---	---	---	---

## TRANSFER PUMP

**Base Sewage Flow:**

Hourly maximum flow ( $Q_{hmax}$ , m<sup>3</sup>/d)

**Design Criteria:**

The following criteria are applied:

- Suction side velocity ( $V_s$ ): 2.0 (m/sec)

**Calculation Equation:**

Diameter of suction pipe  $= 146 \times (Q_{hmax}/V_s)^{0.5}$  (mm)

Shaft power  $= 0.163 \times Q_{hmax}/N_{pump} \times H_{total} \times 1/\eta_{pump} \times 1/1440$  (kw)

**Where:**

$N_{pump}$  : Quantity of duty pump (-)

$H_{total}$  : Total pump head (m)

$\eta_{pump}$  : Pump efficiency (-)

**Calculation Results:**

Design Parameters		Units	CABANGA System
Quantities of pumps	Duty	-	4
	Stand-by	-	1
Conditions	Total head	m	10
	Pump efficiency	%	75
Required figures	Discharge	m <sup>3</sup> /min	16.3
	Diameter of suction pipe	mm	417
	Shaft power	kw	35.4
Actual figures	Type of pump		Mixed flow
	Discharge	m <sup>3</sup> /min	16.5
	Diameter of suction pipe	mm	450
	Motor rated power	CV	50

## TRANSFER TANK

**Base Sewage Flow:**

Hourly maximum flow ( $Q_{hmax}$ , m<sup>3</sup>/d)

**Design Criteria:**

The following criteria are applied:

- Hydraulic retention time ( $T_{D/T}$ ): 1.5 (min)
- Water depth ( $H_{D/T}$ ): 3.5 (m)

**Calculation Equation:**

- Required volume =  $Q_{hmax} \times T_{D/T}$  (m<sup>3</sup>)

**Calculation Results:**

Design Parameters		Units	CABANGA System
Unit numbers		-	1
Required figures		m <sup>3</sup>	98
Actual dimensions	Width	m	3.5
	Length	m	9.0
	Depth	m	3.5
Actual volume		m <sup>3</sup>	110

## TREATED SEWAGE DISCHARGE PIPES

Design Parameters	Units	Systems						
		CONCEICAO	JANGA	CABANGA	BOA VIAGEM	CORDEIRO	PRAZERES	CURCURANA
<b>Design Conditions</b>								
Hourly maximum flow	m <sup>3</sup> /day	20,508	102,382	93,791	44,408	31,091	53,937	40,638
Design water level of discharge points	m (+MSL)	1.36	1.36	1.36	1.36	2.76	3.01	1.36
<i>Design water level of discharge points</i>	<i>m (+EL)</i>	<i>-3.14</i>	<i>-6.64</i>	<i>-1.64</i>	<i>-2.64</i>	<i>-1.24</i>	<i>-1.99</i>	<i>-1.64</i>
Length of discharge pipes	m	2,900	2,300	50	95	50	2,900	1,600
<b>Ground level</b>								
Station site (= Disinfection tank water level)	m (+MSL)	4.50	8.00	3.00	4.00	4.00	5.00	3.00
(= Grand level of STF=EL±0)								
at Discharge point	m (+MSL)	3.00	3.00	3.00	3.00	4.00	4.00	2.50
Discharge point	m (+EL)	-1.50	-5.00	0.00	-1.00	0.00	-1.00	-0.50
<b>Pipe Characteristics</b>								
ND of discharge pipe	mm	800	1,200	1,000	800	800	1,200	1,000
Number of discharge pipes	-	1	1	2	1	1	1	1
A (section area)	m <sup>2</sup>	0.502	1.130	0.785	0.502	0.502	1.130	0.785
V (velocity)	m/sec	0.47	1.05	0.69	1.02	0.72	0.55	0.60
R (A/P)	-	0.20	0.30	0.25	0.20	0.20	0.30	0.25
I (hydraulic gradient)	-	0.00037	0.00107	0.00060	0.00176	0.00086	0.00030	0.00045
<b>Water level of effluent point</b>	m (+MSL)	2.45	3.83	1.39	1.53	2.80	3.87	2.08
<b>Water level of effluent point</b>	m (+EL)	-2.05	-4.17	-1.61	-2.47	-1.20	-1.13	-0.92
<b>Level of discharge pipe (BOP)</b>								
at Effluent box	m (+MSL)	2.05	3.23	0.89	1.13	2.40	3.27	1.58
at Effluent box	m (+EL)	-2.45	-4.77	-2.11	-2.87	-1.60	-1.73	-1.42
at Discharge point	m (+MSL)	0.96	0.76	0.86	0.96	2.36	2.41	0.86
at Discharge point	m (+EL)	-3.54	-7.24	-2.14	-3.04	-1.64	-2.59	-2.14

	Results		OK	OK	OK	OK	OK	OK	OK
Actual Length	(m)			50	40	60			

## Electricity Consumption for STFs

Loading rate: 0.85

Items	Consumption (kwh/day)						
	CONCEICAO	JANGA	CABANGA	BOA VIAGEM	CORDEIRO	PRAZERES	CURCURANA
<b>Daily Max. Flow</b> (m3/d)	14,900	73,585	66,374	31,337	22,245	38,219	28,762
<b>Hourly Max. Flow</b> (m3/d)	20,508	102,382	93,791	44,408	31,091	53,937	40,638
<b>Influent System</b>							
Influent Pump	1,088	2,040	4,080	2,448	2,040	3,060	2,040
Others	51	252	227	107	76	131	98
<b>Biological Treatment System</b>							
Transfer Pump	-	-	2,720	-	-	-	-
Recirculation Pump	-	-	4,896	-	1,632	-	-
Aerator	453	1,208	-	1,132	-	1,683	1,122
Others	21	105	95	45	32	55	41
<b>Disinfection System</b>							
UV unit	408	979	1,632	918	653	1,122	1,020
<b>Sludge Treatment System</b>							
Continuous operation	8	40	375	92	92	21	16
16 hours operation	-	-	510	-	-	-	-
8 hours operation	-	-	170	139	136	-	-
<b>Existing Treatment System</b>							
Continuous operation	-	12,032	-	-	-	-	-
8 hours operation	-	-	-	-	-	-	-
<b>Total</b>	<b>2,029</b>	<b>16,656</b>	<b>14,195</b>	<b>4,881</b>	<b>4,660</b>	<b>6,071</b>	<b>4,337</b>

**Remarks:**

(1) In the Janga STF, the electricity consumption for the existing facilities is included.

### Bill of Quantities of Conceicao STF (1/7)

Work Items	Descriptions	Unit	Quantities
<b>1. Civil Structures</b>			
1.1 Grit chamber Influent well	1) Excavation	m <sup>3</sup>	1,200
	2) Backfill	m <sup>3</sup>	320
	3) Disposal of surplus soil	m <sup>3</sup>	880
	4) Invert concrete	m <sup>3</sup>	30
	5) Reinforced concrete(B200)	m <sup>3</sup>	271
	6) H steel pile(10"x4"5/8") Breast board(2"x10")	m m <sup>2</sup>	451 340
	7) Well piont installation Rental period	unit month	2 3
1.2 RAFA reactor	1) Reinforced concrete(B200)	m <sup>3</sup>	1,800
	2) PC pileD350	m	6,930
1.3 Aerated lagoon	1) Excavation	m <sup>3</sup>	14,000
	2) Embankment	m <sup>3</sup>	3,600
	3) Disposal of surplus soil	m <sup>3</sup>	10,400
	4) Mortar	m <sup>3</sup>	245
1.4 Polishing pond	1) Excavation	m <sup>3</sup>	21,000
	2) Embankment	m <sup>3</sup>	5,000
	3) Disposal of surplus soil	m <sup>3</sup>	16,000
	4) Mortar	m <sup>3</sup>	340
1.5 Disinfection tank	1) Excavation	m <sup>3</sup>	200
	2) Backfill	m <sup>3</sup>	150
	3) Disposal of surplus soil	m <sup>3</sup>	50
	4) Reinforced concrete(B200)	m <sup>3</sup>	30
1.6 Sludge thickener	1) Excavation	m <sup>3</sup>	70
	2) Backfill	m <sup>3</sup>	50
	3) Disposal of surplus soil	m <sup>3</sup>	20
	4) Reinforced concrete(B200)	m <sup>3</sup>	31
1.7 Sludge drying bed	1) Excavation	m <sup>3</sup>	950
	2) Disposal of surplus soil	m <sup>3</sup>	950
	3) Reinforced concrete(B200)	m <sup>3</sup>	360
1.8 Treated sewage discharge pipe	1) Pipe D800	m	2,900
1.9 Treated sewage outfull	1) Reinforced concrete(B200)	m <sup>3</sup>	4.8
	2) RC pileD250	m	16
	3) Sandbag	m <sup>3</sup>	91
	4) Water mat	m <sup>2</sup>	68

Work Items	Descriptions	Unit	Quantities
<b>2. Buildings</b>			
2.1 Influent pump room	RC	m <sup>2</sup>	160
2.2 Disinfection room	RC	m <sup>2</sup>	105
2.3 Electrical room	Brick	m <sup>2</sup>	100
2.4 Administration room	RC	m <sup>2</sup>	1,000
<b>3. Ground Leveling, etc</b>			
3.1 Ground leveling	1) Excavation	m <sup>3</sup>	20,140
	2) Disposal of surplus soil	m <sup>3</sup>	20,140
3.2 Inside road		m <sup>2</sup>	7,740
3.3 Inside drain ditch	U type drain ditch		
	200x200 cast in place	m	2,480
3.4 Fence and gate	Fence	m	1,170
<b>4. Mechanical Equipment and Pipings</b>			
4.1 Coarse bar screen		L/S	1
4.2 Bucket conveyer for grit screen		L/S	1
4.3 Fine bar screen		L/S	1
4.4 Influent pump		L/S	1
4.5 RAFA GLS separator and machinery		L/S	1
4.6 RAFA sludge draw-off pump		L/S	1
4.7 Aerator and operation walkway		L/S	1
4.8 Sludge collector for sludge thickener		L/S	1
4.9 Sludge drying bed machinery		L/S	1
4.10 Gate and weir		L/S	1
4.11 Laboratory equipment		L/S	1
4.12 Pipes and valves		L/S	1
<b>5. Electricals and Instruments</b>			
5.1 Receiving board		L/S	1
5.2 Motor control center		L/S	1
5.3 Supervision board		L/S	1
5.4 Instruments		L/S	1
5.5 Cable and wiring works		L/S	1



### Bill of Quantities of Janga STF (2/7)

Work Items	Descriptions	Unit	Quantities
<b>1. Civil Structures</b>			
1.1 Grit chamber Influent well	1) Excavation	m <sup>3</sup>	1,820
	2) Backfill	m <sup>3</sup>	410
	3) Disposal of surplus soil	m <sup>3</sup>	1,410
	4) Invert concrete	m <sup>3</sup>	40
	5) Reinforced concrete(B200)	m <sup>3</sup>	390
	6) H steel pile(10"x4"5/8") Breast boad(2"x10")	m m <sup>2</sup>	562 410
	7) Well piont installation Rental period	unit month	2 3
1.2 RAFA reactor	1) Reinforced concrete(B200)	m <sup>3</sup>	4,000
1.3 Aerated lagoon	1) Excavation	m <sup>3</sup>	29,000
	2) Embankment	m <sup>3</sup>	6,300
	3) Disposal of surplus soil	m <sup>3</sup>	22,700
	4) Mortar	m <sup>3</sup>	425
1.4 Polishing pond	1) Excavation	m <sup>3</sup>	45,000
	2) Embankment	m <sup>3</sup>	8,100
	3) Disposal of surplus soil	m <sup>3</sup>	36,900
	4) Mortar	m <sup>3</sup>	550
1.5 Disinfection tank	1) Excavation	m <sup>3</sup>	310
	2) Backfill	m <sup>3</sup>	190
	3) Disposal of surplus soil	m <sup>3</sup>	120
	4) Reinforced concrete(B200)	m <sup>3</sup>	150
1.6 Sludge thickener	1) Excavation	m <sup>3</sup>	350
	2) Backfill	m <sup>3</sup>	160
	3) Disposal of surplus soil	m <sup>3</sup>	190
	4) Reinforced concrete(B200)	m <sup>3</sup>	150
1.7 Sludge drying bed	1) Excavation	m <sup>3</sup>	8,800
	2) Disposal of surplus soil	m <sup>3</sup>	8,800
	3) Reinforced concrete(B200)	m <sup>3</sup>	3,300
1.8 Treated sewage discharge pipe	1) Pipe D1200	m	2,300
1.9 Treated sewage outfull	1) Reinforced concrete(B200)	m <sup>3</sup>	6
	2) RC pileD250	m	16
	3) Sandbag	m <sup>3</sup>	94
	4) Water mat	m <sup>3</sup>	70

Work Items	Descriptions	Unit	Quantities
<b>2. Buildings</b>			
2.1 Influent pump room	RC	m <sup>2</sup>	250
2.2 Disinfection room	RC	m <sup>2</sup>	200
2.3 Electrical room	Brick	m <sup>2</sup>	200
2.4 Administration room	RC	m <sup>2</sup>	750
<b>3. Ground Leveling, etc</b>			
3.1 Temporary access road	W=6m,	m <sup>2</sup>	6,000
3.2 New road	W=6m,	m <sup>3</sup>	6,000
3.3 Ground leveling	1) Excavation	m <sup>3</sup>	36,000
	2) Embankment	m <sup>3</sup>	135,000
3.4 Masonry retaining wall	1) Revetment	m <sup>2</sup>	2,150
	2) Turf(Seed despersal)	m <sup>2</sup>	525
3.5 Inside road		m <sup>2</sup>	10,320
3.6 Inside drain ditch	U type drain ditch 200x200 cast in place	m	3,440
3.7 Fence and gate	Fence	m	1,550
<b>4. Mechanical Equipment and Pipings</b>			
4.1 Coarse bar screen		L/S	1
4.2 Bucket conveyer for grit screen		L/S	1
4.3 Fine bar screen		L/S	1
4.4 Influent pump		L/S	1
4.5 RAFA GLS separator and machinery		L/S	1
4.6 RAFA sludge draw-off pump		L/S	1
4.7 Aerator and operation walkway		L/S	1
4.8 Sludge collector for sludge thickener		L/S	1
4.9 Sludge drying bed machinery		L/S	1
4.10 Gate and weir		L/S	1
4.11 Laboratory equipment		L/S	1
4.12 Pipes and valves		L/S	1
<b>5. Electricals and Instruments</b>			
5.1 Receiving board		L/S	1
5.2 Motor control center		L/S	1
5.3 Supervision board		L/S	1
5.4 Instruments		L/S	1
5.5 Cable and wiring works		L/S	1

### Bill of Quantities of Cabanga STF (3/7)

Work Items	Descriptions	Unit	Quantities
<b>1. Civil Structures</b>			
1.1 Transfer well	1) Excavation	m <sup>3</sup>	1,820
	2) Backfill	m <sup>3</sup>	410
	3) Disposal of surplus soil	m <sup>3</sup>	1,410
	4) Invert concrete	m <sup>3</sup>	40
	5) Reinforced concrete(B200)	m <sup>3</sup>	390
	6) H steel pile(10"x4"5/8") Breast board(2"x10")	m m <sup>2</sup>	562 410
1.2 RAFA reactor	1) Embankment	m <sup>3</sup>	8,000
	2) Reinforced concrete(B200)	m <sup>3</sup>	6,500
	3) PC pileD350	m	6,380
1.3 Bio-filter	1) Reinforced concrete(B200)	m <sup>3</sup>	3,200
	2) PC pileD350	m	11,340
1.4 Recirculation tank	1) Excavation	m <sup>3</sup>	200
	2) Backfill	m <sup>3</sup>	40
	3) Invert concrete	m <sup>3</sup>	70
	4) Reinforced concrete(B200)	m <sup>3</sup>	210
	5) PC pileD350	m	810
1.5 Sedimentation tank (Rectangular type)	1) Excavation	m <sup>3</sup>	11,000
	2) Backfill	m <sup>3</sup>	7,700
	3) Disposal of surplus soil	m <sup>3</sup>	3,300
	4) Reinforced concrete(B200)	m <sup>3</sup>	1,250
	5) PC pileD350	m	5,720
1.6 Disinfection tank	1) Excavation	m <sup>3</sup>	400
	2) Backfill	m <sup>3</sup>	230
	3) Disposal of surplus soil	m <sup>3</sup>	170
	4) Reinforced concrete(B200)	m <sup>3</sup>	70
	5) PC pileD350	m	250
1.7 Sludge thickener	1) Excavation	m <sup>3</sup>	280
	2) Backfill	m <sup>3</sup>	140
	3) Disposal of surplus soil	m <sup>3</sup>	140
	4) Reinforced concrete(B200)	m <sup>3</sup>	121
	5) PC pileD350	m	560
1.8 Treated sewage discharge pipe	1) Pipe D1000	m	50
1.9 Treated sewage outfall	1) Reinforced concrete(B200)	m <sup>3</sup>	5.6
	2) RC pileD250	m	16
	3) Sandbag	m <sup>3</sup>	93
	4) Water mat	m <sup>2</sup>	69

Work Items	Descriptions	Unit	Quantities
<b>2. Buildings</b>			
2.1 Transfer pump room	Brick	m <sup>2</sup>	70
2.2 Recirculation pump room	RC	m <sup>2</sup>	300
2.3 Disinfection room	RC	m <sup>2</sup>	200
2.4 Electrical room	Brick	m <sup>2</sup>	200
2.5 Administration room	RC	m <sup>2</sup>	1,800
	PC pileD350	m	
<b>3. Ground Leveling, etc</b>			
3.1 Demolishing	Concrete	m <sup>3</sup>	1,160
3.2 Ground leveling	1) Excavation	m <sup>3</sup>	3,200
	2) Embankment	m <sup>3</sup>	5,300
3.3 Inside road		m <sup>2</sup>	4,920
3.4 Inside drain ditch	U type drain ditch		
	200x200 cast in place	m	1,640
3.5 Fence and gate	Fence	m	860
<b>4. Mechanical Equipment and Pipings</b>			
4.1 Transfer pump		L/S	1
4.2 RAFA GLS separator and machinery		L/S	1
4.3 RAFA sludge draw-off pump		L/S	1
4.4 Bio-filter machinery		L/S	1
4.5 Recirculation pump		L/S	1
4.6 Chain conveyer for sedimentation tank		L/S	1
4.7 S/T sludge draw-off pump		L/S	1
4.8 Sludge collector for sludge thickener		L/S	1
4.9 Thickened sludge pump		L/S	1
4.10 Sludge dehydrator		L/S	1
4.11 Polymer coagulant dosing unit		L/S	1
4.12 Gate and weir		L/S	1
4.13 Laboratory equipment		L/S	1
4.14 Pipes and valves		L/S	1
<b>5. Electricals and Instruments</b>			
5.1 Receiving board		L/S	1
5.2 Motor control center		L/S	1
5.3 Supervision board		L/S	1
5.4 Instruments		L/S	1
5.5 Cable and wiring works		L/S	1

### Bill of Quantities of Boa Viagem STF (4/7)

Work Items	Descriptions	Unit	Quantities
<b>1. Civil Structures</b>			
1.1 Grit chamber Influent well	1) Excavation	m <sup>3</sup>	2,470
	2) Backfill	m <sup>3</sup>	550
	3) Disposal of surplus soil	m <sup>3</sup>	1,920
	4) Invert concrete	m <sup>3</sup>	40
	5) Reinforced concrete(B200)	m <sup>3</sup>	460
	6) H steel pile(10"x4"5/8") Breast board(2"x10")	m m <sup>2</sup>	686 560
1.2 RAFA reactor	1) Reinforced concrete(B200)	m <sup>3</sup>	3,900
1.3 Aerated lagoon	1) Excavation	m <sup>3</sup>	28,000
	2) Embankment	m <sup>3</sup>	5,500
	3) Disposal of surplus soil	m <sup>3</sup>	22,500
	4) Mortar	m <sup>3</sup>	375
1.4 Polishing pond	1) Excavation	m <sup>3</sup>	41,000
	2) Embankment	m <sup>3</sup>	7,000
	3) Disposal of surplus soil	m <sup>3</sup>	34,000
	4) Mortar	m <sup>3</sup>	480
1.5 Disinfection tank	1) Excavation	m <sup>3</sup>	280
	2) Backfill	m <sup>3</sup>	190
	3) Disposal of surplus soil	m <sup>3</sup>	90
	4) Reinforced concrete(B200)	m <sup>3</sup>	50
1.6 Sludge thickener	1) Excavation	m <sup>3</sup>	130
	2) Backfill	m <sup>3</sup>	80
	3) Disposal of surplus soil	m <sup>3</sup>	50
	4) Reinforced concrete(B200)	m <sup>3</sup>	60
1.7 Treated sewage discharge pipe	1) Pipe D800	m	40
1.8 Treated sewage outfall	1) Reinforced concrete(B200)	m <sup>3</sup>	5
	2) RC pileD250	m	16
	3) sandbag	m <sup>3</sup>	91
	4) Water mat	m <sup>2</sup>	68

Work Items	Descriptions	Unit	Quantities
<b>2. Buildings</b>			
2.1 Influent pump room	RC	m <sup>2</sup>	250
2.2 Disinfection room	RC	m <sup>2</sup>	150
2.3 Electrical room	Brick	m <sup>2</sup>	150
2.4 Administration room	RC	m <sup>2</sup>	1,400
<b>3. Ground Leveling, etc</b>			
3.1 Ground leveling	1) Excavation	m <sup>3</sup>	3,500
	2) Embankment	m <sup>3</sup>	26,000
3.2 Inside road		m <sup>2</sup>	8,880
3.3 Inside drain ditch	U type drain ditch	m	2,960
	200x200 cast in place	m	1,260
3.4 Fence and gate	Fence	m	1,260
<b>4. Mechanical Equipment and Pipings</b>			
4.1 Coarse bar screen		L/S	1
4.2 Bucket conveyer for grit screen		L/S	1
4.3 Fine bar screen		L/S	1
4.4 Influent pump		L/S	1
4.5 RAFA GLS separator and machinery		L/S	1
4.6 RAFA sludge draw-off pump		L/S	1
4.7 Aerator and operation walkway		L/S	1
4.8 Sludge collector for sludge thickener		L/S	1
4.9 Thickened sludge pump		L/S	1
4.10 Sludge dehydrator		L/S	1
4.11 Polymer coagulant dosing unit		L/S	1
4.12 Gate and weir		L/S	1
4.13 Laboratory equipment		L/S	1
4.14 Pipes and valves		L/S	1
<b>5. Electricals and Instruments</b>			
5.1 Receiving board		L/S	1
5.2 Motor control center		L/S	1
5.3 Supervision board		L/S	1
5.4 Instruments		L/S	1
5.5 Cable and wiring works		L/S	1

### Bill of Quantities of Cordeiro STF (5/7)

Work Items	Descriptions	Unit	Quantities
<b>1. Civil Structures</b>			
1.1 Grit chamber Influent well	1) Excavation	m <sup>3</sup>	1,760
	2) Backfill	m <sup>3</sup>	470
	3) Disposal of surplus soil	m <sup>3</sup>	1,290
	4) Invert concrete	m <sup>3</sup>	30
	5) Reinforced concrete(B200)	m <sup>3</sup>	350
	6) H steel pile(10"x4"5/8") Breast board(2"x10")	m m <sup>2</sup>	597 480
1.2 RAFA reactor	1) Reinforced concrete(B200)	m <sup>3</sup>	2,500
	2) PC pileD350	m	6,930
1.3 Bio-filter	1) Embankment	m <sup>3</sup>	1,600
	2) Reinforced concrete(B200)	m <sup>3</sup>	680
	3) PC pileD350	m	4,216
1.4 Recirculation tank	1) Excavation	m <sup>3</sup>	850
	2) Backfill	m <sup>3</sup>	370
	3) Disposal of surplus soil	m <sup>3</sup>	480
	4) Invert concrete	m <sup>3</sup>	70
	5) Reinforced concrete(B200)	m <sup>3</sup>	210
	6) PC pileD350	m	660
1.5 Sedimentation tank (Circular type)	1) Excavation	m <sup>3</sup>	5,000
	2) Backfill	m <sup>3</sup>	1,900
	3) Disposal of surplus soil	m <sup>3</sup>	3,100
	4) Reinforced concrete(B200)	m <sup>3</sup>	600
	5) PC pileD350	m	2,280
1.6 Disinfection tank	1) Excavation	m <sup>3</sup>	240
	2) Backfill	m <sup>3</sup>	170
	3) Disposal of surplus soil	m <sup>3</sup>	70
	4) Reinforced concrete(B200)	m <sup>3</sup>	40
	5) PC pileD350	m	372
1.7 Sludge thickener	1) Excavation	m <sup>3</sup>	140
	2) Backfill	m <sup>3</sup>	90
	3) Disposal of surplus soil	m <sup>3</sup>	50
	4) Reinforced concrete(B200)	m <sup>3</sup>	63
	5) PC pileD350	m	264
1.8 Treated sewage discharge pipe	1) Pipe D800	m	50
1.9 Treated sewage outfall	1) Reinforced concrete(B200)	m <sup>3</sup>	4.8
	2) RC pileD250	m	16
	3) Sandbag	m <sup>3</sup>	91

Work Items	Descriptions	Unit	Quantities
<b>2. Buldings</b>			
2.1 Influent pump	RC	m <sup>2</sup>	171
2.2 Recirculation pump room	RC	m <sup>2</sup>	200
2.3 Disinfection room	RC	m <sup>2</sup>	150
2.4 Administration room	RC	m <sup>2</sup>	1,400
	PC pileD350	m	
<b>3. Ground Leveling, etc</b>			
3.1 Ground leveling	1) Demolishon of soil	m <sup>3</sup>	12,000
	2) Sandfill(Replacement)	m <sup>3</sup>	7,600
3.2 Inside road		m <sup>2</sup>	5,640
3.3 Inside drain ditch	U type drain ditch		
	200x200 cast in place	m	1,880
3.4 Fence and gate	Fence	m	860
<b>4. Mechanical Equipment and Pipings</b>			
4.1 Coarse screen		L/S	1
4.2 bucket conveyer for grit screen		L/S	1
4.3 Fine screen		L/S	1
4.4 Influent pump		L/S	1
4.5 RAFA GLS separator and machinery		L/S	1
4.6 RAFA sludge draw-off pump		L/S	1
4.7 Bio-filter machinery		L/S	1
4.8 Recirculation pump		L/S	1
4.9 Sludge collector for sedimentation tank		L/S	1
4.10 S/T sludge draw-off pump		L/S	1
4.11 Sludge collector for sludge thickener		L/S	1
4.12 Thickened sludge pump		L/S	1
4.13 Sludge dehydrator		L/S	1
4.14 Polymer coagulant dosing unit		L/S	1
4.15 Gate and weir		L/S	1
4.16 Laboratory equipment		L/S	1
4.17 Pipes and valves		L/S	1
<b>5. Electricals and Instruments</b>			
5.1 Receiving board		L/S	1
5.2 Motor control center		L/S	1
5.3 Supervision board		L/S	1
5.4 Instruments		L/S	1
5.5 Cable and wiring works		L/S	1

### Bill of Quantities of Prazeres STF (6/7)

Work Items	Descriptions	Unit	Quantities
<b>1. Civil Structures</b>			
1.1 Grit chamber Influent well	1) Excavation	m <sup>3</sup>	2,470
	2) Backfill	m <sup>3</sup>	550
	3) Disposal of surplus soil	m <sup>3</sup>	1,920
	4) Invert concrete	m <sup>3</sup>	40
	5) Reinforced concrete(B200)	m <sup>3</sup>	460
	6) H steel pile(10"x4"5/8") Breast board(2"x10")	m m <sup>2</sup>	686 560
1.2 RAFA reactor	1) Reinforced concrete(B200)	m <sup>3</sup>	4,600
1.3 Aerated lagoon	1) Excavation	m <sup>3</sup>	33,000
	2) Embankment	m <sup>3</sup>	6,900
	3) Disposal of surplus soil	m <sup>3</sup>	26,100
	4) Mortar	m <sup>3</sup>	465
1.4 Polishing pond	1) Excavation	m <sup>3</sup>	52,000
	2) Embankment	m <sup>3</sup>	9,700
	3) Disposal of surplus soil	m <sup>3</sup>	42,300
	4) Mortar	m <sup>3</sup>	650
1.5 Disinfection tank	1) Excavation	m <sup>3</sup>	310
	2) Backfill	m <sup>3</sup>	190
	3) Disposal of surplus soil	m <sup>3</sup>	120
	4) Reinforced concrete(B200)	m <sup>3</sup>	60
1.6 Sludge thickener	1) Excavation	m <sup>3</sup>	170
	2) Backfill	m <sup>3</sup>	90
	3) Disposal of surplus soil	m <sup>3</sup>	80
	4) Reinforced concrete(B200)	m <sup>3</sup>	80
1.7 Sludge drying bed	1) Excavation	m <sup>3</sup>	3,800
	2) Disposal of surplus soil	m <sup>3</sup>	3,800
	4) Reinforced concrete(B200)	m <sup>3</sup>	1,420
1.8 Treated sewage discharge pipe	1) Pipe D1200, pipe jacking	m	30
	Pipe D1200	m	2,470
1.9 Treated sewage outfall	1) Reinforced concrete(B200)	m <sup>3</sup>	6.5
	2) PC pileD250	m	16
	3) Sandbag	m <sup>3</sup>	95
	4) water mat	m <sup>2</sup>	71

Work Items	Descriptions	Unit	Quantities
<b>2. Buildings</b>			
2.1 Influent pump room	RC	m <sup>2</sup>	250
2.2 Disinfection room	RC	m <sup>2</sup>	200
2.3 Electrical room	Brick	m <sup>2</sup>	200
2.4 Administration room	RC	m <sup>2</sup>	1,350
<b>3. Ground Leveling, etc</b>			
3.1 Temporary access road	W=6m,	m <sup>2</sup>	2,400
3.2 New road	W=6m,	m <sup>3</sup>	2,400
3.3 Ground leveling	1) Excavation	m <sup>3</sup>	15,000
	2) Embankment	m <sup>3</sup>	11,100
3.4 Inside Road		m <sup>2</sup>	10,680
3.5 Inside drain ditch	U type drain ditch		
	200x200 cast in place	m	3,560
3.6 Fence and gate	Fence	m	1,360
<b>4. Mechanical Equipment and Pipings</b>			
4.1 Coarse bar screen		L/S	1
4.2 Bucket conveyer for grit screen		L/S	1
4.3 Fine bar screen		L/S	1
4.4 Influent pump		L/S	1
4.5 RAFA GLS separator and machinery		L/S	1
4.6 RAFA sludge draw-off pump		L/S	1
4.7 Aerator and operation walkway		L/S	1
4.8 Sludge collector for sludge thickener		L/S	1
4.9 Sludge drying bed machinery		L/S	1
4.10 Gate and weir		L/S	1
4.11 Laboratory equipment		L/S	1
4.12 Pipes and valves		L/S	1
<b>5. Electricals and Instruments</b>			
5.1 Receiving board		L/S	1
5.2 Motor control center		L/S	1
5.3 Supervision board		L/S	1
5.4 Instruments		L/S	1
5.5 Cable and wiring works		L/S	1

### Bill of Quantities of Curcurana STF (7/7)

Work Items	Descriptions	Unit	Quantities
<b>1. Civil Structures</b>			
1.1 Grit chamber Influent well	1) Excavation	m <sup>3</sup>	1,910
	2) Backfill	m <sup>3</sup>	500
	3) Disposal of surplus soil	m <sup>3</sup>	1,410
	4) Invert concrete	m <sup>3</sup>	30
	5) Reinforced concrete(B200)	m <sup>3</sup>	370
	6) H steel pile(10"x4"5/8") Breast board(2"x10")	m m <sup>2</sup>	637 510
1.2 RAFA reactor	1) Reinforced concrete(B200)	m <sup>3</sup>	3,500
	2) PC pileD350	m	4,060
1.3 Aerated lagoon	1) Excavation	m <sup>3</sup>	26,000
	2) Embankment	m <sup>3</sup>	4,500
	3) Disposal of surplus soil	m <sup>3</sup>	21,500
	4) Mortar	m <sup>3</sup>	300
1.4 Polishing pond	1) Excavation	m <sup>3</sup>	38,000
	2) Embankment	m <sup>3</sup>	5,800
	3) Disposal of surplus soil	m <sup>3</sup>	32,200
	4) Mortar	m <sup>3</sup>	400
1.5 Disinfection tank	1) Excavation	m <sup>3</sup>	280
	2) Backfill	m <sup>3</sup>	190
	3) Disposal of surplus soil	m <sup>3</sup>	90
	4) Reinforced concrete(B200)	m <sup>3</sup>	50
	5) PC pileD350	m	168
1.6 Sludge thickener	1) Excavation	m <sup>3</sup>	140
	2) Backfill	m <sup>3</sup>	90
	3) Disposal of surplus soil	m <sup>3</sup>	50
	4) Reinforced concrete(B200)	m <sup>3</sup>	63
	5) PC pileD350	m	112
1.7 Sludge drying bed	1) Excavation	m <sup>3</sup>	2,200
	2) Disposal of surplus soil	m <sup>3</sup>	2,200
	4) Reinforced concrete(B200)	m <sup>3</sup>	830
1.8 Treated sewage discharge pipe	1) Pipe D900	m	900
1.9 Treated sewage outfall	1) Reinforced concrete(B200)	m <sup>3</sup>	5.2
	2) PC pileD250	m	16
	3) Sandbag	m <sup>3</sup>	92
	4) Water mat	m <sup>2</sup>	69

Work Items	Descriptions	Unit	Quantities
<b>2. Buildings</b>			
2.1 Influent pump room	RC	m <sup>2</sup>	189
2.2 Disinfection room	RC	m <sup>2</sup>	150
2.3 Electrical room	Brick	m <sup>2</sup>	150
2.4 Administration room	RC	m <sup>2</sup>	1,225
<b>3. Ground Leveling, etc</b>			
3.1 Temporary access road	W=6m,	m <sup>2</sup>	5,400
3.2 New road	W=6m,	m <sup>3</sup>	5,400
3.3 Ground leveling	1) Excavation	m <sup>3</sup>	161,000
3.4 Inside Road		m	7,740
3.5 Inside drain ditch	U type drain ditch 200x200 cast in place	m	2,480
3.6 Fence and gate	Fence	m	1,280
<b>4. Mechanical Equipment and Pippings</b>			
4.1 Coarse bar screen		L/S	1
4.2 Bucket conveyer for grit screen		L/S	1
4.3 Fine bar screen		L/S	1
4.4 Influent pump		L/S	1
4.5 RAFA GLS separator and machinery		L/S	1
4.6 RAFA sludge draw-off pump		L/S	1
4.7 Aerator and operation walkway		L/S	1
4.8 Sludge collector for sludge thickener		L/S	1
4.9 Sludge drying bed machinery		L/S	1
4.10 Gate and weir		L/S	1
4.11 Laboratory equipment		L/S	1
4.12 Pipes and valves		L/S	1
<b>5. Electricals and Instruments</b>			
5.1 Receiving board		L/S	1
5.2 Motor control center		L/S	1
5.3 Supervision board		L/S	1
5.4 Instruments		L/S	1
5.5 Cable and wiring works		L/S	1

1101