Stormwater Ponds Seminar

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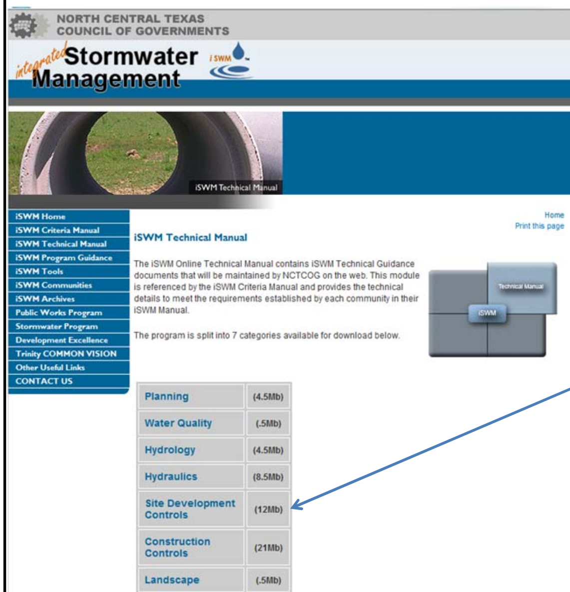
Agenda

- Basics of Stormwater Ponds
- Design Criteria
- Design Calculations and Layouts
- Maintenance and Inspection
- Greening Your Detention Pond: Integrating Detention Ponds in LID Design
- Review of Texas AgriLife Pond

Material Location



http://iswm.nctcog.org/technical_manual.asp

Site Development Controls Manual, Section 22

Basics of Stormwater Ponds

Basics of Stormwater Ponds

Wet Pond vs. Dry Detention Pond

- More aesthetic
- Provides water quality benefit
- Wildlife habitat

- Less maintenance
- Cheaper
- Open space opportunities

Basics of Stormwater Ponds

- Also called a wet pond or retention pond
- Has a permanent pool of water through out the year
- Treats water quality through settling and biological uptake
- Meets erosion control and flood control needs

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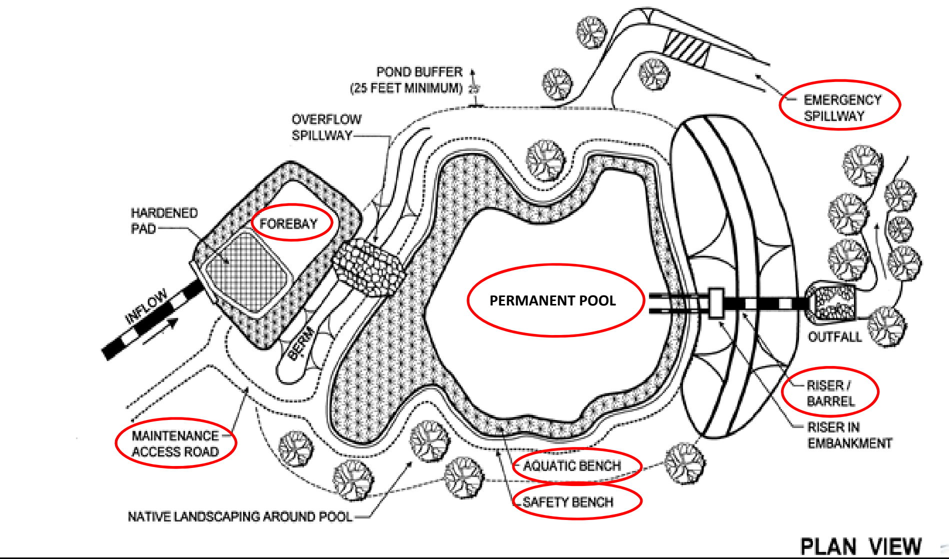
Basics of Stormwater Ponds

Stormwater Pond Components



Types of Stormwater Ponds

1) Wet Pond

- Permanent pool of water equal to the water quality volume
- Runoff displaces water already present in the pool
- Temporary storage provided above the permanent pool elevation

Types of Stormwater Ponds

2) Wet ED Pond

- Permanent pool of water equal to **half water quality volume**
- Other half of water quality volume in ED storage above the permanent pool and discharged over 24 hours
- Requires **less space**

Types of Stormwater Ponds

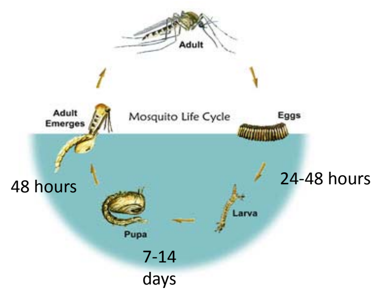
3) Micropool ED Pond

- Small "micropool" maintained at the outlet of the pond
- Outlet structure sized to detain the water quality volume for 24 hours
- Prevents re-suspension of settled sediments and clogging of the low flow orifice

Perceived Problems

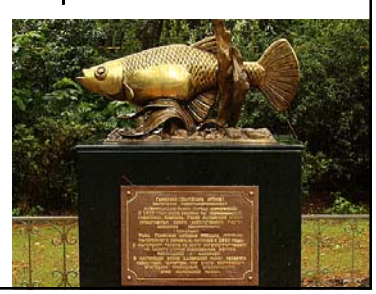
Mosquitos!

- Mosquitos are nearly as likely to be present in dry ponds as they are in wet ponds
- Not a major problem for larger wet ponds
- Shallow pond zones should be designed to dry out in 3 to 4 days
- Biological controls can limit mosquito populations



Perceived Problems

- Mosquito fish (Gambusia affinis) are small, with an average size of 2.8 inches
- Mosquito fish can survive in temperatures from 33°F to 100°F, a pH range of 5 to 9.5, salinities as high as 15ppm, and dissolved oxygen of nearly 0
- Pond depths should be a minimum of 18 inches, 30 inches preferable
- Can be purchased online, approximately $1.30 per fish



Perceived Problems

Maintenance

- Having a maintenance and inspection plan in place is a necessity
- Require maintenance agreement that will identify the responsible party, possibly including a list of qualified contractors to perform maintenance services
- More on maintenance and inspection later and also see the iSWM Program Guidance

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Benefits

- Wildlife habitat
- Aesthetics

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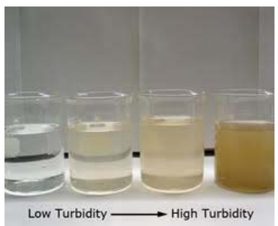
Benefits

Pollutant Removal Efficiency

80%	Total Suspended Solids
50%/30%	Nutrients (Total Phosphorus/Total Nitrogen)
50%	Metals (Cadium, Copper, Lead, and Zinc
70%	Pathogens (Coliform, Streptococci, E. Coli)



Benefits

Erosion Protection

Releasing the 1-year storm event over 24 hours

Benefits

Flood Control

Provide detention storage above permanent pool to reduce peak flow to pre-development conditions

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Design Criteria

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Design Criteria

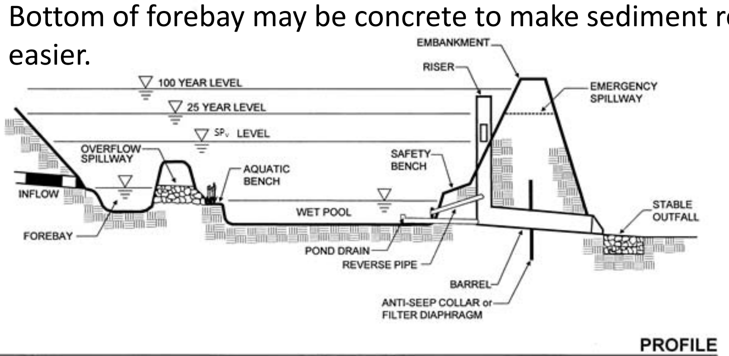
Location and Siting

- Space required will be 1% to 3% of the contributing drainage area
- Minimum drainage area of 25 acres, 10 acres for micropool ED pond (otherwise requires water balance calculations)
- Underlying soils should be C or D or have a liner. Permeability tests are required. Permeability between $4x10^{-6}$ and $4x10^{-7}$ in/sec are adequate. Otherwise can use a clay blanket or other liner
- Cannot be located within a stream or any waters of the U.S. without a Section 404 permit
- Minimum setback requirements
  - 10 feet from a property line
  - 100 feet from a private well
  - 50 feet from a septic tank/leach field/spray area
- Fit design to terrain

Design Criteria

Forebay

- Forebay should be at each inlet unless the inlet provides less than 10% of the total inflow.
- Forebay should be 4 to 6 feet deep.
- Install sediment depth marker to measure sediment deposition over time.
- Bottom of forebay may be concrete to make sediment removal easier.



Design Criteria

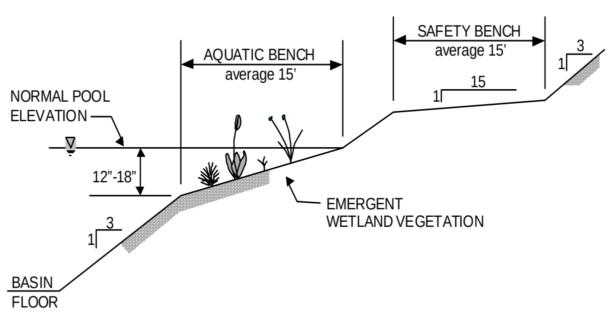
Physical Specifications/Geometry

- Longitudinal slope of 0.5% to 1%
- Minimum length to width ratio of 1.5:1, ideally 3:1. Length to width ratios help avoid short-circuiting or an unequal distribution of inflow.
- Maximum depth of 8 feet, minimum depth of 3-4 ft (2 feet during drought conditions)
- Side slopes not to exceed 3:1
- Wedge-shaped when possible so flow enters gradually
- Baffles, pond shaping, or islands increase the flow path
- Irregular contours and shapes provide a more natural landscaping effect, increases flowpath and increases treatment

Design Criteria

Physical Specifications/Geometry

- Pools 4 feet or deeper shall have two benches, safety and aquatic.
- Safety bench shall be 15 feet wide with a maximum slope of 15:1 (6%).
- Safety bench may be waived if slopes are 4:1 or gentler
- Maintenance access can be located along the safety bench



Design Criteria

Physical Specifications/Geometry

- The aquatic bench is 15 feet on average with a maximum depth of 18 inches.
- Plantings on the aquatic bench can play a very important part.
  - Provides biological uptake
  - Stabilizes side slopes
  - Serves as wildlife habitat
  - Temporarily catches trash and debris
  - Discourages entrance into the pond

Design Criteria

Outlet Structures

- Riser and barrel is the preferred design for outlet flow
- Riser should be located within the embankment
- Install anti- clogging device such as hood, trash rack, or skimmer
- Embankments 6 feet or higher are subject to TCEQ guidelines for Dam Safety

Design Criteria

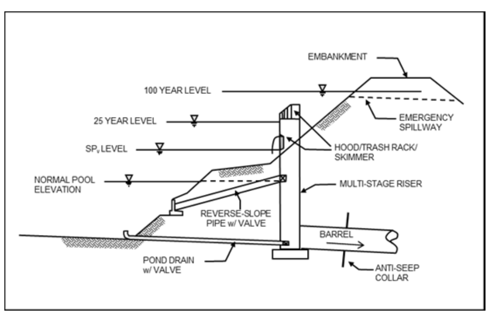
Outlet Structures

- Anti-seep collars on the outlet barrel reduce the potential for pipe failure
- A bottom drain pipe should be able to drain the permanent pool in 24 hours
- Riprap or splash pads are placed at outlet to prevent scouring and erosion
- 1 foot of freeboard for emergency spillway

Design Criteria

Outlet Structures

- Pond drain valve stays closed until the pond needs to be dredged for maintenance. Pond drain valve is usually a handwheel activated knife or gate valve.
- Reverse slope pipe is used for releasing the extended detention volume. This is usually installed as one size larger than calculated. Adjustable gate valves are installed and can be adjusted to adjust detention time.



Design Criteria

Maintenance Access

- Must be provided from a public road or easement
- At least 12 feet wide
- Maximum slope of 15%
- Able to withstand maintenance equipment and vehicles
- Access to the riser provided by lockable manhole covers
- Valve controllers should be accessible and handwheel activated

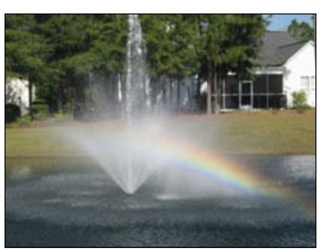
Safety Features

- Spillway opening should not be accessible by small children
- Pipe outfalls greater than 48” should be fenced to prevent access
- Warning signs should be posted prohibiting swimming and fishing

Design Criteria

Landscaping

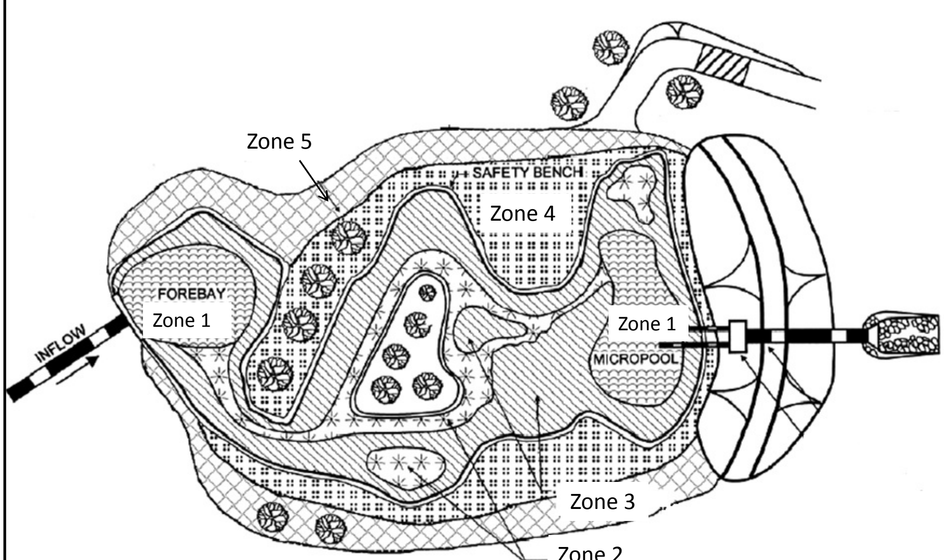
- Important to consult a professional landscape architect
- Landscaping enhances the aesthetics, stabilizes side slopes, can serve as wildlife habitat, adds to the pollutant removal capabilities, and temporarily conceals trash and debris
- Fountains or solar powered aerators can be used for oxygenation



Design Criteria

Table 1.1 Hydrologic Zones		
Zone #	**Zone Description**	**Hydrologic Conditions**
Zone 1	Deep Water Pool	1-6 feet depth (permanent pool)
Zone 2	Shallow Water Bench	Normal pool elevation to 1 foot depth
Zone 3	Shoreline Fringe	Regularly inundated
Zone 4	Riparian Fringe	Periodically inundated
Zone 5	Floodplain Terrace	Infrequently inundated
Zone 6	Upland Slopes	Seldom or never inundated

Design Criteria



Design Criteria

Landscaping Questions

Q: Are trees allowed in vicinity of the pond?

A: Yes, as long as they are tolerant of wetland conditions. Should not be planted near the embankment to prevent potential washout.

Q: How are wetland plants established?

A: Diverted water should be used to irrigate and additional temporary irrigation may be necessary. Wetland plants should be native and be able to tolerate drought periods.

Q: What invasive plants should be removed?

A: Examples include cocklebur, sumpweed, sesbania and cattails. To reduce or eliminate this vegetation you can use a broadleaf registered aquatic herbicide or plant competing species.

Q: Can plants survive in dense clay soils?

A: Plants should be installed while still in their soil pots or a thin later of planting soil should be used.

Q: How do you keep plants roots from penetrating liner?

A: Wetland plants have roots that will want to stay close to the surface to absorb as much water as possible.

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Design Calculations and Layouts

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Calculating WQv

How to Calculate the Water Quality Volume

1. Calculate the volumetric runoff coefficient

$$R_v = 0.05 + 0.009(I)$$

where I = percent of impervious cover (%)

2. Calculate the water quality volume (WQ_v)

$$WQ_v = \frac{1.5\, R_v\, A}{12}$$

where:
WQ_v = water quality protection volume (acre-feet)
R_v = volumetric runoff coefficient
A = total drainage area (acres)
1.5 = inches of rainfall during the 85 percentile storm event

Sizing Ponds

Forebay

- Sized to contain 0.1 inches per impervious acre of contributing drainage area. Volume may be extracted from total WQ_v for permanent pool sizing.

Permanent Pool

- Wet Pond: Permanent Pool = WQ_v
- Wet ED Pond: Permanent Pool = 0.5*WQ_v
- Micropool ED Pond: Permanent Pool sized approximately for 25 to 30% of WQ_v

Sizing Ponds

Streambank Protection

- Detention storage provided above permanent pool. Outfall sized to release the 1-year, 24-hour storm event over 24 hours.

Flood Protection

- Detention storage provided above permanent pool. Experience shows an additional 10-15% of storage is required when extended detention is provided.

Sizing Ponds

Design Procedure Form: Storm Water Ponds

PRELIMINARY HYDROLOGIC CALCULATIONS

1a. Compute WQ_v Volume requirements
Compute Runoff Coefficient, R_v — R_v = ________
Compute WQ_v Volume requirements — WQ_v = ________ acre-ft

1b. Compute SP_v — SP_v = ________ acre-ft
Compute average release rate — release rate = ________ cfs
Compute Q_p (Required 100-year detention volume) — Q_p = ________ acre-ft
Add 15% to the required Q_p volume (if ED) — Q_p* 15% = ________ acre-ft
Compute (as necessary) Q_f — Q_f = ________ cfs

STORM WATER POND DESIGN

2. Is the use of storm water pond appropriate? — **See subsection 5.2.21.4 and 5.2.21.5-A**
3. Confirm local design criteria and applicability
4. Pretretament volume
Vol_{pre} = I(0.1")(1'/12") — Vol_{pre} = ________ acre-ft
5. Allocation of Permanent Pool Volume and ED Volume
Wet Pond: $Vol_{pool} = WQ_v$ — Vol_{pool} = ________ acre-ft
Wet ED Pond: $Vol_{pool} = 0.5(WQ_v)$ — Vol_{pool} = ________ acre-ft
$Vol_{ED} = 0.5(WQ_v)$ — Vol_{ED} = ________ acre-ft
Micropool ED Pond: $Vol_{pool} = 0.25(WQ_v)$ — Vol_{pool} = ________ acre-ft
$Vol_{ED} = 0.75(WQ_v)$ — Vol_{ED} = ________ acre-ft
6. Conduct grading and determine storage available for permanent pool (and WQ_v-ED volume if applicable) — Prepare an elevation-storage table and curve using the average area method for computing volumes.

Elevation	Area	Average Area	Depth	Volume	Cumulative Volume	Cumulative Volume	Volume above Permanent Pool
MSL	ft²	ft²	ft	ft³	ft³	acre-ft	acre-ft

7. WQ_v Orifice Computations
Average ED release rate (if applicable) — release rate = ________ cfs
Average head, h = (ED elev. - Permanent pool elev.) / 2 — h = ________ ft
Area of orifice from orifice equation — A = ________ ft²
$Q = CA(2gh)^{0.5}$ — diameter = ________ in
factor = ________ $(h)^{0.5}$
Discharge equation $Q = (h)^{0.5}$

Compute release rate for SP_v-ED control and establish SP_v elevation — WSEL = ________ ft-NGVD
Release rate = — release rate = ________ cfs
Aerage head, h = SP_v elev. - Permanent pool elev.) / 2 — h = ________ ft-NGVD
Area of orifice from orifice equatin — A = ________ ft²
$Q = CA(2gh)^{0.5}$ — diameter = ________ in
Discharge equation $Q = (h)^{0.5}$ — factor = ________ $(h)^{0.5}$

8. Calculate Qp release rate and WSEL — **Set up a stage-storage-discharge relationship**

Elevation	Storage	Low Flow	Riser			Barrel		Emergency	Total
		WQv-ED	SPv-ED	High Storage Orif.	High Storage Weir	Inlet	Pipe	Spillway	Storage
MSL	ac-ft	H(ft) Q(cfs)	H(ft) Q(cfs)	H Q	H Q	H(ft) Q(cfs)	H(ft) Q(cfs)	H(ft) Q(cfs)	Q(cfs)

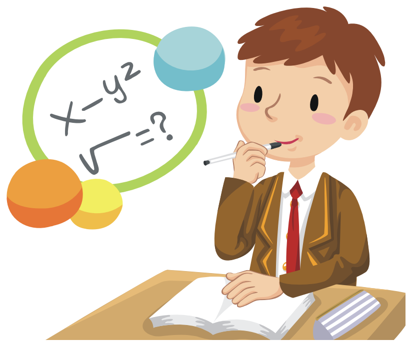
Q_p = pre-dev. Peak discharge - (WQ_v-ED release + SP_v-ED release) — Q_p = ________ cfs

Maximum head = — H = ________ ft
Use weir equation for slot length ($Q = CLH^{3/2}$) — L = ________ ft

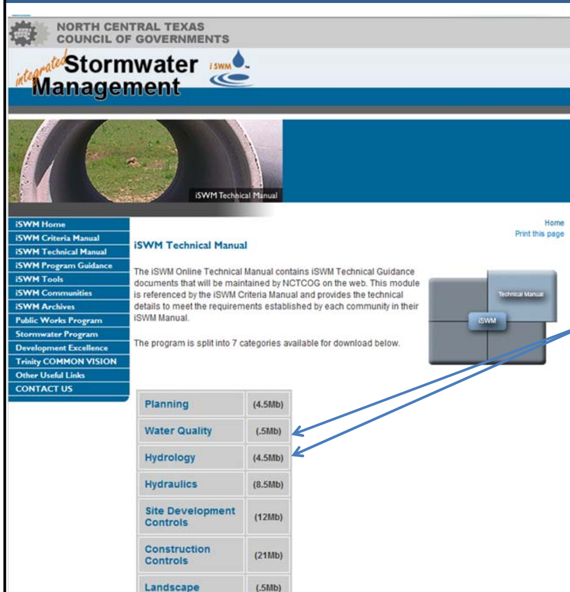
Check inlet condition
Check outlet condition — **Use culvert charts (section 4.3)**

9. Size emergency spillway, calculate 100-year WSEL and set top of embankment elevation — $WSEL_{25}$ = ________ ft; $WSEL_{100}$ = ________ ft; Q_{ES} = ________ cfs; Q_{PS} = ________ cfs
10. Investigate potential pond hazard classification — **See Appendix H**
11. Design inlets, sediment forebays, outlet structures, maintenance access, and safety features. — **See subsection 3.2.15 - D through H**
12. Attach landscaping plan — **See Appendix F**

Example



Material Location



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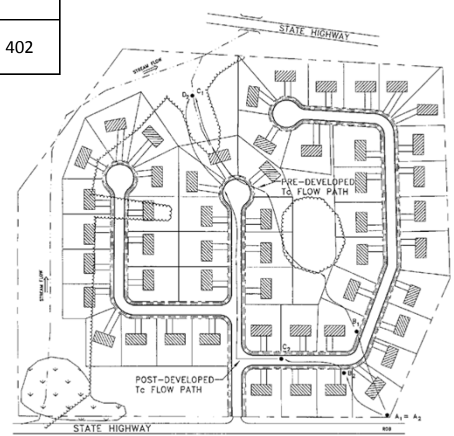
- **Water Quality Section 1.0** – Water Quality Protection Volume and Peak Flow
- **Hydrology Section 1.3** – SCS Hydrological Method
- **Hydrology Section 1.5** – Modified Rational Method
- **Hydrology Section 3.0** – Streambank Protection Volume Estimation

Example

Rolling Meadows Site Plan

Condition	T_c (hr)	CN	C	$Q_{1\text{-}yr}$ (in)	$Q_{1\text{-}yr}$ (cfs)	$Q_{100\text{-}yr}$ (cfs)
Pre-Developed	0.33	76	0.45	0.78	26.9	266
Post-Developed	0.19	85	0.61	1.29	61.3	402

Total Area = 38 acres
Impervious Area = 13.8 acres
Denton County



Example

Calculate the Water Quality Volume

$$R_v = 0.05 + 0.009(I)$$

I = Impervious area (%) = 13.8/38 = 36.3%

$$R_v = 0.05 + 0.009(36.3) = 0.38$$

$$WQ_v = \frac{1.5\,R_v\,A}{12}$$

$$WQ_v = \frac{1.5 * 0.38 * 38}{12} = \underline{1.44\ ac - ft}$$

Example

Calculate Forebay Volume

Forebay sized to treat 0.1”/impervious area
=13.8*0.1/12=0.12 ac-ft
Can be subtracted from the permanent pool volume

Calculate Permanent Pool Volume

Wet Pond = 1*WQv = 1.44 ac-ft

Wet ED Pond = 0.5*WQv = 0.72 ac-ft

Micropool ED Pond = 0.3*WQv = 0.43 ac-ft

Example

Calculate the Streambank Protection Volume

Release 1-yr, 24-hr storm over 24 hours
Utilize SCS approach to compute volume

$$I_a = 200/CN - 2$$
$$I_a = 200/85 - 2 = 0.353$$

$$I_a/P$$

P = accumulated rainfall in inches (1-yr, 24-hr storm event)

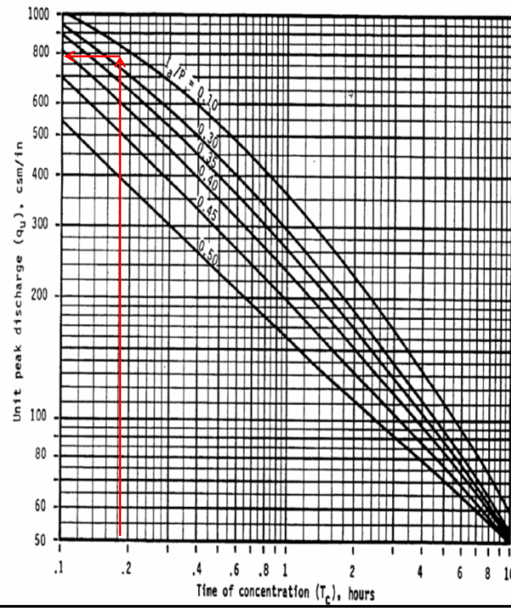
$$I_a/P = 0.353/2.64 = 0.13$$

Example

After determining $I_a/P = 0.13$;
And $T_c = 0.19$ hrs;

Use the nomograph from Figure 1.10 of the Hydrology Technical Manual to find the unit peak discharge;

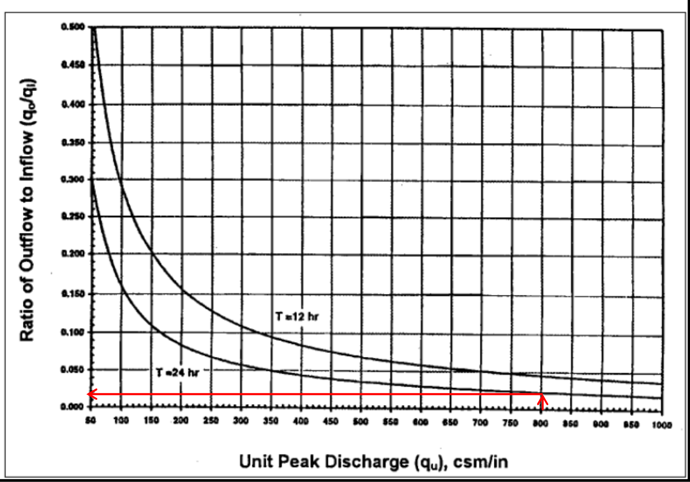
$q_u = 800$csm/in



Example

After determining $q_u = 800$csm/in;
Find ratio of outflow to inflow using Figure 3.1 of the Hydrology Technical Manual and a detention time of 24 hours;

$q_o/q_i = 0.022$



Example

Knowing the discharge ratio (q_o/q_i = 0.022), you can calculate the required storage volume to runoff volume ratio (V_s/V_r):

$$V_s/V_r = 0.682 - 1.43(q_o/q_i) + 1.64(q_o/q_i)^2 - 0.804(q_o/q_i)^3$$

$$V_s/V_r = 0.682 - 1.43(0.022) + 1.64(0.022)^2 - 0.804(0.022)^3$$

$$V_s/V_r = 0.65$$

Required storage (V_s or SP_v) can then be calculated by:

$$V_s = \frac{V_s/V_r * Q_d * A}{12}$$

$$V_s = \frac{0.65 * 1.29 * 38}{12} = \underline{2.66\ ac - ft}$$

Example

The streambank protection volume (2.66 ac-ft) will be released over 24 hours, resulting in a release rate of:

$$Q_{spv} = \frac{2.66 * 43560}{24 * 3600} = 1.34\ cfs$$

Example

Calculate the Flood Control Volume

Maintain pre-development conditions

Estimate using the Modified Rational Method

Determine the allowable release rate:

$$Q_a = C * I * A = 0.45 * 6.99 * 38 = 119.5\ cfs$$

Note this is less than the SCS peak flow that was calculated as 266 cfs.

Example

Determine the critical duration of the storm event:

$$T_d = \sqrt{2(C)(A)(a)(b)/Q_a} - b$$

a and b are rainfall factors for the Modified Rational Method for the 100-yr event

$$T_d = \sqrt{2(0.61)(38)(325.18)(24.822)/119.5} - 24.822$$
$$= 31.1\ minutes$$

Example

With a critical duration time of 31.1 minutes, intensity can be determined from the rainfall data tables for Denton County to be 5.55 in/hr.

Critical duration depth in inches can then be calculated:

P_{Td} = 5.55 in/hr*31.1 min/60 min = 2.88 inches

Now the required storage volume can be determined.

$$V_p = 60[CAa - (2CabAQ)^{0.5} + (Q/2)(b - t_c)]$$

$$V_p = 60\left[.61(38)(325.18) - (2)(.61)(325.18)(24.82)(38)(119.5)^{0.5} + (119.5/2)(24.82 - 11.4)\right] = 99,154\ ft^3$$

Example

Since Modified Rational Method can be a low estimate, an adjustment factor is used to account for under sizing.

$$V_{adj} = V_p * P_{180}/P_{td}$$

The factor (P_{180}/P_{td}) is the ratio of the 3-hour storm depth for the return frequency divided by the previously calculated rainfall depth for the critical duration.

$$V_{adj} = 99,154 * 5.37/2.88 = 184,881 ft^3 = 4.24\ ac - ft$$

An additional safety factor is added for multiple levels of extended detention. Add 15% to the required volume for flood control.

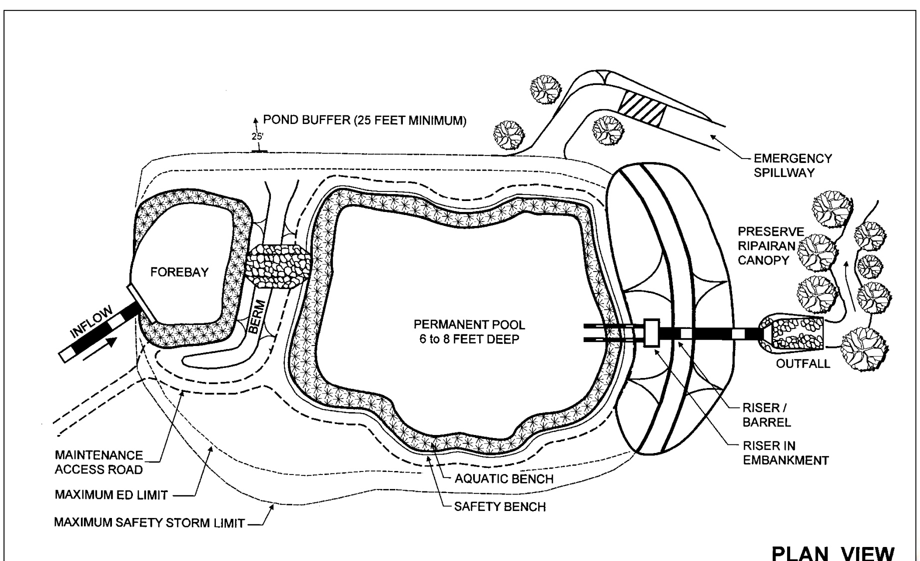
$$V_{adj} = 4.24 * 1.15 = \underline{4.88\ ac - ft}$$

Example

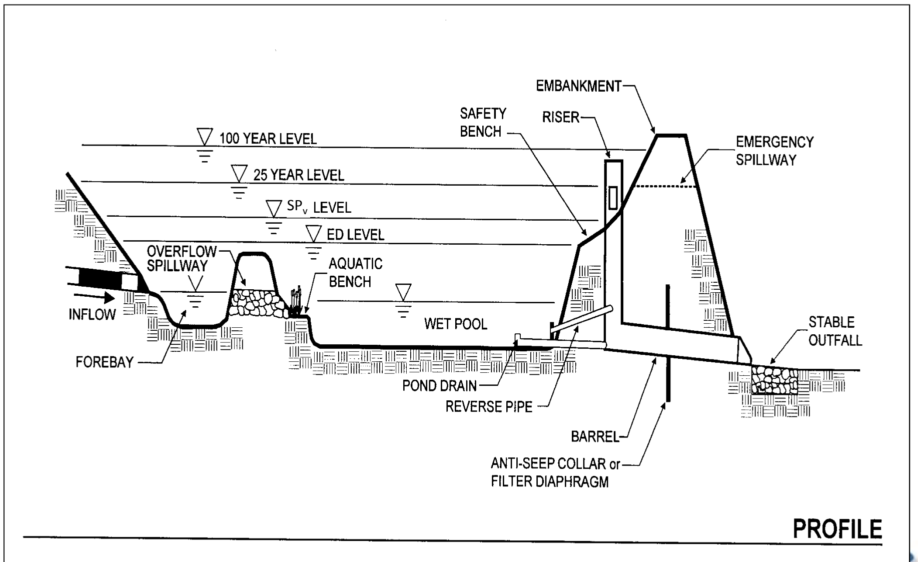
Mitigation Goal	Storm Event	Volume Required (ac-ft)
Water Quality	1.5" of runoff	1.44
Streambank Protection	1-yr, 24-hr storm event	2.66
Flood Control	100-yr, 24-hr storm event	4.88

Next steps are to create a stage-storage table based on grading, size outfalls and spillways, and prepare a landscaping plan.

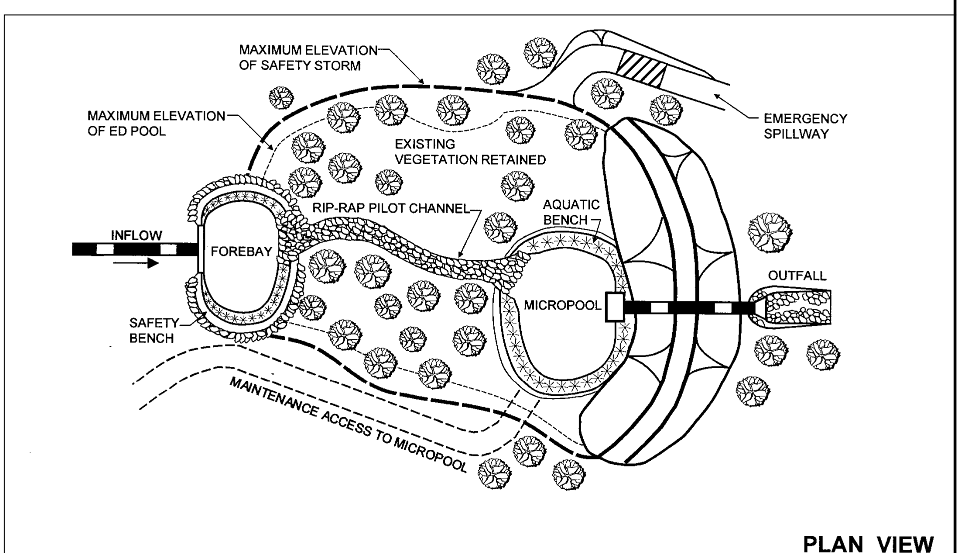
Pond Layouts



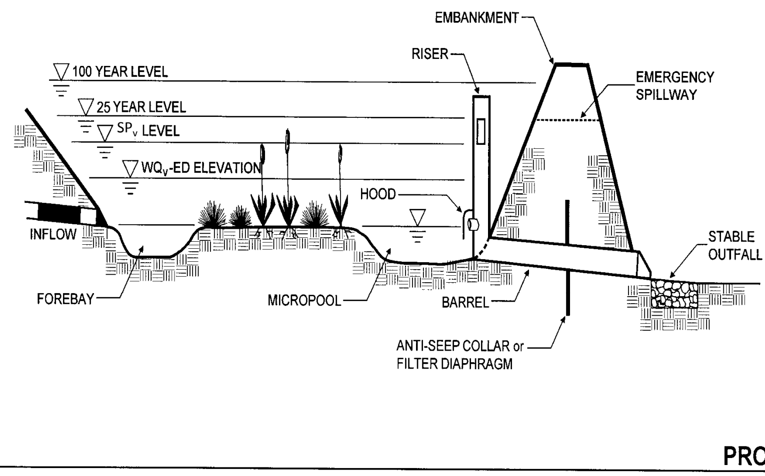
Pond Layouts



Pond Layouts



Pond Layouts



Pond Layouts

Central Market - Austin, TX

Pond Layouts

Town Lake Park – Austin, TX

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Pond Layouts

Central Park Center Pond – Austin, TX

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Maintenance and Inspection

During Construction

Construction Sequence

1. Use of wet pond as a sediment basin
   - De-watered, dredged and re-graded to design dimensions after construction
2. Stabilize drainage area
3. Assemble materials
4. Clear and strip
5. Install E&S controls
6. Excavate the core trench and install spillway pipe
7. Install the riser or outflow structure
8. Construct the embankment and berms
9. Excavate and grade
10. Construct emergency spillway
11. Install outlet pipes
12. Stabilize Exposed soil
13. Plant the area

During Construction

Construction Inspection

- Multiple inspections are needed. Recommended during the following stages:
  - Pre-construction meeting
  - Initial site preparation
  - Excavation/Grading
  - Installation of the embankment, riser spillway, and outlet structure
  - Installation of landscaping
  - Final inspection

Post Construction

First year maintenance

- Maintenance costs can be 10-15% of construction costs for the first year
- For first 6 months, site should be inspected at least twice after storm events exceeding 0.5 inches.
- Temporary irrigation will be necessary while plants are being established. Consider watering every 3 days for the first month and then weekly through the first growing season depending on rainfall
- Look for bare or eroding areas and stabilize with grass cover

Post Construction

Table 22.1 Typical Maintenance Activities for Ponds
(Source: WMI, 1997)

Activity	Schedule
• Clean and remove debris from inlet and outlet structures. • Mow side slopes. • Check visually for illegal dumping or other pollutants.	Monthly
• If wetland components are included, inspect for invasive vegetation.	Semiannual Inspection
• Inspect for damage, paying particular attention to the control structure. • Check for signs of eutrophic conditions. • Note signs of hydrocarbon build-up, and remove appropriately. • Monitor for sediment accumulation in the facility and forebay. • Examine to ensure that inlet and outlet devices are free of debris and operational. • Check all control gates, valves or other mechanical devices. • Check downstream face of dam for seepage (earth and concrete), settling (earth) and cracking (concrete).	Annual Inspection
• Repair undercut or eroded areas.	As Needed
• Perform wetland plant management and harvesting.	Annually (if needed)
• Remove sediment from the forebay.	5 to 7 years or after 50% of the total forebay capacity has been lost
• Monitor sediment accumulations, and remove sediment when the pool volume has become reduced significantly, or the pond becomes eutrophic.	10 to 20 years or after 25% of the permanent pool volume has been lost

Post Construction

Additional Maintenance Considerations and Requirements

- A sediment marker should be located in the forebay to determine when sediment removal is required.
- Sediments excavated from stormwater ponds that do not receive runoff from designated hotspots are not considered toxic or hazardous material and can be safely disposed of by either land application or landfilling. Sediment testing may be required prior to sediment disposal when a hotspot land use is present.
- Periodic mowing of the pond buffer is only required along maintenance rights-of-way and the embankment. The remaining buffer can be managed as a meadow (mowing every other year) or forest.
- Care should be exercised during pond drawdowns to prevent downstream discharge of sediments, anoxic water, or high flows with erosive velocities. The approving jurisdiction should be notified before draining a stormwater pond.

Inspection Checklists

- Construction Checklists
  - Center for Watershed Protection
  - Stormwater Manager's Resource Center (stormwatercenter.net)
  - Department of Environmental Conservation (New York State)
- Maintenance Checklists
  - Center for Watershed Protection
  - Santa Barbara BMP Criteria Manual
  - Department of Environmental Conservation (New York State)

Cost Considerations

Cost Considerations

- From EPA Technology Fact Sheet (1999)
  - $C=24.5*V^{0.705}$

    C=Construction, design and permitting cost

    V=Volume in the pond (CF)

    $139,655 for 4.88 ac-ft example pond

  - Annual maintenance cost at about 3 to 5% of construction cost
  - Typical costs range from $0.50 - $1.00 per CF
  - Study showed “pond front” property can increase selling price by 10% (USEPA, Economic Benefits of Runoff Controls, 1995)

Cost Considerations

Water Rights Permitting

- Regulated by TCEQ, applications and fees can be found at http://www.tceq.texas.gov/permitting/water_rights/wr_applications.html
- Exemptions include:
  - “Domestic and Livestock Use” – this covers the livestock, household use and irrigation for one home and has the 200 ac-ft requirement
  - “Wildlife Management” – 200 ac-ft restriction applies and the pond must be on qualified open-space land
  - “Emergency” – use for fighting fires and similar public services
- Calculate evaporation losses and provide means for providing makeup water. Example include; purchase through municipal source, sink a ground water well, purchase downstream water rights and pump back upstream.

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iSWM

Greening Your Detention Pond: Integrating Detention Ponds in LID Design

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Texas A&M System

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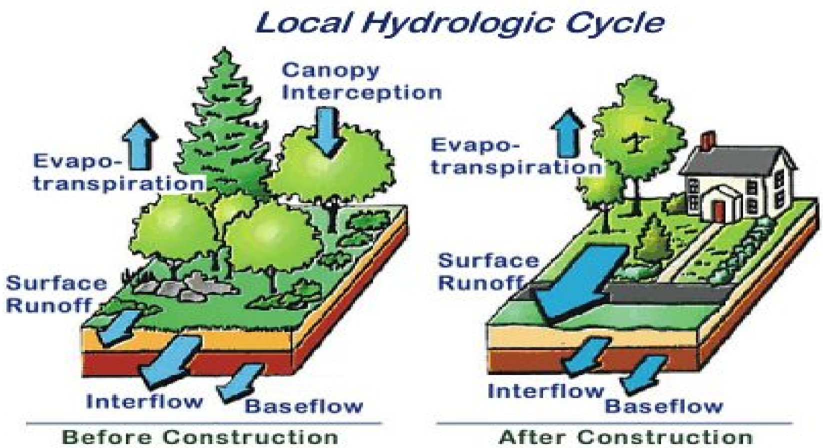
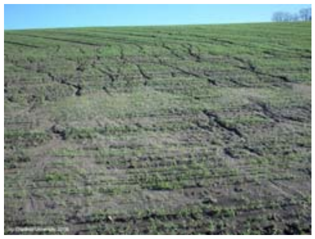
Urban vs. Natural



Why is Stormwater a Concern?

Erosion



Rill erosion

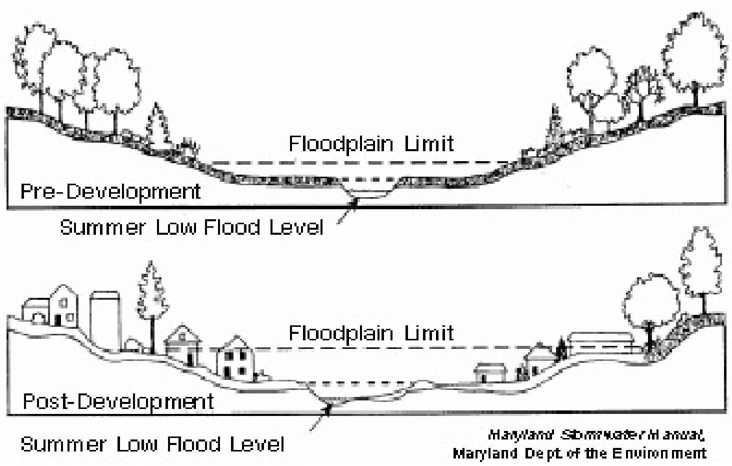
Gully erosion

Depositional Area

Why is Stormwater a Concern?

Why is Stormwater a Concern?

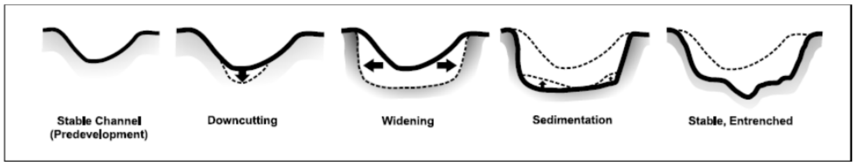
Why is Stormwater a Concern?



Maryland Stormwater Manual,
Maryland Dept. of the Environment

Stream Degradation

- Impacts due to urbanization :
  - **Changes to stream geometry**: stream widening, bank erosion, downcutting, loss of canopy, increase in the floodplain elevation.



Stream Degradation

- Impacts due to urbanization:
  - **Impact to aquatic habitat:** Degradation of habitat structure, loss of pool-riffle structure, reduction in base flow, increased stream temperature, and decline in abundance and biodiversity.

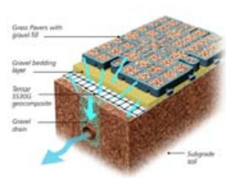
Fish kill at Lake Granbury.

Prevention of Stormwater Pollution

- Better Management (Chemicals/irrigation)
- Reduce stormwater volume
- Reduce contaminant content
- Protect Lakes and Rivers
  - Coastline
  - Riparian zones
  - Pathways to water body

Low Impact Development (LID)

- Low impact development (LID) is increasingly being adopted as an alternative to traditional water management systems.



Detention Ponds

- A more ‘traditional’ best management practice (BMP) to reduce effects of urbanization on stormwater.
- Designed to improve water quality, improve flood control, enhance wildlife habitat, and provide education and recreation.

How Do Detention Ponds Work?

- Sedimentation
- Filtration
- Adsorption
- Flocculation
- UV disinfection
- Microbial activity (Nitrification and Denitrification)
- Biological uptake(Phytoplankton, algae, plants)

Can Detention Ponds Be "Greener"?

- Increased detention times
- Increased retention
- Increased vegetation
- Gentler slopes
- Aesthetically more pleasing
- Part of a treatment train

Increasing Detention Time

- Increasing travel time by designing meanders in detention pond
- Creating shallow ledges that can be vegetated to impede flow
- Elevate outflow to retain water and increase detention time
- Differ from wet detention pond:
  - Designed based on retention volume as compared to Detention time
  - Designed in area with very deep groundwater

Increased Retention

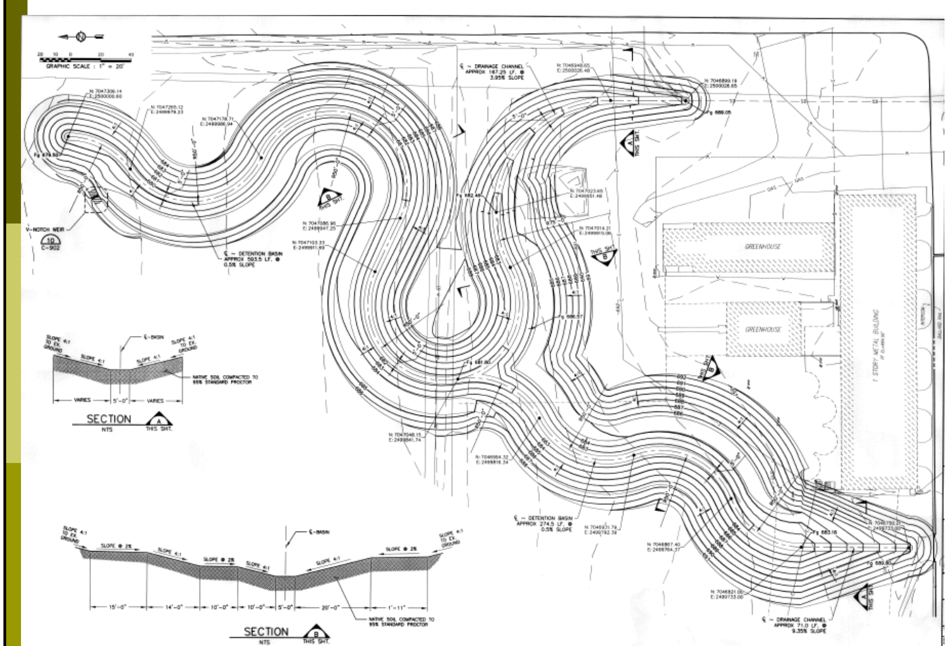
- Pond designed to retain 85% runoff (1.5 inches)
- First 1.5 inches is removed by evapotranspiration and infiltration
- Pond designed to have bioswale features in upstream half and retention in downstream half, thus increasing sedimentation in dry sections of Pond

Increased vegetation

- Pond cross section designed to mimic streams
- Includes a channel and flat bench (flood plain)
- Flood plain section can be vegetated to increase water contact with water
- Side slopes can be vegetated to reduce erosion and increase biodiversity thus reducing mosquitos

Other Considerations

- Detention pond banks landscaped to be acceptable to public
- Native seed mixes commercially available produce colorful flowers while providing erosion control
- Mixes should include grasses as well as native flowers
- Mix broadcasted could take up to 3 years to fully grow. Erosion control measures should be taken meanwhile

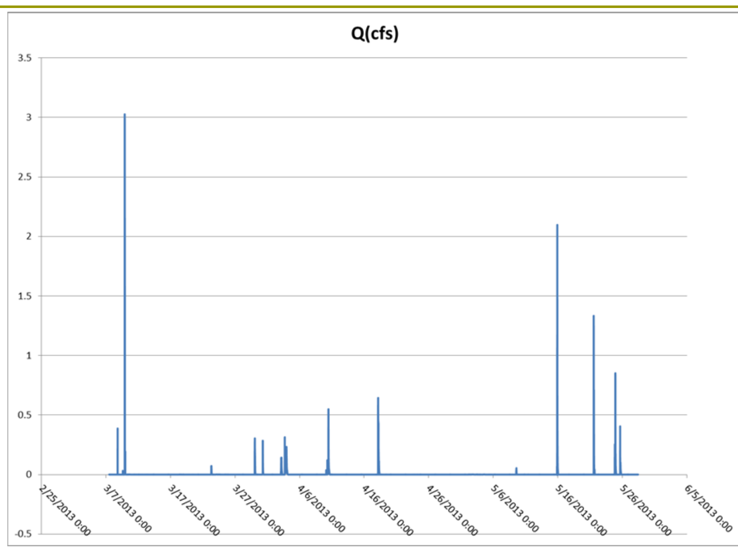


Design Criteria

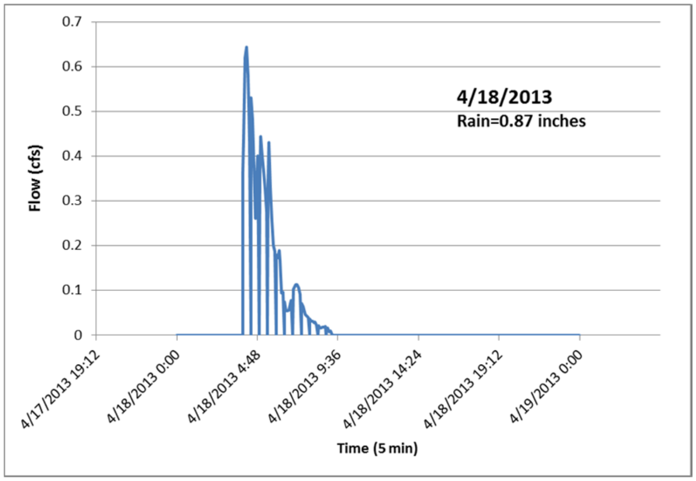
Detention Pond Calculations		
$P_{100\text{-}yr}$ 24-Hour Storm Event	9.73	in
$C^{*}C_{f(100)}$	0.71	
V_{in} 24-hr 100-Year Volume	263,099.58	ft^3
$C_{(1.5\text{-inch rain})}$	0.57	
V_{retain} 1.5-inch Volume	32,451.75	ft^3
V_{out} Discharge Volume	230,647.83	ft^3
T_{drain} Discharge Time	48	hr
Q_{out} Release Rate	1.33	ft^3/s

Drainage Area No.	Area (Acre)	"C" Factor			
		1.00	0.95	0.40	0.30
Pre	7.64	1.14	1.79		4.71
Post	10.52	0.00	3.19	7.33	

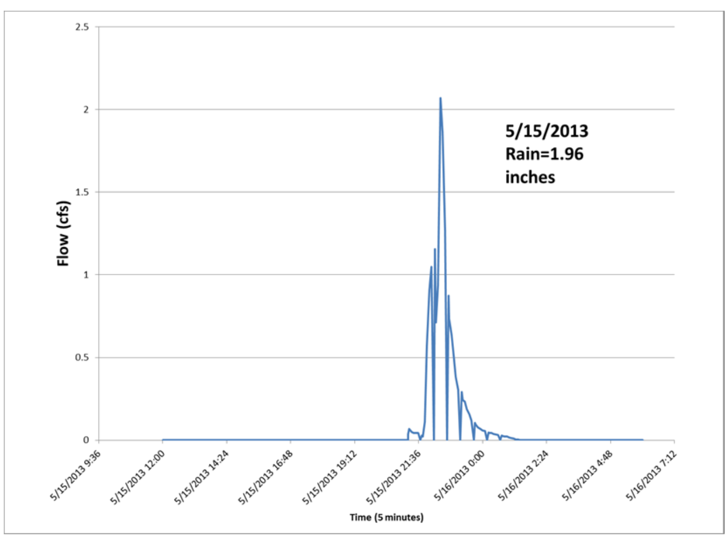
Preliminary Results



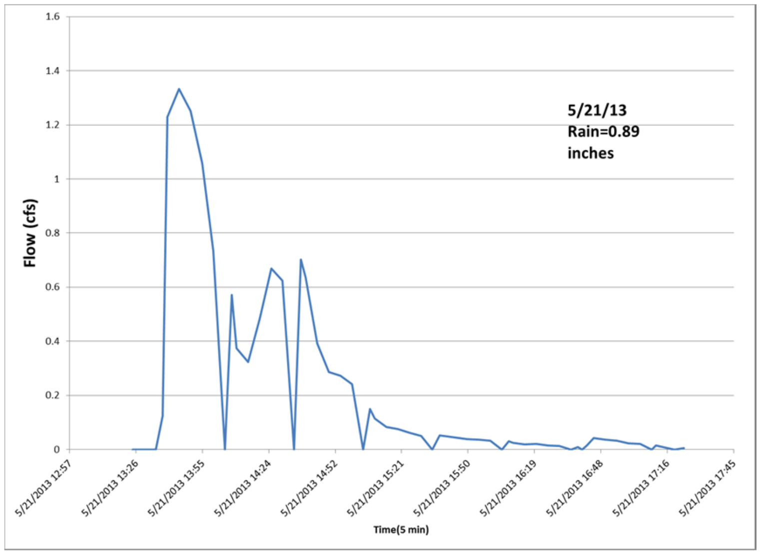
4/18/2013 Storm



5/15/2013 Storm



5/21/2013 Storm



Water Quality

Event	Total rain	NO3 N(mg/L)	NH3 N(mg/L)	TKN(mg/L)	O-P(mg/L)	TP(mg/L)	TSS(mg/L)
4/18/2013	0.87	7.4	0.38	6.1	0.1	0.27	9
5/15/2013	1.96	1.73	<0.05	2.1	0.36	0.47	23.5
5/21/2013	0.89	3.24	0.13	2.54	<0.005	0.37	24.67

Meandering of Pond

Erosion Fabric with Native Plants

Inlet with Automatic Water Sampler

Outlet V-notch Weir

Acknowledgements

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AgriLIFE EXTENSION
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