Residential development choices and consequences: Urban land cover change, perceptions and value of alternative subdivision designs, and the benefits of protected ecosystem services

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Residential development choices and consequences: Urban land cover change, perceptions and value of alternative subdivision designs, and the benefits of protected ecosystem services

by

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A dissertation submitted to the graduate faculty
in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

Major: Forestry

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Ames, Iowa
2011

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ABSTRACT

Municipal officials are often faced with difficult decisions about land uses in and around city boundaries. Urban expansion often causes negative environmental impacts, but there are designs for development which can mitigate some of these effects at the site scale. This dissertation examines urban land cover change in four Iowa cities, examines familiarity with and value for conservation subdivision (CSD) and low-impact design (LID) features, and explores how conservation subdivision design can protect urban ecosystem services. Public datasets and GIS software were used to assess land cover change for four municipalities in Iowa as a framework for predicting land cover change impacts by determining where loss of natural areas has occurred and where future losses are most likely to happen. Urban land cover increased by 28-80% in the four communities examined, primarily involving transitions from grassland and cropland. Losses of mature forest areas occurred (348 to 1335 ha) but were masked by transitions of other lands to early-successional forests. A contingent valuation survey of 777 households and experimental real estate negotiations with 27 participants in Ames, IA assessed residents’ familiarity with alternative residential designs and estimated their willingness to pay for CSD and LID features. Most respondents were not familiar with CSD or LID features, but indicated willingness to pay for some of them (52% indicated WTP for buffered streams, 66% for rain gardens), except for clustered housing (only 27%). Negotiation participants indicated added value for homes in neighborhoods with integrated forest (+22% increment) and open spaces (+17%), and streams buffered by forest cover (+13%). A spatial hedonic model estimated effects on housing values and indicated that the presence of neighborhood-owned forest and water features had positive effects on housing prices, both increasing the value of a home by approximately 6%. Surveys and focus groups involving developers and city officials assessed their familiarity with, and interest in, alternative development designs. Developers and planners were more familiar with LID than CSD, but indicated misperceptions about both designs. Both groups also indicated a preference for alternative designs compared to standard designs. Subdivision regulations and perceived lack of demand were identified as barriers to wider implementation of CSD and LID approaches. Alternative designs could provide protection for ecosystem services in urban areas if implementation is goal-oriented, monitored for effectiveness, and when the design is configured to create broad appeal.
CHAPTER 1: GENERAL INTRODUCTION

Within the next two decades, the world’s urban population is expected to increase from 2.9 billion to around 4.9 billion, about 60% of the total population (Alberti, 2010; Pickett et al., 2010; Rees and Wackernagel, 2008). Current urban land areas (around 6% of the total global land surface) must expand to meet this growth, and already expansive urban footprints that influence biologic, hydrologic, and climatic systems within and around cities will continue to enlarge (Alberti, 2010). This urban expansion brings with it habitat fragmentation, extinction, loss of biodiversity, and disruption of ecosystem services (McKinney, 2002, 2006, 2008). As these changes occur, communities face complicated choices about land use within and around city boundaries. Debates over the impacts of urban land use on the environment often pit conservation efforts against the economic development associated with continued urban growth. While conservation efforts have typically concentrated on preserving large contiguous wildlands, a new focus on smaller-scale urban areas that function within local legal and socioeconomic restraints is beginning to emerge (Alberti et al. 2003).

New alternative residential design approaches may provide opportunities for mitigating the negative effects of urbanization at the local-level by protecting and integrating natural resources across individual sites. There are few examples of these design approaches on the ground in the Midwest, and lack of information about market demand and public perceptions hides possible support for the use of these methods. Three primary stakeholder groups influence residential development: residents who purchase houses and create demand for additional development; developers supply lots and houses to consumers; and public officials who create and enforce regulations that guide the development process. Understanding these groups’ familiarity with and perceptions of alternative development designs is essential for evaluating the potential for their use and acceptance. This dissertation documents a set of studies that provide a comprehensive assessment of urban land cover change trends, the residential housing market for alternative subdivision designs, and the perceptions and attitudes of residents, developers, and city officials regarding alternative subdivision approaches in Iowa.
Alternative residential development methods

Two alternative development approaches, low-impact development and conservation subdivision design, are becoming more widely accepted as ways to limit negative environmental site impacts by integrating and protecting critical natural features as development occurs.

Low-impact development (LID) (Coffman, 2000) is a systems-based engineering approach that uses natural topography and integrated features, such as rain gardens and pervious pavers, distributed across a development site to control stormwater runoff and reduce requirements for storm sewer infrastructure. The effectiveness of LID techniques for controlling runoff and limiting pollution flows has been demonstrated by a number of empirical studies (Dietz, 2007; Dietz and Clausen, 2005; Dietz and Clausen, 2008; Hood et al. 2007). However, continued onsite maintenance is required to sustain the effectiveness and integrity of individual site features (Dietz and Clausen, 2005; Dietz, 2007).

Conservation subdivision design (CSD) (Arendt, 1996, 2004; Pejchar, 2007) is a philosophical and ecological approach that uses a step-wise process to identify, assess, and preserve areas of ecological and functional importance. CSD maintains housing density by decreasing lot sizes and clustering houses away from the preserved areas (Arendt, 1996, 1999). Each conservation subdivision is unique, tailored to fit the requirements of an individual site and therefore, effective CSD implementation requires comprehensive planning, scientific assessment, and monitoring (Lenth et al., 2006). When possible, connectivity through regional-level networks of preserved open space should be pursued as a means of preserving biodiversity in conserved land areas (Arendt, 2004; Lenth et al., 2006; Pejchar et al. 2007; Whyte, 1964).

Impacts of development: what systems are affected?

One key to making effective use of alternative subdivision designs is understanding past and future urban land use patterns and focus on areas likely to be impacted by development (Verburg et al. 2004). By targeting areas of conservation concern for implementation of these designs, urban land use decision-making can move from a very local parcel-by-parcel basis to a more holistic community approach (Brody 2003; Miller et al. 2009). Spatial analysis and modeling applied in the planning and design process could enhance local decision-making by tracking and quantifying the cumulative effects of development decisions on land cover over time and across landscape scales.
Readily available public data sources and GIS modeling software packages can support comparing and mapping changes across images and using those changes, along with land use change “driver” variables (factors/features that directly influence land cover change, such as distance to existing urban areas), to predict likely future outcomes for land cover over time. These analyses could be invaluable for providing a platform for stakeholder groups in communities to work together in making complex planning and management decisions.

**Economic valuation of alternative subdivision designs**

Another important aspect of alternative subdivision design implementation is an understanding of the market for these approaches in order to effectively promote their use to consumers and developers. There are several economic valuation techniques that can be used to estimate consumer value for alternative design features. First, stated preference methods use survey, interview and/or negotiation techniques to directly ask consumers how much they are willing to pay for a good through a series of different choice options. Contingent valuation and hypothetical referendums are two common stated preference techniques used in previous empirical studies.

Contingent valuation (CV) is a survey method using a series of questions to estimate the value a good or series *contingent* upon its hypothetical attributes (Mitchell and Carson, 1993). The hypothetical public referendum is another survey method that asks respondents whether they would support a certain level of tax or payment for the provision of a public good (Mitchell and Carson, 1993). The hypothetical nature of these methods makes them useful in estimating value for goods that either do not currently exist or have substantial non-market values, but this has also lead to controversy about their effectiveness in determining subjects’ “true” willingness to pay (Diamond and Hausman, 1994; McFadden, 1994).

Revealed preference methods use statistical modeling to estimate the value of goods based on consumers’ previous market payments. Hedonic price modeling is an example of this methodology using statistical regression to assess the price effect of individual housing attributes such as structural, neighborhood, and environmental characteristics, on the market value of homes (Freeman, 2003). While revealed preferences, such as hedonic price models, are linked to reality through actual market transactions, estimates cannot be made for items that are not available in the market or that have mainly non-market values.
Combining both stated and revealed preference methods provides a more realistic context for estimating the value of hypothetical goods by placing participants in an experimental market environment. Experimental auctions, along with experimental real estate negotiations are examples of methods using simulated markets to create a competitive environment used to estimate consumer values for goods (Black, 1997; Black and Diaz, 1996; Lusk and Shogren, 2007).

**Resident, developer and planner familiarity with and knowledge of alternative subdivision designs**

Past empirical studies have suggested that, in general, residents are unfamiliar with alternative subdivision design approaches (Bosworth, 2007; Hostetler and Noiseux, 2010; Thompson, 2004). Additionally, those residents who do have knowledge about low-impact or conservation designs may not fully understand the embedded environmental benefits of these approaches, especially benefits that are not immediately visible, such as protection of water quality or biodiversity (Thompson, 2004). Despite their lack of familiarity with alternative development designs, residents tend to prefer features usually found in low-impact or conservation subdivision developments. The presence of open space and conservation features in a neighborhood, especially for houses adjacent to natural areas, is a primary factor in their decision to purchase a home (Bowman and Thompson, 2009; Kaplan et al., 2004; Noiseux and Hostetler, 2010; Vogt and Marans, 2004).

Similar to residents, developers are generally unfamiliar with or misinformed about low-impact design and conservation subdivisions (Bosworth, 2007; Bowman and Thompson, 2009; Westbrook 2010). This lack of knowledge reinforces developers’ tendency to satisfice (to choose development approaches that are already known to meet revenue goals, but not necessarily maximize them, e.g. Mohamed, 2006; Svelka, 2004). Furthermore, lack of information on implementing alternative designs or misconceptions about potential costs and benefits (in particular, consumer demand) can limit the willingness of developers to use alternative design methods (Bosworth, 2007, Bowman and Thompson, 2009, Ryan, 2006, Thompson, 2004).

Civic officials are reported to have greater familiarity with alternative design approaches than either residents or developers (Kaplan et al., 2004). However, they may not be aware of the preferences among their constituency for features associated with these designs (Bosworth, 2007; Ryan, 2006), leading to the creation of ineffective subdivision ordinances (Hamin, 2006). Municipal planners who understand the value of alternative approaches are more willing to offer incentives to developers to
encourage use of conservation subdivision and low-impact developments (Bosworth, 2007) and work toward informing and involving the general public into implementation efforts (Stokes et al., 2010).

**STUDY OBJECTIVES**

This set of studies had several objectives aimed at assessing land use change and the potential value of alternative subdivision designs in Iowa. I used a comprehensive approach to assess stakeholder value for and knowledge of these designs (among residents, developers and city officials) in order to reduce barriers to their use.

First, I assessed land cover change in four major cities (Ames, Cedar Rapids, Council Bluffs, and Davenport) using remote sensing GIS data to determine the extent of urban development in Iowa municipalities and how different types of land cover (in particular, forest cover) are impacted by urban land uses. I then modeled future land cover change in Ames, Iowa to examine how current trends might affect future land use. The analysis and modeling procedures are proposed as a tool for use by urban foresters and municipal planners to improve land use decision-making that could be applied in any municipality.

Second, I examined residents’ preferences for and values related to the use of alternative subdivision design features using four different economic valuation methods (also in Ames, Iowa). I used a contingent valuation survey, a series of experimental real estate negotiations, a spatial hedonic price model, and a hypothetical referendum to determine the value that residents place on a variety of conservation subdivision and low-impact design features. I then explored how demographic factors and environmental preferences affect residents’ willingness to pay for alternative subdivision designs.

Third, I studied resident, developer and civic official knowledge about and familiarity with alternative subdivision designs (also in Ames, Iowa). I assessed the accuracy of stakeholders’ knowledge about low-impact and conservation subdivision designs and explored possible misperceptions between the different groups, in particular, exploring how developers and civic officials perceive residents’ interest in these subdivision features versus residents’ actual interest.

Finally, I offered insight about the implicit and explicit value of conservation subdivision design as a tool for preserving ecosystem services using a set of subdivisions in Cedar Rapids, Iowa as a case study. I studied the features in conservation subdivisions and compared them to standard subdivision
design with respect to the provision of stream water quality and the diversity of plants found in both developed and natural areas. I then combined the estimated value from the ecosystem services preserved by conservation subdivision design with residents’ willingness to pay for conservation features to compare the value generated by conservation subdivisions compared to standard subdivision designs.

**DISSECTATION ORGANIZATION**

The studies in this dissertation meeting these objectives are contained in six chapters: Chapter 1, Introduction; Chapter 2, Land cover analysis for urban foresters and municipal planners: Examples from Iowa; Chapter 3, Multiple approaches to valuation of conservation subdivision and low-impact development features in residential subdivisions; Chapter 4, Residential, developer, and civic official perceptions of alternative subdivision design approaches; Chapter 5, Conservation subdivisions and the value of protected ecosystem services; and Chapter 6, General Conclusions.

Data acquisition and analysis, and the preparation of the text were the responsibility of the candidate. Drs. Jan Thompson and John Tyndall provided help with experiment design, data gathering, project guidance, and editorial advice. Dr. Paul Anderson offered assistance with GIS data analysis and software, and helped with review of Chapter 2. In addition, the remaining committee members (Drs. Joe Colletti, Jim Kliebenstein and Lois Morton) assisted with experiment design, data gathering, guidance for economic experiments, advice on survey creation, framing and analysis, and editorial recommendations.

**LITERATURE CITED**


INTRODUCTION

Over 90% of the land area in Iowa has been converted to some form of agricultural production (ISU Extension 2009). This is representative of the larger Midwestern Cornbelt region, where much of the native habitat has been altered for intensive human uses. Additional changes in land cover and effects on natural areas are especially important to consider in this region, given that remaining natural areas are scarce but at the same time provide increasingly important localized and regional ecosystem services (e.g. Secchi et al. 2008). Among remnant natural areas, forest land in Iowa comprises only about 8% of the total land area in the state (Iowa DNR 2009; Nowak and Greenfield 2010). Land use change affecting any area of perennial land cover in the region’s predominantly agricultural landscape is receiving increasing scrutiny (Secchi et al. 2008). Recently, and in many areas, more attention is being focused on urbanization as a land use change that affects natural systems (including forests), and there is growing evidence that conversion to urban land uses is damaging to ecosystem service provision (Hansen et al. 2005; Theobald et al. 2005; McKinney 2006; Grimm et al. 2008; Stein et al. 2009). This is of concern in Iowa since the majority of the state’s citizens (> 60%) reside in cities and towns (US Census Bureau 2003; Nowak and Greenfield 2010).

Urban growth in Iowa’s largest municipalities manifests itself as outward expansion into suburban and formerly exurban areas as well as significant land cover change within existing municipal boundaries (e.g. Theobald 2005; Nowak and Greenfield 2010). Because several of Iowa’s largest and most rapidly growing cities are located adjacent to river systems, and because the riparian areas of Iowa’s rivers are where a large proportion of natural forest ecosystems remain, land cover change in and near urban areas is a significant issue for the state. Unlike other changes to forest resources (such as agriculture or logging), impacts from urbanization are largely irreversible, typically expansive, and create edge effects and gradients that can negatively affect remaining nearby forest systems (e.g. McKinney 2002; Moffatt et al. 2004). Given the permanent and wide-reaching nature of these changes, judicious planning at multiple scales with strong integration of ecological sciences is
necessary to minimize effects of urban development on these forest ecosystems (Beatley 2000; Broberg 2003; Miller et al. 2009).

Urban land use decision-making takes place primarily at very local municipal scales, typically on a parcel-by-parcel basis (Brody 2003; Miller et al. 2009). Incorporating spatial analysis technologies in the planning process could enhance local decision-making by tracking and quantifying the cumulative effects of development decisions on land cover over time and across landscape scales. Many agencies have the capacity to use GIS technology extensively (e.g. Selvarajan et al. 2009), but often municipalities themselves do not use spatial software to assess the overall impacts of land cover change over time. These analyses could be invaluable for providing a platform for urban foresters and planners to work together in making complex planning and management decisions.

One reason that local governments are not already doing this might be that creating and maintaining custom land cover inventories in-house may be cost-prohibitive. Most municipalities do not have the resources and/or expertise to acquire and analyze remote sensing data themselves. However, many cities do have GIS specialists who could access publicly available land cover information, such as the National Land Cover Datasets (NLCD) and state-level land cover maps. In such cases, analysts could provide valuable information to urban foresters and land use planners who wish to examine land cover changes (e.g. Bridges 2008). These public land cover datasets have already supported a variety of land cover change studies dealing with urban expansion, including the effect of urban growth on forest management (Nowak et al. 2005; Radeloff et al. 2005), relationships between state-level policies and agricultural preservation and urban expansion (Thompson and Prokopy 2008), and assessments of urban forest land cover and canopy characteristics (Bridges 2008; Walton et al. 2008).

While examination of past trends is an important aspect of assessing land cover change, the ability to use GIS models to project trends into the future and to predict potential development outcomes opens an additional realm of useful information. Predictive models can offer urban natural resource managers and planning agencies a glimpse of prospective outcomes from choices made as development decisions are considered (Yang and Lo 2003; Pijanowski et al. 2002; Nowak and Walton 2005; Theobald 2005). Modeling software packages, such as Clark Labs’ Land Change Modeler for Ecological Sustainability (Eastman 2007), can support comparing and mapping changes across images and using those changes, along with land use change “driver” variables (factors/features that directly influence land cover change, such as distance to existing urban areas), to
predict likely future outcomes for land cover over time. Maps produced by such models can help foresters and planners visualize patterns and focus on areas likely to be impacted by development in relation to the variables that have influenced development in the past (Verburg et al. 2004).

It is important to note that land cover maps are created using automated software to analyze remote sensing data (aerial photographs or satellite images) and accuracy can be diminished due to both spatial (location) errors and categorization (land cover types) errors (e.g. Bridges 2008, Thompson and Prokopy 2008; Walton et al. 2008). Overall degree of accuracy depends on complexity of the landscape, quality of the imagery, ability to distinguish among the categories examined, and the specific analysis method used. For example, land cover maps from the NLCD have estimated thematic accuracies for the Midwest ranging from 82 +/- 1% for 1992 (Wickham et al. 2004) and 89 +/- 1% for 2001 (Wickham et al. 2010). For the Iowa dataset and land cover categories we use in this analysis, thematic accuracy has been reported to range from 64% for deciduous forest to 94% for urban land cover (Nusser and Klaas 2003). Although it is beyond the scope of this paper to provide a thorough analysis of the drawbacks associated with limitations in thematic accuracy, we do acknowledge the potential for errors and recommend cautious consideration of the data, particularly at fine spatial scales and among easily confused land cover types (for example, between grassland and forest, as noted in the discussion).

Several previous land cover change studies (e.g., Nowak et al. 2005; Petrov and Sugumaran 2005; Radeloff et al. 2005; Thompson and Prokopy 2008) were conducted at relatively large scales (i.e., state or national). In this paper, we demonstrate that land cover change analysis and predictive modeling, using publicly available data and basic GIS software tools, can be applied at the municipal level, and could be used to assist urban foresters and planners to both understand and predict the impacts of land cover change.

**STUDY QUESTIONS**

This case study uses a set of four Iowa municipalities (Ames, Cedar Rapids, Council Bluffs, and Davenport) to examine the following questions:

1. How has land cover in Iowa municipalities changed, and based on these trends, what can be expected to change in the future?
2. In particular, how have the forest areas in and near Iowa municipalities been affected in the past, and how are they likely to change in the future?
To answer these questions we demonstrate the use of various data sets and geospatial analysis techniques. First, we analyzed land cover change between 1992 and 2002 for each of the four municipalities to assess changes in area for various land cover types. Second, using comprehensive tax parcel data for Ames and Cedar Rapids we examined the impacts of residential construction on land cover change during the same time period. Finally, using Ames as a case study, we used a model to predict land use change between 2002 and 2012 based on past trends and land use variables.

**METHODS**

**Study Areas**

Four cities (Ames, Cedar Rapids, Council Bluffs, and Davenport) were chosen for this case study along an east-west transect across Iowa (Figure 1). Cities were selected on the basis of population (> 50,000), positive population growth, and distribution across the state (Table 1). All four selected cities are located along both major rivers and interstate highways. While all of the study municipalities are considered metropolitan areas (population > 50,000), Council Bluffs and Davenport (located on the state borders) are part of urban complexes that span multiple states.

**Land Cover Change Analysis in Four Municipalities (1992 to 2002)**

We analyzed land cover type changes in the four cities (Ames, Cedar Rapids, Council Bluffs, and Davenport) using raster land cover classification images from both 1992 and 2002 obtained from the Iowa DNR (Iowa Geological Survey 1998, 2004), and based on Landsat imagery. The 1992 land cover inventory included seven classes with a 30-m resolution. The 2002 land cover inventory, which used 17 classes with a 15-m resolution, was reclassified and re-sampled using nearest neighbor sampling with the Raster Calculator tool and a majority filter in ArcGIS 9.3 (ESRI 2009) into the same 7-level classification system and 30-m resolution as the 1992 image. The reclassification was consistent with detailed descriptions in each system of original land classification schemes (Table 2). The land cover classes included urban land (paved roads, residential, commercial, and industrial areas), barren land (exposed soil, quarries), grassland/wetland areas, crop land, water, forest land, and missing data (clouds, shadows, or unclassifiable areas). Although we performed our own reclassification, several spatial data repositories also contain products for consistently meshing different classification systems (e.g. the Iowa Department of Natural Resources “1990-2002 Change Detection Grid”, at ftp://ftp.igsb.uiowa.edu/gis_library/ia_state/Land_Description/LC_Change_1990_2002/change_90_02.htm, and the USGS “1992/2001 Retrofit Change Product”, http://www.mrlc.gov/faq.php#changeProduct).
Land cover inventories for both 1992 and 2002 in each study area were bounded by the incorporated boundaries for each city in 2000. Land cover differences were calculated by cross-tabulation (Shalaby and Tateishi 2007) comparing 1992 and 2002 land cover inventories using the *Tabulate Area* tool in ArcGIS 9.3 (ESRI 2009). Total area and percentage changes were then calculated for each land cover type.

*Parcel-Based Analysis for Residential Areas in Ames and Cedar Rapids (1992 to 2002)*

We used tax parcel information to estimate the impact of residential development on urban land cover in two of the cities (Ames and Cedar Rapids) from 1992 to 2002. Tax parcel layers (vector-based polygons) with complete sets of residential build dates were obtained from city assessor’s offices, and used to extract and cross-tabulate cells from the 1992 land cover inventories using the *Tabulate Area* tool in ArcGIS 9.3. These data were used to estimate the land cover change impact of residential construction by land cover type and year.

*Land Cover Change Modeling for Ames (2002 to 2012)*

The Land Change Modeler for Ecological Sustainability (LCM) extension for ArcGIS (Eastman 2007) was used to predict change for one municipality, Ames. This allowed us to estimate possible land cover changes from 2002 to 2012. The LCM uses a step-wise process with land use driver variables that create land change transition probability maps. These maps are then used in conjunction with a Markov chains probability matrix to create a prediction for future land cover (Eastman 2007). The combination of these two processes addresses the weaknesses of the individual methods. The Markov chain transition matrix provides a general overview of the observed land cover changes independent of previous history. The addition of driver variables removes the inherent limitation that the value of future land cover states can only rely on the value of previous land cover states. Land use driver variables include spatial elements that are believed to influence land cover change within a particular area. Elements that affect urban development can differ, although those consistently identified in previous studies include proximity to urban utility services, distance to water, topographic features, exclusionary zones (such as conservation easements) and distance to roads (e.g. Yang and Lo 2003; Pijanowski et al. 2005). For this study, variables included distance to existing urban area (utilities), slope, and distance to stream, selected on the basis of data availability.

Existing urban area was determined by extracting areas zoned for commercial, industrial and residential land uses from a 2002 Ames zoning map. A slope map (in degrees) was created using a
10-m USGS national digital elevation model (DEM) of Iowa using the Slope tool in ArcGIS 9.3 (ESRI 2009). Distance to streams was calculated using an Iowa stream layer (ftp://ftp.igsb.uiow.edu/gis_library/Counties/Story/rivers_85.htm) and the Euclidean Distance tool in ArcGIS 9.3.

A Markov chains probability matrix created using 1992 and 2002 land cover inventories for Ames was applied with the selected variable transition maps to a multiple objective land allocation model (Eastman 2007) with a target date of 2012. In this model, land cover types could transition to any other land cover type (except water) based on the Markov chains probabilities. The predicted 2012 map was compared to the 2002 land cover inventory by cross-tabulation using the Tabulate Area tool. Total estimated area and percentage changes for each land cover category were then calculated.

RESULTS

Land Cover Change Analysis for Four Municipalities (1992 to 2002)

Overall changes in land cover within city boundaries for Ames, Cedar Rapids, Council Bluffs, and Davenport indicate important increases in urban land cover between 1992 and 2002 (Table 3). Urban land area (in acres) increased in all four cities, with increases ranging from 28% to 80%. In Ames, Cedar Rapids, and Council Bluffs, most of the increases were at the expense of the grassland/wetland land cover class (Table 4). The grassland/wetland cover type also transitioned into crop land and forest land in all of our study areas (Table 4). In Davenport, the grassland/wetlands category also contributed to increased urban acreage, but overall, this category grew at the expense of crop land and forest areas (Table 4).

Crop land within city boundaries decreased between 1992 and 2002 in all four study areas (Table 3). Crop land shifted to both grassland/wetland and urban land (Table 4). In contrast, net forest cover increased for Ames, Cedar Rapids, and Council Bluffs. Net increases in forest were driven by transitions from the grassland/wetland category and by canopy closure in urban areas, even though sizable losses of natural forest land (from 859 to 3,234 acres, Table 3) to both urban and grassland/wetland areas occurred (Table 4).

Urban land (as a percentage of land within each municipal area) increased by 6.3% to 12.8% (Table 5). Crop land decreased as a percentage of each municipal area by 4.7% to 8.4% (Table 5). Percent
of forest land within municipal boundaries increased slightly in Ames, Cedar Rapids and Council Bluffs, by 1.4% to 4.3%. However, in Davenport percent of forest land decreased by 2.5% (Table 5).

Parcel-Based Build Date Analysis for Residential Areas (1992 to 2002)
Land cover inventories for residential parcels built between 1992 and 2002 in Ames and Cedar Rapids indicated that new construction over the 10-year period occurred on different cover types for the two municipalities (Figure 2). In Ames, residential development occurred mainly on former crop land (48.5%) and grassland/wetland (28.1%), and forests were affected to a lesser degree (8.5%) (Figure 2a). In Cedar Rapids, the majority of residential development took place on former grassland/wetland areas (37.1%) followed by forest land (28.1%) and crop land (27.7%) (Figure 2b).

Examination of parcel land use change by year indicated that residential development peaked in 1997 and 1998 in Ames and in 1994 and 1997-98 in Cedar Rapids (Figure 2). In Ames, grassland/wetland cover was more affected by residential development 1992-1998, after which development shifted to crop land. For Ames, increases in the occurrence of development in one land cover type corresponded with decreases in occurrence on other land types (total area affected by development remained relatively constant). In Cedar Rapids, grassland/wetland, crop land, and forest land cover types were all converted to residential development throughout this period (Figure 2b). Increases in development on a particular land cover type did not correspond with decreases in the use of other land cover types as total land area affected increased over time (Figure 2b).

Land Cover Change Modeling (2002 to 2012)
Land cover change model estimates for one municipality, Ames (based on the Markov chains probability matrix) predict changes in land cover for 2002-2012 to be similar to those observed from 1992 to 2002 (Table 6, Figure 3). The model predicts considerable urban growth, a 27.8% increase in urban land area. Most of the increase in urban land is predicted to involve transitions of grassland/wetlands to urban land cover (Table 6b). The model also indicates large transitions from crop land to grassland/wetland and urban land. In addition, the model predicts a slight increase (6.2%) in forest land cover (largely transitions from grassland/wetland areas, Table 6a), but again underlying data indicate losses of former forest land (481 acres) to urban cover (Table 6b).
DISCUSSION

This study uses publicly available information to examine how spatial analysis tools can be used for urban natural resource planning. We examined four cities at the municipal level, comparing land cover maps between 1992 and 2002 using GIS software. We then used build date information from tax parcels of two of the cities to examine impacts of residential development during the same time period. Finally, we used modeling software to estimate how land cover might change in one of the cities from 2002 to 2012. Throughout this discussion we will point out potential limitations related to data sources and classification accuracy.

Urban land cover increased during the 1992-2002 time period in each of our study areas (Table 2) at an expansion rate between 1-2 acres of urban area for each person of added population (Table 1). Generally, larger cities increased both their population and urban land area at a greater absolute rate than smaller cities (Table 3); however, Davenport (which is the largest in terms of total land area) was an exception with the smallest percent and absolute growth for both population and urban land cover. Detection of urban land cover is associated with relatively high levels of thematic accuracy (above 90% for the Iowa dataset, Nusser and Klaas 2003).

Urban growth for these cities is happening primarily at the expense of grassland/wetland and crop land cover types (Table 3). This is mainly because of the availability of these cover types and their locations within the municipality. Grassland/wetlands and crop land combined accounted for between 60 and 71% (in 1992) of land cover within our study boundaries (Table 4). Owing to the dominance of row crop agriculture in Iowa, the thematic accuracy associated with crop land cover types is also fairly high, close to 90% (Nusser and Klaas 2003). These land cover types are located in relatively level areas making them less costly to convert (in terms of site grading) and thus attractive for development. In an earlier analysis of crop land loss, Petrov and Sugumaran (2005) also indicated significant conversion of crop land to urban land cover. This is also borne out by patterns of residential development based on the tax parcel build date analyses (Figure 2) in which grassland/wetland and crop land cover types were the predominant land cover types converted to new residential development. We primarily examined these changes aggregated at a subdivision scale (rather than individual lot scale), nonetheless at this fine scale of resolution the data should be interpreted with caution.
Forests, by contrast, are less abundant, accounting for only 10 – 14% (in 1992) of the total municipal area of our study sites (Table 3), and are most often located in floodplains along rivers and streams or in areas with relatively steep topography. In three of our study areas, overall forest land cover increased by 13.1% to 45.5% (Table 3). Although thematic accuracies are lower in general for distinguishing between grass/wetland and forest cover, increases in forest cover are consistent with other measures of forest area in recent years in Iowa (e.g. Flickinger 2007). New residential development in Cedar Rapids and Ames during the study period generally occurred less frequently on forest land (Figure 2).

One critical aspect of land cover change analysis to take into account is that overall statistics can mask important underlying details. This is particularly important in our analysis with respect to forest land cover change. Cross-tabulations show decreases in former forest land and indicate transitions to and from forest land cover involved changes to/from grasslands/wetlands followed by urban land cover (Table 4). Some of these changes can be attributed to edge effects (where land cover types can be mis-categorized, or as cover type is transitioning). Alternatively, gains in forest land cover from grasslands/wetlands may indicate early-successional forest growth, especially where a majority of gains are made within floodplains (also reported by Petrov and Sugumaran 2005). This interpretation is also supported by trends showing modest increases in forest cover in recent years throughout the state (Flickinger 2007). Likewise, gains in forest land transitioning from urban land cover may be due to maturing street trees with recently closed canopy cover being detected and categorized as forest cover rather than urban cover (Walton et al. 2008). These changes can often be manually verified based on familiarity with the area (and conducting ground-truthing inspections) or using aerial imagery if available (e.g. USDA National Agricultural Imagery Program orthophotos). For example, we used air photos to determine that a single area in Council Bluffs (approximately 120 acres), characterized as forest that transitioned from grassland/wetland, was in fact an early-successional forest in a floodplain area. These types of forest areas are likely to play an important flood mitigation role over time, but they are compositionally less diverse and qualitatively inferior to mature forests in the area in terms of biodiversity and nutrient cycling (e.g. Mabry et al. 2008; Thompson and Mabry 2009).

Compared to gains in forest land cover from other land cover types, losses of forest land (in particular, to urban land cover) may appear to be minor. However, modest losses combined with changes in configuration (including fragmentation of other natural forest areas) have large
implications for forest biodiversity and function, which may both be diminished by such changes (McKinney 2002, 2006; Moffatt et al. 2004; Hansen et al. 2005; Grimm et al. 2008; Mabry et al. 2008). Land change modeling for Ames indicates that overall modest decreases in existing forest land cover are likely to continue to 2012 (Table 6, Figure 3). The relative scarcity of forest land throughout the state as a whole (<8% cover, Nowak and Greenfield 2010), however, leads to potentially greater consequences in terms of diminished ecosystem services from the loss of forest than is true for declines in other land cover types (Nowak and Dwyer 2007; Stein et al. 2009).

Furthermore, based on the rates at which grassland/wetlands and crop lands are being converted (combined decreases of 9% to 39% between 1992 and 2002, Table 3) and an estimated combined 29% decrease in Ames between 2002 and 2012 (Table 6), availability of these land cover types for development is likely to become limited. If current urban growth trends continue, annexation of surrounding land and increased development of all land cover types will be more likely. The location, relative magnitude, and configuration of forest losses should be carefully considered by natural resource managers and planners when examining land cover change trends.

CONCLUSIONS

This study demonstrates a basic framework for land cover change analysis and modeling using readily available spatial data, GIS software, and basic spatial analysis methods. Using spatial technologies to assess land cover changes over time can be an effective tool for planning and managing urban natural resources. By examining changes at the municipal level, urban foresters can work together with planners to make more effective decisions that account for overall land cover change trends. This is particularly true for natural resource conservation decisions, which often require a larger scale approach allowing for interconnected protected land areas across the landscape (i.e., buffer strips, wildlife corridors). Land cover change analysis and predictive modeling can help identify natural areas that are most likely to be affected by future urbanization, and lead to dialog that addresses the costs and benefits of landscape change as part of the decision-making process (Troy et al. 2006).

Incorporating these methods with existing assessment tools can enhance the decision-making process for urban foresters and planners by offering important quantitative and qualitative information (e.g. Stokes et al. 2010). Land cover change analysis and modeling, however, is driven by data, and both the type and quality of available datasets will ultimately determine how effective and applicable the findings are. In order for these methods to provide the greatest value to resource managers and
planners, municipalities should make land use datasets available to support accurate analysis and modeling results.

LITERATURE CITED


Eastman, J.R. 2007. The Land Change Modeler, a software extension for ArcGIS. Clark University, Worcester, MA.


Table 1. Location, size and demographic data for four Iowa municipalities selected for this study.

<table>
<thead>
<tr>
<th>Location</th>
<th>Size (acres)</th>
<th>1990 Population</th>
<th>2000 Population</th>
<th>Population Increase</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ames</td>
<td>Central</td>
<td>13824</td>
<td>47,198</td>
<td>50,731</td>
</tr>
<tr>
<td>Cedar Rapids</td>
<td>East-Central</td>
<td>41216</td>
<td>108,772</td>
<td>120,758</td>
</tr>
<tr>
<td>Council Bluffs</td>
<td>West</td>
<td>25408</td>
<td>54,315</td>
<td>58,268</td>
</tr>
<tr>
<td>Davenport</td>
<td>East</td>
<td>41536</td>
<td>95,333</td>
<td>98,359</td>
</tr>
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</table>
Table 2. Land cover classes used for 1992 Iowa land cover maps (7 classes) and corresponding land cover classes for 2002 Iowa land cover maps (17 classes) that were collapsed into the 1992 categories.

<table>
<thead>
<tr>
<th>1992 land cover class</th>
<th>2002 land cover class</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urban</td>
<td>1 Roads</td>
</tr>
<tr>
<td></td>
<td>2 Commercial/Industrial</td>
</tr>
<tr>
<td></td>
<td>3 Residential</td>
</tr>
<tr>
<td>Barren</td>
<td>4 Barren</td>
</tr>
<tr>
<td>Grassland/Wetland</td>
<td>5 Wetlands</td>
</tr>
<tr>
<td></td>
<td>6 Ungrazed grasslands</td>
</tr>
<tr>
<td></td>
<td>7 Grazed grasslands</td>
</tr>
<tr>
<td></td>
<td>8 Planted grasslands</td>
</tr>
<tr>
<td>Cropland</td>
<td>9 Corn</td>
</tr>
<tr>
<td></td>
<td>10 Soybean</td>
</tr>
<tr>
<td></td>
<td>11 Other rowcrop</td>
</tr>
<tr>
<td>Water</td>
<td>12 Water</td>
</tr>
<tr>
<td>Forest</td>
<td>13 Wet forest</td>
</tr>
<tr>
<td></td>
<td>14 Coniferous forest</td>
</tr>
<tr>
<td></td>
<td>15 Deciduous forest</td>
</tr>
<tr>
<td>Missing</td>
<td>16 Clouds</td>
</tr>
<tr>
<td></td>
<td>17 Missing</td>
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</tbody>
</table>
Table 3. Land cover acreage and percent gains and losses for the period 1992-2002 for four Iowa cities selected for this study.

<table>
<thead>
<tr>
<th></th>
<th>1992 (acres)</th>
<th>2002 (acres)</th>
<th>Gained (acres)</th>
<th>Gained (%)</th>
<th>Lost (acres)</th>
<th>Lost (%)</th>
<th>Net (acres)</th>
<th>Net (%)</th>
</tr>
</thead>
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<td>193</td>
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<td>40.7</td>
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<tr>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
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<td>23438</td>
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<td>Urban</td>
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<td>1558</td>
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<tr>
<td><strong>Davenport</strong></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
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<td>16042</td>
<td>5689</td>
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<td>2199</td>
<td>17.5</td>
<td>3490</td>
<td>27.8</td>
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<td>6148</td>
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<td>759</td>
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</tr>
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<td>40.9</td>
<td>-1379</td>
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</table>
Table 4. Land cover change (acres) cross-tabulation for the period 1992-2002 for four Iowa cities. Numbers in columns represent acreages that transitioned from land cover types in the left-hand column into land cover types indicated across the top row.

<table>
<thead>
<tr>
<th></th>
<th>2002 Land Cover Type (acres)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Urban</td>
</tr>
<tr>
<td><strong>Ames</strong></td>
<td></td>
</tr>
<tr>
<td>1992 Land</td>
<td></td>
</tr>
<tr>
<td>Cover Type</td>
<td></td>
</tr>
<tr>
<td>(acres)</td>
<td></td>
</tr>
<tr>
<td>Urban</td>
<td></td>
</tr>
<tr>
<td>Barren</td>
<td>171.9</td>
</tr>
<tr>
<td>Grass/Wetland</td>
<td>2523.3</td>
</tr>
<tr>
<td>Cropland</td>
<td>1119.3</td>
</tr>
<tr>
<td>Water</td>
<td>7.3</td>
</tr>
<tr>
<td>Forest</td>
<td>425.7</td>
</tr>
<tr>
<td><strong>Cedar Rapids</strong></td>
<td></td>
</tr>
<tr>
<td>Urban</td>
<td>-</td>
</tr>
<tr>
<td>Barren</td>
<td>441.7</td>
</tr>
<tr>
<td>Grass/Wetland</td>
<td>7554.3</td>
</tr>
<tr>
<td>Cropland</td>
<td>2394.5</td>
</tr>
<tr>
<td>Water</td>
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</tr>
<tr>
<td>Forest</td>
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</tr>
<tr>
<td><strong>Council Bluffs</strong></td>
<td></td>
</tr>
<tr>
<td>Urban</td>
<td>-</td>
</tr>
<tr>
<td>Barren</td>
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<td>Water</td>
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<tr>
<td>Forest</td>
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<tr>
<td><strong>Davenport</strong></td>
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<tr>
<td>Urban</td>
<td>-</td>
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<tr>
<td>Barren</td>
<td>338.7</td>
</tr>
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<td>Grass/Wetland</td>
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<td>Cropland</td>
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<td>Water</td>
<td>11.6</td>
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<tr>
<td>Forest</td>
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</table>
Table 5. Land cover as a percent of total municipal area during the period 1992-2002 for four Iowa cities selected for this study.

<table>
<thead>
<tr>
<th></th>
<th>Ames</th>
<th>% 1992</th>
<th>% 2002</th>
<th>% Gained</th>
<th>% Lost</th>
<th>% Overall</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urban</td>
<td>16.0</td>
<td>28.8</td>
<td>15.5</td>
<td>2.7</td>
<td>12.8</td>
<td></td>
</tr>
<tr>
<td>Barren</td>
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<td>0.2</td>
<td>0.2</td>
<td>1.7</td>
<td>-1.5</td>
<td></td>
</tr>
<tr>
<td>Grass/Wetland</td>
<td>30.4</td>
<td>25.6</td>
<td>12.7</td>
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<td>-4.8</td>
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</tr>
<tr>
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<td>0.6</td>
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<tr>
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<td>12.0</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Cedar Rapids</th>
<th>% 1992</th>
<th>% 2002</th>
<th>% Gained</th>
<th>% Lost</th>
<th>% Overall</th>
</tr>
</thead>
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<tr>
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<td>3.4</td>
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<td>0.4</td>
<td>1.6</td>
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<td>Grass/Wetland</td>
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<td>28.6</td>
<td>11.9</td>
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<td>Water</td>
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<table>
<thead>
<tr>
<th></th>
<th>Council Bluffs</th>
<th>% 1992</th>
<th>% 2002</th>
<th>% Gained</th>
<th>% Lost</th>
<th>% Overall</th>
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</thead>
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<th>% Lost</th>
<th>% Overall</th>
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<td></td>
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Table 6. Estimated (A) land cover acreage and percent gains/losses, (B) cross-tabulation results (acres transitioning from cover type in left column to cover type indicated in top row), and (C) land cover change as a percent of municipal area for the period 2002-2012 for Ames, Iowa using the Land Change Modeler program (Eastman 2007).

<table>
<thead>
<tr>
<th></th>
<th>2002</th>
<th>2012</th>
<th>Gained</th>
<th>%</th>
<th>Lost</th>
<th>%</th>
<th>Net</th>
<th>%</th>
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<tr>
<td>A</td>
<td>(acres)</td>
<td>(acres)</td>
<td>(acres)</td>
<td></td>
<td>(acres)</td>
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<tr>
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<tr>
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<tr>
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<table>
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<th>% Lost</th>
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<td>12.7</td>
<td>4.8</td>
<td>4.1</td>
<td>0.7</td>
</tr>
</tbody>
</table>
Figure 1. Map of study sites in Iowa. Red symbols for cities indicate municipal boundaries in 2000.
Figure 2. Number of acres used for residential development by original land cover type based on tax parcel data. Structure build dates include each year between 1992 and 2002 for Ames (a) and Cedar Rapids (b), Iowa.
INTRODUCTION
Developers and civic officials face difficult choices in deciding appropriate land uses as city populations expand and urbanization changes how land is used in and around metropolitan boundaries. Often these parties are pitted against one another in debates over the environmental impacts of development decisions forcing choices between the conservation or the utilization of land resources. New alternative designs for residential development, such as conservation subdivisions or low-impact development, offer the possibility of addressing this by focusing on the purposeful identification, protection and integration of important natural resources on a development site. Such an approach could generate “win-win” outcomes as enhanced ecological functionality in urban contexts can add both private and public value, lower social and infrastructural costs, and support long-term economic development. However, many municipalities across the Midwest do not currently have any examples of conservation design and the lack of community-derived market information to identify possible support for or barriers to the application of these methods prevents more robust decisions for local land use policy from being made. This exploratory research uses both stated and revealed valuation methods in a case study examining consumer value for conservation and low-impact design.

Conservation subdivision design and low impact development
Advocacy for conservation in residential development as a way to preserve important ecological areas during development for communal benefit has a long history tracing its roots from Howard (1902) through Arendt (1996, 1999, 2004). Conservation subdivision design (CSD) can maintain housing density while preserving large areas of land for ecological and aesthetic benefits by decreasing lot sizes and clustering lots away from protected open spaces (Arendt, 1996, 1999). Despite the potential benefits, conservation subdivision design use is limited in the Midwest (Bowman and Thompson, 2009; Crick and Prokopy, 2009; Miller et al., 2009). Further, when implemented, typically only a limited array of conservation features are included (Crick and Prokopy, 2009).
rarity of “true” conservation subdivision designs has led to criticism about the overall effectiveness of current examples of conservation subdivisions (Milder, 2007; Milder et al., 2008). For example, some previous studies have shown little improvement over standard design practices in terms of biodiversity conservation (Lenth et al., 2006). Certainly the benefits of conservation subdivision design are diminished when conservation subdivision features are used in ineffective configurations that do little to protect ecological functionality (Lenth et al., 2006) or at scales that merely protect isolated pockets while overall environmentally compromising development patterns remain unchanged (Daniels, 1999). Nevertheless, modern scientific assessments can help by providing designers with information on which parts of a specific property should be preserved (Pejchar et al. 2007). Effective use of CSD requires comprehensive design and maintenance at the subdivision level (Lenth et al., 2006) as well as regional-level planning for open space connectivity and conservation (Arendt, 2004; Lenth et al., 2006; Whyte, 1964).

Low-impact development (LID) (Coffman, 2000) is an integrated approach that uses a system of practices distributed across a development site designed to help control stormwater runoff eliminating the need for extensive storm sewer systems (common practices include using bioswales, open spaces, rain gardens and pervious surfaces). Empirical studies have demonstrated the effectiveness of LID techniques for controlling runoff from small and moderate rainfall events (Deitz, 2007; Dietz and Clausen, 2005; Hood et al. 2007), and for limiting pollution exportation from residential developments (Dietz and Clausen, 2008). However as with CSD practices, lack of planning and design in the implementation and placement of LID features along with ongoing maintenance and monitoring can compromise the effectiveness of individual practices (i.e., rain gardens, Dietz and Clausen, 2005) as well as whole site impacts (Dietz, 2007).

Methods of Valuation

There are several avenues for eliciting the degree to which consumers have value for certain goods that possess complex attributes. Stated preference methods use survey, interview or negotiation techniques to directly ask consumers how much they are willing to pay for a good through open-ended, multiple choice, or dichotomous choice options. Revealed preference methods use statistical modeling to estimate the value of goods based on consumers’ previous payment behavior. The choice of methods is determined by the type of information needed. While revealed preferences are linked to reality through actual market actions, values cannot be assessed for goods that are not available on the market or that have non-market values. To gain the most robust understanding of
consumer value for conservation and low-impact design features we use four different valuation
techniques to estimate residents’ willingness to pay for CSD and LID features in residential
subdivisions.

**Contingent valuation**

Contingent valuation (CV) is a survey methodology that uses a series of questions to draw out a
respondent’s willingness to pay for a good *contingent* upon the context of a hypothetical market
(Mitchell and Carson, 1993). This method is useful in estimating value for goods in a context where
the goods in question do not currently exist or are associated with non-market values. As is the case
for conservation and low-impact designs in many parts of the Midwest, CV and other hypothetical
estimation methods are a means to assess preferences for specific development features by creating a
theoretical market for these goods for consumers to interact with. Even so, there is some controversy
over the use of CV to assess consumer willingness to pay (Diamond and Hausman, 1994; McFadden,
1994).

CV has been used in a variety of studies to estimate willingness to pay for open spaces and natural
features in residential areas. Across these studies, respondents have expressed a willingness to pay
for parks (Jim and Chen, 2006), forests and trees (Lorenzo et al., 2000; Tyrvainen and Vaananen,
1998), greenways, and undeveloped lots or general open space (Bowman et al., 2009; Breffle et al.,
1998; Peiser and Schwann, 1993). The magnitude of willingness to pay for conservation features has
been found to be influenced by distance to natural areas, household income, gender, age, number of
children, length of residence and education (Bowman et al., 2009; Breffle et al., 1998; Cho et al.,
2005; Lorenzo et al., 2000; Jim and Chen, 2006; Johnson et al., 2003).

**Experimental real estate negotiations**

One issue with standard CV surveys is that they evaluate consumer willingness to pay in a
hypothetical situation outside of a real market. Methodologies such as experimental real estate
negotiations (conceptually akin to experimental auctions) can provide a more real-world context by
placing participants in a simulated environment that more closely resembles the home-buying
experience.

Experimental real estate negotiations (Black, 1997; Black and Diaz, 1996) are hypothetical real estate
pricing negotiations where participants (typically professional negotiators) use available information
to make a series of offers to reach a mutually agreeable price. Black and Diaz (1996) and Black (1997) used these negotiations to examine how starting asking price for homes influenced the outcome of the negotiation process. They found that negotiators typically anchor their offers on asking price. Important aspects with regard to negotiation success included the negotiation time frame, the number of bidding rounds, available information on the property and other participants, and the background of participants (e.g., real estate agents) greatly influencing final prices (Bazerman et al., 1992, Neale and Bazerman, 1992; Ravenscroft et al., 1993).

Within the real estate negotiation framework, an experimental auction mechanism can be used to estimate consumer values for goods or attributes of goods by eliciting bids over a series of negotiating “rounds” (Lusk and Shogren, 2007). There are several types of auction mechanisms, from the second-price (or Vickrey) auction (Vickrey, 1961) to the random nth-price (Shogren et al., 2001). Considerations in choosing an auction format include the duration of bidding and the revelation of bid values. Repeated rounds of bidding with pricing feedback can help participants learn the mechanism (Lusk et al., 2004; Shogren et al., 2001), but can also run the risk of bid affiliation (where revealed bid prices can influence a number of participants to bid similarly, e.g., Harrison et al., 2004).

Auction oriented techniques have been used to examine environmental attributes of market goods in various contexts ranging from non-durable or low-cost goods such as pork chops (Fox et al., 1995) or coffee cups (Corrigan and Rousu, 2006; Lusk, 2003) to more complex environmental attributes such as the impact of tree density in a park settings (Brookshire and Coursey, 1987), subsidized abatement of non-point source pollution (Cason et al., 2003), and land conservation contracts for preserving ecological function (Stoneham et al., 2002).

**Spatial hedonic price models**

Hedonic price models are a revealed preference method based primarily on Rosen’s (1974) extension of Lancaster’s consumer theory (1966) that describes the hedonic price function in a housing market as a sum of the supply and demand functions of the individual housing attributes such as structural, neighborhood and environmental characteristics (Freeman, 1993). Many hedonic price model studies have examined how environmental features influence housing prices. Public parks have been shown to positively influence housing prices by both proximity and amount of use (Kitchen and Hendon, 1967; Lutzenhiser and Netusil, 2001). Likewise, open space can increase the value of home (Bolitzer and Netusil, 2000; Bowman et al., 2009). The type of open space can also affect sale price with greenbelts, forests, and streams having generally positive effects (Bolitzer and Netusil, 2000;
Bowman et al., 2009; Cho et al., 2006; Correll et al., 1978; Geoghegan, 2002; Irwin, 2002; Ready and Abdalla, 2005; Thorsnes, 2002). The legal status of open space also appears to (positively) affect home value, with permanently protected open space more valuable than developable open space (Geoghegan, 2002; Irwin, 2002).

Hedonic price studies also include sets of explanatory factors outside of environmental features in order to control for misspecification error derived from missing variables. Studies have found that important factors that can influence home prices include: characteristics of the house (e.g., size, number of bedrooms, fireplaces), quality and condition of homes, distance to amenities (such as shopping or golf courses), distance to the central business district, degree of neighborhood vacancy and income, school performance, and distance to “disamenities” such as railroad tracks (Bourassa et al., 2004; Bowman et al., 2009; Brasington, 1999; Brigham, 1965; Cho et al., 2006; Dowall and Landis, 1982; Phillips and Goodstein, 2000; Strand and Vagnes, 2001).

Recent hedonic price model studies have focused on methods to incorporate spatial effects into regression models. Neglecting to deal with the effects of spatial dependence in hedonic price models can affect the interpretation of the magnitude and significance of model estimates as well as model diagnostic tests (Kim et al., 2003). There are several ways to incorporate these effects into a regression model including using either a spatial lag or spatial error model (Anselin, 1988). A spatial lag model assumes that the value of the dependent variable for an observation is indirectly affected by the values of the observations neighbors (Kim et al., 2003). This is in addition to the direct effects of other chosen explanatory variables. The spatial error model assumes that there are missing explanatory spatial variables in the model that are influencing the error term within the model (Kim et al., 2003). Simple tests have been developed to assist in identifying the presence and type of spatial dependence (Anselin et al., 1996).

Public purchase referenda

Another method for eliciting consumer willingness to pay is through a survey-based hypothetical referendum that asks respondents whether they would support a certain level of payment for the provision of a public good (Mitchell and Carson, 1993). This methodology has immediate applications given recent increases in public open space referenda indicating that municipalities and grassroots organizations are increasingly using ballot initiatives as a vehicle for public conservation efforts (Banzhaf, 2010; Kotchen and Powers, 2006; Nelson et al., 2007).
Since a referendum typically lacks a voluntary payment mechanism and avoids issues of group size, fair share and free rider questions are not concerns (Bohara et al., 1998). Hypothetical referenda are, however, vulnerable to the effects of respondent anchoring which may lead to inflated willingness to pay estimates and the use of follow-up open-ended evaluations is suggested (Green et al., 1998). Despite this, past studies have demonstrated that hypothetical referenda can be good predictors of real voting behavior (Vossler et al., 2003). In a study examining an open space referendum in Corvallis, OR, Vossler et al. (2003) found that when undecided survey respondents were treated as a “no” response, the willingness to pay results were similar to actual voting responses.

**Study area**

Ames, Iowa (United States) was chosen as the study area because it is an example of a typical Midwestern town experiencing urban infill and growth. The 2000 city population for Ames was 50,731, a 7.5% increase over the 1990 population (U.S. Census Bureau, 2003). Urban land cover within Ames municipal limits during that same time period increased by 80% (Self-citation, in review). Recent controversy over both commercial (Anderson, 2004) and residential (Anderson, 2005) development illustrates the concerns that Ames’ citizens’ have regarding potential social and environmental effects of development. There is no current market information available on consumer preferences for conservation or low-impact features in Ames that would guide developers or city officials to formulate effective development plans and policies.

**Research questions**

In this study, we examined Ames residents’ preference for and valuation of alternative subdivision designs using four different types of valuation methodologies. First, we used a contingent valuation survey of recent Ames homebuyers to investigate consumer preference and willingness to pay for CSD and LID features and what kind of factors may be related to it. Second, we employed a series of experimental real estate negotiations to further refine consumer willingness to pay and explore how residents would value CSD and LID features in an interactive and competitive environment. Third, we developed a spatial hedonic model to examine how property sales values are influenced by aspects of private and public open spaces. Finally, a hypothetical referendum was used to determine what value residents would place on the purchase of public land for conservation and recreation purposes. This study investigates several questions using this combination of valuation techniques. First, are the results of these methods consistent with one another? Second, what factors are important in
determining residents’ willingness to pay for CSD or LID features? Third, what kinds of features are more highly valued by Ames residents?

**METHODS**

*Resident survey - Survey administration*

Two versions of a mail-return survey were created and disseminated using the Dillman tailored design approach (Dillman, 2007) with assistance from the Center for Survey Statistics and Methodology (http://cssm.iastate.edu/) and reviewed by the Office for Responsible Research at Iowa State University. Surveys queried residents on their opinions of and their willingness to pay for four different subdivision features. The first version of the survey included a description of Conservation Subdivision Design (CSD) and questions about two features typically associated with CSD, and the second version included a description of Low-Impact Design (LID) and questions about two features often used in LID. The CSD features used in the survey included clustered housing patterns and a stream with a forest buffer. The LID features included pervious pavers (current city design standards allow pavers only on privately owned areas, such as driveways) and rain gardens. All other items on both versions of the survey were identical, and included questions about whether residents had previously heard of CSD or LID designs, their preferences for general neighborhood characteristics, their rating of the attractiveness and marketability of alternative subdivision design features, willingness to buy and pay for those features, a hypothetical additional tax to purchase land for public conservation, and several general demographic questions.

The City of Ames Assessor’s Office records were used to identify and randomly select 2000 households for which a single-family detached home was purchased between 2003 and 2008 to receive a survey. Homebuyers with recent purchasing experience were chosen because they would be knowledgeable about the Ames housing market. The two versions of the survey (CSD and LID features) were evenly and randomly divided among the 2000-household sample. Reminder postcards were mailed to households that had not responded within two weeks, and after four weeks, an additional survey was mailed. Households that had moved or were incorrectly listed in the Assessor’s database were removed from the sample and were not replaced, resulting in an eligible sample of 1804. Non-response bias was tested by comparing early respondents to those who replied to follow-up survey requests (“late” responders) on important population statistics (Dooley and Linder, 2003). Sample t-tests produced no evidence of significant differences between early and late respondents in the mean responses to several demographic variables (e.g., household income, gender, education).
Previous knowledge about CSD and LID designs was measured using a 3-point scale where “1” indicated a respondent had not previously heard of the design, “2” indicated they may have heard of the design, and “3” indicated they had heard of the design. An open-ended question was available for participants to identify where they may have previously heard of either design. Residents’ opinions of each feature were queried by asking if they thought the feature was attractive, whether a house would be easier to sell with the addition of the feature, and whether they would purchase a home that included the feature. Questions used a rising 5-point Likert scale (Likert, 1931) for which “1” indicated strong disagreement and “5” indicated strong agreement. Willingness to pay for each feature was queried using three survey items. The first was a rising 5-point Likert scale question for which “1” indicated no willingness to pay and “5” indicated strong willingness to pay. The second item was an eight-point ordered-scale question where “0” indicated no willingness to pay, response options 1 – 7 indicated US dollar ranges of $1500 (i.e., “1” = $1 - $1500, “2” = $1501 - $3000), and “8” indicated an amount greater than $9000. The third item was an open-ended question that asked respondents to indicate the greatest amount they would be willing to pay for a particular feature. Participants were provided space to comment on the feature and their willingness to pay for that feature.

Survey data analysis

Likert-scale questions measuring subjective attractiveness, opinions on marketability, and willingness to buy and pay more for each feature were analyzed using means and t-tests to test for differences from the neutral point (scaled neutral = 3). A histogram was created to graphically assess the responses to the 8-point scaled willingness to pay question. The discrete and ordered nature of the scaled data indicated that an ordered probit model (using maximum likelihood estimation) would be the best approach for estimating effects of variables on respondents’ willingness to pay (Greene, 2003). A total of four ordered probit models were fit to estimate effects of variables on willingness to pay for the CSD and LID features included in the surveys, using gender, age, income, presence of children under age 18 in the household, and whether the respondent had a college education as household characteristics. Other factors included 3-point scale ratings of whether residents had previously heard about LID/CSD, and 5-point Likert-scale ratings of each features’ attractiveness and effect on marketability of a home, as variables likely to be related to value of individual subdivision features.
Public purchase referendum
A probit model was also fitted using responses to a referendum question that used randomly generated tax increases to assess the likelihood of passage for public purchase of land to be used for conservation purposes. Each of the two responses were coded “1” if a respondent indicated support of a particular tax value and coded “0” otherwise. The resulting model was evaluated at a z-score of 0 to estimate the tax increase that would result in 50% support for passage of the referendum.

Experimental real estate negotiations - Experimental real estate negotiation methods
A randomly-selected set of 36 households were solicited by telephone to participate in a subsequent experimental real estate negotiation process. This sample was a subset of residential survey respondents who purchased a home within the previous five years with a sale price between U.S. $185,000 and $215,000 (to ensure uniformity with respect to the market segment where these features are usually present, e.g., Bowman et al., 2009). One negotiation event was held on each of three days with 12 participants scheduled for each day. Each respondent who agreed to participate on the telephone was mailed a reminder letter and offered a $40 incentive for their participation. The negotiation protocol was reviewed and approved by Iowa State University’s Office for Responsible Research.

The experimental real estate negotiation was modeled after Black and Diaz (1996) and Black (1997), and modified to include a competitive bidding process (Brookshire and Coursey, 1987; Hayes et al., 1995; Lusk and Shogren, 2007) to better simulate the interaction between multiple buyers in the same housing market. The negotiations were facilitated by staff members from Iowa State University’s Center for Survey Statistics and Methodology, acting as real estate brokers, with four rounds of sealed bidding on properties located in subdivisions with different features. Participants were asked to make hypothetical bids and were instructed to remember the context of their most recent home purchase (which in our sample was within the last five years), and to make bids that would most accurately reflect their true choice assuming that they were in fact a motivated buyer.

During each round participants bid on three subdivision properties which included one standard subdivision property that contained no CSD/LID features, one property that included a feature with negligible environmental benefits (e.g., a flower garden), and a property with a conservation feature that had a similar appearance but included a positive environmental externality (e.g., a rain garden) (Table 1). Features included a neighborhood prairie, a neighborhood forest, a stream, a stream with a
forest buffer, a flower garden, a rain garden, clustered housing with open space, and clustered housing with neighborhood forest.

The appearance and characteristics of the house (i.e., exterior appearance, size, style, number of bedrooms) were the same for all properties. Each property was offered at an initial asking price of $200,000 to reflect the valuation for similar house and lot sizes in the 2009 Ames market. Features were described using sales sheets with a format and language similar to those used by local real estate agents to advertise available properties. Each sale sheet contained one picture of the house (with the CSD or LID feature visible where applicable), two pictures with the feature highlighted, and an image of the subdivision layout with the location of the feature indicated. Information also included descriptions of the aesthetic or environmental benefits. For example, the rain garden description read “Professionally designed rain gardens installed in every yard throughout the neighborhood provide lovely landscaping and help control water runoff, pollution and flooding.” Because of possible negative connotations associated with the term “clustered” housing (as per feedback from the residential surveys) the subdivision layout, presence of open space or forest, and smaller listed lot sizes were explicitly highlighted to differentiate the properties without use of the term “clustered”. Participants were informed that all open space features would be owned and maintained by a neighborhood association.

For each round, participants were asked to bid on each of the three properties side-by-side and simultaneously. In each round, three cycles of bids were collected and recorded: an opening blind bid, an optional second blind bid, and an optional third bid after the highest and second highest bids were revealed. All participants were advised that their opening bids were rejected by the selling party. Participants were given the opportunity to offer another bid for the property but were not required to make any additional bid past the opening offer. The highest bidders were informed confidentially of their bid status while all others were informed their bid was rejected. Participants were then informed of the current first- and second-highest bid amounts and offered a final opportunity to place a bid on the property. After the bidding process was complete, participants were asked to rate their interest in purchasing each property using a rising 5-point Likert scale (“1” = not at all interested, “5” = very interested). After the final round, a brief focus group session was conducted to query participants about the properties offered and the overall negotiation process.
Experimental real estate negotiation data analysis

The standard subdivision property offered in each round allowed control for progressive bid inflation and for the comparison of features across rounds by using the ratio of the bid for a home with a particular feature to the bid for a home in a standard subdivision in each round. Bids were log-transformed to achieve uniform distribution of residuals and were fitted using the REML (restricted maximum likelihood) technique (PROC MIXED, SAS 9.3, Cary, NC). Both participant identification and subdivision feature were selected as class variables, and least square means were used for multiple comparisons with a Tukey adjustment. Effects of each subdivision feature were then back-transformed from log-scale (Kalbfleisch, 1985).

Spatial hedonic price model

Home sale prices for properties sold at arms-length in Ames between 2003 and 2008 were fitted to a spatial lag model (Anselin, 1988). A preliminary OLS model was estimated to test for spatial dependence and multicollinearity. Moran’s I was used to detect the presence of spatial autocorrelation in housing prices (Moran, 1950) and robust Lagrange Multiplier tests were used to evaluate and determine the optimal model choice for minimizing spatial dependence (Anselin et al., 1996). The spatial lag model was specified as:

\[
P = \rho W_s P + \Sigma X\beta + \varepsilon
\]

where \( P \) is a vector of \( n \) housing sale prices, \( n \) is the number of observations in the model, \( \rho \) is a spatial autocorrelation factor, \( W_s \) is a \( n \times n \) matrix of spatial weights, \( X \) is a \( n \times m \) matrix of all variables (structural, neighborhood, environmental) included in the model, \( m \) is the number of variables in the model, and \( \varepsilon \) is a vector of error terms.

Spatial weights for properties within the sample were created using inverse distance with a threshold of 1600m and were standardized. The choice of distance thresholds for spatial weights is generally ad-hoc, but prior studies found significant spatial effects of private and public open space with thresholds of 1600m (Ready and Abdalla, 2005). At this threshold, it was determined that there were no properties without neighbors (islands). A spatial lag model using maximum likelihood estimation was then estimated using the log-transformed last recorded sale price for each house. A preliminary Box-Cox analysis (Box and Cox, 1964) for sale prices indicated that a logarithmic transformation would be appropriate. Coefficients in the spatial lag models were adjusted using a spatial multiplier.
(Kim et al., 2003). Coefficients of dummy variables were also adjusted to account for the semi-log functional form (Kennedy, 1981). Independent variables to describe home characteristics included house and lot sizes, number of bedrooms, the presence of a fireplace, and an external condition rating (0 = Poor, 3 = Good) (Table 4).

Distance to nearest commercial center and railroad tracks, neighborhood income, and school district performance were used as neighborhood factors. Because US Census income data was not available for neighborhoods built after the 2000 census, a neighborhood income surface for Ames was created with demographic information from the residential survey using a Spatial Analyst tool (ArcGIS 9.3, ESRI). Data for some factors, such as neighborhood vacancy and unemployment were unavailable at the time of this study and could not be included. Mean scores on the Iowa Test of Basic Skills were used to control for the influence of school district on home value. Houses in school districts with a score less than 80 were rated as being present in a poor performing school district.

Environmental variables used in the model included amount of open space owned by a neighborhood association, presence of neighborhood association-owned forest and water features, presence of a stream adjacent to property, amount of publicly-owned open space within walking distance, and presence of publicly owned forests and water features within walking distance. Neighborhood association-owned properties were identified using the City of Ames Assessor’s database. Aerial photographs and land cover maps were used to determine the type of vegetation present in each open space property.

Public purchase referendum
As part of the residential survey, participants were asked to respond to a hypothetical referendum scenario to indicate whether they would support a yearly property tax increase in order to allow the city to purchase land that would be “open to public use and recreation, and would help protect water quality, wildlife habitat and biodiversity.” Each survey contained a randomly-generated tax value between $1 and $150 and asked participants to respond to two rising Likert-scale questions (“1” = not at all support, “5” = strongly support) about whether they would support a tax increase of that amount and twice that amount.

A probit model was fitted using responses to each randomly generated tax increase question to assess the likelihood of passage for a referendum for public purchase of land for conservation purposes.
Each of the two responses from each survey were coded “1” if a respondent indicated support of a particular tax value (4 or 5) and coded “0”, otherwise (3, 2, or 1). The resulting model was evaluated at a z-score of 0 to estimate the tax increase that would result in 50% support for passage of the referendum.

Software used for data analysis
Statistical models and tests (including OLS and probit models) were estimated using SAS 9.3. OpenGeoda 0.9.8.14 was used for estimating spatial models. Sizes and distances were measured using ArcGIS 9.3 and ArcView 3.3 with Nearest Feature, and Identify Features within Distance extensions (Jenness, 2003, 2007). Three levels of statistical significance were used for this study: 0.10, 0.05, 0.01.

RESULTS AND DISCUSSION

Resident Survey - Survey response and respondent demographics
Overall, 777 of 1804 eligible surveys (43%) were returned. About half of responses were to the CSD format (clustered housing, stream with forest buffer) of the survey (n = 383) and the other half to the LID format (pervious pavers, rain garden) (n = 394). Respondents were 52% male and 94% white, with an average age of 42 years. The average respondent represented households with 2.9 members and 0.95 children living at home. Overall, 84% of respondents held at least one college degree and, on average, had a household income between $75 000 and $100 000. The mean length of residence in Ames was 11.2 years. Our respondents had both a higher mean household income and percentage with a college education than the overall Ames population. This may be because the sample frame of recent home purchasers specifically excluded renters.

General knowledge and preference for CSD and LID features
Only half or fewer of respondents had previously heard of either CSD (39%) or LID (50%) designs. Fifty-seven percent of respondents thought that CSD design features were used in Ames, while about 47% thought LID features had been used (Figure 1). This is despite the fact that there are no current subdivisions in Ames that have any CSD or LID features. Responses to open-ended questions asking for examples revealed that many respondents were either misinformed (by specifically naming either a well-known “New Urbanist”-inspired planned urban development or a large park that features an artificial lake), or had a case of “wishful thinking” believing that given the progressive nature of
At least one subdivision in town must have these features despite the lack of any explicit knowledge on its existence.

In terms of attractiveness, re-sale advantage, and willingness to buy and pay more, clustered housing was rated significantly lower than any of the other subdivision features (Figure 2). Clustered housing in the context of this survey was presented with specific information about the inclusion of common open space within clustered subdivision layouts. Based on open-ended comments, the phrase “clustered housing” had a negative connotation that may have influenced responses (comments generally focused on perceptions of small lots with little privacy). With regard to the remaining three features, respondents indicated that streams with a forest buffer, pervious pavers, and rain gardens were visually attractive but expressed neutral opinions as to whether presence of these features in a subdivision would make a house easier to sell, and whether they would either buy or pay more for the listed features (Figure 2). Overall lack of knowledge about these alternative subdivision designs may have been a driving factor in ambivalence about CSD and LID subdivision features.

**Willingness to pay for CSD and LID features**

A majority of respondents indicated some willingness to pay for three of the four features (streams with forest buffer, pervious pavers, and rain gardens) on the ordered response questions (Figure 3). For both clustered housing and streams with forest buffers, many respondents indicated they would not pay more to have these included in their subdivisions (over 73% of respondents indicated they would not be willing to pay more for clustered housing alone, see Figure 3). However, the small proportion that indicated willingness to pay for these features were willing to pay larger amounts than respondents indicated they would pay for other features. A majority of respondents indicated they would be willing to pay for pervious pavers and rain gardens in their neighborhood, although they were not willing to pay a large amount for either feature (responses were largely in the US $1-$1500 range, Figure 3). There were no respondents indicating willingness to pay more than US $9000 for either of these features. Respondents indicated mean maximum willingness to pay of US $1269 for clustered housing, $2720 for streams with forest buffers, $1396 for rain gardens, and $1424 for pervious pavers; responses consistent with their choices to the ordered response questions (Figure 3). The maximum value for streams with forest buffers was significantly higher ($p < 0.05$) than any of the other features. There was greater variance in maximum willingness to pay for CSD features (clustered housing and buffered streams) than for LID features (Figure 3). Responses for CSD
features demonstrated a wider spectrum of values, with lower overall willingness to pay in contrast to higher maximum payment values.

One overall difference that may be driving different patterns in willingness to pay for CSD and LID features may be related to the difference in the scale of the features and may not be directly associated with individual lots. CSD features, such as clustered housing and streams with forest buffers are neighborhood-scale features and influence the overall design of the housing development. LID features, such as rain gardens, are implemented on a lot-level scale, and as such, are customizable and “ownable”. Another issue that arose with both the CSD and LID features is the responsibility and costs associated with owning and maintaining features. In the case of CSD features, the maintenance would fall to a neighborhood association that would be required to collect dues from neighborhood property owners. For LID features, the small scale of pervious pavers and rain gardens would require individual homeowners to maintain features on their own property. Pervious pavers, in particular, were singled out by respondents as a maintenance concern during winter weather. Upkeep concerns may also affect respondents’ attitudes toward CSD features. For example, at least one previous study found that residents believed maintenance was a negative issue associated with the used of vegetated stream buffers (Kenwick et al., 2009).

Probit analysis of willingness to pay for CSD and LID features

Across all four models, respondent ratings of the attractiveness and the effect of the feature on marketability were both positive and significant \( (p < 0.001; \ p < 0.10 \text{ for clustered housing}) \) (Table 2, Table 3). In general, the major factors related to the valuation of a feature in our model were the respondents’ assessment of that feature’s appeal as well as their assessment of its appeal to future home buyers.

Different factors were correlated with willingness to pay for the different CSD and LID features. With regard to CSD features, a college education and gender were significant positive factors \( (p < 0.05) \) only for clustered housing, with both college-educated and female respondents reporting greater likelihood of willingness to pay more for clustered housing than non-college-educated or male respondents (Table 3). Age was an important factor \( (p < 0.07) \) for a stream with a forested buffer, with older respondents reporting greater willingness to pay (Table 2). Knowledge about CSD features (which was low overall, Table 1) was not significantly correlated with willingness to pay in any of the models (Table 2).
Income and previous knowledge about CSD were not significant factors in the willingness to pay for CSD features. However, both income and familiarity with LID affected (p <0.05) willingness to pay for pervious pavers and rain gardens - higher incomes and greater prior knowledge correlated with a greater willingness to pay (Table 3). A number of comments about both of these LID features mentioned maintenance costs; it is possible that households with higher reported incomes would be more likely to be able to afford extra costs (if any) associated with installation and maintenance of pavers and rain gardens. Greater familiarity with LID features increases the likelihood that respondents understand the environmental benefits of both features and knowledge residents may be more likely to invest in neighborhoods that incorporate LID features.

**Experimental Real Estate Negotiations - Participant demographics**

Real estate negotiation participants were 54% male, 92% white, and had a mean age of 49.5 years. Participants had mean household size of 3.3 persons with 1.2 children and an average length of residence in Ames of 15 years. Eighty percent of participants had a college education and the average household income was between $75 000 and $100 000. There were no significant differences between the sub-sample of real estate negotiation participants and all survey respondents in terms of stated willingness to pay for either CSD or LID features on the preceding survey.

**Preferences for subdivision features**

Based on a 5-point rising Likert-scale question, participants reported greater interest in purchasing clustered housing with included forest (4.6) compared to homes featuring clustered housing with unspecified open space (3.8) (Figure 4). In addition, participants’ interest in houses with buffered streams (3.7) was greater than for houses with streams that lacked a buffer (2.5) (Figure 4). Overall, features with environmental benefits were rated more highly compared to similar features with only aesthetic attributes listed (Figure 4). Mean ratings for both streams with forest buffers and rain gardens were statistically similar to survey responses (n=777) for the same features (i.e., Figure 2). Other studies have demonstrated similar preferences for added environmental amenities. For example, Kuo et al. (1998) found that people preferred areas with greater tree density and Kenwick et al. (2009) found that suburban residents strongly favored the natural appearance of vegetated stream buffers over streams without buffers.
Consistent attention to landscape features rather than “clustered housing” per se appeared to have shifted negotiation participants’ focus to the embedded subdivision features (compared to reactions of survey respondents). Homes offered in clustered housing designs were in fact the most preferred of all options in the real estate negotiations. Thus, while the term “clustered housing” in and of itself may have negative connotations, perceptions of alternative subdivision layouts can be changed by focusing on very explicit descriptions of open space or forest components and their function.

**Experimental real estate negotiations analysis**

Generally, houses with CSD or LID features had significant positive effects on participants’ bids compared to houses in standard subdivisions (Table 4). Bids for houses with near unbuffered streams, however, were not significantly different than houses in standard subdivisions (Table 4). Clustered housing with preserved forest had the greatest estimated value (+22%) over a house in a standard subdivision. This value was significantly greater \((p < 0.04)\) than most other features (except for clustered housing with open space, Table 4). Clustered housing with open space had the second largest effect on bidding price (+17.2% over a house in a standard subdivision) which was significantly greater \((p < 0.04)\) than a flower garden, a neighborhood-owned forest, and a stream without buffers (Table 4). The stream without buffers had a negligible effect on bid values (Table 4).

The clustered housing options (with either forest or open space) had the largest mean effects on bid price over a standard home, demonstrating that as with preferences, while clustered housing alone may not be preferred (as indicated in the survey), a design with explicit open space components can be highly valued. Moreover, features with well-defined environmental benefits consistently increased the mean amount that participants were willing to bid, although this difference was not always statistically significant. For example, adding a forested buffer to a stream within a subdivision increased the average bid value for a house from 3.5% to 12.9% compared to a home in a standard subdivision (Table 5). In all cases with comparable features (such as flower gardens versus rain gardens) participants valued features with embedded environmental benefits more than those without.

**Spatial Hedonic Price Model**

All structural and house quality characteristics applied to the model (Table 6) had significant marginal effects on house prices (Table 7). These variables had expected signs, except for number of bedrooms which was negative (Table 7). This finding is similar to results from Cedar Rapids, Iowa where hedonic price models also indicated a negative effect of number of bedrooms (Bowman et al.)
Year of sale (2004-2008) was also significant and positive indicating consistent growth in home values in Ames between 2003 and 2008 (Table 7). Most neighborhood characteristics, such as average household income, distance to commercial district and distance to railroad tracks, also had significant effects on house value (Table 7). The presence of a low performing school district did not have an effect on the house price (Table 7).

Overall, marginal effects of environmental amenities on home value were not consistently significant. The effects of neighborhood association-owned forest and water features were positive and significant (Table 7). The marginal effect of these features was approximately 6% at the mean sale price with a value of $11,240 for association-owned forests, and $11,430 for a water feature (Table 7). These findings are similar to other studies (e.g., Lorenzo et al. 2000, Ready and Abdalla 2005) with the presence of private forests associated with higher home prices. Natural features preserved during and after subdivision development can have both economic and environmental benefits and home buyers have revealed that they are willing to pay a premium for such neighborhood amenities. The economic impacts of these features are also additive, affecting all homes with access within the neighborhood association bounds (Bowman et al., 2009).

The overall amount of privately held open space within a neighborhood did not appear to have an effect on house value (Table 7). Private open space within subdivisions is rare in Ames (occurring in only 14% of the houses in our model with a variety of sizes from 2 acres up to 34 acres). Similar to the findings of Acharya and Bennett (2001), the spatial nature and variety of open space integration within neighborhoods may be what is most important to home purchasers. It could be also be the case that the value of private open space in Ames (based largely on the novelty of its occurrence) is captured just on the basis of its presence rather than specifically the features included or the overall size of the area.

However, for publically-held open space size did matter. The amount of publicly-held open space within walking distance (500m) of a house had a marginal effect (at p < 0.08) of 0.04% per acre, which at the mean price of a home in Ames translates to an increase in home price of approximately $22 for every acre of public park within walking distance (Table 7). As Peiser and Schwann (2003) found, this effect is miniscule when compared with the marginal effect of a similar amount of additional lot space ($33,375 at the mean sale price). Ames has a diversity of park sizes, ranging from ½ acre to 440 acres, with larger parks having more recreation opportunities and affording a
higher value to neighboring residences. This is corroborated by the findings of our hypothetical referendum which shows a willingness to pay for public open space. Homebuyers find greater value in larger park areas and this finding should encourage parks and recreation decision makers to consider ways of increasing park connectivity and reducing fragmentation when designing new parks. Interestingly, the presence of a public lake within walking distance had a large and significant negative effect of about -13%, or -$23,490 on house value (Table 7). There is one public lake in Ames that serves as a high-use recreation area with several multi-use trails that extend beyond park boundaries connecting into neighboring subdivisions. We surmise that the high-use nature of the park and intrusion by park visitors into surrounding properties may be driving the large negative effect on sale price.

The presence of public forest within walking distance had no significant effect on home price (Table 7). Fewer opportunities for recreation development within preserved forest areas may limit the effect of those areas on home prices. Likewise, the aesthetic impact of a public forest on home prices would be limited to only immediately adjacent residences within close distance. Similar to findings from the survey and experimental real estate negotiations, the adjacency of a stream without forest buffers had no effect on home price; however, it should be noted that the sign on the effect of stream adjacency was negative as predicted (Table 7).

**Public purchase referendum**

Probit regression (n = 777) estimated that an added annual property tax of $49.31 would result in 50% support for the hypothetical city referendum to purchase and preserve open space. A referendum including a tax value lower than $49.31 would most likely pass, while a higher value would be likely to fail. In response to an open-ended maximum WTP follow-up question, residents (n = 602) indicated that they would support a mean maximum property tax-increase up to $90.72. The expressed support for any property tax increase indicates a valuation among respondents for land conservation within city limits that may not benefit them in a direct monetary manner. Nevertheless, previous hedonic price model studies identify the value of public open space and the significant positive effect they have on home prices within a community (Bolitzer and Netusil, 2000; Correll et al., 1978; Kitchen and Hendon, 1967). This finding is consistent with those studies as well as the hedonic model for Ames presented in this study (section 3.3) by demonstrating a stated willingness to pay for public open space.
Referenda concerning purchase and development of public recreation areas have a recent history in Ames with two consecutive bond issue measures for the construction of an aquatic recreation center. The first measure, presented in 2003, failed with only 43% support. This bond issue was proposed to be financed with a mean total tax increase of $138.91 per year for the average home owner. The second measure, presented in 2007, passed with 76% support and was financed with a mean total of $40.78 per year for the average home owner. Very strong public support for the second referendum indicates that there is a willingness to pay among voters for public recreation goods. The similarity of the amount of increase in property tax values to the hypothetical tax referendum values determined in this analysis indicates that our survey estimate is plausible.

CONCLUSIONS AND IMPLICATIONS

In this study, we examined consumer preferences and willingness to pay for conservation subdivision and low impact development features in residential neighborhoods by employing multiple approaches to valuation using contingent valuation surveys (including multiple choice, open-ended and referendum techniques), experimental real estate negotiations, and spatial hedonic price models. Although we report on a single market in Ames, IA, we believe given the demographic characteristics of our study area that the underlying relationships between variables are generalizable across similar municipalities and housing markets in the Midwestern United States.

The results from these methods consistently indicate that residents value conservation subdivision (CSD) and low impact development (LID) features, and would be willing to pay an additional amount for the inclusion of these features in their neighborhoods. Developers and planners should take into account this interest and value when they consider designing subdivisions. Conservation subdivision design can be a useful tool for protecting specific areas of development sites while maintaining overall residential density requirements, and the effectiveness of LID approaches coupled with their demonstrated lower construction costs (Coffman, 2000), could provide for more profitable and more environmentally responsible development practices in Ames.

This study suggests that familiarity with LID techniques has a positive effect on willingness to pay for these features. While familiarity with CSD approaches did not have a significant effect in our models, previous CSD experience (39%) was uniformly low among our respondents. There was some indication that residents were confusing CSD and LID approaches with “New Urbanist”-style developments which do not provide explicit environmental benefits. Providing more accurate
information to community residents about CSD and LID features would likely increase interest in these features.

Results also consistently indicated that subdivision features with specifically identified environmental benefits were valued more highly than similar features without such positive externalities. Developers and planning officials should be encouraged, when possible, to choose features that provide for additional environmental benefits while maintaining feature aesthetics, and then to explicitly advertise the additional benefits to potential residents.

In places with few or no examples of CSD and LID neighborhoods, market information about consumer interest and values in new subdivision designs and features can provide momentum to lower barriers and encourage the use of alternative approaches to residential development. Developers and city officials will be able to assess the suitability and economic viability of these design features using valuation information that demonstrates consumer interest and willingness to buy into developments that incorporate low impact and conservation design features.

LITERATURE CITED


Table 1

Description of properties available for participant bidding in experimental real estate negotiations by round.

<table>
<thead>
<tr>
<th>Round</th>
<th>Property 1</th>
<th>Property 2</th>
<th>Property 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Standard lot design with no unique subdivision features</td>
<td>Standard lot design with neighborhood association owned prairie outlot</td>
<td>Standard lot design with neighborhood association owned forested outlot</td>
</tr>
<tr>
<td>2</td>
<td>Standard lot design with no unique subdivision features</td>
<td>Standard lot design featuring a stream without a vegetated buffer behind property</td>
<td>Standard lot design featuring a stream with forested buffer running behind property</td>
</tr>
<tr>
<td>3</td>
<td>Standard lot design with no unique subdivision features</td>
<td>Standard lot design with a flower garden provided with each property</td>
<td>Standard lot design with a rain garden that reduce flooding and help clean water provided with each property</td>
</tr>
<tr>
<td>4</td>
<td>Standard lot design with no unique subdivision features</td>
<td>Clustered lot design interspersed with neighborhood association owned open space</td>
<td>Clustered lot design interspersed with neighborhood association owned forest</td>
</tr>
</tbody>
</table>
Table 2
Variables in ordered probit regressions for residential survey responses to willingness-to-pay questions about various subdivision features in Ames, IA.

<table>
<thead>
<tr>
<th>Dependent variable</th>
<th>Mean</th>
<th>St. Dev.</th>
</tr>
</thead>
<tbody>
<tr>
<td>PERVIOUS WILLINGNESS TO PAY FOR USE OF PERVERS PAVERS</td>
<td>1.11</td>
<td>1.23</td>
</tr>
<tr>
<td>RAINGARDEN WILLINGNESS TO PAY FOR USE OF RAINT GARDEN</td>
<td>1.13</td>
<td>1.16</td>
</tr>
<tr>
<td>CLUSTERED WILLINGNESS TO PAY FOR USE OF CLUSTERED</td>
<td>0.77</td>
<td>1.54</td>
</tr>
<tr>
<td>STREAMBUFFER WILLINGNESS TO PAY FOR PRESENCE OF A STREAM</td>
<td>1.80</td>
<td>2.20</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Independent variables</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>GENDER Respondent gender (0 = male, 1 = female)</td>
<td>0.48</td>
<td>0.51</td>
</tr>
<tr>
<td>AGE Age of respondent</td>
<td>41.97</td>
<td>12.86</td>
</tr>
<tr>
<td>CHILDREN Presence of children in home (dummy, 1 = yes)</td>
<td>0.50</td>
<td>0.50</td>
</tr>
<tr>
<td>COLLEGE Level of respondent education (dummy, 1 = college, 0 = no college)</td>
<td>0.84</td>
<td>0.37</td>
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<tr>
<td>INCOME Household income ($25 000s of US dollars)</td>
<td>4.07</td>
<td>1.63</td>
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<tr>
<td>LIDKNOWLEDGE Respondent's having previous heard of LID practices (0 = none, 1 = maybe, 2 = yes)</td>
<td>1.87</td>
<td>0.92</td>
</tr>
<tr>
<td>CSDKNOWLEDGE Respondent's having previous heard of CSD practices (0 = none, 1 = maybe, 2 = yes)</td>
<td>1.68</td>
<td>0.89</td>
</tr>
<tr>
<td>PERVIOUSATTRACT Respondent's rating of attractiveness of pervious pavers (0 = not at all attractive, 4 = very attractive)</td>
<td>2.96</td>
<td>0.91</td>
</tr>
<tr>
<td>PERVIOUSMARKET Respondent's rating of effect of pervious pavers on house market value (0 = will decrease, 4 = will increase)</td>
<td>1.90</td>
<td>1.18</td>
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<tr>
<td>RAINATTRACT Respondent's rating of attractiveness of rain gardens (0 = not at all attractive, 4 = very attractive)</td>
<td>3.26</td>
<td>0.84</td>
</tr>
<tr>
<td>RAINMARKET Respondent's rating of effect of rain gardens on house market value (0 = will decrease, 4 = will increase)</td>
<td>2.18</td>
<td>1.18</td>
</tr>
<tr>
<td>CLUSTERATTRACT Respondent's rating of attractiveness of clustered housing (0 = not at all attractive, 4 = very attractive)</td>
<td>1.91</td>
<td>1.18</td>
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<tr>
<td>CLUSTERMARKET Respondent's rating of effect of clustered housing on house market value (0 = will decrease, 4 = will increase)</td>
<td>1.21</td>
<td>1.12</td>
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<tr>
<td>STREAMATTRACT Respondent's rating of attractiveness of stream with forest buffer (0 = not at all attractive, 4 = very attractive)</td>
<td>3.08</td>
<td>0.91</td>
</tr>
<tr>
<td>STREAMMARKET Respondent's rating of effect of stream with forest buffer on house market value (0 = will decrease, 4 = will increase)</td>
<td>2.17</td>
<td>1.28</td>
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Table 3  
Estimated coefficients for ordered probit model using survey responses to scaled willingness to pay questions about various subdivision features for Ames, IA.

<table>
<thead>
<tr>
<th>Dependent variable</th>
<th>CLUSTERED</th>
<th>STEMBUFFER</th>
<th>PERVIOUS</th>
<th>RAINGARDEN</th>
</tr>
</thead>
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<tr>
<td>β</td>
<td>β</td>
<td>β</td>
<td>β</td>
<td></td>
</tr>
<tr>
<td>GENDER</td>
<td>0.2333</td>
<td>0.1987</td>
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<td>-0.0651</td>
</tr>
<tr>
<td>AGE</td>
<td>0.0056</td>
<td>0.01</td>
<td>0.0067</td>
<td>-0.005</td>
</tr>
<tr>
<td>CHILDREN</td>
<td>0.0123</td>
<td>-0.0706</td>
<td>0.0067</td>
<td>0.0063</td>
</tr>
<tr>
<td>COLLEGE</td>
<td>0.4565</td>
<td>0.151</td>
<td>0.1547</td>
<td>0.2312</td>
</tr>
<tr>
<td>INCOME</td>
<td>-0.0577</td>
<td>-0.017</td>
<td>0.0907</td>
<td>0.1286</td>
</tr>
<tr>
<td>CSDKNOWLEDGE</td>
<td>-0.0526</td>
<td>-0.0494</td>
<td>-0.1533</td>
<td>0.2903</td>
</tr>
<tr>
<td>LIDKNOWLEDGE</td>
<td>-</td>
<td></td>
<td></td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>CLUSTERATTRACT</td>
<td>0.4428</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>CLUSTERMARKET</td>
<td>0.1469</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>STREAMATTRACT</td>
<td>-</td>
<td>0.3411</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>STREAMMARKET</td>
<td>-</td>
<td>0.3832</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>PERVIOUSATTRACT</td>
<td>-</td>
<td>-</td>
<td>0.5302</td>
<td>0.5261</td>
</tr>
<tr>
<td>PERVIOUSMARKET</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.634</td>
</tr>
<tr>
<td>RAINATTRACT</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>RAINMARKET</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
</tbody>
</table>

Model Statistics  
- n = 336  
- Log likelihood: -413.0  
- n = 328  
- Log likelihood: -566.5  
- n = 309  
- Log likelihood: -354.2  
- n = 314  
- Log likelihood: -349.1

*, **, and *** denote statistical significance at 0.10, 0.05, and 0.01 levels respectively

* Intercept variables were included in the model but are not listed in this table
Table 4
Estimates for effects on participant bids for individual subdivision features in experimental real estate negotiations in Ames, IA

<table>
<thead>
<tr>
<th>Subdivision feature (variable name)</th>
<th>Estimate</th>
<th>Mean effect $^a$</th>
<th>S.E.</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clustered housing with forest</td>
<td>0.1992</td>
<td>22.0%</td>
<td>0.0239</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Clustered housing with open space</td>
<td>0.1587</td>
<td>17.2%</td>
<td>0.0239</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Rain garden</td>
<td>0.1268</td>
<td>13.5%</td>
<td>0.0239</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Flower garden</td>
<td>0.0848</td>
<td>8.8%</td>
<td>0.0239</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Stream with forest buffer</td>
<td>0.1209</td>
<td>12.9%</td>
<td>0.0239</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Stream without buffer</td>
<td>0.0341</td>
<td>3.5%</td>
<td>0.0239</td>
<td>0.1550</td>
</tr>
<tr>
<td>Neighborhood forest</td>
<td>0.0843</td>
<td>8.8%</td>
<td>0.0239</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Neighborhood prairie</td>
<td>0.1108</td>
<td>11.7%</td>
<td>0.0239</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

$^a$ The estimated effect that the feature has on the price of home with respect to a house in a standard subdivision without any features

** and *** denote statistical significance at 0.05 and 0.01 levels respectively
Table 5
Estimated least square means comparisons estimates for differences in bids between individual subdivision features in experimental real estate negotiations by round in Ames, IA

<table>
<thead>
<tr>
<th>Round</th>
<th>Feature 1</th>
<th>Feature 2</th>
<th>Estimated Diff.</th>
<th>Mean effect$^a$</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Prairie</td>
<td>Forest</td>
<td>0.0264</td>
<td>2.7%</td>
<td>0.435</td>
</tr>
<tr>
<td>2</td>
<td>Stream with buffer</td>
<td>Stream without buffer</td>
<td>0.0868</td>
<td>9.1%</td>
<td>0.011 ***</td>
</tr>
<tr>
<td>3</td>
<td>Rain garden</td>
<td>Flower garden</td>
<td>0.0413</td>
<td>4.2%</td>
<td>0.223</td>
</tr>
<tr>
<td>4</td>
<td>Clustered housing with forest</td>
<td>Clustered housing with open space</td>
<td>0.0405</td>
<td>4.1%</td>
<td>0.232</td>
</tr>
</tbody>
</table>

*** denotes statistical significance at the 0.01 level

$^a$ The estimated effect that feature 1 has over feature 2 with respect to the price of a home in a standard subdivision without either feature
Table 6
Variables in hedonic price model regression for sales (2003 - 2008) in Ames, IA.

<table>
<thead>
<tr>
<th>Dependent variable</th>
<th>Mean</th>
<th>St. Dev.</th>
</tr>
</thead>
<tbody>
<tr>
<td>SALEPRICE</td>
<td>180628.40</td>
<td>74372.12</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Independent variables</th>
<th>Mean</th>
<th>St. Dev.</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOTSIZE</td>
<td>11396.73</td>
<td>8839.15</td>
</tr>
<tr>
<td>HOUSESIZE</td>
<td>1541.14</td>
<td>530.69</td>
</tr>
<tr>
<td>BEDROOMS</td>
<td>2.97</td>
<td>0.68</td>
</tr>
<tr>
<td>FIREPLACE</td>
<td>0.58</td>
<td>0.49</td>
</tr>
<tr>
<td>AGE</td>
<td>36.41</td>
<td>27.25</td>
</tr>
<tr>
<td>CONDITION</td>
<td>2.11</td>
<td>0.36</td>
</tr>
<tr>
<td>INCOME</td>
<td>3.36</td>
<td>1.10</td>
</tr>
<tr>
<td>COMMERCE</td>
<td>1618.42</td>
<td>967.06</td>
</tr>
<tr>
<td>RAILROAD</td>
<td>3515.13</td>
<td>3180.51</td>
</tr>
<tr>
<td>POORSCHOOL</td>
<td>0.33</td>
<td>0.47</td>
</tr>
<tr>
<td>ASSOC_SPACE</td>
<td>3.36</td>
<td>9.43</td>
</tr>
<tr>
<td>ASSOC_FOREST</td>
<td>0.10</td>
<td>0.30</td>
</tr>
<tr>
<td>ASSOC_WATER</td>
<td>0.07</td>
<td>0.25</td>
</tr>
<tr>
<td>CITY_SPACE</td>
<td>61.11</td>
<td>99.54</td>
</tr>
<tr>
<td>CITY_FOREST</td>
<td>0.34</td>
<td>0.47</td>
</tr>
<tr>
<td>CITY_WATER</td>
<td>0.04</td>
<td>0.20</td>
</tr>
<tr>
<td>STREAM</td>
<td>0.04</td>
<td>0.20</td>
</tr>
<tr>
<td>YR2004</td>
<td>0.17</td>
<td>0.38</td>
</tr>
<tr>
<td>YR2005</td>
<td>0.19</td>
<td>0.39</td>
</tr>
<tr>
<td>YR2006</td>
<td>0.20</td>
<td>0.40</td>
</tr>
<tr>
<td>YR2007</td>
<td>0.24</td>
<td>0.43</td>
</tr>
<tr>
<td>YR2008</td>
<td>0.03</td>
<td>0.18</td>
</tr>
</tbody>
</table>
Table 7
Maximum likelihood estimation coefficients for spatial lag hedonic price model using housing sales (2003 - 2008) for Ames, IA.

<table>
<thead>
<tr>
<th>Dependent variable</th>
<th>LN(SALEPRICE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \beta )</td>
<td></td>
</tr>
<tr>
<td><strong>Independent variables</strong></td>
<td><strong>Coefficient</strong></td>
</tr>
<tr>
<td>LOTSIZE</td>
<td>0.00000455</td>
</tr>
<tr>
<td>HOUSESIZE</td>
<td>0.000432</td>
</tr>
<tr>
<td>BEDROOMS</td>
<td>-0.052224</td>
</tr>
<tr>
<td>FIREPLACE</td>
<td>0.079059</td>
</tr>
<tr>
<td>AGE</td>
<td>-0.003608</td>
</tr>
<tr>
<td>CONDITION</td>
<td>0.044846</td>
</tr>
<tr>
<td>INCOME</td>
<td>0.036978</td>
</tr>
<tr>
<td>COMMERCE</td>
<td>0.000010</td>
</tr>
<tr>
<td>RAILROAD</td>
<td>0.000003</td>
</tr>
<tr>
<td>POORSCHOOL</td>
<td>-0.003701</td>
</tr>
<tr>
<td>ASSOC_SPACE</td>
<td>0.000456</td>
</tr>
<tr>
<td>ASSOC_FOREST</td>
<td>0.062121</td>
</tr>
<tr>
<td>ASSOC_WATER</td>
<td>0.063214</td>
</tr>
<tr>
<td>CITY_SPACE</td>
<td>0.000120</td>
</tr>
<tr>
<td>CITY_FOREST</td>
<td>0.011672</td>
</tr>
<tr>
<td>CITY_WATER</td>
<td>-0.130136</td>
</tr>
<tr>
<td>STREAM</td>
<td>-0.025846</td>
</tr>
<tr>
<td>YR2004</td>
<td>0.057065</td>
</tr>
<tr>
<td>YR2005</td>
<td>0.120575</td>
</tr>
<tr>
<td>YR2006</td>
<td>0.109940</td>
</tr>
<tr>
<td>YR2007</td>
<td>0.116284</td>
</tr>
<tr>
<td>YR2008</td>
<td>0.140806</td>
</tr>
<tr>
<td>CONSTANT</td>
<td>9.818509</td>
</tr>
<tr>
<td>( W_{-\text{LN(SALEPRICE)}} (\rho) )</td>
<td>0.122847</td>
</tr>
</tbody>
</table>

**Model Statistics**
- \( n = 2093 \)
- Log likelihood: 1251.38
- AIC: -2454.77
- Pseudo-\( R^2 \): 0.841331
- Lag coefficient (\( \rho \)): 0.122847

\*, **, and *** denote statistical significance at 0.10, 0.05, and 0.01 levels respectively.

\(^a\) Coefficients have been adjusted to account for spatial lag as per Kim et al. (2003) and dummy variable have been adjust as per Kennedy (1981).
Figure 1. Percentage of survey respondents (n = 364-391 as indicated) that were previously familiar with conservation subdivision design (CSD) and low impact development (LID) and believed that CSD and LID features were used in residential development in Ames, IA.
Figure 2. Respondent ratings (n = 379 – 395 as indicated) of attractiveness, willingness to buy, effect on ease of selling a home and willingness to pay more for individual conservation subdivision design and low impact development features based on 5-point Likert-scale (1 = Strongly disagree, 5 = Strongly agree). Error bars are the 95% confidence interval for the sample mean.
Figure 3. Percentages of survey respondents (n = 307 – 345 as indicated) with willingness to pay for individual conservation subdivision and low impact development subdivision features based on ordered contingent valuation queries and mean maximum willingness to pay for features based on open-ended follow-up questions.
Figure 4. Auction participant (n = 27) ratings of interest in purchasing a property with a particular conservation subdivision design or low impact development feature based on a 5-point Likert scale (1 = Not at all interested, 5 = Very interested). Error bars are the 95% confidence interval for the sample mean.
CHAPTER 4: RESIDENTIAL, DEVELOPER, AND CIVIC OFFICIAL PERCEPTIONS OF ALTERNATIVE SUBDIVISION DESIGN APPROACHES
A paper to be submitted to Landscape and Urban Planning
Troy Bowman, Jan Thompson, John Tyndall

INTRODUCTION
Alternative residential subdivision designs such as low-impact development and conservation subdivisions provide opportunities for addressing the negative effects of standard development practices through the protection and integration of natural resources on development sites. These alternative approaches to development could lower the societal and infrastructural costs of development, but many areas in the Midwest (United States) do not have on-the-ground examples of these design approaches. The perceptions and knowledge base of stakeholders involved in development can determine the propensity for demanding or implementing these alternative subdivision design practices. Limited or inaccurate information and misconceptions about the information that is available can create barriers to the use of low-impact and conservation subdivision designs. Subdivision development itself is a process driven by three primary groups: residents who purchase lots and houses creating demand for developed properties; developers who purchase, subdivide, build and supply lots and houses to consumers; and public officials who draft and enforce regulations that enable the development process. This paper reports on a study that examines the knowledge base and perceptions of these groups (residents, developers and city officials) regarding alternative subdivision designs with a case study of Ames, Iowa using surveys and focus groups.

LITERATURE REVIEW
Alternative subdivision development (low-impact development and conservation subdivisions)
In recent years, two different alternative design techniques have become widely accepted. Low-impact development (Coffman, 2000) is an engineering approach that uses topography, rain gardens, natural features, and pervious infrastructure to control water runoff and reduce the need for storm sewer installations. Conservation subdivision design (Arendt, 1996, 2004; Pejchar, 2007) is an ecological approach that identifies and preserves areas of environmental importance through clustering smaller-sized lots around commonly-held open space. While the ultimate goals of these techniques can be different, they may share similar design features and overall aesthetics.
There have been mixed reports of the conservation effectiveness of alternative subdivision designs. Low-impact approaches have been demonstrated to effectively capture precipitation on-site and limit pollutant export from developed residential areas (Dietz, 2007; Dietz and Clausen, 2008). Conservation subdivision design has been reported to be successful for preserving open space, but effectiveness in achieving biodiversity conservation goals has been questioned (Hostetler and Drake, 2009; Lenth et al., 2006; Milder, 2007). Research has also suggested that implementation of alternative designs with reduced infrastructure (fewer roads, smaller lots, less storm sewer installation) and smaller size of actual developed areas can have lower costs of development (Caraco et al., 1998; Coffman, 2000).

However, even with localized benefits that can be attributed to alternative subdivision designs, these approaches alone cannot address the larger issues associated with urban expansion. Even though the developed area within an alternative subdivision is smaller, it is still part of a larger subdivision plat. Subsequent developments may then “leap-frog” into exurban landscapes, maintaining the effects of standard development patterns at a larger scale in the absence of a regional land-use plan (Daniels, 1999; Pejchar et al., 2007). Low-impact development and conservation subdivision designs should be considered site-level tactics that can be integrated with other higher-level planning tools to address larger scale development issues.

Resident knowledge and perceptions of subdivision designs
Some previous research has indicated that residents select homes in neighborhoods based on their preference for the overall look and design of the area (Nassauer et al., 2009; Vogt and Marans, 2004). Open space and conservation features may play a primary role in those choices (Bowman and Thompson, 2009; Kaplan et al., 2004; Noiseux and Hostetler, 2010; Vogt and Marans, 2004). Views of and proximity to natural areas have also been shown to be important in making housing decisions (Gocman, 2006; Kearney, 2006; Ryan, 2006; Zheng et al., 2010). Furthermore, neighborhoods that have natural amenities tend to be preferred over similar areas that do not (i.e. Kenwick et al., 2009). Legal protection for open areas is also important to residents, as areas with conservation easements tend to be preferred over those without (Geoghegan, 2002).

Despite these preferences for open space and natural features, residents generally lack knowledge about the subdivision design approaches that provide those features (Bosworth, 2007; Hostetler and Noiseux, 2010; Thompson, 2004). In municipalities where these design approaches have not
previously been used, residents may have no reference point to compare to standard subdivision designs (Thompson, 2004). Even when residents do have previous experience with low-impact or conservation designs (including those who reside in alternative subdivision developments), they may not fully understand the embedded environmental benefits of these approaches. This is especially true with regard to less “visible” attributes such as water quality or pollution abatement (Gocmen, 2006; Thompson, 2004).

In general, residents’ preferences tend to reflect the cultural norms and status quo within their location (Gocmen, 2006; Nassauer et al., 2009; Zheng et al., 2010). That is, residents tend to prefer aesthetics that are similar and reinforce the overall look and design of their particular neighborhood area, and may have serious concerns about surrounding areas with features that differ from their own subdivision (Kaplan and Austin, 2004; Nassauer et al., 2009). Preferences extending to surrounding neighborhoods can provide either support (if residents buy in), or resistance (if they do not) for incorporating alternative features in areas adjacent to existing subdivisions (Nassauer et al., 2009; Thompson, 2004).

Developer knowledge and perceptions of subdivision designs

Low impact development and conservation subdivisions are relatively new design approaches with few examples in the Midwest. Not surprisingly, developers across the region are reported to be unfamiliar with or misinformed about alternative subdivision designs (Bosworth, 2007; Bowman and Thompson, 2009; Westbrook 2010). This lack of knowledge can impede developer adoption of alternative designs in several ways. First, the development business is fundamentally risk-averse - investing in untested development techniques (especially given uncertainty about consumer preferences) is unlikely given developers’ nature to satisfice (that is, to choose development options that are already known to meet revenue goals, but not necessarily maximize them, e.g. Bosworth, 2007; Bowman and Thompson, 2009; Mohamed, 2006; Svelka, 2004). Second, lack of technical construction information creates a significant barrier that lowers the willingness of developers to attempt innovative approaches (Bosworth, 2007, Thompson, 2004). And third, misconceptions about the potential benefits or costs of alternative development can dissuade developers from making investments in them (Bosworth, 2007; Bowman and Thompson, 2009; Westbrook 2010).

A key element in developers’ assessment of risk is their perception of consumer demand (Svelka, 2004). Previous studies have indicated both that developers can underestimate consumer preferences
for alternative designs (Bowman and Thompson, 2009; Ryan, 2006) and that developers can accurately assess consumer preferences (Westbrook, 2010). Since developers respond to consumer demand, a perceived lack of interest on the part of consumers would discourage implementation of alternative subdivision designs (Ryan, 2006).

City official knowledge and perceptions of subdivision designs
City officials generally have greater familiarity with alternative design approaches than residents (Kaplan et al., 2004), but may not be as familiar with how residents and developers perceive those approaches (Bosworth, 2007; Ryan, 2006). This can lead to development of ineffective subdivision ordinances that result in poor development decisions (Hamin, 2006). However, municipal planners may recognize the value of alternative approaches and may be able to offer incentives to developers to encourage use of alternative approaches (Bosworth, 2007).

Even knowledge of or familiarity with alternative subdivision design among planners in and of itself does not necessarily lead to implementation. Innes (1998) argues that a shared knowledge base where all agents involved in the process have examined the meaning, accuracy and implications of available information for themselves is necessary to promote effective action. Increasing the accessibility of information for stakeholders may promote greater local implementation compared to a planner-led decision process (Kartez and Casto, 2008; Stokes et al., 2010).

Regulations
If public policy action is taken (often in the form of subdivision standards and regulations), city officials must act within legal boundaries dictated by both state-enabling land use legislation and local ordinances that can limit their power to manipulate proposed developments. In certain cases, conservation efforts must then arise from the private sector (Stokes et al. 2010), and commonly-held community values become an important factor determining the breadth of conservation implementation (Stokes et al., 2010; Thompson, 2004). Regulations and standards themselves can present barriers to innovative development approaches. Strict development regulations meant to facilitate delivery of city services (i.e., street widths and frontages for emergency vehicles and city utilities) can often prevent use of development designs that would decrease environmental impacts (Stone, 2004). Regulations can also impede alternative design use through less direct means if ambiguous language and additional approval processes lengthen the time for approval and thus increase costs for developers (Bowman and Thompson, 2009; Ryan, 2006).
Where specific conservation subdivision enabling regulations exist, there can also be important differences between stated principles and actual outcomes. For instance, a conservation subdivision ordinance that is not supported by a larger-scale land use policy plan to promote interconnectedness of conserved lands is already disconnected from the original design philosophy (Hamin, 2006). Finally, there is an important legal ramification that both developers and city officials must consider. Communal ownership of open space within alternative developments sometimes results in the creation of a neighborhood association. These organizations can cost time and money to create, and if they “fail”, the responsibility and cost of maintaining the shared property would then pass to either the developer or local government agency (Austin and Kaplan, 2003; Austin, 2004; Bosworth, 2007; Bowman and Thompson, 2009).

**CURRENT STUDY**

This investigation was designed to examine and compare the knowledge and perceptions about alternative subdivision designs between three invested groups (residents, developers, and city officials) in one community to explore opportunities for reducing stakeholder barriers and increasing implementation of low-impact and conservation subdivision developments.

**Study area**

Ames, Iowa was chosen as an example of Midwestern United States city with increasing urbanization pressure from residential development along the urban-rural interface. Urban land cover within the incorporated limits increased by 80% between 1992 and 2002 (Bowman et al., in press). While most of this change affected croplands, a significant amount of forest land cover was also converted. In the context of historic large-scale landscape change from natural systems to agricultural uses across the Midwestern United States, the loss of this forest land is a growing concern.

**Study questions**

This study focuses on understanding and comparing the knowledge bases and familiarity of residents, developers and city officials with respect to alternative development approaches. We examined three study questions that would reveal the knowledge and perceptions held by these stakeholders in the development process:
1. Are residents, developers and city officials familiar with alternative subdivision designs? And how accurate is this knowledge?
2. How are alternative subdivision designs perceived by residents, developers and city officials? How do developers and city officials perceive interest in these methods by residents?
3. What are the possible disconnects within between the perceptions and knowledge of the three groups? And what are some possible solutions to address these barriers?

To examine these questions, we used a series of survey instruments and focus groups for residents, developers, and city officials in Ames, Iowa.

**METHODS**

*Resident survey and focus groups*

A mail-return survey instrument was designed and distributed using the Dillman tailored design approach (Dillman, 2007) with assistance from the Center for Survey Statistics and Methodology (CSSM) at Iowa State University. The survey was created to assess resident preferences for alternative subdivision designs and their opinions on the state of residential development and agents involved in development in Ames, Iowa. Two versions of the survey were disseminated: the first version included a series of questions about Low-Impact Development (LID), and the second version included a similar set of questions about Conservation Subdivision Design (CSD). Other items on both versions of the survey were identical and included a series of questions about the variety of subdivisions available and pace of development in the area, the effectiveness of public and private entities with respect to limiting the environmental impacts of development, their own preferences for subdivision amenities, and the effect of their own subdivision on the environment. Several demographic questions were also included.

Two thousand (2000) households who had purchased a single-family home between 2003 and 2008 in Ames, IA were randomly selected from the City of Ames Assessor’s Office GIS database to receive a survey. The two versions (LID and CSD) of the survey were randomly and evenly divided among the sample. Reminder cards were mailed within two weeks to non-respondents, and an additional survey was mailed after one month. Households that were incorrectly listed in the database were removed from the sample and were not replaced, resulting in a total eligible sample of 1804. Non-response bias was tested by comparing demographic responses to first and second mailings of the survey (Dooley and Linder, 2003).
Resident perceptions of the variety of neighborhoods available in Ames were measured using a 3-point scale (1 = there is a neighborhood to fit everyone’s needs, 2 = there are different kinds of neighborhoods; but more could be done to increase variety, and 3 = there is little variety in neighborhoods). Opinions on the overall pace of residential development were also measured on a 3-point scale (1 = too slow and 3 = too fast). Residents’ perceptions of whether City of Ames personnel consider potential negative effects of development when approving subdivisions was rated using a 5-point scale (with 1 = strongly disagree, 5 = strongly agree). Ratings of how well developers, Ames City Council, Ames city planners, and county planners (Story County, Iowa) have done in protecting the natural environment from impacts of residential development were measured on a 5–point scale (with 1 = very poorly, 5 = very well).

The importance of eleven (11) neighborhood attributes from “overall look and feel” of the subdivision to neighborhood “seclusion” were rated on a 5-point scale (with 1 = not at all important, 5 = very important). The amount of concern residents have about the potential negative effects of residential development on the environment were measured on a 5-point scale (with 1 = strongly disagree about concern, 5 = strongly agree with concern). Familiarity with LID or CSD approaches was rated on a 3-point scale (with 1 = had not previously heard of LID or CSD, 2 = had maybe heard of LID or CSD, 3 = had heard of LID or CSD). An open-ended question was provided for respondents to indicate where they had previously heard of LID or CSD designs. Respondents were asked to indicate whether they thought LID or CSD features were included in existing subdivisions (yes/no). An open-ended question was available for respondents to provide an example of LID or CSD in Ames. Finally, respondents were asked to indicate whether they would consider purchasing a home, or if they would pay more for a home in a subdivision with LID or CSD features (measured on a 5-point scale with 1 = strongly disagree and 5 = strongly agree).

Thirty-six (36) survey respondents were randomly selected and solicited by telephone to attend a resident focus group. The participants selected were a subset of respondents who purchased a home with a sale price between U.S. $185,000 and $215,000 (which would ensure a uniform group based on the price range most likely to contain alternative subdivision features, e.g., Bowman et al., 2009). Three focus group events were scheduled with 12 participants in each event. Respondents who agreed to attend were mailed a reminder letter and offered a $40 incentive payment.
The focus group was facilitated by personnel from the Center for Survey Statistics and Methodology and included discussion, rating, and bidding components. Participants were asked to rate various properties and to make hypothetical bids (in an experimental auction format, e.g., Lusk and Shogren, 2007) on a lot with a house across a series of five rounds. Each round included a standard subdivision property that contained no alternative design features, a property that included a feature with little or no environmental benefit (e.g., stream with no buffer), and a property with a feature that had a similar appearance that included a positive environmental attribute (e.g., a stream with a forest buffer). Residents were asked to rate three properties in each round simultaneously using a 5-point scale (1 indicated they had little interest in purchasing the property, and 5 indicated they had a strong interest in purchasing it). Features rated in the focus group included a neighborhood prairie, a neighborhood forest, a stream, a stream with a forest buffer, a flower garden, a rain garden, clustered housing with open space, and clustered housing with forest.

The appearance, dimensions, and characteristics of the house were the same for all properties and the properties were described using sales sheets with a format and language similar to those used by local real estate agents to advertise available properties. Each sale sheet contained a picture of the house (with any applicable features included), two pictures of the individual features, and an overlay of the overall subdivision design with the feature highlighted. Each feature was described in detail with any positive environmental benefits noted. After the final round of rating, a discussion session queried participants about the various properties and the overall focus group process.

**Developer survey and focus group**

Eight developers were invited by telephone to participate in one focus group session facilitated by personnel from the Center for Survey Statistics and Methodology. The selected developers were a census sample compiled by members of the City of Ames Department of Planning and Housing of all individuals who were known to purchase and subdivide land, and subsequently sell the lots (either as a raw lot or a lot developed with a house). The list was checked by cross-referencing with a directory obtained from the Ames Homebuilders Association. Developers from outside of Ames were excluded. Developers were sent a reminder letter and were offered an incentive payment of $40 for their participation.

A survey was given to each developer to complete before the start of the focus group session. Developers were asked to rate their familiarity with low-impact development (LID) and conservation
subdivision design (CSD) on a 5-point scale (1 = not at all familiar and 5 = very familiar), and to provide a list of the most important features of both designs. They were asked to indicate how familiar they thought Ames residents were with these design approaches (in the same scale). Developers were then asked whether features from each design had been included in any of their previous subdivisions and if yes, to describe which features they had used. Developers were asked (on a 5-point scale, 1 = not at all likely, 5 = very likely) their opinion about whether Ames residents would consider either purchasing or paying more for a home in a LID or CSD neighborhood. They were then queried on their opinions about how current regulations affected a developer’s ability to add alternative design features to a subdivision (on a 5–point scale, 1 = impede the use, 5 = encourage the use), and about the overall pace of residential development in the Ames area (on a 3-point scale, 1 = too slow, 3 = too fast). Finally they were asked about the length of their tenure in the development business, the approximate number of subdivision they had developed in the last 5 years, the average cost of a house in one of their subdivisions, and about ways their company gets information on consumer demand.

Developers were asked to rate three subdivision designs on each of two vacant properties selected from aerial photographs of undeveloped property in the Ames area. Each property was 36.5 acres and within city limits with access available from any side of the property. One property contained 16 acres of forest and the other property featured a stream running across the site. Developers were asked to rate and bid on the property containing forest first, and the property containing the stream second.

For each property, each participant was first given an aerial photo of the site and was asked to draw a basic sketch of how they would subdivide the property (indicating the location of roads and lots). Developers were then asked to rate their interest in purchasing the property on a 5-point scale (where 1 = little interest in purchasing, and 5 = strong interest in purchasing) based on their design. Then developers were asked to submit a sealed bid (in US$ per acre) for the amount they would be willing to pay at auction for the property (given that they would be able to obtain city approval for the design). Developers were also asked to provide an estimate of the price they would ask for an individual lot for on the current housing market. Bids were collected and developers were notified of the highest and second-highest bid amount. Participants were given a second aerial photo of the site with an overlay of a standard subdivision design (which included no low-impact development (LID) or conservation subdivision design (CSD) features). Ratings, bids and estimates of sales prices were
collected as before. Each design provided to developers contained 96 lots and met all of the City of Ames minimum subdivision density regulations. Developers were also provided with some information from the resident auctions on residents’ preferences for similar properties. Finally, developers were provided with a third aerial photo of the site with a clustered housing design featuring the forest as shared open space (for the first property), and shared open space with a 100-foot stream buffer (for the second property). Ratings, bids, and estimates of sales prices were again collected as described before. After all designs had been rated, group discussion of the general development process in Ames took place.

City staff survey and focus group
Ames city staff members were invited to attend a focus group session by personnel in the City of Ames Department of Planning and Housing and facilitated by personnel associated with the Center for Survey Statistics and Methodology. All city staff members that were routinely involved in or consulted with during the residential subdivision development approval process were invited to participate.

A short survey was provided to each participant to complete before the start of the focus group. The survey instrument was identical to the instrument provided to developers with two added items. First, city staff members were asked their opinion about how current regulations affect a developer’s ability to add both LID and CSD features to a subdivision on a 5-point scale (with 1 = impede the use, 5 = encourage the use). Secondly, they were asked about the length of their employment with the city and the approximate number of subdivision they had reviewed in the last 5 years.

Focus group participants attended as part of their working day and did not receive any form of additional payment for their involvement. The focus group session was designed to emulate the subdivision approval process using both personal expertise and group discussion to elicit opinions on a variety of subdivision designs in Ames. Participants were given the opportunity to rate their interest in approving four different subdivision layouts provided for one property. The property selected was the same 36.5 acre property with forest used for the developer focus group. The layouts included the same standard subdivision and clustered housing designs from the developer focus groups. An additional clustered design was included (based on developer focus group comments) that did not involve use of culs-de-sac, and which featured the same acreage and density as the previous clustered subdivision design. All designs had the same housing density (96 lots) and met all subdivision code
requirements. Each design also included information on both residents’ and developers’ preferences for similar designs.

For each of the four designs, city staff members were asked to rate (on a 5-point scale, 1 = not at all interested and 5 = very interested) their interest in approving the design for development. They were then asked to provide a list of pros and cons for the design. City staff were then given the opportunity to discuss the design among the whole group with participants giving their professional opinions based on their staff position as if they were given consultation to planning staff during an approval meeting. After the discussion, staff members were asked to re-rate the design and provide additional input on the design. After all designs had been rated, the group participated in a discussion on the general development process in Ames and the focus group process.

Data analysis and software

All of the 3- and 5-point scale questions on the surveys and in focus group interactions were analyzed using means and t-tests to examine differences from the neutral point (on a 3-point scale the neutral point = 2, on a 5-point scale the neutral point = 3) and ANOVA tests for similar questions compared between groups.

Statistical tests were estimated using SAS 9.3 and Microsoft Excel 2007. Three levels of statistical significance were used for this study: 0.10, 0.05, and 0.01.

RESULTS

Survey and focus group participant demographics

Overall, there were 777 of 1804 (43%) eligible resident surveys returned. Survey respondents were 94% white and 52% male with an average age of 41.9 years. Respondents had an average household size of 2.9 persons with 1 child living at home, and had lived in Ames an average of 11.2 years. Eighty-four percent of respondents had a college education and had a mean household income between U.S. $75,000 and $100,000. Sample t-tests showed no evidence of either non-response bias, or a difference between first and second mailings with regard to any demographic variables.

The 27 resident focus group participants were 92% white and 54% male with an average age of 49.5 years. Participants had mean household size of 3.3 people with 1.2 children and had lived in Ames 15
years on average. Eighty percent of participants had a college degree and the mean household income was between U.S. $75 000 and $100 000.

The six developer focus group participants were 100% white and male. On average, participants had been in the development business for 16.8 years, and each had completed approximately six subdivision projects in the past 5 years. Homes in these projects generally sold for a price between $200,000 and $400,000.

The 15 city official focus group participants were 100% white and 81% male. Participants had been employed by the city of Ames for an average of 8.1 years and had reviewed a mean of 15.5 subdivision projects within the last 5 years. Participants represented several city departments, including planning and zoning, inspections, public works, electric, water and pollution control, and parks and recreation.

**Resident perceptions of neighborhood characteristics and subdivision amenities**

Half of resident survey respondents (50%) felt that Ames had a neighborhood that would fit everyone’s need (Figure 1). Forty-five percent of respondents thought that Ames had a variety of neighborhoods, but more could be done to increase variety.

When purchasing their current home, the most important amenity for resident respondents was the “overall look and feel” of their neighborhood (4.4 on a scale of 5, 1 = not at all important and 5 = very important) which was significantly higher than any other item (Figure 2). Mature trees (3.9), neighborhood parks (3.8), and neighborhood open space (3.7) were also important amenities. Wildlife (3.1), closeness to neighbors (3.0), and seclusion (3.0) were not rated significantly different from neutral (3.0). Only neighborhood streams were rated below neutral, with an importance rating of 2.8 (Figure 2).

**Resident, developer, and city staff perceptions of residential development issues and potential environmental impacts**

Residents reported some concern (3.6) about the potential negative environmental effects of subdivision development in Ames (Table 1). However, they indicated that they were not concerned about the effects of their own neighborhood (2.2, on a 5-point scale, where 1 = not at all concerned and 5 = very concerned) reporting that it has little to no impact on the natural environment (3.2, on a
5-point scale, where 1 = large and negative impact and 5 = large and positive impact). Residents (2.4) reported that the pace of development was almost too fast. Developers (1.0) and city staff (1.5), on the other hand, indicated that the current pace of residential development in Ames was too slow (Figure 2).

When asked about the groups in Ames that influence land use and how well their actions protect the environment from potential negative impacts, resident respondents rated each group close to neutral (Figure 3). Residents rated the City of Ames personnel (3.2) around neutral when asked if city staff consider potential negative environmental effects of subdivision development (Table 1). However, it is important to note that a number of respondents did not know how well these groups were doing (Figure 3). For example, over 40% of respondents did not know how well Story County planners performed and 33% did not know how well City of Ames planners performed in protecting the natural environment in and around Ames.

Developers and city officials reported that subdivision regulations did not have a large impact on the implementation of LID or CSD features (Table 2). Developers rated the effects of regulations on alternative subdivision designs slightly below neutral (2.5) and city staff rated regulations’ effect on LID (2.6) and CSD (2.9) use similarly. None of the ratings were significantly different from neutral (Table 2).

**Familiarity with and use of low impact development (LID) and conservation subdivision design (CSD)**

Half of residents surveyed said they had previously heard of LID and nearly half (47%) also believed that LID was currently in use in Ames (Figure 5a). Only 39% of residents had heard of CSD before, but 57% thought that CSD was being used in Ames. A majority of both developers (83%) and city staff (63%) reported they were familiar with LID features and believed (83% of developers, 85% of city staff) that they had previously either used or approved LID. Fewer respondents (67% of developers and 50% of city staff) were familiar with CSD and had used or approved CSD before (50% of developers and 64% of city staff) (Figure 5a). Both developers (3.3) and city staff (3.3) were unsure whether Ames residents were familiar with LID design features (Figure 5b). For CSD designs, developers (2.8) and city staff (2.9) also expressed a neutral opinion with regard to Ames residents’ familiarity with the approach (Figure 5b).
Consumer willingness to purchase and pay more for LID and CSD features

Residents expressed some willingness to purchase a home with LID features (3.6), but did not necessarily agree that they would pay more for it (2.8) (Figure 6). Developers (4.2) and city staff (4.5) indicated that residents would be willing to purchase a home in a neighborhood with LID features. While developers (3.2) were unsure whether residents would be willing to pay more for a home with LID features, city staff (3.9) believed that residents would pay more.

Residents indicated some interest in buying a CSD home (3.3) (though less than for a LID home), but again indicated that they would not be willing to pay more for the home (2.6) (Figure 6). Developers were somewhat less optimistic about residents purchasing (3.2) and paying more (3.2) for a home with CSD features. City staff, however, expressed belief that consumers would buy (3.9) and pay more (4.4) for a CSD home.

Focus group response to LID and CSD examples - Example 1: Clustered housing with forest

Residents expressed strong interest in the clustered design with forest (4.6) rating it higher than the standard design (2.5). Resident ratings for the clustered design were significantly higher than neutral (Figure 7). Developers expressed somewhat greater interest in a clustered design that preserved forest (3.6) compared to a standard design (2.7), although this difference was not statistically significant (Figure 7).

City staff expressed strong concern over the use of culs-de-sac in the clustered housing design. City staff showed greater interest in a clustered design without the implementation of culs-de-sac (3.6, 3.5). While generally lower, individual staff member ratings made after group discussions were not significantly different on average from ratings made before the group discussions.

Developers’ own designs featured shared forest space (6 of 6) and trails (4 of 6) for the property with forest. Although some developers included part of the forest in subdivided lots, all developers saved at least part of the forested land as a common resource for neighborhood residents. Similar to design options featuring the stream, there was no significant difference in the mean bid per acre for any of the designs for the forest property (Table 3). Average purchase prices offered ranged from $16,500 per acre for the standard design to $19,900 per acre for the clustered design with forest (Table 3). There was a significant difference in mean price between a standard lot and a lot in the developers’
Example 2: Stream with forested buffer
Residents gave lower mean ratings for the standard (2.5) and stream without buffer (2.5) scenarios than for the stream design with a forest buffer (3.7) (Figure 8). Residents’ interest ratings for standard and un-buffered stream properties were significantly less than neutral while their rating for the stream with a forest buffer was significantly higher (p < 0.05) (Figure 8). Developers expressed similar levels of interest (2.5 – 3.0) for all three designs for the property with a stream (Figure 8). Developers’ ratings were not significantly different from neutral (3.0). Due to time limitations, the stream buffer scenarios were not used in the city staff focus group.

Developer drawings for the property containing the stream shared common elements including parceling the stream into private lots in 5 of 6 illustrations, and the addition of open spaces in 4 of 6 drawings. None of the developers included a vegetated buffer with the stream in their own designs for the property. Developer bids showed no difference in either purchasing the raw property or for the selling price for subdivided lots for any of the available designs (Table 3). The mean purchase price offered ranged from $15,900 per acre for the standard design to $17,700 per acre for the design with a forested buffer (Table 3). Developers indicated proposed prices for selling lots that ranged from $51,300 for the standard design to $53,200 for the developers’ own designs (Table 3).

DISCUSSION
This study used surveys and focus groups to explore residents’, developers’, and city officials’ perceptions of and interest in low-impact development (LID) and conservation subdivision design (CSD) in Ames, IA. Residents, developers and city staff all expressed interest in alternative subdivision designs and indicated a preference for designs with low-impact and conservation subdivision features over standard designs. Lack of familiarity with and knowledge about LID and CSD features, subdivision design regulations, and disconnects between these groups may serve to limit implementation of these designs.

Form and pace of residential development in Ames
Only half of residents were satisfied with the variety of subdivision types available in Ames (Figure 1). With few exceptions, subdivisions in Ames have similar layouts and styles even across housing
Uniformity among the subdivisions currently in place clearly impacts residents’ perceptions, particularly in light of the importance placed on “overall look” among subdivision amenities (Figure 2). It also presents opportunities for developers to consider incorporation of alternative features as a way to make future subdivisions distinct and create a broader palette of choices for consumers. Since the “overall look” of a neighborhood is an important factor for residents (see also Nassauer et al., 2009; Ryan, 2006), integration of alternative subdivision features could be an important selling point for consumers. Developers and city officials should focus on opportunities to create integrated designs that highlight alternative features and communicate clearly with residents about their embedded environmental benefits.

Rapid residential growth (including both single-family homes and apartment complexes) along the perimeter of Ames has fueled citizen concerns about both land cover change and potential negative environmental impacts associated with those changes. Between 1992 and 2002, urban land cover increased 80%, with only a 7.5% increase in population (Bowman et al., in review). This was the largest increase in urban land cover among the four Iowa cities (Ames, Cedar Rapids, Council Bluffs, and Davenport) included in that study. The overall pace of residential development contributing to land cover change in Ames appears to be a concern for residents, as indicated by their perception that residential development happening too quickly (Figure 3). Developers and city staff, however, indicated that the pace of development was too slow. Differing perceptions of the pace of development between residents, city staff, and developers has also been reported for Cedar Rapids, IA (Bowman and Thompson, 2009). Public involvement in city-wide discussions of development has been heightened in recent years in Ames, with a series of controversies over placement and characteristics of proposed developments, and new activist groups have formed and taken a leadership role among citizens in these debates.

In addition to concerns about the pace of residential development, residents reported concerns about the overall impact of development on the environment. However, they did not think that their own subdivision had any effect on the environment (Table 1). This suggests that one possible focus for public education might be an overview of how all development impacts the environment, possibly using universal examples such as stormwater dynamics (Thompson, 2004).
Resident, developer, and city staff familiarity and knowledge about alternative approaches to development

Residents reported limited familiarity with alternative subdivision designs: one-half or fewer of all respondents indicated they had previously heard of LID or CSD (Figure 5a). Developer and city staff also perceived a lack of knowledge on the part of residents regarding these designs (Figure 5b). Previous studies have shown that residents’ knowledge about alternative subdivision designs is limited, even for those residing in “green” developments (Hostetler and Noiseux, 2008). Further, it has been suggested that residents do not understand how conservation features could be integrated into larger-scale municipal plans (Kaplan et al., 2004). Citizen education could begin with solid examples and interactions at the subdivision scale, which could then lead to efforts to increase residents’ environmental knowledge at larger scales (Hostetler et al., 2008). This could ultimately lead to greater consumer demand for alternative designs (Thompson, 2004). Developer and city staff respondents, on the other hand, reported familiarity with both LID and CSD (to a lesser degree) (Figure 5a). We surmise that there is an important distinction between familiarity with and knowledge about LID and CSD. For example, even though many developers and city staff indicated familiarity with LID and CSD, they were not able to provide accurate information about LID features, and provided no specific information about CSD features on open-ended queries. Thus, developers’ and planners’ actual working knowledge about these approaches may be limited.

Open-ended replies from residents, developers and city staff frequently identified a “New-Urbanist” development as an example of both LID and/or CSD development. Other answers that respondents offered indicated that although they could not identify a specific development with these features they believed that one must exist. Lack of knowledge about LID and CSD design concepts in some cases appears to cause respondents to assume that a different-looking neighborhood layout is associated with environmental amenities even when that is not the case.

Previous city- and homebuilder-association-sponsored workshops, speakers from regional design firms, and state-level agency outreach efforts have provided opportunities for developers and city staff to learn about low-impact and conservation development (to a lesser extent) approaches. Participants’ familiarity with LID features indicates that these activities can be useful, and that additional efforts focused on CSD could prove valuable as well. Additional developer and city staff events should include a greater emphasis on the technical and how-to aspects of alternative subdivision design implementation. Finally, broadening the audience to include the general public
could be especially useful to increase interest in and demand for alternative subdivision designs (see also Thompson, 2004).

Since there are no on-the-ground examples of true LID or CSD subdivisions in Ames, there is no basis for residents, developers, or city staff to develop a heuristic for the differences between traditional and alternative developments. This is an issue across the state (and generally in the upper Midwest region), since the main interactions between developers and consumers about home-buying preferences are through open houses in demonstration homes/subdivisions (Bowman and Thompson, 2009). Without examples of alternative developments, residents are unable to express their preferences about LID and CSD approaches, and without this feedback, developers are less likely to take risks to implement alternative designs. Developers considering implementation of LID and CSD may need assistance from city staff or other local professionals as they expand their efforts to understand consumer preferences and identify potential homebuyers for alternative subdivisions.

**Interest in alternative subdivision designs**

Residents rated features associated with embedded conservation attributes as important in their purchasing decisions (Figure 2). This is consistent with previous studies in Iowa and around the US (Bosworth, 2007; Bowman and Thompson, 2009; Gocmen, 2006; Kaplan and Austin, 2004; Noiseux and Hostetler, 2010; Ryan, 2006) indicating that natural features (in particular, views of open space and nature) are among important home-buying criteria. Mature trees, parks and open spaces were all rated as important in residential purchasing decisions (Figure 2). However, willingness to pay and willingness to purchase homes embedded in subdivisions that incorporate these elements were generally low among survey respondents (Figure 6). Lack of familiarity with and knowledge about these subdivision designs could explain initially low ratings. Resident participant ratings for designs in the focus group sessions (with interaction about both individual features, overarching design themes, and embedded environmental attributes) led to a significant increase in interest in LID and CSD designs and willingness to pay for the environmental attributes associated with these designs (Figures 7, 8). This provides evidence that efforts to engage community residents in learning about alternative subdivision designs could lead to greater demand for these options in the housing market.

Developers also indicated a preference for alternative subdivision designs compared to standard approaches (Figures 7, 8). When providing their own designs for example properties, all developers conserved at least part of the natural areas shown on aerial photos to serve as embedded subdivision
features. Developer bids to purchase properties also revealed a preference for conserving and integrating natural landscape features rather than only maximizing available lot acreage. Developers also indicated that lots in subdivisions with conserved natural areas would be valuable to residents (their mean lot asking price was higher for designs with preserved stream and forest areas, Table 3).

Like developers, city staff also indicated a preference for alternative approaches compared to standard subdivision designs (Figures 7, 8). However, there were particular issues that city staff indicated would make approval for alternative designs difficult to recommend. First, city staff members were not interested in clustered housing designs that included culs-de-sac. Even though participants acknowledged the benefits of this layout (e.g., amount of forest/open space preserved, family safety aspects) the additional resources required to provide city services (utilities, fire protection, and snow removal) were deemed too high. Second, city staff members were concerned about responsibility for neighborhood open space maintenance; in particular, city staff discussed the question of who would be responsible for the upkeep of open areas if a neighborhood association failed to do so. While participants recognized the conservation and recreation value of open spaces, city staff were hesitant to recommend approval for designs with large amounts of open space if it was likely that city departments could become responsible for maintenance in the future.

Real and perceived differences in knowledge and interest
Disconnects between the groups affecting residential development are clearly an important factor. Previous studies have shown that what developers and city staff believe about residents’ preferences can differ from reality (Ryan, 2006). Ames city staff, in particular, indicated misconceptions about residents’ interest in LID and CSD development, consistently overestimating the willingness of consumers to both buy and pay more for LID and CSD developments. While additional focus on embedded subdivision features in education efforts (such as provided during our resident focus groups) may shift resident interest, city staff need to be aware that unless some form of education/interaction occurs, residents may be less willing to invest in alternative designs.

This type of misperception can also lead to decision-making and public policy that may not reflect public sentiment. While most residents believed that the Ames City Council and city planners were performing at an average level in terms of protecting the environment from the impacts of development, about one-third of respondents did not know how well either group was performing (Figure 4). This is important because the public should be informed about the decisions affecting
residential development that are being made on their behalf. Residents should have a greater understanding about the role local governmental officials play in the development of residential housing and what measures are being taken to protect the common interest. Residents are unable to provide guidance to city officials or to make informed choices if they lack the knowledge to do so.

Regulations
Both developers and city staff identified further obstacles to LID and CSD implementation, indicating that current regulations range from “somewhat impeding” the use of alternative designs to having a neutral effect on the implementation of LID and CSD use (Table 2). Neither party believed that regulations encouraged the use of LID or CSD features. This absence of municipal support for alternative design features is prevalent across Iowa (Bowman and Thompson, 2009; Miller et al., 2009) and could be a significant barrier to the use of LID and CSD features. Further, implementation of local regulations is done by city staff members who also must consider a wide spectrum of city services in their decision-making process. Subdivision regulations that are formulated to allow for delivery of city services can limit or at least complicate the incorporation of conservation design or low-impact development features (Stone, 2004). Thus, further research should include closer examination of the perspectives of a broader array of city staff professionals in order to more accurately reflect municipal decision-making processes.

CONCLUSIONS
Alternative development approaches such as low impact development and conservation subdivision design could provide embedded environmental benefits not associated with more standard development approaches. While low-impact development and conservation subdivision design cannot fully address the effects of unrestrained urban growth, they can help to reduce the loss of natural areas and mitigate adverse natural circumstances (i.e. flooding) that can be exacerbated by traditional infrastructure. We found that there is strong interest in these types of designs on the part of residents, developers and city staff in Ames, particularly for designs that integrate preserved natural areas as well as subdivision features that have environmental benefits, once those benefits are made explicit.

However, limited familiarity with and knowledge about LID and CSD features across all groups present barriers that can prevent the adoption of these approaches. Knowledge is an important aspect of real estate marketing and without enough information, residents, developers and city staff are
forced to use heuristics based only on what they know about the current housing market. Many residents are unaware of possible alternative development options. While a greater proportion of developer and city staff participants in our study indicated familiarity with LID and CSD, they were misinformed about the use of these features in Ames. Lack of information and misconceptions about LID and CSD creates a loop of asymmetrical information that reinforces continued use of standard subdivision designs. Regulatory issues further discourage the use of alternative designs and cause uncertainty on the part of developers about approval of LID and CSD developments. The risk-averse and satisficing behavior of developers can hinder the exploration of alternative development options even with strongly expressed consumer interest, if developers are unsure they can garner city planning support.

Broad-spectrum education for all groups, with assistance from state, federal, and non-governmental organization personnel may help break this negative-feedback cycle by providing as much information as possible about development options. A local development mapping and land-cover change study, with input from all groups, would be also useful to assess where adoption of LID and CSD features could have the largest impact. A targeted marketing study would provide both developers and city staff with feedback on potential consumer interest in and willingness to pay for LID and CSD. Additionally, city staff could provide clear guidance on alternative development practices through comprehensive LID and CSD ordinances that outline city goals and recommendations for the use of these designs. Finally, city staff could also consider possible tax or density incentives for meeting conservation criteria, as well as increased flexibility in the design and approval process for future innovative subdivision features.

Education, along with clear, comprehensive regulations that provide incentives for developers to take risks on innovative subdivision designs, as well as a flexible planning outlook on the part of city staff could cultivate a development environment that offers increased opportunities for adoption of alternative subdivision designs. This could be a “win-win-win” solution for development stakeholders as residents would be offered more neighborhood choices, developers could reap additional incentives and opportunities to capture residential preferences for conservation features, and city officials could promote urban growth through designs that reduce impacts on natural systems.
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Table 1. Resident perceptions about effects of development for both overall residential development in Ames and their own neighborhood. Responses were rated on a 5-point scale (1 = strongly disagree, 5 = strongly agree)

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Std. Err.</th>
<th>% Don’t Know</th>
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<td>The City of Ames considers potential negative effects on the environment... before approving subdivision developments</td>
<td>3.2</td>
<td>0.05</td>
<td>16.2%</td>
<td>770</td>
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<td>I am concerned about the potential negative effects on the natural environment of... overall residential development in Ames</td>
<td>3.6</td>
<td>0.05</td>
<td>1.4%</td>
<td>771</td>
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<td>my own neighborhood</td>
<td>2.2</td>
<td>0.04</td>
<td>N/A</td>
<td>764</td>
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<td>My own neighborhood has... what kind of impact on the natural environment? (1 = large and negative, 5 = large and positive)</td>
<td>3.2</td>
<td>0.04</td>
<td>N/A</td>
<td>773</td>
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Table 2.
Developer and city staff perceptions of the effect of development regulations in Ames on the implementation of alternative subdivision design features.

<table>
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<th>Perception</th>
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<th>Std. Err.</th>
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<td><strong>Developers: Ames development regulations affect the implementation of alternative subdivision design features by...</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>encouraging or impeding their use.</td>
<td>2.5</td>
<td>0.50</td>
<td>6</td>
</tr>
<tr>
<td>(1 = Impede, 5 = Encourage)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>City staff: Ames development regulations affect the implementation of LID and CSD subdivision features by...</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>encouraging or impeding LID use.</td>
<td>2.6</td>
<td>0.24</td>
<td>15</td>
</tr>
<tr>
<td>encouraging or impeding CSD use.</td>
<td>2.9</td>
<td>0.25</td>
<td>15</td>
</tr>
<tr>
<td>(1 = Impede, 5 = Encourage)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 3. Mean developer (n = 6) bids (in thousands of US dollars) for purchasing land and estimated developer lot selling price for lots developed based on various neighborhood designs and features.

<table>
<thead>
<tr>
<th>Land description</th>
<th>Design type</th>
<th>Mean bid/acre</th>
<th>Std. Err.</th>
<th>Mean lot price</th>
<th>Std. Err.</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Farmland with stream</em></td>
<td>Standard</td>
<td>15.9</td>
<td>1.9</td>
<td>51.3</td>
<td>7.0</td>
</tr>
<tr>
<td></td>
<td>Own design</td>
<td>17.4</td>
<td>1.6</td>
<td>53.2</td>
<td>8.4</td>
</tr>
<tr>
<td></td>
<td>Stream with forested buffer</td>
<td>17.7</td>
<td>2.3</td>
<td>52.8</td>
<td>5.1</td>
</tr>
<tr>
<td><em>Farmland with forest</em></td>
<td>Standard</td>
<td>16.5</td>
<td>2.1</td>
<td>52.1&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.9&lt;sup&gt;i&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>Own design</td>
<td>17.8</td>
<td>2.4</td>
<td>62.3&lt;sup&gt;b&lt;/sup&gt;</td>
<td>6.3&lt;sup&gt;i&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>Clustered housing with forest</td>
<td>19.9</td>
<td>2.9</td>
<td>57.6&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>3.6</td>
</tr>
</tbody>
</table>

<sup>a,b</sup> differences in letters indicate a significant difference at p < 0.05
Figure 1.
Resident (n = 689) ratings of the variety of residential neighborhoods available in Ames, IA. Respondents were asked to select only one of the four responses.
Figure 3.
Developer (n = 6), city staff (n = 15) and resident (n = 724) perceptions of the pace that residential development is happening in Ames, IA (1 = too slowly, 2 = about right, 3 = too fast). Error bars at the 95% confidence interval of the sample mean.
Figure 4.
Resident (n = 766) perceptions of how well certain groups have protected the natural environment in and around Ames from potential negative impacts of residential development (1 = very poorly, 5 = very well), and the percentage of respondents that indicated they did not know. Error bars indicate a 95% confidence interval around the sample mean.
Figure 2.
Resident perceived of the importance of various neighborhood amenities when purchasing their current residence (1 = not at all important, 5 = very important). Error bars indicate a 95% confidence interval around the sample mean.
Figure 5a.
Percent of developers (n = 6), city staff (n = 15) and residents (LID: n = 391, CSD: n = 376) familiar with LID and CSD, that indicated either use or approval of LID or CSD features, or believe that LID and CSD features are currently used in Ames, IA.
Developer (n = 6) and city staff (n = 15) opinions on Ames residents’ overall familiarity with LID and CSD designs (1 = not at all familiar, 5 = very familiar). Error bars indicate a 95% confidence interval around the sample mean.

Figure 5b.
Developer (n = 6), city staff (n = 14) and resident (LID: n = 389, CSD: n = 377) perceptions of residents’ likeliness to both purchase and pay more for a home with LID or CSD features (1 = not at all likely, 5 = very likely). Error bars indicate a 95% confidence interval around the sample mean.

Figure 6.
Figure 7.
Developer (n = 6), city staff (before and after group discussion) (n = 15), and resident (n = 27) interest in developing (developers), approving (city staff/planners) or purchasing (residents) a home in a subdivision featuring standard and clustered designs (with and without culs-de-sac) (1 = not at all interested, 5 = very interested). Error bars indicate a 95% confidence interval around the sample mean.
Figure 8.
Developer (n = 6) and resident (n = 26) interest in developing or purchasing a home in a neighborhood with no stream, a stream with no buffer, or a stream with a forested buffer (1 = not at all interested, 5 = very interested). Error bars indicate a 95% confidence interval around the sample mean.
CHAPTER 5: CONSERVATION SUBDIVISIONS AND THE VALUE OF PROTECTED ECOSYSTEM SERVICES

A paper to be submitted to Frontiers in Ecology and the Environment

Troy Bowman, Jan Thompson, John Tyndall

INTRODUCTION

The 21st century marks a point of immense change for the world as a majority of its population shifts from living in rural environments to towns and cities (Bolund and Hunhammar 1999; Chamie 2001; Rees and Wackernagel 2008). As these urban areas become more populated, city inhabitants increasingly rely on ecosystem services provided by natural systems located within and around urban areas for their well-being (Bolund and Hurhammar 1999; Novak and Dwyer 2007). Ecosystem processes that reduce air pollution and heat island effects, aid in stormwater and wastewater treatment and transportation, provide noise and odor shielding, offer recreational opportunities, and provide aesthetic variety are among the critical ecosystem benefits that allow cities to function effectively in ways that are cost-effective and broadly appealing to heterogeneous populations (Bolund and Hurhammer 1999; MEA 2005; Niemelä et al. 2010; Pickett et al. 2010; Tzoulas et al. 2007).

The configuration of developed and undeveloped areas within a city strongly influences ecological functionality, which in turn dictates the array of ecological services that can be expected in urban contexts (Botkin and Beveridge 1997; Tratalos et al. 2007; Whitford et al. 2001m). Typically, approaches to development that incorporate contiguous natural areas and ecological and hydrologic connections are better at protecting and maintaining ecosystem function than traditional development types (Niemelä et al. 2010; Tratalos et al. 2007). However, patterns of urban development and expansion often conclude in trade-offs that ultimately compromise ecosystem functionality at local scales leading to increased social costs from water quality impairment and habitat loss that range from local to regional scales (e.g., Czech et al., 2000; McKinney 2002, 2006, 2008; Paul and Meyer 2001; Radeloff et al., 2005).

Additionally, changes resulting from urban development typically have long-lasting residual impacts and promote further urbanization in surrounding areas due to the momentum offered by the increased connectivity of expanding infrastructure (Hansen et al., 2002; Stein et al., 2000). Consequently, targeting the conservation of ecological function (where appropriate) in urbanizing ecosystems is
particularly important not only within existing urban boundaries but also into the urban-rural interface which is often affected by other landscape changes (i.e. agriculture, forestry, introduction of exotic species) (Czech et al., 2000; Hansen et al., 2002, Ricketts and Imhoff, 2003).

**Eco-hydrological Capacity in Urban Contexts**

Historically, cities have used public acquisition of land for “ecosystem preservation” often manifesting as urban parks and/or open space. Yet the vast areas in private ownership and the high cost of purchasing urban property necessitate a refocus of conservation efforts to include private holdings as well (Merenlender et al. 2004). Furthermore, the location and scale of land use within and near urban areas plays a large role in determining how effective ecosystem services will be conserved (Bolund and Hunhammar 1999; Broberg 2003; Miller 2006) and many areas zoned for private development possess important hydrologic and ecological features.

New developments in and near urban boundaries are both source areas for pollutants and drivers of localized biodiversity change. For example, greater amounts of impervious surface across the urban landscape greatly alter surface water flow rates, facilitating transport of sediment and other pollutants into streams (Allan 2004; Groffman *et al.* 2003; Paul and Meyer 2001). In addition, increased surface runoff (from decreased groundwater infiltration) intensifies streambank erosion rates, increases suspended sediment and nutrient loads, and promotes channel incision and widening (Groffman *et al.* 2003; Paul and Meyer 2001). These changes have a wide range of effects on stream ecology, such as increasing algal biomass and reducing macrophytes, invertebrates, and fish number and diversity (Paul and Meyer 2001). The large number and variety of pollutants and watershed areas can make protection of stream habitat difficult (Allan 2004).

The impacts of urbanization on forest and other natural areas can be similarly extensive. Biological homogenization is a primary concern as exotic species can dominate undeveloped areas replacing native plants and animals (McKinney 2006). Compromised urban ecosystems can then serve as a source for non-native species to advance to surrounding areas (Tait *et al.* 2005). In addition, the fragmentation of habitat as a result of urban development disrupts ecosystem function and increases the vulnerability of biodiversity in remaining undeveloped patches (Alberti 2005). Despite these threats, urban areas (forests, in particular) can contain high levels of biodiversity and species of conservation concern that can be maintained given proper protection and management (Alvey 2006).
There are design options for developers to integrate into their planning and construction processes that can minimize or prevent site-level environmental impairments in a variety of different development contexts. One example is low-impact development (LID), an integrated systems approach that aids in managing storm water runoff (Coffman 2000); LID practices include bioretention swales, rain gardens, permeable paving, and green roofs. There are, however, some undeveloped urban areas that possess critical biophysical features and hydrology, making them functionally stronger contributors to ecosystem service provision than other sites and therefore, more sensitive to the impacts of development. Examples of these features include: streams with healthy riparian areas and aquatic ecosystems, significant water storage and evapo-transpirative capacity, critical habitat such as locally scarce core/edge features, rare or unique ecosystems such as wetlands, bogs, mature forest, or prairie remnants. Loss or impairment of ecological functionality within these areas may result in disproportionately large negative impacts with regard to both local and regional ecosystem service provision (e.g., in both qualitative and spatial terms). Development in these areas requires a more complex perspective in order to protect critically important eco-hydrologic functionality that balances ecosystem management principles with economic development goals. One such development approach is conservation subdivision design.

**CONSERVATION SUBDIVISIONS**

Conservation subdivision design (CSD) is an example of a site-scale development approach to identifying and then preserving ecological functionality. CSD is a stepwise design and development process that includes evaluating potential conservation areas of a property using scientific assessment of important hydrologic and ecological features of an area, and delineating residential lots, roads and other infrastructure in a manner that minimizes the impacts to these areas (Arendt 1996, 1999; Pejchar et al. 2007). Fundamental to conservation subdivision design is the primary emphasis on the permanent protection of eco-hydrologically valuable areas (Pejchar et al. 2007), rather than maximizing lot size and developed area. A number of researchers have examined conservation subdivisions and other similar designs (“green” developments, open space neighborhoods, clustered neighborhoods) and reported on their conservation effectiveness, economic value, and/or social acceptability (Table 1).

The challenge of implementing CSD in a manner that maintains ecosystem function through urban development necessitates a common and correct understanding of conservation subdivisions among consumers, planners, and developers that includes the basic principles of CSD structure while also
incorporating the flexibility needed to address the unique requirements of each site. Without a better working understanding of conservation design elements in the public policy sector, there is potential for conservation subdivision-enabling ordinances to lack important conservation-oriented requirements and ecological context (Hamin 2006). Each conservation subdivision has to meet particular environmental goals determined by individual site characteristics (such as topography and unique natural features). In order to maintain consistency in conservation approaches, we suggest the following three elements for effective design and implementation of CSD:

1. Conservation subdivisions are goal-oriented with the aim to be ecologically functional.

   The foremost goal of conservation subdivision design is the identification and preservation of areas of ecological importance (Arendt 1996; Pejchar et al. 2007). Ecological assessments are imperative in determining what and how areas should be protected or restored and in determining the array of indicators (wildlife, floristic, hydrologic) that need to be assessed/measured within each property and the surrounding area (Pejchar et al. 2007). In order to accomplish this, conservation goals must be created for each individual site that are congruent with policy tools and the development features required, what concessions and incentives are necessary to offer for goals to be economically, socially and ecological viable, and how to measure the successful achievement of each goal (Pejchar et al. 2007; Milder et al. 2008).

At the same time, larger-scale goals, such as the potential for connections and corridors to adjacent lands and the effect of those areas on the ecological sustainability of conservation efforts should also be considered. Protected (or restored) corridors can create dissemination vectors for plant and wildlife species, helping to maintain or enhance biodiversity and native species population viability within protected patches (Beier and Noss 1998; Damschen et al. 2006; Nowak and Dwyer 2007). These connections can also increase the effective patch size of conserved areas, in turn supporting increased plant and animal species richness, conservation value, and survival rates (Collins et al. 2009; Godefroid and Koedam 2003; Keitt et al. 1997).

2. Conservation subdivisions should be monitored for effectiveness.

   Measuring the efficacy of each development within the context of monitoring is critical to the principles of CSD. The means of monitoring (e.g. water quality assessment, floristic composition and richness, wildlife survey) will be dependent on the particular configuration of a site and the ecosystem processes that are being protected (and/or promoted). As noted in Miller (2006), such
monitoring is necessary to 1) be able to adapt management of these areas as guided by the indicator data being measured; 2) verify the effectiveness of certain practices and design principles so that use of CSD can grow via empirical precedent; and 3) provide general measures of conservation goal fulfillment which in turn also validates the CSD approach. In terms of guiding policy, the results obtained from monitoring are then used to facilitate subsequent changes and enhancements to development standards.

A major challenge exists, however, in determining ways to appropriately and comprehensively measure ecological process and function, which often require a scientific skillset that many planning departments lack (Miller et al. 2009; Stokes et al. 2010). Partnerships with state or university natural resource units could provide help with developing methods to determine the effectiveness of implemented conservation features. With this in mind, the research community and extension entities should work to develop scale-appropriate tools to facilitate effective monitoring programs. Furthermore, these institutions can seek out opportunities to assist in building monitoring protocols into the initial planning process and then provide support in the actual monitoring of new developments.

3. Conservation subdivisions should have broad appeal to developers, planners and consumers

Conservation subdivisions are entrepreneurial endeavors designed to be broadly appealing in local real estate markets. For developers and planners, there are very often significant cost-savings associated with reduced infrastructure (Mohamed 2006b) and downstream remediation technology (e.g., stormwater treatment). Furthermore, enhanced economic growth associated with consumer demand values and the provision of ecosystem services can be strongly integrated into economic development goals and promotion (Bowman and Thompson, 2009; Boyer and Polasky 2004). Yet for all this to be possible the process of protecting ecological functionality needs to be closely tied to principles of neighborhood design (e.g., architectural function and form, overall aesthetics, quantity and quality of community amenities, etc.), infrastructural requirements, and innovative engineering (e.g. Austin 2004). It is also important to avoid neighborhood designs that may cause private and/or community dissonance and therefore negatively affect sale and resale dynamics. For example, CSD often creates elements of large-scale open space; therefore layouts should provide open space connectivity for residents and prevent isolated “pockets” of open space only accessible to a few residents. Such principles can prevent ownership confusion and increase overall value of protected neighborhood features (Peiser and Schwann 2003; Mohamed 2006a).
Economic valuation studies have generally reported significant market demand for conservation subdivisions or features associated with CSD, and premium consumer values (Bowman et al. in review; Bowman et al. 2009; Mohamed 2006a; Peiser and Schwann 1993). This demand, which has been shown to support higher appreciation rates for housing in conservation subdivisions (e.g. Bowman et al. 2009; Lacy 1990), can drive consumers to consider conservation subdivision homes as vehicles for real estate investment.

**CHALLENGES AND OPPORTUNITIES FOR CONSERVATION SUBDIVISION DESIGN**

Despite the potential positive environmental outcomes and economic value of conservation subdivisions, there are still major challenges for effective implementation. Primary among these obstacles is the lack of information and familiarity with conservation subdivision development among consumers, developers, and planning agencies. The choices made in residential development often reflect misperceptions about consumer demand and local land-use policy guidelines, and deficits in stakeholder knowledge can prevent the effective use of conservation development practices (Chapter 3; Thompson 2004). In addition, the economic and environmental gains of conservation subdivisions are contingent upon effective the understanding of the urban development process and the legal and socioeconomic constraints that limit the scale of urban conservation efforts.

Consumers, even those who reside in subdivisions with conservation (or “green”) features, tend to be unfamiliar with the embedded ecosystem benefits found in conservation developments (Austin 2004; Chapter 4, Hostetler and Noiseux 2010; Thompson 2004). Without this knowledge base, consumers have no reference point to compare CSD with standard development, and are less likely to demand conservation development from developers (Thompson 2004). Similarly, developers can also be uninformed about conservation developments (Bosworth 2007; Bowman and Thompson 2009; Chapter 4). A lack of technical knowledge about implementing conservation subdivision design and misperceptions about the value of CSDs can also hinder the use of conservation subdivision design, particularly in markets where CSD is untested (Chapter 4, Ryan 2006, Thompson 2004).

Planners, on the other hand, are generally familiar with the technical framework for conservation development (Kaplan et al. 2004) although their knowledge base may not extend to its ecological functionality. Planners also often lack knowledge of consumer and developer perceptions (and misperceptions) (Chapter 4; Ryan 2006). Furthermore, the general lack of ecologically trained
personnel in planning departments and the extensive research requirements necessary to assess ecosystem services present challenges in properly judging the ecological value of potential development sites (Kremen 2005; Miller et al. 2009; Stokes et al. 2010). The resulting lack of information, as well as limits to available time and money, can restrict the use of scientific methods of identification and preservation of critical habitat. Collaboration with natural resource scientists could potentially assist in creating and implementing accurate and cost-effective ways of appraising potential development sites (Theobald et al. 2000).

Another issue that arises, even with individuals familiar with conservation subdivision design, is the lack of a common understanding of the features associated with CSD (Austin 2004; Chapter 4; Kaplan et al. 2004). The absence of a commonly shared definition for these features can allow for misleading perceptions about the conservation benefits of individual developments (Parlow 2008). Armed with a clear, consistent definition, researchers studying CSD could help dispel some of this confusion by actively sharing information on conservation subdivisions through articles in the popular press, public presentations, and educational workshops. By engaging planners, developers, and consumers at the local scale, natural resource scientists can provide a reliable knowledge base to encourage land use practices that are compatible with ecological goals (Broberg 2003; Schwartz 2006).

Ultimately the opportunity to create a network of conserved natural systems between conservation subdivision developments and other open spaces at both the local and regional level could dramatically increase the effectiveness of conservation subdivision developments. Maintaining landscapes of plant and wildlife communities would significantly increase survival rates through considerable increases in patch size and ecosystem connectivity (Arendt 1996; Godefroid and Koedam 2003; Keitt et al. 1997; Lenth et al. 2006; Whyte 1964). However, the planning and implementation of conservation designs at such a large-scale can be difficult due to conflicts in property rights and other legal issues, as well as the disinclination of planning agencies to concede authority to other organizations (Godschalk 2004).

The constraints of municipalities’ regulating power in combination with limited time and money necessitate careful targeting of conservation efforts to maximize conservation value of urban ecosystems (Naido et al. 2006; Newburn et al. 2005; Theobald 2003). The lack of political capital or the presence of strong opposition can force planners or advocacy groups to choose to promote
conservation development only for sites having the greatest environmental impact (Hobson, 2004; Chhatre and Saberwal, 2005). In addition, while conservation development may offer a wide range of protective or mitigating measures that maintain existing ecosystems, it cannot create biodiversity or conservation value. It is only as effective as the systems that it protects are valuable, and applying conservation designs to marginal lands without additional restoration efforts will only result in marginal outcomes (Lenth et al. 2006; Milder 2007; Milder et al. 2008). For this reason, conservation development will have the greatest value when implemented on areas of conservation concern.

Furthermore, the structure of conservation subdivision design is limited by the small scale of urban development sites and does little to alleviate urbanization pressure at a landscape or regional level. While CSD may influence the development of adjacent hydrologic and ecological features, the protected areas do not act as barriers to additional urban growth on surrounding sites (Daniels 1999). Managing ecosystem services at broad urban scales will require integrated urban growth planning perspectives using of a suite of planning options (i.e. density bonuses, growth boundaries, impact fees, transfer of development rights) that can promote landscape-scale connectivity to maximize the ecological functionality of natural systems.

Additional considerations are necessary for communities employing CSD in urban growth control strategies that have significant impacts on the availability of broadly affordable residential housing, increasing the costs of development which are then passed on to consumers (Bengston et al. 2004; Ferguson and Kahn 1992). Houses in conservation subdivisions (or neighborhoods with similar features) generally have higher market prices than homes in standard subdivisions (Bolitzer and Netusil 2000; Bowman et al. 2009; Mohamed 2006a). This encourages developers to focus on capturing a higher-end market, creating barriers for lower-income households (Pejchar et al. 2007) and discouraging innovation in subdivision design more broadly. While the increased housing value can generate more municipal funds from property taxes, planning agencies promoting conservation subdivisions should also consider planning tools such as inclusionary zoning or developer incentives that allow a range of income types to reside in conservation developments.

Another significant challenge for CSD is that many of the values generated by this design approach are non-market values. Collecting, interpreting and utilizing the full economic value of CSD is hampered by the complexities of non-market valuation in general (Boyer and Polasky 2004). Yet if
ecosystem services are not given an explicit value in the context of profit-based urban development, they will often be ignored. Furthermore, non-market estimates can be used to target conservation efforts at broader scales (Lupi et al. 2002). The values derived for environmental services provided by an array of urban ecosystems, such as the avoided costs of residential infrastructure, can provide important information for choosing conservation and development options in land use planning decisions (Banzhaf 2010).

ENVIRONMENTAL AND ECONOMIC OUTCOMES OF PRESERVING ECOSYSTEM SERVICES THROUGH CONSERVATION SUBDIVISION DEVELOPMENT: A CASE STUDY IN CEDAR RAPIDS

[SEE PANEL 1, Page 131]

In order to explore the effectiveness of conservation subdivision design in preserving ecosystem function and estimate its added economic (market and non-market) value, we conducted a small study using six subdivisions in Cedar Rapids, Iowa Panel 1). Our case study examined streamwater sediment loading and floristic biodiversity (and the value added by examining species’ coefficients of conservatism) (Panel 1) and provides evidence that conservation subdivision designs can provide protection of both stream water quality and biodiversity (at least in undeveloped areas) by restricting the reach of development on individual sites. Additional maintenance (i.e. exotic species removal) and restoration efforts on undeveloped lands could help sustain or enhance current biodiversity values.

The study further demonstrates explicit and implicit values for conservation subdivision design (Panel 1). Consumers in the housing market expressed willingness to pay for additional ecosystems services, in addition to the value of the water quality and biodiversity provided by protected open spaces. The non-market values of ecosystem services of this type should not be discounted when evaluating the merits of subdivision designs.

CONCLUSION

Development decisions for urbanizing areas have profound, transforming impacts on natural systems (both internal and external) that could provide vital ecosystem services (Rees and Wackernagel 2008). The form that this development takes can determine the effectiveness of the services provided
Conservation subdivision design has strong potential for protecting ecosystems and the benefits they offer by mitigating the negative effects of urbanization through maintaining the function of contiguous natural systems. Researchers are in an excellent position to help municipalities plan and implement conservation subdivisions, as well as measure and monitor CSD success in conserving natural systems.

**LITERATURE CITED**


Lacy, J. 1990. An examination of market appreciation for clustered housing with permanent open space. University of Massachusetts Center for Rural Massachusetts, Amherst, MA.


PANEL 1: MEASURING CSD EFFECTIVENESS IN PRESERVING ECOSYSTEM FUNCTION: AN EXAMPLE CASE STUDY IN CEDAR RAPIDS, IOWA

We conducted a study in Cedar Rapids, Iowa, with the goal of evaluating effectiveness of conservation subdivision design in preserving ecosystem function and estimating its added economic (market and non-market) value. We focused on water and floristic quality of six subdivisions with including three standard and three CSD subdivisions that were selected based on similar housing density, house size and assessed value.

Water quality
Paired upstream and downstream samples were collected from two streams, one each in two subdivisions (one CSD, one standard). The stream in the CSD neighborhood was buffered by approximately 150 feet of riparian forest/grass vegetation with natural sinuosity maintained, while the standard subdivision stream had approximately 10 feet of riparian forest vegetation and had been straightened. We measured discharge rate and total suspended sediment. Upstream-downstream differences were calculated as load rates (Table 2).

While discharge rates were lower in the downstream segments for both subdivisions, the discharge rate for the CSD stream demonstrated a significantly greater decrease in sediment load (Table 2).

Floristic quality
Plant communities were surveyed across all six subdivisions using visual tallies of plant materials in developed areas and a series of 20-m² plots in conserved natural areas. The average coefficient of conservatism (Swink and Wilhelm, 1994) was calculated for both developed and conserved natural areas using Iowa-based coefficient values (Iowa State University, 2004) (Table 2).

Average values for coefficients of conservatism were similar and low for developed areas of both CSD and standard subdivisions (Table 2). However, average ratings for conserved natural areas in the CSD subdivisions were much higher indicating a greater abundance of native species present in protected areas. While not indicative of pristine natural systems, the mean coefficients of conservatism for natural areas in CSDs suggest that these areas can function as conservation refuges for native plant species.
Economic valuation (market and non-market)

Average assessed values were determined from city and county assessors’ offices and were standardized on a per-square-foot basis. Consumer value was derived from contingent valuation surveys distributed to 300 residents across the six subdivisions and estimating maximum willingness-to-pay (WTP) for the availability of open space within their subdivision (Table 3).

Water purification values were based on Cedar Rapids water treatment facility estimated costs ($0.388/U.S. gallon) for filtration. Floristic cost of attainment values were determined (per-home) based on the cost of establishing a plant community with a mean coefficient of conservatism value equal to that of undisturbed reference areas in the vicinity (approximately $593/acre for a CC of 5.2) (Table 3).

Estimated total value was calculated using the following model:

\[
\text{Total value} = \text{Assess value} + \text{Consumer WTP} - \text{Water quality cost} - \text{Floristic quality cost}
\]

The difference between the total value of CSD and standard homes represents the value of the presence of conservation features and the ecosystems services they provide, as well as the consumer willingness to pay for those features and services (Table 3). CSD homes were valued at approximately $5,742 more than standard homes. While small in comparison to the homes’ assessed value, this produces a significant value when considering all homes in a subdivision development.
Table 1. Examples of previous empirical studies examining biologic, social, and economic aspects of alternative subdivision (or similar) designs.

<table>
<thead>
<tr>
<th>Study authors</th>
<th>Publication Year</th>
<th>Type of development</th>
<th>Focus</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lacy</td>
<td>1990</td>
<td>Clustered housing</td>
<td>Valuation</td>
<td>Houses in open space subdivision appreciated in value faster than houses in standard subdivisions.</td>
</tr>
<tr>
<td>Austin</td>
<td>2004</td>
<td>Open space subdivision</td>
<td>Preferences</td>
<td>Residents enjoyed living in open space subdivisions, but their knowledge about design principles was lacking.</td>
</tr>
<tr>
<td>Mohamed</td>
<td>2006</td>
<td>Conservation subdivision (CSD)</td>
<td>Valuation</td>
<td>CSD lots are more highly valued, cheaper to build and sell more quickly than standard subdivisions.</td>
</tr>
<tr>
<td>Lenth et al.</td>
<td>2006</td>
<td>CSD</td>
<td>Conservation</td>
<td>The small scale of CSDs and the exotic vegetation present limited the effectiveness of CSD in biodiversity conservation.</td>
</tr>
<tr>
<td>Kopits et al.</td>
<td>2007</td>
<td>Clustered housing</td>
<td>Valuation</td>
<td>Houses in clustered subdivisions were valued lower than houses in standard subdivisions with larger lots. Shared subdivision open space was not an adequate substitute for private lot size.</td>
</tr>
<tr>
<td>Milder et al.</td>
<td>2008</td>
<td>CSD, Conservation and limited development project (CLDP)</td>
<td>Conservation</td>
<td>CLDPs provided more conservation benefit than CSDs. A lack of functional conservation and stewardship limited the impact of CSD.</td>
</tr>
<tr>
<td>Noiseux and Hostetler</td>
<td>2008</td>
<td>“Green development”</td>
<td>Preferences</td>
<td>“Green” terminology was not detrimental to housing sales and green design features were important to consumers purchasing a home in a green community.</td>
</tr>
<tr>
<td>Bowman et al.</td>
<td>2009</td>
<td>CSD</td>
<td>Valuation</td>
<td>Houses in subdivisions with conservation features are more valuable and appreciate at a faster rate than those in standard subdivisions.</td>
</tr>
<tr>
<td>Hostetler and Drake</td>
<td>2009</td>
<td>CSD</td>
<td>Wildlife</td>
<td>CSD can have positive impacts on wildlife, but open space and corridors must be well-planned and implemented. Residents need to be educated for post-construction responsibilities.</td>
</tr>
</tbody>
</table>
Table 2. Mean stream water parameters and coefficient of conservatism for developed and protected areas in selected conservation and standard subdivisions in Cedar Rapids, Iowa

<table>
<thead>
<tr>
<th>Subdivision type</th>
<th>Difference in discharge (up-downstream)</th>
<th>Difference in sediment load (up-downstream)</th>
<th>Avg. coefficient of conservatism (CC) (developed/protected)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSD</td>
<td>9.08 ft³/second</td>
<td>12.07 tons/acre/day</td>
<td>0.97 / 2.46</td>
</tr>
<tr>
<td>Standard</td>
<td>0.07 ft³/second</td>
<td>1.29 tons/acre/day</td>
<td>0.95 / NA</td>
</tr>
</tbody>
</table>
Table 3. Market and non-market economic values and costs for selected conservation and standard subdivisions in Cedar Rapids, IA.

<table>
<thead>
<tr>
<th>Subdivision type</th>
<th>Standardized avg. assessed home value</th>
<th>Avg. consumer max. willingness to pay for conservation (^a)</th>
<th>Cost of water purification (^b)</th>
<th>Cost of floristic quality attainment for reference CC (5.2)</th>
<th>Estimated avg. total home value</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSD</td>
<td>$223,469</td>
<td>$4,475.15</td>
<td>-$1,251.90</td>
<td>$1,300</td>
<td>$227,895</td>
</tr>
<tr>
<td>Standard</td>
<td>$220,892</td>
<td>$1,985.40</td>
<td>-$37.49</td>
<td>$761</td>
<td>$222,153</td>
</tr>
</tbody>
</table>

\(^a\) See Bowman et al. 2009

\(^b\) Negative values indicate the ecosystem service value of natural stream water quality improvement.
CHAPTER 6: GENERAL CONCLUSIONS

This dissertation used a comprehensive approach to assess the need for, economic value of, and familiarity with alternative residential development designs among residents, developers and city officials with the objectives of determining current perceptions and reducing barriers to their implementation.

Spatial technologies can be effective tools for estimating, planning and managing natural resource conservation efforts in urban areas. Land cover change analysis is particularly important in urban development decisions for estimating the impacts of previous urban land use choices on natural areas (Chapter 2). Incorporating predictive modeling techniques with land cover change estimates can identify natural areas that are most likely to be affected by future urbanization and discover opportunities for preserving and integrating protection for important ecosystems across the landscape (Chapter 2; Troy et al. 2006).

Residents value alternative subdivision design features (e.g. conservation subdivision (CSD) and low impact development (LID) features), and would be willing to pay an additional amount for the inclusion of these features in their neighborhoods (Chapter 3). Residents consistently indicated that subdivision features with specifically identified environmental benefits were more highly valued than similar features without such positive externalities (Chapter 3). This should encourage developers and planning officials to choose features that provide additional environmental benefits when possible, and then to explicitly advertise the additional benefits to potential residents. Developers and city officials can use valuation information about consumer interest and willingness to pay to assess the economic viability of designs that incorporate low impact and conservation design features. This type of market information about consumer interest in and values for alternative subdivision design features can encourage and support their use in residential development.

One barrier to broader implementation of alternative designs is limited familiarity with LID and CSD features across resident, developer and city official groups. Knowledge is imperative for effective real estate marketing and without information, stakeholders are forced to use heuristics based on the current housing market. Furthermore, consumer familiarity with these designs is important, as it can be a driver for willingness to pay for such features (Chapter 3). Ames residents are unaware of alternative development options, and as such, their willingness to pay remains untapped (Chapter 4).
Developer and city staff participants indicate a greater familiarity with LID and CSD, but they are also generally misinformed about the use of these features in Ames (Chapter 4).

Regulatory issues further discourage the use of alternative designs and cause uncertainty on the part of developers about approval of LID and CSD developments (Chapter 4). The risk-averse and satisficing behavior of developers can hinder the exploration of alternative development options even with strongly expressed consumer interest, if developers are not sure they can garner city planning support.

Education for all groups, with assistance from state, federal, and non-governmental organization personnel may help lower these barriers by providing information and support for alternative development options (Chapter 4; Thompson, 2004). Additionally, city staff could provide clearer guidance on alternative development practices through comprehensive LID and CSD ordinances that outline city goals and recommendations for the use of these designs. Finally, city staff could also consider possible tax or density incentives for meeting conservation criteria, as well as increased flexibility in the design and approval process for future innovative subdivision features. These steps could cultivate increased opportunities for adoption of alternative subdivision designs for residents, developers and city officials that could reduce the impacts of development on urban ecosystems, provide more neighborhood housing choices, create opportunities to capture residential preferences for conservation features, and support economic growth through housing construction.

Development choices in growing municipalities can have enormous impacts on ecosystems that provide vital ecosystem services for urban residents (Rees and Wackernagel 2008). Alternative development designs (in particular, conservation subdivision design) have strong potential to protect these ecosystems by effectively mitigating the negative effects of urbanization when implemented in a goal-oriented, monitored and market-savvy manner (Chapter 5). The research community could assist municipalities in planning and implementing alternative designs and by measuring and monitoring their success in conserving ecosystem services.

**LITERATURE CITED**


Ames Residential Development Choices Questionnaire

First, please indicate your opinions about current trends in residential development in Ames. Please check the one answer that best matches your opinion.

1. Which of the following statements best describes your opinion about the variety of residential neighborhoods in Ames:
   1 - There is a neighborhood that would fit everyone’s needs in Ames.
   2 - There are different kinds of neighborhood, but more could be done to increase the variety.
   3 - Neighborhoods in Ames are all the same; there is little variety to choose from.
   4 - I am unsure

2. Please circle the number corresponding to your opinion about the following statements:

<table>
<thead>
<tr>
<th>Strongly disagree</th>
<th>Somewhat disagree</th>
<th>No Opinion</th>
<th>Somewhat agree</th>
<th>Strongly agree</th>
<th>Don’t Know</th>
</tr>
</thead>
<tbody>
<tr>
<td>I am concerned about the potential negative effects that residential development in Ames could have on the natural environment.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>The City of Ames considers potential negative effects on the environment before approving a subdivision development.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

3. Which of the following options best describes your opinion of the overall pace of residential development in the Ames area:

Development is happening: 1 - Too Slowly  2 - About Right  3 - Too Quickly  4 - Not Sure

4. How well do you think the following groups have done protecting the natural environment in and around Ames from the potential negative effects of residential development?

<table>
<thead>
<tr>
<th>Very poorly</th>
<th>Somewhat poorly</th>
<th>Neither well or poorly</th>
<th>Somewhat well</th>
<th>Very well</th>
<th>Don’t Know</th>
</tr>
</thead>
<tbody>
<tr>
<td>Developers of subdivisions</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Ames City Council</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Story County Planners</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>The City of Ames planners</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Other: _________________</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>
Now, thinking about your own neighborhood, please answer the following questions by circling the answer that best matches your opinion.

5. When you purchased your current residence, how important were the following neighborhood amenities:

<table>
<thead>
<tr>
<th></th>
<th>Very unimportant</th>
<th>Somewhat unimportant</th>
<th>Neither important nor unimportant</th>
<th>Somewhat important</th>
<th>Very important</th>
<th>Don’t know</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large lot</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>Neighborhood open space</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>Neighborhood parks</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>Neighborhood streams</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>Having a home secluded from neighbors</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>Woodlands or prairie areas</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>Overall “look” or “feel”</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>Neighborhood trails</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>Living close to neighbors</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>Wildlife habitat</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>Mature trees</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>0</td>
</tr>
</tbody>
</table>

6. What kind of an impact do you think your own neighborhood has on the natural environment?

1 Has a large negative impact
2 Has no impact
3 Has a large positive impact

7. How concerned are you about the possible negative effects that your own neighborhood has on the natural environment?

1 Not at all Concerned
2 Neither Concerned Nor Unconcerned
3 Very Concerned
Conservation Subdivision Design in Ames

There are several new subdivision designs that have been used in other parts of the United States that lower the impact of housing development on the environment. Please circle the answer that best matches your opinion on the following subdivision design:

*Conservation Subdivision Design* is a design strategy of:

- Preserving open space, natural areas (streams, forests, wetlands, etc) and wildlife habitat
- Building homes in clustered locations to conserve as much open space as possible
- Reducing the amount of impervious surfaces (roads, etc) to reduce storm water
- Developing the same number of houses but sometimes on smaller lots
- Keeping open spaces and natural areas communally owned so anyone can use them
- Maintaining at least 50% of a development in open space or natural areas
- Using conservation easements to prevent any future development on conserved land

8. Have you heard about this design?
   
   1 - Yes
   If yes or maybe, please give an example of where you may have heard of this design, ___________________
   
   2 – Maybe
   __________________________________________
   __________________________________________
   
   3 - No
   __________________________________________
   __________________________________________

9. Do you think that any of the neighborhoods in Ames fit the description of Conservation Subdivision Design (Low Impact Design)?
   
   1 - Yes
   If yes or maybe, please give an example of where you may have heard of this design, ___________________
   
   2 – Maybe
   __________________________________________
   __________________________________________
   
   3 - No
   __________________________________________
   __________________________________________

10. Based on the description given above, if you were currently in the market for a new home, how likely would you be to:

<table>
<thead>
<tr>
<th></th>
<th>Very Unlikely</th>
<th>Somewhat unlikely</th>
<th>Neither likely nor unlikely</th>
<th>Somewhat likely</th>
<th>Very likely</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consider <em>purchasing</em> a home in a Conservation Subdivision?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Consider <em>paying more</em> for a home in a Conservation Subdivision than a standard neighborhood?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

Two features that are commonly found in Conservation Subdivisions are described on the enclosed Conservation Subdivision Feature page. Please read the descriptions, look at the illustrations, and then answer the questions on the two pages that follow.
Feature 1: Clustered Housing

11. For the next few questions, think back to the time that you were purchasing your current house and please circle the answer that matches your opinion of clustered housing.

<table>
<thead>
<tr>
<th></th>
<th>Strongly disagree</th>
<th>Somewhat disagree</th>
<th>Neither agree nor disagree</th>
<th>Somewhat agree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>I think clustered housing would make a neighborhood more attractive.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>I would be more likely to buy a house in a neighborhood that had clustered housing than one without this feature.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>I think that having clustered housing in a neighborhood would make a house there easier to sell in the future.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>I would be willing to pay more for a house in a neighborhood that had clustered housing.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

12. How much of an additional price would you have paid for your current house at the time of purchase if the only thing different was the addition of clustered housing to your neighborhood?

<table>
<thead>
<tr>
<th>Price Range</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - $0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 - $1 - $1500</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 - $1501 - $3000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 - $3001 - $4500</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 - $4501 - $6000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 - $6001 - $7500</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6 - $7501 - $9000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7 - More than $9000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8 - Don’t Know</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

13. What would be the maximum amount that you would be willing to offer to have clustered housing included in your neighborhood? $__________

14. How sure are you about this amount?

<table>
<thead>
<tr>
<th>Likelihood</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very Unsure</td>
<td>Very Unsure</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

15. If you indicated that you were unwilling to pay an additional price, please mark any reasons below:

<table>
<thead>
<tr>
<th>Reason</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>I find clustered housing unattractive.</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>I like clustered housing, but I just do not want to pay more for it.</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>I think clustered housing would make my neighborhood unsafe.</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>I don’t think clustered housing adds value to a house.</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Other</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>
**Feature 2: Stream with Preserved Buffers**

16. For the next few questions, think back to the time that you were purchasing your house and please circle the answer that matches your opinion of a stream with preserved buffers.

<table>
<thead>
<tr>
<th>I think a stream with preserved buffers would make a neighborhood more attractive.</th>
<th>Strongly disagree</th>
<th>Somewhat disagree</th>
<th>Neither agree nor disagree</th>
<th>Somewhat agree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>I would be more likely to buy a house in a neighborhood that had a stream with preserved buffers than one without this feature.</th>
<th>Strongly disagree</th>
<th>Somewhat disagree</th>
<th>Neither agree nor disagree</th>
<th>Somewhat agree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>I think that having a stream with preserved buffers in a neighborhood would make a house there easier to sell in the future.</th>
<th>Strongly disagree</th>
<th>Somewhat disagree</th>
<th>Neither agree nor disagree</th>
<th>Somewhat agree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>I would be willing to pay more for a house in a neighborhood that had a stream with preserved buffers.</th>
<th>Strongly disagree</th>
<th>Somewhat disagree</th>
<th>Neither agree nor disagree</th>
<th>Somewhat agree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td></td>
</tr>
</tbody>
</table>

17. How much of an additional price would you have paid for your current house at the time of purchase if the only thing different was the addition of a stream with preserved buffers to your neighborhood?

- 0 - $0
- 1 - $1 - $1500
- 2 - $1501 - $3000
- 3 - $3001 - $4500
- 4 - $4501 - $6000
- 5 - $6001 - $7500
- 6 - $7501 - $9000
- 7 - More than $9000
- 8 - Don’t Know

18. What would be the maximum amount that you would be willing to offer to have a stream with preserved buffers included in your neighborhood? $__________

19. How sure are you about this amount?

   1 - Very unsure
   2
   3
   4
   5 - Very Sure

20. How would your answer have changed if there was a stream but without preserved buffers?

   1 – Would have decreased
   2 – Would have stayed the same
   3 – Would have increased

21. If you indicated that you were unwilling to pay an additional price, please mark any reasons below:

   I would only pay extra if a stream with preserved buffers were next to my house.
   I find streams with preserved buffers unattractive.
   I like a stream with preserved buffers, but I just do not want to pay more for it.
   I don’t think a stream with preserved buffers adds value to a house.
   Other _____________________________________________________

<table>
<thead>
<tr>
<th>Reason for unwillingness</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>I would only pay extra if a stream with preserved buffers were next to my house.</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>I find streams with preserved buffers unattractive.</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>I like a stream with preserved buffers, but I just do not want to pay more for it.</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>I don’t think a stream with preserved buffers adds value to a house.</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>
Hypothetical City Ordinance

One way to protect natural areas from the effects of development might be through a city ordinance to use tax dollars to purchase land in areas that are being developed for residential housing. The land, which could include wooded areas, streams, wetlands or prairies would be purchased from developers at fair market value and preserved through conservation easements.

This land would be open to public use and recreation, and would help protect water quality, wildlife habitat and biodiversity. Developers would not be allowed to build houses or roadways on this land.

Funding for the land purchase would come from an increase in property taxes collected from every housing unit in the city.

33. If your property taxes would increase by $«RANDOM150» per year which would allow the city to purchase and protect «ACRES» acres of land per year, how much would you support this idea?

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Would Not at All Support</td>
<td>Strongly Support</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

34. If your property taxes would increase by $«RANDOM150X2» per year but the city would be able to protect twice as much land, how much would you support this idea?

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Would Not at All Support</td>
<td>Strongly Support</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

22. What is the maximum tax increase that you would be willing to support?

$______________
About You

Finally, we would like to know a little more about you in order to better understand you and your current neighborhood. Please remember that all information provided on this survey is confidential and will not be directly linked to any individual.

What is your gender?

0 – Male 1 - Female

What is your ethnicity?

1 - White or Caucasian 5 - Native American
2 - Black or African-American 6 - East Indian
3 - Hispanic 7 - Middle Eastern
4 - Asian 8 - Other __________________

How many people currently live in your household? ______ people

How many children under 18 currently live in your household? ______ children

How old are you? ______ years

How long have you lived in Ames (including in previous homes)? ______ years

What is the highest level of education that you have completed?

1 - High School
2 - Some College
3 - Two-year College or Technical Degree
4 - Four-year College Degree
5 - Post-Graduate, Medical or Law Degree

Which range best describes your current household income?

1 - Less than $25,000 5 - $100,001 to $125,000
2 - $25,001 to $50,000 6 - $125,001 to $150,000
3 - $50,001 to $75,000 7 - $150,001 to $175,000
4 - $75,001 to $100,000 8 - More than $175,000

Thank you for your time. If you have any additional comments on this survey, feel free to write them in the space below.
APPENDIX B: DEVELOPER SURVEY INSTRUMENT
1. How familiar are you with the term “low-impact development”?

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Not at all familiar</td>
<td>Heard of it</td>
<td>Very familiar</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2. In your opinion, what are the most important features that you would find in a low-impact development?

3. Have you included any low-impact features in any of your subdivision designs? Yes □ No □
   
   If yes, which features have you included:

4. Based on your knowledge of the residential market in Ames, how likely would it be that residents would…

<table>
<thead>
<tr>
<th>Consider purchasing a home in a low-impact development?</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very unlikely</td>
<td>Somewhat unlikely</td>
<td>Neither likely nor unlikely</td>
<td>Somewhat likely</td>
<td>Very likely</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Consider paying more for a home in a low-impact development than a standard neighborhood?</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
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<tbody>
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<td>Very likely</td>
<td></td>
</tr>
</tbody>
</table>

5. How familiar are you with the term “conservation subdivision”?

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Not at all familiar</td>
<td>Heard of it</td>
<td>Very familiar</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

6. In your opinion, what are the most important features that you would find in a conservation subdivision?

7. Have you added any conservation subdivision features in any of your subdivision designs? Yes □ No □
   
   If yes, which features have you included:
8. Based on your knowledge of the residential market in Ames, how likely would it be that residents would...

<table>
<thead>
<tr>
<th></th>
<th>Very unlikely</th>
<th>Somewhat unlikely</th>
<th>Neither likely nor unlikely</th>
<th>Somewhat likely</th>
<th>Very likely</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consider purchasing a home in a conservation subdivision?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Very unaware</th>
<th>Somewhat unaware</th>
<th>Neither aware nor unaware</th>
<th>Somewhat aware</th>
<th>Very aware</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low Impact Development</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

|                          | 1            | 2                | 3                         | 4              | 5          |
| Conservation Subdivisions| 1            | 2                | 3                         | 4              | 5          |

9. Based on your knowledge of the residents in Ames, how aware do you think they are of...

<table>
<thead>
<tr>
<th></th>
<th>Very unaware</th>
<th>Somewhat unaware</th>
<th>Neither aware nor unaware</th>
<th>Somewhat aware</th>
<th>Very aware</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low Impact Development</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

|                          | 1            | 2                | 3                         | 4              | 5          |
| Conservation Subdivisions| 1            | 2                | 3                         | 4              | 5          |

12. Do you think that Ames development regulations affect your ability to add low-impact or conservation features to your subdivisions?

<table>
<thead>
<tr>
<th>Regulations impede the use of alternative features</th>
<th>No Opinion</th>
<th>Regulations encourage the use of alternative features</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

13. Which of the following options best describes your opinion of the overall pace of residential development in the Ames area:

<table>
<thead>
<tr>
<th>Development is happening:</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Too Slowly</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>About Right</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Too Quickly</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Not Sure</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

14. How long have you been in the development business? ________ yrs

15. About how many subdivision projects did your company work on in the last 5 years? _______

16. On average, how much would a house in one of your company’s subdivisions cost? $__________

17. What are some ways that your company gets information about consumer demand for different housing features?

- Surveys
- Realtors
- Own Experience
- Open-houses
- Focus Groups
- Other _______
- Marketing firm or company
- Home-buyer Feedback
APPENDIX C: CITY OFFICIAL SURVEY INSTRUMENT
Please answer the following questions according to your own professional opinion (it is not necessary to provide the “official” position of the city).

1. How familiar are you with the term “low-impact development”?

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not at all familiar</td>
<td></td>
<td></td>
<td></td>
<td>Very familiar</td>
</tr>
</tbody>
</table>

2. In your opinion, what are the most important features that you would find in a low-impact development?

3. Have low-impact features been included in existing Ames subdivisions? Yes □ No □

If yes, which features have been included:

4. Based on your knowledge of the market in Ames, how likely would it be that residents would…

<table>
<thead>
<tr>
<th>Very unlikely</th>
<th>Somewhat at unlikely</th>
<th>Neither likely nor unlikely</th>
<th>Somewhat at likely</th>
<th>Very likely</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consider purchasing a home in a low impact development?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Consider paying more for a home in a low impact development than a standard neighborhood?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>

5. How familiar are you with the term “conservation subdivision”?

<table>
<thead>
<tr>
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<th>2</th>
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</thead>
<tbody>
<tr>
<td>Not at all familiar</td>
<td></td>
<td></td>
<td></td>
<td>Very familiar</td>
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</tbody>
</table>

6. In your opinion, what are the most important features that you would find in a conservation subdivision?

7. Have conservation subdivision features been included in existing Ames subdivisions? Yes □ No □

If yes, which features have been included:

10. Based on your knowledge of the residential market in Ames, how likely would it be that residents would…

<table>
<thead>
<tr>
<th>Consider purchasing a home in a conservation subdivision?</th>
<th>Very unlikely</th>
<th>Somewhat unlikely</th>
<th>Neither likely nor unlikely</th>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Consider paying more for a home in a conservation subdivision than a standard neighborhood?</th>
<th>Very unlikely</th>
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<td>3</td>
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<td>5</td>
</tr>
</tbody>
</table>

11. Based on your knowledge of the residents in Ames, how aware do you think they are of…

<table>
<thead>
<tr>
<th>Low impact development</th>
<th>Very unaware</th>
<th>Somewhat unaware</th>
<th>Neither aware nor unaware</th>
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<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Conservation subdivisions</th>
<th>Very unaware</th>
<th>Somewhat unaware</th>
<th>Neither aware nor unaware</th>
<th>Somewhat aware</th>
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<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

12. Do you think that Ames development regulations affect a developer’s ability to add low-impact features to a subdivision?

1 Regulations impede the use of low-impact features
2 No opinion
3 Regulations encourage the use of low-impact features

13. Do you think that Ames development regulations affect a developer’s ability to add conservation features to a subdivision?

1 Regulations impede the use of conservation features
2 No opinion
3 Regulations encourage the use of conservation features

14. Which of the following best describes your opinion of the overall pace of residential development in the Ames area:

Development is happening: 1 Too Slowly 2 About Right 3 Too Quickly 4 Not Sure

15. Which city department do you work in? ________________________________
16. How long have you been employed with the City of Ames? ______yrs

17. About how many subdivision projects have you been involved in reviewing (in any capacity) during the last 5 years? ______
APPENDIX D: EXPERIMENTAL NEGOCIATION MATERIALS

Example Home Sell Sheet

Example Offer Sheet
LOT # A

1800 Sq. Ft.
3 bedrooms
2 full baths
1 ½ bath
2-car attached garage
800 Sq. Ft. finished basement with
½ bath
Large kitchen, stainless steel appliances
Wood deck overlooking big back yard
Open floor plan
Gas fireplace
Listed Price: $200,000

Lot Size: 16,000 sq. ft.
Spacious yard with open lawn on over 1/3-acre lot located in brand-new subdivision
Very nice neighborhood conveniently located near shopping, dining, and schools
Offer Sheet #A - 101

<table>
<thead>
<tr>
<th>Lot # A</th>
<th>Lot # B</th>
<th>Lot # C</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st Offer</td>
<td>$_________</td>
<td>$_________</td>
</tr>
<tr>
<td>2nd Offer</td>
<td>$_________</td>
<td>$_________</td>
</tr>
<tr>
<td>Final Offer</td>
<td>$_________</td>
<td>$_________</td>
</tr>
</tbody>
</table>

If you were in the market for a new home, how interested would you be in purchasing the lot as listed? (1 = Not at all Interested, 5 = Very Interested)

<table>
<thead>
<tr>
<th>Lot # 001</th>
<th>Lot # 002</th>
<th>Lot # 003</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>Not at All Very Not at All Very Not at All Very</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
APPENDIX E: DEVELOPER AND CITY OFFICIAL FOCUS GROUP MATERIALS

Example Layout Sheet

Example Developer Bid Sheet

Example City Official Evaluation Sheet
36.5 Acres (1,200 ft x 1,145 ft) divided into 96 lots with 0.32 acre average size
15 acres of open space including 6.7 acres in preserved natural forest
Minimal elevation change across property
66% of homebuyers would buy a home in a conservation subdivision; 50% would pay more to live there.
Homebuyers would pay about 9.3% over a standard lot for adjacent forest and 11.5% more for clustered housing with nearby forest.
Developers would pay around 20.6% per acre more and sell lots for around 10.9% more if they were developing a subdivision similar to this layout over a standard lot configuration.
## Ames Developer Design Bid Sheet

### Layout - #1

<table>
<thead>
<tr>
<th>Bid: $ _______________</th>
<th>Estimate of Lot Value: $ _______________</th>
</tr>
</thead>
</table>

How interested in this property would you be if the proposed layout was approved for development?

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not Interested</td>
<td></td>
<td></td>
<td></td>
<td>Very Interested</td>
</tr>
</tbody>
</table>

Comments ____________________________________________________________

### Layout - #2

<table>
<thead>
<tr>
<th>Bid: $ _______________</th>
<th>Estimate of Lot Value: $ _______________</th>
</tr>
</thead>
</table>

How interested in this property would you be if the proposed layout was approved for development?

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
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<th>4</th>
<th>5</th>
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<tbody>
<tr>
<td>Not Interested</td>
<td></td>
<td></td>
<td></td>
<td>Very Interested</td>
</tr>
</tbody>
</table>

Comments ____________________________________________________________

### Layout - #3

<table>
<thead>
<tr>
<th>Bid: $ _______________</th>
<th>Estimate of Lot Value: $ _______________</th>
</tr>
</thead>
</table>

How interested in this property would you be if the proposed layout was approved for development?

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
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<tbody>
<tr>
<td>Not Interested</td>
<td></td>
<td></td>
<td></td>
<td>Very Interested</td>
</tr>
</tbody>
</table>

Comments ____________________________________________________________
# City of Ames Subdivision Design Evaluation Form

## Layout - # 1 (Individual Evaluation)

**Potential Benefits:**

- 
- 
- 
- 
- 
- 

**Potential Concerns:**

- 
- 
- 
- 
- 
- 

**How likely would you be to recommend approval of this type of layout for a subdivision development?**

<p>| | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Not Likely</td>
<td></td>
<td></td>
<td>Very Likely</td>
<td></td>
</tr>
</tbody>
</table>

**Comments**

- 
- 
- 
- 
- 

## Layout - # 1 (After Group Discussion)

**Potential Benefits:**

- 
- 
- 
- 
- 
- 

**Potential Concerns:**

- 
- 
- 
- 
- 
- 

**How likely would you be to recommend approval of this type of layout for a subdivision development?**

<p>| | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
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<th></th>
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</tr>
<tr>
<td>Not Likely</td>
<td></td>
<td></td>
<td>Very Likely</td>
<td></td>
</tr>
</tbody>
</table>

**Comments**

- 
- 
- 
- 
- 

ACKNOWLEDGEMENTS

This dissertation is dedicated to all of the people who have helped me throughout the last 8 years…

My family and friends: Mom, Dad, Eric, Burt – I wouldn’t have gotten half this far without your belief in me. You thought me there is nothing that a little faith and effort couldn’t achieve.

My major professor: Jan – All of the countless meetings, papers, edits of those papers, posters, projects, ideas, reworking of those ideas, publications, and deadlines have all led up to these pages. Thanks for the patience and tenacity. I could not have asked for a better mentor, and I am indebted for the time you devoted to guiding me through research, writing, and all things academic. I only hope that I can live up to what you invested in me.

My second major professor: John – The non-economist economist – Thanks for everything you’ve put into this book and all the ideas you’ve helped me run with. Stay a voice of reason in this crazy neoclassical world.

My committee and GIS major professor: Joe, Lois, Jim, Paul – Every time I hear another horror story from another student about their committee, I am evermore thankful for all the time, effort and great advice that you have offered me.

My office/lab/field/NREM-ites: Michaeleen, Dan, Mustafa, Matt, Todd – the coolest people you could ask to share a cubicle/field season with. Special thanks to Todd for the great GIS help.

The office staff: Janice B., Lynn, Marti, and Jan M. – Navigating the paperwork would have been a nightmare without their limitless willingness to help.

“A new question in the environmentalist’s canon, it seems to me, is this one: who will love the imperfect lands, the fragments of backyard desert paradise, the creek that runs between farms? In our passion to protect the last remnants of virgin wilderness, shall we surrender everything else in exchange? One might argue that it’s a waste of finite resources to preserve and try to repair a place as tame as Horse Lick Creek. I wouldn’t. I would say that our love for our natural home has to go beyond finite, into the boundless…” – Barbara Kingsolver, Hide Tide in Tucson (180)