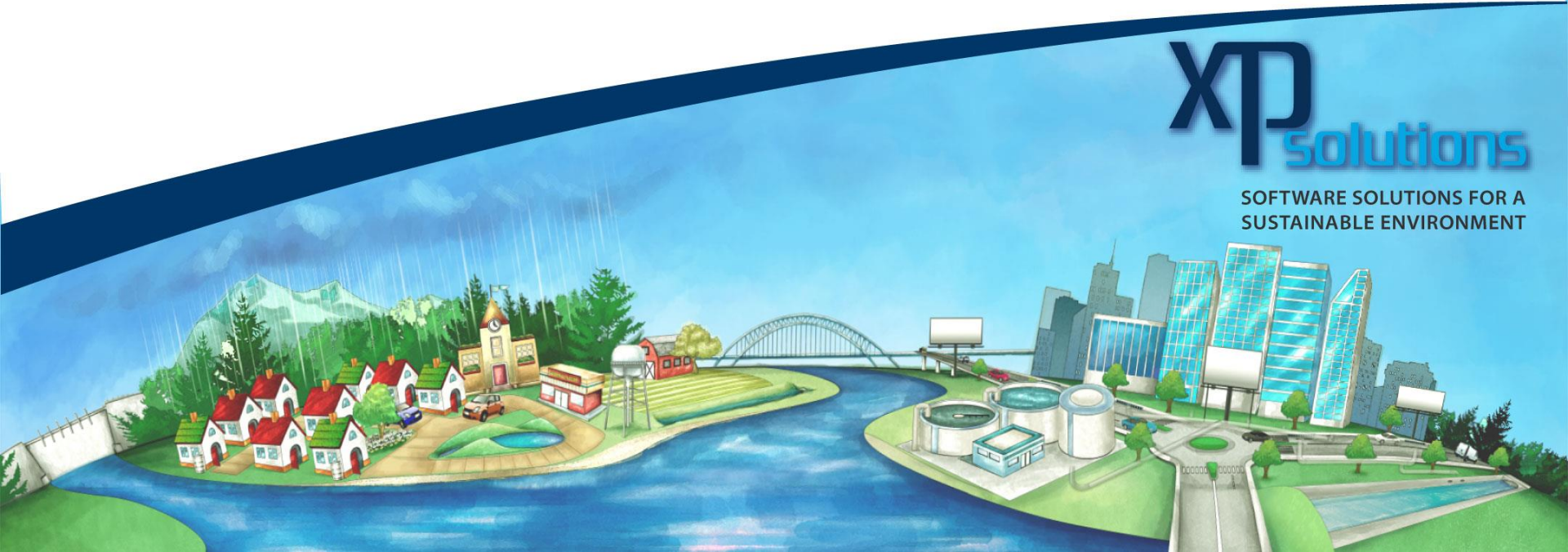


Overcoming Design Waste with Clear Visualization of Green Infrastructure Design

XP
solutions

SOFTWARE SOLUTIONS FOR A
SUSTAINABLE ENVIRONMENT





Presenter



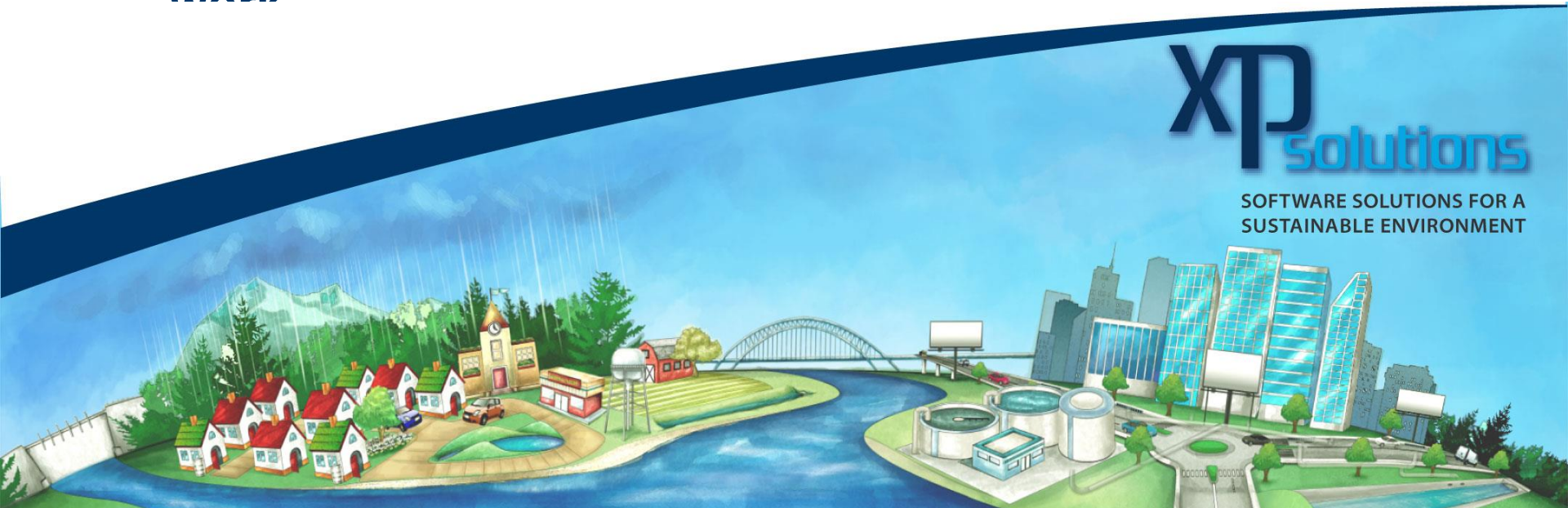
Zach Sample, PE
*Green Infrastructure
Design Products Manager*
XP Solutions



Ashley Francis, PE, CFM
Project Manager
LJA Engineering, Inc.

XP Solutions has a long history of ...

- Providing original, high-performing software solutions
- Leading the industry in customer service and support
- Educating our customers to be more successful in their work



XP solutions

SOFTWARE SOLUTIONS FOR A
SUSTAINABLE ENVIRONMENT

- Overview of conventional Green Infrastructure design
- 'Gaps' in conventional practices
- Solutions by focusing on Clear Visualization of design
- Clear Visualization Solution Case Study with `xpdrainage`





Sustainable Drainage Practices

Low Impact Development (LID)

Green Infrastructure (GI)

Stormwater Controls (SWC)

(Individual LID/GI facilities)



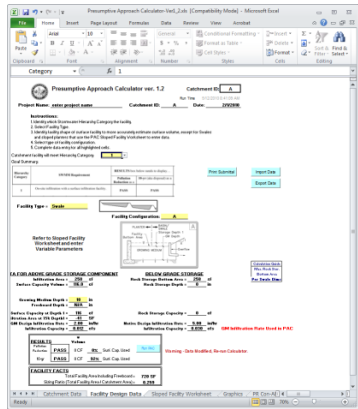
'Water Quality'... only Volume focused!

- Hydrology - 'First Flush' or WQ_v/WQ_e
- Pollutant concentrations ignored
- Facility design requirements:
 - Retain WQ_v
 - Bypass or attenuate 2-100yr ARI
 - Rational Eq and Manning's Eq
- **All calculated by hand or assisted by spreadsheet**



1. Facility design disconnected from site planning/design
2. Design procedures dependent on simplified catchment delineation
3. SWCs designed independently

1. Facility design is disconnected from site planning/design



Estimate area of channel

$$Q = VA$$

or

$$A = \frac{Q}{V}$$

where

$$Q = \text{peak flow rate}$$

$$V = \text{velocity}$$

$A = \text{area}$

$A = Q/V$

P can be calculated using the following

$$P = 0.045 \sqrt{S}$$

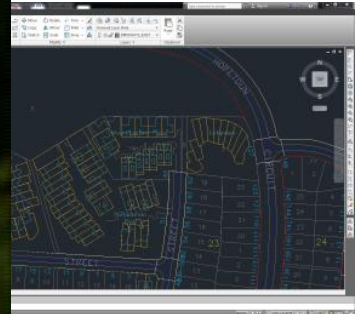
where

- S = wetted perimeter
- W = base width (ft)
- d = depth of draw (ft)
- l = side slope (1:1)

$$P = 0 + 2(0.765 / 2 + 1)$$

Hydraulic Radius = A/P

Slope = 0.0001





Effects of Design 'Gaps'

Facility design disconnected from site planning/design

- Designed facilities 'Don't Fit' proposed site
- Setting vertical elevations – tedious/changes
- Who created/understands spreadsheet/tools?
- Design 'Reactively'
- Constructability jeopardized
- Leads to unnecessary design iterations

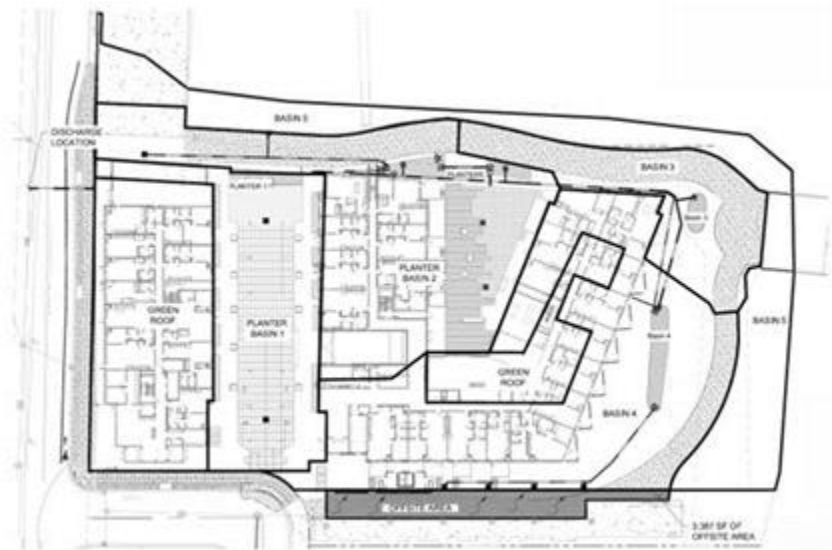


Clear Visualization Solutions

Facility design is disconnected from site planning/design

- Load background data – in order to visualize SWC on plan
- Drawn to scale, on site/plan, SWC facilities
- Automatically sampled elevations, length
- Profile treatment trains
- Inter-watershed impacts between different SWCs
- More confidence that the system will 'work'
- Reduce design iterations + save site area = save \$\$

2. Design procedures dependent on simplified catchment delineation



Design procedures dependent on simplified catchment delineation

- Typically poor understanding of true overland flow paths
- What if more than one catchment?

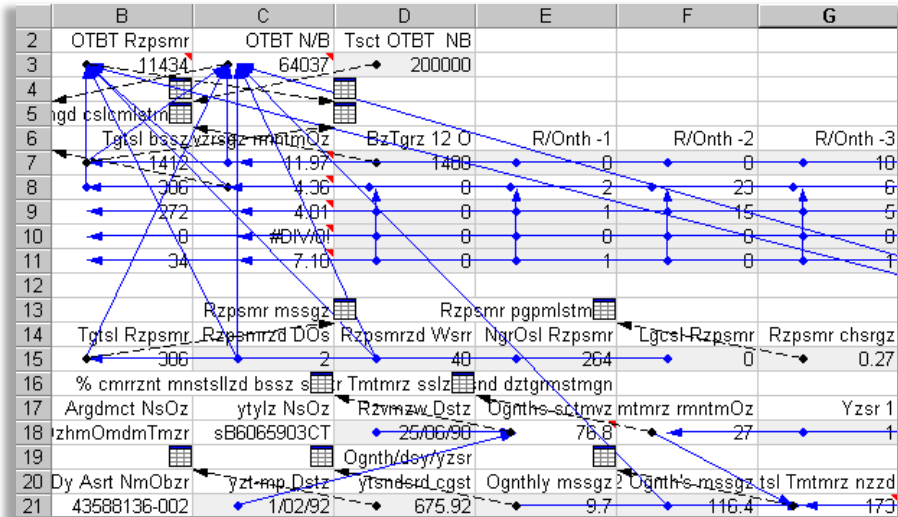
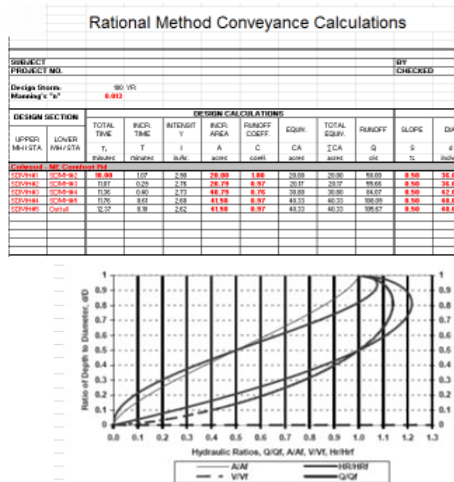


Design procedures dependent on simplified catchment delineation

- Fast/Easy 2D 'Deluge'
- Treatment train approach



3. SWCs designed independently, even if part of a complex treatment train plan



Water Quality Swale

Subject: []
 Project No.: []
 Checked: []
 Date: []

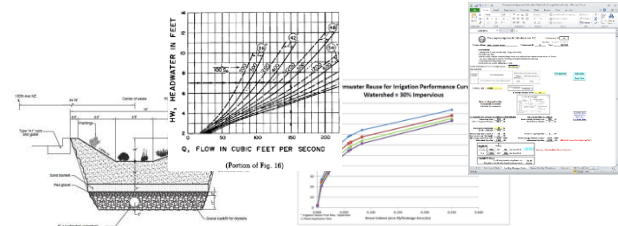
Input	Description	Value
V	Max Velocity	7 ft/s
A	Impervious area	17,000 sq ft
S	Slope of channel (0.005 ft/ft minimum)	0.005 ft/ft
V	Assumed water depth to begin analysis (0.5 ft max)	0.50 ft
n	Roughness factor	0.24
B	Swale width at base	2 ft
Z	Side Slopes	4 H 1 V
t	Minimum treatment time (min)	9.6 min

Output	Description	Value
vol	Water quality volume	510 ft ³
Q	Flow	0.04 cfs
Y	Depth of water	0.06 ft
W	Width of water surface in swale	2.49 ft
V	Velocity	0.26 ft/s
L	Length of swale	137.7 ft

Effects of Design 'Gaps'

SWCs designed independently, even if part of a complex treatment train plan

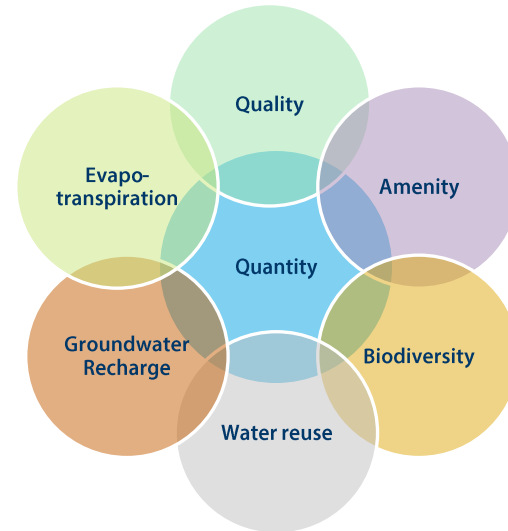
- Designing SWC for WQv, bypass rest of flow
- How is 'bypass' conveyance calculated (i.e. pipe sizing)
- If 'multiple use' facility???
- Inefficient on multiple tools



Clear Visualization Solutions

SWCs designed independently, even if part of a complex treatment train plan

- Using a single fully encompassing tool





Clear Visualization - Design Tenets

Drainage dictates or influences all other project aspects

- Always work 'live' on project data (CAD, GIS, Surface..)
- Communicate drainage plan to greater team - instantly
- Sell yourself – Sell your solution
- Never ignore complexity!
- Seriously – always assess what is being proposed!



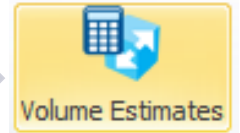
Calculate pre-development

- Runoff and WQv
- Pollutant washoff



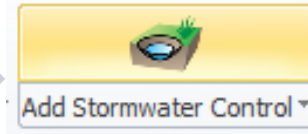
Estimate volumes

- Flow control
- Pollution control



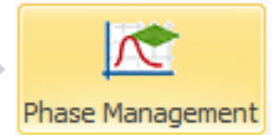
Connect

- Stormwater controls
- Treatment train



Compare

- Pre/post development flows and pollution removal



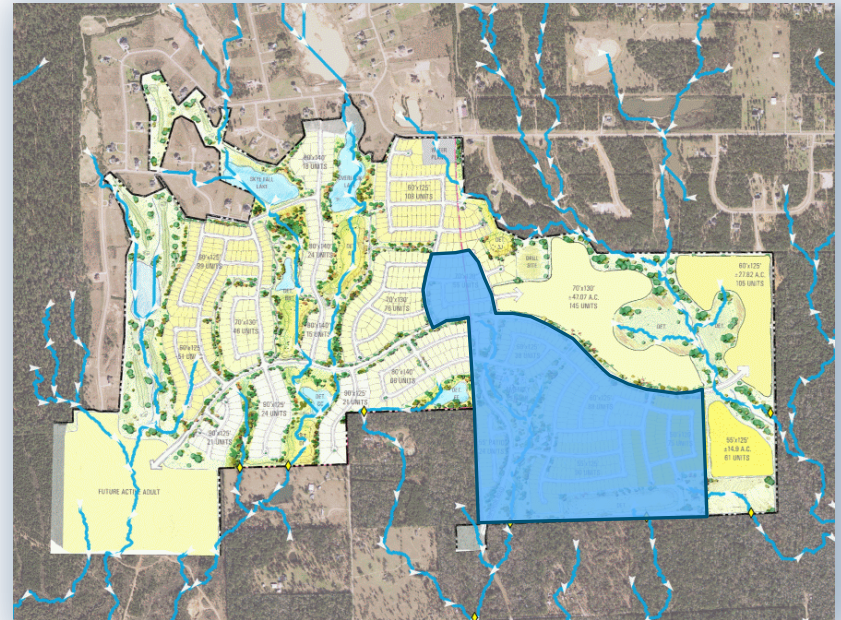
Modify



Mater Planned Community - LJA Engineering

West Central Montgomery, TX

- Total Project: (967 acres)
- Case study portion of Phase 1: (157 Acres-**BLUE**)
- Masterplan developed alongside existing golf courses



Purpose: Develop and improve a residential site with no adverse hydrological impact

- Develop and improve a residential site with no adverse hydrological impact
- Mitigate developed condition runoff rates to pre-developed levels for 25 and 100 year ARI events
- Reduce pollutant runoff through distributed Green Infrastructure
- Reduce size of detention facility
- Assess viability of Green Infrastructure compared to traditional



Methodology

- Preliminary flow assessment
 - Rational Method
 - Pipe Sizing estimate
- Existing Runoff Plan
- Typical drainage plan
- LID based plan





Visualized Design Case Study

Rational Assessment and Pipe Sizing

- Runoff Coefficient (C) and Tc
 - Developed and 'effective Green' scenarios assessed
 - C values decreased and Tc values increased between scenarios
- Pipe Sizing
 - Based on Rational flows and Mannings Eq.
 - Reduction in required pipe sizes shown for the 'effective Green' scenario



Pipe sizing

Pipe Sizing Criteria

Method	Rational Method	Design Level	Level Inverts
IDF	IDF - 5 year MontCo	<input type="checkbox"/> Min. Cover Depth (ft)	4.0
Pipe Size Library	US Default	<input type="checkbox"/> Min. Slope (ft/ft)	0.002
Min. Time of Concentration (mins)	5	<input type="checkbox"/> Min. Velocity (ft/s)	3.0
Max. Travel Time (mins)	30	<input type="button" value="OK"/> <input type="button" value="Cancel"/> <input type="button" value="Apply"/>	

Method Help

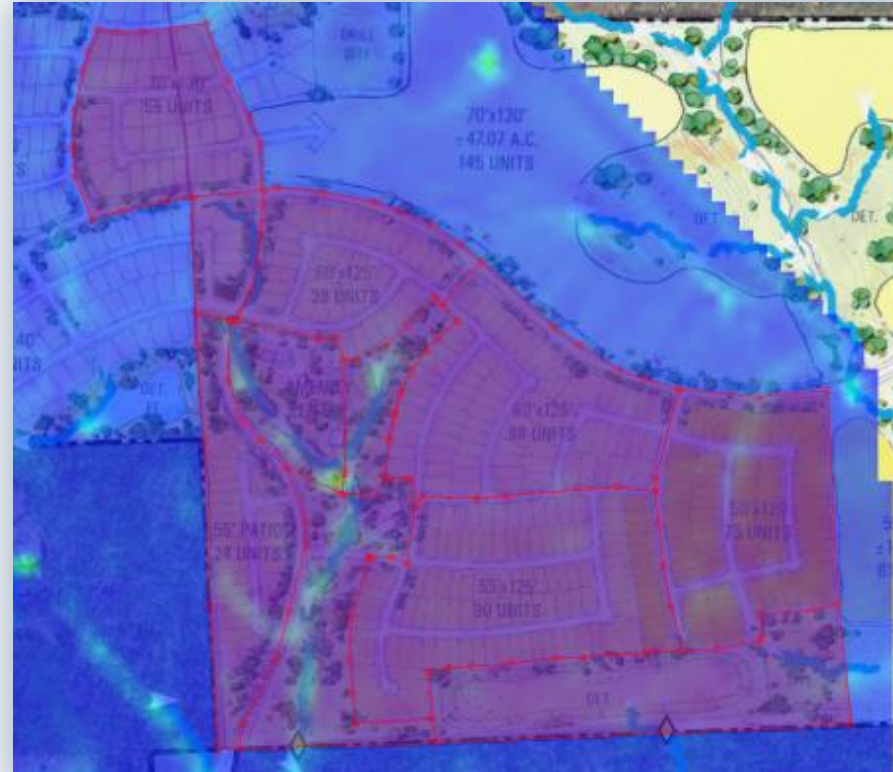
Pipe Full Velocity (ft/s)	Capacity (ft ³ /s)	Flow (ft ³ /s)
8.02	56.702	48.645
8.39	80.737	59.764
10.27	98.822	58.869
6.57	471.893	49.175



Existing Runoff Plan

- Based on 'park' landuses
- 'Deluge' based catchments

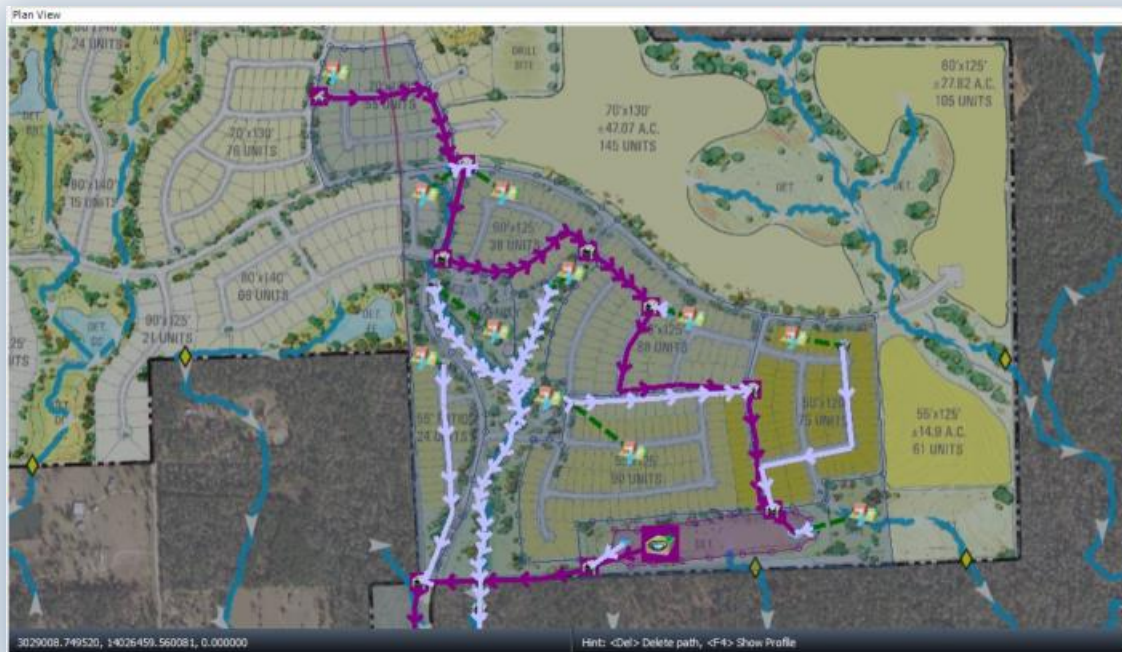
Results	
SCS: ARI: WQe: Type III: 3.8 in : Increase Rainfall (%): +0	
Phase Name	Max Outflow (ft ³ /s)
Existing	48.70005
SCS: ARI: 20 years: Type III: 9.43 in : Increase Rainfall (%): +0	
Phase Name	Max Outflow (ft ³ /s)
Existing	120.85302
SCS: ARI: 100 years: Type III: 12.17 in : Increase Rainfall (%): +0	
Phase Name	Max Outflow (ft ³ /s)
Existing	155.96832



Visualized Design Case Study

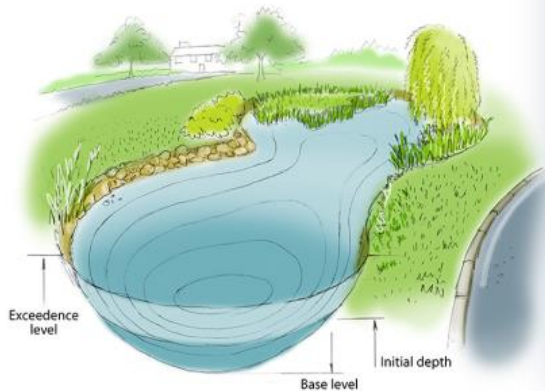
Typical Drainage Plan

- Rational Sized pipe network
- Eastern 'Trunk' system to be attenuated by basin
- Western 'valley' to leave site untreated



Typical Drainage Plan

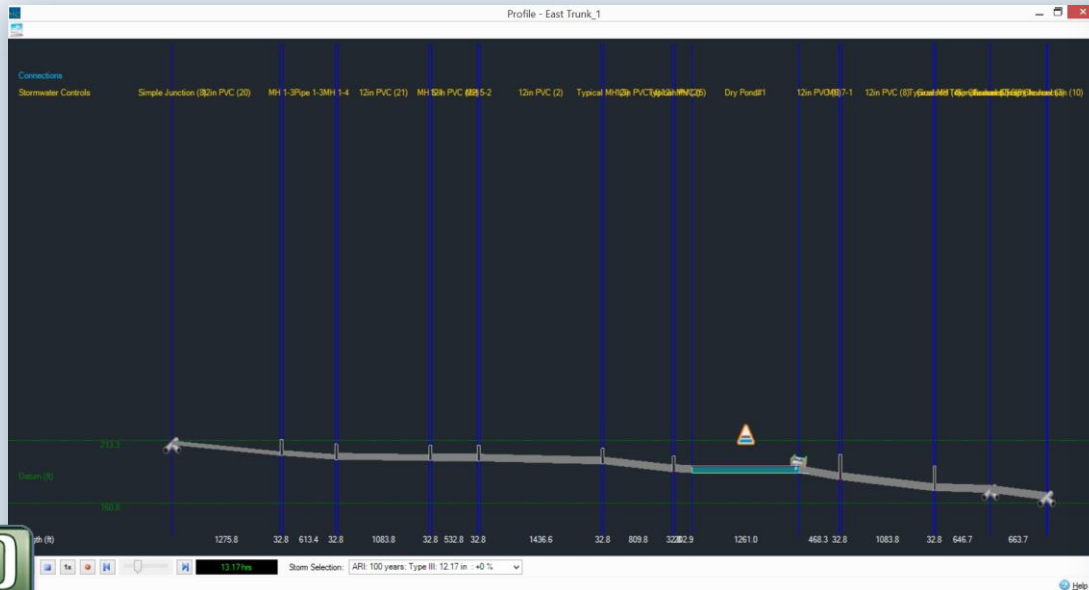
- Pond: 6.7 acres
- Two outfall pipes
- High flow weir





Visualized Design Case Study

Typical Drainage Plan



Results

SCS: ARI: WQe: Type III: 3.8 in : Increase Rainfall (%): +0

Phase Name	Max Outflow (ft ³ /s)
Existing	48.70005
Developed	35.05776

SCS: ARI: 20 years: Type III: 9.43 in : Increase Rainfall (%): +0

Phase Name	Max Outflow (ft ³ /s)
Existing	120.85302
Developed	89.24629

SCS: ARI: 100 years: Type III: 12.17 in : Increase Rainfall (%): +0

Phase Name	Max Outflow (ft ³ /s)
Existing	155.96832
Developed	136.91512



Distributed Green Infrastructure Plan

- 'lumped' Raingarden for each neighborhood catchment

Typical Bioretention

Name: Typical Bioretention

Dimensions	Filtration Layers	Inlets	Outlets	Advanced	Pollution
------------	-------------------	--------	---------	----------	-----------

Ponding Area

<input type="radio"/> Exceedence Level (ft)	218.0	Freeboard (in)	6.0
<input type="radio"/> Depth (ft)	2.0	Length (ft)	353.6
<input checked="" type="radio"/> Base Level (ft)	216.0	Slope (ft/ft)	0.00
<input type="radio"/> Top Area (ft ²)	13525.6		
<input type="radio"/> Side Slope (ft/ft)	0.50		
<input checked="" type="radio"/> Base Area (ft ²)	10697.1		

Filter Area

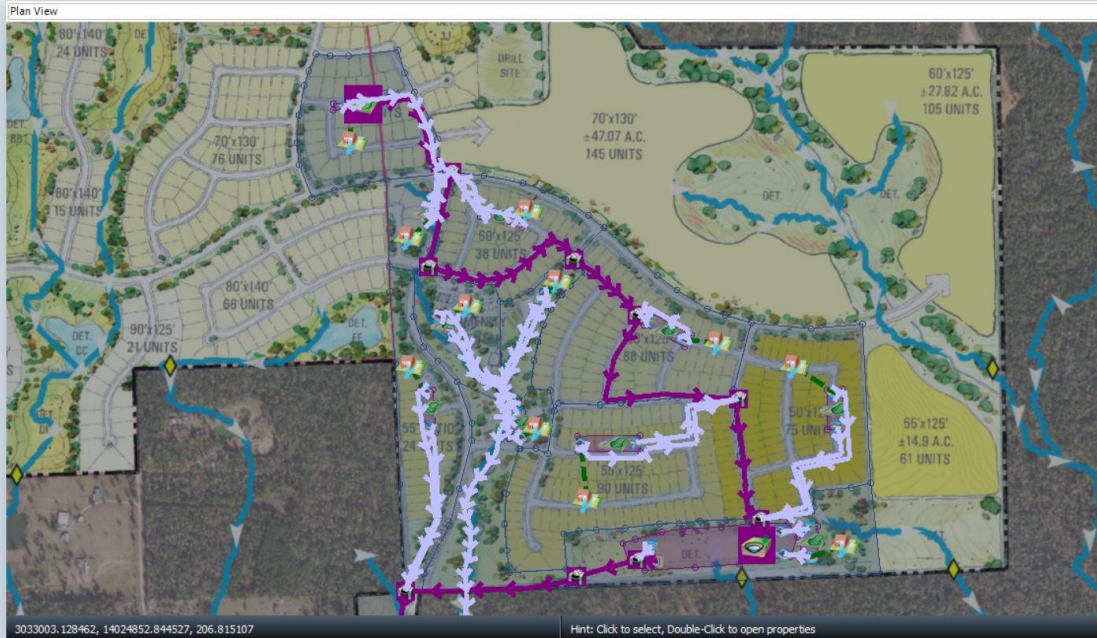
Base Level (ft)	213.0
<input type="checkbox"/> Under Drain	
Height Above Base (ft)	0.0
Diameter (in)	0.0
No. of Barrels	0
Manning's n	0.000
Release Height (ft)	0.0





Visualized Design Case Study

Distributed Green Infrastructure Plan





Visualized Design Case Study

Distributed Green Infrastructure Plan

The screenshot displays the XP drainage software interface. On the left, the 'Plan View' window shows a top-down map of a drainage system with blue lines representing flow paths and a purple rectangular area highlighting a specific bioretention cell. On the right, the 'Typical Bioretention (11)' properties dialog is open, showing the 'Inlets' tab. The dialog includes a table for inlets and a section for capacity and bypass settings.

Name	Inlet Type
Inlet	Point Inflow

Incoming Item(s):
 Urb-Res-Runoff (13)

Capacity Type: **Low/High Flow**

Low/High Flow

High Bypass Rate (ft/s)	13.000
Low Bypass Rate (ft/s)	0.000

Bypass Destination:
Grassed Trap Channel (19)

Buttons: OK, Cancel, Apply

Total Volume (acre-ft): 1.26849

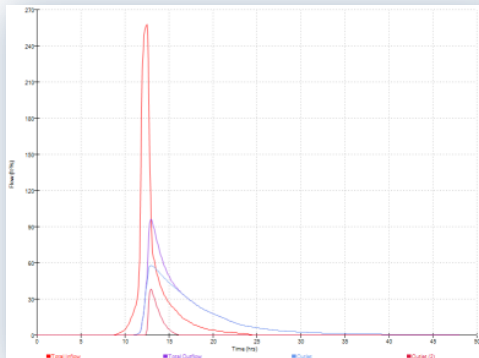
XP drainage logo in bottom left corner.

30318 13.022849, 14025607.834561, 213.997174

Hint: Click to select, Double-Click to open properties

Distributed Green Infrastructure Plan

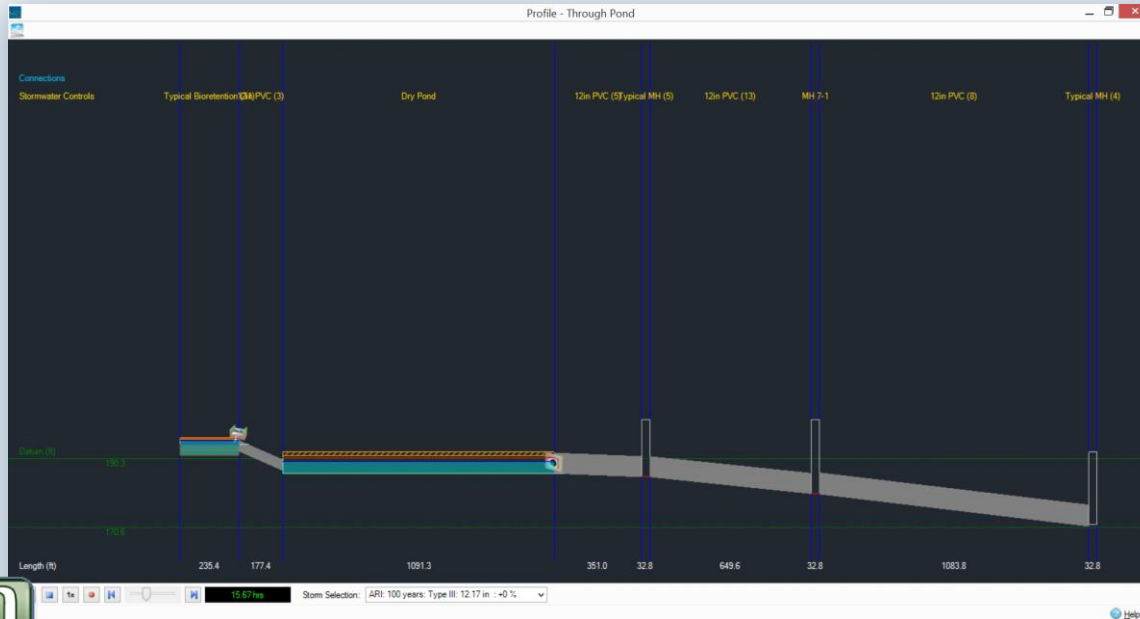
- *1.2 acres smaller!*
- *Single outfall pipe*
- *No Freeboard issues*





Visualized Design Case Study

Distributed Green Infrastructure Plan



Results

SCS: ARI: WQe: Type III: 3.8 in : Increase Rainfall (%): +0

Phase Name	Max Outflow (ft ³ /s)
Existing	48.70005
Developed	35.05776
LID	5.66699

SCS: ARI: 20 years: Type III: 9.43 in : Increase Rainfall (%): +0

Phase Name	Max Outflow (ft ³ /s)
Existing	120.85302
Developed	89.24629
LID	71.23745

SCS: ARI: 100 years: Type III: 12.17 in : Increase Rainfall (%): +0

Phase Name	Max Outflow (ft ³ /s)
Existing	155.96832
Developed	136.91512
LID	113.77116



Visualized Design Case Study

What was learned, next steps..

- Case study - 'detailed' schematic design process
- Refinement of Green scenario
- Alternative LID systems possible
- Drag/drop drainage and LID elements (**time saver**)
- Automated elevation data (**time saver**)
- One approachable, quick tool replaced workflow using *SIX* other programs to juggle same work





Questions? Comments?



Thank you for joining this presentation,
**Overcoming Design Waste with Clear Visualization of
Green Infrastructure Design**

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