REINVENT PHOENIX

SUSTAINABILITY VISION FOR THE GATEWAY TRANSIT DISTRICT

Partners:

City of Phoenix

U.S. Department of Housing and Urban Development

St. Luke's Health Initiatives

ASU Global Institute of Sustainability, Arizona State University

REINVENT PHX

Current State Assessment and Transition Strategy for Sustainable Green Systems in the Gateway District, Phoenix

Report submitted to the City of Phoenix Planning and Development Department by the ASU-SOS Team for the project grant "Reinvent Phoenix – Cultivating Equity, Engagement, Economic Development and Design Excellence with Transit-Oriented Development", funded by the U.S. Department of Housing and Urban Development (HUD)

Principal Investigators

Dr. Aaron Golub, Dr. Arnim Wiek

Faculty Affiliated to the Project

Dr. Edward Cook

Graduate Research Assistants

Starin Butler, Tamsin Connell, John Harlow, Christine Kimpel, Josh Schmidt, Maggie Soffel

Postdoctoral Researcher

Dr. Braden Kay

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School of Sustainability

Arizona State University

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Executive Summary

Sustainable green systems strives for fully functional stormwater, biodiversity, and resource management practices, as well as sustainable levels of thermal comfort, energy efficiency, and access to green space. This report's current state assessment is based on four goals of sustainable green systems, derived from sustainability and livability principles:

1. Reduce stormwater loads and harvest water on-site

2. Reduce potable water consumption

3. Reduce daytime temperatures

4. Improve the social and economic benefits of green systems for health, mobility, and biodiversity

Indicators and targets operationalize each goal (see the table following this executive summary). Based on the data collected for this report, residents' perspectives, and U.S. Department of Housing and Urban Development's livability principles, the current green systems conditions in the Gateway District are unsustainable in each of the four goal domains, although there are some positive aspects:

Insufficient stormwater is managed on-site by green systems. Natural systems capture only about half the sustainable level of stormwater run-off, and there is nearly no rainwater harvesting in the District.

Sustainability of potable water consumption varies by consumption type. High indoor residential potable water use seems balanced by low outdoor residential water use. However, distribution of use within the District is uneven, and there are trade-offs between low outdoor use and sufficient vegetation coverage.

Daytime temperatures are very high. Over 10% of Gateway has surface temperatures above 130oF, and 88.8% are 105—130oF, making nearly the entire District above 105oF.

The social and economic benefits of green systems for health, mobility, and biodiversity can improve significantly. The District has no green streets, low tree canopy cover, and nearly no parks. Adding these amenities would help achieve the preceding goals, as well as improve health, mobility, and biodiversity.

Data from stakeholder engagements in the District confirm the assessment findings. There was broad stakeholder consensus that high temperatures and the lack of parks and shade were priorities. In concert with safety concerns (Hager et al., 2013), these factors make green systems in Gateway insufficient to provide safe and comfortable recreation and mobility for citizens. Though stormwater management also poses challenges, stakeholder input prioritized temperatures, green space, and shade.

The highest priority District green systems challenges are: temperatures, vegetation, permeability, and water use. This table operationalizes goals with specific targets and distances-to-target for the strategy.

Indicator	Sustainability Target	Current State Data	Distance-to-target
Goal 1 – Reduce stormwater loads and harvest water onsite			
Permeable land	70% (1700 acres)	46% (1111 acres)	24% (589 acres)
Goal 2 – Reduce potable water consumption			
Indoor residential	30 GPCD	46 GPCD	16 GPCD
Goal 3 – Reduce daytime temperatures			
Surface temperatures above 130° F	<1%	10.4%	9.5%
Goal 4 – Increase green systems benefits to health, mobility, and the economy			
Vegetation coverage	25%	4.9%	20.1%
Green streets	2 miles	0 miles	2 miles

The transition strategy herein seeks to achieve the above targets with streets, buildings and sites, and open space interventions that detail actions, resources, potential barriers, and specifics on investments.

Streets Intervention: Green parking and streets investments can increase District green streets to the two miles target. The following actions, among others, will be necessary:

- Pilot green street projects to connect Crockett and Wilson elementary schools to Van Buren St.
- Make major green streets investments on Van Buren Street and along Grand Canal.
- Create sustainable financing mechanisms for green streets, such as a business improvement district or an in-lieu fees program for right-of-way and street improvements.
- Research evidence-based green streets and green parking best practices, including material use, vegetation and tree selection, and rainwater management.

Buildings and Sites Intervention: Water harvesting and reuse, and natural and engineered shade and cooling can reduce indoor residential potable water use by 16 gallons per person per day. The following actions, among others, will be necessary:

- Update code with density-dependent guidelines for water harvesting and reuse, and natural and engineered shade and cooling.
- Design, finance, build, and test green systems pilot projects.
- Research next-generation water harvesting and reuse, and engineered shade and cooling technologies.
- Develop incentive programs for cool building materials, water harvesting and reuse technologies, and energy efficiency.

Open Space Intervention: Neighborhood water retention, green civic space, and green parking can increase District permeable land to 300 acres. The following actions, among others, will be necessary:

- Pilot open space projects at Grand Canal, Gateway Community College, Crockett and Wilson Elementary Schools, and the Arizona State Hospital to increase retention capacity with silva cells, orchards, rain gardens, and other water harvesting and retention mechanisms.
- Renegotiate the MS4 permit to allow next-generation stormwater solutions in the District.
- Create long-term funding structures (i.e. in-lieu fees for trees and retention) within a Business Improvement District, neighborhood association, or Community Development Corporation.

The strategy also includes a database of implementation tools (financing tools, partnerships, codes, capacity building, and incentives) available to implement each intervention. There is a 5-year action plan that details actions for critical early wins, and moving the District sustainable green systems transition forward. In summary, the strategy seeks to guide the District toward green systems that naturally manage stormwater on-site, reduce daytime temperatures, and provide safe, cool spaces for citizen recreation and transportation through interventions in streets, buildings, and open space.

The assessment table to the right uses a color rating system. Red indicates that existing conditions fall short of the sustainable target. Green indicates that existing conditions either meet or exceed the sustainability target. Gray indicates that an explicit threshold is not available (NA), or there is no data for that indicator (ND).

Summary table of indicators, targets, current data, and assessments [For details see Chapters 3 & 4]

Indicator	Sustainability Target (Range)	Confidence Level T.	Current Data	Confidence Level C.D.	Distance-to-target	Assessment	Importance	Applies to
Goal 1 – Reduce stormwater loads and harvest water on-site								
Natural stormwater runoff capture	90%	Low	46.0%	High	44% / High		High	All Districts equally
Rainwater harvesting	95%	Medium	Minimal	Medium	~90% / High		Med	All Districts equally
Stormwater quality	NA	Low	High	Low	NA		High	All Districts equally
Goal 2 – Reduce potable water consumption								
Potable water	30 GPCD ~60 GPCD NA	Medium Medium NA	46 GPCD 25 GPCD 56 GPJD	High High ?	16 / Low Fulfilled (-35 GPCD) ?		High	All Districts equally
Goal 3 – Reduce daytime temperatures								
Surface Temperatures	<1% >10%	Medium	10.4% 0.8%	High	9.3% / High 9.2% / High		High	All Districts equally
Asphalt surface parking	<5% of off-street parking	Low	16.9%	High	11.9% / High		Med	All Districts equally
White roofs	>10%	Low	5.5%	High	4.5% / Medium		Low	All Districts equally
Goal 4 – Improve the social and economic benefits of green systems for health, mobility, and biodiversity								
Vegetation coverage	25%	Medium	4.9%	High	~20% / High		High	All Districts equally
Green open spaces	97—215 ft^2/ person	Medium	1.6 ft^2/ person	High	~200 / High		High	All Districts equally
Green streets	2 mi	Low	0	High	2mi / High		Med	All Districts equally

Correspondence to Scope of Work

Scope-of-Work Items	Corresponding Report Chapter
Task 6.1 District Green Systems Assessment	Chapters 4 and 5
Sub-Task 6.1.a: Data Collection	
Building energy use	Appendix
Residential and commercial water use	Chapters 3.2 & 4.2, Appendix
Stormwater facilities	Appendix
3D buildings model	Figure 7; Appendix
Tree inventory	Appendix
Surface parking inventory	Figure 18, Appendix
Resident input	Vision Report
Infrared satellite images	Chapter 4.3, Appendix
Stormwater facilities	Appendix
3D buildings model	Figure 7; Appendix
Sub-Task 6.1.b: Data Analysis	
Percentage of land used for surface parking	Chapter 4.3, Appendix
Analysis of community input	Vision Report
Sub-Task 6.1.c: GIS Analysis	
Existing stormwater facilities maps	Appendix
Building / structural shade maps	Figure 7; Appendix
Surface parking inventory maps	Chapter 4.3, Appendix
Sub-Task 6.1.d: Green Systems Assessment Toolkit	Chapters 1.3, 1.4, 3, 4, and 5
Task 6.2 District Green Systems Strategies	Chapters 6 and 7
Sub-Task 6.2.a: Recommended Green Systems Investments	Chapter 6
Sub-Task 6.2.b: Recommended Regulatory Changes and Economic Development Incentives	Chapter 6

Chapter 1 – Introduction

1.1. Green Systems Challenges in the Gateway District

The Gateway Transit District is the easternmost of Reinvent Phoenix's six light rail corridor Districts (Johnson et al. 2011). It is located just north of the Sky Harbor International Airport and is bound by I-10 to the west, the Loop 202 (Red Mountain Freeway) to the north, State Route 143 (the Hohokam Expressway) to the east, and East Air Lane to the south (see District map in Figure 1 below). This District has the opportunity to become a central nexus and hub of urban activities in the Phoenix Metropolitan area due to its location at the intersection of major highways, the Grand Canal, historic Van Buren Street, the light rail, and Sky Harbor International Airport with its new Sky Train. This segment of the light rail corridor contains three stations: 24th Street/Washington Street, 38th Street/Washington Street and 44th Street/Washington Street. With these three stations (and the possibility of an additional station) this area is a major transportation hub with great potential for transit-oriented development. The Gateway District falls into two of Phoenix's urban villages. Most of the District comprises about one-fifth of the Central City urban village, with the District's northeast corner comprising about one-twentieth of the Camelback East urban village.

The Gateway District has undergone significant changes since the 1970s, when it was a vibrant commercial and residential corridor. The opening of the regional freeway system reduced the importance of Van Buren Street, previously a main thoroughfare of the District and a key east-west connection to the East Valley. This caused a decline in activity in the area through the 1980s and 1990s, resulting in lowered property values, high vacancies, and blight. At the same time, the encroachment of industrial uses and growth of the Sky Harbor International Airport to the south infringed on Gateway's previous residential and commercial character. After decades of divestment and conversion, ca. 300 acres – 13% of the area – lies vacant. Gateway's land uses are a mix of industrial and residential areas typical of older urban neighborhoods. In 2013, Gateway is caught between the new and the old, and between industrial and warehousing uses and residential and commercial uses.

The District was once dotted with the creosote-bursage plant community in small washes carved into desert flats of an ancient lakebed. Around 450 AD, the Hohokam designed and built a large canal system that remains an integral part of the Arizona water system. Delivering water to downtown Phoenix since 1878, Gateway's portion of Grand Canal was once a shady, tree-lined path. Today, those paths are still used for recreation, but the trees have disappeared (Figure 2). No longer a cool path, the canal currently has more asphalt and dirt than vegetation, lessening the canal's viability as a recreational asset.

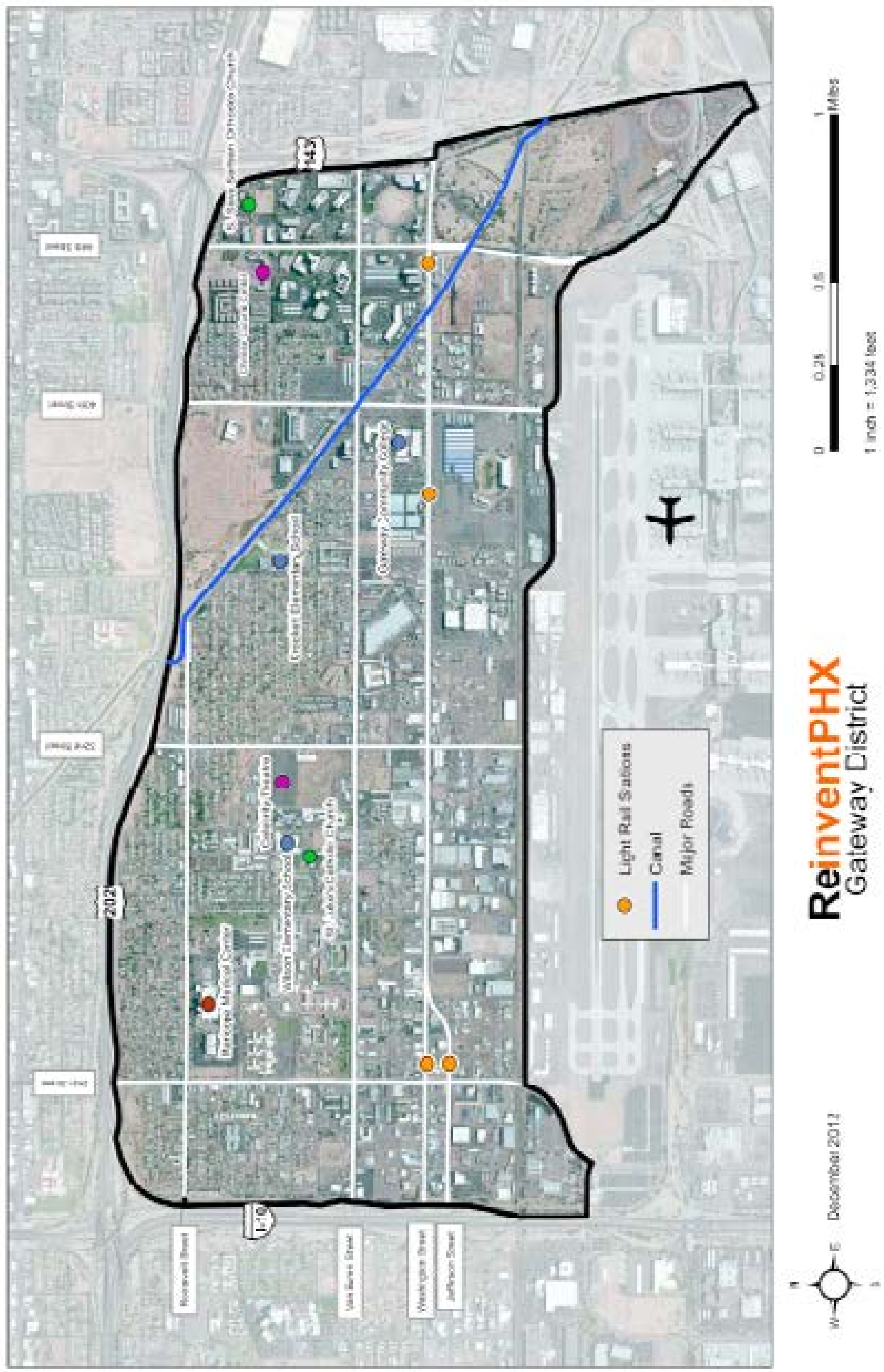

Figure 1. Major Gateway District streets and landmarks

Figure 2. Grand Canal (Source: Toby Roanhorse)

Land use in Gateway consists largely of building footprints (often industrial) and parking areas, with few patches of landscaped area or vegetation (Figures 3 & 4). Most of what does exist is high-water vegetation, which drives higher temperatures and higher potable water consumption for irrigation. Overall, only about 0.1% of the District is parkland, compared to 1.3% for all of Phoenix.

Figure 3. Limited vegetation (Source: Google Earth)

Figure 4. Industrial building with little vegetation (Source: Kimpel & Butler)

Neighborhoods throughout Gateway contribute to higher urban temperatures due to limited trees and vegetation in yards. With little shade, neighborhoods are uncomfortably warm and unwalkable for many residents, particularly in the summer months.

Figure 5. Asphalt and dirt at trailer park (Source: Google Earth)

Many homes were constructed before 2000, and may lack proper insulation and energy efficient appliances. They therefore retain large amounts of heat, contributing to the Urban Heat Island effect. Apartment complexes are some of the hottest areas in Gateway, with their design forming heat-trapping canyons.

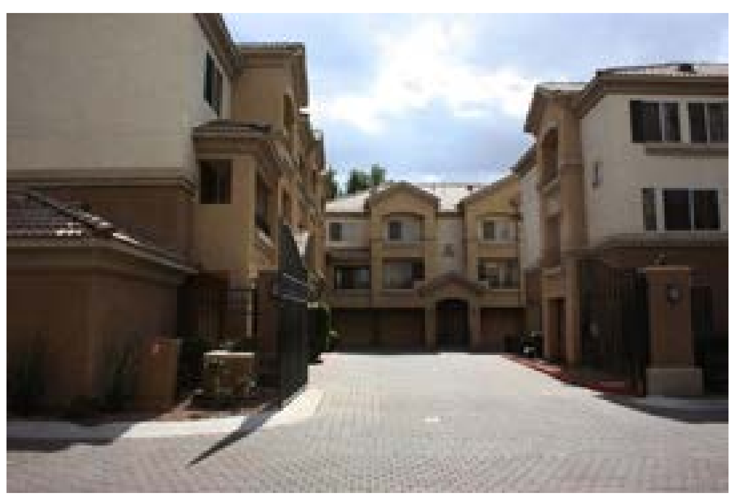

Figure 6. Interior of apartment complex (Source: Kimpel & Butler)

Using building footprints and heights, Figure 7 shows shade and areas exposed to direct sunlight. In the summer, single-story buildings, which are predominant offer very little shade. Only the hospital complex and some of the business parks provide any building shade. Vacant lots are numerous and spread all over, with noticeable concentrations along Van Buren, especially near 32n

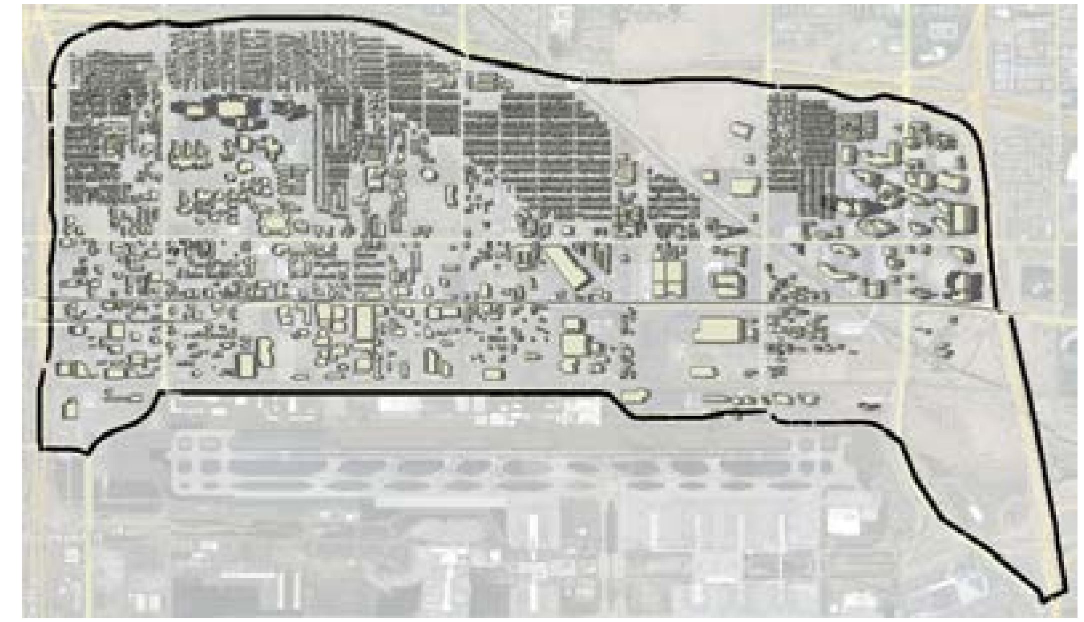

Figure 7. Composite map of summertime shade at 8 AM, 11 AM, 2 PM, and 5PM

1.2. Profile of the “Reinvent Phoenix” Grant

“Reinvent Phoenix” is a City of Phoenix project in collaboration with Arizona State University and other partners, and funded through U.S. Department of Housing and Urban Development’s Sustainable Communities program, for the period 2012—2015. This program is at the core of U.S. Department of Housing and Urban Development’s mission to “create strong, sustainable, inclusive communities and quality affordable homes for all.” It specifically strives to “reduce transportation costs for families, improve housing affordability, save energy, and increase access to housing and employment opportunities” and to “nurture healthier, more inclusive communities” (Office of Sustainable Housing and Communities, 2012). The program explicitly incorporates principles and goals of sustainability/livability (HUD/DOT/EPA, 2009):

1. Enhance economic competitiveness

2. Provide more transportation choices

3. Promote equitable, affordable housing

4. Support existing communities

5. Coordinate and leverage federal policies and investment6. Value communities and neighborhoods.

In this spirit, Reinvent Phoenix aims to create a new model for urban development in Phoenix. The goals for this new model are to improve quality of life, conserve natural resources, and maintain desirability and access for the entire spectrum of incomes, ages, family sizes, and physical and developmental abilities along the light rail corridor. Reinvent Phoenix aspires to eliminates physical and institutional barriers to transit-oriented development. To do so, the grant will work to catalyze livability and sustainability through capacity building, regulatory reform, affordable housing development, innovative infrastructure design, economic development incentives, and transformational research and planning.

Participatory research design ensures that a variety of stakeholder groups identify strategic improvements that enhance safe, convenient access to fresh food, healthcare services, quality affordable housing, good jobs, and education and training programs. Reinvent Phoenix focuses on six topical elements: economic development, green systems, health, housing, land use, and mobility (corresponding to the Livability Principles). These planning elements are investigated in five transit Districts (from east to west and south to north): Gateway, Eastlake-Garfield, Midtown, Uptown, and Solano.

Planning for the Downtown District of the light rail corridor is excluded from Reinvent Phoenix because of previously completed planning efforts, partly using transit-oriented development ideas.

Reinvent Phoenix is structured into planning, design, and implementation phases. The project's planning phase involves building a collaborative environment among subcontracted partners, including Arizona State University, Saint Luke's Health Initiatives, Discovery Triangle, the Urban Land Institute, Local First Arizona, Duany Plater-Zyberk & Company, Sustainable Communities Collaborative, and others. While the City of Phoenix coordinates these partnerships, Arizona State University and Saint Luke's Health Initiatives are working with residents, business owners, landowners, and other relevant stakeholders in each of the grant's five transit Districts. This effort will assess the current state of each District, as well as facilitate stakeholder expression of each District's sustainable vision for the future. Finally, motivated actors in each District will co-create step-by-step strategies to move toward those visions. Transit District Steering Committees, formed in the planning phase, will host capacity building for their members, who will shepherd their Districts through the remaining Reinvent Phoenix phases.

City of Phoenix staff and Duany Plater-Zyberk & Company will lead the design phase. Designs for canal activation, complete streets, and form-based code will complement the compilation of a toolbox for public-private partnerships to stimulate economic development along the light rail corridor. The design phase will take its cues from the public participation in the planning phase, and maintain ongoing monthly contact with Transit District Steering Committees to ensure the visions of each District are accurately translated into policy and regulations. These steps will update zoning, codes, regulations, and city policies to leverage the new light rail system as a major asset. The design phase is crucial for preparing an attractive environment for investment and development around the light rail.

Finally, the implementation phase will use the city's partnerships with the Urban Land Institute, Local First Arizona, and Sustainable Communities Collaborative to usher in a new culture of development in Phoenix. With the help of all partners, transit-oriented development can be the vehicle to renew Phoenix's construction industry, take full advantage of the light rail as a transformative amenity, and enrich Phoenix with a livable and dynamic urban fabric.

1.3. Sustainable Green Systems Research

One sub-project of Reinvent Phoenix in the Gateway District focuses on green systems and aims to develop fully functional stormwater, biodiversity, and resource management practices, as well as sustainable levels of thermal comfort, energy efficiency, and access to green space along the light rail in the District. The green systems project fully aligns with HUD's Sustainable Communities program goals, as stated above (see Livability Principles No. 4 & 6, above).

Sustainable green systems is specified in the following four goals:

1. Reduce stormwater loads and harvest water on-site

2. Reduce potable water consumption

3. Reduce daytime temperatures

4. Improve the social and economic benefits of green systems for health, mobility, and biodiversity

In pursuit of these goals, we employ a transformational planning framework (Wiek, 2009; Johnson et al., 2011), conducting sustainable green systems research in three linked modules. We start with a thorough assessment of the current state of green systems in the Gateway District in 2010/2012 against principles of livability and sustainability (current state assessment); in parallel, create and craft a sustainable vision for green systems in the Gateway District in 2040 (visioning); and finally develop strategies for changing or conserving the current state of green systems towards the sustainable vision of green systems in the Gateway District between 2012 and 2013 (strategy building). The framework is illustrated

Because of the close link between green systems and other planning elements, and the broad impacts of green systems, the central meaning of green systems often remains poorly defined in green systems assessments. Green systems employ natural elements to perform ecosystem services, such as stormwater management, microclimate modification, and improvement of air and water quality, among others (Benedict & McMahon, 2006; Rouse & Bunster-Ossa, 2013). They include building footprints, rights-of-way, public streets, parking areas, landscaping, vegetation, stormwater, water use, and shade patterns affecting local climate conditions. As articulated in Phoenix's tree and shade master plan: Green systems are the interconnected web of parks, streets and canals that help to sustain an active, cool and healthy city. Green systems range from passive water harvesting to porous pavers. Green systems come in a variety of forms from street trees to a large District park. Green systems provide a myriad of economic, social and environmental benefits. Green systems help to reduce energy costs; improve air quality; strengthen quality of place and the local economy; reduce storm water; improve social connections; promote smart growth and compact development; and create walkable neighborhoods. Green systems are solution multipliers that solve many problems with one single investment (2010). According to the U.S. Environmental Protection Agency, "Green infrastructure is an approach that communities can choose to maintain healthy waters, provide multiple environmental benefits, and support sustainable communities. Unlike single-purpose gray stormwater infrastructure, which uses pipes to dispose of rainwater, green infrastructure uses vegetation and soil to manage rainwater where it falls. By weaving natural processes into the built environment, green infrastructure provides not only stormwater management, but also flood mitigation, air quality management, and much more" (2013). With the intent to avoid duplications, overlap, and confusion, we follow in this report's assessment the following definition: green systems use both natural and engineered systems to provide ecosystem services in a given District (Cook, 2007).

1.4. Objectives of the Current State Assessment Study

The current state assessment is a structured procedure that creates a detailed and normative account of the existing conditions of green systems in the District, informed by livability and sustainability principles. The assessment creates a solid foundation and reference point for the strategy building process to achieve sustainable green systems in the Gateway District.

Unlike conventional green systems assessments, which are largely descriptive and analytical, the research documented here is functionally linked to the strategy-building module. Conventional assessments often provide a large number of arbitrary data sets, with unclear reference to the main issues being analyzed. They also tend to lack a meaningful normative reference against which the data is being assessed. In this report, there are transparent indications and justifications of the degree of sustainability or unsustainability of the current state of green systems. In accordance with the mandate of Reinvent Phoenix to contribute to sustainable community development, adapt to rising temperatures, increase resiliency to climate change, and improve energy- and water-efficiency of buildings and infrastructure, this report takes an explicit normative perspective on green systems, based on sustainability and livability principles (Gibson, 2006; HUD/DOT/EPA, 2009).

Contrary to conventional assessment practice, this report only presents information that can directly be linked to the key guiding question of the green systems assessment: How sustainable/unsustainable is the current state of green systems in the Gateway District?

We have excluded from the current state assessment chapters of this report all issues that pertain to future developments of green systems in the District. The issue of green systems trends are addressed in our District green systems strategy chapter.

The core objectives of this current state assessment are:

1. A comprehensible set of goals for sustainable green systems

2. A comprehensible set of performance indicators that operationalize the goals and facilitate detailed description of the current state of green systems

3. Targets for all performance indicators that operationalize the goals and facilitate assessment of the sustainability/unsustainability of the current state of green systems

4. Sustainability assessment of the current state of green systems through comparison of indicators to their identified targets (distance-to-target)

5. Causal problem maps for the performance indicators that identify causal structures and drivers, and thereby suggest promising intervention points for change strategies

Additional objectives include:

1. To develop a process and content template for current state assessment research that can be reproduced in the other four transit Districts and thus guide the Reinvent Phoenix current state assessment activities over the coming years

2. To enhance capacity in current state assessment for planning professionals and collaborating partners to use in subsequent initiatives and projects.

3. To enhance capacity in current state assessment for students and faculty to use in other research, teaching programs, and projects.

1.5. Objectives of the Transition Strategy Study

The strategy presented in this report directly refers to the green systems challenges. It proposes interventions that to address these challenges, significantly improve the green systems situation in the Gateway District, and achieve the vision and goals of sustainable green systems in the District (Wiek et al., 2012). In accordance with the mandate of Reinvent Phoenix to contribute to sustainable community development, this strategy study actively pursues the improvement of green systems conditions, following sustainability and livability principles (Gibson, 2006; HUD/DOT/EPA, 2009).

The guiding question of the sustainable green systems strategy study is: What are evidence-supported interventions to provide fully functional stormwater, biodiversity, and resource management practices, as well as sustainable levels of thermal comfort, energy efficiency, and access to green space in the Gateway District?

The specific objectives are:

6. To link sustainable green systems goals and targets to evidence-supported interventions and investment options.

7. To detail the interventions through actions, actors, assets, coping tactics (for barriers) needed to achieve sustainable green systems goals and targets.

8. To highlight a set of investment options designed to achieve sustainable green systems goals and targets.

9. To compile a set of exemplary implementation tools that help implementing the investment options.

10. To outline a five-year action plan to implement the interventions and investment options.

Additional objectives include:

4. To develop a process and content template for sustainable strategy development research that can be reproduced in the other four transit districts and thus guide the Reinvent Phoenix strategy development activities.

5. To enhance capacity in strategy development among planning professionals and collaborating partners to use in subsequent initiatives and projects.

6. To enhance capacity in strategy development for students and faculty to use in other research projects, teaching programs, and professional projects.

Chapter 2 – Research Design and Data Sources

2.1. Design of the Current State Assessment Study and Data Sources

The methodological approach employed in this study is based on the transformational planning framework in Figure 8. Following specifications for the current state assessment module, this report pursues the aforementioned objectives through five research streams:

1. Development of an assessment framework composed of normative goals, performance indicators, and targets (Chapter 3)

   a. Identification of a comprehensible set of goals for sustainable green systems. This research is based on reviewing scientific literature and reference documents (Akbarit et al., 2001; Gibson, 2006; Birch et al., 2008; Giguere, 2009; HUD/TOD/EPA, 2009; Slavin, 2011; Pankiewicz & Ramirez, 2013). Based on this initial review, we synthesized a large number of goals into a smaller set through systematic comparison and integration.

   b. Identification of a cohesive set of performance indicators that operationalize the goals and facilitate detailed description of the current state of green systems. The indicators are largely determined through literature that suggests a clear link between general goals and measurable indicators (Kuchelmeister, 1998; Sovocool et al., 2001; American Forests, 2002; City of Phoenix, 2008; U.K. Department for Environment, Food and Rural Affairs, 2008; USGBC, 2008; Houston Advanced Research Center, 2009; Wang, 2009; Watershed Management Group, 2010; Bryan, in preparation).

   c. Identification of a target (or range) for each performance indicator that operationalizes the goals and facilitates assessment of the sustainability/unsustainability of the current state of green systems. Indicators facilitate description of the current state through data collection. Yet, they are insufficient for operationalizing the goals of sustainability/livability. This requires targets (one for each indicator) that are discrete (quantitative or qualitative) thresholds (or ranges) that define, all together, sustainable green systems (Wiek & Binder, 2005; Rockström et al., 2009; Machler et al., 2012). Due to insufficient research, this is often tedious and challenging (Hoernig & Seasons, 2004). For indicators lacking firm targets or thresholds in the literature, we rely on our team's expert opinions to make reasonable estimates. Indicators without clear targets are labeled as "not available" (NA).

2. Assessment of the sustainability/unsustainability of the current state of green systems based on comparison of current state data (for each indicator) to the identified targets (distance-to-target). This shows how sustainable/unsustainable the current state of green systems is in specific (for each indicator) and overall (aggregated) (Chapter 4).

3. Identification of the causal structure (drivers) of performance indicators, which reveals promising intervention points for change strategies. Causal assumptions are based on expert input and scientific literature; and, a system analysis explores linkages among all the indicators (Vester, 2008; Wiek et al., 2008). The final step defines the linkages between green systems indicators quantitatively (strength of impact) and qualitatively (type of impact). Causal structure analysis is critical for strategy building, because performance indicators cannot be directly changed. Sustain-able green systems strategies must change the upstream drivers of indicators, which requires detailed knowledge of causal linkages (Chapter 5).

Data for this assessment come from a variety of sources. The City of Phoenix provided public geographical data for land use, zoning, and other infrastructure, and the city water department provided water consumption data. Electricity usage data is still being processed.

The Central Arizona–Phoenix Long-Term Ecological Research (CAP-LTER) program (National Science Foundation grant BCS-1026865) made land cover (porosity) and MASTER remote sensing data available. The MASTER data for surface temperatures is a daytime image from July 12th, 2011. Our research team processed temperature information from the data, and created distributions and averages for census block group geography to insure compatibility with other maps. This allowed us to calculate the percent of surface area in the

District within certain temperature ranges.

For some indicators, no data is available and they are marked "ND" accordingly. They remain in our assessment with the hope that data will become available in the future, and facilitate further assessment.

2.2. Design of the Transition Strategy Study

We acknowledge that the term strategy is being used in a variety of contexts. In context of Reinvent Phoenix, a strategy is defined as a set of interventions coordinated among different stakeholders with the intent to transforming the current state of a system (e.g., a city, a neighborhood, a company) into a sustainable one (Wiek & Kay, 2013). The following document details the coordinated interventions necessary to achieve a sustainable state for green systems in the Gateway District. Each intervention includes investments and implementation tools that residents, businesses, organizations, and city government need to employ in order to achieve the desired outcomes. Conceptually, we differentiate different levels of the strategy, including interventions, investment types, and investment tools (Figure 9). The strategy is composed of several (coordinated) interventions. An Intervention offers several investment types. For realizing an investment types, different implementation tools can be used.

The methodological approach employed in this study is based on the transformational planning framework (Wiek, 2009). The specific procedures for building a transition strategy have been detailed in Wiek and Kay (2013) and Kay et al. (2013), and are here applied to green systems as follows:

4. Summarizing the inputs or ingredients for the strategy, i.e., the current state assessment, the vision, and a theory of change. All three elements need to be specified to an extent that progress can be measured. Key information pertains to the gaps between the current state and trends for green systems on the one hand, and future goals and targets (vision) on the other hand. For example, for the indicator "indoor residential potable water use," the current state is 46 gallons per capita per day, but the target is 30 gallons per capita per day. The 16-gallon gap between the current state and the target state specifies the gap the strategy needs to bridge.

5. Developing a set of coordinated interventions to achieve desired outcomes. Each of the specific goals for sustainable green systems requires specific interventions. For example, to achieve the goal of reducing daytime temperatures, the intervention of shade and cooling on streets and parking lots seems promising. The transformational planning framework is goal oriented and thus the vision, the current state assessment, and the strategy all start with stating the goals of sustainable green systems. Yet, the strategy aims at coordinating interventions that achieve multiple objectives at the same time. For example, shade and cooling on streets and parking lots does not only pursue reduced daytime temperatures, but can also contribute to stormwater management with vegetative shade. Thus, from the perspective of implementation it is more useful to use the interventions as organizing principle, and design interventions in ways that they contribute to as many goals as possible. Thus, we describe each major intervention separately by:

a. Stating the goals and targets the intervention pursues.

b. Identifying the intervention points, i.e., drivers that cause the problematic current state. Systemic relevance of the intervention point and feasibility of intervention at this point are important criteria for the selection of intervention points. A potential intervention point could be building codes that lack to incentivize cooling technologies.

c. Specifying key components of each intervention, i.e., intervention actions, actors, available assets, resources needed, potential barriers, and implementation tools. Components can be identified through using best practices examples across the United States, interviews with city staff, residents, local experts, and academic literature.

d. Describing specific investment types that offer different pathways within an intervention. For example, the streets intervention captures both green streets and green parking (two different investment types). For realizing an investment type, different implementation tools can be used.

e. Describing implementation tools, clustered in tools for financing, capacity building, partnerships, rules (codes), and incentives. We provide key information on the implementation tools, so that residents, developers, and city staff are able to select among available tools. Similar to interventions and investment types, the majority of tools can be used to implement multiple investments. For example, a community development corporations (CDCs) (partnership tool) can be used to support green streets efforts.

6. Providing evidence for the effectiveness and efficiency of the proposed interventions, investments, and implementation tools. Evidence is required to ensure that intervention, investments, and implementation tools are selected that are likely to be capable of 'getting the job done'. Evidence can be provided by local experts, academic literature, or cases of other cities.

7. Detailing actions for a specific 5-year action plan that specify the roles and responsibilities for residents, developers, and city staff, as well as for the Steering Committee.

Data for this strategy document comes from two primary sources:

1. Data inputs for the strategy are drawn from multiple sources as this study builds from the current state assessment and the visioning study. The specifics of these data sets are explained in the respective reports (Wiek et al., 2012; Golub et al., 2013).

2. Data about the core components of the strategy is based on input from local experts (see acknowledgements, above) and through the review of academic literature.

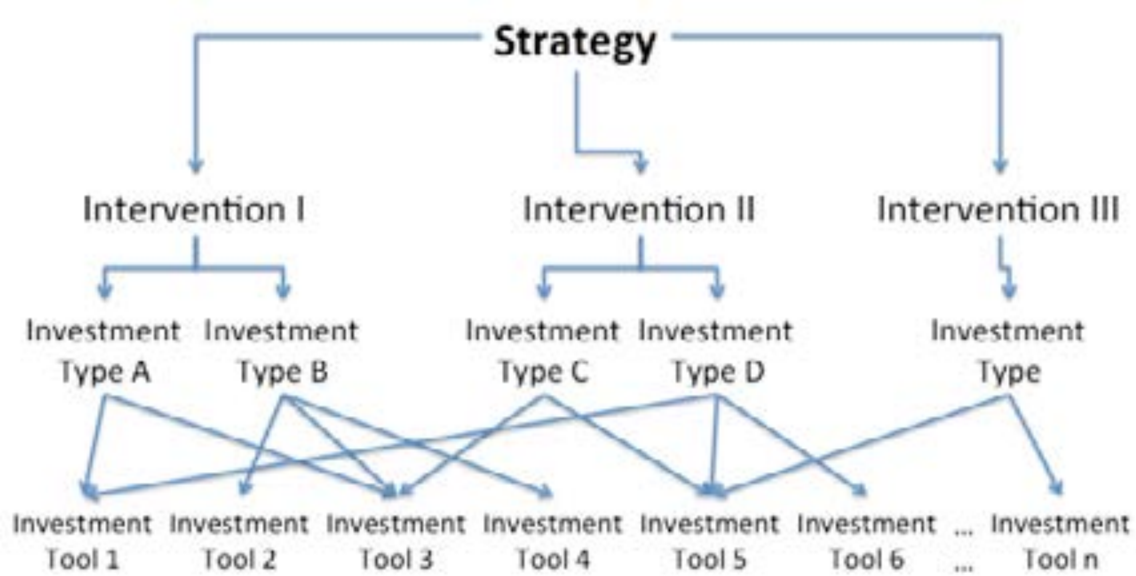

Figure 9. Hierarchical structure of the strategy for sustainable green systems

Chapter 3 – Sustainable Green Systems Goals, Indicators, and Targets

Livability and sustainability are core framing concepts for HUD's Sustainable Communities program, and therefore, the Reinvent Phoenix project. As stated in the introduction (Chapter 1), we follow in this assessment the following definition of green systems: green systems use both natural and engineered systems to provide ecosystem services in a given District (Cook, 2007). Green systems are not inherently sustainable in their design and outcomes. For example, a greenway that runs through a neighborhood (which can be described as a feature of a green system) that uses impermeable surfaces and little plant diversity does not produce a system that effectively harvests stormwater on-site and encourages biodiversity and overall water conservation. Thus, we employ a specific definition of sustainable green systems, which require fully functional stormwater, biodiversity, and resource management practices, as well as sustainable levels of thermal comfort, energy efficiency, and access to green space. These elements must all be present to create a sustainable green system. In other words, the system must seek to harvest stormwater on-site, encourage a diverse range of fawn and flora, reduce overall resource use (e.g. water and energy), reduce overall temperatures in urban environments, and provide access for all people to high quality green spaces. This chapter details the key features of sustainable green systems, based on sustainability and livability literature. It also defines indicators and targets for four sustainable green systems goals (Akbarit et al., 2001; Gibson, 2006; Birch et al., 2008; Giguere, 2009; HUD/TOD/EPA, 2009; Slavin, 2011; Pankiewicz & Ramirez, 2013):

1. Reduce stormwater loads and harvest water on-site

2. Reduce potable water consumption

3. Reduce daytime temperatures

4. Improve the social and economic benefits of green systems for health, mobility, and biodiversity

Recent research indicates that these goals are best pursued in concert, as they offer synergies among them (Birch et al., 2008; Pankiewiz, 2013).

3.1. Goal 1 – Reduce stormwater loads and harvest water on-site

With average annual precipitation of only 5—10 inches, Phoenix has significant incentive to harness water resources that are otherwise lost. Traditional stormwater management practices use impermeable surfaces, such as roads, curbs, and culverts, to divert large quantities of water into centralized infrastructure. This draws pollution and debris into the infrastructure, with negative effects on water quality (Cook, 2007; Gautam et al., 2010). These traditional stormwater management systems increase flooding, pollute surrounding bodies of water, degrade natural habitats, and increase health risks and maintenance costs.

Alternatively, green stormwater management systems use trees, rocks, and vegetation to harvest, treat, and store stormwater runoff. These green systems percolate water into permeable soil to support vegetation, and reduce stormwater burden on sewage and other infrastructure. Soil design (i.e. types of soil, depth of soil beds, etc.) can improve pollutant filtering and increase water percolation for the overall success of the system (Scheyer & Hipple, 2005). Green stormwater management systems are cost-effective and environmentally friendly (Cook, 2007).

To augment green stormwater management systems, rainwater-harvesting systems pipe roof runoff to barrels or downspouts, then filter and chemical/UV treat the water to use for drinking. Complex rainwater-harvesting systems store water in extensive cistern systems for indoor and outdoor uses (drinking water is further filtered and treated) (Oregon Department of Consumer Business and Services, 2013). Stormwater management and water harvesting technologies allow greater water penetration into the ground, and reduce flood risk and water use.

3.2. Goal 2 – Reduce potable water consumption

Table 2. Indicators and targets of sustainable potable water consumption

Potable water consumption includes indoor residential, landscaping and irrigation, and industrial and commercial uses. Reduction of potable water consumption conserves a valuable natural resource in a desert climate. Prominent potable water conservation practices include the rainwater harvesting systems mentioned, and changes in behavior (i.e. personal conservation habits).

There is a conflict between reduced water use and the green space of Goal 4. For example, lower water use is good for water conservation, but higher water use is good for green space and reducing temperatures. If density increases with people moving into apartments and condominiums, average household water use will decrease with smaller outdoor and indoor areas. However, more people might mean more total water use. This tradeoff will be further explored in the subsequent strategy document for the District.

Table 1. Indicators and targets of sustainable stormwater loads and water harvestingLivability and sustainability

Indicator	Definition	Sustainability Target (Range)	Confidence Level T.	Importance	Applies to
Natural stormwater runoff capture	Percentage of permeable land	90%[A]	Low	High	All Districts equally
Rainwater harvesting	Percentage of buildings with rainwater harvesting systems	95%[A]	Medium	Med	All Districts equally
Stormwater quality	Pollution level …	ND	Low	High	All Districts equally

References and Notes:

A. Center for Watershed Protection, 2010; Watershed Management Group, 2010

B. Authors' best estimates

Table 2. Indicators and targets of sustainable potable water consumption

Indicator	Definition	Sustainability Target (Range)	Confidence Level T.	Importance	Applies to
Potable water	Average indoor residential use	30 GPCD[A]	Medium	High	All Districts equally
	Average outdoor residential use[B]	~60 GPCD[A]	Medium	High	
	Average industrial and commercial use[C]	NA	NA	High	

References and Notes:

A. 90by20.org (2013); gallons per capita per day

B. Outdoor data was not available, so winter water use was used as a baseline, and excess water used in the summer was assumed to be for outdoor landscaping use.

C. Authors' best estimates

3.3. Goal 3 – Reduce daytime temperatures

Table 3. Indicators and targets of sustainable daytime temperature

Indicator	Definition	Sustainability Target (Range)	Confidence Level T.	Importance	Applies to
Surface temperatures	Percentage of District >130°F Percentage of District <105°F	<1%[A] >10%[A]	Medium	High	All Districts equally
Asphalt surface parking	Percentage of District that is black asphalt surface parking	<5% of off-street parking[B]	Low	Med	All Districts equally

References and Notes:

A. Authors' estimates based on Bryan, 2001.

B. Authors' best estimates

Phoenix recognizes that thermal comfort is key for the success of Downtown (City of Phoenix, 2008). In a city where outdoor summertime temperatures exceed 110oF, the Urban Heat Island (UHI) effect is a major concern. UHI refers to "hot spots" and higher surface temperatures where exposed pavement and building materials absorb solar energy, creating higher surface temperatures (Stone et al., 2001; Carlson et al., 2008; Houston Advanced Research Center, 2009). Increased temperatures can lead to cardiovascular stress, heat stress, and heat strokes, as well as higher risks of respiratory distress syndrome, kidney and liver failure, and death (Kleerekoper et al., 2012). In general, young children, people with chronic diseases, and the elderly have the highest risk for heat related illnesses (Giguere, 2009).

UHI also increases the demand for air conditioning and cooling, which in turn increases water use for electricity production. Extra energy production to combat UHI accelerates ground level ozone formation, and emits carbon monoxide, carbon dioxide, sulfur dioxide, nitrogen oxide, mercury, and particulate matter into the atmosphere (Healthy Air Living, 2011). Air pollution from these emissions can decrease lung function and lead to, or worsen, lung inflammation. Higher temperatures also transfer heat to stormwater runoff, increasing stream, lake, and river water temperature by up to 4°F, which significantly decreases water quality (Wong, 2013).

The most common strategies for mitigation of UHI are vegetation, shade structures, and cool materials in built infrastructure (Giguere, 2009). Vegetation cover increases biodiversity, reduces cooling demand, and improves stormwater management (Susca et al., 2011). Cool roofs use light-colored or white roofing products, solar roofing systems (Carlson et al., 2008), or reflective elastometric or polyurea membrane coatings, which reduce temperatures on roofs by reflecting sunlight away (Giguere, 2009).

Figure 10. Maintained and irrigated vegetation and lawn (Source: Kimpel & Butler)

Bus stops, covered parking, public kiosks, and gazebos can add shade and help reduce surface temperatures. Cool pavements also help, by using materials that change absorption, storage, and radiation of heat. Such pavements can decrease surface temperatures by up to 7°F (Pomerantz et al., 2000). Vegetation on private land, along streets, and in community gardens, parks, and seasonal shading structures increases evapotranspiration and minimizes ground temperatures. This leads to lower surface temperatures, improved air and water quality, and better quality of life (Giguere, 2009)

Figure 11. Covered parking (Source: Kimpel & Butler)

Non-shaded pavement and rooftops have higher temperatures (Stone et al., 2001; Carlson et al., 2008; Houston Advanced Research Center, 2009). Shade, parks, and living green environments provide opportunities for shaded outdoor recreation and activity, and have physical and mental health benefits (Ulrich, 1984; DeVries et al., 2003). Green streets also reduce temperatures by adding shade structures and vegetation to sidewalks and parking lots to reduce temperatures where people walk or wait for public transit.

Figure 12. Wildlife (Source: Kimpel & Butler)

3.4. Goal 4 – Improve the social and economic benefits of green systems for health, mobility, and biodiversity

The integration of wild or semi-wild nature into cities supports biodiversity (Beatley, 2010; Faeth et al., 2011), which is essential for human health (Chivian & Bernstein, 2008). Safe, comfortable pedestrian and bike mobility is imperative for a city to thrive, and is directly tied to the quantity and quality of green systems. Residents are more likely to use bike and pedestrian paths for recreation and transportation when they are safe and cool. Green spaces and vegetation create these comfortable and cool routes that expand mobility

Table 4. Indicators and targets of improving the social and economic benefits of green systems for health, mobility, and biodiversity

Indicator	Definition	Sustainability Target (Range)	Confidence Level T.	Importance	Applies to
Vegetation coverage	Percentage of District covered by trees	25%[A]	Medium	High	All Districts equally
Green open spaces	Ft^2/person of parks, urban forests, and green open space	97—215 ft^2/ person[B]	Medium	High	All Districts equally
Green streets	Mi of green streets/mi^2	2 mi[C]	Low	Med	All Districts equally

References and Notes:

A. City of Phoenix, 2010

B. Kuchelmeister, 1998; American Forests, 2002; City of Phoenix, 2008; Wang, 2009; Beatley, 2011

C. Author's best estimates

options beyond expensive personal automobile travel. A flourishing urban forest is critical for the social, economic, and environmental health of a city. Air temperature data from Portland, OR found that the most important characteristic separating warmer from cooler urban areas was tree canopy cover, regardless of the time of day (Hart et al., 2009).

Figure 13. Shaded walkways (Source: Kimpel & Butler)

Urban forests improve the quality of urban life in many ways (Kuchelmeister, 1998). Phoenix recognizes the importance of investing in urban forest, and notes in their Tree & Shade Master Plan (City of Phoenix, 2010) that such investment can clean the air, increase biodiversity, address UHI, decrease energy costs, increase property values, and reduce stormwater runoff and Phoenix's carbon footprint.

3.5. Summary

The following overarching questions, based on the sustainability goals above, guide the assessment of green systems sustainability in the Gateway District (Chapter 4):

1. Does current stormwater infrastructure adequately capture water on-site and in the right-of-way (RoW), using soil, porous surfaces, trees, and other types of vegetation?

2. Is potable water use efficient (landscaping, residential, commercial, and industrial)?

3. Are outdoor surface temperatures low enough for pedestrian and cyclist comfort?

4. Are cool or green roofs reducing heat gain in buildings?

5. Is there enough shade and tree canopy to reduce air temperatures?

6. Is there equitable access to public green space?

7. Is there adequate natural environment available to conserve and protect native biodiversity?

This chapter concludes with an overview table that summarizes all relevant information presented in detail above. Table 5 could be used as a checklist for green systems assessments.

Table 5. Summary of sustainability goals, indicators, and targets

Indicator	Definition	Sustainability Target (Range)	Confidence Level T.		Applies to
Goal 1 – Reduce stormwater loads and improve quality of stormwater runoff					
Natural stormwater runoff capture	Percentage of permeable land	90%	Low	High	All Districts equally
Rainwater harvesting	Percentage of buildings with rainwater harvesting systems	95%	Medium	Med	All Districts equally
Stormwater quality	Pollution level	ND	Low	High	All Districts equally
Goal 2 – Reduce potable water consumption					
Potable water	Average indoor residential use Average outdoor residential use Average industrial and commercial use	30 GPCD ~60 GPCD NA	Medium Medium NA	High High High	All Districts equally
Goal 3 – Reduce daytime temperatures					
Surface temperatures	Percentage of District >130ºF Percentage of District <105ºF	<1% >10%	Medium	High	All Districts equally
Asphalt surface parking	Percentage of District that is black asphalt surface parking	<5% of off-street parking	Low	Med	All Districts equally
White roofs	Percentage of District that has white roofs	>10%	Low	Med	All Districts equally
Goal 4 – Improve the social and economic benefits of green systems for health, mobility, and biodiversity					
Vegetation coverage	Percentage of District covered by trees	25%	Medium	High	All Districts equally

Chapter 4 – Sustainability of the Current State of Green Systems

In this chapter, we present the sustainability assessment of the current state of green systems in the Gateway District, based on the goals, indicators, and targets in Chapter 3. This study uses the latest available datasets (2010—2012) from various sources (Chapter 2). The assessment uses a color rating system. Red indicates that existing conditions fall short of the sustainable target. Green indicates that existing conditions either meet or exceed the sustainability target. Gray indicates that an explicit threshold is not available (NA), or data is not available (ND).

4.1. Goal 1 – Current state of reducing stormwater loads and harvesting water on-site

Current State Data

Over half of Gateway's surface is impervious (Figure 14), making on-site storage of stormwater a challenge. Data for rainwater harvesting was not available, though we suspect

Table 6. Sustainability assessment of stormwater load reduction and on-site water harvestingavailable (ND).

Indicator	Sustainability Target (Range)	Confidence Level T.	Current Data	Confidence Level C.D.	Distance-to-target			Applies to
Natural stormwater runoff capture	90%	Low	46.0%	High	44% / High		High	All Districts equally
Rainwater harvesting	95%	Medium	Minimal	Medium	~90% / High		Med	All Districts equally
Stormwater quality	NA	Low	High	Low			High	All Districts equally

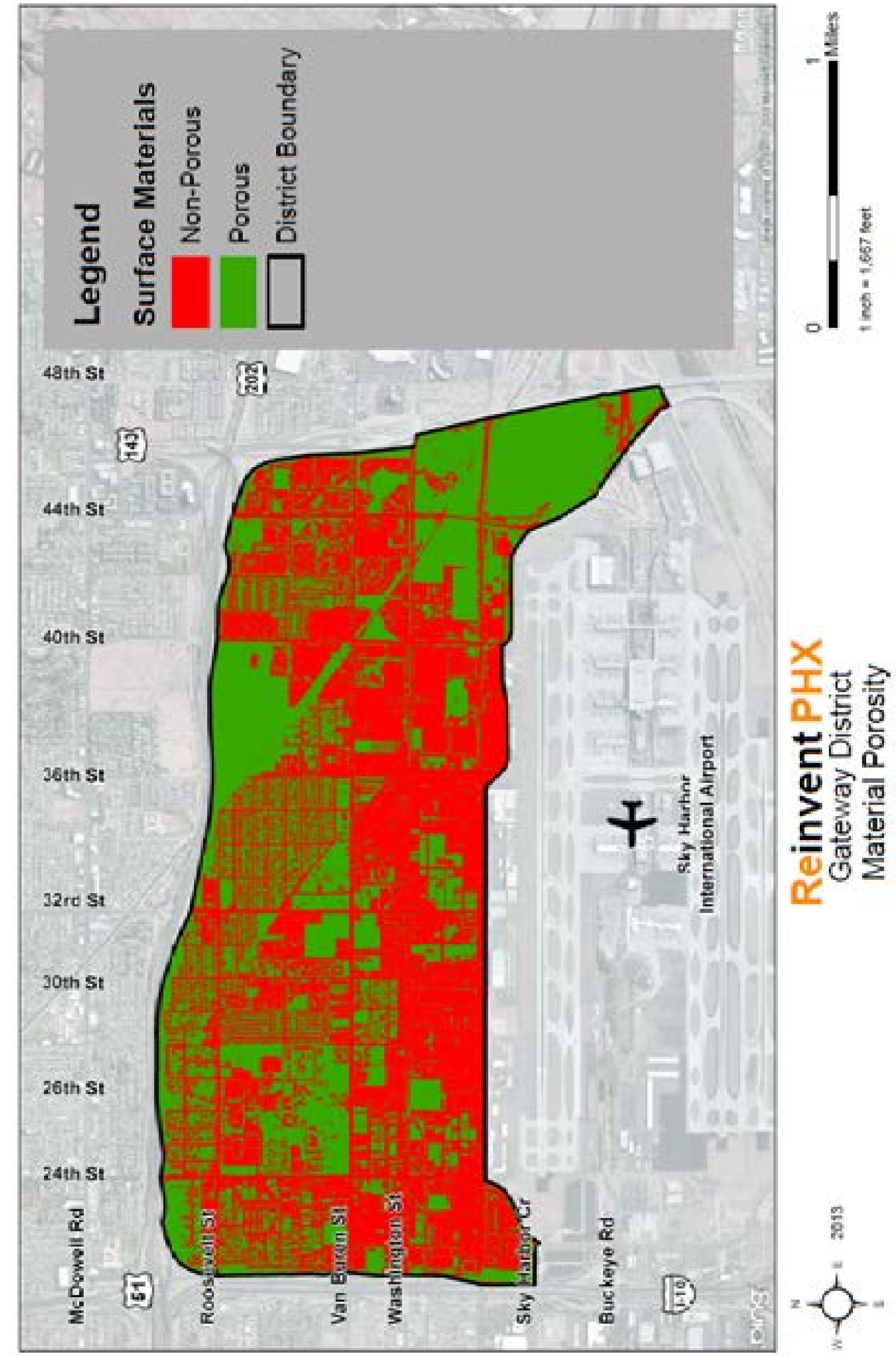

Figure 14. Surface porosity

Assessment

The literature does not specify a sustainability threshold for percentage of stormwater runoff captured by trees and vegetation. However, it is clear that substantial water is lost due to lack of natural stormwater management practices and the low percentage of permeable land. One 8.5 x 20 foot asphalt parking space generates about 100 gallons of runoff in a one-inch storm (Watershed Management Group, 2010). Extrapolating to the District level, during a one-inch storm, Gateway's buildings and pavement respectively produce around 8.4 and 25.1 million gallons of runoff, for a total of 33.5 million gallons of runoff. This would be sufficient for 13 days of District potable water consumption, based on Gateway's 2.6 million gallons per day consumption.

4.2. Goal 2 – Current state of reducing potable water consumption

Table 7. Sustainability assessment of potable water consumption

Indicator	Sustainability Target (Range)	Confidence Level T.	Current Data	Confidence Level C.D.	Distance-to-target	Assessment	Importance	Applies to
Potable water	30 GPCD	Medium	46 GPCD	High	16 / Low		High	All Districts equally
	~60 GPCD	Medium	25 GPCD	High	Fulfilled (-35 GPCD)			
	NA	NA	56 GPJD[A]	?	?			

Notes and References:

A. Gallons per job per day

Current State Data

The District contains no commercial-scale agriculture; therefore, water use is lower than other areas of the Valley. Thus, most of this assessment focuses on typical residential water use: drinking, cooking, bathing, toilet flushing, swimming pools, lawns, gardens, and washing cars, clothes, and dishes (EPA, 2004). Interestingly, total residential water use in Gateway (71 GPCD) falls below the U.S. average (80—100 GPCD) (USGS, 2013). This is likely due to the District's low irrigation needs without agriculture, golf courses, or much green space, as well as to the socio-economic conditions of the District. Median income in Gateway is $29,852, ~50% of the area median income (AMI), and 44% of households fall below the federal poverty line.

Assessment

Gateway's indoor water use exceeds the suggested sustainable threshold by 16 GPCD, whereas outdoor water use is below the sustainable threshold by 35 GPCD. Although combining these distances-to-target imply a fulfilled combined target, distribution of water use is a concern, and many households may not have enough landscape cover and vegetation to provide thermal comfort from higher temperatures in the summer (Figure 15).

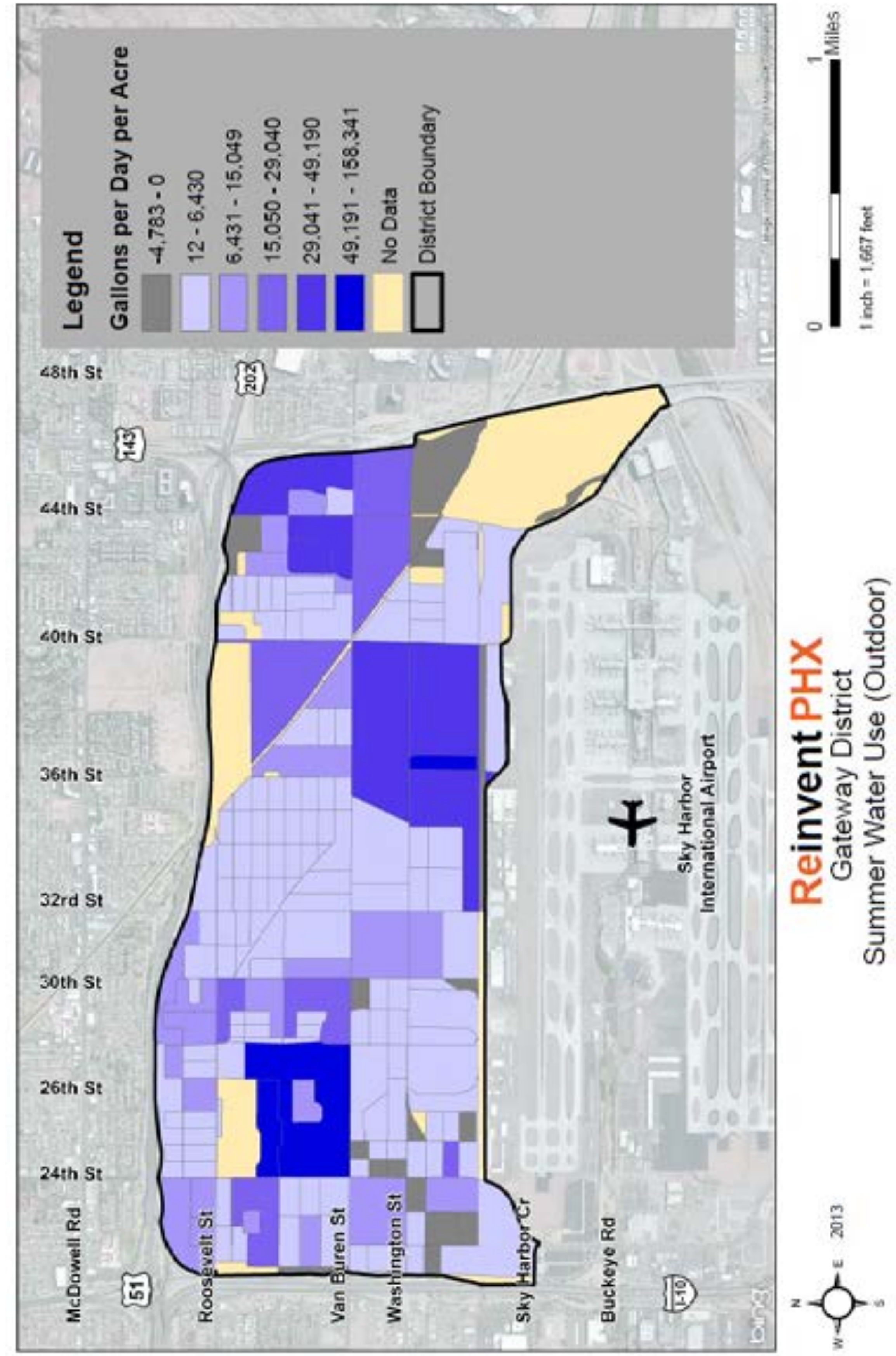

Figure 15. Summer outdoor water consumption

The Leadership in Energy and Environmental Design (LEED) rating system has guidelines for summertime irrigation. For a LEED water efficiency credit (i.e. for a sustainable level of irrigation water consumption), potable water consumption for irrigation should be 50% of the mid-summer baseline average for the surrounding area (U.S. Green Building Council, 2005). Because the sustainability guidelines for summertime irrigation practices in arid regions are geared toward specific reduction strategies, it is difficult to assess the current state of water use in Gateway. Summer outdoor water use is 25 GPCD, which is enough to support hybrid desert-adapted landscaping and a small lawn on a 10,000 square foot lot. A lower target is possible, but would cause tradeoffs with thermal comfort and outdoor recreation discussed in Chapter 3.3. Because the diversity of industrial and commercial uses makes target setting problematic, there is not sufficient context to assess the sustainability of industrial and commercial use.

4.3. Goal 3 – Current state of reducing daytime temperatures

Current State Data

While the translation from surface to ambient air temperatures is not exact, surface temperatures do have strong effects on human thermal comfort. Over 10% of Gateway has surface temperatures above 130oF, and 88.8% are 105—130oF. Gateway is 17% asphalt surface parking, which contributes to its high surface temperatures.

Assessment

The sustainable threshold in Phoenix is around 106oF for outdoor ambient air temperature. As temperatures increase above this threshold, human thermal comfort decreases, and there is increased danger of heat stroke (Bryan, In Preparation). Unfortunately, no good records exist for ambient temperatures, other than at specific weather stations. However, we do have good data on surface temperatures, which seriously exceed acceptable levels with less than 1% of Gateway surface temperatures below 105oF (Figures 16 & 17).

Table 8. Sustainability assessment of daytime temperatures

Indicator	Sustainability Target (Range)	Confidence Level T.	Current Data	Confidence Level C.D.	Distance-to-target			Applies to
Surface Temperatures	<1% >10%	Medium	10.4% 0.8%	High	9.3% / High 9.2% / High		High	All Districts equally
Asphalt surface parking	<5% of off-street parking	Low	16.9%	High	11.9% / High		Med	All Districts equally
White roofs	>10%	Low	5.5%	High	4.5% / Medium		Low	All Districts equally

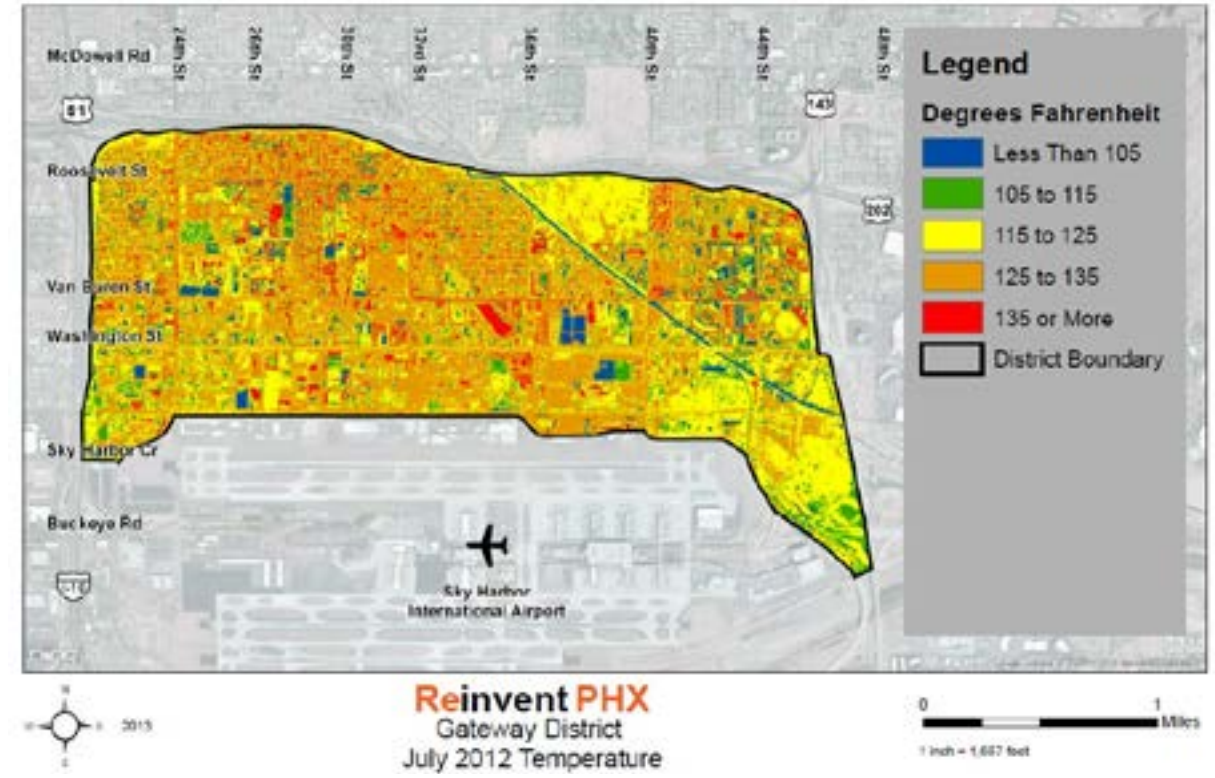

Figure 16. Detailed Daytime Summer Temperature Image

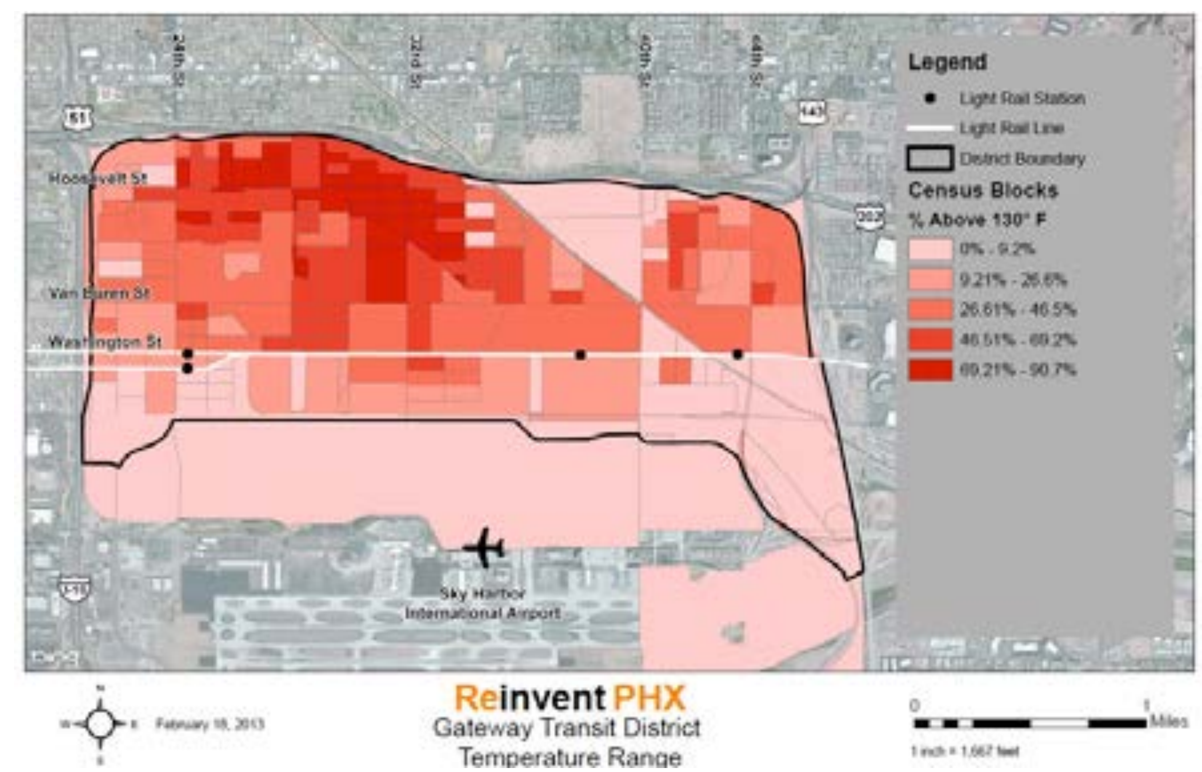

Figure 17. Percentage of census block with surface temperatures hotter than 130ºFof the Gateway District

The sustainable threshold for asphalt surface parking is <5% of the District. In addition, paving should be at least 50% pervious, and have 29% solar reflectance, to reduce UHI (USGBC, 2009; Bryan, In Preparation). Gateway is currently 16.9% asphalt surface parking, which is well above the threshold (Figure 18).

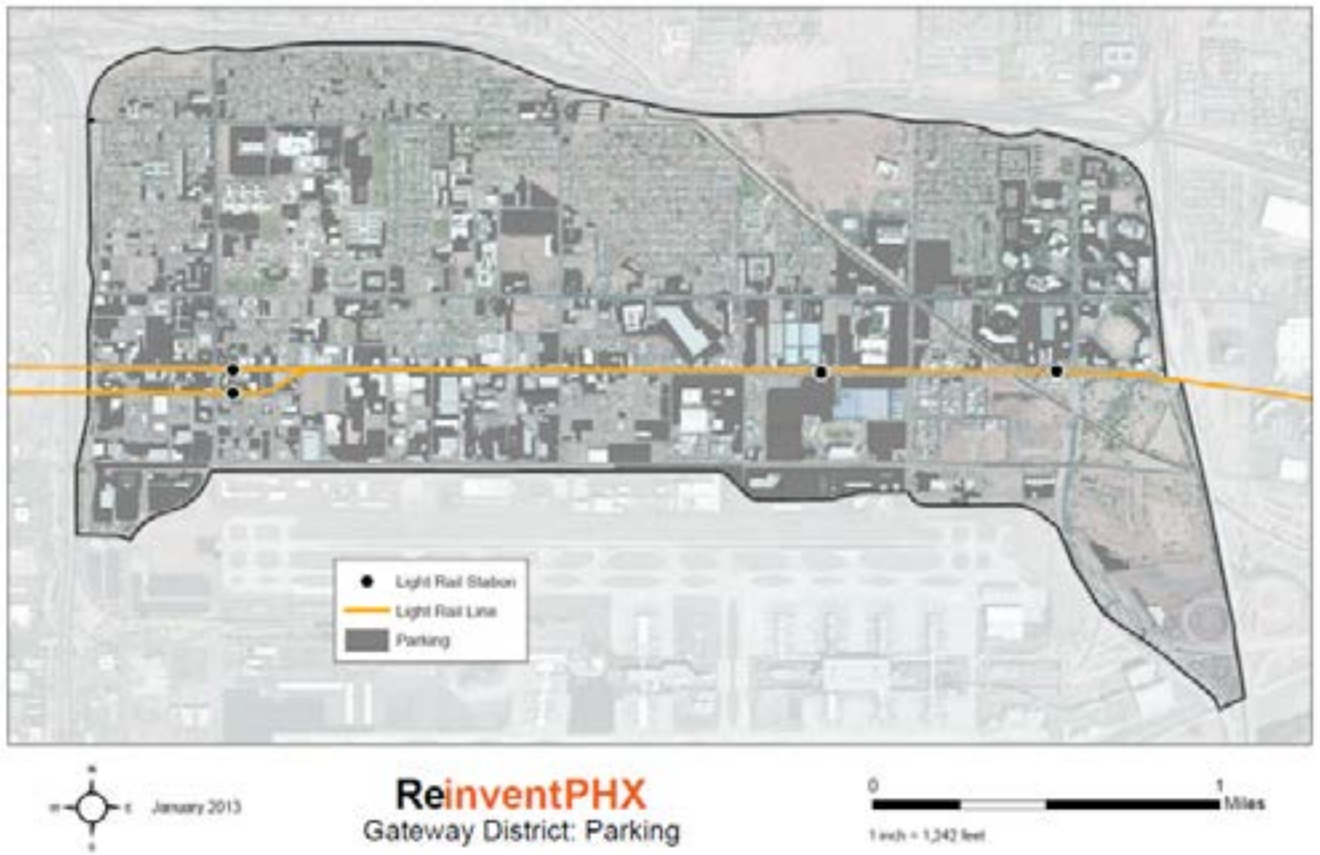

Figure 18. Surface Parking

4.4. Goal 4 – Current state of improving the social and economic benefits of green systems for health, mobility, and biodiversity

Table 9. Sustainability assessment of improving the social and economic benefits of green systems for health, mobility, and biodiversity

Indicator	Sustainability Target (Range)	Confidence Level T.	Current Data	Confidence Level C.D.	Distance-to-target			Applies to
Vegetation coverage	25%	Medium	4.9%	High	~20% / High		High	All Districts equally
Green open spaces	97—215 ft²/ person	Medium	1.6 ft²/ person	High	~200 / High		High	All Districts equally
Green streets	2 mi	Low	0	High	2mi / High		Med	All Districts equally

Current State Data

Gateway has only 4.9% tree coverage, and ~1.6 feet of green space per person. There are no "green streets" or nature preserves open to public use in the District. In addition, much of Gateway is impervious (i.e. concrete) and without shade, creating a highly unpleasant pedestrian environment, and providing little to no opportunity for vegetation to increase biodiversity.

Assessment

A sustainable threshold for tree canopy cover in semi-arid U.S. cities is 25—30% overall, 35—40% in suburban residential areas, 20% in urban residential zones, and 10% in Central Business Districts (American Forests, 2002). Gateway misses its suggested range of 25% tree canopy cover by over 20%. Without tree coverage, shade is minimal, which magnifies the UHI effect, increases heat-related illness and reduces air quality.

The international minimum standard of green open space per city dweller is 97 square feet, and the general standard for developed countries is 215 square feet per person of parkland (Kuchelmeister, 1998; Wang, 2009). There are only two parks in the District, equaling about 1.6 square feet of parkland per person. This falls dangerously below the sustainable range, and indicates a critical need for more parks and green space in the

4.5. Summary

We conclude this chapter with an overview table that summarizes all relevant information presented in detail above. Table 10 could be considered the checklist for Gateway's green systems assessment.

Table 10. Summary table of indicators, targets, current data, and assessments

Indicator	Sustainability Target (Range)	Confidence Level T.	Current Data	Confidence Level C.D.	Distance-to-target	Assess-ment	Impor-tance	Applies to
Goal 1 – Reduce stormwater loads and harvest water on-site								
Natural stormwater runoff capture	90%	Low	46.0%	High	44% / High		High	All Districts equally
Rainwater harvesting	95%	Medium	Minimal	Medium	~90% / High		Med	All Districts equally
Stormwater quality	NA	Low	High	Low	NA		High	All Districts equally
Goal 2 – Reduce potable water consumption								
Potable water	30 GPCD ~60 GPCD NA	Medium Medium NA	46 GPCD 25 GPCD 56 GPJD	High High ?	16 / Low Fulfilled (-35 GPCD) ?		High	All Districts equally
Goal 3 – Reduce daytime temperatures								
Surface Temperatures	<1% >10%	Medium	10.4% 0.8%	High	9.3% / High 9.2% / High		High	All Districts equally
Asphalt surface parking	<5% of off-street parking	Low	16.9%	High	11.9% / High		Med	All Districts equally
White roofs	>10%	Low	5.5%	High	4.5% / Medium		Low	All Districts equally
Goal 4 – improving the social and economic benefits of green systems for health, mobility, and biodiversity								
Vegetation coverage	25%	Medium	4.9%	High	~20% / High		High	All Districts equally
Green open spaces	97—215 ft²/ person	Medium	1.6 ft²/ person	High	~200 / High		High	All Districts equally
Green streets	2 miiles	Low	0	High	2mi / High		Med	All Districts equally

The current state of green systems in the Gateway District is unsustainable across the goals of sustainable green systems, particularly in lowering temperatures, providing vegetation, and managing stormwater. As climate change continues to impact the Southwest with rising temperatures, longer droughts, and less precipitation, water resources will be ever-increasingly stressed and aquifers will reach dangerously low levels. If stormwater management and water consumption issues are not addressed, the District will face rising water costs and tensions among citizens about water access. Low incomes, insufficient political articulation, existing rules, and low funding for new green space and stormwater management drive Gateway's unsustainability, and will be the target of the strategy in this report.

In reviewing the results from the data-driven assessment, stakeholder inputs, and U.S. Department of Housing and Urban Development's livability principles, there are two priorities for the Gateway District to address in the process of achieving low temperatures, more vegetation, and naturally managed stormwater.

1. High temperatures in Gateway command the some of the greatest attention for mitigation. Surface and air temperatures have significant effects on human thermal comfort, and District temperature data reveal that less than 1% Gateway meets the sustainable threshold for temperatures. With global warming driving higher temperatures, and increased urban development as the city's population continues to grow, it will be essential for the District to address climbing temperatures. If these UHI issues are not addressed, Gateway could see increases in heat-related illnesses and diseases from declining air quality. In addition, the District will face rising costs to cool buildings as temperatures continue to increase.

2. Access to parks and green open space is a large area of concern in the District. With only 1.6 square feet of parkland per person and 4.9% tree coverage, there are almost no high quality green spaces. In addition, there are no green streets and few areas of natural conservation. Green spaces and natural habitats connect wildlife corridors and preserve habitats with native, drought-tolerant vegetation. Gateway will not be resilient to future environmental changes if biodiversity and native vegetation is compromised. Without a natural environment that can adapt to rising temperatures, reduced water availability, and declining biodiversity, the political, social, and economic systems that rely on that environment will face major challenges.

The priority for all goals is to overcome institutional and social barriers to sustainable technologies and practices. Further analysis of all four goals will be critical for developing effective strategies. Without intervention, Gateway will lack green space, waste water, and stay hot.

4.6. Open Issues

Tradeoffs between assessment goals require additional interpretation of the assessment results. For example, there are conflicts between water use, landscape quality, and the cooling of homes. Water use is an environmental sustainability issue, but temperatures drive a host of health and energy problems. Lower water use is good for water conservation, whereas higher water use improves the local landscape and thermal comfort. There is a similar conflict between air conditioning, which can improve health, and energy use.

Additional research is also needed to provide truly evidence-supported targets for indicators that operationalize the goals of sustainable green systems. In concert, sufficient data to assess performance relative to those targets is also lacking in some areas. However, this rigorously arranged assessment, even with a few missing data and thresholds, sets the stage for research that fills gaps and results in comprehensive and robust green systems assessments. Public agencies could support these efforts by collecting relevant data, making it accessible, and facilitating a better understanding of green systems sustainability issues. With evidence-supported targets and sufficient data for sustainability assessments, interpretation of distances-to-target would be better linked to priorities expressed by researchers, stakeholders, and funding bodies.

Chapter 5 – Causal Problem Maps of Green Systems

In this chapter, we present the drivers (causal structures) for the problems identified in the sustainability assessment (Chapter 4). The problem maps are primarily defined through those performance indicators that do not meet their sustainability targets. All causal assumptions are based on expert input and scientific literature. Performance indicators themselves cannot be directly changed, because change requires addressing the upstream drivers of indicators. The causal problem maps identify those drivers, and promising intervention points for strategies of change. (Golub et al., 2013).

The major drivers of stormwater management challenges are low funding, high costs, negative perceptions of new technologies, and insufficient technical capacity. Designers and engineers prefer "gray" methods such as non-permeable surfaces in stormwater systems, but costs for construction and maintenance limit implementation of more sustainable technologies. Strategic areas of intervention include funding for green water management systems, and building capacity and desire to build and use those technologies.

5.1. Goal 1 – Problem map of reducing stormwater loads and harvesting water on-site

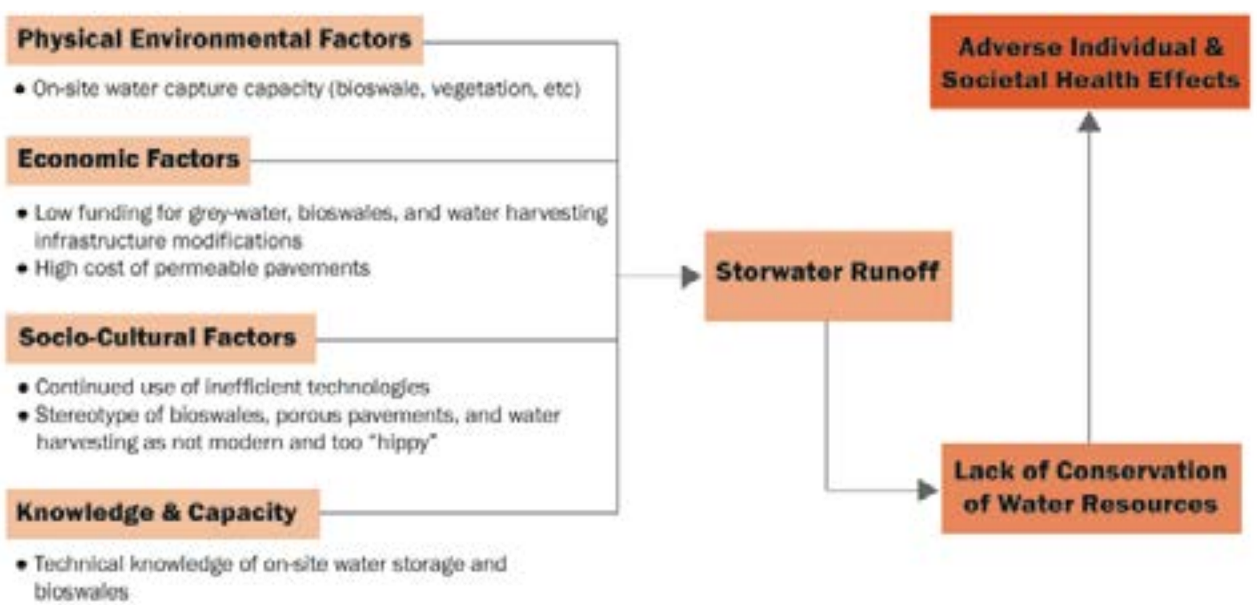

Figure 19. Reduce stormwater loads and harvest water on-site problem map

5.2. Goal 2 – Problem map of reducing potable water consumption

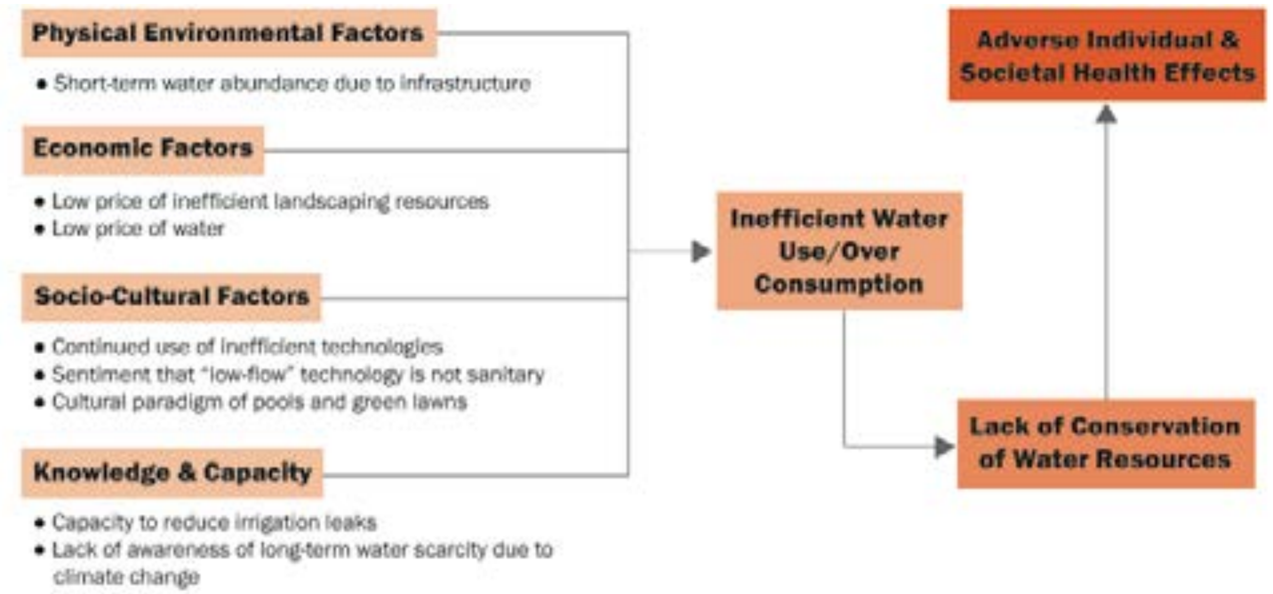

Figure 20. Reduce potable water consumption problem map

In addition to stormwater harvesting, reduction of potable water consumption can aid water conservation. Figure 20 illustrates that water abundance and underpricing in Phoenix encourage high water use. Availability of water-inefficient landscaping resources, such as non-native vegetation and traditional irrigation systems, combine with low prices to drive unsustainable usage rates, especially considering long-term water scarcity due to climate change. With a population often originating from Midwest or Eastern U.S., cultural preferences for lush landscapes are prevalent, and further pressure limited resources.

In addition, negative perceptions of water-saving technologies and insufficient ability to manage irrigation leakage increase water consumption. Often, residents do not know how to water unfamiliar plants and landscaping properly, leading to overwatering. Finally, landscape design often does not use sustainable water consumption as a criterion, leading to water inefficient landscape design. Possible areas of intervention include incentives and rules (city or HOA, etc.) that encourage native, drought-tolerant vegetation, and outreach to build knowledge and capacity about landscape design, water conservation technologies, and long-term water shortage risks.

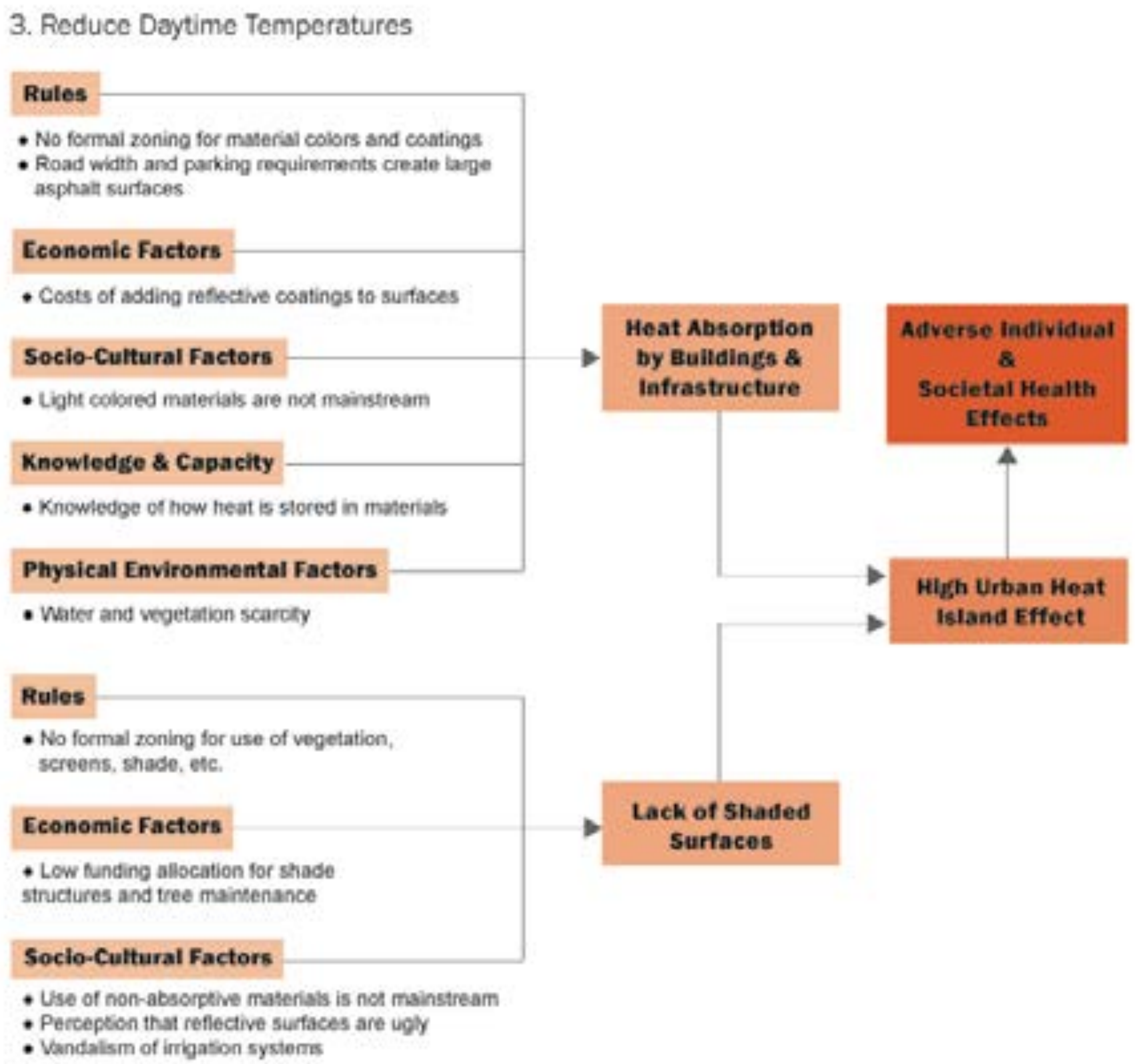

Figure 21. Reduce daytime temperature problem map

5.3. Goal 3 – Problem map of reducing daytime temperatures

Heat absorption by buildings and infrastructure, and a lack of shade, drive the UHI effect. Darker materials tend to have lower reflectance, absorb more solar radiation, and thus increase outdoor air temperatures. Tall buildings with narrow spacing can trap solar radiation and heat (Giguere, 2009), especially near the ground. UHI in Phoenix is compounded by a dearth of shade and low funding for shade structures and tree maintenance. Although there is zoning for initial vegetation, screens, and shade, there is little subsequent regulatory protection of plants and trees. This leads to property owners often removing vegetation in favor of further development.

Others drivers of high daytime temperatures include negative perceptions of reflective and non-absorptive materials and insufficient capacity and funding to retrofit existing infrastructure. Current design and construction practices do not utilize heat-reduction techniques, and many people do not understand the economic, environmental, aesthetic, and social benefits of vegetated landscapes and trees. Finally, heat absorption and high surface temperatures lead to heated stormwater runoff and more heat-related illness.

Focus areas for temperature reduction are zoning for heat reduction efforts (e.g. reflective material colors and coatings), support for property owner UHI mitigation, and marketing for colors and materials that reduce heat.

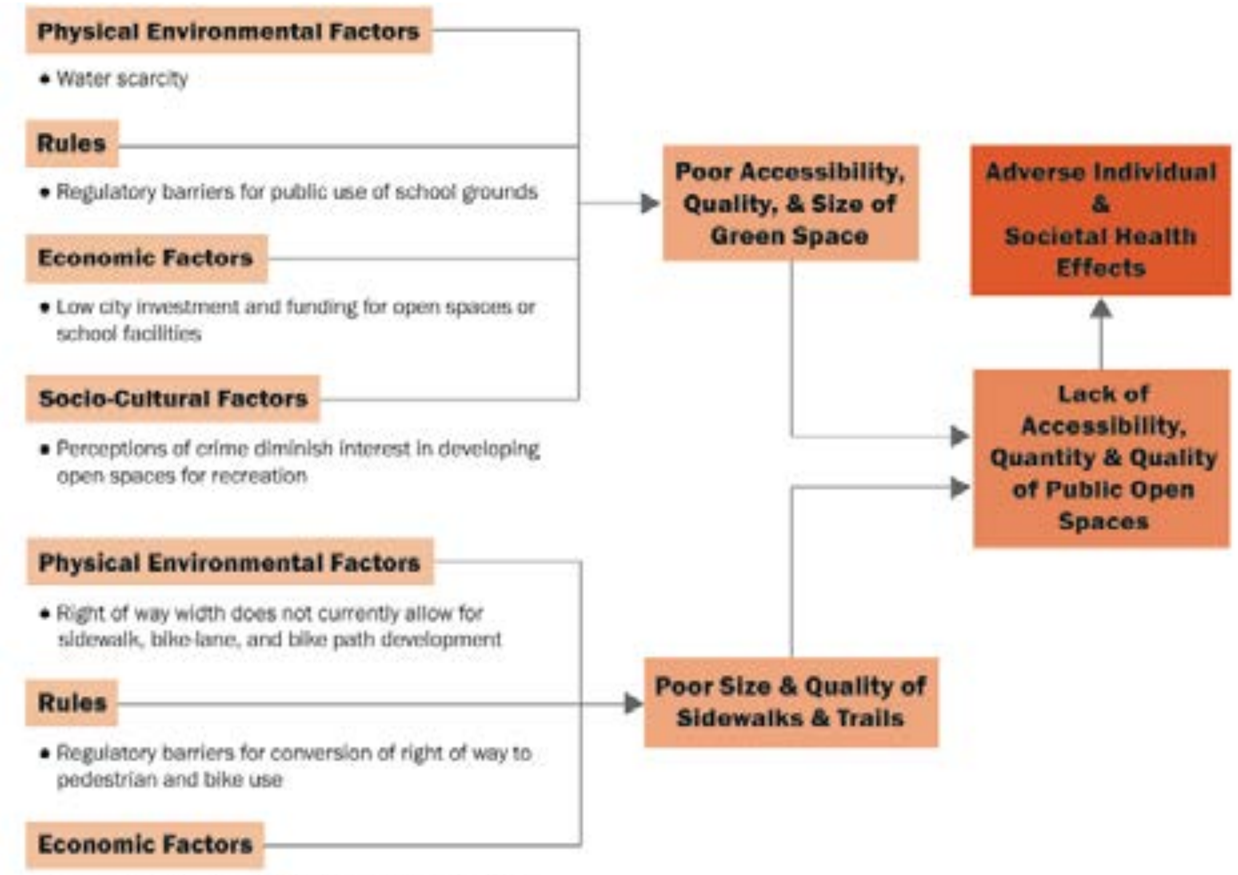

Figure 22. Accessibility, quality, and size of green space, sidewalks, and trails problem map

5.4. Goal 4 – Problem map of improving quantity and quality of green systems for social and economic benefits

Figure 22 illustrates the upstream drivers that affect the accessibility, quality, and size of green space, sidewalks, and trails. Water scarcity and low city funding for open spaces are exacerbated by perceptions of crime in open spaces, often driven by poor lighting and site selection. Regulatory barriers to public use of school grounds for recreational purposes limits access to what might otherwise be open space. City acquisition of new land for green spaces can be challenging and expensive, and high temperatures from the UHI effect disincentive investment in outdoor recreation areas.

Poor and size quality of sidewalks and trails stems from inadequate right-of-way (RoW) widths for bike and pedestrian paths, and low funding for RoW bike lanes. Streets designed for automobiles instead of bikes and pedestrians leaves bicyclists and pedestrians feeling unsafe, and discourages use of existing paths. Code complicates these problems by limiting the height and density of vegetation, and thereby its ability to shade and cool bike and pedestrian paths. Mitigation strategies include funding improvement and new uses of current open spaces, and removing RoW policy barriers.

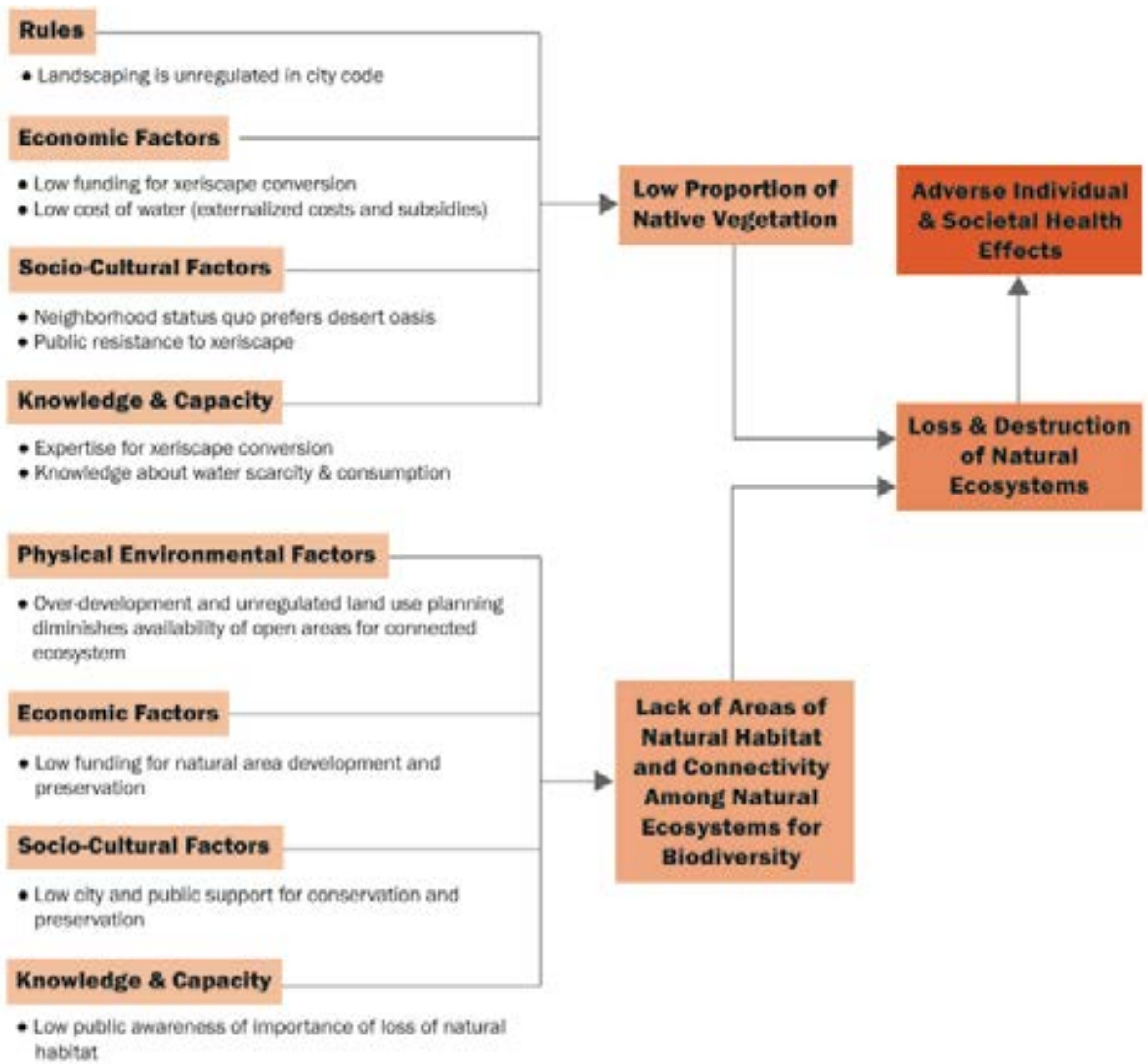

Figure 23. Limited native vegetation, ecosystem connectivity, and biodiversity problem map

Figure 23 shows the drivers of native biodiversity and ecosystem degradation. Cultural preferences for oasis vegetation, the low price of water, and landscaper unfamiliarity with xeriscaping all support conversion of native vegetation to non-native. Similarly, cultural preference for suburban development over natural open space, low funding for such open space, and low public knowledge of benefits from biodiversity and ecosystem services support the loss of ecosystem biodiversity and connectivity.

Chapter 6 – Transition Strategy towards Sustainable Green Systems

The sustainable green systems strategy has been developed based on the detailed expert-based sustainability assessments presented in the previous chapters; a community-informed sustainability vision; and the sketch of a theory of change. All three inputs are briefly summarized in the first section below (6.1.). These inputs were then processed into evidence-informed interventions and investments to transition green systems in the Gateway District from its currently unsustainable state to a sustainable state of fully functional stormwater, biodiversity, and resource management practices, as well as sustainable levels of thermal comfort, energy efficiency, and access to green space. The strategy adopts a long-term perspective that needs to be coordinated with short-term actions and clear roles and responsibilities of various stakeholder groups to be successful.

6.1. Strategy Inputs

6.1.1. Summary of Current State Assessment of Housing in the Gateway District

The most immediate green systems concerns for the Gateway District are high temperatures, low vegetation, and stormwater management. Sustainable green systems strive for fully functional stormwater, biodiversity, and resource management practices, as well as sustainable levels of thermal comfort, energy efficiency, and access to green space. The Gateway District struggles with unsustainable states in each of the four goal domains, while there are few positive aspects (Golub et al., 2013).

1. Insufficient stormwater is managed on-site by green systems. Natural systems capture only about half the sustainable level of stormwater run-off, and there is nearly no rainwater harvesting in the Gateway District.

2. Sustainability of potable water consumption varies by consumption type. High indoor residential potable water use seems balanced by low outdoor residential water use. However, distribution of use within the Gateway District is uneven, and there are trade-offs between low outdoor use and sufficient vegetation coverage.

3. Daytime temperatures are very high. Over 10% of the Gateway District has surface temperatures above 130oF, and 88% are 105—130oF, leaving nearly the entire District with temperatures above 105oF. High temperatures worsen the Urban Heat Island (UHI) effect, and drive a variety of health problems.

4. Green systems benefits to health, mobility, and economic activities can increase substantially. The Gateway District has no green streets, low tree canopy cover, and nearly no parks. Adding these amenities would help achieve the preceding goals, as well as improve health, mobility, and economic opportunities.

In summary, the Gateway District is in need of green systems that naturally manage stormwater on-site, reduce daytime temperatures, and provide safe, cool spaces for citizen recreation and transportation. Thereby, tradeoffs between different green systems features require special attention when crafting sustainable green systems visions and strategies. For example, vegetation that cools and beautifies residential homes also increases water use.

Data from stakeholder engagements in the Gateway District confirm the assessment findings. There was broad stakeholder agreement that high temperatures and the lack of parks and shade were priorities. In concert with safety concerns (Hager et al., 2012), these factors make green systems in the Gateway District insufficient to provide safe and comfortable recreation and mobility for citizens. Though stormwater management also poses challenges, stakeholder input prioritized temperatures, green space, and shade.

HUD has operationalized its mandate through Livability Principles (2009). Stormwater management, temperatures, green space, green streets, and shade are indicators that have a high distance to target, and are closely tied to the principles:

1. Enhance economic competitiveness

2. Provide more transportation choices

3. Promote equitable, affordable housing

4. Support existing communities

5. Coordinate and leverage federal policies and investment

6. Value communities and neighborhoods.

Livability Principle 1 aims at economic competitiveness. Green systems provide higher quality of life through better health outcomes, increased recreation options, and better urban aesthetics. Current state data shows low vegetation cover and no green streets, leading to economic disadvantages relative to places with more robust green systems.

Livability Principle 2 aims at providing safe transportation types. The current state data indicates insufficient shade for comfortable bus stops, which may reduce ridership. There are also no green streets in the Gateway District.

Livability Principle 3 aims at supporting equitable housing. The current state of residential vegetation distribution suggests that vegetative cooling and aesthetics are inequitable in the Gateway District.

Livability Principle 4 aims at supporting existing communities. The current state of residential vegetation distribution suggests that there is improvement potential to enhance green systems and support the quality of life for existing communities in Gateway.

While Livability Principal 6 aims at valuing communities and neighborhoods. Current state data for the Gateway District paint an un-shaded, extremely hot, unwalkable picture, in direct contradiction to HUD's wish to "invest in healthy, safe, walkable neighborhoods."

6.1.2. Summary of the Vision for Green Systems in Gateway

The vision for green systems in the Gateway District is to sustain a network of buildings, open spaces, streets, and canals that support healthy and prosperous neighborhoods through vegetation, building materials, quality design, and water management. The vision for green systems is part of the overall vision for the Gateway District (Wiek et al., 2012), which outlines a sustainability future for the Gateway District. Key excerpts are provided below:

In 2040, the Gateway District hosts new and renovated housing options, a small grocery store, and other family-owned businesses that employ district residents. Aesthetic Sonoran landscaping with strategic oases complements parks, the Grand Canal, and a mix of other land-uses. Mobility hubs in the Gateway District, especially those close to light rail stations, enjoy bustling pedestrian and bike traffic. People can live close to where they work, and are able to satisfy most of their daily needs without a car. Overall, Gateway is a balanced, diverse, thriving, connected, green, and healthy district.

The specific vision for sustainable green systems in the Gateway District is derived from this vision and is aligned with the five sustainable green systems goals mentioned above (1.3). It reads:

In 2040, the Gateway District is landscaped with trees and plants. Most places display the Sonoran landscaping that requires little water and accentuates Arizona's natural character. There are some lush oases of plants and grasses interspersed in the District. These verdant parks, squares, and green streets require more water and maintenance, but they also provide important services, such as cooling (mitigating the urban heat island (UHI) effect), shade for pedestrians, storm water managment, and neighborhood beautification. Along the Grand Canal, strategic landscaping gracefully transitions from Sonoran into the occasional oasis with nonnative or desert-adapted trees that provide a fuller canopy to shade users of the Grand Canal (walking, biking, jogging, etc.).

This green systems vision is further operationalized with quantified targets for lead indicators that allow for measuring progress toward achieving the four sustainable green systems goals. Table 11 summarizes few exemplary targets as well as distances-to-targets as key reference points for strategy building.

Table 11. Greens systems vision target table

Indicator	Sustainability Target (Range)	Current State Data	Distance-to-target
Goal 1 – Reduce stormwater loads and harvest water onsite			
Permeable land	70.3% (1700 acres)	46% (1111 acres)	24.3% (589 acres)
Goal 2 – Reduce potable water consumption			
Indoor residential	30 GPCD	46 GPCD	16 GPCD
Goal 3 – Reduce daytime temperatures			
Surface temperatures above 130° F	<1%	10.4%	9.4%
Goal 4 - Increase green systems benefits to health, mobility, and the economy			
Vegetation coverage	25%	4.9%	~20%
Green streets	2 miles	0 miles	2 miles

Through the visioning process, six priority areas (transition areas or areas of change) were selected in order to make the vision spatially explicit. Vision data determine building types, heights, and other characteristics appropriate for each locality.

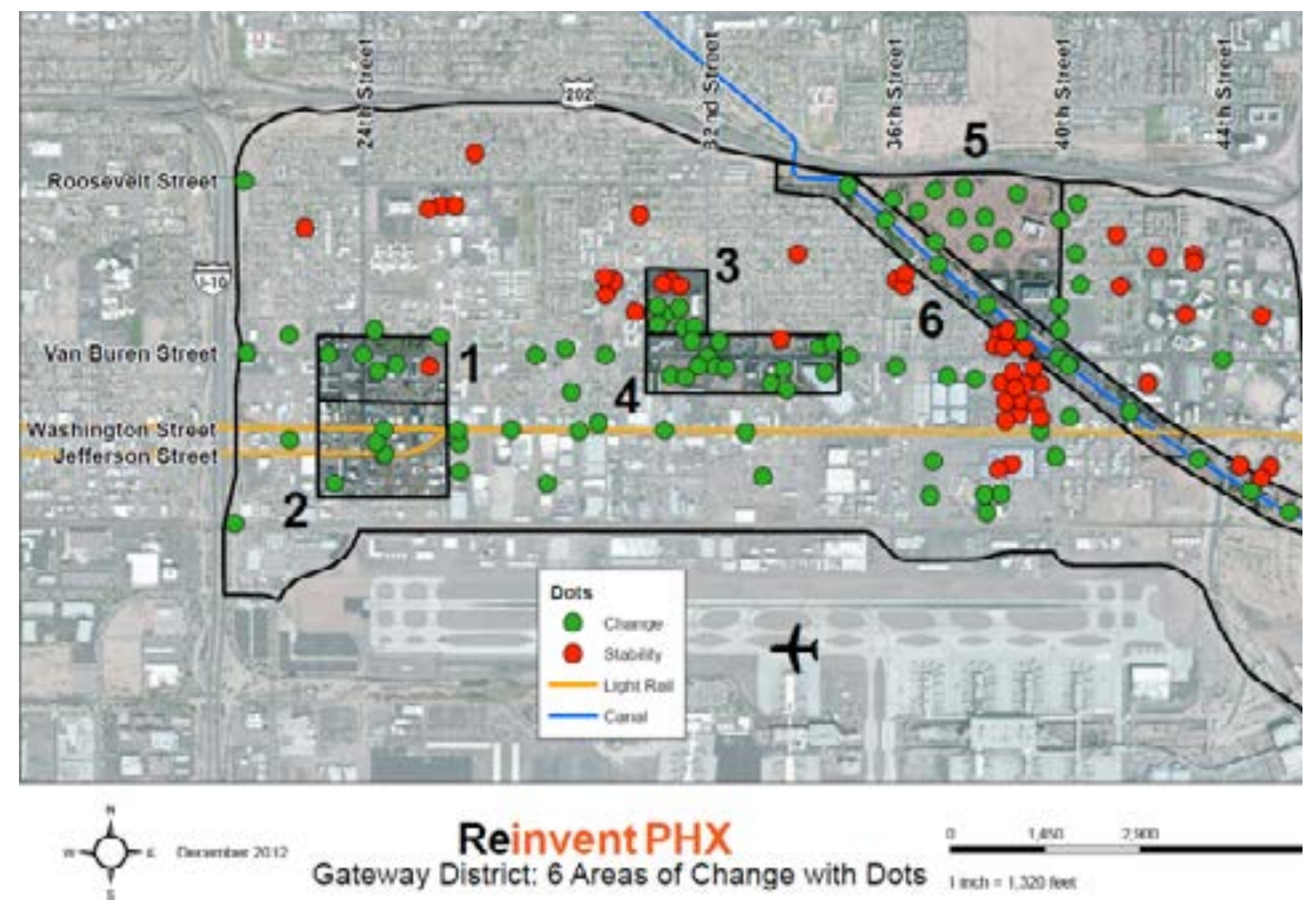

Figure 24. Gateway District Transition Areas

- Transition area 1: In 2040, landscaping in the area is water conscious, and plantings are a hybrid of Sonoran and oasis features. While green infrastructure does require water, it creates a lush feel and attracts people to outdoor public spaces. Native trees and plants use less water while some non-native varieties provide shade, which encourages walking even during the hot summer months.

- Transition area 2: In 2040, landscaping conserves water, as vegetation is a blend of native and non-native plants. The effect is a water-conscious landscape that provides sufficient shade that people can endure summer temperatures. The area's vegetation is beautiful, and people gather in green places.

- Transition area 3: In 2040, landscaping offers shade and improves the neighborhood's aesthetics. Keeping true to the Arizona climate, drought-tolerant Sonoran and hybrid vegetation make up most of the green infrastructure. Trees and shade structures line the streets and dot the neighborhood parks, offering more protection from the summer sun without increasing the use of declining water resources.

- Transition area 4: In 2040, Van Buren Street is landscaped with Sonoran and hybrid vegetation. Low-water trees shade the sidewalks and bike lanes, making walking and cycling more comfortable under the Arizona sun.

- Transition area 5: In 2040, Sonoran and hybrid landscaping create green spaces and shade for the area. Oasis landscaping is an escape from the desert at the main square, but is otherwise limited to preserve water. Rights of way are lined with trees to improve walkability, and parks feature shade structures to protect children from the sun as they play.

- Transition area 6: In 2040, landscaping along the Grand Canal corridor is a mix of both hybrid and Sonoran vegetation. While Sonoran landscaping fosters a regional identity and conserves water, and hybrid landscaping provides extra shade for pedestrian pathways, which extends the Grand Canal's use into the summer months.

Finally, a more detailed map captures desired green systems development in three groups: Streets (areas close to the light rail for taller new and adaptively reused mixed-used green systems), Buildings and Sites (and areas where rehabilitation is necessary), and Open Space (new and adaptive reuse green systems not close to the light rail). These designated areas inform where different interventions in the District should be implemented (Intervention opportunities are numbered 1 through 21).

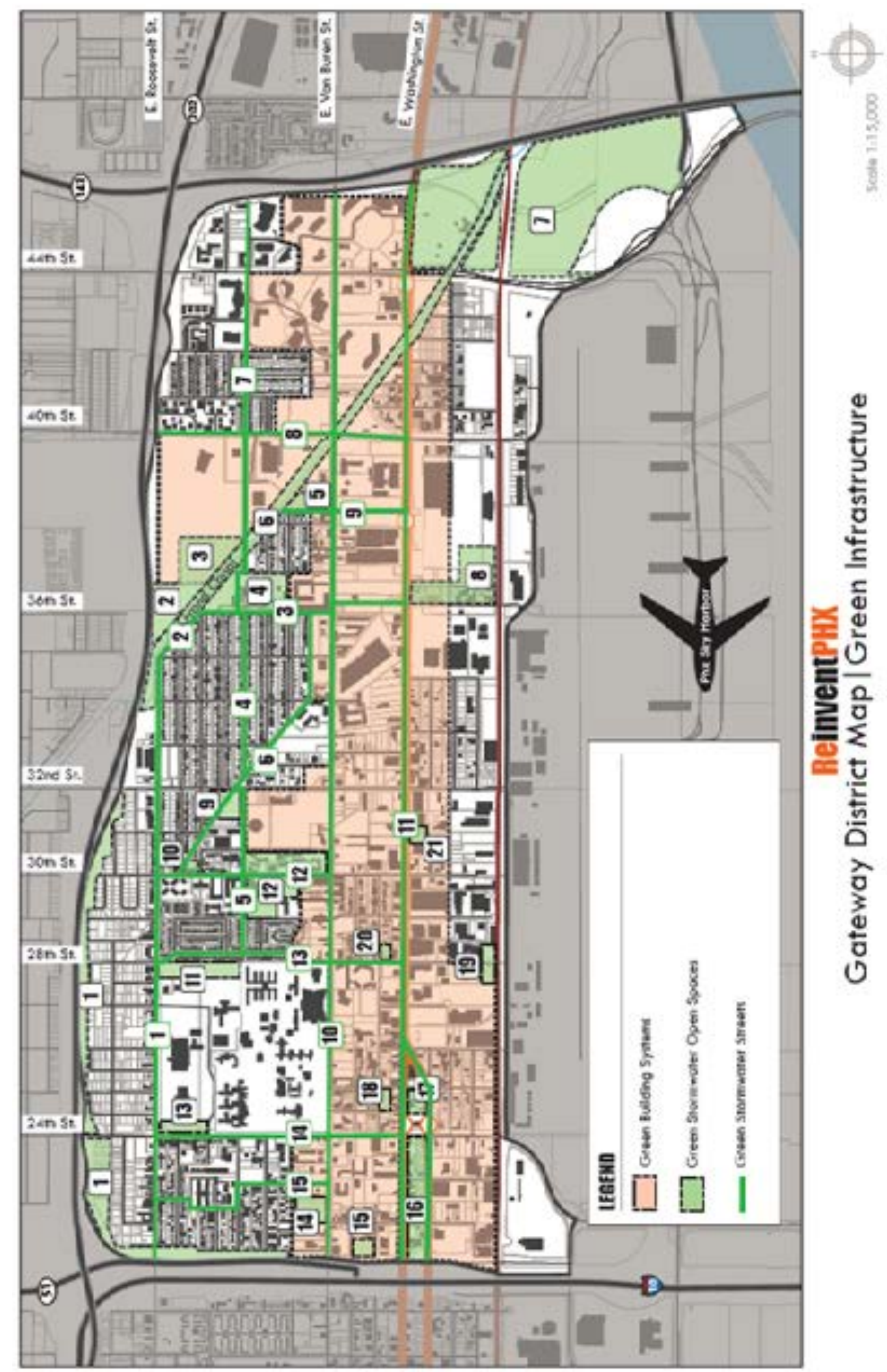

Figure 25: Vision Map for Green Systems

In order to craft actionable strategies, the qualitative descriptions of a sustainable state for green systems in the Gateway District need to be translated into quantitative targets. For each of the four green systems goals, Table 11 contains one or two critical targets that the strategy is designed to achieve.

6.1.3. Theory of Change

The theory of change of this strategy is that additional investments in green systems can support increased vegetation, which can decrease surface temperature and support quality of life and economic development in the Gateway District. This strategy includes interventions of streets, buildings and sites, and open space. Additional investments in cool building materials and engineered shade would support cooling the Gateway District. Investments in improving the stormwater collection on streets, and cooling highly trafficked corridors are important early priorities that will move the District towards the permeable surface target. Investments in using open space for District water retention, incorporating next-generation cooling technologies, and moving towards storing and/or using all stormwater on site may take more time to implement, but could have significant impact on achieving the green systems sustainability targets, such as reaching the desired reduction in surface temperatures. The following strategy will describe how these interventions and corresponding investment types can be enacted over the next 30 years to produce sustainable green systems in the Gateway District.

6.2. Linking Sustainable Green Systems Goals to Interventions and Investment Options

As described before, the overall and specific sustainable green systems goals are the reference point for developing the strategy and its interventions. Yet, the strategy aims at coordinating interventions that achieve multiple objectives at the same time. The interventions of streets, buildings and sites, and open space all contribute to achieving the four goals of sustainable green systems. Thus, from the perspective of implementation it is more useful to use the interventions as organizing principle, and design them in ways that they contribute to as many goals as possible. Therefore, we describe each intervention separately in the subsequent sections, detailing the specific investments, actions, resources, implementation tools, etc.

Goals	**Strategy**		
	Streets Intervention	**Buildings and Sites Intervention**	**Open Space Intervention**
1. Reduce stormwater loads and harvest water onsite	Widespread use of porous materials, and right-of-way bioswales will reduce impervious surfaces, will allow rainwater to be stored in the right of way.	Water capture and reuse is critical throughout the District, but will look different in different areas. Shade and cooling investments can capture and store excess rainwater.	Neighborhood water retention, green parking, and green civic spaces can reduce rainwater loads.
2. Reduce potable water consumption	Green streets and street parking will reuse rainwater, lower reliance on irrigation, and lower temperatures and UHI.	Next generation living buildings use rain and greywater. Shade and cooling investments can capture and store excess water on site, reducing potable water irrigation. Water-saving appliances can also contribute to reducing indoor potable water consumption	Green civic spaces and parking investments on open space will lower reliance on potable water irrigation. Lower temperatures might also reduce water consumption.
3. Reduce daytime temperatures	Green streets, shade, and cooling (including using cool construction materials) can all reduce daytime temperatures. Zoning and codes can cool hot blocks though promoting shade, and cool material usage.	Engineered and natural shade and cooling (e.g. white roofs) can reduce temperatures.	Natural and engineered shade and cooling used in green civic space and green parking lots can reduce temperatures.
4. Increase the benefits of green systems to health, mobility, and the economy	Green streets and parking can create comfortable and beautiful spaces that increase the likelihood of social connections and the success of retail and small business, while improving biodiversity and air and water quality.	Shade and cooling can create important gathering areas and incentive socializing, recreation, and retail and restaurant attendance.	Green civic space can create social connectivity and increase nearby property values. Carefully selected vegetation can contribute to biodiversity and air and water quality.

6.3. Streets Intervention

Street and right-of-way improvements are critical interventions for the Gateway sustainable green systems strategy. Green streets and green parking investments manage stormwater and increase porosity, vegetation, and cooling.

6.3.1. Core Components

The following describes the impacts, actions, resources needed, potential barriers, and timeline for the streets intervention.

Aspired Sustainability Impacts

Through this streets intervention, the following specific sustainable green systems targets will be achieved by 2040:

- 2 miles of green streets
- 100 more acres of permeable land
- 10% increase of District vegetation coverage (240 acres)
- 50 less acres of temperatures greater than 130°F

Intervention Points

Currently, the extensive street system contributes to high temperatures (urban heat island), and reduced economic and social activity in the Gateway District. By promoting cooling, the streets intervention creates more walkable corridors. The streets intervention can also divert water from the streets, buildings, and sites to bioswales in the right-of-way and in neighborhood water retention areas.

Intervention Actions

The following actions are critical for accomplishing the targets outlined above. These are critical actions that will likely need to take place in the first ten years of the transition. Further details on the actions necessary in the first five year are available in Section 3.5. The following actions are critical in meeting the milestones set in the timeline below.

Complete green streets that connect Crockett and Wilson elementary schools to Van Buren Street.

a. Complete the 30th Street green street pilot project with the Wilson School District.

b. Finance and design a similar project with the Balz School District for 36th Street north of Van Buren Street.

c. Work with Gateway Community College to create model green streets near and on campus (such as the progress made on 38th Street) and develop green parking on existing parking lots.

Make major green streets investments on Van Buren Street and the Grand Canal.

a. Seek city, state, and philanthropic funding for Van Buren Street improvement and create a long-term maintenance and street conversion fund with adjacent property owners.

b. Commence design process with acquired Maricopa Association of Governments (MAG) funding.

Build sustainable financing mechanisms for green streets in the Gateway District.

a. Create a business improvement district (BID) along Van Buren Street that can pool money from local businesses, landowners, and organizations to pay for addition street improvements.

b. Neighborhood associations contribute to creating street water retention systems with shade trees (building off the 9th Street example in the Garfield neighborhood with the support of Watershed Management Group).

Support research that improves evidence for best practices in green streets and green parking implementation, including material use, vegetation and tree selection, and rainwater management.

Design and seek funding to develop green street projects that build off successes along Van Buren Street and near schools.

d. Build off of success of Van Buren Street initiatives to finance and design 24th and 40th Street green street improvements.

e. Produce a feasibility study for neighborhood water retention on green civic spaces at local schools, the Greyhound Park, and hospital campuses.

Create educational programming on the multiple benefits of green streets and parking at Gateway Community College and local elementary schools, businesses, and non-profits.

Resources

The following resources are needed to support the streets intervention. Assets (resources that already exist) are in italics:

- Arizona Public Service (APS) and Salt River Project (SRP) Tree and Shade Program
- City of Phoenix Departments
  - Neighborhood Services (NSD) to work with schools and neighborhoods
  - Streets and Transportation (STD) to work on design and engineering
- Educational Institutions that can be involved in pilot projects
  - Crockett Elementary School and the Balz School District
  - Gateway Community College
  - The Global Institute of Sustainability (GIOS)
  - Wilson Elementary School and the Wilson School District
- MAG funding to study green street interventions on Van Buren Street
- Sky Harbor Neighborhood Association (Can support pilot projects)
- Watershed Management Group (WMG) (Can support pilot projects)
- More staff and capacity for organizations like WMG that can support and develop funding for pilot projects
- Development of state and federal funding streams for street improvement, air quality mitigation, and urban heat island reduction

Barriers

- Lack of a funding mechanism to design, build, and maintain green streets
- Current codes and standards that include restrictive rules (i.e. concerning water harvesting)
- Concerns that street retrofits will disturb automobile flow
- Concerns about rain water management in streets
- Existing infrastructure and utilities often prevent plang trees and shaping basins/swales
- Lack of education and understanding about green streets

Intervention Timeline

This timeline outlines a transition towards Gateway's sustainable green systems vision driven by streets over the next 30 years. Much can change during this time; thus, this transition strategy must be revisited and updated. Some of the actions listed as happening by 2025 or 2030 may be feasible before the stated date and could possibly be addressed sooner. The purpose of this timeline is to demonstrate a possible sequence (pathway) to achieve the 2040 vision, with the recognition that some things may come faster or slower. The "By 2020" section includes major milestones that could be accomplished if all of intervention actions in the list above are implemented or at least underway.

By 2020

- Make Van Buren Street and Grand Canal regional models for green streets and green parking.

- Connect the Wilson and Crockett Elementary Schools and Gateway Community College to Van Buren Street with green streets.
- Design and finance green street improvements to 24th and 40th Streets.
- Include durable green parking materials in the above projects.

By 2025

Neighborhood associations and the Van Buren Street BID have their own green street programs that have privately funded several green streets

- Complete 24th and 40th Streets green street improvements.
- Green streets around Van Buren Street are demonstrating positive impacts.

By 2030

- Design and finance green street improvements to 48th, Fillmore, Jefferson, Roosevelt, and Washington Streets.
- Local BID and neighborhood associations have designs and financing models to finish all target green streets by 2040.
- All street parking in the District is green parking due to material used and proximate shade trees.

Figure 26. Visualization of new construction intervention with all core components

6.3.2. Investment Types

6.3.2.1. Green Streets

Green streets use small-scale, vegetated bioswales along streets to help control stormwater. These constructed elements create on-site infiltration, while providing attractive streetscapes, increased canopy coverage, lower temperatures, and supporting biodiversity. They also improve a neighborhood's livability by adding park-like elements that serve as urban greenways.

Figure 26.

Green Streets can support an increase in permeable surfaces, on-site infiltration, and improved stormwater quality. Green streets have the added benefits of providing attractive streetscapes, increased canopy coverage, lowering temperatures and supporting biodiversity.

Implementation Tools (See Section 4.5. for details on each tool)

- Financing - Capital investments, Department of Transportation (DOT) funding (i.e. TIGER grants), and private investment
- Partnerships - BIDs and neighborhood initiatives
- Codes - Right-of-way codes
- Capacity Building - Watershed management training
- Incentives - Tax credits and expedited permitting

6.3.2.2. Green Parking

Green Parking is on-street or on-site parking that redirects and/or stores stormwater, usually through the use of pervious surfaces. Green parking can include stormwater management tools such as bioswales and rain gardens. Green parking offers a cleaner alternative to traditional parking lots that contribute to poor water quality and flooding.

Figure 27.

Green parking can significantly increase pervious surfaces, and contribute to better stormwater quality. Green parking can also support shade and cooling efforts.

Implementation Tools (See Section 4.5. for details on each tool)

- *Financing* - Capital investments, DOT funding (i.e. TIGER grants), BIDs, Community Development Block Grants, HOME Investment Partnerships Program, and private investment
- *Partnerships* - CDCs and neighborhood initiatives
- *Codes* - Land use ordinance, capacity building, and watershed management training
- *Incentives* - Tax credits and expedited permitting

6.4. Buildings and Sites Intervention

The building and sites intervention for the Gateway sustainable green systems strategy addresses the significant potable water use, and contributions to high surface temperatures from buildings and sites. Water harvesting and reuse, and natural and engineered shade and cooling systems are important investments that can be made in new construction and retrofits of buildings to reduce potable water use, and surface temperature, and increase vegetation and social benefits.

6.4.1. Core Components

Aspired Sustainability Impacts

Through the buildings and sites intervention, the following sustainable green systems targets will be achieved in Gateway by 2040:

- Potable water use reduction of ~15 gallons to 30 gallons per capita per day
- 200 more acres of permeable land
- 10% increase of District vegetation coverage (240 acres)
- 200 less acres with surface temperatures greater than 130°F

Intervention Point

Buildings are a good mechanism for engineered shade and cooling, while sites are excellent opportunity for natural shade and cooling. Building and sites present important intervention points for reducing potable water consumption, partially through well-designed rainwater harvesting and reuse mechanisms. Building and sites that use natural and engineered shade and cooling investments have the opportunity to produce positive environmental, social, and economic benefits, such as meeting places, enjoyable retail opportunities, and increased biodiversity.

Intervention Actions

The following actions in the first ten years of the transition are critical for accomplishing the impacts listed above. Further details on the actions necessary in the first five years are available in Section 3.5. The following actions are critical in meeting the milestones set in the timeline below.

- Pass code updates that create density dependent guidelines for water harvesting and reuse, and natural and engineered shade and cooling that is dependent on the density of the area. Form-based codes designate transect zones densities from 1 (least dense) to 6 (most dense).

- Design, fund, and build strong examples of water harvesting and shade and cooling investments on private property.

a .Create clear urban examples of onsite retention and cooling in transect zones 3–6.

b. Market building and sites green systems success stories.

c. Deliver education and capacity building programming that uses pilot projects to teach the benefits of water harvesting and reuse, and natural and engineered shade and cooling.

- Create an awards program that honors the most successful uses of the new code.
- Use the success of pilot projects to pass more progressive building and site codes for the District.
- Support research into next-generation water harvesting, water reuse, and engineered shade and cooling technologies.
- Improve and develop incentive programs for cool building materials, water harvesting and reuse technologies, and energy efficiency.
- Experiment with additional benefits of natural shade and cooling, such as food production, (e.g. on-site citrus or mesquite groves).

Resources

The following resources are needed to support the building and sites intervention. Assets (resources that already exist) are in italics:

- City of Phoenix Departments
  - Planning and Public Works for code updates
  - Neighborhood Services for enforcement
- Reinvent PHX for new code
- Private property owners for investment
- American Society of Landscape Architects (ASLA) for design and developer consultations
- Research to prove impact of water harvesting, and shade and cooling investments
- Training for builders and tradesman
- Incentive structures such as tax credits for use of certain materials or water systems
- Barriers
- Lack of financing mechanisms
- Current codes
- Lack of education and understanding (designers & city staff)
- Climate change including increasing UHI impacts could make using natural vegetation more water intensive
- Lack of resources for maintenance
- Expense of cooling technologies

Intervention Timeline

This timeline outlines a transition towards Gateway's sustainable green systems vision driven by building and sites over the next 30 years. Much can change during this time; thus, this transition strategy must be revisited and updated. Some of the actions listed as happening by 2025 or 2030 may be feasible before the stated date and could possibly be addressed sooner. The purpose of this timeline is to demonstrate a possible sequence (pathway) to achieve the 2040 vision, with the recognition that some things may come faster or slower. The "By 2020" section includes major milestones that could be accomplished if all of intervention actions in the list above are implemented or at least underway.

By 2020

A new form-based code with effective rules and regulations for water harvesting and reuse, and natural and engineered shade and cooling

- Successful engineered cooling, and water harvesting pilot projects for single-family homes in Sky Harbor neighborhood, and mixed-used developments along Van Buren.
- A marketing campaign that includes awards for effective implementation of water harvesting and reuse, and natural and engineered shade and cooling.
- Funding secured from Gateway Community College, and Arizona State University for research on next-generation technologies (for water harvesting, and engineered cooling), with some money for smaller scale research projects at high schools and elementary schools in the District.

By 2025

New projects that test the effectiveness of next generation technologies, such as nanotechnology enhanced cooling materials, and innovative building monitoring systems

- Experiments with multi-functional natural cooling systems, such as school based mesquite groves and citrus orchards.
- Research relative educational outcomes for schools investing in building and site green systems, and relative talent retention of businesses who make similar investments.
- Creation of an incentive program that promotes the use of best available technologies.
- A marketing campaign that highlights the second phase of successful pilot projects and experiments in the District.

By 2030

- Updated code that builds upon lessons learned from pilot projects and uses new heat mapping to target areas in the District where aggressive cooling investments are needed.
- A regenerative code that adjusts standards for cooling and water management projections.

6.4.2. Details on Investment Options for Buildings and Sites

6.4.2.1 On-Site Reuse and Harvesting

Bioretention basins, tree pockets, water harvesting, and greywater systems are landscape and building elements that collect, filter, and slowly release water. Reusing "greywater" from non-toilet inside uses and capturing and "harvesting" rainwater both reduce potable water use in and around buildings. Greywater includes wastewater from bathtubs, showers, bathroom sinks, washing machines, and laundry tubs. (It does not include wastewater from kitchen sinks, photo lab sinks, dishwashers, or laundry water from soiled diapers.) Greywater is typically used for landscaping outside, or for flushing toilets inside. Water harvesting captures and stores rainwater for later use in landscaping around the building.

This investment contributes to potable water use reduction with appliances that use less water, and substituting the use of outdoor potable water with stormwater and greywater when possible. This investment can also increase permeability promote cooling. In general, properly designed and constructed retention cells achieve excellent removal of heavy metals, moderate storm water discharge, enhance wildlife habitats, and act as windbreaks and noise absorption.

Implementation Tools (See Section 4.5. for more details)

- *Financing* - Capital investments, Maricopa County flood control funding
- *Partnerships* - BIDs and neighborhood initiatives
- *Codes* - Building codes (plumbing requirements)

- *Capacity Building* - EPA training, Water Use it Wisely Campaign
- *Incentives* - Tax credits

6.4.2.2. Natural Cooling and Shade

Trees and other vegetation help cool the environment and reduce UHI. They help lower surface and air temperatures, with shaded surfaces 20—45°F cooler than areas without shade. Trees and other plants are most useful when placed in strategic location where they shade buildings and fenestrations. They may also be placed in parking lots and along the street where surfaces may be hotter.

Figure 28.

Trees and vegetation can reduce surface temperatures and support thermal comfort. Cooling effects can reduce UHI and energy use.

Investment Tools (See Section 4.5. for more details)

- Financing - Private financing
- Partnerships – BIDs and neighborhood initiatives
- Codes - Building codes
- Capacity Building - APS and SRP Tree Programs
- Incentives - Tax credits

6.4.2.3. Engineered Shade and Cooling

Mitigation strategies start with the location of buildings, and their orientation to the path of the sun. Facades can limit sun exposure where necessary. The placement of buildings may also create passive cooling systems, which reduce the demand for energy. Engineered cooling materials and practices also include choice of materials, vegetation, and other green infrastructure components (Giguere, 2009). Green roofs, walls and parking lots may be both reflective and pervious, especially in parking lots (Giguere, 2009). Cool zones with misters and other engineered cooling technologies can also be used. All of these components help provide shade and reduce energy demand and temperatures. Shade prevents heavier materials from absorbing the sun's energy and contributing to UHI.

Figure 29.

Engineered shade and cooling can support thermal comfort and reduce surface temperatures, energy use, and UHI.

- Investment Tools (See Section 4.5. for more details)
- Financing – Capital investments, and private investment
- Partnerships – BIDs and neighborhood initiatives
- Codes – Building codes (cool material and shade requirements)
- Capacity Building – Cool material training
- Incentives – Tax credits

6.5. Open Spaces Intervention

The open space intervention refers to investments at large sites including parks, parking lots (or other underutilized lots), and open space on publicly-owned land, such as hospitals and schools.

6.5.1. Core Components

Aspired Sustainability Impacts

Through the open space intervention, the following sustainable green systems targets will be achieved by 2040:

- 300 more acres of permeable land
- 5% increase of District vegetation coverage (120 acres)
- 100 less acres with temperatures greater than 130°F

Intervention Points

Open spaces are a critical point of intervention to cool the District, provide social and economic benefits, and retain rainwater runoff. Given that open space is often publicly owned, it is possible to make the argument that this space needs strong investments to maximize its benefit to residents, and businesses in the Gateway District. Schools, hospitals, and new construction of large-scale mixed-use development are important open spaces to make initial investments.

Intervention Actions

The following actions are critical in the first ten years of the transition for accomplishing the impacts listed above. Further details on the actions necessary in the first five years are available in Section 3.5. The following actions are critical for meeting the milestones set in the timeline below.

- Create pilot open space projects at Crockett and Wilson Elementary Schools, Gateway Community College, Grand Canal, and the Arizona State Hospital to increase retention capacity with silva cells, orchards, rain gardens, and other water harvesting and retention mechanisms.
- Design, finance, and construct a civic space pilot project using silva cells that tests capacity for structured water management in a dense area of the District, such as 44th Street and Washington Street, 24th Street and Washington Street, or 20th Street and Van Buren Street.
- Fund research on the effectiveness of technologies and vegetation in pilot projects.
- Commence a campaign to market pilot project successes, emphasizing the importance of water management and the need for increased public space.
- Renegotiate MS4 permit to allow for next-generation stormwater solutions.
- Create long-term funding structures, such as in-lieu feeds for trees and retention, which could be part of a neighborhood association, BID, or CDC.
- Produce a feasibility study for neighborhood water retention on green civic spaces at local schools, the Greyhound Park, and the hospital campuses.

Resources

The following resources are needed to support the open space intervention. Assets (resources that already exist) are in italics:

- Reinvent PHX to provide goals, and best practices
- APS & SRP shade tree program for increase trees
- Global Institute of Sustainability (GIOS) to research effectiveness of investments
- Watershed Management Group to develop pilot

projects

- American Society of Landscape Architects to design projects and create an awards program
- Private capital
- Nurseries for discounted trees and vegetation
- Schools (Crockett and Wilson) to grow additional plants
- Construction companies for discounted or pro bono work to reduce grade

Barriers

- Labor and time requirement to regrade schools and parks
- Existing infrastructure (expensive and challenging to retrofit existing spaces)
- Lack of capacity and understanding of developers who favor cost-cutting mechanisms
- Lack of current organizational capacity (BIDs, CDCs, and neighborhood associations) to manage and finance needed investments

Intervention Timeline

This timeline outlines a transition towards Gateway's sustainable green systems vision driven by open space over the next 30 years. Much can change during this time; thus, this transition strategy must be revisited and updated. Some of the actions listed as happening by 2025 or 2030 may be feasible before the stated date and could possibly be addressed sooner. The purpose of this timeline is to demonstrate a possible sequence (pathway) to achieve the 2040 vision, with the recognition that some things may come faster or slower. The "By 2020" section includes major milestones that could be accomplished if all of intervention actions in the list above are implemented or at least underway.

By 2020

- A new form-based code with effective rules and regulations for water harvesting and reuse, and natural and engineered shade and cooling that supports using open space for green systems (e.g. using open space as retention for zones 5—6)
- Successful pilot projects at Crockett and Wilson elementary schools, Gateway Community College, a portion of the Grand Canal, and the Arizona State Hospital that lower the grade of large portions of each property to improve its water retention capacity
- A marketing campaign including awards for effective implementation of silva cell-based civic space, neighborhood water retention, green parking on open space
- New MS4 permit that allows for neighborhood retention

By 2025

- Experiments with multi-functional natural cooling systems and water retention, such as school based mesquite groves and citrus orchards
- Updated code that builds on lessons learned from pilot projects and uses new heat mapping to target areas in the District where aggressive cooling investments are needed
- Invest in 2—3 new open space opportunities, such as an urban forest in the northwest corner of the District

By 2030

- A regenerative code that adjusts standards for cooling and water management projections
- A new marketing campaign that highlights successful the second generation pilot projects and experiments in the District, and gathers support for public investment in open space projects critical for ensuring cooling targets will be met by 2040

6.5.2. Details on Investment Types for Open Space

6.5.2.1. Neighborhood Retention Basins

Neighborhood retention basins are landscape elements that collect large amounts of water (e.g. parks, golf courses, or other uses). They filter water and slowly release it back into ground water. This investment can be placed near a dense urban area where on-site retention is not possible due to building density.

This investment contributes to permeability, and can be used to promote cooling. In general, properly designed and constructed retention cells achieve excellent removal of heavy metals, moderate storm water discharge, enhance wildlife habitats, and act as windbreaks and noise absorption.

Implementation Tools (See Section 4.5. for more details)

- Financing – Capital investments and Maricopa Flood control funding
- Partnerships – BIDs, CDCs, and neighborhood initiatives
- Codes - Land use ordinances, capacity building, watershed management training
- Incentives - Tax credits and expedited permitting

6.5.2.2. Green Civic Spaces

Green civic spaces include parks, plazas, open space, and public greens that redirect and/or store stormwater with pervious surfaces, bioswales, rain gardens, and vegetation (including trees). Green public spaces allow the Gateway District to be intentional in using open space and stormwater to beautify and contribute to cooling.

Figure 30.

Green open space can significantly increase the amount of pervious surfaces in a District, and can contribute to higher stormwater quality. Green open space can also support shade and cooling efforts.

Implementation Tools (See Section 4.5. for more details)

- Financing - Capital investments, DOT funding (i.e. TIGER grants), BIDs, and private investment
- Partnerships - CDCs and neighborhood initiatives
- Codes - Land use ordinances
- Capacity Building - Watershed management training
- Incentives - Tax credits and expedited permitting

6.6. Details on Implementation Tools for Green Systems

[Table 12 in separate document]

6.7. Synthesis – 5-year Action Plan for Sustainable Green Systems in Gateway

The following plan details the aforementioned intervention actions that government, non-profits, businesses, residents, and members of the Steering Committee can take to implement the sustainable green systems strategy. Actions are not sequential, but the sub-actions (a, b, c, etc.) are sequential. Actions are designated short-term (year 1), mid-term (1—3 years), or long-term (3—5 years).

Work with local schools and their districts on green systems pilot projects and educational outreach

1. Complete a 30th Street green street pilot project with the Wilson School District that connects the school with Van Buren. (1—3 years)

2. Create educational programming about the evidence for multiple benefits of green systems at Wilson and Crockett Elementary School with Gateway Community College, businesses, and non-profits. (1—3 years)

    a. Partner the Global Institute of Sustainability with local school Districts and Gateway Community College to create a green systems educational working group (GIOS)

    b. Gather data from local pilot projects

    c. Create initial round of testing materials and test with students

3. Finance and design a similar project with the Balz School District for 36th Street north of Van Buren Street. (3—5 years)

4. Create pilot open space projects at Crockett and Wilson Elementary Schools, Gateway Community College with silva cells, orchards, rain gardens, and other water harvesting and retention mechanisms. (3—5 years)

Streets and Transportation Department and Planning Department work on large-scale green streets and civic space projects

1. Make major green streets investments on Van Buren Street and the Grand Canal through commencing design process with MAG funding. (year 1)

2. Seek city, state, and philanthropic funding for Van Buren Street improvement and create a long-term maintenance and street conversion fund with adjacent property owners. (year 1)

3. Design, finance, and construct a civic space pilot project using silva cells that tests capacity for structured water management in a dense area of the District, such as 44th Street and Washington Street, 24th Street and Washington Street, or 20th Street and Van Buren Street. (3—5 years)

Incentivize and market to developers to create open space and building and sites green systems investments

1. Pass code updates that create density dependent guidelines for water harvesting and reuse, and natural and engineered shade and cooling that is dependent on the density of the area. Form-based codes designate transect zones densities from 1 (least dense) to 6 (most dense). (Planning Department) (year 1)

2. Renegotiate MS4 permit to allow for next-generation stormwater solutions. (Public Works Department) (year 1)

3. Create an awards program that honors the most successful uses of the new code, including new technologies (Planning Department) (1—3 years)

4. Develop, Design, and building buildings with state of the art green systems technologies (3—5 years)

    a. Create clear urban examples of onsite retention and cooling in transect zones 3—6.

    b. Market building and sites green systems success stories.

    c. Deliver education and capacity building programming that uses pilot projects to teach the benefits of water harvesting and reuse, and natural and engineered shade and cooling.

Chapter 7 – Discussion and Conclusions

7.1. Critical role of Steering Committee, City Council, City Departments, Local Experts

The proposed strategy is intended to be a dynamic roadmap for people and organizations interested in sustainable change, helping them take ownership and collaborate to achieve the goals and targets set forth. The Steering Committee will play a critical role in executing this strategy, and motivating City Council, city departments, and local organizations to play significant roles in financing, regulating, and supporting the deployment of interventions. While city government cannot be the sole implementer of this strategy, it is critical that City Council and city departments find ways to align their funding, programming, and internal goals with this strategy. Village Planners and Steering Committee members need to be proactive in ensuring that councilmembers and city departments feel invested in supporting sustainable green systems in the District. There is a critical role for local organizations and experts to provide support to the Steering Committee in implementing this strategy. Green systems advocates and sustainability experts can help prioritize and adapt interventions and investments based on monitoring, comparison, and new insights from across the country.

7.2. Testing Strategy, Interventions, Investments

More work needs to be done to further understand the drivers of the green systems challenges, and to specify the vision for sustainable green systems in order to enhance the effectiveness and efficiency of interventions and investment options. Further research needs to scrutinize barriers to implementation and potential coping strategies, such as less expensive ways to improve the grade of properties for water retention or how to overcome common maintenance challenges with street trees. This strategy is intended to provide a basis for use-inspired research that will lead to a culture of evidence-supported sustainable green systems policy-making in Phoenix.

Testing interventions and investments is critical to the success of the strategy. The Steering Committee and supporting staff needs to monitor which interventions are the most effective and efficient. Pilot projects can help determine the sustainability impacts of each investment. For example, an early green streets pilot project can test whether that investment will achieve specific targets, including shade and porosity. If financing, design, or construction of pilot projects proves difficult, then investment in green systems on buildings and property may be a better investment to reach those targets. A culture of experimenting with and testing of investment options can lead to effective and efficient policy making that demonstrates the highest impact with limited resources.

7.3. Coordination across Strategies

A broader transition strategy across all six planning elements is needed, as the greens systems strategy depends on other strategies. For example, strong economic development strategies will improve the green systems in the District. If the economy of the District is strong, businesses and property owners may be willing to pay in-lieu fees for water retention or street trees, but if economic development is weak, it is much less likely that adequate resources will be available to achieve the goals of this strategy. If these strategies are not pursued in concert, it is possible that these targets will not be reached.

7.4. Anticipating the next Set of Interventions, Investments, and Implementation Tools

Interventions and investments are not static. It is most likely that over the next decades, different interventions, investments, and implementation tools will be used to achieve the green systems targets set forth. The Steering Committee and supporting city staff should attempt to anticipate possible future interventions, investments, and implementation tools not yet utilized in the current strategy. It is also likely that new financing mechanisms such as crowdsourcing or TIFs become viable options for the Gateway District, and could be essential implementation tools to reach green systems targets. While this strategy provides a solid set of intervention and investment options, it is important that these options are continually tested and monitored, while emerging options are explored.

7.5. Crafting the next 5-year Plan

It is also important to understand that there is a lot of uncertainty about what will occur in the future that might make aspects of this strategy obsolete. Therefore, it is important that the strategy is regularly revisited and revised. Every five-year cycle should give the Steering Committee, city departments, and other stakeholders the opportunity to revisit progress towards the goals and targets, and craft a new five-year plan. This will give stakeholders an opportunity to decide on critical actions and what roles and responsibilities need to be fulfilled in the next five years. Lessons from the previous five years should inform realistic expectations for what can be accomplished. While the long-term view of this strategy is important in terms of 'keeping the eyes on the prize', it is critical that the Steering Committee and other stakeholders in the District organize themselves around short-term action plans.

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