SOUTH JORDAN
UTAH

LOW IMPACT DEVELOPMENT

HANDBOOK

2020

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1. Introduction

1.1 Purpose

The purpose of this handbook is to aide in understanding and complying with the Requirements of **South Jordan City** Stormwater Program and fulfilling the regulations outlined in Utah's Jordan Valley Municipalities Separate Storm Sewer System (MS4) permit. This information is to provide guidance for individuals involved in new development and redevelopment projects. Specific audiences include developers, designers, contractors, homeowners, and City staff that are responsible for plan-checking, permitting, and inspections. Material covered in this handbook provides information on the City's project review and permitting process, identifies stormwater low impact development practices, and references source and treatment control BMP information.

1.2 Background

Polluted storm water runoff is often transported to municipal separate storm sewer systems (MS4s) and ultimately discharges into local rivers and streams without treatment. EPA's Storm Water Phase II Rule establishes an MS4 storm water management program that is intended to improve the Nation's waterways by reducing the quantity of pollutants that are introduced into storm sewer systems during storm events. Common pollutants include oil and grease from roadways, roadway salts and deicing materials, pesticides and fertilizers from lawns, sediment from construction sites, and carelessly discarded trash, such as cigarette butts, paper wrappers, and plastic bottles. When deposited into nearby waterways through MS4 discharges, these pollutants can impair the waterways, thereby discouraging use of the resource, contaminating water supplies, and interfering with the habitat for fish, other aquatic organisms, and wildlife.

In 1990, EPA promulgated rules establishing Phase I of the National Pollutant Discharge Elimination System (NPDES) storm water program. The Phase I program for MS4s requires operators of "medium" and "large" MS4s, that is, those that generally serve populations of 100,000 or greater, to implement a storm water management program as a means to control polluted discharges from these MS4s. The Storm Water Phase II Rule extends coverage of the NPDES storm water program to certain "small" MS4s but takes a slightly different approach to how the storm water management program is developed and implemented. South Jordan City is currently regulated under the Jordan Valley Municipalities Permit issued in September of 2013. This permit has been administratively extended pending adoption of a revised permit. Draft copies of this new permit have been reviewed. This manual has been prepared to address new requirements proposed in the new permit.

1.3 Scope

The scope of this handbook is to provide information relative to the State of Utah proposed UPDES permit section 4.2.5.3.2 which states "…the program shall include a process which requires the evaluation of Low Impact Development (LID) approach…", furthermore, "If an LID approach cannot be utilized, the Co-Permittee must document an explanation of the reasons preventing this approach and the rationale for the chosen alternative controls on a case by case basis for the project.

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2. Low Impact Development Principles and Stormwater Management Measures

2.1 What is Low Impact development

As defined in the State of Utah's "***A Guide to Low Impact Development within Utah***", " LID refers to engineered systems, either structural or natural, that use or mimic natural processes to promote infiltration, evapotranspiration, and/or reuse of storm water as close to its source as possible to protect water quality and aquatic habitat." Low Impact development generally targets minimizing runoff and may incorporate man made treatment or a combination of processes. This approach treats stormwater runoff as a beneficial resource instead of a nuisance. LID use and planning is a systematic approach to stormwater management that when planned, designed, constructed, and maintained appropriately, can result in improved stormwater quality, improved local water bodies, result in more attractive landscapes, improved wildlife habitats, and elevated life style for all.

Low Impact Development is not a replacement for Flood Control. LID techniques target water quality. These standards should be followed in conjunction with flood control efforts.

2.2 Why use Low Impact development

Good LID planning generally focuses on reduced runoff within the site and ultimately requires fewer structural best management practices. These practices reduce the amount of runoff generated during a storm event, alleviate downstream erosion and filter out pollutants such as oil, bacteria, sediment, and nutrients. Proper planning for use of LID is essential for future land use and sustainable growth of the community. In developing a handbook, input from several disciplines such as planners, engineers, elected officials, developers, contractors and other design professionals can be incorporated to allow proper planning.

2.3 Developing a Low Impact Development Plan

Project applicants for all developments and redevelopments will be required to incorporate stormwater mitigation measures into their design plans and submit the plans and supporting documentation to the City for review and approval. The design plans will be subjected to a review process prior to the issuance of approvals for permits.

The purpose of this manual is to provide information and standards that can be used to select the appropriate BMPs for a given site and to provide a standardized method for sizing the selected BMPs. This manual outlines minimum standards and methods for sizing and designing LID facilities. This is a minimum standard. Other more rigorous methods may be used and will be evaluated on a case-by-case basis.

To develop a plan that works with the site and has a chance of functioning properly, it is imperative to include consideration in the conceptual design phase of the project. It is also important to have a general understanding of the specific site and any site constraints that might exist.

2.3.1 Determining Soil Characteristics

Soil characteristics play a major role in determining LID feasibility and sizing of facilities on a site. A basic soil evaluation will need to be conducted on each site. South Jordan has elected to standardize based on the Natural Resource Conservation Service (NRCS) Hydrologic Soil Group (HSG) classifications. The NRCS system includes four hydrologic soil groups: A, B, C, and D as described below:

Group A is sand, loamy sand or sandy loam types of soils. It has low runoff potential and high infiltration rates even when thoroughly wetted. They consist chiefly of deep, well to excessively drained sands or gravels and have a high rate of water transmission.

Group B is silt loam or loam. It has a moderate infiltration rate when thoroughly wetted and consists chiefly or moderately deep to deep, moderately well to well drained soils with moderately fine to moderately coarse textures.

Group C soils are sandy clay loam. They have low infiltration rates when thoroughly wetted and consist chiefly of soils with a layer that impedes downward movement of water and soils with moderately fine to fine structure.

Group D soils are clay loam, silty clay loam, sandy clay, silty clay or clay. This HSG has the highest runoff potential. They have very low infiltration rates when thoroughly wetted and consist chiefly of clay soils with a high swelling potential, soils with a permanent high water table, soils with a claypan or clay layer at or near the surface and shallow soils over nearly impervious material.

Details of this classification can be found in "*Urban Hydrology for Small Watersheds*" published by the Engineering Division of the NRCS, United States Department of Agriculture Technical Release – 55.

Planning level soils analysis may be done utilizing information obtained from the National Cooperative Soil Survey. They have a web site that provides general information. https://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx. An on-site geotechnical evaluation should be conducted to confirm actual in-field soil types before completing a design. It is best to conduct geotechnical investigations as close to the actual location of the LID facility as possible.

2.3.2 Determining Water Table

Water table is also a major factor in determining feasibility and sizing of LID techniques that infiltrate. Shallow groundwater may severely hinder the effectiveness of infiltration. Shallow groundwater also increases the potential to introduce pollutants into the groundwater. A part of the geotechnical investigation at a site should include an assessment of the high groundwater level. This should include a measurement of the existing water table at the time of the investigation.

2.3.3 Determining Existing Drainage Patterns

An assessment of the existing drainage system/patterns will also assist in locating/sizing LID facilities. A detailed site survey should be conducted and existing contours developed. Any existing storm drains should be identified, located, and elevations established. It is easier to mimic pre-development hydrology if existing drainage patterns can be maintained. Locating LID facilities generally works best by following natural patterns. An understanding of flow direction and locating natural storm drainage collection points can simplify LID design.

2.3.4 Determining Infiltration Rates

The bottom line number that will dictate sizing of most LID facilities is the infiltration rate. There are many different and varied options for measuring/determining infiltration rates. To simplify the efforts, South Jordan City has adopted the approach of using generalized hydraulic conductivity rates based on NRCS HSGs. This is a simplified approach. If a developer chooses to do a more detailed analysis by actually measuring infiltration rates in the field, these will be reviewed on a case-by-case basis. The type of LID facility proposed will dictate acceptable methods for determining the rate at which stormwater can be absorbed into the ground. The following table shall be used to size LID facilities unless a more stringent process is followed by the developer and infiltration rates are determined in the field.

Typical infiltration rates of various soil groups

Table 2-1: Hydraulic Conductivity of NRCS Soil Groups

NRCS HSG	Typical Soil Texture	Saturated Infiltration Rate (in./hr)	Porosity (Volume ratio)	Field Capacity (dimensionless)
A	Sand	8.0	0.437	0.062
A	Loamy sand	2.0	0.437	0.105
B	Sandy loam	1.0	0.435	0.190
B	Loam	0.5	0.463	0.232
C	Silt loam	0.25	0.501	0.284
C	Sandy clay loam	0.15	0.398	0.244
D	Clay loam and silty clay loam	<0.09	0.465	0.325
D	Clay	<0.05	0.475	0.378

(Taken from Design of Urban Stormwater Controls, a revision of the Water Environment Federation's (WEF's) and the American Society of Civil Engineer's (ASCE's) manual of practice titled *Urban Runoff Quality management (1998).* Table 9.2, pg. 367*)*

2.3.5 Determining Water Quality Volume (WQV)

The *Jordan Valley Municipalities (MS4) Permit No. UTS000001,* will require projects to "manage rainfall on-site, and prevent the off-site discharge of the precipitation from all rainfall events less than or equal to the 80th percentile rainfall event." The volume of water generated from this 80th percentile event is being defined as the Water Quality Volume.

Table 2-2: 80th Percentile Precipitation Rates at Surrounding Weather Stations

Location	Station	Elevation	Years of Record	80th Percentile Storm (inches)
Utah Lake Lehi	USC00428973	4504.92	115	0.39
Pleasant Grove	USC00426919	4691.93	73	0.47
Triad Center	USC00427606	4279.86	34	0.48
Salt Lake Airport	USW00024127	4225.07	71	0.44
Cottonwood Weir	USC00421759	4985.89	102	0.65

Elevations in South Jordan range from 4975 on the west side to 4315 down along the Jordan River. To simplify calculations**, <u>South Jordan City has chosen to use 0.47 inches or 0.0392 feet</u>** as the 80th percentile storm depth.

The Water Quality Volume is calculated using the following equation:

$WQV = R_V dA$

Where:
WQV = 80th percentile volume, cf
R_V = Volumetric runoff coefficient, unitless
d = 80th percentile precipitation depth, ft (convert from inches to feet if required)
A = Project area or BMP drainage area, sf

The NRCS has developed regression equations to determine the runoff coefficient R_v. There are three equations based on soil type:

Table 2-3: Runoff Coefficient Equations Based on NRCS Soil Groups

NRCS Soil Group		
A	B	C/D
$R_{V\text{-}A} = 0.84i^{1.302}$	$R_{V\text{-}B} = 0.84i^{1.169}$	$R_{V\text{-}C/D} = 0.83i^{1.122}$

Note: "*i*" is runoff intensity, measured in in/hour

Using these equations a WQV is calculated in cubic feet. This is the volume that needs to be retained (with no discharge) until it infiltrates or evapo-transpires.

2.4 Universal LID Best Management Practices

Not all LID BMPs include construction of a structure. Some LID BMPs involve the implementation of basic principles. These principles should be a general practice on all sites. If applicable and feasible for the given site conditions, the following measures are required and should be incorporated on all projects:

2.4.1 Eliminating Directly Connected Impervious Areas

One of the primary contributors to urban runoff is directly connected impervious areas or DCIAs. They affect both water quality and water volume. A directly connected impervious area is defined as a surface where stormwater conveys directly from an impervious area to a storm drain or waterway. Examples of directly connected impervious areas include; building downspouts that are piped to the gutter or storm drain pipe, and parking lots with inlets in the gutter that go straight to the storm drain pipe.

All new development should eliminate these direct connects and direct runoff through landscape areas and LID facilities whenever possible.

2.4.2 Utilizing Landscaped (Natural) Buffers

Much the same as eliminating DCIAs, maintaining landscaped buffers through which stormwater flows provides opportunities for natural filtering and infiltration that you don't get in a pipe or gutter. The best buffers are ones where the pre-development ground and vegetation are left undisturbed; however, it is recognized that a more groomed approach is desirable in many cases. Development is strongly encouraged to utilized landscape areas as buffers and direct stormwater to these landscaped areas. Stormwater can be collected in the landscaped areas after it has had a chance to filter/infiltrate.

3. BMP Prioritization and Selection

3.1 Best Management Practice Categories

Structural BMPs shall be designed to manage and capture stormwater runoff. Most long-term stormwater BMPs can fit into three general functional categories; BMPs that infiltrate, BMPs that harvest, and BMPs that filter. Some BMPs are hybrids that can accomplish more than one function at a time. The order of priority specified below shall apply to all projects. Each type of BMP shall be implemented to the maximum extent feasible when determining the appropriate BMPs for a project before moving to the next priority.

1. Infiltration
2. Harvesting
3. Natural Filters
4. Combination of any of the above

Because of the retention requirement, BMPs that infiltrate are given the highest priority and should be utilized until the WQV has been captured and stored. If it is not feasible to retain the entire WQV (feasibility is defined in section 3.1.1 below) then harvesting should be considered. Utah water rights laws limit the amount of stormwater that can be harvested and reused. If the WQV cannot be handled by the first two priorities then treating and releasing may be considered. If partial or complete onsite compliance of any type is technically infeasible, the project Site and LID Plan shall be required to document an explanation of the reasons preventing this approach and the rationale for the chosen alternative controls on a case by case basis for the project.

3.1.1 Infiltration Feasibility

Infiltration will be considered feasible only when all of the following criteria can be met:

- The lowest elevation of all retention facilities shall be a minimum of five (5) feet above the measured water table
- Retention volumes must infiltrate or evaporate within three (3) days or 72 hours after a storm has subsided
- Retention facilities can be no closer than fifteen (15) feet from the nearest structural foundation
- Retention facilities can be no closer than fifty (50) feet horizontally from live streams or water bodies
- If a slope is steeper than 20%, there must be a geotechnical investigation to determine a safe setback from the top of slope to allow for any infiltration to occur.
- Retention facilities cannot be placed on slopes exceeding 5%
- Retention shall not be allowed in areas where a licensed geotechnical engineer determines that infiltration would adversely impact the potential for geological hazards on the project site or on neighboring parcels of land

- Side slopes on all open retention facilities must be 3:1 or flatter
- BMPs that focus on infiltration will not be allowed if land drains are required for a development.
- Infiltration will not be allowed in Zones 1 or 2 of any Drinking Water Source Protection Plan for a Public Water System

3.1.2 Infiltration BMPs

The following paragraphs provide general descriptions of various types of infiltration BMPs.

3.1.2.1 Infiltration basin

Description: Infiltration basin consists of an earthen basin constructed in naturally pervious soils with a flat bottom typically vegetated with dry-land grasses or irrigated turf grass. An infiltration basin functions by retaining the design runoff volume in the basin and allowing the retained runoff to percolate into the underlying native soils over a specified period of time.

Application: Infiltration Basins are typically utilized for larger drainage areas

Water Quality Effectiveness:

Target Pollutant	Relative Removal Effectiveness
Sediment	Excellent
Nutrients	Excellent
Metals	Excellent
Bacteria	Excellent
Oil/Grease	Excellent

Design Criteria: The following criteria shall be met for all open infiltration basins:

Parameter	Requirement
Minimum depth to measured water table from the lowest elevation in the basin	5 feet
Maximum standing water time	72 hours
Maximum side slope	3 H: 1 V
Minimum freeboard	1 foot
Other	Must have a safe flood path to convey up to the 100 year storm safely to an established Right-of-way
WQV	As defined in Section 2.3.5
Maximum Infiltration Rate	As determined in Section 2.3.4

3.1.2.2 Infiltration Trenches

Description: Infiltration trenches, which are similar to basins, are long, narrow, gravel-filled trenches, often vegetated, that infiltrate stormwater runoff from small drainage areas. Infiltration trenches may include a shallow depression at the surface, but the majority of runoff is stored in the void space within the gravel and infiltrates through the sides and bottom of the trench.

Application: Infiltration trenches are commonly used for moderately sized drainage areas where the available footprint is narrow.

Water Quality Effectiveness:

Target Pollutant	Relative Removal Effectiveness
Sediment	Excellent
Nutrients	Excellent
Metals	Excellent
Bacteria	Excellent
Oil/Grease	Excellent

Design Criteria: The following criteria shall be met for all infiltration trenches:

Parameter	Requirement
Minimum depth to the measured water table from the lowest elevation in the basin	5 feet
Minimum depth of trench	2 feet
Maximum longitudinal trench slope	1%
Minimum width	2 feet
WQV	As defined in Section 2.3.5
Maximum Infiltration Rate	As determined in Section 2.3.4

3.1.2.3 Infiltration galleries

Description: Infiltration galleries are similar to infiltration basins except they are underground. A number of vendors offer prefabricated, modular infiltration galleries that provide subsurface storage and allow for infiltration. Infiltration galleries come in a variety of material types, shapes and sizes.

Infiltration galleries are best served when there is an isolator row or pretreatment device. Maintaining underground retention without the isolator row or pretreatment can be problematic and costly.

Application: Infiltration Galleries are typically utilized for drainage areas between 5 and 50 acres.

<u>Water Quality Effectiveness</u>:

Target Pollutant	Relative Removal Effectiveness
Sediment	Excellent
Nutrients	Excellent
Metals	Excellent
Bacteria	Excellent
Oil/Grease	Excellent

<u>Design Criteria</u>: The following criteria shall be met for all infiltration galleries:

Parameter	Requirement
Minimum depth to the measured water table from the lowest elevation in the basin	5 feet
Maximum standing water time	72 hours
Other	- Must have a safe flood path to convey up to the 100 year storm safely to an established Right-of-way - Must meet all the requirements of the manufacturer.
WQV	As defined in Section 2.3.5
Maximum Infiltration Rate	As determined in Section 2.3.4

3.1.2.4 Permeable pavements

<u>Description:</u> Pervious surfaces such as permeable asphalt, concrete pavers, pervious concrete, modular open pavers, and other pervious surfaces allow parking or light travel surfaces to also allow infiltrate. Permeable surfaces may not be used for public roads or in the public right-of-way. Permeable pavements contain small voids that allow water to pass through to a stone base. They come in a variety of forms; they may be a modular paving system (concrete pavers, modular grass or gravel grids) or poured-in-place pavement (porous concrete, permeable asphalt). All permeable pavements with a stone reservoir base treat stormwater and remove sediments and metals to some degree by allowing stormwater to percolate through the pavement and enter the soil below.

<u>Application:</u> Permeable pavements are typically used on sites where footprint is at a premium, allowing dual usage of parking and light travel areas. Permeable pavements are typically not recommended on heavy travel surfaces or truck lanes and are not allowed on public streets.

Water Quality Effectiveness:

Target Pollutant	Relative Removal Effectiveness
Sediment	Excellent
Nutrients	Excellent
Metals	Excellent
Bacteria	Excellent
Oil/Grease	Excellent

Design Criteria: The following criteria shall be met for all permeable pavement locations:

Parameter	Requirement
Minimum depth to the measured water table from the lowest elevation in the basin	5 feet
Maximum standing water time	72 hours
Other	- Must have a safe flood path to convey up to the 100 year storm safely to an established Right-of-way. - Must meet all the requirements of the manufacturer.
WQV	As defined in Section 2.3.5
Maximum Infiltration Rate	As determined in Section 2.3.4

3.1.2.5 Injection Wells

Description: An injection well is defined as an excavated, bored, drilled, or driven shaft or hole whose depth is greater than its width. Injection wells are similar to infiltration trenches in their design and function, as they are designed to temporarily store and infiltrate runoff, primarily from rooftops or other impervious areas with low pollutant loading. An injection well may be either a drilled borehole filled with aggregate or a prefabricated storage chamber or pipe segment.

Application: Injection wells are best suited for soils with high conductivity rates. They can contribute to aquifer recharge. As such, they should be registered as Class V Injection Wells with the State Division of Water Quality https://deq.utah.gov/legacy/programs/water-quality/utah-underground-injectioncontrol/drainage-wells/index.htm.

Water Quality Effectiveness:

Target Pollutant	Relative Removal Effectiveness
Sediment	Excellent
Nutrients	Excellent
Metals	Excellent
Bacteria	Excellent
Oil/Grease	Excellent

Design Criteria: The following criteria shall be met for all injection wells:

Parameter	Requirement
Minimum depth to the measured water table from the lowest elevation in the basin	5 feet
Maximum standing water time	72 hours
Other	- Must have a safe flood path to convey up to the 100 year storm safely to an established Right-of-way. - Must meet all the requirements of the manufacturer.
WQV	As defined in Section 2.3.5
Maximum Infiltration Rate	As determined in Section 2.3.4

3.1.2.6 Constructed Wetlands

Description: A constructed wetland is an artificial wetland created for the purpose of treating discharges such as municipal stormwater runoff. Constructed wetlands are engineered system that use natural functions of vegetation, soil, and organisms to treat water running through them. The wetlands should be designed to spread the flow, slow the velocity and maximize infiltration. The wetlands should also be designed to meet the specific needs of the water running through them including sediment removal, nutrient uptake, and heavy metals containment. Constructed wetlands may also serve a secondary purpose of providing habitat for native or migratory wildlife.

Application: Constructed wetlands can handle unlimited volumes of water provided there is a large enough footprint to process the flows. A good rule of thumb in sizing wetlands is to use 0.5% to 2.0% of the contributing drainage area for the wetland footprint (Tyndall & Bowman, 2016 – *A NRS Cost Tool Overview*). Constructed wetlands are typically not as effective when they are less than 0.25 acre in size.

Water Quality Effectiveness:

Target Pollutant	Relative Removal Effectiveness
Sediment	Excellent
Nutrients	Excellent
Metals	Excellent
Bacteria	Excellent
Oil/Grease	Excellent

Design Criteria: The following criteria shall be met for all constructed wetlands:

Parameter	Requirement
Maximum depth to the measured water table from the lowest elevation in the wetland	1.5 feet with no supplemental water
Supplemental water	To keep a wetland viable it requires a fairly consistent water source. Stormwater, by itself in Utah, does not usually provide adequate water source. It is very likely that supplemental water will be needed.
Hydraulic residence time	$\geq$ 48 hours to achieve 80% reduction in Nitrogen
WQV	As defined in Section 2.3.5
Maximum Infiltration Rate	As determined in Section 2.3.4

3.1.2.7 Combined Measures

Any of the above infiltration type BMPs may be combined with any other BMPs to fit the site and to meet the allowable discharge requirements.

3.1.3 Stormwater Harvesting

Stormwater Harvesting refers to a specific type of BMP that operates by capturing stormwater runoff and holding it for efficient use at a later time. In the State of Utah to collect, store, and place the captured stormwater to a beneficial use a person must register the use with the Utah Division of Water Rights. BMPs sized to capture the runoff produced from the 80th percentile storm event, or BMPs designed to capture less than this volume, if being used in conjunction with other BMPs, must therefore drawdown their entire captured volume within 3 days of a likely storm event.

Stormwater harvesting BMPs designed for storm events larger than the 80th percentile storm event are required to disperse enough water from the BMP within 3 days of a likely storm event to ensure that adequate capacity is available to capture the next storm event up to 80th percentile storm event. In instances where the quantity of runoff from the 80th percentile storm event exceeds the volume of the collection tank, partial capture and use can also be achieved as part of a treatment train by directing the overflow to stable vegetated areas where erosion or suspension of sediment is not a factor or through a high flow natural filter type BMP to provide additional volume reduction and water quality treatment. Overflow from the tank into the storm drain system is not allowed.

Capture and use BMPs designed for these extended holding times will require additional treatment such as filtration or disinfection to protect the collection tanks from fouling, to prevent the breeding of mosquitoes, and/or to improve the quality of water for reuse applications. These scenarios will be reviewed on a case-by-case basis

3.1.3.1 Rain Barrels

Description: Rain Barrels are structures designed to intercept and store runoff from rooftops to allow for its reuse and volume reduction. As storm water is stored it is typically reused for irrigation or other water needs. Rain barrels are typically above ground small structures that are directly connected to rooftop downspouts. In the State of Utah a person may collect and store rain water without registering in no more than two covered storage containers. The maximum storage capacity of any one container shall not be greater than 100 gallons.

Application: Rain Barrels are typically utilized on an individual residential home basis and are limited to no more than 200 gallons (no more than two containers with no more than 100 gallons per container) stored at a time.

Water Quality Effectiveness:

Target Pollutant	Relative Removal Effectiveness
Sediment	Good*
Nutrients	Good*
Metals	Good*
Bacteria	Fair*
Oil/Grease	Excellent*

*Water Quality Effectiveness varies a lot for rain barrels depending on the reuse options implemented

Design Criteria: The following criteria shall be met for rain barrels:

Parameter	Requirement
Maximum Capture Volume without registration	200 gallons (no more than two containers with no more than 100 gallons per container)

Maximum Capture Volume with registration	2,500 gallons
WQV	As defined in Section 2.3.5

3.1.3.2 Cisterns

Description: Cisterns are similar to rain barrels and are designed to intercept and store runoff from rooftops to allow for its reuse and volume reduction. As storm water is stored it is typically reused for irrigation or other water needs. Cisterns are typically larger than rain barrels and have more storage capacity. In the State of Utah the total allowed storage capacity with registration is no more than 2,500 gallons. Collection and use are limited to the same parcel of land on which the water is captured and stored. Cisterns can be designed as either above or below ground structures. Above ground cisterns are to be secured in place and meet all applicable building standards.

Application: Cisterns are typically utilized on a small commercial sites and are limited to no more than 2,500 gallons stored at a time.

Water Quality Effectiveness:

Target Pollutant	Relative Removal Effectiveness
Sediment	Good*
Nutrients	Good*
Metals	Good*
Bacteria	Fair*
Oil/Grease	Excellent*

*Water Quality Effectiveness varies a lot for cisterns depending on the reuse options implemented

Design Criteria: The following criteria shall be met for rain barrels:

Parameter	Requirement
Maximum Capture Volume without registration	200 gallons
Maximum Capture Volume with registration	2,500 gallons
WQV	As defined in Section 2.3.5

3.1.4 Natural Filters

Natural Filter facilities are landscaped shallow depressions that capture and filter stormwater runoff. As stormwater passes down through the planting soil, pollutants are filtered, adsorbed, and biodegraded by the soil and plants. Because they are not contained within an impermeable structure, they may allow for infiltration.

Projects that have demonstrated they cannot manage 100% of the water quality design volume onsite through infiltration and/or stormwater harvesting BMPs may manage the remaining volume through the use of a high removal efficiency natural filter BMP. A high removal efficiency natural filter BMP shall be sized to adequately capture **1.5** times the volume not managed through infiltration and/or capture and use.

3.1.4.1 Biofilter

Description: Most natural filter systems can be classified as biofilters. They normally consist of a ponding area, mulch layer, planting soils, plants, and in some cases an underdrain. Runoff that passes through a biofiltration system is treated by the natural absorption and filtration characteristics of the plants, soils, and microbes with which the water contacts. Plants are used to increase infiltration and nutrient uptake.

Application: Biofilters are typically incorporated into site landscaping elements and are commonly used in park strips and parking lot islands

Water Quality Effectiveness:

Target Pollutant	Relative Removal Effectiveness
Sediment	Excellent
Nutrients	Excellent
Metals	Excellent
Bacteria	Excellent
Oil/Grease	Excellent

Design Criteria: The following criteria shall be met for biofilters:

Parameter	Requirement
Minimum depth to the measured water table from the lowest elevation in the basin	5 feet
Maximum standing water time	72 hours
Maximum ponding depth	1 foot

WQV	As defined in Section 2.3.5
Maximum Infiltration Rate	As determined in Section 2.3.4
Minimum freeboard	6 inches
Other	Must have a safe flood path to convey up to the 100 year storm safely to an established Right-of-way.

3.1.4.2 Rain Gardens

Description: Rain gardens are simply gardens designed to capture and treat runoff. Rain gardens usually consist of a small depression with engineered or native soils and a variety of plants. The plants are used to increase infiltration and nutrient uptake. They are often topped with wood or rock mulch. For projects with impervious areas exceeding 4,000 square feet; biofilters, planter boxes with infiltration, vegetated swales or natural buffer strips should be considered.

Application: Small sites – impervious areas < 4,000 square feet

Water Quality Effectiveness:

Target Pollutant	Relative Removal Effectiveness
Sediment	Excellent
Nutrients	Excellent
Metals	Excellent
Bacteria	Excellent
Oil/Grease	Excellent

Design Criteria: The following criteria shall be met for rain gardens:

Parameter	Requirement
Minimum depth to the measured water table from the lowest elevation in the basin	5 feet
Maximum standing water time	72 hours
Maximum ponding depth	18 inches
Maximum side slopes	3H:1V
Minimum freeboard	6 inches
Other	Must have a safe flood path to convey up to the 100 year storm safely to an established Right-of-way.
WQV	As defined in Section 2.3.5
Maximum Infiltration Rate	As determined in Section 2.3.4

3.1.4.3 Planter Boxes with infiltration

Description: Planter boxes with infiltration are natural filtration treatment control measures located in and around structures and facilities to handle larger volumes of water than a typical rain garden. They typically are constructed with vertical or near vertical sides and above ground. They can be equipped with underdrains if necessary. Planter boxes with infiltration should maintain setbacks from adjacent buildings, other structures, sidewalks or roadways.

Application: Planter boxes with infiltration are typically incorporated into site landscaping elements and are commonly used in park strips and parking lot islands. They are sometimes raised planters. Raised planters are most successful for treating stormwater from roof tops.

Water Quality Effectiveness:

Target Pollutant	Relative Removal Effectiveness
Sediment	Excellent
Nutrients	Excellent
Metals	Excellent
Bacteria	Excellent
Oil/Grease	Excellent

Design Criteria: The following criteria shall be met for planter boxes with infiltration:

Parameter	Requirement
Minimum depth to the measured water table from the lowest elevation in the basin	5 feet
Maximum standing water time	72 hours
Maximum ponding depth	1 foot
WQV	As defined in Section 2.3.5
Maximum Infiltration Rate	As determined in Section 2.3.4
Minimum freeboard	6 inches
Other	Must have a safe flood path to convey up to the 100 year storm safely to an established Right-of-way.

3.1.4.4 Bio-Infiltration

Description: Bioinfiltration facilities are designed for partial infiltration of runoff and partial biotreatment. These facilities are similar to bioretention devices with underdrains but they include a raised underdrain above a gravel sump designed to facilitate infiltration and nitrification/denitrification. These facilities can be used in areas where there are little to no hazards associated with infiltration, but infiltration screening does not allow for infiltration BMPs due to low infiltration rates or high depths of fill.

Application: Bio-infiltration systems are typically incorporated into site landscaping elements and are commonly used in park strips and parking lot islands. Bio-infiltration includes a higher likelihood for infiltration than the basic biofilter.

Water Quality Effectiveness:

Target Pollutant	Relative Removal Effectiveness
Sediment	Excellent
Nutrients	Excellent
Metals	Excellent
Bacteria	Excellent
Oil/Grease	Excellent

Design Criteria: The following criteria shall be met for bio-infiltration:

Parameter	Requirement
Minimum depth to the measured water table from the lowest elevation in the basin	5 feet
Maximum standing water time	72 hours
Maximum ponding depth	1 foot
WQV	As defined in Section 2.3.5
Maximum Infiltration Rate	As determined in Section 2.3.4
Minimum freeboard	6 inches
Other	Must have a safe flood path to convey up to the 100 year storm safely to an established Right-of-way.

3.1.4.5 Vegetated Swales

Description: Vegetated swales are open, shallow channels with dense, low-lying vegetation covering the side slopes and bottom that collect and slowly convey runoff to downstream discharge points. An effective vegetated swale achieves uniform sheet flow through the densely vegetated area for a period of several minutes. The vegetation in the swale can vary depending on its location and is the choice of the designer. Most swales are grass-lined.

Application: Vegetated swales serve a dual function. They are used both as a minor treatment alternative and as a conveyance system.

Water Quality Effectiveness:

Target Pollutant	Relative Removal Effectiveness
Sediment	Good
Nutrients	Fair
Metals	Good
Bacteria	Fair
Oil/Grease	Excellent

Design Criteria: The following criteria shall be met for vegetated swales:

Parameter	Requirement
Minimum depth to the measured water table from the lowest elevation in the basin	5 feet
Maximum longitudinal slope	5%
Maximum side slope	3H:1V
Maximum velocity	1.0 ft/s
Maximum flow depth	2/3 vegetation height
WQV	As defined in Section 2.3.5
Minimum freeboard	6 inches
Maximum Infiltration Rate	As determined in Section 2.3.4
Minimum residence time	5. min
Vegetative Cover	>65%

3.1.4.6 Filter or buffer strips

Description: Filter strips are vegetated areas designed to treat sheet flow runoff from adjacent impervious surfaces such as parking lots and roadways, or intensive landscaped areas such as golf courses. While some assimilation of dissolved constituents may occur, filter strips are generally more effective in trapping sediment and particulate-bound metals, nutrients, and pesticides. Filter strips are more effective when the runoff passes through the vegetation and thatch layer in the form of shallow, uniform flow. Filter strips are primarily used to pretreat runoff before it flows to an infiltration BMP or another natural filtration BMP.

Application: Most effective when inflow is not concentrated, but comes in by sheet flow. Works well on road shoulders or off parking lots with no curb and gutter.

Water Quality Effectiveness:

Target Pollutant	Relative Removal Effectiveness
Sediment	Good
Nutrients	Fair
Metals	Good
Bacteria	Excellent
Oil/Grease	Excellent

Design Criteria: The following criteria shall be met for filter or buffer strips:

Parameter	Requirement
Minimum flow length	15 feet
Maximum longitudinal slope	5H:1V
Maximum flow velocity	1.0 ft/s
Maximum flow depth	2/3 vegetation height
Minimum freeboard	6 inches
Minimum vegetation cover	>65%
WQV	As defined in Section 2.3.5
Maximum Infiltration Rate	As determined in Section 2.3.4

3.1.4.7 Velocity Dissipaters

Description: Velocity dissipaters are BMPs designed to slow the velocity and minimize erosive action of flowing water. Check dams and level spreaders are two kinds of velocity dissipaters that are commonly used. Check dams are designed to create a series of step-downs with pools in between while level spreaders are designed like weirs to spread the flow out and to control water levels. Level spreaders are commonly used in wetland areas to maintain a uniform distribution of water and keep the flows from channelizing.

Application: Typically used in flow channels (concentrated flows) or to disperse water entering into a wetland area

Water Quality Effectiveness:

Target Pollutant	Relative Removal Effectiveness
Sediment	Good
Nutrients	Fair
Metals	Fair
Bacteria	Good
Oil/Grease	Fair

Design Criteria: The following criteria shall be met for velocity dissipaters:

Parameter	Requirement
Maximum flow velocity	1.0 f/s
Minimum freeboard	6 inches
WQV	As defined in Section 2.3.5
Maximum Infiltration Rate	As determined in Section 2.3.4

3.1.5 Man-made Treatment

3.1.5.1 Filtration Cartridges

Description: Passing stormwater through a filtration fabric, plate, membrane or device is a viable option for treating stormwater. It is generally expensive to purchase and maintain and is therefore not frequently used. Forcing the water through the medium also usually results in head loss. Various fabrics or media will be considered on a case by case basis to meet the needs of a project.

Application: Filtration cartridges are typically used when other options won't work. They are expensive to buy and maintain. They do have a relatively small footprint.

Water Quality Effectiveness:

Target Pollutant	Relative Removal Effectiveness
Sediment	Excellent
Nutrients	Excellent
Metals	Excellent
Bacteria	Excellent
Oil/Grease	Excellent

Design Criteria: The following criteria shall be met for filtration cartridges:

Parameter	Requirement
Design per manufacturer's requirements	
WQV	As defined in Section 2.3.5

3.1.5.2 Hydrodynamic Separators

Description: Hydrodynamic separators are stormwater management devices that work primarily based on vortex and gravity principles to separate stormwater from the pollutants. They are generally designed as flow-through systems with either on-line or off-line storage of pollutants. They include chambers for settling and storage of pollutants and are often used in conjunction with other BMPs as pretreatment. They are not especially effective for the removal of fine materials or dissolved pollutants. On-line separators are more susceptible to scour or re-suspension of pollutants than systems that incorporate off-line storage. They are generally not designed to treat stormwater flows exceeding 25 cfs.

Application: Typically limited by flow rates. Small footprint, but normally require depth for pollutant storage

Water Quality Effectiveness:

Target Pollutant	Relative Removal Effectiveness
Sediment	Excellent
Nutrients	Good
Metals	Excellent
Bacteria	Fair
Oil/Grease	Good

Design Criteria: The following criteria shall be met for hydrodynamic separators:

Parameter	Requirement
Maximum flow rate for prefabricated units	25 cfs
Design per manufacturer's requirements	
Typically need a high flow bypass	
WQV	As defined in Section 2.3.5

3.1.5.3 Safl Baffle

Description: Safl Baffles are a brand name product designed primarily as a post-construction retrofit pretreatment system. They require a sump structure. A specially designed perforated metal plate is installed inside a sump manhole or vault. Water flows through the plate. This action facilitates improved settling and re-suspension characteristics. Sediment removal rates are generally less than with hydrodynamic separators. These baffles are a fair low cost alternative that require a minimal footprint. Sediments are stored in the lower reaches of the manhole or vault. Safl Baffles are not effective for floatables.

<u>Application:</u> Typically can be used anywhere a hydrodynamic separator can be used, but can handle higher flow rates. Pollutant removal rates slightly worse than a hydrodynamic separator.

<u>Water Quality Effectiveness:</u>

Target Pollutant	Relative Removal Effectiveness
Sediment	Good
Nutrients	Fair
Metals	Good
Bacteria	Fair
Oil/Grease	Poor*

*When used in conjunction with a skimmer their performance with oil/grease is "Good"

<u>Design Criteria:</u> The following criteria shall be met for Safl Baffles:

Parameter	Requirement
Maximum flow rate	50 cfs
Design per manufacturer's requirements	
Removal efficiency goes down with higher flows	
WQV	As defined in Section 2.3.5

3.1.5.4 Skimmer

<u>Description:</u> Skimmers are designed to trap floatables in a holding facility until they can be removed by absorbent materials or a vactor truck. They can take many shapes and sizes. They can be prefabricated or custom built to fit the needs of almost any project. They generally require a certain amount of standing water to maintain a seal so the floatables cannot escape. They also require relatively frequent inspection and maintenance because of small storage capacity. They work on the principle of baffles

<u>Application:</u> Skimmers are typically not used as standalone treatment options. They are best utilized when floatables are the primary pollutant of concern

Water Quality Effectiveness:

Target Pollutant	Relative Removal Effectiveness
Sediment	Poor
Nutrients	Poor
Metals	Poor
Bacteria	Poor
Oil/Grease	Good

Design Criteria:

Per Manufacturer's recommendations

3.2 Sample Calculations

All categories of BMPs require a determination of the Water Quality Volume (WQV). Section 2.3.5 describes that calculation process.

3.2.1 Calculating Size Requirements for Infiltration BMPs

The main challenge associated with infiltration BMPs is preventing system clogging and subsequent infiltration inhibition. In addition, infiltration BMPs must be designed to drain in a reasonable period of time so that storage capacity is available for subsequent storms and so that standing water does not result in unwanted conditions. Infiltration BMPs should be designed according to the requirements listed in Table 3-1 and outlined in the following text:

Infiltration facilities must be sized to completely infiltrate the design capture volume within **72 hours**.

Step 1: Calculate the Design Volume

Infiltration facilities shall be sized to capture and infiltrate the water quality volume as described in section 2.3.5

Table 3-1: Infiltration BMP Design Criteria

Design Parameter	Unit	Basins and Trenches	Galleries	Permeable Pavement	Dry Well	Hybrid Bioretention/ Dry Well
Design Water Quality Volume	cubic feet	See Section 2.3.5				
Design Surface Drawdown Time	hr	72				
Setbacks and Elevations	feet	In accordance with the Infiltration Feasibility Criteria, Section 3.1.1				

Pretreatment	-	Appropriate Treatment Control Measure shall be provided as pretreatment for all tributary surfaces other than roofs				
Hydraulic Conductivity, $K_{sat,measured}$	in/hr	In accordance with Section 2.3.4 or as measured in the field by a certified hydrogeologist				
Factor of Safety, FS	-	3				
Facility geometry	-	Bottom slope ≤ 3% (basins); side slope shall not exceed 3:1 (H:V)	Flat bottom slope	Pavement slope ≤ 5%; If ≥ 2%, area shall be terraced	Typical 18 – 36 inch diameter; flat bottom slope	Bioretention: Bottom slope ≤ 3%; side slope shall not exceed 3:1 Drywell: flat bottom
Ponding Depth	inch	18 (maximum)[a]				
Media Depth	feet	2 (min) 8 (max)	-	2 (min) 8 (max)	-	2 (min) 8 (max)
Gravel media diameter	inch	1 – 3	-	1 - 2	3/8 – 1	3/8 - 1
Inlet erosion control	-	Energy dissipater to reduce velocity				
Overflow device	-	Required if system is on-line and does not have an upstream bypass structure. Shall be designed to handle the peak storm flow in accordance with the Building and Safety code and requirements				

a: Ponding depth may vary for galleries (which have a storage depth) and may be different from one vendor to another. Ponding depth is not necessarily applicable to permeable pavement.

Step 2: Calculate the BMP Surface Area

Determine the size of the required infiltrating surface by assuming the water quality volume will fill the available ponding depth.

Determine the minimum infiltrating surface area necessary to infiltrate the design volume

$$A_{min} = (V_{design} \times 12 \text{ in/ft}) / (T \times K_{sat,\ design})$$

Where:

A_{min} = Minimum infiltrating surface area (sq ft),

V_{design} = Design volume (cf)

T = Drawdown time (hours), 72 hours

$K_{sat,design}$= Design infiltration rate of filter media (in/hr)

For infiltration basins, the surface area should be calculated as the surface area at mid-ponding depth. For infiltration trenches, the surface area should be calculated at the bottom of the trench.

3.2.2 Stormwater Harvesting Calculations

Step 1: Perform site assessment to determine if harvesting is feasible such that the draw down can occur within 3 days. A site investigation may be necessary to understand if there is sufficient landscape to accommodate use.

Step 2: Determine Water Quality Volume – See Section 2.3.5

3.2.3 Natural Filter Calculations

Natural filter facilities can be sized using one of two methods: a simple sizing method or a hydrologic routing modeling method. With either method the design capture volume must be completely infiltrated within the drawdown time shown in Table 3-2. Steps for the simple sizing method are provided below. BMPs should be designed according to the requirements listed in Table 3-2 and outlined in the following text. Swales and filter strips must be handled as indicated in the following sections.

Table 3-2: Natural Filter BMP Design Criteria

Design Parameter	Unit	Rain Garden	Planter Box	Bio-infiltration		Vegetated Swale	Filter Strip
Water Quality Volume, WQV	cubic feet	See Section 2.3.5					-
Design Drawdown Time	hr	72				-	-
Factor of Safety[c]	-	2				-	
Soil Media Infiltration Rate	in/hr	5 (max)				-	
Design Contact Time	min	-				≥ 7	
Slope in Flow Direction	%	-				1% (min) 6% (max)	2% (min) 33% (max)
Design Flow Velocity	ft/sec	-				≤ 1	
Maximum Ponding/Flow Depth	inch	18	12	18	-	5	1
Minimim Width	ft	2			-	2	15
Soil Depth	ft	2 (3 preferred) Topped with 3" of mulch			-	2	-
Underdrain	-	Slotted PVC pipe embeded in 12" gravel section and located 1" from bottom of facility		Slotted PVC pipe at least 2' above bottom of facility		N/A	Not required

Step 1: Calculate Water Quality Volume

See Section 2.3.5

Step 2: Determine Infiltration Rate

See Section 2.3.4

Step 3: Calculate Ponding Depth

Select a ponding depth (d_P) that satisfies geometric criteria and is congruent with the constraints of the site. The ponding depth must satisfy the maximum ponding depth constraint shown in Table 3-2 as well as the following:

$$d_p \text{ (ft)} = (K_{sat,design} \text{ x T}) / 12$$

Where: d_p = Ponding depth (ft)

$K_{sat,design}$= Design infiltration rate of filter media (in/hr)

T = Required surface drain time (hrs), from Table 4.2

Step 4: Calculate Surface Area

$$A_{min} = (V_{design}) / [(T_{fill} \text{ x } K_{sat}/12)+ d]$$

Where:

A_{min} = Design infiltrating area (sq ft)

T_{fill}= Time to fill to max ponding depth with water (hrs) [unless a hydrologic routing model is used, assume a maximum of 3 hours]

$K_{sat,}$= Design infiltration rate of filter media (in/hr)

d = depth of ponded water (ft)

The calculated BMP surface area only considers the surface area of the BMP where infiltration through amended media can occur. The total footprint of the BMP should include a buffer for side slopes and freeboard.

3.2.4 Swale Sizing

Swales shall be designed with a trapezoidal channel shape with side slopes of 3:1 (H:V). They shall incorporate at least two feet of soil beneath the vegetated surface. Swale sizing will be determined on a case-by-case basis. As is the case with other biofiltration BMPs, the sizing criteria presented in Table 3-2 must be met.

3.2.5 Filter Strip Sizing

Because filter strips are most often used for pretreatment purposes, their design will depend on the desired flow-rate to be treated and the type of BMP downstream, among other factors. As a result, filter strip sizing is not covered in this handbook, but will be determined on a case-by-case basis.

4. Offsite Mitigation Measures

4.1 Offsite Mitigation Measures

Offsite mitigation shall only be utilized after on-site mitigation opportunities are exhausted. If on-site mitigation meets the minimum requirements no off-site mitigation will be required. The following criteria shall be implemented in considering off-site mitigation:

1. Locate off-site projects as close as possible to the project site.
2. Locate off-site projects within the same sub-watershed as the proposed project.
3. Off-site projects may be completed on either private or public land.
4. Secure needed easements and rights to the property on which off-site projects are completed.
5. Demonstrate that same level of water quality protection is achieved as if all the runoff were retained on-site.
6. Demonstrate that the off-site project when combined with on-site mitigation addresses the same volume of water that would have been addressed if BMPs were all constructed on-site.
7. The developer shall execute an Agreement in Perpetuity with the city and recorded with the property, for on-going maintenance and upkeep of both on-site and off-site BMP(s).

4.2 Regional Facilities

In lieu of an independent off-site mitigation project designed specifically to meet the needs of a given project, the developer may be able to work together with the City and/or other groups to construct a larger regional water quality mitigation project. If a regional project is pursued, the following criteria should be considered:

1. An agreement shall be obtained with the City and/or other partners for the design, sizing, construction and maintenance of the regional facility.
2. The regional facility shall be sized to accommodate the water quality needs of all interested parties.
3. The same net level of water quality protection shall be achieved for the combined facility as would be required for each separate entity as if they were separate and distinct facilities.
4. The same total volume of water required to be addressed at each individual and independent site shall be addressed as the accumulated total volume at the regional facility.
5. All Maintenance Agreements in Perpetuity that would have been required for each separate facility shall be addressed in agreement(s) for the regional facility and shall be recorded with each parcel encompassed as part of the regional facility.

APPENDIX A

MUNICIPAL ORDINANCES

Appendix A: Municipal Ordinances

APPENDIX B

PERMIT APPLICATIONS, REVIEW FORMS AND CHECKLISTS

Water Quality Report Form

SOUTH JORDAN
UTAH

STORM WATER QUALITY REPORT

Date: ______________________________
Project Name: ______________________________
Project ID: ______________________________
Design Engineer: ______________________________

Is the project within a watershed that is 303(d) listed?

If yes:

Name of Receiving Water(s): ____

Listed Impairment(s): ____

Does the watershed have an approved TMDL?

If yes:

Approved TMDL(s): ____

I have reviewed the storm water quality design and find this report to be complete, accurate, and current.

____
(Name), Project Manager

____
(Name), Permittee's Designated Storm Water Coordinator

____
(PE stamp required) (Name), Permittee's Head of Maintenance

Project Information

Type of Project (New Development, Redevelopment): ____

Area of Land Disturbance (acre): ________________________

Project Impervious Area (acre): _____________________

Project Imperviousness (%): ______________________

Project Runoff Coefficient, R_v: _______________________

90^{th} Percentile Storm Depth (in): _______________________

Project 90^{th} Percentile Volume, V_{goal}(cf): _____________________

Groundwater Information

Depth to Groundwater (ft): _____________________________

Historical High Depth to Groundwater, if known (ft): _______________________

Source: _____________________________

Soil Information

Infiltration Rate (in/hr): _______________________________

Source: ___________________________________

LID Drainage Areas

(add additional rows as needed)

Contributing Drainage Area	Area (acre)	Impervious Area (acre)	Imperviousness (%)	Runoff Coefficient, R_v	Water Quality Volume WQV (cf)
				Total WQV (cf)	

LID BMP Design

(add additional rows as needed)

Contributing Drainage Area	LID BMP Type	Water Quality Volume WQV (cf)	Runoff Retained (cf)	Percent of Runoff Captured (%)
		Total Volume Retained (cf)		

Percent of V_{goal} captured by LID BMPs: _______%

If 100% of V_{gpal} is not captured, document and provide narrative of technical infeasibilities and/or alternate compliance measures below:

____

____

____

____

Describe additional storm water quality measures incorporated into the site:

____

____

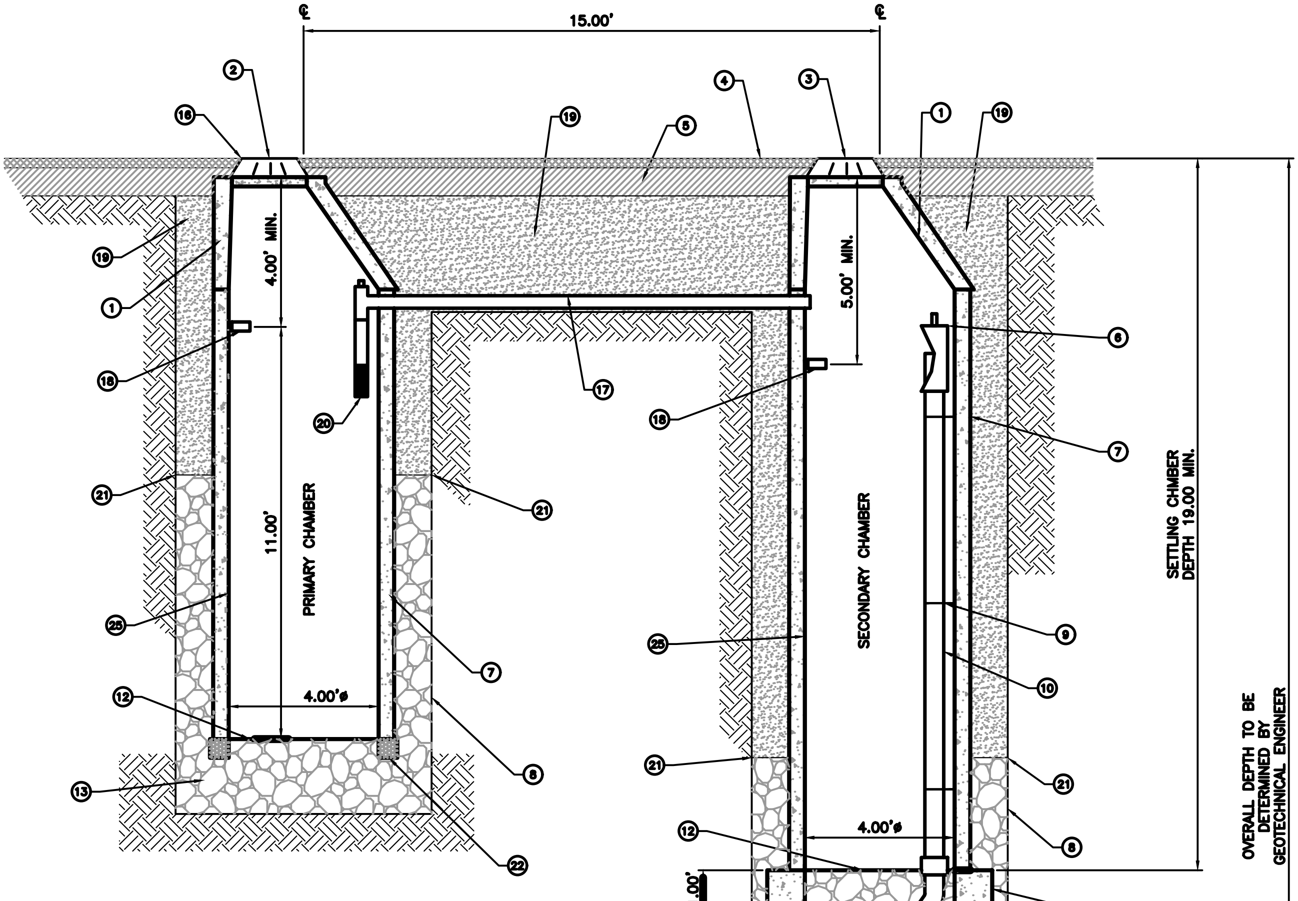
____

____

APPENDIX C

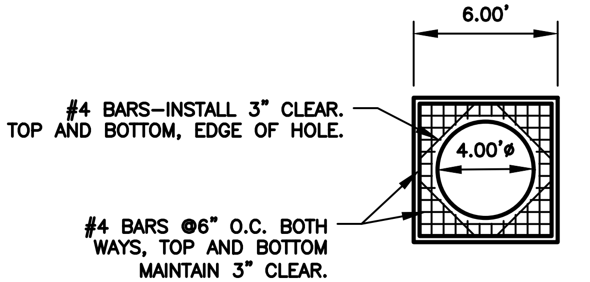
LID BMP STANDARD DETAILS

Appendix C: LID BMP Standard Details



DRY WELL SYSTEM

NOTES
1. PRIMARY CHAMBER REQUIRED ON ALL DRY WELL SYSTEMS.
2. NO OUTSIDE PIPE CONNECTIONS TO PRIMARY OR SECONDARY CHAMBERS. ONLY SURFACE DRAINAGE IS ALLOWED
3. PERCOLATION TEST TO BE PERFORMED AFTER FINAL INSTALLATION OF DRY WELLS AND LANDSCAPING.



CONCRETE FOOTING

PREPARED BY:______________________

SOUTH JORDAN CITY

DATE	REVISIONS	BY	DRAWN: DTJ
11/6/19		DTJ	DATE 11/19

DRYWELL

STANDARD DRAWING
LID 1.1

KEYED NOTES

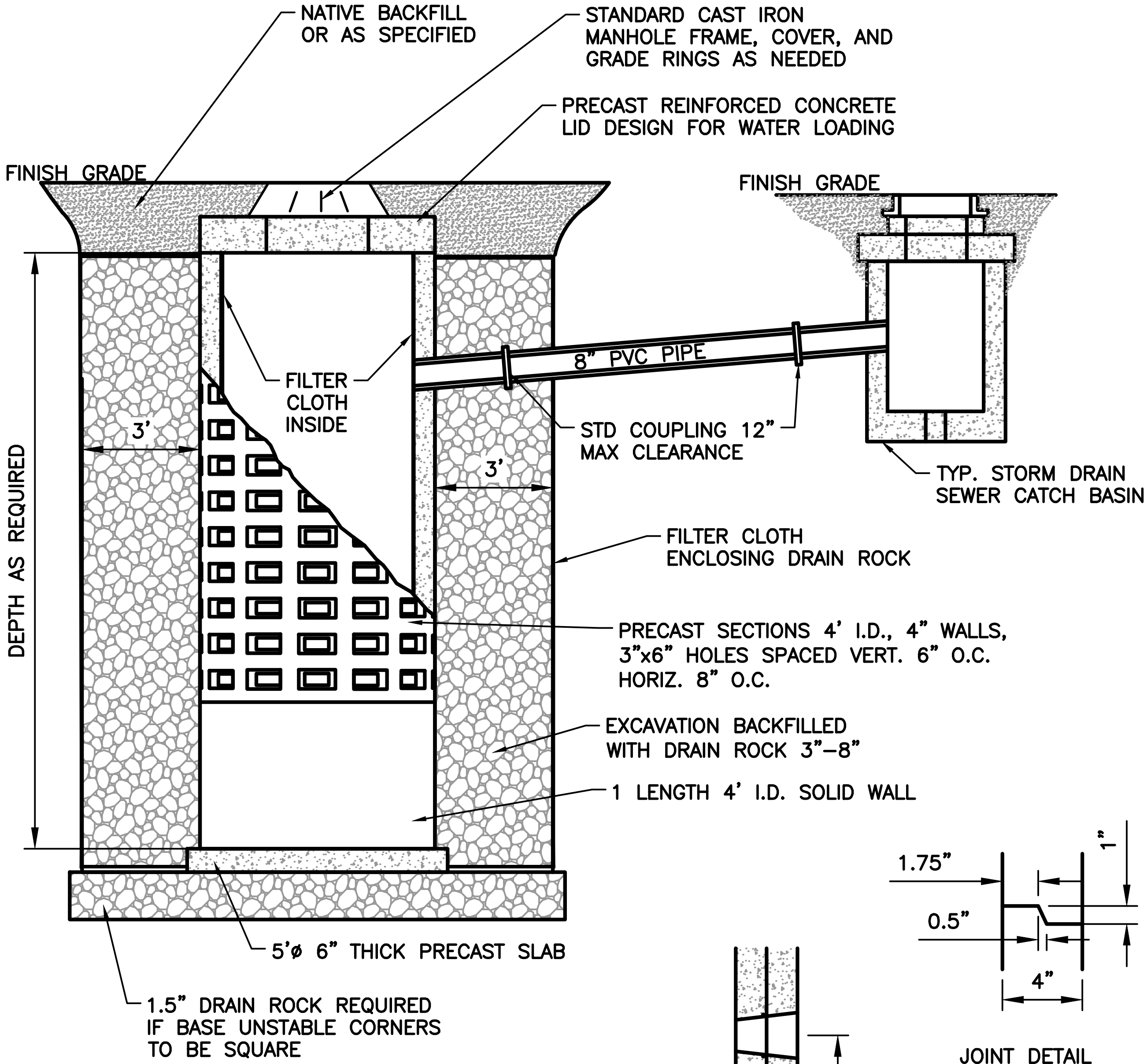
1. MODIFIED FLAT-BOTTOM MANHOLE CONE
2. MIN. 30" DIA BOLTED CAST IRON RING AND GRATE
3. MIN. 30" DIA BOLTED CAST IRON RING AND SOLID SOUTH JORDAN CITY STORM DRAIN COVER
4. GRADED BASIN, CITY VAC TRUCK ACCESS TO BE PROVIDED AT A MIN HORIZONTAL DISTANCE OF 15' AND NO MORE THAN 8% INCLINE FROM EACH MANHOLE LID
5. COMPACTED BASE MATERIAL
6. DEBRIS SHIELD: ROLLED 16 GA X 24" LENGTH W/ VENTED ANTI-SIPHON AND INTERNAL 0.265" MAX SWO FLATTENED EXPANDED STEEL SCREEN X 12" LENGTH, FUSION BONDED EPOXY COATED.
7. PRECAST CONCRETE LINER, 4000 PSI 48" I.D. AND 54" O.D., CENTER IN HOLE
8. MIN. 6' DIA DRILLED SHAFT.
9. SUPPORT BRACKET (TYP), FORMED 12 GA STEEL, FUSION BONDED EPOXY COATED
10. 6" DIA SCH 40PVC OVERFLOW PIPE
11. 6" DIA CORRUGATED HDPE, NO PERFORATIONS BELOW SETTLING CHAMBER
12. NON-WOVEN GEOTEXTILE FABRIC MIRFI 140 NL OR APPROVED EQUAL, PLACED AFTER OVERFLOW PIPE HAS BEEN INSTALLED
13. 3/8" TO 1-1/2" WASHED ROCK
14. DRAINAGE SCREEN: SCH 40 PVC 0.12" SLOTTED WELL SCREEN 32 SLOTS PER ROW/FT
15. MIN. 4' DRILLED SHAFT
16. FABRIC SEAL, UV RESISTANT GEOTEXTILE. COVER GRATE UNTIL PAVING AND OR LANDSCAPING IS COMPLETE.
17. 4" DIA SCH 40 PVC CONNECTOR PIPE W/ VENTED ANTI-SIPHON INTAKE & FLOW REGULATOR, PIPE TO BE FULLY CAPPED UNTIL BASIN FULLY VEGETATED OR AS APPROVED BY CITY ENGINEER.
18. ABSORBANT - HYDROPHOBIC IMBIBER PILLOW, MIN. 4 QUART CAPACITY.
19. 1 SACK SLURRY IN ANNLAR SPACE AROUND CHAMBERS.
20. INTAKE SCREEN, SCH 40 PVC 0.12" MODIFIED SLOTTED WELL SCREEN WITH 32 SLOTS PER ROW/FT. 48" OVERALL LENGTH WITH TRI-C END CAP.
21. 6 MIL PLASTIC LINER WATER STOP.
22. 6" X 6" CONCRETE FOOTING.
23. 6' X 6' X 1' CONCRETE FOOTING (SEE DETAIL, THIS SHEET) OR AS APPROVED BY CITY ENGINEER.
24. NON-WOVEN GEOTEXTILE SLEEVE, MIRAFI TM/ 140 NL. MIN 6' DIA, HELD APPROX 15' OFF THE BOTTOM OF EXCAVATION.
25. 8 FT MIN "FOOT RULER" INSTALLED FROM FINISHED FLOOR OF CHAMBER

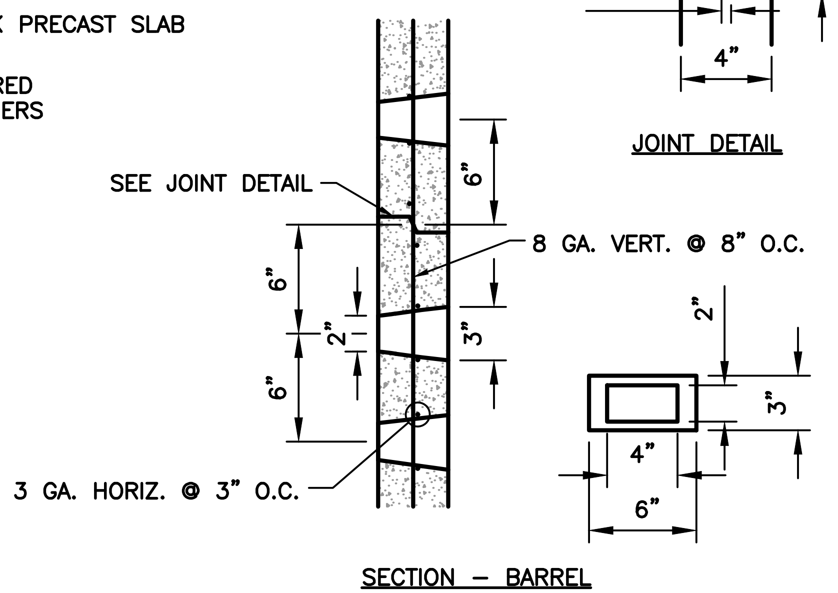
SOUTH JORDAN UTAH

PREPARED BY:

SOUTH JORDAN CITY

DATE	REVISIONS	BY	DRAWN: DTJ	DRYWELL	STANDARD DRAWING LID 1.2
11/6/19		DTJ	DATE 11/19		





NOTES:

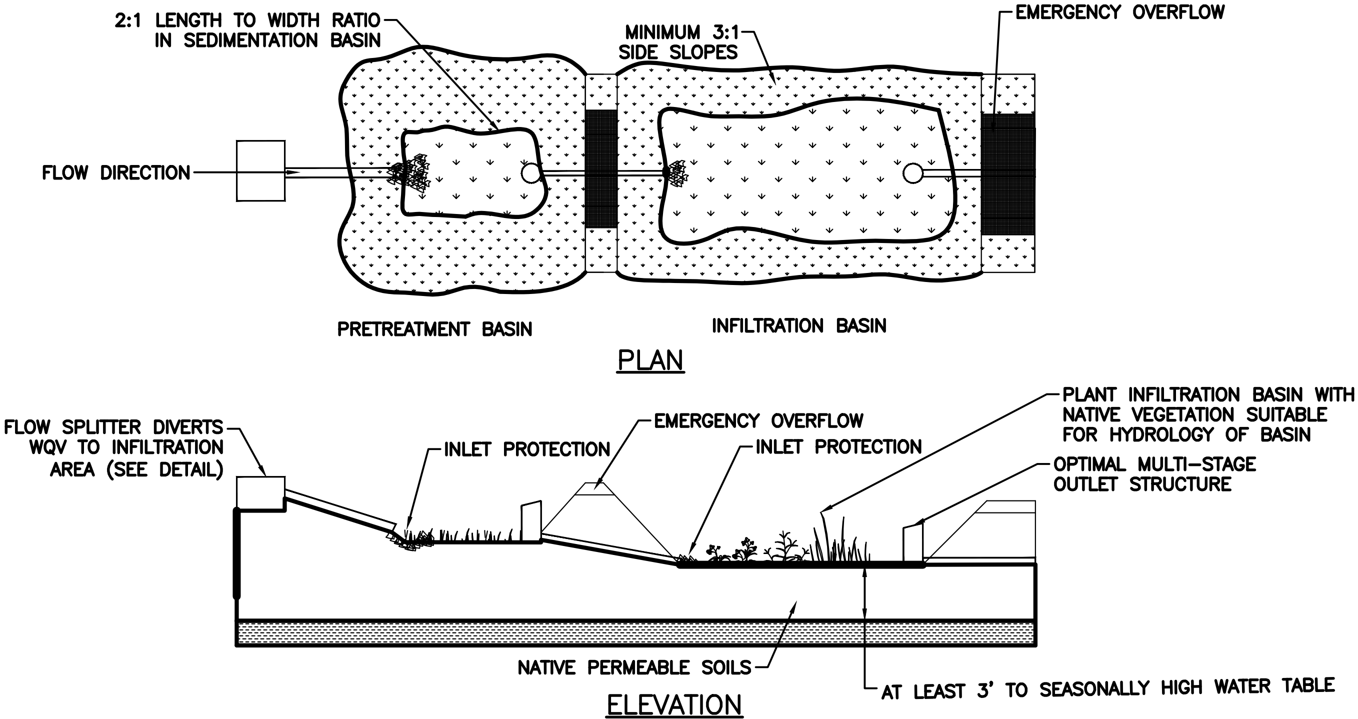
1. FILTER CLOTH TO BE TEXEL MODEL 7609 OR EQUAL
2. SIZE OF EXCAVATION AND VOLUME OF DRAIN ROCK TO BE DETERMINED

SOUTH JORDAN UTAH

PREPARED BY:____________________

SOUTH JORDAN CITY

DATE	REVISIONS	BY	DRAWN: DTJ	DRAINAGE DRYWELL	STANDARD DRAWING LID 2
11/6/19		DTJ	DATE 11/19		



CONSTRUCTION SEQUENCING:

1. PERFORM CONTINUOUS INSPECTIONS OF EROSION CONTROL PRACTICES.
2. INSTALL SILT FENCE ALONG THE PERIMETER OF THE SITE TO PREVENT SEDIMENT FROM LEAVING THE SITE DURING THE CONSTRUCTION PROCESS.
3. ALL DOWNGRADIENT PERIMETER SEDIMENT-CONTROL BMPS MUST BE IN PLACE BEFORE ANY UP GRADIENT LAND-DISTURBING ACTIVITY BEGINS.
4. REMOVE TOPSOIL FROM THE SITE AND PLACE IN TEMPORARY STOCKPILE LOCATION. TEMPORARY SEED THE STOCKPILE.
5. INSTALL UNDERGROUND UTILITIES (WATER, SANITARY SEWER, ELECTRIC AND PHONES) TAKING THE LOCATION AND FUNCTION OF STORM WATER BMPS INTO CONSIDERATION.
6. SEED AND MULCH DISTURBED AREAS ON SITE.
7. CONSTRUCT THE ROADS TAKING THE LOCATION AND FUNCTION OF STORM WATER BMPS INTO CONSIDERATION.
8. PERFORM ALL OTHER SITE IMPROVEMENTS TAKING THE LOCATION AND FUNCTION OF THE STORM WATER BMPS INTO CONSIDERATION.
9. FINAL GRADE THE SITE.
10. STABILIZE THE SITE BY IMPLEMENTING THE NATIVE SEEDING AND PLANTING PORTION OF THE LANDSCAPING PLAN.
11. INSTALL THE EROSION CONTROL BLANKET.
12. REMOVE THE SILT FENCE AFTER THE SITE IS STABILIZED PER PROJECT ENGINEER APPROVAL.

GENERAL NOTES:

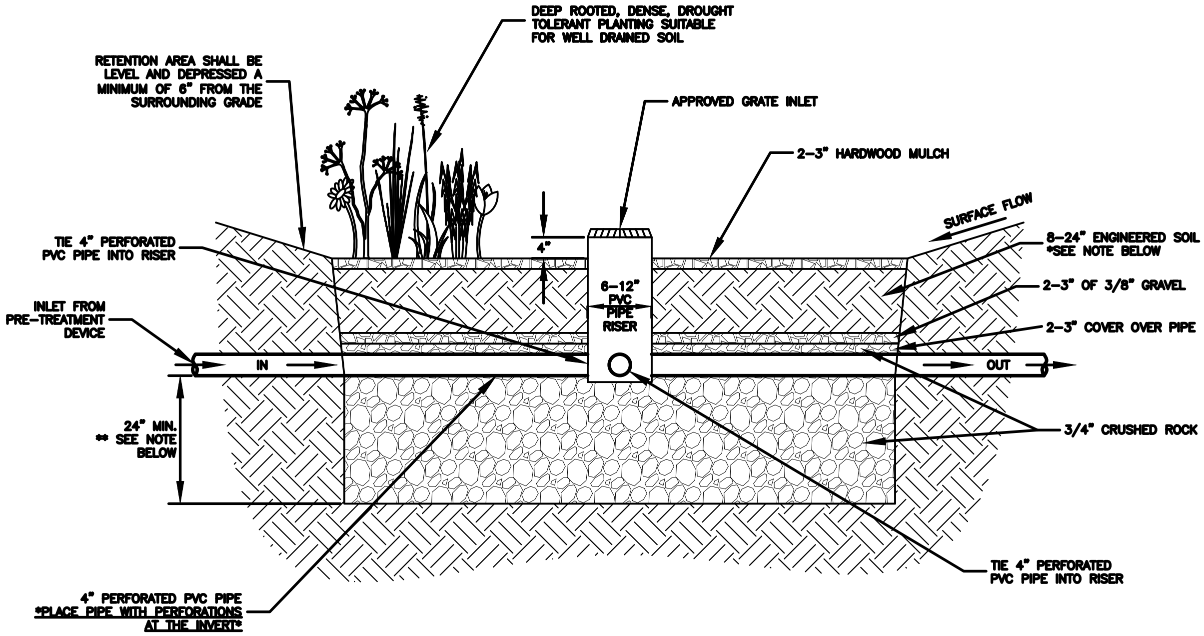
1. INSTALL ALL TEMPORARY EROSION CONTROL MEASURES PRIOR TO THE START OF ANY CONSTRUCTION OPERATION THAT MAY CAUSE ANY SEDIMENTATION OR SILTATION AT THE SITE.
2. INSTALL STORM DRAIN INLET PROTECTION TO PREVENT CLOGGING OF THE STORM SEWER AND SEDIMENT LOADS TO DOWNSTREAM STORM WATER FACILITIES OR WATERBODIES.
3. IF THE STORMWATER BMP IS BEING DESIGNED TO SERVE AS A TEMPORARY SEDIMENT BASIN, GRADE THE BMP TO WITHIN THREE (3) FEET OF FINAL GRADE TO PROTECT THE UNDERLYING MATERIAL FROM CLOGGING. ONCE CONSTRUCTION IN THE CONTRIBUTING DRAINAGE AREA HAS BEEN COMPLETED AND THE SITE IS STABILIZED, EXCAVATE THE INFILTRATION BASIN TO FINAL GRADE AND COMPLETE CONSTRUCTION OF THE BMP.
4. GRADING OF THE INFILTRATION BASIN SHALL BE ACCOMPLISHED USING LOW-IMPACT EARTH-MOVING EQUIPMENT TO PREVENT COMPACTION OF THE UNDERLYING SOILS. SMALL TRACKED DOZERS AND BOBCATS WITH RUNNER TRACKS ARE RECOMMENDED.
5. EXCAVATE THE INFILTRATION BASIN TO THE SPECIFIED DEPTH (ELEVATION). IT IS RECOMMENDED THAT ALL SUB MATERIAL BELOW THE SPECIFIED ELEVATION SHALL BE LEFT UNDISTURBED, UNLESS OTHERWISE DIRECTED BY THE ENGINEER.
6. GRADE TO THE DEPTH (ELEVATION) SPECIFIED IN THE CONSTRUCTION DOCUMENTS UNLESS OTHERWISE DIRECTED BY THE ENGINEER.
7. IN THE EVENT THAT SEDIMENT IS INTRODUCED INTO THE BMP DURING OR IMMEDIATELY FOLLOWING EXCAVATION, THIS MATERIAL WILL NEED TO BE REMOVED FROM THE BASIN PRIOR TO INITIATING THE NEXT STEP IN THE CONSTRUCTION PROCESS. SEDIMENT THAT HAS BEEN WASHED INTO THE BASIN DURING THE EXCAVATION PROCESS CAN SEAL THE PERMEABLE MATERIAL, SIGNIFICANTLY REDUCING THE INFILTRATION CAPACITY OF THE SOILS.
8. SEEDING AND INSTALLATION OF EROSION CONTROL BLANKET SHALL BE COMPLETED WITHIN 48 HOURS OF FINAL GRADING.
9. INFILTRATION AREA SHALL BE STAKED OFF DURING CONSTRUCTION TO RESTRICT HEAVY EQUIPMENT TRAFFIC FROM COMPACTING NATIVE SOILS.

SOUTH JORDAN UTAH

PREPARED BY: ____________________

SOUTH JORDAN CITY

DATE	REVISIONS	BY	DRAWN: DTJ	INFILTRATION BASIN PLAN & PROFILE	STANDARD DRAWING LID 3
11/6/19		DTJ	DATE 11/19		



NOTES:

1. *BIORETENTION "ENGINEERED SOIL" LAYER SHALL BE MINIMUM 8" DEEP "SANDY LOAM" SOIL MIX WITH NO MORE THAN 5% CLAY CONTENT. THE MIX SHALL CONTAIN 50-60% SAND, 20-30% COMPOST OR HARDWOOD MULCH, AND 20-30% TOPSOIL.

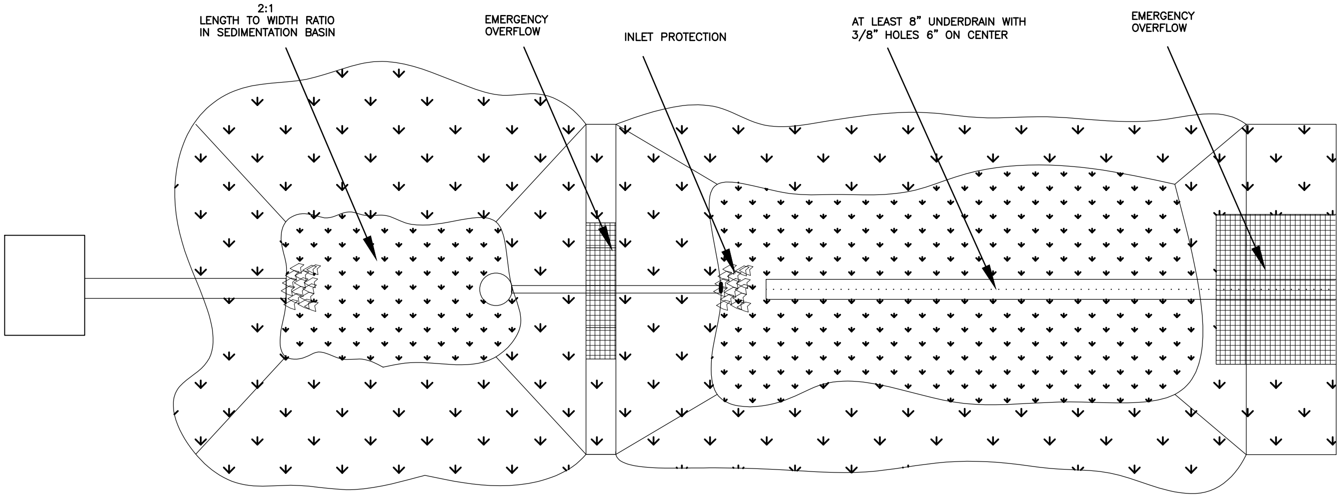
2. **3/4" CRUSHED ROCK LAYER SHALL BE A MINIMUM OF 24" BUT MAY BE DEEPENED TO INCREASE THE INFILTRATION AND STORAGE ABILITY OF THE BASIN.

SOUTH JORDAN UTAH

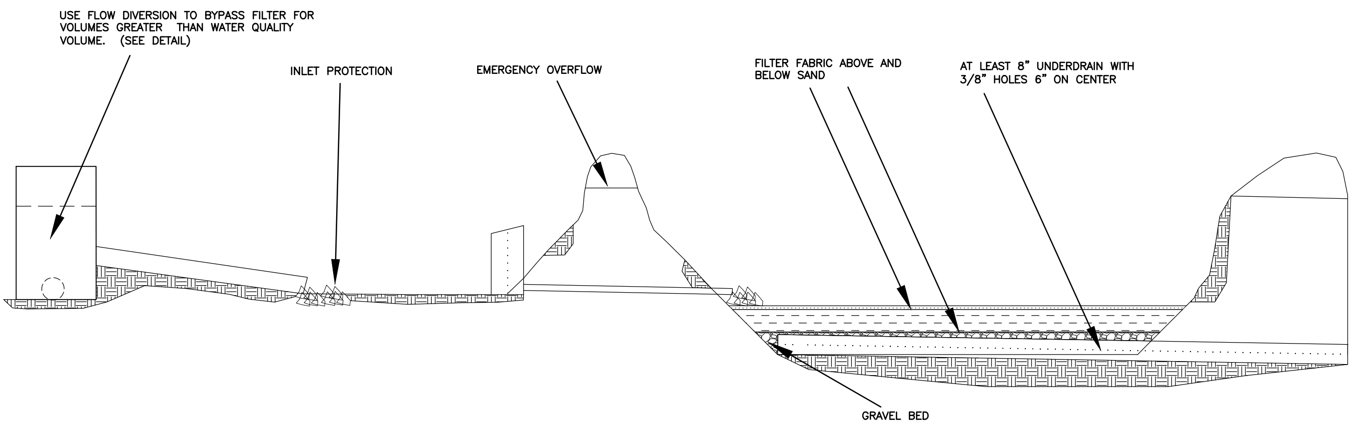
PREPARED BY:

SOUTH JORDAN CITY

DATE	REVISIONS	BY	DRAWN: DTJ	INFILTRATION BASIN WITH BIOFILTER	STANDARD DRAWING LID 4
11/6/19		DTJ	DATE 11/19		



PLAN



PROFILE

GENERAL NOTES:

1. INSTALL ALL TEMPORARY EROSION CONTROL MEASURES (IN ACCORDANCE WITH MnDOT GENERAL CONDITIONS 2573) PRIOR TO THE START OF ANY CONSTRUCTION OPERATION THAT MAY CAUSE ANY SEDIMENTATION OR SILTATION AT THE SITE.
2. INSTALL STORM DRAIN INLET PROTECTION TO PREVENT CLOGGING OF THE STORM SEWER AND SEDIMENT LOADS TO DOWNSTREAM STORM WATER FACILITIES OR WATERBODIES.
3. EXCAVATE THE INFILTRATION BASIN TO THE SPECIFIED DEPTH (ELEVATION). IT IS RECOMMENDED THAT ALL SUB MATERIAL BELOW THE SPECIFIED ELEVATION SHALL BE LEFT UNDISTURBED, UNLESS OTHERWISE DIRECTED BY THE ENGINEER.
4. GRADE TO THE DEPTH (ELEVATION) SPECIFIED IN THE CONSTRUCTION DOCUMENTS UNLESS OTHERWISE DIRECTED BY THE ENGINEER.
5. IN THE EVENT THAT SEDIMENT IS INTRODUCED INTO THE BMP DURING OR IMMEDIATELY FOLLOWING EXCAVATION, THIS MATERIAL WILL NEED TO BE REMOVED FROM THE BASIN PRIOR TO INITIATING THE NEXT STEP IN THE CONSTRUCTION PROCESS. SEDIMENT THAT HAS BEEN WASHED INTO THE BASIN DURING THE EXCAVATION PROCESS CAN SEAL THE PERMEABLE MATERIAL, SIGNIFICANTLY REDUCING THE INFILTRATION CAPACITY OF THE SOILS.
6. NON-STANDARD COMPONENT: CLEAN, WASHED 1.5 TO 3.5-INCH GRAVEL SHALL BE PLACED IN THE BOTTOM OF THE BASIN TO THE DEPTH OF AT LEAST 12 INCHES OR AS SPECIFIED IN THE CONSTRUCTION DOCUMENTS. GRAVEL SHOULD BE PLACED IN LIFTS AND LIGHTLY COMPACTED WITH PLATE COMPACTORS.
7. NON-STANDARD COMPONENT: THE PERFORATED PIPE (UNDERDRAIN) SHALL BE LAID DIRECTLY ON THE GRAVEL BED. GRADE AND ALIGNMENT SHALL NOT VARY FROM THE PRESCRIBED GRADE BY MORE THAN 0.03 FEET (9 MM) AT ANY POINT. THE JOINTS BETWEEN SECTIONS OF PIPE SHALL BE CONNECTED IN A FASHION ACCEPTABLE TO ENGINEER. ONCE THE PIPE IS IN PLACE, IT SHALL BE COVERED IMMEDIATELY WITH GRANULAR MATERIAL AS SPECIFIED IN THE CONSTRUCTION DOCUMENTS. THE GRANULAR MATERIAL SHALL BE OF UNIFORM DEPTH ON BOTH SIDES OF THE PIPE. SPECIAL INLETS AND SPECIAL DEVICES AT THE OUTLET END OF THE PIPE SHALL BE CONSTRUCTED AS SHOWN IN THE PLANS.
8. SEEDING AND INSTALLATION OF EROSION CONTROL BLANKET SHALL BE COMPLETED WITHIN 48 HOURS OF FINAL GRADING.

CONSTRUCTION SEQUENCING:

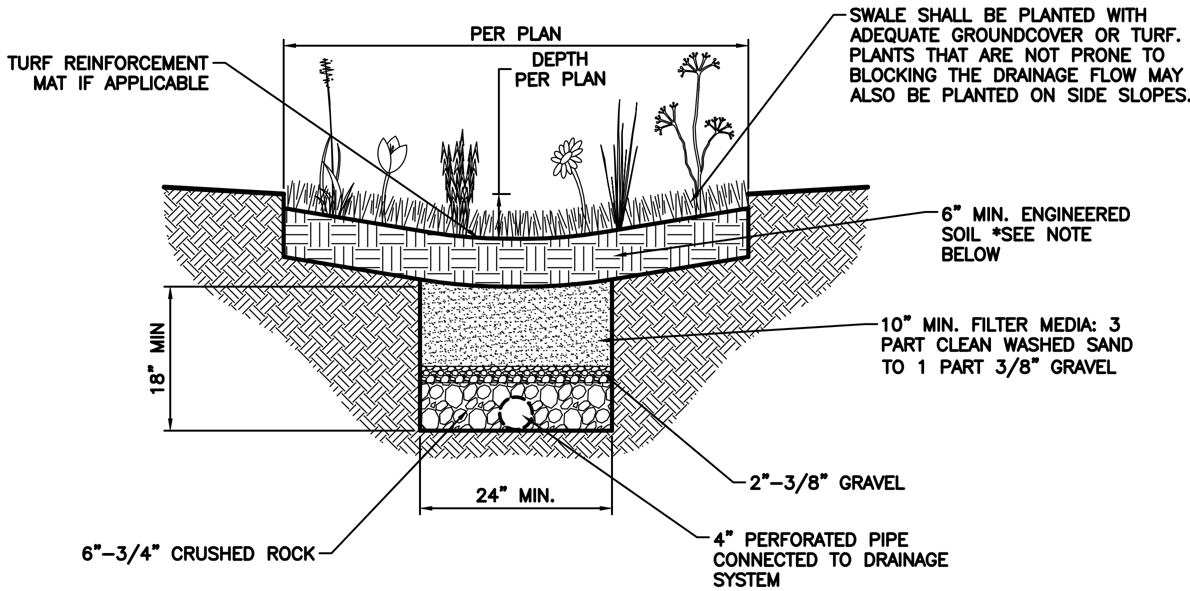
1. PERFORM CONTINUOUS INSPECTIONS OF EROSION CONTROL PRACTICES.
2. INSTALL SILT FENCE ALONG THE PERIMETER OF THE SITE TO PREVENT SEDIMENT FROM LEAVING THE SITE DURING THE CONSTRUCTION PROCESS.
3. ALL DOWNGRADIENT PERIMETER SEDIMENT-CONTROL BMPS MUST BE IN PLACE BEFORE ANY UP GRADIENT LAND-DISTURBING ACTIVITY BEGINS.
4. REMOVE TOPSOIL FROM THE SITE AND PLACE IN TEMPORARY STOCKPILE LOCATION. TEMPORARY SEED THE STOCKPILE.
5. INSTALL UNDERGROUND UTILITIES (WATER, SANITARY SEWER, ELECTRIC AND PHONES) TAKING THE LOCATION AND FUNCTION OF STORM WATER BMPS INTO CONSIDERATION.
6. SEED AND MULCH DISTURBED AREAS ON SITE.
7. CONSTRUCT THE ROADS TAKING THE LOCATION AND FUNCTION OF STORM WATER BMPS INTO CONSIDERATION.
8. PERFORM ALL OTHER SITE IMPROVEMENTS TAKING THE LOCATION AND FUNCTION OF THE STORM WATER BMPS INTO CONSIDERATION.
9. FINAL GRADE THE SITE.
10. STABILIZE THE SITE BY IMPLEMENTING THE NATIVE SEEDING AND PLANTING PORTION OF THE LANDSCAPING PLAN.
11. INSTALL THE EROSION CONTROL BLANKET
12. REMOVE THE SILT FENCE AFTER THE SITE IS STABILIZED PER PROJECT ENGINEER APPROVAL.

SOUTH JORDAN
U T A H

PREPARED BY:

SOUTH JORDAN CITY

DATE	REVISIONS	BY	DRAWN: DTJ	SURFACE SAND FILTER	STANDARD DRAWING LID 5
11/6/19		DTJ			
			DATE 11/19		



NOTES:

1. *"ENGINEERED SOIL" LAYER SHALL BE MINIMUM 6" DEEP "SANDY LOAM" SOIL MIX WITH NO MORE THAN 5% CLAY CONTENT. THE MIX SHALL CONTAIN 50-60% SAND, 20-30% COMPOST OR HARDWOOD MULCH, AND 20-30% TOPSOIL.

2. VEGETATED SWALES ON GRADES OF MORE THAN 2.5% MUST INSTALL CHECK DAMS TO LIMIT THE SLOPE OF THE SWALE TO 2.5% UNLESS OTHERWISE APPROVED BY THE DIRECTOR OF ENGINEERING SERVICES.

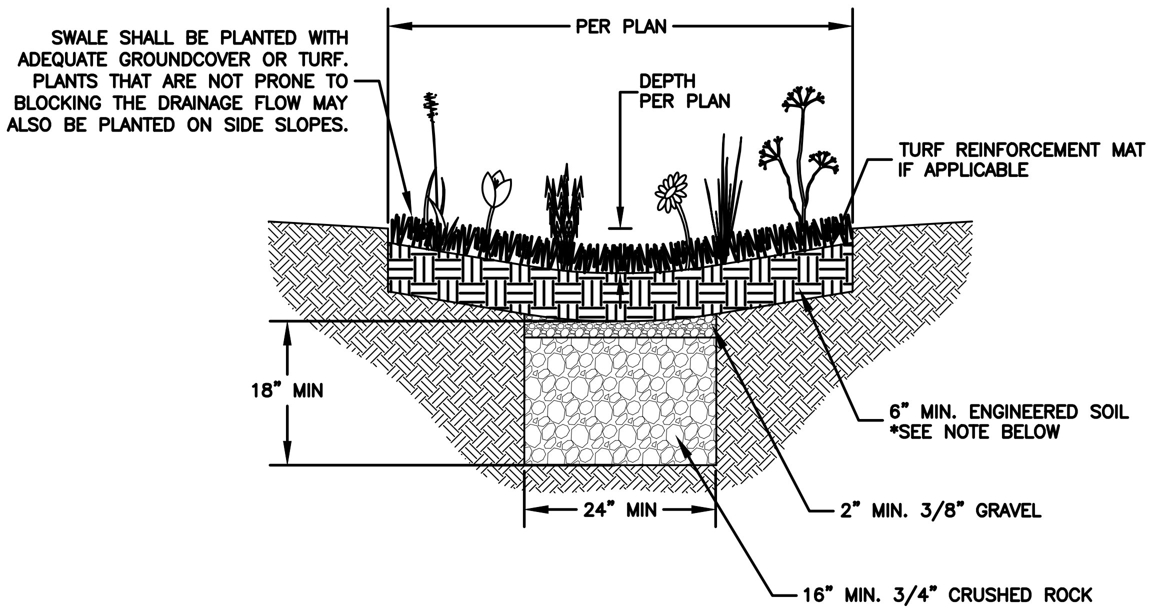
3. NO FILTER FABRIC IS TO BE USED IN THIS SECTION.

PREPARED BY:______________________

SOUTH JORDAN UTAH

SOUTH JORDAN CITY

DATE	REVISIONS	BY	DRAWN: DTJ	VEGETATED SWALE UNDERDRAIN CLAYEY SOIL	STANDARD DRAWING LID 6
11/6/19		DTJ			
			DATE 11/19		



NOTES:

1. *"ENGINEERED SOIL" LAYER SHALL BE MINIMUM 6" DEEP "SANDY LOAM" SOIL MIX WITH NO MORE THAN 5% CLAY CONTENT. THE MIX SHALL CONTAIN 50–60% SAND, 20–30% COMPOST OR HARDWOOD MULCH, AND 20–30% TOPSOIL.

2. VEGETATED SWALES ON GRADES OF MORE THAN 2.5% MUST INSTALL CHECK DAMS TO LIMIT THE SLOPE OF THE SWALE TO 2.5% UNLESS OTHERWISE APPROVED BY THE DIRECTOR OF ENGINEERING SERVICES.

3. NO FILTER FABRIC IS TO BE USED IN THIS SECTION.

SOUTH JORDAN UTAH

PREPARED BY:______________________

SOUTH JORDAN CITY

DATE	REVISIONS	BY	DRAWN:
11/6/19		DTJ	DTJ
			DATE
			11/19

VEGETATED SWALE UNDERDRAIN
SANDY SOIL

STANDARD DRAWING
LID 7

APPENDIX D

80TH PERCENTILE STORM EVENT CALCULATION

Appendix D: 80th Percentile Storm Event Calculations

Utah Lake Lehi

Pleasant Grove

Triad Center

Salt Lake International Airport

Cottonwood Weir

Calculating the 80th Percentile Storm Event

The desire of the National and State Storm Water Regulations is for the hydrology of any given site after development should mimic the hydrology of that same parcel of land in its natural state. The State of Utah has selected the 80th Percentile Storm as the standard to use to meet this desire. The State of Utah has further outlined the steps to be taken to determine the depth of the 80th Percentile storm at any given weather station. The following text was taken from the State of Utah: *A Guide to Low Impact Development within Utah.*

90th Percentile Depth

Determine the 90th percentile precipitation depth.

1. Obtain long-term daily rainfall data from the following sources:
   a. National Oceanic and Atmospheric Administration (NOAA): https://www.ncdc.noaa.gov/cdoweb/datatools/selectlocation; or
   b. Reliable historical local data; or
   c. Any other reliable data source.
2. Sort data low to high
3. Remove small precipitation events (≤0.1 inch) and all snowfall.
4. Use the Excel PERCENTILE function to calculate the 80th percentile rainfall depth.

A more in-depth discussion on determining the 80th percentile precipitation depth is found here: https://owl.cwp.org/mdocs-posts/urban-subwatershed-restoration-manual-series-manual-3/

A reliable record of historical precipitation data should meet the following conditions:

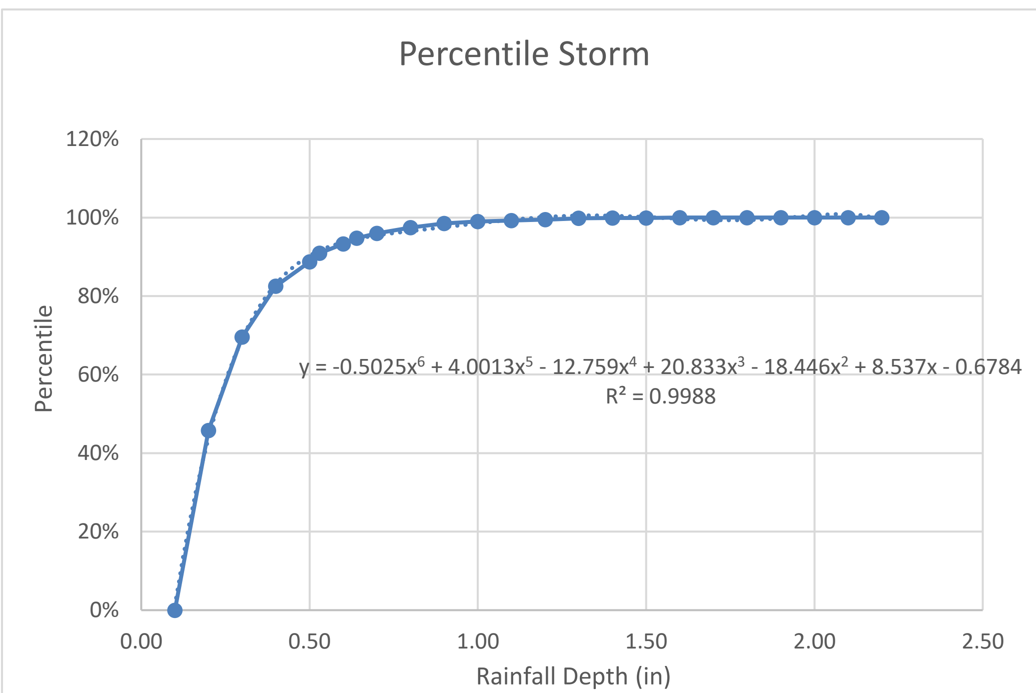
1. Come from an active rain gage;
2. Have at least 30 years of data;
3. Have 90% data coverage for the period of record.

The following pages include a summary of data collected from local rain gages taken from the Utah Climate Center.

Appendix D: 80th Percentile Storm Event Calculations

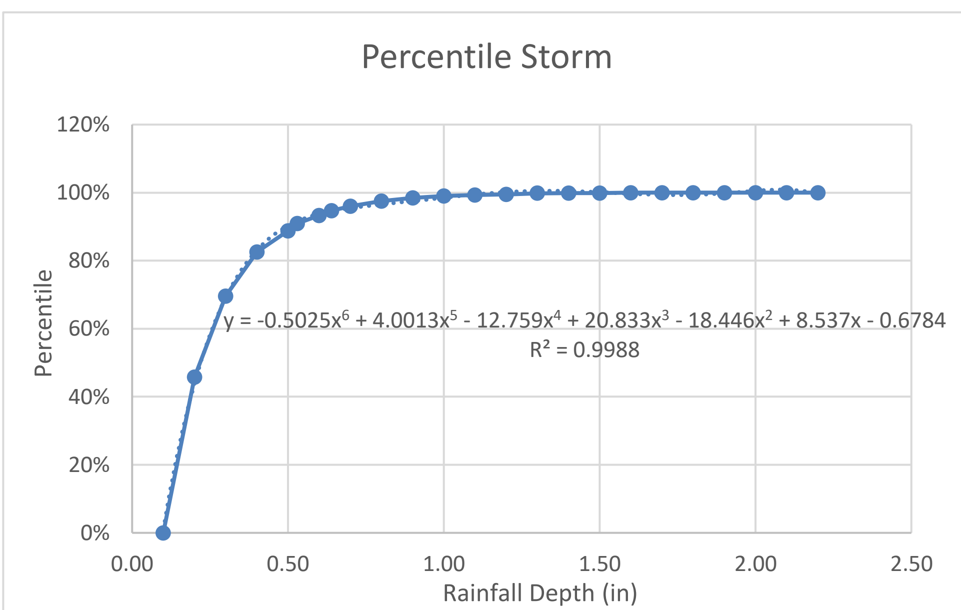
Utah Lake Lehi

Number of Storms Greater than or equal to	Rainfall (in)	Percentile storm
3235	0.10	0%
1754	0.20	46%
984	0.30	70%
658	0.37	80%
565	0.40	83%
364	0.50	89%
294	0.53	91%
217	0.60	93%
171	0.64	95%
130	0.70	96%
82	0.80	97%
49	0.90	98%
33	1.00	99%
24	1.10	99%
18	1.20	99%
7	1.30	100%
4	1.40	100%
3	1.50	100%
0	1.60	100%
0	2.10	100%
0	2.20	100%



Pleasant Grove

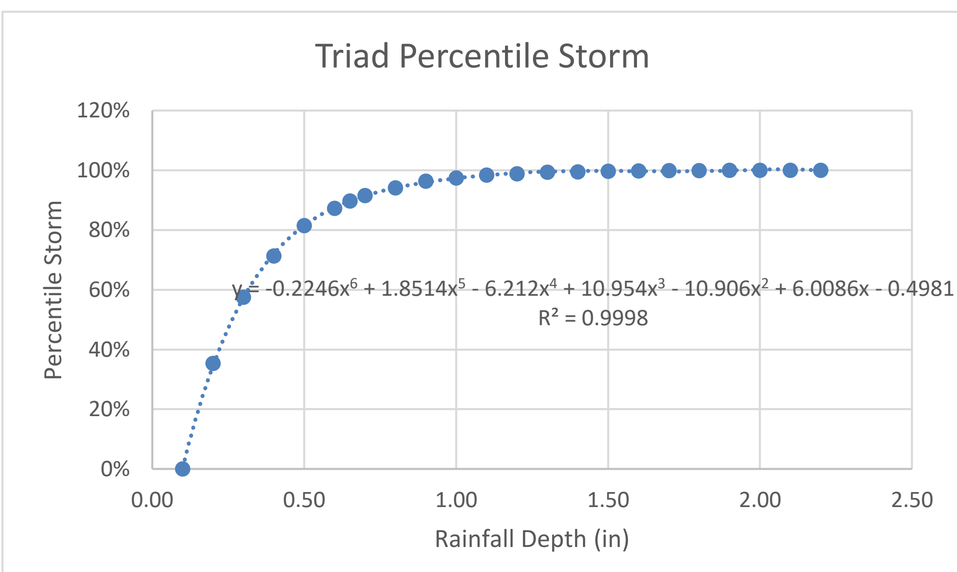
Number of Storms Greater than or equal to	Rainfall (in)	Percentile storm
3165	0.10	0%
1938	0.20	39%
1217	0.30	62%
821	0.40	74%
636	0.46	80%
534	0.50	83%
371	0.60	88%
316	0.64	90%
245	0.70	92%
161	0.80	95%
103	0.90	97%
78	1.00	98%
59	1.10	98%
44	1.20	99%
23	1.30	99%
14	1.40	100%
9	1.50	100%
5	1.60	100%
3	1.70	100%
2	1.80	100%
1	1.90	100%
1	2.00	100%
1	2.10	100%
0	2.20	100%



Appendix D: 80th Percentile Storm Event Calculations

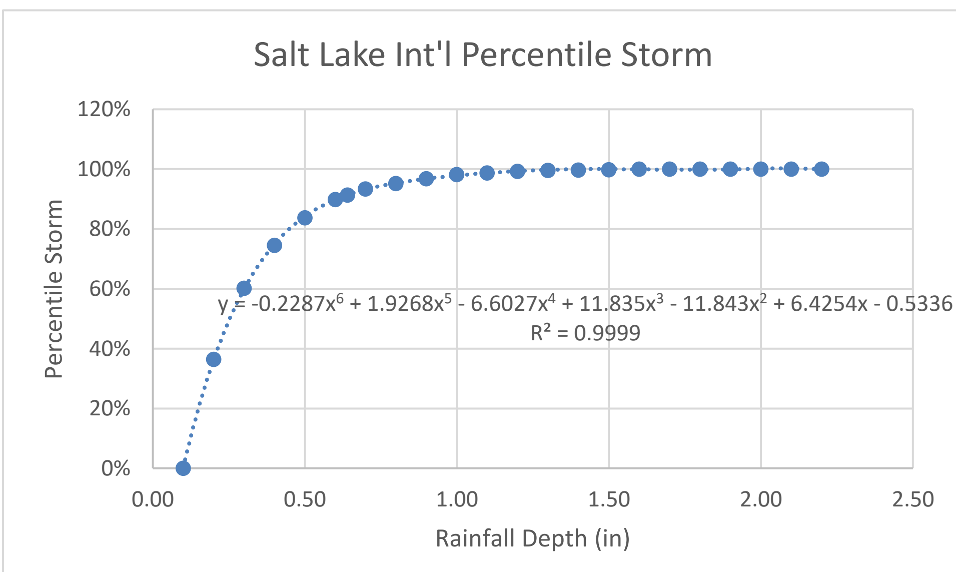
Triad Center

Number of Storms Greater than or equal to	Rainfall (in)	Percentile Storm
1286	0.10	0%
831	0.20	35%
547	0.30	57%
369	0.40	71%
258	0.48	80%
238	0.50	81%
164	0.60	87%
132	0.65	90%
108	0.70	92%
75	0.80	94%
46	0.90	96%
33	1.00	97%
20	1.10	98%
15	1.20	99%
8	1.30	99%
7	1.40	99%
4	1.50	100%
3	1.60	100%
1	1.70	100%
1	1.80	100%
0	1.90	100%
0	2.00	100%
0	2.10	100%
0	2.20	100%



Salt Lake International Airport

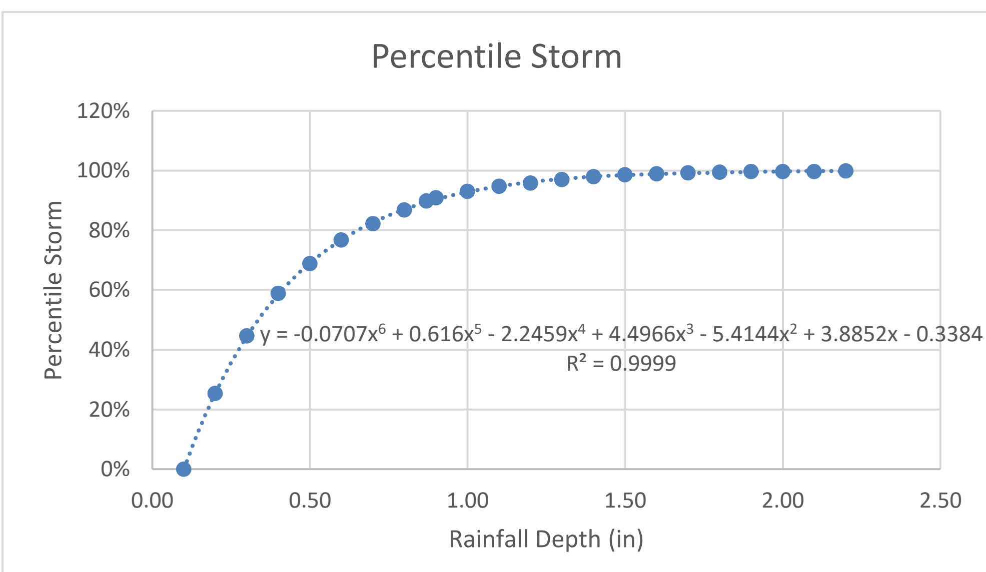
Number of Storms Greater than or equal to	Rainfall (in)	Percentile Storm
1305	0.10	0%
829	0.20	36%
519	0.30	60%
332	0.40	75%
258	0.45	80%
212	0.50	84%
132	0.60	90%
113	0.64	91%
86	0.70	93%
62	0.80	95%
42	0.90	97%
24	1.00	98%
16	1.10	99%
9	1.20	99%
5	1.30	100%
4	1.40	100%
2	1.50	100%
0	1.60	100%
0	2.10	100%
0	2.20	100%



Appendix D: 80th Percentile Storm Event Calculations

Cottonwood Weir

Number of Storms Greater than or equal to	Rainfall (in)	Percentile Storm
1695	0.10	0%
1265	0.20	25%
939	0.30	45%
698	0.40	59%
528	0.50	69%
395	0.60	77%
336	0.66	80%
302	0.70	82%
224	0.80	87%
173	0.87	90%
155	0.90	91%
119	1.00	93%
89	1.10	95%
71	1.20	96%
51	1.30	97%
36	1.40	98%
24	1.50	99%
19	1.60	99%
13	1.70	99%
10	1.80	99%
7	1.90	100%
6	2.00	100%
6	2.10	100%
3	2.20	100%
1	2.30	100%
0	2.40	100%



APPENDIX E

Small Scale Residential Prescriptive Measures

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Appendix E: Small Scale Residential Prescriptive Measures

Small Scale Residential BMP Fact Sheets

The following pages provide fact sheets with recommended criteria for the design and implementation of various residential BMPs. These fact sheets have been designed in a simplified, user-friendly way with the intent of achieving optimal performance of the measures. The siting, design, and maintenance requirements in the fact sheets are not exhaustive. Alternative designs may be approved by the City based on site specific conditions if equivalent pollutant removal performance is provided. New BMPs that are equivalent to those included are acceptable if approved by the City. All BMPs must be designed and implemented to be in full compliance with all applicable sections of the most recent municipal code, including site drainage requirements per the City Building code.

The following BMPs for small scale residential projects are included in this Appendix:

- Rain Barrels and Small Cisterns
- Permeable Pavements (or Porous Pavement Systems)
- Planter Boxes
- Rain Gardens
- Dry Wells

Following the BMP Fact Sheets, a reference section with resources for additional information is provided. Applicable vendor information has also been provided.

RAIN BARREL FACT SHEET

Rain barrels capture runoff from roof downspouts during storms and temporarily store that runoff for later use. They are low-cost, effective, and easily maintained devices that can be sized for a specific volume of water. Retained water may be used for garden watering, and other outdoor non-potable uses. Rain barrel storage can reduce the amount of stormwater pollutants that are picked up and conveyed to local streams and the ocean. In addition, harvested water conserves precious City-supplied potable water and, if directed to unpaved surfaces, can recharge groundwater. Rain barrels are typically made of heavy duty plastic and can range in size from the standard 55 gallons to more than 80 gallons.

How many rain barrels do I need?

The number of rain barrels required to capture runoff from a given roof or impervious area is shown in the following table.

Are Rain Barrels Feasible at My Residence?

Rain barrels are appropriate where the following site characteristics are present:

- Roof areas with downspouts are required.
- A level, firm surface for support of the rain barrel(s) is required. Rain barrels should only be elevated with solid construction materials and kept away from retaining walls as a full 55-gallon rain barrel will weigh over 400 lbs.
- An area where the captured water can be used is required to be present within a reasonable distance from the rain barrel(s).
- Design of an appropriate area for overflow from the barrel is necessary.

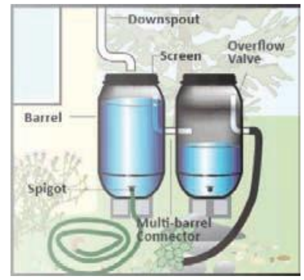
Roof or Impervious Area (sq.ft.)	Number of 55 Gallon Rain Barrels*
500 – 1,000	4**
1,001 – 1,500	8**

* Or equivalent capture using larger rain barrels.

** Minimum landscape area for 4 rain barrels shall be 200 square feet and the minimum landscape area for 8 rain barrels shall be 400 square feet.

Design Criteria and Considerations
(check all that apply)

- ❑ Screens are present on all rain barrel inlets to remove debris and larger particles as the water enters the barrel. Removable child-resistant covers and mosquito screening are in place.
- ❑ Barrel is child safe: access is child-proof and the barrel is properly sited and anchored on a stable surface to prevent barrel from tipping over. Remember – each rain barrel weighs approximately 400 lbs when full!
- ❑ Above-ground barrels are not located on uneven or sloped surfaces; if installed on a sloped surface, the base where the barrel is installed has been leveled using appropriate construction materials prior to installation.
- ❑ Installed rain barrels have not been placed on elevated platforms, decks or porches without consulting local building code officials.
- ❑ Overflow outlet is provided and designed to disperse overflow onsite and through stable vegetated areas where erosion or suspension of sediment is minimized.
- ❑ Dispersion is directed so as not to knowingly cause geotechnical hazards related to slope stability or triggering expansive (clayey) soil movement. Overflow dispersion will take place at least 3 feet away from public sidewalks, at least 5 feet away from property lines and foundations, and at least 10 feet from building foundations.
- ❑ Rain barrels are opaque and dark in color to prevent UV light penetration and discourage algae growth.
- ❑ Barrel placement allows easy access for regular maintenance.



Rain Barrel Setup

Operations and Maintenance (check all that apply)

- ❑ Rain barrel components will be inspected 4 times annually and following major storm events. Screens, spigots, downspouts, and leaders will be repaired or replaced as needed.
- ❑ Rain barrels will be cleaned as necessary to prevent algae growth and the breeding of vectors. Cleaning should always take place on a permeable surface. If vectors are breeding in a rain barrel, the barrel will be drained immediately.
- ❑ During dry periods, spigot drains will be left open when barrel is not in use.
- ❑ Dispersion areas will be maintained to remove trash and debris, loose vegetation. Areas of bare soil should be rehabilitated to minimize erosion.
- ❑ Where possible, effective energy dissipation and uniform flow spreading methods will be used to prevent erosion and aid dispersion.
- ❑ If adequate mosquito control is not in place and well-maintained, rain barrels will be emptied as necessary to prevent standing water from remaining in a barrel for more than 3 days, thereby preventing vectors from breeding. If vector breeding occurs as a result of contained storm water or inadequately maintained BMPs, I understand that the City has the ability to fine site owners.
- ❑ Rain gutters will be inspected and cleaned at least twice annually.

Owner Certification

"As the owner of the project property, I hereby certify that the above information is true, accurate, and complete, to the best of my knowledge."

____________________________________ __________________

Owner Signature Date

PERMEABLE PAVEMENT FACT SHEET

Permeable Paver Driveway
Photo Credit: City of Los Angeles

Permeable pavement contains pores or separation joints that permits non-concentrated water to flow through and seep directly into a base material. Permeable pavement systems include porous asphalt and concrete, permeable pavers (i.e. permeable interlocking concrete pavers), and restrained systems (plastic or concrete grid systems with gravel-filled voids). These systems reduce runoff and encourage infiltration of stormwater into surrounding soils.

Installing permeable pavement reduces stormwater quantity and filters out contaminants that would otherwise run off into storm drains, creeks, and waterways. This improves water quality, reduces runoff velocity and volume, and can encourage groundwater recharge. Permeable pavement is available in many different types that offer environmentally friendly and aesthetically pleasing options for driveways, wallkways, parking areas, and patios.

Is Permeable Pavement Feasible at My Residence?

Permeable pavement is appropriate where the following site characteristics are present

- Permeable pavements should work well on most residential sites where paved surfaces such as patios and driveways exist. Areas with slopes greater than 3 percent may not be appropriate.
- If the permeable pavement is designed to receive runoff other than incidental rainfall (e.g. roof) it should be installed at least 3 feet from public sidewalks and 10 feet from building foundations.
- Promoting infiltration should be avoided under permeable pavements at sites with expansive, clay-rich soils, or soils susceptible to tunnel erosion.
- At sites with certain characteristics that do not permit infiltration, an underdrain system can be installed to route the water to a storm drain or other BMP (i.e. rain garden). This type of system provides temporary storage, slows runoff, and filters some pollutants.
- There are many types of permeable pavements, including pour-in-place concrete or asphalt, unit paver blocks, and granular materials. Modular types, such as stone or brick pavers and open cell pavers, tend to be good options for residential projects. The use of the surface (i.e. vehicles, foot traffic, recreation), site conditions, aesthetic qualities, price, and maintenance requirements should be considered during the design process.

How Much Permeable Pavement Do I Need?

Permeable pavement should be sized to capture the runoff produced from the design storm within the gravel subbase of the pavement. This will ensure the capture and infiltration of the design storm volume. The following table should be used as minimum sizing guidance for permeable pavement.

Contributing Area (ft^2)	Permeable Pavement Area 1ft Gravel Subbase (ft^2)	Permeable Pavement Area 2ft Gravel Subbase (ft^2)
500 – 1000	90	50
1001 – 1500	150	80
1501 – 2000	210	110
2001 – 2500*	280	140

* Projects adding roof or impervious areas in excess of 2,500 sq. ft. shall add 60 sq. ft. of permeable pavement (with 1′ of gravel subbase) or 30 sq. ft. of permeable pavement (with 2′ of gravel subbase) per every 500 sq. ft. of addition.

Design Criteria and Considerations

When installing permeable pavement, the following criteria should be adhered to unless otherwise permitted by the City. The owner should check all boxes that will be complied with.

- ❑ Installed subsurface is an open-graded base of crushed stone, which has 35 to 45 percent pore space, to allow for adequate drainage and storage.
- ❑ Site soils have adequate drainage (at least 0.5 inches per hour) and depth to groundwater (5 feet) if water will infiltrate from the open-graded base into site soils.
- ❑ Infiltration will not cause geotechnical hazards related to expansive soil movement, tunnel erosion, or slope stability.
- ❑ If infiltration hazards are a concern, an underdrain has been installed to drain water into a storm drain inlet or onsite BMP.
- ❑ Slope is not greater than 3 percent.
- ❑ Flow directed to permeable pavement is dispersed so as not to be concentrated at a small area of pavement.
- ❑ Pavers have a minimum thickness of 80 mm (3.14 inches).
- ❑ Pre-fabricated products have been installed per all appropriate manufacturer's specifications. If required, sub-grade soil has been compacted in accordance with product installation specifications.
- ❑ Project is in full compliance with all applicable sections of the current municipal code, including disabled access requirements and site drainage requirements.

Operations and Maintenance

Once permeable pavement is installed, the following criteria should be adhered to. The owner should check all boxes that will be complied with.

- ❑ Pavement will be inspected after rains for pooling or other visible problems. Surface clogging or movement of modular pavers can cause problems with both drainage and pavement function. Missing sand or gravel between pavers will be replaced as necessary.
- ❑ Pavement will be inspected for vegetation. Depending on the type of pavement and growth, vegetation may need to be removed.
- ❑ Home owners have talked with the contractor or manufacturer for additional maintenance requirements for their specific installation. Permeable pavement can involve significant maintenance, depending on the type of pavement installed.

Grass Paver Block Walkway
Photo Credit: City of Los Angeles

Owner Certification

"As the owner of the project property, I hereby certify that the above information is true, accurate, and complete, to the best of my knowledge."

______________________________ ______________________

Owner Signature Da

PLANTER BOX FACT SHEET

Planter boxes function as soil and plant-based filtration devices that remove pollutants through a variety of physical, biological, and chemical treatment processes. The components normally consist of a ponding area, mulch layer, planting soils, plantings, drainage layer, and an outlet drain. As stormwater passes down through the planting soil, pollutants are filtered by the soil and plants.

Photo Credit: Deco Alfresco

Planter boxes at residential locations should be placed beneath rain gutter downspouts, or they may be placed directly beneath roof drip lines where rain gutters are not present so as to directly capture runoff from the roof. The overflow outlet should discharge away from the building to ensure water does not percolate into footings or foundations. Planter boxes can be designed as a single linear trough or a series of "pots" of various shapes and sizes.

Are Planter Boxes Feasible at My Residence?

Planter boxes are appropriate where the following site characteristics are present:

- Roof areas with downspouts, or roof areas without downspouts that drain runoff to impervious surfaces.
- A level, firm surface away from retaining wall structures for support of the planter(s). Planters should only be elevated with solid construction materials.

How Large Does My Planter Box Need to Be?

The total size of planter{s) necessary to capture run-off from a given roof area is shown in the table to the right. The table assumes a minimum planter depth of 2.5 feet, with 2 feet of soil and 0.5 feet of storage space., or "'free-board", above the soil surface.

Roof Area Tributary to Planter Boxes(sq.ft.)	Total Surface Area of Plante<(s) (sq.ft.)
500 – 1,000	32
1,001 – 1,500	52
1,501 – 2,000	108
2,001 – 2,500*	168

• Projects adding roof or impervious areas in excess of 2,500 sq. ft. shall add 20 sa. Ft. of planter box surface area per every 500 sq. ft. of additional area.

The table assumes that all runoff generated from the roof area will be directed to the planter{s). If a planter only extends acrossa fraction of a roof drip line for which it was designed to capture all runoff. one of the following methods shall be implemented:

- Additional planters shall be installed to extend across the entire roof drip line.
- Gutters or other devices shall be installed on the tributary roof to direct all runoff to the planter(s).
- Additional UD BMPs shall be implemented to capture the runoff unaccounted for by the planter(s).

Design Criteria and Considerations

When installing a planter box, the following criteria should be adhered to unless otherwise permitted by the City of Los Angeles. The owner should check all boxes that will be complied with.

- ❑ At locations without rain gutters, planters are placed directly below roof drip lines to capture runoff as efficiently as possible.
- ❑ At least 6 inches of storage is present between the planting surface and the crest of each planter.
- ❑ At locations implementing multiple planters, planters are placed directly adjacent to one another so as to minimize the impervious space between planters.
- ❑ Planters are not located on uneven or sloped surfaces.
- ❑ Planting soil is at least 2 feet deep.
- ❑ Planting soil contains no more than 30% compost.
- ❑ Planters have not been installed on elevated platforms, decks or porches without consulting local building code officials.
- ❑ The project is in full compliance with all applicable sections of the current municipal code, including drainage requirements per the Los Angeles Building and Safety Code.

Photo Credit: City of Los Angeles

Operations and Maintenance

Once a planter box is installed, the following criteria should be adhered to. The owner should check all boxes that will be complied with.

- ❑ Planters will undergo annual plant and soil maintenance typical of landscape care procedures to ensure optimum filtration, storage, and drainage capabilities.
- ❑ Following rain events, planters will be inspected to ensure that standing water is not present in the planter for more than 72 hours (3 days). Ponded water that is not completely drained after 72 hours can cause vector breeding. If vector breeding occurs as a result of contained stormwater or inadequately maintained BMPs, I understand that the City has the ability to fine site owners.
- ❑ Pesticide additives will not be used in the planters.

Owner Certification

"As the owner of the project property, I hereby certify that the above information is true, accurate, and complete, to the best of my knowledge."

______________________________ Owner Signature

____________________ Date

RAIN GARDEN FACT SHEET

Rain gardens are simply gardens designed to capture and treat runoff. Stormwater runoff from impervious surfaces is directed toward a depression in the ground, which is planted with flood and drought-resistant plants. As the water nourishes the plants, the garden stores, evaporates, and infiltrates rainwater, reducing runoff and pollutant loads.

Rain gardens are a low-cost, effective, and aesthetically pleasing way to reduce the amount of stormwater that runs off your property and washes pollutants into storm drains, local streams, and the ocean. They are most often planted with native species. While mitigating the environmental impacts of land development, rain gardens also provide attractive landscaping and habitat for birds, butterflies, and other animals.

Photo Credit: City of Los Angeles

Are Rain Gardens Feasible at My Residence?

Rain gardens are appropriate where the following site characteristics are present:

- Edge of rain gardens should be installed at least 25 feet from building foundations, 3 feet from public sidewalks, 10 feet from property lines, and in an area where potential overflow will not run onto neighboring properties. Rain gardens may be located closer than the above mentioned criteria provided
    1) A geotechnical report is submitted and approved or;
    2) A impermeable liner is installed to prevent infiltration under these facilities, and an over flow drain pipe to the street is installed
- Ground adjacent to the building should slope away at a 2% minimum. The rain garden area should receive full sunlight throughout most of the day. A downspout extension or bioswale can be used to convey rain from a roof directly into a rain garden. They are also appropriately sited downstream from a rain barrel overflow line.
- Do not site rain gardens above septic systems.
- The site should have well-drained soil and be relatively flat. Soil amendments can improve infiltration in areas with poor drainage.
- A front or back yard can work well for a rain garden, but look for areas where the slope naturally takes the stormwater. Areas where water naturally flows or ponds are ideal locations for a rain garden. Work with the site drainage and hydrology.
- Areas highlighted in Figures E-1 through E-3 are not ideal for rain gardens and must be approved by the City prior to installation. Areas highlighted in Figures E-4 require soils amendments to increase the natural soils infiltration abilities.

How Large Does My Rain Garden Need to Be?

Rain gardens should not exceed 300 square feet, and the contibuting impervious area should not be more than 4,000 square feet. A general recommendation for a garden with a 6-inch ponding depth is to size the rain garden to approximately 6% of the contributing area. The infiltration rate of water into the soil will affect how the rain garden should be sized; rain gardens will need to be larger in areas with slower infiltration. The following table can be used as general guidance.

Contributing Area (sq.ft.)	Rain Garden Area (sq.ft.)
500 – 700	36
701 – 900	48
901 – 1100	60
1101 – 1300	72
1301 – 1500	84
1501 – 2000*	105

* Projects adding roof or impervious areas in excess of 2,000 sq. ft. shall add 30 sq. ft. of rain garden surface area per every 500 sq. ft. of additional are

Design Criteria and Considerations

When installing a rain garden, the following criteria should be adhered to unless otherwise permitted by the City of Los Angeles. The owner should check all boxes that will be complied with.

- ❑ Location is at least 25 feet from home foundations, 3 feet from public sidewalks, 10 feet from property lines and in an area where potential overflow will not run onto neighboring properties. Rain gardens may be located closer than the above mentioned criteria provided.
  1) A geotechnical report is submitted and approved by LADBS or;
  2) A impermeable liner is installed to prevent infiltration under these facilities, and an over flow drain pipe to the street is installed.
- ❑ Rain Garden has been located to intercept and collect runoff via a downspout or adjacent impervious area. The rain garden is not located underneath the canopy of existing trees.
- ❑ Rain garden is appropriately sized to the soil type and drainage area.
- ❑ Rain garden is not located over septic systems or shallow utilities. Utilities have been located before digging by calling Blue Stakes, 411. Rain garden is not located within 50 feet of steep slopes (>25%). The rain garden has been built on a relatively flat area.

  Permits are not required for typical residential landscaping projects. If you plan on making major landscaping modifications such as moving more than 50 cubic yards of soil or altering 1 acre or more, contact the City for further assistance.
- ❑ An overflow has been incorporated in the rain garden such that excess water will flow into another pervious area and away from the home's foundation or neighboring property.
- ❑ Detention and infiltration do not (knowingly) cause geotechnical hazards related to slope stability or triggering expansive (clayey) soil movement.
- ❑ Drought and flood resistant native plant species are used whenever possible. Invasive or pest species have been avoided. A listing of resources where information on native plant species can be found is in the reference section.

Operations and Maintenance

Once a rain garden is installed, the following criteria should be adhered to. The owner should check all boxes that will be complied with.

- ❑ Rain gardens will be irrigated deeply once a week during dry months to encourage root growth and keep plants strong, especially while plants are being established. Plants will be inspected for health and weeds will be removed as often as necessary.
- ❑ Rain gardens will be monitored after storm events for signs of overflow. If overflow occurs significantly or often, the size and/or depth of the garden may need to be increased, or other actions to increase infiltration (e.g., soil ammendments, underdrain installation) may be necessary.
- ❑ Signs of erosion will be repaired immediately. Further erosion can be prevented by reinforcing the surrounding area with groundcover or using energy dispersion techniques on downspouts.
- ❑ Infiltration effectiveness and excess sediment deposition will be monitored annually, preferrably prior to the start of the rainy season.
- ❑ Standing water will not remain in a rain garden for more than 3 days. Extended periods of flooding will not only kill vegetation, but may result in the breeding of mosquitos or other vecotrs. If vector breeding occurs at a site as a result of contained stormwater or inadequately maintained BMPs, I understand that the City has the ability to fine site owners.
- ❑ Rain gutters and downspouts will be inspected and cleaned at least twice annually.

Owner Certification

"As the owner of the project property, I hereby certify that the above information is true, accurate, and complete, to the best of my knowledge."

________________________________ ________________

Owner Signature | Date

DRY WELL FACT SHEET

Prefabricated Dry Well
Photo Credit: Canale Landscaping

A dry well is a bored, drilled, or driven shaft or hole designed specifically for the infiltration of stormwater. Simple dry wells may consist of a small excavated pit filled with gravel media, while more advanced dry wells typically consist of a prefabricated storage chamber or perforated pipe segment placed in the ground. These latter types of dry wells offer more storage capacity per unit area since they are not typically filled with media and also conserve land area since they may be buried completely in the ground.

Dry wells are situated to capture runoff from roofs or other impervious areas. They can easily be designed to be directly connected to rain gutter systems to capture runoff from rooftops. Once filled with stormwater, dry wells can accept water at the same rate at which they can dissipate water.

Is a Dry Well Feasible at My Residence?

Dry wells are appropriate where the following site characteristics are present:

- Roof areas with downspouts or other impervious areas are required.
- Sites must have soils suitable for infiltration, with a minimum saturated hydraulic conductivity of 0.3 in/hr.
- Edge of dry wells should be installed at least 25 feet from building foundations, 3 feet from public sidewalks, 10 feet from property lines and an overflow drain pipe to the street is required. Dry wells may be located closer than the above mentioned criteria provided a geotechnical report is submitted and approved by LADBS.
- Do not site rain gardens above septic systems.
- An overflow area that drains to the street is required.

How Large Does My Dry Well Need To Be?

A dry well should be sized to capture the runoff produced from the design storm over the connected impervious area, with account taken for any gravel or fill material that is used. This will ensure the capture and infiltration of the design storm volume. The following table should be used as minimum sizing guidance for dry wells.

Contributing Area (ft^2)	Dry Well Volume - Without Fill (gallons)	Dry Well Volume - Including Gravel Fill (gallons)
500 – 1000	250	600
1001 – 1500	400	1,000
1501 – 2000	550	1,400
2001 – 2500*	700	1,800

* Projects adding roof or impervious areas in excess of 2,500 sq. ft. shall add 150 gallons of dry well volume (without fill) or 400 gallons of dry well volume (with gravel fill) per every 500 sq. ft. of additional area.

Design Criteria and Considerations

Installed Dry Well Schematic
Image Credit: ABHL Landscape Architects

When installing a dry well, the following criteria should be adhered to unless otherwise permitted by the City. The owner should check all boxes that will be complied with.

- ❑ Edge of dry wells should be installed at least 25 feet from building foundations, 3 feet from public sidewalks, 10 feet from property lines and an overflow drain pipe to the street is required. Dry wells may be located closer than the above mentioned criteria provided a geotechnical report is submitted and approved.
- ❑ Dry well has been properly located and installed to intercept and collect runoff via a downspout from a roof or adjacent impervious area.
- ❑ Dry well is appropriately sized in accordance with the sizing table above.
- ❑ For dry wells with gravel fill, gravel used is 2” or greater diameter stone.
- ❑ The soil under the dry well has been over-excavated to at least one foot in depth. The soild has been replaced uniformly without compaction, or amended with 15-30% of coarse sand and replaced without compaction.
- ❑ A fine mesh screen has been installed on the inlet to prevent sediment and debris from entering the dry well.
- ❑ An observation well has been incorporated into the dry well design. The observation well consists of a slotted or perforated pipe (typically PVC), 4-6 inches in diameter, capped with an above-ground, sealable lid.
- ❑ An overflow has been incorporated in the dry well such that excess water will flow into the storm drain system or another pervious area and away from any nearby foundations or neighboring properties.
- ❑ Detention and filtration do not (knowingly) cause geotechnical hazards related to slope stability or triggering expansive (clayey) soil movement.

Operations and Maintenance

Once a dry well is installed, the following criteria should be adhered to. The owner should check all boxes that will be complied with.

- ❑ Water level, drawdown time, and evidence of clogging will be monitored monthly during the rainy season.
- ❑ Standing water will not remain in an exposed dry well for more than 3 days. Extended periods of flooding may result in the breeding of mosquitoes or other vectors. If vector breeding occurs at a site as a result of contained stormwater or inadequately maintained BMPs, I understand that the City has the ability to fine site owners.
- ❑ Rain gutters and downspouts will be inspected and cleaned at least twice annually.
- ❑ If the dry well ever becomes plugged and overflows on a continual basis, the dry well will be excavated and removed. The dry well will be repaired or replaced as necessary, and gravel media fill will be cleaned or replaced to enhance the infiltration capacity.

Owner Certification

“As the owner of the project property, I hereby certify that the above information is true, accurate, and complete, to the best of my knowledge.”

Owner Signature ______________________ Date ______________

Only to be used for Single Family Residences
(Less than 1 acre and not in an ESA)

STORMWATER OBSERVATION REPORT FORM

LOW IMPACT DEVELOPMENT (LID)

STORMWATER OBSERVATION *means the visual observation of the stormwater related Best Management Practices (BMPs) for conformance with the approved LID Plan at significant construction stages and at completion of the project.*

STORMWATER OBSERVATION *must be performed by the contractor responsible for the approved LID Plan or designated staff in their employment. Homeowner can also perform the Stormwater Observation if no licensed contractor was involved.*

STORMWATER OBSERVATION REPORT *must be signed by the contractor responsible for the approved LID Plan and submitted to the City <u>prior</u> to the issuance to the certificate of occupancy. Homeowner can sign the Stormwater Observation Report if no licensed contractor was involved.*

Project Address:	Building Permit No.:
Name Contractor or Owner responsible for the approved LID Plan:	Phone Number:
Name of LID Plan Observer:	Phone Number:

I declare that the following statements are true to the best of my knowledge:

1. I am responsible for the approved LID Plan, and
2. I, or designated staff under my responsible charge, has performed the required site visits at each significant construction stage and at completion to verify that the best management practices as shown on the approved plan have been constructed and installed in accordance with the approved LID Plan.

Signature Date Contractor/Architect/Engineer License

References

Additional Manuals

Many LID manuals exist that offer additional insight and information with regards to residential BMP implementation. The following manuals may be consulted to obtain more information on LID practices:

- County of Los Angeles, 2009. Low Impact Development Standards Manual. January 2009
- Pima County Low Impact Development and Green Infrastructure Guidance Manual, March 2015
- Low Impact Development Handbook for the State of Alabama
- Clean Water Services Low Impact Development Approaches Handbook, July 2009

Web Resources

A host of information is available on the world wide web to help homeowners design and implement LID BMPs. The following is a brief list of agencies and websites devoted to the protection and conservation of our water resources:

- Council for Watershed Health (www.watershedhealth.org)
- The Low Impact Development Center (www.lowimpactdevelopment.org)
- Metro Blooms (Rain garden installation video and information) (http://metroblooms.org)
- Rainwater Harvesting for Drylands and Beyond by Brad Lancaster (www.harvestingrainwater.com)
- The Center for Watershed Protection (www.cwp.org)
- The U.S. Environmental Protection Agency (www.epa.gov/owow/NPS/lid)

Vendor Information

A short list of potential product vendors is provided below. The City does not endorse any specific product or vendor.

Rain Barrels and Planter Boxes:

- Gutter Guy (www.gutterguyonline.com)
- Rain Harvest (www.rainbarrelprogram.org/urc)
- Mark's Barrel Company (marksbarrelcompany.com/basea/2010/05/05/rain-barrel-love-in-utah)
- The Home Depot (www.homedepot.com)
- Rain Barrels International (www.rainbarrelsintl.com)
- City Rain Barrel Program (http://cityrainbarrelprogram.org)
- Lowes (www.lowes.com)
- Simply Rain Barrels (www.simplyrainbarrels.com)
- WalMart (www.walmart.com)
- Water Tanks (www.watertanks.com)

Dry Wells and Underground Storage Solutions:

- Advanced Drainage Systems, Inc. (www.ads-pipe.com)
- Contech Stormwater Solutions (www.contech-cpi.com)
- Cultec, Inc. (www.cultec.com)
- HydroLogic Solutions (www.hydrologicsolutions.com)
- Invisible Structures, Inc. (www.invisiblestructures.com)
- NDS (www.ndspro.com)
- StormTech, Inc. (www.stormtech.com)
- Tensar Technologies, Inc. (www.tensarcorp.com)
- Triton Stormwater Solutions (www.tritonsws.com)

Permeable Pavement:

- Invisible Structures, Inc. (www.invisiblestructures.com)
- Geofill Cellular Concrete (www.geofill.com)
- The Home Depot (www.homedepot.com)
- Lowes (www.lowes.com)
- PermaPave (www.permapave.com)
- Terrafirm Enterprises (www.terrafirmenterprises.com)
- Uni-Group U.S.A. (www.uni-groupusa.org)
- Pave Drain (www.pavedrain.com)