SMALL STANDART SUBIRRIGATION PLANT PROCESSING UNITS WITH PREFAB POTS

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SUMMARY:
Small subsurface flow plants of biological treatment, implement successful method of natural treatment of urban waste water. They meet the requirements of the cleaning of remote settlements and buildings, because they require minimal maintenance and almost zero operating costs. By the method of the root system they use, they combine the functions of the artificial wetland treatment systems and natural ground treatment systems. They meet the requirements of Directive 1991/271 / EEC of EE and the corresponding Greek specifications. They work with individual standard and prefab beds (basins) , which replace the function of a wetland in miniature. .The choice of aquatic plants is critical for proper operation and they create a small ecosystem, or a permanent garden. It is very simple and quick to install them. Construction costs are less than the corresponding conventional municipal waste treatment plants, and maintenance costs are minimal. Their costs are zero. They have a long life, and adapt perfectly into the natural landscape.

Keywords: Wetlands. Subsurface flow plants biological processing, Standard Small units. Prefabricated beds.

1. INTRODUCTION:

In recent years the need to observe the hygiene rules in dwellings not connected to domestic sewerage networks, imposed solutions of autonomous small urban waste water treatment plants. The autonomous units covering urban sewage requirements of remote areas or buildings should require minimal maintenance and operating costs. Artificial wetlands, is a method that ensures the processing and recycling of wastewater while ensuring the restoration of ecosystems. Artificial wetlands are increasingly used in recent years. They are a simple and effective solution for secondary and tertiary treatment of small settlements waste up to 2,000 residents. Small standard subsurface flow processing units implement successfully the method of natural treatment of urban sewage, while they clearly meet the requirements of regulation 1991/271 / EEC of EE and the relevant Greek provisions. It is easy to be designed because they are at standard sizes and their installation is fast because of their prefabricated individual elements. Their operation is complementary and they work as small ecosystem, because they create a permanent garden.

2. NATURAL AND ARTIFICIAL WETLANDS SYSTEMS

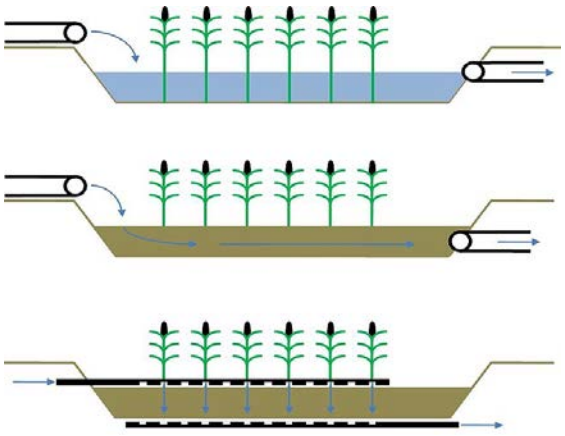
Natural wetlands act like a huge water purification unit. The artificial wetland systems operate with the characteristics of natural wetland. Artificial wetlands to urban and agricultural waste already find application in Europe and in the USA. In the E.U. under the law on small communities <2000 inhabitants the connection to the interconnected public or departmental drainage network is not compulsory. So alternatively the constructed wetlands can be used to dispose of wastewater in small

communities and therefore work in place of other conventional wastewater treatment processes.
In Greece although the climatic conditions are favourable, they are not used very often. So far they have applied some artificial wastewater treatment wetlands in North. Greece on a large scale, (Vassova, Madytos, Korestia, Gallikos, etc.)
(Figure 1.)

Figure 1. Aerial view of the artificial wetland in Gallikos River. Thessaloniki Prefecture [7.5]

Artificial wetlands processing systems unlike conventional systems, operated solely by renewable energy sources, RES. I.e, Solar and wind energy. Their components are aquatic plants that their organic plant action is instrumental in artificial wetland. The most important effects of plants in wastewater treatment is related to physical impacts of the plant tissue. The mark that the metabolism of plants (oxygen release etc.) affect wastewater treatment depends on the type of plant and system design. Primary doffer mechanisms in all of these systems are natural, i.e., flocculation, precipitation and adsorption. Artificial organic plant processing systems are divided into two categories: [7.8.]
Free Water Surface Treatment Wetlands-FWS and artificial wetlands subsurface flow Systems-SFS. Artificial wetlands subsurface flow are divided into two subcategories: Artificial subsurface flow systems-SFS HF, and artificial wetlands vertical flow (VF). [7.1.] **Figure 2.** . The main advantages of these systems are that they do not produce sludge products that require processing, no mechanical parts, and their operating costs are minimal. Basically it is an advanced form of wetland where the natural processes of the natural wetland are selected and applied to artificial.

A



B

C

Figure 2. Principle of artificial wetlands. A:Free Water Surface Treatment Wetlands-FWS. B.:Subsurface Flow Systems-SFS C: Subsurface Flow Systems-VF [7.9]

3. SMALL STANDARD UNITS ROOT ZONE METHOD PROCESSING

Small wastewater treatment plants of biological elaboration, successfully implement the method of natural treatment of wastewater. Particularly the root zone method is a combination of artificial wetlands and natural ground treatment systems mentioned above.

Their function is based on cooperation between three parameters: The permanent water saturated soil, the plantation of hydrophilic plants, and microorganisms in the soil. The plants grow over time creating an extensive and dense root system. Thus, the layers of material are stabilized and this helps in developing the necessary microbial community (which destroys the various pollutants) along the roots. The roots of plants carrying oxygen to the respiration of microorganisms and aquatic plants absorb small amounts of nutrient nitrogen and phosphorus, and toxic and organic ingredients and natural water for their own development. Pollutants (phosphorus) are removed through adsorption onto the grain aggregates. Generally, the removal of organic material, especially nitrogen is favoured. [7.1]

At the same time based on university laboratories research programs which are pilot operated and research small units of biological plant elaboration processing systems, monitored and recorded performances. [7.3 & 7.4] (**Figure 3 & 4)**

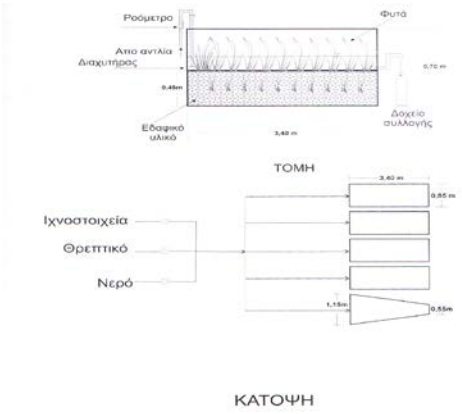


Figure 3. Experimental unit wetland horizontal flow [7.3]

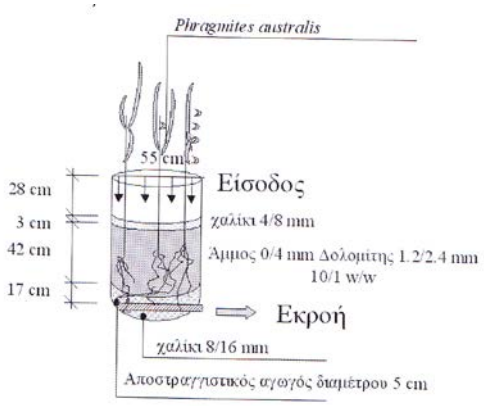


Figure 4. Experimental unit wetland vertical flow [7.4]

After studies in respective pilots, comments and corrections small wetlands processing systems are standardized as follows:
The disposal field is formulated in individual beds. The beds (basins) that are tight, can be constructed on the spot or prefabricated. Prefabricated basins can be of concrete or polyethylene. Usually they are basins with a predetermined volume of a rectangular or hexagonal plan and cone-shaped space saving. Prefabricated basins replace the disposal field. Placed next to each other and connected in series or in parallel or in a combination of both modes. Linked together so as to function as communicating vessels. Filled by 50% with grading pure inert material in layers, preferably river gravel. The 2 or 3 layers of grading material should be groomed every 15cm. or 10cm. respectively.. The pebbles are covered with a membrane preferably geotextile so as to operate at this level as a filter The upper level of the basin to a depth 20-30cm. is filled with topsoil where aquatic plants are placed. The choice of plants is crucial to the operation of waste treatment. This substitutes one physical system of subsurface vertical flow wetland. (Subsurface Flow Systems- VF) **(Figure 5.)**

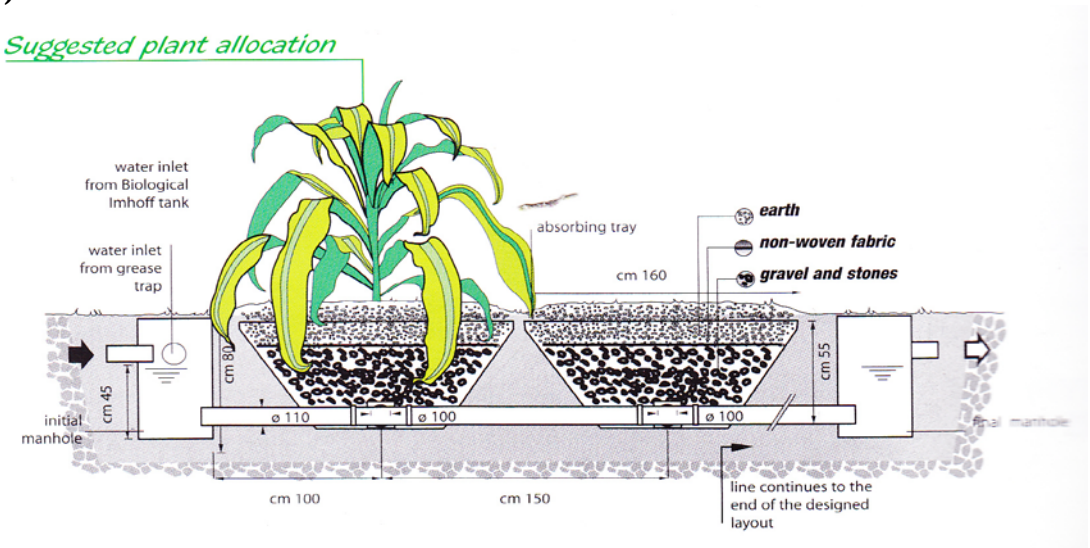


Figure 5. Schematic way small standard wetlands physical system operation unit with prefabricated beds. [7.7]

4. FUNCTION OF SMALL STANDARD UNITS ROOT ZONE METHOD

In the plumping system of a house it is recommended to use a separate hydraulic network for wastewater with different pollution load. We name them for convenience: "black" and "gray". "Black" characterize the wastewater with high pollutant load such as wastewater from toilets. 'Grey' characterize wastewater containing fats and oils, soaps eg wastewater kitchen laundry and bathroom. The "black" waste water shall be diverted to an Imhoff tank, and gray in a grease tank. Then they are transferred to a mixing tank (**Figure 6**). With natural flow water passes in basins functioning as communicating vessels. Pollutants like phosphorus, etc., are removed by adsorption onto the grain aggregates. On the upper level with permanently water saturated soil, hydrophilic plants thrive. And in the root system acting microorganisms that create plant biological processing I.e. carrying oxygen to the respiration of microorganisms, while plants absorb small amounts of nutrients such as nitrogen, phosphorus, etc. alongside and toxic organics with water for their development. The contaminants are removed through adsorption onto the aggregates. In general, the removal of organic material is favoured, so that the treated effluent fulfil the applicable provisions **(Table 2.)**

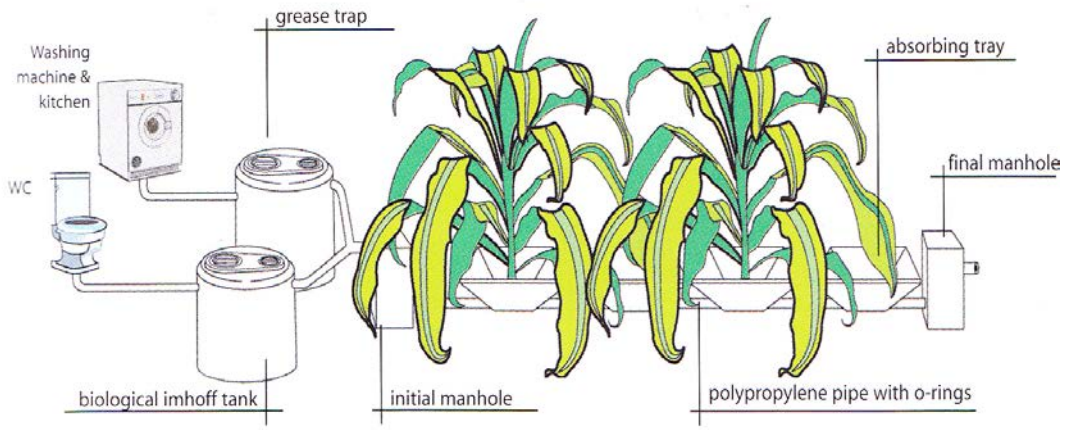


Figure 6. Schematic way of connecting and operating standard wetlands physical system unit with hydraulic separator sewage system. [7.7]

If the hydraulic system of the house is single, then all the used water must be channelled into a 2-chamber or 3-chamber tank to be mixed and equilibrated. In the 2-chamer or 3-chamber tank, it is achieved a corresponding removal of pollutants of 30-35%. Then the effluents pass to a dispensing tank, where they are shared in their respective distribution sectors . The flow for the disposal field, i.e. the standard beds, is made with natural flow. **(Figure 7.)**

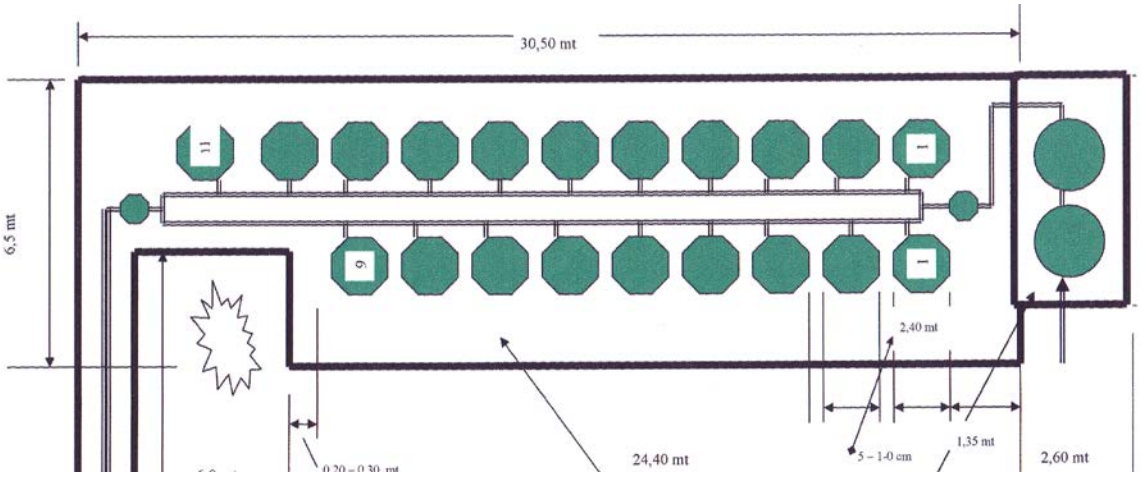


Figure 7. Layout standard plant biological system capacity is 50 P.E. (Population Equivalents) with 2-chamber tank. [7.7]

The excess treated water overflows in the last collection tank and then pumped into the ground, or returns to home delivery tank. In case the treated water is channelled to the ground, or to another recipient e.g. river, lake etc. it has to meet the general and local applicable provisions

5. ELECTION OF PLANTS

The choice of plants is crucial to the functioning of the system. The choice must be aquatic plants and preferably with the same type of vegetation there is in the area of installation. The planting of the basins with reed (Phragmites), straw (Typha), or rushes (Scirpus) has very good results. The choice of flowering aquatic plants makes it possible to create a sensory garden. Flowering plants such as irises (Iris Pseudoacorus) and Iris (Kaemferi), the Hyacinth (Hyacynthus orientalis) etc. give good results. Here below there is a list of aquatic plants suitable for standard plants biological operation units that thrive in Mediterranean climates **(Table 1)** Plants and shrubs should be maintained by an automatic watering system where the houses are inhabited periodically.**(Fig. 8 & 9)**

Plants	**Flowers**
Aucuba Japonica	Auruncus Silvester
Bambu	Astilbe
Calycanthus Florindus	Elymus Arenarius
Cornus Alba	Felci
Cornus Florida	Hyacynthus orientalis
Cornus Stolonifera	Iris Pseudoacorus
Kalmia Latifolia	Iris Kaemferi
Laurus Cerasus	Lythrum Officinalis
Phragmites Australis	Nepeta Musini
Rhamnus Frangula	Pestasites Officinalis
Scirpus	Spirdea salicifolia

Table 1. Aquatic plants suitable for standard biological operation units [7.7]

Figure 8. Construction standardized biological operation unit 50 PE [7.7]

Figure 9. The same plant in Ermione 6 months after planting. [7.7]

6. REMOVAL OF POLLUTANTS

Through the plants, the concentration of micro organisms as a phenomenon of the root system is activated in the first place while the required oxygen is transferred into the soil for the biochemical processes taking place in the reactor territorial cleaning basin. By the method of the root system occurring outside the secondary cleaning, physical and chemical processes that guarantee and the advanced stage, such as nitrification and denitrification, retention in soil phosphorus, sulfur and heavy metals. Also destroys pathogens and viruses. [7.1] In small standard biological process units which are monitored, we have recorded satisfactory averages doffer conditions. The physicochemical parameters that need to be monitored at the output of the unit biological processing are: BOD_5, COD, nitrogen compounds to form ammonia NH_3, phosphorus compounds in the form of orthophosphate PO_4, suspended solids (SS,), pH, and temperature. The average yields in removing pollutants measured in standard biological processing units fully meet the Directive 1991/271 / EEC of EE, and the corresponding Greek provisions: N. 5673/400/1997 (Greece Government Gazette 192B/14-3-1997) N. 145116/2011 (Greece Government Gazette 354 / B / 03.08.2011) etc. (Table 2)

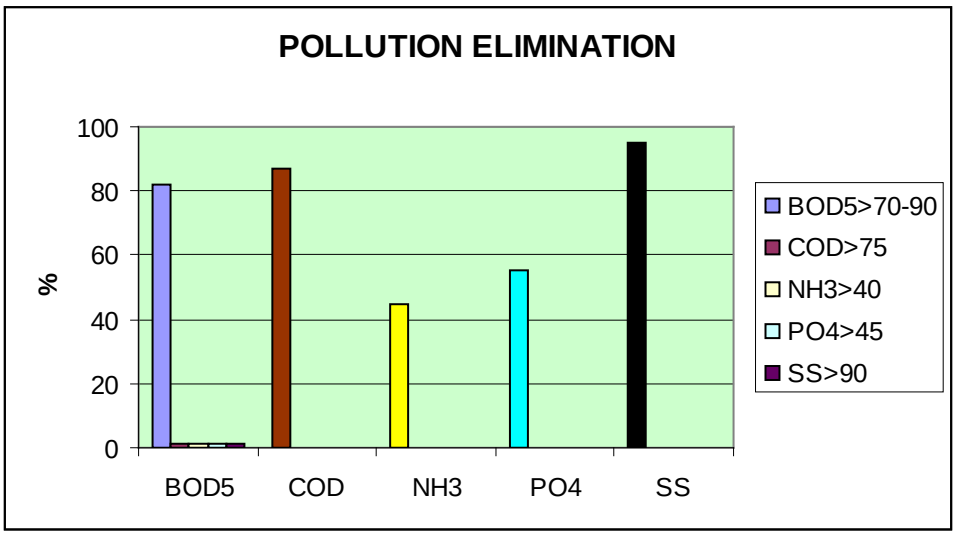


Table 2. Average pollutant removal efficiencies in small standard biological treatment construction units. [7.7]

7. DESIGN, INSTALLATION, CONSTRUCTION, COMPONENTS.

According to the German ATV Directive -262 the following designed parameters for small artificial wetlands vertical flow have been proposed:
Surface of ≥ 2,5 m^2 / PE,. Depth ≥ 0,8 m, the corresponding design with prefabricated basins is calculated according to the surface of each basin. The installation of standard prefab units is performed very easily because all the individual elements that compose it are designed to be connected with quick couplers. The infrastructure on which the basins will be installed should be perfectly horizontal, as in all areas to enter the sewage, and water flows with natural flow. **(Figure10 & 11).**
In buildings that are inhabited periodically (Cottages, etc.) it is necessary to install automatic plant watering system. Alternatively, depending on the level of aggregate manholes of the elaborated sewage treatment we may need to install sewage pump on the unit. In these cases it is necessary to install an alarm.

Figure 10. Installing a standard unit 50 P.E. Porto-Cheli.- Greece [7.7]

Figure 11. The basins are filled with graved aggregate inert, and placed a membrane preferably geotextile [7.7]

8. COST OF CONSTRUCTION AND SERVICING.

The construction cost of wetlands biological treatment units is comparatively smaller than in conventional wastewater treatment plants. Based on feasibility studies of National Agricultural Research Foundation in Greece (N.AG.RE.F.) prices for corresponding construction of natural wetlands and conventional units deviate significantly. [7.5] **(Table 3).** The absence of electro- ant mechanical installation and automation equipment directly affect the cost of construction**.** The payback time of the initial investment of the small standard wetlands treatments unit is much shorter than that of the conventional unit.
The management and service costs are minimal compared to conventional waste water treatment plants **(Table 4).** According to US EPA 2014 (Technical Bulletin 5), supervision and maintenance consists of a three hour project site visit, four times a year to monitor and record the unit. [7.8] Respectively under German technical DWA-A-262 instructions, for private sewage treatment plants it is required to have a monitoring and maintenance contract by an accredited institution. [7.9]

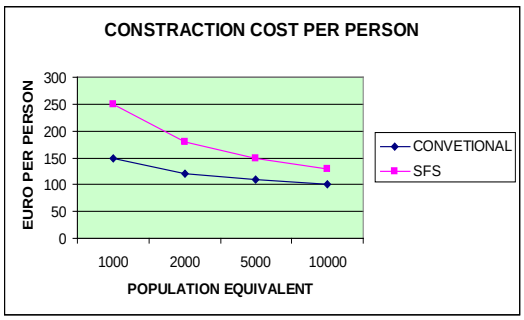


Table 3 Construction cost per person [7.5]

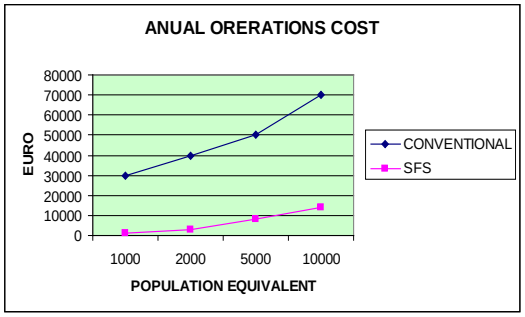


Table 4 Annual operations cost [7.5]

9. ADVANTAGES-DISAVANTAGES

Standard prefab biological treatment units have the following advantages:

- Satisfactory operation since the requirements of the Directive 1991 /271 / EEC of EE, and the corresponding Greek are covered
- Odourless operation because of the underground crossing wastewater.
- There are no mechanical components.
- No maintenance.
- Natural disinfection without chemical additives.
- No operating cost.
- Aesthetics upgrade environment.
- Long lifetime of the installations.

The disadvantages of standard prefab biological treatment units are:

- Compared with conventional systems, considerably greater extent required for their installation. The requirements vary according to the purification requirements and consumption water from 2 to 5 m^2 / per P.E.
- In case of excess of treated wastewater it is required to create a small field distribution.

10. CONCLUSIONS

Standard prefab wetlands of municipal wastewater treatment plants, are systems that meet the requirements of Directive 1991/271 / EEC of EE. . Their installation is easy and fast. They cover a wide range of individuals. They are environmentally friendly, and at the same time they create a permanent aesthetic garden. Their operation is completely odourless. Their cost is less than the corresponding conventional units. Their maintenance cost is minimal, while their operating cost is zero. For Greece this is an environmentally friendly innovation, that can be applied easily and quickly in small settlements, hotels, individual houses and generally in housing units with no sewer.

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