CLAIMS

1. A method of treating wastewater, comprising the steps of:

(i) culturing ~~two or more of~~ a first, ~~and/or~~ a second and~~/or~~ a third microbe population in a first, a second, and a third vessel, respectively, the first, the second and the third vessel being in fluid contact with a side-stream of wastewater diverted from a main stream of wastewater comprising at least one pollutant,

the first microbe population being capable of bioaccumulating at least one pollutant,

the second microbe population being capable of producing a high level of Extracellular Polymeric Substances (EPS) and/or the second microbe population substantially comprises filamentous bacteria being capable of entrapment of at least one pollutant, and

the third microbe population being capable of surface adsorption of at least one pollutant;

(ii) dividing the cultured first and/or second and/or third microbe populations into a first portion and at least a second portion, respectively, wherein each respective at least second portion is ~~capable of~~used to regenerat~~inge~~ the respective microbe population;

(iii) contacting the main stream of wastewater comprising the at least one pollutant with the first portion of ~~two or more of~~ the first, ~~and/or~~ second and~~/or~~ third microbe populations in a contact tank, such that the first portion of the first, ~~and/or~~ second and~~/or~~ third microbe population removes at least part of the at least one pollutant from the wastewater; and

(iv) removing at least part of the first portion of the first, ~~and/or~~ second and~~/or~~ third microbe populations from the main stream of wastewater.

2. The method according to Claim 1, wherein steps (i) to (iv) are repeated continuously in a sequential batch or continuous flow process.

3. The method of Claim 1 or Claim 2, wherein, when the second microbe population is present, the first portion of the second microbe population comprises EPS.

4. The method according to any one of the preceding claims, wherein, after step (iv), the removed microbe population(s) is anaerobically digested.

5. The method according to any one of the preceding claims, wherein:

the first microbe population is capable of bioaccumulating at least one pollutant selected from the group consisting of colloidal and/or soluble organic carbon pollutants; and/or

the second microbe population produces EPS capable of removing at least part of the at least one pollutant selected from the group consisting of colloidal and/or particulate organic carbon pollutants; and/or

the second microbe population is capable of removing by entrapment at least one pollutant selected from the group consisting of particulate organic carbon pollutants; and/or

the third microbe population is capable of removing by surface adsorption at least one pollutant selected from the group consisting of colloidal and/or soluble organic carbon pollutants.

6. The method according to any one of the preceding claims, wherein step (iii) comprises:

increasing the presence of the first microbe population in the main stream of wastewater to between about 0.3 g/L to about 3 g/L; and/or

increasing the presence of the second microbe population in the main stream of wastewater to between about 0.3 g/L to about 3 g/L; and/or

increasing the presence of the third microbe population in the main stream of wastewater to between about 0.5 g/L to about 3 g/L .

7. The method according to any one of the preceding claims, wherein step (i) comprises culturing the first microbe population under conditions that promote dominance of microorganisms capable of glycogen accumulation.

8~~9~~. The method according to claim 7, wherein step (i) comprises culturing the first microbe population using at least one of:

(A) alternating between anaerobic and aerobic phases;

(B) providing feed in the anaerobic phase;

(C) controlling dissolved oxygen levels;

(D) controlling pH levels;

(E) controlling the F:M ratio (feed:mass); and

(F) controlling temperature levels.

9. The method according to claim 8, wherein step (i) comprises at least one of:

(A) alternating between anaerobic and aerobic phases;

(B) providing feed in the anaerobic phase;

(C) maintaining dissolved oxygen levels between about 1.5 mg/L to about 2.5 mg/L during the aerobic phase and/or at about 0 mg/L during the anaerobic phase;

(D) maintaining pH levels between about 6 to about 8.5;

(E) maintaining the F:M ratio between about 0.1 to about 0.3; and

(F) maintaining temperature levels between about 25ºC to about 45ºC.

10. The method according to any preceding claim, wherein the method comprises the use of a first microbe population being capable of bioaccumulating at least one pollutant.

11. The method according to any preceding claim, wherein the first microbe population, when present, comprises at least one microorganism that is capable of glycogen accumulation.

12. The method according to claim 11, wherein the first microbe population comprises at least one microorganism of the class *Gammaproteobacteria* or *Alphaproteobacteria*.

13. The method according to claim 12, wherein the first microbe population comprises a microorganism of the class *Gammaproteobacteria* that is *Candidatus Competibacter phosphatis* and/or a microorganism of the class *Alphaproteobacteria* that is a *Defluviicoccus vanus*-related organism.

14. The method according to any preceding claim, wherein the first microbe population comprises at least one microorganism with:

a biosorption capacity of at least about 40 mg COD/ g SS (Chemical Oxygen Demand per gram of Suspended Solids); and/or

a bioaccumulation capacity of at least about 20 mg COD/ g SS (Chemical Oxygen Demand per gram of Suspended Solids); and/or

a biomass calorific value increase of at least about 0.5 kJ/ g SS (kilojoules per gram of Suspended Solids), between step (i) and step(iv).

15. The method according to any preceding claim, wherein the time of contacting in step (iii) is at least about 10 minutes.

16. The method according to any preceding claim, wherein the second microbe population comprises at least one microorganism isolated from a culture of microbes with a ~~high~~ level of EPS that is at least 150mgEPS/gVSS.

~~17. The method according to any preceding claim, wherein the high level of EPS is at least about 150mgEPS/gVSS.~~

~~18~~17. The method according to any preceding claim, wherein the second microbe population comprises at least one microorganism isolated from a culture of microbes with cellular morphology suitable for entrapment of at least one pollutant by enmeshment.

~~19~~18. The method according to ~~any one of~~ claim~~s~~ 16 ~~to 18~~or claim 17, wherein the at least one isolated microorganism is optionally identified, and is further cultured in nutrient enriched media to obtain the second microbe population, wherein the nutrient enriched media is optionally optimized to encourage growth of the optionally identified isolated microorganism.

~~20~~19. The method according to claim ~~18~~ 17 or ~~19~~18, wherein the at least one isolated microorganism is further cultured with an F:M ratio of between about 0.1 to about 0.3.

~~21~~20. The method according to any preceding claim, wherein the second microbe population, when present, comprises at least one species selected from the group consisting of *Pseudomonas sp., Bacillus sp., Pantoea sp., Serratia sp., Yersinia sp., Microbacterium sp., Enterobacter sp., Photorhabdus sp.*.

~~22. The method according to any preceding claim, wherein step (i) comprises culturing the third microbe population using at least one of:~~

~~(A) low F/M;~~

~~(B) nutrient deficiency;~~

~~(C) low dissolved oxygen levels;~~

~~(D) readily-metabolizeable substrates;~~
~~(E) high Sludge Retention Time (SRT); and~~
~~(F) presence of hydrogen sulfide.~~

~~23~~21. The method according to ~~claim 22~~any preceding claim, wherein step (i) comprises maintaining, in the third vessel, at least one of:

the F:M ratio at between about 0.1 to about 0.3;
a nitrogen concentration of less than 10mg/L;
a phosphate concentration of less than 1 mg/L;
a dissolved oxygen level of between about 0.1 mg/L to about 1.5 mg/L;
a level of readily-metabolizeable substrates of about 150 mg/L, wherein the readily-metabolizeable substrates are selected from the group consisting of low molecular weight organic acids and simple sugars;
a Sludge Retention Time (SRT) of at least about 50 days; and
the presence of hydrogen sulphide.

~~24~~22. The method according to any preceding claim, wherein the third microbe population, when present, comprises at least one species selected from the group consisting of *Thiothrix sp., filamentous bacteria Type 0914, filamentous bacteria Type 0411 (Flexibacter subgroup of Flexibacter-Cytophaga-Bacteriodetes phylum), and 0961, Nocardioforms, Nostocoida Limicola II and III*.

~~25~~23. The method according to any preceding claim, wherein step (ii) further comprises treating the respective first portions of one or more of the first, second and/or third microbe populations.

~~26~~24. The method according to claim ~~25~~23, wherein the second microbe population is present and the treated first portion of the second microbe population has reduced or no further growth after contacting the main stream of wastewater.

~~27~~25. The method according to any preceding claim, wherein the first microbe population is used.

~~28~~26. The method according to claim ~~27~~25, wherein:

step (i) comprises culturing the first microbe population in the first vessel, the first microbe population being capable of bioaccumulating at least one pollutant;

step (ii) comprises dividing the cultured first microbe population into a first portion and at least a second portion, wherein the at least second portion of the first microbe population is capable of regenerating the first microbe population;

step (iii) comprises contacting the main stream of wastewater comprising at least one pollutant with the first portion of the first microbe population, such that the first portion of the first microbe population removes at least part of the at least one pollutant from the wastewater; and

step (iv) comprises removing at least part of the first portion of the first microbe population from the main stream of wastewater.

2927. An apparatus for wastewater treatment, comprising ~~two or more~~ three culturing vessels specifically adapted for culturing microbe populations, said culturing vessels being in fluid communication with at least one contact vessel specifically adapted for contacting portions of cultured microbe populations with a main stream of wastewater, wherein the at least one contact vessel is in fluid communication with the main stream of wastewater, ~~and wherein~~ the ~~two or more~~three culturing vessels are in fluid communication with a side-stream of wastewater diverted from the main stream of wastewater, and wherein the at least one contact vessel is arranged as primary settling tank for liquid-solid separation of the main stream of wastewater and is situated upstream from an aerobic and/or an anaerobic vessel.

~~30. The apparatus according to claim 29, wherein at least one of the two or more culturing vessels is adapted to:~~

~~(A) controlling dissolved oxygen levels; and/or~~

~~(B) providing feed; and/or~~

~~(C) controlling the F:M ratio (feed:mass); and/or~~

~~(D) controlling pH levels; and/or~~

~~(E) controlling Sludge Retention Time (SRT); and/or~~

~~(F) controlling temperature levels; and/or~~

~~(G) controlling hydrogen sulphide levels.~~

3128. The apparatus according to ~~any one of~~ claim~~s~~ 2927 ~~to 30~~, wherein the apparatus is adapted to run a sequential batch or continuous flow process to treat the wastewater.

~~32. The apparatus according to any one of claims 29 to 31, wherein the at least one contact vessel is arranged upstream of an aerobic treatment vessel adapted to receive the wastewater.~~

~~33. The apparatus according to any one of claims 29 to 32, wherein the at least one contact vessel is arranged upstream of an anaerobic treatment vessel adapted to receive at least one portion of cultured microbe population that has been contacted with the main stream of wastewater.~~

~~34. The apparatus according to any one of claims 29 to 33, wherein the at least one contact vessel is configurable as a primary settling tank for liquid-solid separation of the main stream of wastewater.~~