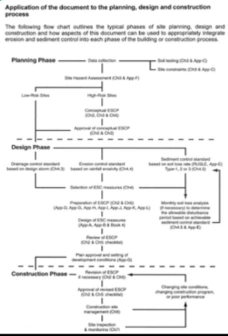
What’s in the IECA Manual?

Site Assessment

and E&SC Planning

Using the IECA Manual



- Flowchart guides you through a stepwise process
- References to relevant Chapters and Appendices
- Copy of flowchart at back of notes

Plan Preparation

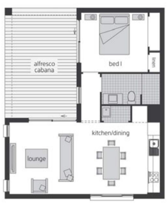
- How much detail does my plan require?
- Look to sediment control standard IECA Manual Section 4.5
- Disturbed area 250m² - 1,000m², simple plan with Type 3 controls may be sufficient
- Disturbed area 1,000m² - <2,500m² ESCP required, with Type 2 sediment controls
- Disturbed area >2,500m² require detailed ESCP (and Conceptual ESCP for High Risk sites)

Examples

- Disturbed area ~250m²: house extension, garage, small driveway
- Disturbed area ~1,000m²: housing, small commercial development or minor civil works
- Disturbed area 1,000-2,500m²: commercial development, minor subdivision or medium-high density housing
- Disturbed area >2,500m²: large subdivisions, roadway construction, community-scale housing and large civil works

What sort of plan do I require?

- What sort of plan do I require if I am proposing to build a granny flat?
- Building width 8.00m
- Building length 9.60m
- Disturbed area 76.8m²
- No formal ESCP required
- Check with consent authority
- Type 3 sediment controls
- Exercise care



What sort of plan do I require?

- What sort of plan do I require if I am proposing to build a house?
- Envelope width 19.74m
- Envelope length 42.50m
- Disturbed area 838.95m²
- Require Basic ESCP
- Address soil erosion and sediment pollution only

What sort of plan do I require?

- What about an industrial subdivision?
- Six lots:
  - 1,218m^2
  - 1,123m^2
  - 985m^2
  - 985m^2
  - 1,186m^2
  - 856m^2

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What sort of plan do I require?

- Total area: 6,353m^2
- Require Detailed ESCP
- Address soil erosion sediment pollution and sediment basin calculation
- If 'High Risk' conceptual ESCP may be required during development planning stage

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Basic ESCP

- IECA Manual Section 5.3 describes minimum requirements for ESCP:
  - Site plan (typically 1:500 or larger)
  - Proposed construction activities
  - General soil information; retained vegetation; sensitive features
  - Site drainage (contours etc.)
  - Construction access, storage and vehicle controls
  - Adopted ESC measures and drainage controls
  - Site stabilisation requirements

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Detailed ESCP

- Expanded requirements for detailed ESCP include:
  - Cut/fill plans (proposed final contours)
  - Construction drainage plans for each stage of activity
  - Design and construction details (specification and installation detail) drainage and sediment control devices
  - Construction specifications for adopted ESC measures
  - Site monitoring and maintenance plans
  - Calculation and sizing details for any structures or devices

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Conceptual ESCP

- IECA Manual Section 5.2 describes purpose to "assist in appropriate planning of development"
- Key outcomes:
  - Identify need for sediment basin
  - Confirm adequate construction footprint (for all activities, including controls)
  - Demonstrate project feasibility while achieving environmental protection goals
  - Identify problem areas and sensitive environmental features

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ESCP measures

Typical ESC measures include:

- Clean water diversion
- Site access controls (barrier fence)
- Construction access points
- Type 3 sediment controls (e.g. sediment fence)
- Designated stockpile locations
- Waste disposal / storage facilities
- Stabilisation measures
- Maintenance

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Clean water diversion

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Access controls/barrier fence

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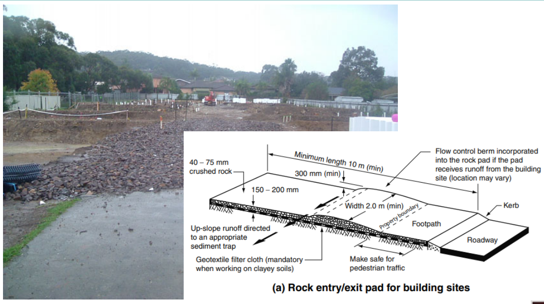
Stabilised access



(a) Rock entry/exit pad for building sites

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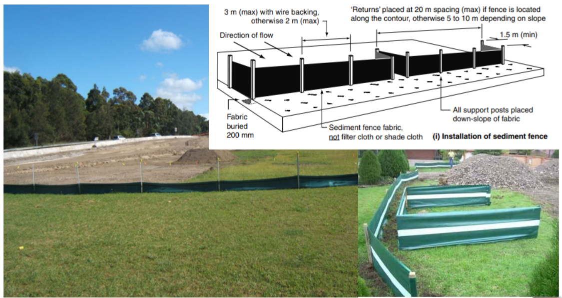
Sediment fence



(i) Installation of sediment fence

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Stockpiles

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Waste storage

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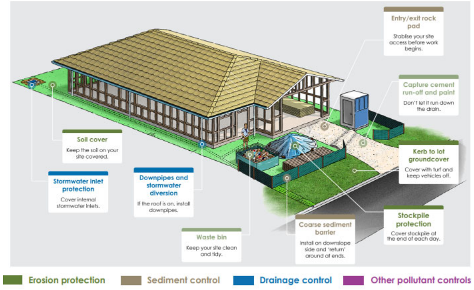
Basic ESC for small development



Source: Healthy Land and Water, QDES

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Single lot ESCP

- Mark up the A3 plan of a single lot residential development, which you will find at the back of the course notes booklet
- Show the various erosion and sediment control measures you would put in place and their appropriate location
- Locate and list the various Standard Drawings you would refer to illustrate the erosion and sediment control measures you have nominated

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What are we trying to avoid?

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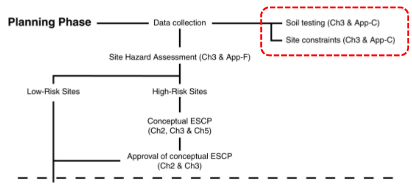
ESCP Planning Process



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Assessment of constraints

IECA Manual Chapter 3 considers:

- Soil limitations Ch3.4.1
- Topographic limitations Ch3.4.2
  - Inundation and Flooding
  - Poor drainage
  - Mass movement
  - Climate
  - Slope
  - Waterways
- Vegetation Ch3.4.4
- Ecology Ch3.4.5

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Soil Data Collection

Link soils to landscape by key features:

- Geology/rock type
- Soil type
- Position on slope
- Landforms
- IECA Manual App C and App E
- Information also from some individual soils reports on VRO

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Wyndham City Council

What's in the IECA Manual

27 June 2024

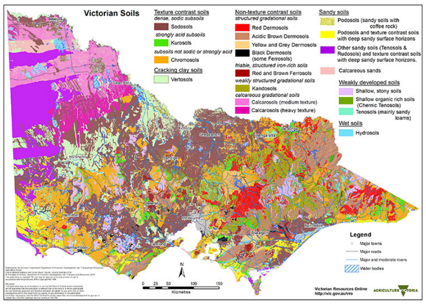
Soil Information Sources

Atlas of Australian Resources, Volume 1 Soils and Land Use (Division of National Mapping, Canberra, 1980)

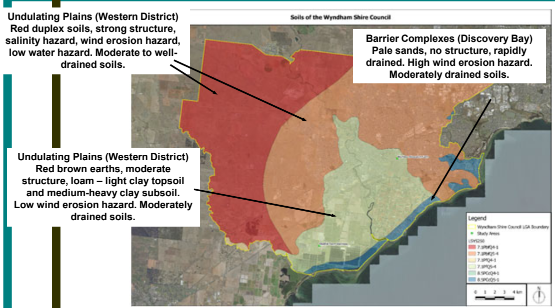
Victorian Resources Online (VRO) soils maps and data from Agriculture Victoria *vro.agriculture.vic.gov.au*

- Generally 1:100,000 – 1:250,000 scale
- Detailed 1:25,000 (irrigation regions)

Soil Mapping



Local Soil Mapping



SH-jp	JERRYS PLAINS SOIL LANDSCAPE

GENERAL

This landscape covers the undulating low hills to the south and west of Jerrys Plains. The main soils are Soloths (Dy3.42, Dy3.22, Dy5.12, Dr2.12, Dr2.42, Db1.42) on the crests to midslopes with Solodic Soils (Dy2.52, Dy3.42, Dy2.82, Db2.42, Dr3.42, Db1.13) on the lower slopes and in drainage depressions. Brown Clays (Uf6.4, Ug5.32) occur in midslope depressions. Solodised Solonetz (Dy3.43) occur on slopes where drainage is severely impeded by bedrock. Areas of severe salting occur in many of the drainage lines. Other soils include Red Earths (Dr3.62) on upper slopes with some Euchrozem – Yellow Solodic Soil intergrades (Dy3.12).

CLIMATIC ZONE: 3B and 3E

LANDFORM

Undulating low hills ranging in elevation from 80 – 180 m. Slope range from 2 – 10%, with most around 6%. Local relief is around 60 m. Slope lengths range from 900 – 3,000 m. Numerous small drainage lines occur, flowing to the north and east, at intervals of 200 – 1,100 m.

NATIVE VEGETATION

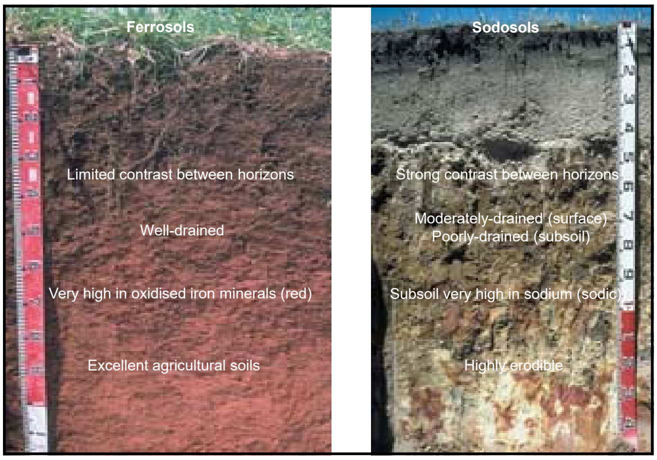
A woodland community of narrow-leaved red ironbark with forest red gum and grey gum with bull oak along drainage lines. Much regrowth occurs on unimproved pastures.

GEOLOGY

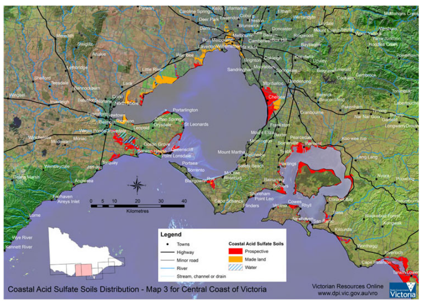
Geological Unit: Jerrys Plains Subgroup of the Wittingham Coal Measures.
Parent Rock: Lithic sandstone, mudstone, some siltstone lenses and polymictic conglomerates.
Parent Material: *In situ* weathered parent rock and derived colluvium.

SOIL EROSION

Severe gully erosion (1.5 – 3.0 m) in some drainage lines with occasional salt scalds. Minor sheet erosion in some disturbed areas on hillslopes.



Acid sulfate soil probability



Acid sulfate soils

- How can acid sulfate soils affect E&SC? p3-6
  - Acid Sulfate Soil Risk Mapping
  - Common in coastal Victoria
  - Excavations in and near coast and estuaries
  - ASSMP - Procedures for handling and pH stabilisation

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Acid sulfate soils

Tweed Shire Council

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Riparian and flood prone land

- What are the E&SC implications for riparian and flood prone land?

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Riparian and flood prone land

- E&SC implications for riparian and flood prone land p3-6 to p3-7:
  - Protection of social, economic, cultural and heritage values of waterfront land
  - Avoid or minimise land degradation, soil erosion, compaction, instability, contamination, acidity, salinity and decline of native vegetation

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Water Tables / Groundwater

- How can groundwater affect E&SC? p3-7
  - Flow into bores, wells and open excavations
  - Collapse of excavations
  - Impede site access
  - Perched watertables
  - Moisture fluctuations
  - Seasonal and permanent watertables
  - Implications for plant growth and stabilisation

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Salinity

- Implications in both rural and urban settings

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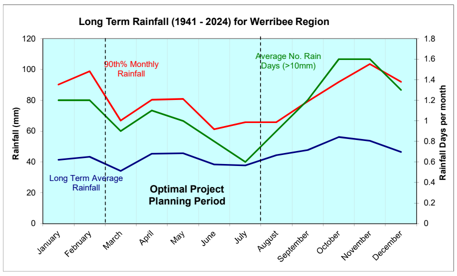
Salinity

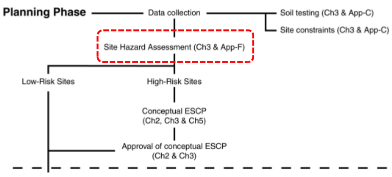
- How can salinity affect E&SC? p3-7
  - Implications for plant growth
  - Reduction in vegetational cover (C-factor) and consequent increase in erosion hazard

Micro-Climate



Source: BOM Laverton RAAF

Site Hazard Assessment



Assessment of erosion hazard and soil loss estimation

- Can use RUSLE, IECA Manual Reference Appendix E, or
- TASK number IECA Manual Reference Appendix F, or
- (A-line test)
- For preliminary assessment of potential erosion hazard
- For high erosion hazard land require:
  - Batter gradient restrictions
  - Timing of works (low rainfall intensity periods)
  - Stabilisation restrictions, C-factors >0.1 only when 3-day forecast suggests rain unlikely

Measured erosion rates

Natural conditions:	(t/ha/yr)
• Forest	0.005 – 0.05
• Grassland	0.1 – 1.0
Human Activity:	
• Grazing land	0.1 – 5.0
• Developed Residential	5 – 10
• Active Construction sites	60 – 100+

Measured erosion rates

By how many fold do we increase erosion rates by undertaking construction on land that was previously grassland?

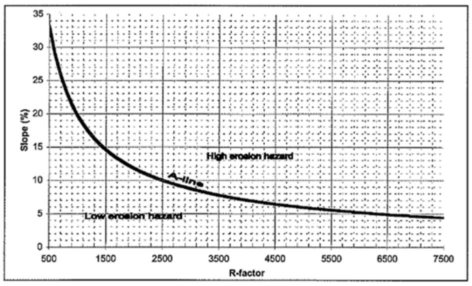
Natural conditions:	(t/ha/yr)
• Grassland	0.1 – 1.0
• Active Construction sites	60 – 100+

Measured erosion rates

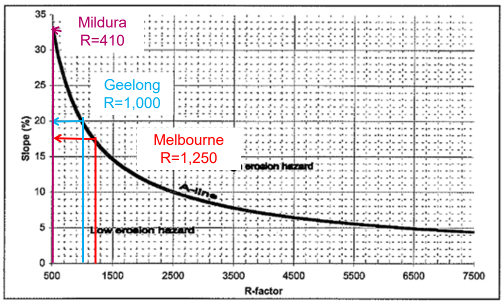
By how many fold do we increase erosion rates by undertaking construction on land that was previously grassland?

- Between 60 and 1,000 fold!

Erosion hazard assessment



A-line test



Erosion hazard assessment

If you were planning to duplicate the width of a railway line in a cutting in Melbourne, where the gradient of the cutting was 15%, what would the erosion hazard be?

TASK number

- Modified version of RUSLE, IECA Manual Appendix F

$$H = T \times A \times S \times K$$

Where:

- H = TASK number
- T = Duration of soil disturbance (months)
- A = Total area of soil disturbance (m^2)
- S = Slope Factor (Table F2) or equation
- K = Soil erosivity (K-factor) (Table F3)

TASK number

Hazard rating:

- <200 Low risk
- 200+ High risk

Calculate the TASK number and hazard rating for a site in Geelong where the soils are inorganic clays of medium to low plasticity, the slope is 3% and 1,000m^2 will be disturbed for four months

TASK number

At what gradient would the same site become a high risk?

200/(4 x 1,000 x 0.058) = 0.862

0.862 is slope factor for a slope of ~7%

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Erosion hazard

Standard erosion controls apply to all sites:
- Stabilised access
- Water management
- Stockpile management
- Stabilisation requirements

High erosion hazard sites also require:
- Timing of works
- If not possible, C-factor >0.1 (60% cover) only when 3-day forecast suggests rain is unlikely
- Management of batter gradients

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Assessing erosion hazard

Erosion hazard is the susceptibility or risk of land to erosion
- Depends on a combination of factors
- Varies from site to site

What factors do you think affect erosion hazard?

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Erosion factors

These factors are significant:
- **Rainfall** erosivity / intensity
- **Soil** type and erodibility
- **Slope** length/steepness
- **Conservation practice**
- **Cover** type

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RUSLE

- Factors influencing erosion form the basis for the **R**evised **U**niversal **S**oil **L**oss **E**quation
  - Empirical equation used to estimate erosion hazard for a location
  - How much soil is likely to be lost from a site?
  - What factors influence the amount of erosion?

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RUSLE

- Equation:

$$A = R \times K \times LS \times P \times C$$

Where:
- A = Computed soil loss (tonnes/ha/year)
- R = rainfall erosivity factor
- K = soil erodibility factor
- LS = slope length / gradient factor
- P = erosion control practice factor
- C = ground cover and management factor

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RUSLE

- Equation:

$$A = R \times K \times LS \times P \times C$$

- If one factor increases, A (computed soil loss) increases
- Equally, if one factor decreases, the estimated annual soil loss (A) decreases
- Important to determine the relative influence of the factors

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RUSLE

- IECA Manual Appendix E
- Use to assess erosion hazard
- Use to estimate soil loss rates
- Use in sediment basin design
- Note that RUSLE only applies to non-channelised erosion (i.e. not concentrated flows)
- Also, RUSLE does not consider dispersibility

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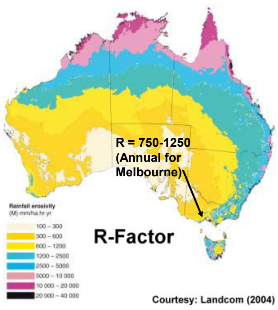
Rainfall Erosivity (R)



- A measure of the ability of rainfall to cause erosion
- Related to the energy and intensity of rainfall
- Varies throughout Australia and throughout the year
- IECA Manual Table E1 for R-factors

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Rainfall Erosivity (R)

- Predominant rainfall droplet size (energy)
- Based on average annual rainfall data
- Ignores prevailing soil moisture
- $R = 164.74 \times 1.1177^{S} \times S^{0.6444}$, where
  - S is the 2-year, 6-hour storm event
- Note variation across Victoria (Table E1)
- Note percentage erosivity over months of the year (Table E2)

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Rainfall Erosivity (R-factor)

- Does not account for seasonality or antecedent conditions affecting peak flow and total runoff
- If a seasonal rainfall pattern is evident work on land with a high erosion hazard should be undertaken in the "drier" months
- Which month would you choose to work in Melbourne based on monthly percentage R-factor values?

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Rainfall Erosivity (R-factor)

Which months would you choose to work in Melbourne?

Melbourne Mean rainfall mm

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
46.8	48	50.1	57.3	55.7	49.5	47.5	50	58	66	60.3	59.1

Monthly R-factor values suggest June – August are preferred months

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Soil type and Erodibility (K)

- A measure of the susceptibility of soil particles to erosion
- Affected by soil texture, structure, organic matter, profile permeability and other parameters
- Generally, fine sands and silts are most erodible, but dispersible clays can be highly erodible
- Tables E4 and E5 or Lab test results

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Soil texture

- Coarse sand 0.2 – 2.0 mm
- Fine sand 0.1 – 0.2 mm
- Very fine sand 0.02 – 0.1 mm
- Silt 0.002 – 0.02 mm
- Clay < 0.002 mm

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Soil organic matter

- % Organic carbon x 1.72
- Based on laboratory analysis

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Soil structure

- Very fine granular - particles mostly < 1mm diameter
- Fine granular – particles mostly 1 - 2 mm diameter
- Medium or coarse granular – particles mostly 2 – 10 mm diameter
- Blocky, platy or massive

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Soil profile permeability

- The rate of infiltration of water (K_{sat}) into the whole soil profile
- Rapid >130 mm/hour
- Moderate to rapid 60 - 130 mm/hour
- Moderate 20 - 60 mm/hour
- Slow to moderate 5 - 20 mm/hour
- Slow 1 - 5 mm/hour
- Very slow <1 mm/hour

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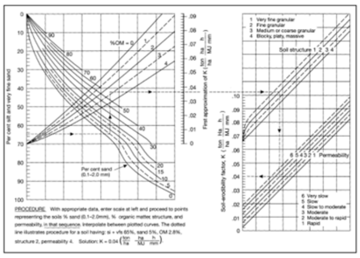
Soil Erodibility K-factor nomogram

- Nomograms allow determination



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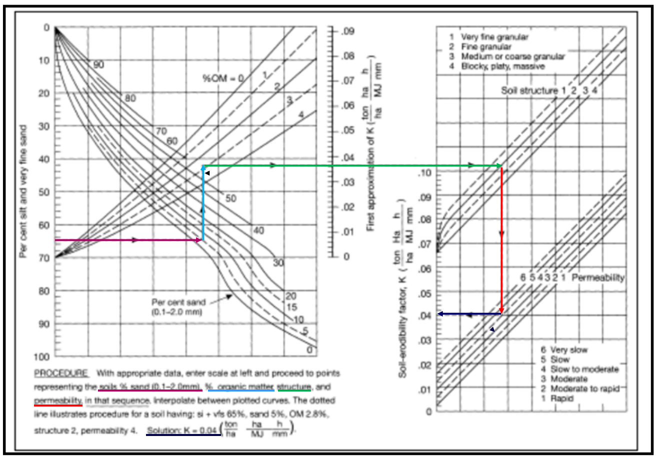

K-factors (after Rosewell 1993)

Table E4 – Default soil erodibility K-factors based on soil texture class

Soil texture	Symbol	Estimated clay content (%)	K-factor [1]
Sand	S	< 10	0.015
Clayey sand	CLS	5–10	0.025
Loamy sand	LS	5–10	0.020
Sandy loam	SL	10–15	0.030
Fine sandy loam	FSL	10–20	0.035
Sandy clay loam	SCL	15–20	0.025
Loam	L	about 25	0.040
Loam, fine sandy	Lfsy	about 25	0.050
Silt loam	SiL	about 25 and more than 25% silt	0.055
Sandy clay loam	SCL	20-30	[0.043]
Clay loam	CL	30–35	0.030
Silty clay loam	SiCL	30–35 and more than 25% silt	0.040
Fine sandy clay loam	FSCL	30–35	0.025
Sandy clay	SC	35–40	0.017
Silty clay	SiC	35–40 and more than 25% silt	0.025
Light clay	LC	35–40	0.025
Light medium clay	LMC	40–45	0.018
Medium clay	MC	45–55	0.015
Heavy clay	HC	> 50	0.012

See large format version in notes

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Soil type and Erodibility (K-factor)

- K-factor is least accurate component of RUSLE
- Much data based on topsoils, yet subsoils are generally of more significance in construction
- Increase by 20% for dispersive soils (Emerson Class 1 and 2)

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Soil type and Erodibility (K-factor)

- Soil is 600mm of silty clay loam topsoil
- Overlying light-medium clay

What is the K-factor of the topsoil?

0.040

How would the K-factor change if the subsoil was exposed?

0.018

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Soil type and Erodibility (K-factor)

What is the implication of this for the A value (calculated soil loss)?

If you were working on a site with these soils what might be a good course of action to reduce erosion hazard?

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Slope Length / Steepness (LS)

- A measure of the combined effect of slope length and gradient on soil loss
- Increases as slopes get steeper and longer
- Gradient has greater influence
- IECA Manual Table E3
- If >1,000m^2 is to be disturbed, assume slope lengths do not exceed 80 metres before forecast rainfall or during shutdown periods (i.e. 80 metres is default)

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LS-factor Table E3

Table E3 – Slope–length, LS-factors for RUSLE

Slope gradient (%)	Slope length (m)												
	5	10	20	30	40	50	60	70	80	90	100	150	200
1	0.09	0.11	0.13	0.15	0.16	0.17	0.18	0.19	0.19	0.20	0.20	0.23	0.24
2	0.14	0.18	0.24	0.28	0.31	0.34	0.36	0.39	0.41	0.43	0.44	0.52	0.58
3	0.17	0.24	0.34	0.41	0.47	0.52	0.57	0.61	0.65	0.69	0.72	0.87	1.00
4	0.21	0.30	0.44	0.54	0.63	0.71	0.78	0.85	0.91	0.97	1.03	1.26	1.47
5	0.24	0.36	0.54	0.68	0.80	0.91	1.01	1.10	1.19	1.27	1.35	1.70	2.00
6	0.28	0.42	0.64	0.81	0.97	1.11	1.24	1.36	1.47	1.58	1.68	2.14	2.54
8	0.34	0.53	0.83	1.08	1.31	1.51	1.70	1.88	2.05	2.21	2.37	3.07	3.70
10	0.42	0.68	1.09	1.44	1.75	2.04	2.31	2.56	2.81	3.04	3.27	4.06	4.94
12	0.52	0.85	1.39	1.85	2.27	2.66	3.02	3.37	3.70	4.02	4.33	5.77	7.07
14	0.62	1.02	1.69	2.26	2.79	3.28	3.74	4.18	4.61	5.02	5.42	7.27	8.95
16	0.71	1.19	1.98	2.67	3.31	3.90	4.46	5.00	5.52	6.02	6.51	8.78	
18	0.80	1.35	2.27	3.07	3.82	4.51	5.17	5.81	6.42	7.02	7.59		
20	0.89	1.50	2.55	3.47	4.32	5.12	5.88	6.61	7.32	8.01	8.68		
25	1.09	1.88	3.23	4.43	5.54	6.59	7.60	8.57	9.51				
30	1.28	2.23	3.86	5.32	6.69	7.99	9.23						
40	1.61	2.83	4.98	6.92	8.74								
50	1.88	3.33	5.89	8.22									

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Slope Length / Steepness (LS)

- Assume slope is 4% and slope length is 100 metres

Calculate the LS-factor?

- Assume slope is 4% but the slope length can be limited to 20 metres

What is the LS-factor?

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LS-factor

Table E3 – Slope–length, LS-factors for RUSLE

Slope gradient (%)	Slope length (m)												
	5	10	20	30	40	50	60	70	80	90	100	150	200
1	0.09	0.11	0.13	0.15	0.16	0.17	0.18	0.19	0.19	0.20	0.20	0.23	0.24
2	0.14	0.18	0.24	0.28	0.31	0.34	0.36	0.39	0.41	0.43	0.44	0.52	0.58
3	0.17	0.24	0.34	0.41	0.47	0.52	0.57	0.61	0.65	0.69	0.72	0.87	1.00
4	0.21	0.30	0.44	0.54	0.63	0.71	0.78	0.85	0.91	0.97	1.03	1.26	1.47
5	0.24	0.36	0.54	0.68	0.80	0.91	1.01	1.10	1.19	1.27	1.35	1.70	2.00
6	0.28	0.42	0.64	0.81	0.97	1.11	1.24	1.36	1.47	1.58	1.68	2.14	2.54
8	0.34	0.53	0.83	1.08	1.31	1.51	1.70	1.88	2.05	2.21	2.37	3.07	3.70
10	0.42	0.68	1.09	1.44	1.75	2.04	2.31	2.56	2.81	3.04	3.27	4.06	4.94
12	0.52	0.85	1.39	1.85	2.27	2.66	3.02	3.37	3.70	4.02	4.33	5.77	7.07
14	0.62	1.02	1.69	2.26	2.79	3.28	3.74	4.18	4.61	5.02	5.42	7.27	8.95
16	0.71	1.19	1.98	2.67	3.31	3.90	4.46	5.00	5.52	6.02	6.51	8.78	
18	0.80	1.35	2.27	3.07	3.82	4.51	5.17	5.81	6.42	7.02	7.59		
20	0.89	1.50	2.55	3.47	4.32	5.12	5.88	6.61	7.32	8.01	8.68		
25	1.09	1.88	3.23	4.43	5.54	6.59	7.60	8.57	9.51				
30	1.28	2.23	3.86	5.32	6.69	7.99	9.23						
40	1.61	2.83	4.98	6.92	8.74								
50	1.88	3.33	5.89	8.22									

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LS-factor

Table E3 – Slope–length, LS-factors for RUSLE

Slope gradient (%)	Slope length (m)												
	5	10	20	30	40	50	60	70	80	90	100	150	200
1	0.09	0.11	0.13	0.15	0.16	0.17	0.18	0.19	0.19	0.20	0.20	0.23	0.24
2	0.14	0.18	0.24	0.28	0.31	0.34	0.36	0.39	0.41	0.43	0.44	0.52	0.58
3	0.17	0.24	0.34	0.41	0.47	0.52	0.57	0.61	0.65	0.69	0.72	0.87	1.00
4	0.21	0.30	0.44	0.54	0.63	0.71	0.78	0.85	0.91	0.97	1.03	1.26	1.47
5	0.24	0.36	0.54	0.68	0.80	0.91	1.01	1.10	1.19	1.27	1.35	1.70	2.00
6	0.28	0.42	0.64	0.81	0.97	1.11	1.24	1.36	1.47	1.58	1.68	2.14	2.54
8	0.34	0.53	0.83	1.08	1.31	1.51	1.70	1.88	2.05	2.21	2.37	3.07	3.70
10	0.42	0.68	1.09	1.44	1.75	2.04	2.31	2.56	2.81	3.04	3.27	4.06	4.94
12	0.52	0.85	1.39	1.85	2.27	2.66	3.02	3.37	3.70	4.02	4.33	5.77	7.07
14	0.62	1.02	1.69	2.26	2.79	3.28	3.74	4.18	4.61	5.02	5.42	7.27	8.95
16	0.71	1.19	1.98	2.67	3.31	3.90	4.46	5.00	5.52	6.02	6.51	8.78	
18	0.80	1.35	2.27	3.07	3.82	4.51	5.17	5.81	6.42	7.02	7.59		
20	0.89	1.50	2.55	3.47	4.32	5.12	5.88	6.61	7.32	8.01	8.68		
25	1.09	1.88	3.23	4.43	5.54	6.59	7.60	8.57	9.51				
30	1.28	2.23	3.86	5.32	6.69	7.99	9.23						
40	1.61	2.83	4.98	6.92	8.74								
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LS-factor

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1	0.09	0.11	0.13	0.15	0.16	0.17	0.18	0.19	0.19	0.20	0.20	0.23	0.24
2	0.14	0.18	0.24	0.28	0.31	0.34	0.36	0.39	0.41	0.43	0.44	0.52	0.58
3	0.17	0.24	0.34	0.41	0.47	0.52	0.57	0.61	0.65	0.69	0.72	0.87	1.00
4	0.21	0.30	0.44	0.54	0.63	0.71	0.78	0.85	0.91	0.97	1.03	1.26	1.47
5	0.24	0.36	0.54	0.68	0.80	0.91	1.01	1.10	1.19	1.27	1.35	1.70	2.00
6	0.28	0.42	0.64	0.81	0.97	1.11	1.24	1.36	1.47	1.58	1.68	2.14	2.54
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18	0.80	1.35	2.27	3.07	3.82	4.51	5.17	5.81	6.42	7.02	7.59		
20	0.89	1.50	2.55	3.47	4.32	5.12	5.88	6.61	7.32	8.01	8.68		
25	1.09	1.88	3.23	4.43	5.54	6.59	7.60	8.57	9.51				
30	1.28	2.23	3.86	5.32	6.69	7.99	9.23						
40	1.61	2.83	4.98	6.92	8.74								
50	1.88	3.33	5.89	8.22									

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Temporary earth banks

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Slope Length / Steepness (LS)

- If temporary earth banks were introduced every 20 metres, what implication would this have for the A value (Calculated soil loss)?

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Erosion Control Practice (P)

- Relates to surface condition rather than cover
- Reduced by practices that reduce both the velocity of runoff and the tendency of runoff to flow directly downhill, e.g.
  - Track walking up/down slope rather than across slope
  - Straw crimping
  - Loose soil surface
- IECA Manual; Table E11

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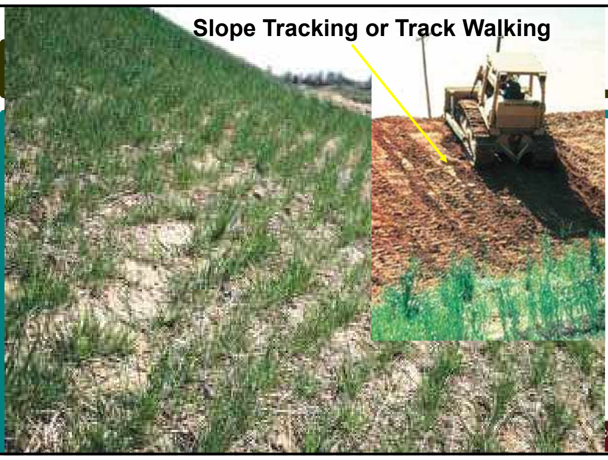

Erosion Control Practice (P)

Table E11 – Erosion control practice, P-factors

Surface condition	P-factor
Compacted and smooth (default construction phase condition)	1.3
Trackwalked along the contour	1.2
Trackwalked up and down the slope	0.9
Straw punched into loose ground by disc harrow	0.9
Loose to 300 mm depth	0.8

Note: [1] Straw mulch has been punched into a loose ground surface with a disc harrow.

- Default P factor is 1.3

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Erosion Control Practice (P)

- Now assume the surface has been track walked along the contour

What is the P-factor?

- Now assume the surface has been track up and down the slope
- Why would track walking up and down the slope be better?

What is the P-factor?

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Cover Type (C-factor)

- IECA Manual; Tables E6 – E10
- A measure of the amount and effectiveness of ground cover
- Reduce the erosion hazard by maintaining good ground cover (lower C-factor) – a key erosion control practice!
- Proper rehabilitation should ensure C-factors drop to below 0.15 within 20 days of completing work

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Cover Type (C-factor) for grass

Grass Cover	C-Factor
No cover, soil smooth and compacted	1.0 **(High)**
20 %	0.45 **(Med)**
50 %	0.15 **(Low)**
70 %	0.05
100%	< 0.01

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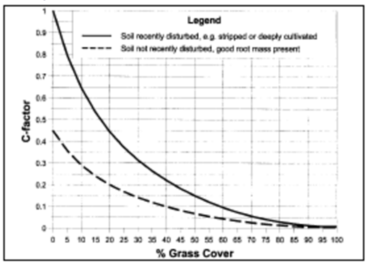
C-factor in RUSLE

- Shows significance of recent disturbance



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Cover Type (C-factor)

- Assume there is no grass cover and the surface is smooth and compacted

What is the C-factor?

What effect would 20% of newly established grass cover have on the C-factor?

- IECA Manual Table E9 C-factors for newly established grass cover
- Default C factor is 1.0

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Cover Type (C)

- Reduce the erosion hazard by maintaining good ground cover (lower C-factor) – a key erosion control practice!
- Proper rehabilitation should ensure C-factors drop to below 0.10 (60% cover) within 30 days of completing work
- So, how do we achieve a suitable C-factor?

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Estimates of soil loss

Estimates of soil loss helps to:

- Assess erosion risk
- Identify measures to overcome erosion risk
- Compare effectiveness of erosion control measures
- Estimate capacity of sediment basins

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RUSLE

- Equation:

$$A = R \times K \times LS \times P \times C$$

Where:

- A = Computed soil loss (tonnes/ha/year)
- R = rainfall erosivity factor
- K = soil erodibility factor
- LS = slope length / gradient factor
- P = erosion control practice factor
- C = ground cover and management factor

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RUSLE

Limitations:

- Only predicts sediment entrained by erosion
- Predicts average annual soil loss, not soil loss for one storm event
- Effective for sheet and rill erosion on slopes <300 metres, but not concentrated flow or long slopes
- Does not adequately take into consideration dispersibility in K-factor

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RUSLE worked exercise

- Consider you are to grade a new storage yard area 100m x 50m at a site in Geelong
- Prior to construction the site has 80% grass cover
- The topsoil will be stripped and stockpiled and the surface graded
- The resultant soil surface will be smooth and compacted
- How will the C-factor change?

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RUSLE worked exercise

- Determine the R-value for Geelong
- Calculate the LS value if the slope is 4% along the long axis of the site
- The soils are 600mm of silty clay loam topsoil (K = 0.04) overlying light-medium clay subsoil (K = 0.018)
- Calculate the post construction A value (estimated soil loss)

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RUSLE worked exercise

- Post-construction soil loss
- Equation:

A = R x K x LS x P x C

A = R x K x LS x P x C

A = 1,027 x 0.018 x 1.03 x 1.3 x 1.0

A = 24.75 tonnes/ha/year

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RUSLE exercise

- How much will you have reduced soil loss by stripping and stockpiling the topsoil?

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RUSLE exercise

- How much will you have reduced soil loss by stripping and stockpiling the topsoil?
- Equation:

A = R x K x LS x P x C

A = R x K x LS x P x C

A = 1,027 x 0.04 x 1.03 x 1.3 x 1.0

A = 55.01 tonnes/ha/year

Soil loss is reduced from 55.01 tonnes/ha/year to 24.75 tonnes/ha/year, a reduction of 30.26 tonnes/ha/year

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Discussion

Which of the previous erosion factors can be readily manipulated to reduce the erosion hazard on your construction site, and how?

- Rainfall, soil type – NO
- Slope length, cover type - Possible
- Conservation practice – DEFINITELY!

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RUSLE

- What is the A value if improved practices are adopted including track walking up and down the slope and installation of temporary earth banks at 20 metre spacing?

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RUSLE

- What is the A value if improved practices are adopted including track walking up and down the slope and installation of temporary earth banks at 20 metre spacing?
- Equation:

A = R x K x LS x P x C

A = R x K x LS x P x C

A = 1,027 x 0.018 x 0.44 x 0.9 x 1.0

A = 7.32 tonnes/ha/year

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RUSLE exercise

- What is the estimated annual soil loss for a three hectare construction site on a site in Melbourne where:
- The topsoil K-factor is 0.027 and the subsoil 0.036, and
- The slopes are 8%?

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Erosion risk based on soil loss

- IECA Manual; Table 4.4.3

Table 4.4.3 – Erosion risk rating based on estimated soil loss rate

Erosion risk rating	Soil loss (t/ha/yr)
Very Low	0 to 150
Low	150+ to 225
Moderate	225+ to 500
High	500+ to 1500
Extreme	>1500

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Soil loss

Table 4.4.3 – Erosion risk rating based on estimated soil loss rate

Erosion risk rating	Soil loss (t/ha/yr)
Very Low	0 to 150
Low	150+ to 225
Moderate	225+ to 500
High	500+ to 1500
Extreme	>1500

- To calculate Soil Loss, use local R and K-factors, local slope gradient, P-factor of 1.3 and C-factor of 1.0. Assume slope length 80m unless a lesser value can be justified

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Soil loss classes

- Low erosion risk typically:
  - Gently sloping
  - Stable soils
  - Low R-factor
- High erosion risk typically:
  - Steeply sloping
  - Erodible soils
  - High R-factor

Timing restrictions

- Timing restrictions for works should be determined by erosion risk ratings based on monthly rainfall erosivity IECA Manual; Table 4.4.4
- Highlights months when work should or should not proceed and associated risk
- At time when activity should be avoided:
  - C-factor >0.1 only when 3-day forecast suggests rain unlikely
  - Management regime in place for rapid stabilisation if required (RECPs etc.)

Soil loss - exercise

- Calculate the Soil Loss for a 2.0ha subdivision site in Sale, with sandy clay loam soil topsoil overlying light clay subsoil and a slope gradient of 20%?
- How would soil loss change if the default slope length could be reduced to 20m?
- Which are the optimum months to work on this site?
- What would be the requirements outside of this window?

Batter limitations

Batter limitations

Relates batter gradients on constructed slopes to risk

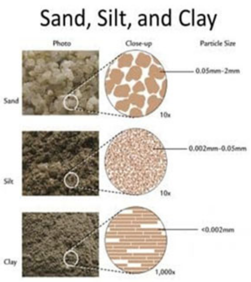
- Moderate risk: stabilise batters greater than 6H:1V, max 3.0m vertical increments
- High risk: stabilise batters greater than 6H:1V, max 3.0m vertical increments
- Extreme risk: stabilise batters greater than 6H:1V, max 2.0m vertical increments

Soil texture class

- Clay particles are <0.002mm
- Silt particles are 0.002 – 0.02mm
- Fine sand particles are 0.02 – 0.2mm
- Coarse sand particles are 0.2 – 2.0mm
- Sediment fence typically has pore openings typically ~ 0.035 mm
- Which particles would you expect to be trapped and which to pass through?
- Clay, silt and fine sand will pass through

Soil Texture

- Sand grains
  - Visible to the eye
  - Roll between fingers
- Silt grains
  - Not visible to the eye
  - Roll between the fingers
- Clay grains
  - Not visible to the eye
  - Smooth to the touch



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Unstable soils

What do you notice about the 3 different soil/water interactions?

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Soil Dispersion

- Severe rilling of exposed (vertical) surfaces
- Subject to gully and tunnel erosion
- High risk of tunnel erosion or piping when used for earthworks
- Generates turbid runoff. May remain turbid for a long time, or never clear
- Negatively charged clay particles leaving a site can transport positively charged contaminants including heavy metals and nutrients

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Piping and tunnelling

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Sodic soils

- All sodic soils are dispersive but not all dispersive soils are sodic
- Cation Exchange Capacity (CEC) (K^+, Na^+, H^+, Ca^{++}, Mg^{++}, Al^{+++}) dominated by sodium (Exchangeable Sodium Percentage, ESP)
- Fluting is a common indicator of sodic soils
- Sodosol and solonised terms

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Management of soil

- (1) Expose only by necessity
- (2) Cover with non-dispersive soil before applying further treatments (erosion controls) or revegetation
- (3) Soil Amelioration:
  - Gypsum application can significantly improve soil stability (dry preferred to liquid form)
  - Blending best approach at application rates 5 – 35 t/ha

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Soil Property group

IECA Manual (Appendix B) describes three (3) Soil Property groups:

- Type C: <33% soil finer than 0.02mm and no more than 10% dispersive
- Type F: >33% soil finer than 0.02mm and no more than 10% dispersive
- Type D: >10% soil dispersive or when strict discharge WQ objectives are required (now Types A and B)

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Soil Property group

- Type C: Coarse
  - Easier to capture or settle out
  - <33% clay and silt
  - Sediment basin not likely required or design relatively simple
- Type F: Fine
  - Harder to capture
  - Require longer time to settle out
  - >33% clay and silt
  - Require "total storm capture" sediment basins
  - Higher emphasis on erosion control

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Soil Property group

- Type D: Dispersive
  - Structurally unstable (slaking and dispersion)
  - Primarily affects clay and silt fraction
  - Not all clays are dispersive
  - Use Emerson test to check
  - Highly erodible if exposed
  - Hard setting and low permeability
  - Particles are kept apart by negative electrical charge
- Now use continuous flow and decant basins (Type A and B), with auto-flocculation

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Soil 'Dispersion' %

- IECA Manual; Table B2 (Note 6)
- The proportion of soil that is considered 'dispersive' is measured as:
  - The combined decimal fraction of clay (<0.002 mm) plus half the fraction of silt (0.002-0.002 mm)
  - Multiplied by the dispersion percentage (App C; Table C14)

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Soil Property group - exercise

- For each of the following soils described by Particle Size Analysis and Dispersion Percentage (DP), determine the Soil Property group (use design spreadsheet)

Clay	Silt	Fine Sand	Coarse sand	Gravel	DP	Soil group
26%	20%	15%	35%	4%	25%	F (9.0)
5%	20%	62%	10%	3%	15%	C (2.25)
52%	14%	20%	13%	1%	25%	D (14.75)

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Sediment basin test

- IECA Manual Appendix B – Step 1 (B.6)
- Run RUSLE to check the annual soil loss from the 'total catchment area'
- Table B1 recommends Type 1 sediment controls (sediment basins) where:
  - Total catchment area >2,500m^2 and Soil loss rate >150 t/ha/yr (or 12.5 t/ha/mth)
  - Total catchment area >1ha and Soil loss rate >75 t/ha/yr (or 6.25 t/ha/mth)
- Narrow (e.g. ROW) areas or difficult (<5% AEP flood level) sites may warrant the use of alternate measures

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Sediment basin test - exercise

Is a sediment basin required for the following?

- A 2.8ha Melbourne site, of which 2.4ha will be disturbed and captured
- Subsoil K-factor is 0.033 (topsoil stockpiled)
- Site gradient (slope) is 5% and slope lengths <80m

- If a sediment basin is not required, what other measures would be appropriate?

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RUSLE solution

- Sediment Basin test – Melbourne site
- Equation: A = R x K x LS x P x C

A = 1,265 x 0.033 x 1.19 x 1.3 x 1.0

A = 64.6 tonnes/ha/year

- Result = 64.6 t/ha/yr x 2.8ha = 180 tonnes (~139m^3)

Sediment basin not required

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Preparing an ESCP

- Split into groups of 3 or 4 and discuss, then list the issues you would consider and tasks you would undertake to prepare a ESCP for:
  - Construction of a 500m x 150m railway storage and maintenance yard on a newly cleared, previously grassed, gently sloping site in Bendigo

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Applying to a site

- Review site background data and sensitivity
- Consider both upslope and downslope catchment
- Take particular note of slopes, soils and watercourses
- Consider water management – clean and dirty
- Determine if sediment basins are required
- Consider site management – barrier fencing and no-go areas
- Identify erosion and sediment control measures that need to be put in place before work commences, and in which order
- Identify and list the specific erosion and sediment control BMPs and Standard Drawings

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Applying to a site

- Install stabilised access
- Install barrier fencing
- Install sediment fencing
- Construct sediment basins
- Provide temporary access to sediment basins
- Construct dirty water catch drains and conveyances to sediment basins
- Construct clean water diversion
- Strip and stockpile topsoil
- Undertake any works around watercourses at appropriate times and with appropriate C-factors

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Applying to a site

- Construct roads
- Undertake other construction (staged)
- Maintain E&SC measures throughout
- Decommission measures and rehabilitate progressively
- Complete checks and fill out check sheets during construction (at least weekly, after all storms >5mm in 24 hours and before site closure)
- Check sheets include condition of all BMPs, maintenance and cleaning, flocculation of sediment basins
- Reporting to Project Manager and Regulatory Agency

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Sediment basin design

- Sediment basin test complete ✓
- If required, consider location(s)
- IECA Manual Appendix B – Step 2 (B.7)
  - Confirm Soil Property group and Basin type
  - Determine basin design criteria
  - Determine basin maintenance requirements
  - Different basin designs and maintenance regimes for Types C, F and D basins

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Purpose

- Collect sediment-laden stormwater runoff and retain pollutants
- Probably the most effective of all sediment control devices due to their large water and sediment storage capacity
- Generally used on larger (>2,500 m^2 construction sites)
- Types C and F (non-dispersive) and D (dispersive)

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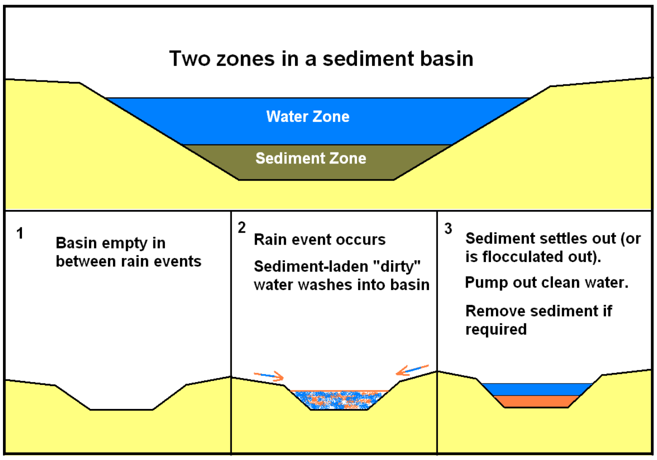

Permanent basins

- Designed by experienced professionals, having regard to the volumes of runoff, quantity and types of sediment expected
- Size includes a sediment settling and a sediment storage zone, mark with pegs
- Prioritise public safety
- Provide length/width ratio > 3:1 – use baffles if necessary
- Ensure inlet/outlet structures are stabilised against erosion

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Wet basins

- Watertight structures that store water for sufficient time to allow settling of fine and dispersed suspended solids
- Complete storm capture devices
- Storage zone for 2 months soil loss (RUSLE) or 50% of water zone on low erosion hazard sites
- Often flocculated to enhance performance if sediments are dispersive (colloidal)
- Pump water out once settling has occurred

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Sediment Basin Design Criteria

- Settling zone (Type D) = 10 x R x Cv x A, where:
  - R = design rainfall depth (mm)
  - Cv = (Volumetric runoff coefficient) (proportion of rainfall expected to runoff as stormwater)
  - A = catchment area of basin (ha)
- Storage (soil) zone design = 50% of settling volume (Table B32) or 2 months soil loss (RUSLE)

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Settling zone capacity – Type D

IECA Manual Appendix B (Equation B35)

- 5 day, 80th percentile is default design parameter
- 85th percentile (or higher) for highly sensitive receiving waters, OR
- Type A (>12 months) or B (<12 months) basin analysis and design based on construction duration

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Example – Wet basin

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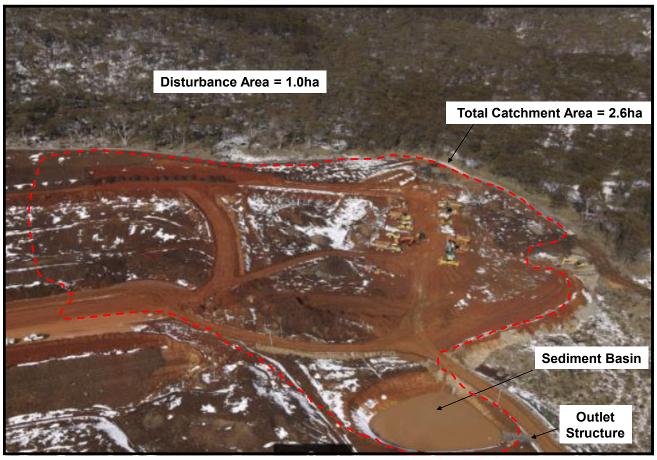
Mine Site problem

- Construction of a 200m x 50m equipment storage and maintenance hardstand
- Assumptions:
  - Total Catchment Area = 2.6ha
  - Disturbance Area = 1.0ha (200m x 50m)
  - Average annual soil loss = 76 t/ha/year
  - Average slope = <5% (20:1)
  - Sediment type = 'D' (dispersible)
  - Soil Hydrologic Group = C (loamy clay)



Design Rainfall depth

- IECA Manual; Table B30

Location	$I_{(1yr, 120hr)}$	R(75%)	R(80%)	R(85%)	R(90%)
Victoria:					
Mildura	0.32	14.0	16.6	20.0	24.9
Bendigo	0.41	15.2	18.2	22.1	27.9
Sale	0.46	15.8	19.0	23.3	29.6
Melbourne	0.55	17.0	20.6	25.4	32.6
Warrnambool	0.42	15.3	18.3	22.3	28.3
Ballarat	0.45	15.7	18.9	23.0	29.3

"Coefficient of Runoff"

- "C" is a calibration term
- Each term only suitable on catchment of similar characteristics to those from which it was derived
  - C_v = Volumetric Runoff coefficient
  - C_{10} = 'Peak' Flow Runoff coefficient
- Based on 'soil hydrologic group' and 'design rainfall' IECA Manual; Table B31

"Coefficient of Runoff"

Table B31 – Typical single storm event volumetric runoff coefficients [1]

Rainfall (mm) [2]	**Soil Hydrologic Group** (refer to Section A3.1, Appendix A)			
	Group A Sand	**Group B Sandy loam**	**Group C Loamy clay**	**Group D Clay**
10	0.02	0.10	0.09	0.20
20	0.02	0.14	0.27	0.43
30	0.08	0.24	0.42	0.56
40	0.16	0.34	0.52	0.63
50	0.22	0.42	0.58	0.69
60	0.28	0.48	0.63	0.74
70	0.33	0.53	0.67	0.77
80	0.36	0.57	0.70	0.79
90	0.41	0.60	0.73	0.81
100	0.45	0.63	0.75	0.83

Notes: [1] Sourced from Fifield (2001) and Landcom (2004).
[2] Rainfall depth based on the nominated 5-day rainfall depth, $R_{(Y\%,5\text{-}day)}$.

Mine Site problem – solution

- Design Criteria:
  - Design rainfall depth = 5-day, 80th percentile (Melbourne) = 20.6mm
  - R-factor = 1,265 (Melbourne)
  - Volumetric runoff (Cv) = 0.27 (moderate)
- Design Solution:
  - Settling zone (Type D) = 10 x Cv x A x R
    = 10 x 0.27 x 2.6 x 20.6 = 145m^3
  - Storage Zone = 72.5m^3 (~95t) (50% settling)

Maintenance

- Pump out wet basins after sufficient settling time / flocculation has occurred, to restore design capacity in time for the next storm
- Inspect / test the quality of outlet waters to assess performance
- Remove sediment once the sediment storage zone is full
- Regularly check the integrity of the basin, particularly inlet/outlet structures, and repair any damage

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Channel Design

- Drainage channels (catch drains, table drains, slope drains, diversion banks etc.) are an important tool for managing both clean and dirty water in and around construction sites
- Critical design characteristic for channel is 'design discharge' or "Q"

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Design Discharge "Q"

- The estimated 'peak' discharge (m^3/s) for a given storm ARI (Y)
- ARI – Average Recurrence Interval
- For example, Q_{10} is the peak discharge from a 1 in 10 year design storm event
- "Q" can be estimated many ways

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Design Methods

- Complex numerical models:
  - DRAINS
  - RORB
  - RAFTS
- The 'Rational Method' – simple empirical formula, 50-200% of real values, but tends to overestimate
- OK for conceptual ESCP and temporary structures

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"Rational Method"

Uses key hydraulic parameters to estimate peak discharge Q=CIA/360

Including:

- Catchment Area – (A) (ha)
- Design Rainfall Intensity – (I) (mm/hr)
- Coefficient of Discharge – (C_{10})
- Critical Storm duration – (t_c) (mins)

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"Catchment Area"

- "A" is the effective catchment area upstream of the point of interest (i.e. discharge point)
- Should be calculated for each sub-catchment area feeding individual structures
- Remember to divert all unnecessary water

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"Average Rainfall Intensity"

- "I" is compound function for a given storm duration (t_c) and storm frequency (Y)
- Typically selected from Intensity-Frequency-Duration (IFD) charts developed for specific locations
- Design storm selection is task specific

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"Time of Concentration"

- "t_c" is the theoretical time required for runoff to flow from the furthest part of the sun-catchment to the point of interest (where discharge is being calculated)
- Determines the shortest storm duration that will contribute flow from the whole sub-catchment at one time
- Can determine from tables/graphs

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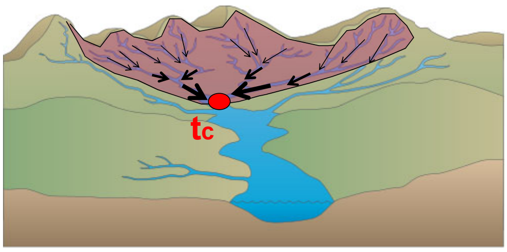
"Time of Concentration"



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"Time of Concentration"

For Urban Areas, either reduce rural t_c values by 50% or undertake detailed calculations:

- Sheet flow estimate
- Kerb flow estimate
- Pipe flow estimate
- Channel flow estimate

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Design Application

- Assume we are to design a temporary catch drain to collect and transfer 'dirty water' from a 1.5ha compound area (20% impervious) to the sediment basin
- Assume the drain will be used throughout the 18 month construction period
- "Y" is a fictitious, isolated storm event of varying frequency and duration

What is the Design Storm Event (Y)?

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"Design Storm Event"

- Selection based on the expected design life of the structure (IECA Manual; Table A1):

Table A1 – Drainage design standard for temporary drainage works

Drainage structure	Anticipated design life		
	< 12 months	12–24 months	> 24 months
Temporary drainage structures [1] Queensland, Northern Territory, and northern Western Australia	1 in 2 year	1 in 5 year	1 in 10 year
Temporary drainage structures [1] New South Wales, Victoria, Tasmania, South Australia and southern Western Australia	1 in 5 year	1 in 10 year	1 in 10 year
Temporary drainage structures (e.g. Catch Drain, Flow Diversion Bank) located immediately up-slope of an occupied property that would be adversely affected by the failure or overtopping of the structure. [1], [2]	1 in 10 year	1 in 10 year	1 in 10 year
Temporary culvert crossing	Minimum 1 in 1 year hydraulic capacity wherever reasonable and practicable.		

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Design Storm Duration/Intensity

- Select 1-hour, 10-year ARI rainfall intensity (I_{10})

	Annual Exceedance Probability (AEP)						
Duration	63.2%	50%#	20%*	10%	5%	2%	1%
1 min	78.4	90.0	129	158	189	233	269
2 min	66.2	75.6	108	131	155	188	216
3 min	59.6	68.1	96.9	118	140	170	196
4 min	54.6	62.5	88.9	108	129	158	181
5 min	50.5	57.8	82.5	101	120	147	170
10 min	37.4	43.0	61.8	75.8	90.6	112	130
15 min	30.3	34.8	50.2	61.7	73.8	91.3	106
20 min	25.7	29.6	42.6	52.4	62.7	77.5	89.9
25 min	22.5	25.9	37.3	45.8	54.8	67.7	78.5
30 min	20.1	23.1	33.3	40.9	48.9	60.3	69.8
45 min	15.6	17.9	25.6	31.3	37.4	46.1	53.3
1 hour	12.9	14.8	21.1	25.8	30.7	37.8	43.6
1.5 hour	9.96	11.3	16.0	19.5	23.2	28.4	32.8
2 hour	8.28	9.39	13.2	16.0	18.9	23.2	26.8

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"Coefficient of Discharge"

- Select C_{10} from IECA Manual; Table A1, based on fraction imperviousness:

Table A4 – Coefficient of discharge (C_{10}) for 1 in 10 year average recurrence interval (source: QUDM, 2007)

Intensity (mm/hr) ¹I_{10}	Fraction impervious						
	0.00	0.20	0.40	0.60	0.80	0.90	1.00
39–44	Refer to Table A5	0.44	0.55	0.67	0.78	0.84	0.90
45–49		0.49	0.60	0.70	0.80	0.85	0.90
50–54		0.55	0.64	0.72	0.81	0.86	0.90
55–59		0.60	0.68	0.75	0.83	0.86	0.90
60–64		0.65	0.72	0.78	0.84	0.87	0.90
65–69		0.71	0.76	0.80	0.85	0.88	0.90
70–90		0.74	0.78	0.82	0.86	0.88	0.90

¹I_{10} = One hour average rainfall intensity for a 1 in 10 year ARI
C_{10} = Coefficient of discharge for a 1 in 10 year ARI

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Design Application

- Assume the catchment is highly compacted, with slopes between 2-5% and the distance from the furthest point to the discharge location is <50m

What is the Time of Concentration (t_c)?

- ~10 minutes (estimated)

What is the average rainfall intensity for the design (t_c)storm duration?

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Design Storm Duration/Intensity

- Select t_c, 10-year ARI rainfall intensity (I_{tc})

	Annual Exceedance Probability (AEP)						
Duration	63.2%	50%#	20%*	10%	5%	2%	1%
1 min	78.4	90.0	129	158	189	233	269
2 min	66.2	75.6	108	131	155	188	216
3 min	59.6	68.1	96.9	118	140	170	196
4 min	54.6	62.5	88.9	108	129	158	181
5 min	50.5	57.8	82.5	101	120	147	170
10 min	37.4	43.0	61.8	75.8	90.6	112	130
15 min	30.3	34.8	50.2	61.7	73.8	91.3	106
20 min	25.7	29.6	42.6	52.4	62.7	77.5	89.9
25 min	22.5	25.9	37.3	45.8	54.8	67.7	78.5
30 min	20.1	23.1	33.3	40.9	48.9	60.3	69.8
45 min	15.6	17.9	25.6	31.3	37.4	46.1	53.3
1 hour	12.9	14.8	21.1	25.8	30.7	37.8	43.6
1.5 hour	9.96	11.3	16.0	19.5	23.2	28.4	32.8
2 hour	8.28	9.39	13.2	16.0	18.9	23.2	26.8

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Design Solution

- Now we can solve for the peak discharge in the 1 in 10 year (Q_{10}) event, remembering:
- Q = C.I.A / 360 (m^3/s)
- Q = (0.44) x (75.8) x (1.5) / 360
- Q = 0.138m^3 per second or (138 L/sec)

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Stabilisation practices

- Employ stabilisation promptly after construction
- Soil stabilisation
- Stabilisation of major channels and watercourses
- Site cleanup, stabilisation and rehabilitation
- Stabilise after each stage of works
- Stabilisation includes revegetation
- Bury dispersive soils beneath non-dispersive soils
- Use temporary stabilisation in event of construction delays
- Erosion risk is linked to the timeframe for stabilisation and revegetation

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Stabilisation with respect to risk

- Risk based on monthly erosivity (Table 4.4.1), average monthly rainfall depth (Table 4.4.2) or soil loss rate (Table 4.4.3)
- Stabilise all completed earthworks prior to anticipated rain
- Very low risk – minimum 60% cover within 30 days if rainfall reasonably possible
- Low risk – minimum 70% cover within 30 days within any area of a work site
- Moderate risk – minimum 70% cover within 20 days within any area of a work site
- High risk – minimum 75% cover within 10 days within any area of a work site
- Extreme risk – minimum 80% cover within 5 days within any area of a work site

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Risk based on average monthly erosivity

Table 4.4.1 – Erosion risk rating (default) based on monthly rainfall erosivity

Erosion risk rating	Average monthly erosivity (R-factor)
Very Low	0 to 60
Low	60+ to 100
Moderate	100+ to 285
High	285+ to 1500
Extreme	>1500

- Also consider erosion risk rating based on monthly rainfall erosivity (Table 4.4.4)

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Risk based on average monthly rainfall depth

Table 4.4.2 – Erosion risk rating based on average monthly rainfall depth

Erosion risk rating	Average monthly rainfall depth (mm)
Very Low	0 to 30
Low	30+ to 45
Moderate	45+ to 100
High	100+ to 225
Extreme	>225

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Risk based on estimated soil loss

Table 4.4.3 – Erosion risk rating based on estimated soil loss rate

Erosion risk rating	Soil loss (t/ha/yr)
Very Low	0 to 150
Low	150+ to 225
Moderate	225+ to 500
High	500+ to 1500
Extreme	>1500

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Erosion risk rating - Exercise

What would the erosion risk rating be for:

- Work in Bendigo in October?
- Work for Geelong in May?
- See Table 4.4.4

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Finally

- Note that every site is different and requires an individual plan
- Note the special requirements of high hazard sites
- Take particular care when working in and around watercourses
- Note requirements for riparian and flood prone land
- Ensure that your plan considers all constraints

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Finally

- You should now be able to confidently and competently use the IECA Manual
- You should understand what should go into your ESCP
- You should be able to consider and assess all issues relevant to a site
- You should be able to use RUSLE and understand how it is used to determine soil loss and erosion risk

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