REVISION	*WHO*	*WHAT*	*WHEN*
0	STS AM	first version	
A	Romain Verchère Fondation Veolia + STS AM	Complete update Veoliaforce mission	1/23/2019
B	STS AM	(Update AM + Final Validation Romain Verchère Fondation Veolia) 0 Hypothesis : cosmetic 1 DP : New HBT update 2 HBT : separation Design & operation 3 ABR : add operation part 4 HCW1 : 3 design theory added & compared 5 Pond : add design calc 6 Infiltration : New HBT update 7 Drying beds : geometry + operation & cleaning some unused lines 8 HCW2 : 3 design theory added & compared 10 Incineration : operation added Updates validated Addition not validated by Veolia Fondation	6/5/2019

Hypothesis

Design parameters			
Time of operation	9	h/d	The STS opens from 8a
Number of operating days	6	d/week	
Time for one tractor to desludge	3	min	

Inlet flow					
	m3				
Volume of a tank	1.5				
Barrel filling ratio	67%				The tractors can transp
Mean volume transported by tractor	1.0				Data from 19 to 29/03/
Number of tractors	9				
	trips/d				
Number of trips per tractor per day	3.9				
	trips/d	trips/h			
Average number of trips	35				Data from June 2018 to
Maximum number of trips	61	6.8			Data from June 2018 to
	m3/day	m3/h	m3/s		
Average inlet flow	35.0	3.9	0.001		
Maximum inlet flow	61.0	6.8	0.002		
Instantaneous inlet flow			0.006		
Max Instantaneous inlet flow			0.011		
Sludge average characteristics = at average	mg/l	kg/d	kg/h	kg/tractor	
TS	13000	455.0	19.0	13.0	
COD	12000	420.0	17.5		
NH4	1000	35.0	1.5		
NO3	70	2.5	0.1		
NGL	1070	37.5	1.6		
P	35	1.2	0.1		
Sludge max characteristics = at maximum	mg/l	kg/d	kg/h	kg/tractor	
TS	24000	1464.0	61.0	24.0	
COD	26700	1628.7	67.9		

m to 5pm

port tanks filled up to about 78% because of weight, depending on the desludging location
/19

o December 2018
o December 2018

Values from the STS Analyses document - March 2019

Values from the STS Analyses document - March 2019

Dumping station

RECEPTION			
	ft	in	m
L1	16	1	4.9
W1.1	2	6	0.8
W1.2	2	7	0.8
H1.high	1	1.5	0.3
H1.low	1	9	0.53
H1.high eff max		9	0.23
Slope			3.9%
	ft3		m3
Volume	46.3		1.7
V1eff max	32.2		1.14

L2	
W2	
H2.high	
H2.low	
Slope	
Volume	

CORRIDOR			
	ft	in	m
L2	10	4	3.15
W3	2	11	0.89
H3.high = H2.low	2	1.5	0.65
H3.low	2	7	0.79
Slope			4.4%
	ft3		m3
Volume	14.4		1.9

L4.1	
L4.2	
W4	
H4.high = H3.low	
H4.low	
H4eff	
H5	
Vertical section L4.1	
Vertical section L4.2	
Vertical section H5	
Volume	
Veff	

Total slope	
	m
L	8.86
H.high	0.34
H.low	0.79
Slope	5.0%

Design calculations

Retention time		
	ft3	m3
Veff total	17.8	0.5
	m3/day	m3/h
Average daily inlet flow	35.0	3.9
Max hourly inlet flow		6.8
	hour	min
Average retention time	0.13	7.8
Min retention time	0.07	4.5

Flow	
	m3/h

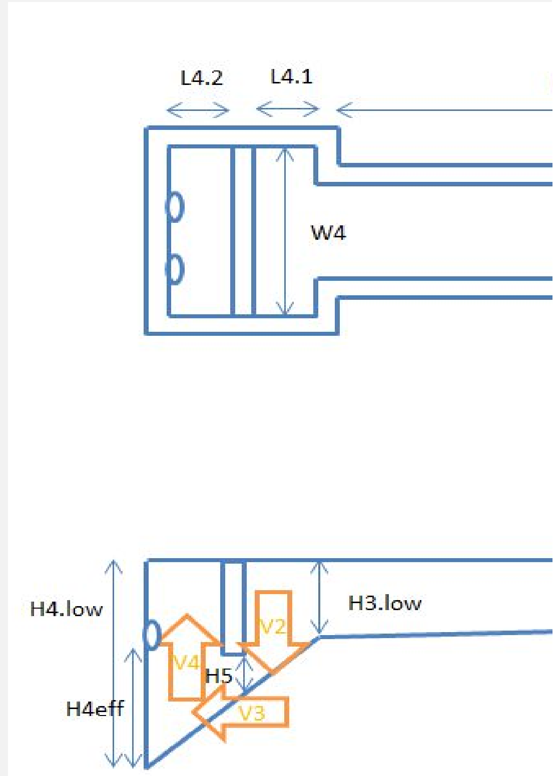
Instantaneous inlet flow	20.0
	DN (mm)
Gate valve diameter	100
	m/h
V1	42.4
V2	35.2
V3	40.3
V4	47.0

The flow has to be >30m/h to avoid sludge sedimentation - V

Operation

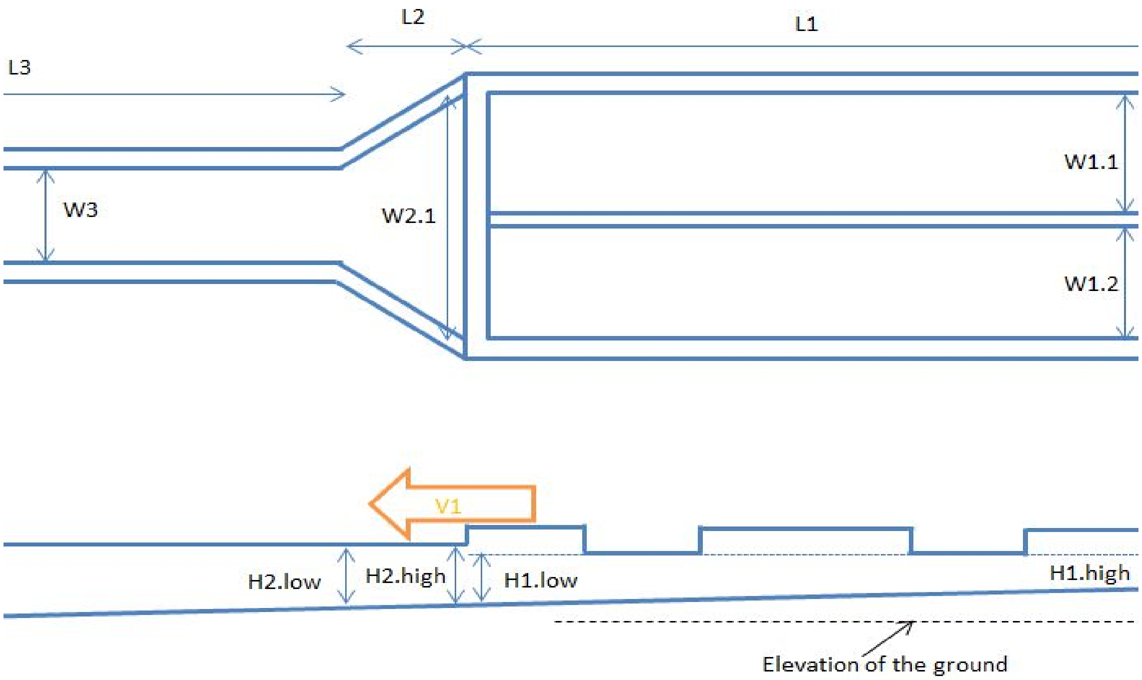
Inlet volume measurement				
	Tank 1 (W1.1)		**Tank 2 (W1.2)**	
Volume	**H1.high eff**		**H1.high eff**	
m3	**cm**	**in**	**cm**	**in**
1.5	30.6	12.1	31.2	12.3
1.4	28.0	11.0	28.6	11.3
1.3	25.3	10.0	26.1	10.3
1.2	22.6	8.9	23.5	9.2
1.1	19.9	7.8	20.9	8.2
1	17.2	6.8	18.3	7.2
0.9	14.6	5.7	15.7	6.2
0.8	11.9	4.7	13.1	5.2
0.7	9.2	3.6	10.5	4.1
0.6	6.5	2.6	7.9	3.1
0.5	3.9	1.5	5.3	2.1

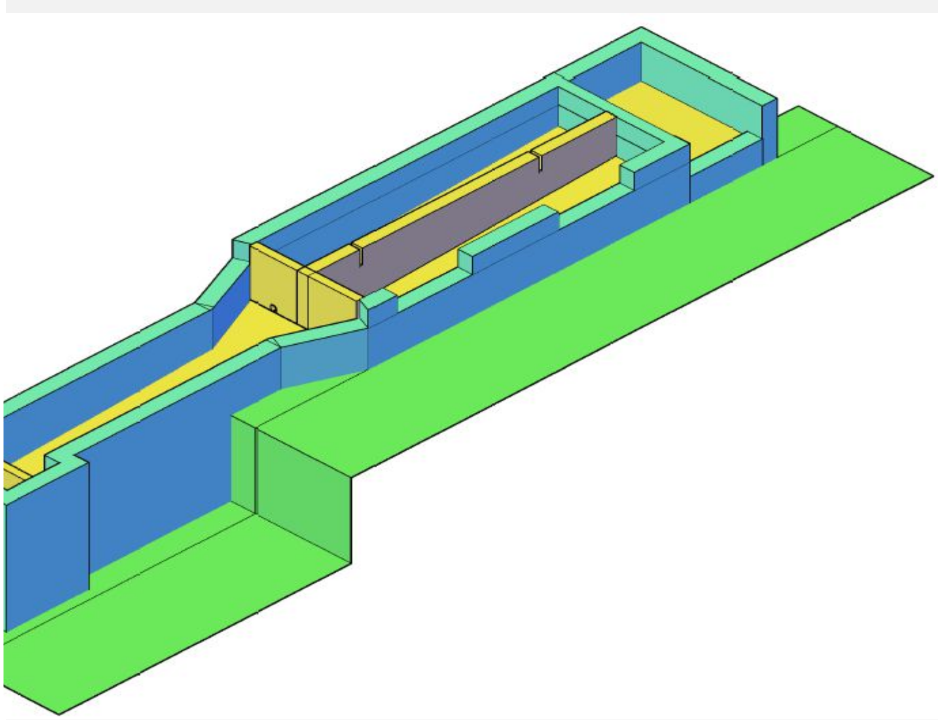
SCREEN		
ft	in	m
2	8	0.81
5	7	1.70
2	0	0.61
2	1.5	0.65
		4.7%
ft3		m3
16.1		0.6

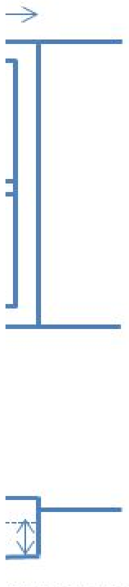


TANK		
ft	in	m
1	4	0.41
1	0	0.30
4	7	1.40
2	7	0.79
6	8	2.03
3	4	1.02
1	2	0.36
ft2		m2
6.1		0.6
4.6		0.4
5.3		0.5
ft3		m3
53.5		1.5
17.8		0.5

Veolia Fondation


L2
L1
L3
W1.1
W3
W2.1
W1.2
V1
H2.low
H2.high
H1.low
H1.high
Elevation of the ground





HBT

Number of HBT			2
	ft	in	m
Diameter	13	0	4.0
Height of the cone	9	3	2.8
Height of the upper part	2	0	0.6
Effective height of the upper part	0	7	0.2
	ft3		m3
Volume 1 HBT	674.7		19.1
Effective volume 1 HBT	486.7		13.8
	ft2		m2
Specific horizontal surface 1 HBT	66.4		6.2

Design calculations

Retention time			
Number of HBT in operation	1	2	
	hour		
Hydraulic retention time at average	3.5	7.1	The HBTs a
Hydraulic retention time at maximum	2.0	4.1	
	m3/day	m3/h	
Design inlet flow	40.0	4.4	From De Bo
	mg/l		
Total solid design value	22000		From De Bo
Average Total solid influent concentration	13000		
	g/l		
HBT solid outlet concentration expected	50		Expected co
Average TS sludge concentration in total HBT	33		Veolia Fonc
TS reduction expected	60%		Hypothesis
	m		
Maximum height of the sludge	1.9		Chosen to b
	m3		
Available volume for the sludge per HBT	3.4		
	kg		
Mass of the sludge equivalent	114.5	228.9	
	kg/d.m2		
Design surfacic mass load	217.7	108.8	
	m3		
Volume of sludge at expected concentration	2.3	4.6	
	hours		
Sludge retention time at design	5.2	10.4	

Operation

	m3/day	m3/h
Average inlet flow	35.0	3.9
Maximum inlet flow	61.0	6.8

Number of HBT in operation	1	2	
	hours		
Sludge retention time at average	10.1	20.1	
Sludge retention time at maximum	3.1	6.3	
	times/d/HBT		
Number of time of desludging at average	2.4	1.2	
Number of time of desludging at maximum	7.7	3.8	
	m3/d/HBT		
Volume extracted per HBT at average	5.5	2.7	
Volume extracted per HBT at maximum	17.6	8.8	
	kg/d		
Load extracted at expected concentration at average	273		
Load extracted at expected concentration at maximum	878		
	g/l		
Total solid concentration liquid outlet at average	6.2		
Total solid concentration liquid outlet at maximum	13.5		24 g/l accor
	m3/d		
Daily flow liquid outlet at average	29.5		
Daily flow liquid outlet at maximum	43.4		

	kg/m3.h		
Peak TS loading per HBT	11.8	5.9	Maximum c

Velocity		
	DN (mm)	
Inlet pipe diameter	100	
	m/h	
HBT rising velocity at average	0.6	< 1m/h to a
HBT rising velocity at maximum	1.1	
	m/h	
Velocity inlet pipe at average	495	>30m/h to
Velocity inlet pipe at maximum	863	

Height to desludge per HBT			
Number of HBT in operation	1	2	
Number of tractors between two HBT desludging	15		Operation p
	m3		
Volume to desludge per HBT	2.3	1.2	
Total volume of HBT	13.8		
Volume in the upper part of the HBT	2.2		
Volume of the cone of the HBT	11.6		
Volume kept per HBT	11.4	12.6	
Remaining volume to desludge from the cone per HBT	0.1	0.0	
Remaining volume in the cone after desludging	11.4		
	m		
Height to desludge per HBT	0.190	0.095	
	in		
Height to desludge per HBT	**7**	**4**	Operation p

Geometrical Volume Calculation

Height			
ft	in	m	ft
0	0	0.0	#N/A
1	3	0.4	#N/A
3	3	1.0	#N/A
5	3	1.6	#N/A
7	3	2.2	#N/A
9	3	2.8	#N/A
10	0	3.0	2.0

re designed for a 3h retention time - De Bonis report

onis report

onis report

oncentration - Veolia Fondation
dation - 2/3 of design concentration
from mass balance 01/12/18 beside

be approximatly 3 ft or 1m below the outlet liquid pipe rding to STS Analysis document

of 8 kg/m3.h according to De Bonis report

allow sedimentation - Fondation Veolia

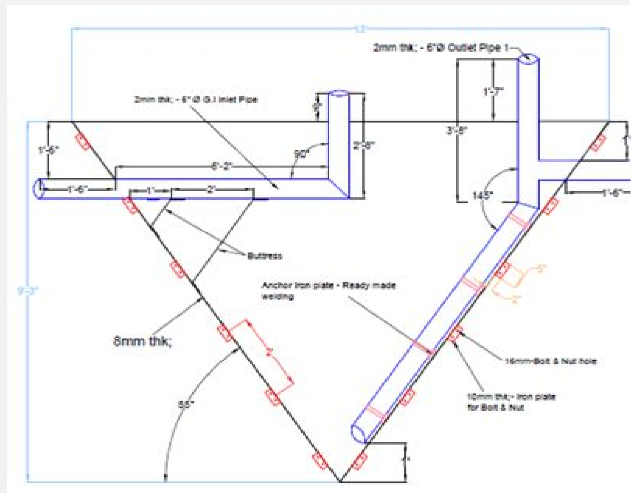
avoid sedimentation - Fondation Veolia

parameter

Calculation for the height to desludge, according to t	
	m
Radius	2.0
Height	2.8
Height to desludge in the cone	0.01

parameter

Diameter	Volume	
m	ft3	m3
0.0	#N/A	0.0
1.3	#N/A	0.2
3.4	#N/A	3.0
5.5	#N/A	12.6
7.6	#N/A	33.2
9.7	#N/A	69.0
0.6	#N/A	69.0



MASS BALANCE		HBT Inlet	HBT liquid	HBT solid o	STS Outlet
Concentration	g/l	13.00	5.50	48.00	0.418
Flow design	m3/d	40	36	4	36
Load	kg/d	520	198	192	15
				390.0	
		HBT Reduc	62%	STS Reduct	97%

the remaining volume in the cone	

ABR - Anaerobic filter

First chamber (inlet) - settler			
	ft	in	m
Length	5	0	1.5
Width	11	7	3.5
Height	6	0	1.8
Effective height	5	0	1.5
	ft2		m2
Area	57.9		5.4
	ft3		m3
Volume	347.5		9.8
Effective volume	289.6		8.2

Chamber without gravel			
	ft	in	m
Length	2	9	0.8
Width	4	7	1.4
Height	5	5	1.7
Effective height	4	5	1.3
Maximum height of sludge	3	6	1.1
	ft2		m2
Area	12.6		1.2
	ft3		m3
Volume	68.3		1.9
Effective volume	55.7		1.6
Maximum volume of sludge	44.1		1.2

Last chamber (outlet)			
	ft	in	m
Length	1	5	0.4
Width	22	7	6.9
Height	6	3	1.9
Effective height	5	3	1.6
	ft2		m2
Area	32.0		3.0
	ft3		m3
Volume	200.0		5.7
Effective volume	168.0		4.8

ABR - anaerobic filter total			
	ft	in	m
Length	43	8	13.3
Width	22	7	6.9
Number chambers without gravels	32		
Number chambers with gravels	16		
	ft2		m2

Area	726		67

Design calculations

Porosity of gravels (0.5" to 2")	
	L
Volume of empty bucket	13
Volume of water poured with gravels	5.5
Porosity	42%

Retention time			
	ft3	**m3**	
Effective volume in ABR chambers	1781	50	
Effective volume in anaerobic filter chambers	891	25	
Minimum volume of the liquid fraction of ABR	370	10	
ABR			
	day		
Hydraulic retention time at average	1.7		Between 1 and 3 days
Hydraulic retention time at maximum	1.2		
	hour		
Minimum hydraulic retention time at average	8.5		> 24 hours at maximur
Minimum hydraulic retention time at maximum	5.8		
Anaerobic filter			
	hour		
Retention time at average	20		An hydraulic retention
Retention time at maximum	14		

Up-flow velocity			
	Average	**Max**	
Number of chambers in a row	4		
	m3/h	**m3/h**	
Operationnal Flow	3.3	4.8	
	m/h	**m/h**	
Baffled Chamber Up-flow velocity	0.7	1.0	Between 1.4 and 2m/h
First Chamber Up-flow velocity	0.6	0.9	
Second Chamber Up-flow velocity	1.1	1.7	
Last Chamber Up-flow velocity	1.1	1.6	

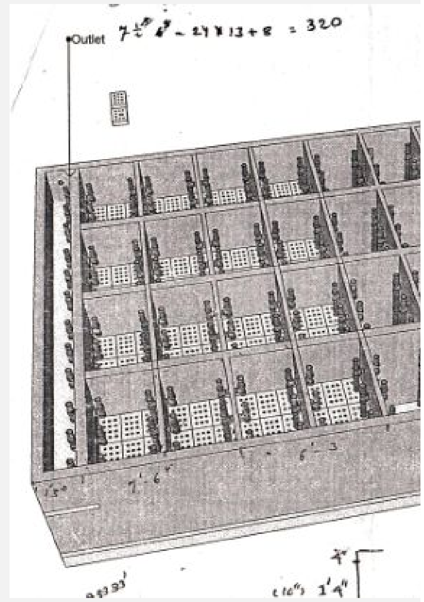
COD loading of ABR		
	mg/l	
COD inlet concentration	5000	According to the document Analy
	kg/m3.d	
COD loading at average	2.9	Maximum 3kg/m3.d - De Bonis re
COD loading at maximum	4.3	

Operation

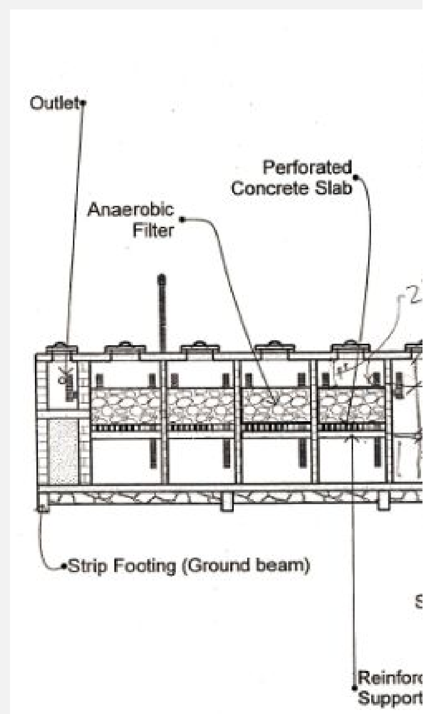
Production of solid sludge from the two first chambers				
	ft	in	m	
Maximum height of sludge	3	6	1.1	
	ft3	m3		
Volume of sludge removed from chamber 1	173.8	5.7		
Volume of sludge removed from chamber 2	93.2	3.1		
	weeks			
Time between two desludging	2			From exper
	m3/d			
Volume of desludged sludge	0.63			

TS sludge reduction of ABR sludge		
	m3/d	
Inlet flow	29.5	
Volume extracted by desludging	0.6	
	g/l	
TS inlet concentration	8	According to the document Analy
TS outlet concentration	2	
TS sludge concentration	50	
	kg/d	
TS loading at inlet	236.3	
TS loading at outlet	57.8	
TS loading remaining in ABR	31.5	
Sludge reduction	82%	

Second chamber - settler			
	ft	in	m
Length	1	4.5	0.4
Width	22	7	6.9
Height	6	0	1.8
Effective height	5	0	1.5
	ft2		m2
Area	31.1		2.9
	ft3		m3
Volume	186.3		5.3
Effective volume	155.3		4.4



Chamber with gravel			
	ft	in	m
Length	2	9	0.8
Width	4	7	1.4
Total Height	5	5	1.7
Height of gravels	0	10	0.3
Effective height	4	5	1.3
	ft2		m2
Area	12.6		1.2
	ft3		m3
Volume	68.3		1.9
Effective volume	55.7		1.6



according to UN Habitat 2008 and De Bonis report

m sludge depth and scum accumulation - UN Habitat 2008 /// The HRT of the liquid fraction (i.e. above the sludge v

time of 12 to 36 hours is recommended - Compendium sanitation

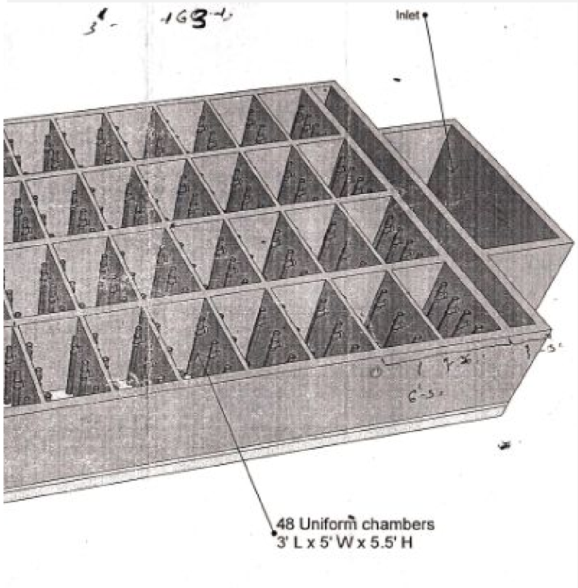
- UN Habitat 2008 /// The up-flow should not exceed 1.0m/h - DEWATS

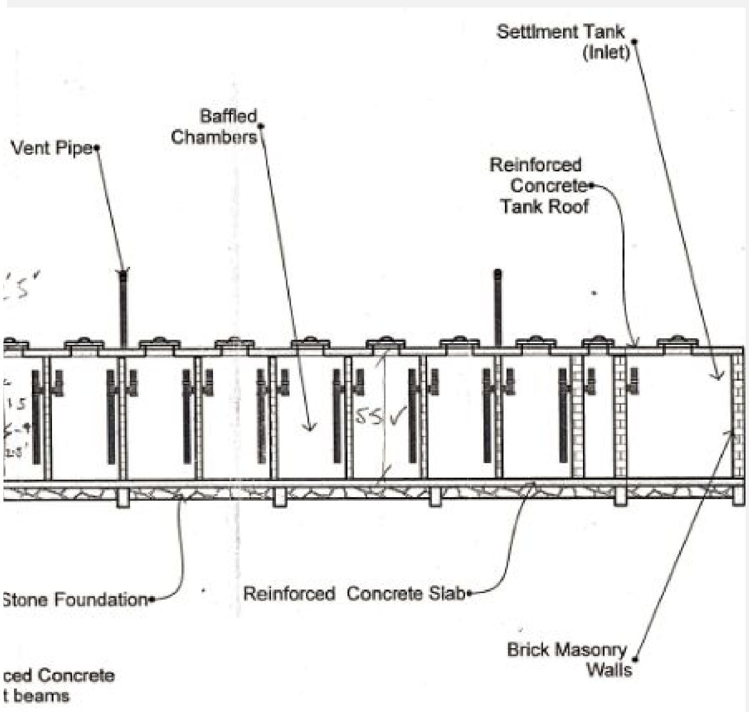
ses STS

port

rience

ses STS


Inlet
48 Uniform chambers
3' L x 5' W x 5.5' H


Settlment Tank
(Inlet)
Baffled
Chambers
Vent Pipe
Reinforced
Concrete
Tank Roof
Stone Foundation
Reinforced Concrete Slab
Brick Masonry
Walls
ced Concrete
t beams

volume) should not be less than eight hours - DEWATS

Horizontal Constructed Wetland 1

	mm/d
Evaporation ratio hypothesis	0.5

Number of CW	2	
	ft	in
L	48	9
L of gravels of more than 1.5"	4	0
L of gravels between 0.5" and 1.5"	44	9
W	38	9
H of gravels	1	1
H of water (left bed)	0	7.25
H of water (right bed)	0	8.25
Volume for 1 bed		
	ft	
Area	3778	
Volume for 2 beds		

	m3/d	
	Average	Max
Outlet daily flow incl. evaporation	29	43

Design calculations

Porosity of gravels (0.5" to 1.5")	
	L
Volume of empty bucket	13
Volume of water poured with gravels	5.6
Porosity	43%

Porosity of gravels (more than 1.5")	
	L
Volume of empty bucket	13
Volume of water poured with gravels	5.7
Porosity	44%

Retention time		
	m2	
One bed area for gravels of more than 1.5"	14	
One bed area for gravels between 0.5" and 1.5"	161	
	at average	at maximum
	days	
Retention time left bed	0.94	0.64
Retention time right bed	1.07	0.73
Retention time total	1.01	0.69
	h	
Retention time total	24	16

Design review with 'UN Habitat 2008' and 'Waste Stabilization Ponds and Constructed Wetlands Desi

Pollutants removal

UN Habitat 2008

Ce= Ci / exp(A * Kbod / Q)

BOD removal		
	mg/l	
Influent COD concentration	4300	According to the do
Influent BOD5 concentration	1720	Extrapolation by Ve
	m/d	
Rate constant	0.15	
	mg/l	
Expected BOD5 effluent concentration	289	
Effluent obtained	1000	According to the do
Reduction of BOD5 expected	83%	
Reduction obtained	23%	According to the do

Ce= Ci * (0,106 + 0,11 * AHLR)

TSS removal		
	mg/l	
Concentration of TSS in the influent	2000	According to the do
	m/d	
Aerial hydraulic loading	0.0842	
	mg/l	
Expected concentration of SS in the effluent	231	
Current concentration of TSS in the effluent	400	According to the do
TSS expected reduction	88%	
Current reduction	65%	According to the do

The first two methods present similar results for BOD and TSS removal and thus should be
The area is well dimensionned for the current flow and inlet concentrations (more than 80
But the constructed wetlands are not reaching the result expected by design on BOD5, TSS

Ce = Ci * exp(-0,126*(1,008)^(T-20)*R)

NH4 removal		
	mg/l	
Concentration of ammonia in the influent	1000	According to the do
	Degree Celcius	
Minimum mean temperature	21	mean temperatur
	mg/l	
Expected concentration of ammonia in the effluent	880	

Current concentration of ammonia in the effluent	890	According to the do
Ammonia expected reduction	12%	
Current reduction	23%	According to the do

The three methods present very different results for amonia removal.

The two methods show similar results for nitrates removal.

The effluent concentration reached is much higher than what is expected.

The two methods show similar results for total phosphorus removal

The effluent concentration reached is much higher than what is expected.
Is total phosphorus equivalent to the P we measure in the STS?

Flow calculation

Waste Stabilization Ponds and Constructed Wetlands Design Manual - Reed's method

UN Habitat 2008

Q = Ac * K * S

Expected inlet flow according to design		
	m2	
Cross sectional area of the bed	7.8	
	m/s	
Hydraulic conductivity of the bed	0.002	For graded gravels
	m/m	
Slope of bottom of the bed	0.01	In most cases, a dH
	m3/d	
Expected inlet flow	13.5	
Current inlet flow	29.5	

The cross sectional area is too small for the current inlet flow - it could explain the differen

BOD loading rate

UN Habitat 2008

Expected BOD5 loading rate according to design	
	mg/l
Influent BOD5 concentration	1720
	g/m2.d

Maximum recommended BOD5 loading	11	According to De Bo

	g/m2.d
BOD5 loading rate according to current inlet flow	144.8
Expected BOD5 loading rate with expected inlet flow	66.0
	m2
Recommended area for current parameters	4619
Current area	351

The BOD5 loading rate is higher than the recommended one, even with the expected inlet f

The recommended area is very big and do not match the calculations from the literature. T

Recommended design for current parameters

Waste Stabilization Ponds and Constructed Wetlands Design Manual - Reed's method

UN Habitat 2008

Ac = Q / (K * S)

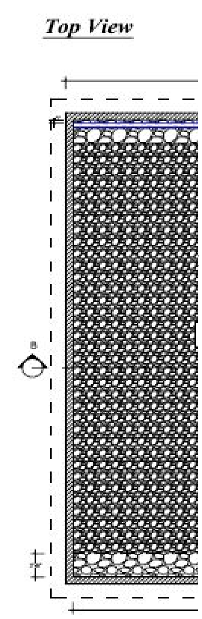
Recommended sizing of the CW		
	m3/s	
Daily flow average	0.0003	
	m/s	
Hydraulic conductivity of the bed	0.002	For graded gravels
	m/m	
Slope of bottom of the bed	0.01	In most cases, a dH
	m2	
Cross sectional area of the bed	17.1	
	m	
Recommended total width	51.8	
Recommended number of beds	4	
Recommended width per bed	12.9	
Recommended length	6.8	
Current total width	23.6	
Current number of beds	2	
Current width per bed	11.8	
Current length	14.9	

Cross sectional area of the flow	m2	Ac = Q / Ks * S
cross-sectional area of wetland bed	m3/m2.day	
Hydraulic conductivity of the medium		
Slope of the bed or hydraulic gradient		(as a fraction or c
	m	
Depth		W = Ac / d
Width		

Kadlec and Knight design method

m
14.9
1.2
13.6
11.8
0.33
0.18
0.21
58
m2
351
m3
116

The water flow is maintained approximately 15 – 30 cm below the bed sur



gn Manual' guidelines

Waste Stabilization Ponds and Constructed Wetlands Design Manual
Reed's method

Ce = Ci * exp (-A*Kt*y*n/Q)

Kt = Kr * θr^(Tw-Tr)

	BOD removal		
		C	
ocument Ana	Water temperature	21	Same as air tempera
eolia fondati	Reference temperature	20	Given by the manua
	Temperature coeficient for rate constant	1.06	Given by the manua
		per day	
	Rate at reference temperature	1.104	Given by the manua
	Rate constant at temperature	1.17	
ocument Ana	Porosity	0.43	
		mg/l	
ocument Ana	Influent concentration	1720	
	Expected effluent concentration	234	
	Current effluent concentration	1000	
	Reduction of BOD5 expected	86%	
	Reduction obtained	23%	

Ce = Ci * (0.1058 + 0.001 * HLR)

HLR = 100*Q/A

	TSS removal	
		cm/d
ocument Ana	Hydraulic loading rate	8.42
		mg/l
	Influent concentration	2000
	Expected effluent concentration	228
	Current effluent concentration	400
ocument Ana	TSS expected reduction	89%
	Current reduction	65%

ocument Analysis STS

prefered to the third one.

% reduction expected for BOD5 and TSS).

Ce = Ci * exp (-A*Kt*y*n/Q)

Knh = 0.01854 + 0.3922 * (rz)^2.6077

Kt = Knh * θr^(Tw-Tr)

	NH4 removal		
		C	
ocument Ana	Water temperature	21	
	Reference temperature	20	Given by the manu
e for Janua	Temperature coeficient for rate constant	1.048	Given by the manu
	Depth of bed occupied by root zone	0	No plants, in %
		per day	

ocument Ana	Nitrification rate constant	0.019
	Rate constant at temperature	0.019
ocument Ana	Porosity	0.43
		mg/l
	Influent concentration	1000
	Expected effluent concentration	967
	Current effluent concentration	890
	Ammonia expected reduction	3%
	Current reduction	23%

Ce = Ci * exp (-A*Kt*y*n/Q)

Kt = Kr * θr^(Tw-Tr)

NO3 removal		
	C	
Water temperature	21	TBC
Reference temperature	20	Given by the manu
Temperature coeficient for rate constant	1.15	Given by the manu
	per day	
Rate at reference temperature	1.00	Given by the manu
Rate constant at temperature	1.15	
Porosity	0.43	
	mg/l	
Influent concentration	25	From the Analyses
Expected effluent concentration	4	
Current effluent concentration	15	From the Analyses
Nitrates expected reduction	86%	
Current reduction	31%	From the Analyses

Ce = Ci * exp(-Kp/HLR)

Removal total phosphorus		
	cm/d	
First order phosphorous reaction rate	2.73	Given by the manu
	mg/l	
Influent concentration	46	From the docume
Expected effluent concentration	33	
Current effluent concentration	77	From the docume
Total phosphorus expected reduction	28%	

Ce = Ci / (1+ t * Kt)^n

Kt = Kr * θr^(Tw-Tr)

Pathogens removal		
	C	
Water temperature	21	
Reference temperature	20	Given by the manu
Temperature coeficient for rate constant	1.19	Given by the manu
	per day	
Rate at reference temperature	2.60	Given by the manu
Rate constant at temperature	3.09	
Number of cells in series	1	
	nb/100ml	
Influent concentration	433500	
Expected effluent concentration	105168	
Current effluent concentration	75583	From the docume
Pathogens expected reduction	76%	
Current reduction	79%	From the Analyses

a value of Kf of 1 x 10-3 to 3 x 10-3 m/s is normally chosen. Here 2 x 10-3 m/s was chosen

/ds of 1% is used - not measured

ce in removal results

nis report

flow.4

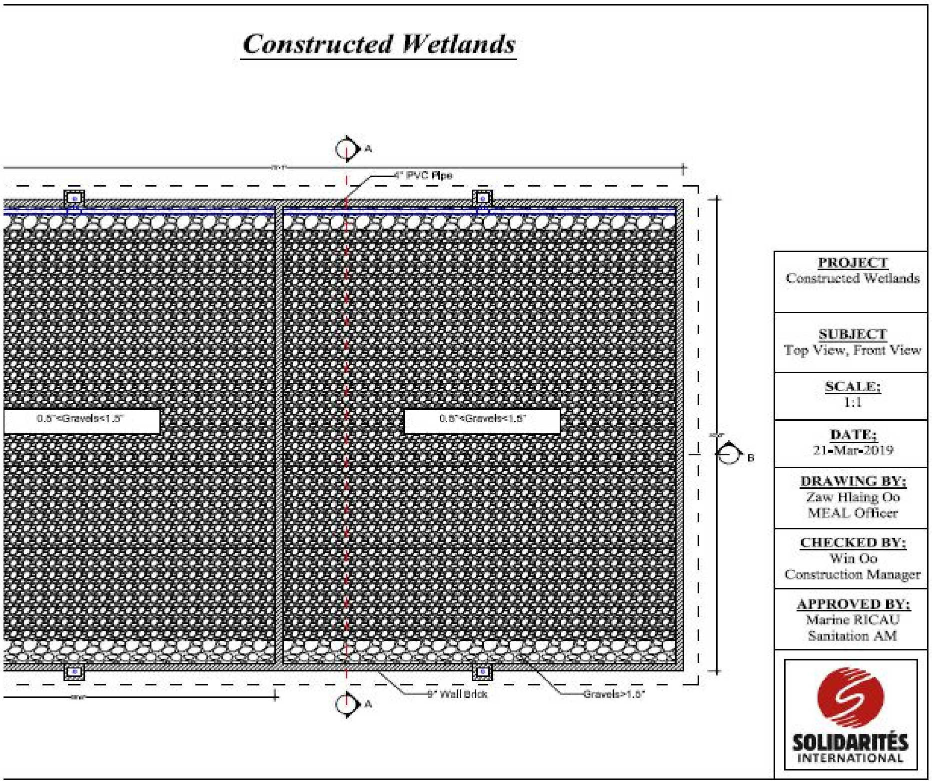
he maximum recommended BOD5 loading of 11 g/m2.d seems to be overestimated.

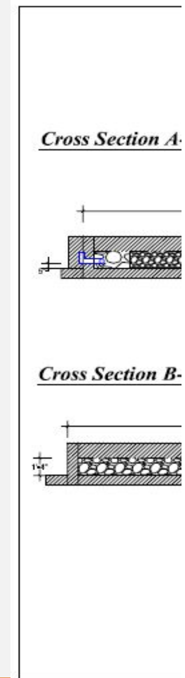
a value of Kf of 1 x 10-3 to 3 x 10-3 m/s is normally chosen. Here 2 x 10-3 m/s was chosen

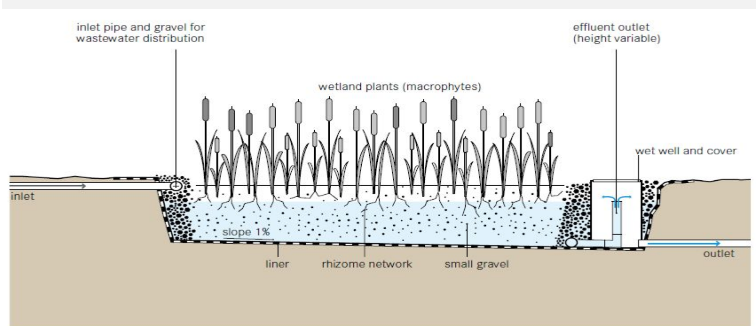
/ds of 1% is used

An L/W value as lo

decimal).


Constructed Wetlands
A
4" PVC Pipe
0.5"<Gravels<1.5"
0.5"<Gravels<1.5"
B
A
9" Wall Brick
Gravels>1.5"
PROJECT
Constructed Wetlands
SUBJECT
Top View, Front View
SCALE;
1:1
DATE;
21-Mar-2019
DRAWING BY;
Zaw Hlaing Oo
MEAL Officer
CHECKED BY;
Win Oo
Construction Manager
APPROVED BY;
Marine RICAU
Sanitation AM
SOLIDARITÉS
INTERNATIONAL


Cross Section A-
Cross Section B-


inlet pipe and gravel for
wastewater distribution
effluent outlet
(height variable)
wetland plants (macrophytes)
wet well and cover
inlet
slope 1%
liner
rhizome network
small gravel
outlet

Waste Stabilization Ponds and Constructed Wetlands Design Manual
Kadlec and Knight design method

Ce = C + (Ci - C) * exp(-A * k / (365 * Q))

BOD removal		
	m/year	
First order aerial rate constant	180	Given by the manual
	mg/l	
Influent concentration	1720	
Background pollutant concentration	95	
Expected effluent concentration	99	
Current effluent concentration	1000	
Reduction of BOD5 expected	94%	
Reduction obtained	23%	

ature
l
l
l

Ce = C + (Ci - C) * exp(-A * k / (365 * Q))

TSS removal		
	m/year	
First order aerial rate constant	1000	Given by the manual
	mg/l	
Influent concentration	2000	
Background pollutant concentration	134	
Expected effluent concentration	134	
Current effluent concentration	400	
TSS expected reduction	93%	
Current reduction	65%	

Ce = C + (Ci - C) * exp(-A * k / (365 * Q))

NH4 removal		
	m/year	
First order aerial rate constant	34	Given by the manual
	mg/l	
Influent concentration	1000	
Background pollutant concentration	0	Given by the manual
Expected effluent concentration	331	

ual
ual

Current effluent concentration	890
Ammonia expected reduction	67%
Current reduction	23%

Ce = C + (Ci - C) * exp(-A * k / (365 * Q))

NO3 removal		
	m/year	
First order aerial rate constant	50	Given by the manual
	mg/l	
Influent concentration	25	
Background pollutant concentration	0	Given by the manual
Expected effluent concentration	5	
Current effluent concentration	15	
Nitrates expected reduction	80%	
Current reduction	31%	

ual

ual

ual

; STS document

; STS document

; STS document

Ce = C + (Ci - C) * exp(-A * k / (365 * Q))

Removal total phosphorus		
	m/year	
First order aerial rate constant	12	Given by the manual
	mg/l	
Influent concentration	46	
Background pollutant concentration	0.02	Given by the manual
Expected effluent concentration	31	
Current effluent concentration	77	
Total phosphorus expected reduction	32%	

ual

nt Analyses

nt Analyses

ual
ual

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nt Analyses STS

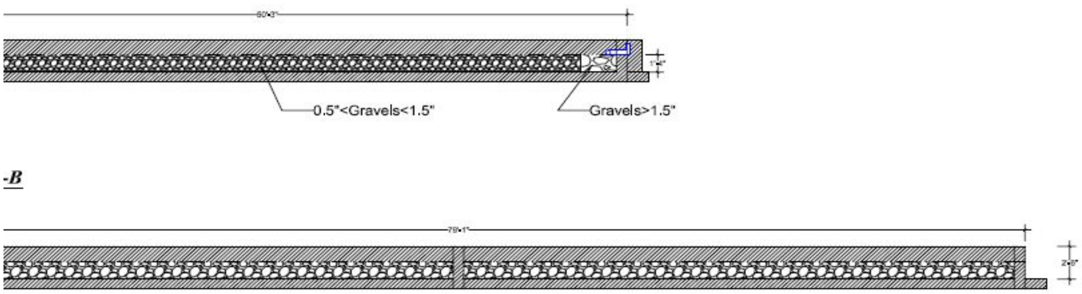
s STS document

ow as 1 is recommended for SSF (Hammer, 1990),

Constructed Wetlands

-A

-B



SOLIDARITÉS INTERNATIONAL	SUBJECT	PROJECT	Date	21-Mar-2019
	Cross Section View	Constructed Wetlands	Scale	1:1
			Drawing By:	Zaw Hlaing Oo MEAL Officer
			Checked By:	Win Oo Construction Manager
			Approved By:	Marine RICAU Sanitation Activity Manager

Maturation pond

Evaporation ratio hypothsesis

First pond	
	ft
Top L1	100
Bottom L1	85
Top W1	41
Bottom W1	26
Top L2	21
Bottom L2	6
Top W2	48
Bottom W2	33
H	3
	ft2
Top Area	5147
Bottom Area	2474
	ft3
Volume	13054

Both ponds	
	ft2
Top Area	8348
	ft3
Volume	21421

Design calculations

Outlet flow including evaporation	
	m3/d
	At average
Maturation pond 1 outlet flow	28.0

Maturation pond 2 outlet flow	27.1

Retention time	
	day
	At average
Maturation pond 1 retention time	13.2
Maturation pond 2 retention time	8.7

Design review with Waste Stabilization Ponds and Constructed Wetlands Design Manual

Expected e. coli concentration	
	col/100ml
Influent e. coli concentration, per 100 mL	75583
	°C
Temperature	21
	per day
First order constant	3.09
	col/100ml
Effluent e. coli concentration, per 100 mL	64
Current effluent concentration	4000
Pathogens expected reduction	99.9%
Current reduction	91%

Helminth egg removal	
% removal in the maturation pond 1	99.72
% removal in the maturation pond 2	98.91

Expected area	
	m2
Expected area of maturation pond 1	357
Current area of maturation pond 1	478
Expected area of maturation pond 2	238
Current area of maturation pond 2	297

BOD surface loading for maturation pond 1	
	mg/l
COD inlet concentration	2500
BOD inlet concentration	1000
	kg/ha.d
Surface loading	242
Maximum recommended BOD surface loading	
	C
Temperature	21
	kg/ha.d
Maximum surface loading recommended	373

mm/d	
2.9	8 max http://www.formules-physique.com/categorie/335

in	m	
2	30.5	
5	26.0	
1	12.5	
4	8.0	
6	6.6	
9	2.1	
0	14.6	
3	10.1	
6	1.1	1-1.5 m recommended - Waste Stabilization Ponds and Const
	m2	
	478	
	230	
	m3	
	370	

Second pond	
	ft
Top L	77
Bottom L	63
Top W1	41
Bottom W1	26
H	3
	ft2
Top Area	3201
Bottom Area	1663
	ft3
Volume	8367

m2
776
m3
607

At maximum
41.9

41.0

At maximum
8.8
5.8

5 days minimum recommended - Waste Stabilization Ponds and Constructed Wetland

Ne = Ni/((1+KbT*R1)*(1+KbT*R2))

From the document Analyses STS

Mean air temperature in the coldest month - mean temperature for January 2019 - https://www.accuw

KbT = 2,6*(1,19^(T-20))

From the document Analyses STS

From the Analyses STS document

E=100*(1-0.41*exp(-0.49*R+0.0085*R^2))

A = 2Qi * R /(2*D+0.001*e*R)

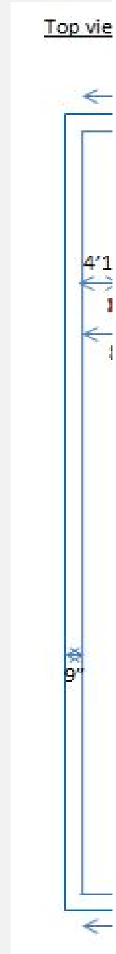
λ = 10*(0.3*Li)*D/R

From the document STS analyses
Extrapolation by Veolia fondation

λ = 350*(1.107-0.002*T)^(T-20)

in	m	
11	23.7	
2	19.3	
1	12.5	
4	8.0	
6	1.1	1-1.5 m recommendec
	m2	
	297	
	155	
	m3	
	237	

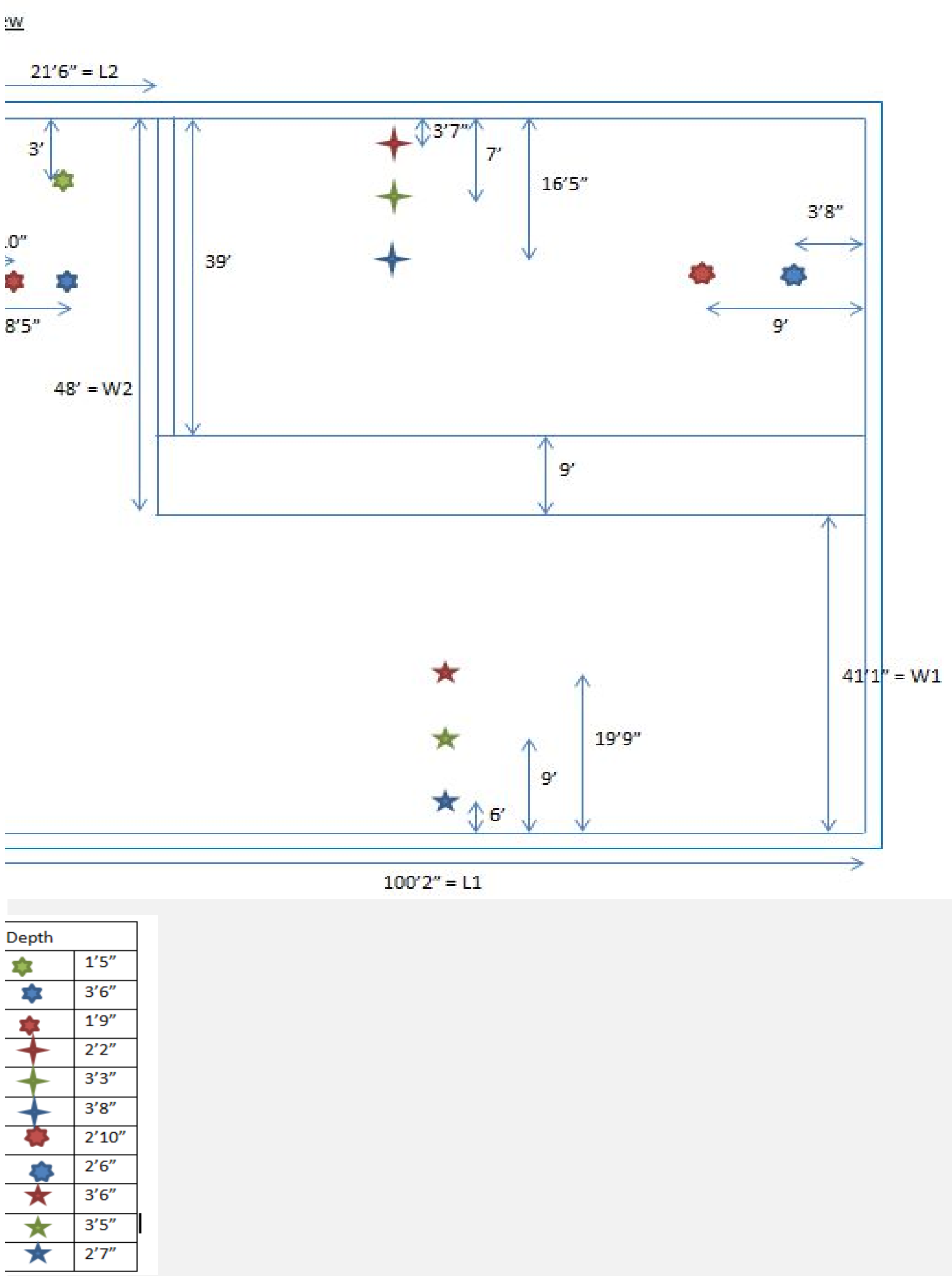
Slopes calculations			
L4	3	7	1.1
D4	2	2	0.7
S4			60%
L5	7	0	2.1
D5	3	3	1.0
S5			46%
L6	16	5	5.0
D6	3	8	1.1
S6			22%
L11	6	0	1.8
D11	2	7	0.8
S11			43%
L10	9	0	2.7
D10	3	5	1.0
S10			38%
L9	19	9	6.0
D9	3	6	1.1
S9			18%
L8	3	8	1.1
D8	2	6	0.8
S8			68%
L7	9	0	2.7
D7	2	10	0.9
S7			31%
L1	3	0	0.9
D1	1	5	0.4
S1			47%
L3	4	10	1.5
D3	1	9	0.5
S3			36%
L2	8	5	2.6
D2	3	6	1.1
S2			42%
Mean slope			48%



1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	

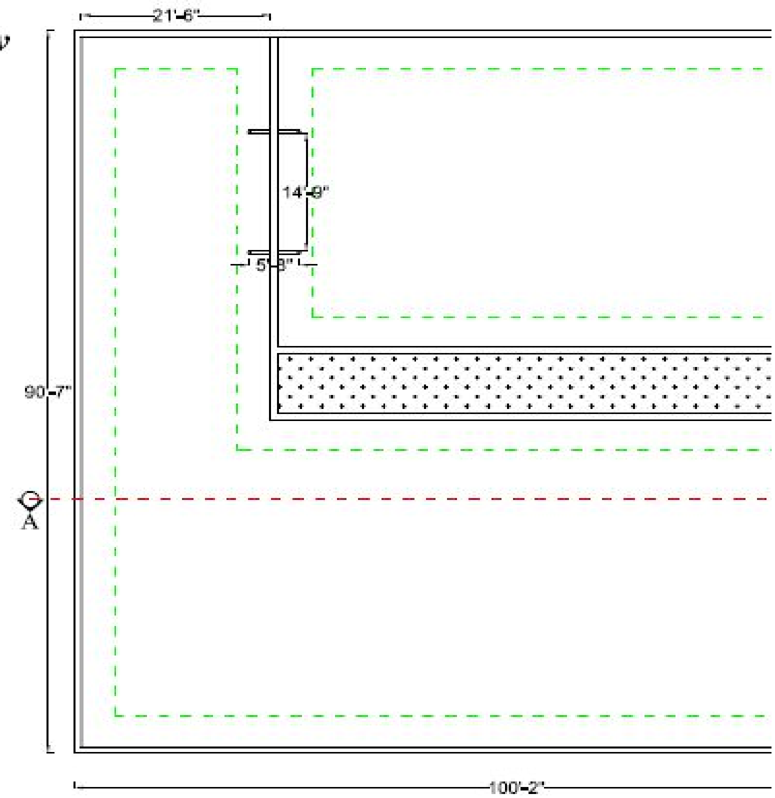
s Design Manual

veather.com/en/mm/sittwe-airport/631_poi/january-weather/631_poi


ew
21'6" = L2
3'
.0"
8'5"
48' = W2
39'
3'7"
7'
16'5"
3'8"
9'
9'
41'1" = W1
19'9"
9'
6'
100'2" = L1
Depth
1'5"
3'6"
1'9"
2'2"
3'3"
3'8"
2'10"
2'6"
3'6"
3'5"
2'7"

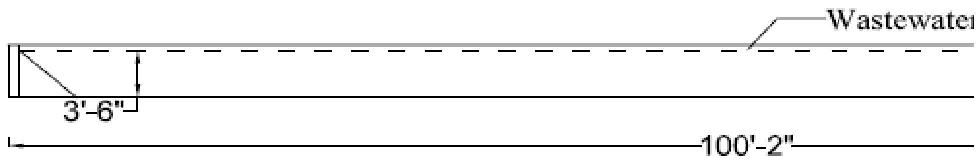
Maturation Ponds at th

Top View

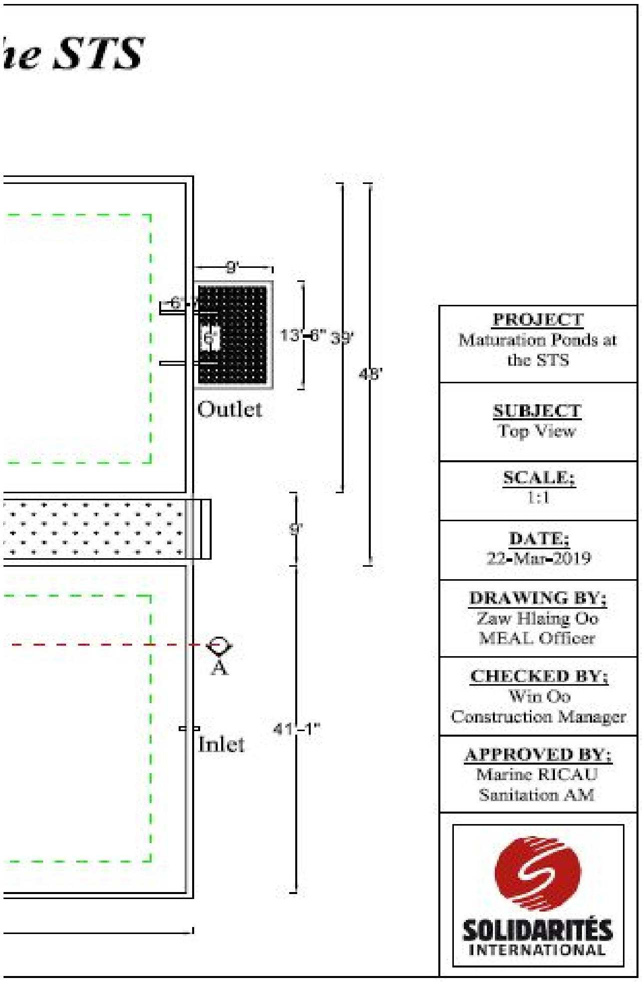


Maturation Ponds at t

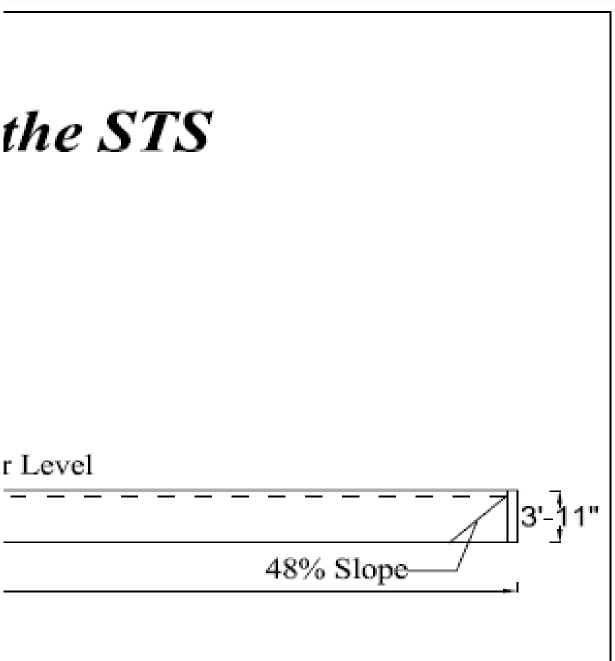
Cross Section A-A



0.5m - 1.5
inlet
O_2
O_2
O_2
O_2
3 aerobic maturation
outlet



he STS
9'
6'
6'
13'-6"
39'
48'
Outlet
9'
A
41'-1"
Inlet
PROJECT
Maturation Ponds at the STS
SUBJECT
Top View
SCALE;
1:1
DATE;
22-Mar-2019
DRAWING BY;
Zaw Hlaing Oo
MEAL Officer
CHECKED BY;
Win Oo
Construction Manager
APPROVED BY;
Marine RICAU
Sanitation AM
SOLIDARITÉS
INTERNATIONAL



the STS
r Level
3'-11"
48% Slope

SOLIDARITÉS INTERNATIONAL

SUBJECT	PROJECT		
Cross Section A-A	Current Design of maturation ponds at the STS	Date	22-Mar-2019
		Scale	1:1
		Drawing By:	Zaw Hlaing Oo MEAL Officer
		Checked By:	Wai Oo Construction Manager
		Approved By:	Marine RICAU Sanitation Activity Manager

Infiltration basins

Basin 1			
	ft	in	m
Side 1	25	0	7.6
Side 2	29	10	9.1
Side 3	34	0	10.4
Side 4	32	0	9.8
Height	1	6	0.5
Effective height	0	6	0.2
	Degree		
Angle 1-2	116		
Angle 3-4	90		
	ft2		m2
Area	879.2		82
	ft3		m3
Volume	439.6		12.4

Maximum d

Design calculations

	mm/d
Evaporation ratio hypothesis	2.9

Hydraulic loading rate		
	at average	at maximum
	m3/year	
Yearly inlet flow	8470.3	12804.6
	m/year	
Hydraulic loading rate	45.7	69.1

Between 15 and 100 d

Operation

Flooding schedule		
	h	
Flooding time	4.5	
Drying time	19.5	
	at average	at maximum
	m3	
Inlet volume of each basin	13.6	20.5
	m3/d	
Volume evaporated	0.53	

Basin 2			
	ft	in	m
Side 1	11	0	3.4
Side 2	66	0	20.1
Side 3	25	2	7.7
Side 4	61	0	18.6
Height	1	6	0.5
Effective height	0	6	0.2
	Degree		
Angle 1-2	102		
Angle 3-4	98		
	ft2		**m2**
Area	1115.2		104
	ft3		**m3**
Volume	557.6		15.8

of 0.2m recommended

Maximum d

epending on the soil - Wastewater treatment and use in agriculture - FAO irrigation and drainage paper of 0.2m recommended - Wastewater treatment and use in agriculture - FAO irrigation and drainage pa

r 47 -M.B. Pescod, 1992

per 47 -M.B. Pescod, 1992

Drying beds

	mm/d		
Evaporation ratio hypothesis	2.9	Around 5 mm/d for moderate	
Number of beds	6		
	ft	in	m
L	48	2	14.7
W	16	0	4.9
Height of sand	1	2	0.4
Height of gravels <0.5"	0	10	0.3
Height of gravels <2" and >0.5"	0	6	0.2
	ft2		m2
Area	4624		430

Slopes			
	ft	in	m
Height 1	4	5	1.3
Height 2	5	0	1.5
Length	7	2	2.2
Slope to reach pipe (inlet side)			8%
Height 1	4	10	1.5
Height 2	5	2	1.6
Length	7	2	2.2
Slope to reach pipe (outlet side)			5%
Height 1	5	7	1.7
Height 2	5	10	1.8
Length	48	2	14.7
General slope (inlet to outlet)			1%

Design calculations

HBT desludging	
	m3/d
Volume extracted at average	5.5
Volume extracted at maximum	17.6
Percentage of total volume desludged on bed per day	90%

ABR desludging	
	m3/d
Volume of sludge removed from ABR	0.6
Percentage of total volume desludged on bed per day	10%

Reduction of TS	
	g/l
Concentration of TS in the effluent of HBT	50

Concentration of TS of the ABR sludge	50	
Concentration of TS in the dryed sludge after a drying cycle	250	According to the document Ar
Water reduction	80%	
Volume reduction	44%	

Drying cycle duration			
	in	**m**	
Depth of sludge for one loading cycle = one bed	8	0.2	Operation par
	m3/cycle		
Volume of sludge for one cycle	14.5		
	cycle/year		
Number of cycles per year	131		
	Days		
Filling phase duration	2.4		
	Weeks		
Drying phase duration	2.0		
Total cycle duration	2.4		

TS loading		
	kg/cycle	
TS loading for one cycle	727	
	tons/year	
Total load to be dryed	95	
	kg/m2	
TS loading per loading cycle	10	Maximum recommended 15
	kg/m2.year	
TS loading	221	Maximum recommended 20

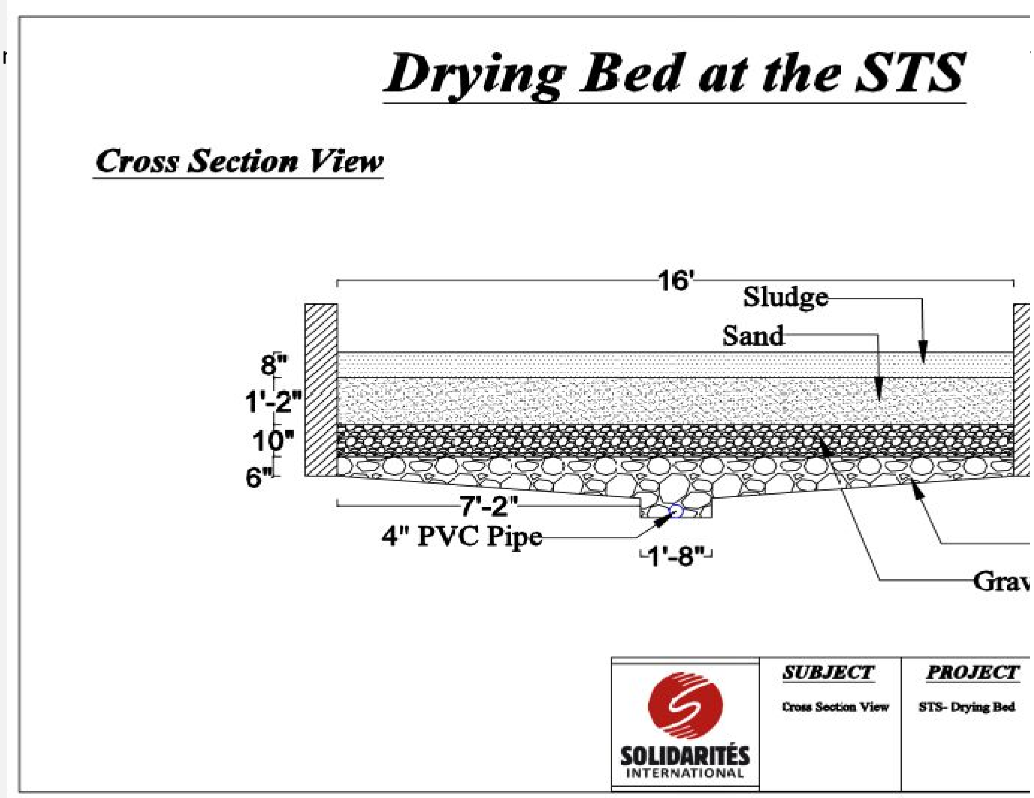
Theoretical approach			Veolia Fondation
Water reduction repartition			
	m3/d		
Evaporated water	0.205		
	m		
Depth of sludge at the end of a drying cycle	0.041		
	m3/cycle	**% of total cycle flow**	
Volume of sludge at the end of a drying cycle	2.9		
Volume of solid sludge at the end of a drying cycle	0.7	5%	
Volume of free & trapped water at the end of a drying cycle	2.2	15%	
Leachate per cycle	8.9	61%	Volume reduc
Volume of evaporated water per cycle	3.4	24%	Volume reduc
	m3/d		
Average flow of leachate infiltrated	3.2		

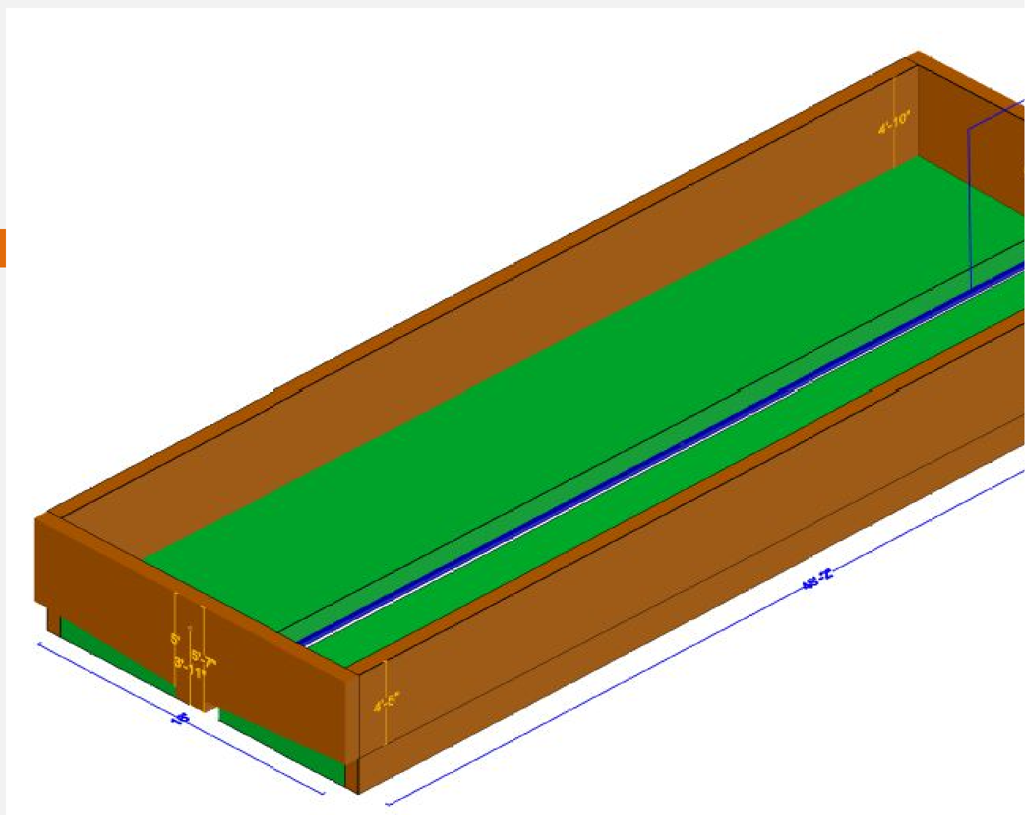
Operation

Operation		
	days	
Filling phase duration	4.9	See document Drying cycles
	weeks	
Total cycle duration	3.4	See document Drying cycles
Drying phase duration	2.7	
	cycle/year	
Number of cycle per year	92	
	tons/year	
Total load to be dryed	67	
	kg/m2.year	
TS loading	156	Maximum recommended 2(

Practical approach			
Water reduction repartition			The difference between the
	m3/d		
Average flow of leachate infiltrated	1.2	Data from 1 to 03/01/19 (se	
	in	m	
Depth of sludge at the end of a drying cycle	4.5	0.11	Data from the
	m3/cycle	% of total cycle flow	
Volume of sludge at the end of a drying cycle	8.18		
Volume of solid sludge at the end of a drying cycle	2.05	14%	
Volume of free & trapped water at the end of a drying cycle	6.14	42%	
Leachate per cycle	2.87	20%	Volume reduc
Volume of evaporated water per cycle	3.50	24%	Volume reduc
	m3/d		
Evaporated water per cycle	0.21		
	mm/d		
Evaporation ratio	2.92		

to warm climate in hur





nalyses STS

rameter

5kg/m2 - De Bonis report

00kg/m2.year - De Bonis report

ction of 50 to 80% due to drainage - Heinss et al. (1998)
ction of 20 to 50% due to evaporation - Heinss et al. (1998)

; of drying beds 12 2018-04 2019

; of drying beds 12 2018-04 2019

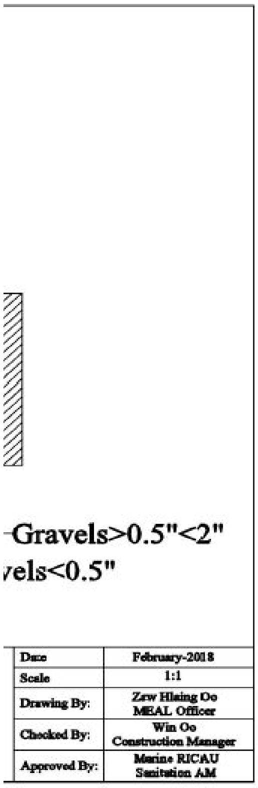
)0kg/m2.year - De Bonis report

· theoretical and practical approaches could be due to the clogging of the filters

ee document Inlet flow secondary constructed wetlands)

· 01/22/19 to 3/27/19

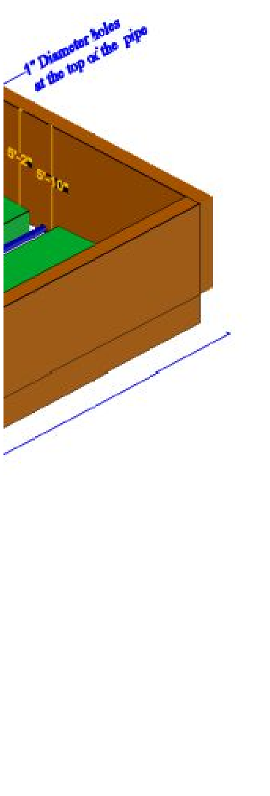
ction of 50 to 80% due to drainage - Heinss et al. (1998)
ction of 20 to 50% due to evaporation - Heinss et al. (1998)



: - FAO Irrigati

Evaporation test			
Length	1.021	ft	311.2008
Width	0.771	ft	235.0008
Height of water evaporated 1	0.125	in	3.175
Height of water evaporated 2	0.1	in	2.54
Evaporation time			1
Evaporation ratio			**2.9**

Permeability test - time for water to go throught the sand		
Dirty sand - 5 years use	35	s
Clean sand	13	s
Permeability increase ratio	**63%**	



mm
mm
mm
mm
day
mm/d

Secondary Horizontal Constructed Wetland

	mm/d
Evaporation ratio hypothesis	0.5
Number of CW	1
	ft
L	28
L of gravels of more than 1.5"	8
L of gravels between 0.5" and 1.5"	20
W	28
H of gravels	1
H of water	0
	ft
Area	808
Volume for 1 bed	

	m3/d
	Average
Outlet daily flow after evaporation	3.17

Design calculations

Porosity of gravels (0.5" to 1.5")	
	L
Volume of empty bucket	13
Volume of water poured when the bucket is filled with gravels	5.6
Porosity	43%

Porosity of gravels (more than 1.5")	
	L
Volume of empty bucket	13
Volume of water poured when the bucket is filled with gravels	5.7
Porosity	44%

Retention time	
	m2
One bed area for gravels of more than 1.5"	21
One bed area for gravels between 0.5" and 1.5"	54
	days
Retention time	0.77

Design review with 'UN Habitat 2008' and 'Waste Stabilization Ponds and Constructed Wetlands Desi

Pollutants removal

UN Habitat 2008

Ce= Ci / exp(A * Kbod / Q)

BOD removal

	mg/l
Influent COD concentration	1000
Influent BOD5 concentration	400
	m/d
Rate constant	0.15
	mg/l
Expected BOD5 effluent concentration	12.003
Effluent obtained	400
Reduction of BOD5 expected	97.00%
Reduction obtained	2%

Ce= Ci * (0,106 + 0,11 * AHLR)

TSS removal	
	mg/l
Concentration of TSS in the influent	60
	m/d
Aerial hydraulic loading	0.0428
	mg/l
Expected concentration of SS in the effluent	7
Current concentration of TSS in the effluent	600
TSS expected reduction	89%
Current reduction	Increase

The area is over dimensioned for the current flow and inlet concentrations (high reduction expected
But the constructed wetlands are not reaching the result expected by design on BOD5, TSS

Ce = Ci * exp(-0,126*(1,008)^(T-20)*R)

NH4 removal	
	mg/l
Concentration of ammonia in the influent	500
	Degree Celcius
Minimum mean temperature	21
	mg/l
Expected concentration of ammonia in the effluent	453
Current concentration of ammonia in the effluent	400
Ammonia expected reduction	9%
Current reduction	16%

The first method gives the closest results to what is currently obtained for Ammonia removal

Flow calculation

Waste Stabilization Ponds and Constructed Wetlands Design Manual - Reed’s method

UN Habitat 2008

$Q = Ac * K * S$

Expected inlet flow according to design	
	m2
Cross sectional area of the bed	3.5
	m/s
Hydraulic conductivity of the bed	0.002
	m/m
Slope of bottom of the bed	0.01
	m3/d
Expected inlet flow	6.1
Current inlet flow	3.2

The area and cross sectional area are bigger than necessary
However the constructed wetlands are not reaching the result expected by design on BOD5

BOD loading rate

UN Habitat 2008

Expected BOD5 loading rate according to design	
	mg/l
Influent BOD5 concentration	400
	g/m2.d
Maximum recommended BOD5 loading	11

	g/m2.d
BOD5 loading rate according to design	17.1
Expected BOD5 loading rate with expected inlet flow	32.4
	m2
Recommended area for current parameters	117
Current area	75

Recommended design for current parameters

Waste Stabilization Ponds and Constructed Wetlands Design Manual - Reed's method

UN Habitat 2008

$$A_c = Q / (K * S)$$

Recommended sizing of the CW	
	m3/s
Daily flow average	0.000037
	m/s
Hydraulic conductivity of the bed	0.002
	m/m
Slope of bottom of the bed	0.01
	m2
Cross sectional area of the bed	1.9
	m
Recommended total width	4.6
Recommended number of beds	1
Recommended width per bed	4.6
Recommended length	16.4
Current total width	8.7
Current number of beds	1
Current width per bed	8.7
Current length	8.7

in	m
5	8.7
0	2.4
5	6.2
5	8.7
4	0.4
3	0.1
	m2
	75
	m3
	30

The water flow is maintained approximately 15 – 30 cm below the bed surface - V

gn Manual' guidelines

Waste Stabilization Ponds and Constructed Wetlands Design Manual
Reed's method

Ce = Ci * exp (-A*Kt*y*n/Q)

Kt = Kr * θr^(Tw-Tr)

BOD removal

		C	
According to the document Analy:	**Water temperature**	21	Same as air temp
Extrapolation by Veolia fondation	**Reference temperature**	20	Given by the ma
	Temperature coeficient for rate constant	1.06	Given by the ma
		per day	
	Rate at reference temperature	1.104	Given by the ma
	Rate constant at temperature	1.17	
According to the document Analy:	**Porosity**	0.43	
		mg/l	
According to the document Analy:	**Influent concentration**	400	
	Expected effluent concentration	3.189	
	Current effluent concentration	400	
	Reduction of BOD5 expected	99.2%	
	Reduction obtained	2%	

Ce = Ci * (0.1058 + 0.001 * HLR)

HLR = 100*Q/A

	TSS removal	
		cm/d
According to the document Analy:	**Hydraulic loading rate**	4.28
		mg/l
	Influent concentration	60
	Expected effluent concentration	7
	Current effluent concentration	600
According to the document Analy:	**TSS expected reduction**	89%
	Current reduction	Increase

According to the document Analysis STS

d for BOD5)

Ce = Ci * exp (-A*Kt*y*n/Q)

Knh = 0.01854 + 0.3922 * (rz)^2.6077

Kt = Knh * θr^(Tw-Tr)

	NH4 removal		
		C	
According to the document Analy:	**Water temperature**	21	
	Reference temperature	20	Given by the m
mean temperature for January	**Temperature coeficient for rate constant**	1.048	Given by the m
	Depth of bed occupied by root zone	0	No plants, in %
		per day	
According to the document Analy:	**Nitrification rate constant**	0.019	
	Rate constant at temperature	0.019	
According to the document Analy:	**Porosity**	0.43	
		mg/l	
	Influent concentration	500	
	Expected effluent concentration	461	

Current effluent concentration	400
Ammonia expected reduction	8%
Current reduction	16%

Ce = Ci * exp (-A*Kt*y*n/Q)

Kt = Kr * θr^(Tw-Tr)

NO3 removal		
	C	
Water temperature	21	
Reference temperature	20	Given by the m
Temperature coeficient for rate constant	1.15	Given by the m
	per day	
Rate at reference temperature	1.00	Given by the m
Rate constant at temperature	1.15	
Porosity	0.43	
	mg/l	
Influent concentration	150	From the Analy
Expected effluent concentration	1.3003	
Current effluent concentration	150	From the Analy
Nitrates expected reduction	99.1332%	
Current reduction	Increase	From the Analy

For graded gravels a value of Kf of 1 x 10-3 to 3 x 10-3 m/s is normally chosen. Here 2 x 10-3 m/s was chosen

In most cases, a dH/ds of 1% is used - not measured

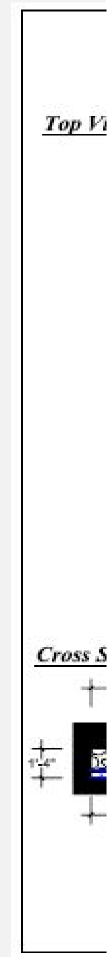
;, TSS and NO3

According to De Bonis report

For graded gravels a value of Kf of 1 x 10-3 to 3 x 10-3 m/s is normally chosen. Here 2 x 10-3 m/s was chosen

In most cases, a dH/ds of 1% is used

Vaste Stabilization Ponds and Constructed Wetlands Design Manual



Waste Stabilization Ponds and Constructed Wetlands Desi
Kadlec and Knight design method

$$Ce = C + (Ci - C) * \exp(-A * k / (365 * Q))$$

BOD removal

perature
nual
nual
nual

	m/year
First order aerial rate constant	180
	mg/l
Influent concentration	400
Background pollutant concentration	25
Expected effluent concentration	25
Current effluent concentration	400
Reduction of BOD5 expected	94%
Reduction obtained	2%

Given by the manual

Ce = C + (Ci - C) * exp(-A * k / (365 * Q))

TSS removal	
	m/year
First order aerial rate constant	1000
	mg/l
Influent concentration	60
Background pollutant concentration	12
Expected effluent concentration	12
Current effluent concentration	600
TSS expected reduction	81%
Current reduction	Increase

Given by the manual

Ce = C + (Ci - C) * exp(-A * k / (365 * Q))

NH4 removal	
	m/year
First order aerial rate constant	34
	mg/l
Influent concentration	500
Background pollutant concentration	0
Expected effluent concentration	57
Current effluent concentration	400
Ammonia expected reduction	88.7%
Current reduction	16%

Given by the manual
Given by the manual

anual
anual

Ce = C + (Ci - C) * exp(-A * k / (365 * Q))

NO3 removal		
	m/year	
First order aerial rate constant	50	Given by the manual
	mg/l	
Influent concentration	150	
Background pollutant concentration	0	Given by the manual
Expected effluent concentration	6.101	
Current effluent concentration	150	
Nitrates expected reduction	95.93%	
Current reduction	Increase	

anual

anual

anual

ses STS document

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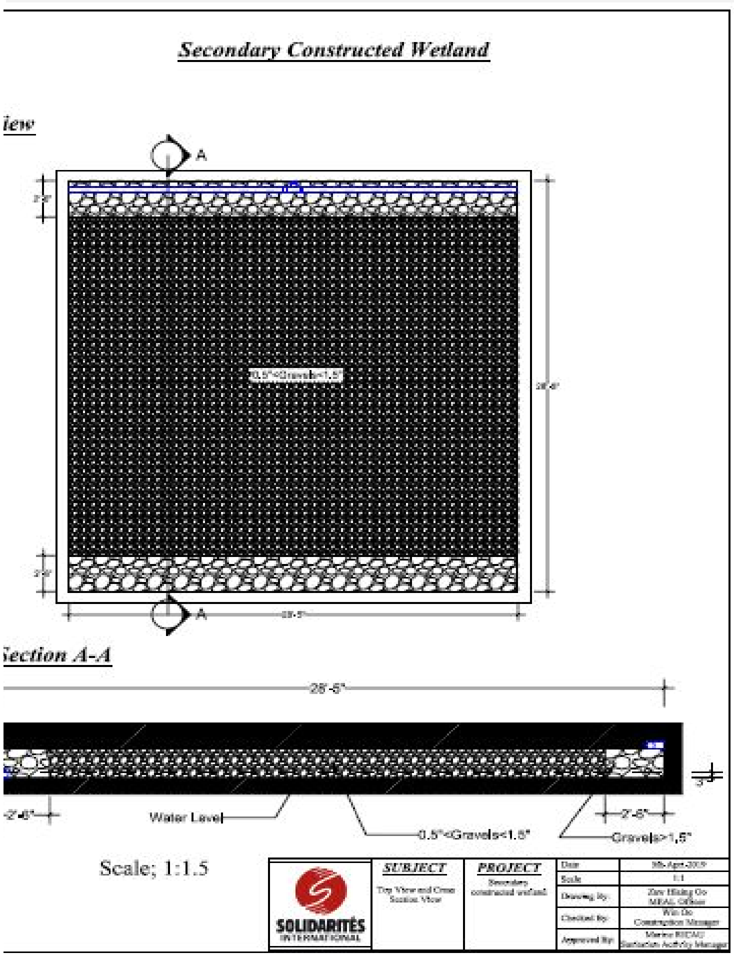
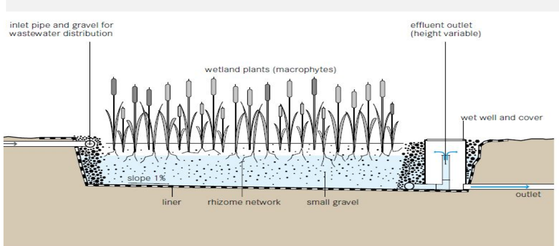
ses STS document


Secondary Constructed Wetland
iew
A
0.5"<Gravels<1.5"
A
Section A-A
28'-6"
Water Level
0.5"<Gravels<1.5"
2'-6"
Gravels>1,5"
Scale; 1:1.5
SOLIDARITÉS
INTERNATIONAL
SUBJECT
Top View and Cross Section View
PROJECT
Secondary constructed wetland
Date
Scale
1:1
Drawing By:
Checked By:
Approved By:


inlet pipe and gravel for
wastewater distribution
effluent outlet
(height variable)
wetland plants (macrophytes)
wet well and cover
slope 1%
liner
rhizome network
small gravel
outlet

Infiltration trenches

Number of trenches	5			Design from the memory of STS st
	ft	**in**	**m**	
L	20	0	6.1	
W	1	0	0.3	
H	1	0	0.3	
	ft2		**m2**	
Area of infiltration	400.0		37.2	
	ft/h		**mm/h**	
Infiltration rate of the ground	0.2		61.2	Following an infiltration test cond
	ft3/h		**m3/h**	
Infiltration rate of the trenches	80.3		2.3	
			m3/d	
Average inlet flow			3.17	

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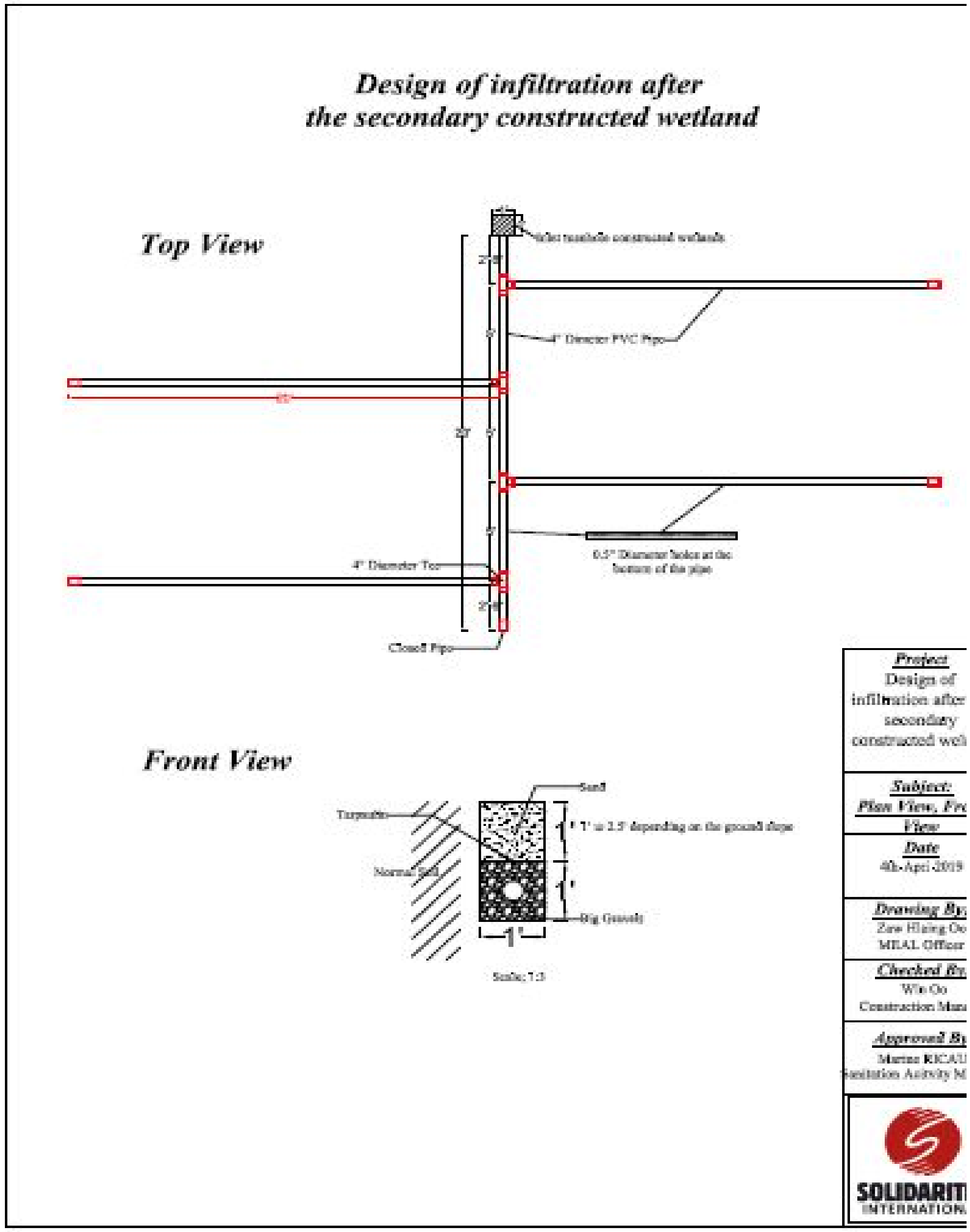

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AL

Sludge storage

Number of storage unit	5		
	ft	in	m
L	7	7	2.3
W	15	1	4.6
Heff	3	1	0.9
	ft3		m3
Volume per case	352.7		10.0
Total Volume	1763.4		49.9

Design calculations

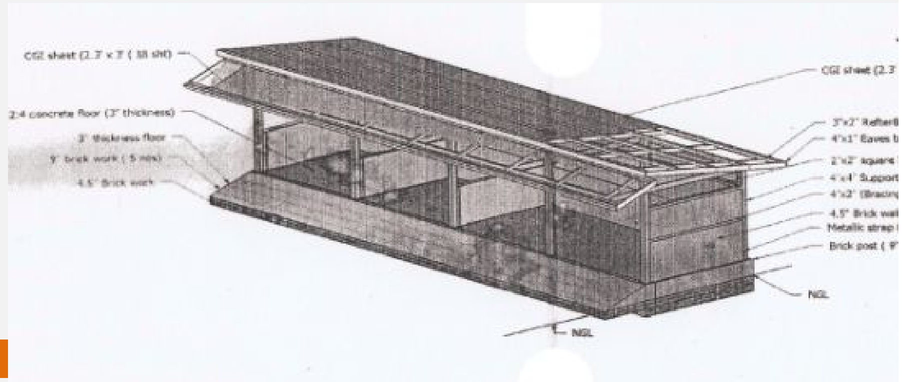
Retention time	
Number of unit for dried sludge	4
Number of beds desludged per empty case	3.4
Number of case filled per year	38.1
	times/y
Frequency of filling per case per year	9.5
	Months
Retention time	1.3

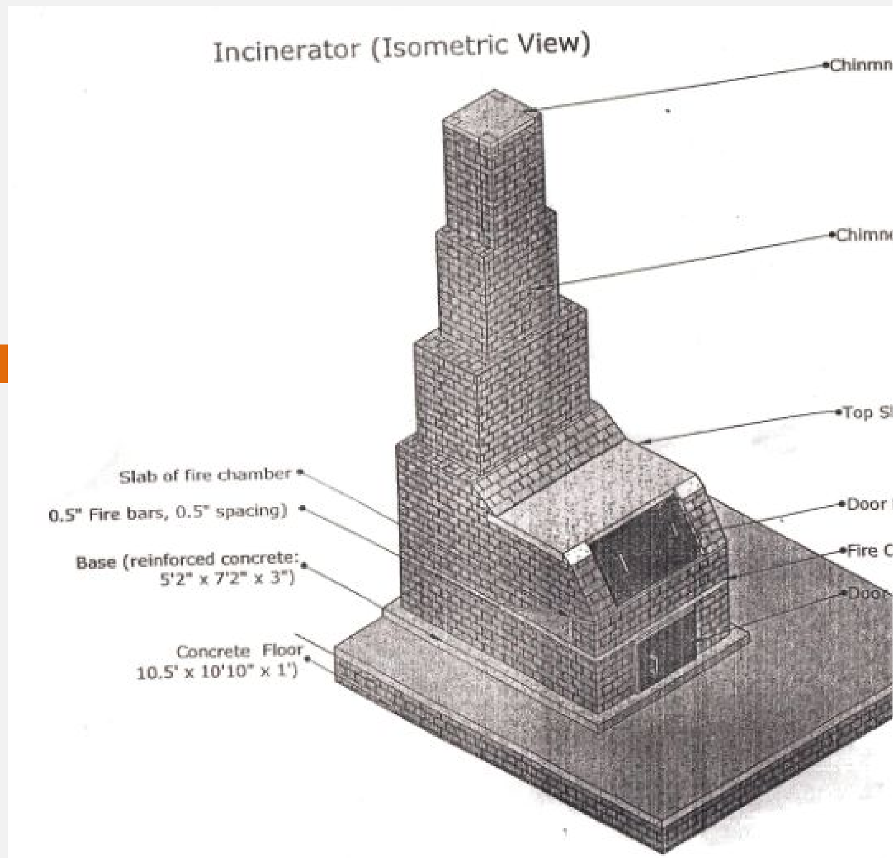
Operation

Volume of sludge to incinerate		
	m3/y	
Newly extracted sludge	380.0	
	g/l	
Siccity of dryed sludge when incinerating	600	According to the document Analys
	m3/y	
Dried sludge after retention time flow per year	158.3	
	d/week	
Number of incineration day per week	6	
	m3/d	
Sludge volume to be incinerated	0.507	
	buck/d	
Number of buckets to be incinerated	26	

Volume of ashes to store	
Volume reduction after incineration	78%
	m3/y
Volume of ashes to store	35
Number of unit for ashes	1
	m3
Volume of storage for ashes	10
	month

Time to fill the unit	3.4





is STS

Calculation of volume reduction after incineration	
	L
Volume of a bucket for sludge	19.5
Number of buckets incinerated	15
Volume of sludge incinerated	292.5
Volume of a bucket for ashes	13
Number of ashes buckets remaining	5
Volume of ashes remaining	65

Volume reduction	78%

' x 18 sht)

& Pullin
board
Iron
t timber(10 nos)
g)
l (48' x 5')
(1.5"x1.5")
7'x9"x2")

ey Lid (Reinforced concrete :1.5' x 1.9' x 2")

ey: 9' x (4.5" thick brick wall)

lab (Reinforced concrete : 2.5' x 4.5' x 3")

for Loading refuse (iron :2'10" x 1'8" x 2")

Chamber slab (reinforced concrete : 3'3" x 4.5' x 3")

of fire chamber (iron : 1'10" x 1'4" x 2")