Drywells: One County's Novel Approach to Stormwater Management and Disposal

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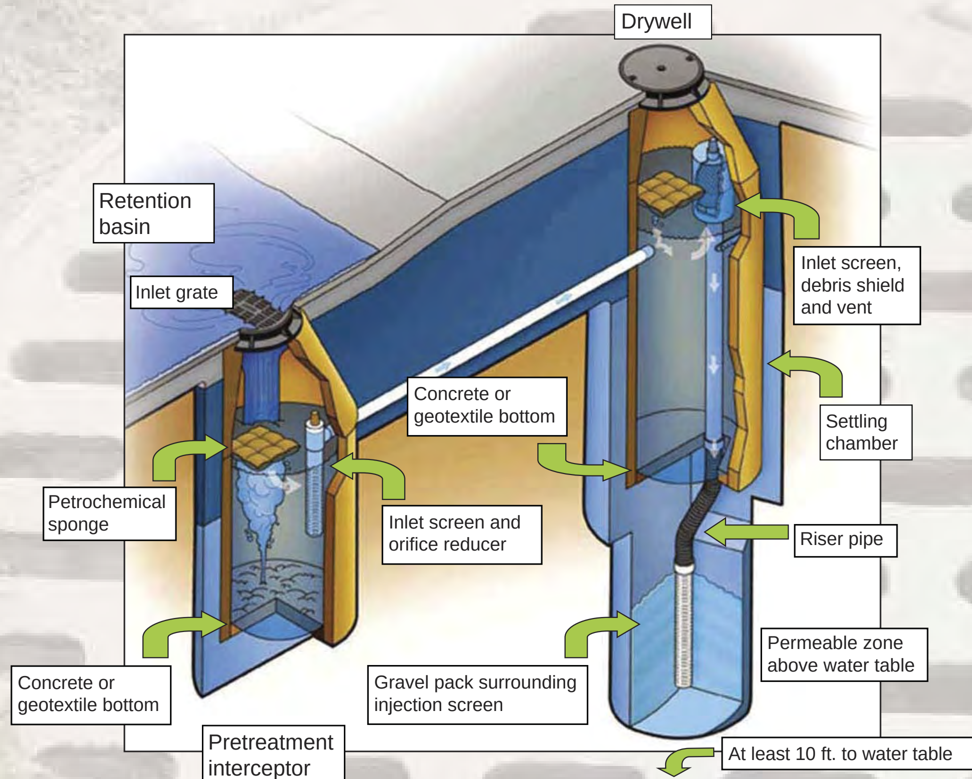

Typical configuration of a modern drywell (from Torrent Resources).

Imagine for a moment that your grandfather started drinking water from his old Army canteen, did that for decades, and chose to amass the world's largest collection of military canteens. You might think that what began as an odd way of hydrating turned into an eccentric fixation. That might be the allegory for Maricopa County, Arizona, with its unique reliance on drywells for controlling stormwater runoff.

Drywells are bored holes completed in alluvial deposits above the water table, designed to efficiently dispose of stormwater into the subsurface. If Maricopa County is any indication, drywells may offer an attractive alternative to manage stormwater in urban areas elsewhere.

Maricopa County, which includes Phoenix and neighboring metropolitan cities, is Arizona's most populous county with 3.95 million residents. Like other Sun Belt areas, the county's growth exploded in the last 20 to 30 years. However, as far back as the 1930s in then-tiny Phoenix, simple rock-filled drywells were used for stormwater disposal. In the early 1970s, local governments started requiring onsite retention of stormwater, leading to development of improved drywells to drain the retained water within 36 hours.

Legal Recognition Spurs Use

By 1987, when the Arizona Legislature created the Arizona Department of Environmental Quality (ADEQ), drywells were so numerous in Maricopa County that the legislature directed ADEQ to 1) establish a drywell registration program for previously installed and newly constructed drywells; and 2) license drywell installers. Since past disposal of hazardous chemicals into these structures had caused several significant groundwater contamination plumes (some of which are still under remediation today), the legislation expressly restricted the use of drywells to stormwater disposal.

The formal regulation of drywells in Arizona in 1987 effectively sanctioned use of the improved technology, spurring construction of drywells as a means of stormwater management in growing municipalities (left chart, opposite page). By the end of 2008, ADEQ had registered 40,586 drywells. Drywell registrations now exceed 3,000 per year. To date, nearly all drywells—96 percent—have been installed in Maricopa County, although their use is now spreading to adjacent developing areas. Drywells have been used for stormwater control and disposal at virtually every new apartment, hotel, office, and commercial complex developed in the county in the last three decades, and in many residential subdivisions and parks as well.

Drywells, which are considered Class V injection wells under the Underground Injection Control (UIC) provisions of the U.S. Environmental Protection Agency-administered Safe Drinking Water Act, also are increasingly being used in other

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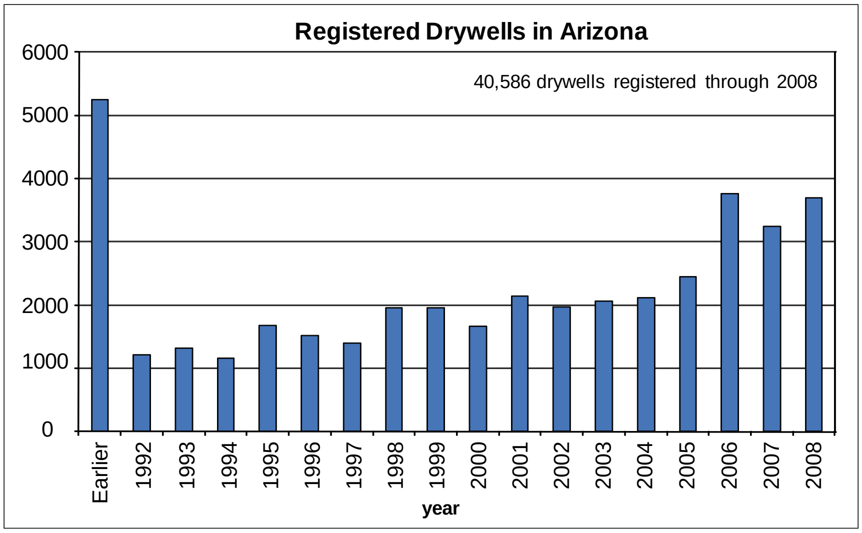
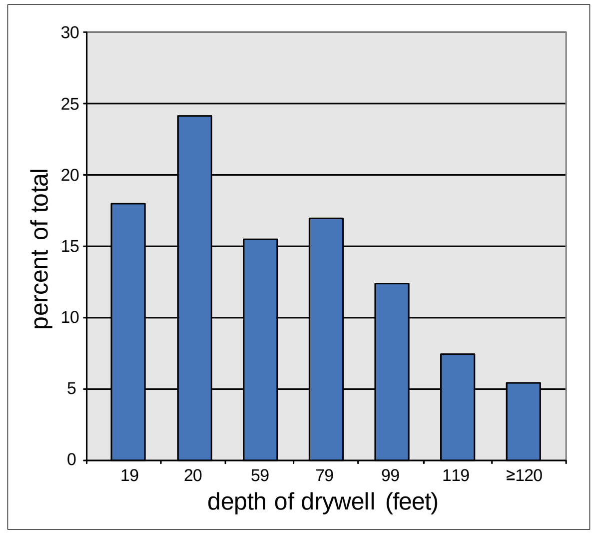


Trend of drywell registrations in Arizona (source: Ramona Rodriguez, ADEQ). The recent boom and recession in construction are evident in the last few years of data.



Drywell depths in Arizona (based on 7,807 drywells for which depth is reported).

states, particularly Washington and Oregon in the West. Washington now has 26,000 registered drywells, primarily used to drain parking lots and roads. Oregon has a very comprehensive program, with 27,600 drywells installed to date, about 12,000 of them in Portland. In states with a significant drywell presence, stormwater pollution prevention plans prepared in accordance with federal Clean Water Act requirements often guide their installation and use.

Design and Construction

The typical drywell in Maricopa County is installed by first drilling a 4-foot-diameter auger hole into alluvial sediments, through any intervening fine-grained and cemented zones, into a permeable layer of clay-free sand, gravel, and cobbles. This layer serves as the discharge interval for the drywell. Drywells are designed so that the bottom is at least 10 feet above groundwater. Because groundwater commonly occurs at significant depth in Arizona's alluvial basins, installers often have considerable leeway to find exceptionally permeable zones that maximize drywell performance while still maintaining acceptable separation between the bottom of the well and groundwater. Drywells as deep as 180 feet below land surface have been constructed. The majority, however, penetrate less than 100 feet (see right chart, above).

In a typical drywell installation (see diagram, opposite page), gravel is placed into the drilled borehole where it surrounds an injection screen located at the permeable zone and the connecting riser pipe above. A settling chamber, adapted from a concrete manhole, is installed above. The riser pipe extends up into the bottom of the settling chamber, through a geotextile filtration fabric or concrete bottom covering the top of the gravel fill, to nearly the top of the chamber. The pipe is capped with an inlet screen and debris shield. A vent in the shield assembly prevents siphoning of floating material.

This design settles solids out of stormwater and minimizes introduction of floating material into the injection pipe and screen. Current systems are installed with petrochemical sponges to remove pavement oils by both absorptive and adsorptive processes. Many installations include a pretreatment interceptor with an orifice reducer to better manage flows and trap "first-flush" constituents. The quality of water conveyed to the injection zone is thus improved, enhancing drainage performance and extending drywell lifetime. Drywells frequently are used with a retention basin, a combination that aids compliance with Maricopa County's requirement of no ponded water after 36 hours.

"Drywell technology has evolved to a high level of sophistication," says Steve DeTommaso, President of Torrent Resources, a long-time licensed drywell installer in Arizona. "Today's drywells are designed to pretreat and maximize stormwater drainage while utilizing an array of technological and

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management approaches to protect groundwater quality as well."

For example, ADEQ requires an aquifer protection permit for drywells that drain stormwater in areas where motor fuels and hazardous substances are present. Added technology-based safeguards may include raised inlet lips; pretreatment sumps, interceptors, settling chambers, or oil-water separators; passive skimmers; inlet filters; and absorbents. Nontechnological measures include requirements for settling chamber sampling, operation and maintenance, inspection, recordkeeping, spill response, and closure and decommissioning.

Effects on the Aquifer

The aggregate net recharge to alluvial aquifers from drywells is significant, according to studies by municipalities in Maricopa County. The overall impact of drywell discharges on groundwater quality has been studied as well and is believed to be low if modern drywell designs are used and the drywells are properly operated and maintained. Clearly, past disposal of contaminants into drywells, either through ignorance or by accident, has created contaminant plumes requiring remediation. However, modern drywell technology, combined with adequate water-table separation and proper operational practices, may actually improve overall groundwater quality.

In 1985, a site-specific study of drywell impact on groundwater quality was conducted for the Maricopa Association of Governments. Groundwater monitor wells were installed just downgradient from drywells draining a shopping center parking lot. Although the stormwater contained typical parking lot contaminants, none were detected in the monitor-well samples. The year-long study concluded that because the total dissolved solids concentration of the stormwater was about one-fifth of the underlying groundwater, discharge from the drywells likely improved the quality of the groundwater.

A similar improvement in water quality resulting from infiltration of storm runoff was documented in a 2005 study conducted in California. This study, undertaken by the Los Angeles and San Gabriel Rivers Watershed Council, detected general improvement of groundwater quality attributed to infiltrated stormwater.

What began as a unique low-tech way of controlling urban runoff in the Arizona desert has emerged as a possible solution for other metropolitan areas. Maricopa County's singular reliance on drywells has provided a laboratory for the evolution of modern, well-engineered, efficient designs that are gaining increasing use in other western states. ■

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