

**Making Privately-Funded Mixed-Use NFL Stadium Development
Feasible:
A Washington DC Case Study**

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Background

As described in the narrative, modern stadiums are becoming larger and more expensive than ever before. In addition, they consume tremendous amounts of land and materials, are rarely used to their full capacity, and oftentimes require a substantial amount of taxpayer funding to build them (Parker, 2015). In a majority of cases, a subsidy is granted to a sports franchise to construct or renovate a new stadium or arena, which typically comes in the form of municipal bonds issued by the team's city or state (Zimbalist & Noll, 1997). A municipal bond can be thought of as a fixed amount of money that is raised for a project beneficial to the community, which is funded by selling attractive, tax-exempt shares to investors. To pay back investors, cities will usually impose an increase in some form of taxes (Roos, 2018). In most cases, municipal bonds are reserved for projects such as road improvements, bridges, airports, public transit, and schools. Projects like this are seen as an investment because they increase productivity and education, creating the potential to increase economic growth and standard of living (Wolla, 2017). Because it has been demonstrated consistently that stadium subsidies usually are not good financial investments for cities (Zimbalist & Noll, 1997), granting them to professional sports franchises has been controversial since they came into existence in the 1950's. This controversy is present because cities are essentially held hostage with the fear of their team relocating to a city that will pay for a new stadium. Ultimately, this creates a bidding war between cities that want to professional sports franchises for their civic and cultural benefits.

Over the last 80 years, no matter what has been done in attempt to financially justify publicly-funded stadiums, there has been no venue that has generated enough revenue to offset taxpayer investment; and as costs keep soaring due to features that aim to attract fans to the games, public contribution is beginning to reach an unsustainable point. Today, there is a continual power struggle between fans that do not want to lose their teams and owners that want to improve

the value of their franchises.

Today, the basic problem with stadium subsidies is the gap between taxpayer investment and return. Although stadiums can provide civic pride, the exorbitant amount of funding required could be better spent on projects that do provide financial return. What makes this situation astonishing is that owners have rarely found new stadiums to be attractive investments. When new venues generate increased revenue through additional amenities, they also cause ticket prices, concessions, and other costs to rise. Because player salaries depend on these increased revenue sources, much of the additional stadium income goes towards payroll. In turn, this allows for the opportunity to build a more competitive team, which will attract more fans and income. This also creates a situation where leftover marginal revenue (amount of change in total revenue created by the sale of one additional unit) is not substantial enough for owners to justify exorbitant construction costs. However, this is not a concern if a large sum of the construction cost is covered by another entity, which is exactly what occurs when a stadium subsidy is granted (Siegfried & Zimbalist, 2000). With all of the moving parts previously mentioned, is there a solution that will allow teams to generate more income to build a competitive team without negatively impacting taxpayers?

This research investigates if mixed use designed within the stadium itself can generate revenue that equals a typical stadium subsidy, which would create justification for a privately-funded venue. Because the Washington Redskins are one of the few teams currently seeking a new stadium, Washington DC was chosen as the city of study.

Methods

1. Baseline subsidy target. Because the goal of the research is to generate enough revenue to offset the cost of an NFL stadium subsidy, a typical subsidy amount needed to be defined. To determine this amount, subsidy percentages from the previous five publicly-funded stadiums were compared and averaged to create a baseline percentage to be used for the purpose of the research. The table below shows construction costs and amounts of funding that were provided by each stadium's city. In the table below, it can be seen that the average public contribution for the last five publicly-funded NFL stadiums is 53%. For the purpose of this research project, this percentage will be generalized as 50% to be set as the target.

Stadium	Year Completed	Public Contribution	Total Construction Cost	Public %
Mercedes-Benz Stadium	2017	\$600 Million	\$1.6 Billion	38%
US Bank Stadium	2016	\$498 Million	\$1.06 Billion	47%
AT&T Stadium	2009	\$325 Million	\$1.3 Billion	25%
Lucas Oil Stadium	2008	\$620 Million	\$720 Million	86%
State Farm Stadium	2006	\$310 Million	\$455 Million	68%
Average				53%

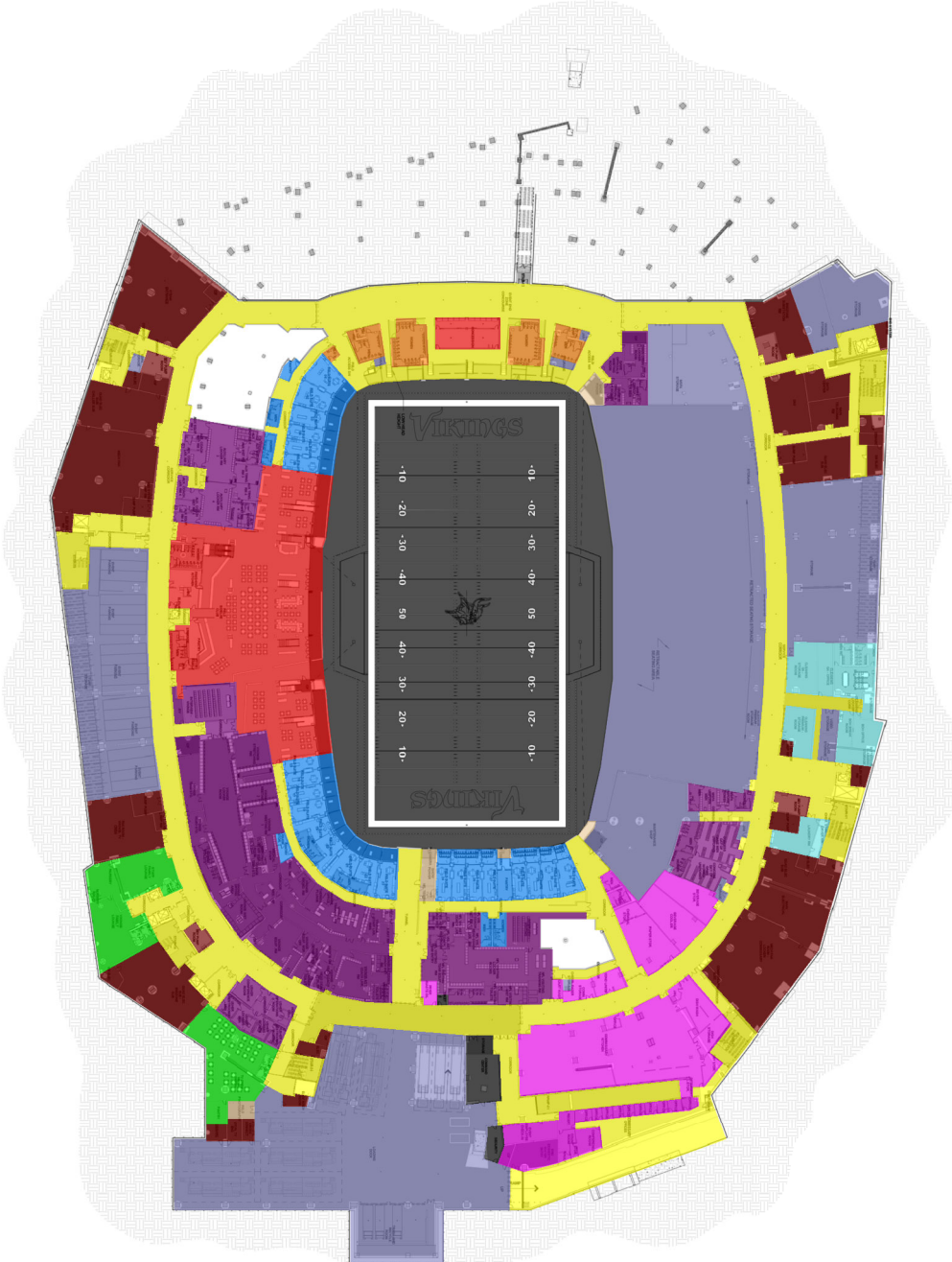
Figure 1. Stadium subsidy amounts for the previous five publicly-funded NFL stadiums.

2. Washington DC stadium parameters. As 50% of total stadium cost was set as the target for the amount of revenue required to be generated by mixed use, there were multiple components that needed to be considered prior to calculating whether the amount of required space to generate adequate revenue was feasible within an NFL stadium envelope. Because the study is aimed towards Washington DC, the definition of “stadium envelope” was determined based upon the desires of the Washington Redskins. Recently, the Bjark Ingles Group was hired by the team to design a potential stadium concept that features a more intimate 60,000-seat stadium. Because US Bank Stadium in Minneapolis is the most recent NFL stadium that is comparable in size, this venue was chosen as a case study to determine the square footage requirements and potential space that would fit within the envelope of a 60,000-seat stadium.

3. US Bank Stadium program case study. The case study for US Bank Stadium looked into multiple aspects of spatial efficiency. In order to obtain accurate square footage amounts for all of the spaces within the stadium, it was required to manually measure square footage through the use of Revit’s room tag function. Floor plan images were imported into Revit, then scaled based upon the size of an NFL field. The process then required each room to be outlined with “room separation lines.” Following the outline process, each room was tagged and color-coated within their respective room occupancy. This allowed for differentiation between spaces that could be compared during the analysis of the stadium.

During the analysis, the square footages of different occupancies were measured to understand the spatial breakups, which would be applied in later processes. On the following pages, the spatial breakup and square footages for every room in US Bank Stadium is shown; the spatial breakups are conveyed level by level.

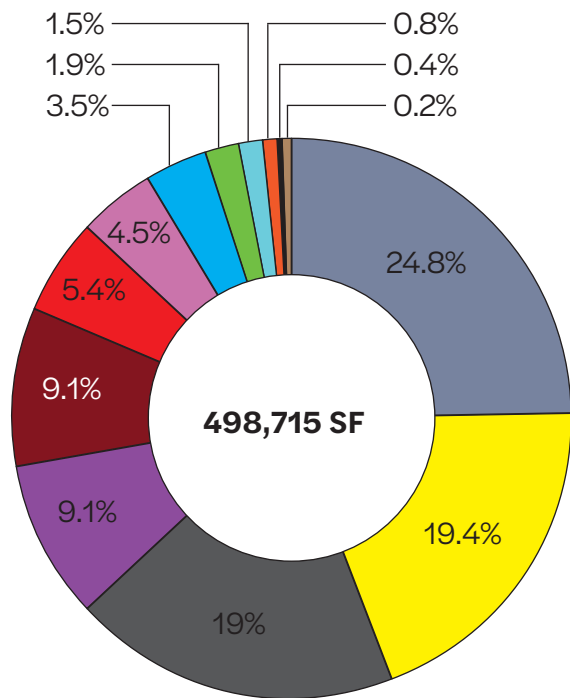
Level 1 - Field Level



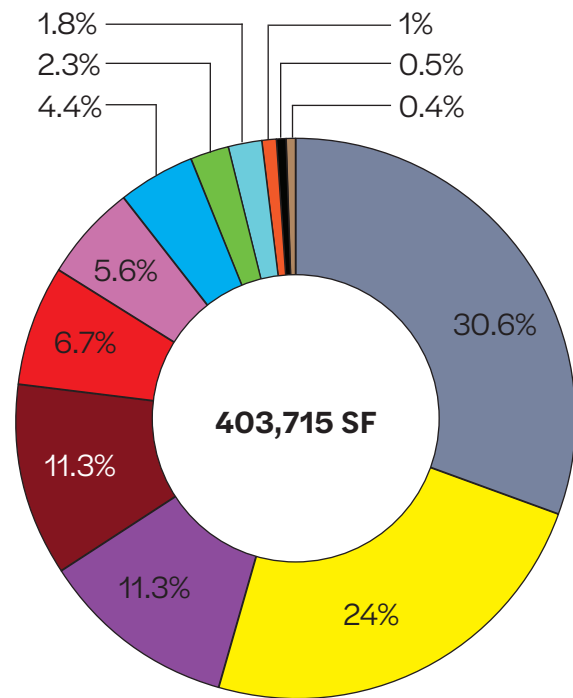
Spatial Breakup

Areas

- Industrial (123,600 SF)
 - Circulation (97,000)
 - Playing Field (95,000 SF)
 - Locker Areas (45,510 SF)
 - Mech/Elec/Other Related (45,410)
 - Areas of Sale (27,250 SF)
 - Commissioner Area (22,750 SF)
- Suite Area (17,630 SF)
 - Private Lounge Area (9,350 SF)
 - Cleaning Services (7,450 SF)
 - Public Restrooms (4,000 SF)
 - Security (2,150 SF)
 - TV/Camera Area (1,615 SF)



Entire Level



"Band Area" (Without Field)

Program**Industrial (123,600 SF)**

Storage Space (70,400 SF)	
Team Storage	13,300 SF
Video Storage	350 SF
Audio Storage	350 SF
Turf Storage	5,650 SF
Auxiliary Storage Space	750 SF
Janitorial Closets	200 SF
Extra Storage Space	44,000 SF
Minnesota Sports Federation Storage	5,700 SF
Cheerleader Storage	100 SF

Other (53,200 SF)	
Loading Dock Area	32,200 SF
Trash & Recycle Room	4,000 SF
Maintenance Shop	6,000 SF
Parking Garage	11,000 SF

Locker Areas (45,510 SF)

Vikings Locker Room (23,950)	
Team Area (10,550 SF)	
Team Lockers	3,900 SF
Stretching Room	1,000 SF
(2) Meeting Rooms	1,700 SF
Team Storage Room 1	850 SF
Team Storage Room 2	450 SF
Video Storage	450 SF
Team Restroom	650 SF
Team Wet Room	850 SF
Drying Area	450 SF
Concession Room	250 SF
Staff Area (4,930 SF)	
Medical Staff Room	300 SF
Medical Room 1	250 SF
Medical Room 2	400 SF
Thermal Plunge	250 SF
Training Room	1,200 SF
Trainer Office	80 SF
Equipment Room	1,200 SF

Equipment Manager Office	500 SF
Staff Locker Room	450 SF
Staff Toilet	100 SF
X-Ray Room	200 SF
Coach/Management Area (2,870 SF)	
Owner's Room	400 SF
Owner's Toilet	100 SF
GM Office	150 SF
Head Coach Office	170 SF
Head Coach Toilet	150 SF
Assistant Coach Locker Room	1,200 SF
Assistant Coach Restroom	450 SF
Assistant Coach Wet Room	250 SF
Interview Area (2,000 SF)	
Interview Room	1,500 SF
A/V Room	250 SF
Mech/Elec/Misc. (3,600 SF)	
Intermediate Distribution Frame (IDF)	350
Circulation	3,250

Visitor Locker Room (7,800 SF)	
Team Area (5,050 SF)	
Team Lockers	2,500 SF
Team Restrooms	700 SF
Team Wet Room	400 SF
Training Room	900 SF
Equipment Room	550 SF
Coach/Staff Area (1,240 SF)	
Head Coach Locker Room	180 SF
Head Coach Wet Room	180 SF
Assistant Coach Locker Room	380 SF
Assistant Coach Wet Room	200 SF
Coaches Restroom	300 SF
Interview Area (900 SF)	
Interview Room	900 SF
Mech/Elec/Misc. (610 SF)	
Circulation	610 SF

Auxiliary Locker Room 1 (3,280 SF)	
Team Area (2,450 SF)	
Team Lockers	1,200 SF
Team Restroom/Wet Room	650 SF
Training Room	400 SF
Equipment Room	200 SF
Coach Area (830 SF)	
Coach Locker Room	350
Coach Wet Room & Toilet	350
Miscellaneous Area	130
Auxiliary Locker Room 2 (2,700 SF)	
Team Area (2,000 SF)	
Team Lockers	900 SF
Team Restroom/Wet Room Area	550 SF
Training Room	350 SF
Equipment Room	200 SF
Coach Area (700 SF)	
Coach Locker Room	350 SF
Coach Wet Room & Toilet	250 SF

Miscellaneous Area	100 SF
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Game Officials Locker Room (2,080 SF)	
Locker Area (1,750 SF)	
Mens Official Locker Room	500 SF
Womens Official Locker Room	300 SF
Chain Crew Locker Room	600 SF
Official Meeting Room	350 SF
Mech/Elec/Misc. (330 SF)	
Intermediate Distribution Frame (IDF)	230 SF
Circulation	100 SF

Concession Worker Lockers (2,900 SF)	
Locker Area (2,750 SF)	
Mens Locker Room	1,100 SF
Mens Restroom	500 SF
Womens Locker Room	800 SF
Womens Restroom	350 SF
Mech/Elec/Misc. (150 SF)	
Circulation	150 SF

Usher Lockers (2,500 SF)	
Locker Area (2,200 SF)	
Mens Locker Room	400 SF
Mens Restroom	300 SF
Womens Locker Room	300 SF
Womens Restroom	250 SF
Usher Conference Room	500 SF
Usher Operations Rooms	450 SF
Mech/Elec/Misc. (300 SF)	
Circulation	300 SF

MSFA Uniform Lockers (1,130 SF)	
Locker Area (1,130 SF)	
Mens Locker Room	300 SF
Mens Restroom	250 SF
Womens Locker Room	300 SF
Womens Restroom	250 SF
Miscellaneous Space	30 SF

Mech/Elec/Other Related (45,410 SF)

Mechanical Fan Rooms (19,600 SF)	
Lower Level Fan Room	5,500 SF
Private Lounge Fan Room	2,700 SF
Visitor Locker & Commissionary Fan Room	5,500 SF
Steam Room	5,900 SF
Main Electrical Rooms (15,250 SF)	
Zone 1 Room	3,750 SF
Zone 2 Room	4,700 SF
Zone 3 Room	3,600 SF
Zone 4 Room	3,200 SF
Beverage Pumps (for Concessions Above - 1,800 SF)	
Pump Room 1	450 SF
Pump Room 2	400 SF
Pump Room 3	500 SF
Pump Room 4	400 SF
Sump Pumps (1,750 SF)	
Pump Room 1	450 SF
Pump Room 2	400 SF
Pump Room 3	500 SF
Pump Room 4	400 SF

Sound System Amp Rooms (650 SF)	
Room 1	150 SF
Room 2	150 SF
Room 3	150 SF
Room 4	200 SF
Information Technology (5,150 SF)	
Data Center	850 SF
Main Telecommunications Room	800 SF
OAS Room	1,800 SF
Other Space	1,700 SF
Fire Stair/Elevator Areas (1,200 SF)	
Electrical Rooms	300 SF
Elevator Mechanical Rooms	760 SF
Intermediate Distribution Frame (IDF)	150 SF

Areas of Sale (27,250 SF)

Bar/Restaurant/Lounge (25,650 SF)	
Club Area (24,650 SF)	
Kitchen	1,000 SF

Pantry	450 SF
Lounge Area	22,500 SF
Mens Restroom	550 SF
Womens Restroom	750 SF
Family Restroom	100 SF
Mech/Elec/Misc. (300 SF)	
Intermediate Distribution Frame (IDF)	130 SF
Circulation	170 SF

General Concession (1,600 SF)

Commissionary Area (22,750 SF)

Storage Area (5,880 SF)	
Beverage Storage	1,200 SF
Beverage Cooler	1,500 SF
Paper Storage	1,500 SF
Chemical Storage	300 SF
Commercial Storage	400 SF
Mens Restroom	250 SF
Womens Restroom	300 SF
Fryer Waste Oil	280 SF
Cart Wash	150 SF

Kitchen Area (11,800 SF)	
Commissionary Kitchen	9,700 SF
Dish wash	1,000 SF
Janitorial Closet	150 SF
Dish Storage	550 SF
Dry Storage	250 SF
Detergent Storage	150 SF
Administrative Area (2,250 SF)	
(10) Private Offices	1,150 SF
Conference Room	450 SF
Receipt	250 SF
Count Room	400 SF
Entry Area (1,700 SF)	
Employee Check-In	800 SF
Domestic Water Entry	900 SF
Mech/Elec/Misc. (1,120 SF)	
Intermediate Distribution Frame (IDF)	150 SF
Condenser Unity (For Cooler)	500 SF
Circulation	470 SF

Suite Area (17,630 SF)

Suite Boxes	14,780 SF
Serving Restrooms	1,950 SF
Serving Pantry Areas	900 SF

Private Lounge (9,350 SF)

Staff & Player Family Lounge	
Staff Family Lounge (1,660 SF)	
Family Lounge Area	1,500 SF
Mens Toilet	80 SF
Womens Toilet	80 SF
Nursery Area (1,000 SF)	
Nursery Room	900 SF
Nursery Toilet	100 SF
Player Family Lounge (2,200 SF)	
Family Lounge Area	2,000 SF
Mens Toilet	100 SF
Womens Toilet	100 SF

Misc. (190 SF)	
Circulation	190 SF

TV Crew/Media Lounge (4,300 SF)	
Lounge Area (4,210 SF)	
Lounge Area	3,700 SF
Pantry	350 SF
Mens Toilet	80 SF
Womens Toilet	80 SF
Misc. (90 SF)	
Circulation	90 SF

Cleaning Services (7,450 SF)

Cleaning (1,100 SF)	
Laundry Room	850 SF
Dryer Room	200 SF
Chemical Storage Closet	50 SF
Storage (2,750 SF)	
Premium Cleaning Storage Room	1,000 SF
Cleaning Storage Room	1,100 SF

Suite/Club Cleaning Storage Room	400 SF
Extra Storage	250 SF
Employee Area (3,600 SF)	
Administrative Office	650 SF
Cleaning Services Break Room	900 SF
BOH Office	600 SF
BOH Break Room	400 SF
Restrooms	650 SF
Circulation	400 SF

Public Restrooms (4,000 SF)

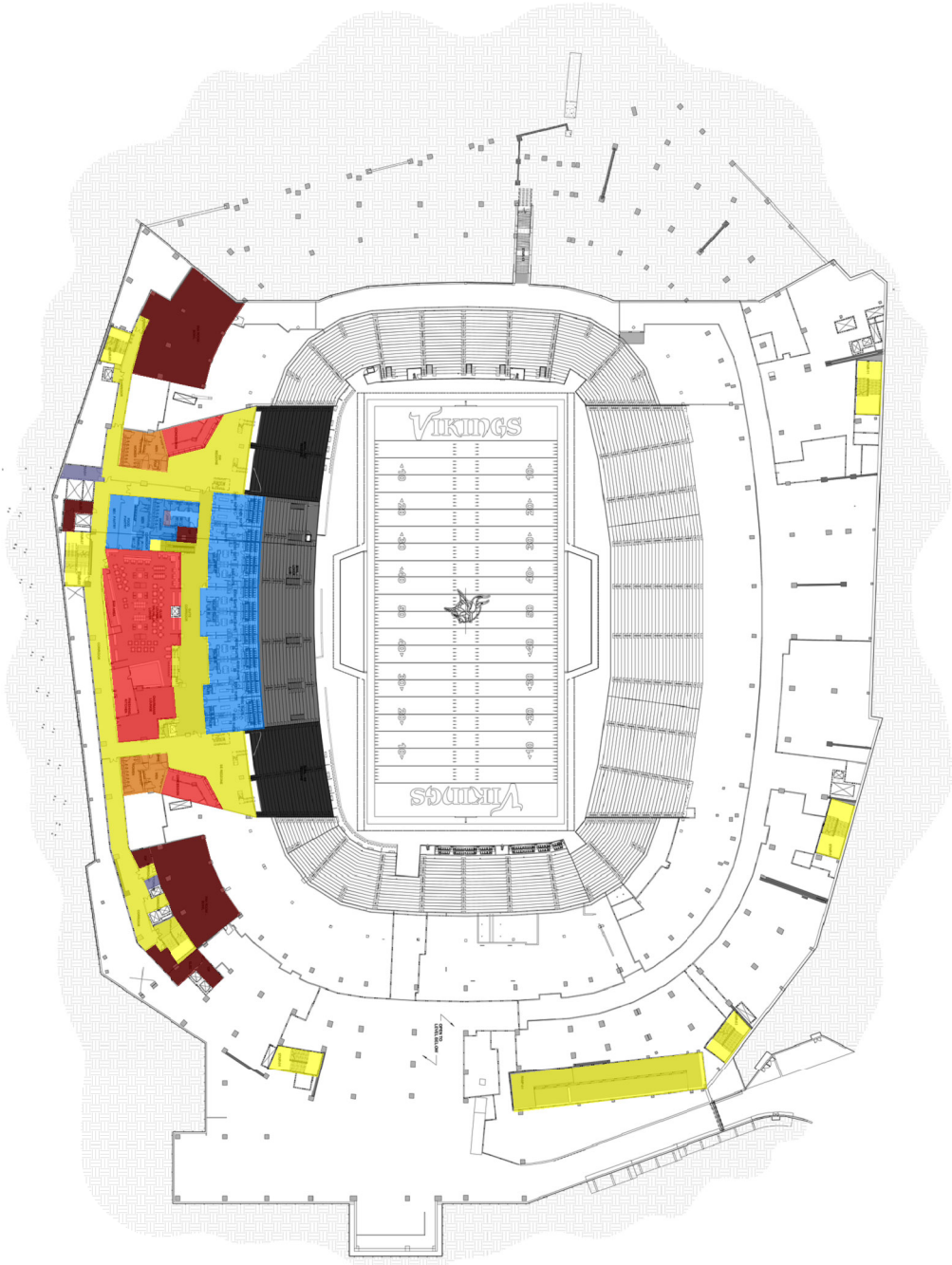
Security (2,150 SF)

Command Center	1,200 SF
Security Room	400 SF
Storage Room	350 SF
Toilet	80 SF
Circulation	120 SF

TV/Camera Area (1,615 SF)

Camera Wells	450 SF
Show Power Rooms	815 SF
Photography Room	350 SF

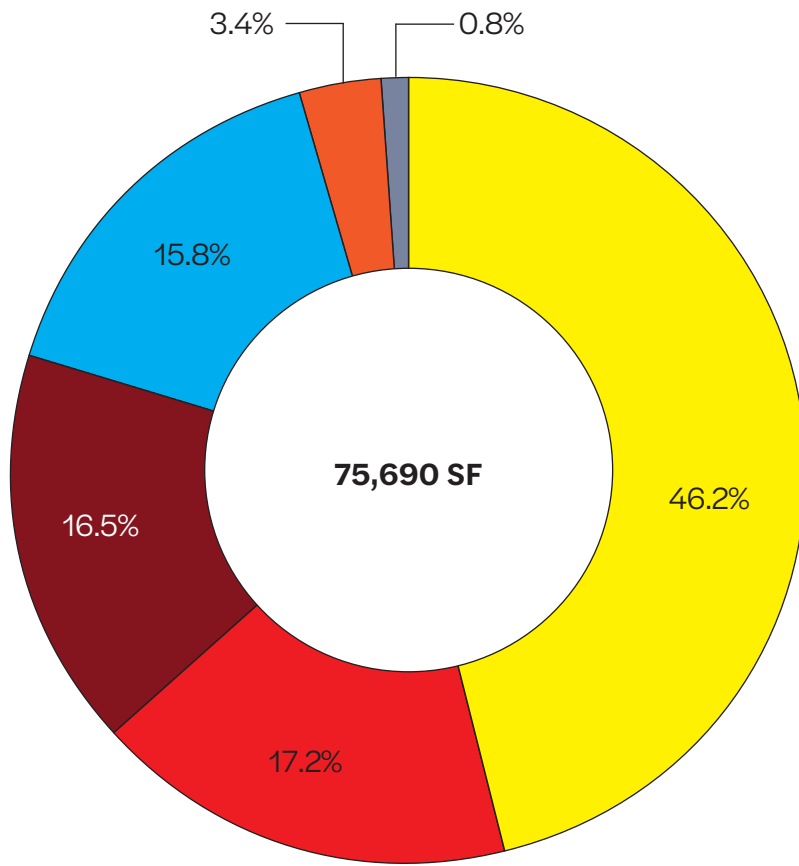
Level 2 - Sideline Suite Level



Spatial Breakup

Areas

- Circulation (35,000 SF)
- Areas of Sale (13,000 SF)
- Mech/Elec/Other Related (12,500)
- Suite Area (11,950 SF)
- Public Restrooms (2,600 SF)
- Industrial (640 SF)



Program

Areas of Sale (13,000 SF)

Bar/Restaurant/Lounge (10,800 SF)	
Kitchen	1,400 SF
Bar	550 SF
Pantry Areas	1,100 SF
Lounge Area	7,750 SF

Club Concession (2,200 SF)

Mech/Elec/Other Related (12,500 SF)

Mechanical Fan Rooms (10,450 SF)	
Lower Bowl Fan Room 1	6,100 SF
Lower Bowl Fan Room 2	4,350 SF
Fire Stair/Elevator Areas (2,050 SF)	
Electrical Rooms	1,300 SF
Intermediate Distribution Frame (IDF)	750 SF

Suite Area (11,950 SF)

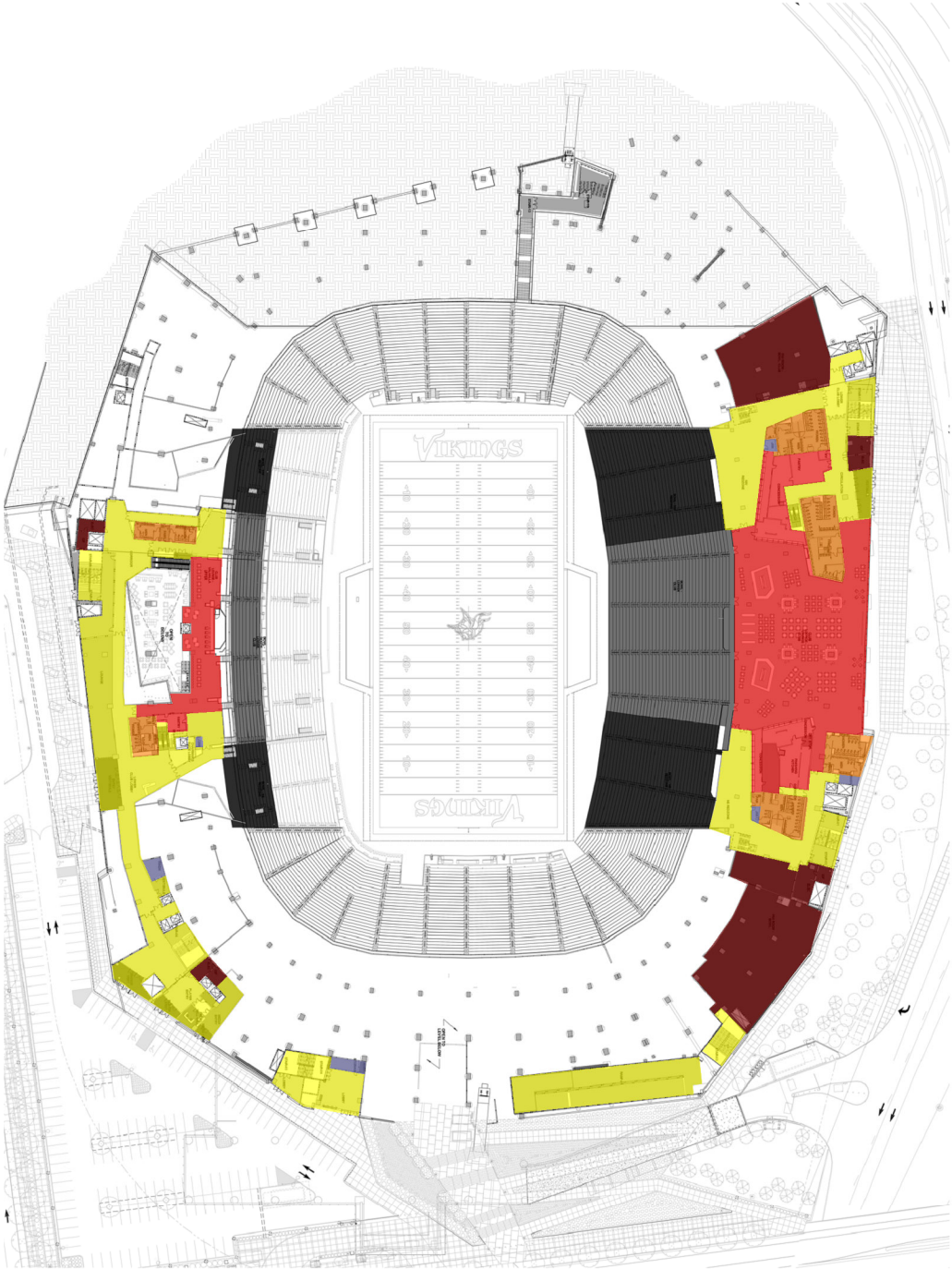
Suite Boxes	10,000 SF
Serving Restrooms	1,950 SF

Public Restrooms (2,600 SF)

Industrial (640 SF)

Storage Space (640 SF)	
Trash Rooms	450 SF
Janitorial Closets	80 SF
Storage	110 SF

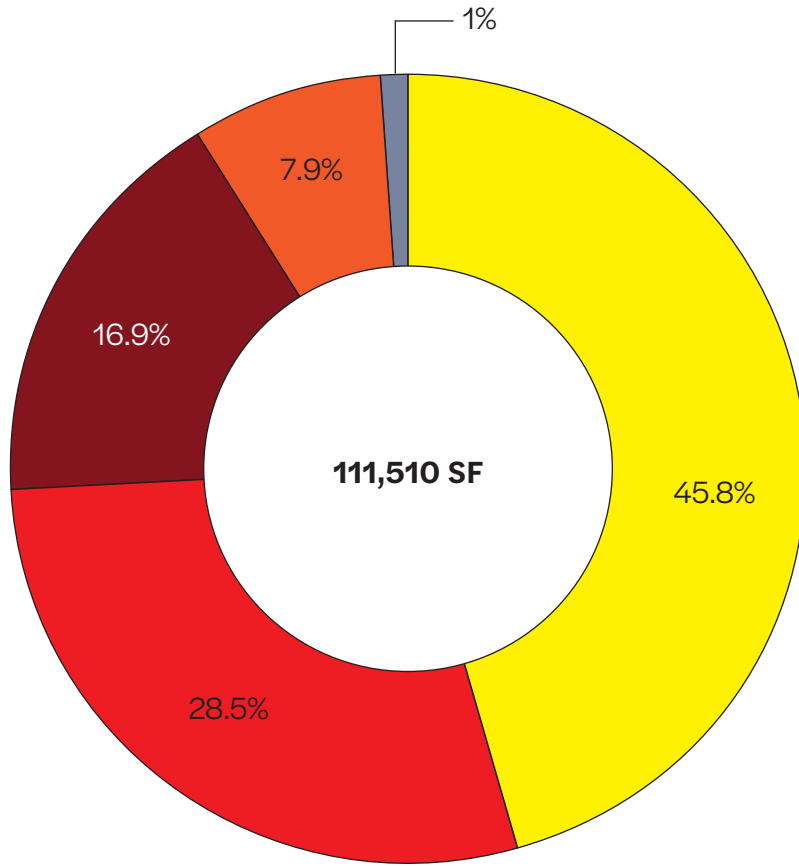
Level 3 - Lower Club Level



Spatial Breakup

Areas

- Circulation (51,000 SF)
- Areas of Sale (31,800 SF)
- Mech/Elec/Other Related (18,800)
- Public Restrooms (8,850 SF)
- Industrial (1,060 SF)



Program

Areas of Sale (13,000 SF)

Bar/Restaurant/Lounge (31,800 SF)	
Kitchen	1,200
Club Concession (built into club area)	4,500
Pantry Areas	1,300
Lounge Area	24,800

Mech/Elec/Other Related (18,800 SF)

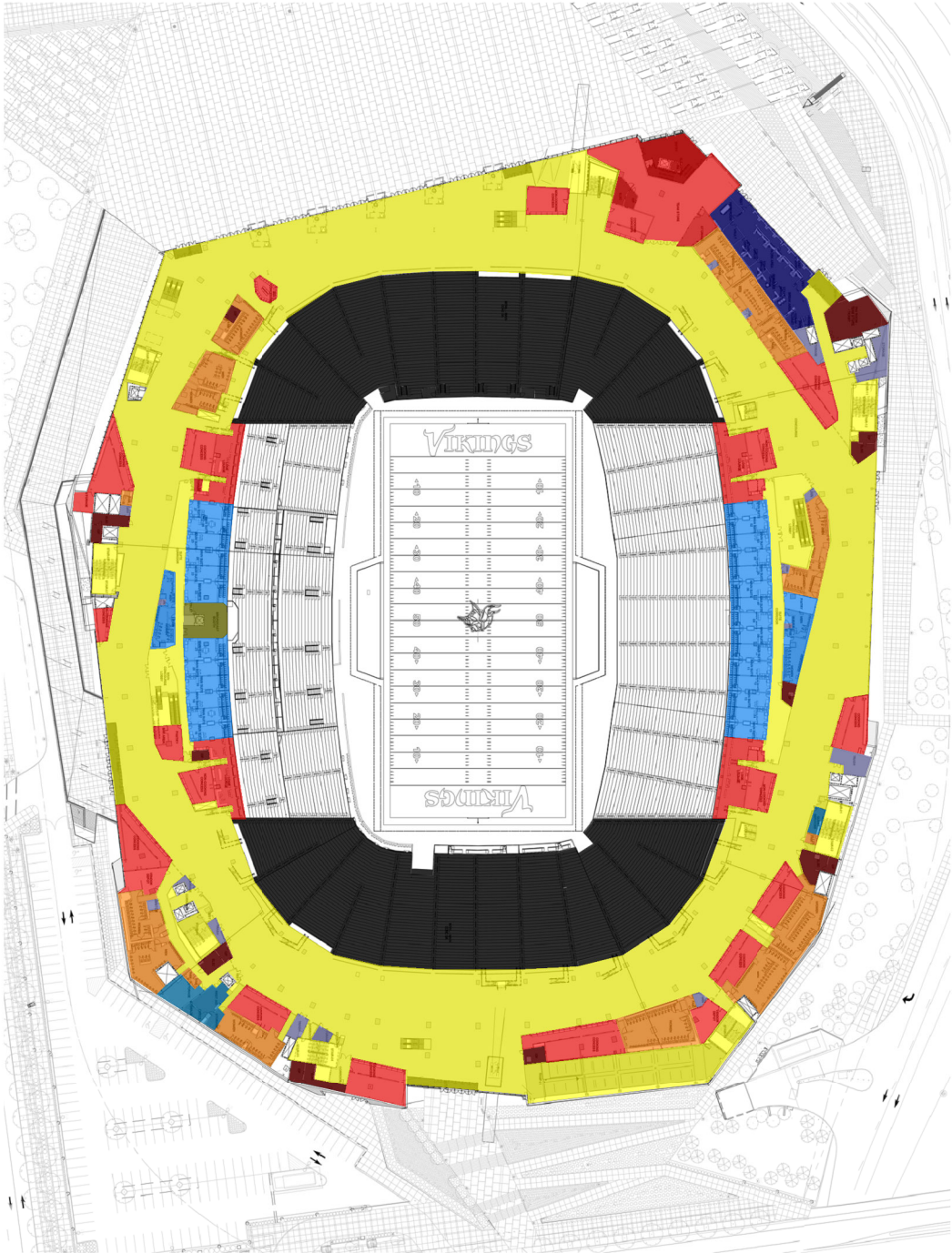
Mechanical Fan Rooms (16,500 SF)	
Lower Club Fan Room	6,500 SF
Lower Bowl Fan Room	10,000 SF
Fire Stair/Elevator Areas (2,300 SF)	
Electrical Rooms	1,400 SF
Intermediate Distribution Frame (IDF)	900 SF

Public Restrooms (8,850 SF)

Industrial (1,060 SF)

Storage Space (1,060 SF)	
Trash Rooms	430 SF
Janitorial Closets	280 SF
Storage	350 SF

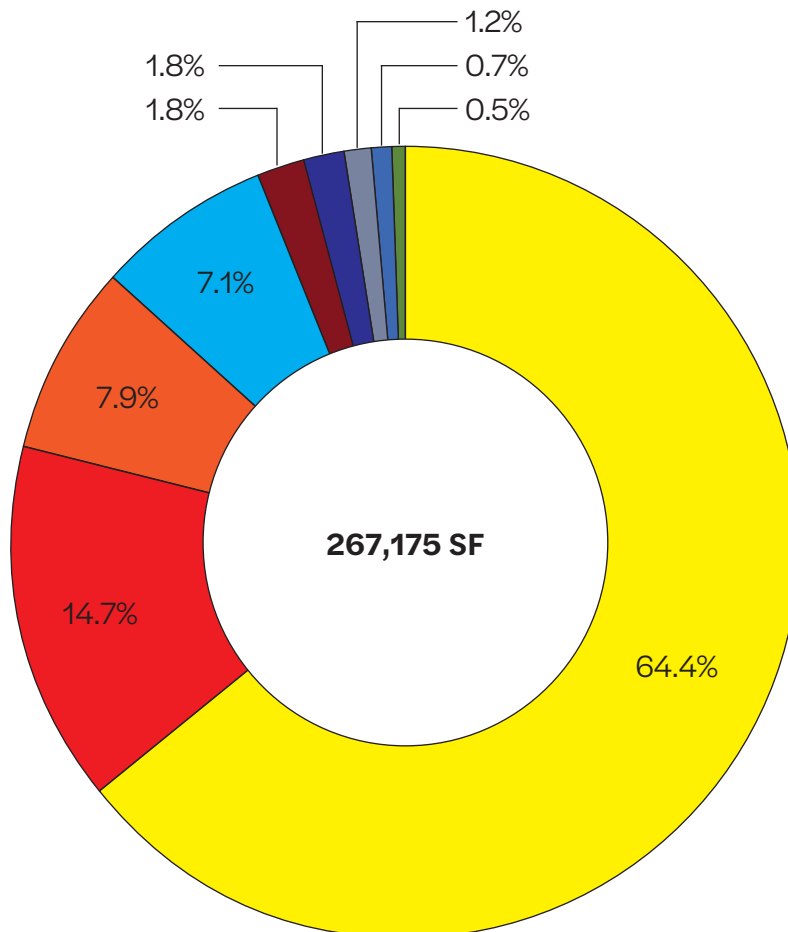
Level 4 - Main Concourse Level



Spatial Breakup

Areas

- Circulation (172,000 SF)
- Administrative Office Area (4,810 SF)
- Areas of Sale (39,275 SF)
- Industrial (3,100 SF)
- Public Restroom (21,000 SF)
- Guest Services (1,930 SF)
- Suite Area (18,950 SF)
- Press Area (1,260 SF)
- Mech/Elec/Other Related (4,850 SF)



Program

Areas of Sale (39,275 SF)

Bar/Restaurant/Lounge (8,000 SF)	
Lounge Area	6,900 SF
Pantry Areas	1,100 SF

Team Store (8,275 SF)

General (7,100 SF)	
Entry Area	1,800 SF
Apparel	5,300 SF

Misc. (1,125 SF)

Electrical Room	250 SF
Intermediate Distribution Frame (IDF)	150 SF
Storage	725 SF

General Concession (23,000 SF)

Public Restrooms (21,000 SF)

Suite Area (18,950 SF)

Suite Boxes	16,000 SF
Serving Restrooms	2,500 SF
Serving Pantry Areas	450 SF

Mech/Elec/Other Related (4,850 SF)

Mechanical Fan Rooms (1,600 SF)	
Team Store & Ticket Office Fan Room	1,600 SF
Fire Stair/Elevator Areas (3,250 SF)	
Electrical Rooms	1,950 SF
Intermediate Distribution Frame (IDF)	1,300 SF

Administrative Office Area (4,810 SF)

Ticket Office (4,810 SF)	
Work Area	2,900 SF
Work Room	500 SF
(5) Private Offices	900 SF
Break Room	250 SF
Storage Closet	100 SF
Mens Toilet	80 SF
Womens Toilet	80 SF

Industrial (3,100 SF)

Storage Space (3,100 SF)	
Trash Rooms	1,100 SF
Janitorial Closets	650 SF
Storage	1,350 SF

Guest Services (1,930 SF)

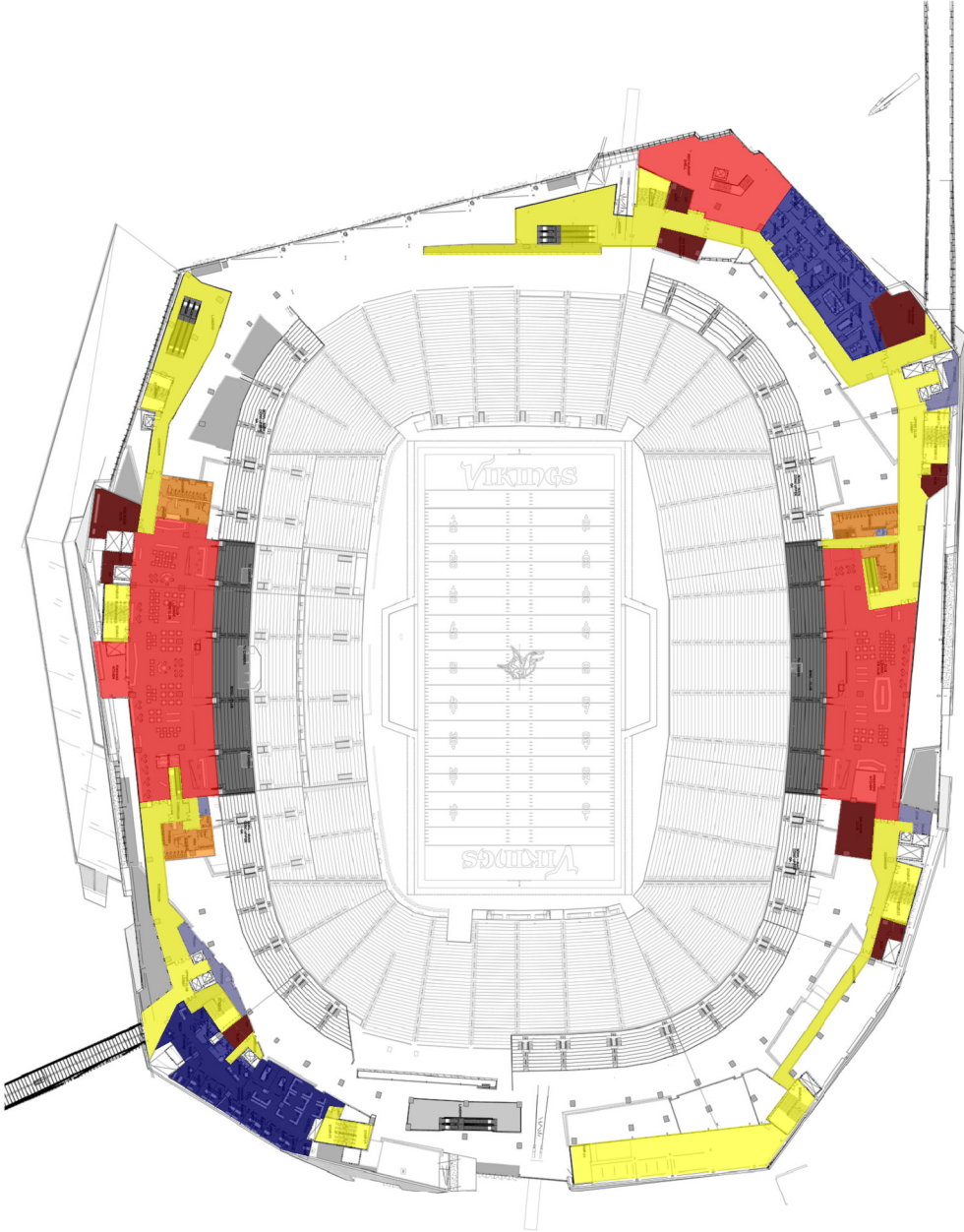
First Aid Area (1,680 SF)	
First Aid Room	600 SF
Office	80 SF
Storage Areas	1,000 SF

Guest Services Booth (250 SF)

Press Area (1,260 SF)

Broadcast Booth (1,260 SF)

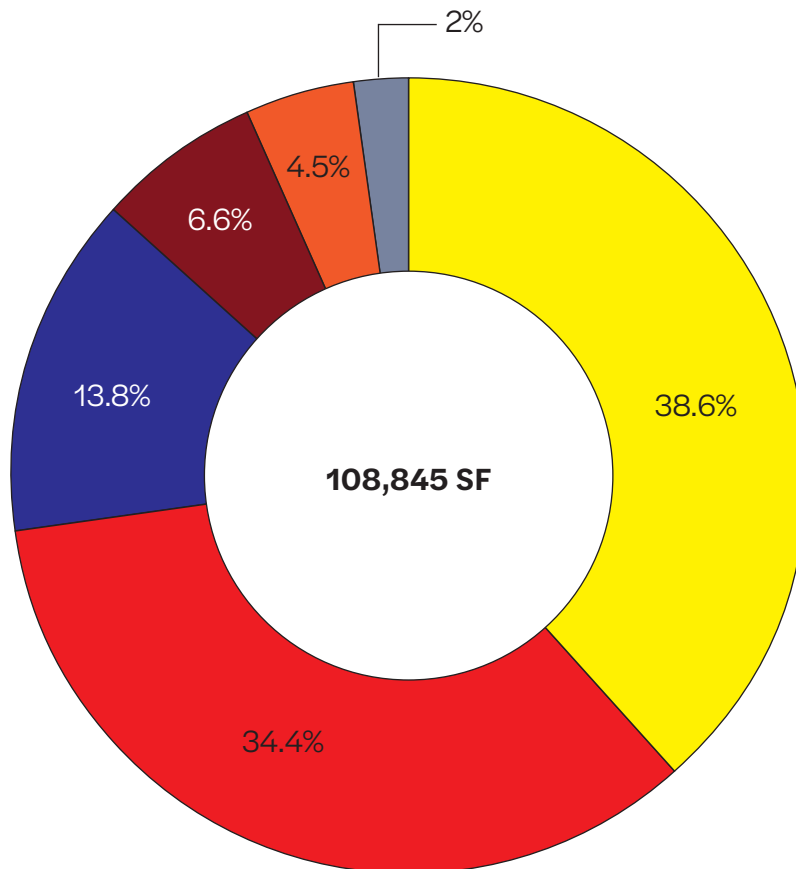
Level 5 - Upper Club Level



Spatial Breakup

Areas

- Circulation (42,000 SF)
- Areas of Sale (37,400SF)
- Administrative Office Area (15,050 SF)
- Mech/Elec/Other Related (7,235 SF)
- Public Restroom (4,950SF)
- Industrial (2,210 SF)



Program

Areas of Sale (37,400 SF)

Bar/Restaurant/Lounge (37,400 SF)	
Kitchen	1,900 SF
Lounge Area	35,500 SF

Administrative Office Area (15,050 SF)

MSFA Offices (7,050 SF)	
Reception Area	350 SF
Offices	2,800 SF
Work Room	200 SF
Conference Room 1	800 SF
Conference Room 2	400 SF
Break Room	250 SF
Storage Closets	300 SF
Mens Restroom	250 SF
Womens Restroom	280 SF
Circulation	1,420 SF

Vikings Staff Offices (8,000 SF)	
Reception Area	600 SF

Offices	2,200
Work Area	2,300
Work Room	150
Conference Room 1	400
Conference Room 2	350
Break Room	350
Storage Closets	120
Mens Restroom	250
Womens Restroom	250
Data Room	150
Circulation	880

Mech/Elec/Other Related (7,235 SF)

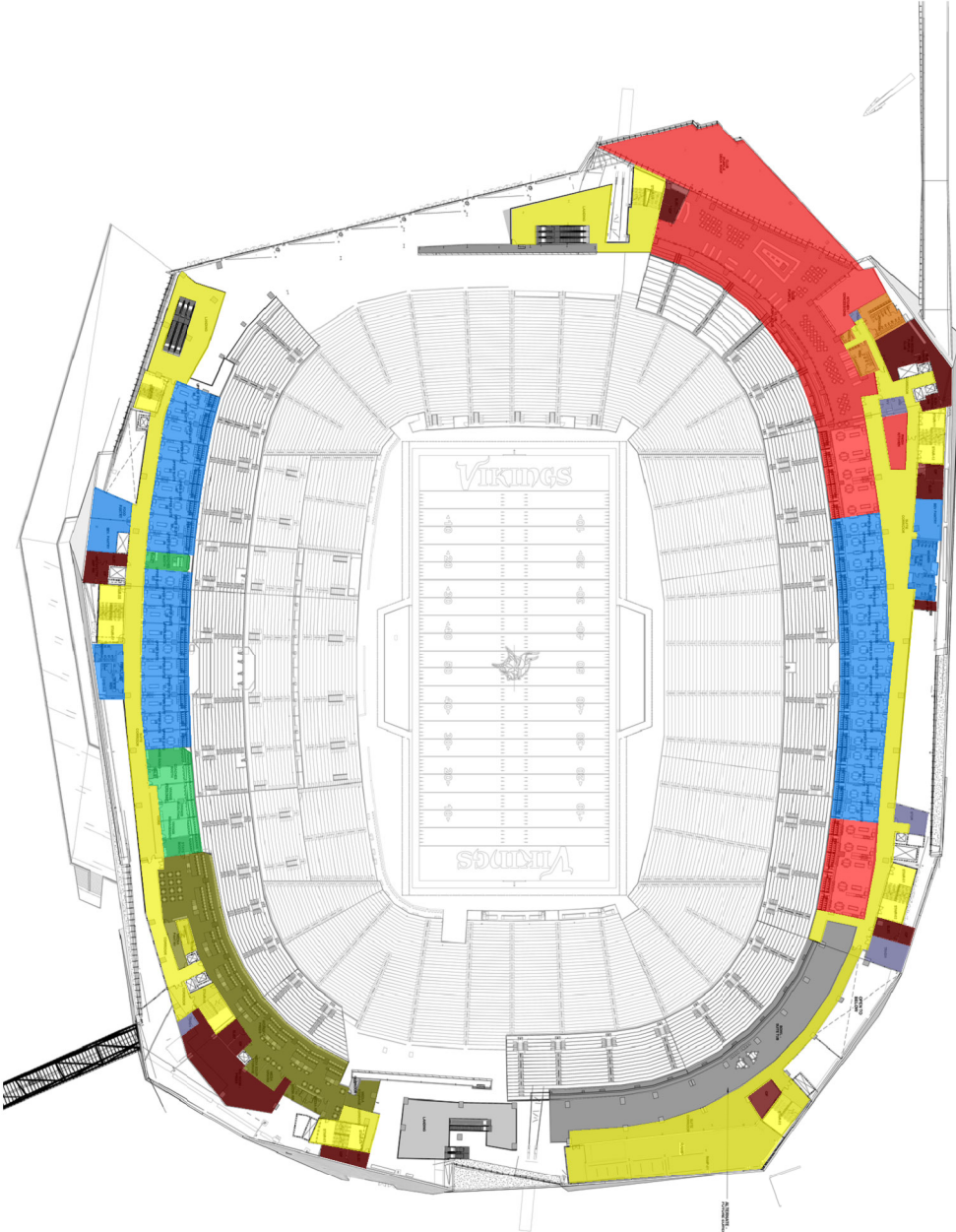
Mechanical Fan Rooms (5,000 SF)	
MSFA Office Fan Room	1,600 SF
Club Area Fan Room 1	1,400 SF
Club Area Fan Room 2	1,300 SF
Restaurant Area Fan Room	700 SF
Fire Stair/Elevator Areas (2,235 SF)	
Electrical Rooms	1,370 SF
Intermediate Distribution Frame (IDF)	865 SF

Public Restrooms (21,000 SF)

Industrial (2,210 SF)

Storage Space (2,210 SF)	
Trash Rooms	450 SF
Janitorial Closets	60 SF
Storage Space	1,550 SF
A/V Room	150 SF

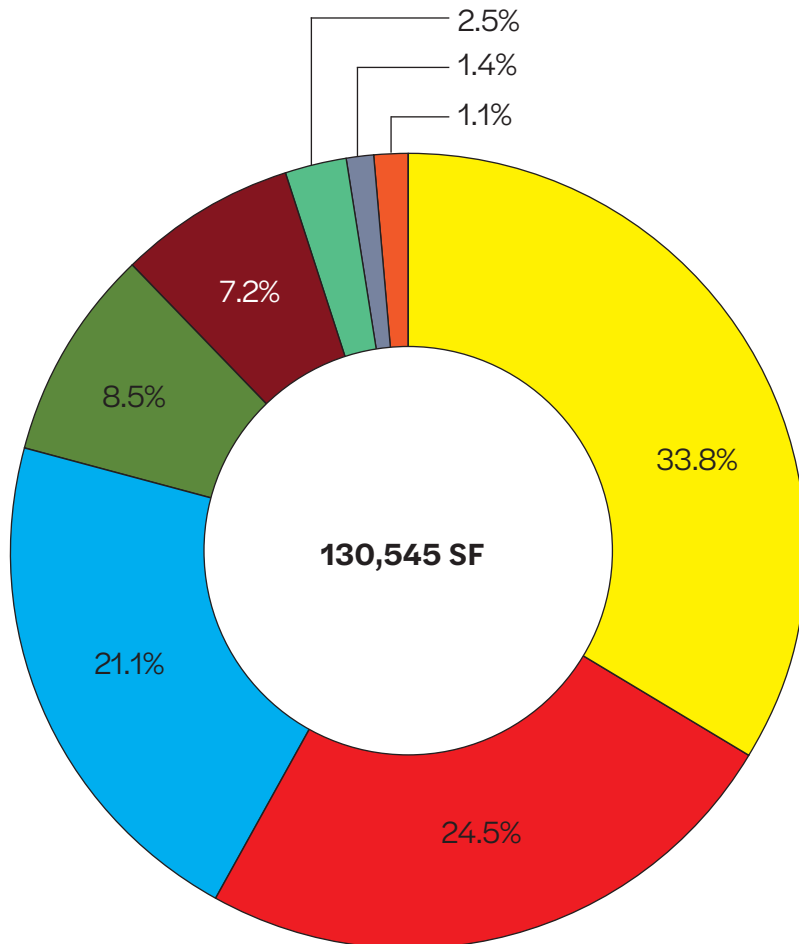
Level 6 - Upper Suite Level



Spatial Breakup

Areas

- Circulation (44,000 SF)
- Areas of Sale (31,800 SF)
- Suite Area (27,360 SF)
- Press Area (11,680 SF)
- Mech/Elec/Other Related (9,330 SF)
- Coaches Booth (3,130 SF)
- Industrial (1,795 SF)
- Public Restroom (1,450 SF)



Program

Areas of Sale (31,800 SF)

Bar/Restaurant/Lounge (31,800 SF)	
Kitchen	2,500 SF
Lounge Area	29,300 SF

Suite Area (27,360 SF)

Suite Boxes	22,800 SF
Serving Restrooms	2,280 SF
Serving Pantry Areas	2,280 SF

Press Area (11,680 SF)

Press Box (11,080 SF)	
Press Area	9,200 SF
Media Work Room	280 SF
Media Equipment Storage	220 SF
Media Storage Closet	500 SF
Pantry	380 SF
Mens Restroom	250 SF
Womens Restroom	250 SF

Home Radio (600 SF)

Mech/Elec/Other Related (9,330 SF)

Mechanical Fan Rooms (4,950 SF)	
Club Fan Room	1,900 SF
Press Area Fan Room	3,050 SF
Sound System Amp Rooms (430 SF)	
Room 1	150 SF
Room 2	280 SF
Fire Stair/Elevator Areas (3,950 SF)	
Electrical Rooms	1,900 SF
Intermediate Distribution Frame (IDF)	1,750 SF
Elevator Control Rooms	300 SF

Coaching Boxes (3,130 SF)

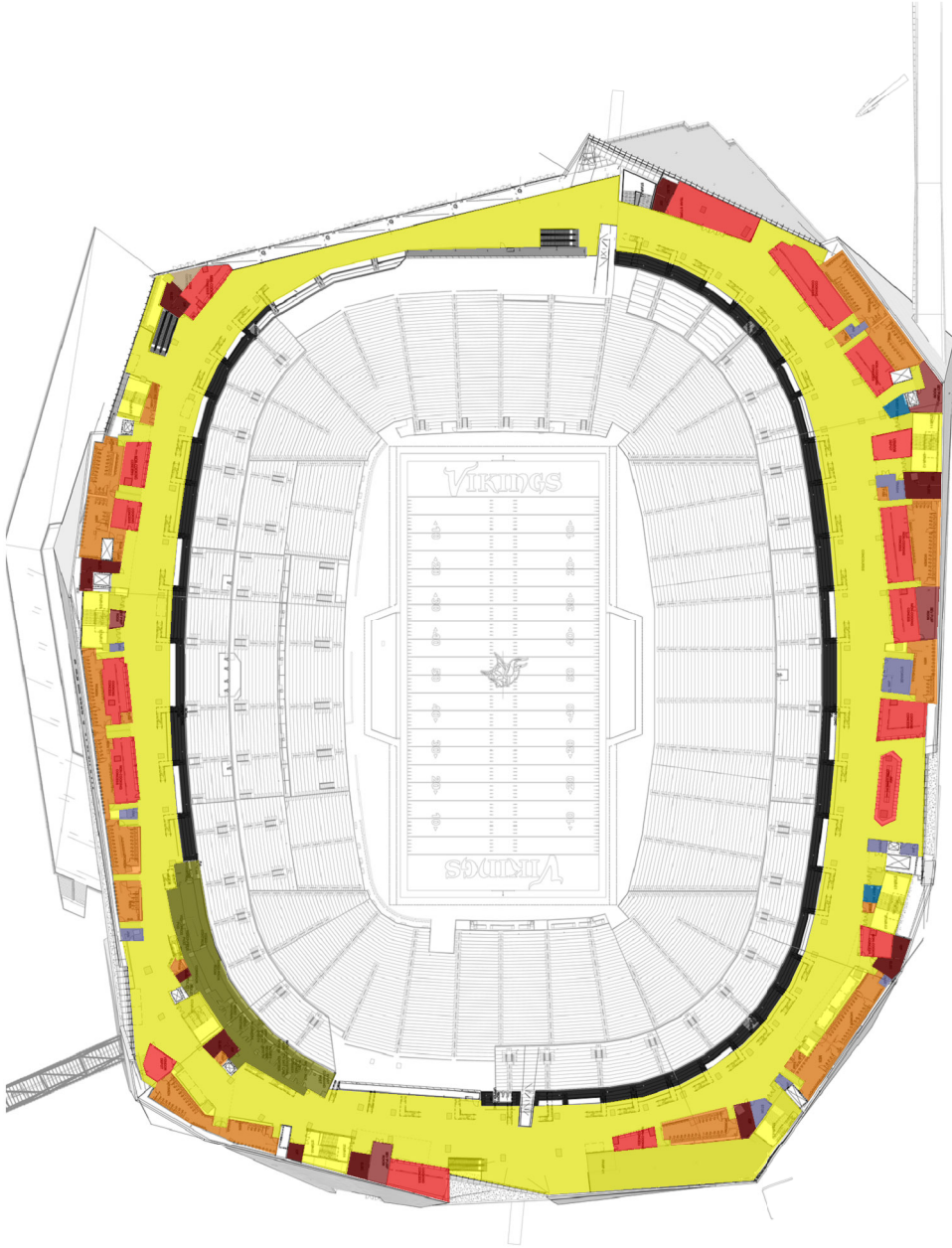
Coaches Booth 1	550 SF
Coaches Booth 2	580 SF
Vikings Personnel	500 SF
Vikings Scouting	500 SF
Vikings Management	500 SF
Stats Booth	500 SF

Industrial (1,795 SF)

Storage Space (1,795 SF)	
Trash Rooms	930 SF
Janitorial Closets	215 SF
Storage Space	500 SF
A/V Room	150 SF

Public Restrooms (1.450 SF)

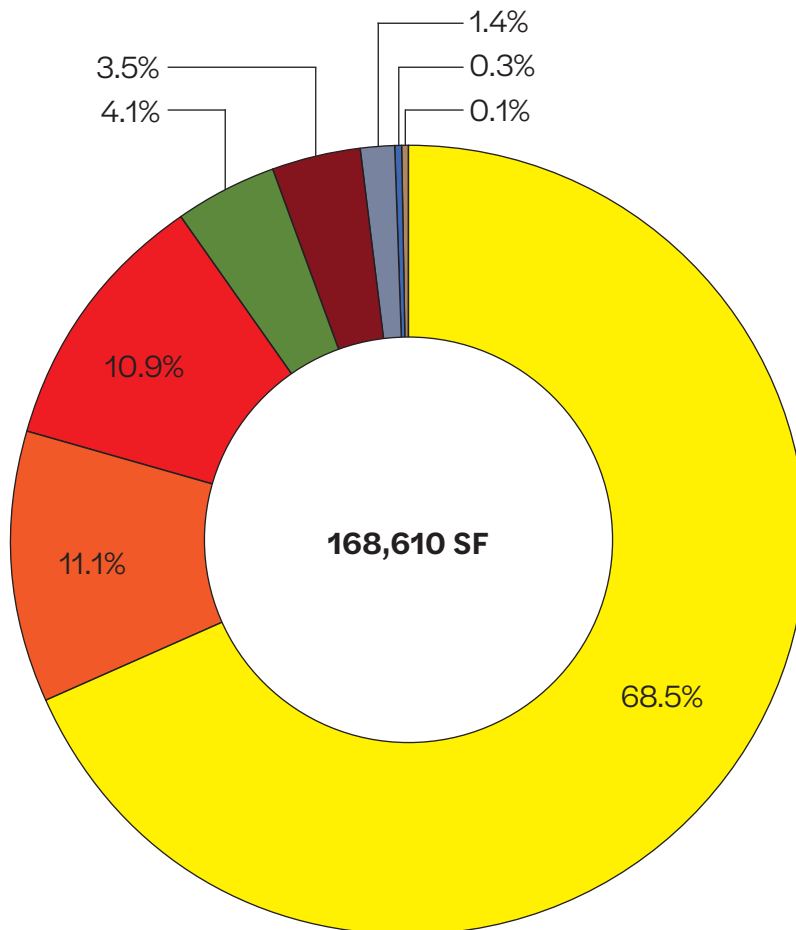
Level 7 - Upper Concourse Level



Spatial Breakup

Areas

- Circulation (115,500 SF)
- Public Restroom (18,780 SF)
- Areas of Sale (18,350 SF)
- Press Area (6,950 SF)
- Mech/Elec/Other Related (5,930 SF)
- Industrial (2,400 SF)
- Guest Services (450 SF)
- TV/Camera Area (250 SF)



Program

Public Restrooms (18,780 SF)

Areas of Sale (18,350 SF)

General Concession (16,450 SF)

Team Store (1,900 SF)

Press Area (6,950 SF)

Video/Radio Press Box (6,950 SF)	
PA Announcer	120 SF
Control Room	215 SF
Video Production Pods	240 SF
Video Control Room	1,050 SF
Video Rack Room	850 SF
Mens Restroom	80 SF
Womens Restroom	80 SF
Individual Broadcast Booths	1,860 SF
Event Command Center	475 SF
Circulation	1,980 SF

Mech/Elec/Other Related (5,930 SF)

Beverage Pumps	
Room 1	700
Room 2	750
Room 3	580
Room 4	200
Fire Stair/Elevator Areas (3,700 SF)	
Electrical Rooms	2,100 SF
Intermediate Distribution Frame (IDF)	1,600 SF

Industrial (2,400 SF)

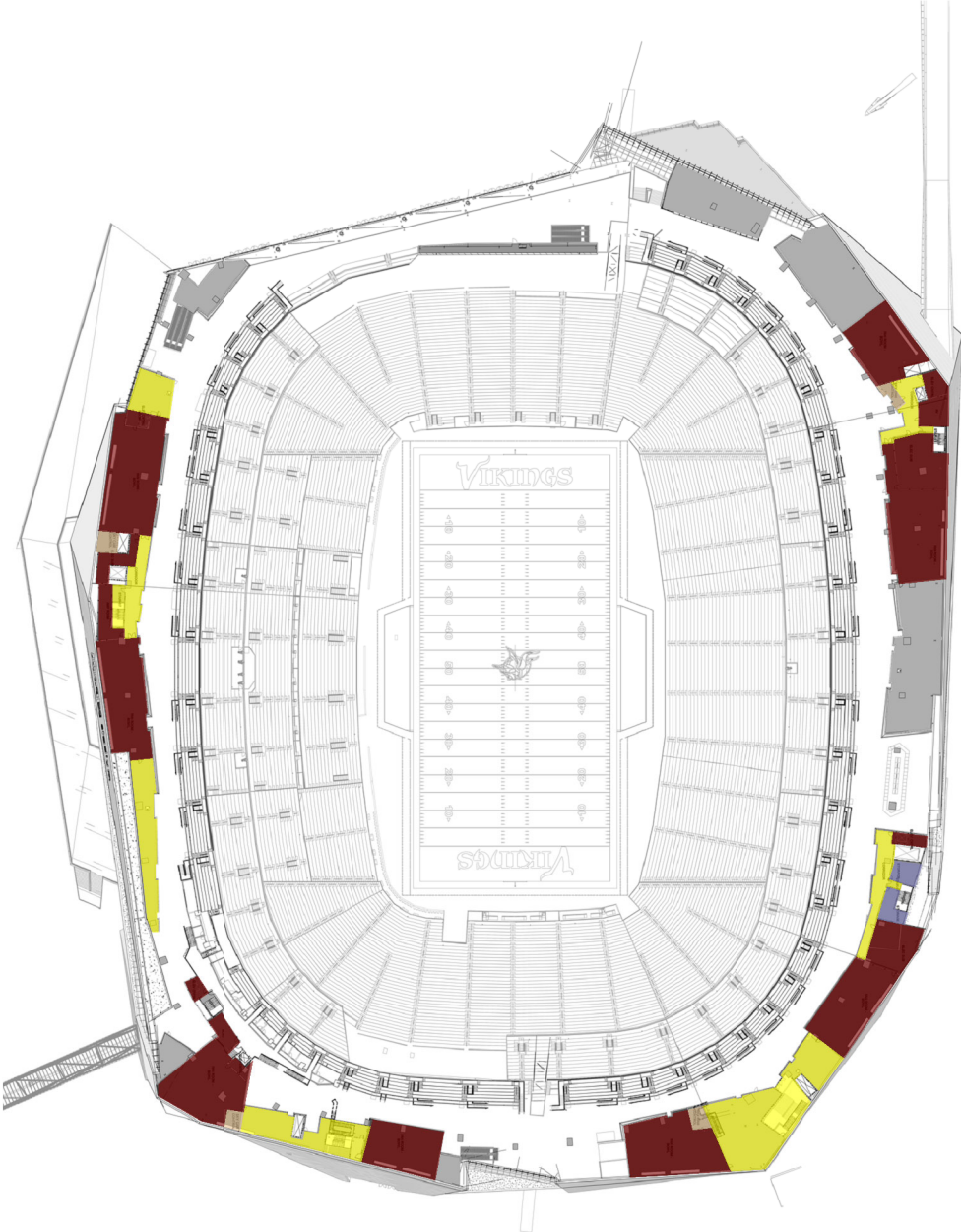
Storage Space (1,795 SF)	
Trash Rooms	550 SF
Janitorial Closets	1,000 SF
Storage Space	850 SF

Guest Services (450 SF)

First Aid Area (200 SF)
Guest Services Booth (250 SF)

TV/Camera Area (250 SF)

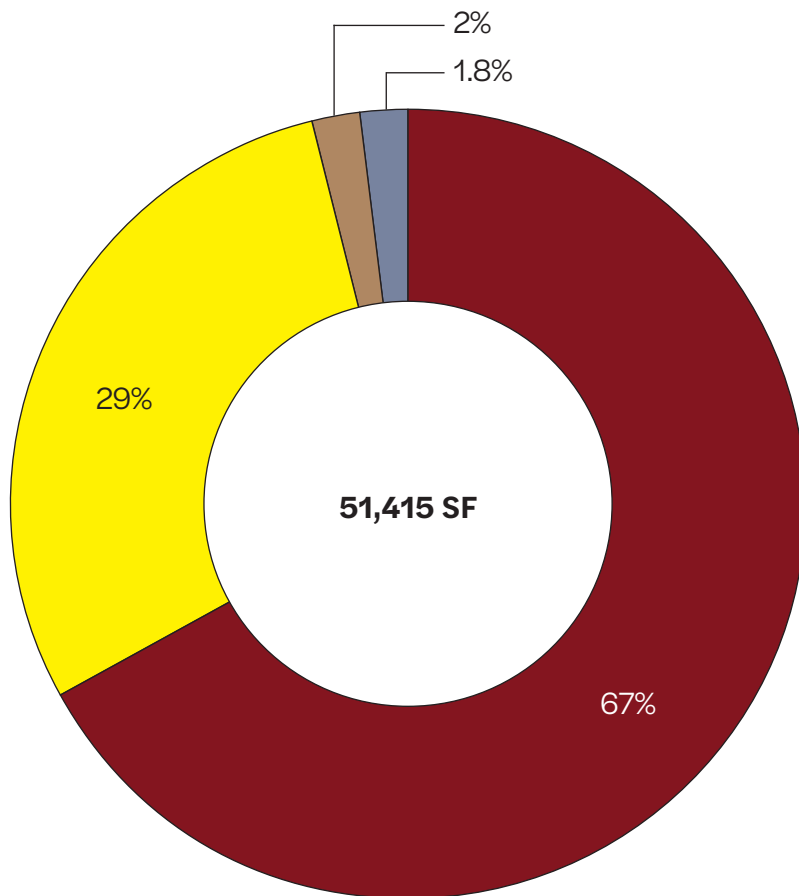
Level 8 - Mechanical Mezzanine



Spatial Breakup

Areas

- Mech/Elec/Other Related (34,465)
- Circulation (15,000 SF)
- TV/Camera Area (1,050 SF)
- Industrial (900 SF)



Program

Mech/Elec/Other Related (34,465 SF)

Mechanical Fan Rooms (27,450 SF)	
Bowl Mechanical Fan Room 1	2,800 SF
Bowl Mechanical Fan Room 2	4,100 SF
Bowl Mechanical Fan Room 3	3,200 SF
Bowl Mechanical Fan Room 4	3,700 SF
Bowl Mechanical Fan Room 5	2,500 SF
Bowl Mechanical Fan Room 6	3,400 SF
Bowl Mechanical Fan Room 7	3,500 SF
Bowl Mechanical Fan Room 8	4,250 SF
Main Electrical (3,950 SF)	
Electrical Sub 1	1,850 SF
Electrical Sub 2	1,500 SF
Electrical Sub 3	600 SF
Sound System Amp Rooms (650 SF)	
Amp Room 1	650 SF
Fire Stair/Elevator Areas (2,415 SF)	
Electrical Rooms	415 SF
Elevator Control Rooms	1,400 SF

A/V Room	600 SF
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TV/Camera Area (1,050 SF)

Sky-Cam Control Rooms (1,050 SF)

Industrial (900 SF)

Storage Space (900 SF)

3.2. Case study results. Because stadiums are designed with concourses surrounding the field surface, each of the levels that were measured are categorized as “band space” in the table below; band space does not include the field or seating areas. In the tables on the right, stadium efficiency is shown. This percentage was calculated by breaking spaces into three categories; these include required and usable space, non-usable space, and field & seating. Required & usable space is defined as all areas of the stadium that are used by its occupants. Non-usable space includes the areas that are required, but aren’t used directly by occupants. Although the field and seating are required and usable space, they will be categorized as a separate group because of calculations that pertain to the addition of mixed-use in later processes.

Level	Square Footage
1 - Field Level	403,715
2 - Sideline Suites	75,690
3 - Lower Club	111,510
4 - Main Concourse	267,175
5 - Upper Club	108,845
6 - Upper Suite	130,545
7 - Upper Concourse	168,610
8 - Mechanical Mezzanine	51,415
Total “Band Space”	1,317,505
Seating Areas	330,000
Field Surface	95,000
Total Stadium	1,742,505

Figure 2.. Square footage breakup by level.

Space	Square Footage
Required & Usable Space	558,525

Non-Usable Space	
General Public Restroom	61,630
Circulation & Fire Stair Areas	592,600
Mechanical & Related	85,550
Electrical	19,200
Total Non-Usable Space	758,980

Seating Areas	330,000
Field Surface	95,000
Field & Seating	425,000

Figure 3. Square footage breakup by usability.

Space	Square Footage
Total Stadium	1,742,505
Non-Usable Space	758,980
Total Stadium Efficiency	66%

Figure 4. Efficiency of US Bank Stadium.

4. Maximum stadium envelope study. In order to understand if it is feasible for a 60,000 seat stadium to include enough mixed-use to offset 50% of the total stadium cost, it was required to determine what potential square footage within the envelope existed. Although different designs could add as much square footage as needed to generate additional revenue, a larger footprint would increase overall stadium cost, which would require information on different stadium elements that increase in size. Because general construction costs of mixed-use are available, if the stadium footprint remains constant, the calculation of added mixed-use in relation to overall stadium cost will be more accurate. The process of this study included the use of sketchup to generate a 3D model that aligned with the overall footprint of US Bank Stadium. As the concourses that sit below stadium seating include a significant amount of interstitial space, this was seen as an opportunity to add additional square footage. Based upon available area below the seating that exists in US Bank Stadium, floor-to-floor heights of 15 feet were created to simulate maximum floor space.

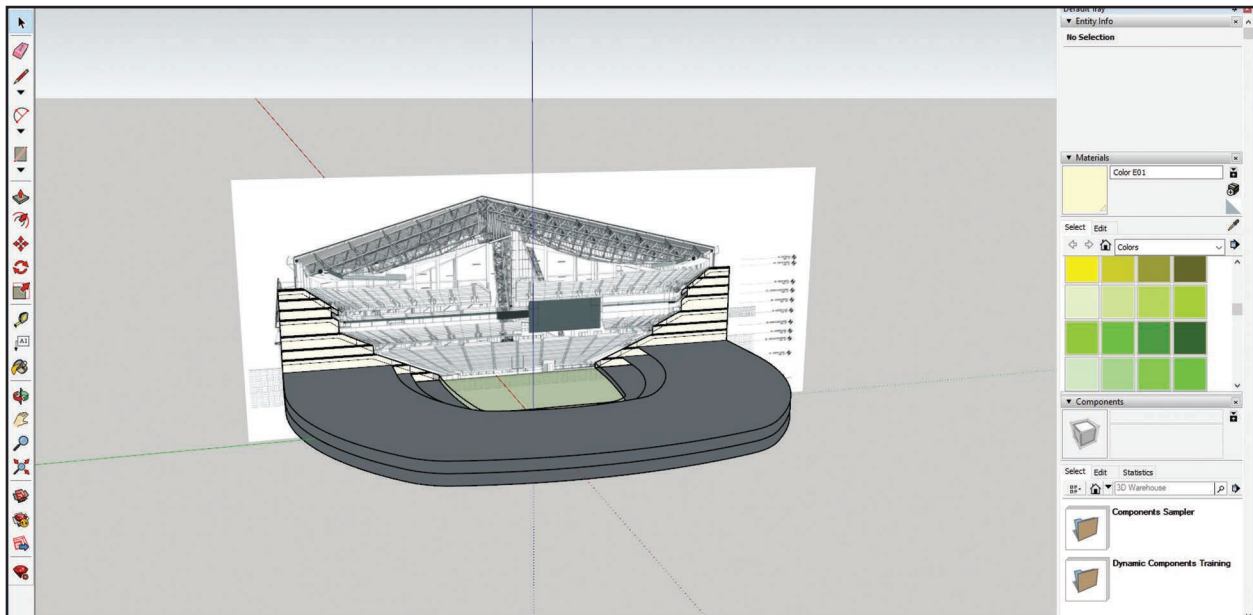


Figure 5. Process of creating maximum stadium envelope model in sketchup.

4.1. Maximum stadium envelope results. It can be seen in the graphic below that the total potential “band space” equates to 2,610,900 square feet, which is about two times the area of the band currently surrounding US Bank Stadium’s field. In order to calculate the amount of square footage that has the potential to be added, US Bank Stadium’s band area (1,317,505 SF) was subtracted from the total potential band area (2,610,900 SF), which equaled 1,293,395 SF. To determine the total amount of “leasable” square footage, 1,293,395 was multiplied by 80%, which is a general percentage for mixed-use buildings. This totaled 1,034,716 square feet, which is the maximum area that can be used to generate revenue to offset the total stadium cost.

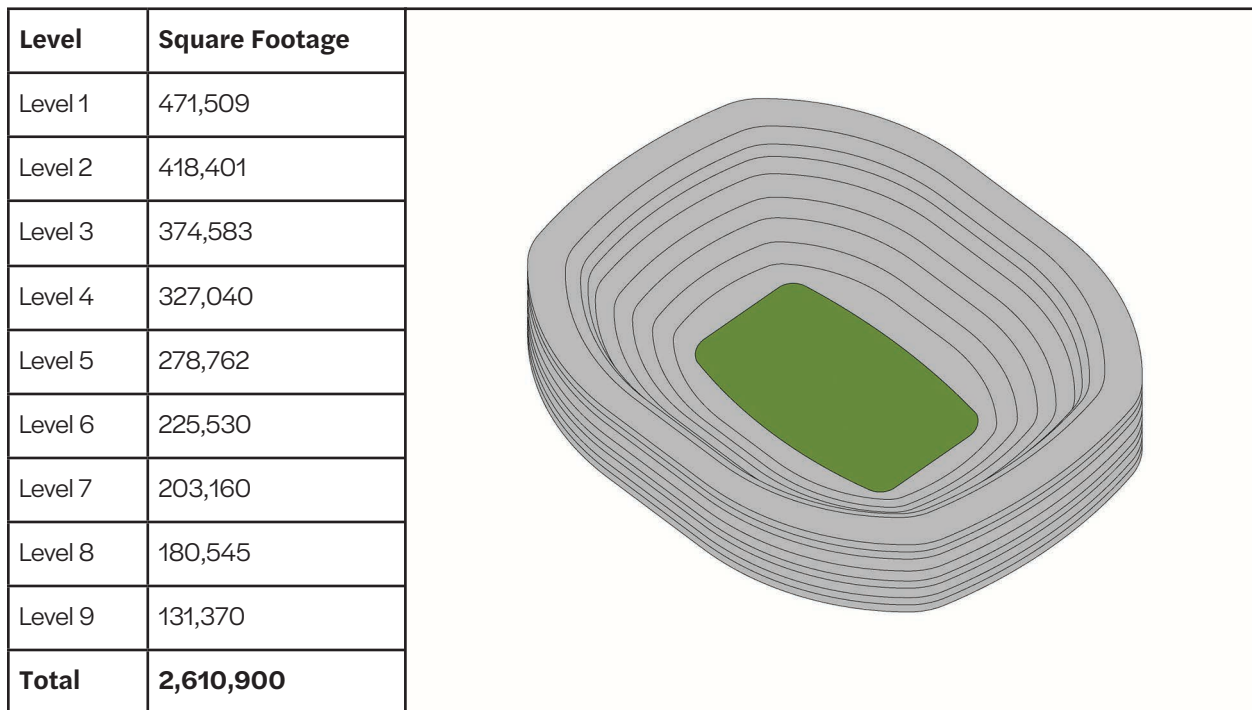


Figure 6. Table and 3D graphic of potential floor area for US Bank Stadium’s building envelope.

Potential Band SF	Current Band SF	Potential Added	Mixed-Use Efficiency	Potential Leasable
2,610,900	1,317,505	1,293,395	80%	1,034,716

Figure 7. Calculation of potential mixed-use space to be leased

5. Washington DC market research & revenue calculations. In order to understand the amount of revenue that mixed-use could generate in Washington DC, market research was performed to determine the variables that would contribute to total net revenue. The first variable that needed to be defined was the breakup of mixed-use. The potential mixed-uses were identified as office, hotel, retail store, restaurant, and entertainment; housing was not included due to issues that might arise, such as tenants earning profit by leasing their units during large stadium events. For the purpose of measuring profit, the category of retail encompasses shopping, restaurant, and entertainment. The table below shows the total square footages of each category; these were then broken up into percentages, which would serve as the breakup to be used in the study.

Use	Total Square Footage in Washington DC	% of Mixed-Use
Hotel	12,352,470	8.6%
Office	108,379,764	75.8%
Retail	22,234,301	15.6%
Total	142,966,535	100%

Figure 8. Washington DC mixed-use breakup to be used in stadium.

Following the determination of mixed-use breakup, revenue needed to be determined. To accomplish this, there were different parameters that applied to the specific type of use. For retail and office space, the city's average cost-per-square foot (2017) was multiplied by its vacancy rate (2017). Because it was assumed that Triple Net (NNN) lease would be the lease structure, maintenance fees and utilities were not calculated, since these are considered separate fees in this type of agreement. For hotel, it was assumed that the space would be sold to a hotel company for an up-front cost. In the following tables, calculation of revenue is shown.

5.1. Office & retail calculation. The following table used average Washington DC rental and vacancy rates for Class A office and retail. Revenue per square foot was measured by multiplying the rents by vacancy rates.

Use	Average Rent SF/Year (2017\$)	2017 Vacancy Rate	Revenue Per SF/Yr. (2017\$)
Office	\$65.00	86%	\$56.00
Retail	\$73.00	96%	\$70.00

Figure 9. Table of revenue per square foot for leased space.

5.2. Hotel calculation. To calculate hotel sale price per square foot, cost and square footage data on hotels currently under construction were used as a measure of value. To determine the value to be used for this project, the value per square foot of all listed projects was averaged.

Square Footage of Hotel	Value (2017\$)	Value Per Square Foot (2017\$)
536,000	\$200,000,000.00	\$373.00
430,000	\$400,000,000.00	\$930.00
409,000	\$309,000,000.00	\$756.00
382,000	\$270,000,000.00	\$707.00
358,126	\$287,000,000.00	\$801.00
350,000	\$225,000,000.00	\$643.00
176,671	\$100,000,000.00	\$566.00
140,000	\$162,000,000.00	\$1,157.00
135,200	\$60,000,000.00	\$444.00
Average		\$709

Figure 10. Table of average value per square foot for hotels under construction.

5.3. Total revenues from mixed-use types. Although previous analysis calculated a maximum mixed-use square footage of 1,034,016, intervals of 100,000 between the range of 100,000 - 1,000,000 square feet were used to determine two factors. The first was to observe if the maximum-allowable square footage was sufficient to generate enough revenue to offset 50% of the overall stadium cost. If the maximum was sufficient, the second factor needed to determine what the minimum square footage requirements were. To understand if various square footages of mixed-use generate enough revenue, the percentage-applied square footage and revenue per square foot were multiplied; the revenues will be measured against construction costs in later processes.

Square Feet	71.5% Office (SF)	Office Revenue Per SF/Yr. (2017\$)	Revenue from Office (2017\$)
100,000	71,500	\$56.00	\$4,004,000.00
200,000	143,000	\$56.00	\$8,008,000.00
300,000	214,500	\$56.00	\$12,012,000.00
400,000	286,000	\$56.00	\$16,016,000.00
500,000	357,500	\$56.00	\$20,020,000.00
600,000	429,000	\$56.00	\$24,024,000.00
700,000	500,500	\$56.00	\$28,028,000.00
800,000	572,000	\$56.00	\$32,032,000.00
900,000	643,500	\$56.00	\$36,036,000.00
1,000,000	715,000	\$56.00	\$40,040,000.00

Figure 11. Table of revenue per year for office in 2017 \$.

Square Feet	14.7% Retail (SF)	Retail Revenue Per SF/Yr. (2017\$)	Revenue from Retail (2017\$)
100,000	14,700	\$70.00	\$1,029,000.00
200,000	29,400	\$70.00	\$2,058,000.00
300,000	44,100	\$70.00	\$3,087,000.00
400,000	58,800	\$70.00	\$4,116,000.00
500,000	73,500	\$70.00	\$5,145,000.00
600,000	88,200	\$70.00	\$6,174,000.00
700,000	102,900	\$70.00	\$7,203,000.00
800,000	117,600	\$70.00	\$8,232,000.00
900,000	132,300	\$70.00	\$9,261,000.00
1,000,000	147,000	\$70.00	\$10,290,000.00

Figure 12. Table of revenue per year for retail in 2017 \$.

Square Feet	13.8% Hotel (SF)	Hotel Sale Price Per SF	Hotel Sale Price (Single Payment, 2017\$)
100,000	13,800	\$709.00	\$9,784,200.00
200,000	27,600	\$709.00	\$19,568,400.00
300,000	41,400	\$709.00	\$29,352,600.00
400,000	55,200	\$709.00	\$39,136,800.00
500,000	69,000	\$709.00	\$48,921,000.00
600,000	82,800	\$709.00	\$58,705,200.00
700,000	96,600	\$709.00	\$68,489,400.00
800,000	110,400	\$709.00	\$78,273,600.00
900,000	124,200	\$709.00	\$88,057,800.00
1,000,000	138,000	\$709.00	\$97,842,000.00

Figure 13. Table of total hotel sale price in 2017 \$.

5.3. Total revenues from mixed-use (combined). Once each type of mixed-use's contribution was determined, values for each interval of 100,000 were added to show a comprehensive mixed-use revenue per year; only office and hotel were added since they are the only two types to be leased. As the sale of the hotel component will be assumed as an up-front payment, it will be subtracted from the total stadium cost in later processes. In the table below, added revenues for office and hotel (gross revenue), which have fixed charges (taxes and insurance) are calculated to determine total revenue per year for leased components.

Square Feet	Gross Revenue	Fixed Charges Deduction (4.5%)	Total Leased Revenue Per Year
100,000	\$5,033,000.00	-\$226,485.00	\$4,806,515.00
200,000	\$10,066,000.00	-\$452,970.00	\$9,613,030.00
300,000	\$15,099,000.00	-\$679,455.00	\$14,419,545.00
400,000	\$20,132,000.00	-\$905,940.00	\$19,226,060.00
500,000	\$25,165,000.00	-\$1,132,425.00	\$24,032,575.00
600,000	\$30,198,000.00	-\$1,358,910.00	\$28,839,090.00
700,000	\$35,231,000.00	-\$1,585,395.00	\$33,645,605.00
800,000	\$40,264,000.00	-\$1,811,880.00	\$38,452,120.00
900,000	\$45,297,000.00	-\$2,038,365.00	\$43,258,635.00
1,000,000	\$50,330,000.00	-\$2,264,850.00	\$48,065,150.00

Figure 14. Table of total leased revenue in 2017 \$.

6. Mixed-use construction cost analysis. As total revenue per year was now understood, the dollar amounts needed to be measured against construction costs and financing to determine if leased revenue generated enough to cover 50% of overall stadium cost. To accomplish this, there were multiple conversion factors to be calculated. The first factor was the construction cost of mixed-use in Washington DC, which was obtained through “RS Means” recommended charts and conversion processes. In the tables below, mixed-use construction cost conversion is shown. \$212.00 was identified as the national average for mixed-use cost per square foot construction, which was then adjusted to each square footage interval since cost per square foot decreases as area increases. In figure 15, the “typical size from below” (which is 27,200 SF) is divided by each proposed square footage (100,000-1,000,000) to give a “size factor.” This size factor is then read as a “cost multiplier” where the vertical line intersects the “cost modifier curve”, and multiplied by \$212.00 to obtain cost per square foot for each given 100,000 interval.

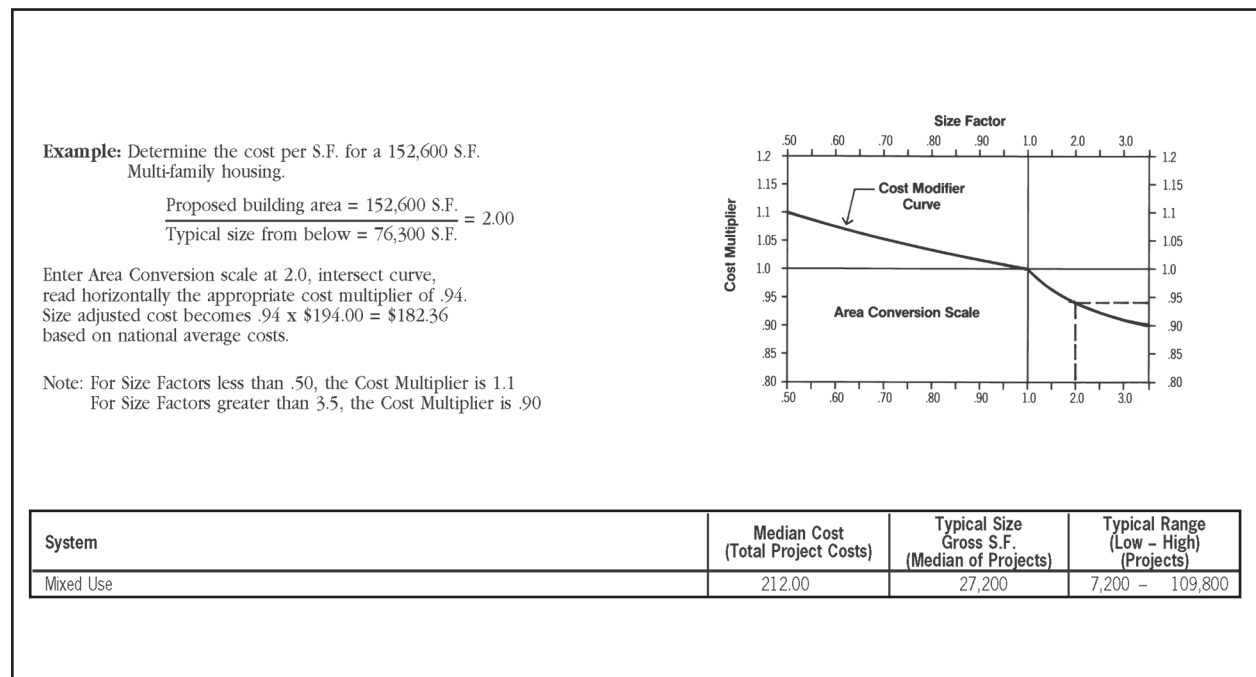


Figure 15. Table of mixed-use construction cost conversions (RSMMeans).

Because national average mixed-use construction costs were calculated, Washington DC-specific costs needed to be applied. To convert national average amounts to Washington DC costs, *RS means* construction cost index was used, which identified Washington DC as 4.8% lower than the national average. Following the calculation of total construction costs for various 100,000 square foot intervals, the calculated mixed-use amounts needed to be added to the stadium base cost, which was defined by US Bank Stadium's cost in 2017 dollars. To convert US Bank Stadium's cost to Washington DC, the *RS means* construction cost index was again used to determine the difference between Minneapolis and Washington DC, which was 10.1%. In the tables below, the process of calculating total mixed-use stadium cost is shown.

Square Feet	National Average Construction Cost	DC Cost Index	Total Construction Cost (DC\$)
100,000	\$19,080,000.00	-4.8%	\$18,164,160.00
200,000	\$38,160,000.00	-4.8%	\$36,328,320.00
300,000	\$57,240,000.00	-4.8%	\$54,492,480.00
400,000	\$76,320,000.00	-4.8%	\$72,656,640.00
500,000	\$95,400,000.00	-4.8%	\$90,820,800.00
600,000	\$114,480,000.00	-4.8%	\$108,984,960.00
700,000	\$133,560,000.00	-4.8%	\$127,149,120.00
800,000	\$152,640,000.00	-4.8%	\$145,313,280.00
900,000	\$171,720,000.00	-4.8%	\$163,477,440.00
1,000,000	\$190,800,000.00	-4.8%	\$181,641,600.00

Figure 16. National average to Washington DC construction cost conversion.

City	Materials	Installation	Composite
Minneapolis, MN	100.4	113.0	105.9
Washington, DC	101.1	87.6	95.2
National Average	100.0	100.0	100.0

Figure 17. RS means cost index.

US Bank Stadium Cost (2017\$)	Mpls. to DC Cost Index	Stadium Base Cost (DC\$)
\$1,079,750,000.00	-10.1%	\$970,695,250.00

Figure 18. US Bank Stadium, with Minneapolis to Washington DC cost conversion.

Square Feet	Mixed-Use Construction Cost	US Bank Stadium Base (DC\$)	Total Construction Cost
100,000	\$18,164,160.00	+\$970,695,250.00	\$988,859,410.00
200,000	\$36,328,320.00	+\$970,695,250.00	\$1,007,023,570.00
300,000	\$54,492,480.00	+\$970,695,250.00	\$1,025,187,730.00
400,000	\$72,656,640.00	+\$970,695,250.00	\$1,043,351,890.00
500,000	\$90,820,800.00	+\$970,695,250.00	\$1,061,516,050.00
600,000	\$108,984,960.00	+\$970,695,250.00	\$1,079,680,210.00
700,000	\$127,149,120.00	+\$970,695,250.00	\$1,097,844,370.00
800,000	\$145,313,280.00	+\$970,695,250.00	\$1,116,008,530.00
900,000	\$163,477,440.00	+\$970,695,250.00	\$1,134,172,690.00
1,000,000	\$181,641,600.00	+\$970,695,250.00	\$1,152,336,850.00

Figure 19. Total mixed-use stadium construction costs for various 100,000 SF intervals.

7. Final cost-to-revenue comparison. Once total construction cost with mixed-use additions were calculated, the hotel sale price that correlated with each square footage interval was subtracted. The reason the hotel was subtracted from the construction cost is because the sale revenue is paid in full, which could be directly applied to the total building cost. Once each final construction cost was determined, they were entered into an amortization calculator with parameters of 6% interest over 30 years; the annual payment can be seen in figure 21. Because the goal of this study was to generate enough revenue to cover 50% of construction cost, that is the percentage of yearly payment that was measured against annual revenue from mixed-use, which can be seen in figure 22. The final conclusion is that there must be at least 800,000 square feet of leased mixed use to pay for half of the stadium cost in 2018.

Square Feet	Total Construction Cost	Hotel Sale Price	Cost to be Amortized (Final)
100,000	\$988,859,410.00	-\$9,784,200.00	\$979,075,210.00
200,000	\$1,007,023,570.00	-\$19,568,400.00	\$987,455,170.00
300,000	\$1,025,187,730.00	-\$29,352,600.00	\$995,835,130.00
400,000	\$1,043,351,890.00	-\$39,136,800.00	\$1,004,215,090.00
500,000	\$1,061,516,050.00	-\$48,921,000.00	\$1,012,595,050.00
600,000	\$1,079,680,210.00	-\$58,705,200.00	\$1,020,975,010.00
700,000	\$1,097,844,370.00	-\$68,489,400.00	\$1,029,354,970.00
800,000	\$1,116,008,530.00	-\$78,273,600.00	\$1,037,734,930.00
900,000	\$1,134,172,690.00	-\$88,057,800.00	\$1,046,114,890.00
1,000,000	\$1,152,336,850.00	-\$97,842,000.00	\$1,054,494,850.00

Figure 20. Final construction cost to be amortized.

Square Feet	Cost to be Amortized (Final)	Annual Payment (6% Interest over 30 years)
100,000	\$979,075,210.00	\$70,722,318.00
200,000	\$987,455,170.00	\$71,399,748.00
300,000	\$995,835,130.00	\$71,839,756.00
400,000	\$1,004,215,090.00	\$72,308,542.00
500,000	\$1,012,595,050.00	\$72,870,858.00
600,000	\$1,020,975,010.00	\$73,332,450.00
700,000	\$1,029,354,970.00	\$73,700,511.00
800,000	\$1,037,734,930.00	\$74,126,130.00
900,000	\$1,046,114,890.00	\$74,652,473.00
1,000,000	\$1,054,494,850.00	\$75,178,816.00

Figure 21. Annual payment schedule.

Square Feet	Annual Payment	50% of Annual	Annual Mixed-Use Revenue	Net Annual Profit
100,000	\$70,722,318.00	\$35,361,159.00	\$4,806,515.00	-\$30,554,644.00
200,000	\$71,399,748.00	\$35,699,874.00	\$9,613,030.00	-\$26,086,844.00
300,000	\$71,839,756.00	\$35,919,878.00	\$14,419,545.00	-\$21,500,333.00
400,000	\$72,308,542.00	\$36,154,271.00	\$19,226,060.00	-\$16,928,211.00
500,000	\$72,870,858.00	\$36,435,429.00	\$24,032,575.00	-\$12,402,854.00
600,000	\$73,332,450.00	\$36,666,225.00	\$28,839,090.00	-\$7,827,135.00
700,000	\$73,700,511.00	\$36,850,255.00	\$33,645,605.00	-\$3,204,650.00
800,000	\$74,126,130.00	\$37,063,065.00	\$38,452,120.00	\$1,389,055.00
900,000	\$74,652,473.00	\$37,326,236.00	\$43,258,635.00	\$5,932,398.00
1,000,000	\$75,178,816.00	\$37,589,408.00	\$48,065,150.00	\$10,475,742.00

Figure 22. Calculation of annual net profit.

8. Conclusion. Although the cost analysis proves that mixed-use area greater than 800,000 square feet is sufficient to offset 50% of the cost of a 60,000 seat modern NFL stadium in Washington DC, it only guarantees this would be enough in 2018. Due to potential changes in the market, there could be fluctuations in vacancy rates that would impact revenue in following years. However, based on historical data, vacancy rates and rental rates have continually increased over the span of the past 15 years. One of the benefits of Washington, DC is its strong tourism market, which always returns even after economic downturns. In addition, there is a strong technology sector and working class that is established, which is what the majority of leased space relies on for annual income in this analysis (office).

One of the major factors that had an impact on the results of this study were the percentages of different mixed uses. The possibility of a lower square footage requirement does exist if higher percentages of hotel and retail are used, although more retail would be a riskier investment for the team, as there are many unknowns with the future of its market. If variations to the percentages of mixed-use were made, they would need to be justified by the stadium's location and surrounding elements. However, one possibility for most locations is that hotel could be increased since a strong tourism market exists, which makes the purchase attractive to investors.

Another consideration in the attempt of a mixed-use stadium is its aesthetic. If a mixed-use stadium were attempted in Washington, DC, the architecture of the stadium would be just as important as the programming. Even if the potential to generate money from leased sources exists, it must be executed in such a way that is aesthetically pleasing, functional, and attractive to potential tenants.

In conclusion, the analysis does demonstrate that it is possible to program sufficient mixed-use to offset the cost of a typical subsidy in Washington, DC. However, there are various factors that would ultimately determine the success of the project since the revenue is not guaranteed.

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