

City of Phoenix Code Review to Promote Green Infrastructure – Case Study

1 Introduction

Green infrastructure uses vegetation and soil to manage rainwater where it falls. This broad term can include minimizing impervious area on a development site; preserving a site’s natural features, vegetation, and water; planting new trees; or installing “engineered” best management practices (BMPs) that mimic natural functions such as rainwater storage, infiltration, and cleansing. The US Environmental Protection Agency (USEPA) states that green infrastructure “is an approach that communities can choose to maintain healthy waters, provide multiple environmental benefits, and support sustainable communities” (<http://water.epa.gov/infrastructure/greeninfrastructure/index.cfm>). To support this approach, USEPA—through its contractor Tetra Tech—is providing green infrastructure technical assistance to the City of Phoenix and 16 other communities across the country.

The City of Phoenix provides a unique opportunity to serve as a case study for green infrastructure code analysis and the application of the EPA Water Quality Scorecard to an urban, arid environment. Phoenix is the 6th largest city in the United States, encompassing an area of approximately 600 square miles. Phoenix is located in a dry, desert environment, characterized by only 7 inches of rain per year, high evaporation rates, and low soil permeability. These defining characteristics require modified approaches to green infrastructure techniques, as compared to those typically used in a more temperate environment. The City’s leadership recognizes the value of green infrastructure in addressing stormwater management as well as other key issues for the City such as conserving and protecting the water supply and open space, creating more shade for bikable and walkable streets, improving air quality, and reducing the urban heat island effect.

Often development codes and standards can work against these goals. Local codes and ordinances can include inflexible standards or incorporate outdated requirements that result in excess impervious area and reduce the functionality of the landscapes.

To identify potential green infrastructure barriers in the City of Phoenix, Tetra Tech and the City Team reviewed relevant sections of the City Codes and Zoning Ordinance, using two existing green infrastructure code and policy evaluation tools: Tetra Tech’s Green Infrastructure Opportunity Checklist Tool and the EPA Water Quality Scorecard (hereafter referred to as the “Checklist” and “Scorecard”). Tetra Tech worked with the City Team to modify the Checklist and Scorecard tools, tailoring them for use in the City’s arid, urban environment.

This case study summarizes the approach used for the code review and key findings.

2 Code Review Approach

First, the City formed a multi-departmental team and a cadre of expert advisors to guide and assist the code review. The team included the City’s Office of Environmental Programs, Parks and Recreation, Water Services, Planning and Development, and Street Transportation Departments, Arizona State University, local consultants, and EPA.

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Prior to conducting the code review, Tetra Tech worked with the City Team to identify the following codes, ordinances, standards, guidelines, and plans that could have bearing on green infrastructure implementation and should be subject to review:

- City Code Chapter 23 – Morals and Conduct
- City Code Chapter 24 – Parks and Recreation
- City Code Chapter 27 – Solid Waste
- City Code Chapter 31 – Streets and Sidewalks (including Street Landscape Standards and Street Planning and Design Guidelines)
- City Code Chapter 32 – Subdivisions (Article III)
- City Code Chapter 32A – Grading and Drainage and the referenced Stormwater Policies and Standards Manual
- City Code Chapter 32C – Stormwater Quality
- City Code Chapter 34 – Trees and Vegetation
- City Code Chapter 39 – Neighborhood Preservation Ordinance and Code Enforcement Policy
- City Code Chapter 41 – Zoning Ordinance
- 2006 Phoenix Building Code
- 2006 Uniform Plumbing Code
- 2006 Phoenix Residential Code
- Phoenix General Plan 2002
- Phoenix Tree and Shade Master Plan, and
- 2011 Phoenix Green Construction Code

Next, Tetra Tech worked with the City Team to identify the goals within the Checklist and Scorecard tools that are most relevant to the City’s arid, urban environment and most closely aligned with the City’s other environmental objectives. Several goals emerged as priorities, including:

- Preserving trees (to provide water quality, heat island, and other triple-bottom-line benefits).
(**Figure 1**)



Figure 1. Trees Along 3rd Avenue and Roosevelt (courtesy City of Phoenix)

- Reducing the impervious area of streets and parking (to reduce water quality, flooding, and hydromodification impacts).
- Promoting green infrastructure practices that capture stormwater on site (to reduce water quality, flooding, and hydromodification impacts). (**Figures 2, 3, & 4**)
- Protecting washes.



Figure 2. Retention in recreation area.



Figure 3. Parking lot runoff captured by bioretention in parking islands



Figure 4. Permeable paver patio (courtesy Summer Waters, UA Cooperative Extension)

Several sections of the tools were also de-emphasized based on the City's geography, climate, and local priorities. The Phoenix area has a mean annual precipitation of approximately 7 inches. On average, there are 15 distinct rainfall events annually with a measured rainfall of over 0.10 inches, about four of these which provide rainfall greater than 0.5 inches. The average rain event is approximately 0.2 inches, but nearly half of all measured events range from 0.01 – 0.09 inches. Historically, the majority of the rainfall has fallen during the winter season, when many plants are dormant or have minimal water needs. May and June are the driest months of the year, with almost no rainfall, but are also among the hottest months. In any given year, certain localized areas in the region may receive only light rain to almost no

measurable rain during the entire summer wet season. During the summer wet season (July-October), after the sparse rain events, storing collected rainwater for extended periods for future use can present challenges related to evaporation, as temperatures can easily soar above 110 degrees and air masses may become exceptionally dry. The City Team considered several green infrastructure practices (green roofs, rainbarrels, and cisterns) to be less practical and cost-effective than other stormwater controls given the City's frequency and amount of rainfall, as well as local building norms (e.g., lack of gutters and downspouts).

There are very few intermittent or perennial streams or rivers in the region; however, there are many dry washes and ephemeral washes. For washes, minimizing erosion and potential for flooding were deemed of more importance than preservation of hydrologic function. The City Team therefore de-emphasized stream buffers in their code review.

3 Summary Scorecard Findings for City of Phoenix

The review of City plans, policies, and codes found that the City of Phoenix is already implementing a number of strong green infrastructure practices, most notably:

- Community level plans, district plans, and incentives to promote infill, redevelopment, and mixed use development and reduce overall imperviousness.
- Regulations for new development that require development of urban tree canopy, preservation of existing, mature vegetation and healthy Sonoran vegetation, as well as strong protections for existing street trees.
- Requirements for using drought tolerant plants.
- Tree Care Workshops, a Citizen Forester Program, and partnerships with various non-profit tree-focused organizations.
- Progressive stormwater management standards for new development, including the requirement to retain the stormwater runoff from a 100-year, 2-hour duration storm (translating to a 2.5-inch storm event) falling within the development's boundaries.
- A stormwater policy that stresses the establishment of natural corridors for multi-use flood control, trails, recreation, and habitat, linking required open space to stormwater management. (Figure 5 and 6)
- Building code that effectively allows rainwater harvest, and plumbing code that allows graywater use.



Figure 5. Water from roof directed to swale at Musical Instrument Museum (courtesy Summer Waters, UA Cooperative Extension)



Figure 6. Retention/detention area also serving as volleyball court

The review also identified a number of gaps and barriers that, if remedied, could better promote the use of green infrastructure. Some of the most important of these include:

- Lack of a City-wide parks and open space plan that could serve as a foundation for an overall green infrastructure plan.
- Lack of tree protection regulations for existing, private development. Street tree ordinance that has somewhat high and prescriptive pruning requirements compared to other municipalities, which does not reflect current arboriculture best practices.
- Lack of a strategic green infrastructure retrofit plan for existing development.
- The need to explicitly allow green infrastructure in the street right-of-way (e.g., parkway areas).
- Requirements for overly wide streets and right-of-ways in residential areas.
- Requirements for overly large parking stalls and aisles.
- Parking area landscape and screening requirements (e.g., plant height and spacing) that limit the use of green infrastructure.
- Lack of weather-based or moisture-based irrigation controls.
- Lack of design templates for green infrastructure in the Street Landscape Standards and Street Planning and Design Guidelines. (**Figure 7**)
- Lack of a Green Infrastructure Design Manual.
- Lack of an on-going inspections program for post-construction stormwater BMPs.
- Lack of offsite mitigation provisions for previously developed infill sites. Such offsite mitigation could help meet the City's habitat conservation goals (**Figure 8**), and help fund regional facilities to reduce existing impacts of stormwater runoff.

Tetra Tech worked with the City Team to identify a number of potential code revisions to address the key code barriers and opportunities identified. Code revisions and example language were provided to the City in the *Opportunities for Code Revisions to Encourage Green Infrastructure Implementation* document.



Figure 7. Example downtown streetscape standard for bioretention and pervious concrete



Figure 8. Example habitat conservation area for off-site mitigation (courtesy City of Phoenix)