Quick Reference for Turfgrass Soil Paste and Analysis

	Soil Report	Paste Report
pH of Soil Sample	6.2	6.2
Organic Matter (OM) %	1.0 – 4.0	
Total Exchange Capacity		

Anions	**ppm / lbs**	**ppm**
S Sulphur	25 ppm	5-10
P_2O_5 Phosphorus	250 lbs / acre	1-3

Major Elements	**Exchangable (lbs / acre)**	**Base Saturation Pecent**	**Soluble ppm**	**Percent**
Ca Calcium	>2,000	65	40-60	60
Mg Magnesium	>200	15	8-12	20
K Potassium	350	5	15-20	10
Na Sodium	<80	0-3	<20	2-8

Minor Elements	**ppm**	**ppm**
B Boron ppm	1.2	0.1
Fe Iron ppm	100-150	0.3
Mn Manganese ppm	40-120	0.1
Cu Copper ppm	5-15	0.08
Zn Zinc ppm	6-20	0.08

Based on 6” depth samples. Percentages and values will vary based on Sample depth, pH, compaction, and stress factors.

Balance Your Soil Structure!!

Golf Ventures

Soil Test Guidelines

REFERENCE	DEFINITION/RESULTS
pH	pH measures the acidity and/or alkalinity of the soil. It's important to understand that pH should not be the focus of any management program, it only represents the "percentage of hydrogen" that is found in the soil colloid. The pH balance of basic cations are found in the base saturation and is easily managed by managing Ca, Mg, K, Na and other cations
Organic Matter Percentage (OM%)	Organic matter encompasses the roots and thatch, both of which are forms of carbon that and are not easily digested by soil microbes. Organic matter is very important as a foundation for the development of humus; however it does not represent pure humus in soil.
Total Exchange Capacity (TEC)	The holding capacity of the soil. The TEC represents the soils ability to maintain nutrients on colloidal sites. Colloidal sites are plate-like structures that are made up of mainly clay and organic matter. There are other elements that can increase TEC, such as sands, where clay and organic matter are low. However, in heavy soils, the TEC will be greater.
ANIONS	
Sulfur (S)	Sulfur should be maintained at levels between 50 and 100 pounds per acre seeing how it plays a major role in mobilizing excessive nutrient levels out of the soil. Sulfur is important for the uptake of nitrogen and development of amino acids, enzymes and protein systems. (Sulfur levels are calculation in parts per million (ppm), when multiplied by 2 equals pounds per acre)
Phosphorus (P_2O_5)	Phosphorus levels should be maintained around 250 pounds per acre except in heavy soils where levels can be higher. Phosphorus is an essential building block for the development of sugar, healthy roots and for transporting other nutrients into the plants.

MAJOR ELEMENTS

Calcium (Ca)

Calcium percentage should be maintained at a base saturation of 68% in heavy soils and at 60% in sandy soils. (Calcium is noted in pounds per acre and the base saturation percentage shows the balance of calcium with other cations.) Calcium when not balanced will severely affect soil compaction by restricting air and water flow through the soil, limiting microbial activity. Depending on how much Ca is needed; a combination of high calcium lime (low Mg) and dolomitic lime (high Mg) may be needed to avoid driving off too much Mg.

Magnesium (Mg)

Magnesium percentages should be maintained at a base saturation of 12% in heavy soils and close to 20% in sandy soils. Mg is shown in pounds per acre and has a close relationship with Ca. Often times high Mg drives up the pH balance. Magnesium is essential for photosynthesis and the development of amino acids and enzymes systems.

Potassium (K)

Potassium is important for reducing plant stress and root development. Potassium percentage should be maintained at a base saturation of 5%. When the pH level is above 6.5, potassium availability is limited and without the use of organic sources becomes very difficult to build up levels of K.

Sodium (Na)

Sodium percentages should be maintained at a base saturation of 3% or 40-50 pounds per acre. Soils with high levels of Na will restrict activity of beneficial bacteria and could result in a sodium-induced wilt

Base Saturation Percentage (BSP)

The base saturation percentage always adds up to 100% representing a balance in the soil, 68% Ca, 12% Mg, 5% K, 2% Na, 3% other base trace nutrients and 10% H) This is where soil management begins and if the percentages stay within their "ideal" values, pH will always be between 6.0 - 6.5.

MINOR ELEMENTS

Boron (B)

Boron is a very soluble nutrient and is the "gate keeper" for calcium uptake. Boron should be maintained at 1.2 ppm and is needed in most soils on a small basis. Boron can be very toxic but is needed to with the uptake of nitrogen as well as many other plant/soil functions.

Iron (Fe)

An ideal iron level in soil is 100-150 ppm (higher levels are tolerable for most soils). There is a crucial Fe:Mn relationship in soil which should always be at least 1.5:1

Manganese (Mn)	Manganese levels should be maintained at 25-40 ppm minimum to 120 ppm maximum. Mn mobilizes Fe in the soil and can be used as a good Fe replacement. Mn plays an important role is the metabolism of plant and soil microorganisms. When there is a lack of Mn this can create plant stress, encouraging diseases.
Copper (Cu)	Copper levels should be maintained at 5 ppm minimum to 10-15 ppm max. Copper is a major player is disease suppression and is a major ingredient in many fungicides.
Zinc (Zn)	Zinc level should be maintained at a minimum of 6 ppm to a max of 10-20 ppm. Zinc plays a major role in disease suppression in soil.

Paste Extract Guidelines

These guidelines help identify what is happening in the soil short term. It's a great tool for determining what nutrients are soluble in soil solution, including sodium and salt levels and in identifying solubility of calcium. When interpreting a paste extract test, it is important to understand that there is a need to maintain both strategic nutrient levels as well as a balanced ratio of nutrient levels.

Several factors can influence a paste extract soil test and need to be considered when interpreting results:

- Weather conditions; including the direction of storms, amount of rainfall, and influence of acid rainfall
- Irrigation
- Poor water quality
- Recent fertilization applications (i.e. water soluble nutrients may be in solution)
- High bicarbonate levels
- Compaction layers
- Plow pan
- Black layer
- Improper aerification and/or topdressings
- Very low exchange capacities/no buffering capacity

Testing protocol:
These tests should not be done as a stand-alone test; instead, they should initially be done in conjunction with a standard soil test on the same site. As a monitoring tool, these tests can be run on a 6-8 week schedule.

REFERENCE	**DEFINITION/RESULTS**
pH	Levels may or may not be the same as standard soil tests.
Soluble Salt	High levels are undesirable and can harm turfgrass. Excessive concentrations can be leached from the root by extreme irrigations. This can only be accomplished with good subsoil drainage and exceptional soil permeability. **< 960 ppm (same guidelines as soil test)**
Chlorides	Chloride concentrations contribute to the total soluble salt concentration and are readily leached from soils with good drainage. High levels will reduce biological activity.
Bicarbonate	High levels will cause calcium to precipitate in the soil forming calcium carbonate causing a serious reduction in permeability of the soil when sodium is present. Soil will tighten if there are high levels of bicarbonate an indication of poor drainage and improper watering practices. **< 50 ppm**

ANIONS

Sulfur (S) Sulfur deficiencies are most prevalent on sandy soils subject to leaching, soils with low organic matter content, high nitrogen use, and when clippings are removed.
5 – 10 ppm

Phosphorus (P_2O_5) Not very soluble; high levels of aluminum & iron tie-up phosphorus.
1 – 3 ppm

MAJOR ELEMENTS

Calcium (Ca) Calcium should always be greater than the combination of Mg & K.
The percentage ration of Ca: Mg should be 3:1 or a ppm ratio of 5:1.
40 – 60 ppm (ideal range 55 – 60%)

Magnesium (Mg) Magnesium plays a key role in chlorophyll production. Deficiencies are often associated with low CEC, acidic (ph<5.5) soils subject to leaching, high inputs of Ca as lime or gypsum, and high K fertilization.
8 – 12 ppm (ideal range 18 – 20%)

Potassium (K) Should always be higher than sodium (Na) as a percentage, especially when bicarbonate levels are high. Potassium is very soluble and is easily fixed in the presence of certain clay types.
15 – 20 ppm (ideal range 9 – 10%)

Sodium (Na) Should always be less than K as a percentage. The negative effects of sodium are critical where there is heavy traffic. Compaction of clay soils results in a decrease in aeration, water infiltration and percolation of soil water. As results rise above the optimum level, soil biology is weakened.
< 20 ppm (8 – 2%)

MINOR ELEMENTS

Boron (B) A water soluble, essential micro-nutrient for plant growth. While turfgrasses are generally tolerant of boron, soil accumulation can be problematic because boron can form chemical complexes that do not easily leach from the soil. Availability is reduced when soils have been recently limed to pH > 6.5 or in calcareous soils with high Ca content.
0.1 ppm

Iron (Fe) High levels can tie-up phosphorus, while deficiencies are often associated with poor rooting or root viability conditions, pH > 7.0, high P levels at high pH, excess thatch, and low organic matter soils.
0.3 ppm

Manganese (Mn)	Availability is reduced on high pH soils, calcareous soils, acid and heavily leached sands, peat and muck soils at pH > 7.0, and during dry, warm weather. **0.1 ppm**
Copper (Cu)	Deficiencies are most common on organic soils, heavily leached sands, high pH, and with high levels of P, Fe, Mn, Zn and N. **0.08 ppm**
Zinc (Zn)	Deficiencies are most common on alkaline soils, during cool, wet weather, on highly weathered acid, coarse textured soils, and with high levels of N, P, Fe, Cu and Mn. **0.08 ppm**
Aluminum (Al)	High levels can tie-up phosphorus.

Please note: With all trace nutrient levels, an acceptable range of variability for the ideal levels would run plus (+) or minus (-) 0.02 ppm.