CACHE VALLEY

STORMWATER

DESIGN STANDARDS

As Amended by Logan City
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These design standards provide the required storm water design criteria and methodology to be utilized for all public and private development and redevelopment required by the Utah Pollutant Discharge Elimination System (UPDES) General Permit for Discharges from Small Municipal Separate Storm Sewer Systems (MS4 or MS4 Permit). Any deviations from these criteria shall be reviewed and approved, only if adequate, by the City Engineer in writing prior to initiating and again before finalizing the design or bidding the project. Where any deviations may also affect a canal company or irrigation ditch, a written approval of the canal company shall also be required before the designs will be approved and before bidding the project.

All designs must utilize and comply with the most current edition of the PWD Construction Standards and Specifications.

A. DEFINITIONS

Certified Percolation Test: A saturated soil percolation test completed in accordance with Utah Administrative Rule, R317-4-5 with the exception that the test shall extend 2.0 feet below the bottom of the proposed invert of the pond. These tests shall be done in accordance with the certification requirements by a "qualified individual" as defined in R317-11.

Detention: The detaining or holding of water on site and releasing the water from the site into a pipeline, channel, or other water bodies at a slower rate than would otherwise occur.

DEQ: Utah Department of Environmental Quality

Detention Basin: A pond or basin, either above ground or below, that catches the storm water runoff from a contributing area and uses the detention process.

DWQ: Utah Division of Water Quality, a division of the DEQ.

EM 1110-2-1601: Engineering and Design – Hydraulic Design of Flood Control Channels, CECW-EH-D, US Army Corp of Engineers, June 1994

EPA: United States Environmental Protection Agency

HEC-11: Design of Rip-Rap Revetment, Hydraulic Engineering Circular No. 11, US Dept. of Transportation, Federal Highway Administration. (FHWA-IP-89-016, March 1989)

HEC-22: Urban Drainage Design Manual, Hydraulic Engineering Circular No. 22, US Dept. of Transportation, Federal Highway Administration. (FHWA-SA-96-078, August 2001).

HISTORICAL RUNOFF FLOW: The runoff that has historically flowed off of a given piece of land in the specified storm frequency and duration prior to development, either in the land's pre-development agricultural (to be calculated as grass pasture in good condition) or native condition.

NOI: A notice of intent to construct permit obtained from the DWQ which is required for all construction on areas greater than or equal to 1.0 acres.

NOT: A notice of termination to construction submitted to the DWQ upon the stabilization of 70 percent of the project site that required a NOI.

PWD: Public Works Department

Retention: The retaining or keeping of water on site and preventing its release from the site by any method other than infiltration or evaporation.

Retention Basin: A pond that is built to capture and retain the design storm on site and dispose of it through infiltration.

Return Frequency: The frequency or likelihood of a storm of occurring. A 100-year storm has a one (1) percent chance of occurring in any given year while a 10-year storm has a ten (10) percent chance of occurring in any given year. This should never be interpreted as happening only once every 100 or 10 years for the two given examples.

Spread Width: The width of water flow as measured from the flow line of the gutter into the asphalt.

Stream Alteration Permit: A permit that is obtained through the Utah Division of Water Rights and is necessary anytime construction impacts a stream, wetland, riparian zone, or other water body defined as the waters of the U.S.

Storm Event: The event and hyetograph that define the design volume of precipitation, duration of the storm, intensity of the storm, and the pattern in which the precipitation falls.

SWPPP: A storm water pollution prevention plan which is required on any construction site.

Underground Injection/Retention System: A system designed to be fully underground and to dispose of water, entirely or in part, through infiltration. These require a special permit from the DWQ known as a Class 5 injection well permit.

Underground Injection Well: A facility, such as a pressured injection well, free draining injection well, sump, or other buried underground facility that infiltrates or injects surface water into the subsurface or groundwater system to eliminate surface runoff.

Wetlands Mitigation, or 404, Permit: A permit obtained through the US Army Corp of Engineers which allows the wetlands to be impacted and provides for required mitigation before the project can be approved.

B. DESIGN REQUIREMENTS

All projects, irrespective of the size or type, shall meet these requirements. Where projects are governed by a state or federal agency, their standards shall take precedence. All designs shall be in compliance with the PWD's constructions standards and specifications.

Subsequent sections identify the required methodology based upon the size and type of the project.

1. Storm Water Submittals

a) Submittals Required

Every submittal shall include the calculations in Table B-1 based on contributing storm water runoff source area.

Table B-1: Storm Water Submittals Required

Contributing Areas	Requirements
Less than 1.0 Acre disturbed and not part of a common plan of development	Pollution Control Plan (See B.2) Hydrologic checklists and summary calculations required on checklist. LID and BMP Selection Checklist
Greater than 1.0 acres disturbed or part of a common plan of development.	SWPPP Hydrologic report and copy of checklists, with associated calculations for each drainage basin Water Quality/Treatment Requirements Checklist LID and BMP Selection Documentation and Checklist

2. Storm Water Pollution Prevention Plan

Storm water pollution prevention plans (SWPPP) are required on all projects in PWD boundaries and every project must comply with PWD standards and specifications, whether approved by the PWD or not. Table B-2 summarizes the requirements of the SWPPP.

Table B-2, SWPPP Requirements

Contributing Area	Minimum Requirements

Size	
Less than 1.0 Acre and NOT part of a common plan of development	A pollution control plan that will address at a minimum the control and prevention of the following: erosion and sediment; dust; debris and garbage; concrete washout and excess material, wastewater from washout and cleanout of stucco, paint, form release oils, curing compounds or other construction materials; soaps solvents or detergents used in vehicle or equipment washing; and toxic or hazardous substances from spills or other releases. Each pollution control plan shall also include an inspection and maintenance plan, record keeping and training, and final stabilization. These can be on a standard design sheet as detailed notes with supporting details or a standalone document.
1.0 Acre and larger OR Less than 1.0 Acre and part of a common plan of development	A full SWPPP using the UDEQ template downloadable from the DWQ at the following web site: http://www.deq.utah.gov/Permits/water/updes/stormwatercon.htm All elements in the SWPPP document must be included in the submittal.

3. Irrigation Canals and Systems

Every existing irrigation ditch or canal has played a part of the City storm water facilities from the settling of the community. When the canals were built, they delivered water from the river and intercepted storm water runoff from uphill naturally. However, when the canals flooded, there weren't houses at risk back then. Now, with ongoing development, these conditions have changed. Design of storm drainage systems using the canals have special requirements as a result and must be approved by not only the City, but also the canal company serving the area of question.

The PWD requires that irrigation ditches and canals that deliver irrigation water be preserved to deliver the water to the water users and to allow access to the ditch or canal for maintenance.

All irrigation canals, pipes, ditches, channels, structures, diversions, and other portions of the system shall be designed for the full range of base flows including historical maximum flows, historical minimum flows, and the full water right flow. Then the channel shall have the upstream storm drain inflows and irrigation return flows added to the model to ensure that all future systems have sufficient capacity. These design flows must to be approved by the associated canal company or irrigation ditch owners in writing and the City Engineer.

a) Water Right Flows

The design flow will be the maximum flow allowed by the canal water rights. Flows down laterals and distribution ditches shall be obtained in accordance with the agreements between the Cities and the canal companies Obtain the water righted flows and the lateral flows directly from the canal companies. These must be documented in a letter signed by an authorized canal company representative to be accepted by the City. Primary canal company contacts are available from the City.

b) Return Flows

Many of the canals receive return flows from the upstream canals. This can seriously complicate the storm water design since many people turn off their irrigation water and simply pass it down the ditch during storms. This can result in major flooding issues on some canals, even without any storm water entering the canals. When designing a section of the canal, it shall be necessary to take the return flows into consideration and to discuss them with the canal companies. Again, the agreed upon flows must be obtained in accordance with the canal agreements with the Cities.

4. Storm Event (Frequency and Duration Requirements)

Design all storm water facilities associated with projects shall be designed in accordance with Table B-3.

Table B-3: Storm Event Frequency and Duration Design Requirements

Contributing Area Size	Temporary Construction BMPs Design Frequency	Permanent Construction BMPs Design Frequency	Design Storm Duration	Rainfall Depths at KVNU Radio Station
Less than 1.0 acres	2-Year	100-year	Retention/Infiltration: 48 hours All Other BMPS: 24 Hours	24 Hour, 2-year: 1.46 inches 10-year: 2.04 inches 25-year: 2.41 inches 50-year: 2.71 inches 100-year: 3.02 inches 48-hour, 2-year: 1.68 inches 10-year: 2.33 inches 25-year: 2.75 inches 50-year: 3.08 inches 100 Year: 3.42 inches
1.0 acres and less than 640 acres	2-Year	100-year	Retention/Infiltration: 48 hours All Other BMPS: 24 Hours	
640 Acres and larger	2-year	10-year, 25-year, 50-year, and 100-year	Retention/Infiltration: 48 hours All Other BMPS: 24 Hours	

Existing development shall be required to construct storm water facilities to meet the new storm water design criteria at the time of redevelopment or reconstruction of any facilities. However, the return frequency and design duration may be modified under extreme conditions at the direction of the City Engineer with approval of the agency managing the receiving waters in writing.

5. Allowable Storm Water Discharge

There are two criteria related to the allowable discharge that shall be met by all projects. Any exceptions to this requirement shall be evaluated and approved on a case by case basis using the methodology provided in this document and other equivalent water quality treatments shall be utilized. Approval by the PWD is required before any deviations are allowed.

a) Mandatory Onsite Management

Under the MS4 Permit, all new development and re-development, including roads, shall be designed to manage the 90th percentile rainfall event as defined Table B-4 and Table B-5 of these design standards. The MS4 permit requires that the entire volume of the 90th percentile storm that falls on the site shall be infiltrated, evaporated, and/or harvested (not exceeding amounts allowed by Utah Division of Water Rights).

Table B-4: 90th Percentile Storm Definitions in Cache County

Gauging Station	LOGAN RADIO KVNU UT US	LOGAN UT STATE UNIVERSITY UT US	LOGAN 5 SW EXPERIMENTAL FARM UT US
Depth (Inches)	.60	.66	.63
Elevation (ft)	4,505	4,778	4,491

Table B-5: 90th Percentile Design Criteria by PWD.

PWD	90th Pecentile Criteria
Logan City	Elevation < 4,642: Use 0.60 inches (KVNU) Elevation > 4,642: Use 0.66 inches (UT State University)

Under conditions where the 90th percentile storm cannot be managed on site, the designer shall provide a storm water design report that shall document the following:

1. Why the 90th percent storm cannot be managed on site.
2. Provide an alternative design rational that maximizes all of the following:
    a. Infiltration,
    b. Rain harvesting as allowed by the Utah Division of Water Rights,
    c. Evapotranspiration.

b) Maximum Allowable Discharge

Most of the storm water in Cache Valley discharges to irrigation ditches and canals before reaching the rivers and streams. However, the ditches and canals are not designed to carry the increase in flows and are at risk of flooding both private and public property. Through negotiations with the canal companies, the following flow rate restrictions have been agreed upon:

1) The storm water runoff leaving the site during the 1 percent (100-year) event shall not exceed the lesser of:

1. Discharge prior to development (Historical Runoff Flow), or
2. 0.2 cfs per acre.

2) All storm water calculations shall include the following:
   a) A calculation of Historical/Predevelopment flow rate. This is defined as the flow rate off of an irrigated pasture in good condition using the NRCS Curve Number Methodology defined in Section 3 of this standard.
      i) If the Historical /Predevelopment flow rate is greater than 0.2 cfs/acre, then the maximum allowable discharge is 0.2 cfs/acre.
      ii) If the Historical/Predevelopment flow rate is less than 0.2 cfs/acre, then the Historical/Predevelopment flow rate is the maximum allowable discharge.
   b) A calculation of the Post-Construction flow rate and volume. If the Post-Construction flow rate, after the removal of the 90^{th} percentile storm in B.4.a above, exceeds the maximum allowable discharge, additional detention or retention of flows shall be included in the design until the discharge is reduced to not more than the maximum allowable discharge.
3) The locations of the storm water discharge shall not be altered without permission. This is interpreted to mean that the ditches or canals receiving the discharge cannot be changed without express approval of the managers of the receiving ditches or canals.

6. Water Quality/Treatment Requirements and Possible BMPs

Under the MS4s Permit, Logan City is required to "ensure that any storm water controls or management practices for new development and redevelopment will prevent or minimize impacts to water quality. BMPs must be selected that address pollutants known to be discharged or anticipated to be discharged from site." The BMPs and Procedures included in this section summarize the design requirements for the most common BMPs to meet the MS4 permit requirements. Table B-6 summarizes many of the pollutants of concern based on expected land use.

Table B-6: Primary Pollutants of Concern

Pollutant Source	Potential Pollutant Material	Actual Pollutant	Narrative Requirement
Residential Yard runoff	Organic trash such as leaves, grass trimmings, decomposing vegetation,	Phosphorus, Nitrogen, BOD, E.coli,	Limit: □ total phosphorus < 0.07

	and animal waste. Application of fertilizers, pesticides, and herbicides	pesticides, herbicides, and other chemicals.	mg/L. - total nitrogen < 6 mg/L - BOD_5 < 5 mg/L. - E.Coli < 126
Roadway and Parking Lots	Oils, Fuel, Fuel Combustion byproducts, salt, sediment, garbage and trash.	TDS, TSS, Phosphorus, Nitrogen, Petroleum Products, Trash	Limit: - total phosphorus < 0.07 mg/L. - total nitrogen < 6 mg/L - BOD_5 < 5 mg/L. - E.Coli < 126 - TDS < 1200 mg/L - TSS cause <10 NTU increase in receiving water - TSS < 70 mg/L - Petroleum cause no sheen - Trash cleaned up
Commercial Malls, Industrial Parks	Organic trash such as leaves, grass trimmings, decomposing vegetation, and animal waste. Application of fertilizers, pesticides, and herbicides Oils, Fuel, Fuel Combustion byproducts, salt, sediment, garbage and trash.	TDS, TSS, Phosphorus, Nitrogen, Petroleum Products, Trash, BOD, E.coli, pesticides, herbicides, and other chemicals.	Limit: - total phosphorus < 0.07 mg/L. - total nitrogen < 6 mg/L - BOD_5 < 5 mg/L. - E.Coli < 126 - TDS < 1200 mg/L - TSS cause <10 NTU increase in receiving water - TSS < 70 mg/L - Petroleum cause no sheen - Trash cleaned up - Other chemicals related to the specific industry at no discharge.
Retail Gasoline Outlets	Oils, Fuel, Fuel Combustion byproducts, salt, sediment, garbage and trash.	Petroleum Products, Trash, BOD, E.coli, pesticides, herbicides,	Limit: - total phosphorus < 0.07 mg/L. - total nitrogen < 6 mg/L - BOD_5 < 5 mg/L. - E.Coli < 126

		and other chemicals.	☐ TDS < 1200 mg/L ☐ TSS cause <10 NTU increase in receiving water ☐ TSS < 70 mg/L ☐ Petroleum cause no sheen ☐ Trash cleaned up
Large Grassed Areas (parks, churches, etc.) and Golf Courses	Organic trash such as leaves, grass trimmings, decomposing vegetation, and animal waste. Application of fertilizers, pesticides, and herbicides	Phosphorus, Nitrogen, BOD, E.coli, pesticides, herbicides, and other chemicals.	Limit: ☐ total phosphorus < 0.07 mg/L. ☐ total nitrogen < 6 mg/L ☐ BOD_5 < 5 mg/L. ☐ E.Coli < 126
Animal Operations (Feed Lots, Veterinary Clinics, Research Facilities)	Animal wastes	Phosphorus, Nitrogen, BOD, E.coli, pesticides, herbicides, and other chemicals.	Limit: ☐ total phosphorus < 0.07 mg/L. ☐ total nitrogen < 6 mg/L ☐ BOD_5 < 5 mg/L. ☐ E.Coli < 126 ☐ TSS cause <10 NTU increase in receiving water ☐ TSS < 70 mg/L

7. Required LID and BMP Selection

Under the MS4s Permit, Logan City is required to "ensure that all storm water controls or management practices for new development and redevelopment will prevent or minimize impacts to water quality. BMPs must be selected that address pollutants known to be discharged or anticipated to be discharged from site." As part of the selection of BMPs, the designer is required by the MS4 Permit to evaluate and utilize LID methods that infiltrate, evapotranspire, or harvest and use storm water on site to protect water quality. The BMPs and Procedures included in this section summarize the design requirements for the most common BMPs.

a) Mandatory LID Evaluation

Each project shall be evaluated for the use of LID approach with encourages the implementation of BMPs that infiltrate, evapotranspire or harvest and use storm water on site to protect water quality. The evaluation shall use shall include both structural and non-structural BMPs. If the designer determines that an LID approach cannot be utilized,

the designer shall document and explain the reasons that LID will not work on the specific site and provide the rationale for the chosen alterative controls that will be used to obtain the same water quality objectives. This evaluation shall be completed on a case by case basis. As a minimum, the evaluation shall document:

1. Why LID won't work.
2. Rational for the chosen alternative controls on a case by case basis for each project.

b) Mandatory LID included on all Projects

(i) Development in riparian areas

1. Riparian areas are defined as being within 75 feet of centerline of stream drainage a basin larger than 1 square mile, and land within 25 feet of stream centerline for streams that drain areas of one square mile or less.
2. All structures shall maintain a setback of 25 feet from the top of the stream bank within a riparian area.
3. No more than 50% of the land area within the riparian area may be disturbed, including grading, clearing, grubbing, tree removal etc. All disturbed areas shall be revegetated within 60 days of initial disturbance.
4. Trees larger than 12" dbh shall not be removed from the riparian area unless they are considered a hazard tree, diseased or dead.

(ii) Open Space Preservation

1. Open space is an area of land or water that may be used for passive or active recreation, agriculture, conservation, landscaped areas, preservation of the natural environment, scenic land, and/or other similar uses.
2. Minimum open space by development type shall include:
    a. Residential: 20%
    b. Commercial: 10%
    c. Industrial: 10%
3. A permanent restrictive covenant in the form of a perpetual conservation easement shall be placed upon open space land requiring its maintenance as open space.

(iii) Land Designation as a Resource Conservation Zone

1. The Resource Conservation Zone includes lands protected from development such as highly productive agricultural lands, areas of high visual value, and critical environmental resources especially including lands critical to protecting the water quality of our rivers and streams. Much of this land would be wetlands.
2. This zone is intended to maintain the vegetation in this area.

(iv) Landscaping

Refer to Hyde Park City Code 12.160 Landscaping

c) Infiltration BMPS

(i) At Grade Retention/Infiltration Basins

1. All retention basins shall be sized to meet the requirements of Section B of this chapter and to contain 100 percent of project site runoff from the design storm.
2. Side slopes shall not be steeper than 3:1 (H:V).
3. The maximum depth of the pond shall be three feet plus one (1) foot of freeboard above the emergency overflow and a maximum water depth of three (feet) below the emergency overflow. All other ponds require special design, approval, and permitting including safety precautions on a case by case situation.
4. All ponds shall be stabilized with rocks or planted vegetation to prevent internal erosion. Vegetation or other stabilization shall be maintained.
5. All ponds shall drain within 3 days (72 hours) from the end of the storm event. This is to be documented with a certified percolation test of the native sub-grade material and the material placed during construction, and documented in the soils report.
6. Emergency overflows and the flow path of the overflows shall be mapped for purpose of flooding.
7. The emergency overflow shall be designed to pass the full 100 year event.
8. Other utilities (for example water lines, sewer lines, gas lines, power lines, phone lines, etc.) shall not be allowed through the retention pond or within 5 feet of the pond berms.
9. The invert or lowest point in the pond shall be not less than 12-inches above the historically highest groundwater levels.
10. The bottom of the pond shall be finished to maintain historical infiltration.

(ii) Underground Retention/Infiltration Systems

3. Underground buried retention and injections systems, are not allowed in drinking water source protection zones 1 and 2.
4. Underground systems shall provide adequate access points for cleaning and maintenance of the underground chambers.
5. All systems shall drain by infiltration within 3 days (72 hours) from the end of the storm event. This is to be documented with a certified percolation test and documented in the soils report.
6. Sumps shall provide adequate water quality treatment to prevent contamination of the ground water aquifer.
7. Emergency overflows and the flow path of the overflows shall be mapped for purpose of flooding and flood insurance requirements.
8. The emergency overflow shall be designed to pass the full 100 year event.

9. Other utilities (for example water lines, sewer lines, gas lines, power lines, phone lines, etc.) shall not be allowed through or under the underground retention system.
10. Registration with the DWQ and a Class 5 Injection Well Permit are required for all underground retention/infiltration systems.

(iii) Infiltration Trenches

1. Infiltration trenches are not allowed in drinking water source protection zones 1 and 2.
2. Infiltration trenches shall provide adequate access points for cleaning and maintenance underground piping.
3. Infiltration trenches shall drain by infiltration within 3 days (72 hours) from the end of the storm event to provide adequate storage for a subsequent event. This is to be documented with a certified percolation test and documented in the soils report.
4. Infiltration trenches shall have adequate water quality treatment to prevent contamination of the ground water aquifer.
5. Emergency overflows and the flow path of the overflows shall be mapped for purpose of flooding and flood insurance requirements.
6. The emergency overflow shall be designed to pass the full 100 year event.
7. Other utilities (for example water lines, sewer lines, gas lines, power lines, phone lines, etc.) shall not be allowed through or under the infiltration trenches.
8. Registration with the DWQ and a Class 5 Injection Well Permit are required for all infiltration trenches.

(iv) Infiltration Swales

1. Side slopes shall not be steeper than 4:1 (H:V).
2. The maximum depth of the pond shall be one (1) foot.
3. All ponds shall be landscaped per landscaping requirements. Vegetation or other stabilization shall be maintained.
4. All swales shall drain within 3 days (72 hours) from the end of the storm event. This is to be documented with a certified percolation test of the native sub-grade material and the material placed during construction, and documented in the soils report.
5. Emergency overflows and the flow path of the overflows shall be mapped for purpose of flooding to ensure all emergency overflows are to the PWD drainage system
6. The invert or lowest point in the pond shall be not less than 12-inches above the historically highest groundwater levels.
7. The bottom of the pond shall be finished to maintain historical infiltration.

(v) Permeable Pavements

Permeable (or pervious) pavements contain small voids that allow water to pass through to a stone base. They come in a variety of forms; they may be modular paving system (concrete pavers, modular grass or gravel grids) or poured0in0place pavement (porous

concrete, permeable asphalt). All permeable pavements with a stone reservoir base treat storm water to remove sediments and metals to some degree by allowing storm water to percolate through the pavement and enter the soil below. All permeable pavement systems shall be designed to ensure that water in the pavement and the rocks below completely infiltrate into the soil within 72 hours.

(vi) Injection Wells (Sumps)

1. Injection wells also known as sumps are not allowed in drinking water source protection zones 1 and 2.
2. Injection wells shall provide adequate access points for cleaning and maintenance underground piping.
3. Injection wells shall drain by infiltration within 3 days (72 hours) from the end of the storm event to provide adequate storage for a subsequent event. This is to be documented with a certified percolation test and documented in the soils report.
4. Injection wells shall have adequate water quality treatment to prevent contamination of the ground water aquifer.
5. Emergency overflows and the flow path of the overflows shall be mapped for purpose of flooding and flood insurance requirements.
6. The emergency overflow shall be designed to pass the full 100 year event.
7. Registration with the DWQ and a Class 5 Injection Well Permit are required for all injection wells.

d) Storm Water 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 90^{th} 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 90^{th} 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 90^{th} percentile storm event. In instances where the quantity of runoff from the 90^{th} 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 vectors, and/or to improve the quality of water for reuse applications. These scenarios will be reviewed on a case-by-case basis.

e) 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.

(i) Bio-Filters

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.

(ii) Rain Gardens

Rain gardens are simply gardens designed to capture and treat runoff. They are generally small in size and should not be used to treat impervious areas exceeding 4,000 square feet. Rain gardens most often utilize native plant species and soil amendments to encourage absorption of stormwater. For projects with impervious areas exceeding 4,000 square feet biofilters, planter boxes with infiltration, vegetated swales or natural buffer strips should be considered.

(iii) Planter Boxes with infiltration

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.

(iv) Vegetated Swales

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.

(v) Filter or Buffer Strips

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.

f) Man-Made Treatment

(i) Planter Boxes

Planter boxes are bioretention treatment control measures that are completely contained within an impermeable structure with an underdrain (they do not infiltrate). They are similar to bioretention facilities with underdrains except they are situated at or above ground and are bound by impermeable walls. Planter boxes may be placed adjacent to or near buildings, other structures, or sidewalks.

(ii) Hydrodynamic Seperators

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.

g) Settlement systems

Settlement systems are used to store and settle out sediment using Stokes Law. This approach does not infiltrate, harvest, or evaporate sufficient water. However, it can be used in combination with other BMPs to ensure treatment of water above the 90th percentile storm to ensure water quality requirements and the flow requirements of the canal companies are met.

(i) At Grade Detention Basins

1. Side slopes shall not be steeper than 3:1 (H:V).
2. The maximum depth at the emergency overflow location of the pond shall be three feet plus one (1) foot of freeboard above the emergency overflow and a maximum water depth of three (feet) below the emergency overflow. All other ponds require special design, approval, and permitting including safety precautions on a case by case situation.

3. All ponds shall be stabilized with rocks or planted vegetation to prevent internal erosion. Vegetation or other stabilization must be maintained.
4. Where orifice and snouts are used, the orifice size is limited to not less than three (3) inches in diameter to prevent clogging.
5. Emergency overflows and the flow path of the overflows shall be mapped to natural streams, canals, or city approved drainage system for purpose of flood mapping using existing topographic mapping.
6. The emergency overflow shall be designed to pass the full 100 year event.
7. Other utilities (for example water lines, sewer lines, gas lines, power lines, phone lines, etc.) shall not be allowed through the detention pond or within 5 feet of the pond berms.
8. The invert or lowest point in the pond shall be not less than 12-inches above the historically highest groundwater levels (whichever is higher).
9. The bottom of the pond shall be finished to maintain historical infiltration.

(ii) Underground Detention Systems

1. Underground systems shall provide adequate access points for cleaning and maintenance.
2. All Detention systems shall drain by discharge (detention basins) within 3 days (72 hours) from the end of the storm event. This is to be documented.
3. Emergency overflows and the flow path of the overflows shall be mapped for purpose of flooding and flood insurance requirements.
4. The emergency overflow shall be designed to pass the full 100 year event.
5. Other utilities (for example water lines, sewer lines, gas lines, power lines, phone lines, etc.) shall not be allowed through or under the underground retention system.

8. Curb and Gutter Flow Design

1. The flow depth in the gutter shall not be allowed to exceed the lesser of the top back of curb elevation (TBC) or the peak drive way approach elevation during the required storm event. This includes a combination of piping, curb and gutter, and ditches.
2. Where the flow depth is exceeded, storm drain inlets and a piped system shall be required and appropriate actions taken to eliminate overtopping of the curbs and flooding private property.

9. Channel Design

1. Channel side slopes shall not be steeper than 3:1 (H:V) unless they are concrete. Where they are incorporated into landscaping, flatter slopes shall be required. This will be evaluated on a case by case basis.

2. Channel velocities shall be slow enough to prevent scour, and where possible, facilitate further settlement of sediments unless the channel is used to deliver irrigation water as well. If the channel will also carry irrigation water, maintain velocities above 2 ft/sec if possible, but at no time exceed 4 ft/sec.
3. Where rip-rap is used, design shall be in accordance with EM-1110 from the US Army Corp of Engineers or HEC-11 from the Federal Highway Administration.
4. Free board on the channels shall be in compliance with the Bureau of Reclamation, Design of Small Canal Structures.
5. Channel maintenance easements shall be maintained as required in the City and Canal Company agreements.

10. Pipe Design

1. For storm water pipes, roughness coefficients listed in the table included in Section D of these standards that coincide with the accepted pipe materials in the City's Standard Specifications, most current edition shall be used.
2. Maintain velocities in the pipes at design flows sufficient to prevent sediment deposition and low enough to prevent scour damage to the pipe.
3. Pipe outlets shall have a flared end discharge unless more stringent methods of energy dissipation are required.
4. Minimum diameter of storm drains shall be:
5. 12 inches for laterals
6. 15 inches for trunk lines
7. 18 inches under the UDOT right of way.
8. Pipe sizes shall not decrease in the downstream direction.
9. Maximum flow depth in the pipe during the design storm shall not exceed 0.85 times the diameter of the pipe.

C. REQUIRED HYDROLOGIC METHODOLOGY

1. Design Methodology

Table C-1 summarizes the required methods based on the area contributing flows to the system, including offsite flows. THE RATIONAL EQUATION IS NOT ALLOWED FOR DESIGN OF BEST MANAGEMENT PRACTICES.

Table C-1, Hydrologic Methods Required

Contributing Area (Acres)	Methodology Required
Less than 10.0 Acre	SCS Method with calculated time of concentration. Time of Concentration shall not be less than 5 minutes.

Greater than 10.0 Acres	SCS Method. The time of concentration can be calculated or hydrodynamic solutions may be used. If hydrodynamic solutions are used, the model must be provided to the PWD for detailed review of all assumptions and data used.

2. Design Hyetographs

Table C-2 summarizes the hyetograph which shall be used during the design.

Table C-2, Required Design Hyetograph

Contributing Area (Acres)	Methodology Required
Less than 10.0 Acres	SCS Type II Storm
10.0 Acres or Larger	SCS Type II Storm or other acceptable Hyetograph with special approval.

3. Hydrologic Procedures

The SCS method, as developed in TR-55 by the Soil Conservation Service in the 1950s, requires the designer to address the soil conditions, vegetative cover, and the antecedent soil condition (AMC) being evaluated.

a) SCS Soil Conditions

Soil maps and references available from the Natural Resource Conservation Service will identify the group associated with each soil class. HOWEVER, the designer needs to consider the effects of the final landscaping, such as the use of top soil, as part of his design.

There are four primary soil conditions available in the SCS method, grouped as A, B, C, and D.

Group A soils typically are gravels and sands with fast infiltration rates and low runoff potential. While there are Group A soils on some of the benches and along the Logan river in some places, as soon as any landscaping with topsoil occurs, the storm water benefit is lost. Unless specific LID design is incorporated to maintain the infiltration potential of these soils, final landscaping will require a different soil group.

Group B soils have moderate infiltration rates when wetted and consist of moderately well drained soils with moderately fine to course textures, typically without clay.

Group C soils have slow infiltration rates if thoroughly wetted and consist of soils that have a layer that impedes vertical infiltration.

Group D soils have a slow infiltration rate if thoroughly wetted and consist of clays, usually with high swelling potential, soils with a permanent high water table, soils with a clay pan or hard pan later near the surface, and shallow soils over an impervious material.

b) Antecedent Soil Conditions

In addition to the soil group, the antecedent moisture condition (AMC) must also be considered. For the average case, the SCS has defined AMC II to apply as the definition of the conditions preceding most annual floods. For this purpose, AMC II will be used for all PWD approved projects.

Upon selecting the soil group, the appropriate curve number can be selected from various standard references and text books. A common free reference is the HEC-HMS technical reference manual which can be downloaded from the Army Corp of Engineers HEC website. Runoff coefficients are subject to approval by the City Engineer.

c) Runoff Coefficients

PWD has established standard runoff coefficients that shall be used to ensure compatibility of results from the base model and each individual project. Calculations differing from these values shall be returned to the design professional for corrections.

Table C-3, Required Runoff Coefficient (CN)

Condition	Soil Group A	Soil Group B	Soil Group C	Soil Group D
Asphalt	98	98	98	98
Concrete Pavement	98	98	98	98
Grassed Open Space (Grass Cover > 75%)	39	61	74	80
Grassed Open Space (Grass Cover 50-75%)	49	69	79	84
Graveled Areas	76	85	89	91
Woods and Forested Areas (Good Condition)	25	55	70	77
[1)]Residential Lots, less than ¼ acre	77	85	91	94
[1)]Residential Lots, ¼ acre to ½ acre	61	75	83	87
[1)]Commercial Business Areas	89	92	94	95
[1)]Industrial Areas	81	88	91	93

[1)] Where the weighted values are too cumbersome to calculate, or insufficient data is available outside of the project area, use these values.

d) Time of Concentrations Calculations

There are numerous equations for calculating the time of concentrations. While many may be applicable to various locations, Table C-4 identifies the methods that shall be used in determining the time of concentrations within the PWD areas.

Table C-4, Time of Concentration Calculations

Larger of Contributing Area or Project Area (Acres	Sheet Flow	Open Channel Flow	Piped Flow
Less than 10.0 Acres	Calculated per HEC-22	Calculated per HEC-22	Calculated per HEC-22
10.0 Acres or Larger	Coordinate with City Engineer	Coordinate with City Engineer	Coordinate with City Engineer

D. HYDRAULIC CALCULATIONS

Hydraulic calculations shall be used for sizing pipes and open channels associated with the total design flows.

1. Channel Design

Channels shall be designed with a trapezoidal cross section using roughness coefficients associated with the final restored condition. The Manning's equation methodology shall be used for sizing and considering the associated backwater impacts from downstream conditions. Computer software can be used to calculate the channel size, but sufficient data and results shall be provided to validate the procedure, assumptions, and conclusions.

2. Pipe Design

For design of pipes and culverts, the designer shall demonstrate that the pipes meet the standard design requirements using Manning's equation for open channel flow and standard culvert calculation procedures to determine inlet and outlet control conditions. Full pipe flow designs are not allowed for gravity systems. For storm water pressure mains from pump stations, either the Hazen-Williams or Darcy-Weisbach equations will

be allowed. Roughness coefficients and assumptions shall be in accordance with Table D-1 selected from various references.

Table D-1, Mannings Coefficients for Pipe

Material	Roughness "n"
Smooth Interior HDPE or ADS Pipe	.010
Corrugated Metal Pipe (CMP)	.024
Concrete	.013
PVC	.010

The design and sizing may be done manually or with the use of computer software. However the results must be provided as part of the submittal review process.

3. Spread Width Calculations

Spread width calculations and depth of flow in the gutters shall be completed in accordance with HEC-22 methodology developed by the Federal Highway Administration (FHWA). These calculations can be completed using numerous available software or manually. However, the calculations must be documented and provided to the City for review for the design storms.