Appendix 9

Sediment Retention Structure Capacity Calculations

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Note: These "Detailed Calculation" spreadsheets relate only to high erosion hazard lands as identified in figure 4.6 or where the designer chooses to use the RUSLE to size sediment basins. The "Standard Calculation" spreadsheets should be used on low erosion hazard lands as identified by figure 4.6 and where the designer chooses not to run the RUSLE in calculations.

1. Site Data Sheet

Site Name: Bogo Quarry

Site Location: Paynes Road, via Hume Highway and Bookham

Precinct: N/A

Description of Site: Sediment Retention Structures for the Bogo Quarry Production Increase Project

Site area	Sub-catchments						Remarks
	FGK	H	I	J			
Total catchment area (ha)	8.1	2.2	2.7	0.5			
Disturbed catchment area (ha)	8.1	2.2	2.7	0.5			

Soil analysis (enter sediment type if known, or laboratory particle size data)

Sediment Type (C, F or D) if known:	D	D	D	D			From Appendix C
% sand (fraction 0.02 to 2.00 mm)							Soil texture should be assessed through mechanical dispersion only. Dispersing agents (e.g. Calgon) should not be used
% silt (fraction 0.002 to 0.02 mm)							
% clay (fraction finer than 0.002 mm)							
Dispersion percentage							E.g. enter 10 for dispersion of 10%
% of whole soil dispersible							See Section 6.3.3(e). Auto-calculated
Soil Texture Group	D	D	D	D			Automatic calculation from above

Rainfall data

Design rainfall depth (days)	5	5	5	5			See Sections 6.3.4 (d) and (e)
Design rainfall depth (percentile)	95	95	95	95			See Sections 6.3.4 (f) and (g)
x-day, y-percentile rainfall event	40.8	40.8	40.8	40.8			See Section 6.3.4 (h)
Rainfall R-factor (if known)	1170	1170	1170	1170			See Appendix B
IFD: 2-year, 6-hour storm (if known)	6.67	6.67	6.67	6.67			See IFD chart for the site

RUSLE Factors

Rainfall erosivity (*R*-factor)	1170	1170	1170	1170			Auto-filled from above
Soil erodibility (*K*-factor)	0.05	0.05	0.05	0.05			RUSLE LS factor calculated for a high rill/interrill ratio.
Slope length (m)	40	40	60	100			
Slope gradient (%)	5	5	5	5			
Length/gradient (*LS*-factor)	0.80	0.80	1.01	1.35			
Erosion control practice (*P*-factor)	1.3	1.3	1.3	1.3			
Ground cover (*C*-factor)	1	1	1	1			

Calculations

Soil loss (t/ha/yr)	61	61	77	103			
Soil Loss Class	1	1	1	1			See Section 4.4.2(b)
Soil loss (m^3/ha/yr)	47	47	59	79			
Sediment basin storage volume, m^3	64	17	27	7			See Sections 6.3.4(i) and 6.3.5 (e)

2. Storm Flow Calculations

Peak flow is given by the Rational Formula:

$$Qy = 0.00278 \times C_{10} \times F_Y \times I_{y,\,tc} \times A$$

where:
- Q_y is peak flow rate (m^3/sec) of average recurrence interval (ARI) of "Y" years
- C_{10} is the runoff coefficient (dimensionless) for ARI of 10 years. Rural runoff coefficients are given in Volume 2, figure 5 of Pilgrim (1998), while urban runoff coefficients are given in Volume 1, Book VIII, figure 1.13 of Pilgrim (1998) and construction runoff coefficients are given in Appendix F
- F_y is a frequency factor for "Y" years. Rural values are given in Volume 1, Book IV, Table 1.1 of Pilgrim (1998) while urban coefficients are given in Volume 1, Book VIII, Table 1.6 of Pilgrim (1998)
- A is the catchment area in hectares (ha)
- $I_{y,\,tc}$ is the average rainfall intensity (mm/hr) for an ARI of "Y" years and a design duration of "tc" (minutes or hours)

Time of concentration (t_c) = $0.76 \times (A/100)^{0.38}$ hrs (Volume 1, Book IV of Pilgrim, 1998)

Note: For urban catchments the time of concentration should be determined by more precise calculations or reduced by a factor of 50 per cent. Place an x in the appropriate column below to automatically halve the time of concentration for that sub-catchment.

Peak flow calculations, 1

Site	A (ha)	Place an x here to halve tc	tc (mins)	Rainfall intensity, I, mm/hr						C_{10}
				$1_{yr,tc}$	$5_{yr,tc}$	$10_{yr,tc}$	$20_{yr,tc}$	$50_{yr,tc}$	$100_{yr,tc}$	
FGK	8.1	x	9	43.3	77	90	107	130	149	0.86
H	2.2	x	6	51	91	107	127	155	191	0.88
I	2.7	x	6	51	91	107	127	155	191	0.88
J	0.5	x	3	51	91	107	127	155	191	0.88
		x								
		x								

Peak flow calculations, 2

ARI (yrs)	Frequency factor (F_y)	Peak flows						Comments
		FGK (m^3/s)	H (m^3/s)	I (m^3/s)	J (m^3/s)	(m^3/s)	(m3/s)	
1 yr,tc	0.8	0.671	0.220	0.269	0.050			
5 yr,tc	0.95	1.417	0.465	0.571	0.106			
10 yr,tc	1	1.743	0.576	0.707	0.131			
20 yr,tc	1.05	2.176	0.718	0.881	0.163			
50 yr,tc	1.15	2.895	0.959	1.177	0.218			
100 yr,tc	1.2	3.463	1.234	1.514	0.280			

3. Volume of Sediment Basins: *Type C* Soils

Basin volume = settling zone volume + sediment storage volume

Settling Zone Volume

The settling zone volume for *Type C* soils is calculated to provide capacity to allow the design particle (e.g. 0.02 mm in diameter) to settle in the peak flow expected from the design storm (e.g. 0.25-year ARI). The volume of the basin's settling zone (V) can be determined as a function of the basin's surface area and depth to allow for particles to settle. Peak flow/discharge for the 0.25-year, ARI storm is given by the Rational Formula:

$$Q_{tc,0.25} = 0.5 \times [0.00278 \times C10 \times Fy \times I\ 1yr, tc \times A\ ]\ (m3/sec)$$

where:

$Q_{tc,0.25}$ = flow rate (m^3/sec) for the 0.25 ARI storm event
C_{10} = runoff coefficient (dimensionless for ARI of 10 years)
F_y = frequency factor for 1 year ARI storm
$I_{1\ yr,tc}$ = average rainfall intensity (mm/hr) for the 1-year ARI storm
A = area of catchment in hectares (ha)

Basin surface area (A) = area factor x $Q_{tc,\ 0.25}$ m2

Particle settling velocities under ideal conditions (Section 6.3.5(e))

Particle Size	Area Factor
0.100	170
0.050	635
0.020	4100

Volume of settling zone = basin surface area x depth (Section 6.3.5(e)(ii))

Sediment Storage Zone Volume

In the detailed calculation on Soil Loss Classes 1 to 4 lands, the sediment storage zone can be taken as 100 percent of the settling zone capacity. Alternately designers can design the zone to store the 2-month soil loss as calculated by the RUSLE (Section 6.3.5(e)(iv)). However, on Soil Loss Classes 5, 6 and 7 lands, the zone must contain the 2-month soil loss as calculated by the RUSLE (Section 6.3.5(e)(v)).

Place an "X" in the box below to show the sediment storage zone design parameters used here:

	100% of settling zone capacity,
X	2 months soil loss calculated by RUSLE

Total Basin Volume

Site	$Q_{tc,\ 0.25}$ (m^3/s)	Area factor	Basin surface area (m^2)	Depth of settling zone (m)	Settling zone volume (m^3)	Sediment storage volume (m^3)	Total basin volume (m^3)	Basin shape		
								L:W Ratio	Length (m)	Width (m)
FGK	0.335	4100	1375	0.6	825	64	889			
H	0.110	4100	450	0.6	270	17	287			
I	0.135	4100	552	0.6	331	27	358			
J	0.025	4100	102	0.6	61	7	68			
		4100								
		4100								

4. Volume of Sediment Basins, *Type D* and *Type F* Soils

Basin volume = settling zone volume + sediment storage zone volume

Settling Zone Volume

The settling zone volume for *Type F* and *Type D* soils is calculated to provide capacity to contain all runoff expected from up to the y-percentile rainfall event. The volume of the basin's settling zone (V) can be determined as a function of the basin's surface area and depth to allow for particles to settle and can be determined by the following equation:

$$V = 10 \times C_v \times A \times R_{x\text{-day, y-\%ile}} \ (m^3)$$

where:

10 = a unit conversion factor

C_v = the volumetric runoff coefficient defined as that portion of rainfall that runs off as stormwater over the x-day period

$R_{x\text{-day, y-\%ile}}$ = is the x-day total rainfall depth (mm) that is not exceeded in y percent of rainfall events. (See Sections 6.3.4(d), (e), (f), (g) and (h)).

A = total catchment area (ha)

Sediment Storage Zone Volume

In the detailed calculation on Soil Loss Classes 1 to 4 lands, the sediment storage zone can be taken as 50 percent of the settling zone capacity. Alternately designers can design the zone to store the 2-month soil loss as calculated by the RUSLE (Section 6.3.4(i)(ii)). However, on Soil Loss Classes 5, 6 and 7 lands, the zone must contain the 2-month soil loss as calculated by the RUSLE (Section 6.3.4(i)(iii).

Place an "X" in the box below to show the sediment storage zone design parameters used here:

	50% of settling zone capacity,
X	2 months soil loss calculated by RUSLE

Total Basin Volume

Site	C_v	$R_{x\text{-day, y-\%ile}}$	Total catchment area (ha)	Settling zone volume (m^3)	Sediment storage volume (m^3)	Total basin volume (m^3)
FGK	0.51	40.8	8.1	1685.448	64	1749.448
H	0.51	40.8	2.2	457.776	17	474.776
I	0.51	40.8	2.7	561.816	27	588.816
J	0.51	40.8	0.5	104.04	7	111.04

Note that designers should achieve a minimum 3:1 length:width ratio in Type D or F basins

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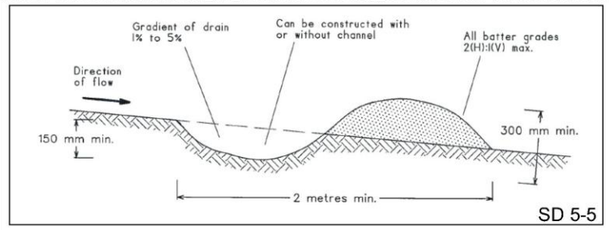
TN
MN

Paynes Road

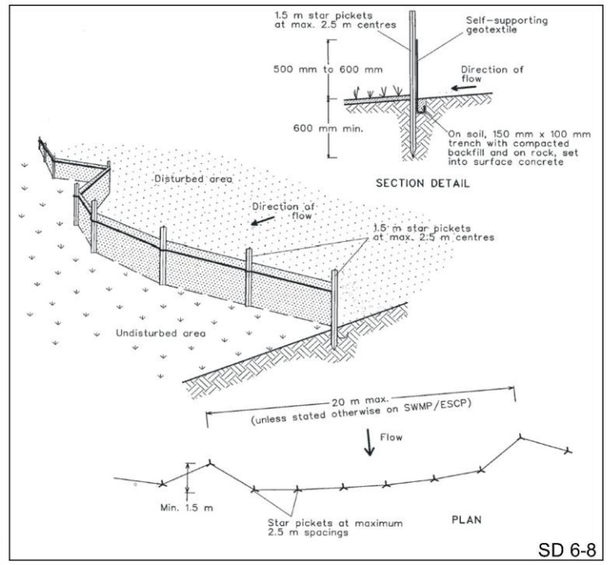
Dam 1
Dam 2
Dam 3
Dam 4
Dam 5
Dam 6
Dam 7
Dam 8
Dam 9

A Extraction Area
B
D
E Site Entrance Catchment
F Workshop
G Processing Plant Catchment
H Western Stockpile Area Catchment
I
J
K Extraction Area Catchment
M Asphalt Plant Catchment

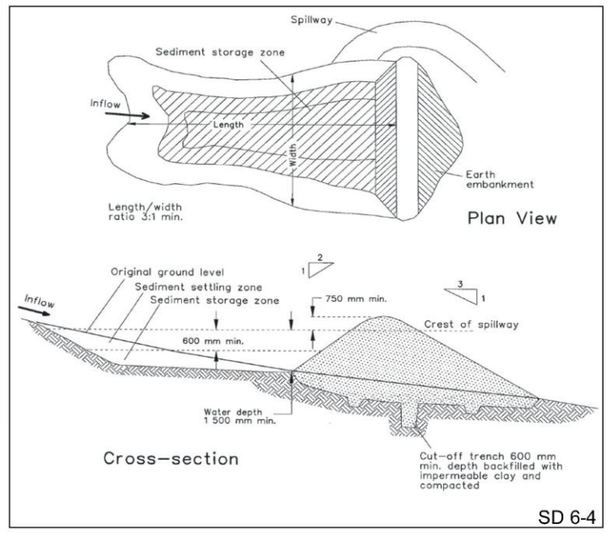
Northern Stockpile Area Catchment
Weighbridge
Office
Concrete Plant Pad
Processing Plant
Asphalt Plant Pad



SD 5-5



SD 6-8



SD 6-4

REFERENCE

- Quarry Site Boundary
- Proposed Limit of Extraction (Life of Quarry)
- Product Stockpile Area Boundary
- Catchment Boundary
- H Catchment Reference
- Sediment Fencing (SD 6-8)
- Low Flow Diversion Bank (SD 5-5)
- Low Flow Catch Bank (SD 5-5)
- Lined Waterway (C Factor <0.05)
- Sediment Basin (SD 6-4)
- 545 Contour (m AHD)(Interval = 1m)
- Dam / Water Storage (& No.)
- Watercourse / Drainage Line
- Unsealed Road / Track
- Fence
- Perimeter Tree Screen (30m Wide)
- Topsoil Stockpile Area Boundary

SCALE 1:3 500 (A3)
50 0 50 100 150m

Base Map Source: Geo-Spectrum (Australia) Pty Ltd - Date of Mapping: 11 September 2008

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