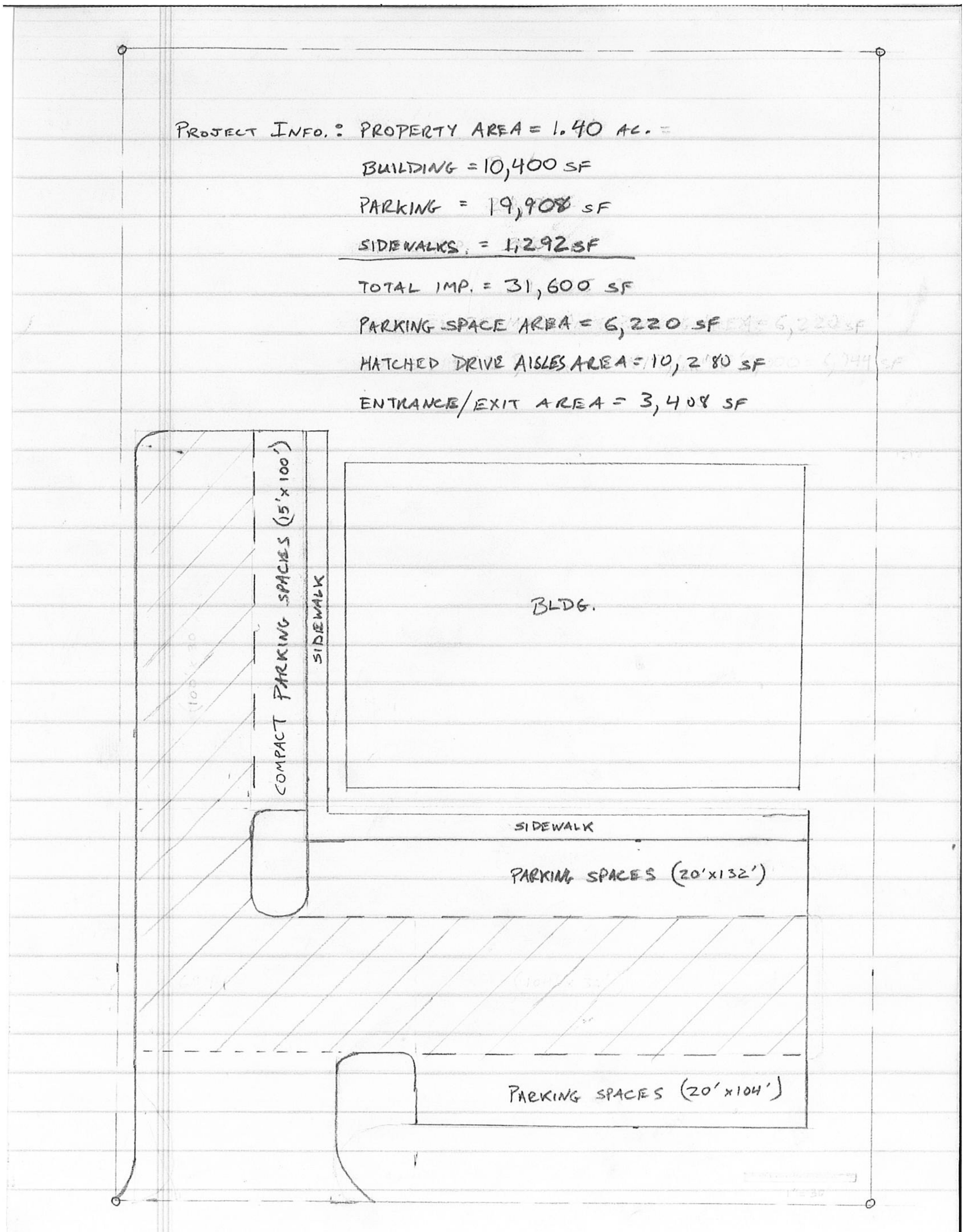
Example Permeable Pavement Calculations

Commercial project located in Piedmont region.
P = 1.0”
Low Density Threshold = 24%
Property Area = 60,984 sf
Building = 10,400 sf
Parking = 19,908 sf (of which 6,220 sf are parking stalls, 10,280 sf hatched drive aisles)
Sidewalks = 1,292 sf
Total Impervious Area = 31,600 sf (if not counting any permeable pavement)
Estimated BMP DA = 1.0 ac.
HSG C => use 50% BUA credit



<u>Scenario 1: No Permeable Pavement Proposed</u>

Determine whether the project is low density or high density:

$\% \, BUA = \left(\frac{Impervious\ Area}{Property\ Area}\right) \times 100 = \left(\frac{31{,}600}{60{,}984}\right) \times 100 = 51.8\ \%$

51.8% > 24% therefore, it is High Density, must provide structural BMP(s).

Calculate the minimum required treatment volume:

$R_v = 0.05 + 0.9I\ ; where\ I = \left(\frac{Impervious\ Area}{Drainage\ Area}\right) = \frac{31{,}600}{43560} = 0.725$

$R_v = 0.05 + 0.9(0.725) = 0.7025$

$V = 3630\ P\ R_v\ DA = 3630(1)(0.7025)(1.0) = 2{,}550\ cf$

Could construct a 2,550 sf bioretention cell.

<u>Scenario 2: Permeable Pavement in Parking Stalls Only</u>

Step 1: Determine whether the project is low density or high density:

Pervious Area of parking spaces = 50% of 6,220 sf = 3,110 sf

Total Impervious Area = 10,400 + 1,292 + (19,908 – 3,110) = 28,490 sf

$\% \, BUA = \left(\frac{Impervious\ Area}{Property\ Area}\right) \times 100 = \left(\frac{28{,}490}{60{,}984}\right) \times 100 = 46.7\ \%$

46.7% > 24% therefore, it is High Density, must provide structural BMP(s).

Step 2:

Calculate the minimum required treatment volume:

Parking stalls are considered 100% treating themselves. Also, treating ½ of the building area in the permeable pavement. So, remove all parking stall area and ½ of the building area from treatment volume calc.

$R_v = 0.05 + 0.9I\ ; where\ I = \left(\frac{Impervious\ Area}{Drainage\ Area}\right) = \frac{\{31{,}600 - 6{,}220 - (0.5 \times 10{,}400)\}}{43560} = 0.463$

$R_v = 0.05 + 0.9(0.463) = 0.4667$

$V = 3630\ P\ R_v\ DA = 3630(1)(0.4667)(1.0) = 1{,}694\ cf$

Could construct a 1,694 sf bioretention cell to treat the traditional pavement and other ½ of building.

Step 3:

Soils info from onsite investigation: HSG C, Ksat = 0.24 in/hr, SHWT > 4' deep

Step 4:

Determine if it can be an infiltration permeable pavement system.

$T = \frac{P(1+R)}{24\ SF\ i} = \frac{1(1+\left(\frac{5200}{6220}\right))}{24*0.2*0.24} = 1.6\ days$

1.6 days < 5 days, so can do infiltration permeable pavement system. YEAH!!

Step 5:

Choosing PICP for surface course; with No.8 stone bedding and No.2 stone aggregate base. *Note: the No.8 bedding layer cannot be used for storage.*

Step 6:
Set subgrade at 0%
Porosity of aggregate, n = 0.40
½ building area treated = 10,400/2 = 5,200 sf

$$D_{wq} = \frac{P(1+R)}{n} = \frac{1(1+\left(\frac{5200}{6220}\right))}{0.40} = 4.6\ inches$$

Verify that 4.6 inches meets manufacturer's minimum for structural requirements.

Step 7: Chose one of the overflow options.

To infiltrate the 10-yr, 24-hr storm (D_{10}):

$$D_{10} = \frac{P_{10}(1+R) - d\ i\ SF}{n} = \frac{5.11\left(1+\left(\frac{5200}{6220}\right)\right)-(24*0.24*0.2)}{0.40} = 20.6\ inches$$

$D_{10} > D_{wq}$; so use D_{10} for depth of aggregate needed below the pavement course *(and bedding layer)*.

Could also decide to not infiltrate the 10-yr, 24-hr storm, and instead route the 10-yr, 24-hr storm event to determine the additional storage aggregate needed above the D_{wq}.

Step 8:
Observation well(s) required since it is a commercial project.

Scenario 3: Permeable Pavement in Most of Parking Area:

Step 1: Determine whether the project is low density or high density:
Pervious Area of parking parking area = 50% of 10,280 + 6,220 = 8,250 sf
Total Impervious Area = 10,400 + 1,292 + (19,908 – 8,250) = 23,350 sf

$$\%\ BUA = \left(\frac{Impervious\ Area}{Property\ Area}\right) \times 100 = \left(\frac{23{,}350}{60{,}984}\right) \times 100 = 38.3\ \%$$

38.3% > 24% therefore, it is High Density, must provide structural BMP(s).

Step 2:
Calculate the minimum required treatment volume:
Parking stalls and hatched drive aisles are considered 100% treating themselves. Also, treating entire building, sidewalks, and entrance/exit pavement area in the permeable pavement. So, remove all parking stall area, hatched drive aisles, road entrance drive, sidewalks, and all of the building area from treatment volume calc. So, impervious area left to treat goes to zero…**no additional BMP needed beyond the permeable pavement**.

Step 3:
Soils Info from onsite investigation: HSG C, Ksat = 0.24 in/hr, SHWT > 4' deep

Step 4:
Determine if it can be an infiltration permeable pavement system.

$$T = \frac{1(1+R)}{24\ SF\ i} = \frac{1(1+\left(\frac{10{,}400+1{,}292+3{,}408}{10{,}280+6{,}220}\right))}{24*0.2*0.24} = 1.7\ days$$

1.7 days < 5 days, so can do infiltration permeable pavement system. YEAH!!

Step 5:
Choosing PICP for surface course; with No.8 stone bedding and No.2 stone aggregate base. *Note: the No.8 bedding layer cannot be used for storage.*

Step 6:
Set subgrade at 0%
Porosity of aggregate, n = 0.40
Non-permeable entrance drive area = 3,408 sf

$$D_{wq} = \frac{P(1+R)}{n} = \frac{1(1+\left(\frac{10{,}400+1{,}292+3{,}408}{10{,}280+6{,}220}\right))}{0.40} = 4.8\ inches$$

Verify that 4.8 inches meets manufacturer's minimum for structural requirements.

Notice that with *very minimal* additional aggregate storage depth than Scenario 2, all the BUA for this site can be captured and treated…*with no other BMP needed beyond the permeable pavement*!

Step 7: Chose one of the overflow options.

To infiltrate the 10-yr, 24-hr storm (D_{10}):

$$D_{10} = \frac{P_{10}(1+R) - d\ i\ SF}{n} = \frac{5.11\left(1+\left(\frac{10{,}400+1{,}292+3{,}408}{10{,}280+6{,}220}\right)\right) - (24*0.24*0.2)}{0.40} = 21.6\ inches$$

$D_{10} > D_{wq}$; so use D_{10} for depth of aggregate needed below the pavement course *(and bedding layer)*.

Could also decide to not infiltrate the 10-yr, 24-hr storm, and instead route the 10-yr, 24-hr storm event to determine the additional storage aggregate needed above the D_{wq}.

Step 8:
Observation well(s) required since it is a commercial project.