

JOB AID
International Building Code
(Through 2018 Edition)
Allowable Building Area Adjustment Equations

INTRODUCTION

The *International Building Code*[®] (IBC[®]) allows building sizes to be adjusted for maximum usage based on occupancy, construction type, setbacks (called “frontage”) from adjacent exposures, and built-in fire protection. These increases are measured in percentages above the values derived from Table 506.2 “Allowable Area Factor in Square Feet.”

IBC Chapter 5 “General Building Heights and Areas” employs five equations the designer and building code official use to determine the eventual maximum allowable area a building can be.

For most of this job aid, the subject building will be a Group B (Business) of Type VB construction, non-sprinklered. (See Illustrations No. 1 and No. 2). When we get to mixed-occupancy buildings, we will add a Group S-2 open parking garage of Type IIB construction non-sprinklered and the Group B will become VA construction.

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TABULAR ALLOWABLE BUILDING AREA

IBC Table 506.2 includes allowable area factors based on occupancy and construction type.

Each occupancy table value is further refined when the building is sprinklered.

Refer to the second column in Table 506.2:

NS = Not sprinklered.

S1 = Maximum one-story above grade building value based on NFPA 13 sprinkler design.

S13R = Group R occupancy building value based on NFPA 13R design.

SM = Two- or more-story above grade building value based on NFPA 13 sprinkler design.

For this job aid, we are proposing a building that measures 50 feet by 180 feet or 9,000 sq. ft. The perimeter lengths are:

Side	Length (feet)
A	180
B	50
C	180
D	50
Total	460

For most of this this job aid, we arbitrarily select the following area factors from Table 506.2:

Occupancy	Sprinklers	Construction Type	Area Factor
B	NS	VB	9,000

We also will assume the building is symmetrical: all floors are the same size.

For the “Mixed Occupancy – Multi-story Building” example, we arbitrarily select the following area factors from Table 506.2:

Occupancy	Sprinklers	Construction Type	Area Factor
B	SM	VA	54,000
S-2	NS	IIB	26,000

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ALLOWABLE AREA INCREASES BASED ON WHERE THE BUILDING SITS ON THE PROPERTY

To qualify for an area increase based on frontage, a building must have at least 25% of its perimeter on a *public way* or open space with a minimum distance (W) of 20 feet measured at right angles to the closest interior lot line, the entire width of a street, alley, or public way, or the exterior face of an adjacent building on the same property. The 20-foot open space must be accessible to the fire department for manual firefighting.

A *public way* is “a street, alley or other parcel of land open to the outside air leading to the street, that has been deeded, dedicated or otherwise permanently appropriated to the public for public use and which has a clear width and height of not less than 10 feet.” [IBC §202]

If the value of the minimum distance (W) is greater than 30 feet, use 30 feet in the formula regardless of the actual distance. Thirty feet is the maximum distance credit allowed for this formula.

Allowable Area Increase with 20 or More Feet on All Sides (See Illustration No. 1)

We'll start with Illustration No. 1 because it has more than 20 feet of clearance (frontage) on all sides.

To determine the allowable percentage increase based solely on frontage:

$$I_f = [F/P - 0.25]W/30 \quad \text{(Equation 5-5)}$$

Note that the maximum allowable area increase based on frontage is 75% more than the tabular value. The 0.25 value in the formula is included to limit the allowable area increase to 75% of the tabular value.

Where:

I_f = Area factor increase for frontage.

F = Building perimeter that fronts on a public way or open space 20 or more feet wide.
[Sum of Sides A through D = 460 feet]

P = Perimeter of the entire building in feet. [Sum of Sides A through D = 460 feet]

W = Width of public way or open space in feet (Maximum credit = 30 feet)

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Solution:

$$I_f = [F/P - 0.25]W/30$$

$$I_f = [460/460 - 0.25] 30/30$$

$$I_f = [1 - 0.25] 1$$

$$I_f = 0.75 * 1$$

$$\therefore I_f = 75\%$$

I_f = Area factor increase for frontage that will be employed in the following Equations 5-1, 5-2 and 5-3.

Weighted Average Perimeter Where Not All Sides Are 20 Feet Clear (See Illustration No. 2)

Notice that in Illustration No. 2 the property line at the top of the drawing and the alley on the left have different dimensions from the previous illustration: 12 and 22 feet, respectively. Since these dimensions are less than the full 30 feet allowance, we must adjust the perimeter values based on their proximity.

Where the W value varies around the perimeter, use the following Equation 5-4 to find the “weighted” average width.

$$W = (L_1 \times w_1 + L_2 \times w_2 + L_3 \times w_3 + L_4 \times w_4 \dots) / F \quad \text{(Equation 5-4)}$$

Where:

W = (Width: weighted average) = Calculated width of public way or open space in feet.

L_n = Length of a portion of the exterior wall.

w_n = Width equal to or greater than 20 feet adjacent to that portion of the exterior perimeter wall.

F = Building perimeter that fronts on a public way or open space 20 or more feet wide.

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Solution:

$$W = (L_1 \times m_1 + L_2 \times m_2 + L_3 \times m_3 + L_4 \times m_4 \dots) / F$$

$$W = [\text{Side A} = (180 \times 30) + \text{Side B} = (50 \times 22) + \text{Side D} = (50 \times 30)] / F$$

(Side C cannot be credited because it is less than 20 feet from the property line.)

$$W = (5,400 + 1,100 + 1,500) / F$$

$$W = 8,000 / F$$

F (The open perimeter of Sides A, B and D) = 280 ft.

$$W = 8,000 / 280 = 28.57$$

∴ Weighted average of open sides equals 28.57 feet.

This value W is used in Equation 5-5 when one or more sides is between 20 and 30 feet from the closest interior lot line, the entire width of a street, alley, or public way, or the exterior face of an adjacent building on the same property.

Allowable Increase with Weighted Average Perimeter

Using the values derived from Illustration No. 2, we will evaluate the allowable increase based on frontage.

$$I_f = [F/P - 0.25]W / 30 \quad \text{(Equation 5-5)}$$

Where:

I_f = Area factor increase for frontage.

F = Building perimeter that fronts on a public way or open space 20 or more feet wide
[Sides A, B and D = 280 feet]

P = Perimeter of the entire building in feet. [460 feet]

W = Calculated width of public way or open space in feet.

To compute for a solution, we will use the weighted average results obtained from the Equation 5-4.

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Solution:

$$I_f = [F/P - 0.25] W/30$$

$$I_f = [280/460 - 0.25] 28.57/30$$

$$I_f = [0.777 - 0.25] 95.2$$

$$I_f = [0.527] 95.2$$

∴ Increase factor for frontage (I_f) = 35.8%

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FRONTAGE AND SPRINKLER INCREASES

Once the open frontage values are determined, allowable area increases can be computed. The IBC uses additional equations to compute the allowable area for:

One-story, single occupancy building (Equation 5-1)

Multiple-story single occupancy building. (Equation 5-2)

Multiple-story, multiple occupancy building (Equation 5-3)

ONE-STORY SINGLE OCCUPANCY BUILDING

IBC allows area increases when the building is protected by sprinklers *and* meets frontage minimums. If the building contains one occupancy classification and is a single story above grade, the following equation is used to compute area:

$$A_a = A_t + (NS \times I_f) \quad \text{(Equation 5-1)}$$

Where:

A_a = Allowable area in square feet.

A_t = Table 506.2 allowable area factor for sprinklered building

NS = Table 506.2 allowable area factor for a non-sprinklered building (regardless of whether the building is sprinklered)

I_f = Area factor increase for frontage.

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One-story Single Occupancy – Not Sprinklered:

Note: For this equation, we will solve using the one-story building without sprinklers from Illustration No. 2. From Table 506.2 the Group B, Type VB non-sprinklered area is 9,000 sq. ft.

$$A_a = A_t + (NS \times I_f)$$

$$A_a = 9,000 + (9,000 \times 35.8\%)$$

(50.2% was the result of the weighted average of the perimeter from Equation 5-5.)

$$A_a = 9,000 + (3,222)$$

∴ Allowable area for this building is 12,222 sq. ft.

One-story Single Occupancy Sprinklered:

Note: For this equation, we will solve using a one-story building from Illustration No. 2 protected by a NFPA 13 design sprinkler system. From Table 506.2 the Group B, Type VB sprinklered area is 36,000 sq. ft.

$$A_a = A_t + (NS \times I_f)$$

$$A_a = 36,000 + (9,000 \times 35.8\%)$$

$$A_a = 36,000 + (3,222)$$

∴ Allowable area for this building is 39,222 sq. ft.

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MULTI-STORY SINGLE OCCUPANCY BUILDING

If the building has multiple stories with a single occupancy classification, we use a different equation.

$$A_a = [A_t + (NS \times I_f)] \times S_a \qquad \text{Equation 5-2}$$

Where:

A_a = Allowable area in square feet.

A_t = Table 506.2 allowable area factor for non-sprinklered or sprinklered building

NS = Table 506.2 allowable area factor for a non-sprinklered building (regardless of whether the building is sprinklered)

I_f = Area factor increase for frontage.

S_a = Actual number of stories above grade not to exceed three*

*For Group R buildings protected with a NFPA 13R design, use the actual number stories above *grade plane*, not to exceed four.

No individual story may exceed the allowable area (A_a) from this equation using the value $S_a = 1$.

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Multiple-story Single Occupancy – Not Sprinklered:

Note: For this equation, we will solve for a two-story building without the sprinkler system.

$$A_a = [A_t + (NS \times I_f)] \times S_a$$

$$A_a = [9,000 + (9,000 \times 35.8\%)] \times 2$$

$$A_a = [9,000 + (3,222)] \times 2$$

$$A_a = [12,222] \times 2$$

∴ Allowable area for this two-story non-sprinklered building is 24,444 sq. ft.

Multiple-story Single Occupancy – Sprinklered:

Note: For this equation, we will solve for a two-story building with the sprinkler system.

$$A_a = [36,000 + (9,000 \times 35.8\%)] \times 2$$

$$A_a = [36,000 + (3,222)] \times 2$$

$$A_a = [39,222] \times 2$$

∴ Allowable area for this two-story non-sprinklered building is 78,444 sq. ft.

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MULTI-STORY MIXED-OCCUPANCY BUILDING

Multi-story mixed occupancy buildings can be confusing when computing allowable areas.

Each story of a mixed-occupancy building with more than one story above grade plane must individually comply with the IBC mixed occupancy and use requirements. This means that some buildings must include fire-resistive rated separations between occupancies yet others are permitted to be constructed without them (see IBC §508.3: Nonseparated and §508.4: Separated)

For the purpose of this handout, let's assume the proposed building is four stories tall: two levels of open parking garage (Group S-2) with two levels of office space (Group B) above it. The building's top two floors will be sprinklered in accordance with IBC §903.3.1.1 (NFPA 13 design), but due to cold conditions the open parking garage will not. The designer wants each floor area to be 24,300 sq. ft. (See Illustration No. 3). Note also, that to allow a B occupancy on the fourth floor, the construction type has changed to VA.

We will assume the designer has elected to create one-hour horizontal fire separation between the two occupancy types. We will use a same weighted perimeter value of 55.5% due to the increased building perimeter.

Now that we know how to compute increases using sprinklers, we will modify our inputs to install sprinklers in the Group B occupancy. The open parking garage is not sprinklered. To keep it simple, we will assume the building is symmetrical: all floors are the same size.

Occupancy	Sprinklers	Construction Type	Allowable Area	Proposed Area*
B	SM	VA	54,000	24,300
S-2	NS	IIB	26,000	24,300

*Per floor

For buildings with more than three stories above grade plane, the total building area is limited so the aggregate sum of the ratios of the actual area of each story divided by the allowable area of each story does not exceed three. (See IBC §506.2.2.1 for special rules about Group H-2 and H-3 occupancies.)

The equation to determine the allowable area for each story is familiar: we used it as Equation 5-1. For the multi-story mixed occupancy calculations, it is referred to as Equation 5-3.

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$$A_a = [A_t + (NS \times I_f)] \quad \text{Equation 5-3}$$

Where:

A_a = Allowable area in square feet.

A_t = Table 506.2 allowable area factor for sprinklered building

NS = Table 506.2 allowable area factor for a non-sprinklered building (regardless of whether the building is sprinklered)

I_f = Area factor increase for frontage.

We will work this equation in steps.

Solution:

Step 1. Determine the allowable area for the first-floor sprinklered open parking garage:

$$A_a = [A_t + (NS \times I_f)]$$

$$A_a = [26,000 + (26,000 \times 55.5\%)]$$

$$A_a = [26,000 + (14,430)]$$

$$A_a = 40,430 \text{ sq. ft.}$$

∴ Allowable area for this sprinklered story 40,430 sq. ft. per story.

Step 2. Since the building is symmetrical, we know the second floor of the sprinklered Group S-2 also is 24,300 sq. ft.

Step 3: Floor three is a Group B, VA sprinklered space measuring 24,300.

$$A_a = [54,000 + (9,000 \times 55.5\%)]$$

$$A_a = [54,000 + (4,995)]$$

$$A_a = 58,995 \text{ sq. ft.}$$

Step 4. Since the building is symmetrical, we know the fourth floor of the Group B also is 24,300 sq. ft.

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Step 5: Calculate the sum of the ratios of actual area divided by allowable area:

Floor	Actual	Allowable	Ratio
1	24,300	40,430	0.601
2	24,300	40,430	0.601
3	24,300	58,995	0.411
4	24,300	58,995	0.411
		Sum	2.024

∴ The building passes the sum of the ratio analysis (less than three).

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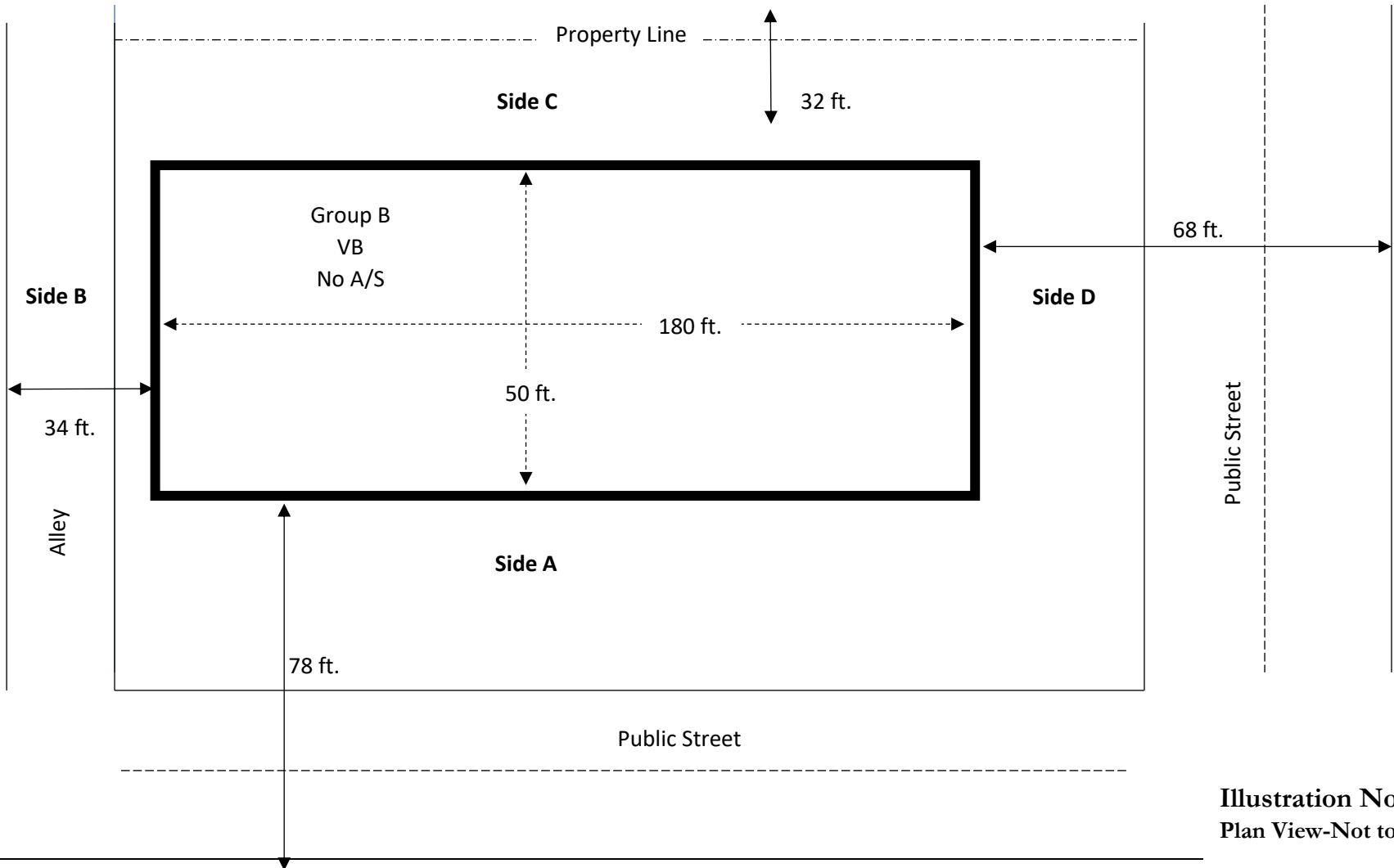


Illustration No. 1
Plan View-Not to Scale

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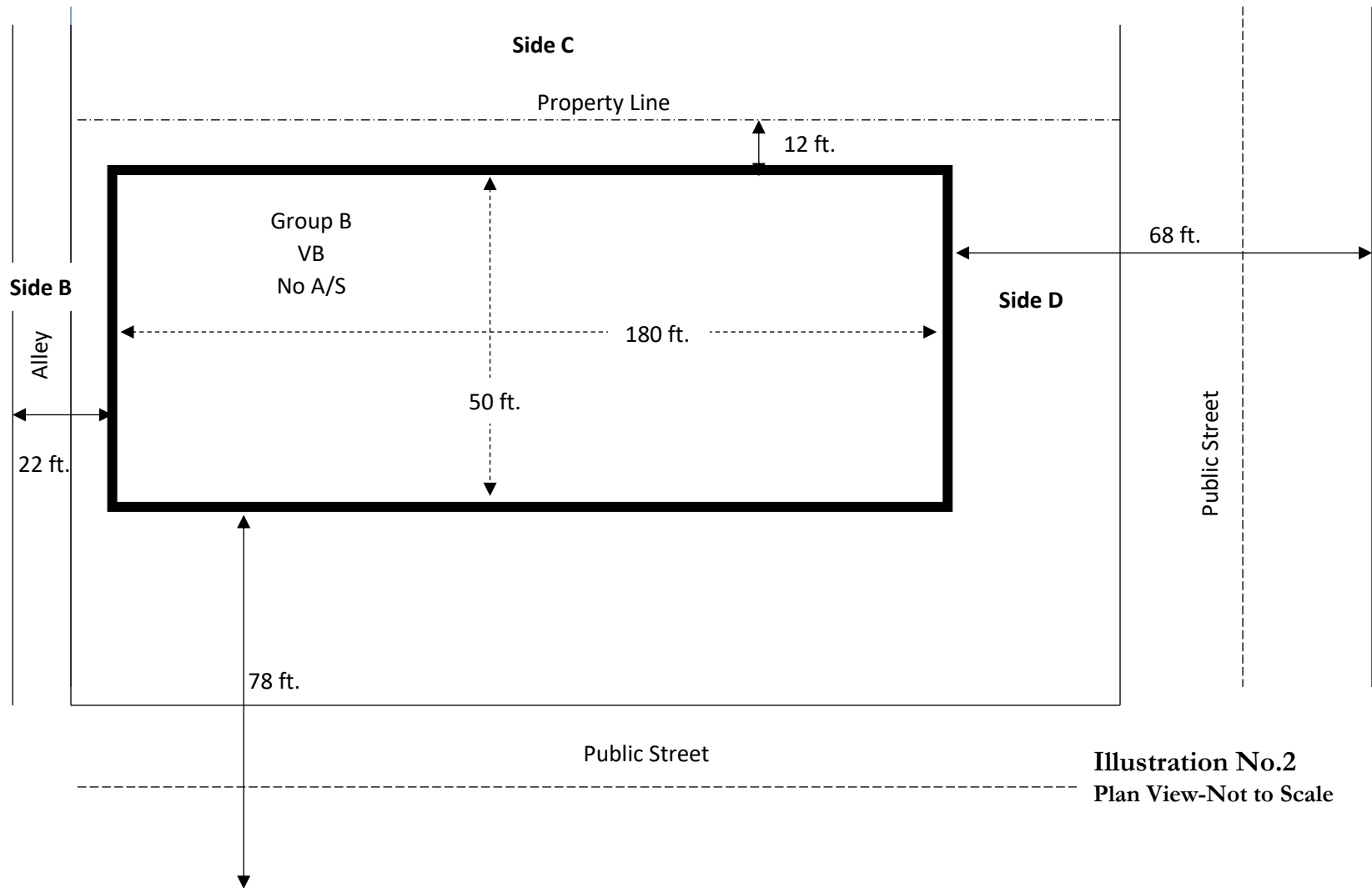


Illustration No.2
Plan View-Not to Scale

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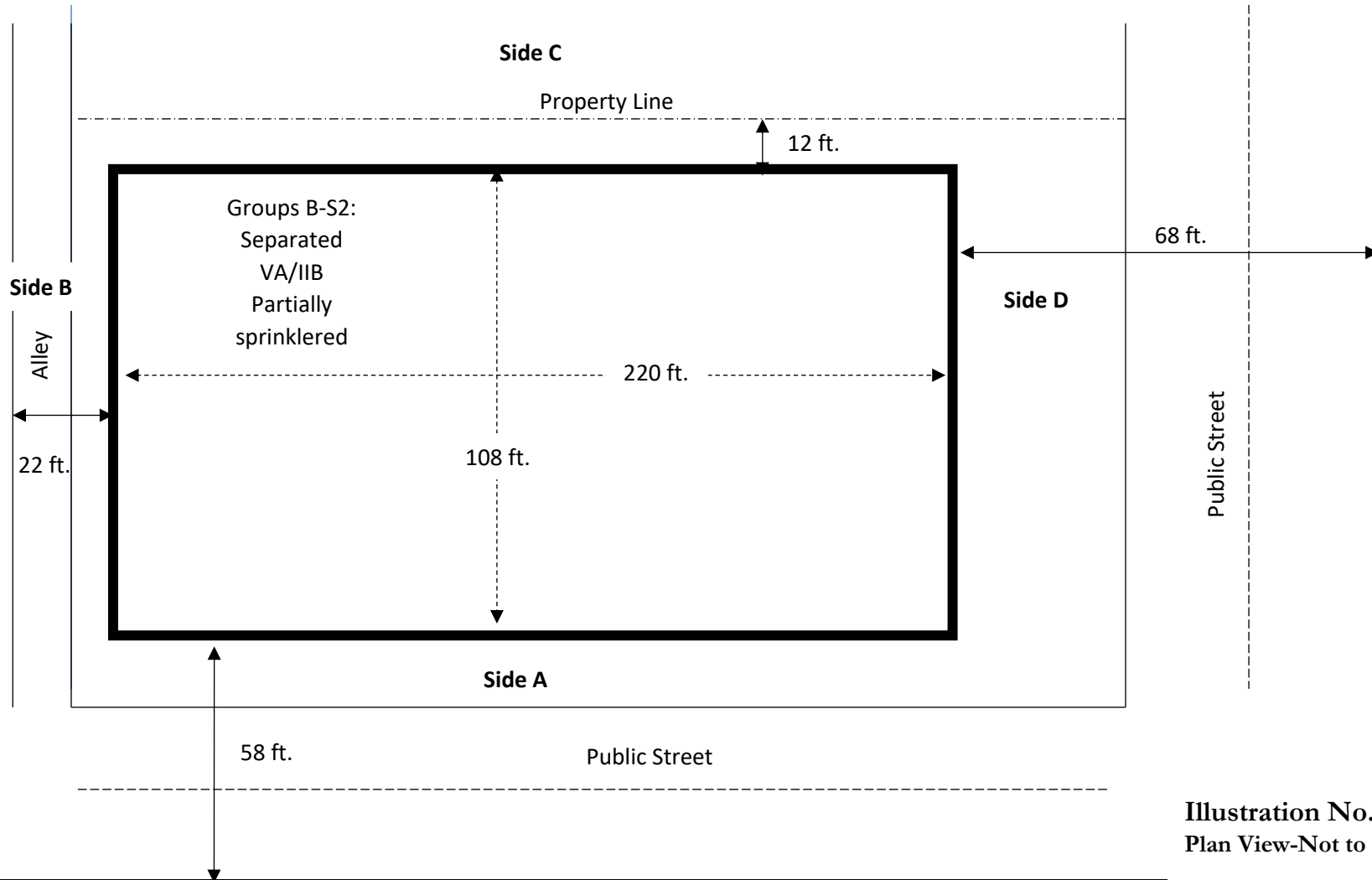


Illustration No. 3
Plan View-Not to Scale