City of Austin

Austin Water Utility

TCEQ Experimental Exemption Permit Annual Research Report 2008-2009

TCEQ Permit No. WQ0003823000

Austin Water Utility Center for Environmental Research and The Hornsby Bend Biosolids Research Partnership

Long-term Study of the Ecological Impacts of Biosolids Land Application

Austin Water Utility Hornsby Bend Biosolids Management Plant
Austin Water Utility Center for Environmental Research

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July 2009

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I. REPORT SUMMARY 2008-2009

The current report reflects research activity under the Experimental Exemption for Permit WQ0003823000 for the period July 2008 – June 2009.

- Research partnership receives $399,347 USDA research grant focused on Environmental Trace Contaminants [ETCs]
- First ETC research sampling by USDA, USGS, and TPWD
- Host Environmental Trace Contaminants meeting for City of Austin
- CER Sideroll study of mammal and fireant density and soil peturbation
- Soil Food Web sampling not possible in 2008 due to exceptional drought conditions
- Regular soil and groundwater sampling for 2009 completed

II. Land Application and Experimental Exemption Fields Map

III. Background and Rationale for Biosolids-Soil Ecology Study

On both a national and global level, questions are being raised about the safety of biosolids reuse, particularly in terms of Class B biosolids. The National Biosolids Partnership has initiated efforts to address these concerns on a national level, and the research at Hornsby Bend by the Austin Water Utility Center for Environmental Research is an effort to address concerns about biosolids reuse in Texas. Although there has been no formal public opposition to Austin's biosolids reuse program, the Austin Water Utility and other local entities are very interested in furthering our knowledge of the effects, both positive and negative, of land applying and composting biosolids.

From the Austin Water Utility's perspective, it is more economically effective, environmentally sustainable, and ecologically beneficial to reuse biosolids through land application and composting than to landfill the material. Biosolids reuse incorporates beneficial nutrients and organic material into agricultural soils and urban soils, particularly soils that have been degraded by farming and other human practices. The goals of this research effort are to add to current knowledge about the long-term safety, sustainability, and ecological impacts of applying Class B biosolids to land. Most of the existing research has until now been focused on nutrients, crop yields, and contaminants, but significantly, not on effects on soil biology. Over the planned 10-year course of research, this project will utilize crop productivity records, soil biodiversity indicators (i.e., the soil food web), and other parameters to address some of the ecological questions associated with biosolids.

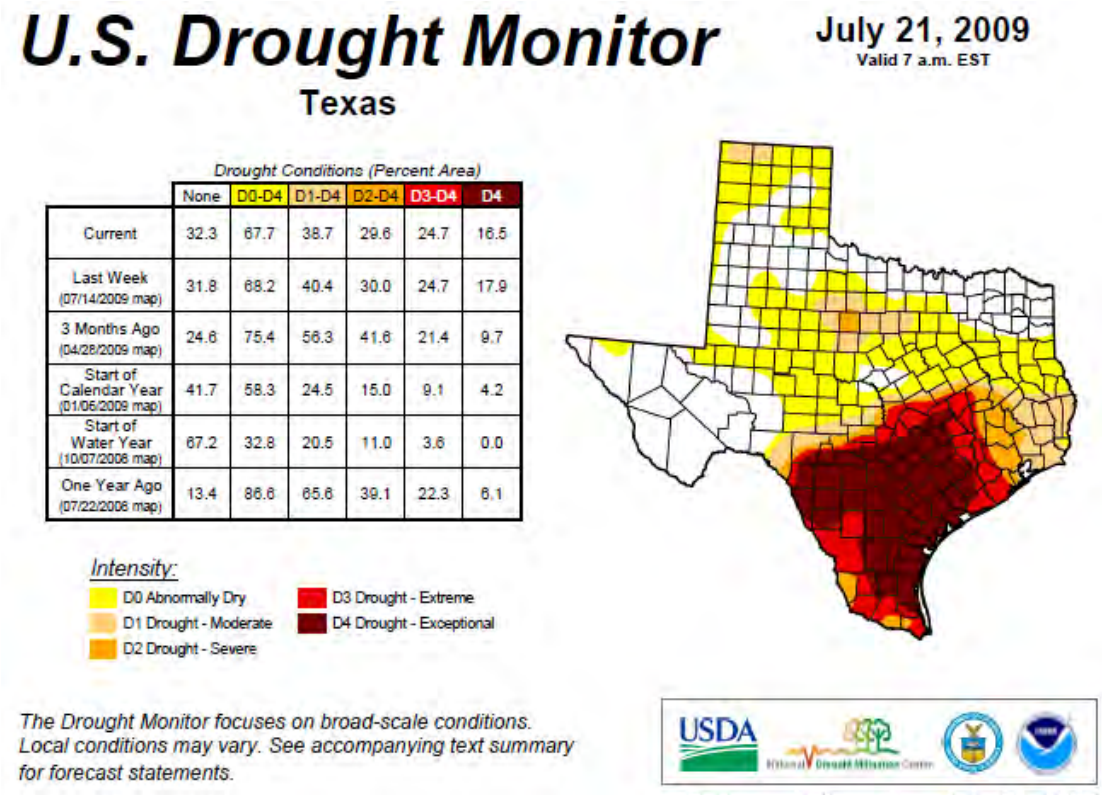
Biosolids land application fields include those applied annually at the site since 1986. These older fields are now applied every other year (bi-annually) in accordance with the Nutrient Management Plan. The Experimental Exemption fields are applied at 10, 20, and 30 dry tons per acre (DT/acre) and consist of adjacent agricultural land purchased by the Austin Water Utility in 2000 to expand the onsite land application acreage. This additional acreage allows comparisons of application methods, including annual application for over 20 years, new application, and application at varying rates.

IV. Summary table of land application fields at the Hornsby Bend site:

Fields in use since 1986	Acreage	Application Rate	Application Frequency
Tract B	27.1	9.8 DT/acre	Bi-annual
Sideroll	60		Currently not used
CP1E	9	9.8 DT/acre	Bi-annual
CP1W	32.7		Currently not used
CP2E	13.6	9.8 DT/acre	Bi-annual
CP2W	26.5		Currently not used
Admin/Pecan Orchard	15.6	9.8 DT/acre	Bi-annual
Tree Farm	8.7		Currently not used
CP 3	16.6	9.8 DT/acre	Bi-annual
CP 4	13.6		Currently not used
South Tract	40	9.8 DT/acre	Bi-annual
Fields under Experimental Exemption			
Platt 1	60.7	30 DT/acre	Annual
Platt 2	57.8	30 DT/acre	Annual
Platt 3	47.5	20 DT/acre	Annual
Platt 4	42.6	20 DT/acre	Annual
Platt 5	26	10 DT/acre	Annual
Platt 6	22	10 DT/acre	Annual
Tract C	28.8	10 DT/acre	Annual

V. Climatology Report for 2008-2009

Drought has been the dominant factor affecting our research, and, with the exception of a wet period from January to July 2007, Central Texas has been exceptionally dry. The severe drought intensified from July 2008 to July 2009 to reach "exceptional" level. 2008 was the fourth driest year on record since 1856 with 15.98 inches, and 2009 is on track to be even drier.



Travis County and the Hornsby Bend facility site are particularly dry and hot which has affected our soil sampling and groundwater sampling. June 2009 set a new record for consecutive days of 100 degrees or higher with 10 in a row from June 20th to June 29th with the average maximum temperature of 97.9 degrees matching June 2008 as second

hottest on record. July has continued that trend with only two days below 100 degrees from July 1st to July 22nd. July 2009 should end as the hottest July on record.

The lack of soil moisture has meant that biological activity in the soil is very limited, and so we could not do soil food web sampling in 2008. A 2 inch rain in March 2009 did stimulate some earthworm activity, and, with Texas Parks and Wildlife Department, we were able to collect some earthworms for preliminary tests at their Environmental Contaminants Laboratory. This same rain allowed for USDA to take some 60 cm soil cores, but there was insufficient deep soil moisture to take full meter cores. A second attempt to take soil cores by USDA in July 2009 was even less successful, and we will have to wait for substantial rains to resume soil cores and biological sampling.

Rain Data 2008-9

Year	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sept	Oct	Nov	Dec	Total
2008	0.82	1.16	3.45	2.86	1.34	0.79	1.37	2.16	0.34	1.20	0.11	0.38	15.98
2009	0.40	0.94	3.21	3.74	1.73	1.03							

VI. Key Events for 2008-2009

Soil Food Web sampling cancelled for 2008 due to exceptional drought

Having delayed soil food web sampling through the summer of 2008 in hopes of sampling in the fall did not work. The drought continued through the fall of 2008 and without adequate soil moisture there was insufficient biological activity to warrant the cost of sampling. Soil food web sampling will resume in 2009 if it rains sufficiently to increase biological activity.

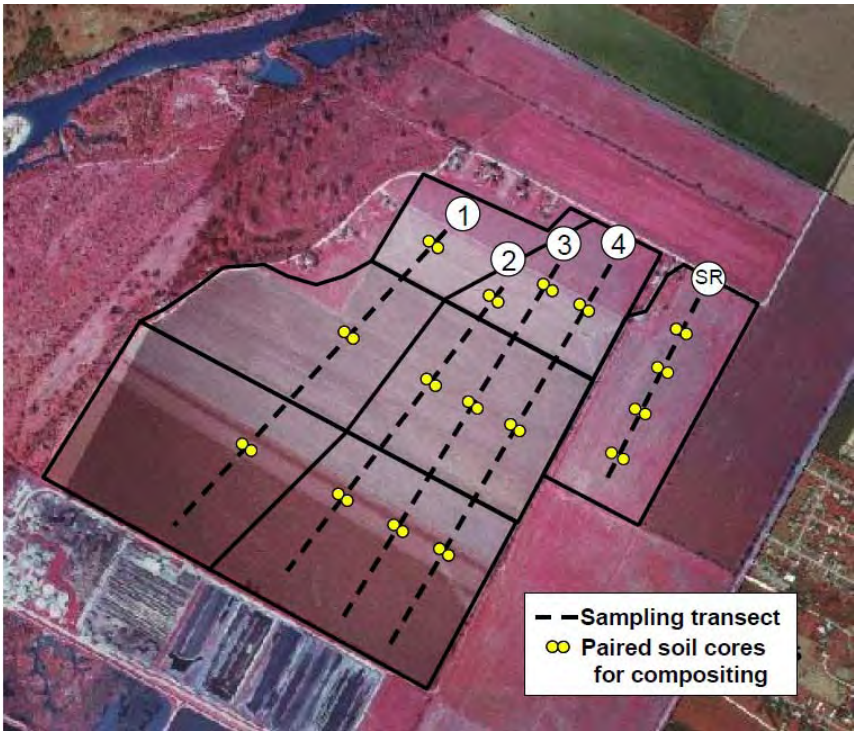
August 2008

As noted in last year's report, two researchers with the USDA Agricultural Research Service (USDA-ARS) Grassland, Soil and Water Research Laboratory in Temple, Texas collaborated with the AWU-CER on writing a grant proposal for USDA funding to start research on soil, biosolids, and environmental trace contaminants at Hornsby Bend which was submitted in December 2007. The project proposal was entitled "Biosolids Application: Quantifying and Modeling Impacts on Ecosystem Services across Urban, Agricultural, and Wildlife Interfaces" and submitted for funding under the USDA's National Research Initiative Cooperative State Research, Education, and Extension Service. The USDA-ARS researchers learned in August 2008 that the proposal was accepted and funding of almost $400,000 was awarded. The grant supports collaborative research on biosolids between the USDA-ARS, the Texas Parks and Wildlife Department's Environmental Contaminants Laboratory in San Marcos, the U.S. Geological Survey's Texas Water Science Center in Austin and the USGS National Water

Quality Assessment Laboratory in Denver, Colorado; and the Austin Water Utility's Center for Environmental Research.

The grant is primarily funding the cost of sampling and sample analysis by the USGS. Soil cores will be taken across the Platt Experimental Exemption fields and from the Sideroll [SR] field. Additional sampling across the site is meant to give a one-time picture of ETC levels at the site. USDA will do the soil coring and USGS will extract samples from these one meter cores to look at surface and subsurface soil. Additionally USGS will collect samples from pond sediments, groundwater, and river water and sediments. All these samples will be analyzed by the USGS Denver lab. TPWD staff will collect organisms from the fields, ponds, and river to test for ETCs at the TPWD Environmental Contaminants Laboratory in San Marcos.

Map. Planned USDA Baseline Soil Core Sampling Transects



September – December 2008

Fall of 2008 was devoted to planning meetings with USDA, USGS, and TPWD to plan the sampling for 2009. Samples will be sent to the USGS National Water Quality Laboratory in Denver for analysis. The contaminants profile that they will test for is below:

USGS National Water Quality Laboratory (NWQL; Denver, CO)

SCHEDULE S4433: COMMON ORGANIC CONTAMINANTS PROFILE

Cotinine	Decafluorobiphenyl	**4-Octylphenol monoethoxylates**
2,2',4,4'-Tetrabromodiphenyl ether	N,N-diethyl-meta-toluamide (DEET)	**para-Cresol**
3,4-Dichlorophenyl isocyanate	**Diazinon**	4-Cumylphenol
5-Methyl-1H-benzotriazole	**Dichlorvos**	**para-Nonylphenol (total)**
Anthraquinone	**Bisphenol A**; Bisphenol A-d3	**4-n-Octylphenol**
Acetophenone	Triethyl citrate (ethyl citrate)	**4-tert-Octylphenol**
Acetyl hexamethyl tetrahydronaphthalene	Tetrachloroethylene	Phenanthrene
Anthracene	Fluoranthene	**Phenol**
Atrazine	**Hexahydrohexamethylcyclopentabenzopyran**	**Pentachlorophenol**
1,4-Dichlorobenzene	Indole	Tributyl phosphate
Benzo[a]pyrene	Isoborneol	Triphenyl phosphate
Benzophenone	Isophorone	Tris(2-butoxyethyl)phosphate
Bromacil	Isoquinoline	**Tris(2-chloroethyl)phosphate**
Bromoform	d-Limonene	**bis(2-Ethylhexyl) phthalate**
3-tert-Butyl-4-hydroxy anisole (BHA)	Menthol	**Diethyl phthalate**
Caffeine; Caffeine-C13	Metalaxyl	Prometon
Camphor	Metolachlor	**Pyrene**
Carbaryl	Naphthalene	Methyl salicylate
Carbazole	1-Methylnaphthalene	3-Methyl-1(H)-indole (Skatole)
Chlorpyrifos	2,6-Dimethylnaphthalene	**β-Sitosterol**
Cholesterol	2-Methylnaphthalene	β-Stigmastanol
3-β-Coprostanol	**4-Nonylphenol diethoxylates**	**Triclosan**
Isopropylbenzene	**Nonylphenol, monoethoxy- (total)**	**Tris(dichlorisopropyl)phosphate**
Fluoranthene-d10	**4-Octylphenol diethoxylates**	

The sampling is planned for spring 2009 although the worsening drought may control when sampling can take place. Additionally, the election of a new administration in Washington is anticipated to delay the transfer of funds for the grant. These contingencies force all of us to be flexible about the sampling schedule.

January 2009

On January 22, the Center for Environmental Research held a half-day seminar focused on current research by the US Geological Service about environmental trace contaminants that affect water and wastewater. AWU Special Services Division

Manager Tony Canales, USGS Hydrologist Lynne Fahlquist, and CER Coordinator Kevin Anderson organized the seminar. The seminar was attended by AWU and City of Austin Watershed Protection staff along with staff from USGS, USDA, and the Texas Park and Wildlife Department. AWU Environmental and Regulatory Services Division Manager Raj Bhattarai played host, introducing speakers and entertaining the attendees with his humor and eloquence.

The morning began with a presentation by USGS Texas Water Science Center Director Robert L. Joseph who gave an overview of the USGS national programs and responsibilities as the federal government's primary scientific agency and the work of the Texas Water Science Center. He was followed by webcast presentations from USGS scientists in Iowa and New York who are leading researchers in emerging contaminants and wastewater. After a short break, the rest of the morning was filled with presentations by USGS scientists from the Austin office who described their studies of drinking water in Texas and by USGS Office Chief Tim Raines from Fort Worth who discussed a new research study that has just started focused on pharmaceuticals and personal care products in Dallas waterways.

To make sure that the entire water and wastewater system was covered by the seminar, a brief presentation was also made by Dr. Virginia Jin from the USDA describing the emerging contaminants research on biosolids and the Hornsby Bend ecosystem that is beginning this year at the Hornsby Bend Biosolids Management Plant through a partnership between the Austin Water Utility, USDA, USGS, and Texas Parks and Wildlife Department. This packed morning of presentations was followed by lunch and a tour of

the Hornsby Bend facility for participants. The success of the seminar was measured by the request from all participants for regular follow-up seminars at the CER in order to stay updated on national and local research about emerging contaminants.

Bob Joseph, Director of the USGS Texas Water Science Center, addresses the CER ETC Seminar

Mike Canova, USGS hydrologist, addresses the CER ETC Seminar

Raj Bhattarai, AWU Environmental and Regulatory Services Division Manager, addresses the CER ETC Seminar

Virginia Jin of USDA give a presentation on ETC biosolids research at Hornsby Bend for the CER ETC Seminar.

February 2009

Soil sampling for Hornsby Bend facility begun in November 2008 is completed in February 2009. All land application fields sampled and laboratory results included below. Additionally, a CER study was begun on the number and density of rodent burrows and fire ant mounds by flagging in a portion of the Sideroll field to document surface soil dynamics. New leaf-cutter ant mounds on the land application fields were also monitored beginning in February. The Sideroll study continued until the first hay mowing in May.

Soil Sampling in Platt 2
February 2009

Soil Sampling with auger
Tractor operator Steve Hall

Soil Sampling with auger
February 2009

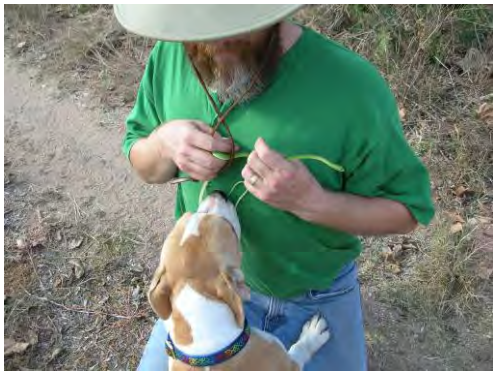
UT Intern Laura Read taking soil sample
Jody Slagle and David Greene assist

Jody Slagle and David Greene assist in flagging for Sideroll study

Sideroll study plot
March 2009

Soil disturbance by cotton rat burrowing
March 2009

New Leaf-cutter Ant mound
February 2009



Kevin Anderson and Pumpkin conducting reptile monitoring

New Leaf-cutter Ant mound
March 2009

March 2009

The first soil coring and organism sampling for the research grant occurred in March as preliminary practice sampling before the full USGS sampling planned for later in the spring. The USDA researchers came to Hornsby Bend and took soil cores for study in their lab in Temple to measure nutrient levels. Although there was surface soil moisture from a recent two inch rain, subsoil was so dry that the lower 30cm of the one meter cores fell apart. But 60-70cm cores were taken from the Platt fields and the Sideroll field and samples of biosolids and compost were collected. At the same time, staff from the TPWD Environmental Contaminants Laboratory came and made initial collections of earthworms from the Platt and Sideroll fields to make practice tests in their lab.

USDA soil coring

USDA soil coring

TPWD earthworm sampling

TPWD earthworm sampling

June 2009

A legal agreement between the USDA and the City of Austin is signed to formalize the research project as a cooperative partnership.

July 2009

Delays in federal funding and lack of rainfall forced the postponement of USGS sampling throughout the spring, but in July USGS was able to schedule sampling at Hornsby Bend. TPWD decided to delay sampling until the fall of 2009 because of the drought and river levels. Over three days, July 20-22, USGS staff collected samples from across the Hornsby Bend site and at the AWU Walnut Creek Wastewater Treatment Plant. The wastewater samples were funded directly by the AWU and included influent and effluent from the plant. At the Hornsby Bend plant, samples were take on incoming sludge, biosolids at the belt press, and Dillo Dirt compost. Groundwater samples were taken from six wells across the Hornsby Bend site [see map below]. Pond sediment cores were taken from Pond 1 West, Pond 1 East, and Pond 2. River water and sediment samples were taken from an up river location on the Hornsby Bend site and from downstream of the site at the FM 973 bridge.

USGS Groundwater sampling at monitoring well 15 in the Tree Farm field near the

USGS groundwater sampling at monitoring well 3 near the river below Pond 3

basins.

USGS staff planning river water and sediment sampling at the river crossing site

USGS collecting river water samples

USGS staff collecting pond sediment samples from Pond 1 West

USGS cutting a sediment core removed from Pond 1 East

USDA soil core failure from hard dry soil – note that only half the one meter core sleeve has soil

USDA researchers decide to postpone coring after difficulty in getting intact one meter cores due to drought conditions

VII. USGS Sampling Sites Map

VIII. Hornsby Bend Groundwater Wells Map

IX. Biosolids Research Partnership

The research partnership and their contributions for this project are as follows:

- AWU Hornsby Bend Biosolids Management Plant

Jody Slagle, P.E., Biosolids Reuse Engineer and Research Project Manager

- Provides research support
- Coordinates hauling and land application
- Supervises University of Texas undergraduate interns and students

- AWU Center for Environmental Research

Kevin M. Anderson, CER Coordinator and Research Project Manager

- Manages research partnership with USDA, USGS, TPWD Environmental Contaminants Lab, University of Texas, and Texas A&M University
- Writes grants in collaboration with research partners
- Supervises University of Texas undergraduate interns and students

- U.S. Department of Agriculture – Agricultural Research Service Grassland, Soil, and Water Research Laboratory, Temple, Texas

USDA research scientists, Dr. Mari-Vaughn Johnson and Dr. Virginia Jin

- U.S. Geological Survey Texas Water Science Center, Austin, Texas

- U.S. Geological Survey National Water Quality Assessment Laboratory in Denver, Colorado

- Texas Parks and Wildlife Department - Environmental Contaminants Laboratory, San Marcos, Texas

- University of Texas at Austin

- Consultation services provided by Drs. Richard H. Richardson and Patricia Q. Richardson, Department of Integrative Biology
- Hydrology research by Department of Geological Sciences

- Soil Food Web, Inc. Laboratory

- Provides qualitative and quantitative analyses of soil and compost for soil food web criteria

- Texas Plant & Soil Lab, Inc.

- Provides conventional soil analyses

X. Historical Background for Hornsby Bend site and research

2008

- USDA researchers from USDA-ARS Grassland, Soil, and Water Research Laboratory, Texas Parks and Wildlife Department Environmental Contaminants Laboratory, and USGS join the biosolids research project
- Research partnership applies for USDA research grant
- Expand research focus to include Environmental Trace Contaminants [ETCs]
- Host first Emerging Environmental Contaminants meeting for City of Austin
- University of Texas School of Geosciences begins hydrogeology research at Hornsby Bend

2007

- Application of Unison Novel Broadleaf Herbicide to fields to control growth of broadleaf weeds on the Platt fields on March 20 and other Hornsby Bend fields on April 5.
- Soil Food Web sampling and ground water sampling completed 2007
- Results of the two-year study, **"**Repellency of Red Imported Fire Ants (*Solenopsis invicta*) to Dillo Dirt, a Sewer Sludge-Based Compost Material," with Texas A&M Cooperative Extension entomologist Elizabeth Brown reveal sporadic differences, inconsistency over time, and the necessity of further testing to develop definite conclusions.
- The first 8 months of 2007 was the wettest start to a year on record for Austin-Bergstrom [39.33 inches], and then the rains stopped in mid-August for a very dry second half of 2007. Despite the dry fall, 2007 was the seventh wettest at Austin Bergstrom, with 45.91 inches.

2006

- Sampling of the permitted fields at Hornsby Bend was completed, including first analysis for soil food web characteristics and conventional nutrient criteria. First-year results indicate expected bacteria-dominated soils, which are desirable for grasses.

- A Nutrient Management Plan set new reduced recommended biosolids application rates for the fields not included in the Experimental Exemption based on nitrogen and phosphorous levels. This change forces an adjustment in research protocol for Hornsby Bend.

2005

- The Experimental Exemption is discontinued as a separate permit and incorporated into the Permit WQ0003823000. The Exemption now includes land only at Hornsby Bend (Platt fields 1-6 and Tract C).
- UT-Austin collaborators decide to serve the Hornsby Bend Research Partnership in an advisory-only capacity based on the loss of the Webberville fields for research.

2004

- Land application ended at the Webberville site. Because the Experimental Exemption was incorporated into the permit, it could no longer include the offsite fields at Webberville. Land application at Webberville stopped in late 2004.
- The Platt fields continue to be marked and mapped at the Hornsby Bend site.
- A new farming lease begins for the entire Hornsby Bend site utilizing two farmers and includes the fields under the Experimental Exemption (the Platt fields and Tract C).
- Platt fields are sprigged with Bermuda grass for hay production.
- A study of the repellent effects of composted biosolids (Dillo Dirt) on fire ants (*Solenopsis invicta*) with Texas A&M Cooperative Extension entomologist Elizabeth Brown begins.

2003

- Vegetation is shredded on Platts 1, 2, 3, and 4, which formerly grew row crops unsuitable for hay. Application of Unison Novel Broadleaf Herbicide to fields to control growth of broadleaf weeds.

- Hay is baled from Platts 5 and 6, which previously grew hay.
- The Texas A&M soils laboratory analyzes soil samples before land application begins at the Platt fields, and University of Texas students conduct preliminary biological assays on the samples.
- Fields at Hornsby Bend and Webberville receive biosolids land application.
- Organic control treatments for fire ants are studied on plots near Platt 6 in collaboration with Travis Extension.

2002

- Webberville study plots are enlarged in keeping with traditional farming practices and are applied with three rates of biosolids across sorghum and feed corn crops.
- The new Platt fields on the Hornsby Bend property are divided into six large-scale study plots [Platt 1 – 6] on 258 acres of agricultural fields in preparation for land application and sprigging to hay crops.
- The Platt fields are marked and mapped at the Hornsby Bend site with 10-acre buffer zones for roadways and wells. These buffer zones serve as control sites, which receive no biosolids land application to allow comparisons with the application plots.

2001

- The Experimental Exemption is granted by the (former) Texas Natural Resource Conservation Commission (TNRCC) to research the long-term effects of biosolids land application on soil biology. The Exemption includes offsite fields at Webberville as well as the Platt fields and Tract C field at Hornsby Bend.
- Land application of Class B biosolids begins to approximately 600 acres of farmland at Webberville (not part of the Hornsby Bend site) and includes multiple sets of one-acre research plots of land in varying application rates under the Experimental Exemption.

2000

The City purchases adjacent “Platt” agricultural and bottomland [457 acres], expanding the Hornsby Bend site to 1237 acres.

1988

The Center for Environmental Research (CER) is established at the Hornsby Bend site in partnership with the University of Texas and Texas A&M University.

1987

Biosolids composting begins as a pilot program to recycle City of Austin yard waste and a portion of the biosolids.

1986

Hornsby Bend Biosolids Management Plant is built as a reuse/recycling facility for all of Austin’s sewage sludge, including use of biosolids land application on permitted agricultural fields onsite.

1957

City of Austin sewage treatment ponds built at Hornsby Bend and total 185 acres.

XI. 2001 – 2004 Historical Narrative of Experimental Exemption design activity

Webberville

(Although the City no longer land applies biosolids at Webberville, the history of research at these fields provides information for the ongoing research at Hornsby.)

In its first year (2001), this project involved a first land application of Class B biosolids to some 600 acres of farmland at the Webberville site by Synagro, Inc., and the Austin Water Utility committed to a second hauling and application contract. The research team planned and laid out multiple sets of one-acre research plots at the Webberville site that received varying application rates of biosolids. First-year land application at Webberville concluded with no complaints from neighbors. In fact, neighboring farmers inquired about getting involved with the application program. The farmers receiving the biosolids were extremely impressed with the apparent increase in crop growth and productivity, and they became excited about the cumulative effects of continuing applications. Preliminary results indicated increased crop productivity correlating to increasing biosolids applications.

In the second year of application at Webberville, researchers, farmers, and the contractor, Enviroganics, Inc., learned a great deal. The small one-acre research plots were determined to pose more difficulties than the results warranted. Harvesting equipment could not accurately quantify the yields from such small areas. In addition, the research team had doubts about the accuracy of application in such small areas. As a result, the decision was made to change to larger field areas to be more in keeping with traditional farm practices. Fields were “banded” with three rates of application across sorghum and feed corn crops. Unfortunately, the spring season was unusually dry, and the crop yields were poor, and research results were adversely affected. Even with less than ideal weather, the farmers had greater yields from the biosolids applied areas than from commercial fertilizer. However, soil nitrate levels showed high in only one sampling below six inches. This occurred in field AC-1 and only in the area applied with 30 dry tons per acre. None of the other fields receiving this loading rate exhibited

this effect. Application was adjusted downward in the next year to avoid nitrate build up and movement.

In the third year of application, the fields were applied without the small research plots. A variety of crops harvested included hay, winter crops, and row crops such as sorghum and feed corn. The fields also included some pastureland for cows. Favorable rain in the spring allowed good harvests for the summer of 2004. According to the farmers, they experienced increasing yields in proportion to the amounts of sludge applied. The farmers continued to be very excited about the observed improvements in the soil and crops and anxiously awaited the next year's application. In addition, improvements in soil organic matter, fertility, and biological activity are expected over time with subsequent applications.

Some objections were raised by a neighboring community about the odors and "sludge dumping" occurring at the Webberville site. A meeting and presentation could not be coordinated with the community's City Council, but one of the concerned citizens visited the site and was given a tour. This citizen appeared to leave with a complete change of heart, observing nothing wrong with the sludge application program, and community objections subsided.

Because the Experimental Exemption was incorporated into the permit, it could no longer include the offsite fields at Webberville. Land application at Webberville stopped in late 2004.

Hornsby Bend

The research team began working in 2002 to design and create large research fields (25-30 acres) and small-scale research plots (1-4 meter$^{2)}$ on the new Platt fields at the Hornsby Bend property. However, because of experience with smaller plots at Webberville, the plan was adjusted to focus on only larger plots. Lessons drawn from the experience at Webberville influenced plot design. The research team worked closely with land application staff in laying out fixed roadways that defined field edges and minimized journeys across plots in order to avoid compaction.

During 2003 – 2004 all the plots were marked and mapped on the new Platt fields at the Hornsby Bend site, which were divided into six plots labeled Platt 1 through 6 (see attached map in Appendices). Buffer zones were created for roadways and wells, which continue to function as control sites that receive no biosolids for comparison to application plots. The six plots range in size from 22 – 60.7 acres with two plots receiving each rate of application. The large plots allow for the averaging of application rates across larger areas, avoiding the uneven application problems in small plots. These large plots also represent the decision of the research team to focus on "real world" application situations rather than artificial application protocols of small (meter square) plots. This decision was made because the small plots would not adequately address our research interest in long-term soil food web dynamics. Additionally, there has been little long-term research on large plots, and Hornsby Bend offers a unique opportunity to create large long-term plots.

Final Details of Platt Fields

FIELD	ACREAGE	BIOSOLIDS
Control areas	Approx. 10 acres	No application
Platt 1	60.7 acres	30 dry tons/acre
Platt 2	57.8 acres	30 dry tons/acre
Platt 3	47.5 acres	20 dry tons/acre
Platt 4	42.6 acres	20 dry tons/acre
Platt 5	26 acres	10 dry tons/acre
Platt 6	22 acres	10 dry tons/acre

Plot size and application rates on the Platt fields at Hornsby Bend

Permanent markers and vehicle roadways delineate all the plots. Roadbase was laid down for the main roadway between all the plots in order to concentrate vehicle travel to limited areas thereby avoiding compaction on the plots. Soil samples were taken before application began and analyzed by the Texas A&M soils laboratory. Additionally, during the summer of 2003, University of Texas students did preliminary biological assays on soil samples from the Platt fields. Before land application began in June 2003, vegetation was shredded on Platt 1, 2, 3, and 4 (which had been in row crops in previous years and were not suitable for hay), and hay was baled from Platt 5 and 6 (which were previously used for hay production).

During 2003 – 2004 a new farming lease was created for the entire farm site at Hornsby Bend (both the fields under the Experimental Exemption and the land under the standard permit). The lease began in the fall of 2004 and includes the farmer in research decisions about the crops grown and techniques used. All fields were converted to hay production, providing continuous ground cover and eliminating opportunities for runoff and erosion, while also supporting uniform crop-related comparisons across all fields.