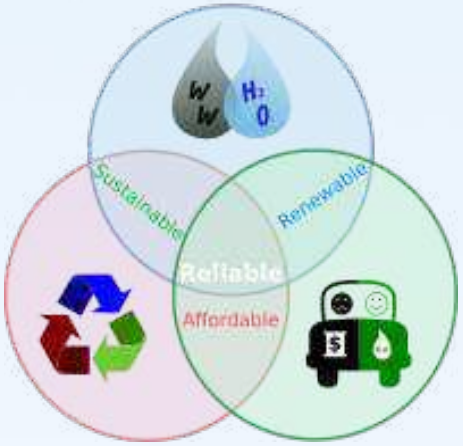
Virtuous Sustainable and Financial Water Cycle



WASTEWATER PURIFICATION

A Zero Emission Technology Proposal

Sergio Arturo Constante Castro

1. **Paradigm Change**

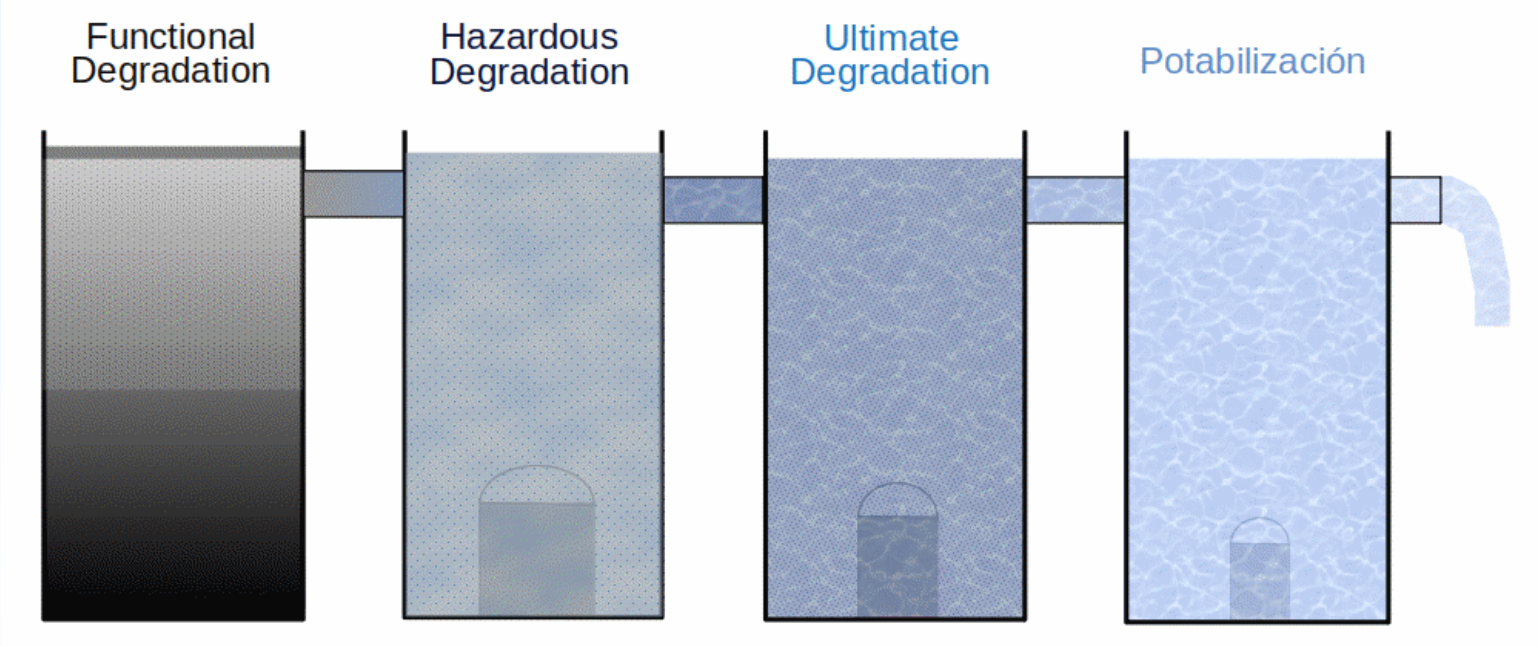
HUMAN GENERATION OF WASTEWATER HAS EXCEDED EARTH'S NATURAL CAPACITY

SHOULD BE OUR HUMAN PRIORITARY TO RESTORE ITS NATURAL CONDITION

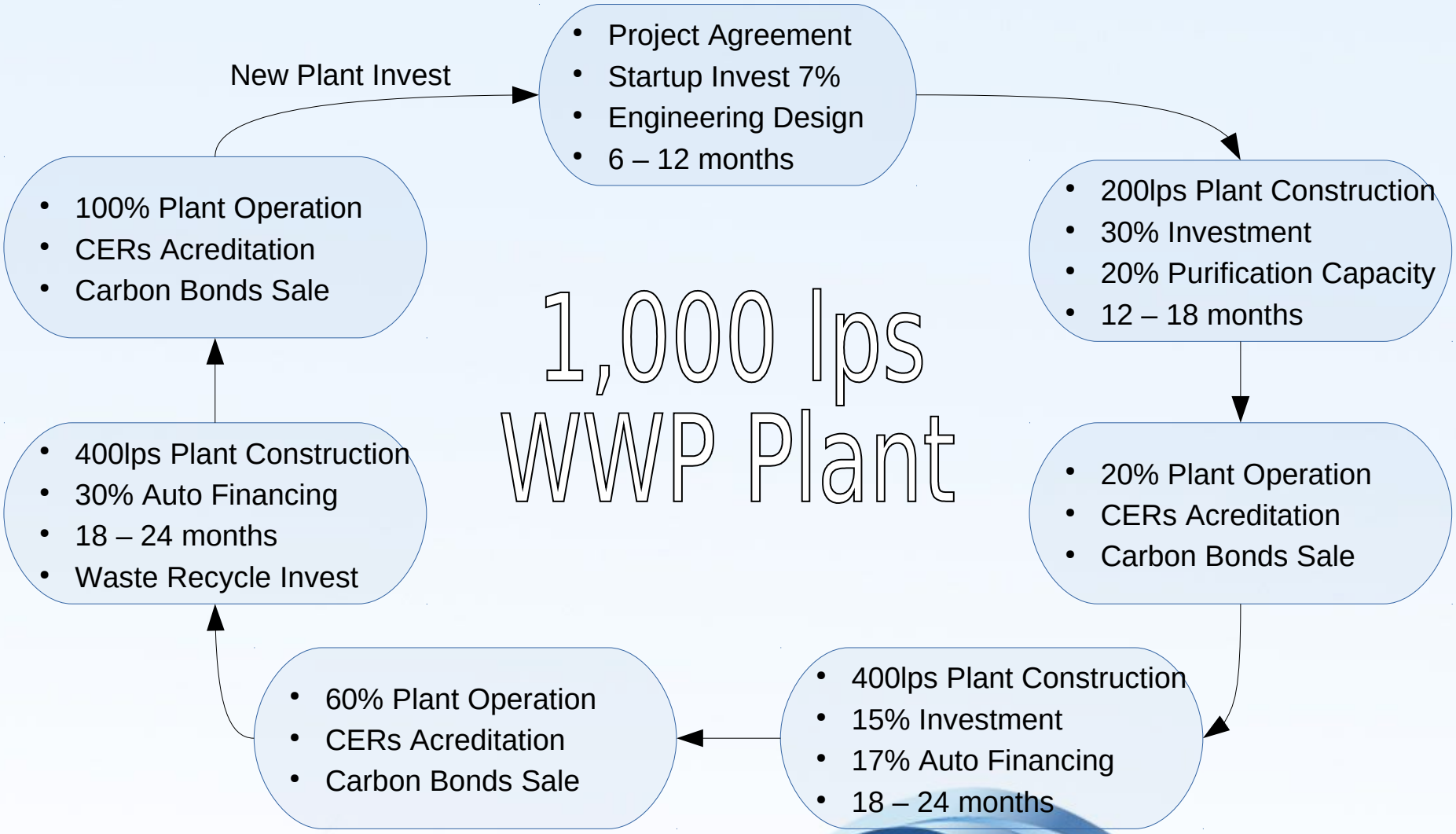
2. **Proposal of Wastewater Purification**

Consists in the purification of any kind and flow of wastewater into potable water at very low operating costs using only low power renewable energy with 95% efficiency and not any volatile neither solid contaminating emissions.

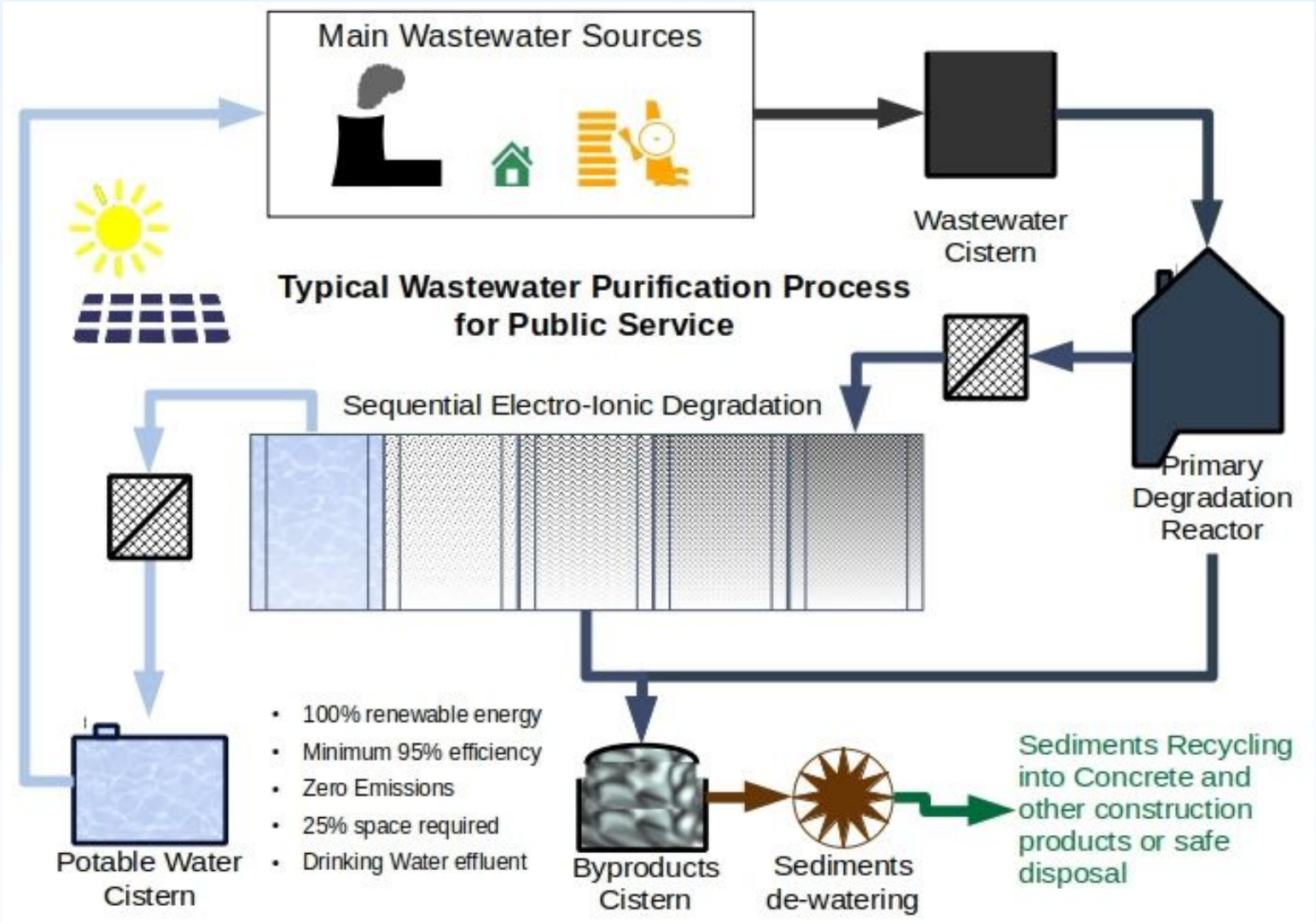
Financial Catalization is got through water service fees, Carbon Bonds sale, recycling and processing solid waste into concrete or construction products.



3. **Virtuous Financial-Sustainable Circle**



4. **Wastewater Purification Process**



5. **Purification and Treatment AOP Plants**

Chiapas State 1,100 m³/día

Mexico State 100 m³/día

Mexico City 100 m³/día

O&G Refinery WWTP

Fabric Plant 5,400 m³/día

Offices 75 m³/día

Note: with permision of expartner FI-EGC

6. **Performance Comparison**

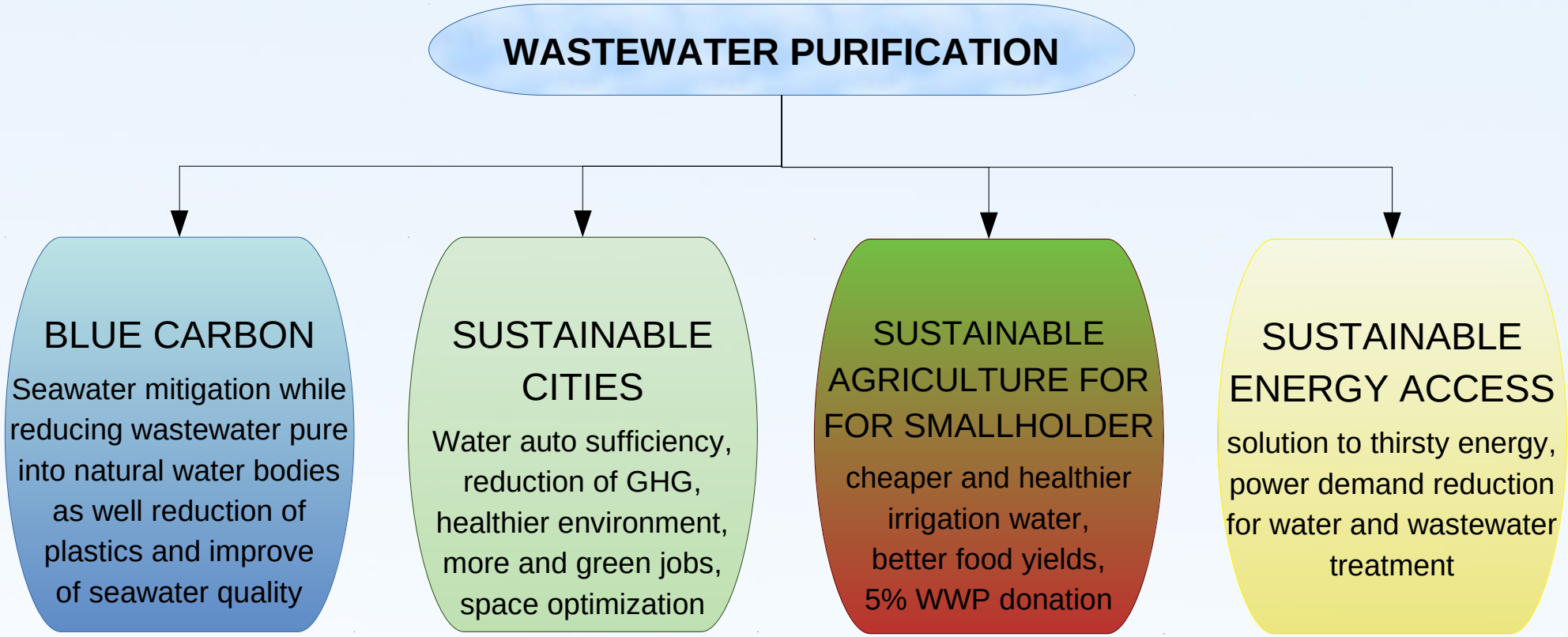
PARAMETER	CONVENTIONAL WASTEWATER TREATMENT PLANT	ADVANCED OXIDATION TREATMENT
INFLUENT WASTEWATER QUALITY	CONSTRAINED TO HIGH CONTAMINATED < 800 DBO	ANY CONTAMINATION DEGREE EVEN O&G, PATHOGENIC OR RADIOACTIVE
EFFLUENT QUALITY	JUST TREATED FOR IRRIGATION	POTABLE WATER
POWER CONSUMPTION	12.0 kW/m3	1.4 kW/m3 – RENEWABLE ENERGY
REACTIVE DOSING	CHEMICAL AND BIOLOGICAL	NOT REQUIRED
OPERATING & MAINTENANCE COSTS	~$55,000 USDLS/YEARLY	< $20,000 USDLS/YEAR
INVESTMENT COSTS (US$/LPS)	$35,000 a $75,000	$150,000 a $300,000
REQUIRED AREA (m2/LPS)	100 – 120 m2/LPS	18 a 36 m2/LPS
FACILITIES CONFIGURATION	HORIZONTAL	HORIZONTAL AND VERTICAL
AUTOMATION LEVEL	AUTOMATED	FULLY AUTOMATED
BY-PRODUCTS QUALITY	HAZARDOUS SLUDGE	RECYCLABLE INERT SEDIMENTS
BY-PRODUCTS TREATMENT COSTS	TOO HIGH	NOT REQUIRED
PLANT AVERAGE LIFE TIME	25 YEARS	50 YEARS
HEALTHY	PESTILENT AND NOISY	NOT ODORS AND NEGLECTED NOISE
GREEN HOUSE GASES (TON CO2e/LPS)	0.72 TON CO2e/LPS aprox.	ZERO EMISSIONS

7. **Municipality Investment Comparison (1 lps)**

INVESTMENT CONCEPT (USDls)	WASTEWATER TREATMENT PLANT	WW PURIFICATION PLANT
Plant Construction Investment	$ 25,000	$ 80,000
Annual Operating Costs (realistic water standard costs)	~ $ 100,000	~ $ 40,000
Investment after Second year	~ $ 225,000	~ $ 160,000
Cost of each m^3 treated	$ 3.17	$ 1.27

Average Estimated Unitary Prices for 1 m^3/sec Plant Capacity

8. Impact on Key Targets



9. **Lab Criteria Matching**

ACTIONABILITY

Entities: governments at all levels, UN agencies, communities, industry, investors.

Implementation Pathway: see virtuous F-S circle

Implementation Challenges: authority corruption none appropriate legal project agreements

INNOVATION

Address Financial Barriers: 50% less direct Investment required than conventional techs

Financial Efficiency: Carbon Bonds auto-financing Very low operating costs, short to medium term BEP amortization

CATALYTIC POTENTIAL

Private Finance Mobilization: very attractive for private sector, minimum technical risks

Scalable / Replicable: ful financially scalable; physical, management and operatively replicable

Sustainable Benefits: full achievement of SDG6 more Water Jobs, Zero Emission technology

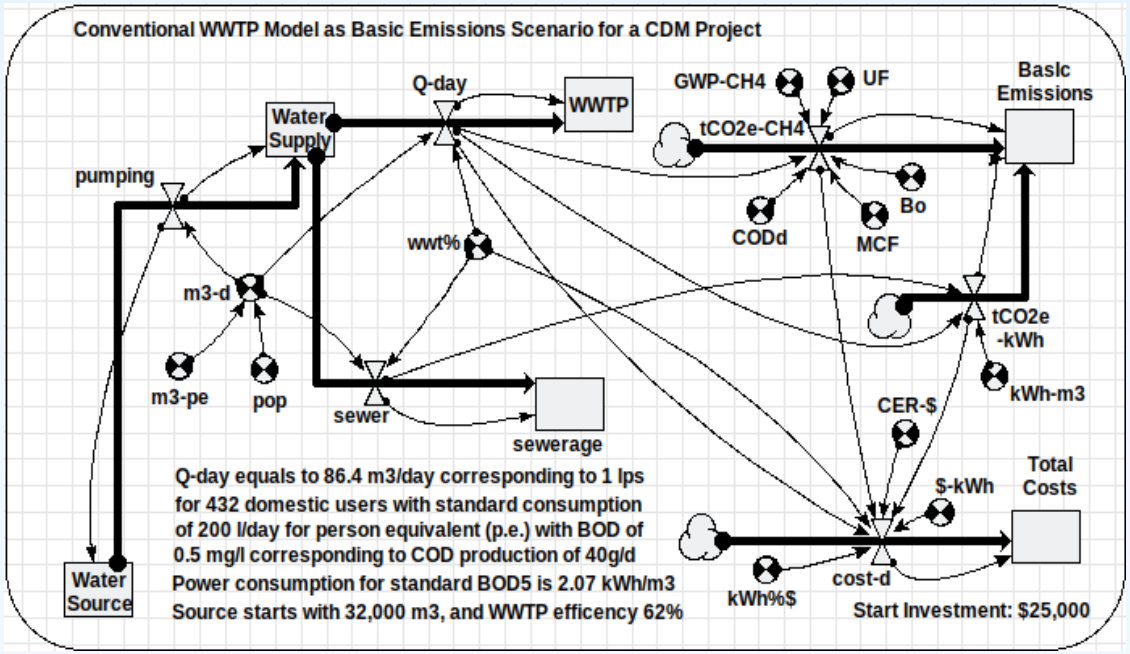
FINANCIAL SUSTAINABILITY

Out of Public Financial Strategy: highly profitable for private sector like industrial and commercial

Market Viability: mostly for high water consumption industry, but also for contaminating ones

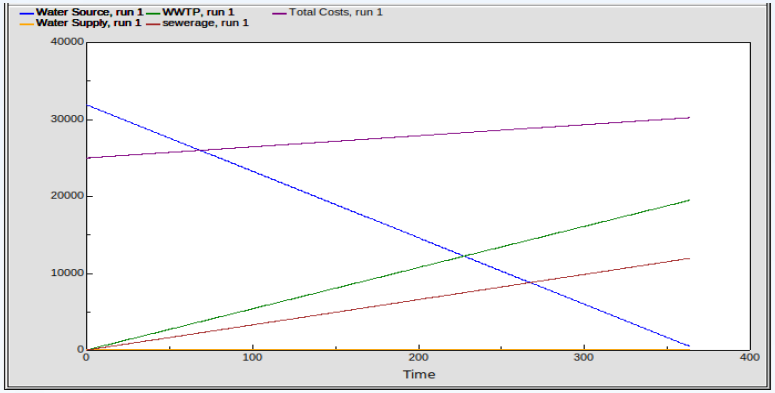
Challenges & Mitigation: water authority barriers, water and environment standards mandatory

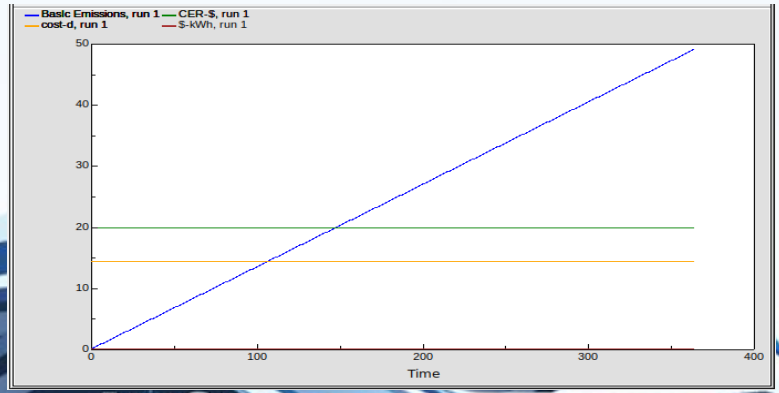
10. **Base Wastewater Model for 1 lps WWTP**



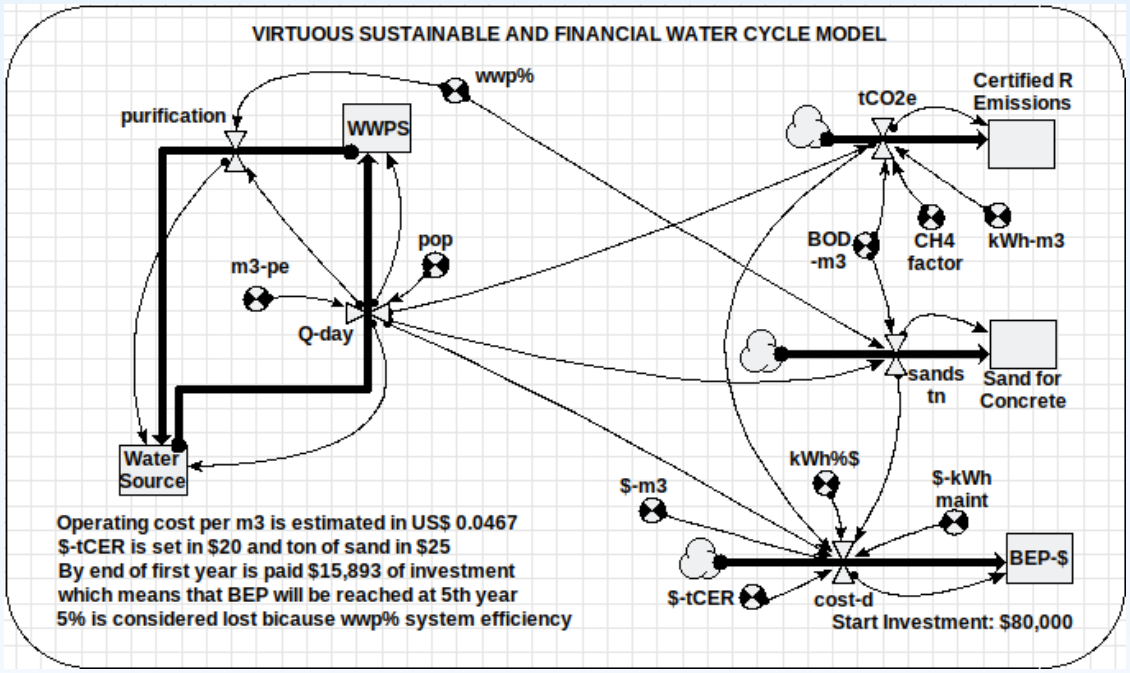
- This simulation is based on Technical Note No 116 on iadb.org about CDM methodology for WWTP CER projects.
- publications.iadb.org/handle/11319/5506
- Because the simulation software is constrained to limited equations, both were simplified.
- Water Source starts with 32,000 m3 as WWPS model, but WWTP one ends empty after one year.
- Daily costs (cost-d) are investment + power costs – CER bonds.

Time \ Name	Water Source	Water Supply	WWTP	sewerage	Basic Emissions	cost-d	Total Costs
345	2105.6000	86.4000	18534.5280	11359.8720	46.6578	14.3983	29981.8011
346	2019.2000	86.4000	18588.0960	11392.7040	46.7927	14.3983	29996.1993
347	1932.8000	86.4000	18641.6640	11425.5360	46.9275	14.3983	30010.5976
348	1846.4000	86.4000	18695.2320	11458.3680	47.0624	14.3983	30024.9959
349	1760.0000	86.4000	18748.8000	11491.2000	47.1972	14.3983	30039.3941
350	1673.6000	86.4000	18802.3680	11524.0320	47.3321	14.3983	30053.7924
351	1587.2000	86.4000	18855.9360	11556.8640	47.4669	14.3983	30068.1907
352	1500.8000	86.4000	18909.5040	11589.6960	47.6018	14.3983	30082.5889
353	1414.4000	86.4000	18963.0720	11622.5280	47.7366	14.3983	30096.9872
354	1328.0000	86.4000	19016.6400	11655.3600	47.8715	14.3983	30111.3855
355	1241.6000	86.4000	19070.2080	11688.1920	48.0063	14.3983	30125.7838
356	1155.2000	86.4000	19123.7760	11721.0240	48.1412	14.3983	30140.1820
357	1068.8000	86.4000	19177.3440	11753.8560	48.2760	14.3983	30154.5803
358	982.4000	86.4000	19230.9120	11786.6880	48.4109	14.3983	30168.9786
359	896.0000	86.4000	19284.4800	11819.5200	48.5457	14.3983	30183.3768
360	809.6000	86.4000	19338.0480	11852.3520	48.6806	14.3983	30197.7751
361	723.2000	86.4000	19391.6160	11885.1840	48.8154	14.3983	30212.1734
362	636.8000	86.4000	19445.1840	11918.0160	48.9503	14.3983	30226.5716
363	550.4000	86.4000	19498.7520	11950.8480	49.0851	14.3983	30240.9699
364	464.0000	86.4000	19552.3200	11983.6800	49.2200	14.3983	30255.3682





11. 1 lps Model · Wastewater CDM Project

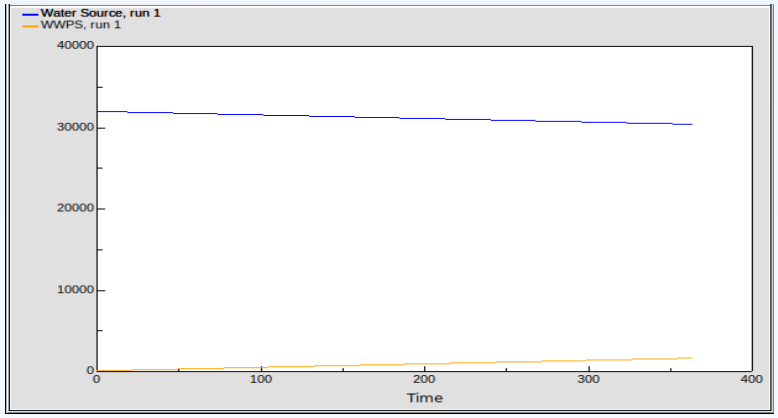


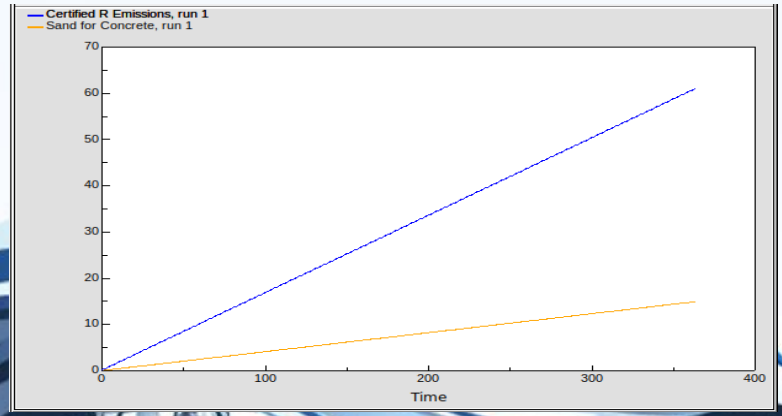
✔The model simulates unitary plant 1 liter per sec, so 432 people, 0.2 m^3/d, each m^3 price US$0.50

✔GHG reduction is full due is supplied with 100% supplied with renewable energy like PV.

✔Byproduct are mineralized sands to be sold for concrete production or construction products.

✔Another savings are not considered like reduction of well pumping, N2O emissions, industrial WW's.

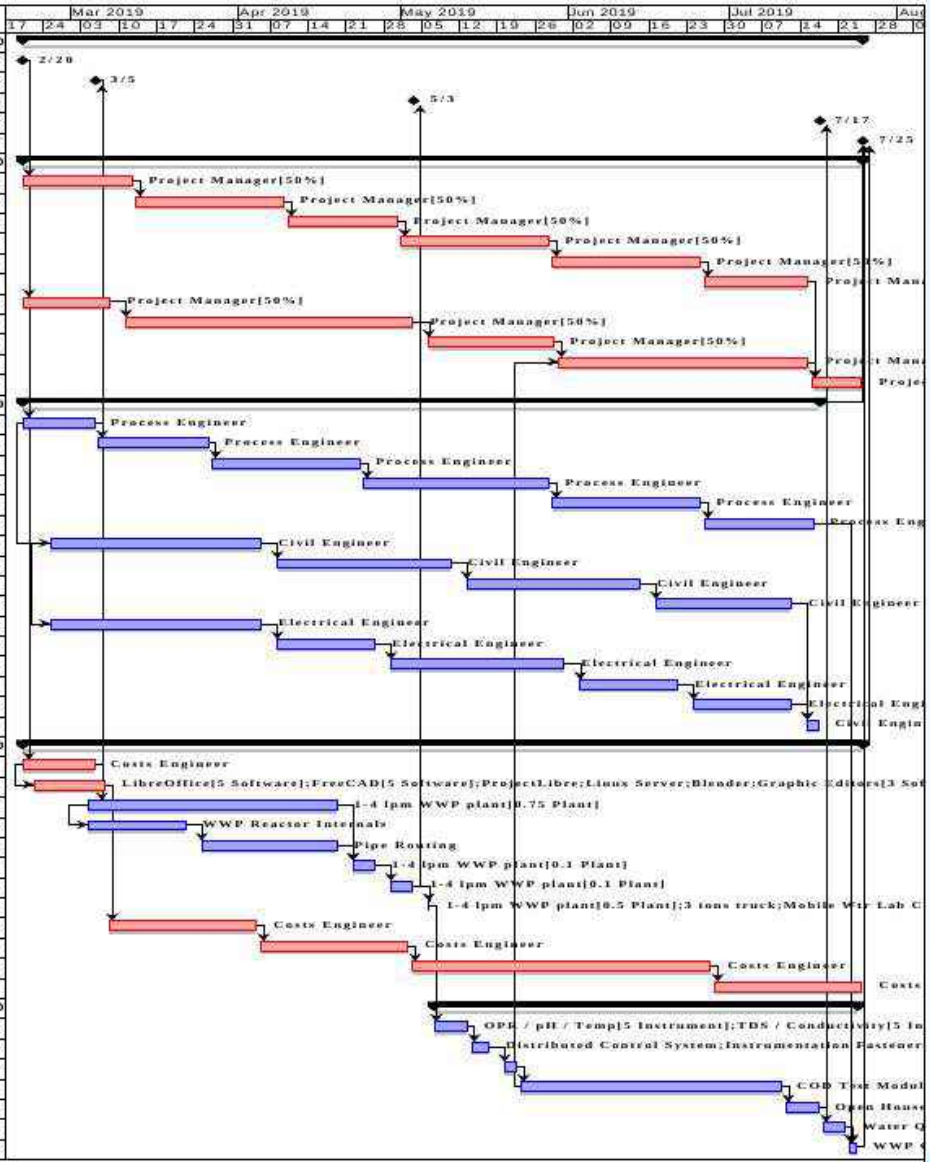




Time \ Name	Water Source	WWPS	Certified R Emissions	Sand for Concrete	cost-d	BEP-$
345	30505.2800	1576.8000	57.9597	14.1998	43.5443	-64933.6812
346	30500.9600	1581.1200	58.1273	14.2409	43.5443	-64890.1369
347	30496.6400	1585.4400	58.2948	14.2819	43.5443	-64846.5926
348	30492.3200	1589.7600	58.4623	14.3230	43.5443	-64803.0484
349	30488.0000	1594.0800	58.6298	14.3640	43.5443	-64759.5041
350	30483.6800	1598.4000	58.7973	14.4050	43.5443	-64715.9598
351	30479.3600	1602.7200	58.9648	14.4461	43.5443	-64672.4155
352	30475.0400	1607.0400	59.1323	14.4871	43.5443	-64628.8713
353	30470.7200	1611.3600	59.2999	14.5282	43.5443	-64585.3270
354	30466.4000	1615.6800	59.4674	14.5692	43.5443	-64541.7827
355	30462.0800	1620.0000	59.6349	14.6102	43.5443	-64498.2384
356	30457.7600	1624.3200	59.8024	14.6513	43.5443	-64454.6942
357	30453.4400	1628.6400	59.9699	14.6923	43.5443	-64411.1499
358	30449.1200	1632.9600	60.1374	14.7334	43.5443	-64367.6056
359	30444.8000	1637.2800	60.3049	14.7744	43.5443	-64324.0613
360	30440.4800	1641.6000	60.4724	14.8154	43.5443	-64280.5171
361	30436.1600	1645.9200	60.6400	14.8565	43.5443	-64236.9728
362	30431.8400	1650.2400	60.8075	14.8975	43.5443	-64193.4285
363	30427.5200	1654.5600	60.9750	14.9386	43.5443	-64149.8842
364	30423.2000	1658.8800	61.1425	14.9796	43.5443	-64106.3400

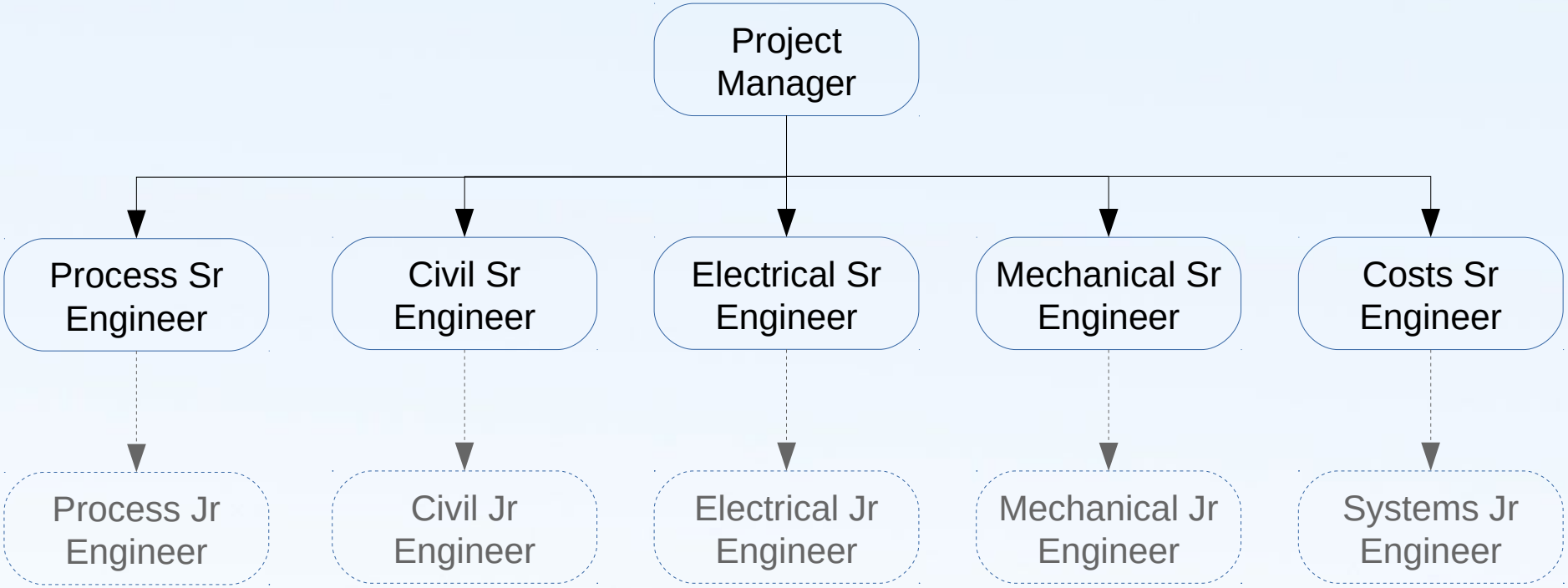
12. **Project Schedule for 2nd Stage**

	Name	Duration	Start	Finish	Cost
1	**Wastewater Purification Project**	**112 days**	**2/20/19 ...**	**7/25/19 5...**	**$222121.00**
2	CPI Lab Award	0 days	2/20/19 8...	2/20/19 8:...	$0.00
3	AFC Drawings	0 days	3/5/19 5:...	3/5/19 5:0...	$0.00
4	WWP Plant Factory Test	0 days	5/3/19 5:...	5/3/19 5:0...	$0.00
5	WW Purification Certification	0 days	7/17/19 5...	7/17/19 5:...	$0.00
6	WWP Final Project Report	0 days	7/25/19 5...	7/25/19 5:...	$0.00
7	**MANAGEMENT**	**112 days**	**2/20/19 ...**	**7/25/19 5...**	**$22400.00**
8	Intellectual Proporerty Applications	15 days	2/20/19 8...	3/12/19 5:...	$1500.00
9	Detailded Instrument Mechanics	20 days	3/13/19 8...	4/9/19 5:0...	$2000.00
10	Assessment of Inovative Aspects	15 days	4/10/19 8...	4/30/19 5:...	$1500.00
11	Implementation Contex Analisis	20 days	5/1/19 8:...	5/28/19 5:...	$2000.00
12	Financial Sustainability Assessment	20 days	5/29/19 8...	6/25/19 5:...	$2000.00
13	V Sustain & Financial Water Model	14 days	6/26/19 8...	7/15/19 5:...	$1400.00
14	Main Suppliers Assessment	13 days	2/20/19 8...	3/8/19 5:0...	$1300.00
15	Engineering & Manuf Supervision	40 days	3/11/19 8...	5/3/19 5:0...	$4000.00
16	Unitary Plant Assembly Supervision	18 days	5/6/19 8:...	5/29/19 5:...	$1800.00
17	WWP Tests Management	33 days	5/30/19 8...	7/15/19 5:...	$3300.00
18	WWP Implementation Planning	8 days	7/16/19 8...	7/25/19 5:...	$1600.00
19	**100 lps DETAILED ENGINEERING**	**106 days**	**2/20/19 ...**	**7/17/19 5...**	**$45216.00**
20	Unitary Processes Calculation	10 days	2/20/19 8...	3/5/19 5:0...	$1440.00
21	PFD, P&ID, I&C, Control Philosophy	15 days	3/6/19 8:...	3/26/19 5:...	$2160.00
22	Piping Engineering Design	20 days	3/27/19 8...	4/23/19 5:...	$2880.00
23	WWP Operations Manual	25 days	4/24/19 8...	5/28/19 5:...	$3600.00
24	Laboratory Water Analysis Protocols	20 days	5/29/19 8...	6/25/19 5:...	$2880.00
25	WWP CDM/CER Development	15 days	6/26/19 8...	7/16/19 5:...	$2160.00
26	Process Concrete Structure Design	30 days	2/25/19 8...	4/5/19 5:0...	$4320.00
27	Plant Renewable Structure Design	25 days	4/8/19 8:...	5/10/19 5:...	$3600.00
28	1 m3/s Plant Building Design	25 days	5/13/19 8...	6/14/19 5:...	$3600.00
29	Outdoor Facilities Design	20 days	6/17/19 8...	7/12/19 5:...	$2880.00
30	Electrical Power Systems Design	30 days	2/25/19 8...	4/5/19 5:0...	$4320.00
31	Process Power Sypply Design	15 days	4/8/19 8:...	4/26/19 5:...	$2160.00
32	Renewable Energy System Design	25 days	4/29/19 8...	5/31/19 5:...	$3600.00
33	Lighting Plant Design	15 days	6/3/19 8:...	6/21/19 5:...	$2160.00
34	Safety and Alarm Systems Design	15 days	6/24/19 8...	7/12/19 5:...	$2160.00
35	3D Plant Design Integration	3 days	7/15/19 8...	7/17/19 5:...	$1296.00
36	**PROCUREMENT (Unitary Plant)**	**112 days**	**2/20/19 ...**	**7/25/19 5...**	**$81650.00**
37	Procurement Negotiations	10 days	2/20/19 8...	3/5/19 5:0...	$1200.00
38	Stationary Supply	10 days	2/22/19 8...	3/7/19 5:0...	$3950.00
39	Plant Vessels Manufacture	35 days	3/4/19 8:...	4/19/19 5:...	$22500.00
40	Treatment Equipment Manuf	15 days	3/4/19 8:...	3/22/19 5:...	$1000.00
41	Piping Routings Fabrication	20 days	3/25/19 8...	4/19/19 5:...	$2500.00
42	Unitary Plant Assembly	5 days	4/22/19 8...	4/26/19 5:...	$3000.00
43	Equipment Factory Aceptance Tests	5 days	4/29/19 8...	5/3/19 5:0...	$3000.00
44	WWP Plant Transportation Onsite	1 day	5/6/19 8:...	5/6/19 5:0...	$32500.00
45	Procurement Market Research	20 days	3/8/19 8:...	4/4/19 5:0...	$2400.00
46	1 m3/s Plant Concepts Catallog	20 days	4/5/19 8:...	5/2/19 5:0...	$2400.00
47	1 m3/s Plant Unitary Prices	40 days	5/3/19 8:...	6/27/19 5:...	$4800.00
48	Project Execution Unitary Prices	20 days	6/28/19 8...	7/25/19 5:...	$2400.00
49	**EXECUTION**	**57 days**	**5/7/19 8:...**	**7/24/19 5...**	**$72855.00**
50	Instrumentation & Control Assy	5 days	5/7/19 8:...	5/13/19 5:...	$10645.00
51	Renewable & Power Supply Assy	4 days	5/14/19 8...	5/17/19 5:...	$6250.00
52	WWP Equipment Setup	3 days	5/20/19 8...	5/22/19 5:...	$0.00
53	WW Potabilization Test	35 days	5/23/19 8...	7/10/19 5:...	$19350.00
54	WWP Demostration Open House	5 days	7/11/19 8...	7/17/19 5:...	$27500.00
55	WWP Process Certification	3 days	7/18/19 8...	7/22/19 5:...	$4110.00
56	WWP CDM/CER Certification App	2 days	7/23/19 8...	7/24/19 5:...	$5000.00



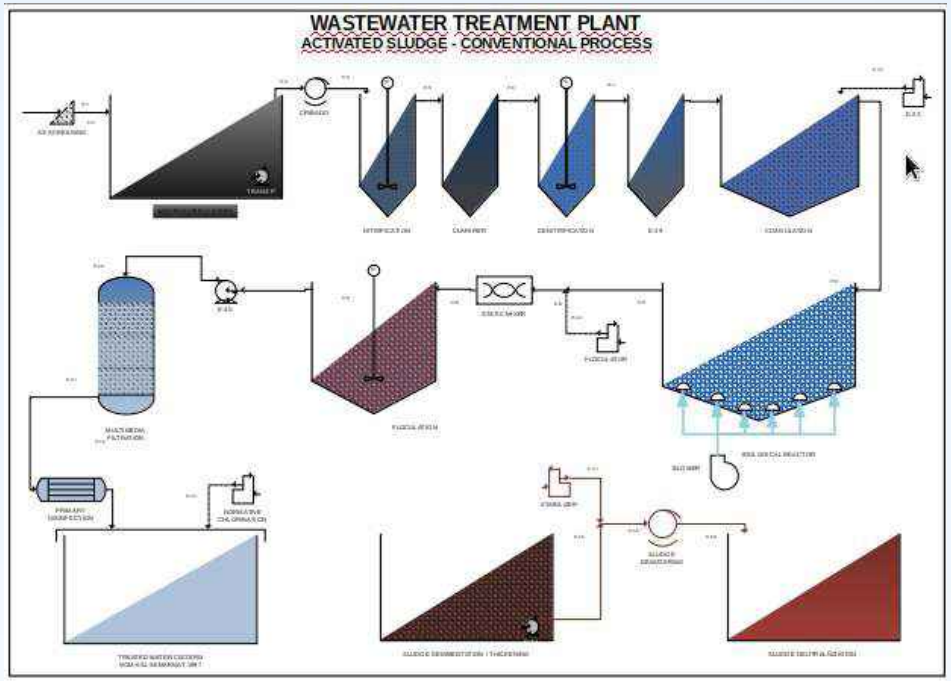
WWP Proposal CPI Lab - page1

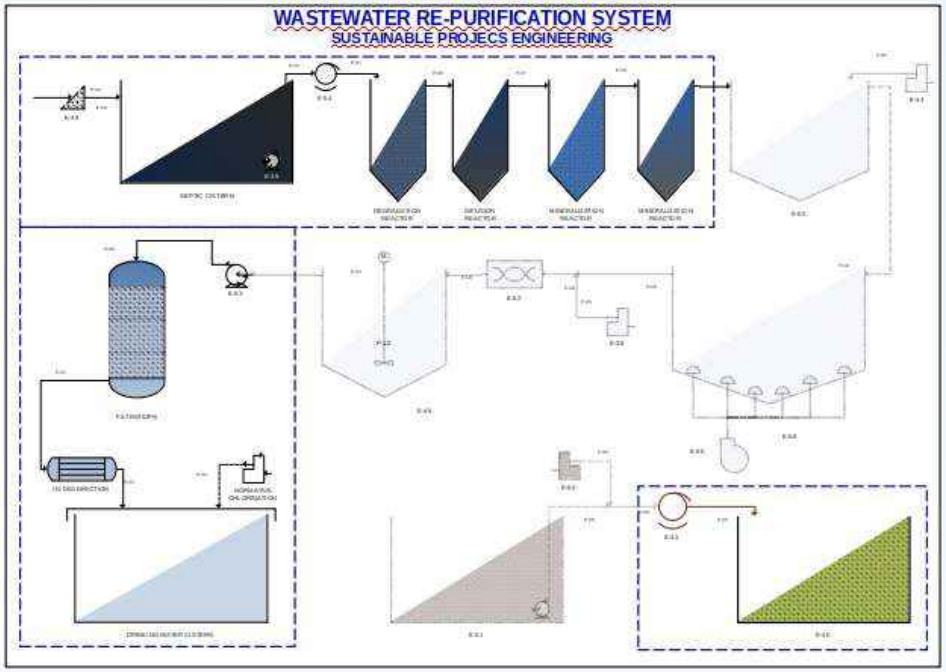
13. **Required Team for 2nd Stage**



This third staff level will depend of available financing resources

14. **Comparison between WWTP vs WWPP**





WWPS DIFERENCES:

- Non Rotating Equipment
- Not Blowing System – none Bio-solids
- Non Bio-solids – Less CO_2e
- ⅓ to 1/5 of required space

15. **Conventional WWTP & Disadvantages**

It generates Pestilent Odors (VOC) reaching 10 km around and being infection focus

Treated Byproducts disposal area after 3 years operation at 40% capacity.

Bio Digesters burn methane,also CO_2 producers

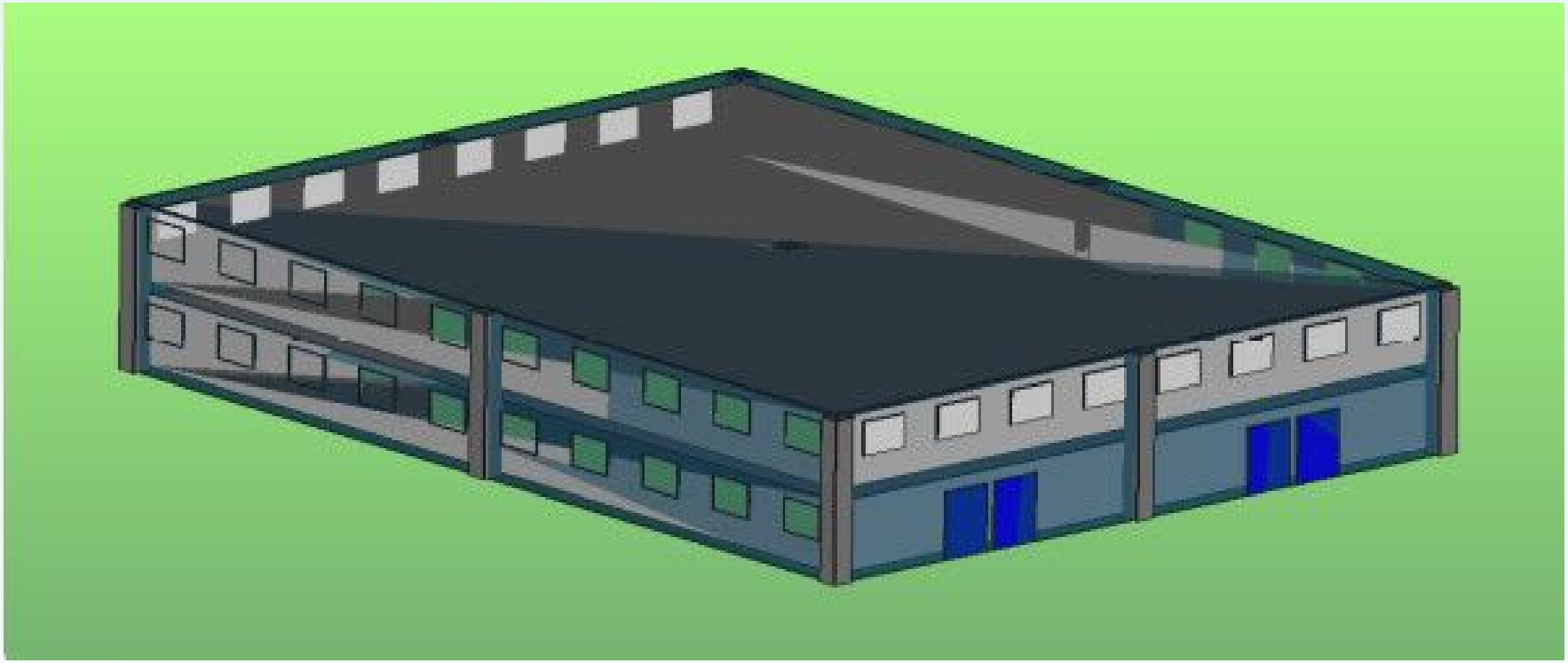
Actually PTAR just operates at 40% of its full capacity (2018)

De/Nitrification generators emiters of N_2O

Coagulators generate methane, and Sand Removers are CO_2 emissions

Atotonilco's 23 m^3/seg WWTP 2014

16. **Conceptual WWPS Plant**



Conceptual Wastewater Purification Plant for 1 m^3/s; 25,000 m^2.

Ingeniería en Proyectos Sustentables

Zero Emission Technologies

Wastewater Purification System

Ing. Arturo Constante
arturo.k01@gmail.com
https://sites.google.com/view/inprosu-ze/inicio
+52 55 3155-9654