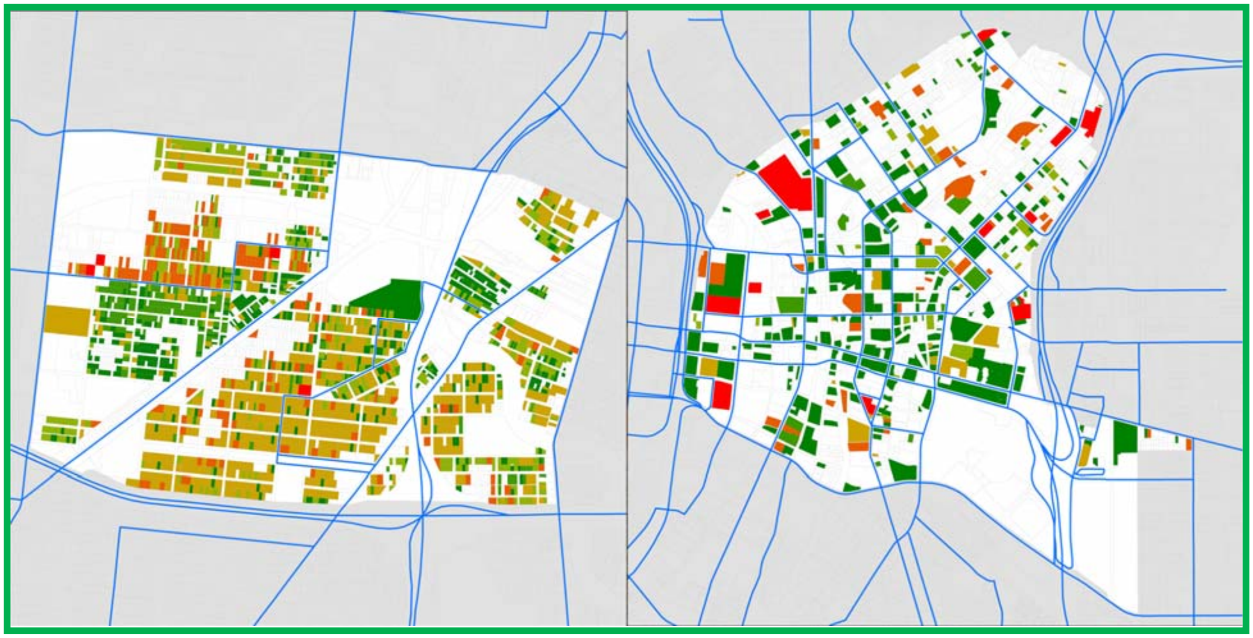
College of Architecture
University of Texas at San Antonio

The City of San Antonio Neighborhood Sustainability Assessment



Final Report
Part I: Summary Report

Report submitted to:

Office of Environmental Policy
City of San Antonio

July 2012

College of Architecture
University of Texas at San Antonio

The City of San Antonio Neighborhood Sustainability Assessment

Final Report
Part I: Summary Report

Project Team:

Primary Investigator: **Hazem Rashed-Ali, Ph.D.**
Project Team: **Chun-lin Lin**
Halit Beyaztas

Report submitted to:

Office of Environmental Policy
City of San Antonio

This project was funded by the Office of Environmental Policy, City of San Antonio, with funds from the Energy Efficiency and Conservation Block Grant Program, US Department of Energy.

July 2012

ACKNOWLEDGEMENTS

The project team would like to offer their thanks and gratitude to the City of San Antonio's Office of Environmental Policy (OEP) for providing the funds that made this project possible, and for their continued support throughout the duration of the project. The team would also like to thank the Energy Efficiency and Conservation Block Grant (EECBG) Program, US Department of Energy, the original funding source. The team would also like to offer their thanks and appreciation to all the organizations and agencies that provided data for the project. These include the Office of Environmental Policy, the City of San Antonio's Planning Department, VIA Metropolitan Transit, San Antonio Water System, the San Antonio River Authority, The San Antonio Bexar - County Metropolitan Planning Organization, and the Bexar County Appraisal District. Without all of their support, this project would not have been possible.

TABLE OF CONTENTS

LIST OF TABLES

INTRODUCTION

Project Background

Increasing the sustainability of the built environment, through more efficient use of resources and reduced environmental impact, is a major component of urban sustainable development. Consequently, increasing the energy efficiency of the built environment, in the buildings, transportation and other sectors, and reducing harmful emissions of greenhouse gases are rapidly becoming important components of community planning processes. The effectiveness of planning decisions can be greatly enhanced by providing planning professionals, policy makers, and other stakeholders with methods and tools to evaluate the different impacts of proposed planning decisions on urban sustainability at different scales. Such methods should rely, as much as possible, on quantifiable metrics and indicators that can be easily measured and tracked over time. Developing such metrics and indicators at the neighborhood scale will provide planners, policy makers, neighborhood associations, and other stakeholders with the means to assess the current sustainability of their neighborhoods, and to compare and evaluate potential future plans based on quantifiable objective metrics.

In this context, the City of San Antonio's Office of Environmental Policy (OEP) engaged a team of researchers from the College of Architecture, the University of Texas at San Antonio (UTSA) to explore the implementation of a Neighborhood Sustainability Assessment tool across the city, and to use this tool to identify and measure different neighborhood-level sustainability performance indicators for all the city's neighborhoods. These indicators were then to be used to develop a neighborhood-level sustainability assessment model, which would inform planning decisions at the neighborhood scale. The results of this project are intended to assist planners, policy makers and neighborhood associations across the city in making informed decision that would lead to improving San Antonio's overall sustainability. These results will also fulfill the city's comprehensive and ambitious sustainability objectives illustrated in the SA2020 plan and the City of San Antonio's Mission Verde Plan discussed in the following section.

The City of San Antonio and Sustainability

In 2011, the City of San Antonio conducted a six-month community visioning effort, which culminated in developing the SA2020 plan. SA2020 aims to develop a unifying vision for the city and to provide inspiration to expand existing public-private partnerships or create new ones in the areas of education, economic development, public health and safety, government accountability, and the new energy economy[1]. This goal of this vision was described by San Antonio Mayor Julián Castro as "Growing [San Antonio] into a world class city, while holding on to what makes us special"[2]. Several sections of the plan sections addressed sustainability-related issues, which illustrates the city's strong commitment to achieving and maintaining leadership in this area. These sections include: Natural Resources & Environmental Sustainability, Transportation, Neighborhoods & Growth Management, Economic Competitiveness, and Health & Fitness. In each of these areas, SA2020 identified a vision for San Antonio as well as a set of indicators and measurable performance targets. This approach to making planning decisions based on measurable and trackable indicators provides the foundation for the Neighborhood Sustainability Assessment Project described in this report.

In particular, the Natural Resources and Environmental Sustainability section within SA2020 defines the

---

1 http://www.sanantonio.gov/mayor/SA2020b.aspx

2 SA2020 Dream It Report. Available at: http://www.sa2020.org/wp-content/themes/sa2020/pdf/SA2020_Final_Report.pdf

main challenge facing the city as "achieving a balance between rapid economic growth, and protecting our natural resources and environment for future generations". SA2020 also describes San Antonio's vision in this area as: "[being] recognized as a respectful steward of its natural resources and a model for responsible resource management"[3].

Prior to SA2020, the Office of Mayor Phil Hardberger took the lead in developing the Mission Verde Plan presented to the City Council on January 28. 2009[4]. This led to the formal adoption of the Mission Verde Resolution by City Council on February 4, 2010[5]. Mission Verde aims to address the city's sustainability issues, to create a long-term vision for the city, and to provide guidance to sustainability and energy efficiency efforts within both city operations and the community. The Mission Verde plan includes a comprehensive approach for improving the city's sustainability through identifying 11 citywide initiatives across six areas of interest including energy infrastructure, clean and green technology development, sustainable buildings, transportation and land use, community outreach, and citywide leadership. The emphases placed by Mission Verde on improving environmental sustainability while at the same time not neglecting economic and social issues provides the bases and the inspiration for the work described in this report.

The objectives and activities of this project also coincide with the objectives of the US Department of Energy, which place increasing emphases on quantifiable metrics, as well as the objectives of the "Partnership for Sustainable Communities"[6] developed between the Department of Housing and Urban Development (HUD), the Environmental Protection Agency (EPA), and the US Department of Transportation (USDOT). The six livability principles[7] developed by the partnership provide the bases for the neighborhood sustainability indices developed within this project. Those principles are:

- Provide more transportation choices
- Promote equitable and affordable housing
- Enhance economic competitiveness
- Support existing communities
- Coordinate and leverage federal policies and investment
- Value communities and neighborhoods

Project Objectives

The objectives of the Neighborhood Sustainability Assessment project aim to build on the principles and objectives included in the SA2020 and Mission Verde plans and to enable the achievement of the comprehensive vision of San Antonio illustrated in these plans. To achieve this, the Neighborhood Sustainability Assessment project encompasses the following objectives:

1. Explore the use of the INDEX PlanBuilder[8] GIS-based planning software in the City of San Antonio as a means of identifying and measuring neighborhood-level sustainability performance indicators across the city, and assess the suitability of the tool for implementation in the city.
2. Implement the INDEX software across the city to support planning efforts to reduce energy and

---

[3] Ibid.
[4] City of San Antonio's Mission Verde Sustainability Plan. Available at: http://www.sanantonio.gov/oep/SustainabilityPlan/Mission%20Verde.pdf
[5] http://www.sanantonio.gov/oep/SustainabilityPlan/Adopted%20Mission%20Verde%20Resolution%202-4-10.pdf
[6] http://www.sustainablecommunities.gov/aboutUs.html
[7] Ibid
[8] INDEX PlanBuilder Planning Support System, Release 9.3 User Notebook, May 2011. Available electronically at: http://www.crit.com/

water consumption, vehicle miles of travel, pollution emissions (including greenhouse gas emissions), and the carbon footprint of the city.

3. Use the INDEX PlanBuilder software to develop a neighborhood sustainability assessment model for the city that can be both measured and tracked overtime. This model is based on existing national-level models and indicators for assessing neighborhood sustainability, and at the same time is informed by available data and information in different organizations within the city.
4. Develop an "existing conditions" sustainability assessment for the city's neighborhoods using the INDEX PlanBuilder software.
5. Explore the capabilities of the tool in evaluating alternative future planning scenarios and assess the impact of these plans on improving a neighborhood's sustainability performance.

Project Team

The project manager for the Neighborhood Sustainability Assessment project was Bill Barker, AICP, from the Office of Environmental Policy for the City of San Antonio. The project was conducted by a team of researchers from the College of Architecture, UTSA. The team was led by Hazem Rashed-Ali, Ph.D., Associate Professor of Architecture in UTSA and included Chun-lin Lin, PhD Candidate, and Halit Beyaztas, M.S. Arch.

Project Funding

Funding for the project was provided by the City of San Antonio's Office of Environmental Policy through a Department of Energy (DOE) Energy Efficiency and Conservation Block Grant (EECBG)[9]. This program is funded by the American Recovery and Reinvestment Act (Recovery Act) of 2009 and is intended to assist U.S. cities, counties, states, territories, and Indian tribes to develop, promote, implement, and manage energy efficiency and conservation projects and programs designed to:

- Reduce fossil fuel emissions;
- Reduce the total energy use of the eligible entities;
- Improve energy efficiency in the transportation, building, and other appropriate sectors;
- Create and retain jobs.

Report Structure

This report consists of two major parts:

1. ***Part 1- Summary Report:*** Including a summary of the project background, its objectives, and how they relate to the overall City of San Antonio Sustainability objectives and the objectives of the EECBG program. This is followed by a description of the project, its potential and impact, and a summary of the process and methodology used to develop the Neighborhood Sustainability Index and to conduct the neighborhood-level sustainability assessments. A summary and preliminary analysis of the results of the neighborhood sustainability assessments is then presented followed by a discussion of the potential applications of those results and recommendations for future work.
2. ***Part II - Results:*** Including the detailed results of the neighborhood sustainability assessments conducted within the project including both the existing conditions assessments for 275 neighborhoods across the city, as well as the future conditions assessment conducted for the Ingram Hill neighborhood as an example of the potential of the assessment tool and model.

---

[9] US Department of Energy (DOE) Energy Efficiency and Conservation Block Grant Program. Available electronically at: http://www1.eere.energy.gov/wip/eecbg.html

PROJECT DESCRIPTION

INDEX PlanBuilder

To achieve the project's objectives of developing measurable neighborhood-level sustainability performance indicators for San Antonio, a survey was conducted to identify the best available methodologies and tools for this at the national level. Based on this survey, the PLACE^{3}S Planning method was identified as the best method for that purpose. The PLACE^{3}S planning method is a land use and urban design method created specifically to help communities understand how their growth and development decisions can contribute to improved urban sustainability[10]. The PLACE3S method, an acronym for PLAnning for Community Energy, Economic and Environmental Sustainability, uses energy as a yardstick to evaluate the efficiency with which we use land, design neighborhoods to provide housing and jobs, manage transportation systems, operate buildings and public infrastructures, site energy facilities, and use other resources. The PLACE^{3}S method relies of having quantitative performance indicators that measure the energy and environmental impacts of community plans and monitors these indicators over time, thus providing decision makers with quantitative information that strengthens the argument for resource-efficient choices. The PLACE^{3}S method uses a scenario planning approach in which a number of planning alternatives are measured and compared using a set of performance indicators to identify the preferred alternative.

The PLACE^{3}S method has been implemented as a planning software tool. This software was originally developed by the California Energy Commission (CEC)[11] and is currently available as web-based tool (I-PLACE^{3}S), which has been used in several US urban regions and cities[12]. As I-PLACE^{3}S was designed to work more at the regional scale, the project team opted for the use of another tool, INDEX PlanBuilder, which is based on the same planning method and is designed specifically for neighborhood-scale studies. INDEX PlanBuilder is desktop software consisting of an integrated suite of interactive GIS-based planning support tools for assessing community conditions, designing future scenarios in real-time, measuring and ranking scenarios with performance indicators, and monitoring implementation of adopted plans. INDEX PlanBuilder has been used by approximately 175 organizations in 35 states across the US and Canada[13] . INDEX PlanBuilder software includes several useful features including inclusion of stakeholder objectives and priorities, case designer for digital charretting, indicator mapping, multi-modal travel network, and incremental development evaluation.

The San Antonio Neighborhood Sustainability Index

The Neighborhood Sustainability Assessment Project utilized the INDEX PlanBuilder software to develop a neighborhood sustainability model for the City of San Antonio. The model was informed by similar case studies, the available indicators in INDEX PlanBuilder, as well as the available GIS data acquired

---

[10] The California Energy Commission (1996). The Energy Yardstick: Using PLACE^{3}S to Create More Sustainable Communities. A report for: Center of Excellence for Sustainable Development, Office of Energy Efficiency and Renewable Energy, U.S. DOE. Available electronically at: http://www.energy.ca.gov/places/PLACESGB.PDF

[11] The California Energy Commission (1996). The Energy Yardstick: Using PLACE^{3}S to Create More Sustainable Communities. A report produced for: Center of Excellence for Sustainable Development, Office of Energy Efficiency and Renewable Energy, U.S. Department of Energy. Available electronically at: http://www.energy.ca.gov/places/PLACESGB.PDF

[12] Sacramento Area Council of Governments and the California Energy Commission (2008). I-PLACE^{3}S Use Guide Version 1.1. Available electronically at: http://www.sacregionblueprint.org/sacregionblueprint/the_project/pdf/PLACE3S_User_Guide_forInternet.pdf

[13] INDEX PlanBuilder Planning Support System, User Notebook, 2011. Available at: http://www.crit.com/

from different organizations in the city. The model was based on 29 sustainability indicators, and was used to calculate an overall *Neighborhood Sustainability Index* for each neighborhood within the city. Neighborhoods were identified based on the Neighborhood Associations boundaries map[14] developed by the City's Department of Planning and Community Development. In total, a sustainability assessment was conducted for 275 neighborhoods across the city.

This overall *Neighborhood Sustainability Index* consists of seven component indices, six of which are in turn based on the six livability principles developed by the Partnership for Sustainable Communities and discussed previously. A seventh component index was also developed for Environmental Impact, and was primarily aimed at assisting the City of San Antonio in its efforts to reduce energy and water consumption, vehicle miles of travel, pollution emissions (including greenhouse gas emissions), and the overall carbon footprint. Each of the component indices is calculated through aggregating the standardized scores of a subset of the 29 indicators calculated within the study. The overall index is calculated based on a relative weighting of the 7 component indices. A more detailed discussion of the calculation process for the indices is provided in the following section.

Both the overall Neighborhood Sustainability Index and the component indices provide a simplified quantitative evaluation of the sustainability of different neighborhoods in San Antonio. The indices scores should be considered only for comparative purposes between the different neighborhoods or between the existing conditions of a neighborhood and an expected future state. These indices are not meant to provide an absolute measure of neighborhood sustainability and should not be considered as such. Such an absolute measure can be found by examining the raw scores of the 29 Individual sustainability indicators, each of which offer a measure of one or more aspects of neighborhood sustainability.

Impact and Potential

The major impacts and future potential of the Neighborhood Sustainability Assessment project can be summarized as follows:

1. The neighborhood sustainability assessment conducted in this project provides planners and policy makers in the city with a previously-unavailable quantitative assessment of the existing sustainability conditions across the city's neighborhoods. This assessment can then be used to inform planning decision across the city by identifying neighborhoods and areas in need of improvements based on objective criteria.
2. The project provides the potential for developing a long-term tracking system for neighborhood sustainability in San Antonio. By updating the assessment on regular (e.g., annual) basis to reflect changes in conditions, this tracking system could provide planners and policy makers with the ability to objectively assess the performance of various activities and initiatives within the city. Conducting such an assessment will be greatly facilitated by the expertise developed within this project.
3. The neighborhood sustainability assessment also provides neighborhood associations and San Antonio residents with a valuable resource to evaluate the sustainability of their neighborhood compared to other neighborhoods in the city. Through this comparison, residents and neighborhood associations can identify potential areas of improvement within their neighborhood and select appropriate projects for implementation. This potential of the project is enhanced by the development of a public website which includes all neighborhood assessment results.

[14] Available at: http://www.sanantonio.gov/planning/GIS/map_catalog.aspx

4. In addition to the assessment of existing conditions, the project results clearly illustrates the capabilities of the INDEX PlanBuilder tool in evaluating and comparing the effectiveness of proposed future planning alternatives in different San Antonio neighborhoods and areas. Taking advantage of these capabilities can offer a very important resource to all stakeholders which will enable a more informed planning decision making process. This will assist in achieving the city's sustainability objectives of reducing energy and water consumption, vehicle miles of travel, pollution emissions (including greenhouse gas emissions), and the overall carbon footprint of the city.
5. Having a system in place to benchmark and track neighborhood sustainability performance can facilitate the process of applying for state and federal grants, most of which now require some form of performance evaluation and tracking based on measurable criteria.
6. The website developed to publicize the results of this project to the general public can have a positive impact on San Antonio residents by increasing their interest in neighborhood sustainability issues, educating them regarding important indicators and how they are typically measured, and potentially creating a competitive environment between different neighborhood residents about the sustainability of their neighborhood relative to surrounding ones or the city as a whole.

PROCESS AND METHODOLOGY

This section provides a summary of the process and methodology used to develop the neighborhood sustainability assessment model and index. It also describes to process used to implement it in neighborhoods across the city. Several limitations of the study are also identified and discussed.

Data Collection

The first phase of the project included the collection of relevant data for the project from a variety of organizations and sources within the City of San Antonio and Bexar County. This process aimed to determine the availability of data for calculating different sustainability indicators within the study. The collected data included GIS data as well as other required inputs and values for the assessment model. Organizations which contributed data to the project include:

- The City of San Antonio's Office of Environmental Policy,
- The City of San Antonio's Planning and Community Development Department,
- VIA Metropolitan Transit,
- San Antonio Water System,
- The San Antonio River Authority,
- The San Antonio Bexar - County Metropolitan Planning Organization,
- The Bexar County Appraisal District.

Appendix 1 includes a listing of the GIS data collected from each organization.

Neighborhood Sustainability Model Development

Indicator selection

The process of selecting the neighborhood sustainability indicators used to develop the Neighborhood Sustainability Index consisted of three phases:

1. A literature review was conducted of similar sustainability assessment studies in a variety of US cities to identify the significant issues and indicators typically used in assessing urban sustainability at the neighborhood level. Notable studies reviewed include a sustainability framework for the Twin Cities Region[15], and the STAR Community Index[16]. Several case studies of the use of the INDEX software in different US cities were also reviewed including studies in Portland, Kansas City, Redwood City, Austin, and Grand Rapids[17]. Based on the literature review, an initial set of more than 50 indicators was identified for further evaluation.
2. The sustainability indicators available in the INDEX software was reviewed and compared to the previously-developed indicators set. Based on this comparison, a smaller set of 35 sustainability indicators was selected for the study.
3. The availability of citywide GIS data and other required inputs for the indicators was investigated, and indicators which did not have all required data were excluded. Based on this process, a final set of 29 sustainability indicators was identified for the project.

---

[15] Kaydee Kirk et al., Framework for Measuring Sustainable Regional Development foe the Twin Cities Region, Center for Urban and Regional Affairs and Center for Transportations Studies, University of Minnesota, January 2010.

[16] STAR Community Index, Sustainability Goals and Guiding Principles, ICLEI - Local Governments for Sustainability USA, 2010.

[17] INDEX studies available at: www.crit.com

Following the selection of indicators, appropriate target values and upper and lower thresholds were also identified for each indicator. These thresholds are used in the indicator scores standardization process described later. Target values and thresholds were identified based on accepted planning norms or, when such norms did not exist, based on maximum and minimum indicator scores within the city. Appendix 2 provides detailed information about each of the indicators used including definitions, description of the sustainability issues they address, their method and units of measurement, their target values (or objectives), and their minimum/maximum thresholds.

Indicator Score Calculation (INDEX PlanBuilder)

Raw scores for selected indicators are calculated using the INDEX PlanBuilder Software. The Process involves loading the GIS data collected from various sources as well as other needed data and defaults into INDEX. When available, required data and defaults representative of local conditions (San Antonio or Texas) were used (See Appendix 1). If this data was not available, national level data or INDEX software defaults (also representing national level averages) were used.

In certain cases, pre-processing of GIS data was needed to avoid generating errors in the INDEX software. This was mostly related to calculations of proximity, which relied on having a complete street centerline network and generated errors if there were any gaps in this network or if major highways are located inside the study area. Other data requiring pre-processing included employment and amenities. Appendix 3 gives a summary of the procedures used to calculate indicator raw scores in INDEX PlanBuilder.

Neighborhood Sustainability Indices

While the raw sustainability indicator scores provide extremely valuable information about the performance of a certain neighborhood vis-à-vis specific sustainability issues, they do not provide the ability for an overall evaluation of the sustainability of a neighborhood. To achieve such an evaluation, the indicators were combined into seven sustainability indices. Six of those indices were based on the HUD/EPA/USDOT livability principles discussed earlier, while the seventh related to the environmental impact of the neighborhood. Adding the seventh index was in response to the sustainability objectives of the City of San Antonio and the focus of the EECBG, and was primarily aimed at assisting the city in reducing energy and water consumption, vehicle miles of travel, pollution emissions (including greenhouse gas emissions), and the overall carbon footprint.

Each of the seven indices was based on a subset of the indicators calculated within the study based on the relevance of the issues addressed by each indicator to the focus area of the index. To aggregate the indicator raw scores, scores were standardized so that they all fall on scale from 0-1. The standardization was achieved by comparing each indicator's raw score to a maximum and minimum threshold score for it (see Appendix 2, Table 3). Indicators were assigned equal weights in calculating different index scores. However, several indicators were used in more than one index thus resulting in increasing their relative weight. All index scores were calculated on a scale of 1 -100. The approach of relating neighborhood sustainability indices to livability principles was based on the Twin City Region study discussed earlier[18].

Finally, an overall *Neighborhood Sustainability Index* was calculated based on the seven component indices. Different relative weights were assigned to each component index based on the relevance of the issues it addresses to the environmental performance focus of the project. Accordingly, indices

---

[18] Kaydee Kirk et al., Framework for Measuring Sustainable Regional Development foe the Twin Cities Region, Center for Urban and Regional Affairs and Center for Transportations Studies, University of Minnesota, January 2010.

relating to environmental impact, housing equity, and transportation were assigned higher relative weights than other indices. This resulted in further modifications in the relative weight of each indicator in the overall *Neighborhood Sustainability Index.* Appendix 4 shows a list of the indices developed, their relative weights, the indicators used in calculating each of them, and the resulting weight each indicator has in the overall index.

Pilot Neighborhoods

To test the capabilities of the INDEX PlanBuilder software and the effectiveness of the developed neighborhood sustainability model, the model was first applied to two San Antonio neighborhoods with contrasting urban sustainability characteristics: 1) the Westside Development District, and 2) the Stone Oak Neighborhood. The Westside Development District represented a neighborhood with high urban density, high use mix, high street connectivity, available amenities, and good transportation coverage. Conversely, the Stone Oak neighborhood represented a low-density mostly single use neighborhood with low street connectivity, low public transportation coverage, and low availability of amenities.

Through comparing the assessment results for these two neighborhoods, the project team explored the indicators selected for the assessment and identified relevant issues in the processing of GIS data. The results of this initial assessment were consistent with expectations and clearly exhibited the contrasting sustainability characteristics of the two neighborhoods.

Citywide Implementation

The model was then applied on a city-wide scale. To achieve this, the City of San Antonio was divided into 10 zones based on geographic location and the major highway network (see figure 1). Each of these 10 zones was then divided into its constituent neighborhoods based on the map of all registered neighborhood association in San Antonio. Areas with no neighborhood associations were divided based on major streets. In total, 275 neighborhoods were assessed within this project. A list of the neighborhoods is included Part II of the report. The following assessments were conducted.

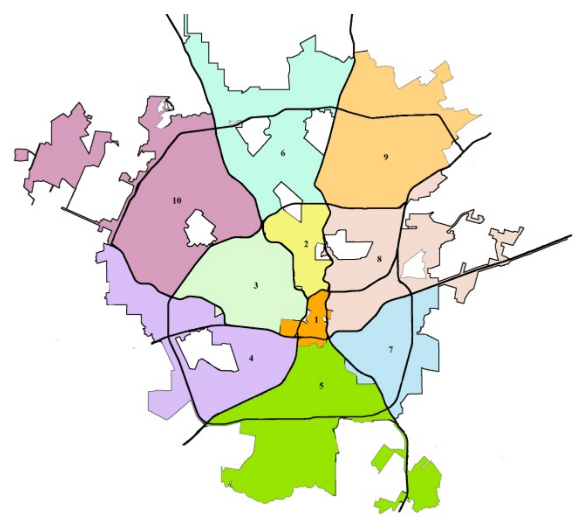


Figure 1. Geographical zones used in the study

Assessment of Existing Conditions

An assessment of existing sustainability conditions was conducted for each of the 275 neighborhoods identified within the city. Results generated for each neighborhood include scores for all indices (the overall Neighborhood Sustainability Index and the seven component indices), raw scores for the 29 indicators used, as well as maps describing the geographical distribution of some of those indicators within the neighborhoods[19]. A summary and preliminary analysis of the results is included in the next section, while detailed neighborhood results (including scores and maps) are included in part II of this report.

[19] Map outputs are only available for some INDEX PlanBuider indicators.

Assessment of Future Scenarios

To explore the capabilities of the INDEX PlanBuilder software in assessing future planning scenarios and comparing planning alternatives, an assessment was conducted for the Ingram Hill Neighborhood. The assessment was based on the existing neighborhood plan developed in 2009 by the City of San Antonio's planning department for the neighborhood[20]. The following three future scenarios were evaluated:

1. Scenario 1 reflects the future land use changes proposed in the Ingram Hill Neighborhood plan.
2. Scenario 2 reflects a 20% reduction in building energy use (both residential and commercial) which represents the adoption of an energy efficiency program within the neighborhood, combined with an increase of 10% in transit service coverage and density.
3. Scenario 3 combines the impact of scenarios 1 &2.

A summary of the results of this assessment comparing the base case assessment with the three future scenarios are included in the next section, while detailed results (including scores and maps) are included in part II of this report.

Study Limitations

The following limitations of this study should be considered when interpreting the results:

1. The accuracy of the neighborhood sustainability assessment results are based on the accuracy of the input data used. As this information was collected from different organization in San Antonio, the project team cannot guarantee their accuracy. However, every reasonable effort was made to guarantee the accuracy of the results included in this report.
2. While most of the indicators are based on neighborhood level (parcel level) GIS data, some of these indicators also use average values for certain inputs. As much as possible, when parcel-level data was not available or could not be obtained, locally-relevant values were used representing conditions in San Antonio or in specific areas within the city.
3. In certain cases, some state and national level average inputs were used when parcel-level data or city/state-level averages were not available. These cases were, however, very limited and do not impact the potential of the tool in achieving a comparative evaluation of the sustainability of San Antonio neighborhoods,

---

[20] Ingram Hill Neighborhood Plan, City of San Antonio Planning and Development Services Department, May 2009. Available at: http://www.sanantonio.gov/planning/pdf/neighborhoods/Ingram_Hills_Neighborhood_Plan.pdf

RESULTS SUMMARY AND PRELIMINARY ANALYSIS

The following discussion provides a brief summary and preliminary analysis of the results of the neighborhood sustainability assessments conducted within this project. The volume and depth of the results, however, offer considerable potential for more detailed analysis and comparisons. This need for further analysis is elaborated further in the recommendations section.

Existing Conditions Assessment

1. The average *Neighborhood Sustainability Index* score for all neighborhoods was 40.8 (on a 100 point scale), while the median score was 41. The standard deviation for the overall index scores was 11.2.
2. Average index scores for the 7 component indices ranged from 23.4 (for the *Supporting Existing Communities Index)*, to 58.8 (for the *Environmental Impact Index*). Median scores ranged from 25.6 to 59 for the same indices respectively. Table 1 shows the scores for all indices across the 10 zones.
3. Table 1 also shows that the average scores for the 10 geographical zones used in the study showed an apparent correlation between the proximity of the zone to the down town area and its average *Neighborhood Sustainability Index* score. The highest average score was achieved by zone 1, followed by zones 2 and 3 (see figure 1). Similar correlations can also be seen in the results of the component indices. This result reinforces the opinion that higher density urban areas have higher sustainability performance than lower density areas. A more detailed statistical analysis is needed to evaluate this correlation.

Table 1. Average indices scores for 10 zones

Zone	Environmental. Impact	Transportation Choices	Housing Equity	Supporting. Existing Communities	Valuing Communities.	Economic. Competiveness.	Leveraging Federal Investment	Neighborhood. Sustainability. Index
Zone 1	74.2	63.3	76.5	36.7	58.0	51.2	67.2	61.8
Zone 2	66.3	55.5	56.3	34.4	53.5	43.7	56.1	53.2
Zone 3	58.4	53.4	62.9	37.0	46.3	42.1	48.5	51.1
Zone 4	65.0	35.6	58.1	19.4	33.2	23.5	47.8	42.1
Zone 5	69.5	33.1	59.6	13.1	31.5	23.3	50.4	41.9
Zone 6	53.9	27.1	32.7	21.7	27.4	21.9	35.1	32.8
Zone 7	76.9	38.3	67.0	17.4	34.9	25.3	59.4	47.7
Zone 8	43.5	42.7	49.2	24.9	39.4	32.3	35.3	39.2
Zone 9	62.1	30.2	44.3	19.5	30.9	20.0	42.6	37.5
Zone 10	50.7	28.4	35.1	21.7	29.4	17.9	33.4	32.4
Overall Median	58.8	37.3	49.8	23.4	35.5	26.9	43.5	40.8
Overall Average	59.0	37.0	50.0	25.6	35.0	28.2	43.0	41.0

4. The lowest average scores for the overall index were achieved by zones 6, 9, and 10 which mostly consist of suburban, low density area. This further reinforces the observation made in point 3.
5. The maximum *Neighborhood Sustainability Index* score calculated within this study was 74 and was achieved by the Down Town Neighborhood. This was followed by the Lavaca neighborhood, with a score of 69, Five Points, with a score of 62, then Avenida Guadalupe, Frio, and Highland Park with scores of 60 each. In contrast, the lowest scores were achieved by The Dominion neighborhood, with a score of 14, and the Grey Stone Estates neighborhood, with a score of 18. Summary tables of all neighborhood scores as well as a preliminary statistical distribution of those scores are included in part II of the report.

Future Scenarios Results

The objective of the future scenario assessment was primarily to explore the capabilities of INDEX PlanBuilder to assess and compare future planning alternatives for a neighborhood. Figure 2 shows the results of the assessment for the Ingram Hill Neighborhood including the base case and the three scenarios described previously. Appendix 5 includes detailed indicator scores for all 4 scenarios.

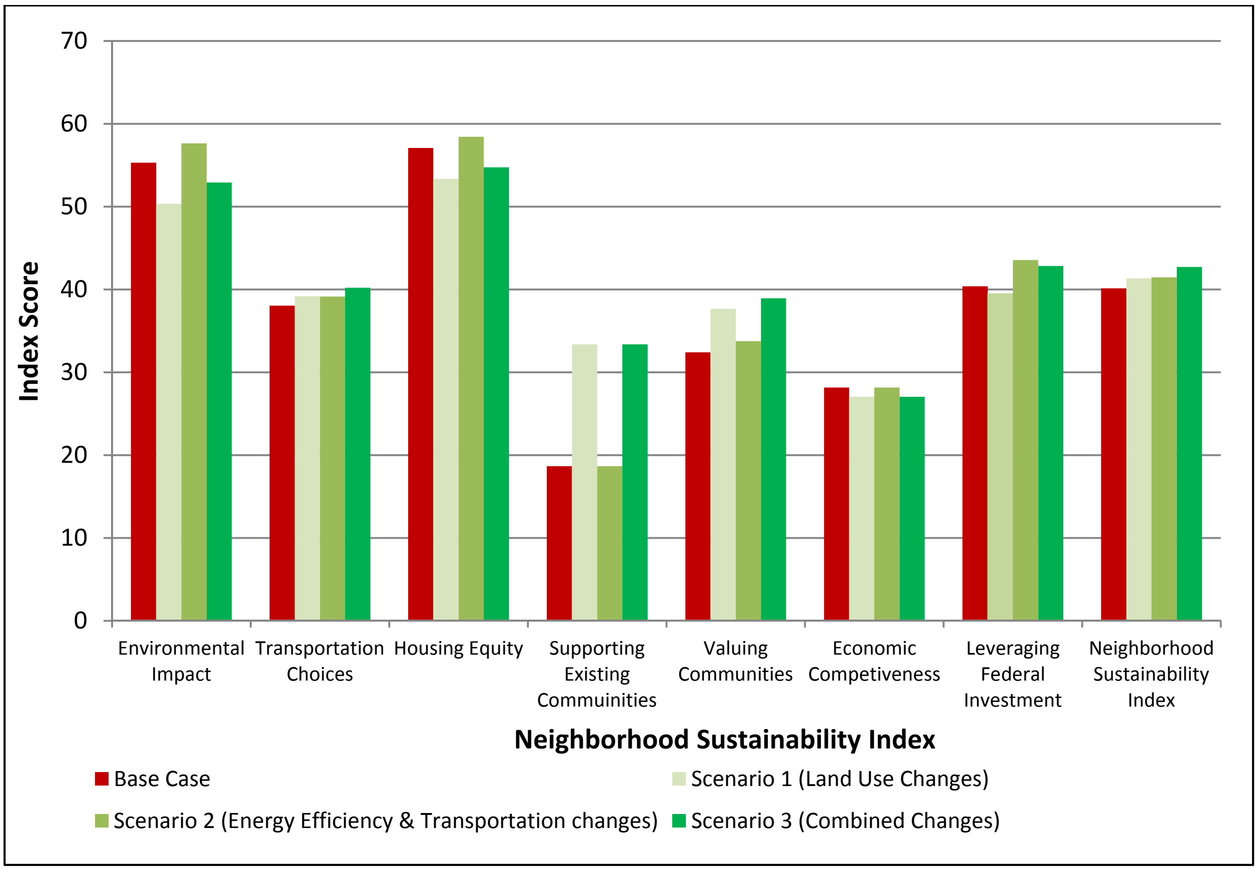


Figure 2. Index scores for Ingram Hill base case and three future scenarios

The following can be concluded from the assessment

1. Scenario 1, showing the impacts of the proposed land use changes, resulted in a small increase in the Neighborhood Sustainability Index (increasing it from 40 to 41). Scores for component indices, however, were mixed. Detailed indicator scores (see part II of the report) show that the proposed changes did result in positive improvements in several indicators including use mix, development footprint, proximity to amenities and transportation, residential water consumption, transit

oriented densities, and non-residential energy use and emissions. However, increased neighborhood populations resulting from the land use changes caused decreases in several indicators including wastewater and solid waste generation, imperviousness, and residential energy use and emissions (resulting from the addition of energy intensive single-family housing).

2. The second scenario, showing the impact of increased public transportation coverage and building energy efficiency programs resulted in an almost equal improvement in the overall index score again increasing it to 41. This was the result of improvements in the travel, energy use, and emissions indicators.
3. Combining the two scenarios, however, resulted in a larger increase in the overall neighborhood sustainability score, increasing it to 43. In this case, most indicators showed improvement relative to the base case.

The analysis of these future scenarios illustrates the need for considering issues of energy efficiency and environmental impact when making planning decisions. As shown in figure 2, while the first scenario did result in an increase in the overall index, it also resulted in a drop of 9% in the environmental impact index. The raw indicator scores show that this is caused by a small increase in building energy use and emissions and larger increases in wastewater and solid waste production resulting from the increased neighborhood population. Scenario 3, on the other hand, which adds an energy efficiency program into the mix, resulted in a considerably better situation in which the land use objectives of the proposed plan were still achieved but in the same time, the environmental impact of the neighborhood was reduced compared to the base case. To illustrate this, in the third scenario, residential energy use was reduced from 24.2 MMBtu/yr/capita to 19.9 MMBtu/yr/capita, a reduction of approximately 8%. Non-residential building energy use showed an even larger decrease on a per employee bases dropping from 27.2 MMBtu/yr/employee to 17 MMBtu/yr/employee. This was due to the increase in utilization of commercial land uses in the neighborhood.

In conclusion, the analysis clearly illustrates the value such a tool can bring to the neighborhood planning process. Through having these quantitative metrics, planners, policy makers, and other stakeholders will be able to evaluate the long term environmental impacts of their decisions. Based on this, they can compare available planning alternatives, select optimum ones, develop new alternatives to address issues identified in the analysis, and generally make more informed planning decisions that lead to reductions in energy use, emissions, and other environmental impacts benefiting both the neighborhood and the City of San Antonio. The availability of the tool, the existing conditions assessments conducted within this project, and the expertise developed through it will facilitate this process and provide valuable assistance to neighborhoods in their planning activities.

RECOMMENDATIONS FOR FUTURE WORK

As previously discussed in the impacts and potential section, the results of the neighborhood assessments conducted in this project are in themselves very valuable for different stakeholders in San Antonio including planners, policy makers, neighborhood associations and the general public. However, these assessments also offer considerable potential for future work that would further build on the advantages offered by having such an assessment system in place. The following is a brief summary of possible future work based on this project:

1. Assessment results reached in this study provide a wealth of information regarding sustainability performance across San Antonio's neighborhoods. Further analysis of these results is needed and could provide valuable information for planners and policy makers in the city. Potential types of analysis include, but are not limited to:

    a. A statistical analysis of the results correlating the sustainability scores with other variables such as geographic location, demographics, public health, economic, and other variables,
    b. An analysis of the geographical distribution of the different indices scores across the city to identify areas in need of improvement,
    c. An analysis of the results of individual indicators and their geographical distribution across the city.

    These types of analysis and others can inform the city's sustainability strategies and assist in improving its sustainability performance.

2. Assessments conducted in this study represent the existing conditions of different neighborhoods and are based on GIS data available at the time of conducting the analysis. Repeating this assessment on regular bases would offer the City of San Antonio the ability to track progress towards achieving its sustainability objectives as well the potential for evaluating the success of different sustainability and other initiatives, at both the city and/or neighborhood levels, in improving sustainability. Conducting such an assessment will be greatly facilitated by the expertise developed within this project.

3. The model developed within this project and the data and inputs used in it represent the available data at the time of conducting the project. The comprehensive nature of this model results in it overlapping with several existing models in different sectors (e.g. emissions models, transportation models, etc.). While most of these models work at a higher level of aggregation than the one addressed in this project, comparing the results of the neighborhood sustainability assessment project with those of other existing models can result in further improvements in the accuracy of the neighborhood model.

4. At the neighborhood scale, the existing conditions results offer a valuable starting point for neighborhood associations to evaluate existing and future development plans they may have and to compare different alternatives and identify the ones achieving the best improvement in neighborhood sustainability.

APPENDICES

Appendix 1: GIS Data and Sources

Table 2. Sources for GIS data used in the project[21]

#	Source	Contact	Data Type
1	Bexar County Appraisal District (BCAD)	Barbara Adan	Land use types
			Street centerlines
			Population
			House Values
2	City of San Antonio Office of Environmental Policy (OEP)	Julia Diana	Bicycle routes
3	City of San Antonio Planning and Community Development Department	Kristin Egan	Demographics
			Employment (point data)
			Pedestrian network
			Imperviousness
4	City of San Antonio Solid Waste Management Department	Lynn Cox	Average residential solid waste produced
5	CPS Energy	N/A	Average residential buildings electricity and gas consumption (based on 2010 CPS annual report)
			Average commercial buildings electricity and gas consumption (based on 2010 CPS annual report)
			CO_2 Emissions factor (based on EPA eGrid data base)
6	San Antonio Bexar - County Metropolitan Planning Organization(MPO)	Gregory Ruiz	Baseline home-based VMT
			Baseline non-home-based VMT
7	San Antonio River Authority	Karen Bishop >	Imperviousness
8	San Antonio Water System	Mark Peterson	Average residential water consumption
			Applied water requirements
			Average residential waste water generation
9	VIA Metropolitan Transit	Abigail Kinnison	Public transportation routes & frequency
			Public transportation stops

[21] Parcel level data unless otherwise stated

Appendix 2: Neighborhood Sustainability Indicators

Table 3. Neighborhood sustainability indicators definitions and measurement

ID[22]	Indicator Name	Definition & Issues	Indicator Measurement
I	***Land Use Indicators:***		
7	Use Mix	Mixed-use development is the use of a building, set of buildings, or neighborhood for more than one purpose (residential, retail, office, etc.). Mixing of uses is a desirable characteristic for sustainable neighborhoods and could result in multiple benefits including creating an all-day active urban environment, making optimum advantage of infrastructure, increasing pedestrian and transit use, and reducing vehicle trips, and alleviating environmental consequences of automobile use.	*The Use Mix Indicator* measures Proportion of mixed or dissimilar developed land-uses among a grid of cells of a certain size. The indicator is measured on a scale of 0 to 1 and typically ranges from 0.25 – 0.4 for moderately diverse area and from 0.65 – 0.8 for highly diverse areas
9	Development Footprint	The development footprint of a neighborhood represents a measure of the area within the neighborhood which is affected by all types of development. A higher footprint is typical in high density urban areas. Increasing urban densities through activities such as urban revitalization can reduce energy consumption in transport, and space heating and cooling, as well as improve economic support for public transportations, and save open space.	*The Development Footprint Indicator* measures the developed area (in acres) within a neighborhood per each 1000 residents. Development footprints can range from 4 acres/ capita in rural areas (an indicator score of 4000), to 0.04 acres/capita in high-density urban areas (an indicator score of 40).
II	***Housing Indicators***		
20	Amenities Proximity	The proximity of housing to different amenities is considered as a measure of the likelihood that the residents of a neighborhood will travel to those amenities using alternative modes of transportation. Neighborhood residents with short travel distances to amenities are more likely to walk or bike to those amenities thus reducing vehicular energy use and emissions, and improving health.	*The Amenities Proximity Indicator* measures the average travel distance in feet of all residents within a neighborhood to the closest designated amenity. An indicator score of 1,000 – 2,000 feet is typical for urban areas, while rural areas can reach indicator scores of 5,000 ft. or above

[22] Indicator ID within the INDEX software

ID[22]	Indicator Name	Definition & Issues	Indicator Measurement
21	Single-Family Housing Affordability	Single-family housing affordability is an important metric of the economic sustainability of a neighborhood. The availability of affordable housing has been shown to have a positive impact on creating jobs and stimulating local economic development	*The Single-Family Housing Affordability Indicator* measures the ratio of an affordable price vs. 120% of average assessed value. An indicator score of less than 1 is considered unaffordable, while greater than 1 is affordable
23	Transit Proximity to Housing	The proximity of public transit to housing is considered as a measure of the likelihood for residents to use public transit. Having public transit stops within short walking distances from housing encourages the residents of a neighborhood to use public transportation thus reducing vehicular energy use and emissions.	*The Transit Proximity to Housing Indicator* measures the average walking distance in feet from all residents of a neighborhood to the closest public transit stop. A travel distance of ¼ mile (1,320 feet) is typically considered walkable.
76	Wastewater Generation	Wastewater generation levels impact the need for waste water treatment infrastructure within the city.	*The Wastewater Generation Indicator* measures the total neighborhood wastewater generation in gallons.
77	Solid Waste Generation	The solid waste generation indicator measures the total neighborhood solid waste generation in bounds.	*The Solid Waste Generation Indicator* measures the total neighborhood solid waste generation in bounds.
59	Residential Water Consumption	The efficient use of water is an important characteristic of sustainable neighborhoods in general and especially in San Antonio given the situation with the city's water supply.	*The Residential Water Consumption Indicator* measures the total residential indoor and outdoor water use in gallons per day per capita. Typical indicator scores vary by neighborhood composition and climate and can range between 30 gallons/capita/ day in low-residency highly dense neighborhoods to as high as 150 gallons/ capita/ day in low density neighborhoods with a percentage of single-family housing.
III	***Employment Indicators***		
24	Jobs to Housing Balance	A job to housing balance refers to the approximately equal distribution of employment opportunities and workforce population across the neighborhood. Benefits of having a good "jobs to housing balance" include reduced driving and congestion, fewer air pollution emissions, lower costs to businesses and commuters, and higher quality of life.	*The Jobs to Housing Balance Indicator* measures the total number of jobs within the neighborhood divided by the number of dwelling units in the same neighborhood. Scores for this indicator vary depending on the neighborhood composition and range from by study area type (residentially-oriented areas vs. employment-oriented areas).

ID[22]	Indicator Name	Definition & Issues	Indicator Measurement
25	Employment Density	Employment density is a measure of the availability and concentration of employment in employment areas within a neighborhood. Higher employment densities in urban areas could reduce vehicle travel, energy use, and carbon dioxide emissions.	*The Employment Density Indicator* measures the number of employees per net acre of land designated for employment uses. Scores for this indicator can range between 10 to 30 employees/acre.
28	Transit Proximity to Employment	The proximity of public transit to employment area is considered as a measure of the likelihood for employees to use public transit. Having public transit stops within short walking distances from employment areas encourages the residents of a neighborhood to use public transportation thus reducing vehicular energy use and emissions.	*The Transit Proximity to Employment Indicator* measures the average walking distance in feet from employees' places of employment to closest public transit stop. A travel distance of ¼ mile (1,320 feet) is typically considered walkable.
IV	***Environmental Indicators***		
32	NOx Pollutant Emissions	Oxides of nitrogen, or NOx, are highly reactive gasses contributing to the formation of ground-level ozone and fine particulate matter. In fact, ozone can only form when NOx is in the air. The risks to human health associated with breathing ozone, fine particulate matter, and one of the NOx gasses called nitrogen dioxide, is so severe that they are classified as "criteria pollutants" under the Clean Air Act. Breathing these air pollutants may cause or worsen respiratory diseases and aggravate heart disease	*The NOx Pollutant Emissions Indicator* measures NOx pollution emitted from light vehicles.
38	Imperviousness	Impervious surfaces include roads, parking lots, sidewalks, rooftops, and any other surfaces in the landscape that are impermeable to water. The amount of impervious surfaces affects the amount of storm water runoff that occurs.	*The Imperviousness Indicator* measures the amount of impervious surface as percent of total land area within a neighborhood. Typical indicator values range from 10-15% for low density development patterns; 30-40% for high density areas.
V	***Travel Indicators***		
41	Internal Street Connectivity	Street connectivity is a measure of how well the roadway network connects origins and destinations. Good street connectivity means providing a variety of ways to get from one point to another and is typically associated with more opportunities for walking within a neighborhood, which reduces vehicular travel.	*The Internal Street Connectivity Indicator* measures the ratio of street intersections versus the sum of intersections and cul-de-sacs. Measured on a scale of 0 to 1, typical values for this indicator can be as high as 0.7 - 0.9 for highly connected street networks, and as low as 0.3 - 0.5 for poorly connected networks.

ID[22]	Indicator Name	Definition & Issues	Indicator Measurement
42	External Street Connectivity	External street connectivity refers to the existence of external access points to the neighborhood. Neighborhoods with high external street connectivity are considered to be more walkable.	*The External Street Connectivity Indicator* measures the average distance between ingress/egress streets on study area cordon in ft. (excluding freeways). Indicator values over 1,000 ft. are unfavorable; while values less than 500 ft. are favorable.
45	Transit Service Coverage	Transit service coverage describes the availability of public transportation stops within the neighborhood and is considered a key parameter in attracting ridership. Having good transit service coverage encourages neighborhood residents to use public transportation.	*The Transit Service Coverage Indicator* calculates the number of stops per square mile. Values for this indicator vary from less than 10 stops/square mile in suburban areas to more than 100 stops/square mile in high density urban areas.
46	Transit Service Density	Transit service density is a measure of the frequency and availability of public transport lines in a neighborhood. Higher transit service densities offer residents more choices and less wait time which encourages them to use public transport.	*The Transit Service Density Indicator* calculates the miles of transit routes multiplied by number of transit vehicles traveling those routes each day, divided by total square miles. Units for this indicator are in vehicle route mi/sq. mi./day. Indicator values of good transit coverage in urban areas can be as high as 1500-3000 vehicle route mi/sq. mi./day.
65	Transit-Oriented Residential Density	Transit-oriented development (TOD) is a relatively new concept ion planning, which refers to communities with high quality public transit services, good walkability, and compact, mixed land use. TODs provide their residents with easy access to Alternative modes of transport and people who live and work in such communities tend to own fewer vehicles, drive less, and rely more on alternative modes.	*The Transit-Oriented Residential Density* Indicator measures the average number of dwelling units per net acre in the neighborhood, which are located within ¼ mile walking distance from transit stops. Higher indicator values indicate morel likelihood that the residents will use alternative modes of transport.
66	Transit-Oriented Employment Density	See *Transit-Oriented Residential Density*.	*The Transit-Oriented Employment Density Indicator* measures the average number of employees per net non-residential acre within a neighborhood who are located within ¼ mile walking distance from transit stops. Higher indicator values indicate morel likelihood that the employees will use alternative modes of transport.
47	Pedestrian Network Coverage	Having a good pedestrian network in a neighborhood is a key requirement for increasing network walkability and the	*The Pedestrian Network Coverage Indicator* measures the percent of total street frontage within the neighborhood

ID[22]	Indicator Name	Definition & Issues	Indicator Measurement
		associated environmental, public health, and social benefits	with improved sidewalks on both sides. Values for this indicator can be as high as 90% in urban walkable areas.
53	Bicycle Network Coverage	Neighborhoods with good bicycle network coverage offer more potential for residents to use bikes to commute as well as for recreational reasons. This typically results in a reception in the use of private vehicles and also has positive impacts on public health.	*The Bicycle Network Coverage Indicator* measures the percent of total street centerline distance with designated bike route. Values for this indicator typically range between 10 – 25%.
VI	***Climate Indicators***		
78	Residential Building Energy Use	Energy use, including the use of energy in both buildings and transportation, is a key environmental indicator and the reduction of energy use is an important objective for all sectors of the economy. Reduction in energy use directly correlates with reduction in harmful emissions and also has positive impacts on energy resource availability and security.	*The Residential Building Energy Use Indicator* measures the annual energy use per capita for residential operational energy in the neighborhood
79	Residential Vehicle Energy Use	See *Residential Building Energy Use*	*The Residential Vehicle Energy Use Indicator* measures the annual energy use per capita for home based residential vehicle energy use in the neighborhood.
89	Non-Residential Building Energy Use	See *Residential Building Energy Use*	*The Non-Residential Building Energy Use Indicator* measures the annual energy use per employee for non-residential building operations energy use in the neighborhood.
88	Non-Home Based Vehicle Energy Use	See *Residential Building Energy Use*	*The Non-Home Based Vehicle Energy Use Indicator* measures the annual energy use per employee for non-home based vehicle energy use in the neighborhood.
85	Residential Building CO_2 Emissions	The amount of CO_2 emissions is one of the most important environmental sustainability indicators for a neighborhood. CO_2 and other greenhouse gases emissions have been linked with a variety of environmental and health problems at the local, regional, national, and global scales.	*The Residential Building CO_2 Emissions Indicator* measures CO_2 pollution emitted from the operational energy use within residential buildings in the neighborhood. Typical values for this indicator range from 1,000 – 10,000 lbs/capita/year.

ID[22]	Indicator Name	Definition & Issues	Indicator Measurement
86	Residential Vehicle CO2 Emissions	See *Residential Building CO2 Emissions*	*The Residential Vehicle CO2 Emissions Indicator* measures CO2 pollution emitted from home-based travel of light vehicles within the neighborhood (exclusive of transit fuel). Typical values for this indicator range from 1,000 – 10,000 lbs/capita/year
90	Non-Residential Building CO2 Emissions	See *Residential Building CO2 Emissions*	*The Non-Residential Building CO2 Emissions Indicator* measures the total annual CO2 pollution per capita resulting from the operation of non-residential buildings within the neighborhood. Typical values for this indicator range from 1,000 – 10,000 lbs/capita/year.
87	Non-Home Based Vehicle CO2 Emissions	See *Residential Building CO2 Emissions*	*The Non-Home Based Vehicle CO2 Emissions Indicator* measures CO2 emitted from non-home-based light vehicle travel within the neighborhood. Typical values for this indicator range from 1,000 – 10,000 lbs/capita/year.

Table 4. Sustainability indicators units and thresholds

ID	Indicator Name	Units	Target Score	Lower Threshold	Upper Threshold
I	**Land Use Indicators:**				
7	Use Mix	0-1 scale	0.50 or more	0.20	0.50
9	Development Footprint	net acres/1000 residents	40.0 or less	400.00	40.00
II	**Housing Indicators**				
20	Amenities Proximity	average walk ft. to closest	1,000 or less	5,000.00	1,000.00
21	Single-Family Housing Affordability	affordable price/120% value ratio	2.00 or more	0.00	2.00
23	Transit Proximity to Housing	average walk ft to closest stop	800 or less	6,000.00	800.00
76	Wastewater Generation	gallons/day	72,600.0 or less	1,089,000.00	72,600.00
77	Solid Waste Generation	lbs/day	3,360.0 or less	50,400.00	3360.00
59	Residential Water Consumption	gallons/day/capita	80.0 or less	400.00	80.00
III	**Employment Indicators**				
24	Jobs to Housing Balance	jobs/DU	2.00 to 4.00	1.00	5.00
25	Employment Density	emps/net acre	30.00 or more	10.00	30.00
28	Transit Proximity to Employment	average walk ft to closest stop	400 or less	3,960.00	400.00
IV	**Environmental Indicators**				
32	NOx Pollutant Emissions	lbs/capita/yr	15 or less	50.00	15.00
38	Imperviousness	% of total net land area	3 or less	40.00	3.00
V	**Travel Indicators**				
41	Internal Street Connectivity	cul-de-sac/intersection ratio	0.90 or more	0.30	0.90
42	External Street Connectivity	Ave. ft between ingress/egress streets	500 or less	1,000.00	500.00
45	Transit Service Coverage	stops/sq mi	120.0 or more	2.00	120.00
46	Transit Service Density	vehicle route mi/day/sq. mi.	1,500.0 or more	100.00	1,500.00
65	Transit-Oriented Residential Density	DU/net acre w/i user buffer of stops	12.00 or more	2.00	12.00
66	Transit-Oriented Employment Density	emps/net acre w/i user buffer of stops	50.00 or more	5.00	50.00
47	Pedestrian Network Coverage	% of streets w/sidewalks	100.0 or more	20.00	100.00
53	Bicycle Network Coverage	% street centerlines w/i bike route	50.00 or more	10.00	50.00

ID	Indicator Name	Units	Target Score	Lower Threshold	Upper Threshold
VI	**Climate Indicators**				
78	Residential Building Energy Use	MMBtu/yr/capita	14.00 or less	28.00	14.00
79	Residential Vehicle Energy Use	MMBtu/yr/capita	10.00 or less	25.00	10.00
89	Non-Residential Building Energy Use	MMBtu/yr/emp	5.00 or less	420.00	5.00
88	Non-Home Based Vehicle Energy Use	MMBtu/yr/emp	10.00 or less	25.00	10.00
85	Residential Building CO2 Emissions	lbs/capita/yr	4,000 or less	10,000.00	4,000.00
86	Residential Vehicle CO2 Emissions	lbs/capita/yr	1,000 or less	10,000.00	1,000.00
90	Non-Residential Building CO2 Emissions	lbs/emp/yr	4,000 or less	10,000.00	4,000.00
87	Non-Home Based Vehicle CO2 Emissions	lbs/emp/yr	1,000 or less	10,000.00	1,000.00

Appendix 3: Indicator Scores Calculation Procedures

Table 5. Summary of indicator raw scores calculation procedures[23]

Step	Objectives	Platforms
I.	Create study case, and load default values in Paint Editor • Create spatial reference in INDEX using the street centerline shapefile. • Map land uses in assessment area to INDEX paint editor paints (land uses). • Change default values in paint editor to reflect local defaults (including energy use averages, emissions factors, and other attributes	INDEX PlanBuilder
II.	Create/edit shape files needed for INDEX • Attributes are created in GIS shapefiles corresponding to needed INDEX feature classes[24]. • GIS shapefiles are then loaded to corresponding feature classes in INDEX. • Major feature classes needed are: – Case boundary area. – Land uses. – Dwellings. – Employers. – Pedestrian routes. – Points of Interest. – Street Centerlines. – Transit Routes. – Transit stops. • Certain feature classes required additional preprocessing of GIS shape files such as employment, amenities, and street centerlines.	GIS
III.	Load shapefiles into INDEX PlanBuilder[25]: • Choose Feature Class, • Load required shapefiles, and • Match source field (in shapefiles) to target input attribute (in feature class).	INDEX PlanBuilder
IV.	Select desired indicators set and run in INDEX PlanBuilder[26]	INDEX PlanBuilder
V.	Export output from INDEX to GIS: • A table of indicator raw scores is generated. • Maps of indicators are opened ion GIS and printed to PDF	GIS

[23] Detailed procedures for running INDEX PlanBuilder are available in INDEX PlanBuilder Planning Support System, Release 9.3 User Notebook, May 2011. Available electronically at: http://www.crit.com/

[24] More attributes can be assigned or computed to shapefiles depends on what feature classes are needed. A comprehensive list of attributes for all shapefiles can be found in the part of *Indicator Dictionary* in *INDEX PlanBuilder (http://www.crit.com/documents/planuserguide.pdf)*.

[25] After loading shape file for Land Uses feature class, an error message may occur stating that *"certain parcels have multi-polygon*", which results from the original parcel file. In thiscase, polygons should be manually edited for these parcels so that one of polygons in a parcel is selected and extend it to cover other polygons, and then delete the other extra polygons in the parcel.

[26] While INDEX PlanBuilder has the cap ability of assigning relative weights to indicators during the assessment, only indicator raw scores were calculated in INDEX. Indicator standardized scores and weights calculations were conducted in a separate spreadsheet.

Table 6. Land use match table

Property Level State Code	State Code Description	Status	State Reporting Category	INDEX PlanBuilder land use id	INDEX PlanBuilder land use type
A1	Single Family Res	Active	A	20	Residential-Single Family
A2	Mobile Home With Land	Active	A	23	Residential-Mobile Home Park
B1	Multifamily Residence	Active	B	22	Residential-Multi Family
B2	Multifamily Over 4 Units	Active	B	22	Residential-Multi Family
B6	Apportioned Multifamily Residence	Active	B	22	Residential-Multi Family
C1	Small Vacant Tracts Of Land	Active	C	1	Vacant
D1	Vacant Ranch Land Qualified For Productivity Value	Active	D1	1	Vacant
D2	Raw Acreage Not Qualified For Productivity Value	Active	D2	1	Vacant
E1	Farm And Ranch Improvements	Active	E	50	Greenway
F1	Commercial Real Property	Active	F1	30	Commercial Retail
F2	Industrial Real Property	Active	F2	35	Industrial Light
F3	Nominal Ancillary Improvements	Active	F1	35	Industrial Light
J4	Telephone Company	Active	J4	30	Commercial Retail
O1	Inventory Lots	Active	O	36	Industrial Warehouse
X	Totally Exempt Property	Active	X	1	Vacant
Z0	Totally Exempt Property	Active	X	1	Vacant

Table 7. Chosen Feature Classes and major target input attribute

Feature Class	**Major Target Input Attribute**
Land Uses	Land-Use Type ID Total Assessed Value (Land+Structure) Average Percent Impervious Landscape Type Water Use Factor Dwelling Group ID Dwelling Unit Count DwellingUnitCountSF DwellingUnitCountMF Residential Population ResidentialPopulationSF ResidentialPopulationMF Average Household Income ($/yr) Indoor Water Use (gal/day) Employment Group ID Employment Count Employment Floor Area (sqft)
Case Boundary Area	Defined boundary Regional Population Regional Employment Affordable Single-Family Housing Unit Price Base Case Home Based VMT Produced (miles/capita/day) Base Case Non-Home Based VMT Attracted (miles/emp/day) Base Case Home Based VT Produced (trips/capita/day) Base Case Non-Home Based VT Attracted (trips/emp/day) Municipal Solid Waste Disposed (pounds/capita/day) Waste Water Produced (gallons/capita/day) Applied Water Requirement (inches/year)
Dwellings	Dwelling Unit Count Residential Population Worker Count
Employers	Employment Count
Pedestrian Routes	Shape
Points of Interest	Shape
Street Centerlines	Shape Street group types
Transit Routes	Shape Traffic frequency
Transit Stops	Shape

Table 8. List of amenities used in the assessment

#	Amenity
1	Banking and Credit
2	Bike Racks
3	Bike Share Locations
4	Community Service Centers
5	COSA Facilities
6	Direct Patient Healthcare
7	Education Facilities
8	Emergency Medical Services
9	Health Supporting Facilities
10	Hospitals
11	Information Services
12	Libraries
13	Outdoor Events Facilities
14	Postal Service
15	Public Assembly
16	SAMHD Clinics
17	Service Centers
18	VIA Info Centers
19	VIA Park And Ride

Appendix 4: Neighborhood Sustainability Indices

Table 9. Neighborhood Sustainability Indices

Category	Indicator Name	Environmental Impact	Transportation Choices.	Housing Equity	Supporting Existing Communities	Valuing Communities	Economic Competitiveness	Leveraging Federal Investment	Neighborhood Sustainability Index
Index Weight		**20%**	**20%**	**15%**	**15%**	**10%**	**10%**	**10%**	**100.0**
Land Use	Use Mix				X	X		X	5.8%
	Development Footprint				X	X			5.0%
Housing	Amenities Proximity			X					3.0%
	Transit Proximity to Housing		X	X				X	5.8%
	Single-Family Housing Affordability			X					3.0%
	Wastewater Generation	X							1.5%
	Solid Waste Generation	X							1.5%
	Residential Water Consumption	X							1.5%
Employment	Jobs to Housing Balance						X		2.5%
	Employment Density						X		2.5%
	Transit Proximity to Employment		X				X	X	5.3%
Environment	NOx Pollutant Emissions	X							1.5%
	Imperviousness	X							1.5%
Travel	Internal Street Connectivity		X			X			3.3%
	External Street Connectivity		X			X			3.3%
	Transit Service Coverage		X			X		X	4.0%

Category	Indicator Name	Environmental Impact	Transportation Choices.	Housing Equity	Supporting Existing Communities	Valuing Communities	Economic Competitiveness	Leveraging Federal Investment	Neighborhood Sustainability Index
Index Weight		**20%**	**20%**	**15%**	**15%**	**10%**	**10%**	**10%**	**100.0**
	Transit Service Density		X			X		X	4.0%
	Transit-Oriented Residential Density		X		X				5.8%
	Transit-Oriented Employment Density		X		X		X		8.3%
	Pedestrian Network Coverage		X			X			3.3%
	Bicycle Network Coverage		X			X			3.3%
Climate Change	Residential Building Energy Use	X		X				X	5.3%
	Residential Vehicle Energy Use	X		X				X	5.3%
	Non-Residential Building Energy Use	X						X	2.3%
	Non-Home Based Vehicle Energy Use	X						X	2.3%
	Residential Building CO2 Emissions	X						X	2.3%
	Residential Vehicle CO2 Emissions	X						X	2.3%
	Non-Residential Building CO2 Emissions	X						X	2.3%
	Non-Home Based Vehicle CO2 Emissions	X						X	2.3%

Appendix 5: Ingram Hill Future Scenarios Assessment

Table 10. Detailed indicator scores for Ingram Hill Neighborhood

ID	Indicator	Base Case	Scenario 1 (Land Use Changes	Scenario 2 (Energy Eff.& Trans. Changes)	Scenario 3 (Combined Changes
7	Use Mix	0.19	0.22	0.19	0.22
9	Development Footprint	204.7	77.6	204.7	77.6
20	Amenities Proximity	2,055	1,726	2,055	1,726
21	Single-Family Housing Affordability	1.03	0.39	1.03	0.39
23	Transit Proximity to Housing	1,958	1,824	1,958	1,824
76	Wastewater Generation	175,982.40	427,029.50	175,982.40	427,029.50
77	Solid Waste Generation	8,144.60	19,763.40	8,144.60	19,763.40
59	Residential Water Consumption	93.1	77.9	93.1	77.9
24	Jobs to Housing Balance	0.66	0.67	0.66	0.67
25	Employment Density	15.5	19.47	15.5	19.47
28	Transit Proximity to Employment	1,219	1,403	1,219	1,403
32	NOx Pollutant Emissions	37	37	37	37
38	Imperviousness	27	46.56	27	46.56
41	Internal Street Connectivity	0.88	0.87	0.88	0.87
42	External Street Connectivity	1,120	1,120	1,120	1,120
45	Transit Service Coverage	5.7	5.7	6.27	6.27
46	Transit Service Density	0	0	159	150
65	Transit-Oriented Residential Density	5.61	12.17	5.61	12.17
66	Transit-Oriented Employment Density	23.77	21	23.77	21
47	Pedestrian Network Coverage	100	100	100	100
53	Bicycle Network Coverage	0	0	0	0
78	Residential Building Energy Use	24.18	24.83	19.344	19.864
79	Residential Vehicle Energy Use	23.67	23.67	23.67	23.67
89	Non-Residential Building Energy Use	27.19	21.25	21.752	17
88	Non-Home Based Vehicle Energy Use	21.53	21.53	21.53	21.53
85	Residential Building CO2 Emissions	6,186	9,121	4,948.8	7,296.8
86	Residential Vehicle CO2 Emissions	3,615	3,615	3,615	3,615
90	Non-Residential Building CO2 Emissions	8,691	10,918	6,952.8	8,734.4
87	Non-Home Based Vehicle CO2 Emissions	3,289	3,289	3,289	3,289