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Alsberg et al.

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[54] **DRAINAGE SYSTEM**

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[52] **U.S. Cl.** **61/10,** 404/4

[51] **Int. Cl.** **E02b 11/00**

[58] **Field of Search** 61/10, 11, 16, 1; 404/4, 404/5

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Assistant Examiner—Philip C. Kannan
Attorney, Agent, or Firm—Alvin D. Hooper

[57] **ABSTRACT**

A drainage system for reducing flooding simultaneously with recharging underground water supplies includes structures such as dry wells which connect to underground water sources, water conveying means for conveying water to the structures and storage basins for providing temporary storage of excess water until it can be handled by the structures.

15 Claims, 5 Drawing Figures

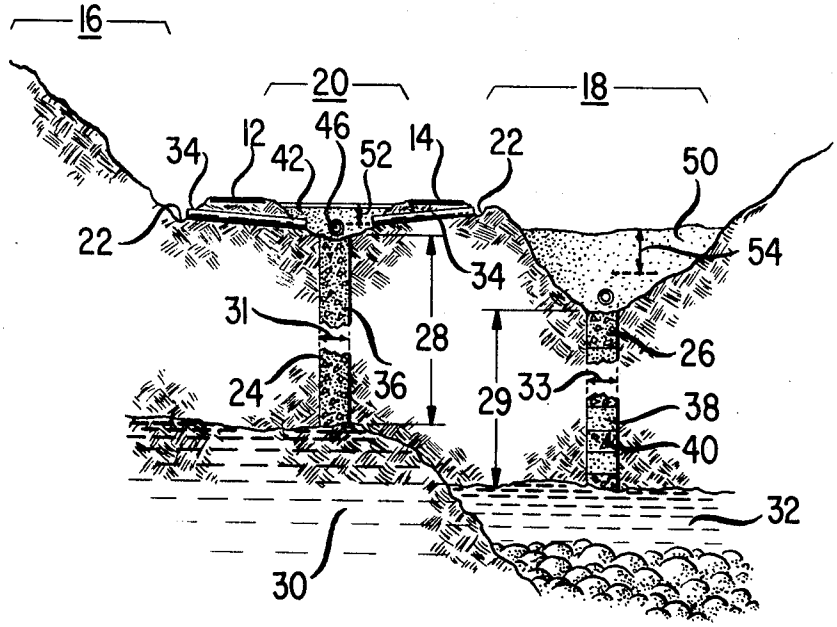


FIG. 1

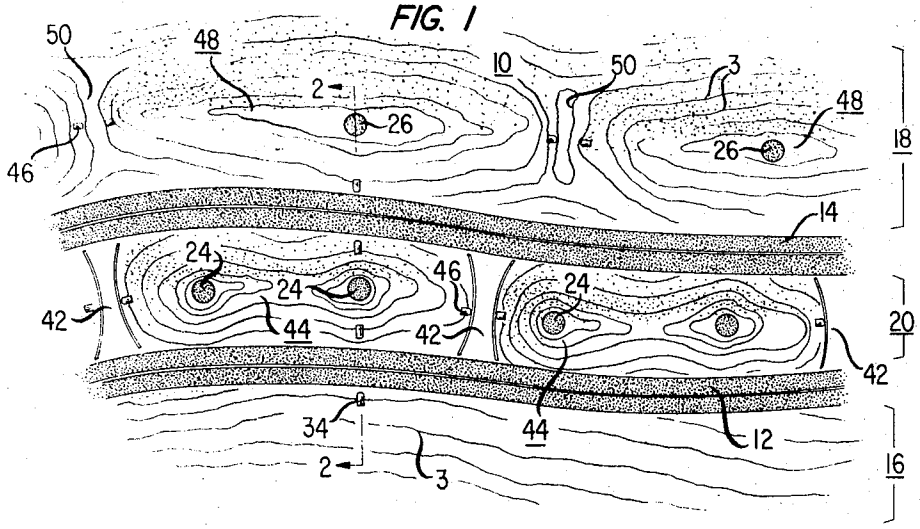


FIG. 2

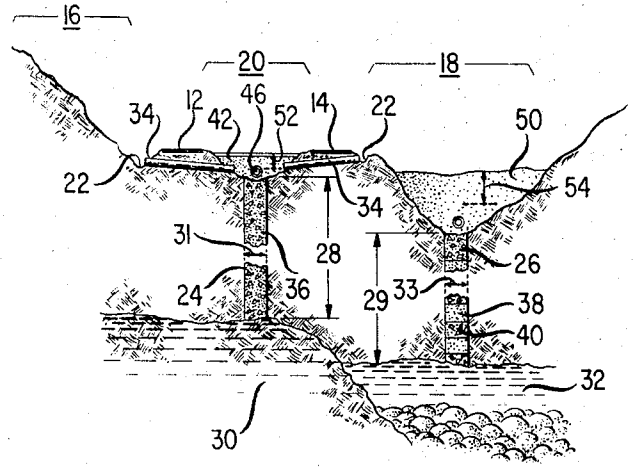


FIG. 3

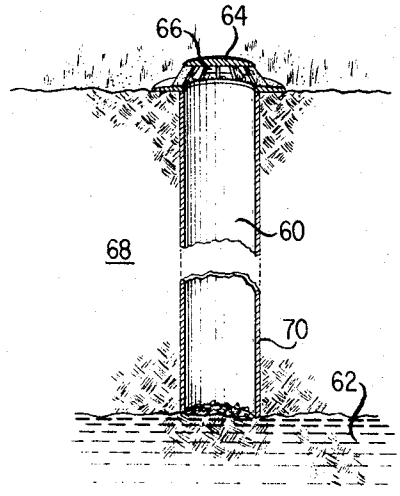


FIG. 4

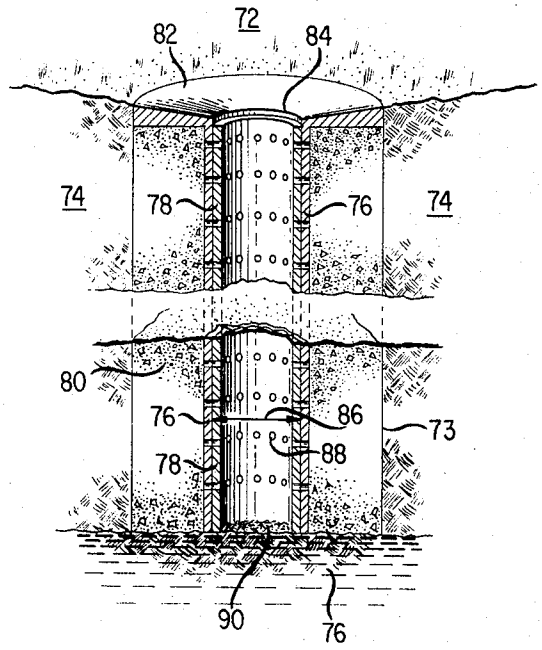
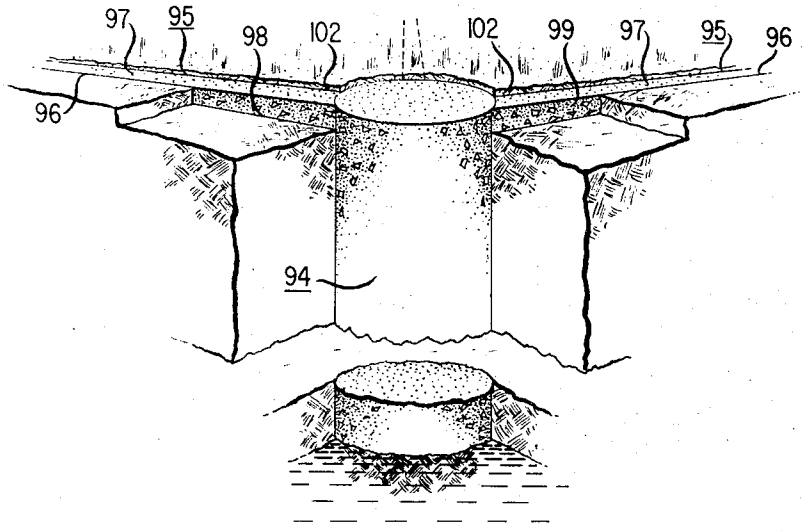

72
82
84
74
78
76
74
80
76
86
73
78
88
90
76

FIG. 5


97
95
98
102
102
99
97
95
96
96
94

DRAINAGE SYSTEM

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to a drainage system and more particularly to a drainage system for discharging excess surface waters into underground water supplies and to decrease the discharge into streams.

2. Description of the Prior Art

The increased urbanization of many parts of the country has greatly increased building and pavement coverage of the land with a corresponding decrease in vegetation covered land needed to absorb rainfall. Accordingly, there has been a substantial increase in the amount of runoff or drainage of surface waters which can no longer be absorbed at a sufficiently rapid rate.

The conventional method of handling this runoff has been to utilize storm sewers and drainage ditches to direct the runoff into local streams. This conventional method has major disadvantages. The first disadvantage is that the increased discharge of water into local streams often produces flooding of these streams with resulting property damage. In some areas a moderate rainfall will require evacuation of areas adjacent to streams into which much surface water is directed. Another major disadvantage of the conventional system is the depletion of the underground water supply. Rainfall which heretofore has been absorbed to recharge the local aquifers is instead carried away in streams. This depletion of the underground water supply necessitates the boring of deeper wells and in some cases has resulted in restrictions on further construction which would add to the demand on the underground water supply.

Accordingly it is an object of this invention to provide a surface water drainage system which simultaneously recharges the local aquifer and prevents excessive discharge into local streams.

Another object is to improve drainage systems for surface waters to prevent flooding of local streams.

SUMMARY OF THE INVENTION

The foregoing objects and others are achieved in accordance with this invention by a drainage system including water permeable connectors, structures or soil penetrations such as dry wells which connect with porous substrata that communicate with the local aquifers or which connect directly to underground streams and which discharge the runoff water into these underground water supplies. Depending upon the seepage rates of the connectors, surface runoff water from the area to be drained is channeled directly to the connectors or to temporary storage basins which in turn direct the water to the connectors at lower rates commensurate with the seepage rates of the connectors. The connectors can be filled with coarse aggregate and can contain filtering layers such as layers of sand interspersed with the coarse aggregate where additional filtering is deemed desirable. In one embodiment of the system particularly suited for drainage of divided lane highways, the highway median is sectionalized into a series of temporary retention basins. Connectors are sunk from these basins to the local aquifers or underground streams. A plurality of small basins or different portions of a drainage area can be connected to a single connector by suitable means such as french drains. Similar combinations of temporary storage basins and connectors to the aquifer could be provided for parking lots and similar high-runoff areas. This discharge of excess surface water into the underground water supplies replenishes these supplies while simultaneously reducing the flooding of local streams.

BRIEF DESCRIPTION OF THE DRAWING

The invention will be more fully comprehended from the following detailed description and accompanying drawing in which:

FIG. 1 is a plan view of a drainage system for a section of highway and surrounding area in accordance with this invention;

FIG. 2 is a sectional view along line 2—2 of FIG. 1;

FIG. 3 is a sectional view of another embodiment of a connector for use in the system of FIG. 1;

FIG. 4 is a sectional view of still another embodiment of a connector for use in the system of FIG. 1; and

FIG. 5 is a sectional view of a variation of the system of FIG. 1.

DETAILED DESCRIPTION

Referring now to FIG. 1 in which lines 3 represent contour lines or lines of constant elevation, the invention will be described with reference to a specific embodiment of a drainage system particularly adapted for use with a multi-lane divided highway. The construction of a divided highway 10 including first and second paved portions or lanes 12 and 14 requires a right-of-way or path substantially wider than the combined widths of the paved portions 12 and 14. Portions of this path are used for grading and drainage on the outsides of the lanes 12 and 14 as illustrated by areas 16 and 18 and another portion 20 provides a median or dividing strip between lanes 12 and 14. The paved portions 12 and 14 are normally given a crown or shape to facilitate the drainage of water therefrom to one or both sides thereof and side areas 16 and 18 and median 20 are graded to prevent the flow of water therefrom onto paved lanes 12 and 14. For example, as shown more clearly in the sectional view of FIG. 2, area 16 on the outside of lane 12 may slope downward toward lane 12. However a drainage ditch 22 or similar water conveyance device prevents the runoff from area 16 from flowing onto lane 12. Median 20 slopes downward from both lanes 12 and 14 and area 18 on the outside of lane 14 slopes downward away from lane 14.

In accordance with a feature of this invention, a plurality of water permeable soil penetrations, structures or connectors 24 and 26 are located at spaced points throughout the areas where water tends to collect. Each connector 24 or 26 is of sufficient depth 28 or 29 to communicate with the local aquifer 30 or an underground stream 32 in the sense of being able to discharge water therein. Depth 28 or 29 will depend upon the local geology and may typically range from a few feet to over a hundred feet. Likewise the diameter 31 or 33 of connector 24 or 26 will depend upon the flow rate desired to be accommodated. The runoff or surface water enters connector 24 or 26, permeates down this connector and discharges into aquifer 30 or stream 32 thereby replenishing these bodies. For example, connectors 24 can be placed in the lowest points of median 20. Thus water discharging from lanes 12 and 14

will flow into these connectors **24**. Water from surfaces outside of lanes **12** and **14** such as surface **16** can also be directed into connectors **24** within median **20** by providing appropriate culverts or storm sewers **34** underneath lanes **12** and **14** which connect drainage ditches **22** to median **20**. Likewise connectors **26** can be placed in areas outside of lanes **12** and **14** such as in area **18** where water tends to collect. Surface water in median **20** and area **18** can readily be directed into appropriate connectors **24** or **26** by proper grading and sloping of median **20** and areas **16** and **18** and by the use of drainage means such as ditches **22**, culverts **34** and like conventional drainage techniques.

In one embodiment such as illustrated by connectors **24** and **26** the water permeable structure comprises a dry well filled with suitable water permeable material. Where the dry well communicates with an aquifer such as illustrated by connector **24** in FIG. **2** connecting with aquifer **30**, the filtering properties of the porous substrate may provide adequate filtering for the surface water. In such a case the dry well can contain a coase aggregate **36** such as coarse gravel which provides only limited filtering. When the dry well connects substantially directly to an underground stream such as illustrated by connector **26** in FIG. **2** connecting with underground stream **32**, additional filtering can be provided by interspersing layers of sand **38** in coarser aggregate such as gravel **40**.

In another embodiment, connectors **24** and **26** can comprise open wells **60** which are sunk to the depth of a local aquifer or underground stream **62** as shown in section in FIG. **3**. Such wells **60** advantageously are provided with covers **64** which prevent the entry of debris but allow the ingress of water through openings **66**. Depending upon the makeup of the surrounding soil **68**, wells **60** may require a rigid lining **70** to prevent deterioration by cave-ins.

In still another embodiment connectors **24** and **26** comprise a structure **72** as shown in section in FIG. **4**. Structure **72** includes an opening **73** through soil **74** down to an underground water supply **76**. First and second concentric pipes or tubes **76** and **78**, respectively, are substantially centered within opening **73**. The space between pipes **76** and **78** and the walls of opening **73** is filled with a lining **80** of coarse aggregate such as gravel or other water permeable material. A cover **82** having an opening **84** in the top thereof which has a diameter approximately the same as the outer diameter **86** of second or inner pipe **78** is placed over the ends of pipes **76** and **78** and lining **80** flush with or slightly below the surface of soil **74**. Pipes **76** and **78** contain perforations **88** which make them water permeable so that water draining into pipe **78** through opening **84** can readily permeate into lining **80** and thence to underground water source **76**. Structure **72** is advantageous in that silt **90** or other debris in the water draining into inner pipe **78** through opening **84** tends to collect in the bottom thereof while the water permeates pipes **76** and **78** and lining **80** to enter source **76**. Accordingly inner pipe **78** is designed to be removable so that it can be removed and cleared of silt **90** periodically and then replaced. When pipe **78** is removed pipe **76** remains in place to prevent shifting of the material in lining **80** so that pipe **78** can be readily replaced. Where the silt **90** is sufficiently coarse that it will settle at the bottom of pipe **78** and will not clog the perforations or pores **88** of pipes **76** and **78**, pipe **78** may be omitted and the clean out function be limited to removing the accumulated silt deposits at the bottom of pipe **76**.

In many instances connectors **24** and **26** of sufficient capacity can be provided to accommodate in real time all runoff water directed thereto by the previously mentioned graded slopes, culverts, drainage ditches, storm sewers and the like, i.e., is able to discharge water into the underground supplies as fast as it is directed thereto. However, in the event of high rates of sustained rainfall it is likely that connectors **24** and **26** will be unable to discharge the runoff into the aquifer or underground streams at the same rate as the runoff is received. Accordingly it is another feature of this invention to provide retention basins for temporary storage of excess runoff until such time as this excess runoff can be handled by connectors **24** and **26** for discharge into aquifer **30** or underground stream **32**.

Median **20** is well suited for the establishment of retention basins. A series of abutments or small dams **42** are placed across median **20** at spaced points therealong thereby sectionalizing or dividing it into a plurality of retention basins **44** which store runoff from adjacent sections of lane **12** and **14** and area **16**. Sectionalizing median **20** has the additional advantages of preventing the flow of runoff therealong for substantial distances which tends to produce erosion. Each basin **44** includes therein one or more connectors **24** for discharging the water collected therein into aquifier **30** or stream **32**. Water can be directed from one basin **44** to another by providing culverts **46** or the like through dams or abutments **42** as indicated. Such culverts **46** might be desirable where more runoff is expected to flow into one particular basin **44** than into adjacent basins **44**.

In like manner temporary storage basins **48** can be easily provided in the areas such as area **18** on the outside of lanes **12** and **14** by forming suitable abutments **50** at suitable points along depressions in these areas. These basins **48** would include connectors **26** for discharging runoff water as previously described.

The average effective depths **52** and **54** of basins **44** and **48**, respectively, will depend upon such factors as the ratio of the surface area of basins **44** and **48** to the surface area draining into the respective basins and the rate of discharge of water from basins **44** and **48** by the associated connectors **24** and **26**. For example the available surface area for basins **44** may be on the order of one-half to one-third of the surface area of the corresponding sections of area **16** and lanes **12** and **14** draining therein. Accordingly, a basin **44** having an average depth **52** of at least two to three times the total rainfall expected within a specified storage time sufficient for connectors **24** to discharge the runoff would be adequate.

Because basins **44** and **48** and associated connectors or penetrations **24** and **26**, respectively, are advantageously formed in areas already disturbed by construction activity, there should be little if any incremental cost in forming these structures. The savings obtained from the elimination of extensive drainage ditches and storm sewers should easily offset any increase in costs without considering the major advantages of reduced flooding in local stream and replenishment of the underground water supply.

In areas where it is difficult to slope basins **44** and **48** to insure good drainage from all points therein into

connectors **24** and **26** and also in areas where water must be conveyed over any substantial distance to these connectors, french drains advantageously can be used in connection with the connectors as illustrated in section in FIG. **5**. A connector **94** comprising a dry well filled with gravel or similar aggregate in the illustrative embodiment has radiating outward therefrom a plurality of french drains **95** comprising trenches **96** filled with coarse aggregate **97** such as gravel. Drains **95** are sloped toward connector **94** so that water therein will flow along aggregate **97** into connector **94**. A bed **98** of aggregate **99** can be formed about the top or mouth of connector **94** to serve as a collection basin to feed connector **94**. French drains **95** can be formed very economically and because they are covered with a layer of soil **102** no unsightly structures are visible.

While the invention has been described with reference to a specific embodiment particularly suited for a highway drainage system, it should be apparent that it has a much broader application. For example, connectors and temporary storage basins could readily be provided adjacent parking lots, building complexes and the like. All such systems involve the use of the combinations of the primary features of a water permeable connector or penetration in the earth which communicates with the local aquifer or an underground stream, water direction means for directing runoff to such connectors, and storage basins for the temporary storage of excess runoff which cannot be handled on a real-time basis.

What is claimed is:

1. A water drainage system for removing excess water from a section of highway having a plurality of paved lanes and unpaved shoulder areas of ground on the outside of said lanes comprising, in combination:

at least one water permeable structure penetrating said ground within said shoulder areas connecting with an underground source of water; and

at least one water retaining basin formed in said shoulder areas providing temporary storage of said excess water and directing said excess water into said water permeable structure.

2. A water drainage system for removing excess water from a section of highway having a plurality of paved lanes with an unpaved median portion therebetween comprising, in combination:

at least one water permeable structure penetrating the ground within said median portion connecting with an underground source of water; and

at least one water retaining basin formed in said median portion providing temporary storage of said excess water and directing said excess water into said water permeable structure.

3. The system of claim **2** wherein said water permeable structure comprises a dry well containing sand.

4. The system of claim **2** wherein said highway includes shoulder areas on opposite sides of said lanes with respect to said median portion and including at least one of said water permeable structures and at least one of said water retaining basins formed in said shoulder areas.

5. The system of claim **2** including a plurality of dams across said median portion forming a plurality of said water retaining basins which sectionalize said median portion.

6. The system of claim **2** wherein said highway includes shoulder areas on opposite sides of said lanes with respect to said median portion and including water conveying means transversing said lanes and connected with said basin in said median portion for directing water from said shoulder areas into said structure.

7. The system of claim **2** wherein said water permeable structure comprises an open well.

8. The system of claim **2** wherein said structure is connected to an aquifer.

9. The system of claim **2** wherein said structure is connected to an underground stream.

10. The system of claim **2** wherein said water permeable structure comprises a dry well containing a water permeable coarse aggregate material such as gravel.

11. The system of claim **10** including layers of sand interspersed with said coarse aggregate material for filtering said excess water permeating said dry well.

12. The system of claim **2** wherein said water permeable structure comprises a well including:

a first water permeable pipe extending downward through said well;

a lining of water permeable coarse aggregate material surrounding said first pipe; and

a cover over said first pipe and said lining having an opening therein for directing water into said first pipe whereby silt can be removed from said water and collected in said first pipe prior to being discharged into said underground source.

13. The system of claim **12** including a second water permeable pipe removably mounted within said first pipe, said water being directed into said second pipe by said opening whereby said silt can be removed from said structure by removing said second pipe.

14. The system of claim **2** wherein said water permeable structure comprises a dry well containing a water permeable coarse aggregate material therein; and

said basin includes a plurality of trenches filled with said aggregate material and having a covering of soil thereover, said trenches connecting said basin to said dry well.

15. The system of claim **14** including a bed of said coarse aggregate material surrounding said dry well for directing water therein, said trenches being connected with said bed.

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