Field Guide to Assessing PEI Soils for On-Site Sewage Disposal Systems

1st Edition

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Message from the Minister

The proper soils assessment for sewage disposal systems is an essential component in the protection of our water resources in Prince Edward Island. Sewage disposal systems that are installed in unsuitable soils can malfunction and result in groundwater contamination.

This *Soils Assessment Handbook*, the first of its kind in Prince Edward Island, is a valuable resource to evaluate soil suitability for on-site sewage disposal systems.

The publication of this field guide is part of the Drinking Water Strategy to maintain the quality of PEI's drinking water now and for the future.

While the Department of Fisheries, Aquaculture and Environment, Water Resources Division, is responsible for managing, protecting and enhancing the Province's water resources, many other individuals and groups play an important role in protecting our groundwater. The *Soils Assessment Handbook* is an excellent example of how the Department works in partnership with these groups.

J Chester Gillan

J. Chester Gillan, *Minister*
Fisheries, Aquaculture
and Environment

Preface

This field guide has been prepared to assist Environmental Officers, Planning Development Officers, engineering consultants and private contractors (herein referred to as "inspectors") to describe soils in the field. Many published references exist for describing soils; however, these references focus on evaluating soils for either soil genesis and classification purposes or for assessing soils for agricultural use. The specific intent here is to provide soils information that meets the needs of field personnel who perform site suitability analyses for on-site sewage disposal systems, using information that is relevant and applicable to PEI soil conditions and referenced to existing PEI regulatory requirements for on-site sewage disposal system installations.

The following sources of information are acknowledged for the information contained herein:

1. Agriculture Canada Research Branch. 1988. Soils of Prince Edward Island. PEI Soil Survey. J.I. MacDougall, C. Veer and F. Wilson (ed.) Land Resource Research Centre Publication # 83-54, Charlottetown, PE.
2. Agriculture Canada Research Branch. 1987. The Canadian System of Soil Classification. 2nd Edition. Agriculture Canada Publication #1646. Agriculture Canada Expert Committee on Soil Survey.
3. Expert Committee on Soil Survey. 1982. The Canada Soil Information System (CanSIS) Manual for Describing Soils in the Field. J.H. Day (ed.) Land Resource Research Institute, Agriculture Canada, Ottawa.
4. Munsell® Soil Colour Charts. 1994. Munsell® Color, MacBeth Division of Kollmorgan Instruments Corporation, New Windsor, NY.
5. Ontario Centre for Soil Resource Evaluation. 1993. Field Manual for Describing Soils in Ontario. Guelph Agricultural Centre Publication #93-1, Guelph, ON.
6. Kelly Galloway, Engineering Technologies Canada.

Table of Contents

1 Introduction

The structure, format and much of the content of this field manual are based on information contained in the "Field Manual for Describing Soils in Ontario - 4th Edition (1993)", published by the Ontario Centre for Soil Resource Evaluation (OCSRE). The OCSRE field manual is a useful tool for describing field soils; however, it was designed to aid field personnel in describing soils from a soil genesis and classification perspective for use in soils mapping and for agricultural purposes. In addition, the information is most applicable to soil conditions found in Ontario.

This field guide has been developed to provide soil information to field personnel, specifically for the purposes of describing and evaluating soils for their suitability to support on-site sewage disposal systems, using referenced soils information that is relevant to PEI. Little emphasis is placed on organic soils in this guide since their use for sewage disposal systems is severely limited by drainage problems.

The information provided in this guide focuses on the methods for describing mineral soils that can support sewage disposal systems, and on describing soil properties that influence the movement of water through soil, and hence, the treatment of the waste from the sewage disposal system.

1.1 Definition of Soil

The following definition of a soil is taken from the Canadian System of Soil Classification (Agriculture Canada, 1987):

> "Soil is a naturally occurring, unconsolidated, mineral or organic material at the earth's surface that is capable of supporting plant growth. Its properties usually vary with depth and are determined by climatic factors and organisms, as conditioned by relief and hence water regime, acting on geologic materials and producing genetic horizons that differ from the parent material."

With respect to on-site sewage disposal systems, only mineral soils should be considered as potential sites since organic soils (such as those found in depressional areas, lower slope positions and in bogs) are unsuitable for supporting the systems due to poor drainage characteristics.

Traditionally, soil investigations have been performed for soil genesis and classification for mapping or agricultural purposes and these investigations are usually limited to a depth of about one metre. When evaluating soils for sewage disposal systems, test pits are usually prepared to a depth of 1.8 metres (6 feet) and the focus is on evaluating soil properties such as texture, structure and internal drainage characteristics which most directly affect the efficiency of treatment.

2 Site Information

When performing test pit evaluations, it is important to maintain an accurate and complete record of all site information for reference purposes. This information must be recorded in a systematic manner to allow consistent evaluations from site to site.

Two types of information should be recorded: (1) general site information and (2) test pit (soil) information.

2.1 General Site Information

At each site being evaluated, the inspector should complete a brief site survey and record any pertinent site information that will help to properly assess the suitability of the site for on-site sewage disposal. The general site information should be recorded using **FORM A** (General Site Information). The following provides a description of the types of information that should be recorded:

- **Site Information** - Proponent's name and contractor's name, phone numbers, case number, property number, test pit number (if more than one test pit is completed), date excavated, the inspector's name, and site location.

- **Site Observations/Comments** - Identify the geographic location of the property, including the highway, road or rural route number. If a GPS is available, record the geographic coordinates for the location using either NTS or UTM coordinates; provide a description of surrounding land use; provide a description of the site characteristics, including percent slope, slope position of the proposed sewage disposal system, observations of ponded water on the soil surface (indicating poor surface drainage), type of vegetation, etc. For a further explanation of this information, see Section 2.2, 2.3 and 2.4 of this manual.

- **Site Sketch** - Use this section to provide a sketch of the site, including the following information: a north arrow; the location of all existing or proposed structures; locations of existing and/or proposed site access (driveways/laneways); any physical features such as telephone poles, out buildings, trees, surface water (streams, ponds, etc.) and existing or proposed well locations. Identify where the test pit(s) and proposed sewage disposal system will be located; measure and record all distances from the sewage disposal system to the above site features (see *Planning Act* and the *Environmental Protection Act* - Sewage Disposal Regulations for reference). Care should be taken to evaluate the position of existing adjacent wells and sewage disposal systems.

2.2 Surface Drainage

Surface drainage refers to the loss of water from an area by flow over the surface. It depends on many factors, acting independently or in combination, such as the amount and intensity of rainfall or snow melt, the soil water state at the beginning of the rainfall event, the type of vegetation or land use, to name a few. An estimate of surface drainage characteristics can be made by visually inspecting the site for areas of standing water, wet or saturated soil, etc. Surface drainage can range from very rapid through rapid, moderate, slow, very slow and ponded. On-site sewage disposal systems should be located in areas where the surface drainage is very rapid to moderate.

2.3 Slope Class

Percent slope can be estimated or it may be measured more precisely with a clinometer or Abney Level. The following slope classes should be recorded on **FORM A**:

Table 2.3.1 Slope Description

Description	Percent Slope	Code (FORM A)
Level	0 - 0.5 %	**1**
Nearly level	0.5 - 2.0 %	**2**
Very gentle slope	2.0 - 5.0 %	**3**
Gentle slope	5.0 - 9.0 %	**4**
Moderate slope	9.0 - 15 %	**5**
Strong slope	15 % - 30 %	**6**
Not suitable	> 30 %	**NS**

2.4 Slope Position Classification

The design and operation of the septic system will often be determined by its actual position in the landscape. For this reason, it is important to note where the proposed system is to be situated topographically. The following descriptions are included to provide a slope position designation on **FORM A**:

Table 2.4.1 Slope Position

Slope Position	Code
Crest	1
Shoulder	2
Back Slope	3
Foot Slope	4
Depression	5
Level	6

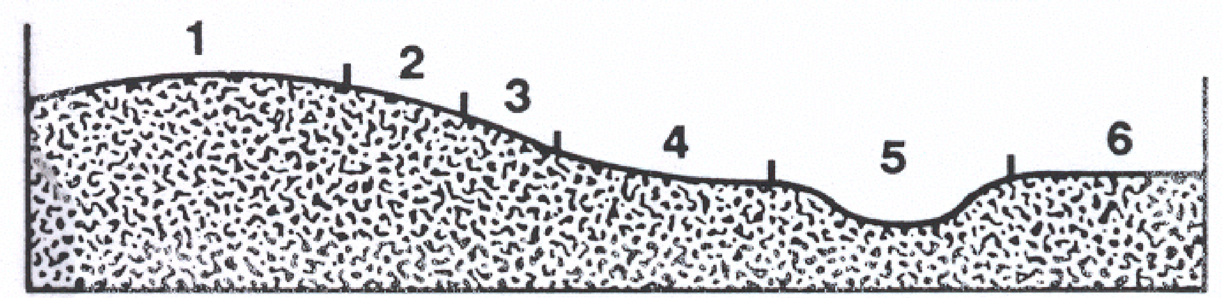


Fig. 2.4.1 Slope Position

3 Description of Mineral Soils

Once the general site information has been recorded, the site soils must be evaluated. Since soil properties may exhibit significant spatial variability (i.e., both laterally and with depth), **it is important the test pit is completed in the area where the sewage disposal field will actually be located.**

3.1 Site Investigation Checklist

Step

1 Obtain the **soils map** for the property before going to the site.

2 **Contact** the proponent and/or contractor to confirm your arrival time and exact location of the property.

3 Upon arrival, review where the proposed septic field will be located with the proponent/contractor and **locate the test pit**.

4 **Excavate** the test pit to a depth of 1.2 metres (4 feet).

5 Before entering the test pit, **visually inspect** the soil conditions **for stability**. Both very dry, granular soils (such as coarse sands) or very wet, fine textured soils (i.e., those containing significant silt and clay content) may become unstable and collapse during the inspection, causing injury. Do not enter a test pit that has been left unattended unless protective measures (i.e., shoring, etc.) have been installed to the standards established by the *Occupational Health and Safety Act*.

6 After entering the test pit, **prepare the soil profile** for inspection by selecting a representative vertical column of soil. Use a knife, spatula or mason hammer to scarify the pit face for the full depth of the test pit. This removes any smearing caused by the excavation equipment and allows you to see the soil horizon boundaries and their physical characteristics more clearly.

7 Exit the test pit and have the contractor **excavate an additional** 0.6 metres (2 feet) so that the test pit is a total of at least 1.85 metres (6 feet) in depth. Without re-entering the test pit, inspect the pit for evidence of a visible water table and the presence of bedrock.

8 Have the contractor fill in the test pit. **Do not leave test pits open and unattended**.

3.2 Collection of Soils Information (FORM B)

Using **FORM B** - Soil Profile Description, record the following information:

1. Record the depth of the root mat (surficial vegetation and organic matter) from the surface to the start of the first mineral soil horizon. For example, record the layer as "5-0 cm." The top layer of the mineral soil will then be the starting point for your evaluation.

2. Starting at the top of the first mineral soil layer (i.e., below the root mat), identify the total depth of any visible roots, rootlets and worm holes that are present. Deep penetration of roots and worm holes is used as an indicator of secondary permeability and indicates a well-drained soil.

3. Identify and mark distinct horizon boundaries and, using a measuring tape, record the thickness (depth) of each horizon.

4. Refer to **Fig. 3.2.1** and identify the three major diagnostic horizons (A, B and C).

5. Refer to **Table 3.2.1** to identify any sub-layers within these horizons. Each horizon may have one or more sub-units which can be identified as A1, A2, B1, B2, etc.

6. For each layer identified, record the following: texture (**Fig. 3.2.2**), structure (**Table 3.2.2**), Munsell colour (**Fig. 3.2.6**), density (**Table 3.2.3**), and drainage classification (**Table 3.2.4**).

7. Site Observations: look for evidence of dense or confining layers that may impede drainage, and record depth if present. This may be assessed using the re-bar techniques described in **Table 3.2.3**.

8. Complete **FORM B** and using the data recorded in Steps 1 to 7, categorize the soils as per the *Planning Act* regulations.

Major Soil Horizon Designations

Table 3.2.1 Visual Description of Typical Mineral Soil Horizons in PEI

Horizon Designation	Description
A1	Darker coloured surface layer enriched with organic matter.
A2	Lighter coloured A horizon; light colour due to loss of iron, organic matter, or clay.
AB	A transitional layer sometimes present (difficult to distinguish clear boundary between A and B).
B1	Reddish-brown sub-surface layer that may be enriched with iron, clay, etc. Observable difference from A due to change in colour, texture, structure or density.
B2	Presence of another B layer that is different from B1 due to a change in one or more of the following: texture, structure, colour, or density.
BC	A transition between B and C. Boundary difficult to distinguish.
C	Unweathered, parent material.

Please Note:

1. This table provides a generalized list of typical horizons. Individual sites may differ where some sites may not contain any sub-units (i.e., A2, AB, B2, BC may not be present) while at other sites additional layers may be present (i.e., A3, B3, etc.).
2. Actual colour must be identified using the Munsell Soil Colour Chart.

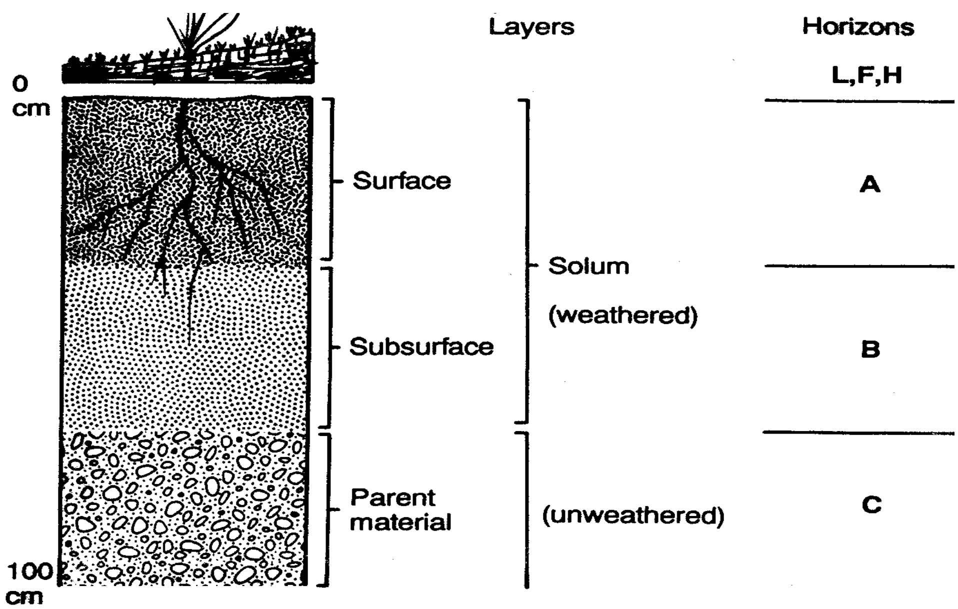


Fig. 3.2.1 Major Soil Horizon Designation

FORM A - General Site Information

Proponent's Name:	**Phone No.:**
Contractor:	**Phone No.:**
Case No.:	**Property No.:**
Test Pit No.:	**Date Excavated:**
Inspector (Print):	**Inspector (Signature)**
Site Location:	**Geographic Coordinates.:**
Site Observations/Comments:	
% Slope **(Section 2.3):**	**Slope Position of Proposed Septic System** **(Section 2.4):**

Site Sketch

FORM B - Soil Profile Description

Proponent: ____________________________ **Case No.:** ______________________________ **Property No.:** ___________________
Inspector: ____________________________ **Date:** ________________________________ **Time:** ________________________
Root Mat Depth: ______________________ **Rooting Zone Depth:** ___________________ **Test Pit No.:** ____________________
Weather Conditions:

Horizon Fig. 3.2.1 Table 3.2.1	Depth (cm)	Texture (Fig. 3.2.2)	Structure (Table 3.2.2)	Colour (Fig. 3.2.6)	Density (Table 3.2.3)	Drainage Class (cm)		
						0 - 60	60 - 120	120 - 180

Estimated Depth of Permeable Soil: __________ **cm** **Depth to Confining Layer (if applicable):** __________ **cm** **Depth of Test Pit:** _______ **cm**

Depth to Water Table: **< 60 cm** ☐ **60 to 120 cm** ☐ **120 to 180** ☐
Depth to Bedrock: **< 60 cm** ☐ **60 to 120 cm** ☐ **120 to 180** ☐
Comments:

Lot Category: ____________________________ **Inspector's Signature:** ____________________________

Recommendations:

Finger Assessment of Soil Texture

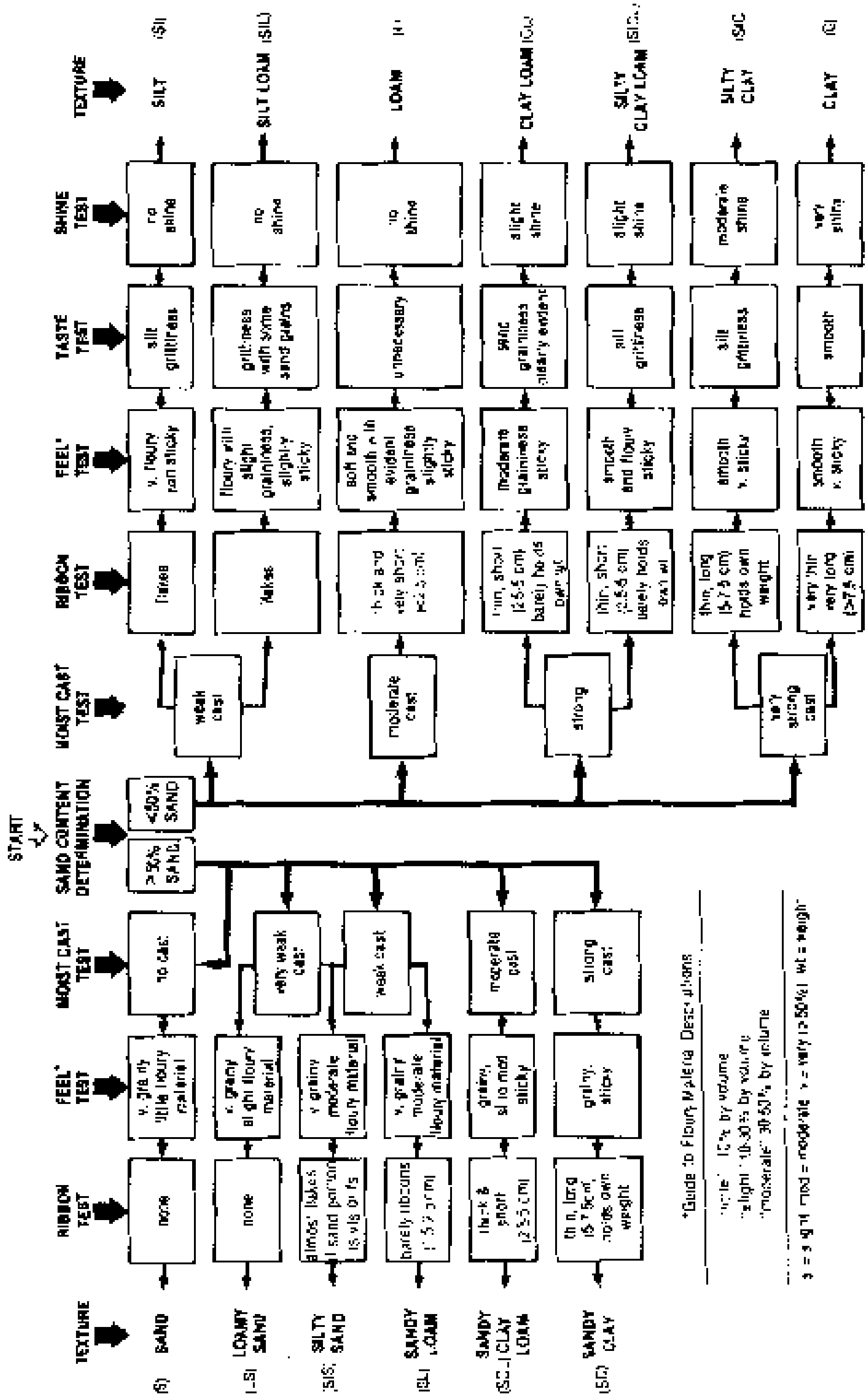


Fig. 3.2.2 - Soil Texture

For a description of each test method, see next page.

Determination of Soil Texture - Method Description

Feel Tests

Graininess Test - Soil is rubbed between the thumb and fingers to assess the percent sand. Sand will feel gritty, while silt feels "silky" and clay feels like flour and is often sticky if moist.

Dry Feel Test **-** For soils with greater than 50% sand content. Soil is rubbed in the palm of the hand to dry it and to separate and estimate the size of the individual sand particles. The sand particles are then allowed to fall out of the hand and the finer material (silt and clay content) remaining is noted. Usually, the higher the clay content, the more soil that will remain due to its stickiness.

Stickiness - Soil is wetted slightly and compressed between the thumb and forefinger. The degree of stickiness is determined by noting how strongly it adheres to the thumb and finger upon release of pressure.

Moist Cast Test

Compress some field moist soil by clenching it in your hand. If the soil holds together (i.e. forms a cast), test its strength by tossing it from hand to hand. The more durable it is, the more clay that is present.

Ribbon Test

Moist soil is rolled into a cigarette shape and then squeezed out between the thumb and forefinger in an upward direction to form the longest and thinnest ribbon possible. Soils with a high silt content will form flakes or peel-like thumb imprints rather than ribbons. Clays will form ribbons more easily**.**

Taste Test

A small amount of soil is worked between the front teeth. Sand will feel gritty; silt particles will have a fine grittiness but individual grains cannot be identified. Clay particles have no grittiness.

Shine Test

A small amount of moderately dry soil is rolled into a ball and rubbed once or twice against a hard, smooth object such as a knife or mason hammer. A shine on the soil indicates the presence of clay in the soil.

TEXTURE CLASS	FEEL TEST	MOIST CAST	RIBBON TEST	TASTE TEST	SHINE TEST
SAND	grainy, little floury material	no cast	none	unnecessary	unnecessary
LOAMY SAND	grainy with slight amount of floury material	very weak cast no handling	none	unnecessary	unnecessary
SILTY SAND	grainy with moderate amount of floury material	weak cast, no handling	almost flakes if sand portion is vfs or fs	unnecessary	unnecessary
SANDY LOAM	grainy with moderate amount of floury material	weak cast, allows careful handling	barely ribbons (1.5-2.5 cm)	unnecessary	unnecessary
LOAM	fairly soft and smooth with evident graininess	good cast, readily handled	thick and very short (<2.5 cm)	unnecessary	unnecessary
SILT LOAM	floury, slight graininess	weak cast, allows careful handling	flakes, rather than ribbons	silt grittiness, some sand gaininess	unnecessary
SILT	very floury	weak cast, allows careful handling	flakes, rather than ribbons	silt grittiness	unnecessary
SANDY CLAY LOAM	very substantial graininess	moderate cast	short and thick (2.5-5 cm)	sand graininess clearly evident	slightly shiny
CLAY LOAM	moderate graininess	strong cast	fairly thin, breaks readily, barely supports own weight	sand graininess clearly evident	slightly shiny
SILTY CLAY LOAM	smooth, floury	strong cast	fairly thin, breaks readily, barely supports own weight	silt grittiness	slightly shiny
SANDY CLAY	substantial graininess	strong cast	thin, fairly long (5-7.5 cm) holds own weight	sand graininess clearly evident	moderately shiny
SILTY CLAY	smooth	very strong cast	thin, fairly long (5-7.5 cm) holds own weight	silt grittiness	moderately shiny
CLAY	smooth	very strong cast	very thin, very long (>7.5 cm)	smooth	very shiny

Field Test Characteristics of Texture Classes

Fig. 3.2.3

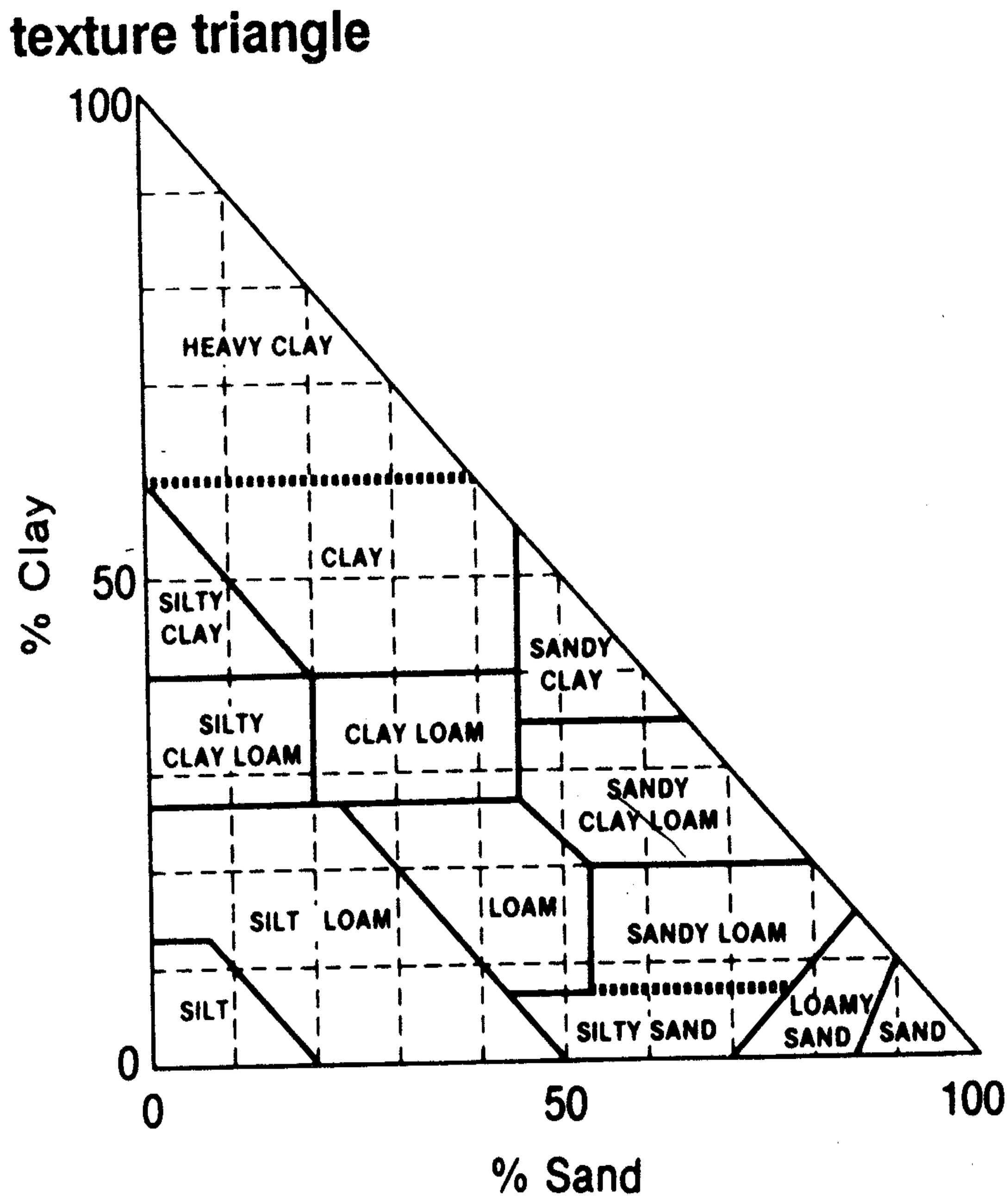

texture triangle
100
% Clay
50
0
HEAVY CLAY
CLAY
SILTY CLAY
SANDY CLAY
SILTY CLAY LOAM
CLAY LOAM
SANDY CLAY LOAM
SILT LOAM
LOAM
SANDY LOAM
SILT
SILTY SAND
LOAMY SAND
SAND
0
50
100
% Sand

Fig. 3.2.4

Table 3.2.2 Soil Structure

Type	Description	Kind
Structureless	No observable aggregation or joining together of individual soil particles.	Single grain (loose sands).
Blocky	Soils joined togther to form larger units arranged with flat or round surfaces.	Observable sharp or rounded surfaces on aggregates.
Platy	Structure is layered on a horizontal plane.	Horizontal layering appearing as plates. Usually associated with soils high in clay content.
Columnar	Structure is arranged in a vertical plane.	Aggregates formed in vertical arrangement. Often good secondary permeability.
Massive	Solid structure.	Appears as solid mass.

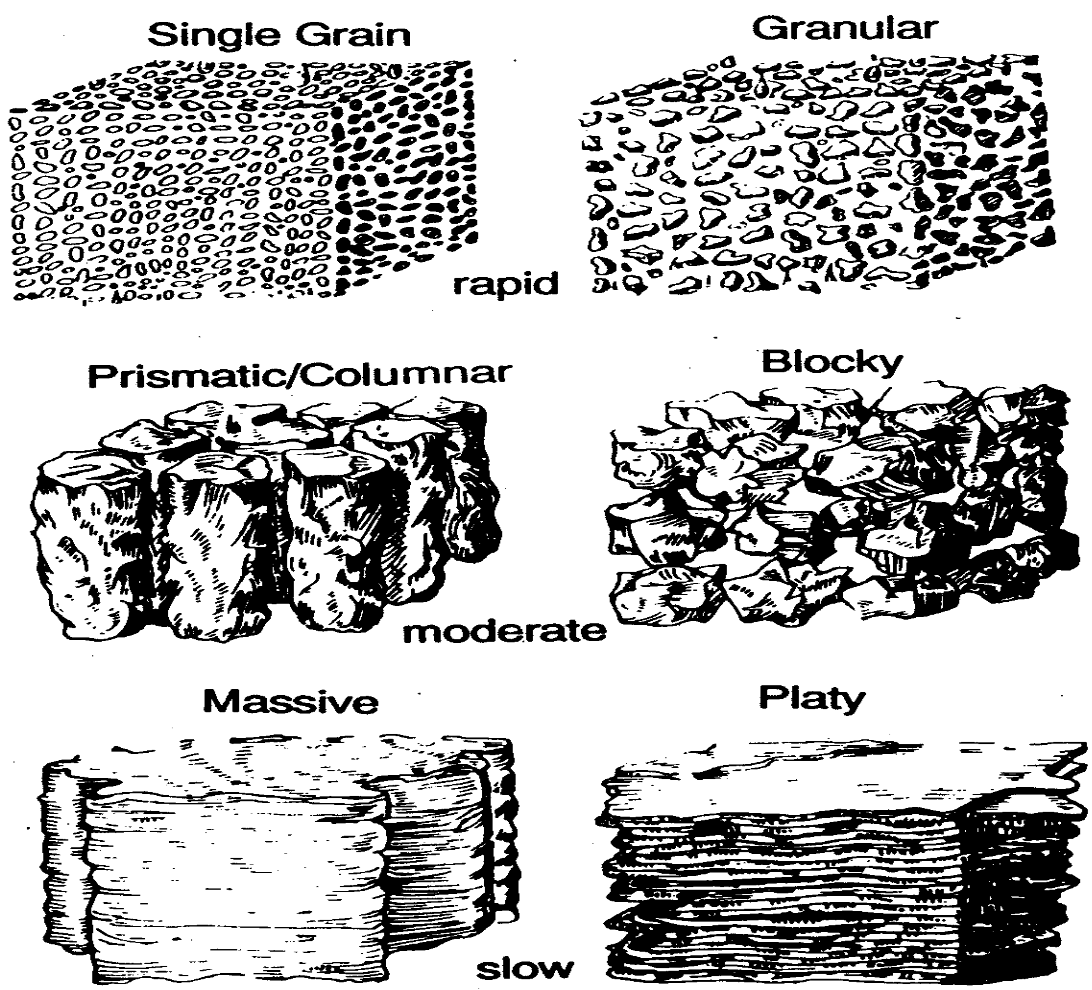


Fig. 3.2.5

Soil Colour and Moisture Condition

Soil colour is an indication of soil development processes which have taken place, soil drainage and water table fluctuations. Using the Munsell Soil Colour Charts, separate descriptions of HUE, VALUE and CHROMA are recorded (in that order) to form a Munsell notation.

The **HUE** represents a page in the Munsell Colour Chart and is the letter abbreviation R for red, YR for Yellow Red, and Y for yellow, and is preceded by a number from 1 to 10. As the number increases within each letter range, the HUE becomes more yellow and less red.

The **VALUE** represents the relative lightness of a colour, while the **CHROMA** represents the relative purity, strength or saturation of a colour.

Use the Munsell Colour Chart as follows:

1. Select the appropriate HUE card.
2. Hold the soil sample directly behind the card apertures separating the closest matching colour chips.
3. Record the soil colour using the notation: HUE VALUE/CHROMA. For example, a typical Charlottetown soil may have a horizon that is a 2.5YR 4/6m. The suffix "m" indicates the colour of the soil when "moist", whereas the same soil dry (d) might be a 5YR 5/6d.

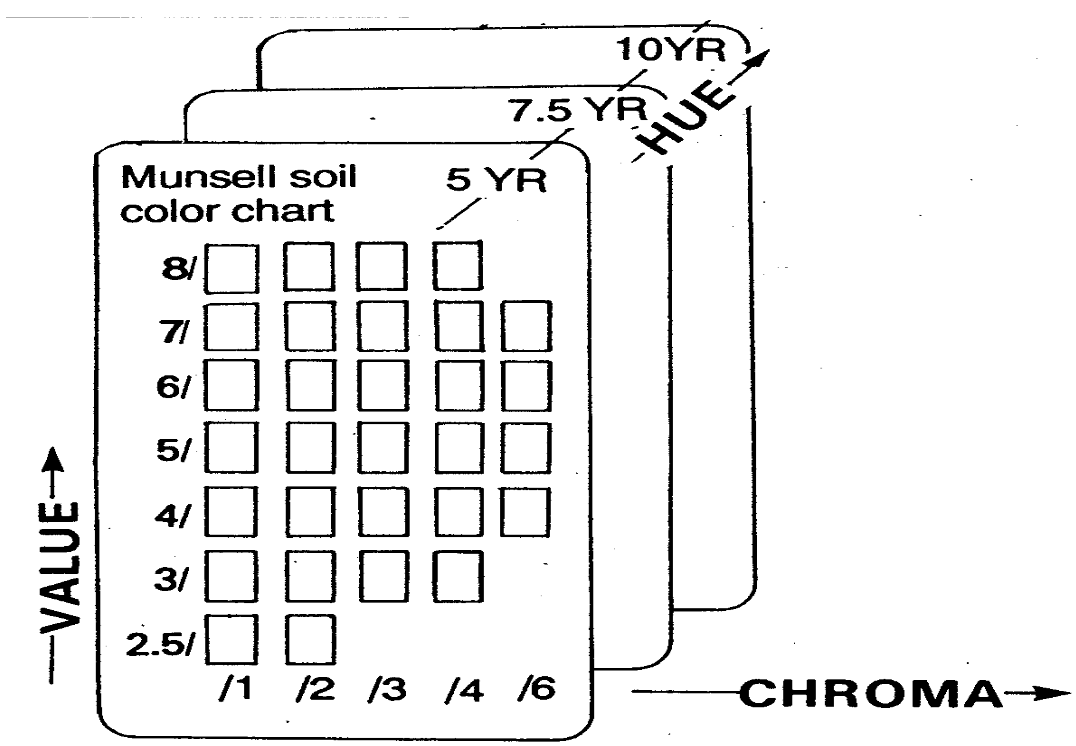
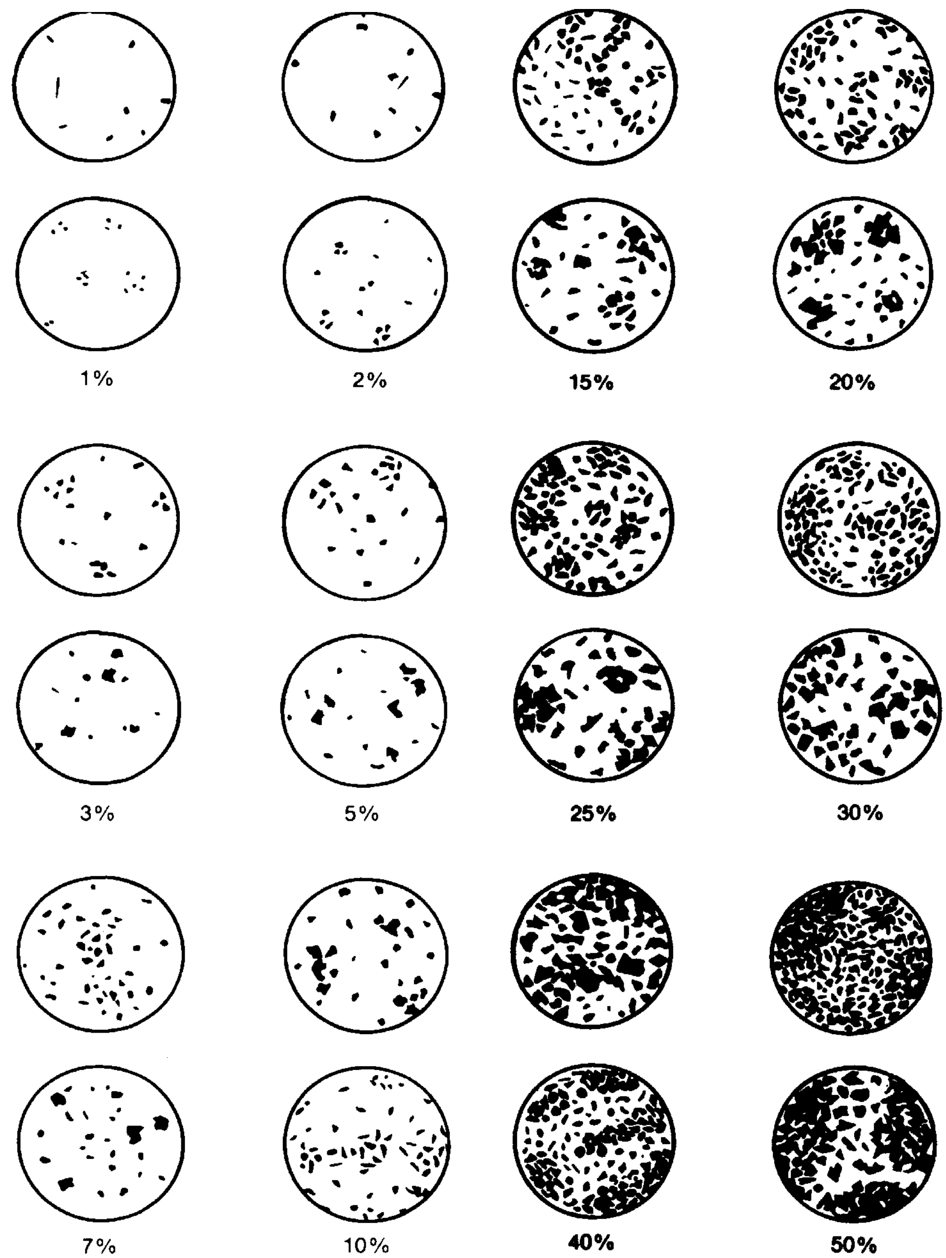


Fig. 3.2.6 Munsell Soil Colour Chart

Presence or Absence of Mottling

Mottles are spots or blotches of different colour or shade of colour interspersed with the dominant colour of a horizon. Usually mottles are seen as greying or dulling of colour due to poor aeration, which is in turn caused by the soil horizon being wet or saturated most of the time due to poor drainage, a perched water table or a seasonally high water table. In PEI, the dominant red colour of soil often masks the presence of mottles. In poorly and very poorly drained soils, mottling may be more evident. In other soils, mottles may be difficult to identify.



After Richard D. Terry and George V. Chilingan. 1955.

Soil Density

Soil structure is defined as the arrangement of primary soil particles (sand, silt and clay) into secondary particles (aggregates). Aggregated soils are considered to be better suited for on-site sewage disposal systems because they generally have lower bulk densities, good porosity and thus exhibit permeabilities that are neither "too fast" nor "too slow" to allow for proper treatment of the sewage to occur. For example, coarse sands may allow water to move through the soil profile at too high a rate, whereas fine textured soils such as clays will restrict movement. The measurement of soil bulk density is often used as a relative measure of soil structure and permeability. Precise determination of bulk density is not required but may be accomplished by collecting soil cores and determining bulk density in the laboratory. For the purposes of assessing the site for suitability for on-site sewage disposal, the inspector can estimate soil density by two methods: resistence to penetration using a soil probe (i.e. a re-bar), and evaluating the consistency of soil aggregates by hand.

Step 1

Prepare a soil probe made from a minimum 1.25 cm diameter (0.5 inch) re-bar. Use the re-bar to probe each horizon independently to assess the density of the soil. Make sure that an equal amount of pressure is applied each time. Observe the penetration depth of the re-bar for all horizons from 0-120 cm (0-4 feet) and for 120-180 cm (4-6 feet) depths and record in **FORM B**. Note the depths of any confining layers in the comments section of **FORM B**.

Step 2

Assess the nature and consistency of the soil aggregates by collecting an aggregate from each horizon. Soils that are permeable will range from a loose, granular texture to aggregates that are easily broken up in your hand (i.e. friable). Soils with increasing silt and clay content will become less friable and may be sticky to the touch. In addition, if the clay content is significant, the aggregate may be plastic or slightly plastic (i.e. the aggregate will not break easily and can be molded in the hand like putty). These soils will have a lower permeability and are less suited for on-site sewage disposal systems.

Table 3.2.3 Soil Density Classification

Code (FORM B)	Typical Penetration Depth (cm)	Description
1	> 10 Re-bar penetrates easily	Very loose, granular (coarse to medium textured sands, rapid permeability)
2	5-10 Re-bar penetrates easily Easily excavated using shovel	Loose, aggregated soil, friable, non-sticky, non-plastic (coarse to medium textured soils, non-compacted with good permeability)
3	2.5-5 Can excavate with effort	Compact, aggregated soil, slightly sticky but non-plastic (medium textured soils, slightly more dense with good to moderate permeability for on-site disposal systems)
4	1.0-2.5 Difficult to excavate with shovel	Dense, aggregated soil, friable, sticky and slightly plastic (slightly compacted soil horizon, predominantly fine textured (silt and clay) with slower permeability, unsuited to on-site sewage disposal)
5	< 1.0 Very difficult to excavate with shovel	Very dense, compacted layer, non-friable, sticky, plastic (compacted silts and clays with poor permeability, unsuited to on-site sewage disposal)

Table 3.2.4 Soil Drainage Class

When considering the suitability of soil for on-site sewage disposal systems, one of the key elements to consider is the internal drainage characteristics of the soil. Soil drainage is partially controlled by the soil texture and also by the structure and density of the soil. Evaluations of the soil test pit should be performed for the following depths: 0-60 cm (0-2 feet), 60 - 120 cm (2-4 feet), and 120-185 cm (4-6 feet).

Drainage Class Code (FORM B)	Drainage Class	Soil Moisture Condition	Description	Hydraulic Conductivity (cm/s)
1	Unacceptable	Dry	Soil feels dry to the touch. No evidence of free moisture in the pit face. Very low water holding capacity. Drainage too rapid to allow sufficient treatment to occur; predominantly coarse textured soils including: coarse sands, medium sands.	$> 8 \times 10^{-3}$
2	Acceptable	Moist	Excess water has drained away from the horizon while retaining enough moisture to feel slightly moist to the touch. No water escapes when squeezed. These soils are well drained to moderately well drained and are generally medium textured with good soil structure. Soil textures include: loamy sands, sandy loams, silty sands.	8×10^{-3} to 8×10^{-5}
3	Marginal	Moist to Wet	Generally the same as Class 2 except more water retained when squeezed. Generally poorly drained soils depending on secondary permeability conditions. Soil textures include: loams, silts, sandy clay loams.	8×10^{-4} to $<8 \times 10^{-5}$
4	Unacceptable	Wet	Water is released from a grab sample when squeezed. These soils are imperfectly drained and are wet a significant amount of the time due to slow internal drainage caused by low permeability. Not suitable for on-site sewage disposal systems. Usually contain higher silt and clay content when compared to “moist” soils. Soil textures include sandy clay, clay and silty clays, heavy clay.	$< 8 \times 10^{-5}$
5	Unacceptable	Seepage	Water is released when soil is squeezed. Visible evidence of water moving laterally from the test pit face due to underlying impermeable layer. Internal drainage is restricted. Not suitable for on-site sewage disposal systems.	Variable. Main limitation is drainage of underlying soils
6	Unacceptable	Inflow	Free flowing water into test pit. Water table present within diagnostic layer. Severe limitation for on-site sewage systems.	