USING DEEP INFILTRATION AND DRYWELLS FOR GROUNDWATER RECHARGE

Source: California Department of Water Resources
James Mayer, M. ASCE

- Engineering/Development Industry since 1994
  - City Engineering Department
  - Civil Consultant/PM
  - Real Estate Developer/PM
  - Design/Build Contractor/PM
  - Technical Marketing Manager
Drywell Experts

- Employee owned stormwater management company
- Started as a drilling company in 1972
- General Engineering Contractor – offices in Phoenix, AZ, Bloomington, CA, and Fairfield, CA
- Licensed in AZ, CA, NM, NV, OR, WA, TX, and MT
- Specialize in the design and installation of drywells for stormwater infiltration
- Only install and maintain drywell systems
- Revolutionized the drywell industry with the MaxWell®
- More than 80,000 installations in the west
Stormwater 101

- The Impact of Development

Additional runoff due to impervious
Stormwater 101

Both additional runoff and less infiltration can be big problems...
Stormwater 101

**Managing Stormwater**

- **Old way**
  - Grade to drain off site
  - Creates downstream problems
- **New way**
  - Catch rain where it falls
    - Capture
    - Treat
    - Infiltrate
  - Mimic pre-development hydrology
Stormwater 101

• Provision C.3 (typical)
  – Project Types
    • New development projects
    • Redevelopment projects
    • Special projects
    • Road projects
  – Project Thresholds
    • Size
    • Percent
  – “Regulated Project”
Stormwater 101

- Most Current Regulations Require
  - Infiltration
  - Harvest/use
  - Evapotranspiration
  - Biofilter/discharge
Why Infiltrate?

- Droughts come and go
- Take advantage of wet years
- Use aquifer as a storage tank
Why Infiltrate?

**SUBSIDENCE**

- Result of groundwater withdrawal
- Agricultural uses limit infiltration
- Infiltration can reduce further subsidence

Santa Rita Bridge, Merced, CA
Getting Stormwater in the Ground

• Types of Infiltration Systems

Shallow

Deep
Shallow Infiltration Systems

• Proprietary Infiltration Systems
  – Ideal for well drained shallow soils
  – Acts as storage and infiltration
  – Helps with earthwork
  – Pre-treatment critical
Shallow Infiltration Systems

• Natural Shallow Infiltration
  - Bioswale
  - Rain garden
  - Infiltration trench
  - Amended soils
Deep Infiltration Systems

- Drywells designs vary greatly
  - Simple
  - No pre-treatment
  - Short life
Deep Infiltration Systems

- Drywells designs vary greatly
  - Complex
  - With pre-treatment
  - Long life
Choosing a Drywell

**Things to identify**

- Depth to Groundwater
- Proximity to Water wells
- Soil permeability (at depth)

<table>
<thead>
<tr>
<th>HYDROLOGIC SOIL GROUP</th>
<th>TYPE</th>
<th>PERMEABILITY</th>
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</thead>
<tbody>
<tr>
<td>A</td>
<td>DEEP, WELL DRAINED SANDS AND GRAVELS</td>
<td>HIGH</td>
</tr>
<tr>
<td>B</td>
<td>MODERATELY DRAINED, MODERATELY FINE TO MODERATELY COARSE TEXTURE</td>
<td>MODERATE</td>
</tr>
<tr>
<td>C</td>
<td>IMPEDING LAYER, OR MODERATELY FINE TO FINE TEXTURE</td>
<td>LOW</td>
</tr>
<tr>
<td>D</td>
<td>CLAY SOILS, SOILS WITH HIGH WATER TABLE</td>
<td>VERY LOW</td>
</tr>
</tbody>
</table>
Choosing a Drywell

- **Things to identify**
  - Contamination
  - Site specific constraints
  - Geotechnical hazards
The Role of Infiltration

- **What role does infiltration play?**
  - Flood control measure
  - Prevents downstream erosion
  - Mitigates hydromodification
  - Maintains pre-development hydrology
  - Increases aquifer recharge

- **Added benefits of a drywell**
  - Bypasses upper confining layer
  - Maintainable for long life
  - Small footprint
  - Simple to retrofit

*Note: soils do the infiltrating, not the system*
Drywells have been studied for decades

- **EPA Final Determination**
- MAG Study – Phoenix, AZ
- Tucson Water Study – Tucson, AZ
- USGS Report 93-4140 – Modesto, CA
- **HydroSystems Study – Chandler, AZ**
- Bouwer Study – Phoenix, AZ
- **Chandler Recharge Study – Chandler**
- **Water Augmentation Study – Los Angeles, CA**
- Elk Grove – City of Elk Grove, CA
- **Drywell Design for Enhanced Infiltration – Central Coast, CA**
EPA Final Determination

• Conclusions

...“the absence of frequent, widespread, or significant cases of actual contamination is good evidence of a low potential for these wells to endanger.”

“Class V wells, as a class or sub-class, do not pose an endangerment to USDWs since documented cases of contamination attributable to these Class V wells are rare.”

...“did not show any evidence that Class V wells, as a well class, or any Class V sub-class, are contaminating USDWs.”
HydroSystems Study – Chandler, AZ

- **Reason for study**
  - How effective is MaxWell Plus at pre-treatment?
    - 24.3 total acres
    - 81% impervious
    - Dual chamber drywell system
HydroSystems Study

• Study Description
  - 7 month study (2010 – 2011)
  - 17 storms/6 events sampling
  - 7.47” total rainfall
  - 92% average TSS removal
  - 3,800,000 gallons recharged
  - Effective mitigation of all pollutants
HydroSystems Study

• Conclusions
  – “...quality of the stormwater that was processed through the MaxWell Plus exceeded expectations.”
  – “...supports the use of the drywells for efficient treatment and recharge of stormwater runoff in commercial areas.”
  – “...does not pose a significant threat to groundwater quality.”
  – “...significant portion of stormwater runoff to be recharged into the subsurface instead of being routed off site.”
Chandler Recharge Study – 2004

• Reason for study
  
  – How does City’s Stormwater Policy affect groundwater recharge?
  
  ▪ Stormwater retention and drywells increase groundwater recharge
  
  ▪ Average recharge on undeveloped land = 191 AFA
  
  ▪ Average recharge on urbanized land = 2,610 AFA
  
  ▪ Study estimates a 1,266% increase
  
  ▪ “…groundwater recharge from stormwater runoff and capture represents a potentially significant water resource for the City.”
Water Augmentation Study

LOS ANGELES BASIN
WATER AUGMENTATION STUDY
PHASE II FINAL REPORT SUMMARY

THE LOS ANGELES
AND
SAN GABRIEL RIVERS
WATERSHED COUNCIL

2000 – 2007

Water Augmentation Study

- **Reason for Study**
  - Is it safe/effective to infiltrate urban stormwater into aquifer?
  - Estimated 578,000 acre-feet/year
  - Stormwater BMPs varied
  - Land use at test sites varied
  - 7 year study period
  - Results = infiltration good
Study Conclusions

- “…no apparent trends to indicate that stormwater infiltration will negatively impact groundwater.”

- “…suggested that groundwater quality at the six monitored sites was stable or improved for most constituents.”

- “…implement decentralized stormwater management practices to advance infiltration…”

- “Soil appears to be very effective in removing TSS and bacteria from stormwater.”
Elk Grove Drywell Study – 2014

- Reason for study
  - Infiltrate stormwater
  - without impacting groundwater
  - alleviate flooding
  - Review of existing drywell studies
Elk Grove Drywell Study

- Locations of studies reviewed
  - Millburn, NJ
  - Park Ridge, WI
  - Los Angeles, CA
  - Modesto, CA
  - Hawaii, HI
  - Portland, OR
  - Tacoma – Pierce County, WA
  - Pima County, AZ
  - Missoula, MT
  - Tucson, AZ

- Basic findings
  - Drywells don’t appear to contaminate groundwater
  - Use pre-treatment
  - Consider use of drywells on a site by site basis
  - Vadose zone soils provide excellent filtration
  - Stormwater is a valuable resource
Elk Grove Drywell Study

- **Review of “Drywell Studies”**
  - “...little evidence stormwater had a negative impact on groundwater...”
  - “...use pre-treatment to minimize the likelihood of groundwater contamination and clogging of the drywell...”
  - “Using urban runoff to recharge groundwater is a practical option for expanding local water supplies.”
  - “...infiltrating runoff can make significant contributions to recharge...”
  - “...metals were attenuated in the vadose zone...”
Central Coast LID Initiative

• **Suggested Drywell Detail for Enhanced Infiltration**
  
  – Geosyntec 2015
  
  – Evaluated drywell BMPs
  
  – Provided recommendations for:
    
    • statewide regulations
    
    • drywell maintenance
    
    • site specific infiltration testing
    
    • drywell design requirements
    
    • evaluation criteria for drywell use
Central Coast LID Initiative

- Proposed Drywell Design Guidelines
  - Well drained soils only
  - Test for infiltration rate at proposed depth
  - Separation set for:
    - groundwater, water well, other drywell
  - Penetrate 10’ into permeable soil
  - Provide setbacks from slopes, foundations, etc
  - Avoid areas of known contamination
  - Common sense safety factors
  - Register drywells with EPA
• **Findings**

  - “...drywells provide significantly greater stormwater runoff volume reductions and aquifer recharge...”
  
  - “...drywells enhance infiltration by penetrating clay and other less permeable soil layers that otherwise limit infiltration...”

  - “...combining biofiltration and drywells can optimize water resource benefits...”

  - “...State level drywell regulations and a standardized drywell BMP are needed to give practitioners the proper guidance for siting and design...”
## Sample of Current Regulations

<table>
<thead>
<tr>
<th>Location</th>
<th>Year</th>
<th>Use Low Impact Development</th>
<th>Promote Infiltration First</th>
<th>Regulation Allows Drywells</th>
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<tr>
<td>Alameda County</td>
<td>2007</td>
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<tr>
<td>Bakersfield</td>
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<tr>
<td>Central Coast</td>
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<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Central Valley</td>
<td>2015</td>
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<td>✓</td>
<td>✓</td>
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<tr>
<td>Contra Costa County</td>
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<tr>
<td>Fresno</td>
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<td>✓</td>
<td>✓</td>
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<tr>
<td>Placer County</td>
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<td>✓</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>San Francisco</td>
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<tr>
<td>San Mateo County</td>
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<td>✓</td>
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<tr>
<td>Santa Clara County</td>
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<tr>
<td>Stanislaus County</td>
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<td>✓</td>
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<tr>
<td>Yolo County</td>
<td>2010</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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</table>
Cities With Drywell Details

• Many Cities Across the US have adopted Drywell Details
  – Bend, OR
  – Chandler, AZ
  – Cheney, WA
  – Coeur d’Alene, ID
  – Covington, WA
  – Crystal Lake, IL
  – Glendale, AZ
  – Goodyear, AZ
  – Hesperia, CA
  – Kennewick, WA
  – Kirkland, WA
  – Los Angeles, CA
  – Manzanita, OR
  – Mesa, AZ
  – New Haven, CT
  – Oakdale, CA
  – Lake Oswego, OR
  – Palm Desert, CA
  – Palm Springs, CA
  – Palmdale, CA
  – Portland, OR
  – Rancho Mirage, CA
  – Redmond, OR
  – San Bernardino, CA
  – Spokane, WA
  – Surprise, AZ
  – Vancouver, WA
  – Victorville, CA
  – Woodland, WA
City Drywell Examples

Hesperia, CA

Victorville, CA
City Drywell Examples

Los Angeles, CA
City Drywell Examples

Sedimentation Well

Drywell

Portland, OR
City Drywell Examples

Lake Oswego, OR

Palm Desert, CA
Modern Engineered Drywell

- Pre-treatment device
- Infiltration device
- Site specific
- Engineered design
- Technique is critical
• **Effectiveness of Deep Infiltration**
  - Permeable soils are typically >25’
  - Deeper soils are typically more permeable – alluvium and sand
  - Taller water column increases pressure and infiltration rate
    - 1’ of depth ≈ 0.43 PSI
      - 69’ deep ≈ 30 PSI
      - Pressure increases perc rate
    - Huge difference maker
Engineered Drywell

- **Single Chamber**
  - Ideal in large landscaped areas
  - Use with bioswale type BMPs
  - Settling chamber for TSS removal
  - Screen/Shield keeps trash out
  - Floating hydrocarbons captured
  - Number of drywells is calculated

*Note: soils do the infiltrating, not the system*
Engineered Drywell

- **Dual chamber**
  - Ideal for large impervious areas
  - Greater sediment capture potential
  - With or without bioswale type BMPs
  - Extra pre-treatment
  - Stormwater treated twice
  - Number of drywells is calculated

**Note:** soils do the infiltrating, not the system
Selecting a Drywell - Recap

• **Ideal Site Conditions**
  
  - Groundwater depth > 130’
  - No proposed HazMat use/storage
  - Room for bioswale and drywell
  - Confining layer near surface
  - Generous landscape areas
  - No water wells in vicinity
  - Contamination free
Drywell Installation

DRILLING AND BUILDING AN ENGINEERED DRYWELL
Drywell Installation

- Drilling a new drywell
Drywell Installation

- 4’ diameter lower shaft for well construction and gravel pack
- 6’ diameter upper shaft for precast concrete liner construction
Drywell Installation

- Geotextile fabric prevents the migration of fines into gravel pack
Drywell Installation

- Installing downhole components
Drywell Installation

• Installing the gravel pack
Drywell Installation

- Placing concrete liner
Drywell Installation

- Setting the cone to final grade
Drywell Installation

- Installing the crossover pipe
Drywell Installation

- Completing crossover pipe
Drywell Installation

- Backfill with 2 sack slurry to grade
  - Locks components in place
  - Prevents subsidence
Drywell Installation

- Installing protective fabric
- Removed when all site work is complete
How does MaxWell® Plus Operate?
CA Drywell Database

- ± 15,000 installations
AZ Drywell Database

- ± 65,000 installations
Typical Application

- Commercial Office
Typical Application

- Warehouse/Distribution Center
Typical Application

• Single Family Residential
Typical Installation

- **Dual Chamber System** in a residential area
Typical Installation

- **Single Chamber System** in a residential area
Typical Installation

- **Dual Chamber System** in commercial area
Typical Installation

- **Tying into UG Storage**
  - Large detention system feeding into primary chamber
Specialty Installation

- **Glen Oaks Boulevard Project**
  - Green Street retrofit in LA
  - Dual Chamber System systems
  - Up to 9.3 million gallons per year
Specialty Installation

- **Glen Oaks Boulevard Project**
  - Funded through Proposition O
  - Praised as “the most cost effective of all Prop O projects.”
  - Meter to track recharge
Specialty Installation

- Sun Valley EDA Project
  - Green Street retrofit in Los Angeles
  - Dual chambered drywell and curb inlet
Specialty Installation

- **Sun Valley EDA Project**

- **Project details**
  - 146 acre watershed
  - 93 acre feet/year available
  - 46 drywells installed
Specialty Installation

- **Urban Infill Downtown LA**
  - Installed in lowest level
Ideally Suited for a Confining Layer

- **San Diego Project**
  - Clays at surface
  - Evaluated deeper soils
  - Better material beneath
  - Drywells performed
  - Cost savings
Drywell Maintenance

- System Maintenance is Simple
  - Regular maintenance = longevity
  - Indefinite life span

**MaxWell™ DRAINAGE SYSTEMS**

TorrenT Resources IncorPoratTed
AZ FIC. 9387948 K, 9387949 B-A: KIS: 305
EIN: C339084 A, C 40, AP: 931220 A - BM SH. 95024 GEN

1506 Cost Chabad Court
Phoenix Arizona 85010-1201
Phone 602-316-3300
Fax 602-368-6200

www.TorrentResources.com
An evolution of McEnroe Drilling

**I mporTanT MAINTENANCE DATA AND WAranTyy INFORMATION**

This property is equipped with the finest on-site drainage system ever designed. With regular inspection and maintenance, it will last for many years. The reverse of this sheet has an illustration that shows how the standard MaxWell™ works to trap silt and trash, and dispose of surplus surface water.

**MAINTENANCE**

Once each year, and after every major storm, you can check the debris level in your MaxWell™ settling chamber by dropping a weighted tape measure through the surface grate. On MaxWell Plus™ systems, the primary settling chamber can be checked the same way.

When the measurement to the bottom of the chamber is less than specified under “cleanout depth” or if the floating absorbent pillow is submerged, the MaxWell™ should be serviced.

MaxWell™ drainage systems are designed to efficiently dispose of retained stormwater. Drainage time is normally dependent upon site design, user convenience or rainfall intensity. If drainage appears slow, or if water is standing for more than 36 hours, the system should be inspected.

For your convenience, Torrent Resources offers a complete Maintenance Program including Service Maintenance Agreements. Please call us for information on this valuable service.
Engineered Drywells are Proven

**Benefits of engineered drywells**

- Minimal risk of aquifer contamination
- Get past confining layer
- Recharge groundwater
- Long service life
- Small footprint
- Low cost
- Fast to construct
- Simple to maintain
- Handles flow or volume based designs
Water is Precious

• Manage what we have...
  – Salt water 95.5%
  – Fresh water 4.5%
  • Available fresh water ≈ 0.1%

<table>
<thead>
<tr>
<th>Water Form</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salt Water</td>
<td>95.5%</td>
</tr>
<tr>
<td>Ice Caps</td>
<td>1.74%</td>
</tr>
<tr>
<td>Swamps</td>
<td>1.0238%</td>
</tr>
<tr>
<td>Saline Groundwater</td>
<td>0.094%</td>
</tr>
<tr>
<td>Fresh Groundwater</td>
<td>0.076%</td>
</tr>
<tr>
<td>Lakes</td>
<td>0.022%</td>
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<tr>
<td>Saline Lakes</td>
<td>0.006%</td>
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<tr>
<td>Atmosphere</td>
<td>0.001%</td>
</tr>
<tr>
<td>Permafrost</td>
<td>0.0007%</td>
</tr>
<tr>
<td>Rivers</td>
<td>0.0002%</td>
</tr>
</tbody>
</table>
Secure Water Supply

- **Reservoirs**
- **Desalination Plants**
- **Aquifer Storage**
  - Aquifer capacity is enormous
  - Won’t evaporate
  - Improves ecosystem
  - Minimal permitting
  - Low environmental impact
  - Lowest cost

*Info from Stanford Woods Institute – Water in the West*
Conclusions

- Stormwater is a valuable resource
- Infiltration (recharge) is beneficial
- Investigate proposed site carefully
- Incorporate pre-treatment
- Drywell guidance needed
- Look to others for guidance
Question and Answer

ANY QUESTIONS?
THANK YOU

WE ARE HAPPY TO PROVIDE COPIES OF ANYTHING DISCUSSED TODAY