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(54) **MODULAR BLOCKS FOR RAINWATER RECOVERY SYSTEM**

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(60) Provisional application No. 60/407,162, filed on Aug. 30, 2002.

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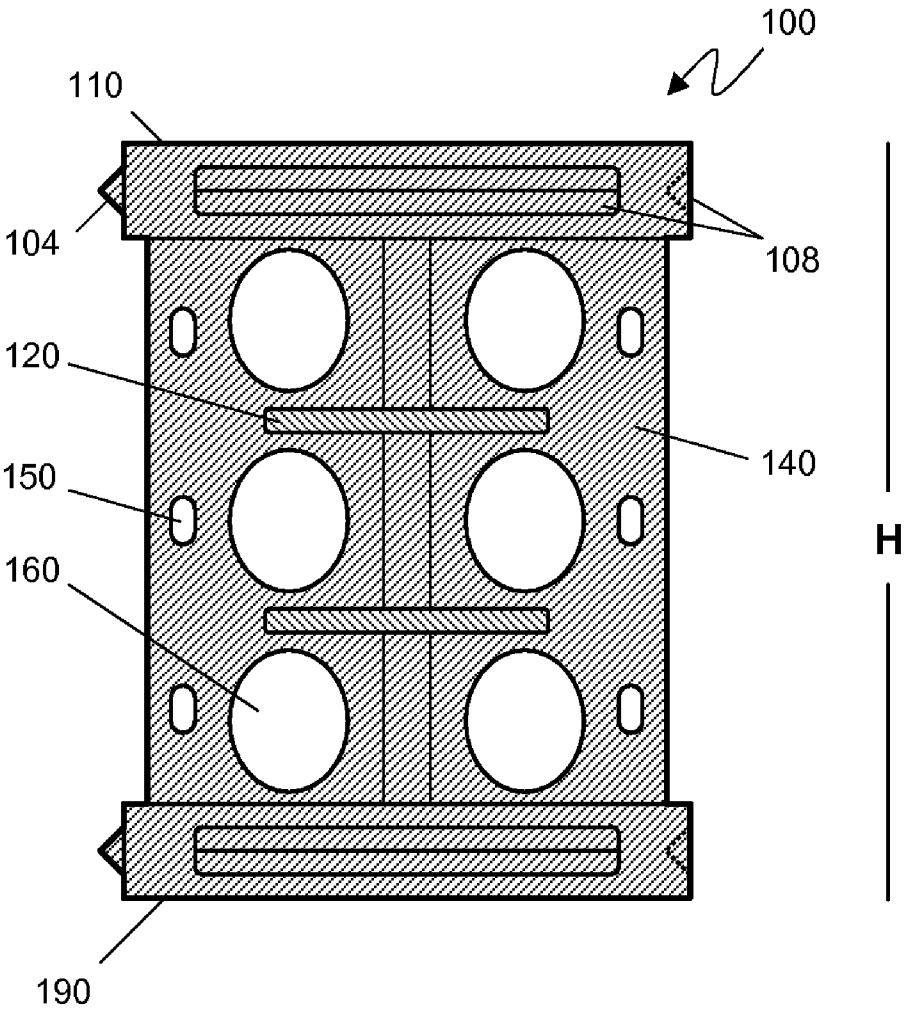
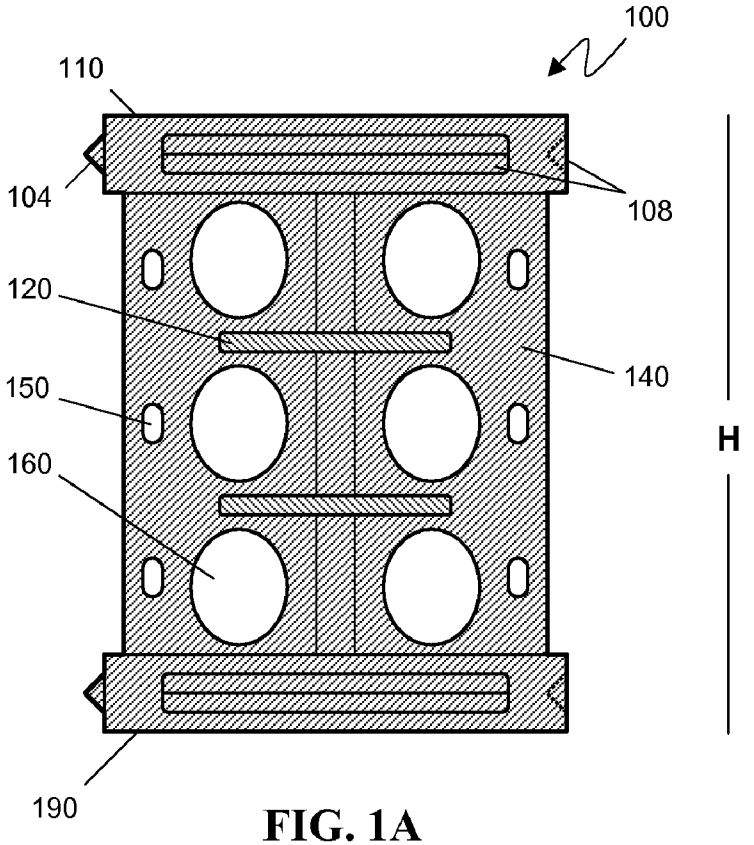
(57) **ABSTRACT**

A modular block, useful for constructing liquid-storage tanks for water-recovery systems, is described. The blocks can support large vertical loadings, may be fabricated from synthetic materials, and can be assembled into a tank-like structure. Because of their small size, light weight and easy portability, custom-sized water-recovery tanks may be readily assembled and installed at competitive costs. The water-recovery tanks may be used to reclaim runoff rainwater from water-impervious surfaces.




100
110
104
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H
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FIG. 1A

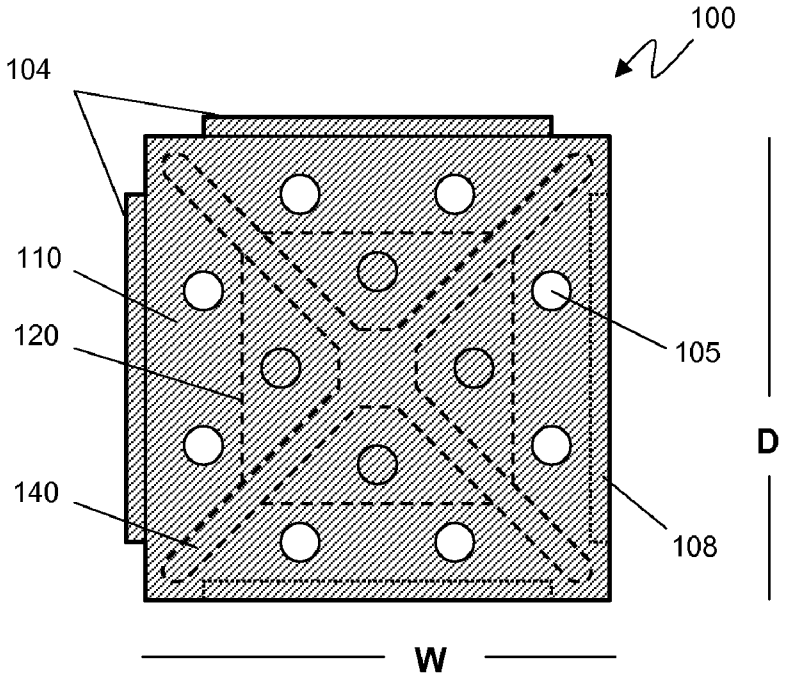
100
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FIG. 1B

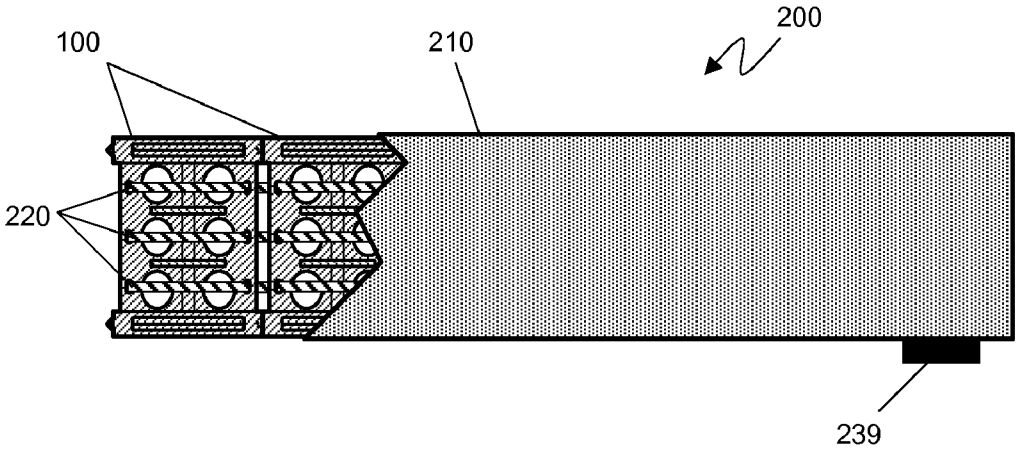

FIG. 2A

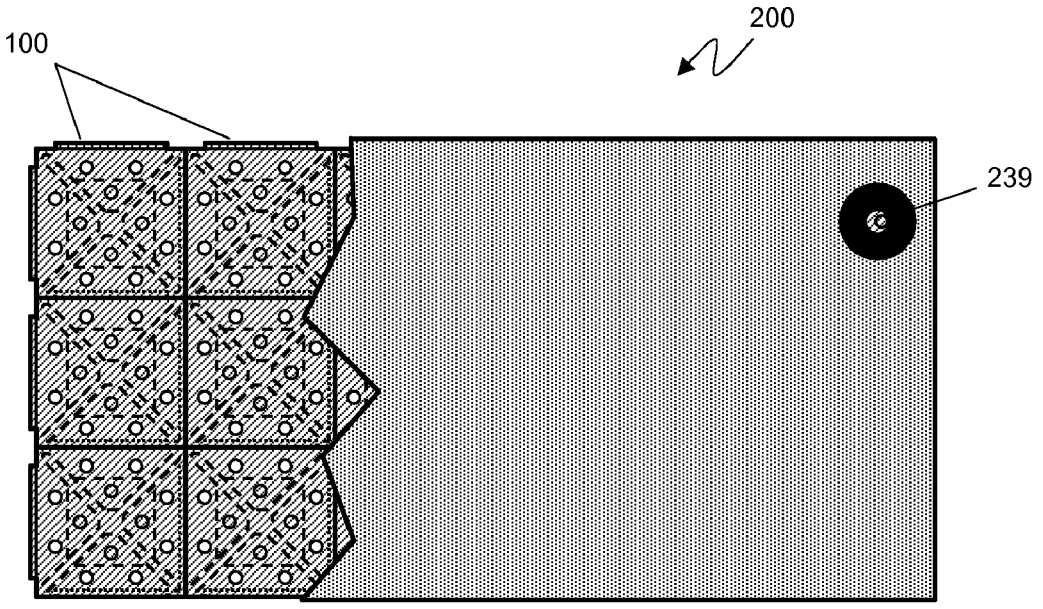

FIG. 2B

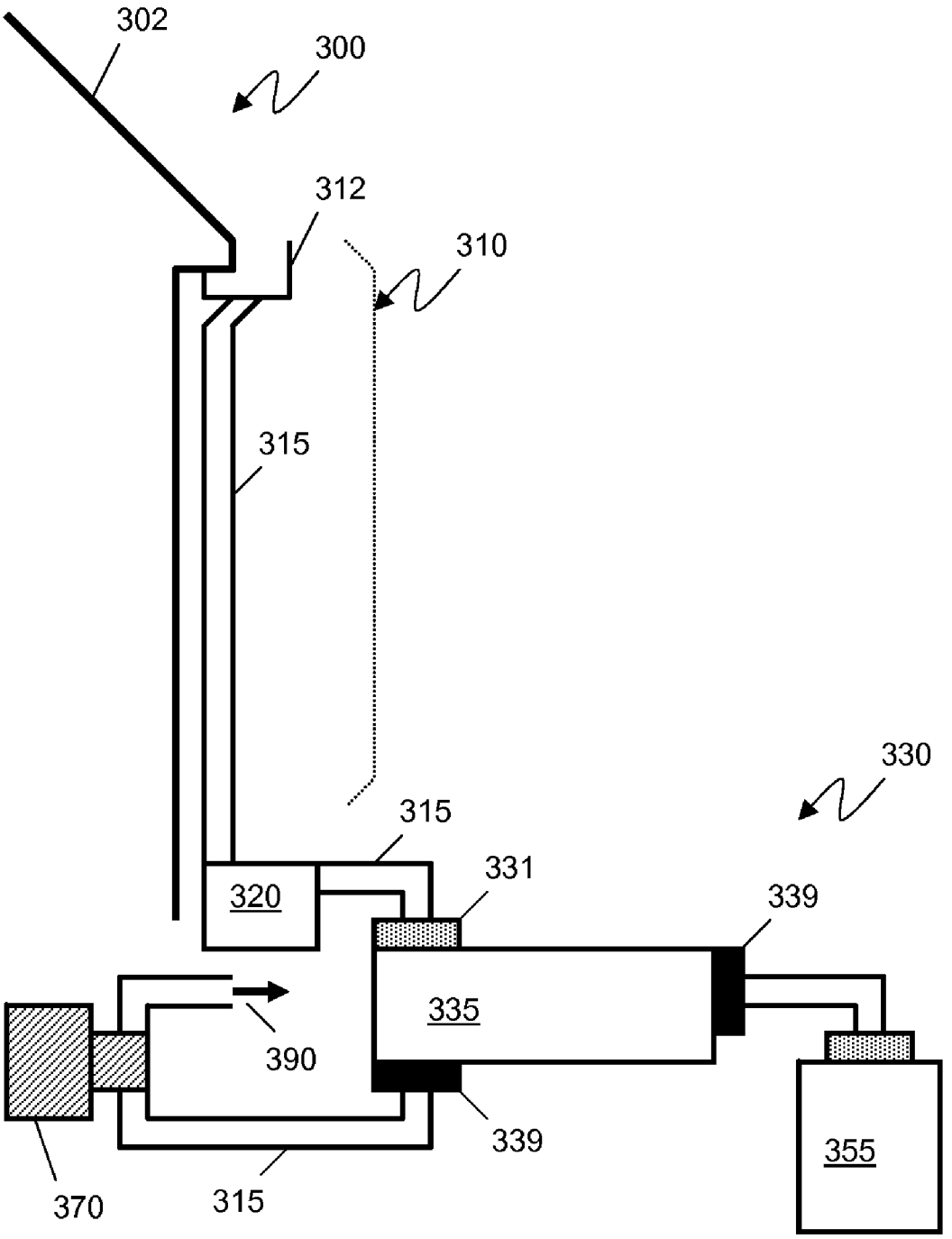

FIG. 3

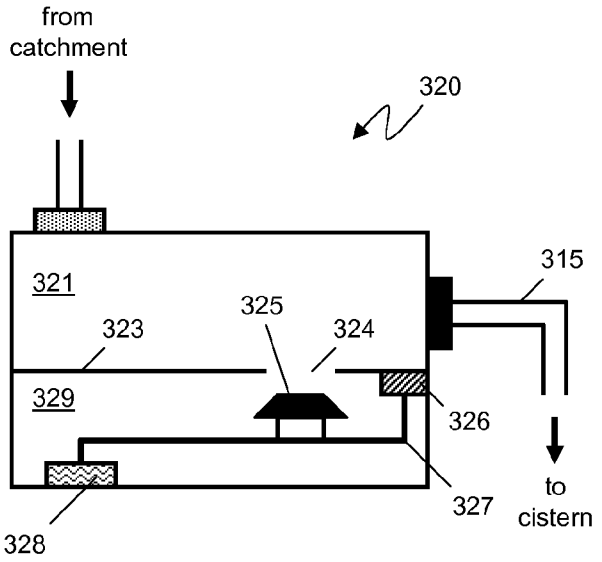

FIG. 4

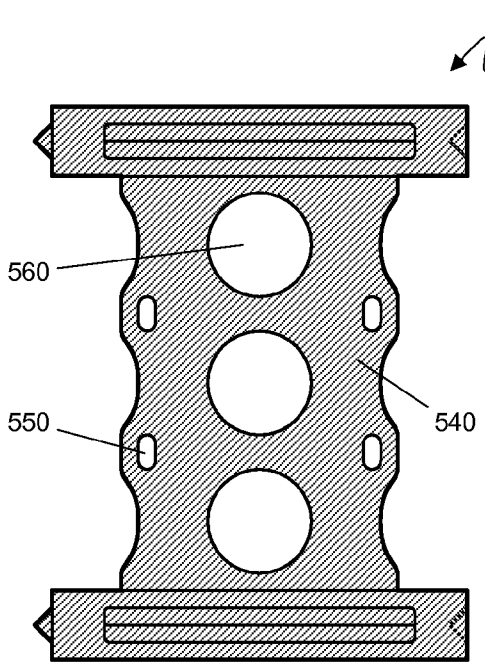

FIG. 5A

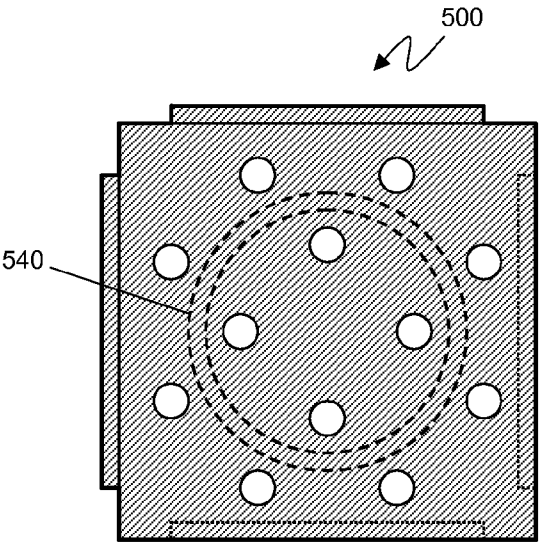

FIG. 5B

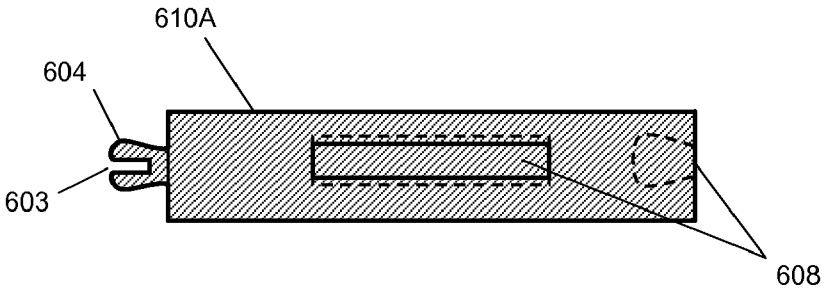

FIG. 6A

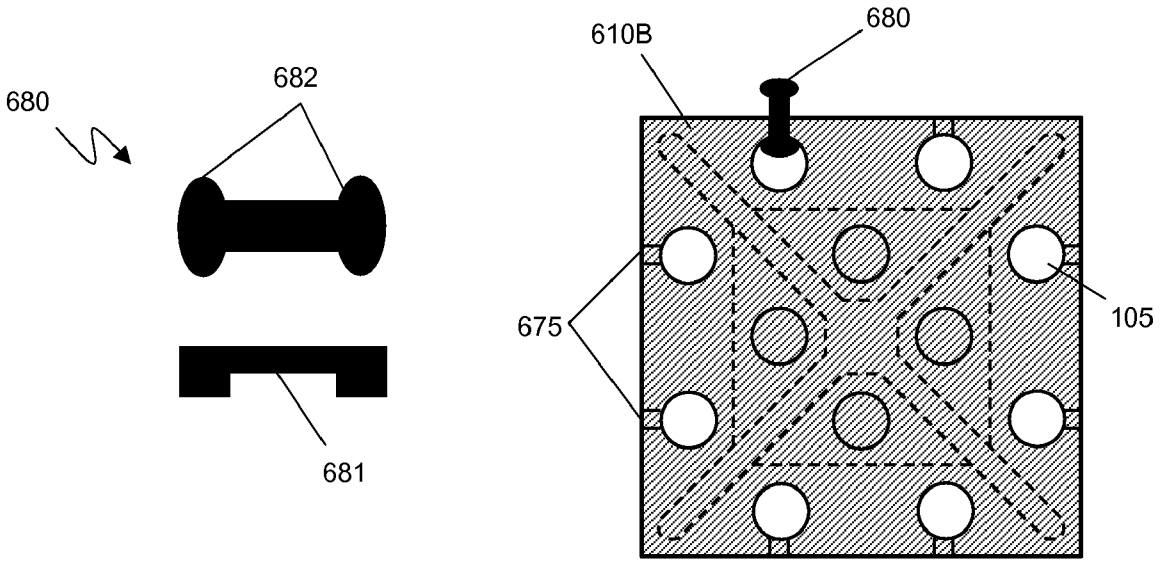

FIG. 6B

MODULAR BLOCKS FOR RAINWATER RECOVERY SYSTEM

CROSS-REFERENCE TO RELATED U.S. APPLICATIONS

[0001] The present continuation-in-part application claims priority to U.S. patent application Ser. No. 11/395,989 filed on 31 Mar. 2006, which is a continuation of U.S. patent application Ser. No. 10/651,570, now issued U.S. Pat. No. 7,025,076, which claims priority to Provisional Application No. 60/407,162, filed on 30 Aug. 2002.

FIELD OF THE INVENTION

[0002] This invention relates to underground liquid-storage tanks or cisterns. In particular, modular blocks are described which can be assembled to form a cavity of an underground storage tank. The tank can be used for reclaiming and recovering rain water.

BACKGROUND

[0003] Many urbanized areas in the United States are running out of potable water, and improvements in water quality are becoming increasingly difficult and expensive to attain. Most of these environmental problems are related to the proliferation of impervious (paved or constructed) surfaces. Imperviousness has a double-edged effect: it interrupts the natural hydrologic cycle, and it contributes to flooding-related problems. Interruption of the hydrologic cycle disconnects rainfall from replenishing groundwater supplies, particularly by natural water infiltration into soil covered with vegetation. Impervious surfaces also contribute to storm-water runoff, flooding problems, in-stream erosion, and increased frequency of Combined Sewer Overflow (CSO) discharges. For a general treatise on the hydrologic cycle, the interaction of ground water and surface water, and water management, see Winter et al., Ground Water and Surface Water: A Single Resource, U.S. Geological Survey Circular 1139, U.S. Government Printing Office, Denver, Colo., 1998, 79 pp., the teachings of which are incorporated herein by reference.

[0004] Imperviousness is generally associated with growth, and growth is associated with greater water demand. The consequence is that there is less water stored while more water is demanded. Additionally, each summer demand for potable water doubles in many communities as residents seek to irrigate their lawns, while in urbanized areas a preferred method of treating wastewater is through large regional systems that move water out of a basin or sub-basins. The result is that demand for potable water frequently exceeds supply and causes many communities to enforce restrictive water bans during the summer months.

[0005] One system used to mitigate the effects of urbanization on water resources has been disclosed in U.S. Pat. No. 7,025,076. Such a system employs underground water storage tanks to capture and hold rainwater runoff for later use.

SUMMARY

[0006] There is a need for low-cost, easily-transportable, readily-installable liquid-storage tanks that are useful for such applications as rainwater reclamation. To this end, an interconnecting block system, useful for constructing liquid-storage tanks, is described. In various embodiments, a connectable modular block has a substantially rectangular lower surface element perforated with holes, and a similar rectangular upper surface element also perforated with holes. The lower surface and the upper surface are substantially parallel to each other, and connected to each other with at least one vertical support having multiple perforations. In some embodiments, one or more reinforcing braces attach to the vertical supports to provide greater rigidity to the block, and a block having upper and lower surfaces measuring about two feet by two feet can support at least about 1,000 pounds.

[0007] In some embodiments, integrated onto the block are male-type and female-type fastening mechanisms. These fasteners permit aligned and registered assembly of multiple blocks, so that a large liquid-storage volume can be readily formed from smaller, easily-transportable modular blocks. Once assembled, the ensemble can be reinforced with synthetic cord and wrapped with a water-impermeable barrier to form a tank suitable for underground storage of water for various non-potable uses.

[0008] The blocks can be fabricated from a variety of low-cost materials using any one of several fabrication processes. Materials that may be used to form the blocks include various plastics such as, but not limited to, nylon, vinyl, polyvinyl-chloride, polycarbonate, acrylic, polyethylene, polyurethane, or polystyrene. The blocks may be formed by extrusion, injection molding, rotational molding, or casting processes known to those skilled in the art of forming plastics.

[0009] A liquid-storage tank formed from multiple interconnected blocks may contain at least one inlet port and at least one outlet port. In some embodiments, rainwater collection system may be connected to the tank's inlet port, and a pump may be connected to an outlet port from the tank. The pump may be used to move the stored water for irrigation purposes, washing purposes, ornamental purposes, or other non-potable applications.

[0010] In various embodiments, one or more tanks formed from the interconnecting blocks may be connected by piping or tubing. In other embodiments, one or more tanks may further be connected to a dry well, such that collected water in excess of the total tank volume flows into the dry well for infiltration into groundwater supplies and aquifer recharge.

[0011] In some embodiments, a roofwasher first-flush system may be disposed between a roof-water collection system and a tank's inlet. The roof washer system collects a first runoff water volume, and diverts it away from the storage tank. Accordingly, debris and pollutants that may accumulate during non-rainy periods are diverted away from the storage tanks.

[0012] The present invention offers the following environmental benefits: increased ground water recharge; decreased runoff volume and peak flows to storm drains; decreased potential for flooding; improved storm-water quality; reduced potable water demand; strategic emergency non-potable water supply; potential to offset the effect of local well withdrawals by recharging groundwater supply.

[0013] When used by a homeowner, the present invention offers the following benefits: a supply of non-potable water for lawn care, car washing, plantings etc.; a reduction in municipal water expense by reducing the dependency on municipal water supplies for non-potable uses; a source of water during town watering bans and restrictions; knowledge that you are helping to restore our natural environment.

[0014] The foregoing and other aspects, embodiments, and features of the present teachings can be more fully understood from the following description in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015] The skilled artisan will understand that the figures, described herein, are for illustration purposes only. It is to be understood that in some instances various aspects of the invention may be shown exaggerated or enlarged to facilitate an understanding of the invention. In the drawings, like reference characters generally refer to like features, functionally similar and/or structurally similar elements throughout the various figures. The drawings are not necessarily to scale, emphasis instead being placed upon illustrating the principles of the teachings. The drawings are not intended to limit the scope of the present teachings in any way.

[0016] FIG. **1**A is an elevation view of an embodiment of a modular block useful for constructing a liquid-storage tank. The block has substantially flat top surfaces and bottom surfaces.

[0017] FIG. **1**B is a top-down view of the modular block of FIG. **1**A.

[0018] FIG. **2**A is an elevation view of a liquid-storage tank. The volume of the tank is substantially defined by an assembly of modular blocks. The blocks are covered or wrapped with a water impermeable barrier. In the illustration, the barrier is portrayed in cut-away view to reveal the blocks inside the tank.

[0019] FIG. **2**B is a bottom-up view of the tank of FIG. **2**A.

[0020] FIG. **3** is a schematic illustration of a rainwater recovery system according to one embodiment of the invention. In this embodiment, water is collected from a building's roof and directed into a storage tank **335** formed from multiple blocks.

[0021] FIG. **4** is a schematic illustration of a first flush diverter system according to one embodiment of the invention. The first flush of water is collected in a lower tank **329** until the stopper **325** closes the entry port **324**.

[0022] FIG. **5**A is an elevation view of an embodiment of a modular block useful for constructing a liquid-storage tank.

[0023] FIG. **5**B is a top-down view of the modular block of FIG. **5**A.

[0024] FIG. **6**A is an elevation view of the top element of a modular block, and depicts and embodiment for registering and interlocking the modular blocks.

[0025] FIG. **6**B is a schematic illustration of an interlocking system for the modular blocks. A dumbbell-shaped fastener, shown in top view and side view at left, snaps into receptacles in the top and bottom of the block, as indicated in the diagram on the right.

[0026] The features and advantages of the present invention will become more apparent from the detailed description set forth below when taken in conjunction with the drawings.

DETAILED DESCRIPTION

[0027] The present invention is useful for capturing runoff water and storing some of the water for non-potable uses, such as but not limited to, irrigation, car washing, exterior building washing, walkway cleaning, and ornamental purposes. The present invention can reduce the demand of potable water and depletion of valuable potable water supplies for such non-potable uses. The present invention can be used to construct one or more liquid-storage tanks that may be located above ground or underground, and these tanks can be used to collect and store runoff rainwater.

[0028] In overview and referring to FIG. **1**A-**1**B, a modular block **100**, useful for constructing liquid-storage tanks, is depicted in elevation view and top-down view. The modular block has substantially flat or smooth top **110** and bottom **190** surfaces, and these surfaces are joined to vertical members **140**. In various embodiments, holes **150**, **160**, and **105** are distributed throughout the structure. The block may have width, depth and height dimensions represented substantially by W, D, and H. Any number of blocks may be joined together to form a skeleton which defines the cavity or volume of a tank as indicated in FIG. **2**A-**2**B.

[0029] The block shown in FIG. **1**A-**1**B may be formed from a variety of materials using various forming processes. For example, the material used to make the block may be any one of the following synthetics: nylon, vinyl, polyvinylchloride, polycarbonate, polystyrene, polyurethane, polyethylene, acrylic, lexan, and other similar plastics. Other materials such as fiberglass, cermamics and cement may be used, as well as aluminum. The block may be comprised of a coated material, such as rubber- or plastic-coated steel. In various embodiments, the block may be formed by casting, rotational molding, extrusion or injection-molding processes, as well as mechanical assembly.

[0030] The enclosed volume V_e of a block **100** may be defined substantially by its overall dimensions: $V_e = W \times D \times H$. The occupancy volume V_o of the block may be defined as the actual volume filled by the block material, and can be found from the following relation:

$$V_o = \frac{M}{\rho} \tag{1}$$

where M is the mass of the block, and ρ is the density of the material comprising the block. The occupancy ratio R_o can be defined according to the following expression:

$$R_o = \frac{V_o}{V_e} \tag{2}$$

In various embodiments, the occupancy ratio may be less than about 0.15. In other embodiments, it may be less than about 0.10, and in yet other embodiments it may be less than about 0.05.

[0031] The block may be formed into various sizes. For example, the W×D×H measurements may be 2 ft×2 ft×3 ft, 1 ft×2 ft×3 ft, 1 ft×1 ft×2 ft, 2 ft×2 ft×2 ft, or other dimensions scaled from these values. Reinforcing members **120** join to the vertical members **140** for the embodiment shown in FIG. **1**A and increase the rigidity of the block structure. Holes **160** and **105** disposed in the vertical members **140** and top **110** and bottom **190** members reduce the amount of material required to form the block, and reduce its occupancy volume V_o without significantly reducing the block's vertical compression strength. These holes additionally increase the amount of volume available for liquid storage and facilitate movement of liquid throughout the enclosed volume. In some embodiments, holes **150** may be used for strapping multiple blocks

together as indicated in FIG. **2**A. A synthetic cord or strap **220** may be threaded through holes **150** to secure an assembly of blocks.

[0032] The structure of the blocks provide substantial vertical strength, so that a tank could be located under about 18 inches of topsoil, and support additional loading. The thickness of the vertical members **140** and the top **110** and bottom **190** members can be dimensioned such that the block supports a pre-selected amount of weight. For example, a block measuring 2 ft×2 ft×3 ft is designed to support at least about 1,000 pounds, or about 2 pounds per square inch, in some embodiments. This loading capability of the block permits safely the support of about 18 inches of topsoil and one large person. In some embodiments, a block of similar outer dimensions is designed to support at least about 4,000 pounds.

[0033] In various embodiments, a modular block **100** has registration features **104** and **108**, which may be located on the outer edges of the top **110** and bottom **190** members. These features may be used to align and lock together plural blocks. In the illustrated embodiment, a protruding wedge **104**, representing a male-type fastening mechanism, of one block inserts into a V-groove receptacle **108**, representing a female-type fastening mechanism, of an adjacent block. This fastening system prevents vertical displacement of a block with respect to its adjoining blocks.

[0034] Any number of blocks **100** may be assembled to form a liquid-storage tank **200**, as indicated in FIGS. **2**A-**2**B. The blocks may be assembled using the registration features **104** and **108**, and then bound together using synthetic cord **220**. The blocks may be formed into a two-dimensional array as shown in FIGS. **2**A-**2**B, and they may be stacked to form a three-dimensional array (not shown). In various embodiments after assembly, the skeleton of blocks is encased in a material **210** which substantially prevents the outflow of water. This material may comprise, but not be limited to, a waterproofed fabric, a water-resistant fabric, a fiber-reinforced plastic, a rubber membrane, a vinyl sheet or a heat-shrinkable wrap. An advantageous feature of the blocks' smooth and substantially flat upper and lower surfaces is that they provide a substantially uniform surface against the encasing fabric. This helps prevent wear and puncturing of the fabric when the tanks are located underground. Additionally, all outer edges of the block may be rounded and smoothed to further reduce the possibility of puncturing the encasing fabric.

[0035] In some embodiments, the covering **210** may include one or more entry ports (**331** in FIG. **3**) and exit ports **239** for attaching a hose, tubing, pipe, vent or fluid-level guage. In other embodiments, the entry and exit ports may be added after encasing the blocks. For example, a hole may be formed in the covering **210**, and a threaded hole may be formed in the top **110** or bottom **190** members of the block. A hose fitting or pipe fitting with a sealing gasket may then be screwed securely into the block, where the fitting presses against the sealing gasket which presses against the underlying covering **210** and block **100**.

[0036] As shown in FIGS. **1**A-**1**B and **2**A-**2**B the modular block provides a convenient and potentially low-cost system for constructing liquid-storage tanks useful for rainwater recovery and reuse. The materials can be lightweight, and easily transported. An average homeowner could purchase the materials at a local supply store, transport them easily to the home, and assemble them without the need of hiring professional, specialized tank-installation services. Additionally, safety considerations are reduced for the tank structure shown in FIGS. **2**A-**2**B, since there is no large free-space volume into which a child or animal could fall.

[0037] The potential low profile of a tank formed from the blocks reduces the depth of excavation necessary for subsurface installation of the tank. As an example of water storage capability, the tank depicted in FIGS. **2**A-**2**B, comprising 18 blocks measuring about 2 ft×2 ft×3 ft, would hold about 1600 gallons of water, a volume equivalent to about six standard-size home-heating-oil tanks.

[0038] FIG. **3** is a schematic illustrating the incorporation of a liquid-storage tank into a rainwater-recovery system **330** for roof-top runoff. In various embodiments, the tank is connected to roof gutters **312** and downspouts or tubing **315**. In some embodiments, a multiple tanks may be used. The tanks collect and store rainwater runoff during rainfall, and make it available for later non-potable uses. A pump **370** may be connected to the tank **335** for future retrieval of the stored water, or depending on the local grade of the land and location of the tanks, the water may be extracted from the tank by a gravity-feed system. All of a building's roof area can be linked to the tank with aboveground or belowground piping **315**.

[0039] A buildings roof **302** can serve as a catchment area to collect rainwater. For a description of the use of a building roof as a catchment area and the amount of water typically available, see A. W. Selders, SW-12, Agricultural Engineering, U.S. Department of Agriculture and West Virginia University, Cooperative Extension Service, Oct. 17, 1971, the teachings of which are incorporated herein by reference. Water flows from the roof **302**, through a roof gutter **312**, and through gutter conduit and piping system **315**. The gutter conduit and piping system can comprise 1-inch, 2-inch or 3-inch diameter PVC pipe with 45-degree and 90-degree elbows, or flexible tubing. The collected water flows through a first-flush system **320**, and then to an entry port **331** of a storage tank **335**.

[0040] In various embodiments, the one or more tanks can be located in one central area or distributed around a building **300**, and they may be located underground or above ground. Because of their lightweight construction, a tank located above ground may be moved and stored inside during winter months and placed in service outside during summer months. Because of their low profile, the tanks may be placed in about a three-foot-deep hole, easily dug by a homeowner, and covered with about 18 inches of soil for gardening. Multiple tanks may be linked together easily with tubing or piping **315** to increase storage capacity for the irrigation of larger lawns or gardens, or a tank of virtually any size may be assembled due to the modularity of the blocks.

[0041] Most any type of hose or piping can be used to link multiple storage tanks together. Hose connections can be made with 1-inch-diameter or larger hose, tubing or piping. Various length hoses, tubes or pipes and hose nipples, clamps, pipe junctions, couplers and elbows and bulkhead fittings may be used. For example, an entire water-recovery system **330** may be interconnected with inexpensive and readily-available PVC tubing. In some embodiments, any of a variety of valves can be used to provide manual control of liquid flow within a multiple tank system.

[0042] In embodiments to provide for heavy and excessive rainfall, the one or more storage tanks **335** may be connected to a dry well **355**. Any excess water is directed to the dry well,

which permits infiltration of the water into the ground and assists in recharging the groundwater supply. Any additional overflow from the dry well can be directed away from the house or building structure **300**. In various embodiments, the dry well construction requires excavation of about 85 cubic feet for a 600 gallon dry well and 2000 square foot roof area. Examples of dry well systems are described in U.S. Pat. Nos. 6,095,718 and 5,848,856 both to Bohnhoff and U.S. Pat. No. 4,689,145 to Mathews et al., the teachings of which are incorporated herein by reference.

[0043] The pumping system **370** can be used to convey water from the storage tank **335** to various non-potable applications **390** such as, but not limited to, irrigation of lawn, shrubs, trees and garden, and washing of cars, building, driveways and walkways, and supplying ornamental fountains. The pump may be located within the tank **335** or located external to the tank system. In some embodiments, the pump may be located within the basement of a building **300** for convenient servicing. The pump may also be located above ground or below ground. Various adaptor valves and fittings, and pipes, tubing and hoses **315** may be used to connect the pump to the tank **335**.

[0044] The water-recovery system **330** can be equipped to deal with many possible forms of contamination from the rooftop. A first level of protection can be in the form of a removable, cleanable screen, disposed over the gutter **315** to catch leaves and large solids. A second level of protection is a flow diverter **320** which minimizes potential chemical contamination by diverting a first-flush runoff water away from the recovery system **330**. A third level of protection is in the storage tanks themselves. They serve as a settling basin for any suspended solids that enter the tanks. Finally, the dry well can include a maintenance port enabling periodic cleanout.

[0045] An embodiment of the first-flush system **320** is depicted in greater detail in FIG. **4**. Water entering an inlet from the catchment area flows into a primary tank **321**, and flows into an empty secondary tank **329** through an opening **324** located at the bottom of the primary tank. As water collects in the secondary tank **329**, float **328** attached to arm **327** mounted securely on hinging assembly **326** rises. As more first-flush water enters the lower tank, the arm rises and the attached stopper **325** plugs the opening **324**. Once the hole **324** is plugged, subsequent water will flow out the exit port and to the cistern or storage tank system. In this manner, the contaminated first flush of water is diverted away from the water-recovery system **330**.

[0046] In various embodiments, the amount of water collected in the secondary tank **329** can be adjusted according to the size of the catchment area. This can be done coarsely by selecting a size of the secondary tank **329**, and finely by adjusting the height of the stopper **325** with respect to the float **328**. In some embodiments, the first-flush system can be configured to collect the first 1 millimeter of water that falls on the catchment area.

[0047] The secondary tank **329** can be adapted to provide evaporative removal of the collected water, e.g. holes may be located along its upper exterior surface, or it may extend and open outwards in the form of an evaporative pan. First-flush water with contaminants can collect in the pan during a storm, and the water may evaporate between storms leaving a solid residue. The solid residue may be easily cleaned from the pan.

[0048] In some embodiments, the first-flush system can be automated with electronic valves. In such an embodiment, a rainfall sensor can detect the start of a rain storm and actuate an electronic valve which provides an opening for fluid flow into the secondary tank **329**. A float within the tank could then trigger the closing of the electronic valve.

[0049] Introducing the catchment runoff water to the water-recovery system **330** in this manner helps prevent the introduction of pollutants, such as oil and other contaminants which may collect on catchment surfaces during dry periods, into storm drains, surface and ground waters. Further examples of systems for removing pollutants from stormwater are described in U.S. Pat. No. 6,241,881 to Pezzaniti and U.S. Pat. No. 6,086,756 to Roy, the teachings of which are incorporated herein by reference.

[0050] Although the embodiments described above pertain substantially to a particular modular block style and a particular use in a roof-top, rainwater catchment application, other embodiments of block styles and applications exist.

[0051] Examples of other modular block styles are illustrated in FIGS. **5**A-**5**B and FIGS. **6**A-**6**B. The modular block shown in FIGS. **5**A-**5**B is similar to that shown in FIGS. **1**A-**1**B except for the vertical members **140**. For the block shown in FIGS. **5**A-**5**B, the vertical member **540** comprises a cylindrical tube. Holes **550** and **560** are disposed in the tube for similar purposes as described in connection with FIGS. **1**A-**1**B.

[0052] In an additional variation to the block style, slight convex or concave shapes may be incorporated into the upper **110** and lower **190** surfaces of the block **100**. A convex shape may provide added compressive strength, and still provide a substantially smooth outer surface. Also, convex or concave upper and lower surfaces may reduce any tendency for lateral motion of the blocks when located underground.

[0053] Two embodiments depicting interlocking systems for the modular blocks are shown in FIGS. **6**A-**6**B. A dovetail-type interlocking system is depicted in FIG. **6**A. For this embodiment, a flared bar **604** having a central slot **603** extends along one or more edges of the upper block element **610**A. (Although not shown, the same features can be included on the blocks lower element.) Receptacles **608** are located on the opposing sides of the element **610**A. When the blocks are pressed together, the slot **603** allows compression of the outer edges of the flared bar **604**, so that the bar snaps into the receptacle **608** in the adjacent block.

[0054] FIG. **6**B depicts an embodiment for interlocking the blocks wherein one or more fasteners **680** are pressed into receptacles on the block's upper and lower surfaces. The fastener **680** is dumbbell shaped having two enlarged ends **682** and a linking bar **681**. The receptacles can be readily formed in the upper and lower block surfaces during block manufacture and comprise holes **105** and channels **675**. After the blocks are aligned, the fastener is pressed into the receptacles such that the enlarged ends **682** recess into a portion of the holes **105** and the linking bar **681** recesses into the channels **675**. The fasteners may be fabricated from synthetic material, e.g. nylon, vinyl, polyvinylchloride, polycarbonate, etc. For the embodiment shown in FIG. **6**B, it may not be necessary to use synthetic cord or straps **220** to bind the blocks as shown in FIG. **2**A.

[0055] In other embodiments, synthetic or metallic pins or pegs may be used to attach the blocks. For example, holes may be formed in the outer edges of the block's upper **110** and lower **190** elements. One or more pins may be driven into the

holes such that about one-half of a pin's length remains outside the block. An adjacent block with matching holes may then be driven onto the protruding pins.

[0056] The modular blocks **100** and water-recovery system **330** can be used in other embodiments. For example, the system may be used to collect runoff water from other water impervious surfaces such as driveways, walkways, decks and patios. Larger systems may be employed for parking lots. The tanks may also be used for septic systems in some locations where conforming to local code.

[0057] The water recaptured by this system will help relieve demand on municipal water systems in urban and sub-urban areas, particularly during the summer months. This can help sustain public drinking water supplies. Any water infiltrated by the dry well **355** will promote recharge of groundwater supplies and enhance aquifer storage. The water-recovery system provides useful storage and reduces loss of storm water runoff.

EXAMPLES

Example 1

[0058] As an example of the rainwater-handling capability of the water recovery system **330** illustrated in FIG. **3**, a system servicing a 2000 square-foot roof area is considered. The system of this example has only one 800-gallon storage tank **335** and one 600-gallon dry well **355**. A storage tank for holding about 800-gallons of water can be constructed from nine modular blocks **100** measuring about 2 ft×2 ft×3 ft. Construction for a 600-gallon dry well requires excavation of about 85 ft^3. The total volume of the system, about 1400 gallons of water in this example, can be collected and recovered for subsequent use. The actual amount of recovered water may be greater than this amount depending on the rate of rainfall and rate of infiltration of water from the drywell **355**. For this example, a rainfall of about 1.12 inches falling on the 2000-ft^2 roof area would substantially fill the system, assuming no infiltration of water into the ground from the drywell.

[0059] All literature and similar material cited in this application, including, but not limited to, patents, patent applications, articles, books, treatises, and web pages, regardless of the format of such literature and similar materials, are expressly incorporated by reference in their entirety. In the event that one or more of the incorporated literature and similar materials differs from or contradicts this application, including but not limited to defined terms, term usage, described techniques, or the like, this application controls.

[0060] The section headings used herein are for organizational purposes only and are not to be construed as limiting the subject matter described in any way.

[0061] While the present teachings have been described in conjunction with various embodiments and examples, it is not intended that the present teachings be limited to such embodiments or examples. On the contrary, the present teachings encompass various alternatives, modifications, and equivalents, as will be appreciated by those of skill in the art.

[0062] The claims should not be read as limited to the described order or elements unless stated to that effect. It should be understood that various changes in form and detail may be made by one of ordinary skill in the art without departing from the spirit and scope of the appended claims. All embodiments that come within the spirit and scope of the following claims and equivalents thereto are claimed.

What is claimed is:

1. A liquid-storage tank comprising:

at least one block, the block having:

a substantially rectangular lower element perforated with at least one hole;

a substantially rectangular upper element perforated with at least one hole, the lower element and the upper element substantially parallel to each other; and

at least one vertical support member connecting the upper element and the lower element, the support having at least one perforation;

a covering material enclosing the at least one block to form a liquid-storage volume;

at least one liquid inlet into the storage volume; and

at least one liquid outlet from the storage volume.

2. The apparatus as claimed in claim **1** wherein the at least one block can support a vertical loading of at least about two pounds per square inch and wherein the occupancy ratio of the at least one block is less than about 0.10

3. The apparatus as claimed in claim **1** wherein the at least one block can support a vertical loading of at least about four pounds per square inch and wherein the occupancy ratio of the at least one block is less than about 0.10

4. The apparatus as claimed in claim **1**, the at least one block further including:

at least one integrated female-type fastening mechanism located on each of at least two sides of each block; and

at least one integrated male-type fastening mechanism located on each of at least two sides of each block; wherein

the female-type and male-type fastening mechanisms enable registered assembly of plural, substantially similar, rectangular-shaped blocks.

5. The apparatus as claimed in claim **1** wherein the vertical support of the at least one block comprises at least one wall-like structure having plural perforations, the wall like structure being located and attached substantially along a diagonal of the upper and lower elements; and further includes

at least one reinforcing brace comprising a planar member, oriented substantially parallel to the upper and lower elements and attached to one or more vertical support members.

6. The apparatus as claimed in claim **1** further including:

synthetic cord threaded through at least one perforation in at least one vertical support of each block located at the periphery of an assembled multiple block structure, the synthetic cord providing structural reinforcement of the assembled block structure.

7. The apparatus as claimed in claim **1** wherein

the at least one block is fabricated from a synthetic material using a process selected from the following group: extrusion, injection molding, rotational molding, or casting.

8. The apparatus as claimed in claim **1** wherein

the material used to form the at least one block is selected from the following group: nylon, vinyl, polyvinylchloride, polycarbonate, acrylic, polyethylene, polyurethane, or polystyrene.

9. The apparatus as claimed in claim **1** wherein

the upper element and the lower element are substantially flat.

10. The apparatus as claimed in claim **1** wherein at least a portion of the upper element and at least a portion of the lower element incorporate a shape selected from the following group: convex and concave.

11. The apparatus as claimed in claim **1** further including: at least one dry well connected to the liquid-storage tank.

12. The apparatus as claimed in claim **1** further comprising: a pump connected to the liquid-storage tank; and at least one roof-water collection system connected to the liquid-storage.

13. The apparatus as claimed in claim **12** further comprising at least one filter disposed between the at least one roof-water collection system and liquid-storage tank connected thereto.

14. The apparatus as claimed in claim **12** further comprising at least one roof washer disposed between the at least one roof-water collection system and liquid-storage tank connected thereto, the at least one roof washer includes a flow diverter that diverts a first flush of water away from the liquid-storage tank connected thereto and permits water in excess of said first flush of water to flow to the liquid-storage tank connected thereto.

15. A modular block adapted for constructing a liquid-storage tank comprising:

a substantially rectangular lower element perforated with plural holes;

a substantially rectangular upper element perforated with holes, the lower element and the upper element substantially parallel to each other;

at least one vertical support member connecting the upper element and the lower element, the support having plural perforations;

at least one receptacle for receiving an interlocking fastener; wherein

the block is adapted to support a vertical loading of greater than about two pounds per square inch, has an occupancy ratio of less than about 0.10, has a substantially smooth outer surface, is adapted to be registered and assembled with plural similar blocks, and is adapted to permit movement of liquid to and from all regions within an assembly of plural similar blocks.

16. The apparatus as claimed in claim **15** wherein the vertical support member is substantially cylindrical in shape.

17. The apparatus as claimed in claim **15** wherein the vertical support of the at least one block comprises at least one wall-like structure having plural perforations, the wall like structure being located and attached substantially along a diagonal of the upper and lower elements; and further includes

at least one reinforcing brace comprising a planar member, oriented substantially parallel to the upper and lower elements and attached to one or more vertical support members.

18. The apparatus as claimed in claim **15** wherein the material used to form the at least one block is selected from the following group: nylon, vinyl, polyvinylchloride, polycarbonate, acrylic, polyethylene, polyurethane, or polystyrene.

19. The apparatus as claimed in claim **15** wherein the upper element and the lower element are substantially flat.

20. The apparatus as claimed in claim **15** wherein the at least one receptacle is located on the outer surface of upper element or the lower element, and is adapted for recessing of the interlocking fastener into the upper or lower element.

21. A method for storing non-potable liquid comprising:

forming a tank structure by registering and assembling plural similar modular blocks, each block having:

a substantially rectangular lower element perforated with plural holes;

a substantially rectangular upper element perforated with holes, the lower element and the upper element substantially parallel to each other; and

at least one vertical support member connecting the upper element and the lower element, the support having plural perforations;

covering the tank structure with a substantially water impermeable material; and

providing at least one port for conveying liquid into or out of the tank.

22. The method of claim **21** further comprising: burying the tank structure underground.

23. The method of claim **21** further comprising: connecting a pump to the at least one port.

24. The method of claim **21** further comprising: providing structural reinforcement of the assembled block structure by threading at least one synthetic cord through at least one perforation in at least one vertical support of each block located at the periphery of an assembled multiple block structure and binding the assembled blocks.

25. The method of claim **21** further comprising: collecting non-potable water in the formed tank.

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