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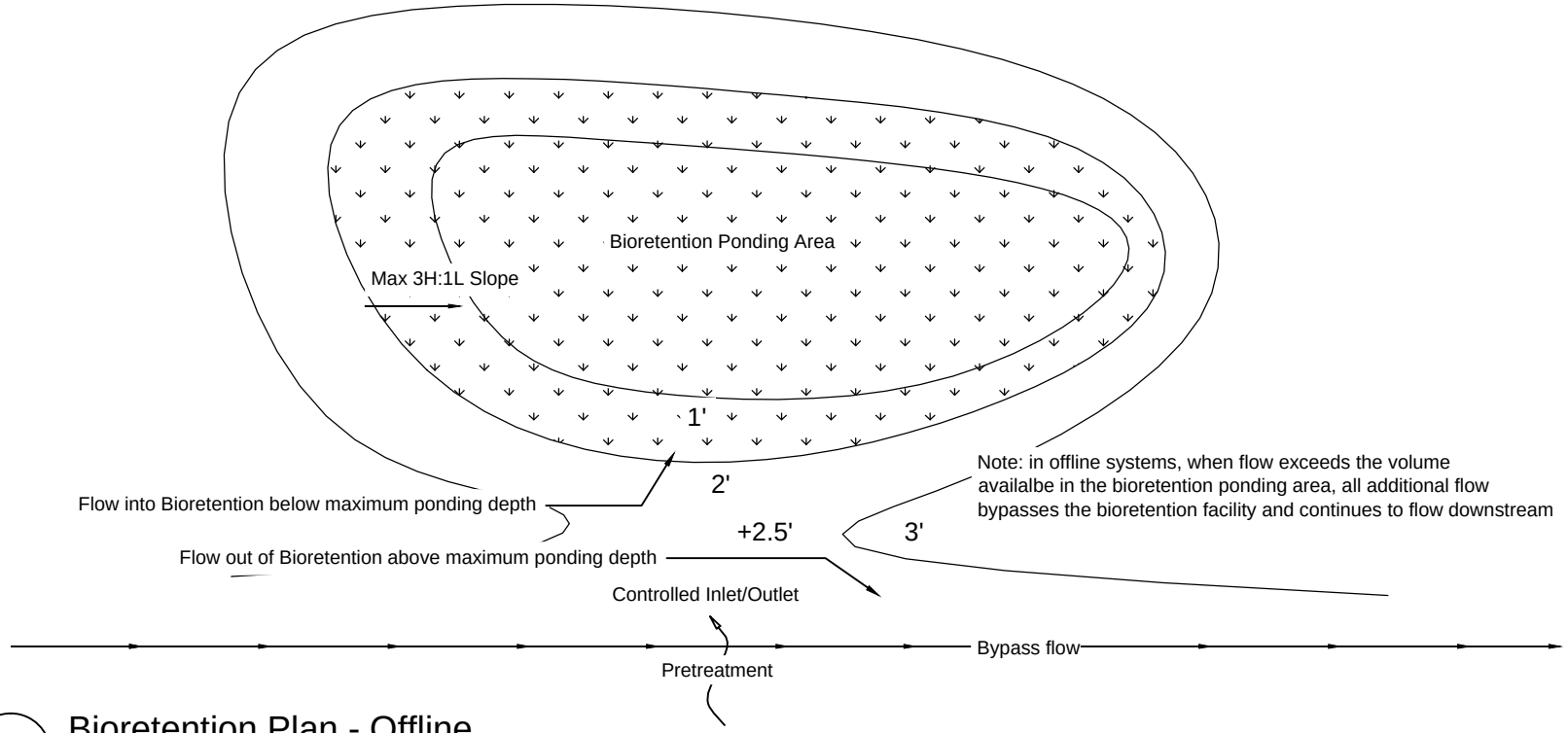
MATERIAL SPECIFICATIONS

1. See Minnesota Stormwater Manual for material specifications recommendations for bioretention soil, mulch, underdrains, etc.



Bioretention Plan - Offline

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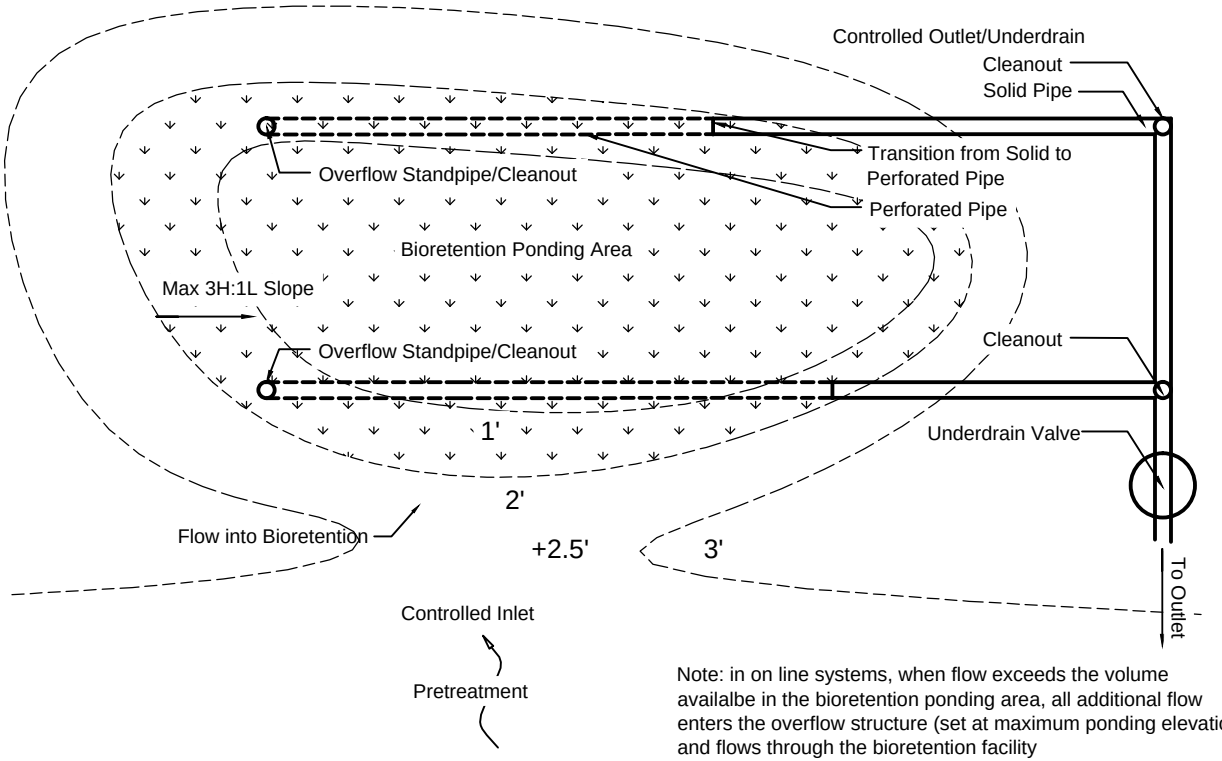

Note: in on line systems, when flow exceeds the volume availalbe in the bioretention ponding area, all additional flow enters the overflow structure (set at maximum ponding elevation) and flows through the bioretention facility

Bioretention Plan - On Line

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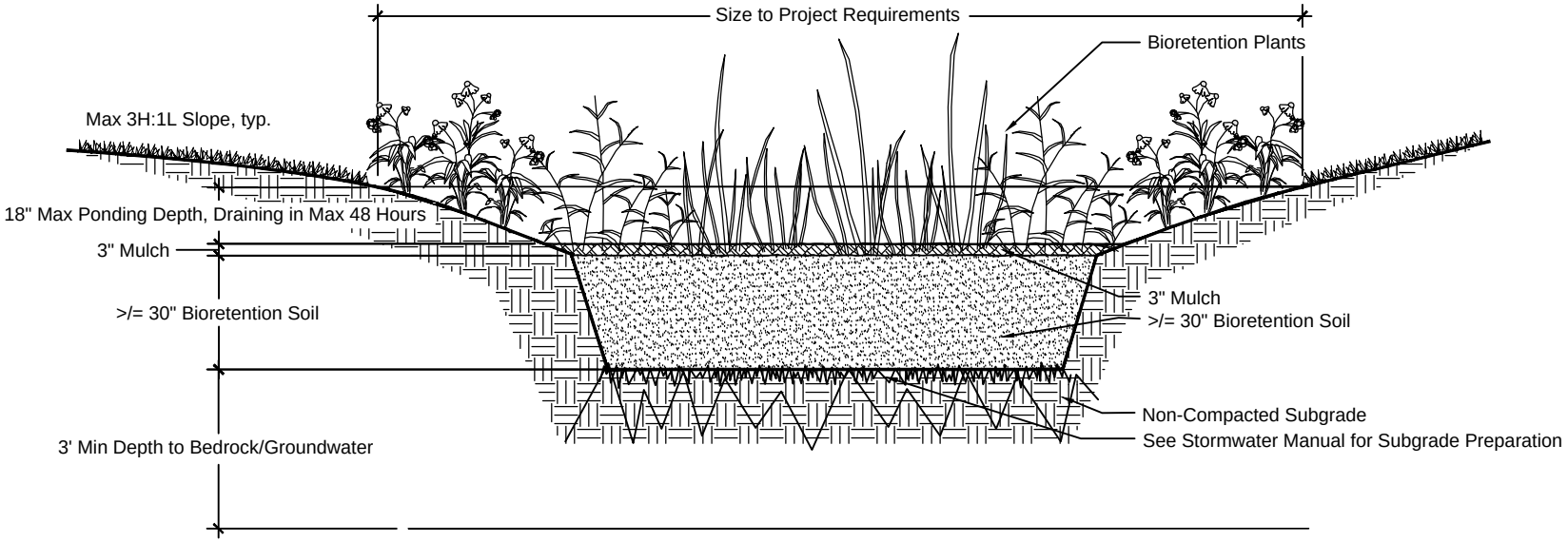

Bioinfiltration

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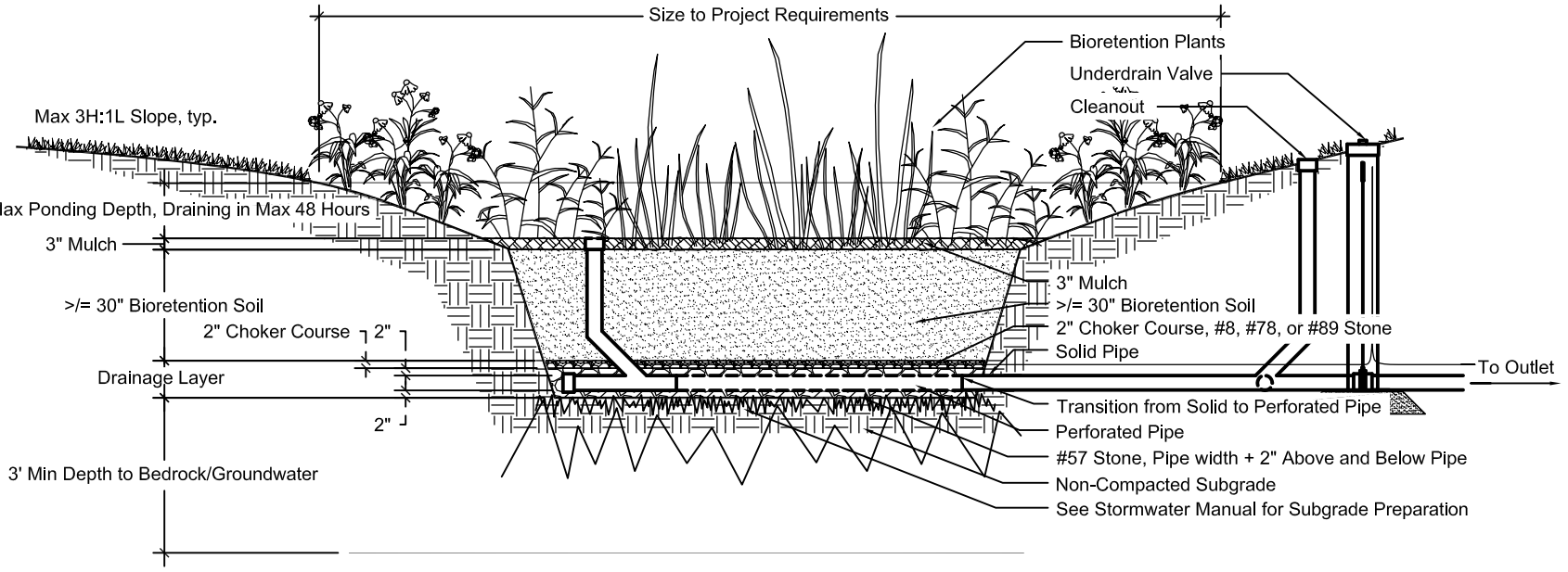

Biofiltration with Underdrain at Bottom

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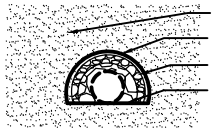

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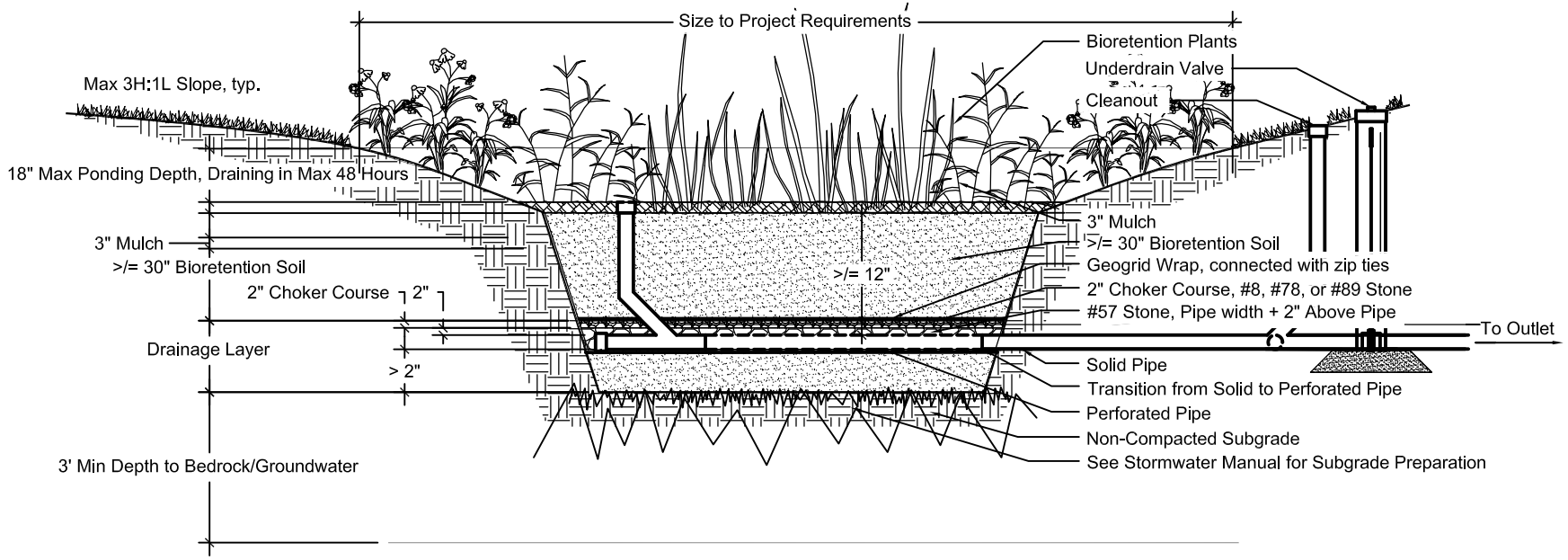

Biofiltration with Elevated Underdrain

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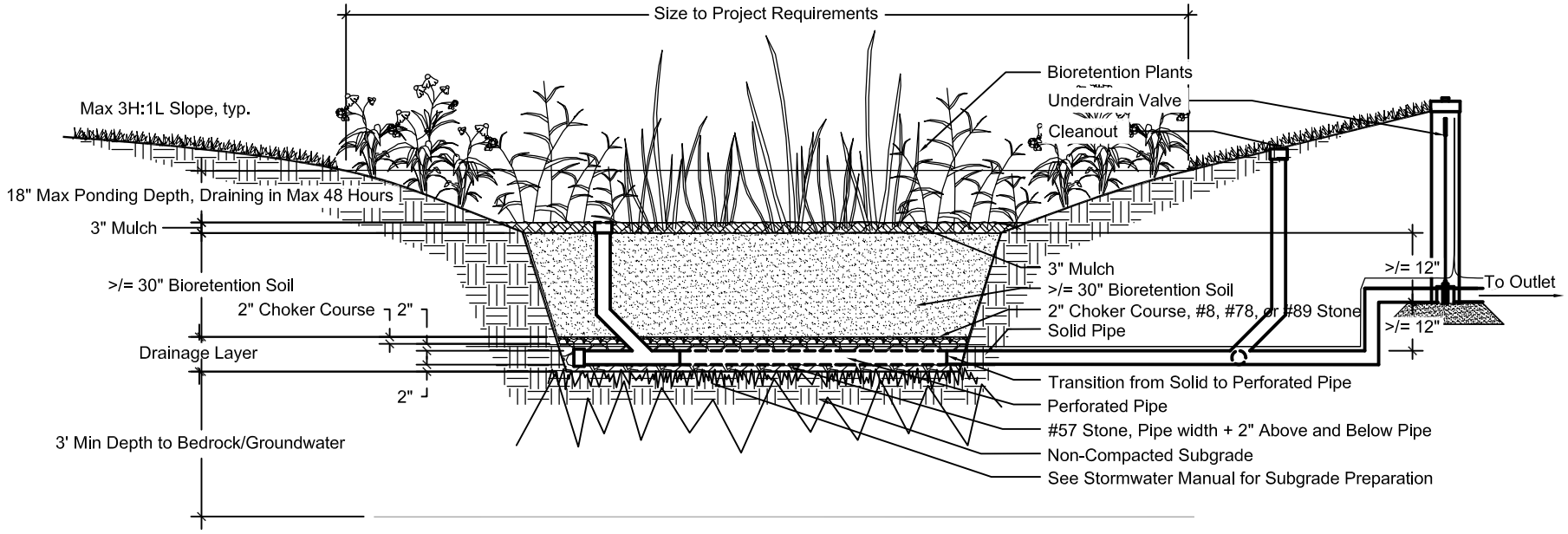

Biofiltration with Internal Water Storage

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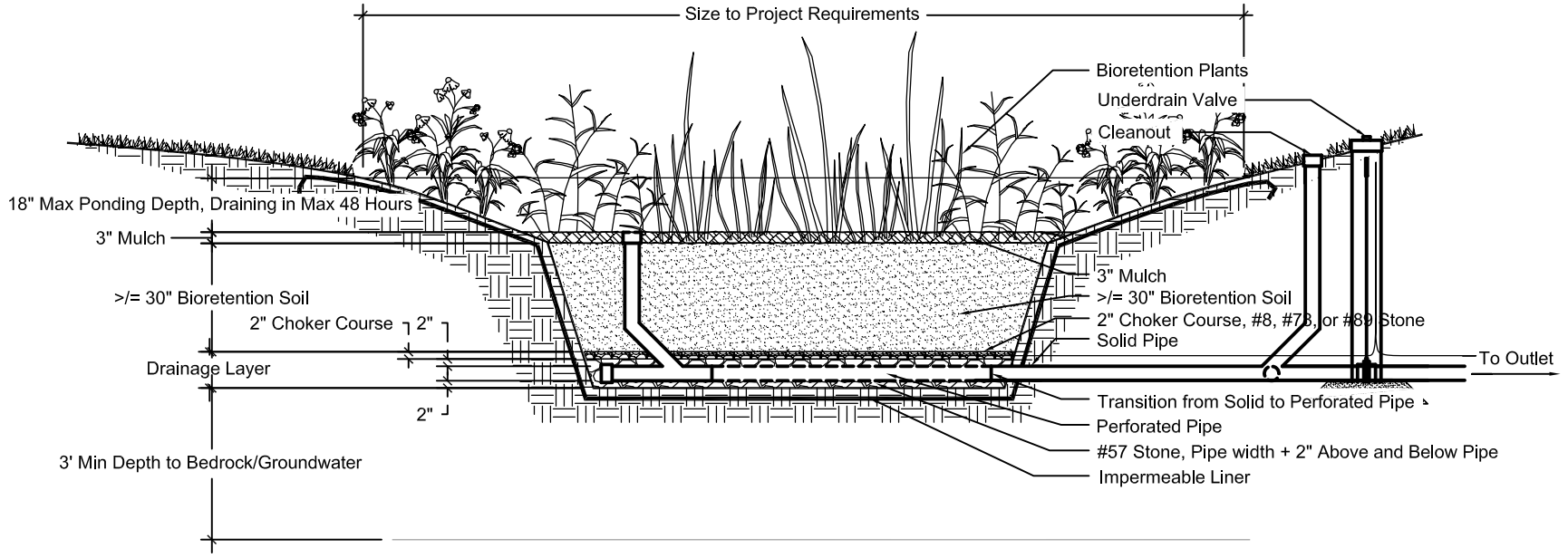

Biofiltration with Liner

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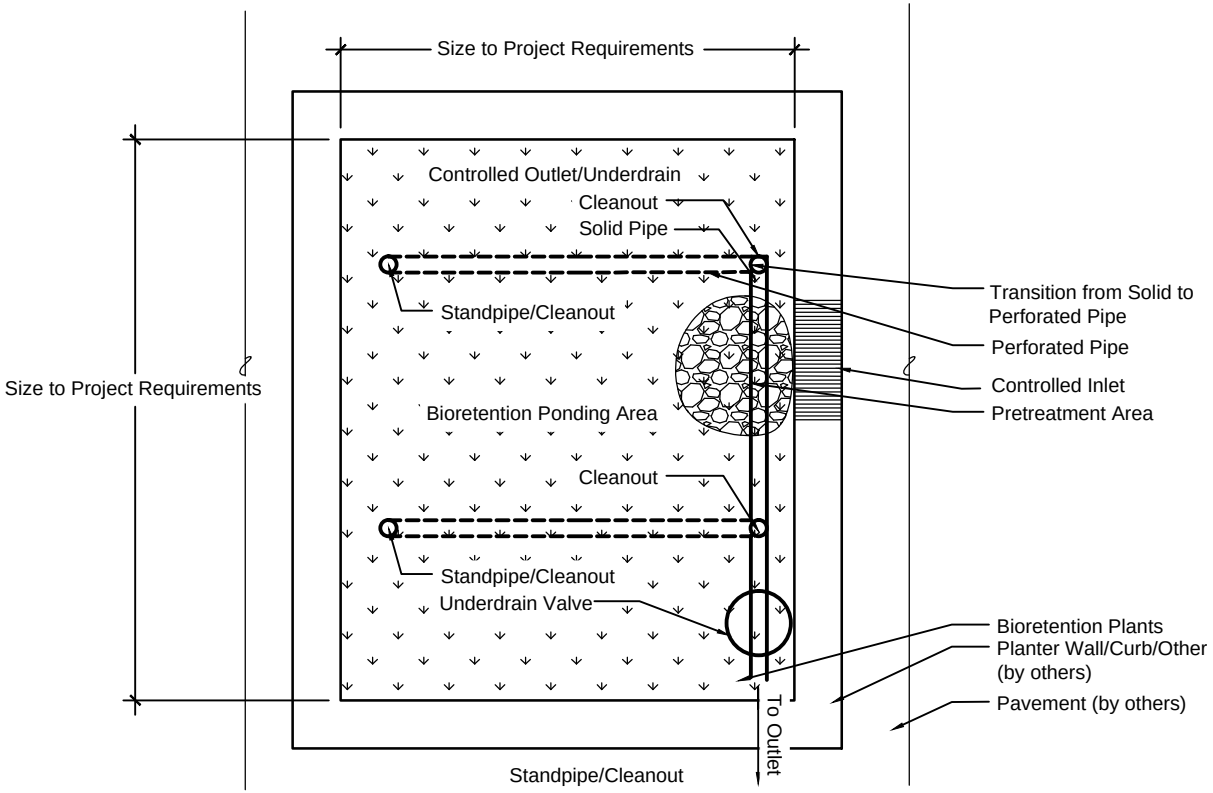

Biofiltration Planter - Plan

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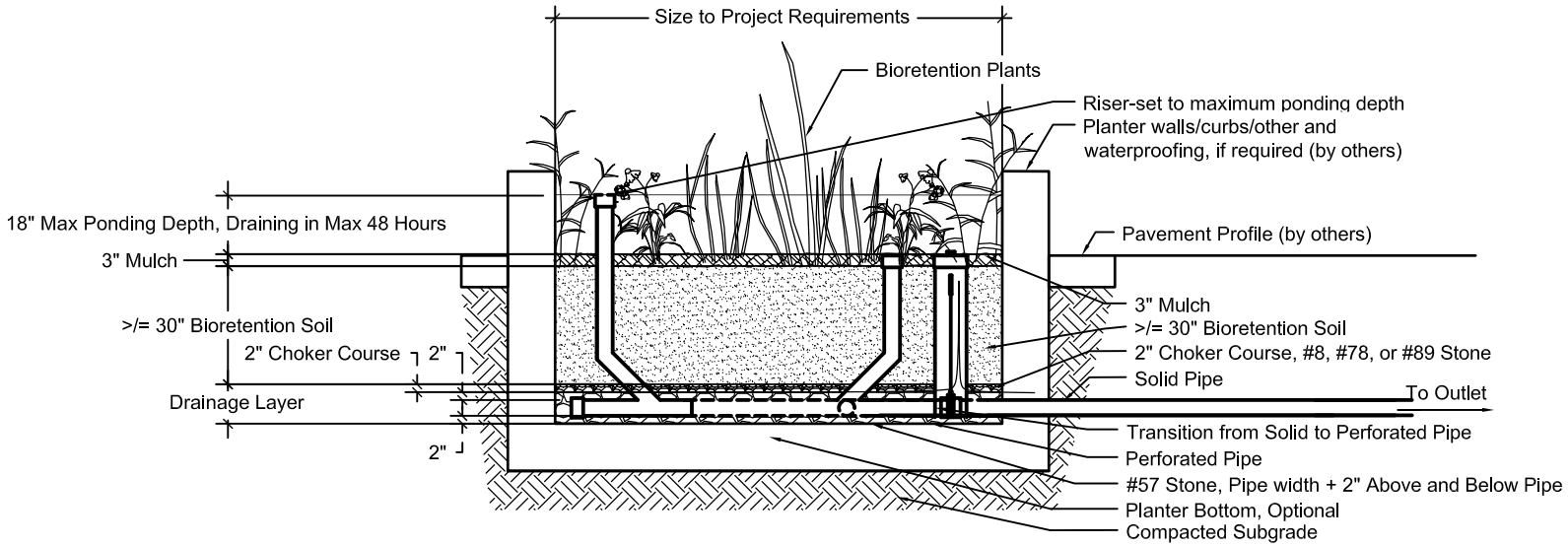

Biofiltration Planter - Section

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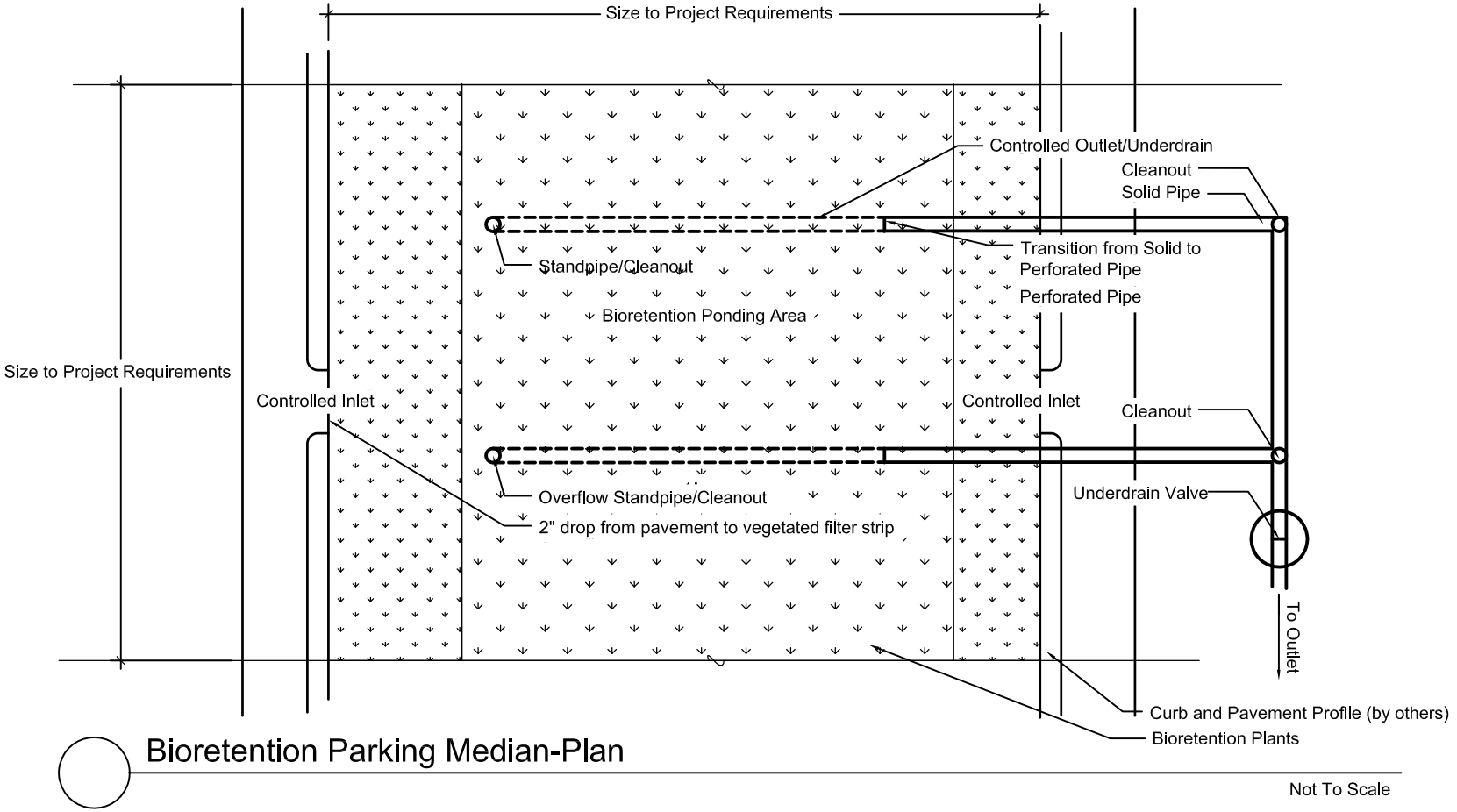

Bioretention Parking Median-Plan

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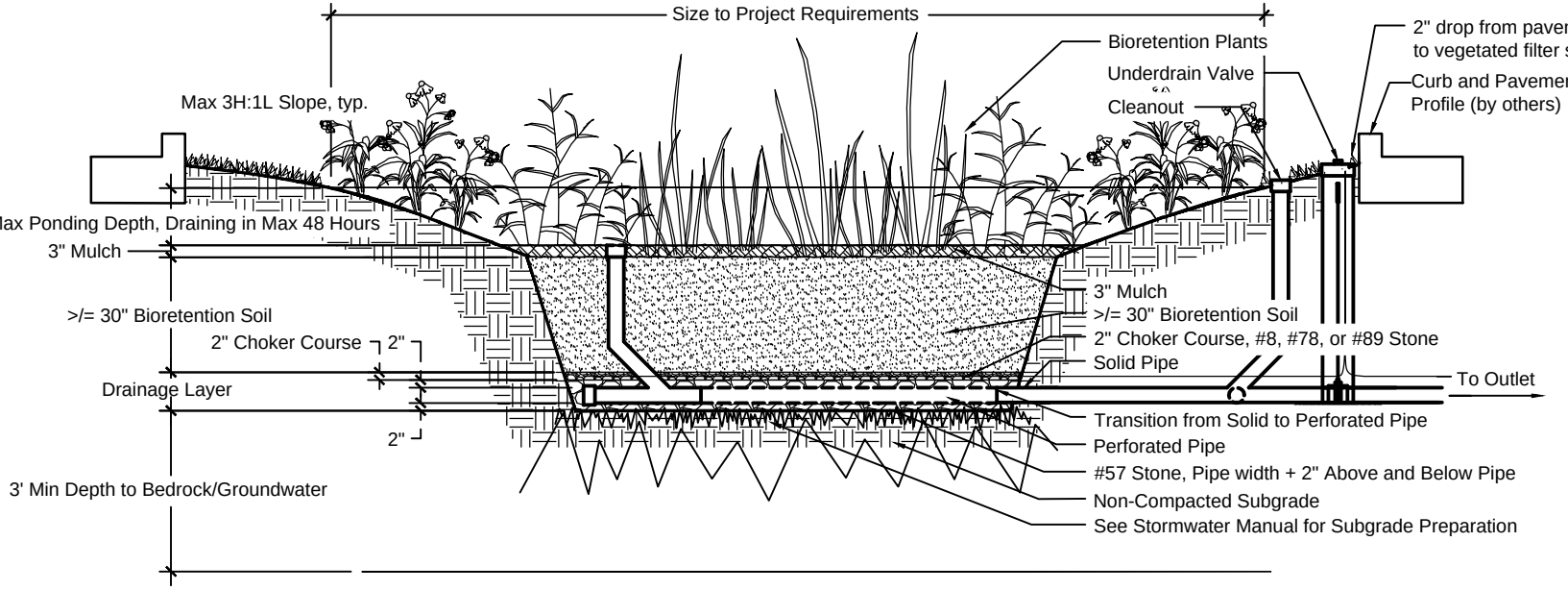

Bioretention Parking Median-Section

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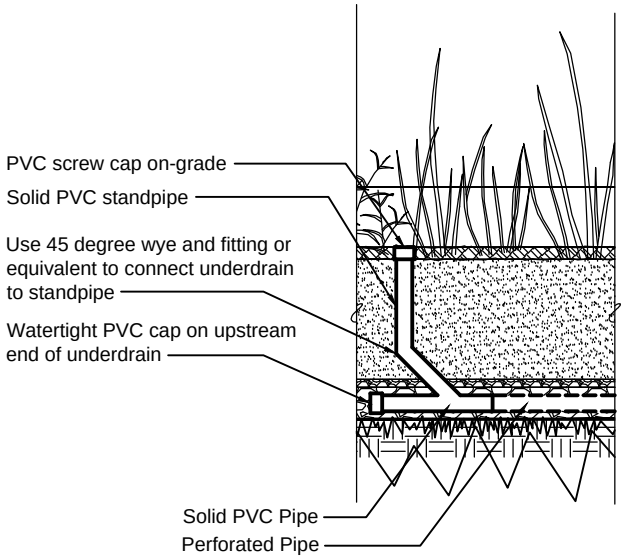

Cleanout

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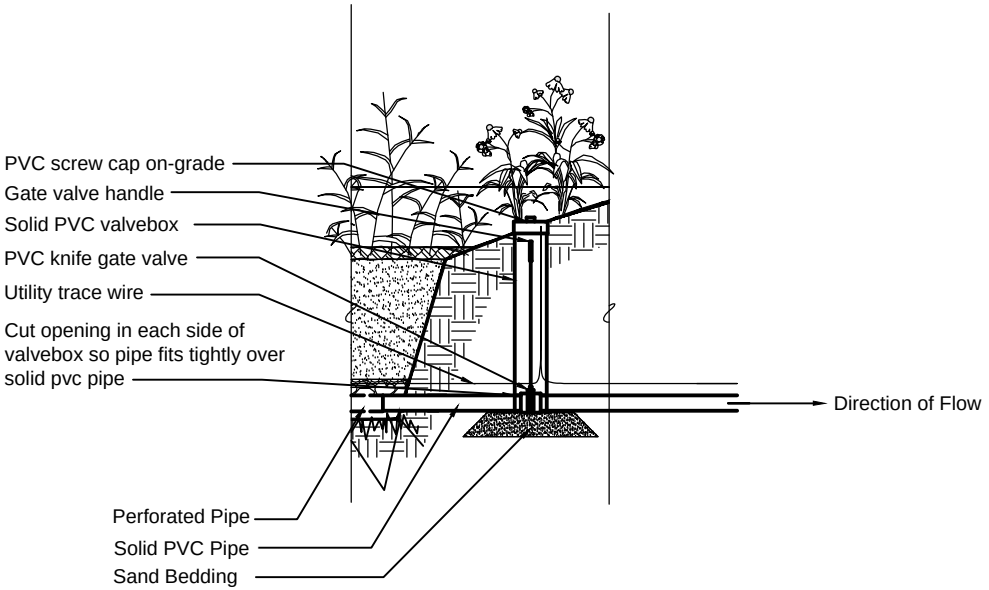

Underdrain Valve

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Biofiltration with Elevated Underdrain

More of the runoff that flows into the basin and does not overflow into an overflow structure is abstracted from the stormsewer system through infiltration or evapotranspiration compared to bioretention with an underdrain at the bottom of the basin; the remainder is filtered by the growing medium but then leaves via an elevated underdrain.

Because elevating the underdrain increases hydraulic retention time, it (1) allows for **more infiltration and evaporation** compared to biofiltration with underdrain at the bottom, but likely some flow short circuits media below underdrain invert, resulting in slightly less volume and water quality benefits than biofiltration with an underdrain with upturned elbow (2) improves **thermal pollution abatement** and **nitrogen removal** (longer retention time allows runoff to cool more before discharge and allows denitrification to occur under anoxic condition).

With an elevated outlet, biorfiltration can be added as retrofits in more areas with restricted outlet depth.

Requires more aggregate than biofiltration with upturned elbow

In-situ soils must have adequate permeability for an elevated underdrain to be beneficial.

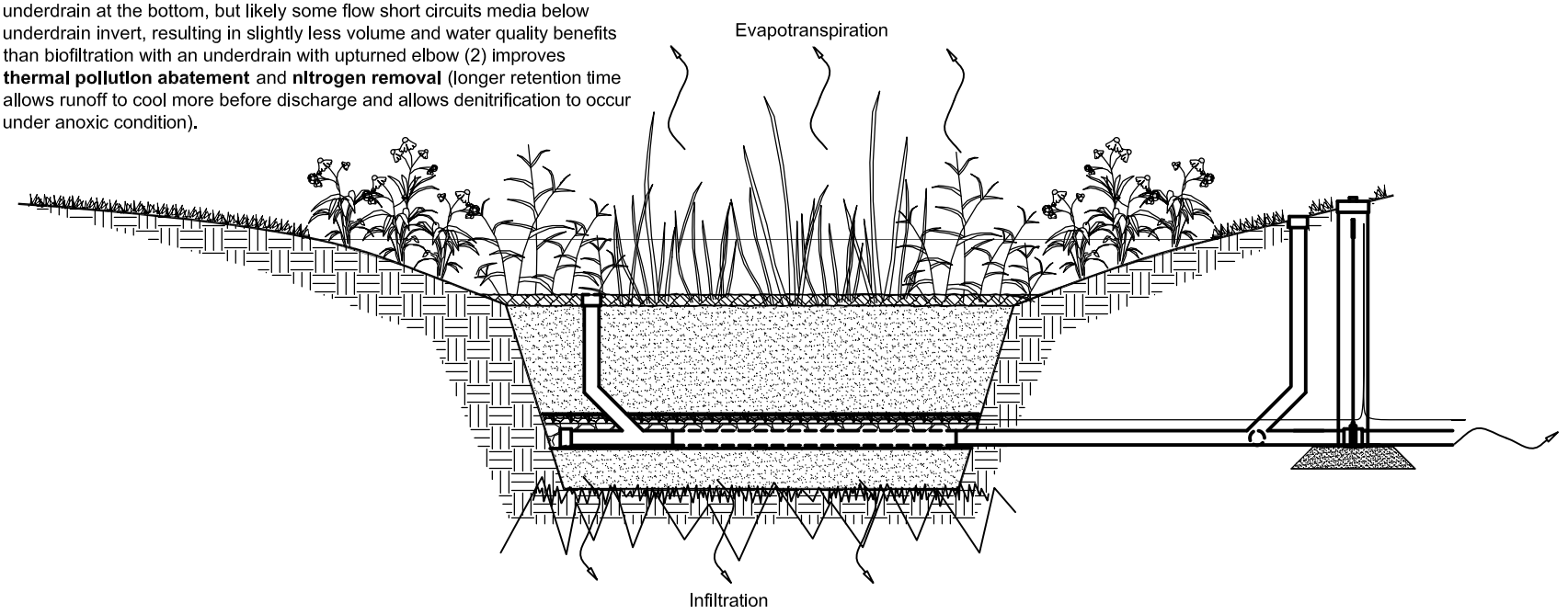

Figure 2-3: Biofiltration with Elevated Underdrain

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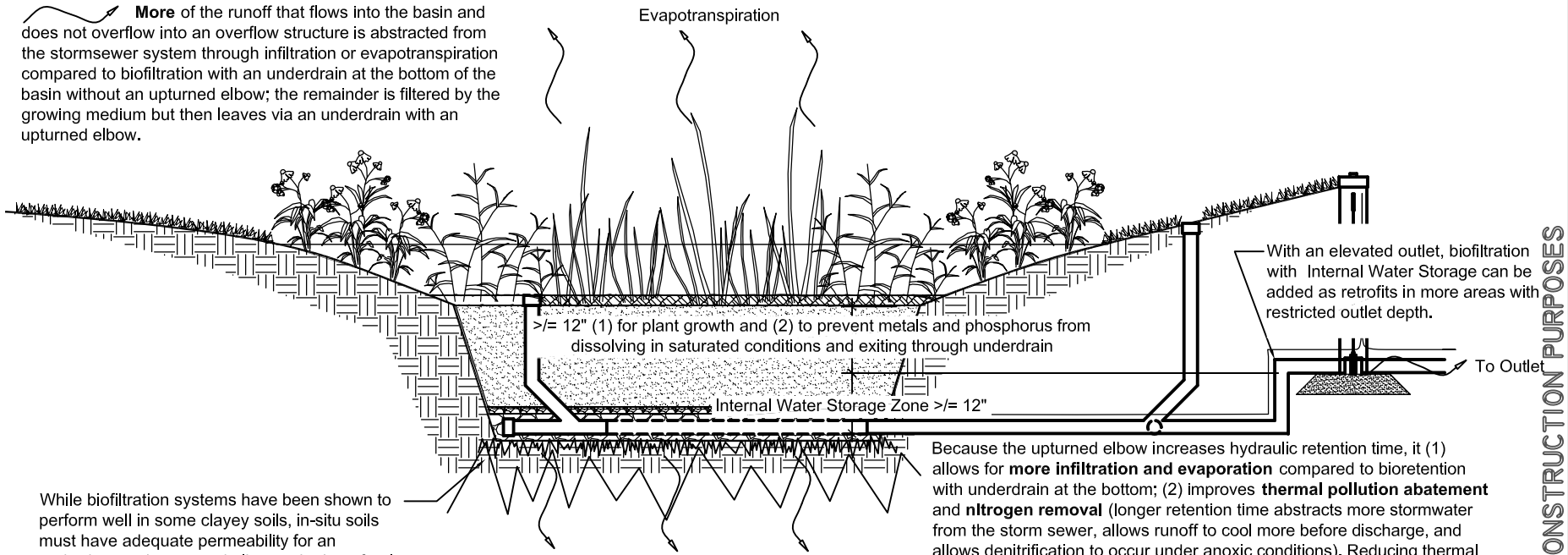
Biofiltration with Internal Water Storage

More of the runoff that flows into the basin and does not overflow into an overflow structure is abstracted from the stormsewer system through infiltration or evapotranspiration compared to biofiltration with an underdrain at the bottom of the basin without an upturned elbow; the remainder is filtered by the growing medium but then leaves via an underdrain with an upturned elbow.



While biofiltration systems have been shown to perform well in some clayey soils, in-situ soils must have adequate permeability for an underdrain with upturned elbow to be beneficial.

Because the upturned elbow increases hydraulic retention time, it (1) allows for **more infiltration and evaporation** compared to bioretention with underdrain at the bottom; (2) improves **thermal pollution abatement** and **nItrogen removal** (longer retention time abstracts more stormwater from the storm sewer, allows runoff to cool more before discharge, and allows denitrification to occur under anoxic conditions). Reducing thermal pollution is especially beneficial for temperature reductions in trout waters.

Figure 2-4: Biofiltration with Internal Water Storage

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Biofiltration with Underdrain at Bottom

A small amount of the runoff that flows into the basin and does not overflow into an overflow structure is abstracted from the stormsewer system through infiltration or evapotranspiration; the remainder is filtered by the growing medium but then leaves via an underdrain.

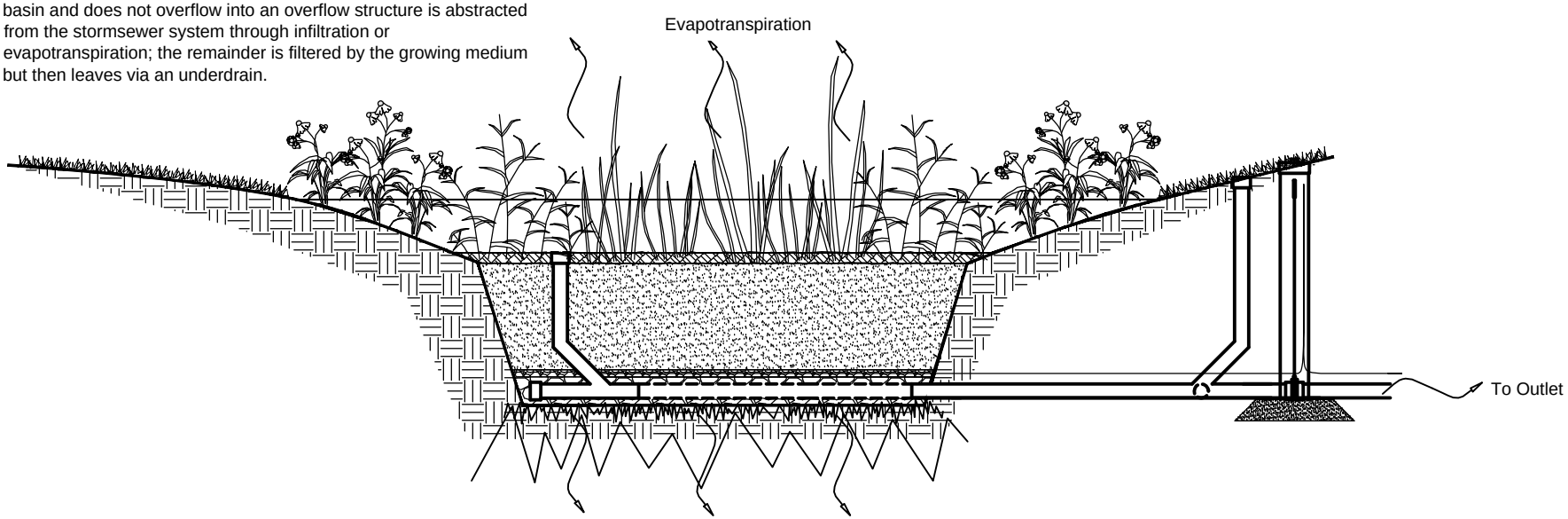

Figure 2-2: Biofiltration with Underdrain at Bottom

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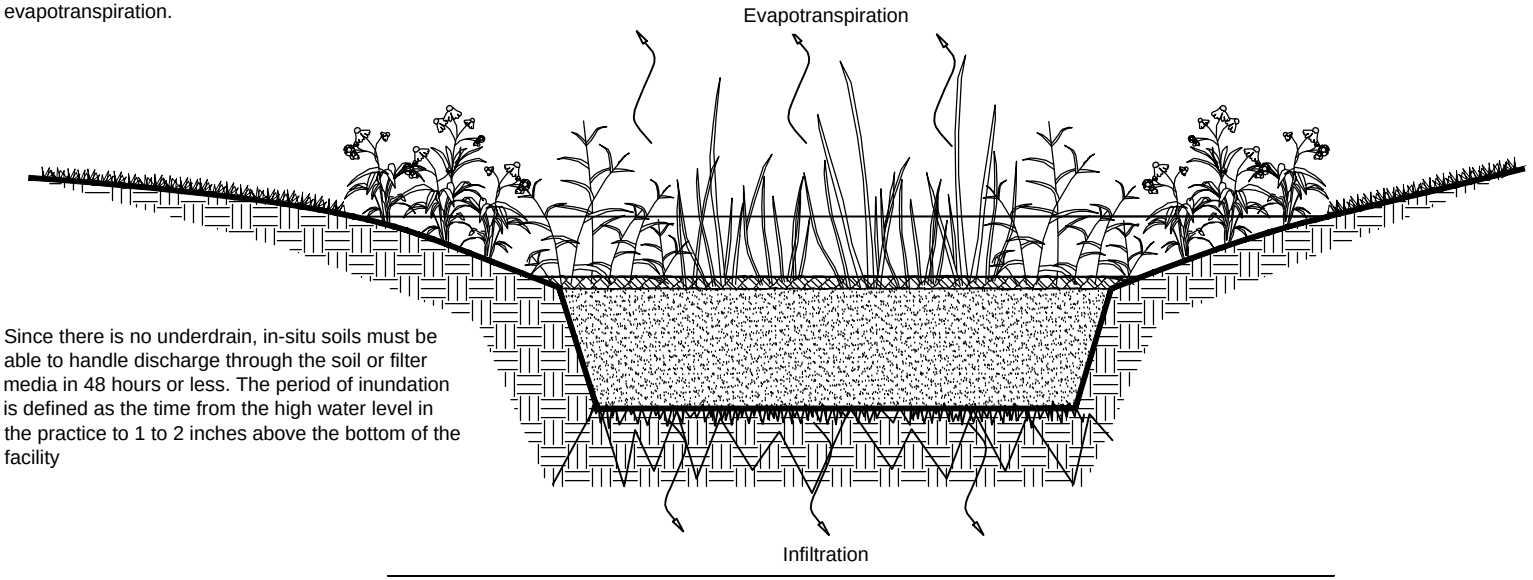
Bioinfiltration

There is no underdrain, so all runoff that flows into the basin and does not overflow into an overflow structure is abstracted from the stormsewer system through infiltration or evapotranspiration.



Since there is no underdrain, in-situ soils must be able to handle discharge through the soil or filter media in 48 hours or less. The period of inundation is defined as the time from the high water level in the practice to 1 to 2 inches above the bottom of the facility

Figure 2-1: Bioinfiltration

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Biofiltration with Liner

None of the runoff that flows into the basin is abstracted from the stormsewer system through infiltration but some is abstracted through evapotranspiration; i.e. all of the runoff that flows into the basin without flowing into an overflow structure, and is not evapotranspired, is filtered by the growing medium but then leaves via an underdrain

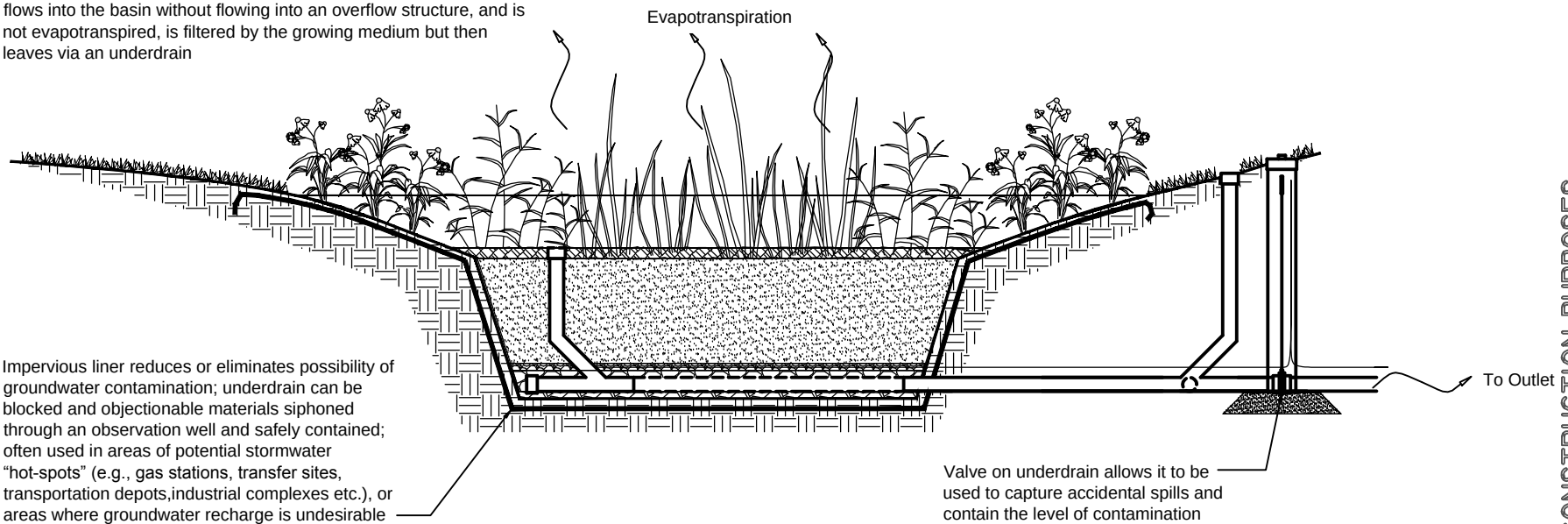

Figure 2-5: Bioretention with Liner

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