

Appendix A

SOIL / ROOTS / PHOSPHATES, ETC . . .

Soils should generally have a base minimum of **2% organics**, with an **ideal level of 4%**; most soils, however, contain **1% or less** of such basics. The constituent particles of soil include gravels, sand, silt and clay. The clay fraction provides a medium for plant nutrition—it is the feeding fraction. It absorbs nutrient molecules and allows them to be reabsorbed by plant roots. Also clay acts as an **ion exchange medium**. The clay condition determines water permeability and regulates the speed with which nutrients are fed to plant roots, and it also regulates the speed of water loss to evaporation and leaching.

The suspension of clay and other soil particles, or colloids, determines the success of a plant's sustenance; if the clay fractions are low, nutrients will speed by the root zones leaving little behind for later uptake, uptake especially for new-growth root hairs. If clay fractions are high, nutrients will remain longer, but if organic content is low, such clay will compact tightly and strangle root progress. Water and air penetration will suffer and the ground will grow less plant life and be less productive.

Adding Organics:

Addition of organic material to the soil act to flocculate, allowing greater open spaces as particles aggregate and lump together providing for better air and water absorption and beneficial bacterial growth. The *softness* which organic material adds to the soil colloids also provides for better ion exchanges—the clay fraction acts as a buffer store for *cations* (+), and the organics serve as a store for *anions* (-). Use of the BER fertilizer returns productive balance of natural elements to the soil—the essence of **recycling** for **beneficial reuse**. Overloading land with biosolids just to be rid of it is not only counterproductive, but it's an expensive waste of land and the *resource* which biosolids can become if properly and insightfully treated.

It is generally accepted that addition of organic matter to the soil enhances the structural properties of soil by binding together soil particles into aggregates or lumps and creating large pores through which air and water move. In cropped land, soil organic matter is gradually lost which leads to deterioration of the soil's growth sustaining properties. The **return of organic matter** from crop residues is **out-paced by** the loss due to normal organic decomposition—amendment with organics is therefore required.

It is a fact that most inorganic trace elements in treated sludge are either not transferred from soil to plant tissue or that translocation to edible tissues does not reach harmful levels under normal agricultural conditions, especially when sludge is used to reach an agronomic rate of nutrient loading—specifically nitrogen. Further it is known that when soil pH is consistently close to neutral or slightly base, immobility of trace elements (metallic elements) becomes even more pronounced.

Root structures, especially the absorbent hairs, are enshrouded in a membrane which almost entirely disallows the heavier elements absorption. The root hair excretes a citric-like acid compound which solubilizes surrounding minerals for uptake, however, for the dissolved metallic ions to **cross the nano-membrane** of the root hair, they must have a **lower molecular weight than forty**; big molecular weight metals simply will not traverse the filter membrane easily.

An Acre-Root-Zone:

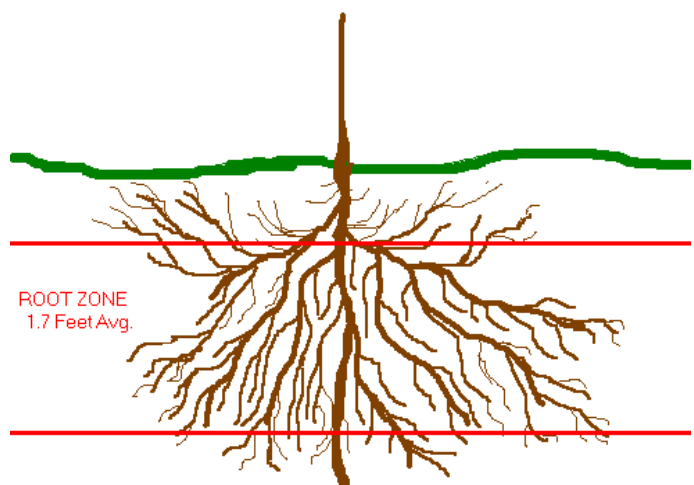
An acre is comprised of approximately **44,000 square feet**, and the standard which is basic to virtually all soils, is that the root growth area involves a maximum **depth of 1.7 feet**. Multiplying the 1.7 times 44,000 shows the size of an **acre-root-zone** to be **74,800 cubic feet**. Using an average soil density of 1.4 equates to **90 lbs/cubic foot**. Taking the density of 90 lbs/cubic foot times the cubic footage of the root zone, 74,800, leaves you with an **active soil weight** of roughly **seven million pounds to the acre**.

In treating and/or disposal of biosolids, where sufficient macro-nutrients reside in the treated material, the application rate must be held to an agronomic one; this insures a minimal amount of trace elements will be applied and found in the root zone.

In the BER process there is a **conversion** of the organic biosolids to fertilizer by creating an organic-macro-nutrient-chelate, comprised of an ammonium phosphate molecularly grouped with the molecules of the organic matrix. The organic substrate fraction can be as high as 80%, or as low as 40% . . . therefore, with application at an agronomic rate determined by nitrogen and phosphorous, one would need to apply roughly **1,200 lbs/acre** as opposed to using **10-50 tons/acre of sludge**. The twelve hundred pounds represents **500 lbs/fertilizer** and **700 lbs/organics**.

Phosphates and the Soil:

The BER process makes use of additional phosphates in treating biosolids, thus providing for lower pH's. One of the main positive effects this has is to lower the localized pH in the immediate root zone, increasing the mobility of all phosphates. The phosphate nutrient fraction, described as P_2O_5 , *stimulates new and advanced growth of fine root hairs and internal root and stem tissue*. These added phosphates overcome the calcium-lock-up reaction--nutrients, macro and micro alike, are bound by the soil calcium. The release occurs because the phosphates are clustered with the organics at a proper pH.



Biosolids in the United States:

There are currently **5.3 million metric tons** (dry weight) of biosolids produced annually in the United States at Publicly Operated Treatment Works (POTW's) - approximately 15,000 in number.

Of that tonnage:

- 36%** goes to land application (horticultural and agricultural)
- 38%** is landfilled
- 16%** is incinerated
- 10%** approximately is marketed as compost and other products

There are **309,000,000 acres of crop land** in the contiguous United States . . . **if all biosolids produced were applied at an agronomic rate for N, it would fill 1.6% of the national need.**