LANDSCAPE PERFORMANCE SERIES
presented by the Landscape Architecture Foundation

2015 LAF CSI Program Landscape Performance Series: The Belo Center for New Media, Austin, TX

Research Title: The University of Texas at Austin's Case Study Investigation 2015: The Belo Center for New Media at The University of Texas at Austin

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Sponsor/Research Partner: Landscape Architecture Foundation (LAF)

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Staff at the University of Texas Facilities Department
John Burns, Jim Carse, Markus Hogue, Lisa Lennon, Jim Walker

Overview of CSI: This investigation was conducted as part of the Landscape Architecture Foundation's 2015 *Case Study Investigation* (CSI) program. CSI matches faculty-student research teams with design practitioners to document the benefits of exemplary high-performing landscape projects. Teams develop methods to quantify environmental, economic and social benefits and produce Case Study Briefs for LAF's *Landscape Performance Series*.

The full case study can be found at: https://landscapeperformance.org/case-study-briefs/belo-center

Introduction

The design intent of Belo Center for new Media courtyard was to demonstrate a style of landscape never seen before on the University of Texas Campus. The goal was to reinvent the concept of the urban plaza for the University by creating comfortable and inviting spaces for students, faculty, and the public that are interwoven with nature and cycles of water. Located on West Dean Keeton between Guadalupe and Whitis Street, the building is under the administration of the Moody College Dean's office.

The Belo landscape is a multifunctional space that accommodates several programs in a small area. As per the client's request, the grass lawn and plaza can be used as an outdoor classroom and a performance space. There are various places to sit and tables to enjoy a meal or to study.

The landscape itself is a high-performance space. Rainwater harvesting and use of air conditioning condensate are intended to support all irrigation needs. The native plant palette represents the most significant use of native plants on campus. Pollinator plants were specifically chosen to attract native pollinator fauna to the site. The vegetated fountain incorporates native wetland plants, illustrating a refreshing contrast between different native ecosystems on a single small site.

Landscape Performance Benefits and Methods

Environmental

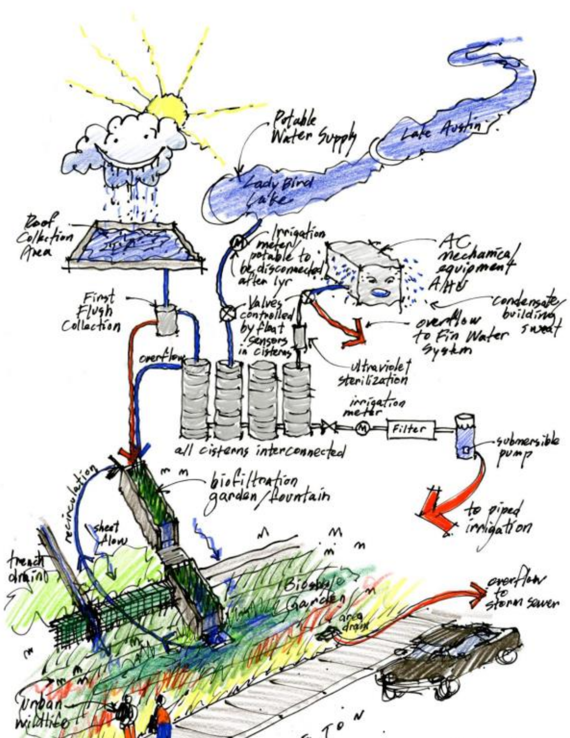


Figure 1: Drawing by Ten Eyck

Saves an average of 464,907 gallons of potable water and $2,712 annually by using air conditioning condensate and harvested rainwater for irrigation.

Background

The LEED certified building is designed to collect runoff from the building roof and air conditioning condensate and send it to 4 7,180 gallon tanks (nearly 30,000 gallons total). During storm events, rainwater falls from the roof and the first flush enters through the biofiltration fountain. When the fountain reaches capacity, a valve redirects stormwater to on-site cisterns where it is stored for irrigation. In extreme flood events, excess cistern water is rerouted to the biofiltration fountain, causing it to overflow into the streetscape bioswale.

Methods
The University of Texas at Austin uses a cutting-edge irrigation system. Data from each sprinkler head is recorded with software which is then analyzed by campus facilities employees. The amount of water purchased from the City of Austin is also monitored by location on campus. Subtracting the City water bill from the total water used for irrigation equals the water that was supplemented by the cistern system.

Data

2013 Irrigation Use in Gallons

January	48,095
February	44.536
March	64,967
April	82,284
May	65,139
June	78,121
July	81,366
August	86,390
September	88,184
October	38,589
November	23,902
December	6,007
Total	**707,544**

2014 Irrigation Use in Gallons

January	13,188
February	42,372
March	31,914
April	80,895
May	66,728
June	66,656
July	96,117
August	113,120
September	99,581
October	151,723
November	15,167
December	18,045
Total	**795,470**

Calculations
City Water used 2013: 244,300 gallons
Irrigation used 2013: 707,544 gallons

707,544 – 244,300= **463,244 gallons**

City Water used 2014: 328,900 gallons
Irrigation used 2014: 795,470 gallons

795,470 – 328,900= **466,570 gallons**

Average water saved in 2013 and 2014= **464,907 gallons saved**

The dollar value of potable water for this area is $5.85 per 1,000 gallons.
2013: 463,000 gallons of potable water saved→ (463,000/1,000)* $5.85 **=$2,708.55**

Limitations
There were difficulties establishing the complicated air conditioning condensate water system during installation. The irrigation coordinator also explained that the rainwater harvesting system has had to be refined in the first few years. These challenges, in

addition to establishing new plant material and issues with the fountain feature, resulted in a higher use of potable water than anticipated for this year and future use. The irrigation coordinator anticipates that beginning this year there will be no potable water used on the landscape. All irrigation needs will be met using rainwater harvesting and air conditioning condensate.

References

- The University of Texas at Austin's irrigation monitoring data
- Personal communication, Markus Hogue, Irrigation Coordinator, June 2015

Reduces the peak rate of runoff leaving the site for a 2-year storm by 46% compared to site's previous use as a parking lot.

Background

Before The Belo Center for New Media was developed, the site was a parking lot with few trees. There were 2 small indoor parking lot buildings and a large asphalt lot. Most of the site was covered with impermeable surface. Stormwater runoff is greatly reduced with the New Belo Center design. There are 4 systems that contribute to this reduction. First, all rainwater that falls on the rooftop is collected into the cisterns, unless there is a very large storm at which time the overflow system will deposit water into the bioswales. Second, permeable pavers are used in the courtyard and pathways. Third is the increased plant material which aids in slowing sheet flow and storing water in the soil. Fourth is the planted bioswale. This swale is located at the lowest elevation of the site, so any runoff not collected in the earlier systems will flow into the swale.

Methods

Calculations are sourced from the Drainage Area Plan and were conducted by the civil engineer on the project, Charles Gojer & Associates, Inc. The rational method is used to calculate the runoff rate in cu ft per second for a 2-year storm event.

Rational Method

> "The equation is based on the theory that the peak rate of runoff from a small area is equal to the intensity of rainfall multiplied by a coefficient which depends on the characteristics of the drainage area, including land use, soils and slope, and by the size of the area" (p.208 Site Engineering for Landscape Architects, Steven Strom and Kurt Nathan)

$q=CiA$

q = Peak runoff rate, cubic feet per second (cfs)

C = Dimensionless coefficient (A number between 0 and 1, where 0 is completely pervious and 1 in impervious. For example, asphalt=0.9 or meadow=0.2)

I = Rainfall intensity, inches per hour (iph) for the design storm frequency and for the time of concentration of the drainage area

A = Area of drainage area, acre

Data

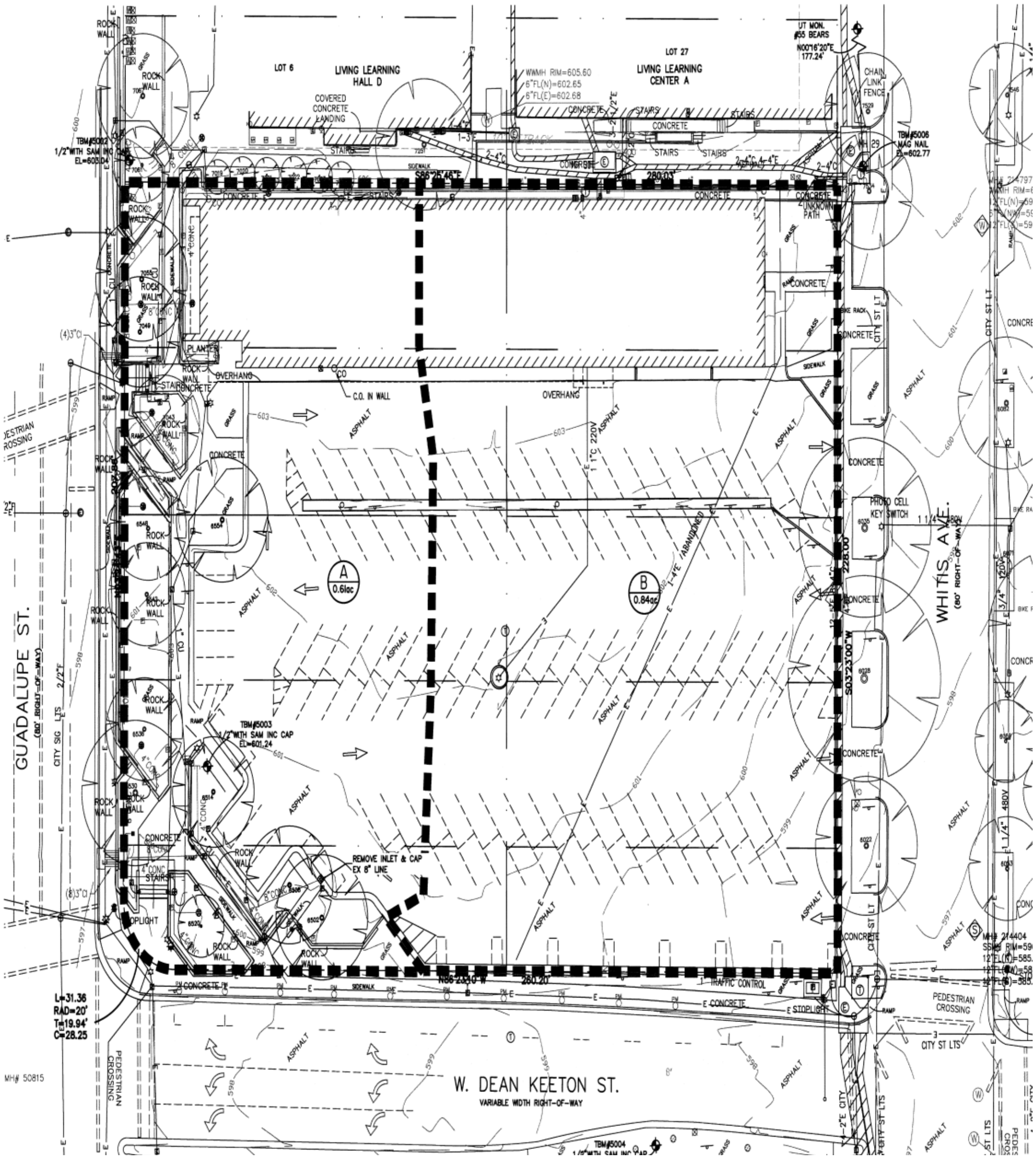


Figure 2: Pre-Construction Conditions provided by Ten Eyck Drainage Area Plan from Construction Documents

Pre-Construction Calculations

Description	Area	C	C X A	Tc (Min)	1_5 (in/hr)	Q_5 (cfs)	Remarks
A	0.59	0.90	0.53	10	5.6	2.97	Sheet flow to Guadalupe
B	0.86	0.90	0.77	10	5.6	4.31	Sheet flow to Whitis
TOTAL	1.45		1.3			7.28	

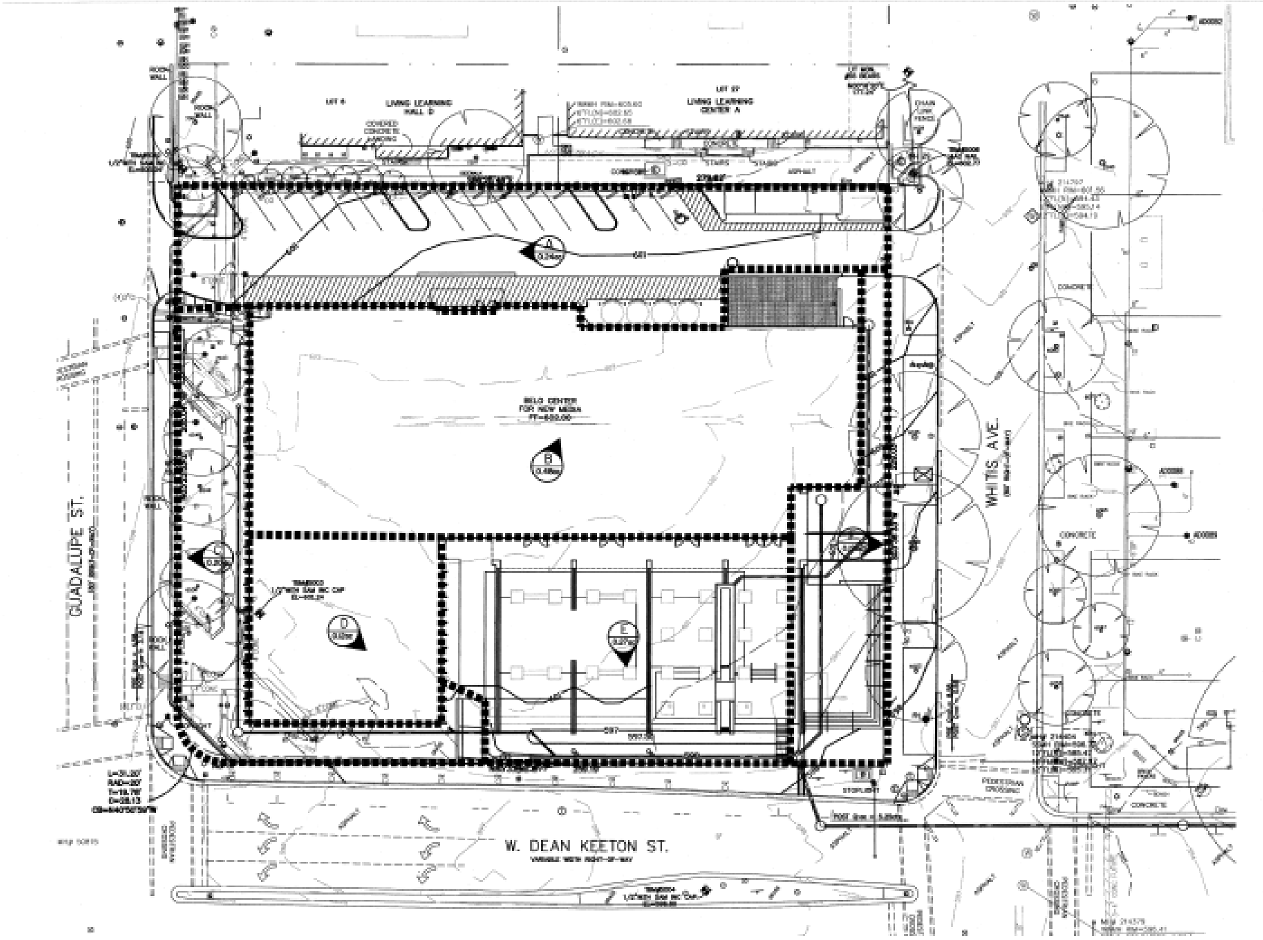


Figure 3: Post-Construction Conditions provided by Ten Eyck Drainage Area Plan from Construction Documents

Post-Construction Calculations

Description		**Area**		**C**	**C x A**	**Tc (Min)**	**1 (in/hr)**	**Q (cfs)**	I_{100} (in/hr)	Q_{100} (CFS)	**Remarks**
	Pervious	Impervious	Total								
A	0.12	0.21	0.33	0.72	0.24	10	5.6	1.33			Sheet Flow
B		0.45	0.45	0.95	0.43	10	5.6	2.39			Roof Drains (To Cisterns)
C	0.14	0.01	0.15	0.44	0.07	10	5.6	0.37			Existing grate inlets
D		0.12	0.12	0.95	0.11	10	5.6	0.64			KUT roof
E	0.17	0.16	0.33	0.67	0.22	10	5.6	1.23			Bioswale
F		0.07	0.07	0.95	0.07	10	5.6	0.37			Sheet Flow
TOTAL	0.43	1.02	1.45		1.13			6.33			

Calculations

q=CiA

Pre-construction
Sheet flow to Guadalupe: 0.9 X 5.6iph X 0.59ac = 2.97cfs
Sheet flow to Whitis: 0.9 X 5.6iph X 0.86ac = 4.31cfs

2.97cfs + 4.31cfs = **7.28cfs**

Post-construction
Sheet flow A: 0.72 X 5.6iph X 0.33ac = 1.33cfs
Roof drains to cistern: 0.95 X 5.6iph X 0.45ac = 2.39cfs
Existing grate inlets: 0.44 X 5.6iph X 0.15ac = 0.37cfs
KUT roof: 0.95 X 5.6iph X 0.12ac = 0.64cfs
Bioswale: 0.67 X 5.6iph X 0.33ac = 1.23cfs
Sheet flow F: 0.95 X 5.6iph X 0.07ac = 0.37cfs

1.33 + 2.39 + 0.37 + 0.64 + 1.23 + 0.37 = **6.33cfs**

6.33cfs (Post-construction) – 2.39cfs (roof runoff to cisterns) = 3.94cfs

7.28cfs (pre-construction) – 3.94cfs (post-construction adjusted with cisterns) = 3.34 / 7.28 = 0.4587 = **46% reduction in peak rate of runoff flowing off the site**

Limitations

The Rational Method assumes that there is uniform sheet flow across similar surface materials with the same slope. It also does not account for chances in storm patterns but instead accepts uniform rain intensity for the entire site (up to 200 acres).

References

- Strom, Steven, Kurt Nathan, and Jake Woland. *Site Engineering for Landscape Architects*. 6th ed. Hoboken, NJ: John Wiley & Sons, 2013. Print.
- Ten Eyck Drainage Area Plan from Construction Documents, November, 2011

Sequesters 5,211 lbs of atmospheric carbon and intercepts 18,720 gallons of stormwater annually in 55 newly-planted trees.

Background

This project uses the native Texas honey mesquite (*Prosopis glandulosa torr.)* to create a “living umbrella” over the courtyard and lawn. In addition to the mesquite, local Texas persimmons, possumhaw holly, bald cypress, Texas mountain laurel, and Mexican plums were planted. 55 new trees were planted on this site and 13 existing large live oaks were preserved.

Methods

The online *National Tree Benefit Calculator* was used to generate carbon sequestration and stormwater reduction numbers associated with averages in Austin, TX. Only new trees were included in the calculation. Tree calipers were collected on site and input into online calculator.

Data

Type of Tree	Caliper (inches)	# of Branches	Combined caliper (square root of the sum of squared stems)	Pounds of Carbon sequestered- Annual	Gallons of stormwater intercepted-annual
Holly	1.5	7	3.97	56	227
Cypress	9	1		229	1,044
Holy	1	5	2.23	25	141
Holly	1,1.5	4	2.54	30	156
Cypress	6	1		122	509
Holly	1, 1.5	6	3.12	40	185
Holly	1.5	4	2.44	28	151
Cypress	7	1		157	687
Holly	2	5	4.47	251	64
Holly	1.5, 2	5	3.84	220	53
Cypress	6	1		122	509
Holly	0.5	5	1.11	9	78
Holly	1.5, 2.5	3	3.5	47	204
Holly	1.5	3	2.6	31	159
Holly	2	3	3.46	46	202
Mesquite	3, 3.5, 4	3	6.1	125	527
Mesquite	3 to 7	4	7	157	687
Mesquite	2,3,3,4	4	6	122	509
Mesquite	4,5	2	6	122	509
Mesquite	3,6	2	7	157	687
Mesquite	2	2	3	39	148
Mesquite	2,4	2	5	86	331
Mesquite	4,3,2	3	5	86	331
Mesquite	3,5	2	6	122	509
Mesquite	3,4,5.5	3	7	157	687
Mesquite	3.5, 4	2	5	86	331
Mesquite	1,1.5,2.5	3	3	39	148
Mesquite	4	3	7	157	687
Mesquite	2.5, 3, 3	3	5	86	331
Mesquite	2.5 to 4	4	6	122	509
Mesquite	1.5, 2.5, 3, 4	4	6	122	509
Mesquite	2.5, 3.5, 3, 5	4	6	122	509
Mesquite	3.5, 4	2	5	86	331
Mesquite	1.5 to 3	4	4	58	221
Mesquite	3 to 4	4	6	122	509
Texas Persimmon	.5-1.5	8	3	56	228
Texas Persimmon	1 to 2	11	5	77	291
Texas Persimmon	.5-1.5	15	4	56	228
Texas Persimmon	.5-2	19	6	56	228
Texas Persimmon	1.5	5	3	56	228

Texas Persimmon	2	5	4	56	228
unknown	6.5	1		196	850
Live Oak	7	1		156	613
Live Oak	6	1		121	458
Live Oak	6.5	1		138	535
Live Oak	6	1		121	458
Mexican Plum	3	5	7	418	58
Mexican Plum	1.0-3.0	4	4	22	170
Mexican Plum	1.0-2.0	4	3	16	128
Mexican Plum	1.0-2.0	4	3	16	128
Mexican Plum	1.0-2.0	4	3	16	128
Mexican Plum	1.0-2.0	4	3	16	128
Mexican Plum	1.0-2.0	4	3	16	128
Mexican Plum	1.0-2.5	4	3	16	128
				5,211.00	**18,720.00**

Limitations

The *National Tree Benefits Calculator* results are an approximation. Though it is necessary to include location of the site and the tree sizes, there are many variables not included such as shade, tree health, and nutrient availability of soils. The calculator only provides common tree species. Some of the trees found at Belo were not listed on the website. With recommendations from facilities' landscape architect and arborist, the below substitutions were made.

Actual Tree	Substitution
Texas Honey Mesquite	Honey Locust
Texas Mountain Laurel	Other-Evergreen Broad Leaf Small
Possumhaw Holly	Other-Deciduous Broad Leaf Small
Mexican Plum	Plum

References

- "National Tree Benefit Calculator." *National Tree Benefit Calculator*. Casey Trees and Davey Tree Expert Co., n.d. Web. 02 July 2015.
- "What Is I-Tree?" *I-Tree*. Forest Service, Davey Tree Expert Company, National Arbor Day Foundation, Society of Municipal Arborists, International Society of Arboriculture, and Casey Trees, n.d. Web. 02 July 2015.
- Ten Eyck Planting Plan from Construction Documents, November, 2011

Maintains summer surface temperatures in the seating area that are an average of 14-25°F cooler than surface temperatures on the nearby sidewalk and street.

Background

In the middle of summer in Austin, TX, daytime temperatures regularly reach 95°F or higher. Shade is an invaluable characteristic of usable outdoor space on the university campus for half of the year.

Methods

A designated seating area was determined (see figure 4). This area was chosen because it contains most of the tables and all benches. It is the main part of the courtyard and includes all mesquite trees which are intended to provide the bulk of shade protection within the courtyard. Temperature measurements were collected on different surface materials within the seating area and outside of the seating area. Surface temperatures were recorded at various areas on the site using an infrared thermometer. These measurements were taken on 2 days, July 8th and 23rd, at 1pm.

Data

July 8th at 13:00, 84°F Ambient temperature

In Seating Area	Oustide Seating Area
84	102.5
85	103.4
92.1	108.5
94	96.4
88.9	107
88.3	99.6
102.5	116.3
88.2	102.3
86.4	112.6
85.9	101.2
89	100.5
90.1	
85.8	
105.5	
Averages	
90.41	104.57

July 8th
104.57°F – 90.41°F = 14.17°F difference in temperature

July 23rd
136.18 °F – 110.81 °F = 25.36 °F difference in temperature

July 23rd at 13:00, 91°F Ambient temperature

In Seating Area	Oustide Seating Area
99.6	142.7
131.2	130.8
125.7	143.7
107.5	127.5
100	
96	
126.5	
103.4	
107.4	
Averages	
110.81	136.175

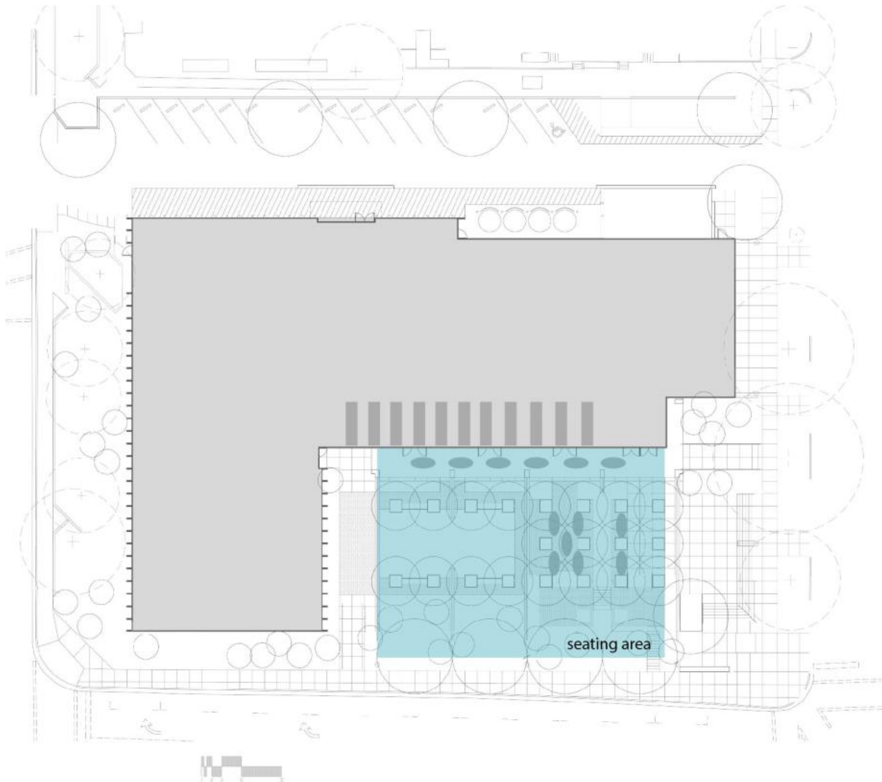


Figure 4: Specified "seating area" at the Belo courtyard

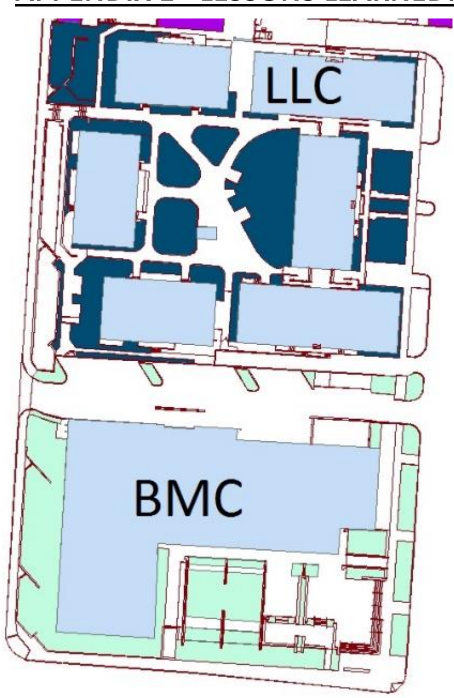
Limitations

The first day of testing (July 8th) the temperature was cooler than an average summer day in July due to an overcast sky. These clouds also created a narrower contrast between the temperatures of the seating area and non-seating area.

References

- **Data collected July 8th and 23rd, 2015**

APPENDIX 1 - LESSONS LEARNED: ADDITIONAL ANALYSIS



The courtyard at the neighboring Living Learning Center had an irrigation cost of $3,044.18 from January 2013 to April 2015. The Belo Center for New Media's landscape cost $5,127.92 (not incorporating fountain costs, because the Learning Living Center does not have one) for the same time period. As the courtyard at the LLC is a more conventional landscape with turf and exotic plants, it was expected that irrigation demands would be higher. The high water use at Belo Center is likely a result of the plant establishment period and early technical issues; the cost is expected to go down significantly over time.

Background
The campus Facilities Irrigation Coordinator recommended comparing the water use of The Belo Center for New Media (BCM) with the Living Learning Center (LLC) because both sites have similar evapotranspiration and rainfall levels and are similar in size.

Methods
Using data from the University's irrigation monitoring system, the 2 zones were compared for irrigation usage and costs. Irrigation use for BCM was adjusted to account for the water used from rainwater harvesting and air conditioning condensation stored in the cisterns on site. The fountain's water usage was also removed to show irrigation demand only.

Data
BCM water use adjusted for potable water saved with cistern system

Month	BMC (Belo) water usage (gallons)	City water usage	Potable water used on irragtion	Costs
Jan-13	48,095.00	9,300.00	38,795.00	$ 226.95
Feb-13	44,536.00	31,700.00	12,836.00	$ 75.09
Mar-13	64,967.00	16,800.00	48,167.00	$ 281.78
Apr-13	82,248.00	19,900.00	62,348.00	$ 364.74
May-13	65,139.00	15,100.00	50,039.00	$ 292.73
Jun-13	78,121.00	21,000.00	57,121.00	$ 334.16
Jul-13	81,366.00	14,900.00	66,466.00	$ 388.83
Aug-13	86,390.00	38,200.00	48,190.00	$ 281.91
Sep-13	88,184.00	33,100.00	55,084.00	$ 322.24
Oct-13	38,589.00	8,400.00	30,189.00	$ 176.61
Nov-13	23,902.00	14,900.00	9,002.00	$ 52.66
Dec-13	6,007.00	21,000.00	-14,993.00	$ (87.71)
Jan-14	13,188.00	20,200.00	-7,012.00	$ (41.02)
Feb-14	42,372.00	26,700.00	15,672.00	$ 91.68
Mar-14	31,914.00	25,200.00	6,714.00	$ 39.28
Apr-14	80,859.00	39,100.00	41,759.00	$ 244.29
May-14	66,728.00	18,300.00	48,428.00	$ 283.30
Jun-14	66,656.00	0.00	66,656.00	$ 389.94
Jul-14	96,117.00	34,500.00	61,617.00	$ 360.46
Aug-14	113,120.00	73,100.00	40,020.00	$ 234.12
Sep-14	99,581.00	23,500.00	76,081.00	$ 445.07
Oct-14	151,723.00	68,200.00	83,523.00	$ 488.61
Nov-14	15,167.00	0.00	15,167.00	$ 88.73
Dec-14	18,045.00	100.00	17,945.00	$ 104.98
Jan-15	55,259.00	0.00	55,259.00	$ 323.27
Feb-15	43,277.00	9,100.00	34,177.00	$ 199.94
Mar-15	2,421.00	0.00	2,421.00	$ 14.16
Apr-15	196,302.00	56,100.00	140,202.00	$ 820.18
Total:	**1,800,273.00**	**638,400.00**	**1,161,873.00**	**$ 6,796.96**

Cost comparison between LLC and BCM

Month	LLC water usage (gallons)	LLC Costs	BMC (Belo) water usage (gallons)	BMC (Belo) water usage adjusted with cistern water savings(gallons)	BMC Costs	Fountain usage (gallons)	BMC usage without fountain	BMC Costs adjusted without fountain use
Jan-13	4,594	$ 26.87	48,095	38,795	$ 226.95	5,646	33,149	$ 193.92
Feb-13	34,522	$ 201.95	44,536	12,836	$ 75.09	2,443	10,393	$ 60.80
Mar-13	23,778	$ 139.10	64,967	48,167	$ 281.78	9,792	38,375	$ 224.49
Apr-13	20,534	$ 120.12	82,248	62,348	$ 364.74	11,719	50,629	$ 296.18
May-13	32,923	$ 192.60	65,139	50,039	$ 292.73	8,628	41,411	$ 242.25
Jun-13	41,041	$ 240.09	78,121	57,121	$ 334.16	10,600	46,521	$ 272.15
Jul-13	33,419	$ 195.50	81,366	66,466	$ 388.83	9,114	57,352	$ 335.51
Aug-13	38,988	$ 228.08	86,390	48,190	$ 281.91	6,282	41,908	$ 245.16
Sep-13	37,349	$ 218.49	88,184	55,084	$ 322.24	3,742	51,342	$ 300.35
Oct-13	10,910	$ 63.82	38,589	30,189	$ 176.61	0	30,189	$ 176.61
Nov-13	4,497	$ 26.31	23,902	9,002	$ 52.66	0	9,002	$ 52.66
Dec-13	83	$ 0.49	6,007	14,993	$ 87.71	0	14,993	$ 87.71
Jan-14	111	$ 0.65	13,188	7,012	$ 41.02	1,378	5,634	$ 32.96
Feb-14	4,778	$ 27.95	42,372	15,672	$ 91.68	10,277	5,395	$ 31.56
Mar-14	11,915	$ 69.70	31,914	6,714	$ 39.28	6,222	492	$ 2.88
Apr-14	26,305	$ 153.88	80,859	41,759	$ 244.29	20,069	21,690	$ 126.89
May-14	24,656	$ 144.24	66,728	48,428	$ 283.30	15,839	32,589	$ 190.65
Jun-14	30,204	$ 176.69	66,656	66,656	$ 389.94	14,422	52,234	$ 305.57
Jul-14	41,871	$ 244.95	96,117	61,617	$ 360.46	28,534	33,083	$ 193.54
Aug-14	23,345	$ 136.57	113,120	40,020	$ 234.12	27,226	12,794	$ 74.84
Sep-14	18,188	$ 106.40	99,581	76,081	$ 445.07	14,500	61,581	$ 360.25
Oct-14	28,097	$ 164.37	151,723	83,523	$ 488.61	17,703	65,820	$ 385.05
Nov-14	181	$ 1.06	15,167	15,167	$ 88.73	0	15,167	$ 88.73
Dec-14	964	$ 5.64	18,045	17,945	$ 104.98	2,423	15,522	$ 90.80
Jan-15	146	$ 0.85	55,259	55,259	$ 323.27	45,701	9,558	$ 55.91
Feb-15	2,780	$ 16.26	43,277	34,177	$ 199.94	11,890	22,287	$ 130.38
Mar-15	365	$ 2.14	2,421	2,421	$ 14.16	0	2,421	$ 14.16
Apr-15	23,828	$ 139.39	196,302	140,202	$ 820.18	9,244	130,958	$ 766.10
Total:	**520,372**	**$ 3,044.18**	**1,800,273**	**1,161,873**	**$ 6,796.96**	**285,305**	**876,568**	**$ 5,127.92**

LLC irrigation costs January 2013- April 2015: **$3,044.18**
BCM irrigation costs January 2013- April 2015: $6,796.96 (with fountain)
BCM irrigation costs January 2013- April 2015: **$5,127.92 (without fountain)**

Limitations

There are no landscapes on the campus which are truly comparable to that at Belo. The landscape was designed to be innovative and distinct from the rest of campus. The LCC landscape is composed of mostly turf and non-native species. LLC also does not have a fountain like the BCM. The fountain at BCM has added a great deal of water usage and therefore cost. Part of this surge in water use is a result of technical issues which caused the fountain to use more water than originally intended. The irrigation demands from BCM represent a time during plant establishment. This affects the water use as well. The Irrigation Coordinator explained that in the coming years, water use at BCM will decrease due to technical corrections to the water recycling system and because the plants will be established.

References

- The University of Texas at Austin's irrigation monitoring data
- Personal communication, Markus Hogue, Irrigation Coordinator, June 2015

Appendix 2 - Biomass Density Index

Provides a 1.34 Biomass Density Index, increasing available habitat and aiding in supporting ecosystem services such as nutrient cycling.

Background

Biomass density index (BDI) is a measure of vegetation development appropriate to the specific regional climate.

> "Environmental, economic, and social benefits emerge from all general characteristics of living vegetation, such as shading of structures or recreational spaces, atmospheric and building cooling, building protection from cold or otherwise damaging winds, reduced soil water evaporation (hence reducing irrigation), improved air quality (absorption of particulate PM10 and PM20 and low level ozone), noise reduction, storm runoff reduction (from improved soil permeability and vegetation canopy interception and transpiration), and improved water quality (as runoff or sub-soil recharge)." (Sites V2 Reference Guide, p.135)

Methods

The biomass density index is calculated using the methods described in the Sites V2 Reference Guide.

1. Draw a map of the zones of land cover or vegetation types on site. Determine the percent of total area for each distinct zone.
2. Decide on a vegetated area or land cover zone categorized in the Sites reference book, areas should not overlap
3. Exclude areas of open water or invasive species.

Data

Land cover/vegetation type zone	**Biomass density value***	**Percent of total site area**	**Biomass density value x percent total site area (column B x column C)**
A	**B**	**C**	**D**
Tree understory	6	17.4%	1.03

Shrubs	3	7.74%	0.23
Desert plants	1.5	1.42%	0.02
Managed turf <3”	2	1.99%	0.04
Wetlands	6	0.24%	0.02
Impervious cover (includes building footprint)	0	71.9%	0
Site BDI	n/a	100%	1.34

References

- "Google Maps." *Google Maps*. N.p., n.d. Web. 20 June 2015.
- *SITES V2 Reference Guide: For Sustainable Land Design and Development*. Austin, TX: Sustainable Sites Initiative, n.d. Print. 2014
- Ten Eyck Planting Plan from Construction Documents

Appendix 3 - Behavior Mapping

Accomplishes 10 of the 12 successful public space criteria outlined in prominent studies.

Background

The Project for Public Spaces, Inc. is a nonprofit whose work focuses on sustaining usable public space. In their book *How to turn a place around,* the authors list characteristics which are found in a successful public place.

1. High proportion of people in groups
2. Higher than average proportion of women
3. Different ages
4. Varied activities
5. Affection

In *The Social Life of Small Urban Spaces* William H. Whyte outlines the affordances of a well-used public space.

1. Integral seating
2. Wind protection
3. Seating in both sun and shade
4. Proximity to water
5. Proximity to food
6. View of the street
7. Contains trees

Methods

An observational survey, or “behavior mapping” (Whyte, p. 101), was used to record locations and actions of people using the site. The study was conducted on July 7th from

10am-2pm. Every 10 minutes a survey was taken of where people were seated at a given moment. In addition to marking their location, the activities and characteristics of courtyard visitors was also recorded. The number of people sitting inside the Café at the Belo Center building was recorded as well.

Data

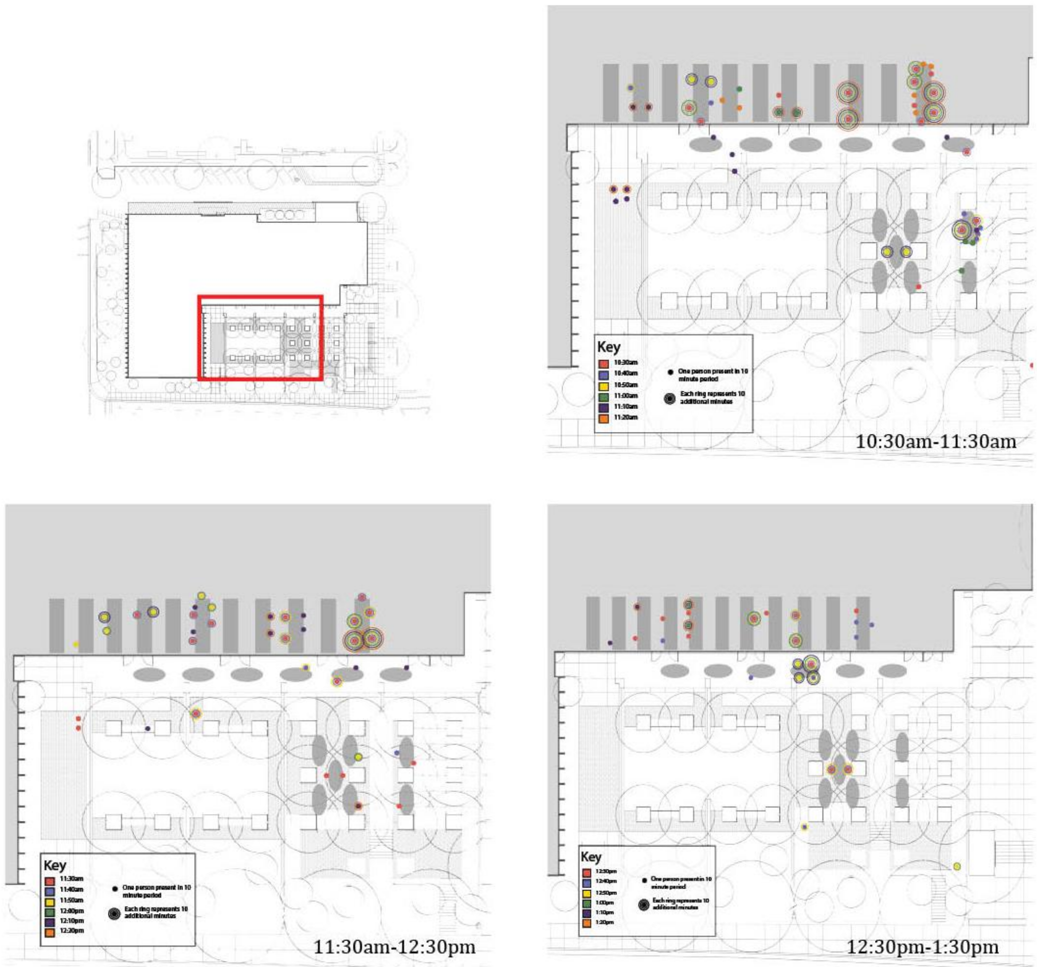


Figure 5: Occupancy diagram

10:30-11:30: 50 people observed
11:30-12:30: 39 people observed
12:30-1:30: 26 people observed

Belo visitors were observed alone reading books, studying alone and in groups, eating lunch alone and in groups, meeting over coffee, talking on and looking at their phones. People used all types of seating provided at the site.

1	High proportion of people in groups	yes
2	Higher than average proportion of	yes

	women	
3	Different ages	yes
4	Varied activities	no
5	Affection	no
6	Integral seating	yes
7	Wind protection	yes
8	Seating in both sun and shade	yes
9	Proximity to water	yes
10	Proximity to food	yes
11	View of the street	yes
12	Contains Trees	yes

10 out of 12 criteria accomplished

Limitations

Though there were different ages observed, these ages appeared to be composed of 2 groups common to a campus environment, students (early 20s) and professors (middle-aged). There were no children or elderly people observed. The various activities observed were either sedentary activities, such as studying, or standing in groups talking. Since no other activities were observed, no credit was given for "varied activities".

This study was conducted during the summer session when fewer students are on campus then the normal school year. In the morning hours, many of the students were wearing badges and appeared to be attending an orientation meeting.

Reference

- Gehl, Jan, and Brigitte Svarre. *How to Study Public Life: Methods in Urban Design*. S.l.: Island, 2013. Print.
- Whyte, William Hollingsworth. *The Social Life of Small Urban Spaces*. Washington, D.C.: Conservation Foundation, 1980. Print.
- http://www.pps.org/