

Soil Analytical Methods

1. Soil Moisture Content

- Gravimetric moisture is used to determine soil moisture content (on a dry-weight basis).

Method Reference:

- Soil Water Content, Gravimetric Method with Oven Drying, Section 70.2. G.C. Topp, G. Parkin & T. Ferrè. Soil Sampling and Methods of Analysis, Edited by Martin R. Carter & E.G. Gregorich, Canadian Society of Soil Science. Taylor & Francis Group for CRC Press, 2008.

2. Soil pH and Electrical Conductivity (EC)

- Soil pH is a measure of ionized H (H^+) in the soil solution. All chemical and biological reactions in soil are influenced by soil pH. Soil salinity affects crop growth and soil structure, and is estimated from measurement of soil electrical conductivity. The electrical conductance is expressed as mS/cm.

Method Reference:

- Soil pH and Lime Requirement, Section 12, E.O. McLean. Electrical Conductivity & Soluble Ions. J.J. Miller, D. Curtin, Section 15. Methods of Soil Analysis Part 2, Chemical and Microbiological Properties, Second Edition, 1982. American Society of Agronomy, Inc., Soil Science Society of America, Inc., Publisher, Madison, Wisconsin, USA.

3. Organic Matter (LOI)

- The Loss on Ignition used as an estimate of organic matter in non-calcareous soils. This method gives quantitative oxidation of organic matter, but other soil constituents may be altered or destroyed in the process, therefore resulting in weight losses in excess of the actual organic content.

Method Reference:

- Methods for Loss on Ignition, p. 4, C.H. Lim & M.L. Jackson. Methods of Soil Analysis Part 2, Chemical and Microbiological Properties, Second Edition, 1982. American Society of Agronomy, Inc., Soil Science Society of America, Inc., Publisher, Madison, Wisconsin, USA.
- Moisture & Ash Content, part 28.3, A. Karam. Soil Sampling and Methods of Analysis, Edited by Martin R. Carter & E.G. Gregorich, Canadian Society of Soil Science. Taylor & Francis Group for CRC Press, 2008

4. Light Fraction C and N

- Light Fraction (LF) organic matter generally accounts for 0.1% to 3% of the total weight of cultivated soils, but grassland and forest soils with relatively slow decomposition rates may contain considerably higher percentages (3% - 10%).
- The LF organic matter is separated using a Sodium Iodide (NaI) solution, and the resulting LF is analyzed for C and N content by dry combustion using a Costech 4010 Elemental Analyzer.

Method References:

- Improved Method for Separating Light & Heavy Fraction Organic Material from Soil, T.C. Strickland & P. Sollins. *Soil Science Society of America Journal*, 1987, 51:1390-1393
- Light Fraction Organic Matter, p. 610-616, E.G. Gregorich & M.H. Beare. *Soil Sampling and Methods of Analysis*, Edited by Martin R. Carter & E.G. Gregorich, Canadian Society of Soil Science. Taylor & Francis Group for CRC Press, 2008

5. Water Soluble Organic Carbon, WSOC

- The water soluble organic carbon (WSOC) content functions as the immediate organic substrate for soil microbes. Soil samples are extracted with water, filtered, and analyzed for total organic carbon using a Shimadzu TOC-V/TN instrument.

Method Reference:

- Dynamics of Soil Microbial Biomass & Water Soluble Organic Carbon in Breton after 50 Years of Cropping to Two Rotations, W.B. McGill, K.R. Cannon, J.A. Robertson, & F.D. Cook. *Canadian Journal of Soil Science*, 66:1-19. Volume 66, 1986.
- Extraction & Characterization of Dissolved Organic Matter, Ch 48. M.H. Chantigny, D.A. Angers, K. Kaiser, & K. Kalbitz. *Soil Sampling and Methods of Analysis*, Edited by Martin R. Carter & E.G. Gregorich, Canadian Society of Soil Science. Taylor & Francis Group for CRC Press, 2008

6. Microbial Biomass C and N

- Soil microbial biomass C & N measures the quantity of living microbial organisms present in soil. This is an indication of the health of a soil system where changes can indicate early stresses on the ecosystem. Fumigation with chloroform kills soil microorganisms by dissolving the lipids of the cell membrane, causing the cells to lyse and expel cellular fluids. This expelled biomass is extracted and analyzed for total organic carbon and total nitrogen using a Shimadzu TOC-V/TN instrument compared to an un-fumigated control sample, providing an index of the microbial biomass present initially.

Method References:

- *Soil Microbial Biomass C, N, P, and S*, R.P. Voroney, P.C. Brookes, & R.P. Beyaert. *Soil Sampling and Methods of Analysis*, Edited by Martin R. Carter & E.G. Gregorich, Canadian Society of Soil Science. Taylor & Francis Group for CRC Press, 2008.
- Soil Water Content, Gravimetric Method with Oven Drying, Section 70.2. G.C. Topp, G. Parkin & T. Ferrè. *Soil Sampling and Methods of Analysis*, Edited by Martin R. Carter & E.G. Gregorich, Canadian Society of Soil Science. Taylor & Francis Group for CRC Press, 2008.

7. Available Nitrate and Nitrite

- Nitrate and Nitrite are and the filtrate measured colorimetrically on a SmartChem Discrete Wet Chemistry Analyzer. In this method, the nitrate is reduced to nitrite in a copperized cadmium column, then reacts reagents to form a reddish purple azo dye. Nitrite is determined similarly but without the reduction step.

Method References:

- Nitrate and Exchangeable Ammonium Nitrogen. D.G. Maynard and Y.P. Kalra. Soil sampling and Methods of Analysis, M.R. Carter, Ed, Canadian Society of Soil Science.1993 Lewis Publisher p.25-38
- SmartChem 200 Method 375-100E-1, Westco Scientific, April 2000
- Determination of Nitrate-Nitrite Nitrogen by Automated Colorimetry, Method 353.2 Revision 2.0, Methods for the Determination of Inorganic Substances in Environmental Samples, EPA/600/R-93/100, August 1993.
- G. Norwitz, P. N. Keliher, Analyst, 1985, 110, 689-694, doi: 10.1039/AN9851000689
- G. Norwitz, P. N. Keliher, Analyst, 1986, 111, 1033-1037, doi: 10.1039/AN9861101033

Sample Extraction References:

- Nitrate and Exchangeable Ammonium Nitrogen, p. 71-80. D.G. Maynard, Y.P. Kalra & J.A. Crumbaugh. Soil Sampling and Methods of Analysis, Edited by Martin R. Carter & E.G. Gregorich, Canadian Society of Soil Science. Taylor & Francis Group for CRC Press, 2008
- Methods of Soil Analyses for Canadian Prairie Agricultural Soils. Prepared by Alberta Agriculture based on the methods used in Alberta, Saskatchewan and Manitoba Provincial laboratories. Sept. 1987.
- Method SO23 Determination of Soil Ttest Nitrogen, Phosphorus, Sodium and Potassium using Norwest Extractant. Standard Operating Procedures Manual, Soil and Crop Diagnostic Center, Alberta Agriculture, Edmonton, Canada, 1995.
- Laboratory Guide for Conducting Soil Tests and Plant Analysis, J. Benton Jones, Jr., CRC Press, 2001.
- Methods Manual for Forest Soil and Plant Analysis, Y.P. Kalra and D.G. Maynard, Northwest Region, Information Report NOR-X-319, Forestry Canada, Edmonton, Canada, 1991.

8. Available Ammonium

- Ammonium in aqueous solution is determined colorimetrically on a SmartChem Discrete Wet Chemistry Analyzer using the modified Berthelot reaction.

Method References:

- Nitrate and Exchangeable Ammonium Nitrogen. D.G. Maynard and Y.P. Kalra. Soil sampling and Methods of Analysis, M.R. Carter, Ed, Canadian Society of Soil Science.1993 Lewis Publisher p.25-38
- Determination of Ammonia Nitrogen by Semi-Automated Colorimetry, Method 350.1 Revision 2.0, Methods for the Determination of Inorganic Substances in Environmental Samples, EPA/600/R-93/100, August 1993.

- R. G. Harfmann, S. R. Crouch, *Talanta*, 1989, 36, 261-269, doi:10.1016/0039-9140(89)80105-5
- SmartChem 200 Method 210-203D, Ammonia (by Salicylate and Dichloroisocyanuric Acid Buffer) in Water, Waste Water and Soil Extracts and Other Aqueous Samples, Westco Scientific Instruments, Inc, Brookfield, CT 06804, USA, January 2010

Sample Extraction References:

- Nitrate and Exchangeable Ammonium Nitrogen, p. 71-80. D.G. Maynard, Y.P. Kalra & J.A. Crumbaugh. *Soil Sampling and Methods of Analysis*, Edited by Martin R. Carter & E.G. Gregorich, Canadian Society of Soil Science. Taylor & Francis Group for CRC Press, 2008
- Laboratory Guide for Conducting Soil Tests and Plant Analysis, J. Benton Jones, Jr., CRC Press, 2001.
- Methods Manual for Forest Soil and Plant Analysis, Y.P. Kalra and D.G. Maynard, Northwest Region, Information Report NOR-X-319, Forestry Canada, Edmonton, Canada, 1991

9. Use of Hot KCl to estimate fertilizer N requirements

- Hot KCl extraction is used as an estimator of the mineralizable organic nitrogen present in soils. A hot extraction of $\text{NH}_4\text{-N}$ is gravity filtered and the resulting filtrate analyzed for ammonium ion by colorimetry.

Method References:

- Kowalenko, C. G., *Canadian Journal of Soil Science*, 2006, 86, 911-20
- Campbell, C.A., Jame, Y.W., Jalil, A., *Canadian Journal of Soil Science*, 1997, 77, 161-166

10. Kjeldahl Nitrogen

- Total nitrogen is determined by converting the various nitrogen forms to NH_4^+ . In the Kjeldahl digestion of organic matter, sulfuric acid is added to finely ground samples to

ash them. The sulfuric acid decomposes organic matter to its elemental forms, comparable to the process of dry ashing. The ammonium formed is determined colorimetrically on a SmartChem Discrete Wet Chemistry Analyzer at 660 nm.

Method References:

- Total Nitrogen, P.M. Rutherford, W.B. McGill, J.M. Arocena, & C.T. Figueiredo. Ch. 22, *Soil Sampling and Methods of Analysis*, Edited by Martin R. Carter & E.G. Gregorich, Canadian Society of Soil Science. Taylor & Francis Group for CRC Press, 2008.
- Kjeldahl J., *Z. Anal. Chem.*, 1883, 22, 366

11. Kjeldahl Phosphorus

- Total phosphorus is determined by converting the various phosphorous forms to PO_4^{3-} . In the Kjeldahl digestion of organic matter, sulfuric acid is added to finely ground samples to ash

them. The sulfuric acid decomposes organic matter to its elemental forms, comparable to the process of dry ashing. The phosphomolybdenum complex is read at 660nm on a SmartChem - Discrete Wet Chemistry Analyzer.

Method References:

- Total Nitrogen, P.M. Rutherford, W.B. McGill, J.M. Arocena, & C.T. Figueiredo. Ch. 22, Soil Sampling and Methods of Analysis, Edited by Martin R. Carter & E.G. Gregorich, Canadian Society of Soil Science. Taylor & Francis Group for CRC Press, 2008.
- Kjeldahl J., Z. Anal. Chem., 1883, 22, 366

Available Phosphorus for Non-Calcareous Soils – Bray & Auxley-Miller Extractions

- Bray and Auxley-Miller extractions are two widely used methods for determination of available P in soils. The combination of HCl or H₂SO₄ with NH₄F is designed to easily remove acid soluble P forms, largely calcium phosphates and a portion of aluminum and iron phosphates. NH₄F dissolves aluminum and iron phosphate by forming complexes with metal ions present in the acidic solution.

12. Bray Extractable Phosphorus (PO₄³⁻)

- Phosphorus is extracted by shaking 2.5g of air-dried soil in 25 ml of 0.025M HCl and 0.03M NH₄F for 5 minutes. Phosphorus in the filtrate is determined by the molybdate-blue method using ascorbic acid as a reductant. Color development is measured on a SmartChem - Discrete Wet Chemistry Analyzer at 880nm.

Method References:

- Laboratory Guide for Conducting Soil Tests and Plant Analysis, J. Benton Jones, Jr., CRC Press, 2001.
- Methods Manual for Forest Soil and Plant Analysis, Y.P. Kalra and D.G. Maynard, Northwest Region, Information Report NOR-X-319, Forestry Canada, Edmonton, Canada, 1991

13. Auxley-Miller Extractable Phosphorus (PO₄³⁻)

- Phosphorus is extracted by shaking 5g of air-dried soil in 25 ml of 0.025M H₂SO₄ and 0.03M NH₄F for 5 minutes. Phosphorus in the filtrate is determined by the molybdate-blue method using ascorbic acid as a reductant. Color development is measured on a SmartChem - Discrete Wet Chemistry Analyzer at 880nm.

Method Reference:

- Methods of Soil Analyses for Canadian Prairie Agricultural Soils. Prepared by Alberta Agriculture based on the methods used in Alberta, Saskatchewan and Manitoba Provincial laboratories. Sept. 1987

14. Kelowna Modified Extractable Phosphorus (PO_4^{3-} , and also $\text{NH}_4^+\text{NO}_3^-$, Na^+ , K^+)

- This method is used for formulation of fertilizer recommendations or diagnosis of P deficiency in agricultural soils. Phosphorus is extracted by shaking 5g of air-dried soil in 50 ml of solution (0.015M NH_4F , 1m NH_4OAc and 0.5M CH_3COOH). This method can also be used for the extraction of Ammonium, Nitrate, Sodium, & Potassium.

Method Reference:

- Method SO23 Determination of Soil Test Nitrogen, Phosphorus, Sodium and Potassium using Norwest Extractant. Standard Operating Procedures Manual, Soil and Crop Diagnostic Center, Alberta Agriculture, Edmonton, Canada, 1995

15. Water-Soluble Phosphorus (PO_4^{3-} , and also Na^+ , K^+ , Mg^{2+} , Ca^{2+})

- This method quantitatively determines the amount of soluble P in water. Phosphorus concentration in water is determined on a SmartChem - Discrete Wet Chemistry Analyzer.

Method Reference:

- Laboratory Guide for Conducting Soil Tests and Plant Analysis, J. Benton Jones, Jr., CRC Press, 2001

17. Exchangeable Cations and Total Exchange Capacity, CEC

- The Cation Exchange Capacity (CEC) of a soil is a measure of the soil's ability to retain readily exchangeable cations that are available to neutralize negative charges within that soil. Soil samples are saturated with a buffered Ammonium Acetate solution then leached with unbuffered Sodium Chloride. The first stage NH_4OAc leachate is analyzed for Na, K, Ca, & Mg. The final NaCl leachate is analyzed for exchangeable NH_4^+ .

Method Reference:

- Ion Exchange and Exchangeable Cations, W.H. Hendershot, H. Lalande & M. Duquette, Ch. 18. Soil pH, Effective Cation Exchange Capacity, & Exchangeable Cations (in Forest Soils), N. Bélanger, D. Paré, W.H. Hendershot, Ch. 27. Soil Sampling and Methods of Analysis, Edited by Martin R. Carter & E.G. Gregorich, Canadian Society of Soil Science. Taylor & Francis Group for CRC Press, 2008
- 3.2 Measuring the Cation Exchange Capacity of Forest Soils. COMMUN. SOIL SCI. PLANT ANAL., M.F. Skinner, etc. 32(11&12), 1751-1764, 2001.

18. Exchangeable Sodium Percentage (ESP) and /or Sodium Adsorption Ratio (SAR)

ESP is used in the classification of saline and alkali soils or to determine if a sodium hazard exists. This method requires the determination of CEC and ESP. If soluble sodium is present, the exchangeable value is corrected by analysis of Na in a saturated extract. SAR is used to estimate ESP by analyzing for Na, Ca and Mg in a soil extract. SAR is commonly determined for irrigation water to classify the sodium hazard.

Method Reference:

- Electrical Conductivity & Soluble Ions, Sodium Adsorption Ratio sect 15.4.4 & Exchangeable Sodium Percentage sect 15.4.5, Soil Sampling and Methods of Analysis, Edited by Martin R. Carter & E.G. Gregorich, Canadian Society of Soil Science. Taylor & Francis Group for CRC Press, 2008

19. Extractable/Exchangeable Cations

- Base cations are determined in soils by extraction in ammonium acetate solution. The extracts are analyzed for cations using a Varian 880 Atomic Absorption Spectrophotometer.

Method Reference:

- Ion Exchange and Exchangeable Cations, W.H. Hendershot, H. Lalande & M. Duquette, Ch. 18. Soil pH, Effective Cation Exchange Capacity, & Exchangeable Cations (in Forest Soils), N. Bélanger, D. Paré, W.H. Hendershot, Ch. 27. Soil Sampling and Methods of Analysis, Edited by Martin R. Carter & E.G. Gregorich, Canadian Society of Soil Science. Taylor & Francis Group for CRC Press, 2008

20. Textural Analysis, Hydrometer

- This method quantitatively determines the physical proportions of three sizes of primary soil particles (sand ranging from 2000-50um, silt ranging from 50-2.0um, and clay <2.0um) as determined by their rate of settling in solution using a hydrometer. The percentage of sand, silt and clay in the soil is calculated from hydrometer readings.

Method References:

- Hydrometer Method Improved for Making Particle Size Analysis of Soils, G.J. Bouyoucos. Agron. J. 54:464-465. 1962
- Standard Test Method for Particle-Size Analysis of Soils. ASTM D422-63 (2007). American Society for Testing & Materials International.
- Methods Soil Sampling and Methods of Analysis, Ed. Martin R. Carter, Canadian Society of Soil Science, 1993. Chapter 47, Particle Size Distribution.

21. Isolation of Humin Fraction

- The residue of the alkali extraction (NaOH 0.5 M), sometimes referred as to humin, is largely composed of organic material tightly bound to the mineral fraction. The humin is retained for analysis of C, N and Organic C.

Method Reference:

- Organic Matter Characterization, R.S. Swift, pages 1018-1019. Methods of Soil Analysis, Part 3 – Chemical Methods, Soil Science Society of America Book Series #5, J.M.Bartels, Editor. Soil Science Society of America, Inc., Madison, Wisconsin

22. Determination of Dry Aggregate Size Distribution

- Soil aggregation is one of the main factors controlling the chemical, physical, and biological processes that contribute to soil productivity and agricultural sustainability. Air-dry aggregates are separated and reported as MWD(Mean Weight Diameter).

Method Reference:

- Dry Aggregate Distribution, Larney, F.J., p. 821-831. Soil Sampling and Methods of Analysis, Edited by Martin R. Carter & E.G. Gregorich, Canadian Society of Soil Science. Taylor & Francis Group for CRC Press, 2008

23. Shimadzu Carbon and Nitrogen Analyzer

- This method measures the quantity of total organic carbon (TOC) as non-purgeable organic carbon (NPOC) and/or total nitrogen (TN) in water and soil extracts.

Method References:

- Total Organic Carbon Analyzer TOC-V User Manual, Shimadzu Corporation, Analytical & Measuring Instruments Division, Kyoto, Japan, 2001.
- Non-Purgeable Organic Carbon (NPOC): Shimadzu TOC-5050A Total Organic Carbon Analyzer, Dr. Mark W. Williams, Institute of Arctic and Alpine Research, University of Colorado, 2000.

24. Total Carbon, Total Organic Carbon, Total Nitrogen and Total Sulfur Analysis by Dumas Combustion using Costech Elemental Analyzer

- Solid samples submitted for Total Nitrogen, Total Carbon, Total Organic Carbon, and Total Sulfur are finely ground with a Brinkmann ball grinder (Retsch , MM200), dried overnight and analyzed by the Dumas Combustion Method using a Costech 4010 Elemental Analyzer System (Costech Analytical Technologies Inc., Valencia, CA, USA). Samples are flash combusted under helium in the presence of oxygen and the resulting gases are separated by gas chromatography and detected quantitatively by thermal conductivity detector (TCD).

Method References:

- Micro-chemical Determination of Carbon, Hydrogen, and Nitrogen, Automated Method. Official Methods of Analysis of AOAC International, 17th Edition (2000), AOAC International, Arlington, VA. Method 972.43,.
- Methods of Soil Analysis, Part 3 – Chemical Methods, Soil Science Society of America Book Series #5, Soil Science Society of America, Inc., Madison, Wisconsin. Dumas Methods, Determination of Total Nitrogen and Total Carbon by Combustion.
- ECS 4010 Elemental Combustion System CHNS-O Operating Manual, Costech Analytical Technologies Inc., Valencia, CA

25. $\delta^{13}\text{C}$ and/or $\delta^{15}\text{N}$ Stable Isotope Ratios in Soils and Solid Samples

- Solid samples submitted for carbon and/or nitrogen isotopic composition $\delta^{13}\text{C}$ and/or $\delta^{15}\text{N}$ are finely ground with a Brinkmann ball grinder (Retsch, MM200) and analyzed using a Costech ECS 4010 Elemental Analyzer System (Costech International Strumatzione, Florence, IT) connected to a Conflo III & Continuous Flow Delta Plus Advantage IRMS (ThermoFinnigan, Bremen, Germany). Samples are flash combusted under helium in the presence of oxygen and the resulting gases are separated by gas chromatography and detected by a thermal conductivity detector (TCD). Sample gases enter the mass spectrometer system where intensities of mass 46/45/44 for CO_2 and mass 28/29/30 for Nitrogen are measured. Internal standards, calibrated against the International Reference scale (i.e. ^{13}C vs. VPDB and ^{15}N vs. Air), are used to determine sample isotopic results.
- conductivity detector (TCD).

Method References:

- Micro-chemical Determination of Carbon, Hydrogen, and Nitrogen, Automated Method. Official Methods of Analysis of AOAC International, 17th Edition (2000), AOAC International, Arlington, VA. Method 972.43,
- Methods of Soil Analysis, Part 3 – Chemical Methods, Soil Science Society of America Book Series #5, Soil Science Society of America, Inc., Madison, Wisconsin. Dumas Methods, Determination of Total Nitrogen and Total Carbon by Combustion.
- ECS 4010 Elemental Combustion System CHNS-O Operating Manual, Costech Analytical Technologies Inc., Valencia, CA.
- de Groot P.A., Handbook of Stable Isotopic Analytical Techniques, Volume 1, Elsevier, 2004, ISBN:0 444 511148

26. Metal Cations in Soils, Plant, and Water by Atomic Absorption Spectrophotometry

- Cations such as Na, K, Ca, Mg, Al, Cu, Fe, Zn, Mn and Li are determined in solution using a Varian 880 Atomic Absorption Spectrometer by aspiration into a high temperature air / acetylene or nitrous oxide/acetylene flame where the ground state atoms absorb light of a specific wavelength supplied by a hollow cathode lamp, progressing to an excited state. The amount of light absorbed is proportional to the concentration of absorbing species in the sample, as defined in the Beer – Lambert law, and is measured by a photomultiplier tube. Sample

responses are compared to known calibration standards and the sample concentrations are determined.

Method References:

- Basic Atomic Absorption Theory, Varian Inc., 1998.
- SpectrAA 880 Operating Manual, Varian Inc., 1999.
- Flame Atomic Absorption Spectrometry Analytical Methods, Varian Australia Pty. Ltd., Rev. March 1989.
- Atomic Absorption and Flame Emission Spectrometry, p. 13-27. D.E. Baker & N. H. Suhr. Analysis, pgs. 229-231 (K), 238-239 (Na), 257-258 (Ca & Mg), 294-295 (Al), 302-304 (Fe), 314-315 (Mn), 326-327 (Cu & Zn). Methods of Soil Analysis Part 2, Chemical and Microbiological Properties, Second Edition, 1982. American Society of Agronomy, Inc., Soil Science Society of America, Inc., Madison, Wisconsin, USA.

27 . Anions in Water by Ion Chromatography

- Anions such as SO_4 , NO_2 , NO_3 , Cl, Br, PO_4 are determined in aqueous matrix using a Dionex Ion Chromatograph. Water samples submitted must be of low dissolved solids concentration & be filtered before analysis. Sample responses are compared to known calibration standards and the sample concentrations are determined.

Method References:

- Small H., Stevens T.S., Bauman W.C. Analytical Chemistry, 1975; 47:1801
- Small H., Riviello J., Analytical Chemistry, 1998; 70:2205
- Ion Chromatography, M.A. Tabatabai & W.T. Frankengerger, Jr., Pg. 236-244, Methods of Soil Analysis, Part 3- Chemical Methods. Edited by D.L. Sparks, 1996. American Society of Agronomy, Inc., Soil Science Society of America, Inc. Madison, Wisconsin, USA

28. Carbonates as Alkalinity

- Total alkalinity as CaCO_3 is determined on the SmartChem using the methyl orange indicator method. Alkalinity of a water sample can be described as its acid neutralizing capacity and is the sum of all the titrable bases present in the sample. The endpoint pH used determines which basic species have been included in the final concentration reported, so it is important to select the appropriate indicator and report the associated pH with the final result.

Method References:

- SmartChem 200 Method 111-0405D: Alkalinity in Water, Waste Water and Soil Extracts and other aqueous samples, Rev: April 2007. Westco Scientific Instruments Inc.
- US EPA Method 310.2, Rev. 1974

29. Saturated Paste & Saturation Percentage

- Soil samples are brought to their water saturation point by the gradual addition of water and then vacuum filtered. The resulting filtrate is used for the determination of dissolved salts by atomic absorption spectrophotometry.

Method Reference:

- Saturation Extract and Aqueous Extraction, Section 10. J.D Rhoades. Methods of Soil Analysis Part 2, Chemical and Microbiological Properties, Second Edition, 1982. American Society of Agronomy, Inc., Soil Science Society of America, Inc., Publisher, Madison, Wisconsin, USA.