DISCLAIMER

This project was conducted with financial assistance from a grant from the Metropolitan Water District of Southern California (Metropolitan), the U.S. Bureau of Reclamation, the Central Arizona Project, and the Southern Nevada Water Authority through Metropolitan's Innovative Conservation Program (ICP). The ICP provides funding for research to help document water savings and reliability of innovative water savings devices, technologies, and strategies. The findings of this project, summarized in this report, are solely from the project proponent.

Metropolitan and the ICP funding partners do not endorse any particular product, service, or company, including those discussed in this report. The information provided within this report is not certified by Metropolitan and any party referencing this report should verify information as needed for its own purpose.

Executive Summary of Final Results
Metropolitan Water District - Innovative Conservation Program

Title: G3 Soil Food Web Project: Water Conservation Effects of AACT Applied to Turf

FROM: Green Gardens Group [Pamela Berstler: CEO]
149 S. Barrington Ave. Suite 758, Los Angeles, CA 90049
Tel: (310) 649-8351 Email: Info@GreenGardensGroup.com

TO: The Metropolitan Water District of Southern California
Attn: Marcia Ferreria - Ref: AGREEMENT NO. 143539

Participants:
Metropolitan Water District of Southern California
Las Virgenes Water District
City of Santa Monica
City of Calabasas

September 2015

TRIAL PERIOD: MAY 13, 2014 – AUGUST 14, 2015

G3 SoilFoodWeb Project Final Report

1. Project Background and Objectives

In the midst of this historic drought, landscaping strategies on a large scale must change in order to achieve the necessary water reductions in Los Angeles, and the entire Southwest. Cities and states are increasingly pressured to shift their physical landscapes from water-intensive to drought-tolerant, which can be challenging with turf-grass dominating the landscapes of many cities in the region. Removing and replacing large areas of turf with drought-tolerant substitutes can be expensive, and can decrease valuable open space for recreation. Reducing the amount of water in turf-covered areas is key to decreasing outdoor water-use, and Green Gardens Group is exploring some of these possible reduction solutions.

Hypothesis: Our hypothesis for this project was that the professional application of tested qualified, and "standardized" Actively Aerated Compost Tea (AACT) to street median turf areas on a monthly or quarterly basis will result in improved infiltration and tilth, greater carbon sequestration, and improved soil moisture content, which allows irrigation managers to reduce applied water without compromising the appearance of the turf as measured by the National Turf Evaluation Procedures (NTEP).

If our hypothesis contributes significantly to the reduction of applied water on public turf areas, then the results may be extrapolated to any irrigated landscaped area, reducing water use, fertilizer applications, necessity of aeration and dethatching, and the subsequent reduction in maintenance labor hours. This would lead to more research on increasing soil health and biology as a potential solution to decreasing water use on landscapes.

Research Objective: Our primary objective of this research was to find water reduction solutions in publicly managed landscaped areas, with the added benefits of potentially reducing time, costs, and other resources associated with urban landscaping.

This project also explores the incredibly important link between soil science and sustainable landscapes. Our project, along with any further research that expands our methods, can be used to explore correlations between the levels of biological activity within our soils, and the relative amount of maintenance and human intervention needed to sustain our public landscapes.

2. Experimental design

The G3 SoilFoodWeb Project had an initial experimental design with two different studied sites, each with separate control and experimental groups. The proposed experimental design consisted of the following steps:

1. The G3 SoilFoodWeb Project was to be conducted over 19 months from April 2014 through November 2015. Analysis and final reported to be concluded by June 2016. This experiment began later than expected, in August of 2014, and ended prematurely in April of 2015 due to a number of issues that will be described in following sections.
2. Contracts and liability waivers were completed and signed by April 30, 2014. Compost tea applications and data gathering commenced on May 1, 2014.
3. Three median plots had been identified in Santa Monica (Site 1 at 4th & Montana) and three median plots had been identified in Calabasas (Site 2):
   - One plot and each site will be control (1A & 2A).
   - One plot on each site will receive applications of AACT on a quarterly basis (1B & 2B).
   - One plot on each site will receive applications of AACT on a monthly basis (1C & 2C).
4. Only the AACT application crew, CompostTeana, and the project designer knew which plots were receiving AACT and on what schedule. All other involved parties were only informed of the project, and specific duties related to running the experiment.
5. A plot plan with irrigation layout was prepared for each plot. Each plot had only one irrigation zone.
6. An irrigation audit was conducted for the one irrigation zone in each plot, and the irrigation was tuned to maximize efficiency. The results of the audit and the tuning were recorded. This process established a baseline distribution uniformity of each plot.
7. Each irrigation zone (6 total) was metered in order to record actual water application. The irrigation controller was turned to manual operation for each of these valves.

8. An Evapotranspiration (ET)-based irrigation schedule was created as a baseline for the projects. Irrigation schedule of the control plots (1A/2A) was based upon a fixed percentage of Real Time ET.
9. The quality of the turf in each plot was documented and described using NTEP standards. Both sites were described as acceptable by the respective City representatives. The first description became the baseline description to which the appearance of the turf was compared in subsequent site visits. The minimally accepted quality was established by the City representatives and described relative to the baseline.
10. A description of the maintenance procedures for the turf was documented, which only permitted mowing on each plot (control and experimental) for the duration of this project. Maintenance crews were not informed of which plots were used as control or experimental groups, and every plot was expected to receive the same amount or mowing maintenance.
11. Soil samples were taken at each plot to establish a baseline for the following:
    a. Soil type, structure, infiltration, moisture content, biological diversity and activity, fertility and any other results deemed necessary by Dr. Elaine Ingham, the project's SoilFoodWeb scientific advisor.
12. A one-hour orientation for all agency, maintenance, and other stakeholders involved in the project may be conducted at each site to share the intent of the project and answer any questions of staff or contractors.
13. Dr. Ingham worked with G3 to determine verifiable, consistent AACT standards that can be documented with photographs so that each application has substantially the same quality and content. These standards became the G3 SFW AACT Standards.
14. Each month during the 18 months, at a regularly scheduled time and day, G3's compost tea brewing contractor, CompostTeana, visited both sites and thoroughly sprayed G3 SFW AACT on plots 1C/2C. CompostTeana documented the temperature, weather conditions, and any unusual observations with photographs. CompostTeana also documented the quality of the G3 SFW AACT with photographs and notes.
15. Each quarter during the 18 months, at a regularly scheduled time and day, CompostTeana visited both sites and thoroughly sprayed G3 SFW AACT on plots 1B/2B. All temperature, weather conditions and unusual observations were documented with photographs. CompostTeana also documented the quality of the G3 SFW AACT with photographs and notes.
16. Each week during the 18 months, at a regularly scheduled time and day other than the day of CompostTeana visit, G3's biologist visited both sites and recorded the results of collected data and visual observations. The temperature, weather conditions, and appearance of the plots were documented with photographs. Any unusual observations were documented with photographs. The general appearance of each plot was observed and photographed. The overall appearance of the plot was determined by an average of the appearance samples from 3-4 pre-determined areas on the plot.
17. Each quarter during the 18 months, at a regularly scheduled time and date,

the biologist visited both sites and collected all soil samples necessary to determine any deviation from the soil baseline. Any unusual observations, temperature and weather conditions were documented and photographed.

18. In collaboration with the Water Conservation Specialists at Las Virgenes MWD (Scott Harris) and the City of Santa Monica (Russell Ackerman), the biologist documented the proposed changes in irrigation (as a % of ET) on the AACT plots (1B/2B & 1C/2C). These changes were made to the irrigation controller by Scott Harris and Russell Ackerman at their respective sites. Irrigation was not reduced after a minimal acceptable appearance of each test plot (1B/2B & 1C/2C) in comparison with the baseline.
19. Reporting and analysis was conducted continuously as data was added. A final report was to be generated by June 2016 to receive the final payment on the grant. The final report and any unusual quarterly reports was to be reviewed with Dr. Ingham.

This experimental design was set up to find out enough about the turf, soil, and water use in each plot to determine the validity of our hypothesis. However, there were several challenges that made this study increasingly difficult to follow the design plan. The two sites in Santa Monica and Calabasas both had specific issues, which forced G3 to end the project prematurely, and to make any conclusions we can with the data we were able to gather.

3. Challenges

Test Area Groundcover Uniformity: The main challenges throughout the project, revolved around the consistency and groundcover uniformity of the test areas. Finding comparable study areas in Santa Monica and Calabasas was difficult, and held up the start of the project.

It was especially difficult to find three comparable-enough plots within the Calabasas site. In order to proceed with the study, after a significant delay in finding our test sites, each participating entity agreed to use Site 1 in Santa Monica, a median with three plots of high groundcover uniformity. The less ideal site was also decided to be Site 2 in Calabasas, a parkway (not a median) with far less microclimate and groundcover uniformity, width of study area, water application rates, and competing plant matter in addition to turf. This Calabasas site was the only area that was available to use for this study, and for the sake of continuing with the project, the lack of uniformity had to be noted and accepted.

Technical Issues: Getting the project started became even more challenging after deciding where to do the study, due to technical issues on each site. At both sites, there was a lot of trouble contracting to get the irrigation controllers and irrigation sub-meters installed (the installations were relatively small, conducted on public sites, required approvals). This postponed the start of the project. The irrigation began to be adjusted in March of 2014, and the data collection of the project did not begin until August of 2014.

Finding a quality compost source in the Los Angeles was difficult, and necessitated the shipping of compost from Northern California, which resulted in increased costs. The AACT applicaton team worked with Las Virgenes MWD to try to build a satisfactory pile, but this was not achieved by the time the study was terminated. The pile was generally anaerobic and more bacterially dominated.

Only high quality (Good or Excellent) compost tea was applied to the sites. The size of the sites was supposed to be only 1,500 sq. ft., which was easily achieved in Santa Monica. One of the test plots in Calabasas was almost 6,000 sq. ft. As a result, more compost tea needed to be brewed and applied, increasing costs.

Communication and Quality Control: A major hindrance to the overall success of the project also became the ongoing communication with the different project stakeholders. For example, G3 had direct contact with both the maintenance and conservation staff at the City of Santa Monica. However, in Calabasas, the City would only talk directly to Las Virgenes WMD conservation staff. Santa Monica had a clear view of what was considered minimum turf quality, while Calabasas did not. This issue was exacerbated by the variation in groundcover uniformity in Calabasas; a fact that only became apparent after the study was underway. The baseline for turf quality, which sets the lower limit to turf appearance before ending scheduled water-use decreases, was not clearly defined and communicated to everyone involved in Calabasas. Las Virgenes MWD was forced to increase water use on study plots only after finding moisture deficits. The problem could have been rectified with more consistent stakeholder meetings in Calabasas.

Maintenance: Other key issues that affected the integrity of the study involved maintenance. In the experimental design plan, we had planned to have each plot discontinue all maintenance practices besides regular mowing. The lack of direct communication between Calabasas and G3 was evidenced by apparent application of fertilizer and possibly other substances like pesticides and herbicides. The ACCT Application crew observed pellets at some of the Calabasas plots. The exact information regarding these applications is unknown, and would have been done by maintenance crews who were not appropriately informed about the needed conditions for these sites.

CA Governor's Order: There were some significant challenges led to the early termination of this project. Specifically, on April 1, 2015, CA Governor, Jerry Brown, ordered the cessation of all irrigation on public medians. Pursuant to this order, the City of Santa Monica cancelled its contract with G3 on April 16, 2015 and rescinded authorization to perform work on the median properties. The testing was ended in Calabasas as of June 1, 2015. After discussing this issue with MWD, we decided that the study must end early, due to lack of water resources allotted for the Santa Monica site.

4. Results

The turf appearance at each site was rated on a scale of one to ten, with one representing the lowest quality appearance, and ten representing the highest quality appearance. Both sites were rated an eight or nine on this scale, prior to conducting the study. By creating a baseline turf quality, through taking the average turf quality of each site, we set the minimum turf appearance that is acceptable throughout the project. If a plot on a site reached the minimum acceptable appearance quality, reductions in water-use would discontinue until the turf quality increases above the minimum standard. Over time, the turf quality was expected to decrease, as the water applied to each plot decreases. The application of AACT in the experimental plots 1B, 1C, 2B, and 2C was expected to yield a slower rate of quality loss due to improved soil biology and subsequent increase in water retention.

5. Summary

This research is inconclusive. However, preliminary results seem to reinforce the hypothesis that applications of AACT on turf increases water retention in the soil, by stimulating soil biology. When examining the data collected from Site 1 in Santa Monica, we see that the average turf appearance over time decreased the least in the two plots, which had regular applications of AACT. This data suggests that the difference between quarterly and monthly applications of AACT on turf is minimal, and that quarterly applications may actually be more appropriate, given the recorded high-quality turf appearances of plot 1B.

Data from Site 1 also suggests that applications of AACT correlates with increased root depth of turf in both of the experimental plots. Here, the higher application of AACT (monthly application in plot 1C) yields the largest root depth increase. Increased root depth can be related to increased soil health, where moisture is retained through increased soil biology.

Due to the excessive unplanned variables in this project, we have learned the importance of having uniform experimental sites. Establishing ongoing turf quality was difficult and inconsistent at the Calabasas site, largely as a result of the poor site selection and the relatively unengaged City. The site selection in Santa Monica was the result of an engaged City with clear ideas about how to conduct the study. The result was that the Santa Monica sites were more uniform, a contribution to the significantly more clear results from Santa Monica.

Working with different agencies and municipalities was difficult, as there were many different people acting to manipulate the experiment in some way. For future studies, we recommend limiting the interactions of projects like this to a single team, who have meetings regularly to go over goals and procedures of each section of the experiment. The experimental plan will work much better in a more uniform and easily manipulated setting. A great deal of research still needs to be done, and we recommend that the research be conducted through universities, where the test sites are not on university test plots, but remain in the field.

6. Figures and Appendix

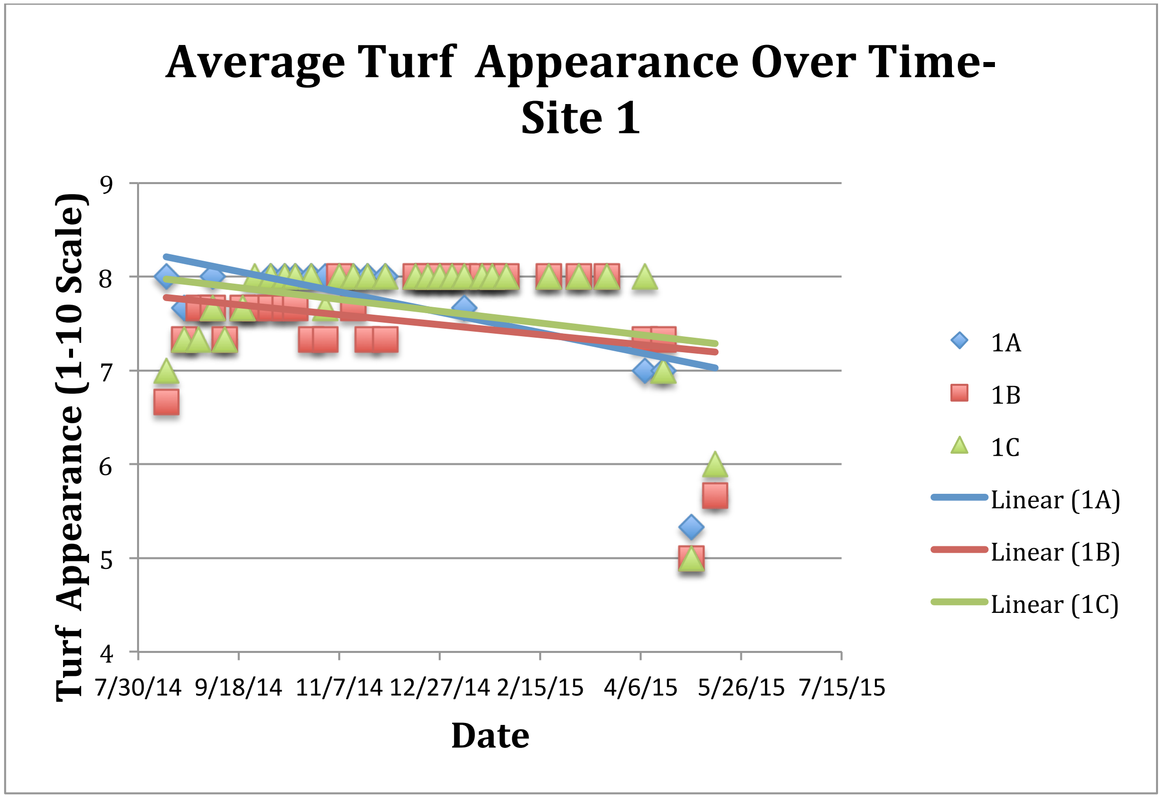

Fig: 1a: Data from Site 1 in Santa Monica seems to show clear evidence of this hypothesis. The control plot 1A (without an AACT application) decreased the fastest in turf appearance over time. Plot 1B (with quarterly AACT applications) actually seemed to perform the best overall, by decreasing the slowest over time. Plot 1C (monthly AACT applications) performed almost as well as plot 1B, but turf appearance did decrease slightly faster. This data implies that the AACT applications may have encouraged soil biology and moisture retention, supporting the hypothesis that AACT applications to landscapes and turf may reduce water requirement.

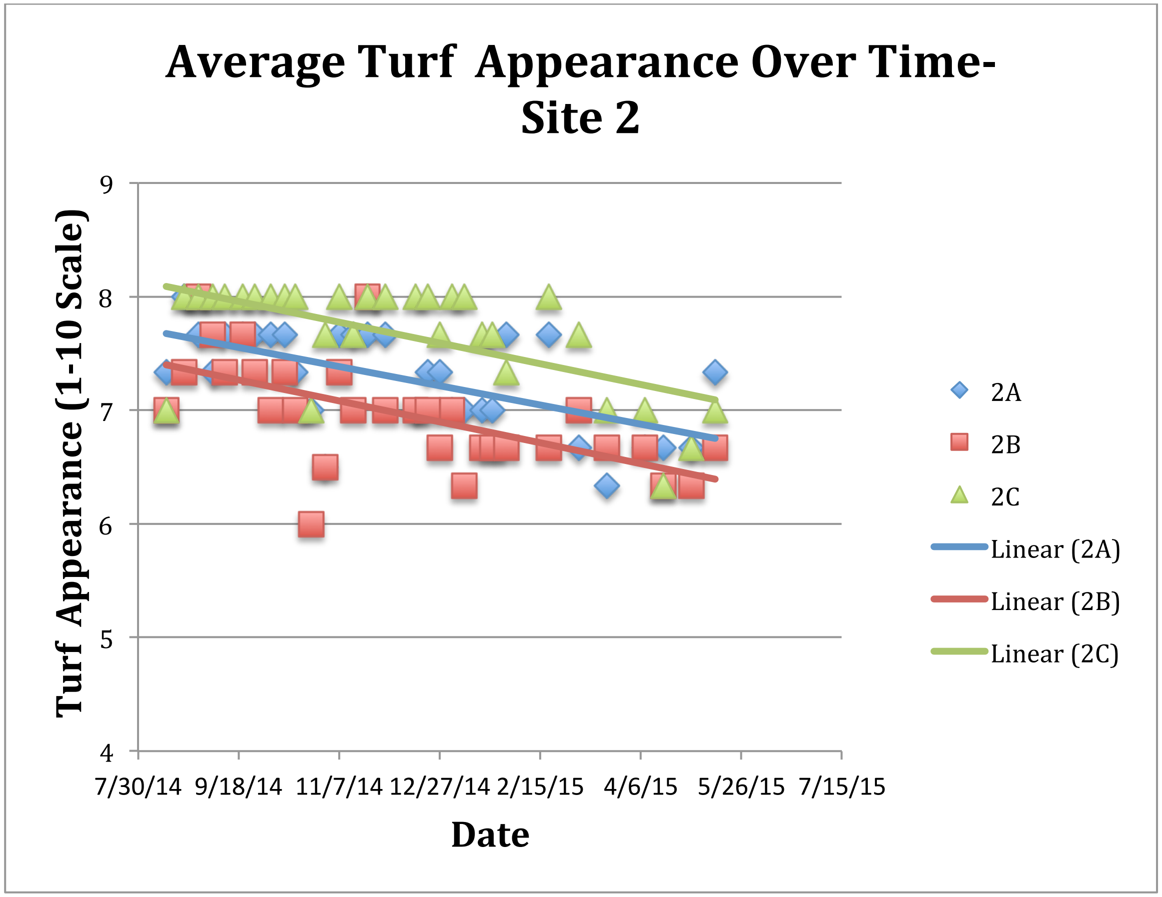

Fig: 1b: Data from Site 2 in Calabasas is quite different, which was expected due to the challenges associated with the site. The turf appearance at all three plots on this site seems to have decreased in quality at the same rate. However, there was too much inconsistency between plots on the site to consider this data completely valid. The conflicting microclimates and other factors discussed in the text, make the data from Site 2 difficult to compare to the data from Site 1, which had more uniform conditions.

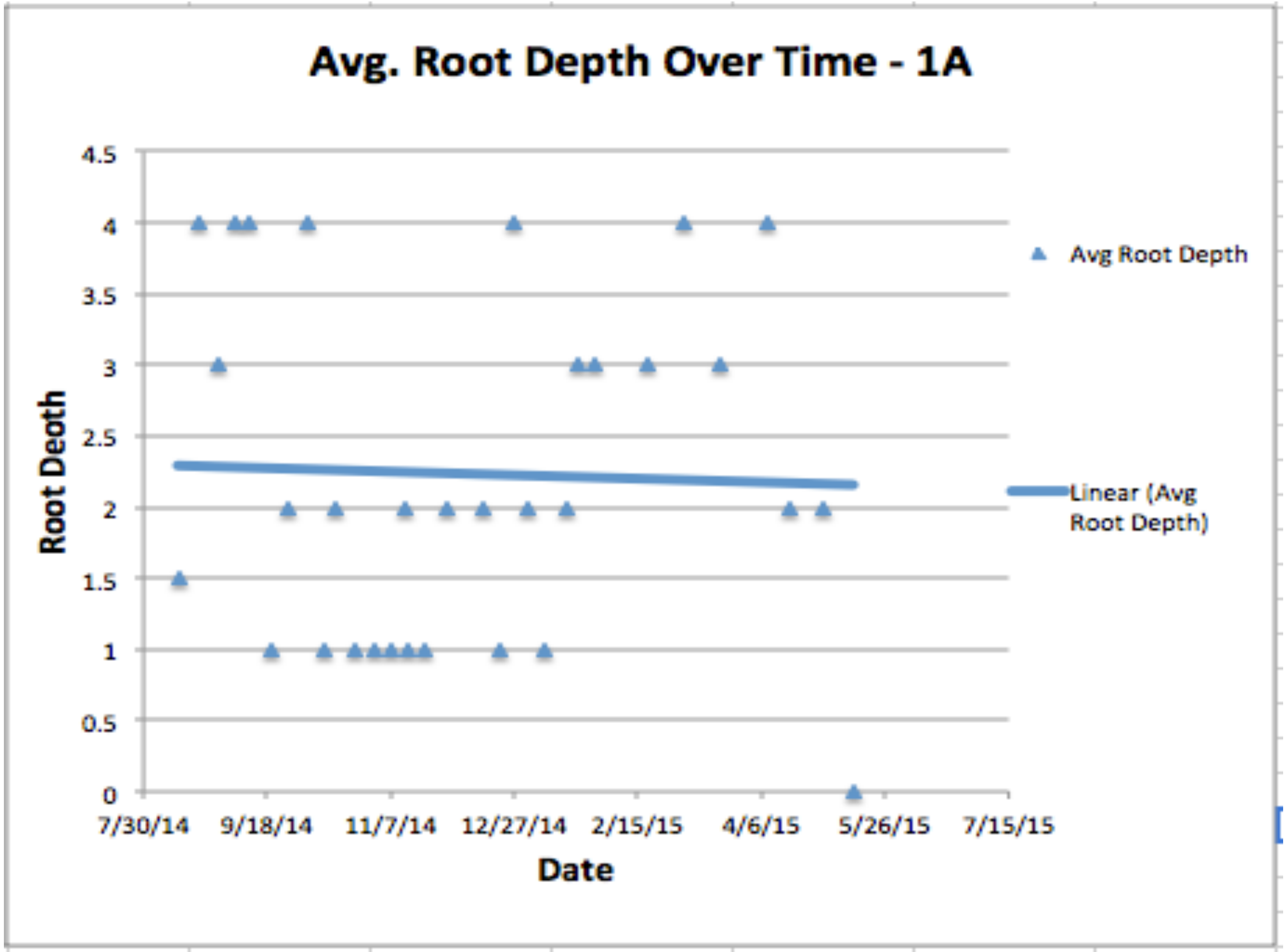

Fig. 2a: The root depth data that was gathered at each site yields similar results the turf appearance data, in that we found Site 1 in Santa Monica to have data that is more consistent with our hypothesis. Again, because the conditions of Site 1 were far more controlled, the data from Site 1 is more reliable. We looked at the root depth of turf grass over time for both sites, where three samples were taken at each plot. In the following graphs, we show data for each plot individually, where the three trend-lines represent data from the three different samples on each plot.

Plot 1A serves as a baseline for root depth data in Santa Monica, as it was the control group on this site, with no applications of AACT. The data shows the average of three samples taken at each sample period. In the graph above, the data shows a slightly decreasing root depth over time in the control plot 1A.

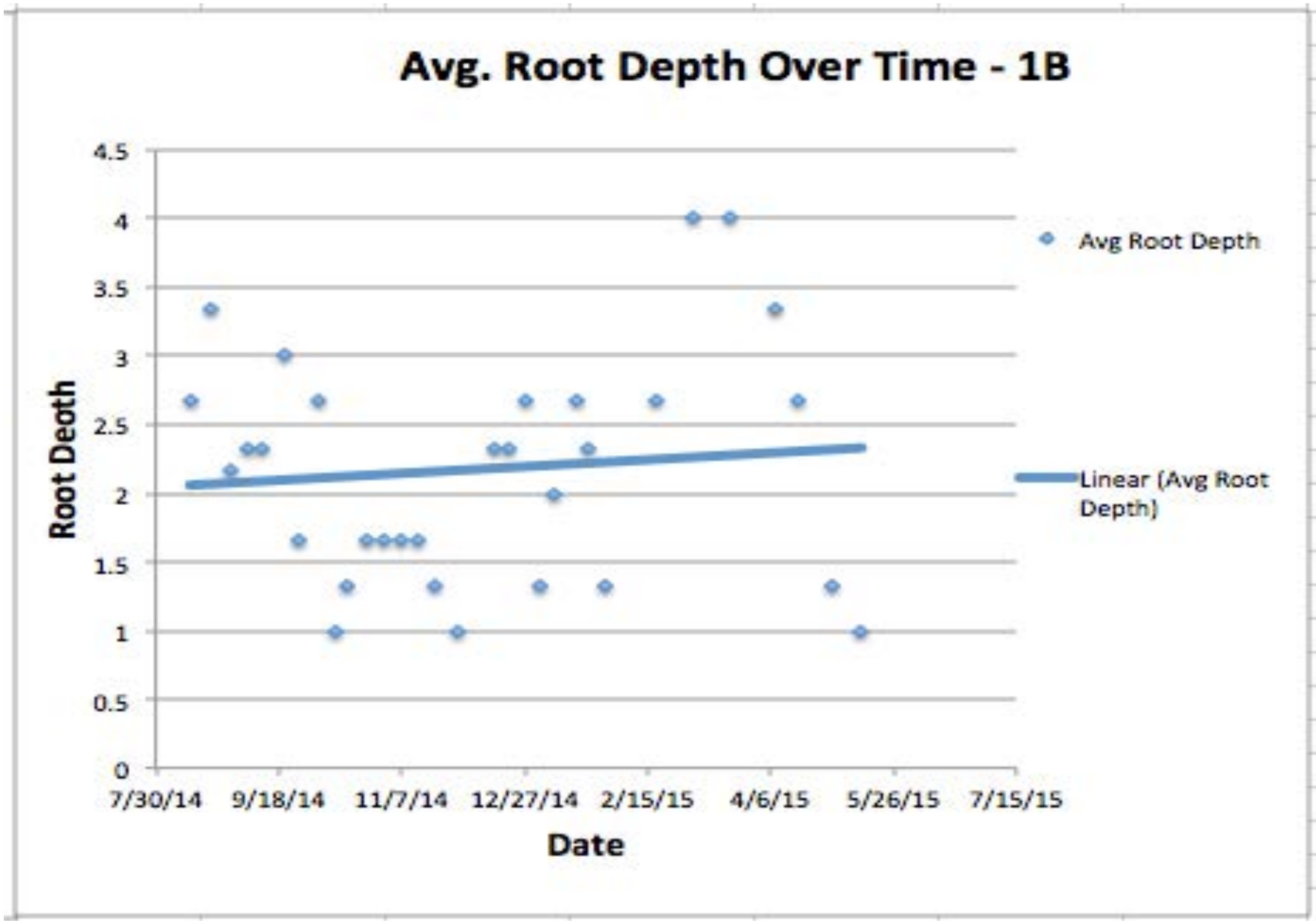

Fig. 2b: Plot 1B received quarterly applications of AACT, and show significant differences from plot 1A. The average root depth over time went from a downward trend to an upward trend with these quarterly applications of AACT, where root depths are increasing.

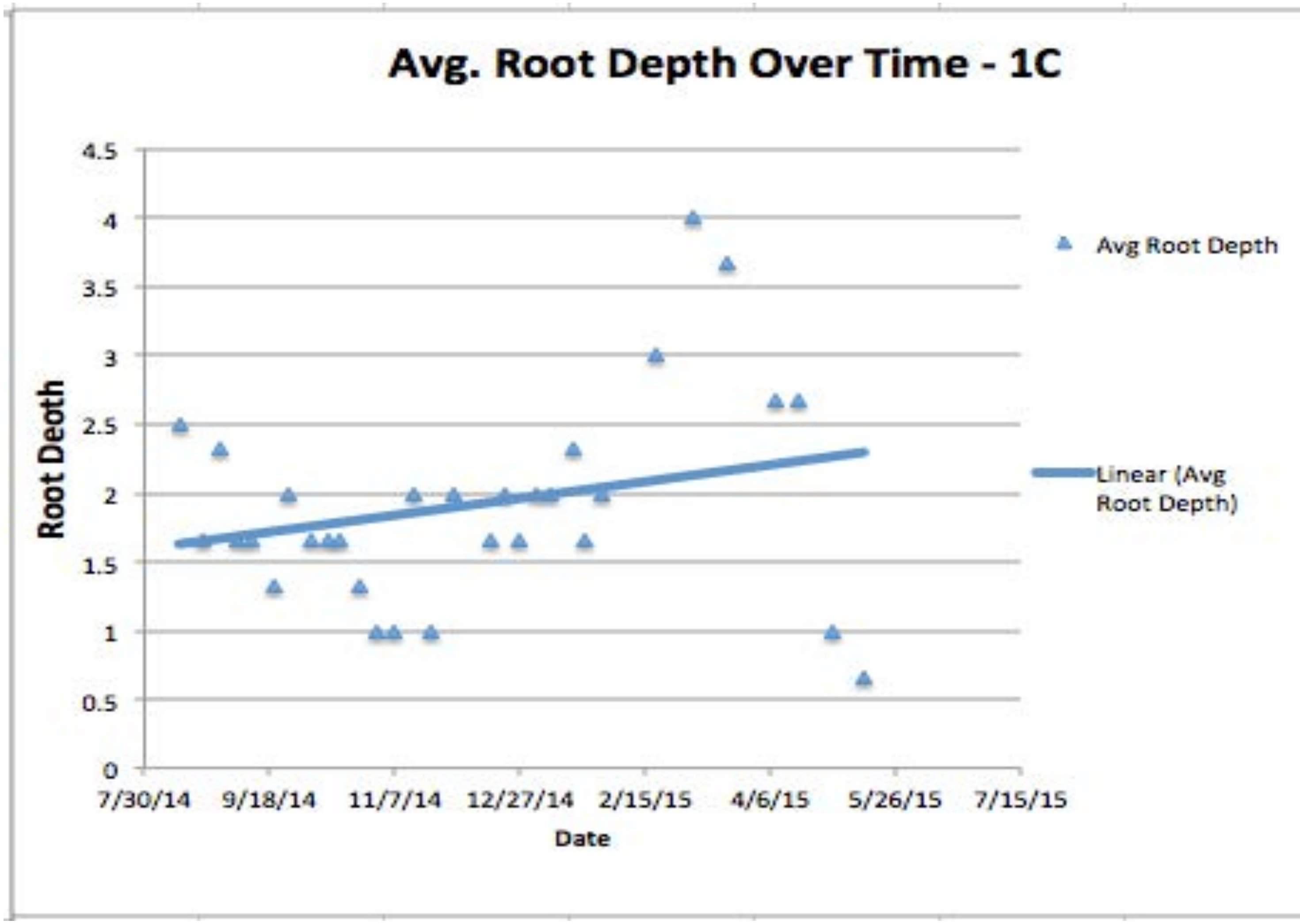

Fig. 2c: Plot 1C received monthly applications of AACT and showed even larger increases in root depth, compared to both plots 1A, and 1B. This plot had an even larger increase in root depth from the beginning of the study through the end. An important note is that this plot started with a particular short average root depth compared to the other plots, so there may have been more room to grow, as each plot seems to have a maximum average root depth of 2.5 inches. However, this plot with the highest application of AACT does yield the largest change in root depth over time.

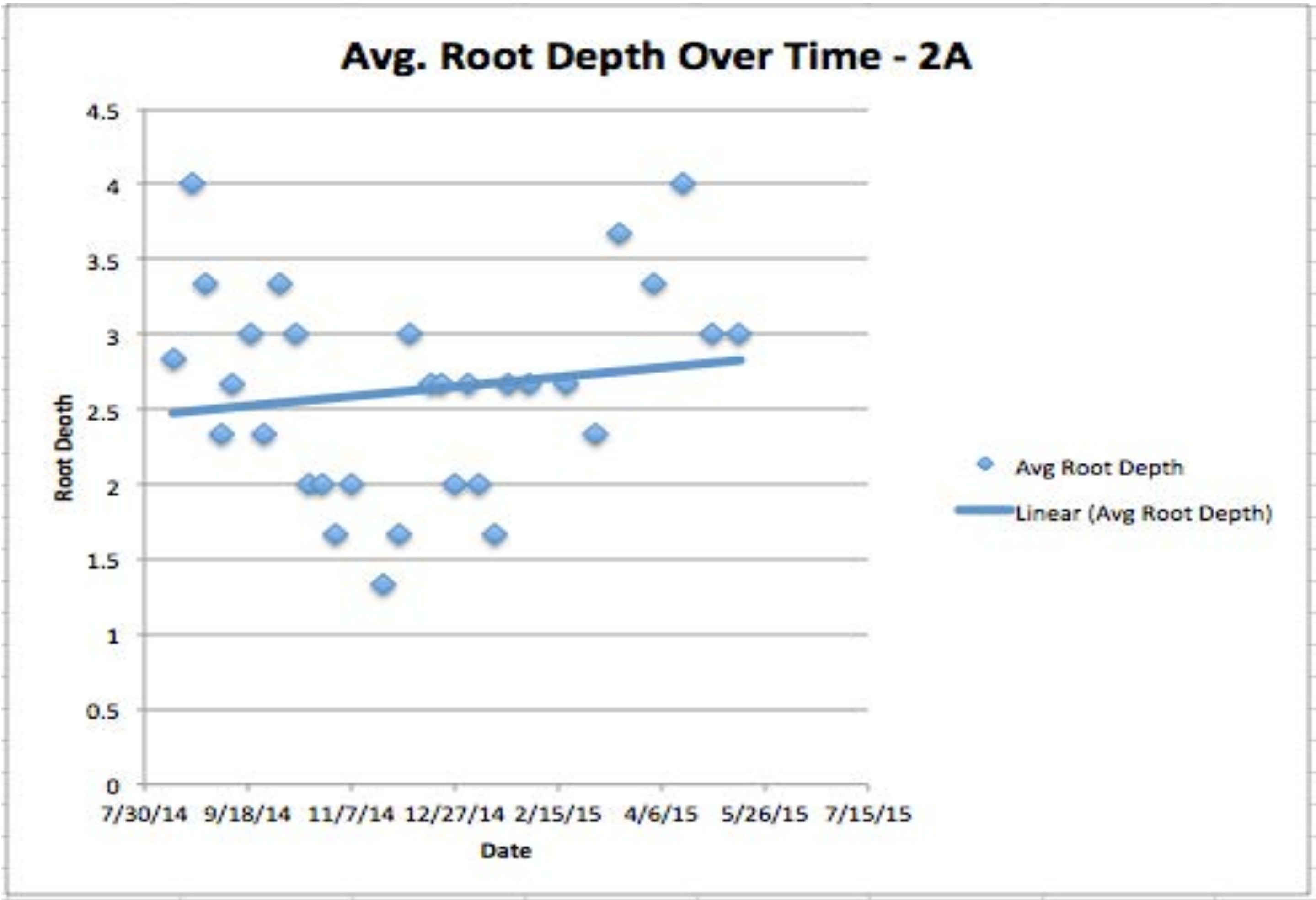

Fig. 3a: Site 2 had different root depth data than Site 1. In fact, the data from the two sites were almost completely opposite of one-another, where the control group was the only plot to have an increase in root depth over time, while both experimental groups had decreased root depths over time.

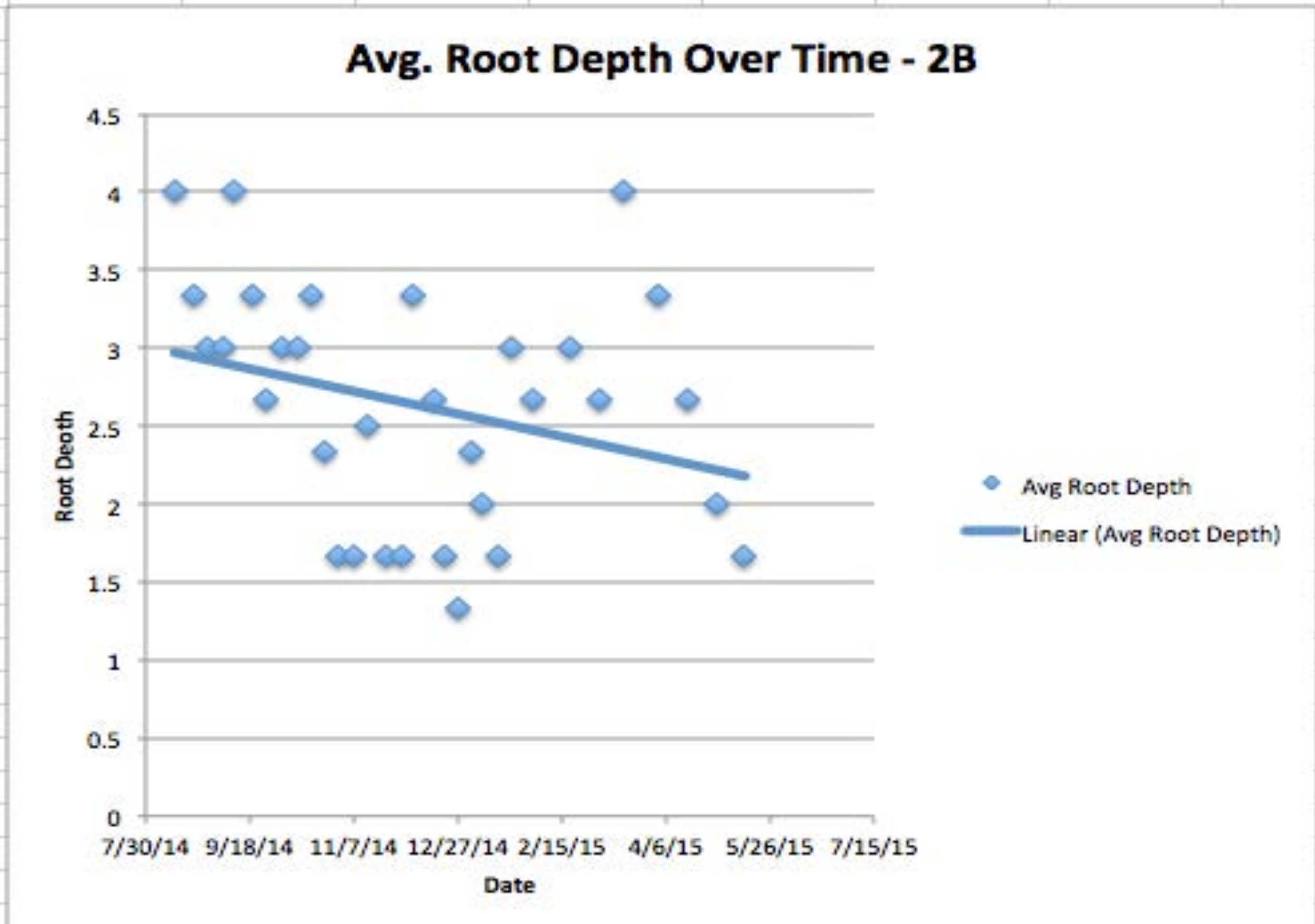

Fig. 3b: Plot 2B, with quarterly applications of AACT, and Plot 2C, with monthly applications of AACT, had similar decreases in average root depths over time. Plot 2B seems to show the largest decrease in root depth over time between the three plots on the Calabasas site.

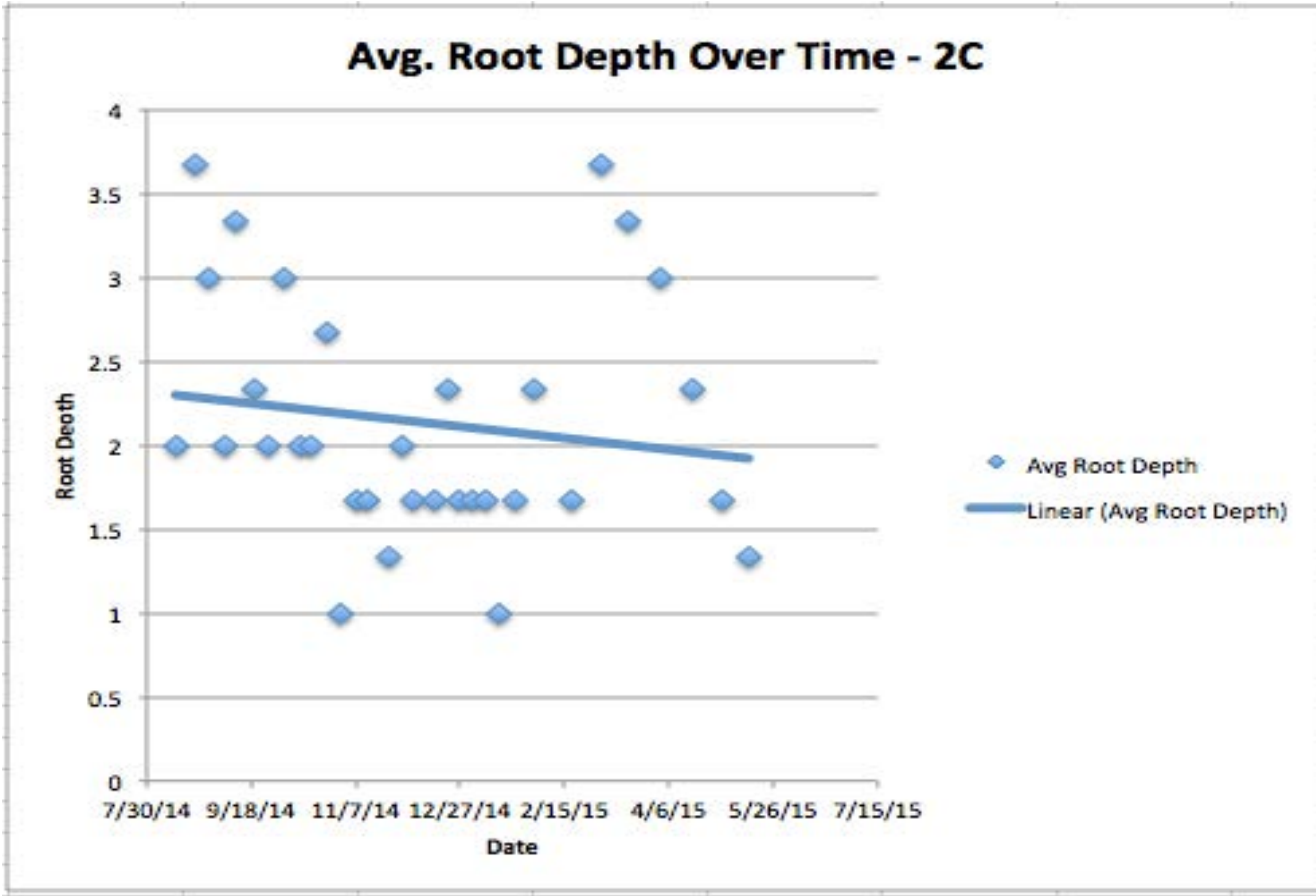

Fig. 3c: This plot shows similar decrease in root depth over time to plot 2B, however this plot seems to have slightly less of a decrease in average root depth.

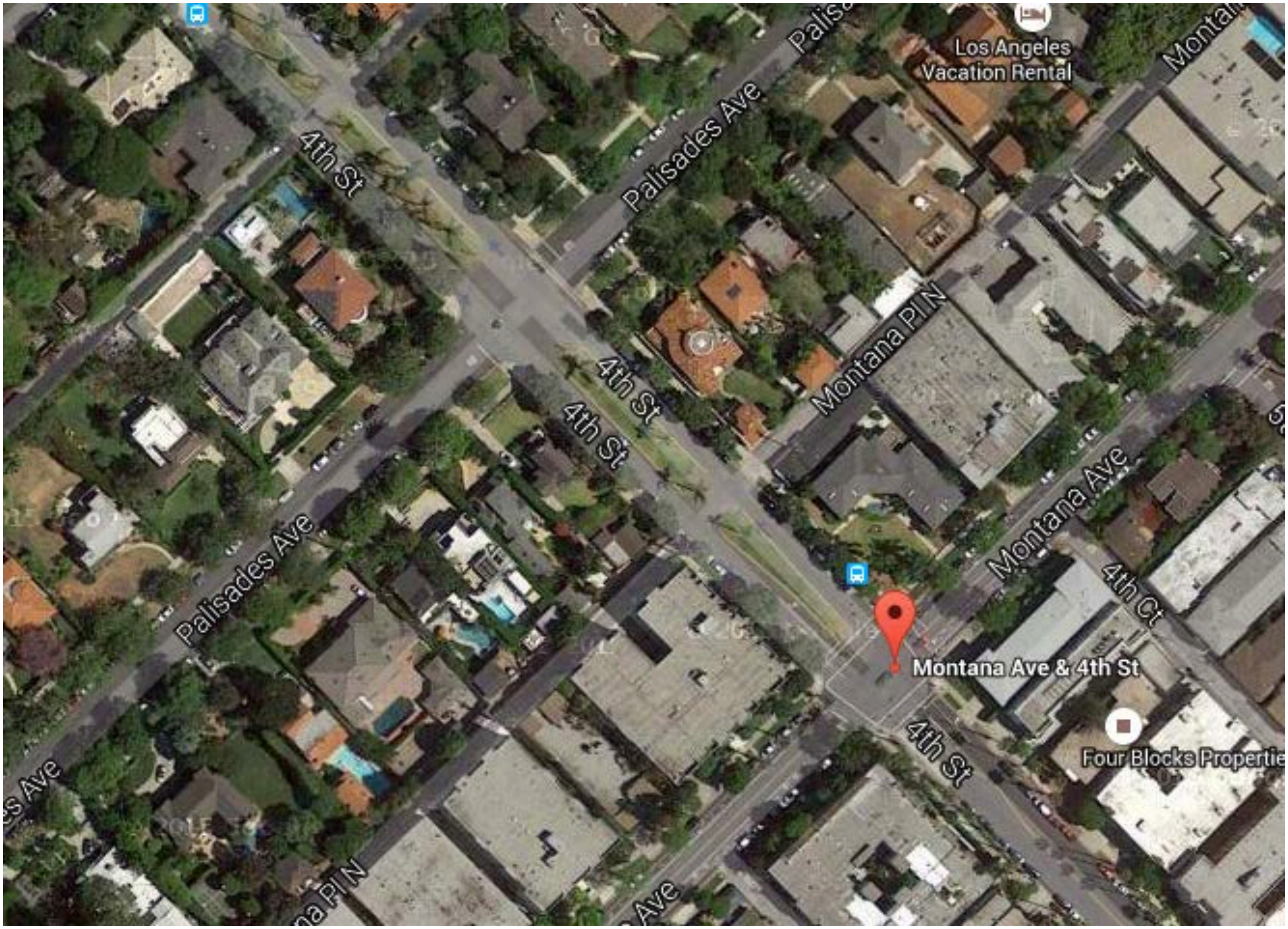

Fig. 4a: Map of the Santa Monica plots, along the 4th Street Medians.

Fig. 4b: Typical plots on Site 1 in Santa Monica, at the intersection of 4th Street and Montana Avenue.

Fig. 4c: Laying catch-cans for Irrigation Audit at Site 1 (Santa Monica).

Fig. 4d: Taking soil samples at Site 1 (Santa Monica).

Fig. 5a: Map of the Calabasas plots, along the sidewalk of Calabasas Hills Road.

Fig. 5b: Plot on Site 2 in Calabasas.

Fig. 5c: Performing cup test for Irrigation Audit at Site 2 (Calabasas).

Fig. 5d: Taking soil samples at Site 2 (Calabasas).

Fig 6: Materials for Irrigation Audit.

Fig 7: Soil Sampling Equipment.

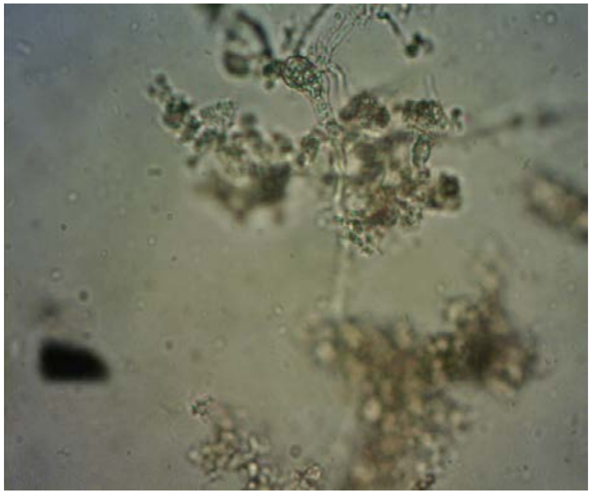

Fig 8a: Images of microbiology within AACT samples. High biological content shown.

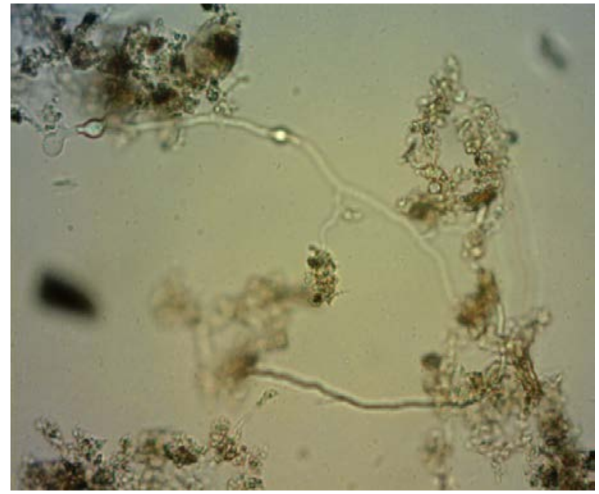

Fig 8b: Images of microbiology within AACT samples. High biological content shown.

Fig 8a: Images of microbiology within AACT samples. High biological content shown.

Protocol for Compost Tea Evaluation for G3 Grant Project

Compost – The compost to be used will be provided by Dr. Ingham's source in San Jose, Calfornia provided that this compost comes back with a satisfactory biology test from Earthfort Laboratories. A satisfactory test result should reflect excellent levels of all microbes: bacteria, fungi, protozoa (balanced as well as good numbers) and nematodes (numbers and diversity).

The choice in using compost from the source in San Jose, CA, is particularly important for creating high biological activity in the AACT. The compost from this source specifically has remarkably high levels of biological activity, especially fungus strands, which is generally in low quantities in the greater Los Angeles area.

Once the compost has passed the test and is approved, it was then used to brew a compost tea with the following ingredients.

300 gallon, Dirt Simple brewer:

- 280 gallons of city water – complexed with 250 ml of MicroMate humic/fulvic acids (http://www.humates.com/ps/micromate.pdf) and allowed to off-gas for at least 6 hours.
- 8 lbs of approved compost
- 2 lbs of fresh worm castings
- 64 oz of fish hydrolysate
- 64 oz of liquid kelp

This will be aerated for a minimum of 24 hours.

This tea will be then evaluated under the microscope and 20 fields of view (fov) will be evaluated and will be classified as such:

Excellent:
Average of 2 fungal strands per fov
Both cocci and bacilli forms of bacteria present
Average at least 2 protozoa (either flagellate or amoeba) per fov
At least 1 nematode per slide

Good:
Average of 1 fungal strand per fov
Both cocci and bacilli forms of bacteria present
Average of at least 1 protozoa (either flagellate or amoeba) per fov

Fair:
Average of 1 fungal strand per every other fov
Both cocci and bacilli forms of bacteria present
Average of at least 1 protozoa (either flagellate or amoeba) per every other fov

Any tea with biology present in quantities less than those indicated above will be deemed unacceptable for the purposes of this study.

Only AACT with a measured quality of "Good" or better will be used for this project.
Once the tea has been evaluated and it's quality rated, the tea will then be applied evenly, using only a spray method, to cover each approximately 1500 sq. ft. plot in the quantities that follow:

For "Excellent" compost tea, 5 gallons
For "Good" compost tea, 10 gallons

G3 Compost Tea Trials

Date	Plot	Start	Finish	Temp	Quality	Volume	Notes
8/26/14	SM-M	8:42am	8:50am	70°	G	10 gal	clear day, light breeze
8/26/14	SM-Q	8:50am	8:59am	70°	G	10 gal	clear day, light breeze
8/27/14	C-M	9:15am	9:35am	77°	G	20 gal	Plot seems larger than 1500 sq. ft. Took more tea than expected to cover
8/27/14	C-Q	9:35am	9:45am	77°	G	20 gal	Will Measure plots at our next spray
9/15/14	SM-M	8:45am	8:55am	75°	E	15 gal	clear, light breeze, HOT!
9/16/14	C-M	8:05am	8:48am	80°	E	30 gal	seeds germinating around oaks. Measured plots , HOT!
10/13/14	SM-M	9:00am	9:15am	66°	G	15 gal	Sunny, but cooler
10/14/14	C-M	9:00am	9:25am	61°	E	33 gal	hazy, lots of seeds germinating
11/17/14	SM-M	9:15am	9:30am	70°	E	25 gal	sunny & clear
11/17/14	SM-Q	9:30am	9:55am	70°	E	27 gal	sunny & clear
11/18/14	C-M	9:15am	9:35am	57°	E	37 gal	Partly cloudy - smelled AMMONIA in this plot and the grass had patches of brown, dead turf
11/18/14	C-Q	9:35am	9:50am	57°	E	38 gal	Partly cloudy
12/15/14	SM-M	9:30am	9:45am	55°	G	15 gal	sunny, cool - ground moist after rains
12/17/14	C-M	9:23am	9:46am	52°	G	45 gal	cool & overcaste, very wet
1/19/15	SM-M	8:55am	9:38am	57°	E	30 gal	Cool & sunny
1/20/15	C-M	8:45am	9:15am	52°	E	45 gal	cool and overcast
2/16/15	SM-M	9:12am	9:32am	59°	E	35 gal	cool and overcast
2/16/15	SM-Q	9:32am	9:55am	59°	E	35 gal	cool and overcast
2/17/15	C-M	9:42am	9:53am	61°	E	40 gal	cloudy when started, sunny by finish
2/17/15	C-Q	9:53am	10:12am	61°	E	22 gal	cloudy when started, sunny by finish
3/16/15	SM-M	9:18am	9:35am	75°	VG	30 gal	sunny & clear
3/17/15	C-M	9:30am	9:45am	71°	G	40 gal	sunny & clear

4/13/15	SM-M	9:15am	9:32am	63°	VG	30 gal	partly cloudy
4/14/15	C-M	9:20am	9:42am	59°	VG	40 gal	sunny & clear
5/18/15	SM-M	8:55am	9:12am	63°	VG	35 gal	overcast
5/18/15	SM-Q	9:12am	9:30am	63°	VG	30 gal	overcast
5/19/15	C-M	9:35am	10:07am	59°	VG	30 gal	sunny
5/19/15	C-Q	10:07am	10:30am	59°	VG	40 gal	sunner

<u>Sq. Footage</u>

Calabasas:

plot #1 3906 (control)
plot #2 3031 (quarterly)
plot #3 6846 (monthly)

Santa Monica:

plot #1 1720 (control)

plot #2 1610 (quarterly)
plot #3 1530 (monthly)