

# Drywells

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Drywells are vertically installed, underground infiltration facilities that receive runoff from impervious surfaces via buried pipes. Drywells reduce runoff flow rates, volumes, and temperature by infiltrating runoff into the surrounding soils (BES 2006). Drywells have limited storage capacity, but do store some runoff during a rainfall event. These systems provide fewer benefits than other low-impact development measures. They also tend to be one of the more expensive types of facilities to construct and are complex to permit. Because of these factors, they are generally chosen as a last resort when surface-infiltration facilities (such as rain gardens, planters, and porous pavements) either cannot be used or cannot be placed on the site in such a way that they reduce storm water volumes. By their design, drywells are underground injection control (UIC) devices and will trigger state UIC requirements. (See Permits section below.)

In Oregon, there are generally two kinds of drywells that are commercially available, both of which are perforated manhole rings. In other areas of the country, the information available suggests designs that don't use a prefabricated chamber at all, but instead fill the entire vertical excavation with storage aggregate



*Drywell with silt box receiving rooftop runoff (BES 2006).*

and line it with geotextile fabric on all sides. While this isn't commonly seen in Oregon, it is allowed.

For runoff from large areas, a drywell is usually made from perforated concrete manhole rings installed vertically, 10 to 30 feet deep. Rings with a diameter of 4 feet are the most widely available size. A foot of clean, washed, storage drain rock is usually placed around the outside of the drywell as backfill. For runoff from

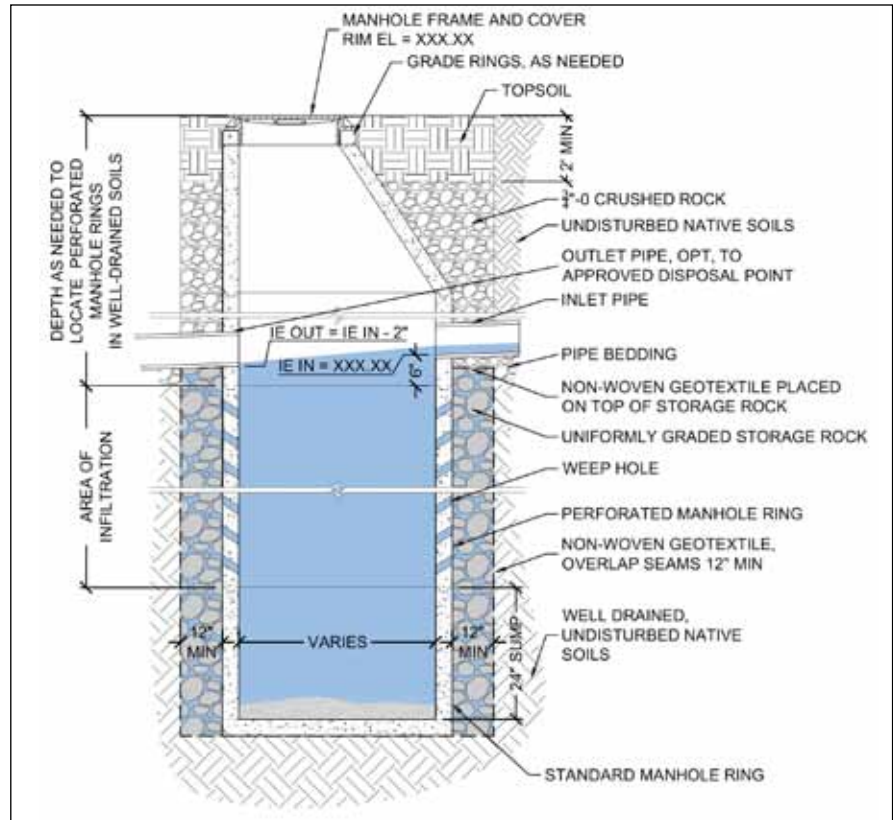
small areas, a cost-effective variation of the concrete drywell is a mini drywell designed with polyolefin (a very hard plastic). These facilities measure about 2 feet in diameter and 2 feet in depth, and their small size and lightweight material makes them quite versatile. For both types, the drywell should be wrapped in nonwoven geotextile to prevent fine sediments from the surrounding soils (that is, silts and clays) from migrating into the system and clogging it.

City of Portland BES

## Design

Throughout Oregon, drywells must be designed to infiltrate varying volumes of runoff. In Portland, where combined sewer overflows are the driving factor for infiltration requirements, the 10-year, 24-hour design storm is used, while in Eugene, the planners have determined that infiltrating the 5-year, 24-hour design storm will meet the city's stormwater-management goals. Infiltration facilities are typically designed to capture and treat the stormwater runoff from surfaces draining to them during 80 to 90% of annual storm events, on average. This will often be a 1-inch, 24-hour design storm, but this volume probably will vary on the Oregon coast. For jurisdictions with no standards, the minimum infiltration volume should be chosen to protect scouring of the downstream natural waterways, which in Oregon has often been found to be the 1- to 2-year, 24-hour design storm (FWS 2006). In some cases, cities may require rain gardens to infiltrate larger storm events, especially where local soils drain well or where the drywell has no overflow. *Check with your local planning department for specific design requirements for your area.*

Plantings at the surface are acceptable, but they must allow access for maintenance (BES 2006) and do not provide any water-quality benefit, since runoff will be conveyed via a buried pipe underneath the plantings. Generally, uniformly graded drain rock with a minimum 30% void ratio is placed between the walls of the drywell and the filter fabric.



Typical detail of a drywell in a landscape area. (Available through the SWAMP resources, <http://extension.oregonstate.edu/watershed/stormwater-assessment-and-management>.)

### SIZING

Sizing of these facilities is based on the runoff volume they receive from both pervious and impervious surfaces. The amount of runoff routed to the drywell will depend on local rainfall patterns, the drainage area, and how much of the water runs off these surfaces. Because of western Oregon's pattern of small, frequent storms, drywells are designed to drain within 24 to 36 hours. The volume of runoff that a drywell is capable of infiltrating depends on the depth and diameter of the perforated rings and the infiltration rates of soils surrounding the facility.

For the small, plastic drywells, installing 1 unit per 500 square feet

of impervious area is recommended, but this suggestion may vary with the infiltration rate of the soil.

Typical drywell depths range from 2 to 20 feet. There are a few excavators who can install drywells as deep as 30 feet, but 20 feet tends to be the maximum constructible depth in most areas. If adequate disposal cannot be achieved by building the maximum depth of drywell constructible in your area, drywells can be linked together in series by piping. *Consult a civil engineer to model the stormwater runoff for your area and provide recommendations for drywell diameter, depth, number, and spacing.*

## SOILS

Because stormwater runoff is concentrated from a large area to a facility with a relatively small storage capacity, soils must drain well, and an infiltration test or bore log test should be submitted and approved by the local jurisdiction (BES 2008). Soils may vary with depth and must be tested in the location of the facility and in the different soil horizons, to ensure that the facility will function as designed. See the fact sheet “Infiltration Testing” for more information.

## ROUTING

Different pretreatment mechanisms are required, depending on the runoff source, prior to entering the drywell. In most drywells, silt traps are suggested to prolong the life of the facility (BES 2008). For drywells collecting roof runoff, a silt basin is highly recommended, in addition to gutter screens to filter debris (NRCS 2008). For drywells capturing runoff from impervious areas other than residential roofs, employing proprietary treatment facilities with a filtering medium is a common pretreatment strategy (BES 2006). A filtration rain garden or flow-through planter could also serve this pretreatment need.

A bypass system is used for occasions when the drywell reaches saturation. In this case, an overflow pipe can deposit runoff onto a splash block (NRCS 2008). Alternatively, it can deliver the excess runoff to a secondary facility (SEMCOG 2008). Excess runoff should never be directed to neighboring private property without a utility easement, nor should

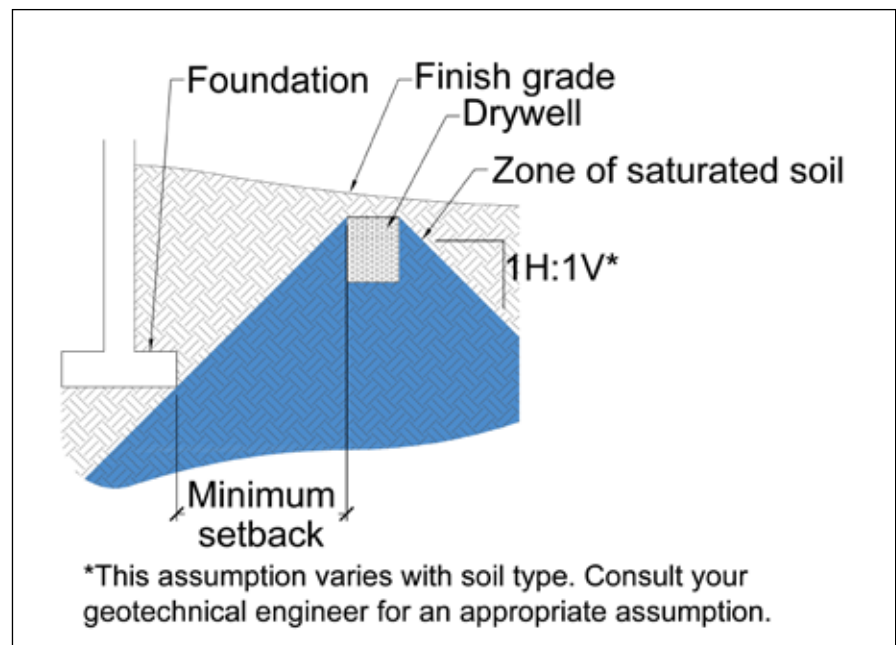
it be allowed to back up the system. Figure 1 shows Portland’s standard residential installation, in which runoff from a large storm could back up and cause flooding. This flooding would occur at the point where the downspout connects to the drain pipe at finish grade, unless the rim of the catch basin, set lower than that elevation, is used as a large-storm relief valve.

Due to pipe cover requirements, the overflow pipe will often be too deep to daylight with these options and is connected to another pipe. An overflow pipe at the top of the facility or some other conveyance system should be used to convey water to an approved disposal point. An approved disposal point is usually a public or private storm pipe, or an outfall location that won’t impact structures and other property.

## Setbacks

Setbacks can vary by jurisdiction. The City of Portland (BES 2008) requires a 5-foot setback from property lines and a 10-foot setback from building foundations. Additionally, drywells should be located 20 feet from cesspools and 500 feet from drinking wells (BES 2006, NRCS 2008, BES 2008). However, in eastern Oregon, where fractured bedrock can be shallow and many feet deep, drywells are often drilled into bedrock as long as the water table is still sufficiently deep to allow positive drainage out of the drywell.

Since the small, plastic drywells are not as deep as the concrete drywells, the City of Portland requires only an 8-foot setback from a building foundation rather than the standard 10 feet (BES 2008), and it’s possible that an even smaller setback is required.



*Assessing appropriate setbacks for drywells.*



*Drywells in a public right-of-way setting with pretreatment sediment manhole.*

A common guideline to determine an appropriate setback distance for infiltration facilities in general is to assume that water moves equally horizontally as it does vertically (in other words, that it moves in a 1H:1V ratio). An appropriate setback can be calculated by ensuring that saturated zone of soil is outside the structural components of the building (see figure on previous page). *Consult the state building codes and a geotechnical engineer to confirm how close your infiltration facilities can be located to critical infrastructure.*

### Physical Setting

Impervious surfaces of varying types are acceptable. Areas of caution are those with minimally infiltrating soils, wellhead protection areas, and wastewater drainage areas (BES 2006). Flat slopes are preferred, and slopes 20% or greater require geotechnical evidence prior to installation (NRCS 2008, PSMM 2008).

Since these are vertical systems with depths of up to 30 feet, they cannot be used in areas with high water tables. For roof runoff, the Oregon

DEQ requires 5 feet between the bottom of a drywell and the top of the seasonal high groundwater table, and 10 feet for all other runoff.

Other areas where infiltration should not occur include

- where the seasonal groundwater table is higher than 5 feet from the bottom of the facility for roof runoff, and 10 feet for other areas of runoff
- in contaminated soils and groundwater
- on slopes exceeding 10% or in landslide areas
- in potential stormwater hotspots (vehicle fueling areas, industrial loading, unloading, and material storage areas)
- where bedrock is higher than 10 feet from the bottom of the facility.

### Pollutant Removal

According to some sources, drywells provide nominal treatment, but infiltration of runoff can also mean groundwater contamination from pollutant runoffs (NRCS 2008). If the runoff is from vehicular areas, it is necessary to pair this facility with a secondary water-quality facility. Based on published research, the Center for Watershed Protection estimated that the total amount of phosphorus to be removed is 60% to 93%, and nitrogen to be removed is 57% to 92%. However, this and other water-quality benefits are not recognized by Oregon DEQ's UIC Program. *See Permits section below for more detailed discussion.*

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## Construction

To prevent clogging, provide erosion-control measures such as a compost sock and diversion methods. You may also consider staging construction of the drywell in such a way that the surrounding land has been stabilized to prevent clogging (NJDEP 2004).

Construction of the drywell should disturb as little of the surrounding soil as possible. To avoid clogging the drywell during construction, at no time should runoff from other areas be directed to the drywell until those areas have been stabilized or fully constructed. Steps to install the drywell itself are as follows:

1. Excavate a hole that is 2 feet larger in diameter than the outside diameter of the manhole rings. A clamshell is often used to excavate deep, narrow holes.
2. Place the nonwoven geotextile fabric so that a continuous piece reaches the bottom and overlaps a minimum of 12 inches at the edges. It should be draped on all sides and to the bottom of the drywell. This geotextile will prevent fine sediments from migrating from the native soils into the surrounding drainage rock and will help protect against long-term clogging.
3. Place the solid 3-foot-deep sump in the bottom and rearrange the geotextile if it has been pulled out of place. Position the rest of the specified number of perforated and nonperforated rings that will set the top ring at the correct finish grade.

4. Install the uniformly graded (that is, almost all the same size) drain rock between the outside walls of the drywell and the geotextile to the depth specified on plans. Dust or fine particles not washed away could clog the geotextile (Hicks and Lundy 1998), so not only should the base rock be delivered clean from the quarry, but it should also be washed carefully on site. One successful method for this is to hose the rock off in the delivery truck when it arrives. Another method might be to dump the rock and wash off the pile. In both instances, scooping of the rock should be done from the surface, and the rock should be closely monitored for fine sediments. As you work your way down the pile, fine sediments from above might only

have been washed off partway through. If careful attention isn't paid to this step, the geotextile fabric could become clogged with sediment, which would cause the drywell to fail.

5. After rock has been placed a few inches above the highest perforated ring, trim the geotextile and lay it over the top of the rock and up the sides of the geotextile a few inches more, then trim it.
6. Remove any debris that may have entered the drywell during construction.
7. Install the lid and bolt the lid down.

Inlet and outlet pipe installation can be done by the same means used to connect pipes to standard manholes. Surface backfill construction should follow project specifications.



*Prefabricated concrete drywell chambers.*

Howard's Excavating, New Buffalo, Mich.

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## Maintenance

The City of Gresham's drywells have been cared for properly and are over 80 years old. It is unlikely that a facility can be repaired when it becomes clogged, so maintenance is very important. Maintenance activities include removing excess debris, controlling erosion and trash, and maintaining inlets and outlets. Vegetation that may clog inlets or outlets should be removed (BES 2006). When the facility clogs, it must be replaced (BES 2004). Inspections should occur frequently, declining in frequency with larger facilities (NRCS 2008). The design we recommend has a 3-foot-deep solid sump at the bottom to make suctioning excess sediment easier.

## Permits

Drywells are considered a Class V Injection Well and must be approved by the Oregon Department of Environmental Quality (ODEQ) through the Underground Injection Control (UIC) permitting process. According to the U.S. Environmental Protection Agency, a Class V UIC well is, by definition, any bored, drilled, or driven shaft, or dug hole that is deeper than its widest surface dimension. These systems are regulated throughout the state because they don't remove pollutants like rain gardens and swales do, and because they are much more likely to pollute groundwater because of their vertical nature. Special care must be taken to protect the groundwater by treating runoff first. For roofs, the ODEQ doesn't require any treatment, but a silt basin that reduces sediment to protect the system against long-term clogging is recommended. In

sensitive basins, additional treatment may be required since roofs may have a number of soluble pollutants, such as biological contaminants and hydrocarbons from asphalt shingles. Runoff from vehicular traffic requires more robust treatment.

In addition to the permitting paperwork, a long-term stormwater management plan must be developed, including a description of the best management practices for the entire site, spill prevention and response, a maintenance plan and schedule, and an employee training record. The plan must be revisited every 5 years, or immediately after a spill, and the drywell itself must be reevaluated. The ODEQ has very specific guidelines for pretreatment and other permitting requirements that you can find on their Web site (ODEQ 2010a).

It's worth noting that "State rules prohibit the use of injection systems where better treatment or protection is available (for example, when a stormwater or municipal sewer is available), and must also meet the requirements of the state Groundwater Act (Div. 40). By policy, these services are considered available if the system is not at capacity or is within 300 feet of the site. ODEQ will confirm availability with the jurisdiction before allowing the use of injection systems" (ODEQ 2010b).

Most UICs are under rule authorization, not permits. Individual residential roof drywells are not required to register and get ODEQ approval as UICs, unless the city requests the review because of high groundwater concerns. Fourplexes, apartment

houses, commercial, and industrial roof drains do need ODEQ approval though rule authorization. Usually no pretreatment is needed, as long as the discharge is only roof runoff. If the drywell serves a parking area, driveway, garbage bin, or loading dock, it needs to be registered and approved by ODEQ. Please note that cities and counties cannot approve UICs; only ODEQ can do this as the agency designated by EPA.

If a drywell is to be decommissioned, there is a separate rule-authorization process that includes testing, reporting, and additional paperwork.

Check with your local planning, engineering, or development services department for specific design requirements for your area.

## Cost

Cost varies with the size of the facility, but in general, both construction and maintenance of small residential facilities costs between \$1,200 and \$1,500.<sup>1</sup> The construction cost of larger concrete facilities is similar to the cost associated with installing a standard, deep manhole—around \$10,000 to \$15,000.

If runoff is from a surface other than a rooftop, a water-quality facility will be required for pretreatment. When drywells are used in locations where other surface infiltration (non-UIC) facilities cannot fit, proprietary treatment structures with filter cartridges must be used for water quality. These proprietary pretreatment systems range in cost from \$6,000 to \$25,000 installed, depending on the system

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<sup>1</sup> Values are in 2010 dollars.

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and the amount of impervious area being treated. In addition, an annual maintenance contract to replace the filter cartridges, costing about \$120 per year per cartridge, is also required.

Permitting costs for drywells vary from \$100 to \$300, and the cost of preparing the required permitting

documentation can be as high as \$2,000. Purchasing spill-response materials to be kept on site, and training in spill response measures for employees or maintenance staff, will also add to the cost.

New state regulations went into effect in September 2001, requiring numerous existing drywells around Oregon to meet the current standard (ODEQ

2010a) This regulation indicates that there will be no grandfathering of these systems and, if new rules are believed necessary to protect Oregon's groundwater resources, there could be an unpredictable future cost associated with retrofitting.

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Editing and layout by Rick Cooper; template design by Patricia Andersson.

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This report was prepared by Oregon Sea Grant under award number NA06OAR4170010 (project number A/ESG-07) from the National Oceanic and Atmospheric Administration's National Sea Grant College Program, U.S. Department of Commerce, and by appropriations made by the Oregon State legislature. The statements, findings, conclusions, and recommendations are those of the authors and do not necessarily reflect the views of these funders.

