Harvard Yard
Soils Restoration Project

Summary Report
February 2009

Prepared by Harvard Facilities Operations Maintenance

Project Background

- The Harvard Yard Soils Restoration Project was a pilot effort modeled on the fully organic landscape maintenance program successfully operating at Battery Park City Parks (BPCP) in lower Manhattan since 1989. The BPCP program was developed by Eric T. Fleisher, a 2008 Harvard Loeb Fellow, and participant in the Project Team.
- Project Team also included: FAS Physical Resources and Planning, Facilities Maintenance Operations (FMO), Professor Michael Van Valkenburgh, from the Graduate School of Design, and James Sotillo of Treewise, Inc., a New York-based arborist specializing in organic care practices.

Project Objectives

- Restore health and vitality of Harvard Yard soils and plants without the use of chemicals or synthetic fertilizers.
- Transfer knowledge from Eric T. Fleisher's BPCP experience to develop capacity of FMO Landscape Services to implement and sustain a fully organic program at Harvard. Determine investment needed to support such efforts.
- Raise awareness of Harvard community to the benefits of organic landscape management. Provide opportunities for teaching and academic research.

Site Selection and Timeline

- A one acre Test Plot located between Massachusetts Hall and Phillips Brooks House was selected to carry out the 8 month organic test: March through November 2008.

- A Control Plot was identified behind Grays Hall.

Test Plot (partial) March 2008

Test Plot Activities
March - June 2008

- Soil Tests
- Soil Amendment Strategy
- Compost and Fertilizer Applications
- Root Measurements

The 5 Step Process

1. Eliminate the use of toxic pesticides, herbicides, fungicides and insecticides.
2. Test existing soil to determine current biological, textural, and nutrient conditions.
3. Develop specific compost teas and application schedules to balance soil biology and restore natural nutrient cycling. Reduce irrigation requirements and minimize need for nitrogen applications.
4. Perform biweekly root measurements through November 1st, and compare results to the Control Plot.
5. Record and analyze findings; adjust amendment program accordingly.

March 11: Initial Soils Tests

- Performed field tests for water percolation, pH content, and root analysis.
- All tests performed by Eric T. Fleisher, assisted by FMO horticulturist, Kieran Clyne.
- Soil samples collected for lab testing, including: biological, nutrient, and textural analysis.

Field Analysis & Lab Results

Field Analysis

- Water percolation was satisfactory across all three areas tested.
- Measured pH ranged from 6.2 to 6.4.
- Significant compaction zone identified 2” – 6” below soil surface
- Roots measured in both the Test Plot and Control Plot consistently reached a depth of 2”.

Lab Results

- Relatively low organic matter content, avg. 4.6%.
- Elevated bacteria levels
- Insufficient numbers of predators (protozoa), and inadequate fungal colonization.
- Soil creating just 25 to 50 lbs. of nitrogen per acre (typical healthy level is 150 lbs. per acre.)

Soil Amendment Strategy

Test results clearly indicated an inefficient natural nutrient cycling system.

- Amendment strategy focused on properly balancing soil microbial population and activity for optimal nutrient cycling capacity.
- Specific compost tea formulations designed to boost the number of *protozoa* (Amoeba and Flagellates) and increase fungal colonization. Compost tea is an aerated solution made by extracting and replicating the beneficial biology in compost into a liquid form.

Note: *Identification of specific products contained in this report are provided for information purposes only and do not represent an endorsement of any kind.*

April 1: Initial Tea Application

- Applied 300 gallons of Compost Tea containing one gallon of liquid humic acid and one quart of North Atlantic kelp. Humic acid and kelp mixed into tea just prior to application.
- Applied granular humate (Hydra Hume made by Helena Chemical*) at a rate of 8 lbs. per 1,000 s.f.
- Applied Turf Pro® (granular)* at rate of 10 lbs. per 1,000 s.f.

April 8: Turf Seeding

- Turf area in the Test Plot core aerated to a depth of two to three inches to relieve compaction.
- All turf over-seeded with predominantly shade and drought tolerant fescue. Selection made to increase diversity of grass cultivars.
- Grass seeding in early Spring also helps minimize weed seed germination.

April 15: Compost Application

- Applied one-half to three-quarters of an inch of compost to the Test Plot surface.
- Compost will increase the amount of organic matter within the Test Plot and provide a stable source of micro-organisms.
- Additional grass seed was sowed to fill-in bare spots.

May 2: Root Measurements / Injections

- Comparison revealed Test Plot root growth of 6” to 8” (penetrating the identified compaction zones.)
- Root growth in the Control Plot measured between 2” to 3” and failed to break into the identified compaction zone.
- Injected root zones of all trees with a Fungal Compost Tea (50% tea and 50% water.) For every 200 gals, 1 gal. of humic acid and a 1/2 gal. of North Atlantic kelp mixed just prior to application. Endo and ecto mychorrizal spores also added.

May 20: Organic Fertilizer Application

- Applied a half-dose of “North Country Organics 5-4-3” organic fertilizer*.
- Application timed to ensure the plants could absorb all nitrogen applied.
- Conventional salt-based chemical fertilizers kill off the beneficial microbes that support the natural nutrient cycle and force dependency on continual applications.

June 11: Organic Tea Application
June 25: Organic Fertilizer Application

- **June 11** Applied 300 gallons of fungal dominant Compost Tea containing one gallon of liquid humic acid and one quart of North Atlantic kelp. Humic acid and kelp mixed into tea just prior to application.

- **June 25** Applied a half-dose of "North Country Organics 5-4-3" organic fertilizer.

Objective #1

Improve Health of Soils

- Root Growth
- Nitrogen Levels
- Irrigation and Maintenance
- Visual Conditions

Results: Soil Structure

From the mid-point of this project, the visible vitality of the turf and trees in the Test Plot was clear. More importantly, significant improvement in the natural nutrient cycling system of these soils is clearly supported by the evidence of improved root growth, nitrogen levels and reduced need for irrigation.

- Root growth in the Test Plot increased by 3” to 5” over the Control Plot. Enhanced root system created without use of any synthetic fertilizers.

Root Growth in the Test Plot increased by 3 to 5” over Control Plot. Enhanced root system created without use of any synthetic fertilizers.

Results: Nitrogen Levels

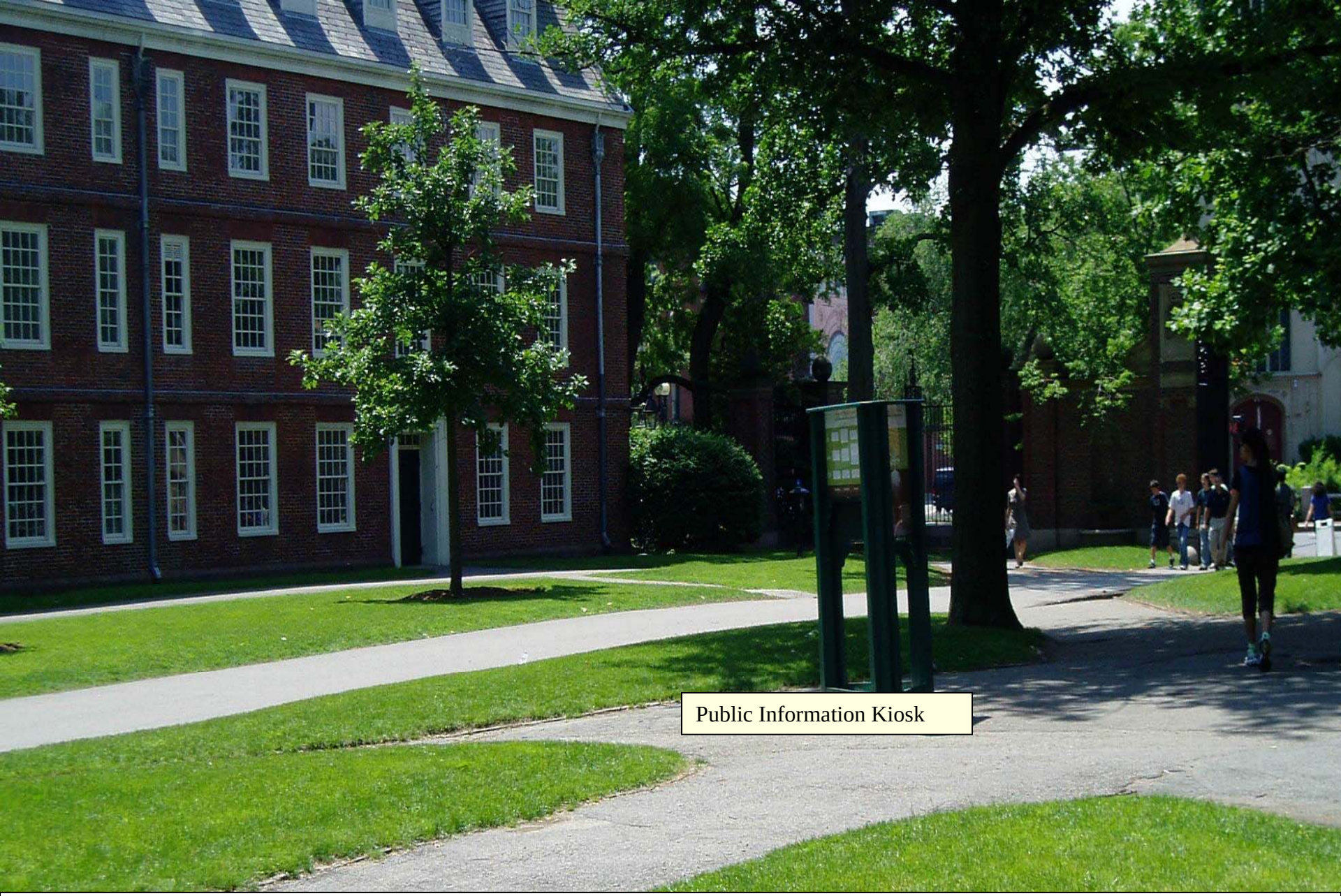
- Retesting of the Test Plot in September revealed available nitrogen had increased to a healthy range, between 100 to 150 lbs. per acre.

Here's How it Worked:

- The compost soil and tea amendments increased the biomass of beneficial fungi, bacteria, and predator populations (protozoa and nematodes) -- the determining factors for available nitrogen.
- The fungi and bacteria effectively immobilized the nitrogen in the root zone, particularly the *rhizosphere* (a 1mm zone immediately around the roots), preventing it from leaching away from the plant and making it available for consumption by the predator populations.
- These predators then release this nitrogen through their waste products allowing it to be consumed by the plant.

Results: Irrigation and Maintenance

- Our program focuses on encouraging root growth rather than foliage growth; the result is healthier plants that require less water and are less vulnerable to disease.
- Irrigation in the Test Plot was reduced by over 30% from the Control Plot due to the improved moisture retention capacity of the deeper root structures.
- Irrigation rates at BPCP typically average 50% less than the conventionally maintained landscapes at Harvard. Similar results in the Yard would save more than 2 million gallons of water annually!
- Absence of excess nitrogen in the soil also slows the rate of plant growth. This resulted in the need to cut the Test Plot only half as often as the Control Plot!



Test Plot – June 17, 2008

Objective #2

Knowledge Transfer

- FMO Staff Training
- Creating and Managing Compost
- BPCP Learning Experience
- Program Costs and Investments

BPCP Knowledge Transfer Activities

- Educated FMO horticultural staff in the philosophies and science of organic landscape maintenance.
- FMO staff directly involved in all aspects of *The 5 Step Process* performed at the Test Plot.
- Field trained FMO horticultural staff in the diagnostic techniques and appropriate environmental response repertoire developed by Eric T. Fleisher at BPCP.

Creating and Managing Compost

- In May, FMO created a small-scale composting operation at 175 North Harvard Street in Allston, used primarily for training.
- FMO Horticultural staff trained in the BPCP management practices for creating composted soils and *vermicompost* as well as the brewing of compost teas.
- Shared composting recipes, tea brewing methods, and application techniques developed at BPCP.

FMO Composting Facility at
175 North Harvard Street

Opportunities to See and Learn

- Selected Harvard horticultural staff visited lower Manhattan to learn directly from BPCP staff.
- During the two day training staff shared advanced techniques for responding to a wide variety of conditions, including pest infestation, nutrient deficiencies, controlling compost odors, etc.
- Developing professional networks leads to ongoing information sharing and learning opportunities.

BPCP Landscape and Tea Brewing Operations

Program Costs and Investments

- Costs for the Pilot totaled ~ $40K and included consulting and staff training, contracted labor for initial applications of compost, and lab analysis.
- An initial investment of ~$45K for equipment to support the FMO organic programs going forward, includes: compost tea brewers, and creation of soil composting facility at the Arnold Arboretum.
- At maturity however, total operating costs of our organic maintenance programs are expected to be the same as our conventionally-based programs.

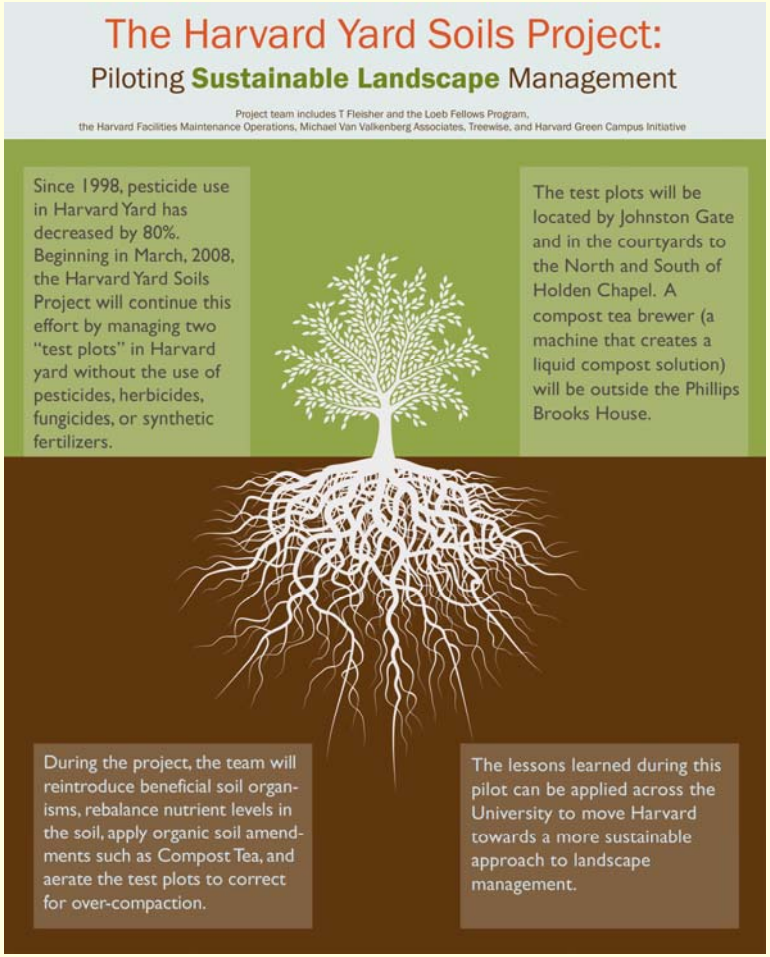
Eric T. Fleisher and Wayne Carbone (Manager FMO Landscape Services) show off the new Compost Tea Brewer in Harvard Yard.

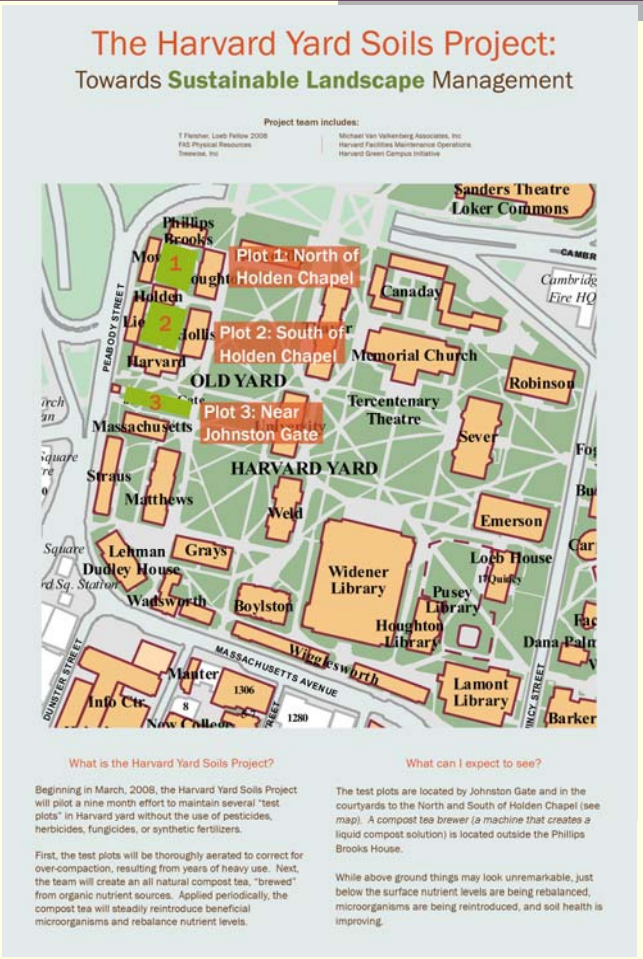
Objective #3

Education and Outreach

- Public Information Kiosk
- Teaching and Research Opportunities
- Sharing Results
- Sustainability Week Events

Public Education Outreach





In May 2008, a public information kiosk was installed adjacent to Test Plot that displayed information about organic soils management as well as specific project objectives.

FMO Landscape Manager, Wayne Carbone, shows local youngsters how Compost Tea is made.

Teaching and Research Opportunities

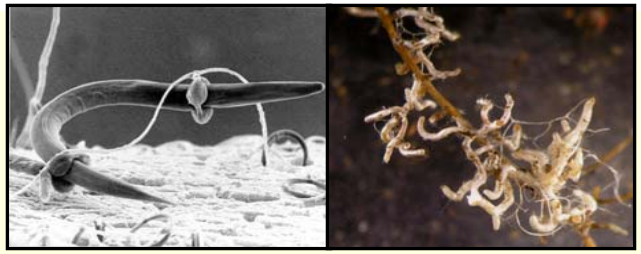
Arnold Arboretum Senior Research Scientist, Peter Del Tredici, used the Test Plot results for his *Ecological Strategies for Disturbed Sites* class in October.

Eric T. Fleisher explains vermicompost uses to facilities management team from the Harvard Kennedy School.

Academic Research

- Growing scientific interest understanding the role of soils in maintaining plant health generating exciting biological research opportunities.
- Understanding the diversity and function of the soil microbial communities in Harvard Yard may improve our ability to sustainably manage this system.
- Surveys of the fungi, bacteria and archaea, using molecular genetic approaches, are beginning to reveal the cryptic diversity of Harvard Yard.
- For more information on this research, visit: www.oeb.harvard.edu/faculty/pringle/Ben.php

Benjamin Wolfe, PhD candidate in Organismic and Evolutionary Biology, performed DNA sequencing analysis on soil samples from Harvard Yard to determine fungal and bacterial diversity.



Sharing Results

Preliminary results of the Project featured during:

- GSD Loeb Fellow Project, presented by Eric T. Fleisher, October 2008
- Harvard Sustainability Week, October 20 - 24
- Ivy Plus Conference, hosted by Harvard University Operations Services, November 17 – 18.
- Greenbuild 2008 International Conference – *The Harvard Sessions*, hosted at Harvard Business School, November 20.
- Seminar presented by PhD candidate, Benjamin Wolfe, on his soils research to a class from the Arnold Arboretum's Landscape Institute. (Research paper on this work soon to be published in a microbial ecology journal.)
- Dr. Anne Pringle's undergraduate Mycology course also used data from this project for a lab exercise on bioinformatics.

Eric T. Fleisher demonstrates Compost Tea Brewer to President Faust and Harvard leadership.

Sustainability Week, October 2008.

Next Steps

- Sustaining Results
- New Composting Facility
- Program Expansion and Ongoing Commitment
- Additional Resources

Next Steps – Sustaining Results

Identified areas for future focus, include:

- Strengthening the partnership between FMO and BPCP. This direct learning exchange has proven to be key to the success of this initial effort.
- Leveraging academic research opportunities as an important part of a long term success strategy. (Ben Wolfe, PhD candidate, launched his research project after learning about the Yard Soils project in the *Harvard Gazette*.) Potentially exciting research avenues include identifying the carbon sequestration capacity of organic programs.
- Engaging the Harvard community by sharing the benefits of organic landscaping. Harvard Dining Services offers a good example. Already participating in food composting programs with FMO, they are currently evaluating related programs that include raising a limited volume of organic foods on campus.

Next Steps – Composting Facility

- Local composting is a primary component in sustainable landscape management. At the start of the pilot project Harvard had no composting capacity; as a result, most of the compost used during the pilot project was purchased from facility in Wrentham, MA.
- In May, FMO created a small-scale composting operation at 175 North Harvard Street in Allston, used primarily for training.
- Currently, FMO is building a larger compost facility in partnership with the Arnold Arboretum and funding support from the Environmental Loan Fund (Office for Sustainability.) This outdoor facility will enable FMO to consolidate all landscape waste (most of which is currently hauled off-site at a cost of more than $35K annually) and better control the quality of the compost used on the Harvard landscapes.

FMO Composting Facility under construction at the Arnold Arboretum.
November 2008

Next Steps – Program Expansion

The success of the Harvard Yard Soils Restoration Project has already resulted in an expansion of the organic program, specifically:

- The entire Harvard Yard (~16 acres) has been benefiting from organic maintenance since August, 2008.
- Beginning in Spring 2009, the following graduate schools will be added to the FMO organic program: Kennedy, Design, and Education.
- FMO has established an aggressive goal of transitioning all of its landscape operations in Cambridge to fully organic programs during the next three years. Costs and benefits of these program will continue to be monitored and evaluated to ensure overall effectiveness.
- FMO and Eric T. Fleisher are also helping to develop the soils specifications and maintenance programs for the Allston Development.

Ongoing Commitment

The results from the Harvard Yard Soils Restoration Project appear very promising. Nevertheless, the 20 year BPCP experience has shown that sustaining a highly utilized public landscape using only organic methods requires regular monitoring and continual program adjustment.

Since each project demands a customized approach, successful expansion of these programs requires ongoing training of management, skills development of field staff, and some limited investment in composting infrastructure.

FMO Landscape Services, with the support of its clients in the Schools, is fully committed to sustainable practices in the maintenance of Harvard's landscape systems.

Additional Resources

There is strong interest in sustainable landscapes at Harvard and elsewhere. The following sites offer more information on holistic management techniques and maintaining proper soil conditions:

www.bpcparks.org

www.soilfoodweb.com

www.umassvegetable.org

www.soils.usda.gov

www.sustainablestudies.org

The new FMO Organic Landscaping page is also attracting a lot of attention. Check it out at:
www.organiclandscaping.uos.harvard.edu

Thanks!

Special thanks to the many people who helped make the Harvard Yard Soils Project a success. In particular:

- President Drew Faust, Harvard University
- Professor Michael Van Valkenburgh, GSD
- Eric T. Fleisher, Battery Park City Parks
- Tessa Huxley, Battery Park City Parks
- Peter Del Tredici, Arnold Arboretum
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- Kieran Clyne, FMO Landscape Services
- Paul Smith, FMO Landscape Services
- Jessica Smiddy, FMO Landscape Services
- Arthur Libby, FMO Landscape Services
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- Zack Gingo, FAS Physical Resources
- Jay Phillips, FAS Physical Resources
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- Carina Myteveli, FAS Physical Resources
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- Dr. Anne Pringle, Biology Department
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- Sally Young, Loeb Fellowship Program
- Cindy Fallows, Loeb Fellowship Program
- James Sotillo, Treewise, Incorporated