APPENDIX 2:
Sediment Basin Sizing

Sediment basins shall, at a minimum, be designed to reduce incoming suspended soil particles having diameters of 0.02-mm and larger from the runoff volume of a 2-year, 24-hour storm by 90%. In addition, sediment basins shall not detain stormwater for more than 96-hours, or as dictated by local vector control regulations. Vector control guidance and regulations vary throughout the state. The designer is responsible for designing basins that are in compliance with all applicable local regulations.

The following equations can be used to calculate the minimum physical parameters needed for a sediment basin to meet the sediment reduction design standard above (from Fifield, 2004).

$SA_{min} = (1.2 \times Q) \div V$ Equation 1

$L_{min} = (L{:}W_e \times SA_{min})^{0.5}$ Equation 2

$W_e = SA_{min} \div L_{min}$ Equation 3

$Vol_{min} = Depth \times SA_{min}$ Equation 4

$NEff = AEff \times PEG$ Equation 5

Where SA_{min} = Minimum surface area of the sediment basin (square feet)

V = Terminal velocity of a particle in water ≈ 0.00065 feet per second

L_{min} = Minimum flow path length within the sediment basin (feet)

$L{:}W_e$ = Length to Width ratio of the sediment basin (values range from 0 to 10)

W_e = Effective width of the sediment basin (feet)

Vol_{min} = Minimum containment volume of the sediment basin ≥ 3,600 cubic feet per acre draining to the structure

Depth = Average pond depth ≥ 3.0 feet and at least 2.5 feet deep at the outlet structure

NEff = Net Effectiveness of a sediment basin to remove all suspended particles

AEff = Apparent Effectiveness of a sediment basin to remove 0.02-mm and larger suspended particles (see the chart at the end of this section)

PEG = Percent of particles that are Equal to or Greater than a design size particle (see the chart at the end of this section)

EXAMPLE 1: DESIGNING AN EFFECTIVE SEDIMENT BASIN

The following steps demonstrate the design of a sediment basin that will result in gravitational deposition of suspended particles having diameters of 0.02-mm and larger.

Assume the following table provides a representative soil analysis for a 12.5-acre watershed that will contribute runoff to a sediment basin. Determine the sediment basin parameters necessary for reduction of 90% or more of incoming suspended particles having diameters of 0.02-mm and larger. Also, calculate the maximum discharge from the containment system before reduction of 0.02-mm and larger diameter particles becomes less than 90%.

Particle Diameter (mm)	0.850	0.425	0.250	0.150	0.075	0.028	0.019	0.011
Percent Passing	100	99.9	99.7	98.2	90.5	60.8	52.9	46.0

Step 1: Determine the PEG value.

Figure 1 illustrates values of the above table when plotted on a PEG chart. A PEG chart can be developed for any representative soil analysis. In this example, the PEG for suspended particles ≥ 0.02-mm is:

$$PEG_{\geq 0.02} \approx 46\%$$

In other words, about 46% of the inflowing suspended particles will be 0.02-mm and larger. Notice, the percentage of particles smaller than 0.02-mm will be:

$$PEG_{<0.02} \approx 100\% - 46\% \approx 54\%$$

Thus, these soils contain large amounts of small silt and clay particles that are difficult to remove by a gravitational system.

Step 2: Calculate runoff volume for the containment system

The designer shall calculate runoff volume using a runoff curve number or runoff coefficient for the site and a design rainfall depth for a 2-year, 24-hour storm event (available at the Western Regional Climate Center (http://www.wrcc.dri.edu/) or from local public works or water agencies). The sediment basin must contain at least 3,600 cubic feet of runoff per acre of watershed.

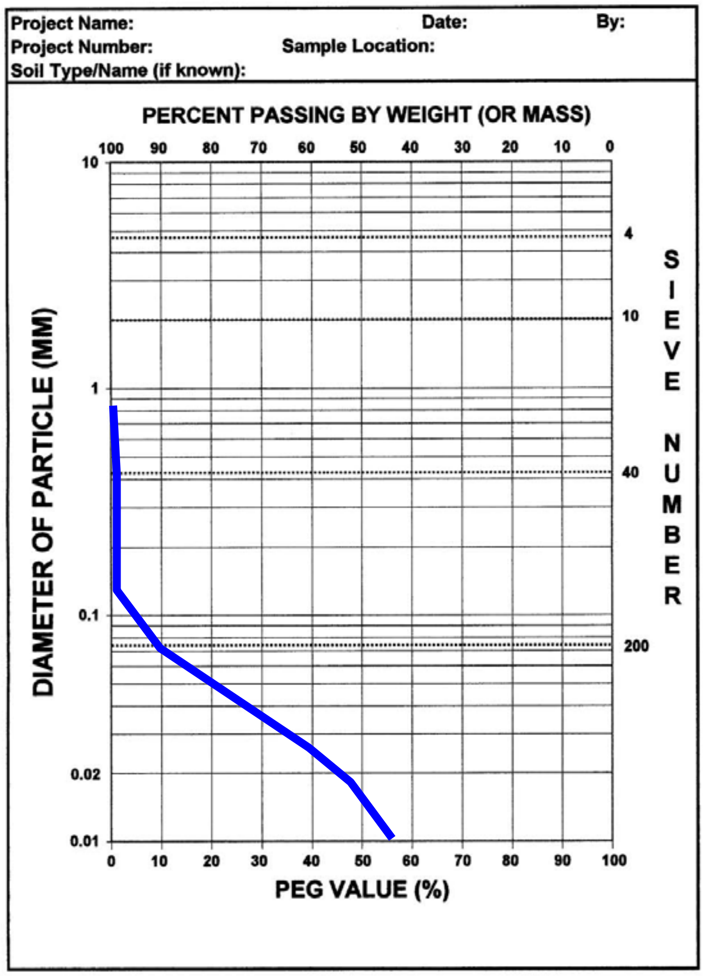

Figure 1. PEG chart for contributing soils (chart from Fifield, 2004).

$$VOL_{min} = 3{,}600 \times 12.5 = 45{,}000 \text{ ft.}^3$$

Step 3: Calculate the minimum surface area

Use Equation 4 to calculate the minimum surface area if an average depth of the sediment basin is 4.0 feet. Surface area may be larger if the calculated runoff volume is greater than 3,600 cubic feet of runoff per acre of watershed.

$$Vol_{min} = \text{Depth} \times SA_{min}$$

$$45{,}000 = 4.0 \times SA_{min}$$

$$SA_{min} = 11{,}250 \text{ ft.}^2$$

Step 4: Calculate the minimum flow path length and effective width

Critical for any sediment basin system is ensuring that a minimum flow path length within the contained waters exists for

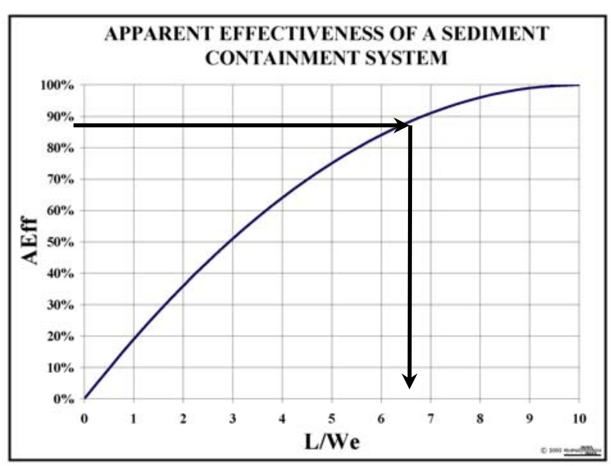

Figure 2. AEff and Length-Width ratio value (chart from Fifield, 2004).

suspended particles to achieve an AEff = 90% when a design discharge occurs. This requires using the AEff chart and Equation 2.

From Figure 2, it is evident that if AEff = 90%, the length-width ratio will be at least 6.9. Thus, the length of sediment-laden waters flowing in a sediment basin must be 6.9 times longer than the width.

Using Equation 2 and Equation 3, it is possible to determine the minimum flow path length for sediment-laden waters in a sediment basin.

$$L_{min} = (L{:}W_e \times SA_{min})^{0.5} = (6.9 \times 11{,}250)^{0.5} = 279 \text{ ft.}$$

$$W_e = SA_{min} \div L_{min} = 11{,}250 \div 279 = 40 \text{ ft.}$$

Step 5: Calculate the maximum discharge from the system

Equation 1 provides a method to assess a (theoretical) maximum discharge value from the sediment basin before removal by gravity of 0.02-mm and larger suspended particles becomes less than 90%.

$$SA_{min} = (1.2 \times Q) \div V$$

$$11{,}250 = (1.2 \times Q) \div 0.00065$$

$$Q = 6.1 \text{ cfs}$$

In summary, if runoff waters from 12.5-acres enter a rectangular shape sediment basin having the following dimensions:

$$VOL_{min} = 45{,}000 \text{ ft.}^3$$

$$SA_{min} = 11{,}250 \text{ ft.}^2$$

$$L_{min} = 279 \text{ ft.}$$

$$W_e = 40 \text{ ft.}$$

and discharges from the system (e.g., over a spillway) do not exceed 6.1 cfs, then it is feasible to capture at least 90% of the suspended particles with diameters 0.02-mm and larger.

Step 6: Calculate the net effectiveness of the system

Step 6, while recommended, is not necessary to meet the design standards found in this Appendix. Steps 1 through 5 above illustrate what is necessary for development of a sediment basin to remove 90% or more on the incoming sediments having diameters of 0.02-mm or larger and a design discharge of 6.1 cfs exists. However, the PEG graph illustrates significant amounts of particles will be smaller than 0.02-mm. Thus, the net effectiveness of the system to capture all sediment-laden particles will be less than 90%.

Use Equation 5 to calculate the net effectiveness of the sediment basin when a discharge of 6.1 cfs exists.

$$NEff = AEff \times PEG$$

$$NEff = 90\% \times 46\%$$

$$NEff = 41.4\%$$

When discharge values exceed 6.1 cfs (e.g., flood flow conditions), net effectiveness of the sediment basin to capture sediments will become less than 41.4%. However, net effectiveness of the system will increase as discharge rates become less than 6.1 cfs.

Thus, if detained waters in the sediment basin take (as an example) 48 hours to drain, a net effectiveness of the structure greater than 41.4% should occur since the average discharge rate is 45,000 ÷ (48 x 3600) = 0.26 cfs.

EXAMPLE 2: DEVELOPING A SEDIMENT BASIN FOR A DESIGN DISCHARGE

Development of sediment basins must always include a "design discharge" from the system based upon outflows caused by a specific frequency storm (e.g., 2-year, 24-hour) event. Using information found in Example 1, the following illustrates how to calculate minimum sediment basin parameters when a design discharge rate of 9.2 cfs exists.

Step 1: Calculate the minimum surface area

$$SA_{min} = (1.2 \times Q) \div V$$
$$= (1.2 \times 9.2) \div 0.00065$$
$$= 16{,}985 \text{ ft.}^2$$

Step 2: Calculate the minimum flow path length and effective width

$$L_{min} = (L{:}W_e \times SA_{min})^{0.5}$$
$$= (6.9 \times 16{,}985)^{0.5}$$
$$= 342 \text{ ft.}$$

$$W_e = SA_{min} \div L_{min}$$
$$= 16{,}985 \div 342$$
$$= 50 \text{ ft.}$$

Step 3: Calculate the minimum volume

$$Vol_{min} = Depth \times SA_{min}$$
$$= 4 \times 16{,}985$$
$$= 67{,}940 \text{ ft.}^3$$

SUMMARY

An optimal shape of a sediment basin for removing untreated suspended particles in runoff waters by gravity is rectangular. However, the final design of a sediment basin is dictated by topographic conditions of the site. Thus, the challenge for designers is to make innovative use of internal baffles and basin shapes to ensure incorporation of the four critical parameters (i.e., Vol_{min}, SA_{min}, L_{min}, and W_e) into any final design.

It is important to recognize that draining a sediment basin by a perforated riser pipe may result in discharging large amounts of undesirable suspended particles found throughout the water column. The discharger can overcome this problem by employing a skimmer that removes contained waters within the top 3- to 6-inches of the pond, which is where the smallest amounts of suspended particles exist. Additional guidance on outlet structures can be found in the California Best Management Practice Construction Handbook (available at www.cabmphandbooks.com) as well as in other publications.

Lastly, it is important to note that local vector control regulations may apply and sediment basins might need to be fenced off accordingly.

REFERENCES

Fifield, Jerald S. 2004. Designing for Effective Sediment and Erosion Control on Construction Sites. ForesterPress, Santa Barbara, CA. 305 pages.