Soil Judging training webpage

General resources and links

- 2022 National New Zealand Soil Judging Competition Handbook
  Download here

- New Zealand Soil Description Handbook (Revised edition)
  https://digitallibrary.landcareresearch.co.nz/digital/collection/p20022coll14/id/79

- New Zealand Soil Classification (3rd Edition)
  https://digitallibrary.landcareresearch.co.nz/digital/collection/p20022coll1/id/268

Introduction

This information is designed to help both beginners and seasoned competitors to Soil Judging, as well as adjust competitors from other countries, or those unfamiliar with the Rotorua/Taupō area and its geological history.

This training will not cover all aspects of Soil Judging but will cover the main skills required for Soil Judging. There will be opportunities to ask coaches, judges and event staff questions during the two practice days.

Where possible references will be made to appropriate sections of the 2022 NZ SJC handbook, NZSC (New Zealand Soil Classification), and Soil Description Handbook for further reading.

The first section of training will cover the basic soil description properties such as texture, structure, colour. While the second section will cover classification, geology and some competition specific tips! Keep an eye out for the second section dropping soon!

Texture

Particle sizes in New Zealand are fractionated as follows:

Table 5 Particle-size fractions (mm)

Coarse fraction		
Boulders		>200
Very coarse gravel		200–60
Coarse gravel		60–20
Medium gravel		20–6
Fine gravel		6–2
Fine-earth fraction		
Sand	Coarse sand	2.0–0.6
	Medium sand	0.6–0.2
	Fine sand	0.2–0.06
Silt		0.06–0.002
Clay		<0.002

Figure 1: Particle size fractions, New Zealand Soil Description Handbook, pg 45

Field texture classification involves creating a hand-worked bolus (ball) of soil at or around field capacity. The ideal size for a bolus is around 2-3 teaspoons of soil material. Water is slowly added to this material, and the soil is kneaded like dough to work out and break down any structure or lumps in the soil. The final bolus should be cohesive (if the texture allows) and uniform throughout. Be careful how much water you add! It's easier to add more water than remove it! You may need to add water over time as your skin will adsorb small amounts as you work it. All the following tests are designed to be done at soil 'field capacity'. The bolus should look moist and have a slight sheen of water, without having visible free water or feeling flooded.

The mechanical and physical properties of this bolus are used to infer approximate amounts of clay and sand. The proportions of clay and sand can be used to classify the soil according to a texture group.

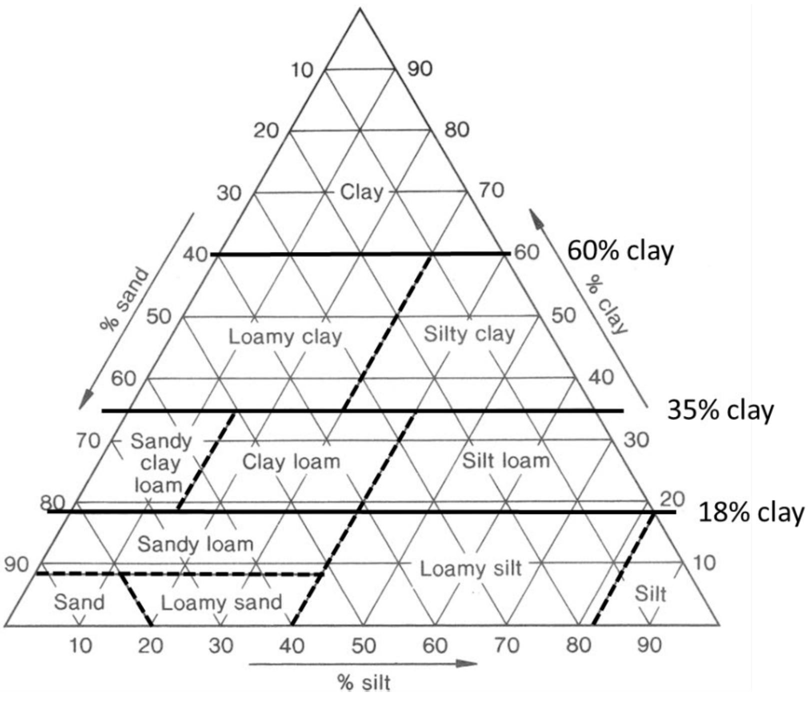
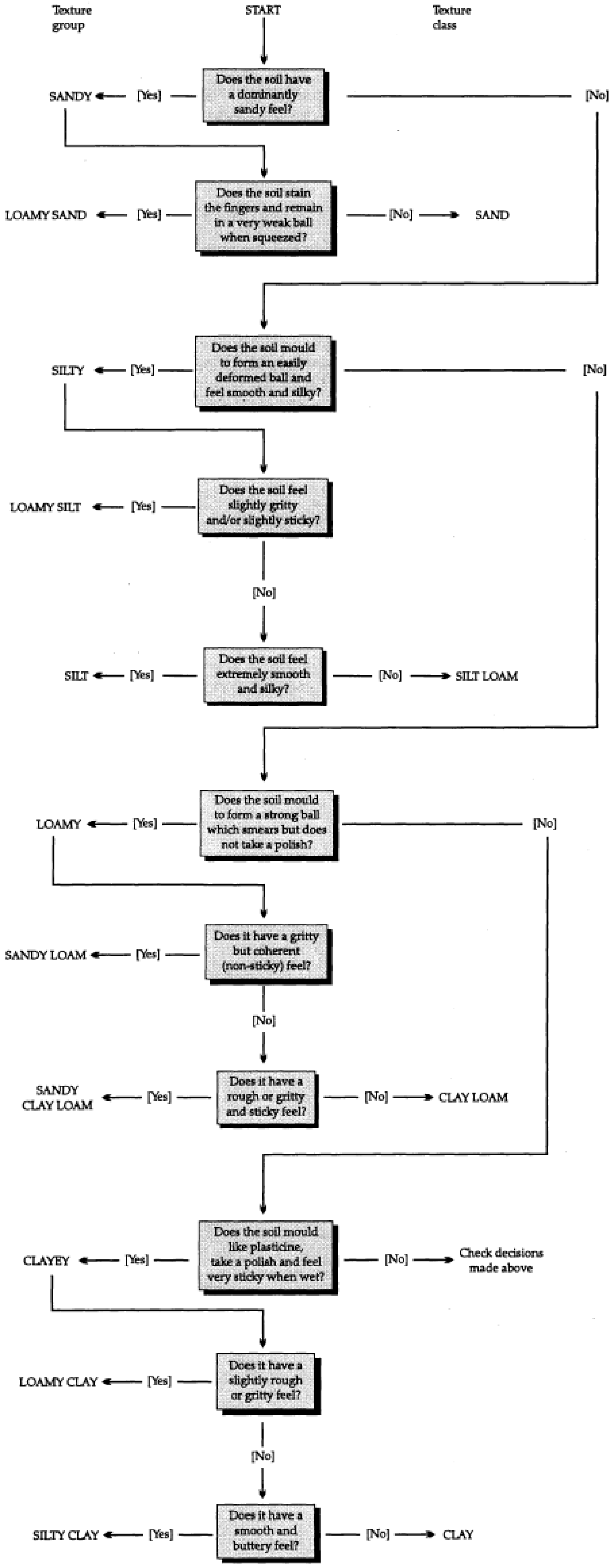


Figure 2: New Zealand Soil Texture Triangle, New Zealand Soil Description Handbook, pg 52

Textures are primarily defined into three broad groups based off the clay percentages, below 18% clay, 18 -35% clay and above 35% clay. Secondarily the proportion of sand and silt can be estimated and further divide the classes into the textures found above.

For field texture beginners, the flowchart on pages 50-51 of the New Zealand Soil Description Handbook is an excellent place to start. However, this is a rough guide, and aims to describe the average feel and properties of a given texture class. In order to use the flowchart correctly (this advice goes for many flowcharts, such as the NZSC) the instructions must be read carefully as linking words hold great importance. Eg *"does the soil feel slightly gritty and/or slightly sticky"* means that the answer can be yes if any of the following conditions are met; slightly sticky, slightly gritty, or a combination of both.



Texture group
START
Texture class
Does the soil have a dominantly sandy feel?
SANDY
[Yes]
[No]
Does the soil stain the fingers and remain in a very weak ball when squeezed?
LOAMY SAND
[Yes]
[No]
SAND
Does the soil mould to form an easily deformed ball and feel smooth and silky?
SILTY
[Yes]
[No]
Does the soil feel slightly gritty and/or slightly sticky?
LOAMY SILT
[Yes]
[No]
Does the soil feel extremely smooth and silky?
SILT
[Yes]
[No]
SILT LOAM
Does the soil mould to form a strong ball which smears but does not take a polish?
LOAMY
[Yes]
[No]
Does it have a gritty but coherent (non-sticky) feel?
SANDY LOAM
[Yes]
[No]
Does it have a rough or gritty and sticky feel?
SANDY CLAY LOAM
[Yes]
[No]
CLAY LOAM
Does the soil mould like plasticine, take a polish and feel very sticky when wet?
CLAYEY
[Yes]
[No]
Check decisions made above
Does it have a slightly rough or gritty feel?
LOAMY CLAY
[Yes]
[No]
Does it have a smooth and buttery feel?
SILTY CLAY
[Yes]
[No]
CLAY

Seasoned pedologists will quickly move away from this method, and instead use experience and practical techniques to gauge the amount of clay and sand. Depending on the parent material and dominant particle sizes in the area these techniques may not always be applicable.

Keep an eye on the training page for a video showing how to do texture, as well as some tips and tricks, coming soon!

Structure

Structure covers the type and strength (or lack thereof) of development of aggregates in soil (aggregate being the term for all combinations of soil particles including natural peds & casts, as well as structure that has been influenced by human activities such as clods and fragments).

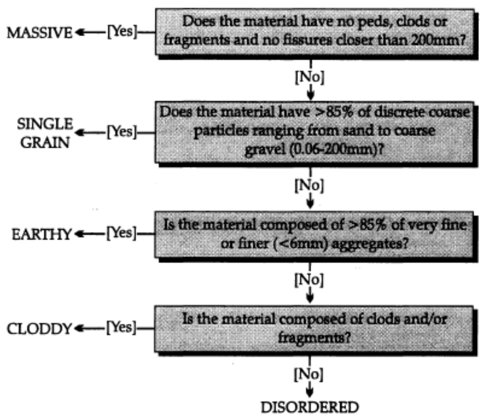
Structure is split into three categories that cover: strength of soil development, shape, and size. Combined with structure is soil consistence, a measure of the behaviour of soil across different moisture contents in relation to applied stress levels. For soil judging we focus in on soil strength (resistance to crushing) and failure mode as measures of consistence. Properties such as fluidity, penetration resistance, and packing are other examples of measurements of consistence.

Structure, like many soil description properties, requires both a larger expanded view of the soil profile as well as a detailed look at each horizon. Size of structural units can vary from 1mm to over 100mm in size, and single structural units can occasionally span across horizons. Because of this it is important to look at the soil face from a distance as well as examining small sections.

When assessing structure, the first thing to determine is the degree of pedality (how much of the soil is made up of structural units).

CODE	CLASS	DEFINITION
X	Structureless	Apedal. Contains less than 15% in peds*.
W	Weak	Peds are barely observable in place, 15-25% in peds.
M	Moderate	Peds well-formed and evident in place, 25-75% in peds.
S	Strong	Peds are distinct in place, >75% in peds.

If the soil contains less then 15% peds, it is considered structureless. However, there are still classifications within structureless to consider. Large continuous cemented or semi cemented layers are considered as massive, while sand and gravel material is considered as single grain. A point of difference from other soil description systems such as the United States and Australia is that if all soil structure is below 6mm in size the structure is determined to be structureless, earthy. Cloddy material *(see inset photo)* is reserved for large, often human influenced structural units that result from poor soil structure management.

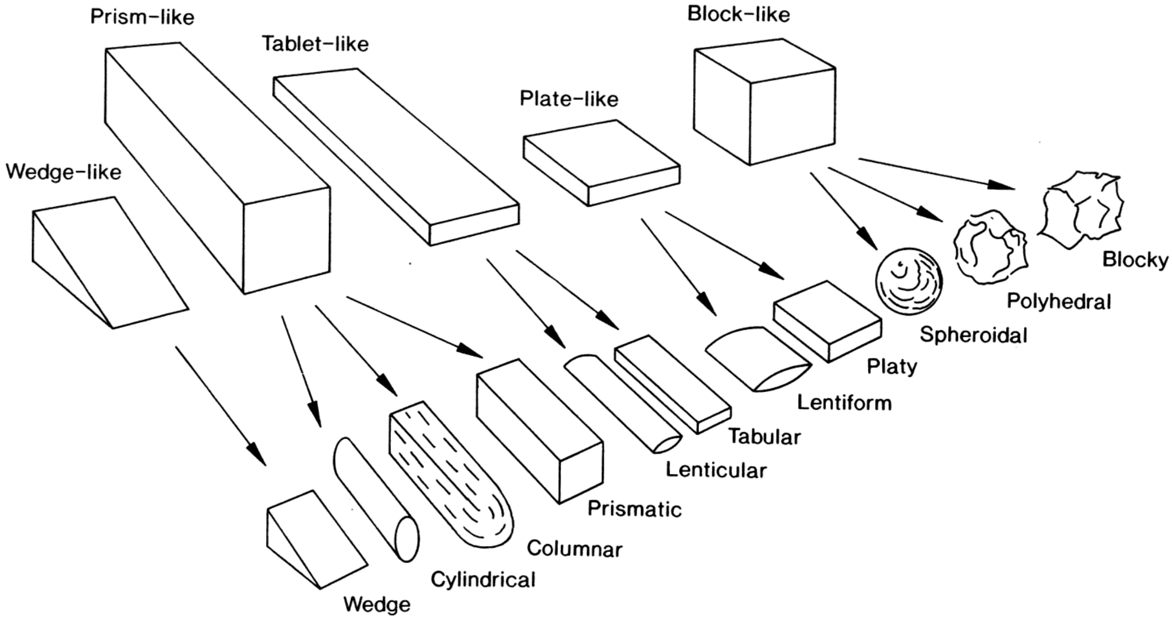


If the soil is determined to have more then 15% structural units it can be classified as either weak (15-25%), moderate (25-75%) or strongly structured (>75%). This can be determined either by use of the percentage abundance charts or by visual estimation of how evident the peds are.

Photo 1 - Cloddy Structure

Once the degree of pedality has been established, the type of structure can be determined, primarily by using the diagram found below or on page 69 of Milne. Most soils in New Zealand have block like structure, either blocky or polyhedral. Blocky and polyhedral can be separated by the angles found on the ped, blocky material will tend towards cubelike shapes with multiple 90-degree (or similar) corners, while polyhedral will have varying angles and mixed rounded edges. Other different structure types can be strongly related to different soil types and will be specific to different areas in New Zealand so won't be covered here. Examples of structures found in the area will be shown in the practice days.

Once the shape has been determined, the dominant size(s) of the peds can be determined. Size is based off the shortest axis of the ped. So tall/long prism like shapes are based off the diameter of a cross section, while platelike shapes are measured on the front face.



Horizination

Horizon depths and boundaries

Horizons are ways of splitting the soil profile into discrete layers that have differing soil properties. Any change in soil properties (such as, but not limited to), texture, structure, colour, consistence, and stoniness can constitute a change in horizon. Horizons may also have transitional properties between a horizon above and below it.

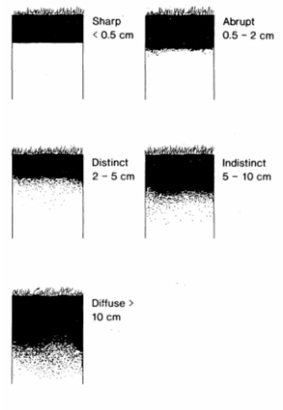
- *For the purposes of the competition, to simplify and add consistency, the number of horizons & the bottom depth of the last described horizon will be given to competitors. A marker will also be put somewhere in the third horizon.*

Horizons are described in cm based on the bottom depth of the horizon. This depth is based on the average across the area to be described – rather than the depth at the measuring tape.

- *For the final horizon - the depth can be described as 140 or 140+ depending on whether this horizon meets lithic or paralithic (rock) contact or soil material continues, in which case a '+' is added to describe that soil continues below the described area.*

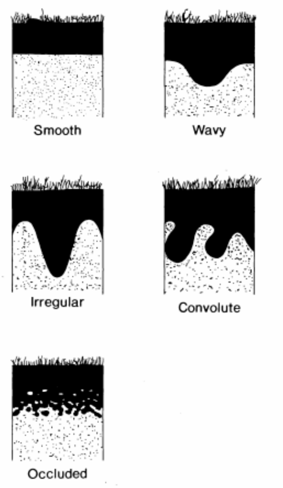
Horizon distinctness & topography

Horizon distinctness describes the distance over which the change between horizons occurs. Milne Pg 38-39



- *A good trick for the team competition to gauge the change area is to compare where all team members place the centre of the change. If everyone picks the same spot the change is likely to be sharp or abrupt. If there is large variation, it is likely to be distinct or indistinct.*
- *If the change occurs over a large area it may be possible that this is a 'transitional horizon' and will be described as a separate horizon. A good rule of thumb is that transitions over 8cm thick are often described as a transition horizon.*

Horizon topography describes the shape and variation of depth of the boundary where two horizons meet



- *The difference between wavy and irregular is the amplitude vs wavelength. In a wavy boundary the change in height is LESS then the length of the 'wave'. For a irregular boundary the change in height is MORE then the length of the 'wave'.*
- *Convolute boundaries tend to be complicated boundaries with complex shapes, these tend to curve and overhang itself.*
- *Occluded is a modifier that can be added to any of the other boundaries (e.g. wavy occluded) if there are distinct parts of the horizons separated via processes such as worm mixing.*

Horizon Notation(s)

Horizon notation is a complex topic that depends on information gained from other sections, so is often done after completing the other soil description sections. For this training we will cover some of the more commonly used notations, but a full list is available in Appendix 11 of the Soil Description Handbook, and all notations there are available for use in the competition.

Horizon designation is split into 4 parts – Master Prefix, Master Letter(s), letter suffix(es), and numeric suffix.

Master Letters

Master letters describe the major property of that soil horizon and are broken down as follows (These are always described using capital letters)

- O Horizons - Organic horizons with more then 30% organic matter (18% organic carbon content)
- A Horizons – Topsoil horizons (less then 30% OM) enriched in organic matter, generally darker in colour then the subsoil horizons it overlays.
- E Horizons – 'Eluviated' horizons. Strongly leached horizons with significantly reduced amounts of OM, clay, iron oxides etc then the horizons below it. Generally pale grey/white due to lack of OM and iron oxides.
- B Horizons – Subsoil horizons that show evidence of change and/or weathering from the parent material (C or R) horizons. This weathering is often identified by formation of colour or structure.

- C horizons – Unconsolidated or weakly consolidated parent material eg gravels lacking in evidence of pedogenic processes (formation of colour structure etc)
- R horizons – unweathered bedrock/regolith.

- Some of these master letters may be combined to describe a transition horizon as discussed above. These can be differentiated by how the properties of the soil interact
    - Where soils have a gradual continuous change between two horizons E.g. A and B, then the horizon is notated with two capitals and NO slash, E.g. AB or BC horizon.
      *This type of transition horizon can be used without an underlying horizon matching the second horizon. E.g. A horizon overlying an AB overlying a C horizon (note the lack of a full B horizon)

    - Where horizons have two distinct and separate properties in a transition horizon they can be described using a slash, E.g. A/B or B/C. This can occur when parts of an A horizon 'interfinger' into a B horizon or vice versa. This can occur from both natural causes as well as mechanical action such as plowing.

Letter Suffixes

For O horizons there are notations such as o,f,h to describe the state of decomposition of the organic material. *See the soil description handbook for a full list.*

For A horizons the following suffixes apply.

- h – No evidence of human disturbance.

- p - Evidence of human intervention, eg plowing, fertilizer, introduce grass species, manure usage etc.

- pp – Cloddy horizon due to cultivation within previous year *(*unused in soil judging)*.

- If more then > 2% redox segregations are present a g can be added alongside any of the above E.g. Apg

For B horizons (and some can be used for C & E horizons) there is a large list of notations that can be used, below is a selection of the more common ones. Some suffixes can be combined (generally the redoximorphic horizons) with others. A & B horizons must always have a suffix, while C,R & E do not always have a suffix. *See appendix 11 of soil description handbook for a full list of possible combinations.*

- Gleying suffixes: w(f), w(g), g, r. These suffixes can be used depending on the proportion of both low chroma colours in the soil matrix (chromas of 2/3 or less) and/or the amount of mottles. See the table below for the relationship between the horizons. The further down the table the more the horizon is waterlogged

	Redox segregations (%)	Low chroma colours (%) In matrix		On ped faces
Bw	<2	None		None
Bw(f)	≥2	None		None
Bw(g)	≥2	<50	and	<50
Bg	≥2	50–85	or	>50
Br	Not diagnostic	>85		Not diagnostic

Milne Pg 140

- Depletion/accumulation suffixes: There are a large number of suffixes associated with accumulation of leached soil components. These are particularly associated with E horizons and Podzols and represent various combinations of leached soil components such as iron oxides, aluminium, and organic matter that have accumulated at depth. These include fm (cemented pan – commonly called an iron pan),sm (pan, thicker then 25mm) ,s (enriched mixture of sesquioxide's and associated organic matter), and h (enriched mixture of organic matter and associated sesquioxide's). Many of these can be found stratified together as different components precipitate out at different depths.
- Translocation suffixes: Soil processes can lead to movement of soil components downwards through the soil profile. Examples of translocation horizons include t (translocated clay), k (enriched in secondary carbonates)
- Other common horizons include x (fragipan – a dense hard subsurface silty layer), o (enrichment of kaolin group clays with iron and aluminium oxides).
- If a B horizon doesn't have any distinct properties such as translocation, accumulation or gleying, then the horizon is given the suffix of w to represent weathering (a key property for development of a B horizon).

Master prefixes and numeric suffixes

In the case of complex profiles containing multiple parent materials, lithologic events or similar horizons designations are given to differentiate these from other horizons.

Soils that have differing parent materials or stratigraphic changes (lithologic or stratigraphic discontinuities) have a numeric prefix added to differentiate the different events

- *The first event doesn't require a numeric prefix, but all subsequent events number up by 1, starting at 2. eg Ap, Bw, 2Bw, 2Bw(g), 3Bw(g)*

For soils with burial events a lowercase b is added to the prefix, this is combined with the numeric prefix for each burial event as it constitutes a discontinuity.

- E.g. Ap, Bw, 2bAh, 2bBw, 3bBw, 3bBw(f)

For soils with multiple identical horizon notations that are adjacent, a numeric suffix is added to differentiate these horizons. Numbering restarts for each set of adjacent identical horizons. A numeric suffix is not required if there is no adjacent identical notation.

- E.g. Ap, Bw1, Bw2, Bw(g)1, Bw(g)2, 2bBw(g),3bBw(g)

Colour

Soil colour tells us a significant amount of information about soil physical and chemical properties with very little effort. We can learn information such as:

- Relative organic matter content
- Mineralogy
- Fluctuations in water table and/or waterlogging status
- Geologic history
- Genesis of diagnostic features in the soil

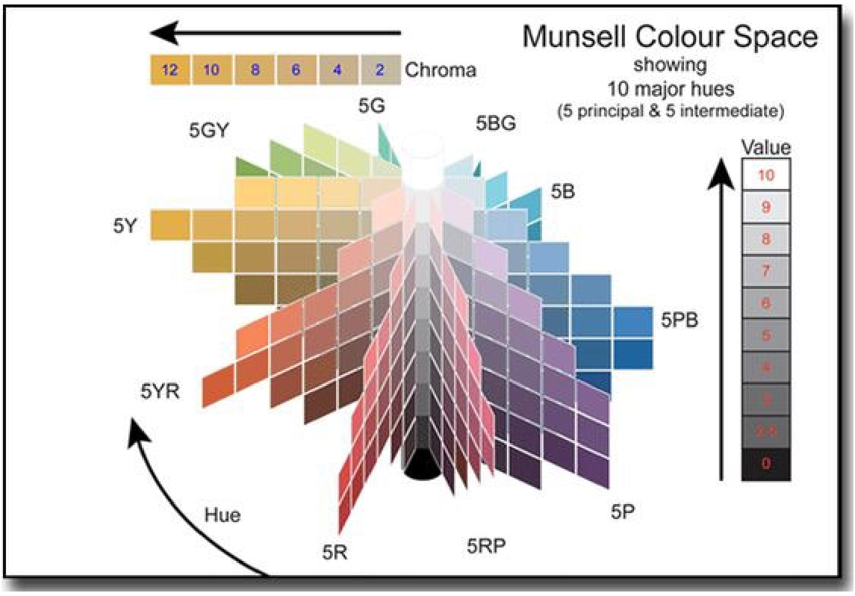
Some examples of this are:

- Reds, yellows and browns in subsoils can tell us about the form of iron oxide present, E.g.
    - Hematite – Red
    - Goethite – Yellowish brown
    - Ferrihydrite – Reddish brown

- Grey – Quartz and silicate minerals
- White – Carbonates and other salts
- Green – Potassium (Glauconite)
- Black/dark brown – Organic matter
- Black Manganese oxides.

The Munsell colour system is used to describe soil colours – specifically the Munsell Soil Colour book. Fun fact - there are Munsell colour books for describing things like plants, rocks, and even French Fries!

Colour descriptions are split into three components - Hue, Value and Chroma. Eg 10YR (Hue) 3(Value)/2(Chroma)



- Hue describes the dominant colour – for soils this is generally colours ranging from red ® to yellow (Y) with browns in between (categorised as YR, and shown below as the fraction between yellow and red), as well as various shades of grey, white and green.
- Value describes how light or dark a colour is, the lower the value the darker a colour is.
- Chroma describes the intensity of the colour – from a black/grey/white up to the pure hue/colour (IE more intensity of colour.

Reading Soil Colours

Soil colours can be broken up as follows:

- Matrix colour – the dominant background colour(s) of the soil horizon. There may be more than one background colour. The primary and secondary colours are determined by area (larger area is the primary)
- Mottle colour - Mottle colours are spots of colour that differ from the matrix due to differing mineralogy, waterlogging, accumulation, depletion etc. These features will be covered in a later topic in more depth.

- The mottles may become the matrix colour if they occupy more then 50% of the horizon area – See pages 42/43 of the Soil Description Handbook for more information

Soil colours should ideally (not always possible!) be done out of direct sunlight, ideally on a fresh (moist and not worked/altered) ped face by finding the best matching colour chip in the Munsell Soil Colour book.

- For most New Zealand soils 10YR is the best starting page, and work either redder or yellower from there.
- Once you have found the closest match – it can be helpful to check against one page yellower, and one page redder to confirm you are on the correct page.
- If the colour is outside of the yellow/red colour space then there are green, gley, and white pages at the back of the colour book.

Record the appropriate code(s) on the description card as follows 10YR 3/2 split across the Hue, Value and Chroma boxes. If no secondary colours are required put a dash in the boxes to indicate this.

Part 2 – coming soon!

Part 2 will contain information about soil classification, Rotorua geology, competition specific tips and tricks.