ABSTRACT

In one application for remediating sediments, employing a geocomposite sheet eliminates the need for a thick cap or removal and subsequent ex situ treatment of the sediment. A geocomposite with at least one layer of reactive material is placed over the area to be remediated. A layer of available surcharge materials such as sand, gravel, or riprap covers the geocomposite. The weight of the surcharge materials causes pore water to flow from the sediment through the reactive layer or layers of the geocomposite. Contaminants may be trapped in this reactive layer or layers. A top or bottom layer, or both a top and bottom layer, may be provided to inhibit incursion from outside the sediment layer, while permitting appropriate flow direction of pore water into the reactive layer or layers.
REACTIVE GEOCOMPOSITE FOR REMEDIATING CONTAMINATED SEDIMENTS

RELATED APPLICATIONS


STATEMENT OF GOVERNMENT INTEREST

[0002] The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

FIELD OF THE INVENTION

[0003] The field of the invention is remediation of contaminants, in particular the use of reactive geocomposites for remediating contaminated sediments.

BACKGROUND

[0004] Conventional isolation or treatment of contaminated soils and sediments is by either “capping” or removal. Capping may use natural materials such as soils or gravel, or geosynthetic layers, or a combination of any of these.

[0005] Capping systems comprised of soil or gravel layers are relatively thick and prone to erosion and disturbance. This may cause mixing with the adjacent contaminated soil or sediment. In sub-aqueous applications, such as harbors or shipping channels, thick caps may present obstructions to ships. The cap may be damaged by the turbulence caused by ship traffic as well as by direct contact. Additionally, these thick caps are not designed to interact with any contaminant chemicals that may be in the pore fluid.

[0006] Soil may be removed for ex situ treatment, simple off-site storage, or both.

[0007] However, sub-aqueous sediment removal is expensive and can result in significant contaminant re-suspension in the overlying water column during removal of the sediment.

[0008] Embodiments of the present invention address the above deficiencies in a cost-effective manner.

SUMMARY

[0009] A preferred embodiment of this invention incorporates at least one chemically reactive layer in a geocomposite that may itself comprise multiple additional layers. The reactive layer or layers constitutes an active “clean-up” element that concentrates contaminants in a very thin zone, neutralizes contaminants, or does both. Simultaneously, contaminated sediment is isolated from overlying water or the atmosphere by a geocomposite structure comprising the geocomposite itself and a cover or surcharge layer. This inhibits erosion from either moisture or air, while also inhibiting re-suspension of contaminants. Because the geocomposite structure is thin compared to conventional “caps,” it is suited for use in sub-aqueous applications such as shipping channels and harbors. Further, a preferred embodiment of this invention may be removed or “rejuvenated” to achieve further interaction with pore fluids containing dissolved contaminants or chemicals sorbed onto small particles.

[0010] Provided in a preferred embodiment of the present invention is a geocomposite structure or system (hereafter referred to as geocomposite structure) for remediating contaminated sediments that includes a geocomposite incorporating a top layer of geosynthetic material, one or more middle layers of reactive material, and a bottom layer of geosynthetic material. Depending on site conditions, the top or bottom layer, or both the top and bottom layers, may be omitted and achieve the same functionality. The geosynthetic material used for the geocomposite may be selected from that commercially available and may be woven or non-woven. Likewise, the reactive material used in the geocomposite may be chosen from that commercially available including: activated carbon, zeolites, particulate polymers, granular forms of commercially available chemical adsorption materials, activated carbon fabric commercially available in sheets, and geosynthetic drainage net incorporating pores for holding granular reactive material, and combinations of these.

[0011] Further, a method is provided for remediating contaminated sediments. When the geocomposite is employed in a remediation configuration it may have a layer of surcharge materials overlaid to facilitate the flow of pore water from the sediment through the geocomposite structure. The geocomposite structure may be employed horizontally, such as laying a sheet over sediments in a harbor or ship channel or vertically such as pressing it into soft soil to capture horizontally flowing pore water.

[0012] Advantages of embodiments of the present invention include:

[0013] uses conventional geosynthetic materials for ease in fabrication of the structure;

[0014] reduces encroachment on shipping lanes as compared to conventional caps;

[0015] resists erosion or other deterioration because of its enhanced stability and tensile strength;

[0016] captures solid contaminants and chemicals sorbed onto small particles that are pulled from the sediments via the consolidation induced by the surcharge layer as opposed to simple isolation of conventional capping;

[0017] renders some chemicals less toxic or insoluble depending on specific reactions occurring in the reactive layer;

[0018] provides an alternative site remediation tool in soft soils that may be inherently difficult to remediate;

[0019] reduces expense when compared to conventional methods of removal and treatment;

[0020] facilitates reuse via removing from service and re-constituting the reactive layer;

[0021] is accepted readily by regulatory bodies and the public; and

[0022] minimizes disturbance of the environment as compared to conventional methods.
BRIEF DESCRIPTION OF DRAWINGS

[0023] Like numbers depict like elements in all figures.

[0024] FIG. 1 depicts a side view of layers of a preferred embodiment of the present invention as used in a single plane that may be horizontal.

[0025] FIG. 2 depicts a cross-section view of a preferred embodiment of the present invention as used in a vertical configuration for lateral fluid flow collection.

DETAILED DESCRIPTION

[0026] Refer to FIGS. 1 and 2. A preferred embodiment of this invention inhibits dispersal of harmful environmentally mobile chemicals in areas likely to hold them, such as sediments 104. While doing this, it may also chemically neutralize or physically immobilize one or more of these chemicals.

[0027] A preferred embodiment of this invention envisioning a reactive geocomposite "sandwich" structure 100 incorporating a geocomposite with at least one reaction layer 103 that may be an inner, or middle, layer. In one embodiment, the geocomposite also comprises two sheets of geotextile fibers, one being a top layer 101, and the other being a bottom layer 102. Conventional geotextile materials may be employed. These generally are fabricated as synthetic sheets of material that may be woven or non-woven. The reactive layer 103 may comprise: activated carbon, zeolites, particulate polymers, and granular forms of available chemical adsorption materials. Commercially available products that may facilitate fabrication include activated carbon fabric available in sheets and geosynthetic drainage net incorporating pores for holding granular reactive material.

[0028] In one application, the structure 100 separates contaminated sediments 104 from adjacent uncontaminated material 107. Pore fluid 106 and some small solid particles (not separately shown) contained therein are induced to flow through the geocomposite structure 100. One method of inducing flow of the pore fluid is by applying the overlying surfacing layer 105 to the employed geocomposite. The combined flow of the geocomposite structure 100 and the reactive layer 103 comprises the geocomposite structure 100. The weight of surfacing materials facilitates consolidation within the targeted sediment 104. Employed in a horizontal configuration as depicted in FIG. 1, the bottom layer 102 retards passage of at least some suspended particles so that pore fluid 106 and dissolved chemicals enter the geocomposite structure's reactive layer (or layers) 103. Depending on the makeup of this bottom layer 102, very fine solid particles may pass to the reactive layer 103. The reactive layer 103 interacts with chemicals in the contaminated sediment 104 that pass through the bottom layer, the pore fluid 106 itself within the geocomposite structure 100, or both. The top layer 101 prevents overlying particles (not separately shown) from engaging the middle or reactive layer 103, while allowing the pore fluid 106 to pass completely through the geocomposite structure 100 into the overlying surfacing layer 105.

[0029] Referring again to FIG. 1, in one embodiment, the geocomposite used in the geocomposite structure 100 may be fabricated in large sheets, e.g., rolls of 30 m (100 ft) in length or more by 34.6 m (10-15 ft) in width. These sheets may be deployed on the surface of a sediment deposit 104. The deposit 104 may be saturated or near saturated, subaqueous or terrestrial. After emplacement of the geocomposite, a layer 105 of surcharge materials, such as riprap, gravel, or sand, is placed on the geocomposite to facilitate consolidation of the sediment 104.

[0030] Subsequent consolidation of the sediment 104 expels pore fluid 106 that contains targeted harmful chemicals or small particles upon which the chemicals may be sorbed. As the pore fluid 106 flows through the geocomposite structure 100, the reactive material in the reactive layer or layers 103, interacts with the chemicals in the fluid 106. For example, the reactive material may simply adsorb them. Alternatively, it may also chemically "neutralize" them. This both isolates and concentrates the targeted chemicals within the reactive layer 103, or layers. In addition, this reactive layer 103, or layers, may retain fine particles on which chemicals may have sorbed.

[0031] Refer to FIG. 2. An embodiment of the present invention may also be employed as a geocomposite structure in a vertical orientation, having an outer layer 201, or layers, and at least one middle reactive layer 103. This embodiment may be employed vertically by pressing it into the ground. A surfacing layer 105 of material such as gravel, sand, or riprap may be emplaced above the soil adjacent to the vertically oriented geocomposite and the consolidation of the sediment 104 may occur both horizontally and vertically, due to the weight of the surfacing layer 105. In an embodiment installed vertically, the geocomposite structure 104 may employ a sleeve 201 surrounding the reactive layer 103, thus forming a continuous outer layer for the geocomposite, much like a sack used to protect a mattress when moving. One or more layers 103 of reactive material may be emplaced inside the sleeve 201 (i.e., the continuous outer layer or layers).

[0032] Although specific types of geocomposite structures are discussed, other similar geocomposite structures, including those that may have only some of the constituents used in the above described examples, may be suitable for remediation using a structure or method that falls within the ambit of a preferred embodiment of the present invention as provided in the claims herein.

We claim:

1. A geocomposite comprising:
   at least one first layer of geosynthetic material;
   at least one second layer of geosynthetic material; and
   at least one third layer composed of at least some reactive material, said at least one third layer affixed between said first and second layers,

2. A geocomposite of claim 1 in which said geosynthetic material is commercially available.

3. A geocomposite of claim 2 in which said commercially available geosynthetic material is selected from the group consisting of woven, non-woven, and combinations of woven and non-woven geosynthetic material.

4. A geocomposite of claim 1 in which said reactive material is commercially available.

5. A geocomposite of claim 4 in which said commercially available reactive material is selected from the group...
consisting of activated carbon, zeolites, particulate polymers, granular forms of commercially available chemical adsorption materials, activated carbon fabric commercially available in sheets, geosynthetic drainage net incorporating pores for holding granular reactive material, and combinations thereof.

6. A remediation configuration comprising:
   a geocomposite comprising:
   at least one first layer of geosynthetic material;
   at least one second layer of geosynthetic material; and
   at least one third layer composed of at least some reactive material, said at least one third layer affixed between said first and second layers, and
   a layer of surcharge materials placed above said geocomposite, wherein said remediation configuration may be employed to remEDIATE sediments.

7. The remediation configuration of claim 6 in which said geosynthetic material is commercially available.

8. The remediation configuration of claim 7 in which said commercially available geosynthetic material is selected from the group consisting of woven, non-woven, and combinations of woven and non-woven geosynthetic material.

9. The remediation configuration of claim 6 in which said reactive material is commercially available.

10. The remediation configuration of claim 9 in which said commercially available reactive material is selected from the group consisting of activated carbon, zeolites, particulate polymers, granular forms of commercially available chemical adsorption materials, activated carbon fabric commercially available in sheets, geosynthetic drainage net incorporating pores for holding granular reactive material, and combinations thereof.

11. The remediation configuration of claim 6 in which said surcharge materials are selected from the group consisting of riprap, gravel, sand, and combinations thereof.

12. A method for remediating sediments, comprising:
   deploying a geocomposite in a plane, said geocomposite having at least a topmost edge when deployed approximately vertically and comprising:
   at least one layer of geosynthetic material,
   wherein at least one said at least one layer is composed of at least some reactive material, and
   covering said geocomposite with a layer of surcharge materials,
   wherein if more than one layer is used in said geocomposite, each of said layers is arranged approximately parallel to each other in said plane, and
   wherein said method facilitates remediating sediments.

13. The method of claim 12 in which said layer of surcharge materials is deployed over said geocomposite along said plane.

14. The method of claim 13 in which said plane is approximately horizontal.

15. The method of claim 13 in which said plane is approximately vertical, wherein said layer of surcharge materials is deployed above said topmost edge and over the surface horizontally adjacent to said topmost edge for the length of said topmost edge.

16. The method of claim 12 in which said geosynthetic material is commercially available.

17. The method of claim 16 in which said commercially available geosynthetic material is selected from the group consisting of woven, non-woven, and combinations of woven and non-woven geosynthetic material.

18. The method of claim 12 in which said reactive material is commercially available.

19. The method of claim 18 in which said commercially available reactive material is selected from the group consisting of activated carbon, zeolites, particulate polymers, granular forms of commercially available chemical adsorption materials, activated carbon fabric commercially available in sheets, geosynthetic drainage net incorporating pores for holding granular reactive material, and combinations thereof.

20. The method of claim 12 in which said surcharge materials are selected from the group consisting of riprap, gravel, sand, and combinations thereof.

21. A geocomposite for remediating sediments comprising:
   at least one layer of geosynthetic material,
   wherein at least one of said at least one layers is composed of at least some reactive material.

22. The geocomposite of claim 21 in which said geosynthetic material is commercially available.

23. The geocomposite of claim 22 in which said commercially available geosynthetic material is selected from the group consisting of woven, non-woven, and combinations of woven and non-woven geosynthetic material.

24. The geocomposite of claim 21 in which said reactive material is commercially available.

25. The geocomposite of claim 24 in which said commercially available reactive material is selected from the group consisting of activated carbon, zeolites, particulate polymers, granular forms of commercially available chemical adsorption materials, activated carbon fabric commercially available in sheets, geosynthetic drainage net incorporating pores for holding granular reactive material, and combinations thereof.

26. A remediation configuration for remediating sediments comprising:
   a geocomposite comprising:
   at least one layer of geosynthetic material,
   wherein at least one of said at least one layers is composed of at least some reactive material; and
   a layer of surcharge materials placed above said geocomposite.

27. The remediation configuration of claim 26 in which said geosynthetic material is commercially available.

28. The remediation configuration of claim 27 in which said commercially available geosynthetic material is selected from the group consisting of woven, non-woven, and combinations of woven and non-woven geosynthetic material.

29. The remediation configuration of claim 26 in which said reactive material is commercially available.

30. The remediation configuration of claim 29 in which said commercially available reactive material is selected from the group consisting of activated carbon, zeolites,
particulate polymers, granular forms of commercially available chemical adsorption materials, activated carbon fabric commercially available in sheets, geosynthetic drainage net incorporating pores for holding granular reactive material, and combinations thereof.

31. The remediation configuration of claim 26 in which said surcharge materials are selected from the group consisting of riprap, gravel, sand, and combinations thereof.

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