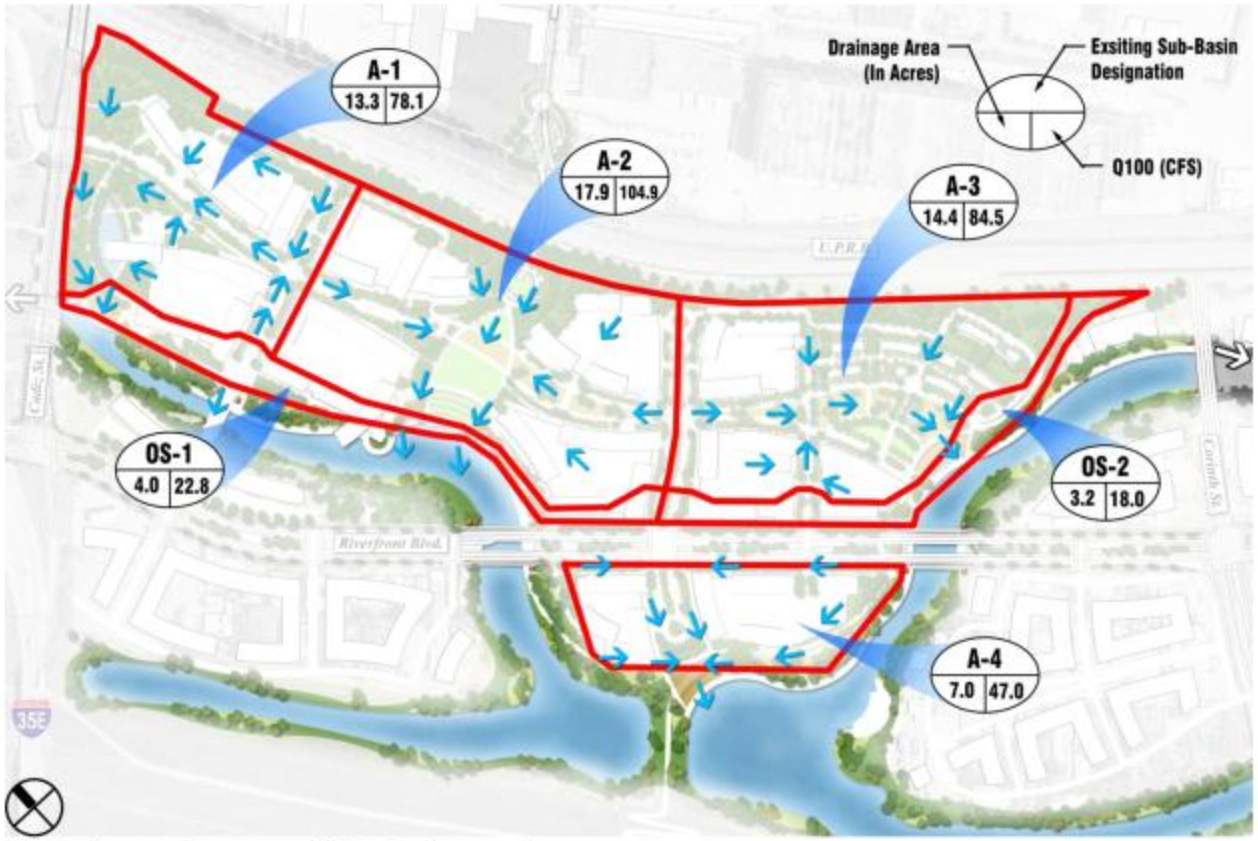
Drainage Plan and Calculations

- The drainage plan is purposefully designed to effectively implement LID features, including a **Treatment Train** process that conveys water from the site interior to key outfall locations along the sump.
- The bioretention system is adequately sized, with cross-sections, and storage capacities for 100-year runoff discharges and runoff volumes throughout each sub-basin.
- By having multiple drainage divides and outfall features, storm drain pipe size and overall quantity is reduced. This results in aesthetically pleasing amenities with economic benefits!
- For traditional drainage area calculations, the impervious percentage was approximately 85 percent and a shorter time of concentration was estimated for each basin, resulting in higher peak discharges and detention volumes required than the Cedars West LID design.

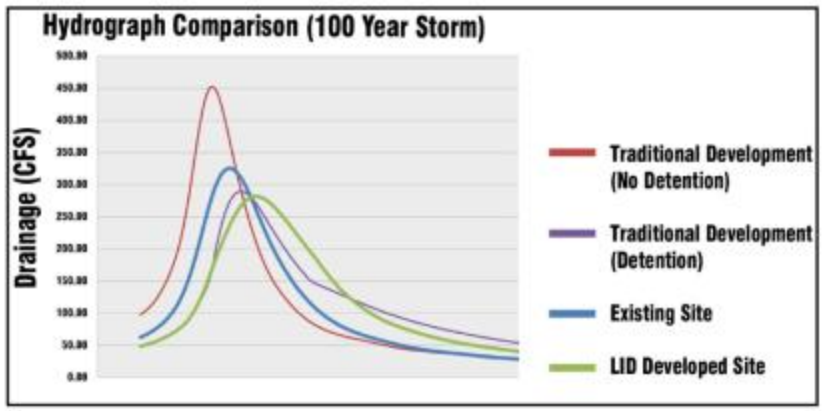
PROPOSED LID DRAINAGE AREA CALCULATIONS							
CEDARS WEST DRAINAGE AREA	AREA (ACRES)	% IMP	CN	Tc (MIN)	STORM RUNOFF		
					Q_1 (CFS)	Q_{25} (CFS)	Q_{100} (CFS)
A-1	13.3	50	80	25	20.3	52.5	78.1
A-2	17.9	50	80	25	27.2	70.4	104.9
A-3	14.4	50	80	25	21.9	56.7	84.5
A-4	7.0	50	80	18	12.6	31.7	47.0
OS-1	4.0	30	80	25	5.0	14.9	22.8
OS-2	3.2	30	80	25	3.9	11.8	18.0

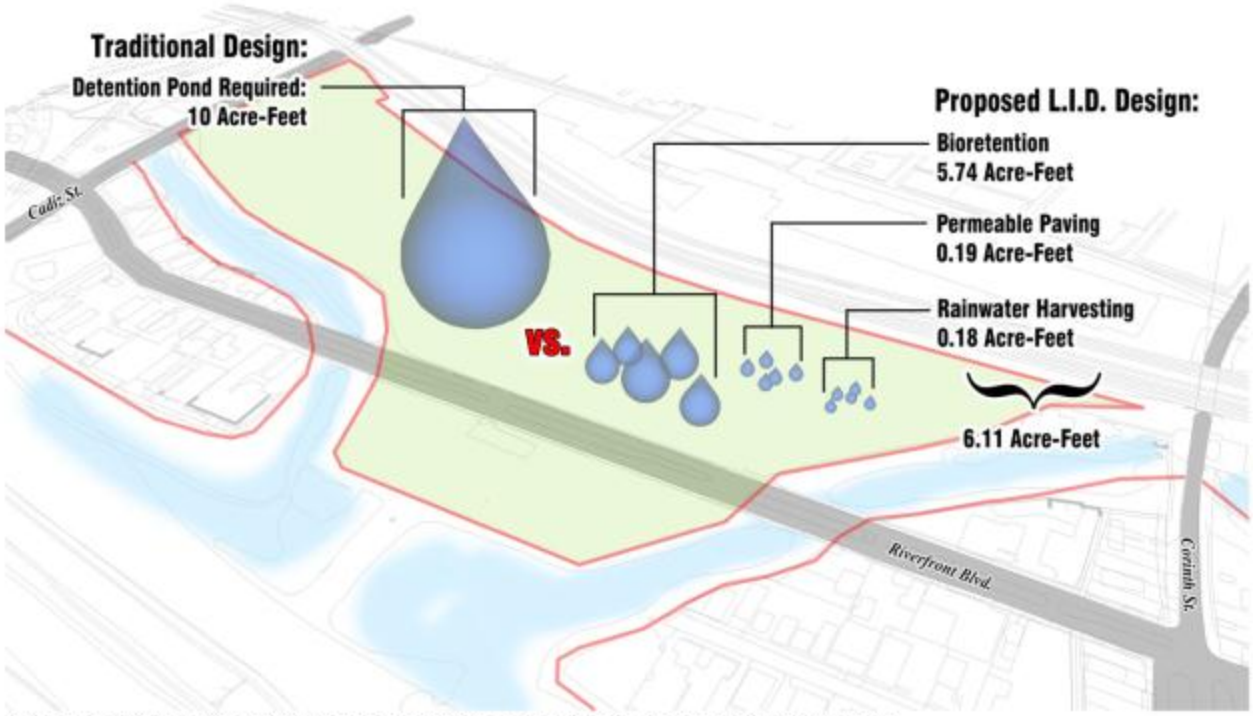


Hydrology – Proposed LID Drainage Area

Hydrology Comparison for the 100-Year Storm

- For traditional detention schemes, 2 to 3 large ponds would be located at major out fall locations
- For the LID design, detention is distributed throughout the site and reduces the runoff volume due to increased vegetated cover and longer time of concentrations resulting from the designed bioretention **Treatment Train**. This is also a benefit to stormwater quality!
- Another benefit is the reduced total annual site runoff. For example, in a normal year, between 85% and 90% of rainfall will infiltrate, evaporate, or be reused on site. Even in an extremely wet year, as much as 70% of annual rainfall will only leave the site throught evapatranspiration or deep percolation.

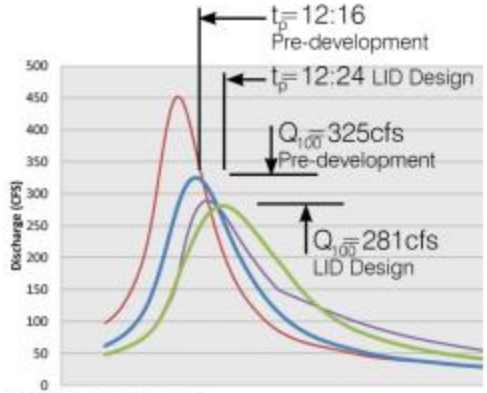




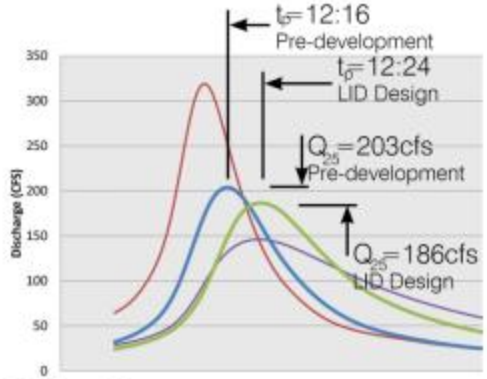
Stormwater Detention Strategy Comparison at 100 Year Storm

Hydrology

The following hydrographs illustrate the difference for 1, 25 and 100-year storm events comparing a traditional versus a LID designed site.



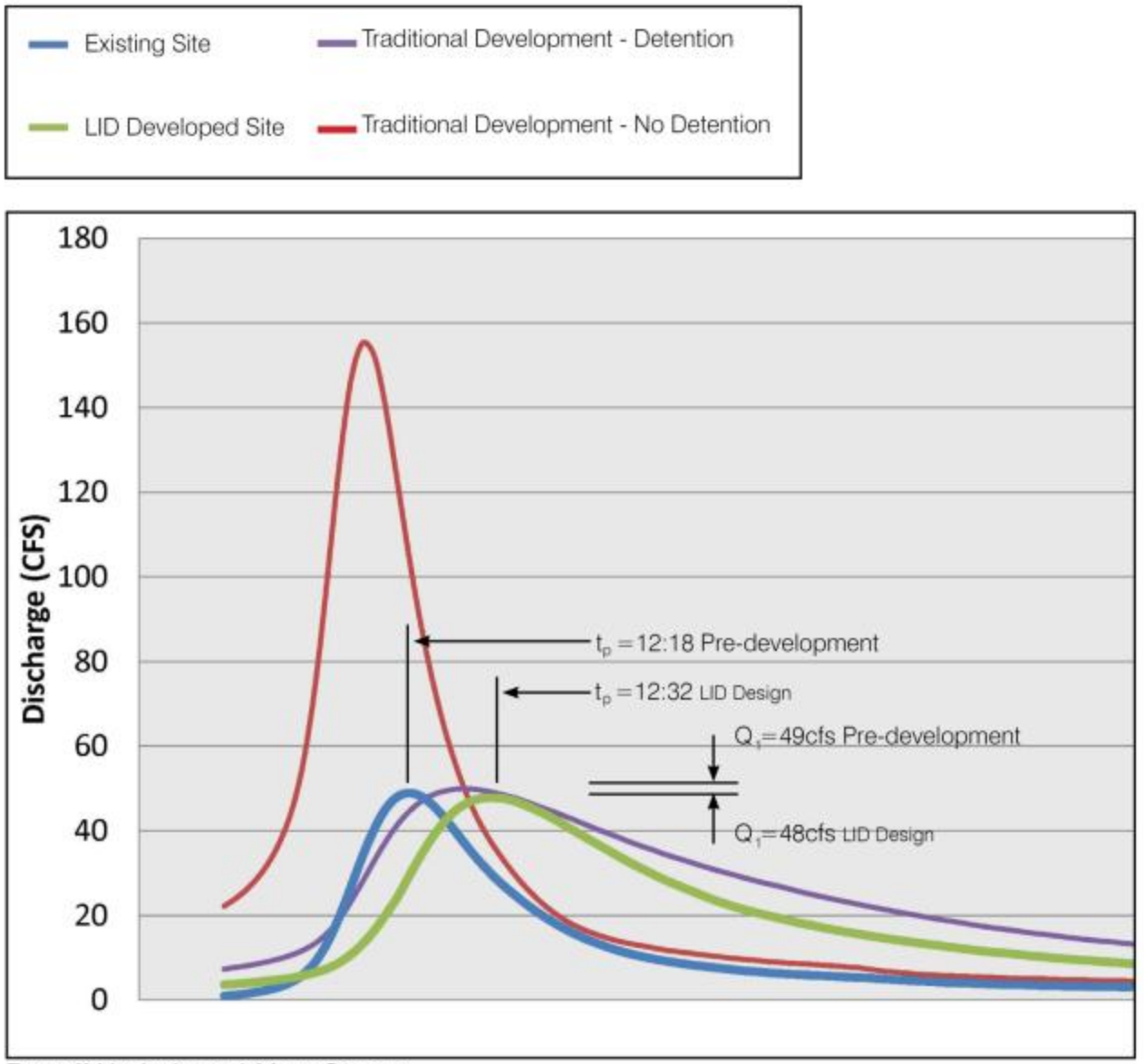
100 Year Storm



25 Year Storm

t_p =time to peak

Q_x=peak flow rate for the x-year storm



Runoff Hydrology 1 Year Storm

LID Strategy

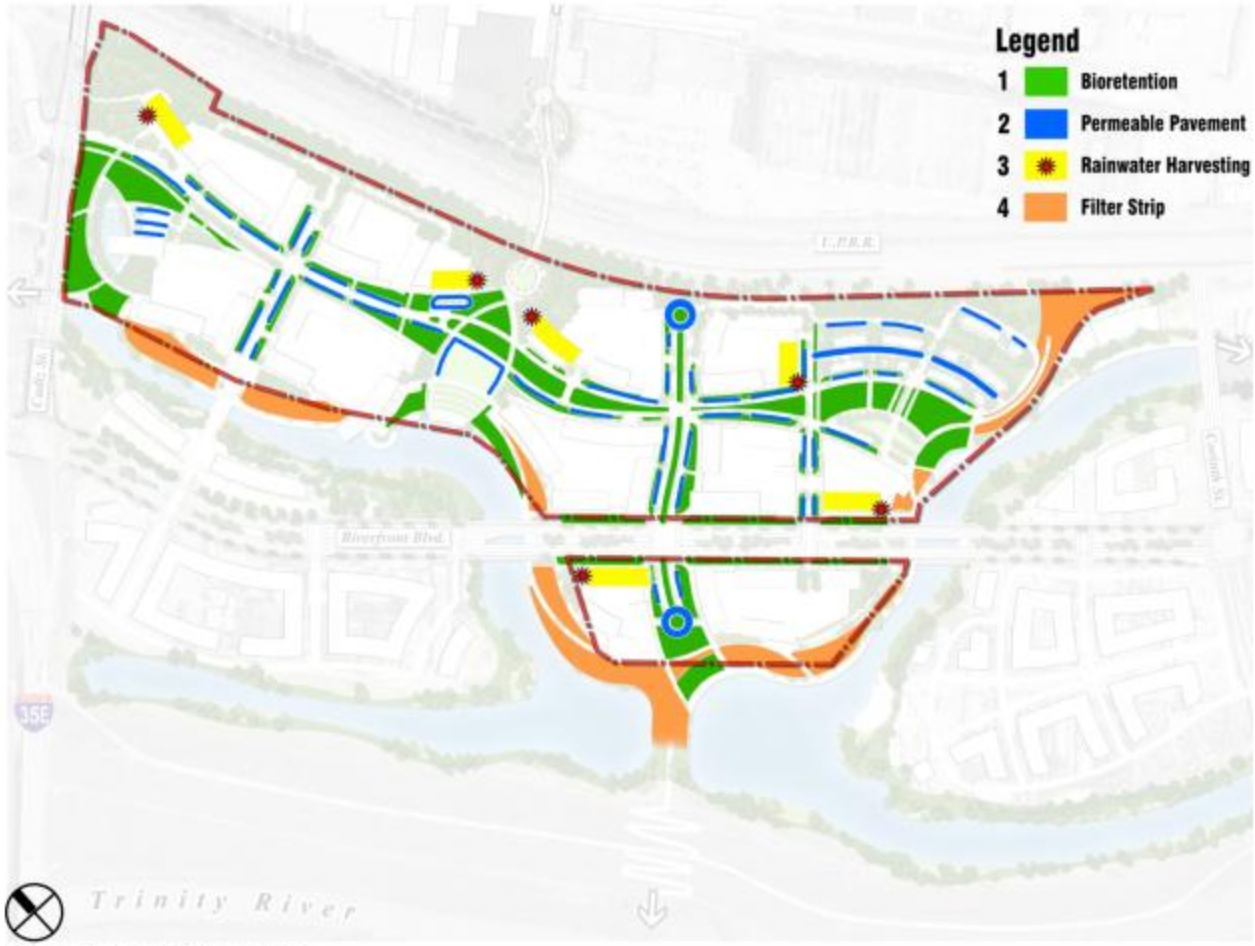
LID addresses pollution from urban areas by implementing storm water quality techniques in combination with water conveyance, detention, and retention. The bioretention **Treatment Train** is an example of water quality and conveyance functioning in unison.

Filter strips are utilized along the riparian edges of Cedars West to help treat runoff and remove pollutants through increased infiltration and vegetative filtering.

The Cedars West LID site was designed to store a total of 6 ac-ft of storm water runoff volume which includes 3.75 ac-ft of retention for water quality and an additional 2.25 ac-ft of storm water detention. This storage requirement was met through a LID strategy that utilized three different storage features:

- Rainwater Harvesting – 0.18 ac-ft
- Permeable Pavement – 0.19 ac-ft
- Bioretention – 5.74 ac-ft

LID design at the Cedars West site also yields additional available areas where LID practices can be implemented. Thus, the LID approach gives the designer multiple templates to work with to achieve sustainable goals, integrated throughout a final Master Plan



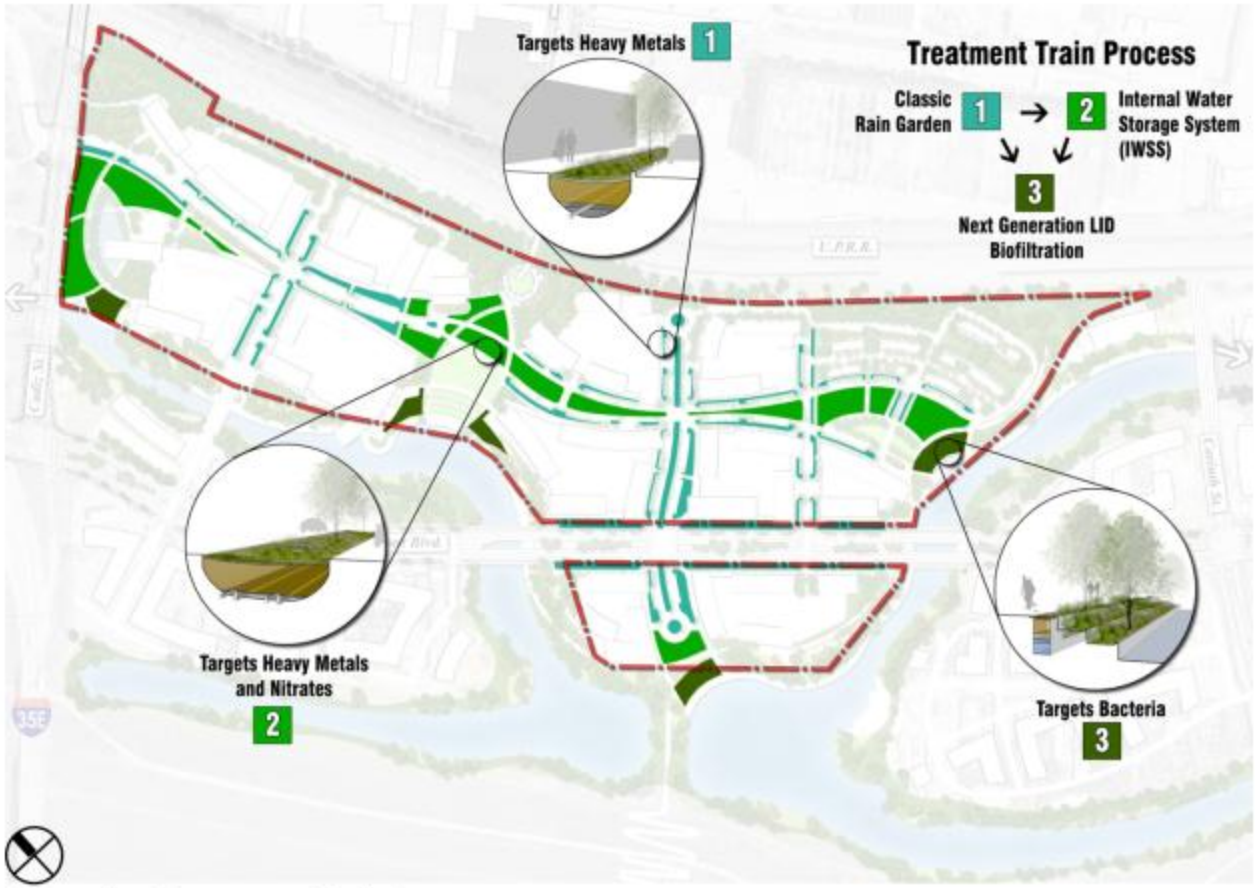
Overall LID Strategies

The **Treatment Train** focuses on the bioretention areas, integrated as LID features on the site. The three **Treatment Train** strategies are appropriately located within the bioretention system where they will have the most impact on targeted water quality indicators.

Classic and Internal Water Storage (IWS) Bioretention would always travel through Next Generation LID features to fully utilize water quality treatment for Cedars West.

Cedars West Example - Classic Bioretention and woodland plant community

"A Treatment Train will provide the best water quality improvement of any LID design"



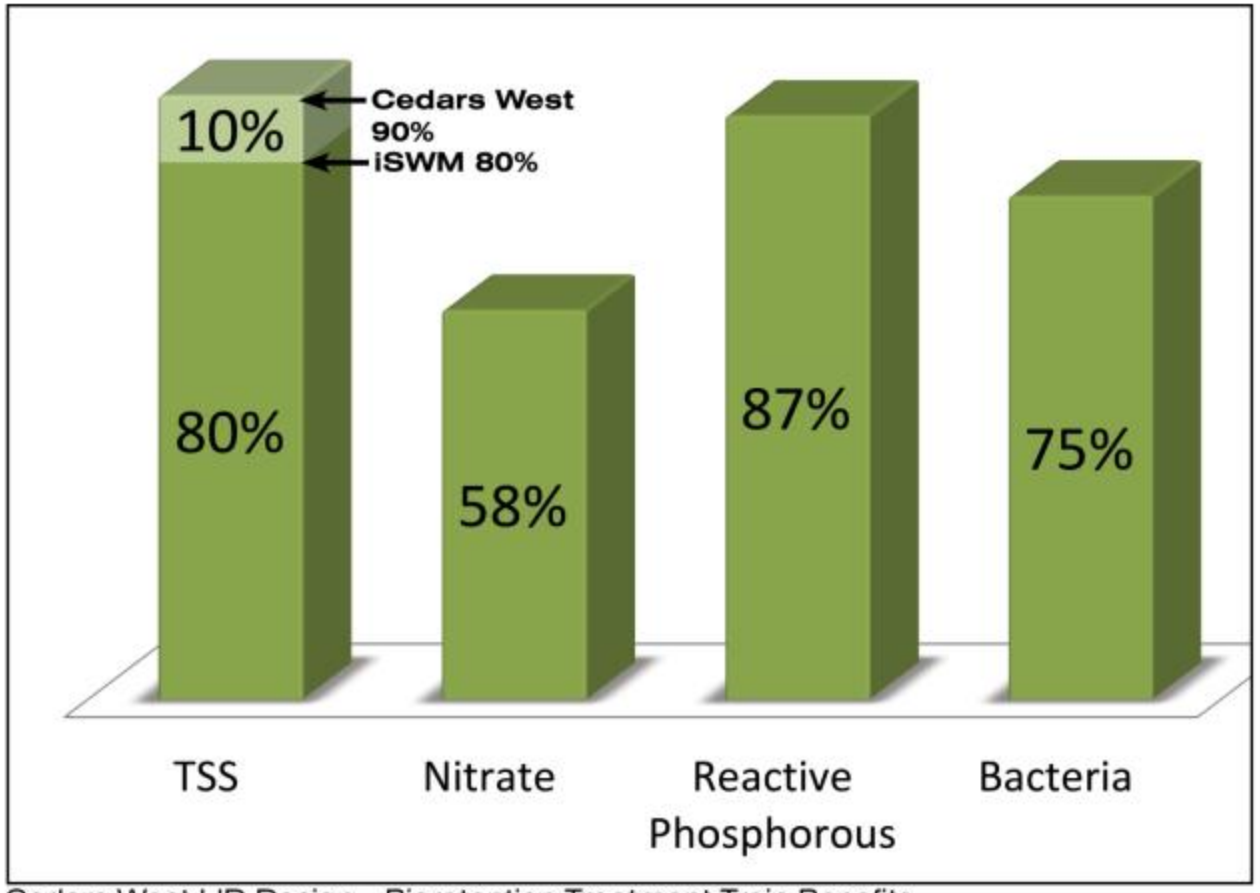
Innovative Treatment Train Process

DESIGN | Water Quality

iSWM requires 80% TSS removal for Storm Water Quality. With the Cedars West LID plan, the expected TSS Removal is 90%. Therefore, Team 36322 exceed iSWM!

With the innovative **"Treatment Train"** Bioretention system, the Cedars West LID plan goes **above and beyond** the water quality requirements and also achieves removal of:

- Nitrates
- Reactive Phosphorous
- Bacteria (an indicator pollutant in the Trinity River according to TCEQ)



Cedars West LID Design - Bioretention Treatment Train Benefits

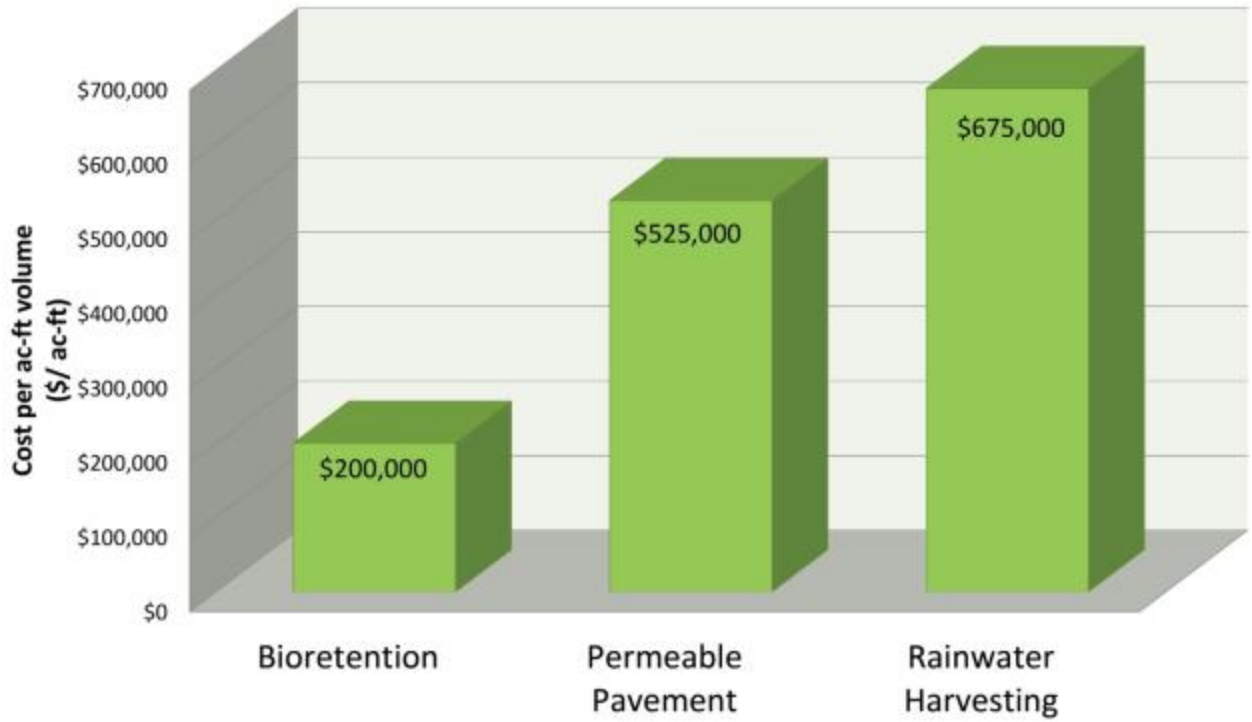
Source: Dietz (2007), Brown and Hunt (2011), Convergentwater.com (accessed September 13, 2012)

Southern Aerial View

1. Great Lawn and amphitheater
2. Main boulevard with meandering median
3. Floating wetlands providing habitat, beauty and pollutant removal
4. Community Lawn containing short grass prairie (native turf)
5. Next Gerneration LID Biofiltration treating bacteria
6. Re-establishment of natural wetland plant community

Economic Considerations

- Bioretention provides the highest return on investment considering the LID goals of water storage and water quality improvement.
- Permeable pavement and rainwater harvesting should be utilized strategically and where it makes sense e.g. in areas where there is substantial runoff volumes and not enough area available for bioretention.
- Green Roofs were estimated to cost almost $8,000,000 per ac-ft of storage. Green roofs provide many benefits along with LID, however they were not included in our LID analysis for this competition due to the high initial cost as a site infrastructure feature.



LID Feature Cost Per Acre-Ft of Storage

Other Benefits

Additional economic benefits not accounted for in the bid tabulation:

- Since less space is needed for traditional detention ponds, extra space is available for buildings and/or amenities
- Due to less irrigation, mowing and maintenance energy savings can occur
- Access to nature has proven health benefits
- More green space leads to cleaner air, thus reducing air pollution

SUSTAINABLE SITE BID TABULATION FOR - CEDARS WEST

BID ITEM DESCRIPTION	ENGINEER'S ESTIMATE			
	TRADITIONAL AMOUNT BID	LOW IMPACT DEVELOPMENT AMOUNT BID	Difference	% Difference
Civil				
I. Site Preparation and Earthwork	$ 1,060,000.00	$ 851,000.00	$ (209,000.00)	-20%
II. Drainage	$ 1,881,000.00	$ 558,000.00	$ (1,323,000.00)	-70%
III. Bridge Structure	N/A	N/A	N/A	-
IV. Subgrade and Paving	$ 1,870,500.00	$ 1,716,300.00	$ (154,200.00)	-8%
V. Traffic Control	$ 50,000.00	$ 50,000.00	$ -	-
VI. Signing and Striping	$ 18,000.00	$ 18,000.00	$ -	-
VII. Traffic Signal	$ 150,000.00	$ 150,000.00	$ -	-
VIII. Stormwater Pollution Prevention Plan	$ 120,000.00	$ 95,000.00	$ (25,000.00)	-21%
IX. Utilities	$ 1,837,900.00	$ 1,837,900.00	$ -	-
X. Extra Work Items	N/A	N/A	N/A	-
TOTAL AMOUNT BID (ITEMS 1 THROUGH 43)	$ 6,987,400.00	$ 5,276,200.00	$ (1,711,200.00)	-24%
Landscape				
I. Subtotal for Site Preparation and Earthwork	$ -	$ -	$ -	-
II. Best Management Practices (Bioswales, Water Harvesting)	$ -	$ 1,120,000.00	$ 1,120,000.00	100%
III. Hardscapes (Sidewalks, Porous Pavement, Patios, Etc.)	$ 4,819,800.00	$ 4,819,800.00	$ -	-
IV. Miscellaneous Landscape Planting	$ 2,939,500.00	$ 2,939,500.00	$ -	-
V. Miscellaneous Warranty and Maintenance	$ -	$ -	$ -	-
VI. Extra Work Items	$ -	$ -	$ -	-
TOTAL AMOUNT BID (ITEMS 1 THROUGH 23)	$ 7,759,300.00	$ 8,879,300.00	$ 1,120,000.00	14%
Totals	$ 14,746,700.00	$ 14,155,500.00	$ (591,200)	-4.0%
		Percent Savings for Revised Bid Items (Site Prep, Drainage, Paving, SWPPP, BMPs, and Landscape)		-12.0%

Economic Considerations