City of Austin
Austin Water Utility

TCEQ Experimental Exemption Permit
Annual Research Report 2007-2008

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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Contents

I. REPORT SUMMARY 2007 – 2008

The current report reflects research activity under the Experimental Exemption for Permit WQ0003823000 for the period July 2007 – June 2008.

- USDA researchers from USDA-ARS Grassland, Soil, and Water Research Laboratory join the project
- Texas Parks and Wildlife Department Environmental Contaminants Laboratory to collaborate with research partnership
- Research partnership applies for $300,000 USDA research grant
- Expand research focus to include Emerging Environmental Contaminants [EEC]
- Host first Emerging Environmental Contaminants meeting for City of Austin
- University of Texas School of Geosciences begins hydrogeology research at Hornsby Bend
- University of Texas Geotechnical Engineering Program begins using Platt research fields
- Soil Food Web sampling and ground water sampling completed 2007
- Weather turns from flood in July 2007 to “exceptional” drought in June 2008 affecting soil sampling and hay production

II. 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.

This variation in application rates and practices is essential to achieve the goals of this study.

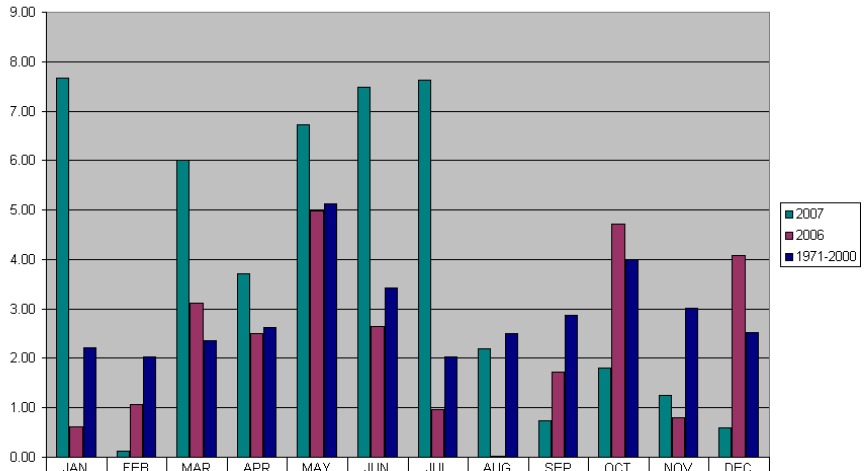
Summary table of fields at the Hornsby Bend site include:

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

IV. Climatology Report for 2007-2008

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. In addition to ample rains, June to August of 2007 was one of the more moderated summers in many years with more clouds, rain, showers and thunderstorms than usual. This meant ample soil moisture and great growing weather for hay crops in 2007. However the September 2007 to June 2008 period has been very dry, the fourth driest since 1943. Additionally, the May-July 2008 period has been very hot, since May 18, 2008 every day has been above 90 degrees. June 2008 was the third warmest since 1943 and the seventh driest with only .79 inches of rain. January to June 2008 rainfall was only 10.42 inches compared to 31.71 inches for the same period in 2007, and this lack of rain combined with high temperatures has pushed eastern Travis County into "exceptional" drought conditions.

Austin Bergstrom Monthly Rainfall 2007, 2006, and the 30 Year 1971 to 2000 Normal



	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
2007	7.66	0.12	6.00	3.71	6.73	7.49	7.62	2.19	0.73	1.80	1.26	0.60
2006	0.62	1.06	3.11	2.50	4.98	2.64	0.97	0.03	1.72	4.72	0.80	4.08
1971-2000	2.21	2.02	2.36	2.63	5.12	3.42	2.03	2.51	2.88	3.99	3.02	2.53

V. Key Events for 2007-2008

May – July 2007

University of Texas Geological Sciences Hydrogeology professors Dr. Jack Sharp and Dr. Bayani Cardenas and students begin research on groundwater at Hornsby Bend. This is a new collaboration to study the alluvial aquifer underneath the Hornsby Bend site by utilizing existing groundwater monitoring wells and by drilling new wells in order to create a cluster of wells in order to do "draw-down" studies. In June 2007, the University of Texas research team drilled the first new well near the Platt fields and hold part of a field course in hydrology at Hornsby Bend utilizing the research fields. They also bring University of Texas Environmental Science Institute NSF summer students for a field day to tour the biosolids recycling facility and the research fields in order to learn about groundwater monitoring.

Geoprobe soil core samples being taken on Platt 4 field June 2007

University of Texas Geological Sciences Hydrogeology professors Dr. Jack Sharp and Dr. Bayani Cardenas and students research on groundwater at Hornsby Bend.

University of Texas Environmental Science Institute NSF summer students with Dr. Cardenas and Jody Slagle measure groundwater depth

University of Texas Environmental Science Institute NSF summer students compare well depth between new and old wells near Platt 4 field

August - September 2007

Soil Food Web sampling completed after fields dry sufficiently for sampling. See results in appendix.

September 2007

USDA-ARS Grassland, Soil, and Water Research Laboratory research scientists, Dr. Virginia Jin and Dr. Mari-Vaughn Johnson tour the Hornsby Bend facility and propose collaboration on biosolids research.

October 2007

Groundwater monitoring is completed. See results in appendix.

October 2007

The second meeting with USDA researchers from USDA-ARS Grassland, Soil, and Water Research Laboratory in Temple, Texas is held to plan collaboration. It is decided to write a grant proposal to apply for USDA funds which would support the initial two years of research at the USDA laboratory. The focus of this proposal is to fund research on emerging environmental contaminants [EECs] in the soil food web and, in particular,

anthropogenic endocrine disrupting compounds. This new research collaboration can draw on USDA expertise to model the persistence and movement of these compounds using USDA-ARS's Soil and Water Assessment Tool (SWAT). We will then use SWAT to predict the long term effects of various biosolids management scenarios and climate variability on the persistence and infiltration of anthropogenic compounds. It is decided to invite the Texas Parks and Wildlife Department's Environmental Contaminants Laboratory to participate as additional collaborators.

November 2007

The USDA grant proposal planning meeting is held with USDA-ARS researchers and Texas Parks and Wildlife Department's Environmental Contaminants Laboratory staff. All participants tour the facility and TPWD ECL agrees to participate. AWU staff and USDA staff immediately begin writing a $300,000 grant proposal to fund two years of research beginning in the fall of 2008 if granted.

November 2007

Although not focused on biosolids research, the University of Texas Geotechnical Engineering Program begins using Platt research fields for seismic geosensor research in November. Their research needs large size fields with deep soils, and they learn of the Platt research fields from the Geological Sciences researchers. This new research is a synergistic effect of the TCEQ Experimental Exemption, and a new benefit for University of Texas research.

The University of Texas Geotechnical Engineering Program begins using Platt research fields

The University of Texas seismic geosensor array research in November 2007 on Platt 4 field.

Seismic research vehicle

Seismic geosensor array research

December 2007

AWU and USDA staff write and submit the $300,000 USDA grant proposal for biosolids research and emerging environmental contaminants. Notification of award for the grant will be in late summer 2008.

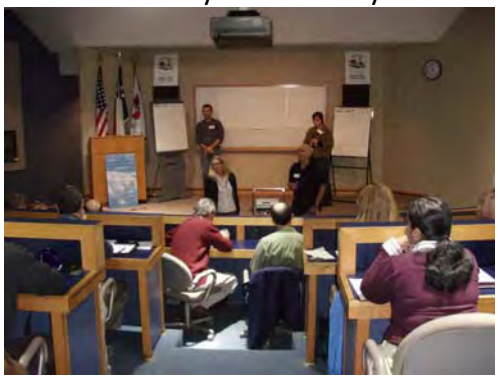
January and February 2008

As a result of the grant proposal, the CER plans and hosts the first meeting on Emerging Environmental Contaminants for the City of Austin. The purpose of the meeting was to discuss proposed research on environmental trace contaminants, identify priorities for Austin-area research, and brainstorm potential collaborations. Staff from across City departments attends representing the Austin Water Utility treatment plants and laboratories, COA Watershed

Protection, and COA Health and Human Services. Additionally, research staff from the USDA-ARS Grassland, Soil, and Water Research Laboratory including the Directory of the laboratory, Dr. Jeff Arnold, attends along with staff from the US Geological Service, LCRA, TCEQ, and Texas Parks and Wildlife Environmental Contaminants Laboratory. A total of 52 people attend the meeting on February 13th. CER Coordinator Kevin M. Anderson and Hornsby Bend plant environmental engineer Jody Slagle, and USDA research scientists, Mari-Vaughn Johnson and Virginia Jin, do presentations. Attendees tour the Hornsby Bend facility and the research fields.

Jody Slagle gives a presentation about the Hornsby Bend facility.

Kevin Anderson gives a presentation about the CER research projects at Hornsby Bend



David Greene, Jody Slagle, Mari-Vaughn Johnson and Virginia Jin lead a group discussion about EECs.

Mari-Vaughn Johnson and Virginia Jin of USDA give a presentation on EEC research opportunities at Hornsby Bend.

USDA research scientists, Mari-Vaughn Johnson and Virginia Jin, discuss research ideas for USDA proposal.

Jody Slagle and David Greene lead a tour of the composting pad.

March 2008

We held a research planning meeting between CER, USDA, and Hornsby Bend hay farmers to discuss placement of smaller research study plots for switch grass, but it was decided that it was too late to plant the switch grass for 2008 and that the dry weather conditions in 2008 was not conducive to starting these plots. We will reassess incorporating switch grass into the Platt fields next year.

April – June 2008

The University of Texas Geological Sciences Hydrogeology professors and students expand research on groundwater at Hornsby Bend. They drill a second well near Platt fields creating a cluster of three wells for drawdown studies. Two Master's students begin research on hydrology of river banks at Hornsby Bend to study groundwater and surface water interaction by installing piezometers in the river bank. Once again a hydrology field course is held utilizing the Platt research fields and includes measurements of soil moisture in the upper 8 inches of soil across a transect from the control buffers into the land application area in Platt 4.

Drilling the third well of the clustered wells near Platt 4 during June 2008

Collecting core samples of alluvial deposits beneath Platt 4 June 2008

Guest lecture by Dr. Jeff Paine on EM geophysical methods June 2008

Core samples of subsoil on Platt 4 research field June 2008

UT students taking measurements of soil moisture in the upper 8 inches of soil across a transect in Platt 4

UT students measuring soil moisture in across the transect from the control buffers into the land application area in Platt 4

UT Geology students installing piezometers in the river bank June 2008

UT geology students along the Colorado River at Hornsby Bend June 2008

July 2008

Due to “exceptional” drought conditions all soil sampling is delayed until it rains enough to produce sufficient soil moisture for sampling.

VI. 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, 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

USDA USDA-ARS Grassland, Soil, and Water Research Laboratory

USDA research scientists, Mari-Vaughn Johnson and Virginia Jin

Texas Parks and Wildlife Department - Environmental Contaminants Laboratory

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

V. The Soil Food Web Sampling

The soil food web conceptualizes soil biology as a complex, interdependent system of trophic levels (scales). Biological activity cycles energy and nutrients among trophic levels from photosynthesizing organisms (e.g., plants), decomposing organisms (e.g., bacteria and fungi), and higher-level predators (e.g., protozoa, nematodes, etc.). This cycling of energy and nutrients within the soil controls many of the conditions for plant growth. The abundance, activity and diversity of soil life are good indicators of a healthy ecosystem (i.e., one in which nutrient cycling and productivity are optimized). Studies of the soil food webs in different ecosystems have suggested that food web compositions are different for different ecosystems. Hence, grassland soils have been found to be dominated by bacteria, whereas forest soils are dominated by fungi.

Soil food web analyses evaluate active and total populations of bacteria and fungi, as well as numbers and diversity of organisms like protozoa, nematodes, and microarthropods. Specialized laboratory and microscopy techniques are required for this ecosystem-based research, some of which have been developed by Dr. Elaine Ingham's Soil Food Web laboratory in Corvallis, Oregon.

The soil food web analyses completed in 2006 and 2007 are the first two annual samples of the long-term monitoring effort at Hornsby Bend. As such, it is too soon to draw any conclusions about the analytical results generated to date. Subsequent analyses may reveal clearer trends and correlations among factors, but trends are not expected to become apparent until five years of data is compiled.

VI. Appendices

Previous key events by year for the Hornsby Bend Experimental Exemption Project

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.

- 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.

2001 – 2007 Details of activity at Webberville and Hornsby Bend Sites

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 planned 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.

Additionally, during 2003 – 2004 the buffer areas along the Platt fields were utilized for fire ant (*Solenopsis invicta*) research studies with Texas A&M Cooperative Extension entomologist Elizabeth Brown. During the summer and fall of 2003, organic control treatments were studied on plots near Platt 6. Anecdotal accounts of fire ants

disappearing from yards treated with Dillo Dirt, a biosolids compost, were reported, and so in May 2004 a study of biosolids compost (Dillo Dirt) application and fire ant response began. At the close of two-year study in 2007, findings were non-conclusive due to sporadic differences and inconsistency over time attributable to seasonal changes in mound densities and environmental conditions, including rainfall, topography, and variability of mound locations across all the plots. It was determined that further testing would be required to develop definite conclusions.


Hornsby Bend Well Locations
MW-19
Platt 10707
MW-18
MW-17
MW-20 Cluster
PW-1
MW-2
MW-1
MW-16
MW-3
MW-12
MW-15
MW-11
MW-13
MW-4
MW-14
MW-5
MW-10
MW-6
MW-7
MW-8
MW-9
N
0 0.125 0.25 0.5 Miles
Legend
Active Monitoring Wells
Inactive Monitoring Wells