# Overcoming Design Waste with Clear Visualization of Green Infrastructure Design

# Presenter

Zach Sample, PE

*Green Infrastructure*

*Design Products Manager*

XP Solutions

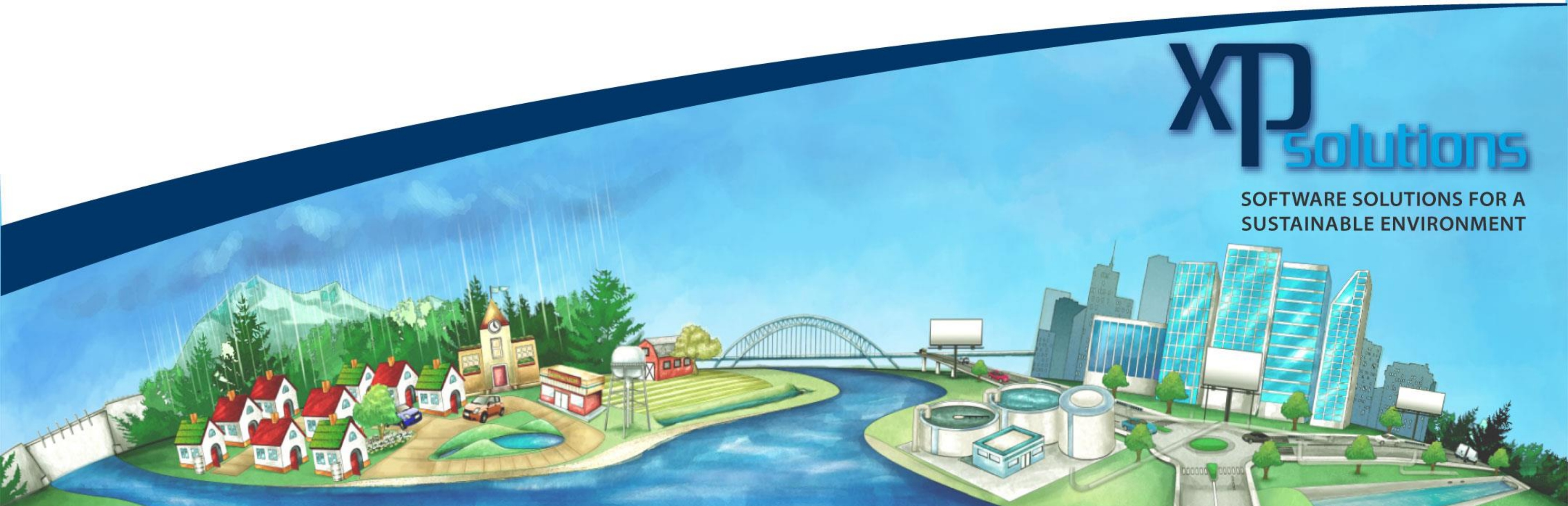
Ashley Francis, PE, CFM

*Project Manager*

LJA Engineering, Inc.

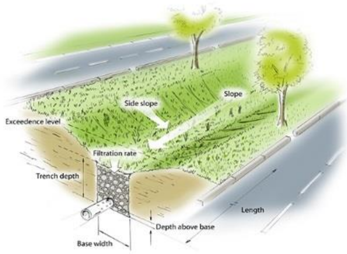
# XP Solutions has a long history of …

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

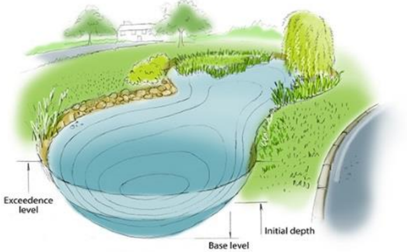


# Agenda

- 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)*

# Conventional GI design

## 'Water Quality'… only Volume focused!

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

# Design ‘Gaps’

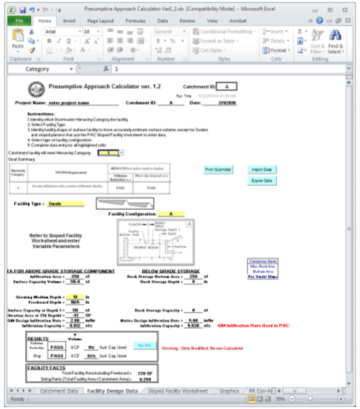
1. Facility design disconnected from site planning/design

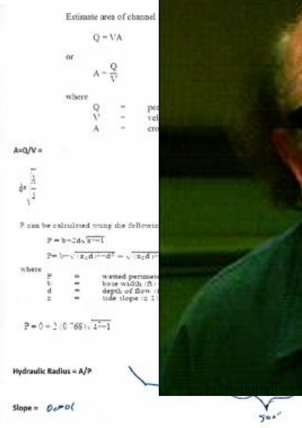
2. Design procedures dependent on simplified catchment delineation

3. SWCs designed independently

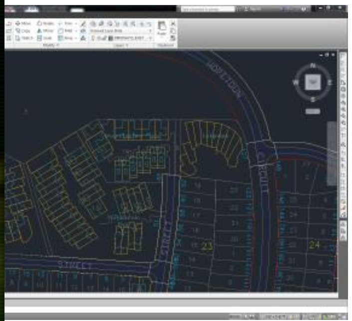
# Design 'Gaps'

1. Facility design is disconnected from site planning/design









juzzodiac.tumblr.co

# 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

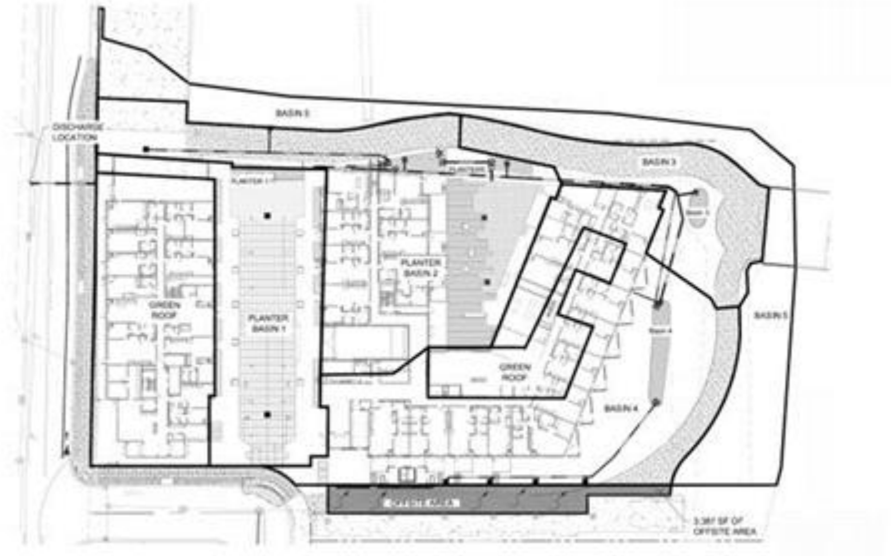
# Clear Visualization Solutions

## 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 $$

# Design ‘Gaps’

2. Design procedures dependent on simplified catchment delineation



# Effects of Design 'Gaps'

Design procedures dependent on simplified catchment delineation

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

pathwriter.wordpress.com

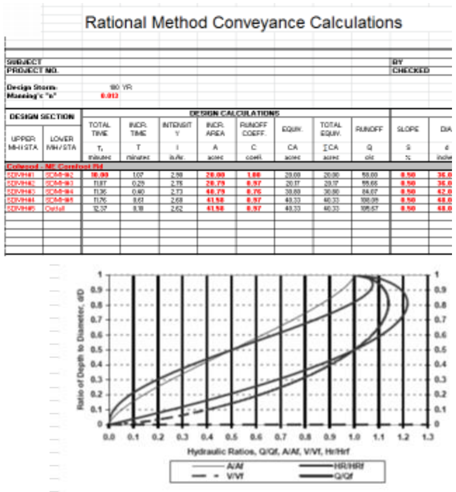
# Clear Visualization Solutions

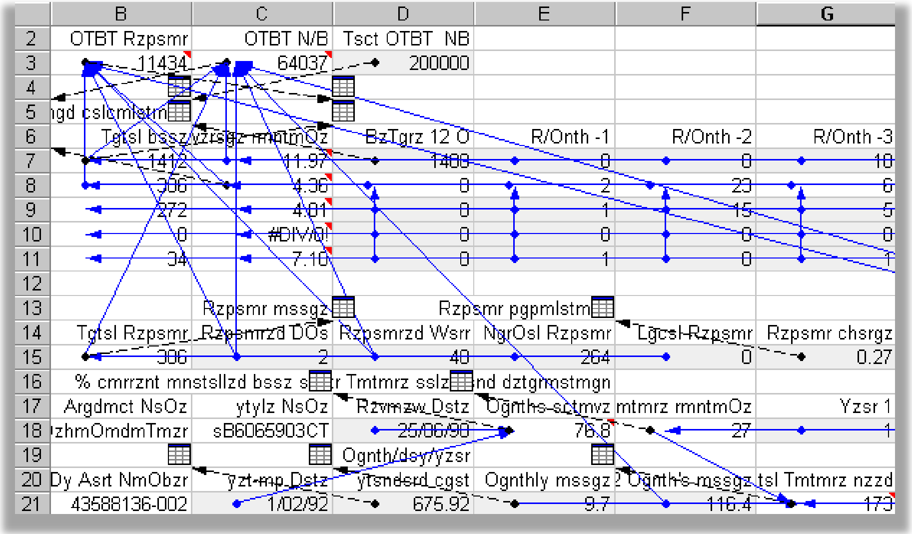
Design procedures dependent on simplified catchment delineation

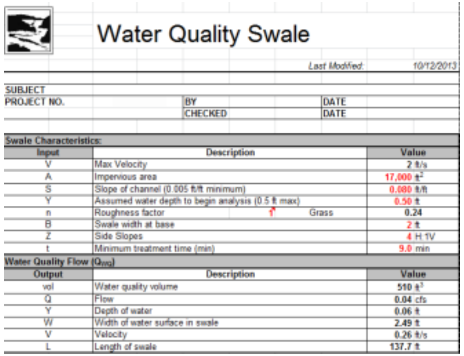
- Fast/Easy 2D 'Deluge'
- Treatment train approach

# Design 'Gaps'

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



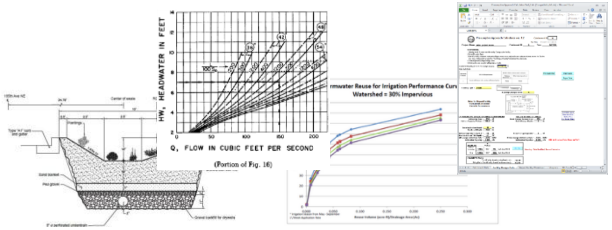



# Effects of Design 'Gaps'

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

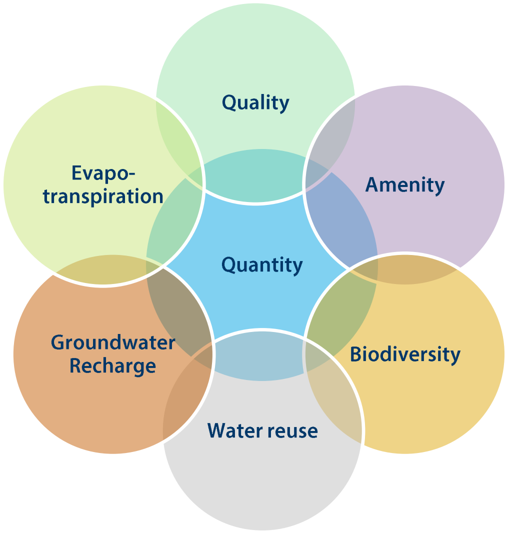
- Designing SWC for WQv, bypass rest of flow
- How is 'bypass' conveyance calculated (i.e. pipe sizing)
- If 'multiple use' facility???
- Inefficient on multiple tools



# Clear Visualization Solutions

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

- Using a single fully encompassing tool



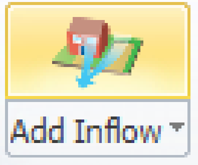
# Clear Visualization - Design Tenets

Drainage dictates or influences all other project aspects

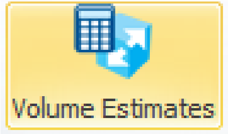
- Always work 'live' on project data (CAD, GIS, Surface..)
- Communicate drainage plan to greater team - instantly
- Sell yourself – Sell your solution
- Never ignore complexity!
- Seriously – always assess what is being proposed!

# xpdrainage Workflow

**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

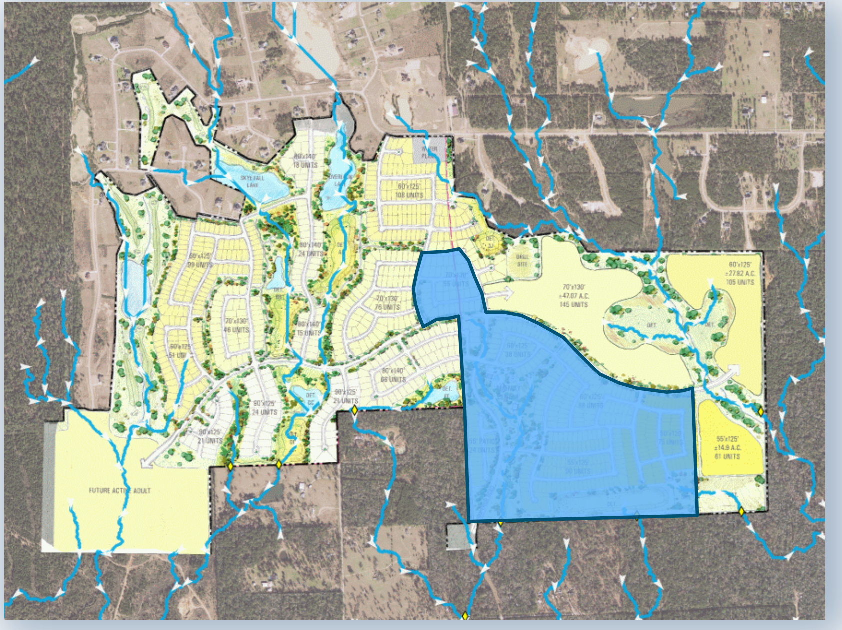

**Modify**

# Case Study

## Mater Planned Community - LJA Engineering

West Central Montgomery, TX

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



# Visualized Design Case Study

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

# Visualized Design Case Study

## Methodology

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

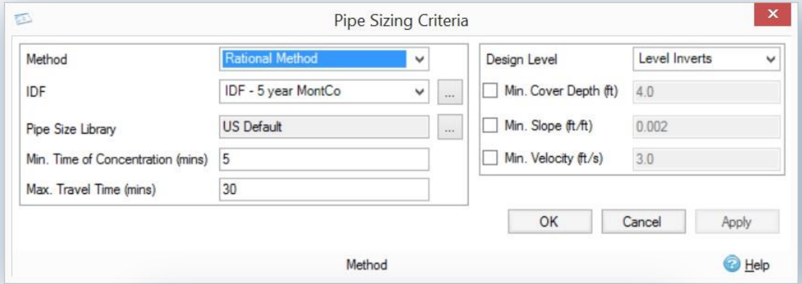
# Visualized Design Case Study

## 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

# Visualized Design Case Study

## Pipe sizing




| Pipe Full Velocity (ft/s) | Capacity (ft³/s) | Flow (ft³/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 |

# Visualized Design Case Study

## Existing Runoff Plan

- Based on ‘park’ landuses
- ‘Deluge’ based catchments

**Results**

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

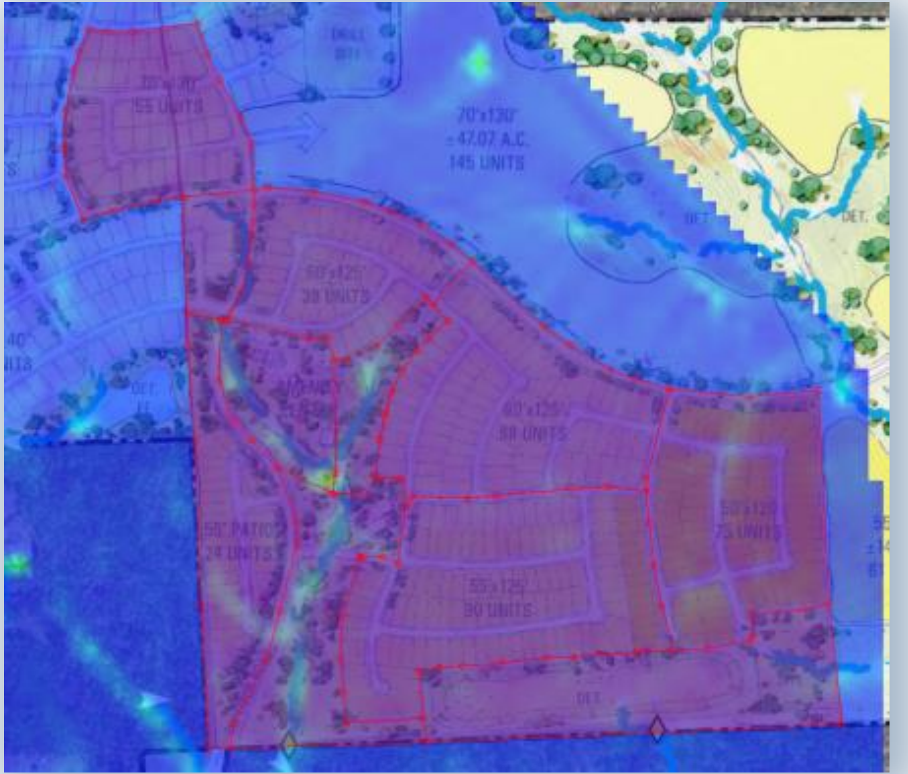
| Phase Name | Max Outflow (ft³/s) |
|---|---|
| Existing | 48.70005 |

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

| Phase Name | Max Outflow (ft³/s) |
|---|---|
| Existing | 120.85302 |

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

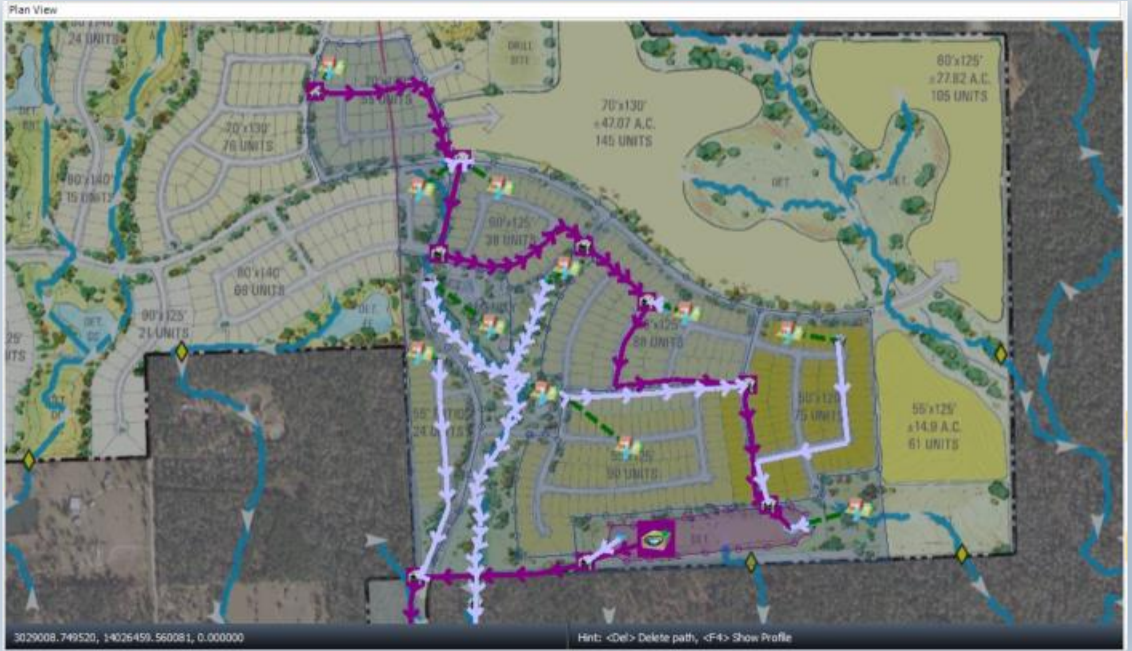
| Phase Name | Max Outflow (ft³/s) |
|---|---|
| Existing | 155.96832 |



# Visualized Design Case Study

Typical Drainage Plan

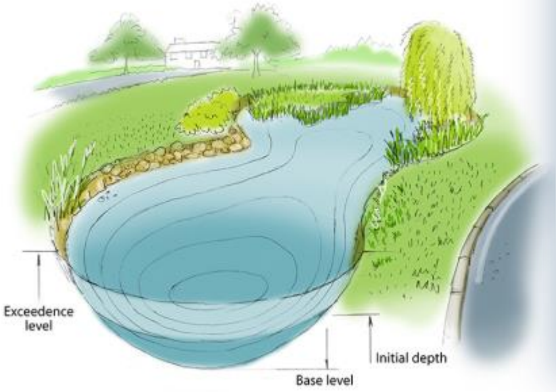
- Rational Sized pipe network
- Eastern ‘Trunk’ system to be attenuated by basin
- Western ‘valley’ to leave site untreated



# Visualized Design Case Study

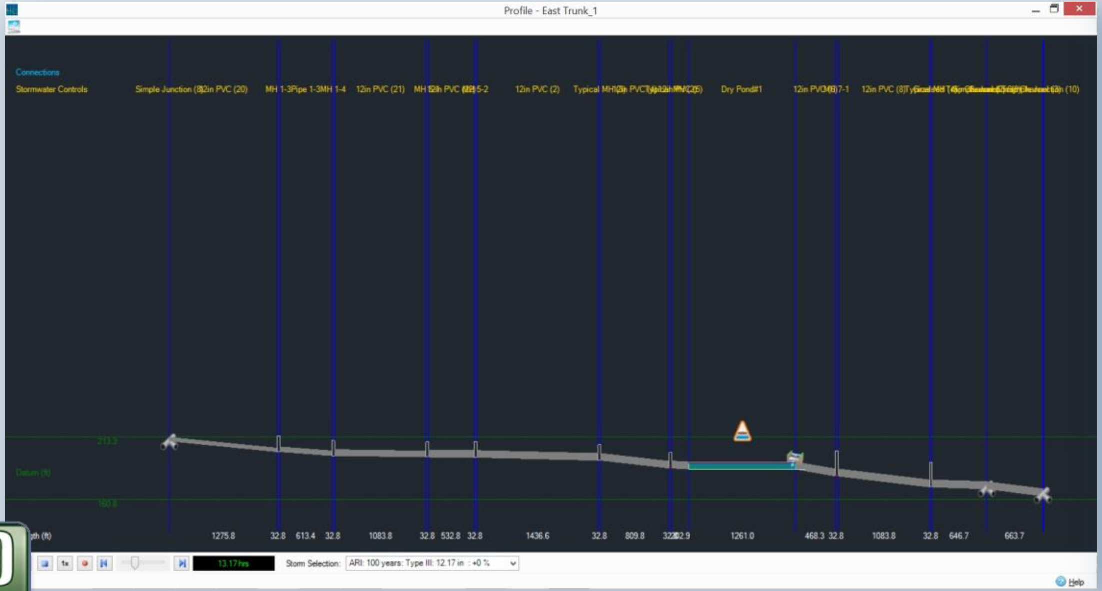
## Typical Drainage Plan

- 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 (ft³/s) |
|---|---|
| Existing | 48.70005 |
| Developed | 35.05776 |

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

| Phase Name | Max Outflow (ft³/s) |
|---|---|
| Existing | 120.85302 |
| Developed | 89.24629 |

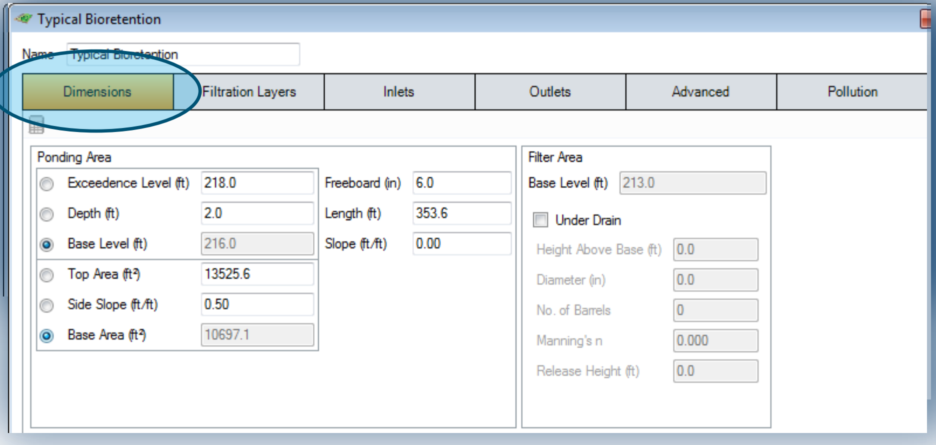
SCS: ARI: 100 years: Type III: 12.17 in : Increase Rainfall (%): +0

| Phase Name | Max Outflow (ft³/s) |
|---|---|
| Existing | 155.96832 |
| Developed | 136.91512 |

# Visualized Design Case Study

## Distributed Green Infrastructure Plan

- ‘lumped’ Raingarden for each neighborhood catchment

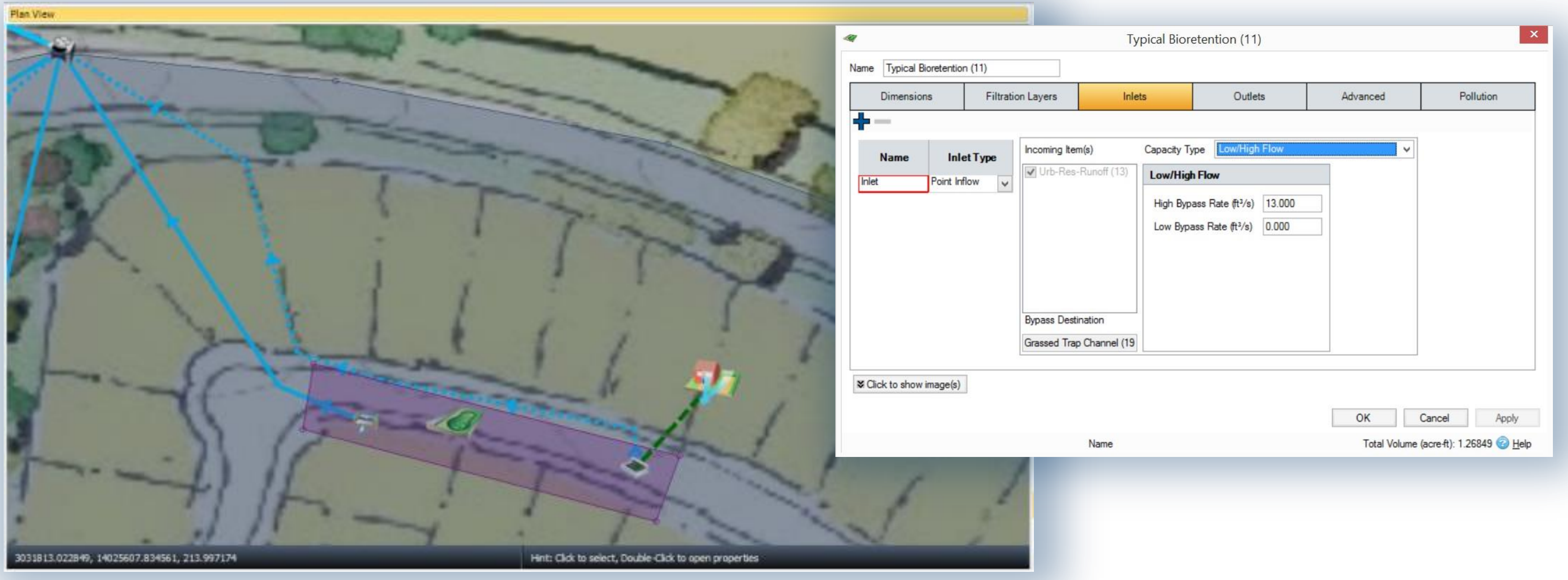



# Visualized Design Case Study

## Distributed Green Infrastructure Plan

# Visualized Design Case Study

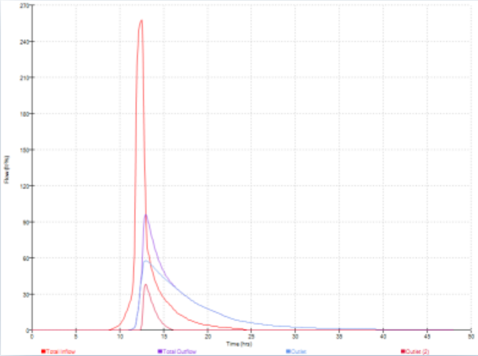
## Distributed Green Infrastructure Plan



# Visualized Design Case Study

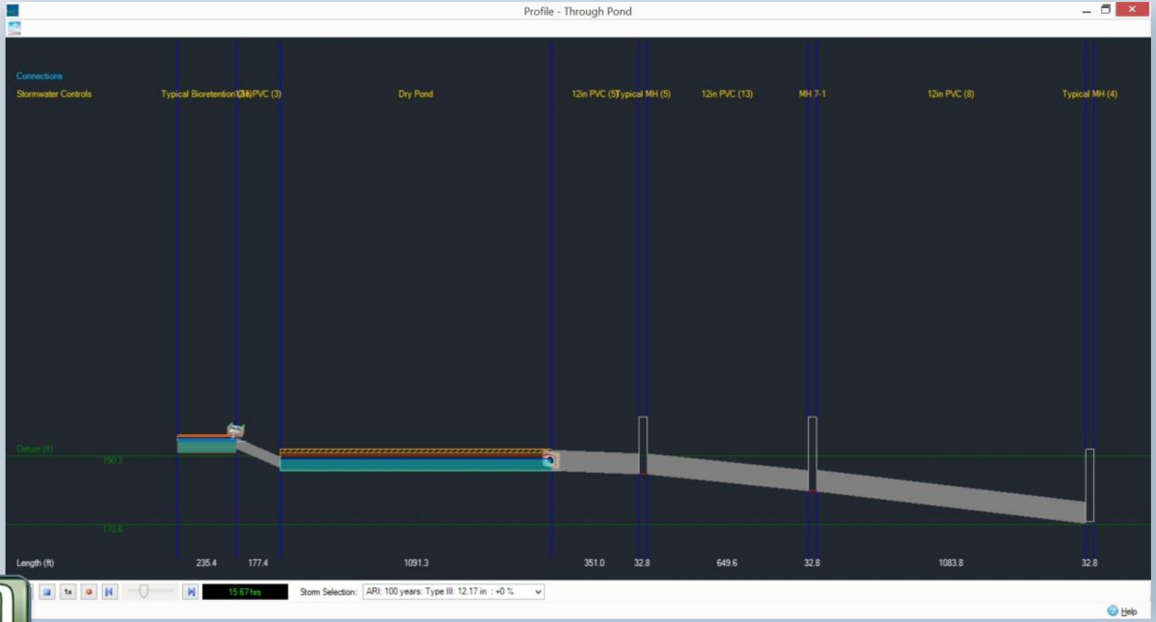
## Distributed Green Infrastructure Plan

- *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 (ft³/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 (ft³/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 (ft³/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

Zach Sample
Zach.Sample@xpsolutions.com

## Contact XP Solutions

| | | |
|---|---|---|
| Americas: | +1 888 554 5022 | amsales@xpsolutions.com |
| Asia Pacific: | +61 7 3310 2302 | ausales@xpsolutions.com |
| EMEA: | +44 0 1635 582555 | uksales@xpsolutions.com |

www.xpsolutions.com