# Evaluation of Hydroseeding with Compost Additive

RECYCLING TECHNOLOGY ASSISTANCE PARTNERSHIP
ReTAP

AN AFFILIATE OF MANUFACTURING EXTENSION PARTNERSHIP™

# HYDROCOMPOST EVALUATION PROJECT

## FINAL REPORT

*Prepared for:*

**CWC**
A division of the Pacific NorthWest Economic Region (PNWER)
2200 Alaskan Way, Suite 460
Seattle, WA 98104

**February 1999**

*Prepared by:*

**Tech Help**
**Hamilton Manufacturing, Inc.**

*This recycled paper is recyclable*



**REPORT NO. CM-99-2**

## ACKNOWLEDGMENTS

CWC is a nonprofit organization providing recycling market development services to both businesses and governments, including tools and technologies to help manufacturers use recycled materials. CWC is an affiliate of the national Manufacturing Extension Partnership (MEP) – a program of the US Commerce Department's National Institute of Standards and Technology. The MEP is a growing nationwide network of extension services to help smaller US manufacturers improve their performance and become more competitive. CWC also acknowledges support from the US Environmental Protection Agency and other organizations.

**TechHelp** provided oversight management on this project, and is Idaho's Manufacturing Extension Center under NIST. Idaho's public universities are partnered with TechHelp to provide additional resources.

**Hamilton Manufacturing, Inc.** is a manufacturer of various recycled content products, including cellulose fiber used in the home and commercial insulation industries. Another one of their products is paper mulch used in Hydro-seeding of residential and commercial lawns. . Hamilton initiated this project with CWC to evaluate the use of compost with traditional hydroseeding formulations.

# TABLE OF CONTENTS



## TABLES

# 1.0 INTRODUCTION

This report reviews the application of traditional recycled materials, such as newsprint and mixed waste paper, combined with compost, to provide a base media for hydroseeding applications. Primary uses of hydroseeding include landscaping, soil erosion control, forest reseeding, and reclamation of disturbed land (e.g., road beds, mine lands, overgrazed lands, excavation sites, and other disturbed land). The hydroseeding mulch or base material protects the seed and retains moisture in the soil to promote good germination. The conventional practice in hydroseeding is to prepare the surface and then make a single application of material consisting of mulch and seed.

The mulch base material in conventional hydroseed products varies, but typically consists of wood fibers, wood excelsior, virgin or low-grade recycled paper mulch or straw waddles. Compost has not been widely used or tested as a supplemental mulch media in the hydroseeding industry, partly due to inconsistencies in particle size and density which affects operation of the spray hydro-machines.

Hydroseeding application methods vary depending on the base material. The spray application process mixes the seed, mulch, and water (and other additives) at the site of application. Materials are mixed in a large tank, then pumped through a hose and sprayed onto the ground. A glue or tackifier may be added to improve the stability or holding capacity on sloped surfaces. Fertilizers may be added during application or later to assist in plant establishment and growth. Alternatively, some of these materials may be manufactured into blankets or mats which are placed directly on the ground.

Two weeks is generally required for initial germination of hydorseeded residential grasses that are irrigated. Most residential sites have irrigation or sprinkler systems, and if the hydroseeded area is watered regularly, the germination is usually much better than on arid highway and mine reclamation sites that typically do not receive consistent moisture during germination. The germination period and success rate of highway and mine site recovery is dependent upon weather conditions, as well as other factors such as slope, soil condition and contaminant levels, terrain, etc.

The hypothesis for this project is that by adding compost to a paper-based hydromulch (heretofore termed hydrocompost), the product can be successfully applied with a spray hydro-machine, and the hydrocompost will improve seed germination, require less chemical fertilizer, have better water holding capacity, and provide better soil erosion control. This project will evaluate the potential for and challenges of mixing and applying hydrocompost in hydroseeding applications.

The project was carried out in the following steps:

1. Develop hydrocompost product formulations and application procedures that will be compatible with current equipment and application methods.
2. Evaluate and field test the various formulations using industry standard application equipment.
3. Conduct lab tests on the hydrocompost and conventional hydroseed products for erosion control capabilities.
4. Conduct lab tests for water holding capacity, compost maturity, organic and heavy metal content, and chemical analysis of hydrocompost.
5. Develop cost comparisons between various products available on the market.

## 2.0 METHODS, RESULTS AND DISCUSSION

### 2.1 Formulation and Application Procedures

The optimum product formulation was determined to be a mixture of three parts (by weight) compost and one part recycled-paper mulch, plus tackifier and water. The amount of tackifier used varies, depending upon the application site, slope, anticipated weather conditions, and soil type. The constituents are described below:

- Recycled newsprint mulch, containing up to 20% mixed waste paper, which is a difficult recycled commodity to market;
- Compost, in a 3:1 weight ratio of compost to paper mulch. The compost used for this project was derived from dairy manure feedstocks. Straw-based compost is not preferred for this application due to the abrasiveness of straw which affects the pump in the hydroseeding machine; and
- Tackifier, added at 7.5 pounds per acre. For the rainfall simulation experiment, Formulation 1 used liquid acrylic polymer as a tackifier, and Formulation 2 used dry powder called "Hold & Grow™" as the tackifier.

As a result of this initial work, Hamilton Manufacturing proved that existing mechanically-agitated hydroseeding machines with an impeller, are capable of mixing and applying a mulch plus compost hydroseeding mixture. Jet-agitated machines do not readily mix the heavy solutions that have been developed for hydrocompost. However, working with dry mixtures of mulch and compost, the materials can separate due to density differences, which may require addition of ingredients in smaller batches.

The hydrocompost formulations for these applications were mixed in hydro-machines with fairly small tank sizes. This initial formulation development and testing provided baseline information for Hamilton Manufacturing to develop and publish a matrix of hydrocompost formulations for a range of tank sizes, from 300 gallons up to 3,000 gallons.

## 2.2 Field Application and Evaluation

The field site applications originally intended for this project included residential sites, Department of Transportation (DOT) highway roadside, and mine reclamation sites, although only three residential sites and one highway site were actually evaluated. Only one highway site, Horseshoe Bend, was seeded with hydrocompost in April 1997 and was monitored throughout the course of the project. The other DOT site could not be completed because hot summer temperatures prohibit seeding on DOT jobs.

Due to climatic and project time limitations, the field applications were limited to three residential sites and one highway site. The three residential plots seeded in this project were rolling to flat conditions normally found in residential locations. Each plot was sprinkler irrigated and thus received adequate moisture for proper germination and growth during the summer months. The highway site was exposed to available ground moisture and normal weather conditions with no additional water application. The application sites and results are detailed in Table 1. No direct comparison or control plots were planted, therefore these results are only qualitative.

**Table 1: Application Sites**

| Residential Test Site | Application Material/ Rate | Conditions | Results |
|---|---|---|---|
| Twin Falls, Idaho South Park | 4,000 lb/acre hydrocompost, 8 pounds lawn seed/1000 square feet | Irrigated, zero slope, sun/shade exposure | Poor growth – cause determined to be high pH soil. Treated with neutralizer and reapplied |
| Buhl, Idaho | 4,000 lb/acre hydrocompost, 8 pounds lawn seed/1000 square feet | Irrigated, zero slope, sun/shade exposure | Excellent growth; well filled in, germinated within one week |
| Mountain Home | 4,000 lb/acre hydrocompost, 8 pounds lawn seed/1000 square feet | Irrigated, zero slope, sun/shade exposure | Excellent growth; well filled in |
| **Highway Test Plot** | **Application: Material, Method, and Rate** | **Conditions** | **Results** |
| Horseshoe Bend | 5,280 square feet covered, with 4000 pounds per acre hydrocompost (or 2.72 cubic yards per acre), native seed added at 20 pounds per acre | No irrigation; Summer sun; winter shade; 2.5 to 1 slope. | Good growth. Has not been monitored since shortly after application in spring 1997. |

## 2.3 Rainfall Simulation Testing at Utah State University (USU)

Two separate lab tests were performed in the Rainfall Simulation unit at USU's Water Research Laboratory, to compare the hydrocompost product to a conventional mat product (MFP) for erosion control, water run-off, and plant growth. Laboratory tests allowed comparison of the performance of each product under relatively controlled environmental conditions that are virtually impossible to duplicate in the field. The first test was conducted in June 1998 and the second in December 1998.

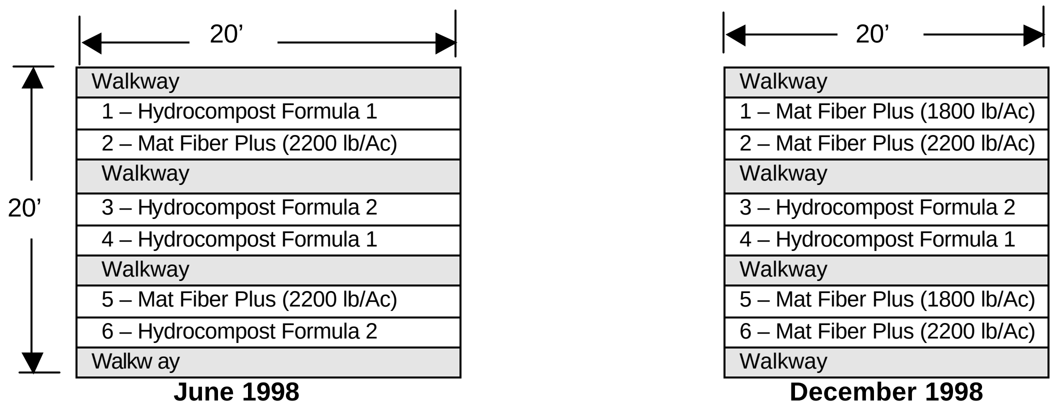
Rainfall can be varied from a mist up to 30 inches per hour. The USU rainfall simulator is a drip-type device that produces drops simulating rainfall at different rates. Five separate inlet orifices are used in each plot chamber. The rainfall rate can be varied at between approximately 2 to 25 inches per hour. Raindrop sizes are representative of typical high intensity storms. The spatial distribution of rain is essentially uniform, and the control of application rates is within the accuracy requirement of most experimental protocols. The USU equipment allows a controlled slope of anywhere from horizontal to a slope (rise to run) of 2.5:1.

The test flume is a 20 feet square, divided into six 2' x 19.5' test plots that are separated by 2' wide walkways. The total growing area per single plot is 39 square feet. Two separate tests on the test flume (six plots per test) were conducted; one in June 1998 and one in December 1998.

The June test applied four plots with hydrocompost (two with hydrocompost formulation 1 and two with hydrocompost formulation 2), one plot with Mat Fiber Plus (MFP) at 1800 pounds/acre (lb/acre), and one plot with MFP at 2200 lb/acre. The MFP product is 100% virgin wood mulch with 3% guar tackifier. The December test applied one plot with hydrocompost formulation 1, one plot with hydrocompost formulation 2, two plots with Mat Fiber Plus at 1800 lb/acre, and two plots with MFP at 2200 lb/acre, as illustrated in Figure 1.

Prior to application of the hydroseeding product, all plots were prepared at one-foot soil depth with a sandy-loam soil consisting of 56% sand, 29% silt, and 15% clay. The soil was cultivated with a tiller to a depth of approximately 6 inches, then raked smooth and uniformly compacted with a roller.

**Figure 1 (Not to scale)**




Barley seed was added to the hydrocompost formulation at a rate of 200 lb/acre. All ingredients were mixed in a laboratory-size hydromulcher and applied directly to the prepared plots per Figure 1. The sunlight simulator was then stationed overhead for three days to dry the plots.

For the rainfall simulation, the slope was set at 2.5:1 run to rise, and rainfall was applied at five inches per hour for a duration of 30 minutes (which equates to 60.8 gallons per plot). The conditions were replicated in both the June and December tests as closely as possible, therefore, the average values shown in Table 2 and Figure2 correspond to the average of three repetitions of the test for each material.

The sediment and water runoff from each plot were collected and weighed together. After the sediment settled, the clean water was filtered, weighed, and converted to a value in gallons. The sediment was dried and weighed. Table 1 and Figure 2 show runoff and soil erosion results.

**Table 2. Water Runoff and Soil Erosion Data**
**(Slope = 2.5:1, Rainfall = 5 inches/hour)**

| | | | Runoff | | Soil Erosion | |
|---|---|---|---|---|---|---|
| **Test** | **Plot** | **Hydroseed Material** | (Gal/hour) | % Water Lost | (Dry Pounds Sediment) | (Pounds/hr) |
| June | 1 | Hydrocompost Formula 1 | 61.32 | 50.4% | 13.491 | 26.98 |
| June | 2 | Mat Fiber Plus (MFP) At 2200 Lb/acre | 61.80 | 50.8% | 15.696 | 31.39 |
| June | 3 | Hydrocompost Formula 2 | 53.31 | 43.8% | 13.101 | 26.20 |
| June | 4 | Hydrocompost Formula 1 | 62.71 | 51.5% | 11.488 | 22.98 |
| June | 5 | MFP (1800 lb/acre) | 63.38 | 52.1% | 21.666 | 43.33 |
| June | 6 | Hydrocompost Formula 2 | 56.86 | 46.7% | 11.679 | 23.36 |
| Dec | 1 | MFP (1800 lb/acre) | 50.39 | 41.4% | 16.714 | 33.43 |
| Dec | 2 | MFP (2200lb/acre) | 45.30 | 37.2% | 13.508 | 27.02 |
| Dec | 3 | Hydrocompost Formula 2 | 61.40 | 50.5% | 11.035 | 22.07 |
| Dec | 4 | Hydrocompost Formula 1 | 60.12 | 49.4% | 13.429 | 26.86 |
| Dec | 5 | MFP (1800 lb/acre) | 37.15 | 30.5% | 15.727 | 31.45 |
| Dec | 6 | MFP (2200 lb/acre) | 49.18 | 40.4% | 17.537 | 35.07 |

| | **Runoff (Gallons/Hr)** | **Soil Erosion (Pounds/Hr)** |
|---|---|---|
| Combined Average for Hydrocompost Formula 1 | 61.38 | 25.61 |
| Combined Average for Hydrocompost Formula 2 | 57.19 | 23.88 |
| Combined Average for MFP (1800 lb/acre) | 50.31 | 36.07 |
| Combined Average for MFP (2200 lb/acre) | 52.09 | 31.16 |

Following the rain treatment and measurement of the soil erosion and runoff, a sunlight simulator was positioned continuously above the plots for seven days. Samples were then collected, consisting of all plant material from distinct areas in three different locations from each plot; the upper third, center third, and lower third. This material was combined into a composite sample for each plot (see Table 3 *). The number of plants from each sampling location were counted, measured, dried, and weighed. Germinating, non- germinating, and lost seeds were counted. The results are presented in Tables 3, 4 and 5, as well as Figures 3, 4, and 5.

**Figure 2: Average Runoff Rate and Soil Erosion Rate**

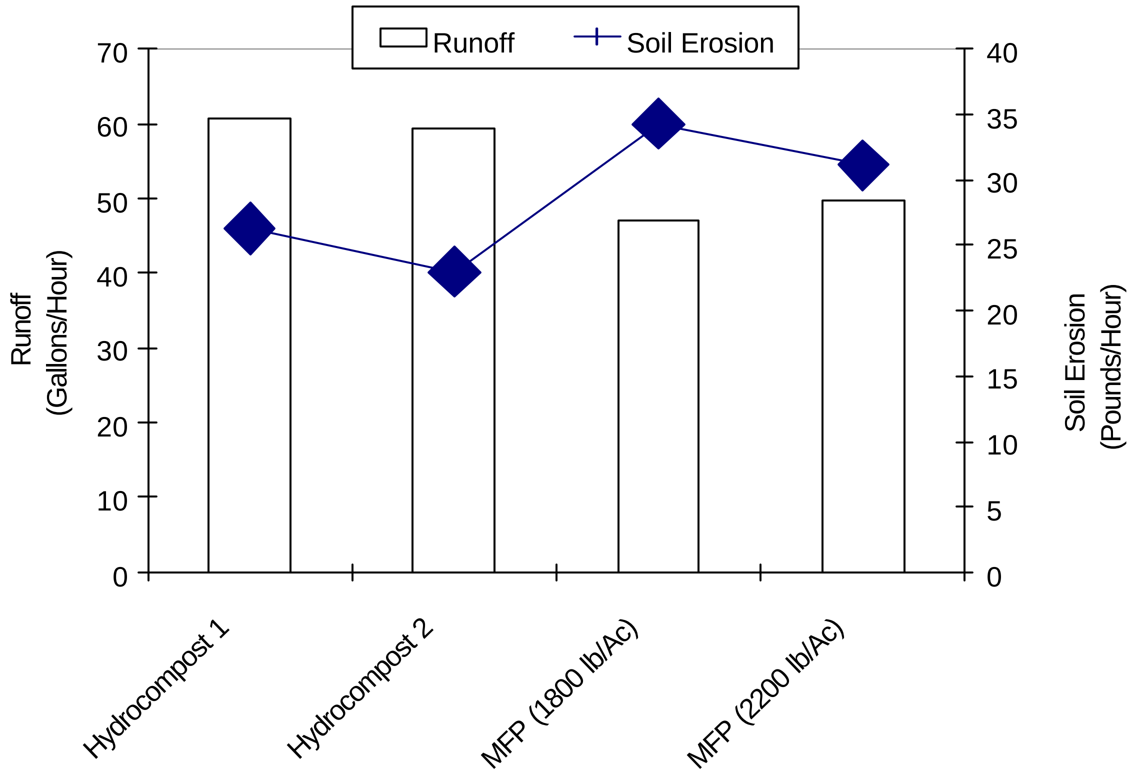



**Table 3. Plant Quantity and Height**

| Test | Plot # | Material | Number of Plants | | | Plant Height (cm) | | |
|---|---|---|---|---|---|---|---|---|
| | | | Top | Middle | Bottom | Top | Middle | Bottom |
| June | 1 | Hydrocompost Formula 1 | 39 | 34 | 32 | 18.00 | 17.25 | 16.40 |
| June | 2 | MFP (2200 lb/acre) | 25 | 26 | 32 | 17.25 | 16.75 | 18.50 |
| June | 3 | Hydrocompost Formula 2 | 39 | 39 | 31 | 17.50 | 15.75 | 16.50 |
| June | 4 | Hydrocompost Formula 1 | 25 | 32 | 33 | 17.00 | 17.00 | 16.20 |
| June | 5 | MFP (1800 lb/acre) | 22 | 25 | 30 | 17.25 | 17.50 | 16.25 |
| June | 6 | Hydrocompost Formula 2 | 38 | 27 | 33 | 18.50 | 16.75 | 17.00 |
| Dec | 1 | MFP 1800 lb/acre | 64 | 70 | 86 | 17.30 | 18.40 | 17.10 |
| Dec | 2 | MFP (2200 lb/acre) | 64 | 78 | 82 | 18.10 | 17.40 | 16.90 |
| Dec | 3 | Hydrocompost Formula 2 | 92 | 60 | 100 | 16.70 | 18.10 | 17.40 |
| Dec | 4 | Hydrocompost Formula 1 | 88 | 73 | 76 | 17.60 | 18.70 | 18.00 |
| Dec | 5 | MFP (1800 lb/acre) | 59 | 52 | 48 | 15.40 | 17.20 | 16.70 |
| Dec | 6 | MFP (2200 lb/acre) | 52 | 55 | 41 | 14.30 | 15.30 | 13.70 |

| Averages | Average Number of Plants per Composite Sample* | Average Plant Height for All Plants Collected (cm) |
|---|---|---|
| Hydrocompost Formula 1 | 144 | 17.35 cm (6.82 inches) |
| Hydrocompost Formula 2 | 153 | 17.14 cm (6.75 inches) |
| MFP (1800 lb/acre) | 152 | 16.96 cm (6.69 inches) |
| MFP (2200 lb/acre) | 152 | 16.5 cm (6.5 inches) |

**Figure 3: Average Number of Plants per Composite Plot Sample**

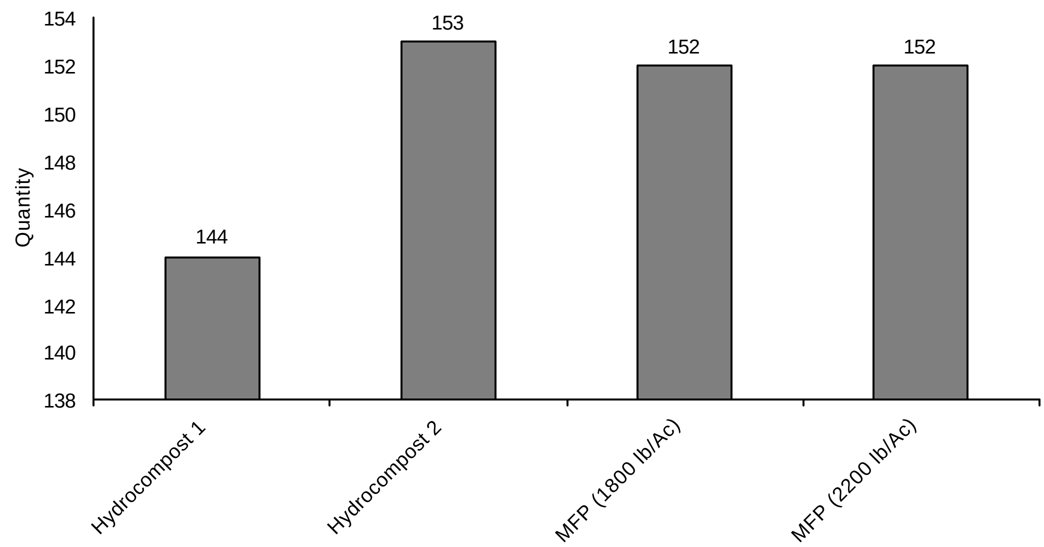
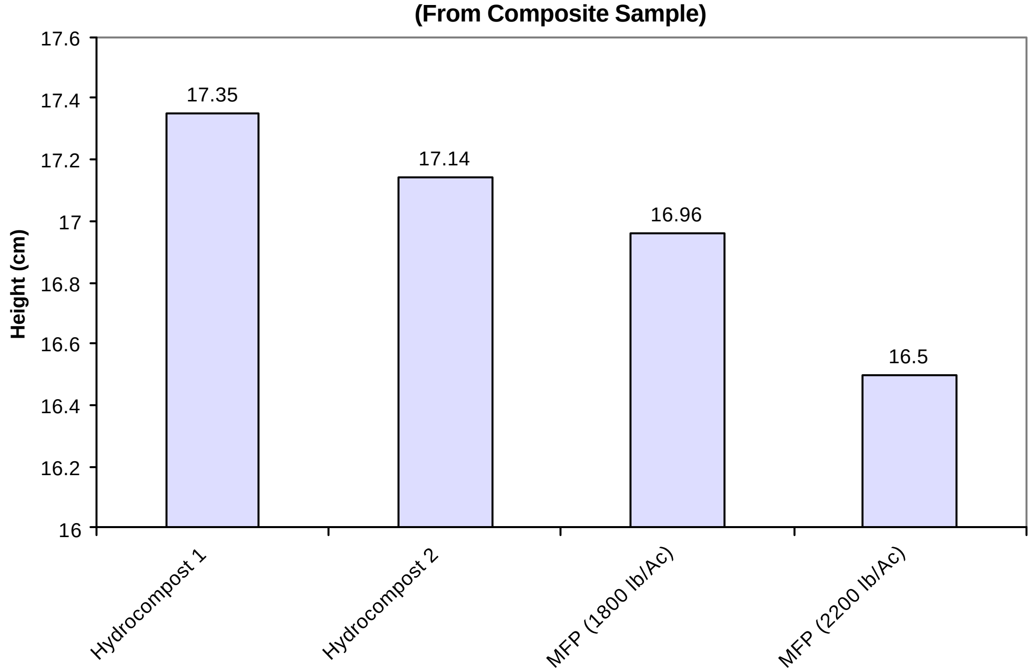



**Figure 4: Average Plant Height per Plot (From Composite Sample)**



## Table 4. Dry Weight of Plant Matter

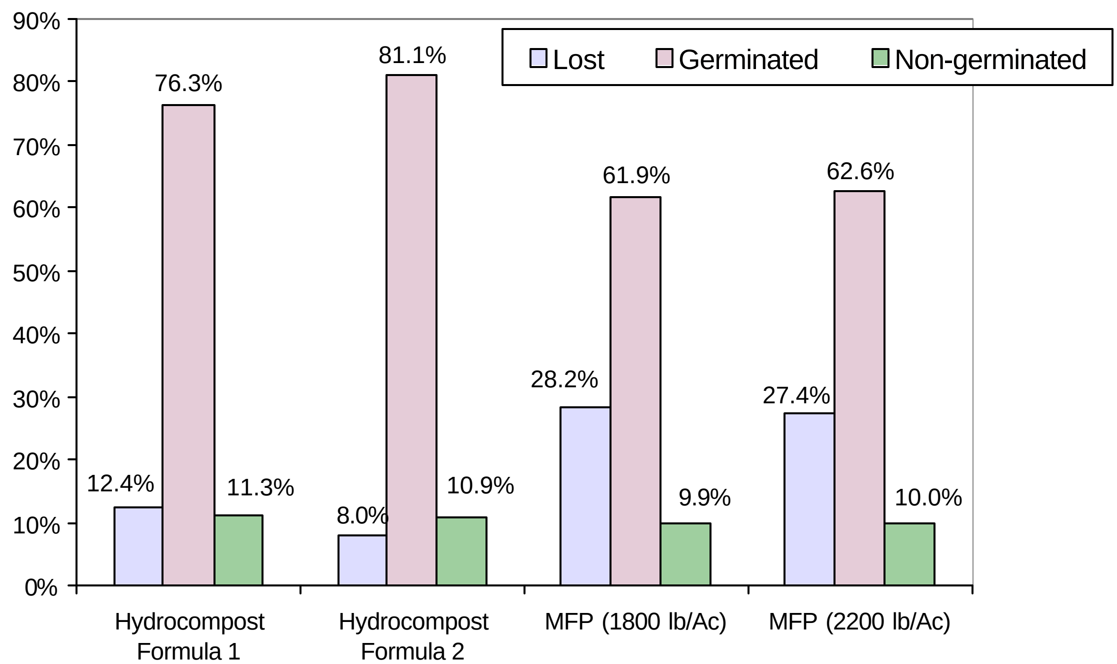
| Test & Plot | Material | Dry Weight of Sample (Gram) | | | | Dry Weight for Plot (Extrapolated from 3 $ft^2$ sample area) |
|---|---|---|---|---|---|---|
| | | Top | Middle | Bottom | Sample Total (per plot) | |
| June 1 | Hydrocompost Formula 1 | 1.00 | 1.20 | 0.82 | 3.02 | 49.99 |
| June 2 | MFP (2200 lb/acre) | 0.68 | 1.20 | 0.63 | 2.51 | 41.55 |
| June 3 | Hydrocompost Formula 2 | 1.34 | 1.45 | 0.84 | 3.63 | 60.08 |
| June 4 | Hydrocompost Formula 1 | 0.87 | 1.43 | 1.12 | 3.42 | 56.61 |
| June 5 | MFP (1800 lb/acre) | 0.83 | 1.04 | 0.96 | 2.83 | 46.84 |
| June 6 | Hydrocompost Formula 2 | 1.02 | 0.95 | 0.98 | 2.95 | 48.83 |
| Dec 1 | MFP (1800 lb/acre) | 0.80 | 0.88 | 0.94 | 2.62 | 43.37 |
| Dec 2 | MFP (2200 lb/acre) | 0.76 | 0.96 | 0.92 | 2.64 | 43.70 |
| Dec 3 | Hydrocompost Formula 2 | 1.06 | 0.89 | 1.17 | 3.12 | 51.64 |
| Dec 4 | Hydrocompost Formula 1 | 0.99 | 1.06 | 0.97 | 3.02 | 49.99 |
| Dec 5 | MFP (1800 lb/acre) | 0.67 | 0.73 | 0.87 | 2.27 | 37.57 |
| Dec 6 | MFP (2200 lb/acre) | 0.54 | 0.69 | 0.48 | 1.71 | 28.30 |

| Averages | Average Dry Weight of Composite Samples (grams) | Average (Extrapolated to and Estimated Total Dry Weight Per Plot, in grams) |
|---|---|---|
| Hydrocompost Formula 1 | 3.05 | 50.54 |
| Hydrocompost Formula 2 | 3.07 | 50.76 |
| MFP (1800 lb/acre) | 2.79 | 46.24 |
| MFP (2200 lb/acre) | 2.33 | 38.62 |

**Table 5. Percentage of Germinated Seed**

| Test & Plot | Material | Lost Seed | % of Germinated Seed | % of Non-Germinated Seed | Check |
|---|---|---|---|---|---|
| June 1 | Hydrocompost Formula 1 | 13.08 | 80.77 | 6.15 | 100 |
| June 2 | MFP (2200 lb/acre) | 29.23 | 63.85 | 6.92 | 100 |
| June 3 | Hydrocompost Formula 2 | 0.77 | 83.85 | 15.38 | 100 |
| June 4 | Hydrocompost Formula 1 | 17.69 | 69.23 | 13.08 | 100 |
| June 5 | MFP (1800 lb/acre) | 33.08 | 59.23 | 7.69 | 100 |
| June 6 | Hydrocompost Formula 2 | 19.23 | 75.38 | 5.38 | 100 |
| Dec 1 | MFP (1800 lb/acre) | 16.33 | 73.33 | 10.33 | 100 |
| Dec 2 | MFP (2200 lb/acre) | 13.67 | 74.67 | 11.67 | 100 |
| Dec 3 | Hydrocompost Formula 2 | 4.00 | 84.00 | 12.00 | 100 |
| Dec 4 | Hydrocompost Formula 1 | 6.33 | 79.00 | 14.67 | 100 |
| Dec 5 | MFP (1800 lb/acre) | 35.33 | 53.00 | 11.67 | 100 |
| Dec 6 | MFP (2200 lb/acre) | 39.33 | 49.33 | 11.33 | 100 |
| **Averages** | | | | | |
| | Hydrocompost Formula 1 | 12.4% | 76.3% | 11.3% | 100 |
| | Hydrocompost Formula 2 | 8.0% | 81.1% | 10.9% | 100 |
| | MFP (1800 lb/acre) | 28.2% | 61.9% | 9.9% | 100 |
| | MFP (2200 lb/acre) | 27.4% | 62.6% | 10.0% | 100 |

**Figure 5: Percentage of Seed Germinating**



## 3.0 DISCUSSION OF RESULTS FOR RAINFALL SIMULATION TESTING

Because of the limited replications of the test, the results presented herein are believed to be indicative only, not conclusive. Additionally, the tests were performed for a specific set of conditions, and the results, or performance in the field, will differ due to changing environmental conditions.

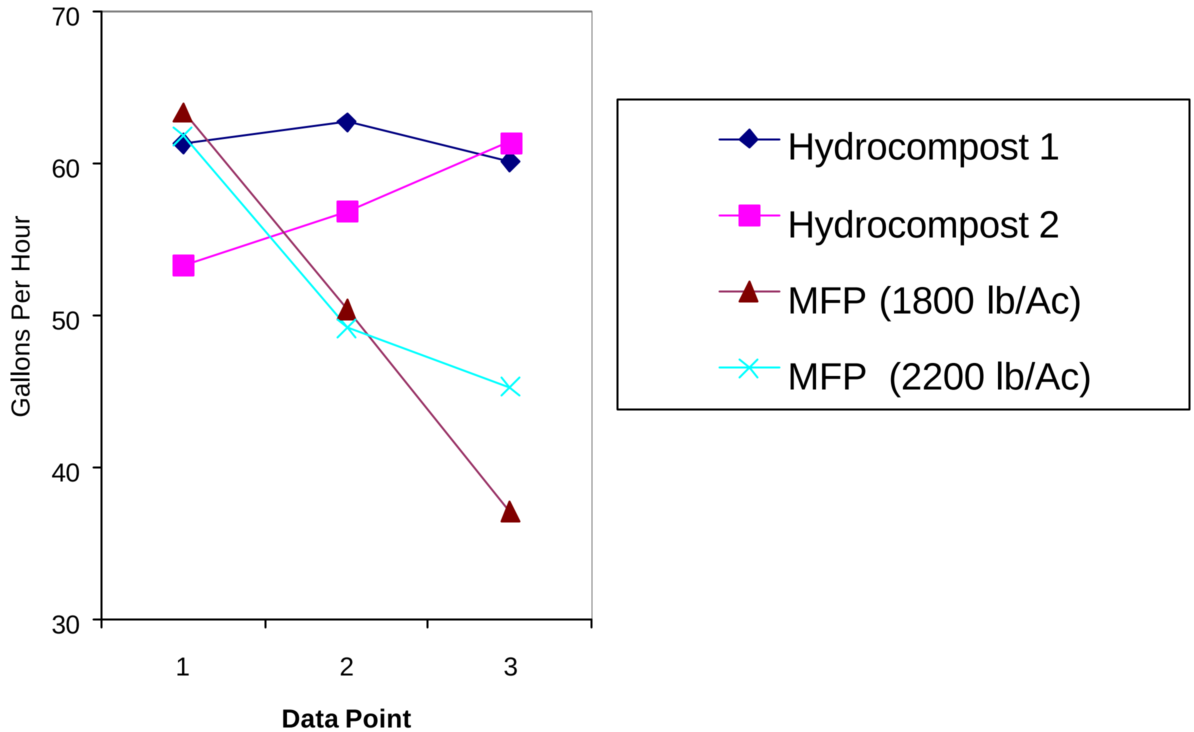
*Disclaimer: Utah State University states: "It is understood that the publication of this data does not constitute an endorsement by the University of any of the products tested."*

**Erosion Control**: This test indicated that the two hydrocompost formulations resulted in lower soil erosion rates than the two MFP applications. Hydrocompost Formula 2 produced the lowest average soil erosion rate of the four products tested, at an average rate of 23.88 pounds/hour. Hydrocompost Formula 1 performed better than Formula 2 in two of the three tests, but had a slightly higher average erosion rate, at 25.61 pounds/hour. The MFP applied at 2200 lb/acre resulted in somewhat higher average erosion rate (31.16 lb/hr) and finally, the MFP at 1800 lb/acre had the worst performance on average (36.07 lb/hr) and for all single data points.

**Runoff:** The average water runoff rates for the two hydrocompost formulas were higher than the MFP applications. Interestingly, in the June test, both hydrocompost formulas yielded less runoff than both MFP applications, as shown in Figure 6 below, while the December tests showed that the MFP applications performed much better than the hydrocompost formulations in retaining water. The reason for the much poorer performance of the MFP for December as opposed to June is unknown.

The hydrocompost had more water runoff but less erosion. Better performance of the MFP with respect to runoff may be attributable to the guar content which may have absorbed more water.

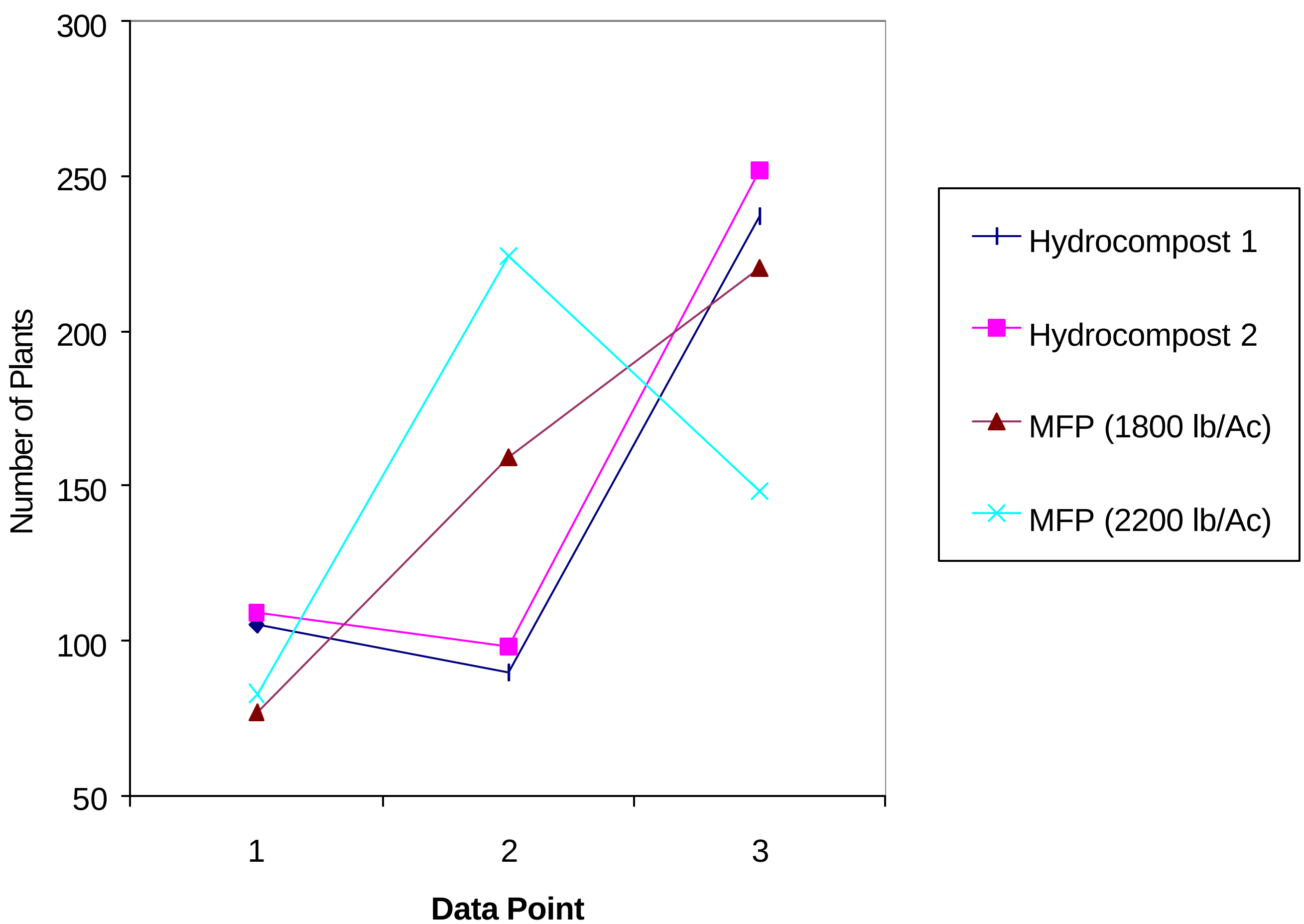
**Figure 6: Runoff for Individual Tests**



**Plant Height**: Plant height growth results are comparable for all four hydroseeding applications, with the hydrocompost formulas producing slightly taller plants. The difference in average plant height among the four materials tested is negligible. This data should be considered along with the plant quantity and dry weight before drawing any conclusions on biomass production.

**Plant Quantity:** (Also refer to the germination rate discussion below when evaluating plant yields.) The plant quantity data show a fairly wide spread for plant counts. The two hydrocompost formulations produced very similar results when individual data points are compared (Figure 7).

**Figure 7: Quantity of Plants in Sample**



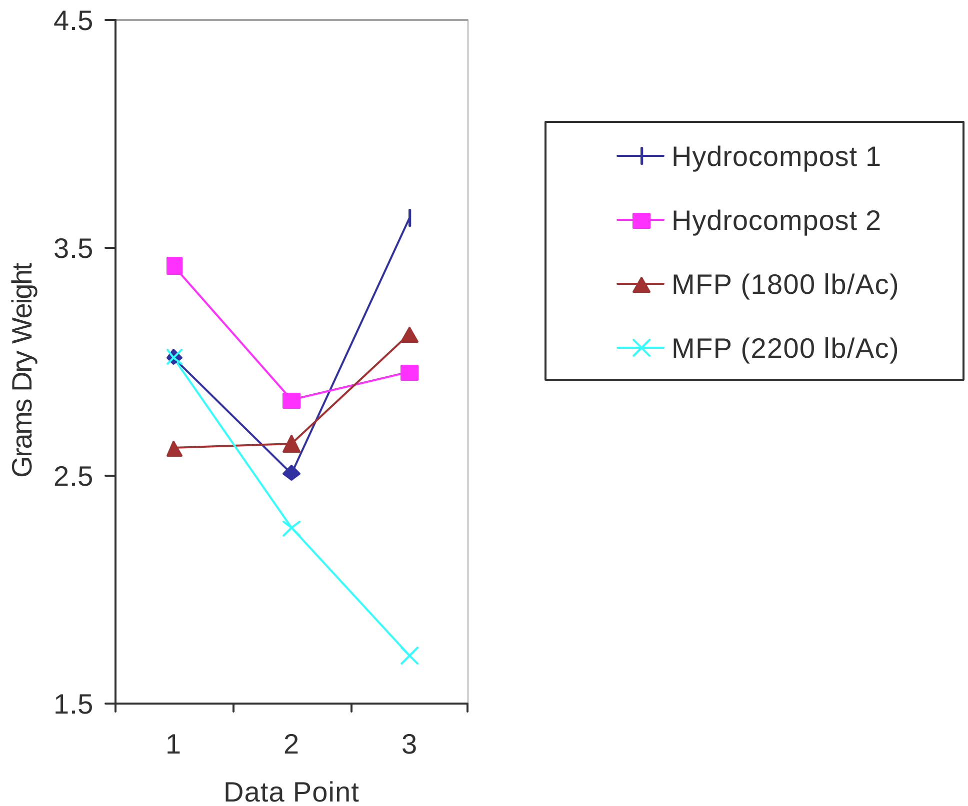
When plant counts are averaged, for all tests, the hydrocompost and MFP appeared to perform similarly, with hydrocompost formula 1 producing the lowest average yield as shown in these composite sample averages:

- Average for Hydrocompost Formula 1 144
- Average for Hydrocompost Formula 2 153
- Average for MFP (1800 lb/acre) 152
- Average for MFP (2200 lb/acre) 152

**Dry Weight of Biomass Sampled:** Hydrocompost formula 2 produced the highest average dry plant weight per sample (3.07 gm), followed closely by hydrocompost formula 1 (3.05 gm). The MFP products produced lower average dry weight at 2.79 grams for the 1800 lb/acre application rate and 2.33 grams for the 2200 lb/acre application rate. It was not determined what caused the lower biomass growth in the higher application rate of the MFP product. When single data points are evaluated, as in Figure 8, all products appear to perform similarly for the first two data points (June test), and on the third point (December test), the hydrocompost formula 1 and the MFP (2200 lb/acre) show significant spread. Again, additional testing is required to draw statistical conclusions from this data.

**Germination:** The hydrocompost products provided significantly better germination performance than the MFP applications. Hydrocompost formula 2 yielded the highest average germination rate and the lowest percentage of lost seed, followed closely by hydrocompost formula. These results indicate that the hydrocompost does provide better germination than wood fiber mulch, likely attributable to the nutrient content of the compost. The percentage of non-germinating seed was similar for all four products.

**Figure 8: Dry Weight of Plant Matter Sample**




## 3.1 Compost Analysis

Since the two primary ingredients in the hydrocompost formulation, compost and recovered paper or wood mulch, are derived from non-homogeneous, constantly changing feedstock, the characteristics of either can change from batch to batch or supplier to supplier. This variability may be an issue in developing and adhering to specifications or developing an MSDS for the compost (and/or mulch) to be used in the hydrocompost. Development of an MSDS was attempted, hoping that the baseline information on the batch used in this project could be used to compare future batches or lots of hydrocompost. However, due to the inherent variation in compost products, the different feedstocks, and the different processing methods, an MSDS for one batch of compost may become quickly obsolete for the next batch.

Variability in the compost can be minimized by establishing a stable compost supplier who uses consistent ratios of feedstock inputs, and blends the final compost product on a large scale. Likewise, a paper or wood mulch supplier could minimize variability by using feedstocks from the same generators and mixing on a large-scale basis.

Despite batch-to-batch variations, the compost used in this project was tested in an attempt to characterize the compost product for optimizing hydrocompost formulations, and develop baseline information on the desired properties for compost to be used in this type of application. The Soil Control Lab in Watsonville, California conducted various index tests on samples from the batch of compost used in this project. In addition, a test kit for compost maturity, from the WoodsEnd laboratory in Maine, called the Solvita test, was used to determine compost maturity for the compost product used in these trials. The results and conclusions are presented and discussed herein.

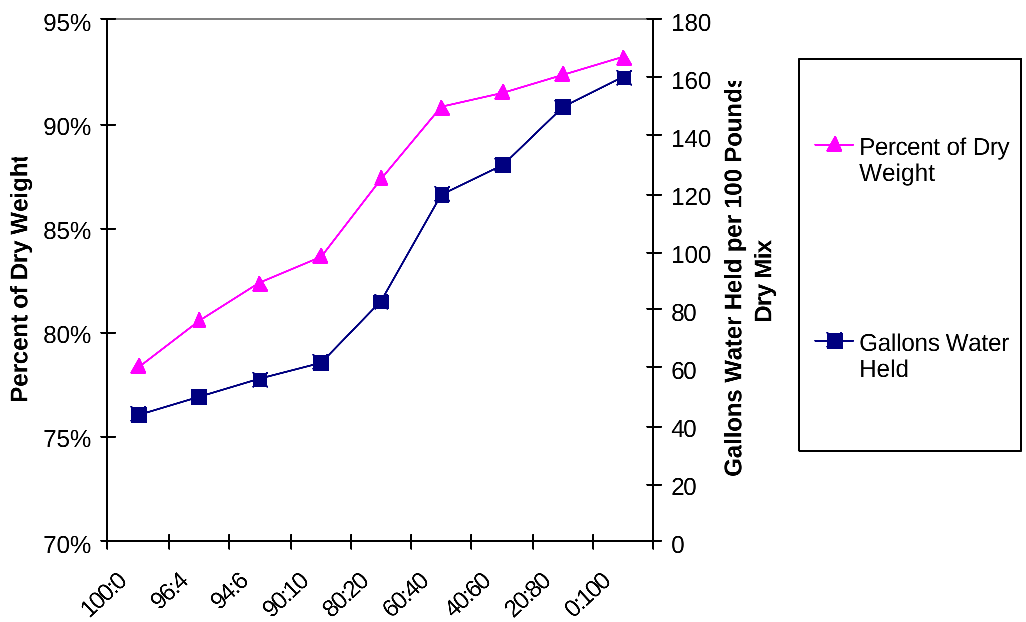
**Water Holding Capacity:** Water holding capacity (WHC) is the ability of a compost/mulch mixture to hold water, and is usually measured as a percent of dry weight, and in this case, also in gallons of water held per 100 pounds dry mix. Higher WHC correlates to greater potential benefit of reducing the gross water requirements for irrigation of the plants or crop[1].

Several different test methods for WHC of compost/mulch materials are currently used in the industry with some reported inconsistency in results between the various tests. The American Society for Testing Methods (ASTM) is currently developing a new WHC test that will help standardize this metric.

The WHC results for various ratios of compost to mulch product, from the same batch of mulch and compost used in the field and USU trials, are shown in Figure 9. The left axis shows the WHC as a percent of dry weight value and the right axis showing the corresponding gallons of water held per 100 pounds of dry mix. The test indicates that the higher the mulch content, the better the water holding capacity. The WHC of the compost (78.4%) fell in the low end of the typical WHC range for compost (75 to 200%) per the Field Guide to Compost Use[1].

The mixture of 75:25 compost to mulch (as used in the field trials for this project), if interpolated from this data, yields a WHC of nearly 85% of dry weight, or roughly 90 gallons of water per 100 pounds of dry mix. This equates to a water holding capacity of 7.5 times its own dry weight.

**Figure 9: Water Holding Capacity**




**Moisture Content:** Moisture content is the amount of water in a product, and is measured as a percent of total solids. A good compost needs to have at least 40% during the composting process, but when the compost is mature, the moisture content is less important. For compost, moisture affects bulk density (and therefore transportation costs) and product handling. Compost that is dryer is lighter and less expensive to transport; yet if too dry, it may produce potentially harmful airborne dust. Compost that is too wet is heavy, clumpy, more expensive to transport, and more difficult to apply.

There is ongoing debate about the optimum moisture content of processed compost. The Field Guide to Compost Use recommends 40 to 50% moisture as ideal for product handling, but states that compost moisture typically ranges from 30 to 60% moisture[1]. For mixing and transportation of the hydrocompost application, moisture content below 25% is best. The moisture content of the compost product used in these trials, as received at the test lab, was found to be 40.5%.

**Other Properties.** The results of the nutrient analysis on the compost follow in Table 6. The electrical conductivity (EC), which is a measure of the salinity (or soluble salt concentration), was also tested. The compost used in these tests was derived from dairy manure, which commonly has higher salinity than some other composts with different feedstocks.

Most seed planted directly in the media – as in the case of hydroseeding – should have an EC of < 500 per the Soil Control Lab. Some plants/seeds do have a higher salinity tolerance than others. This compost had a (dry weight) EC of 6700 μmhos/cm, and the mulch had a (dry weight) EC of 1413 μmhos/cm. Note that the EC of the product used in the field will be lower due to dilution from the water content, and some of the soluble salt will leach out through drainage. When used for turf seed, and mixed with the mulch and water, however, the EC of 6700 μmhos/cm for this compost is not considered to be a concern.

**Table 6: Chemical Analysis of Compost**
**(*Industry Rating for Quality: A = Good B = Average C = Caution)**

| Properties | Quality Rating*[2] |
|---|---|
| Nutrients (N, $P_2O_5$, $K_2O$) | B |
| Organic:Ash | A |
| C:N Ratio | B |
| pH | C |
| AgIndex (Nutrients /[Na + Cl]) | B |
| Total Dissolved Salts | B |
| Calcium:Magnesium Ratio | A |
| Carbonate | A |

**Compost Maturity.** Compost maturity with respect to use of compost in a hydroseeding product is very important because compost that has not cured adequately (i.e., not yet mature), may inhibit or delay germination, causing seed or plant damage, and/or death[1]. Some laboratories have found that maturity testing is best done by actually allowing seeds to germinate and grow, however, growth tests can take up a few months for conclusive results.

For this project, the *Solvita Test* (developed by the Woods End Laboratory in Maine) was used to evaluate compost maturity. (The *Solvita test* can be purchased as a kit, and provides a safe and simple method for four to six-hour field testing for compost maturity. The test actually measures soil biological respiration by a patented colormetric CO2-Gel technology in a safe and easy-to-use test process).

This test was conducted several times, by different entities, on the same batch of compost. Each test yielded different results. The test conducted by CalTrans in California, indicated that the compost failed the maturity test, while the tests conducted by Hamilton and Woods End Laboratory in Maine indicated the same batch of compost passed. Following the results at CalTrans, Hamilton Manufacturing work with CalTrans (California) on a consistent method of using the *Solvita test* kit, and proved that the compost did pass the maturity test. Therefore, even this simple field kit can provide varying results.

**Heavy Metal Content.** The results of the heavy metals analysis on the compost follow in Table 7. The results show that all the heavy metals in this compost were well below the EPA 503 concentrations for Sewage Sludge Regulations Limits.

**Table 7: Heavy Metal Content**

| Constituents | **Parts per Million (mg/kg)** (Dry Weight) | **EPA 503 Pollutant Concentration Limit (mg/kg)** (for Exceptional Quality Bulk Biosolids) |
|---|---|---|
| Arsenic | 0.99 | 41 |
| Cadmium | 0.57 | 39 |
| Chromium | 183 | - |
| Copper | 377 | 1500 |
| Lead | 7.5 | 300 |
| Mercury | <0.001 | 17 |
| Molybdenum | 133 | - |
| Nickel | 5.7 | 420 |
| Selenium | 2.3 | 100 |
| Zinc | 244 | 2800 |

**Physical Properties.** The compost used in these tests was determined to have 0.51 g/cc bulk density as received (861.7 pounds/cubic yard) and 0.30 g/cc dry weight (506.9 pounds/cubic yard). For compost, a measurement of bulk density less than 0.35 g/cc indicates mostly organic content, while 0.35 to 0.g/cc indicates a mix of mineral and organic, and greater than 0.60 indicates mostly mineral content[2].

The Field Guide to Compost Use[1] states that the preferred range of bulk density for various compost applications under average field conditions is 800 to 1000 pounds per cubic yard, and the typical range is 700 to 1200 pounds per cubic yard. Thus, the compost used in this project (as received) falls in the preferred range for most applications. The bulk density of the compost combined with the mulch was not tested.

### 3.2 Cost Comparison

A rudimentary cost and performance comparison was produced from results gathered during several erosion control tests at Utah State University, on different hydroseeding products. The cost data were compiled in late 1997 and may no longer be current. The results are presented in Table 7 below and are considered to be indicative only due to the limited number of test replications on each product.

## Table 8: Erosion Control Performance and Cost Comparison

| Material | Application Loading *(Lbs/acre) | Water Runoff (gal/hr) | Sediment (lbs/hr) | Plant Height (cm) | Plant Matter (Dry Weight in grams) | Germination Rate | Number of Plants | Material Cost (*per ton??)* |
|---|---|---|---|---|---|---|---|---|
| **Hydrocompost Formula 1** | 4,000 | 62.01 | 24.98 | 17.01 | 3.22 | 75 | 49 | $265 |
| **Hydrocompost Formula 2** | 4,000 | 55.08 | 24.78 | 17.03 | 3.29 | 79.62 | 52 | $265 |
| **Mat Fiber Plus** | 1,800 | 63.38 | 43.33 | 16.94 | 2.83 | 58.23 | 38.5 | $261 |
| **Mat Fiber Plus** | 2,200 | 61.80 | 31.39 | 17.58 | 2.51 | 63.85 | 41 | $319 |
| **Silva Fiber** | 2,000 | 87.66 | 70.4 | 13.27 | 1.83 | 40.61 | 5 | N/A |
| **Nature's Own (Mulch Hydroseeding Product)** | 2,000 | 84.88 | 107.73 | 12.39 | 1.2 | 26.06 | | $235 |
| **Conwed** | 3,000 | 38.11 | 8.17 | 16.99 | 3.29 | 49.19 | | $1,350 |
| **Soil Guard** | 3,500 | 9.15 | 0.119 | 16.53 | 4.05 | 62.93 | | $1,405 |

[1] Field Guide to Compost Use. The Composting Council. 1996.
[2] Test Results from Soil Control Lab, A Division of Control Laboratories, Inc. Watsonville, CA. 1999.