



## City of Wichita Preferred Site Design Strategies

December 7<sup>th</sup>, 2010

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## Water Quality Volume



1. Standard site design produces a big WQv
2. I reduce the WQv with Preferred Site Design strategies
3. I obtain WQv Reductions through specific qualifying designs
4. I treat the remaining WQv volume with structural controls to a set standard





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### A Comparison of Two Different Land Plans

PROJECTED RESULTS FROM TOTAL DEVELOPMENT			
Total Site	Conventional Plan	Revised Green Plan	
Lot Yield	360	375	
Linear Feet - Street	21,770	21,125	
Linear Feet - Collector Street	7,360	0	
Linear Feet - Drainage Pipe	10,098	6,733	
Drainage Sections (Inlets, Boxes, Headwalls)	103	79	
Estimated Total Cost	\$4.6 million	\$3.9 million	

ACTUAL RESULTS FROM PHASE ONE			
Total Site (engineer's estimate)	Conventional Plan	Green Plan	
Lot Yield	63	72	
Total Cost	\$1,028,544	\$28,523	
Cost Per Lot	\$16,326	\$11,507	



ECONOMIC AND OTHER BENEFITS FROM LOW-IMPACT DEVELOPMENT			
Higher Lot Yield	17 additional lots		
Higher Lot Value	\$3,000 more per lot than competition		
Lower Cost per Lot	\$4,800 less per lot		
Enhanced Marketability	80 percent of lots sold in the first year		
Added Amenities	23.5 acres of green space/parks		
Recognition	National, state, and professional groups		

**TOTAL ECONOMIC BENEFIT** More than \$2.2 million in savings.

Source: National Home Builders Association

No, I'm not kidding!

No guarantees, but these approaches can save money while protecting the environment.


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**“You treat this much water volume”** amec

A simple equation:

$$WQv = P * Rv * A * 12 \text{ ac-ft}$$

Where: P = 85% rainfall depth = 1.2"  
 Rv = Table 4-13  
 A = site area in acres


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**Rv** amec

Table 4-13 Volumetric Runoff Coefficients by Land Use and Hydrologic Soil Group

Land Use	Hydrologic Soil Group			
	A	B	C	D
Undisturbed Woods, Meadow or Ag. Land (R <sub>vU</sub> )	0.02	0.03	0.04	0.05
Turf or Disturbed Soils (R <sub>vD</sub> )	0.15	0.20	0.22	0.25
Impervious Cover (R <sub>vI</sub> )	0.95	0.95	0.95	0.95

Like a Rational “C” Factor but for volume


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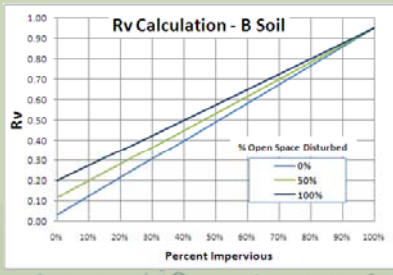
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**Rv directly related to IA** amec

Rv Calculation - B Soil



Reductions in impervious area are directly related to reducing the overall cost of development

15% IA increase = 0.1 Rv increase


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## WQv Reduction amec

**Table 2-2 Methods to Reduce the WQv**

Practice	Description
<b>Reduction 1:</b> Natural Area Conservation	Undisturbed natural areas are conserved on a site, thereby retaining their pre-development hydrologic and water quality characteristics.
<b>Reduction 2:</b> Vegetated Stream Buffers	Storm water runoff is treated by directing sheet flow runoff through a naturally vegetated or wooded buffer as overland flow.
<b>Reduction 3:</b> Specially Engineered Vegetated Channels	Engineered vegetated channels are used to provide storm water treatment.
<b>Reduction 4:</b> Overland Flow Filtration/Infiltration Zones	Overland flow filtration/infiltration zones are incorporated into the site design to receive runoff from rooftops and other small impervious areas.
<b>Reduction 5:</b> Environmentally Sensitive Large Lot Subdivisions	A group of site design techniques are applied to low density residential development.

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## Reductions work on the "A" amec

- Areas qualifying for Reduction are subtracted from the "A" in the treatment volume equation – reducing treatment cost

$WQv = P \cdot Rv \cdot A / 12 \text{ ac-ft}$

- They might also reduce Rv
- And...

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## "but wait, there's more!" amec



- Not only do you get a volume reduction but each of the reductions acts like a Structural Control in the TSS calculation




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**Practices That Provide Reductions** 

- Natural Area Conservation
- Stream Buffers
- Use of Vegetated Channels
- Overland Flow Filtration/  
Infiltration Zones
- Environmentally Sensitive  
Large Lot Subdivisions



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**Reduction #1 – Natural Area Conservation**

**Rule: Subtract conservation areas from total site area when computing water quality volume requirements.**



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Criteria: 

- Area not disturbed during project construction
- Native. Non-invasive, vegetation
- Protected by limits of disturbance on construction drawings
- Located within an acceptable reserve that ensures perpetual protection
- Boundaries marked during construction and permanently
- Contiguous area  $\geq 10,000$  sq ft
- Reduction area gets 100% TSS removal



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**Criteria:**

- Buffer width ≥ 50 ft from bank top
- Contributing length ≤150 ft pervious surfaces and ≤ 75 ft impervious
- Area slope ≤3% maximum or use flow spreader
- Runoff must be overland sheet flow.
- Buffers shall remain naturally vegetated other than routine debris removal
- Reduction area gets 80% TSS removal





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**Example Residential Subdivision**

A = Area = 40 acres  
 P = 85<sup>th</sup> percentile rainfall = 1.2 inches  
 Area draining to buffer = 4 acres  
 Buffer area meeting Reduction #1 requirements = 1 acre  
 R<sub>v</sub> = 0.38 (calculation method presented in Chapter 4)

**With Reduction:**  
 Effective drainage area = 40 - 4 - 1 = 35 acres  



$$WQ_v = \frac{P * R_v * A}{12} = \frac{1.2 * 0.38 * 35}{12} = 1.33 \text{ ac-ft}$$

**Without Reduction:**  

$$WQ_v = \frac{1.2 * 0.38 * 40}{12} = 1.52 \text{ ac-ft}$$

**Note: Double Dipping!**  
 Must include runoff area in R<sub>v</sub> calculation

1. A is reduced by the qualifying area
2. Runoff area gets 80% TSS removal in weighted TSS reduction calculation


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**Reduction #3 – Use of Vegetated Channels**

**Rule:** Subtract the areas draining to a grass channel meeting specifications from total site area when computing water quality volume requirements.


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**Criteria:**

- Residential only ≤ 3 dwelling units per acre
- Flow velocity for WQv ≤ 1.0 fps
- Residence time ≥ 5 min
- The bottom width ≤ 6 ft or use compound channel
- The side slopes ≤ 3:1 (H:V)
- The channel slope ≤ 3%
- Locate channel in a reserve
- Reduction area gets 50% TSS removal


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**Example: Residential Subdivision**

Area = 40 acres  
 P = 95<sup>th</sup> percentile rainfall = 1.2 inches  
 Area of channel and area draining to channel = 12.5 acres  
 R<sub>v</sub> = 0.38 (calculation method presented in Chapter 4)

**With Reduction:**  
 Effective drainage area = 40 - 12.5 = 27.5 acres



$$WQ_v = \frac{P \cdot R_v \cdot A}{12} = \frac{1.2 \cdot 0.38 \cdot 27.5}{12} = 1.05 \text{ ac-ft}$$

**Before Reduction:**  

$$WQ_v = \frac{1.2 \cdot 0.38 \cdot 40}{12} = 1.52 \text{ ac-ft}$$

**Note: Double Dipping!**  
 Must include runoff area in R<sub>v</sub> calculation

1. A is reduced by the qualifying area
2. Runoff area gets 50% TSS removal in weighted TSS reduction calculation


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**Reduction #4 – Overland Flow Filtration / Infiltration Zones**

**Rule:** If impervious areas are adequately disconnected, they can be deducted from total site area when computing the water quality volume requirements.


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**Criteria:** 

- A and B soils should be present & not a designated hotspot
- Must drain through a vegetated conveyance to property line or structural control
- U.S. Impervious flow path length  $\leq$  75 ft
- The surface imperviousness area per discharge location  $\leq$  5,000 sq ft
- The length of the "disconnection"  $\geq$  the contributing length
- The vegetative "disconnection" slope  $\leq$  3 %
- Located in a reserve
- Downspouts  $\geq$  10 feet away from any impervious surface
- Areas draining to such zones receive 80% TSS reduction


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**Example** 

Area = 3 acres  
 P = 85<sup>th</sup> percentile rainfall = 1.2 inches  
 Disconnected Impervious Area = 0.5 acres  
 R<sub>v</sub> = 0.4 (calculation method presented in Chapter 4)

**With Reduction:**  
 Effective drainage area = 3 - 0.5 = 2.5 acres  



$$WQ_v = \frac{P * R_v * A}{12} = \frac{1.2 * 0.4 * 2.5}{12} = 0.10 \text{ ac-ft}$$

**Without Reduction:**  

$$WQ_v = \frac{1.2 * 0.4 * 3}{12} = 0.12 \text{ ac-ft}$$

**Note: Double Dipping!**  
 Must include runoff area in R<sub>v</sub> calculation

1. A is reduced by the qualifying area
2. Runoff area gets 80% TSS removal in weighted TSS reduction calculation


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**Reduction #5 – Environmentally Sensitive Large Lot Subdivisions** 

**Rule:** Targeted towards large lot subdivisions (e.g.  $\geq$ 2 acre lots).

**Structural practices requirement waived.**





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**Criteria:** amec

For Single Lot Development:

- ≤ 12% imperviousness
- Lot size ≥ 2 acres
- Rooftop runoff is disconnected
- Grass channels

For Multiple Lots:

- ≤ 12% imperviousness
- Lot size ≥ 2 acres or  
Clustering: ≥ 25% natural conservation, ≥ ½ acre lot size
- Rooftop runoff is disconnected
- Grass channels
- Designed as Reduction Method #4



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**Franklin Strip Mall** amec

Conventional Design



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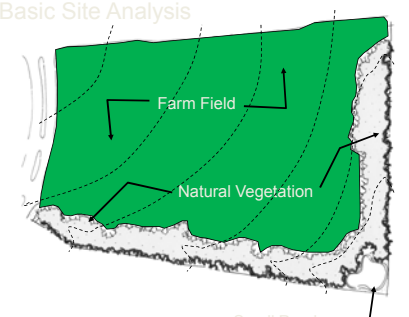
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Basic Site Analysis





Farm Field

Natural Vegetation

Small Pond

FRANKLIN STRIP MALL – CONVENTIONAL DESIGN



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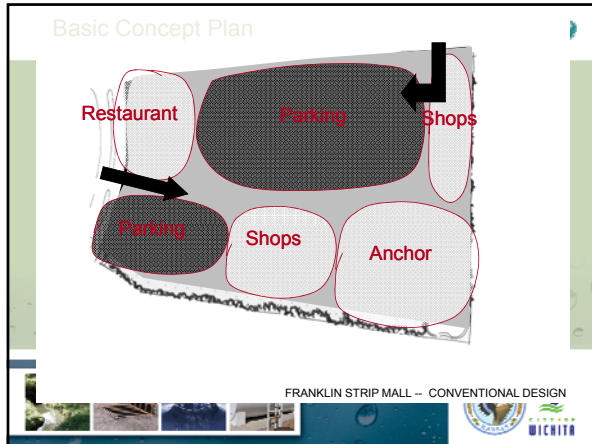
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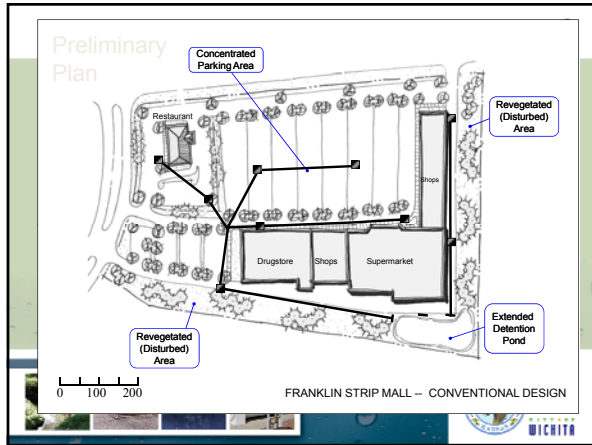
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**Franklin Strip Mall**  
Conventional Design

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- Area = 18 acres 84% impervious, B Soil
- $R_v = 0.84 \cdot 0.95 + 0.16 \cdot 0.20 = 0.83$
- $WQ_v = 0.83 \cdot 1.2 / 12 \cdot 18 = 1.494$  ac-ft
- Dry Ed Pond at 60% TSS removal hmmm?

FRANKLIN STRIP MALL -- CONVENTIONAL DESIGN

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Ok what will the method do for me?

Franklin "Glen"

Preferred Site Design



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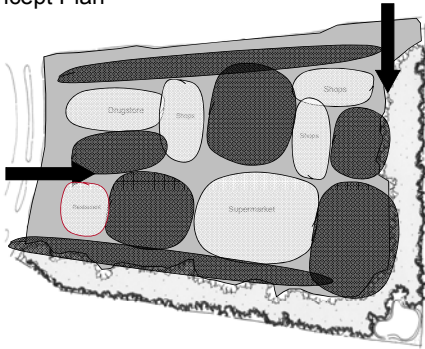
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Concept Plan



FRANKLIN GLEN -- PREFERRED SITE DESIGN

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COMMERCIAL DEVELOPMENT -- BETTER WITH DESIGN



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### Site Details amec

If site taken as one unit:

- 18 acres with 12.38 acres IA
- 1.5 acres undisturbed
- 4.12 acres disturbed
- $R_v = 12.38 \times 0.95 + 1.5 \times 0.03 + 4.12 \times 0.20 = 0.70$
- $WQ_v = 1.2 \times 0.70 \times 18 / 12 = 1.260 \text{ ac-ft}$
- Was 1.494 ac-ft
  - 15.7% reduction due to preferred site design
  - Still have not taken a WQv reduction


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### WQv reduction investigation: amec

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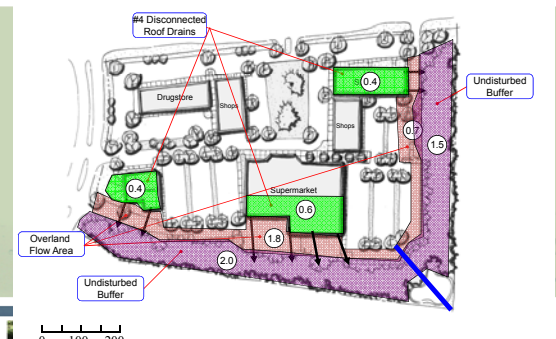
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### Same number of parking spaces but with slightly narrower widths



FRANKLIN GLEN – BETTER SITE DESIGN




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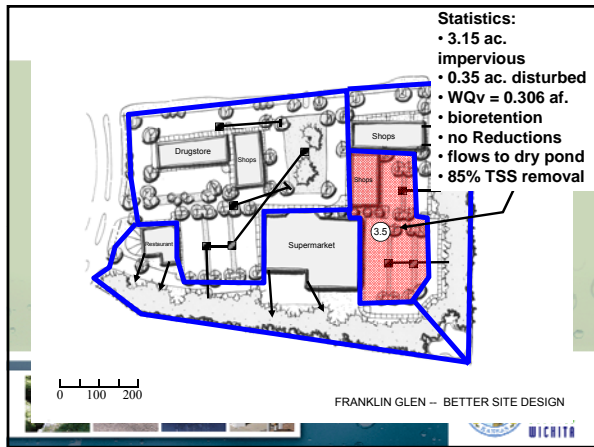
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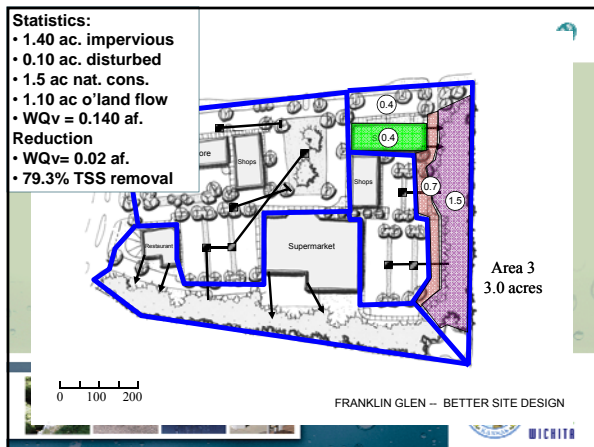
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