The Etowah Cherokee Association of REALTORS® comprises 287 members, including REALTOR® members and affiliated businesses. Our office is located at S. 5th Street, Gadsden.

I am Sheila Freeman, President of ECAOR, speaking on behalf of the Association and its members.

Upon learning of the proposed sale of land and consideration for the Rendering Plant by the Gadsden Airport Authority and the City of Gadsden, the Association sought to determine the effect on property values and quality of life for all of Etowah.

A survey of our members has revealed

- 95% perceive the plant as harmful to the local real estate market.
- Area real estate agents have noted immediate adverse effects of the proposed plant: Transactions to purchase homes have been placed on hold, and decisions for home purchases delayed.
- Agents report clients who made recent purchases have expressed regret and fear for future property values.
- An estimated 30% or more of local real estate transactions in 2020 involved a buyer moving into our area from out of state. This is an upward trend. The Gadsden area is a CHOICE because of our beautiful river and the amenities that our city has to offer. Today, many buyers are not tied to a particular location; this may be due to a job that requires regional travel or allows remote work or retirement.

Our area's natural beauty and the rivers and lakes are priceless assets that influence property values. People want to live in areas that include outdoor activities such as parks, hiking, boating, and more. The livability of Gadsden and the surrounding communities would be greatly affected due to environmental hazards, health complications, and quality of life issues. We MUST GUARD our natural resources to protect property values. The environmental impact of a rendering plant is a genuine concern for every person in Etowah County.

The loss of real property value due to external factors is called "Economic or Locational obsolescence." One example is an industry that adversely impacts an area.

Economic obsolescence is INCURABLE, meaning that it is beyond the control of property owners. Appraisers and real estate brokers are required to include factors of economic and locational conditions that negatively impact a particular property on their reports.

What are the results of Economic Obsolescence?

- DECREASING property values on appraisals adversely affects loans for both the purchase of homes and refinancing.
- DECLINE in the CONSTRUCTION OF NEW HOMES which, in turn, negatively impacts contractors and the sale of building supplies and services.
- INCREASING Days on Market for properties, as people make choices not to live near such a site; this creates an additional reduction of property values.

Simply because a project is proposed or recommended does not necessarily make it a good fit for Etowah County or the right jobs for our people. It is a decision to be made locally with careful consideration to **doing the right thing** for all of our neighbors, our communities, and our children.

Why is Gadsden and Etowah County NOT the right choice for this project?

Etowah County is the smallest county in land area, ranked 67 out of the 67 counties in Alabama. It is one of the most densely populated, ranked 12 out of the 67 counties in population.

Most major rendering plants are located in rural agricultural communities with low population density.

Examples:

Ward, SC 91 persons

Broadway, VA, 3880 persons

Timberville, VA, 2645 persons

The rendering plant in Hanceville, Al, population 3,391, is located **8.6 miles OUTSIDE** the city limits in a rural agricultural setting with no other adjoining towns.

In comparison, at a two-mile radius from the proposed site, more than 2500 properties, and three schools are impacted. At a radius of 4 miles from the plant, over 10,000 properties and four schools are affected. (Etowah County Tax Records). Studies of areas with "Animal Operations" indicate loss of property value from 10% to 60% depending on proximity to the plant.

ECAOR members sell real estate in surrounding counties in Northeast Alabama. As the largest city, Gadsden **is the hub or center of commerce for our entire county.** Our clients and customers who live in Etowah County and the adjoining towns and counties, rely on Gadsden for shopping, restaurants, medical care, and other services. Many live outside of the Gadsden City limits but work in Gadsden, or own businesses in Gadsden. Gadsden benefits directly from the support of **All** of the people in these communities. The City of Gadsden's economy is closely intertwined with all of Etowah County and especially adjoining towns. **So much so that a city data map of Gadsden, AL** includes the zip codes for Attalla, Rainbow City, and Glencoe **as the greater Gadsden area**. (see attached.) Because of the close connection of the local economies, property values are also **intricately connected.**

To protect property values, we must balance local needs and concerns with the needs and concerns of neighboring communities and the region. We must ensure decisions serve the public interest AND that the City of Gadsden is a " good neighbor." **We are all in this together; what affects one of us affects all of us. And we are, in fact, Better Together and Stronger Together.**

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Greenfield Advisors
Economic, Market and Valuation Analysts

August 22, 2012

[redacted]

In re: Delta County

Dear Client:

Thank you for the opportunity to talk with you and your neighbors about the chicken plant which is being developed near your home. As I understand it, you have asked me to comment on the likely impacts on the value of nearby real estate stemming from the development of this enterprise.

I also understand that this letter may be presented to local officials, the media, attorneys, and members of the general public. To aid these potential readers in understanding who I am, why I have been asked to write this, and what the limitations on this opinion are, it is important that I note two things at the onset. First, although I am a Colorado State Certified (General) Real Estate Appraiser, this memorandum does not constitute an appraisal *per se* as normally defined by the Uniform Standards of Professional Appraisal Practice or, as I understand it, Colorado state law and regulation. It is simply a summary of my professional experience and training on matters such as this. However, given the breadth and depth of that experience, it is safe to say that the matters on which I opine in this letter represent those which an appraiser in Colorado, or any appraiser anywhere for that matter, would be well advised to consider when conducting an actual appraisal of a home or other property impacted by a animal operation ("AO").

Second, why is an appraiser from Seattle opining about Colorado real estate? Greenfield Advisors consults on projects throughout the U.S. and, occasionally, the rest of the world. We are best known for appraising properties with negative environmental impacts – and animal feeding operations fall into that category. We also do many other things, and our clients in recent years have included the University of Chicago endowment (advising on the value of real estate holdings) and the Hearst Family (advising on the preservation of the Ranch at San Simeon, California) as well as individual property owners and government entities affected by contamination problems. We are frequently engaged in very complex, high-profile litigation matters, such as the Gulf Oil Spill, the *Exxon Valdez* Oil Spill, the Celebrity Cruise Lines Legionnaires' Disease case, post-Hurricane Katrina class actions, Chinese Drywall cases, and others. For example, I was the sole testifying expert for the affected property owners in *Allison versus Exxon,* in which just last year a jury in Baltimore awarded 154 property owners $1.5 Billion in damages resulting from environmental impacts. (A complete copy of my professional qualifications is attached to this letter).

More specifically, I wrote an article for *The Appraisal Journal* in 2001 titled "Concentrated Animal Feeding Operations and Proximate Property Values". This journal is published by the Appraisal Institute, and it is widely read and often relied upon by practicing appraisers. I understand that in the past decade this article has gained a significant following as one of the more authoritative sources for appraisal guidance on the impact of animal operations and is widely cited by appraisers in their work in this arena. Indeed, when I was conducting additional research for this matter, I found myself cited in the bibliography of other more recent published papers.

Since 2001, I have consulted on several projects, particularly litigation projects, in which an AO was affecting surrounding property values. I've summarized those as follows. What do we know about the impacts of AOs on surrounding property values? In short, it is clear from the broad array of empirical studies and case studies that diminished marketability, loss of use and enjoyment, and loss of exclusivity results in a diminishment which can range from 50% to nearly 90% of otherwise unimpaired value for homes which are adjacent to the facility. Negative impacts are noted at distances exceeding 3 miles, and in the case of a flood or other weather event, waste from the facility can be spread over far greater areas.

Overview of the AO Literature

AOs are often called "feedlots", but they may also include other kinds of processing operations. They may include facilities in which animals are raised or facilities in which animals are brought for slaughter. The common denominator is a large perpetual inventory and density of animals[1]. AOs are a relatively new phenomenon. The genesis of the AO is generally credited to Smithfield Slaughterhouses in North Carolina in the late 1980's. Large numbers of genetically enhanced hogs were kept in pens and dosed with antibiotics, then fed growth enhancers. Waste run-off was discharged onto adjacent landscapes and waterways[2].

Recent data from the U.S. Department of Agriculture (USDA) and the Environmental Protection Agency (EPA) estimate that livestock in the U.S. produce 130 times the total amount of manure as the entire human population of the country. One hog excretes nearly 3 gallons of waste per day, or 2.5 times the average human's daily total. A 3,000-sow hog factory will produce about 25 tons of raw manure a day[3]. A similar number of chickens, for example, will produce about 700 pounds of manure per day (plus or minus 30%), containing about 9 pounds of nitrogen gas, 7.5 pounds of phosphorus pentoxide (a powerful irritant and corrosive) and over 4 pounds of potassium oxide, a highly reactive deliquescent that reacts violently with water to produce potassium hydroxide[4].

Spills from AOs have killed fish in several states; excessive levels of phosphorus in land and water have been correlated with livestock density; and manure has caused eutrophication and degradation of U.S. waterways[5]. AOs are generally recognized to affect the surrounding environment in several key ways: air quality and odors (ammonia, hydrogen sulfide, methane, and particulate matter), greenhouse gas and climate change, insect vectors (often carrying resistant strains of pathogens), groundwater and surface water contamination, and a variety of pathogens[6].

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[1] Quite a few documents were reviewed to develop this section – see subsequent footnotes for details. However, much of the nomenclature comes from Kershen, Drew L. and Chuck Barlow, "Concentrated Animal Feeding Operations and Water, Air, Land, and Welfare", a report on the ABA's Special Committee on Agricultural Management Roundtable II on Environmental Challenges in Animal Feeding Operations, dated September 23, 1999. Mr. Kershin is a professor of law at the University of Oklahoma, and Mr. Barlow is an adjunct professor of law at Mississippi College. The two professors co-chaired the ABA's roundtable, which is the subject of their report.

[2] Dines, R.E., D. Henderson, and L. Rock, "The Case Against Intensive Hog Operations", unpublished working paper.

[3] Hopey, Don, "Study Finds Large Hog Farms Lower Property Values", Post Gazette, 6/7/2003.

[4] Tao, Jing, and Karen Mancel, "Estimating Manure Production, Storage Size, and Land Application Area", Ohio State University, 2008 Agricultural Fact Sheet.

[5] Jann, Stephen, "Recent Developments in Water Pollution Control Strategies and Regulations", a talk presented at the ABA's Special Committee on Agricultural Management Roundtable II on Environmental Challenges in Animal Feeding Operations, Minneapolis, MN, May 12, 1999.

[6] Hribar, Carrie, Understanding Concentrated Animal Feeding Operations and Their Impact on Communities, National Association of Local Boards of Health, 2010

For example, on September 15, 2006, the U.S. Food and Drug Administration (FDA) issued a press release informing consumers of an outbreak of E. coli 0157:H7 that began between August 26 and September 12, and was associated with the consumption of fresh spinach. By October 10, there had been 199 reported cases of infection related to this outbreak in 26 states including 31 case of Hemolytic Uremic Syndrome, 102 hospitalizations and 3 deaths. This stimulated national recalls of fresh-bagged spinach for products either bagged by or purchased from Natural Selection Foods, LLC of San Juan Batista, California. The spinach implicated in the outbreak was grown in the Salinas Valley region of California, which is located 100 miles south of San Francisco Bay Area.[7]

The FDA released a guide to minimizing Microbial Hazards in 1998, and lists potential sources of this type of contamination including: agricultural water, wild or domestic animals, worker hygiene, production environment (use of manure, previous or adjacent land use), and sanitation of facilities and equipment.[8] An *L.A. Times* article concerning the outbreak stated that growers do not draw water from the local surface water source for agriculture use because they are known to be contaminated from AOs. The Centers for Disease Control, the California Department of Health Services, and the FDA finally traced the source of the contamination to manure[9].

One of the leading causes of food and waterborne illness in the United States is this E. coli 0157:H7 organism. The E. coli 0157:H7 is a specific strain of the Escherichia coli bacteria, and it can commonly be found in the intestines of healthy cattle. One of the common means of transfer to humans is when untreated manure is able to enter water sources or used for fertilization.[10] AOs are regarded as potential sources for contamination because of the large amounts of manure that they produce, and the proximity in which the animals are confined allows for disease to be easily transferred.[11] The reduction in space that the animals inhabit requires that the facility must collect and process the waste instead of letting it lay where it falls.[12] It was because of their potential to spill that EPA acting under the Clean Water Act designated AOs as point sources of pollution and required that they have zero discharge, or apply for a permit that requires an extensive Waste Management Plan. Even with these regulations spillage will typically occur when manure storage locations are allowed to spill due to flooding, leeching into the soil, or through disregard of regulations (see the Central Industries matter, cited later in this letter, as an example of such violations). The EPA's data from the 2000 Inventory lists agriculture as the fifth leading contributor to general water quality impairments. Although the data did not explicitly review contamination because of AOs, water quality concerns were greatest in regions that were intensively cultivated and where livestock operations were concentrated.[13]

Because the trend toward AOs has been so rapid and pronounced in the U.S., federal and state laws are generally considered to have some gaps. In addition to water quality issues resulting from manure and

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[7] "FDA Announces Findings from Investigation of Foodborne E. coli 0157:H7 Outbreak in Spinach U.S. Food & Drug Administration. 2 Oct. 2006 <http://www.fda.gov/bbs/topics/NEWS/2006/NEW01474.html>.
[8] "Guide to Minimize Microbial Food Safety Hazards for Fresh Fruits and Vegetables." U.S. Food & Drug Administration 28 Sept. 2006 < http://www.cfsan.fda.gov/~dms/prodguid.html>
[9] "Tainted spinach tied to cattle ranch," Los Angeles times, March 24, 2007
[10] "Disease Listing, Escherichia Coli 0157:H7, Gen Info" Center for Disease Control & Prevention 2 Oct. 2006 <http://www.cdc.gov/ncidod/dbmd/diseaseinfo/escherichiacoli_g.htm>
[11] "National Pollutant Discharge Elimination System Permit Regulation and Effluent Limitation Guidelines and Standards for Concentrated Animal feeding Operations (CAFOs); Final Rule" Federal Resister 68 (12 February 2003)
[12] Ikerd, John "Social, Econmoic, and Cultural Impacts of Large-Scale, Confinement Animal Feeding Operations." Working Paper, University of Missouri (Viewed Oct. 2, 2006)
[13] "National Pollutant Discharge Elimination System Permit Regulation and Effluent Limitation Guidelines and Standards for Concentrated Animal feeding Operations (CAFOs); Final Rule" Federal Resister 68 (12 February 2003)

waste run-off, these facilities attract flies and other insects and then other pests that parasitize the insects[14].

Prof. John Ikerd, an agricultural economist with the University of Missouri, Columbia, sums up the problems quite succinctly in a recent working paper, using hog AOs as an example, when he says, "Piling up too much 'stuff' in one place causes problems." He goes on to comment, "If you spread out the hogs and let hog manure lay where it falls in a pasture, it doesn't bother anyone very much. But if you start collecting it, flushing it, spreading and spraying it around – all normal practices in confinement hog operations – it becomes air pollution."[15]

As a result of the noxious and obvious problems associated with AOs, many states have enacted severe restrictions on permitting. For example, in 1997 the legislature of typically livestock-friendly Oklahoma mandated setbacks and other pollution controls, and in 1998 that legislature enacted a moratorium on new livestock permits[16]. Kansas is another typically agriculture-friendly state which has recently enacted a moratorium on AOs and is considering legislation to end AOs[17]. In 1998, the North Carolina legislature – the home of AOs and faced with unregulated establishment of AOs in that state – enacted House Bill 1480, which mandated the registration of growers for integrators, extended a moratorium, and mandated substantial elimination of both atmospheric emission of ammonia as well as odor beyond the boundary of existing AOs[18]. Minnesota had enacted similar odor control legislation in 1997, and established both a complaint control protocol and an enforcement response protocol specific to AOs[19].

In 2000 – 2001, the U.S. Environmental Protection Agency began levying fines against concentrated beef production facilities in the Northwestern U.S. which met two criteria: the facility confined animals for at least 45 non-consecutive days per year and the confinement area was devoid of vegetation. The rules generally applied to any operation with 300 head of cattle or more. At the time of the regulations, the EPA estimated that this would affect between 26,000 and 39,000 AOs in the U.S[20].

An AO affects the value of proximate properties in two ways. First, the AO is viewed by market participants as a negative externality[21]. As an externality, it is not typically considered to be

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[14] "Concentrated Animal Feeding Operations – Resources for Environmental Responsibility", working paper prepared by Smith-Comeskey Ground Water Sciences, April 1, 2000. See http://www.groundwatersystems.com/agwaste.html for more details.

[15] Ikerd, John, "Social, Economic, and Cultural Impacts of Large-scale, Confinement Animal Feeding Operations", U. of Missouri unpublished working paper.

[16] Stephens, Michelle, "NGO and Grassroots Perspectives and Action", a talk presented at the ABA's Special Committee on Agricultural Management Roundtable II on Environmental Challenges in Animal Feeding Operations, Minneapolis, MN, May 12, 1999.

[17] Myers, Roger, "Graves May Lift Licensing Ban on Large-Scale Hog Farming", The Topeka Kansas Journal, Saturday, January 24, 1998.

[18] Williams, C. Mike, "CAFO Odor Control Options", North Carolina State University unpublished working paper presented at the ABA's Special Committee on Agricultural Management Roundtable II on Environmental Challenges in Animal Feeding Operations, dated September 23, 1999.

[19] Sullivan, Mike, "Minnesota's Program Regarding Hydrogen Sulfide Emissions from CAFOs", Minnesota Pollution Control Agency unpublished working paper presented at the ABA's Special Committee on Agricultural Management Roundtable II on Environmental Challenges in Animal Feeding Operations, dated September 23, 1999.

[20] Steward, Peggy, "Cattlemen Find CAFO Rules Confusing", Capital Press Agricultural Weekly, 3/9/2001, page 9. Also, www.epa.gov/owm/afo.htm. Also, Hansen, Alice Sherman, "CAFO Rules May Prompt Need for Farm Consultants," Capital Press Agricultural Weekly, 2/9/2001. Also, Steward, Peggy, "EPA Fines Toppenish Feedlot," Capital Press Agricultural Weekly, 3/2/2001, page 12.

[21] For a thorough discussion in this context, see The Appraisal of Real Estate 11th ed, and specifically pages 46-48, 336-337, and 398.

economically "curable" under generally accepted appraisal theory and practice[22,23]. Hence, the value diminution of a property attributable to proximate location of an AO can be attributed to stigma.

Second, as Gomez and Zhang (2000) have substantiated[24], AOs have a substantial indirect negative impact on surrounding communities, which would include property values in those communities, via shifts in sources of purchases and other inputs in the factors of production. Gomez and Zhang studied 1106 rural communities and concluded that economic growth rates in communities with conventional farming were 55% higher than in those with AOs. They note that conventional farmers buy most or all of their supplies locally, thus stimulating the local community and, by extension, stimulating the local real estate market. On the other hand, AOs bypass local retailers and import the factors of production. AOs exacerbate the economic negative impact by "importing" large quantities of pollution and the attendant costs. Hence, local communities suffer the negative economic byproducts without the attendant economic benefits.

The Gomez and Zhang study was reinforced by a more recent study by Kim and Goldsmith (2008), in which they studied property values of 2,155 homes located within 3 miles of an AO in North Carolina. The principle focus of their study was on spatial hedonics (in short, the impact of distance), but within a three-mile area, they found the average impact to be *negative* 18%. At one mile, the impact was *negative* 23.5%[25].

Similarly, Kuethe and Keeney (2012) examine the scale of an AO to determine which factors specifically contribute to property losses[26]. Intriguingly, they found that the negative impacts of AOs are comparable to those generated by industrial waste, solid waste, and septic waste facilities. They focused on airborne-related problems, and noted two things which are germane to the problem at hand:

1. Odor is a particular source of nuisance
2. Higher valued neighboring properties (e.g. – residences) are more severely impacted than lower valued ones

The odor and airborne particulate issues have been explored by two studies in Iowa (2002) and two in North Carolina. The first North Carolina study[27] reported emotional impacts (tension, depression, anger, reduced vigor, fatigue, and confusion) linked to airborne contamination emanating from an AO The second North Carolina study[28] reported increased incidences of headache, runny nose, sore throat, excessive coughing, diarrhea, burning eyes, and "reduced quality of life." The first Iowa study[29] found

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[22] The Appraisal of Real Estate, op. cit, pgs. 336-337.
[23] Smith, Hal, and John Corgel, Real Estate Perspectives 2nd, (Boston: Irwin, 1992), pg. 524 specifically deals with the incurability of external obsolescence.
[24] Gomez, Miguel, and Liying Zhang, "Impacts of Concentration in Hog Production on Economic Growth in Rural Illinois", Illinois State U. working paper presented to the American Agricultural Economics Association, July, 2000.
[25] Kim, Jungik, and Peter Goldsmith, 2008, "A Spatial Hedonic Approach to Assess the Impact of Swine Production on Residential Property Values", Environmental Resource Economics 42-4, 509-534.
[26] Kuethe, Todd H., and Roman Keeney, "Environmental Externalities and Residential Property Values: Externalized Costs along the House Price Distribution", 2012, Land Economics 88-2, 241-250.
[27] Schiffman, S., E. Miller, M. Suggs, and B. Graham, 1995 "The Effect of Environmental Odors Emanating from Commercial Swine Operations on the Mood of Nearby Residents," Brain Research Bulletin 37, 369-375.
[28] Wing, S. and S. Wolf, 2000, "Intensive Livestock Operations, Health, and Quality of Life Among North Carolina Residents," Environmental Health Perspectives 108, 233-238
[29] Thu, K., K. Donham, R. Ziegenhorn, S. Reynolds, P. Thorne, P. Subramanian, P. Whitten, and J. Stookesberry, 1997 "A Control Study of the Physical and Mental Health of Residents Living Near a Large-Scale Swine Operation," Journal of Agricultural Safety and Health 3, 13-26.

increases in eye and upper respiratory problems among those living within 2 miles of an AO. The second Iowa study[30] summarized the extant empirics, including studies of AO workers, and concluded two things:

1. "There is now an extensive literature documenting acute and chronic respiratory disease and dysfunction among workers, particularly swine and poultry workers, from exposures to complex mixtures of particulates, gases, and vapors."
2. "It is, therefore, also concluded that CAFO air emissions may constitute a public health hazard."

Even the owners of AOs understand this problem. Greenfield Advisors was engaged by the owners of a closed AO in eastern Washington (the Shaake Feedlot, Ellensburg, Washington) to advise on adaptive re-use of the facility. The livestock slaughter business had been purchased by a consolidating firm which did not want to buy the real estate itself. The business was consolidated to another facility in distant town, leaving the host town with an abandoned, contaminated site. The business, which had originally been promised as an economic boon to the town, now employed no one. In addition, the real estate which remains after an AO is closed is contaminated and value-less, and thus no longer producing local tax revenues. As a final insult to the local economy, the contaminated AO site was a blight on surrounding development[31].

In 2008, the EPA published revised regulations which addressed the Federal 2nd Circuit's ruling in Waterkeeper Alliance v. EPA. Some aspects (particularly certain requirements for National Pollutant Discharge Elimination System (NPDES) permitting for water runoff) were struck down by the 5th Circuit in 2011 (*National Pork Producer's Council v. EPA),* but the remainder of the regulations stand in force, recognizing the significant environmental impact of an AO.

Extensive studies reveal the impacts of AOs on community life and values. The 2002 Iowa State/University of Iowa study cited the Gomez and Zhang (2000) research which documented the negative impact of AOs on the economy of the surrounding community, as revealed by sales tax receipts and reduced local purchases. This finding replicated an earlier Michigan study, which showed, somewhat ironically, that AOs had the effect of crowding out more traditional farmers, and purchases by those farmers decreased in local stores[32]. Indeed, a similar study out of Minnesota found that smaller farms made nearly 95% of their expenditures locally, while larger operations spent less than 20% locally[33].

These problems have been well known and documented by the State of Colorado for some years. In a study performed for the Colorado State University Extension Office this year, poultry operations and swine operations were lumped together as generators of biogas, "containing methane and carbon dioxide." The study was conducted to examine the feasibility of anaerobic conversion, and noted that there was a fairly high threshold of cost and requirements for this to be feasible. In support of this, the study documented ten recent lawsuits in which claimants were awarded as much as $50 million for

[30] Iowa Concentrated Animal Feeding Operations Air Quality Study – Final Report, Iowa State University and the University of Iowa Study Group, February, 2002
[31] Source: Greenfield Advisors LLC files and personal inspections
[32] Abeles-Allison, M., and L. Connor, 1990, An Analysis of Local Benefits and Costs of Michigan Hog Operation Experiencing Environmental Conflicts, Department of Agricultural Economics, Michigan State University.
[33] Chism, J., and R. Levins, 1994, "Farm Spending and Local Selling: How Do They Match Up?", Minnesota Agricultural Economist 676, 1-4

agricultural nuisance. Notably, the two largest awards cited ($50 million and $19 million) were for poultry operations[34].

These economic issues lead inexorably to property value declines, as will be more fully discussed in the remainder of this letter.

Impairment and Value – an Overview

From an economic perspective, the rights enjoyed by a fee-simple owner fall into three categories:

1. Right of use
2. Right of exclusion, and
3. Right of transfer[35]

It is important to note that in the United States, property itself is not "owned," but rather the rights of the property are owned[36]. The ability to delineate these rights, and the ability of owners to transfer some or all of these rights voluntarily is a necessary condition for property valuation.

The first of these, the right of use, is generally interpreted to mean that the owner may determine how property will be used, or if it is to be used at all. The right of use is traditionally limited in western culture by both public restrictions (e.g. -- eminent domain, police power) and private restrictions (e.g. -- liens, mortgages). Private restrictions are generally voluntary, and property owners willingly submit to the disutility of such restrictions in trade for some other economic benefit. For example, a property owner will issue a mortgage to a lender in trade for leverage in the purchase. Also, a homeowner will purchase in a subdivision with covenants and restrictions in trade for the assurance of uniform property use within the neighborhood. It is noteworthy to stress that the voluntary acceptance of private restrictions is always in trade for some economic compensation. Impairment places a restriction on the right of use without some economic compensation. This is illustrated in potential restrictions which may be placed on the use of real estate due to a physical impairment and which can thus limit the property to something less than its highest and best use.

The right of exclusion -- often called the right of exclusive use or right of exclusive enjoyment -- provides that those who have no claim on property should not gain economic benefit from enjoyment of the property. In other words, the right of use is exclusive to the property owner, and any violation of the right of exclusive use typically carries either payment of compensation to the rightful owner or assessment of a penalty. For example, if "A" trespasses on land owned by "B," then "A" will be guilty of a crime and a possible criminal penalty may be in order, as well as civil damages. Physical impairment by a third party is, in effect, a trespass on property rights, violating the right of exclusion.

Society places a high value on the right of exclusion, for justifiable reasons. Exclusion provides that both the current benefits of ownership as well as future benefits accrue only to the rightful owner, and his/her successors and assigns. In the absence of exclusion, the right of use is under constant threat of nullification without just compensation. In an economy without the right of exclusion, property owners would adopt short-term strategies for use, rather than long-term strategies. In an economic sense, this

[34] Keske, C., 2012 "Determining the Economic Feasiblity of Anaerobic Digestion in Colorado: Guidelines for Animal Farm Producers", CSU Extension Fact Sheet 1.229.

[35] While delineated in one fashion or another in many texts, this specific wording derives from Jaffee, Austin J. and Demetrios Louziotis, Jr., "Property Rights and Economic Efficiency", Journal of Real Estate Literature 4, July, 1996, pg. 137-162.

[36] Alchian, Armen A. and Harold Demsetz, "The Property Rights Paradigm", Journal of Economic History 53, March 1973, pg. 16-27. Also, see Demsetz, Harold, "Toward a Theory of Property Rights", American Economic Review 57, May, 1967, pg. 347-373.

would lead to widespread inefficiency in the allocation of resources. Hence, the right of exclusion carries with it a significant societal good[37], and thus a significant societally-recognized value.[38]

Finally, the right of transfer provides the owner with the ability to swap one resource for another. An impairment restricts the right of transfer, and may in fact destroy the right of transfer altogether.

Effects of Proximate Contamination on Property Values

Real estate economics – and appraisal practice – uniformly recognizes that contamination has a negative impact on property values. Indeed, appraisers are required by the Uniform Standards of Professional Appraisal Practice to consider the impacts of such contamination in the value estimation process[39].

Fitchen (1989)[40] was one of the first to look at the value of the rights of a property owner in the face of impairment – in this case, a toxic chemical pollution. As an anthropologist and a Professor of Anthropology at Ithaca College, she looked principally at residential values, and not only at the real aspects of "violation of the home" by contamination (e.g. – carcinogenic effects of polluting chemicals) but also the symbolic interference on what she called "...a threat to the assumptions people have about themselves and the way life is supposed to be[41]." She continued, "Toxic contamination also attacks the valued institution of homeownership, violating many of the rights that are assumed to flow from the ownership of ones home, including the assumed right to control entry to it....chemical contamination may affect homeowners more seriously than renters, not only in terms of potential financial loss, but also in terms of devaluation of the achieved status of homeowners."

Edelstein (1986) also dealt with this "home" theme, and he called impairment to or near a residence an "...inversion of home..." when "...the previous locus of family security and identity becomes instead a place of danger and defilement.[42]" He builds on previous works, such as Perin (1977)[43] and Altman and Chemers (1980)[44], who show the very special place the home has in American society, culture, and economics. To quote Perin (1977): "Not being a nation of shopkeepers, America is one of homeowners, busily investing in plant maintenance and expansion with both money and time, keeping the product attractive for both use and sale.[45]"

Edelstein (1986) specifically stressed the investment diminution aspect of the inversion of home principle. In citing case studies of experiences following neighborhood-wide impairment in the Legler section of Jackson Township in southern New Jersey, he showed that residents could not separate the psychological pride in home ownership from the question of economic value. Surveys of the population

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[37] See, for example, Snare, Frank, "The Concept of Property", American Philosophical Quarterly 9, April 1992.
[38] Stigler, George, "Law or Economics?", Journal of Law and Economics 35, October, 1992, pg. 455-469.
[39] This is specifically covered under USPAP Rule 1-2(e). An appraiser may not fail to take physical disutility into account, except through a totally fictional hypothetical condition, the impact of which must be disclosed under USPAP Rule 2-1(c). A thorough discussion of the appraiser's responsibility is also contained in Eaton, J.D., Real Estate Valuation in Litigation (Chicago: The Appraisal Institute, 1995). For specific references, see pages 128, 129, 149-54, and 235-37. It is clear that an appraisal of a residence which fails to account for a physical deficiency such as a failure in the siding would violate the Uniform Standards. As of this writing, all 50 states have adopted these standards as a matter of law. In addition, adherence to these standards is mandatory for all federally-insured mortgage transactions.
[40] Fitchen, Janet M., "When Toxic Chemicals Pollute Residential Environments: The Cultural Meanings of Home and Homeownership," Human Organization 48, Winter, 1989, pgs. 313-324.
[41] Ibid, pg. 320.
[42] Edelstein, Michael R., "Toxic Exposure and the Inversion of the Home", Journal of Architecture Planning and Research 3, 1986, pgs. 237-251.
[43] Perin, Constance, Everything in its Place: Social Order and Land Use in America (Princeton: Princeton University Press, 1977)
[44] Altman, I, and M. Chemers, Culture and Environment (Monterey: Brooks/Cole Publishing, 1980)
[45] Perin, op, cit., pg. 120.

found uniformity of opinion that property values had diminished as a result of the problem. While previous studies had focused on the diminution of value from exiting homes, Edelstein (1986) was one of the first to focus on the opportunity costs stemming from the inability to move. In short, homeowners were stuck holding unsellable homes with stagnant prices, while homes in other neighborhoods were soaring in value. Thus, the owners were harmed not only by the diminution of value in the existing residences, but by the opportunity costs inherent in lost gains from alternative home investments.

Value Loss: Stigma Issues

Edelstein (1986) refered in a general sense to the issue of stigma as a mechanism for manifestation of value diminution in residential property. Stigma is an increasingly common term in the appraisal and real estate economics literature, and refers in fact to a very specific quantitative mechanism by which value is impacted by proximate contamination or negative externalities.

The earliest references to stigma as a quantitative concept in real estate economics appears to be in the writings of Patchin (1991)[46] and Mundy (1992)[47]. This latter study differentiated between the costs to cure and stigma. The former is an out-of-pocket expense born by either the property owner or some other responsible party, while the latter manifests in property value diminution even in the absence of a cost to cure. For example, a property which is completely cured may continue to suffer a diminution in value, and hence damages, as a result of stigma.

Kilpatrick (1999) outlined the quantitative model by which the value of income producing property is reduced by stigma effects, which are manifested via increases in market driven capitalization rates[48]. He outlined four components of income producing property value impacts: Net Operating Income, actual Cost-to-Cure, Ongoing Increases in Maintenance, and Stigma. In his model, the stigma losses actually overwhelm the other three factors as a component of value diminution. He concluded that, under many circumstances, the stigma impacts are actually the greater portion of value losses to property owners.

Overview of the Air Quality Literature

The valuation literature on the impact of air quality on residential property values traces its origins to Ridker and Henning (1967)[49], who used 1960 Census information in St. Louis and measures of both sulfation and suspended particulates to show a direct correlation between poor air quality and property value diminution. In the wake of their groundbreaking hedonic study, the consensus of studies has shown this causal relationship.

In 1974, Deyek and Smith studied 100 metropolitan areas using 1970 Census data and compared housing values with air pollution[50]. They found a statistically significant relationship between housing values and air pollution across the U.S. Harrison and Rubinfeld (1978) examined owner-specific house values in Boston against NO_2 levels and found highly statistically significant value diminution[51]. Nelson

[46] Patchin, Peter, "Contaminated Properties – Stigma Revisited", Appraisal Journal, April, 1991, pgs. 162-172.
[47] Mundy, Bill, "Stigma and Values", Appraisal Journal, January, 1992, pgs. 7-13.
[48] Kilpatrick, John, "Appraisal of Contaminated Property", presentation to the IAAO, 1999.
[49] Ridker, R.G., and J.A. Henning, "The Determinant of Residential Property Values with Special Reference to Air Pollution", Review of Economics and Statistics 49-2, 1967, 246-57.
[50] Deyek, T.A., and V.K. Smith, "Residential Property Values and Air Pollution: Some New Evidence", Quarterly Review of Economics and Business 14-4, 1974, 93-100.
[51] Harrison, D., and D.L. Rubinfeld, "Hedonic Housing Prices and the Demand for Clean Air", Journal of Environmental Economics and Management 5, 1978, 81-102.

(1978) examined median property values by census tract in Washington, DC, against particulate and oxidant concentration, again finding statistically significant value diminution[52].

Li and Brown (1980) examined sales prices in suburban Boston towns relative to sulfur dioxide and total suspended particles, and found statistically significant diminution. Murdoch and Thayer (1988) used 1979 sales data from California and found property value diminution from a variety of air quality issues[53]. Zabel and Kiel (2000) studied nitrogen dioxide and sulfur dioxide in four different urban areas, and consistently found negative property value diminution[54].

Kiel and Boyle (2001)[55] noted that the most significant air quality studies are those which measure impacts which are important to homeowners. In other words, air quality issues which directly impact homeowners' enjoyment of their property will have a measurable, direct, and statistically significant impact on property values.

Case Studies, Surveys, and Comparable Properties

North Carolina Statewide Study[56]

Palmquist, et Al., were the first to quantitatively determine that AOs depressed nearby home values and to determine a model for spatial impacts of AOs. They were able to measure differential impacts at 0.5, 1.0, and 2.0 miles.

Iowa Study[57]

Weida (2004) cites a Padgett and Johnson 1996 which followed up on Palmquist. They reportedly found that homes within ½ mile of an AO decreased in value by 40%, within 1 mile by 30%, 1.5 miles by 20%, and 2 miles by 10%.

Minnesota Study[58]

In 1996, the Minnesota Department of Agriculture commissioned a study to be done by researchers at the U. of Minnesota on the topic of value diminution resulting from proximate AOs. In addition to substantial secondary research in the area, the study authors also conducted primary research into value impacts in that state. Specifically, they conducted a hedonic price analysis on 292 rural residences which sold in 1993-94 in two Minnesota counties. They find a statistically significant pricing impact related both to the existence of an AO as well as the distance to the AO. In other words, not only is an AO a significant impact on house price, but the nearer the AO, the more of an impact it is. However, they also find that AO's tend to be located near older or lower valued homes. Hence, the pricing impacts in a simple empirical study may be muted by other negative impacts to value. Hence, otherwise

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[52] Nelson, J.P., "Residential Choice, Hedonic Prices, and the Demand for Urban Air Quality", Journal of Urban Economics 5-3, 1978, 357-69.
[53] Murdoch, J.C., and M.A. Thayer, "Hedonic Price Estimation of Variable Urban Air Quality", Journal of Environmental Economics and Management 15-2, 1988, 143-46.
[54] Zabel, J.E., and K. Kiel, "Estimating the Demand for Air Quality in Four U.S. Cities", Land Economics 76-2, 2000, 174-94.
[55] Kiel, K, and M. Boyle, "Hedonic Studies of the Impact of Environmental Externalities", Journal of Real Estate Literature 9-2, 2001, 117-144.
[56] Palmquist, R., F. Roka, and T. Vukina (1997), "Hog Operations, Environmental Impacts, and Residential Property Values", Land Economics
[57] Weida, W., 2004, "The CAFO: Implications for Rural Economies in the US, Colorado College unpublished working paper
[58] Taff, Steven J., Douglas Tiffany, and Sanford Weisberg, "Measured Effects of Feedlots on Residential Property Values in Minnesota: A Report to the Legislature", U. Minnesota Staff Paper Series, July, 1996.

high-valued residences may be impacted to a greater degree by AOs than would be suggested by their findings.

Missouri Study[59]

Researchers at the University of Missouri quantified both the average value impact of an AO as well as the impact by distance with a study of 99 rural, non-family real estate transactions of more than one acre near an AO. Thirty-nine of the properties in the study included a residence. An average residential parcel within 3 miles of an AO experienced a loss of about 6.6%. However, if that parcel was located within one-tenth of a mile of the AO (the minimum unit of measure in their study), then the loss in value was estimated at about 88.3%. Based on an average land value of $1,709 per acre, the approximate aggregate loss in value within 3 miles of an AO was estimated at $2.68 million.

Julie Janson, Minnesota[60]

Ms. Janson lives about 2 miles from one swine AO and about ¾ mile from a second AO. When these AOs were first opened, she was initially a supporter. However, she and her family immediately began suffering illnesses which they attributed to the proximate AOs. She contacted the Minnesota poison control center and for the first time learned about the dangers of hydrogen sulfide emissions. She kept track of her illnesses and weather conditions (e.g. – wind and direction) and concluded that her illnesses were caused by the emissions from the AOs. Badge testing was warranted, and on at least one occasion the reading was above 1,000 ppb hydrogen sulfide, well above danger levels.

Bob and Phyllis Twietmeyer, Wichita, Kansas[61]

In 1998, a jury in rural Cheney, Kansas, awarded the Twietmeyers both actual and punitive damages (in excess of $15,000) as a result of the nuisance from a nearby swine AO.

Pasco, Washington[62]

A 309-acre family farm which had been operated for many years produced alfalfa, asparagus, corn, apples, peaches, nectarines, cherries, melons, and a range of garden produce. An AO was located nearby (distance not available), and as a result their farm product was impacted by dust, flies, fly fecal matter, and odor. The farm was appraised for litigation purposes and a value diminution of over 50% was determined, based on traditional farm appraisal methods.

Glen Haven Farm, Dalkeith, Ontario[63]

Deborah Henderson's farm is now downwind from a 3000 hog finishing plant, close enough that the manure lagoon can be seen from her bedroom window. According to Ms. Henderson, sales of homes in the area have ceased, and real estate agents have suggested a drop in price of $40,000 or more from previous unimpaired values in order to entice buyers to the area.

Lake Huron[64]

In the summer of 2003, health officials declared about 40 kilometers of beaches on Lake Huron permanently unsafe because of E. coli bacteria emanating from nearby AOs. This became the first new

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[59] Hamed, Mubarek, Thomas Johnson, and Kathleen Miller, "The Impacts of Animal Feeding Operations on Rural Land Values", U. Missouri-Columbia Community Policy Analysis Center Report R-99-02, May, 1999.
[60] Presentation made at the ABA's Special Committee on Agricultural Management Roundtable II on Environmental Challenges in Animal Feeding Operations, dated September 23, 1999.
[61] "Sides Debate Effect of Neighbor's Victory Against Feedlot", The Topeka Capital-Journal, May 28, 1998.
[62] Greenfield Advisors files.
[63] Greenfield Advisors files
[64] Spears, Tom, "Ontario's West Coast Permanently Polluted", The Ottawa Citizen, 11/15/03.; Dines, R.E., Deborah Henderson, and Louise rock, "The Case Against Intensive Hog Operations", February, 2004, unpublished working paper.

pollution hot-spot on Canada's side of the Great Lakes in almost 20 years. Lab tests demonstrated that the E. coli levels in the streams feeding Lake Huron, and draining off nearby AOs, exceeded water quality standards by as much as ***41,000*** per cent.

Colorado College Study[65]

Dr. William J. Weida of Colorado College performed an extensive study of the economic and financial impact of AOs. While his study principally focused on the diminished economic growth rates in communities surrounding AOs, he also noted the substantial decreases in property values in those areas, as evidenced by property tax reductions. (See Table 1)

Table 1

Property Tax Reductions In Areas Around AOs

Area	Amount of Reduction	Reduction In Value Of:
Grundy Co, MO	30%	
Mecosta Co, MI	35% dwellings only	
Changed to	20% total property (land and structures)	
Midland Co, MI	20%	
DeWitt Co, IL	30% rescinded	
McLean Co, IL	35%	
DeKalb Co, AL	base reassessment, variable rates	
Renville Co, MN	base reassessment, variable rates	dwellings only
Humbolt Co, IA	20-40% dwellings only--now rescinded	
Frederick Co, MD	10% now reduced to 5%	
Muhlenberg Co, KY	18% dwellings only	

Illinois State Study[66]

Complimentary to Professor Weida's study, Miguel Gomez and Liying Zhang of Illinois State University conducted a comprehensive study of the impact of AOs on rural economies, and found that AOs are the cause of "...disruption of local social and economic systems, pollution problems resulting from intensive agriculture, and negative impacts on the quality of life in rural communities."

Clark County, Illinois[67]

The county established a property tax abatement in 2001 for 50 homes around a swine AO. Homes within ½ mile were found to be diminished 30%, ranging down to a 10% reduction for homes at 1½ miles.

Gabrjolek farm, Dunnville, Ont.[68]

Four large hog farms have been developed near the Gabrjolek's family farm – one about 200 meters distance, one about 400 meters, and two about a kilometer away. Each facility houses 2,500 – 3,000 animals. The family has been forced to install central air conditioning and air purification systems, but still suffer from the effects of noxious odors. Untreated manure is being dumped near their home, bringing with it swarms of flies.

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[65] Weida, William J., "A Summary of the Regional Economic Effects of CAFOs", Colorado College working paper, July 21, 2001.
[66] Gomez and Zhang, op. cit.
[67] Beasley, Lee, 2001,"Cumberland Hog Facility May Affect Clark County Homeowners Property Values, Guardian Publishing
[68] Dines, Henderson, and Rock, op. cit.

Central Industries Inc. – Central, Mississippi[69]

Central Industries Inc. operated a large-scale poultry rendering plant near Central, Mississippi. As part of the process large quantities of poultry processing byproducts, which are highly susceptible to bacterial contamination were brought to this facility for further processing. The plant had been subject to a number of flooding events where the holding ponds were allowed to overflow into nearby creeks spreading bacteria laced poultry byproducts into nearby creeks and rivers. Poultry byproducts were discovered in trees, low density livestock areas, crop fields, and personal residences up to 50 miles away from the rendering plant. Greenfield Advisors inspected several homes and interviewed owners from which it was discovered that a significant disruption in property values and the ability to sell these properties occurred after and as the result of the Central Industries Inc. actions. We found property value diminution of up to 60% for farms closest to the plant, and diminution evidenced (via transactional analyses) as far as 11 miles away. In a parallel case, the company and its officers of the facility plead guilty to 26 Clean Water Act charges, officers were individually fined varying amounts up to $300,000 each, and two of them were sentenced to confinement. The company was fined $14 million.

Livingston v Jefferson Board of Equalization[70]

In 2002, the Nebraska Court of Appeals ruled that county board of equalization erred in not considering a rural residence's proximity to a swine facility in determining the residence's valuation. The owner of the facility, which contained 5,200 sows, also built a house ¾ of a mile away. He had further obtained an easement to spray the hog manure on the cropland across the road from his house. The court ordered the county to ignore the fact that the swine were also the property of the owner. The court cited Nebraska livestock nuisance decisions which show that hog odors would influence the home's value. Upon the ruling the county accepted a determination by a local, independent appraiser that the value was diminished 30%.

Craven County, North Carolina Study[71]

This study utilized GIS and a hedonic price model similar to the Herriges et. al study and Ready et. al to evaluate the effect of swine concentration and proximity of those operations on residential property values. It was determined that for a farm with 5,000 animals 1 mile away had a statistically significant impact on home values.

Berks County, Pennsylvania Study[72]

Ready and Abdulla (2005), of Penn State's Agricultural and Environmental Economics Department expand upon the hedonic analyses of others and reviewed the amenity and disamenity impacts of agriculture including different types of open space (publicly owned, eased, vacant, pasture/crops), landfills, airports, mushroom production, and AFOs. The study determined that "...only landfills have a worse effect on adjacent property values." Further, "...a sewage treatment plant has less depressing effects on nearby housing prices than a factory farm operation..." according to their findings. The study found that the clustering of AFOs within a certain area is the controlling factor not the nearest operation when considering proximity. A threshold impacts of 4.1% from AFOs within 800m, and at least 6.4% from within 500m, both of which were half of a landfill's. The study also reviewed the effects of size,

[69] Greenfield Advisors files, also http://www.justice.gov/enrd/3505.htm
[70] Aiken, J. David "Property Valuation May be Reduced by Proximity of Livestock Operation" Cornhusker Economics, Department of Agricultural Economics University of Nebraska – Lincoln May 2002
[71] Milla, Katherine, Michael H. Thomas, Winsbert Ansine "Evaluating the Effect of Proximity to Hog Farms on Residential Property Values: A GIS-Based Hedonic Price Model Approach" URISA Journal Vol. 17, No. 1 2005 Pg. 27 – 32
[72] Ready, Richard & Charles Abdalla "The Impact of Open Space and potential Local Disamenities on Residential Property Values in Berks County, Pennsylvania" American Journal of Agricultural Economics 87 May 2005 p. 314-326

species, and environmental stewardship (registration of waste management plans). Their findings were presented at the Sustainable Hog Farming Summit in Gettysburg, PA, in June, 2003.

Iowa State University Study[73]

Similar to the Berks County study this study attempts to expand upon the work done in the Univ. of Minnesota & University of Mississippi studies. The variables used to quantify the effects in this hedonic analysis included proximity, size, and direction of nearest facility. Direction from site was included to determine the effect of being downwind and the odor and pest issues associated. Results from this study determined that a moderate size facility (250,000 live weight) has an impact up to 6% within 1 ½ miles and 26% within a ¼ mile.

Michigan Odor Impacts[74]

Abeles-Allison and Connor (1990) were among the first to examine property value impacts resulting from airborne contamination and odors. Examining 288 sales between 1986 and 1989, they found that for every thousand animals added within a five-mile area, there was an average sales drop of $430 per property. The most significant losses were within 1.6 miles. Notably, during the first half of 1989, they found that an AO with greater than 500 animals was 50 times more likely to have an odor complaint lodged with the state than one with fewer than 500 animals.

Alabama Airborne Study[75]

Greenfield examined a 17,000 acre hunting club near Eufaula, Alabama, located several miles downwind from the Charoen Pokphand chicken processing facility. Despite extensive forest lands between the club and the facility, odors and airborne contaminants had driven away the deer and other wildlife, resulting in severely diminished utility of the hunt club.

Colorado AO Nuisance Lawsuit Study

As earlier discussed, Keske (2012) documents ten lawsuits over AO nuisance in which the plaintiff prevailed, with jury awards ranging up to $50 million:

Table 2
Jury Awards from Colorado Study

Year/State	Jury Award	Case/Remarks
1991/NE	$375,600	Kopecky v. National Farms, swine operation
1996/KS	$12,100	Swine settlement – parties undisclosed in news article
1998/KS	> $15,000	Twietmeyer, beef operations (see above)
1999/MO	$5,200,000	Hanes v. Continental Grain, swine operation
2001/OH	$19,182,483	Seelke et al v. Buckey Egg Farm, poultry
2002/IA	$33,065,000	Blass, et. al, v. Iowa Select Farms, swine operation
2004/OH	$50,000,000	Bear et. al. v. Buckey Egg Farm, et al, poultry
2006/AL	$100,000	Sierra Club, et. al, v. Whitaker and Sons, swine
2006/MO	$4,500,000	Turner v. Premium Standard Farms, swine
2007/IL	$27,000	State of Illinois (respondent unreported), swine

[73] Herriges, Joseph A, Silvia Secchi, and Bruce A. Babcock "Living with Hogs in Iowa: The impact of Livestock Facilities on Rural residential Property Values" Working Paper, Iowa State University Center for Agricultural and Rural Development (August 2003)
[74] Abeles-Allison and Connor, op. cit.
[75] Greenfield Advisors files

Summary of AO Empirical Findings

The establishment of an AO results in value diminution to other nearby properties both through a negative externality as well as through indirect economic impacts. The amount of the value loss is an inverse function of distance (closer properties diminish more), a function of property type (newer, nicer residences lose more) and a function of property use (farms will lose due to diminished productivity and comparative marketability to other farm lands while residential use will no longer be a highest-and-best use). While the appraisal profession has only begun to quantify the loss attributable to AOs, it is clear from the broad array of empirical studies and case studies that diminished marketability, loss of use and enjoyment, and loss of exclusivity results in a diminishment which can range from 50% to nearly 90% of otherwise unimpaired value for homes which are adjacent to the facility. Negative impacts are noted at distances exceeding 3 miles, and in the case of a flood or other weather event, waste from the facility can be spread over far greater areas.

Table 3
Summary of AO Impacts

Case Study	Value Loss	Remarks
North Carolina	N/A	Established distance component to value
Iowa	Up to 40%	Impacts 10% at 2 miles
Minnesota D. of Ag	N/A	AO sited near older, less-expensive homes
U. Missouri	6.6% - 88%	Largest loss if within 1/10 mile
Janson case study	N/A	Confirmed respiratory problems
Twietmeyer Case	> $15,000	One of the cases cited by Colorado
Pasco, Washington	50%	Mainly from airborne contamination
Dalkeith, Ontario	> 50%	Severe loss of marketability
Lake Huron	N/A	40km of beaches closed due to AO emissions
Colorado St. Study	5% - 40%	Losses confirmed by tax assessors in 8 states
Illinois St. Study	N/A	Impacts on rural economies
Clark Co., IL	Up to 30%	Impacts 10% at 1.5 miles
Dunnville, Ontario	N/A	Noxious odors and flies
Central, MS	Up to 60%	Farms impacted up to 11 miles away
Livingston Case	30%	Diminution at 0.75 miles
Craven Co., NC	N/A	Impact at 1 mile away
Craven, NC	N/A	Statistically significant at one mile
Berks, PA	Residence ¼ mile: > 6.4% Residence ½ mile: 4.1%	Roughly ½ of the impact of a landfill
Iowa St. Study	Residence ¼ mile: 26% Residence 1.5 miles: 6%	Larger facility has greater impact
Mich. Odor Study	$430/property within 5 mi	Greatest impact within 1.6 miles
Alabama Study	N/A	Loss of wildlife and utility of a hunt club
Colorado Study	Up to $50,000,000	Odors and airborne ctm result in litigation

Since the initial review of AOs effect on proximate property values, multiple new trends have been identified. First, the increased use of GIS in local governments has provided researchers with the ability to conduct investigations that are more thorough. Providing researchers with more data, in abundance and in detail, allows them to better locate which factors and to what degree are having an affect. Second, in conjunction with more data and use of GIS, there are substantial improvements in the hedonic analyses performed. The Berks County study noted that previous studies such as the, University of Minnesota study and the North Carolina study, were conducted on less than 300 sales transactions

each, but that the Berks County study and the Iowa State studies reviewed 8,090 and 1,145 sales transactions respectively. While more data does not imply more significant results it does allow researchers to be more discriminating when compiling their datasets.

Second, because of the increased use of GIS and the results from the hedonic analysis that were found in the new case studies it was shown that an AOs basic impact is related to proximity and size, but that other factors such as the operations waste management practices can reduce or exacerbate that impact. Overall, the new studies confirm the valuation impacts from the previously cited studies as they ranged from 3.1% to 26% loss depending on multiple factors. More importantly however was the discussion on the impact of other site-specific factors that were considered as part the hedonic analyses. The Berks County Study showed at 800 meters that an operation with a waste management plan diminished a house's value 1.1%, while an operation without such a plan would diminish the value 4.2%. Also related to this was the effect of operation size on property values. Both the Berks County study and Iowa State study showed that a larger facility in close proximity would not necessarily decrease the value of a more than a smaller facility. Both of the studies concluded that this effect could be attributed to un-modeled characteristics such as waste management practices and other site-specific attributes.

Mitigation of Impacts

There is surprisingly little empirical evidence of attempts to mitigate the negative impact of AO's, given the fairly consistent evidence of negative impacts on surrounding property values. In our observation, such mitigation would be difficult, expensive, and not terribly effective. In short, the most significant and transcendent impacts are to surrounding community values and economics and to air quality. Neither of these is well suited to mitigation efforts. We have generally found that mitigation attempts fall into three categories, as outlined below. Nonetheless, it is our experience that such mitigation does not have a material impact on nearby property values. I will explore these attempts at mitigation to more fully understand why these effort are not effective.

Waste Management Plan[76]

Wastewater runoff treatment is typically required by law and/or regulation. However, some facilities go beyond that with actual waste management plans. There is some evidence that such plans will have marginal impact – the Berks County study noted a differential of 4.2% versus 1.1%. Notably, though, some of the most severe impacts have occurred near facilities with mandated waste management plans, particularly when and after those plans failed. For example, in one four-month period, the Central Industries facility committed approximately 1,114 permit violations, exceeding the pollutant limitations set forth in the company's permit by hundreds of percentage points and its permitted flow rate by millions of gallons. Hence, the efficacy of such a waste management plan must be taken in the light of potential impacts of violations.

Planting Trees[77]

The University of Delaware, College of Agriculture and Natural Resources, proposes planting windbreaks around poultry houses to reduce odor, dust, feathers, and noises, and suggest that this can also ameliorate nitrogen in the groundwater. However, several things are obvious from their study:

[76] Ready and Abdalla, op. cit.
[77] Malone, George W., 2001, "Environmental and Production Benefits of Trees for Poultry Farms", U. Deleware Cooperative Extension Service,

1. The focus is on protecting the poultry houses themselves, not adjacent or nearby neighbors
2. Establishment of an effective windbreak takes quite a few years, and quite a few trees.
3. The windbreak may partially ameliorate view problems, but do not seem to address the major issues of odor and other airborne contaminations (particles, insects, etc.)

Given the cost of establishing and maintaining such a windbreak, it is not surprising that we've not seen one that effectively addressed property values. Indeed, in the Eufuala, Alabama, matter, we inspected a hunt club with extensive tree growth (17,000 acres of forest land surrounding the club) in between it and the chicken facility. The odors were nonetheless sufficiently strong to chase off deer and other wildlife[78].

Anaerobic Digestion Facility

The purpose of the Colorado State study (Keske, 2012) was to propose guidance on the financial feasibility of a biogas-fueled cogeneration facility. First, it is noteworthy that the study admits the significant production of flammable biogas produced by AOs. Second, though, the feasibility of such a facility depends on a number of factors. First, the up-front costs can be prohibitive – typically $1.2 million, and up to $5 million depending on the technology used. The study notes that in colder counties in Colorado, the cost will go up. Annual operating costs will be significant, and while these technologies are sold with the promise of offsetting electric bills, Keske notes that Coloradoans already pay lower electric rates than other parts of the U.S. Hence, AO operators should be "particularly wary of relying on anaerobic digestion to generate revenues by selling electricity to the utility." Finally, he notes that for the biogeneration facility to be at all feasible, at least two of the following criteria must be met:

1. The AO meets the definition of a confined AO
2. The waste stream can be combined with the waste stream of another operation or business (e.g. – food manufacturing, municipal waste)
3. The AO already receives frequent odor complaints
4. The AO produces swine or chickens (the two most egregious sources of biogas)
5. The AO incurs more than $5,000/month in average electricity or heating charges.

Keske notes that the dry climate in Colorado means that such a facility will be water-dependent, and will use water to liquefy the high solids content in the manure.

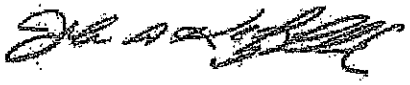
Summary and Conclusions

The impact of a chicken AO can be significant – studies note that chicken operations and swine operations have similar contamination and economic impacts. Property value impacts can range as high as 88% for homes located immediately adjacent to the AO, rendering the property useless and unmarketable for any residential purpose. The existence of a facility, such as is proposed in this case, constitutes an incurable external obsolescence on the surrounding and nearby residences. While there are proposals for potential mitigation, these have not proven to be effective in our observation, and may not even be feasible.

[78] Greenfield Advisors files, op. cit.

As noted in the introduction, while I am a Colorado State Certified (General) Real Estate Appraiser, my opinions in this matter do not constitute an appraisal, per se, and this letter does not constitute an appraisal report. Nonetheless, the data, analysis, and conclusions contained herein are based on and a natural extension of my 2002 Appraisal Journal article, and are the types of issues which an appraiser should consider when valuing properties impacted by an animal operation.

Sincerely,
GREENFIELD ADVISORS LLC



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FEATURES

Animal Operations and Residential Property Values

by John A. Kilpatrick, PhD, MAI

ABSTRACT

Animal feeding and processing operations have grown more concentrated, with each facility handling much larger numbers of animals than traditional farms. The larger concentration of animals impacts the quality of surrounding air and water. In addition, the facilities impact the economic conditions of the communities where they are located. All of these factors can potentially affect the value of nearby houses. This article summarizes the current literature on how animal operations may affect the value of residential properties located near such facilities; this information will be useful to practicing appraisers faced with valuing houses in these communities.

Animal operations (AOs) may be broadly defined as facilities in which animals are raised or brought for slaughter. The common denominator is a large perpetual inventory and density of animals.[1]

Although livestock and poultry production has more than doubled in the United States since the 1950s, the number of animal operations has decreased by 80%.[2] Food animal production in the United States has shifted to concentrated facilities where animals usually are raised in confinement. This concentration of animals brings environmental concerns related to air and water quality as well as animal and human health. As a result, animal operations are subject to regulation by the US Environmental Protection Agency (EPA), the US Department of Agriculture (USDA), and a variety of state entities. Laws and government regulations related to animal operations include specific definitions based on the function and size of the operations. For example, the EPA defines *animal feeding operations* (AFOs) as

> agricultural enterprises where animals are kept and raised in confined situations. AFOs congregate animals, feed, manure and urine, dead animals, and production operations on a small land area. Feed is brought to the animals rather than the animals grazing or otherwise seeking feed in pastures, fields, or on rangeland.[3]

To qualify as an AFO, an animal operation must confine animals for at least 45 days in a twelve-month period.[4] According to the EPA, there are approximately 450,000 AFOs in the United States.[5] The EPA also designates certain AFOs as *concentrated animal feeding operations* (CAFOs) based on the confinement of large numbers of animals and the pollutant discharge. At CAFOs, there is a higher concentration of waste that increases the potential impact on air, water, and land quality.[6] CAFOs are regulated by the EPA under the Clean Water Act,

1. Quite a few documents were reviewed to develop this discussion; see subsequent footnotes and Drew L. Kershen and Chuck Barlow, "Concentrated Animal Feeding Operations and Water, Air, Land, and Welfare," report on the American Bar Association (ABA) Special Committee on Agricultural Management Roundtable II on Environmental Challenges in Animal Feeding Operations (September 23, 1999).
2. EPA, *Literature Review of Contaminants in Livestock and Poultry Manure and Implications for Water Quality* (EPA 820-R-13-002, July 2013), 3; http://water.epa.gov/scitech/cec/upload/Literature-Review-of-Contaminants-in-Livestock-and-Poultry-Manure-and-Implications-for-Water-Quality.pdf.
3. EPA, "What Is a CAFO?", http://www.epa.gov/region07/water/cafo/.
4. Ibid.
5. EPA, "Animal Operations," http://www.epa.gov/agriculture/anafoidx.html.
6. http://www.epa.gov/region07/water/cafo/cafo_impact_environment.htm.

as environmental concerns arise when waste runoff is discharged onto adjacent landscapes and waterways.[7]

As the structure of the livestock industry has trended toward concentration of more animals in fewer operations, state and local governments also have acknowledged the problems associated with large operations by enacting legislation imposing stricter regulations on CAFOs and increasing separation distances.[8] For example, in North Carolina the following mandatory setbacks are imposed on new or expanded farms with 250 or more hogs: 1,500 feet from occupied residences, 500 feet from any residential property boundary to swine houses and lagoons, and 75 feet from any residential property boundary to sprayfield boundaries.

Overall, the empirical evidence indicates that residences near AOs are significantly affected, and data seems to suggest a valuation impact of up to 26% for nearby properties, depending on distance, wind direction, and other factors. Further, there has been some suggestion that properties immediately abutting an AO can be diminished as much as 88%. One study estimates the total negative impact to property values in the United States at $26 billion.[9] Mitigation makes a marginal impact. Not only are residences affected, but nearby small farms can be impacted by such factors as water degradation and insects.

Environmental Impacts and Regulation of Animal Operations

AOs are generally recognized to affect the surrounding environment in several key ways: air quality and odors (ammonia, hydrogen sulfide, methane, and particulate matter), greenhouse gas and climate change, insect vectors (often carrying resistant strains of pathogens), groundwater and surface water contamination, and a variety of pathogens.[10]

Data from the USDA and the EPA estimate that livestock in the United States produce 130 times the total amount of manure as the entire human population of the country. For example, one hog excretes nearly three gallons of waste per day or 2.5 times the average human's daily total. A 3,000-sow AO will produce about 25 tons of manure a day.[11] A similar number of chickens will produce about 700 pounds of manure per day (plus or minus 30%), containing about 9 pounds of nitrogen gas, 7.5 pounds of phosphorus pentoxide (a powerful irritant and corrosive) and over 4 pounds of potassium oxide, a highly reactive deliquescent that reacts violently with water to produce potassium hydroxide.[12] Manure from livestock production can contain bacteria (salmonella, E. Coli 0157:H7), parasites, viruses, and antimicorbials (antibiotics and vaccines).[13] Excessive levels of phosphorus in land and water have been correlated with livestock density; and manure has caused eutrophication and degradation of US waterways.[14]

AOs are regarded as potential sources for contamination because of the large amounts of manure that they produce, and because the proximity in which the animals are confined allows for disease to be easily transferred.[15] A 2006 outbreak of E. coli 0157:H7 was associated with the consumption of fresh spinach that had been in contact with water contaminated with animal feces.[16] One of the

7. The USDA and EPA first regulated animal operations under the 1999 "Unified National Strategy for Animal Feeding Operations," see http://water.epa.gov/polwaste/npdes/afo/Animal-Feeding-Operations-Regulations.cfm. The USDA Economic Research Service presents a discussion of regulatory issues related to animal waste at http://www.ers.usda.gov/topics/animal-products/animal-production-marketing-issues/policy-regulatory-issues.aspx#regulatory. Up-to-date information on the Clean Water Act is available at http://www2.epa.gov/laws-regulations.
8. Joseph Herriges, Silvia Secchi, and Bruce A. Babcock, "Living with Hogs in Iowa: The Impact of Livestock Facilities on Rural Residential Property Values" (Iowa State University Center for Agricultural and Rural Development working paper, August 2003).
9. Doug Gurian-Sherman, *CAFOs Uncovered: The Untold Cost of Confined Animal Feeding Operations* (Cambridge, MA: Union of Concerned Scientists, 2008).
10. Carrie Hribar, *Understanding Concentrated Animal Feeding Operations and Their Impact on Communities* (National Association of Local Boards of Health, 2010), available at http://www.cdc.gov/nceh/ehs/docs/understanding_cafos_nalboh.pdf.
11. Don Hopey, "Study Finds Large Hog Farms Lower Property Values," *Post-Gazette* (June 7, 2003).
12. Jing Tao and Karen Mancel, "Estimating Manure Production, Storage Size, and Land Application Area," Ohio State University, 2008 Agricultural Fact Sheet. According to a study by the University of Wisconsin-Madison, the average chicken farm has 14,500 birds, with farm sizes ranging up to 50,000 birds; see UW-Madison College of Agricultural and Life Sciences, Center for Integrated Agricultural Systems, Research Brief 63, January 2003.
13. EPA, *Literature Review of Contaminants in Livestock and Poultry Manure.*
14. Stephen Jann, "Recent Developments in Water Pollution Control Strategies and Regulations," presentation at ABA Special Committee on Agricultural Management Roundtable II on Environmental Challenges in Animal Feeding Operations, Minneapolis, MN (May 12, 1999).
15. "National Pollutant Discharge Elimination System Permit Regulation and Effluent Limitation Guidelines and Standards for Concentrated Animal Feeding Operations (CAFOs); Final Rule" *Federal Register* 68 (February 12, 2003). Note that portions of this were subsequently overturned in *Waterkeeper Alliance v. EPA*, 399 F.3d 486.
16. "FDA Finalizes Report on 2006 Spinach Outbreak," FDA (March 24, 2007), http://www.fda.gov/NewsEvents/Newsroom/PressAnnouncements/2007/ucm108873.htm.

leading causes of food and waterborne illness in the United States is this E. coli 0157:H7 organism, which is a specific strain of the Escherichia coli bacteria commonly found in the intestines of healthy cattle. One means of transfer of E. coli to humans occurs when untreated manure is able to enter water sources or used for fertilization.[17] The EPA acting under the Clean Water Act has designated AFOs as point sources of pollution and requires that they have zero discharge or apply for a permit that requires an extensive waste management plan. Despite regulatory efforts to segregate manure-related contaminants from the water supply, contaminants still may enter the supply because of flooding, leeching into the soil, or through disregard of regulations.

In addition to water quality issues related to manure and waste run-off, animal operations facilities attract flies and other insects and parasites.[18]

As noted in Kilpatrick, state entities began regulating AFOs in the late 1990s.[19] In 2000–2001, the EPA began levying fines against concentrated beef production facilities in the Northwestern United States that met two criteria: the facility confined animals for at least 45 non-consecutive days per year and the confinement area was devoid of vegetation. The rules generally applied to any operation with 300 head of cattle or more. At the time of the regulations, the EPA estimated that this would affect between 26,000 and 39,000 AFOs in the United States.[20]

On December 11, 2002, the EPA issued its final revised regulations.[21] The regulations affirmed the prior definitions of AFOs and CAFOs, provided for an explicit duty to apply for a permit, established required performance standards and best management practices, and explicitly required nutrient management plans.[22]

Overview of AO Impacts on Property Values

An AO can affect the value of proximate properties in two ways. First, AOs have a substantial indirect negative economic impact on surrounding communities, including property values in those communities, via shifts in sources of purchases and other inputs in the factors of production. An early study by Chism and Levins reports that smaller farms make nearly 95% of their expenditures locally, while larger operations spend less than 20% locally.[23] Gomez and Zhang study 1,106 rural communities and conclude that economic growth rates in communities with conventional farming are 55% higher than in those with AOs.[24] They document the negative impact of AOs on the economy of the surrounding community, as revealed by sales tax receipts and reduced local purchases. They note that conventional farmers buy most or all of their supplies locally, thus stimulating the local community and, by extension, stimulating the local real estate market. On the other hand, AOs bypass local retailers and import the factors of production. Gomez and Zhang state that AOs exacerbate the economic negative impact by "importing" large quantities of pollution and the attendant costs; they also find AOs cause "disruption of local social and economic systems, pollution problems resulting from intensive agriculture, and negative impacts on the quality of life in rural communities." This finding replicates those of an earlier study by Abeles-Allison and Connor, which showed AOs have the effect of crowding out more traditional farmers and decreasing purchases in local stores.[25]

Hence, local communities suffer the negative economic byproducts without the attendant economic benefits.

17. "Disease Listing, Escherichia Coli 0157:H7, Gen Info," Centers for Disease Control and Prevention, http://www.cdc.gov/ecoli/.

18. Stuart A. Smith, "Concentrated Animal Feeding Operations—Resources for Environmental Responsibility" (working paper prepared by Smith-Comeskey Ground Water Sciences, April 1, 2000); for additional information see http://www.groundwaterscience.com/resources/tech-article-library/100-concentrated-animal-feeding-facilitiesresources-for-environmental-responsibility-.html.

19. John A. Kilpatrick, "Concentrated Animal Feeding Operations and Proximate Property Values," *The Appraisal Journal* (July 2001): 301–306.

20. Peggy Steward, "Cattlemen Find CAFO Rules Confusing," *Capital Press Agricultural Weekly* (March 9, 2001): 9.

21. Claudia Copeland, "Animal Waste and Water Quality: EPA Regulation of Concentrated Animal Feeding Operations (CAFOs)," Congressional Research Service Report for Congress No 7-5700, February 16, 2010. The regulations were published in the *Federal Register* on February 12, 2003 and went into effect on April 14, 2003.

22. http://water.epa.gov/polwaste/npdes/afo/. Permitting is under the EPA's National Pollutant Discharge Elimination System (NPDES) program, which regulates the discharge of pollutants from point sources; CAFOs are defined as point sources by the Clean Water Act.

23. John W. Chism and Richard A. Levins, "Farm Spending and Local Selling: How Do They Match Up?" *Minnesota Agricultural Economist* 676 (1994): 1–4.

24. Miguel Gomez and Liying Zhang, "Impacts of Concentration in Hog Production on Economic Growth in Rural Illinois" (Illinois State U. working paper presented at annual meeting of American Agricultural Economics Association, July 30–August 2, 2000).

25. M. Abeles-Allison and L. Connor, *An Analysis of Local Benefits and Costs of Michigan Hog Operations Experiencing Environmental Conflicts* (Agricultural Economic Report 536, Department of Agricultural Economics, Michigan State University monograph, 1990).

Second, AOs impact values at the individual residential value level. Property values are impacted as market participants view the AO as a negative externality. As an externality, it is not typically considered economically curable under generally accepted appraisal theory and practice. Hence, the value diminution attributable to proximate location of an AO can be attributed to stigma. The next section discusses case studies regarding the effects of AOs.

Proximity Case Studies

Kilpatrick presented a series of case studies from the 1990s that document the impacts of AOs.[26] For example, a Minnesota homeowner lived near two swine AOs when her family reportedly became ill and testing found that the level of hydrogen sulfide was well above the danger levels.[27] An early study in North Carolina by Schiffman et al. reports emotional impacts (tension, depression, anger, reduced vigor, fatigue, and confusion) linked to airborne contamination emanating from an AO.[28] A later North Carolina study by Wing and Wolf reports increased incidences of headache, runny nose, sore throat, excessive coughing, diarrhea, burning eyes, and "reduced quality of life."[29] An early study in Iowa by Thu et al. finds increases in eye and upper-respiratory problems among those living within 2 miles of an AO.[30] A later Iowa study[31] finds extensive literature documenting acute and chronic respiratory disease and dysfunction among CAFO workers from exposures to complex mixtures of particulates, gases, and vapors; it concludes that CAFO air emissions may constitute a public health hazard.

Ables-Allison and Connor were among the first to examine property value impacts resulting from airborne contamination and odors.[32] Examining 288 sales between 1986 and 1989, they find that for every thousand animals added within a 5-mile area, there is an average sale price drop of $430 per property, with the most significant losses within 1.6 miles. Notably, they find that during the first half of 1989 an AO with greater than 500 animals was 50 times more likely to have an odor complaint lodged with the state than one with fewer than 500 animals.[33]

Taff, Tiffany, and Weisberg perform a hedonic price analysis on 292 rural residences in Minnesota and find a statistically significant pricing impact related both to the existence of an AO as well as the distance to the AO.[34] A 1996 study by Padgett and Johnson finds that homes within 0.5 mile of a CAFO decrease in value by 40%, and homes within 1.0 mile decrease in value by 30%, within 1.5 miles by 20%, and within 2.0 miles by 10%.[35] Palmquist, Roka, and Vukina quantitatively determine that AOs depress nearby home values. They develop a model to measure the spatial impacts of AOs and, like Padgett and Johnson, find differential value impacts at 0.5, 1.0, and 2.0 miles.[36]

Hamed, Johnson, and Miller, quantify both the average value impact of an AO as well as the impact by distance with a study of 99 rural, non-family real estate transactions of more than one acre near an AO. Thirty-nine of the properties in the study included a residence. An average residential parcel within 3 miles of an AO experienced a loss of about 6.6%. However, if that parcel was located within 0.10 mile of the AO (the minimum unit of measure in the study), then the loss in value was estimated at about 88.3%.[37]

26. Kilpatrick, "Concentrated Animal Feeding Operations."
27. Presentation at ABA Special Committee on Agricultural Management Roundtable II.
28. Susan S. Schiffman, Elizabeth A. Miller, Mark S. Suggs, and Brevick G. Graham, "The Effect of Environmental Odors Emanating from Commercial Swine Operations on the Mood of Nearby Residents," *Brain Research Bulletin* 37, no. 4 (1995): 369–375.
29. S. Wing and S. Wolf, "Intensive Livestock Operations, Health, and Quality of Life Among North Carolina Residents," *Environmental Health Perspectives* 108, no. 3 (March 2000): 233–238.
30. K. Thu, K. Donham, R. Ziegenhorn, S. Reynolds, P. Thorne, P. Subramanian, P. Whitten, and J. Stookesberry, "A Control Study of the Physical and Mental Health of Residents Living Near a Large-Scale Swine Operation," *Journal of Agricultural Safety and Health* 3, no. 1 (1997): 13–26.
31. *Iowa Concentrated Animal Feeding Operations Air Quality Study—Final Report*[End ital], Iowa State University and the University of Iowa Study Group (February 2002), http://www.public-health.uiowa.edu/ehsrc/CAFOstudy/CAFO_final2-14.pdf.
32. Abeles-Allison and Connor, *Analysis of Local Benefits and Costs of Michigan Hog Operations*.
33. As previously discussed, this study also reports that AOs affect the economics of local communities.
34. Steven J. Taff, Douglas G. Tiffany, and Sanford Weisberg, "Measured Effects of Feedlots on Residential Property Values in Minnesota: A Report to the Legislature" (U. Minnesota Staff Paper Series, July 1996), http://ageconsearch.umn.edu/bitstream/14121/1/p96-12.pdf.
35. Reported in William J. Weida, "The CAFO: Implications for Rural Economies in the US" (Colorado College working paper, February 24, 2004), http://www.columbus.in.gov/planning/staff-reports/gelfius-materials-part-1/.
36. R. Palmquist, F. Roka, and T. Vukina, "Hog Operations, Environmental Impacts, and Residential Property Values," *Land Economics* 73, no. 1 (1997): 114–124.
37. Mubarek Hamed, Thomas Johnson, and Kathleen Miller, "The Impacts of Animal Feeding Operations on Rural Land Values," University of Missouri-Columbia, Community Policy Analysis Center Report R-99-02 (May 1999).

Additional empirical studies have supplemented these findings. Kim and Goldsmith analyze property values of 2,155 homes located within 3 miles of an AO in North Carolina. The principle focus of their study is spatial hedonics, and within a 3-mile area they find the average impact to be negative 18%. At 1 mile, they find the impact is negative 23.5%.[38]

Weida studies the economic and financial impact of CAFOs. While this study principally focuses on the diminished economic growth rates in communities surrounding CAFOs, it also notes the substantial decreases in property values in those areas, as evidenced by property tax reductions.[39]

Kuethe and Keeney find that the negative impacts of AOs are comparable to those generated by industrial waste, solid waste, and septic waste facilities.[40] They focus on airborne-related problems and note that odor is a particular source of nuisance, and higher-valued residences are more severely impacted.

The odor and airborne particulate issues also have been explored in a more recent study by Isakson and Ecker. They examine the impact of swine CAFOs on sale prices of 5,822 houses in Iowa. The study shows large adverse impacts for houses located within 3 miles and directly downwind from a CAFO—a loss of value of as much as 44.1%. Value loss diminished to 16.6% for houses not directly downwind, and loss in value decreased to 9.9% for houses directly downwind but 3 miles away. Isakson and Ecker also find a correlation between CAFO size and value loss; a 10% increase in CAFO size resulted in a 0.67 % decrease in house price as far as 7 miles from the nearest CAFO.[41]

Studies Using GIS

Increasingly, AO studies have relied on geographic information systems (GIS) technology and other spatial methods to investigate property value impacts.

Worley Rupert, and Risse use GIS to examine the efficacy of buffers to mitigate AO impacts.[42] They find that adding buffers to animal operations reduces the amount of land available within an area for such operations.

Cajka, Deerhake, and Yao present a study technique using GIS and modeling software to investigate the dispersion of air pollution emanating from CAFOs. The advantage of this approach is it looks at cumulative emissions from multiple sources.[43]

Milla, Thomas, and Ansine, study homes in Craven County, North Carolina, use a GIS-based hedonic pricing model to evaluate the impacts of CAFOs, particularly hog operations, on residential property values. Their results indicate a negative and significant impact on property value from hog operations and a relationship between distance to hog farms and property sale prices. They determine that a farm with 5,000 animals has a statistically significant impact on values of homes 1 mile away, with an impact on the average home of 3.1%.[44]

Based on the results of the case studies, it is quite apparent that significant externalities are associated with animal feeding operations, that the relationship between externalities, farm characteristics, and community attributes can be quite complex, and that negative impacts of animal facilities, as reflected in lowered property values, can extend beyond established setbacks. The GIS-based studies suggest the externalities associated with AOs are a function of distance and that the GIS-based hedonic price modeling is a promising method for assessing property value damages associated with animal operations, for evaluating potential impacts when siting new operations, and for developing setback guidelines.

38. Jungik Kim and Peter Goldsmith, "A Spatial Hedonic Approach to Assess the Impact of Swine Production on Residential Property Values," *Environmental and Resource Economics* 42, no. 4 (April 2009): 509–534.

39. William J. Weida, "Potential Regional Economic Effects of CAFOs" (Colorado College working paper, August 24, 2001), available at http://sraproject.org/wp-content/uploads/2007/12/commentsonthepotentialregionaleconeffectsoffeedlots.pdf.

40. Todd H. Kuethe and Roman Keeney, "Environmental Externalities and Residential Property Values: Externalized Costs Along the House Price Distribution," *Land Economics* 88, no. 2 (2002): 241–250, available at http://naldc.nal.usda.gov/naldc/download.xhtml?id=54130&content=PDF.

41. Hans R. Isakson and Mark D. Ecker, "An Analysis of the Impact of Swine CAFOs on the Value of Nearby Houses," *Agricultural Economics* 39, no. 3 (November 2008): 365–372.

42. J. W. Worley, C. Rupert, and L. M. Risse, "Use of GIS to Determine the Effect of Property Line and Water Buffers on Land Availability," *Applied Engineering In Agriculture* 17, no. 1 (September 2000): 49–54; available at https://www.itos.uga.edu/library/buffers.pdf.

43. Jamie Cajka, Marion Deerhake, and Chengwei Yao, "Modeling Ammonia Dispersion from Multiple CAFOs Using GIS," *Proceedings of the 24th ESRI Users Conference*, August 9–13, 2004, available at http://proceedings.esri.com/library/userconf/proc04/docs/pap1381.pdf.

44. Katherine Milla, Michael H. Thomas, and Winsbert Ansine, "Evaluating the Effect of Proximity to Hog Farms on Residential Property Values: A GIS-Based Hedonic Price Model Approach," *URISA Journal* 17, no. 1 (2005): 27–32.

Legal and Regulatory Actions

Legal and regulatory actions also can reveal the impacts of AOs on nearby properties. For example, in 2000, Central Industries operated a large-scale poultry rendering plant near Central, Mississippi. As part of the process, large quantities of poultry processing byproducts were brought to this facility for further processing. The plant had been subject to a number of flooding events, spreading bacteria-laced poultry byproducts into nearby creeks and downstream rivers. Poultry byproducts were discovered up to 50 miles away from the rendering plant. For violations of the Clean Water Act, company officers were fined varying amounts up to $300,000 each, and the company was fined $14 million.[45] Researchers found property value diminution of up to 60% for farms closest to the plant, and transaction prices impacted as far as 11 miles away.

In numerous counties across the country tax assessors have granted property value reductions as a result of proximity to AOs. For example, Beasley reports that Clark County, Illinois, established a property tax abatement for fifty homes around a swine AO. Homes within 0.5 mile were determined to have values diminished by 30%, ranging down to a 10% reduction in value for homes at 1.5 miles.[46]

Aiken reports that the Nebraska Court of Appeals ruled that county board of equalization erred in not considering a rural residence's proximity to a swine facility in determining the residence's valuation. The owner of the facility also built a house 0.75 mile away and obtained an easement to spray the hog manure on the cropland across the road from the house. The court ordered the county to ignore the fact that the swine were also the property of the owner. The court cited Nebraska livestock nuisance decisions that show that hog odors would influence the home's value. Upon the ruling, the county accepted a determination by a local, independent appraiser that the value was diminished 30%.[47]

Spears reports that in the summer of 2003, health officials declared about 40 kilometers of beaches on Lake Huron permanently unsafe because of E. coli bacteria emanating from nearby AOs. This became the first new pollution hot spot on Canada's side of the Great Lakes in almost twenty years. Lab tests demonstrated that the E. coli levels in the streams feeding Lake Huron, and draining off nearby AOs, exceeded water quality standards by as much as 41,000 percent.[48]

Table 1 Property Tax Reductions in Areas Around AOs

Area	Amount of Reduction	Property Type
Grundy Co, MO	30%	
Mecosta Co, MI initially:	35%	Dwellings only
later changed to:	20%	Land and structures
Midland Co, MI	20%	
DeWitt Co, IL	30%	
McLean Co, IL	35%	
DeKalb Co, AL	Base reassessment, variable rates	
Renville Co, MN	Base reassessment, variable rates	Dwellings only
Humbolt Co, IA	20%-40%	Dwellings only
Frederick Co, MD	10%	
Muhlenberg Co, KY	18%	Dwellings only

Ready and Abdalla expand upon the hedonic analyses of others and reviewed the amenity and disamenity impacts of agriculture in Berks County, Pennsylvania, including different types of open space (publicly owned, eased, vacant, pasture/crops), landfills, airports, mushroom production, and AOs. The study determines that "only landfills have a worse effect on adjacent property values,"[49] and further states, "a sewage treatment plant has less depressing effects on nearby housing prices

45. US Department of Justice Press Release, November 2, 2000.

46. Lee Beasley, "Cumberland Hog Facility May Affect Clark County Homeowners Property Values," *Guardian Publishing* (2001).

47. J. David Aiken, "Property Valuation May Be Reduced by Proximity of Livestock Operation" Cornhusker Economics, Department of Agricultural Economics, University of Nebraska–Lincoln (May 2002).

48. Tom Spears, "Ontario's West Coast Permanently Polluted," *The Ottawa Citizen* (November 15, 2003); also R. E. Dines, Deborah Henderson, and Louise Rock, "The Case Against Intensive Hog Operations" (working paper, February 2004).

49. Richard C. Ready and Charles W. Abdalla, "The Amenity and Disamenity Impacts of Agriculture: Estimates from a Hedonic Pricing Model," *American Journal of Agricultural Economics* 87, no. 2 (May 2005): 314–326.

than a factory farm operation." The study also finds that the clustering of AOs within a certain area is the controlling factor, not the location of the nearest operation when considering proximity. The study reports a value impact of -4.1% from AOs within 800 meters, and at least -6.4% from within 500 meters, both of which were half the impact of a landfill at comparable distances. The study did not find any statistically significant difference in the effects based on AO size or species.

Herriges, Secchi, and Babock expand upon previous work on AO price effects by using variables to quantify the effects in a hedonic analysis of proximity, size, and direction of nearest facility. Direction from site was included to determine the effect of being downwind, and the odor and pest issues associated with AOs. Results from this study indicate that a moderate-size facility has a value impact up to -6% within 1.5 miles and -26% within a 0.25 mile.[50]

Finally, Keske documents ten lawsuits over AO nuisance in which the plaintiff prevailed, with jury awards ranging up to $50 million (Table 2). The size of these awards suggests that preventive measures, even if expensive, might be cost effective.[51]

Summary of AO Empirical Findings

The establishment of an AO results in value diminution to nearby properties, both through a negative externality as well as through indirect economic impacts. The amount of the value loss is an inverse function of distance (closer properties diminish more), a function of property type (newer, nicer residences lose more), and a function of property use (farms will lose value due to diminished productivity and comparative marketability to farm lands further away; residential use will no longer be a highest-and-best use). The empirical studies and case studies results indicate diminished marketability, loss of use and enjoyment, and loss of exclusivity that can range up to nearly 90% of otherwise unimpaired value for homes that are adjacent to the facility. Negative impacts are noted at distances exceeding 3 miles, and in the case of a flood or other weather event, waste from the facility can be spread over far greater areas, extending the area of negative impact (Table 3).

Mitigation of Impacts

There is surprisingly little empirical evidence of attempts to mitigate either the physical impacts or the perception of negative externality of AOs given the fairly consistent evidence of negative impacts on surrounding property values. The most significant and transcendent impacts are to surrounding community values and economics and to air quality. However, neither of these is well suited to mitigation efforts. Generally, mitigation fall into three categories: waste management plans, tree windbreaks, and anaerobic

Table 2 Damage Awards Related to AOs

Year/State	Jury Award	Case/Remarks
1991/NE	$375,600	*Kopecky v. National Farms*, swine operation
1996/KS	$12,100	Swine settlement – parties undisclosed in news article
1998/KS	> $15,000	*Twietmeyer v. Blocker*, beef operations
1999/MO	$5,200,000	*Hanes v. Continental Grain*, swine operation
2001/OH	$19,182,483	*Seelke v. Buckey Egg Farm*, poultry
2002/IA	$33,065,000	*Blass v. Iowa Select Farms*, swine operation
2004/OH	$50,000,000	*Bear v. Buckey Egg Farm*, poultry
2006/AL	$100,000	*Sierra Club v. Whitaker*, swine
2006/MO	$4,500,000	*Turner v. Premium Standard Farms*, swine
2007/IL	$27,000	State of Illinois (respondent unreported), swine

Source: Catherine M. H. Keske, "Determining the Economic Feasibility of Anaerobic Digestion in Colorado: Guidelines for Animal Farm Producers," CSU Extension Fact Sheet 1.229 (2012).

50. Herriges, Secchi, and Babcock, "Living with Hogs in Iowa."

51. Catherine M. H. Keske, "Determining the Economic Feasibility of Anaerobic Digestion in Colorado: Guidelines for Animal Farm Producers," CSU Extension Fact Sheet 1.229 (2012), http://www.ext.colostate.edu/pubs/livestk/01229.pdf.

Table 3 Summary of Studies of AO Value Impacts

Case Study	Value Loss	Remarks
Ables-Allison and Connor (1990)	$430 within 5 miles	Greatest impact within 1.6 miles
Taff, Tiffany, and Weisberg (1996)	N/A	AO sited near older, less-expensive homes
Palmquist, Roka, and Vukina (1997)	9%	Average up to 2 miles
Hamed Johnson, and Miller (1999)	6.6%—88%	Largest loss if within 0.10 mile
ABA Presentation (1999)	N/A	Confirmed respiratory problems
Central Industries (2000)	60% for farms closest to plant	USDOJ cases, values by appraisal
Beasley (2001)	Up to 30%	Impacts 10% at 1.5 miles
Aiken (2002)	30% @ 0.75 mile	Confirmed by court and local appraiser
Spears (2003)	N/A	40 km of beaches closed due to AO emissions
Herriges, Secchi, and Babcock (2003)	26% at 0.25 mile	Moderate-size AO, 6% at 1.5 miles
Weida (2004)	40% at 0.50 mile	10% at 2 miles
Ready and Abdalla (2005)	Residence at 0.25 mile > 6.4% Residence at 0.50 mile 4.1%	Roughly half the impact of a landfill
Kim and Goldsmith (2008)	23.5% at 1 mile	18% average within 3-mile radius
Isakson and Ecker (2008)	44%	Directly downwind and within 2 miles

Source: Catherine M. H. Keske, "Determining the Economic Feasibility of Anaerobic Digestion in Colorado: Guidelines for Animal Farm Producers," CSU Extension Fact Sheet 1.229 (2012).

digestion. Nonetheless, such mitigation does not appear to have an economically material impact on nearby property values.

Waste Management Plan

Laws or regulations typically require wastewater runoff treatment. However, some facilities go beyond that with actual waste management plans. There is some evidence that such plans will have marginal impact, as noted in the Ready and Abdalla study, which found a residential value differential of 4.2% versus 1.1%. Notably though, some of the most severe impacts have occurred near facilities with mandated waste management plans, particularly when and after those plans failed. For example, in one four-month period, the Central Industries facility studied by Ready and Abdalla committed approximately 1,114 permit violations, exceeding the pollutant limitations set forth in the company's permit by hundreds of percentage points and exceeding its permitted flow rate by millions of gallons. Hence, the efficacy of a waste management plan must be taken in the light of potential impacts of violations.[52]

Planting Trees

The University of Delaware, College of Agriculture and Natural Resources, studied the planting of windbreaks around poultry houses to reduce odor, dust, feathers, and noises, and suggests that this approach can also ameliorate nitrogen in the groundwater.[53] However, several aspects regarding this mitigation study should be noted:

1. The study focus is on protecting the poultry houses themselves, not adjacent or nearby neighbors.
2. Establishment of an effective windbreak takes quite a few years and quite a few trees.
3. A windbreak may partially ameliorate view problems but does not seem to address the major issues of odor and other airborne contaminations (particles, insects, etc.).

Anaerobic Digestion Facility

The purpose of Keske's study was to provide guidance on the financial feasibility of a biogas-fueled cogeneration facility.[54] The study recognizes the significant production of flammable biogas by AOs and notes the feasibility of biogas-fueled cogeneration

52. Ready and Abdalla, "The Amenity and Disamenity Impacts of Agriculture."
53. George W. Malone, "Environmental and Production Benefits of Trees for Poultry Farms," U. Delaware Cooperative Extension Service (2001).
54. Keske, "Determining the Economic Feasibility of Anaerobic Digestion."

is limited by a number of factors. First, the up-front costs can be prohibitive—typically $1.2 million, and up to $5 million depending on the technology used. Also, annual operating costs are significant, and while these technologies are sold with the promise of offsetting electric bills, Keske notes that in the study area (Colorado) electricity rates are already lower than other parts of the United States. Hence, AO operators should be "particularly wary of relying on anaerobic digestion to generate revenues by selling electricity to the utility." Finally, Keske notes that for a biogeneration facility to be feasible, at least two of the following criteria must be met:

1. The AO meets the definition of a confined AFO.
2. The waste stream can be combined with the waste stream of another operation or business (e.g., food manufacturing, municipal waste).
3. The AFO already receives frequent odor complaints.
4. The AFO produces swine or chickens (the two most egregious sources of biogas).
5. The AFO incurs more than $5,000/month in average electricity or heating charges.

Keske notes that given the high threshold of cost of this mitigation approach, the approach is feasible only if it outweighs costs associated with not implementing a mitigation plan. As previously mentioned, to support this Keske documents ten lawsuits in which claimants were awarded as much as $50 million for agricultural nuisance (Table 2). Notably, the two largest awards cited ($50 million and $19 million) were for poultry operations.[55]

Summary and Conclusions

Since *The Appraisal Journal*'s previous review of AO effects on proximate property values,[56] new study approaches have been identified. First, there has been an increased use of GIS by local governments, which has given researchers the ability to conduct more thorough investigations. GIS provides researchers with more data—in abundance and in detail—and allows researchers to better locate which factors, and to what degree, have an effect on value.

Second, in conjunction with more data and use of GIS, there are substantial improvements in the hedonic analyses performed. Keske noted that early studies (such as the Taff, Tiffany and Weisberg study and the Palmquist, Roka, and Vukina study) were conducted on fewer than 300 sales transactions each, while the later study by Ready and Abdalla reviewed 8,090 sales, and the Herriges, Secchi, and Babcock study examined 1,145 sales transactions.

Third, because of the increased use of GIS and the results from the hedonic analysis in newer case studies, it has been shown that an AO's basic impact is related to proximity and size, but there are also other factors, such as the operations' waste management practices, that can reduce or exacerbate that impact. Overall, the new studies confirm the valuation impacts reported in earlier studies, as they range from 3.1% to 26% loss depending on multiple factors, and that properties immediately abutting an AO can be diminished as much as 88%. More importantly, however, is the discussion of the impact of other site-specific factors that were considered as part the hedonic analyses.

With respect to mitigation efforts, the Ready and Abdalla study of Berks County (Pennsylvania) shows that at 800 meters an operation with a waste management plan diminishes a house's value 1.1%, while an operation without such a plan would diminish the value 4.2%. Also related to this is the effect of operation size on property values. Both the Ready and Abdalla study and the Herriges, Secchi, and Babcock study show that a larger facility in close proximity would not necessarily decrease the value of a nearby property more than a smaller facility. Both of the studies concluded that this effect could be attributed to unmodeled characteristics such as waste management practices and other site-specific attributes.

55. Ibid.

56. Kilpatrick, "Concentrated Animal Feeding Operations."

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Web Connections

Internet resources suggested by the Y. T. and Louise Lee Lum Library

eXtension Land-Grant University Cooperative Research Information
—Geospatial Technology
http://www.extension.org/geospatial_technology

—Animal Manure Management
http://www.extension.org/animal_manure_management

Food & Water Watch—Factory Farms
http://www.foodandwaterwatch.org/food/factoryfarms/

Texas A&M University, Texas Animal Management Issues Clearinghouse
http://tammi.tamu.edu/index.html

US Department of Agriculture, National Agricultural Library
http://www.nal.usda.gov/topics

US Environmental Protection Agency
—Agriculture Center
http://www.epa.gov/agriculture

—Drinking Water Regulations
http://water.epa.gov/lawsregs/rulesregs/sdwa/currentregulations.cfm

—Animal Feeding Operations Overview
http://water.epa.gov/polwaste/npdes/afo/index.cfm

Etowah County, AL Population in 102,268

Smallest County in Alabama: 67 out of 67 Counties
Population Density: 12 out of 67 Counties
Gadsden, AL Population in 2017: 35,409 (98% urban, 2% rural)

Nearest cities:

Reece City, AL (2.1 miles); Attalla, AL (2.2 miles); Tidmore Bend, AL (2.3 miles); Rainbow City, AL (2.3 miles); Glencoe, AL (2.4 miles), Ridgeville, AL (2.5 miles); Southside, AL (2.7 miles), Turkeytown, AL (2.8 miles), Whorton Bend, Unincorporated.

Read more: https://www.city-data.com/city/Gadsden-Alabama.html

Most rendering plants are located in rural agricultural settings.

2-Hanceville, AL

Population in 2017: 3,391 (93% urban, 7% rural).
Read more: http://www.city-data.com/city/Hanceville-Alabama.html

"Hanceville" Rendering Plant owned by Tyson is

- located 8.6 miles OUTSIDE the city limits of Hanceville and the closest community, Blount Springs is more than 5 miles away.
- No schools within a 5-mile radius of that plant. I
- Surrounded by large tracts of timber land and farmland.
- Current lawsuit from the State of Alabama and area landowners against the plant for the largest fish kill (2019) on record in Alabama and the odor and pollution this plant emits.
- Population of Nearby Communities: Blount Springs-Population: 156; Hayden, 1298

2-Ward, South CarolinaPopulation in 2017: 92 (0% urban, 100% rural).
Read more: http://www.city-data.com/city/Ward-South-Carolina.html

3-Timberville, VA Population in 2017: 2,645 (98% urban, 2% ruralRead more: http://www.city-data.com/city/Timberville-Virginia.html

4-Broadway, VA Population in 2017: 3,880 (98% urban, 2% rural). Population change since 2000: +77.0%
Read more: http://www.city-data.com/city/Broadway-Virginia.html

5-Linville, VA Population 1420 Valley Proteins (Rendering Plant)

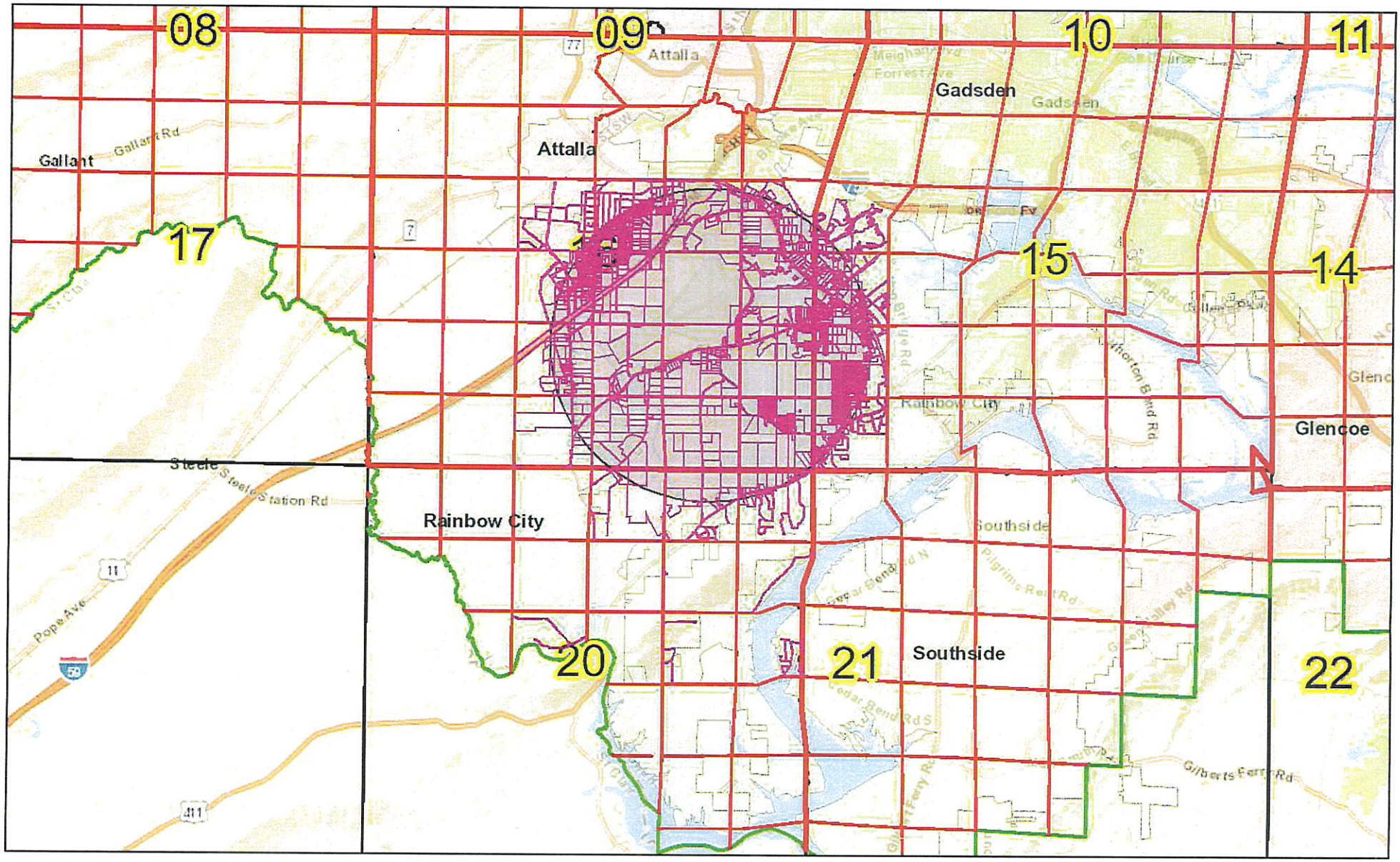
Cities and towns with rendering plants and other Animal Operations often face legal battles to control odor emissions and other environmental issues.

Plants that are located in cities and more densely populated areas are facing increasing pressure from area residents and some are even relocating due to pressure from communities.

In almost every instance, the plants have violations and fines imposed for non-compliance, accidental spills, pollution that causes fish kills, traffic accidents and road contamination. Many have unpaid fines and have resisted demands to make improvements to their plants.

Etowah County Tax Record Viewer Map

2 Mile Radius: Over 2500 Properties



December 14, 2020

polygonLayer

Override 1

polygonLayer

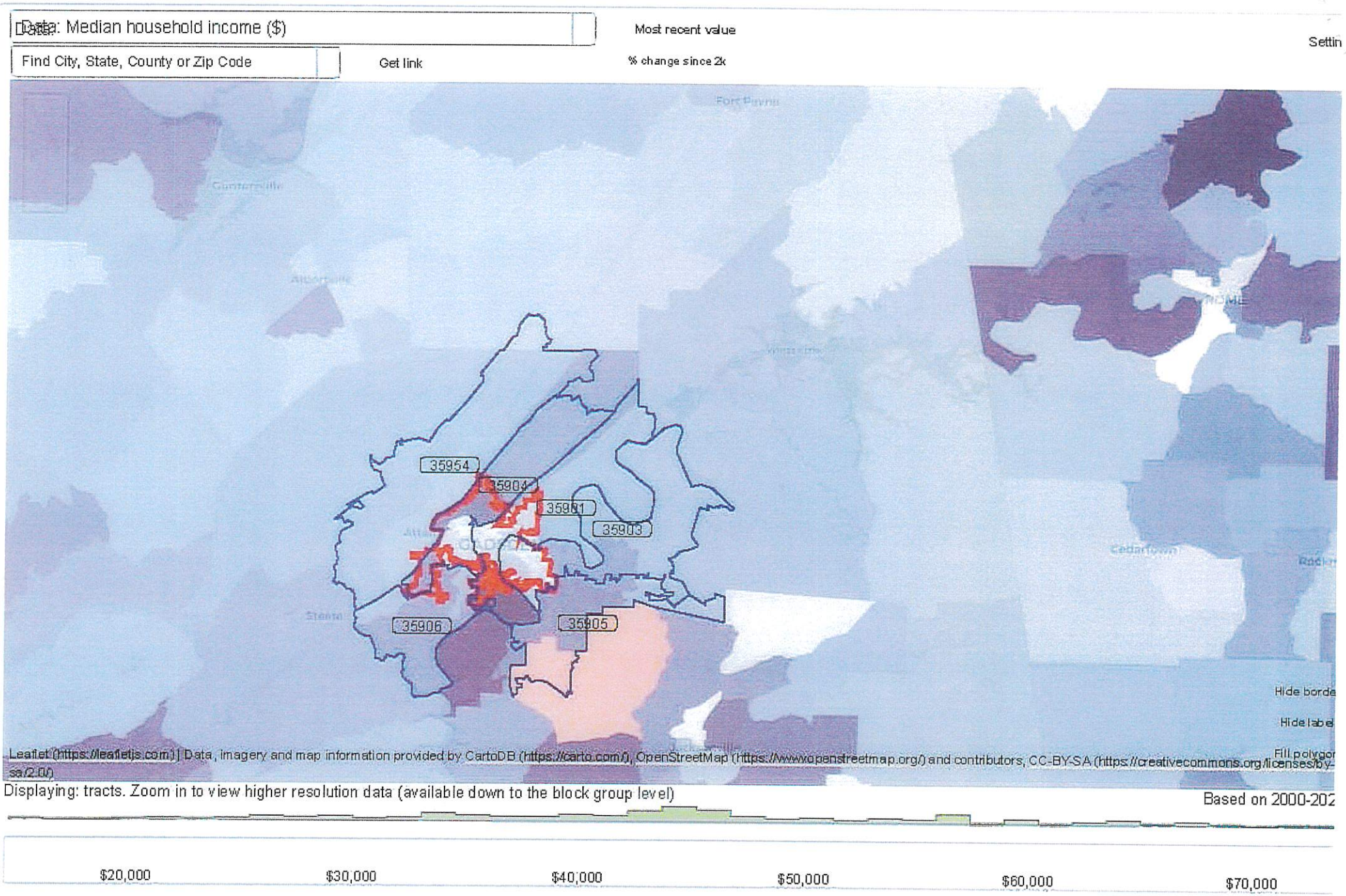
Override 1

1:144,448

0 1.25 2.5 5 mi

0 2 4 8 km

Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand),


Data: Median household income ($)
Most recent value
Settin
Find City, State, County or Zip Code
Get link
% change since 2k
35954
35904
35901
35903
35906
35905
Hide borde
Hide label
Fill polygor
Leaflet (https://leafletjs.com/) | Data, imagery and map information provided by CartoDB (https://carto.com/), OpenStreetMap (https://www.openstreetmap.org/) and contributors, CC-BY-SA (https://creativecommons.org/licenses/by-sa/2.0/)
Displaying: tracts. Zoom in to view higher resolution data (available down to the block group level)
Based on 2000-202
$20,000
$30,000
$40,000
$50,000
$60,000
$70,000