

# SUSTAINABLE DESIGN PROPOSAL : RECONNECT THE CANAL



# Green Infrastructure for Climate Resiliency

Climate change is impacting urban areas in many ways, from exacerbating the urban heat island effect to elevating flood risk. Build green infrastructure to help improve community resilience.

### FLOODING



By the end of the century, annual damages from flooding in the U.S. are projected to **increase by 30%**<sup>1</sup>

### DROUGHT



**1 out of 3** U.S. counties in the lower 48 states face higher risks of water shortages by mid-century.<sup>2</sup>

### COASTAL DAMAGE



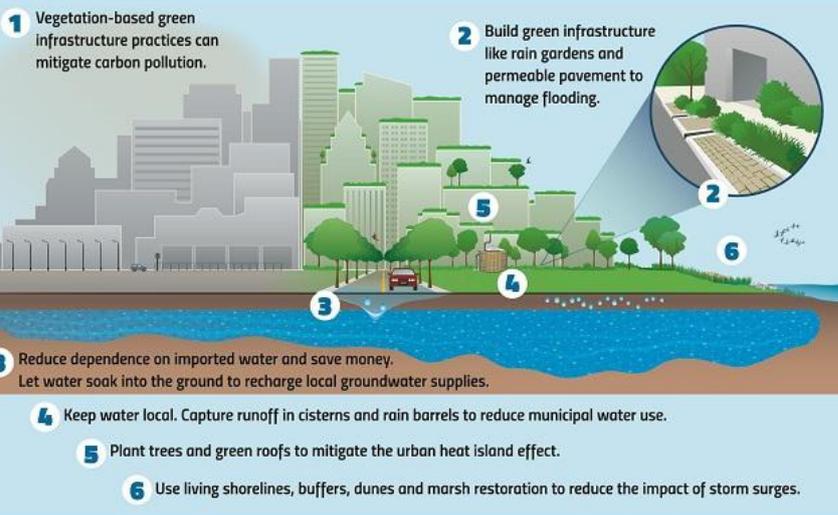
**50%** of Americans live in coastal counties, where water and energy infrastructure are increasingly vulnerable to higher sea levels.<sup>3</sup>

### URBAN HEAT



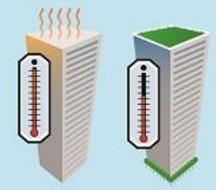
Climate change will likely lead to **more frequent and severe** heat waves during summer months.<sup>4</sup>

## Green Infrastructure Builds Resiliency



## Green Infrastructure at Work

### LOWER URBAN HEAT ISLAND EFFECTS



Studies show that green roofs can **reduce the energy** needed for cooling on the floor below the roof by more than **50%**<sup>5</sup>

### KEEP WATER LOCAL



By capturing rain where it falls, urbanized Southern California and the San Francisco Bay area could boost water supplies by up to **200 billion gallons per year** – as much water as the city of Los Angeles uses annually.<sup>6</sup>

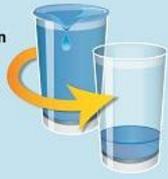
### BUILD COASTAL RESILIENCY



Research suggests that **wave height can be reduced by 50%** within the first 16 feet of marsh and 95% after crossing 100 feet of marsh.<sup>7</sup>

### MANAGE FLOOD RISK

A study in Burnsville, MN showed a **93% reduction** in runoff volume after the installation of 17 rain gardens in a 5.3 acre neighborhood.<sup>8</sup>



### USE LESS ENERGY



Give your air conditioner a rest! One young, healthy tree can produce cooling effects **equivalent to ten room-size air conditioners** operating 20 hours a day.<sup>9</sup>



For more information on green infrastructure, see: [www.epa.gov/greeninfrastructure](http://www.epa.gov/greeninfrastructure)

# CONTENTS

## 03

INTRO - ABOUT

## 04

HISTORY OF THE CANAL

## 06

BACKGROUND

## 07

THE CONCERNS FOR PHOENIX

## 09

WHAT IS GREEN INFRASTRUCTURE

## 10

GREEN INFRASTRUCTURE BENEFITS

## 11

CURRENT POLICIES / PLANS

## 13

MY PROPOSAL RELATING TO CURRENT POLICIES / PLANS

## 15

METHOD OF SOLUTION

## 21

OVERALL BENEFITS OF GREEN INFRASTRUCTURE

## 25

WORKS CITED

1. <http://onlinelibrary.wiley.com/doi/10.1111/jfr3.12043/pdf>  
 2. [www.nrdc.org/media/2010/100720.asp](http://www.nrdc.org/media/2010/100720.asp)  
 3. <http://nca2014.globalchange.gov/report>  
 4. USGCRP (2009). *Global Climate Change Impacts in the United States*. Karl, T.R., J.M. Mearns, and T.C. Peterson (eds). United States Global Change Research Program. Cambridge University Press, New York, NY, USA  
 5. [www.nrdc.org/water/pollution/files/GreenRoofsReport.pdf](http://www.nrdc.org/water/pollution/files/GreenRoofsReport.pdf)  
 6. [www.nrdc.org/water/files/ca-water-supply-solutions-stormwater-1B.pdf](http://www.nrdc.org/water/files/ca-water-supply-solutions-stormwater-1B.pdf)  
 7. Knutson, P.L., R.A. Brochia, W.N. Seelig, and M. Inskeep. 1982. Wave Damping in Spartina alterniflora Marshes. *Wetlands*. 2:87-104.  
 8. [www.ci.burnsville.mn.us/DocumentCenter/Home/View/449](http://www.ci.burnsville.mn.us/DocumentCenter/Home/View/449)  
 9. [www.arborday.org/trees/benefits.cfm](http://www.arborday.org/trees/benefits.cfm)

# INTRODUCTION

## ABOUT



Hi my name is Alexis Mullard and I am presenting my design proposal Reconnect The Canal, in response to my Sustainable Design Challenge: Redesigning the Arizona Canal. My sustainable design proposal targets The UN Sustainable Development Goals, specially achieving goal 11.



ACCESS THE CHALLENGE HERE: [HTTPS://DOCUMENTCLOUD.ADOBE.COM/LINK/TRACK?URI=URN:AAID:SCDS:US:31F72557-249B-4F29-9DE4-CCFB48E624E9](https://documentcloud.adobe.com/link/track?uri=urn:aaid:scds:us:31f72557-249b-4f29-9de4-ccfb48e624e9)

## DID YOU KNOW

Historically, the Phoenix canals were the community's social spot and were always associated with recreation. Instead of concrete and electricity lines, the canals used to be described as lush pathways full of cottonwood trees with swings hanging from the branches over the water. The canal banks provided the community with an area to walk, fish, swim, picnic, ride bicycles, and horses. People even water skied in areas of the canals that consisted of roads along the bank for cars to pull people by ropes.



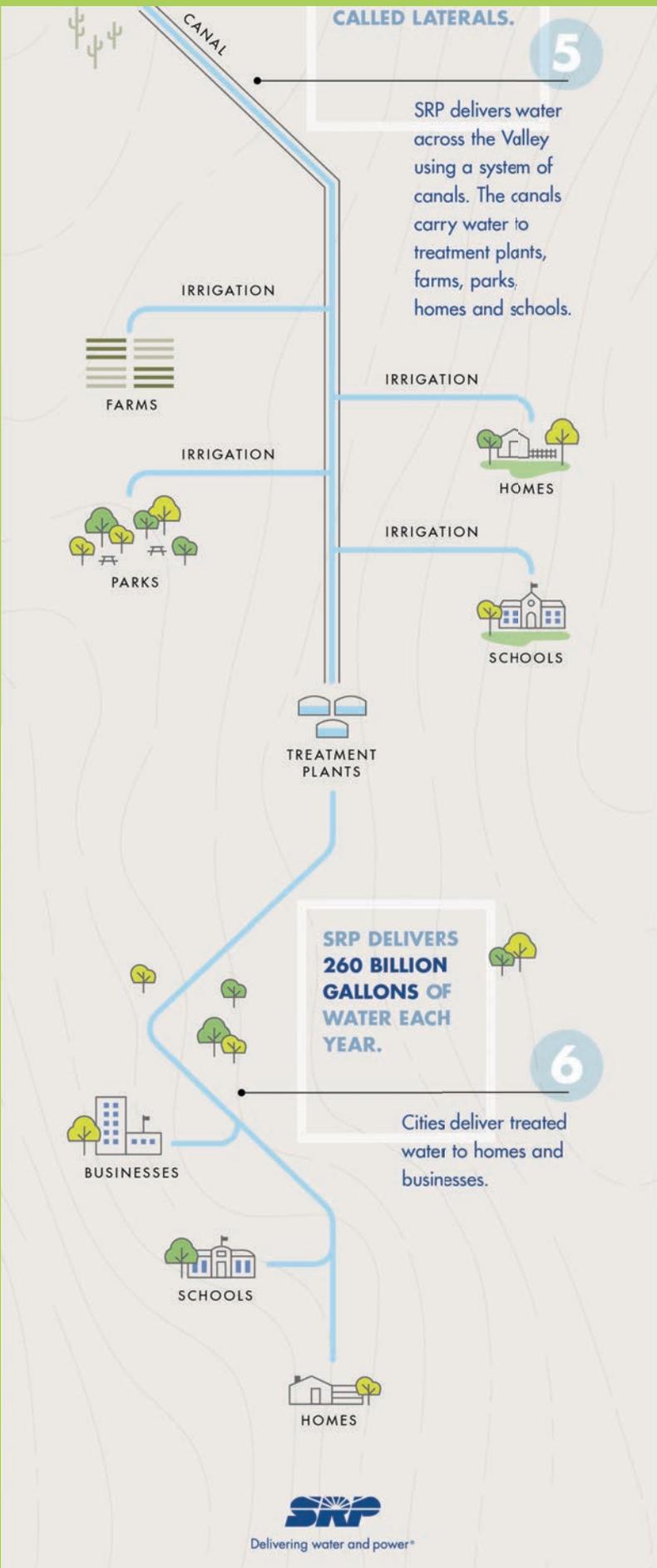
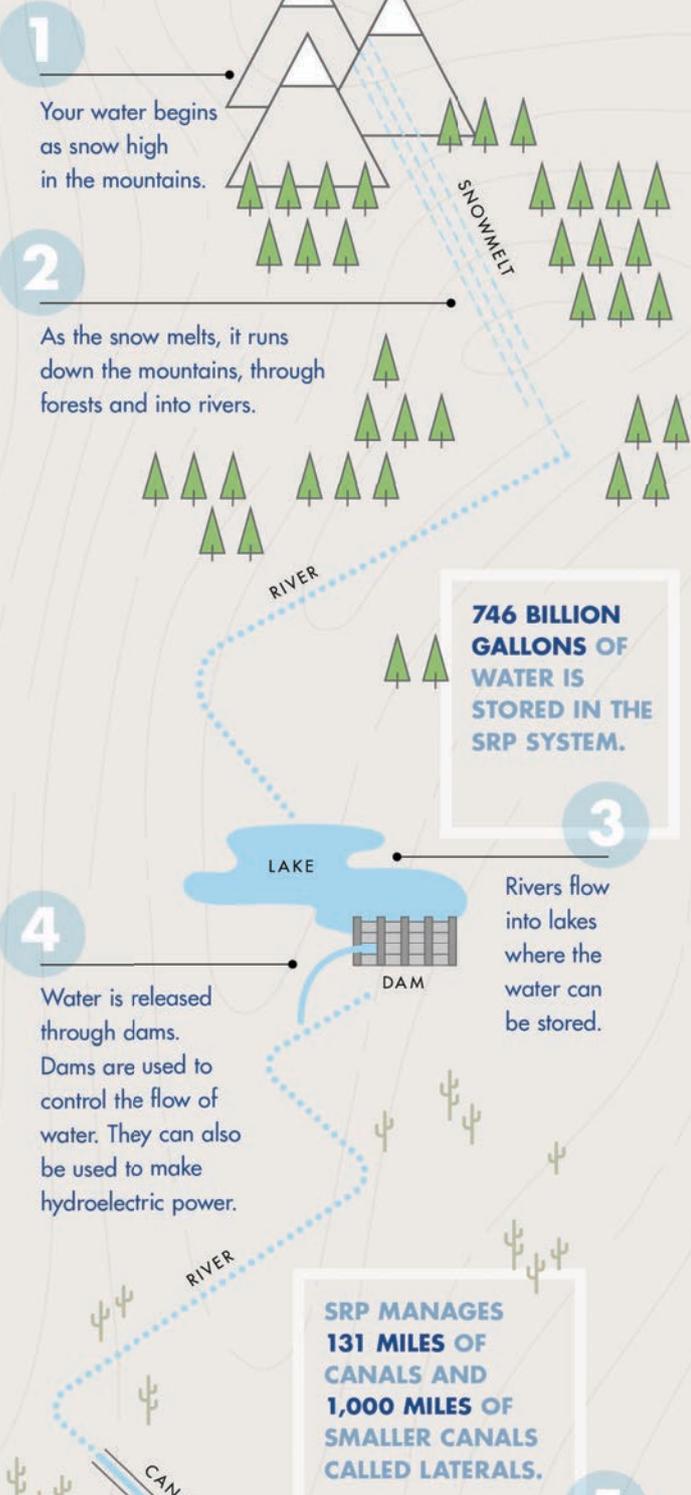
# THE HISTORY OF THE CANAL

Although Phoenix is regarded as a new city, it is built on the remains of an ancient civilization having much historical significance. From A.D. 600 to 1450, the Hohokam, a prehistoric group of Native Americans, constructed one of the largest and most sophisticated irrigation systems. The Hohokam constructed the canals using only their hands, stones, simple tools, and innovative engineering concepts that are still in use today. The canals allowed the Hohokam to sustain their crops, enabling agriculture to thrive and transform the desert Salt River Valley into a fertile agricultural city providing water to thousands of individuals. The canals consisted of much vegetation and lushness, several native fish species, and almost 200 species of Sonoran Desert plants, providing the community with an environment for playing games, fishing, and hunting and gathering food. The canals were the community gathering place during the hot summer; people swam in the canals and picnicked or relaxed along the canal due to numerous cottonwood trees providing shade. In A.D. 1450, the Hohokam disappeared for unknown reasons, leaving behind the last physical clues describing people with unique cultural significance and innovation and many ruins, rock art, and canals. In the 1600 and 1700s, early Spanish explorers found and used the Hohokam canal system to irrigate their crops. By the late 1860s, Phoenix emerged along the Salt River with the remains of the ancient canals lying below the streets of the city. In the 1950s, the recreational aspects of the canal vanished as swimming pools, and A.C. became popular, and SRP transformed the waterways to make them more efficient by giving them steeper banks and lining them with concrete. Today, the trees along the canal have never returned as SRP limits landscaping to prevent trees from interfering with maintenance access or power lines.



# CITIZENS OF PHOENIX :

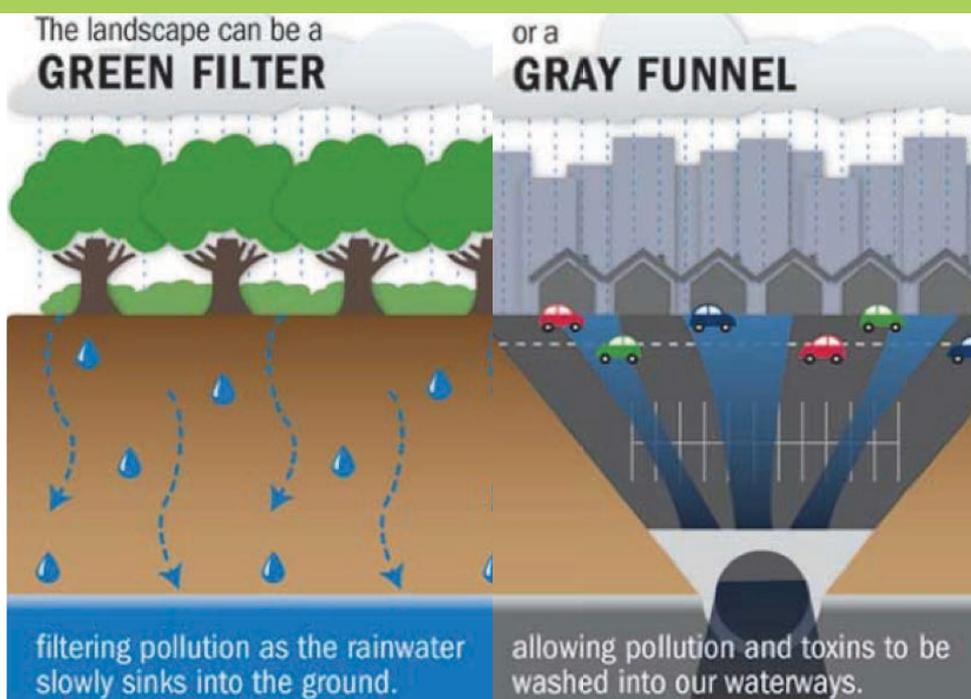
## WHERE YOUR WATER COMES FROM



# BACKGROUND

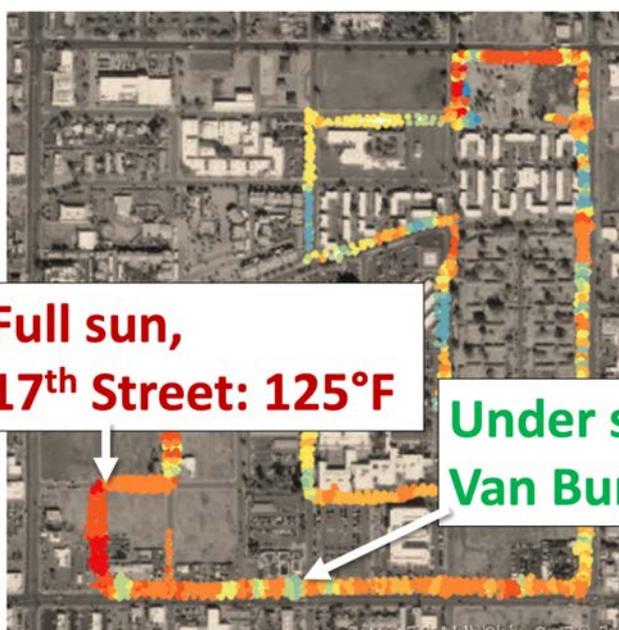
The world's urban population has crossed the 50% mark of the global population. It continues to grow, expecting to be about 5.06 billion (60%) by 2030. The rapid progression of urbanization, however, is accompanied by both challenges and opportunities. Improper policies, plans, and designs have led to increased slums and overcrowding, poor access to essential services, social inequality and segregation, and environmental degradation such as pollution. Furthermore, the impacts of climate change affect different areas of the world in diverse ways, requiring new and innovative actions for adaptation.

Stormwater runoff is a primary cause of water pollution in communities across the globe. As cities continue to develop, vegetation is removed and replaced with grey infrastructure - impervious concrete surfaces that prevent water from infiltrating into the ground. Stormwater carries trash, bacteria, heavy metals, and other pollutants, which contaminates the receiving waters and jeopardizes human health.



Grey infrastructure retains and radiates heat, causing the "urban island heat effect," which leads to increased temperatures, energy consumption, air pollutants, and greenhouse gases, and compromised human health and comfort. Additionally, lack of enough trees, parks, and vegetation causes increased ozone and particulate pollution levels, which can cause serious health effects.

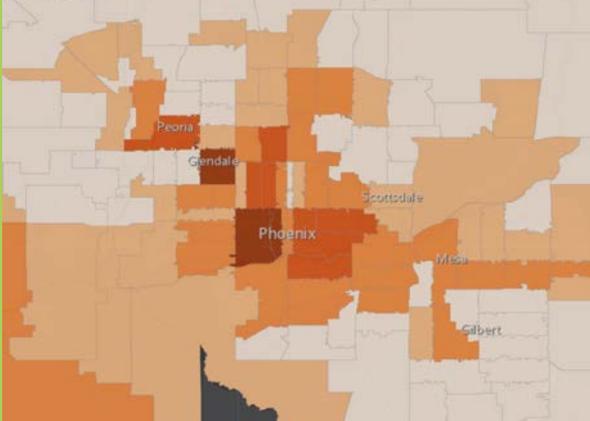
## Thermal Index "PET" Measurements in Edison-Eastlake



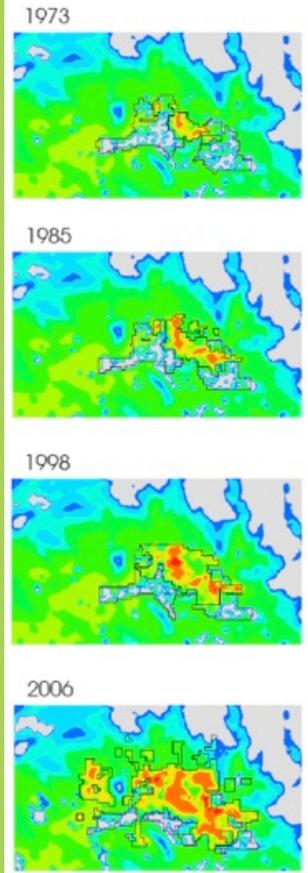
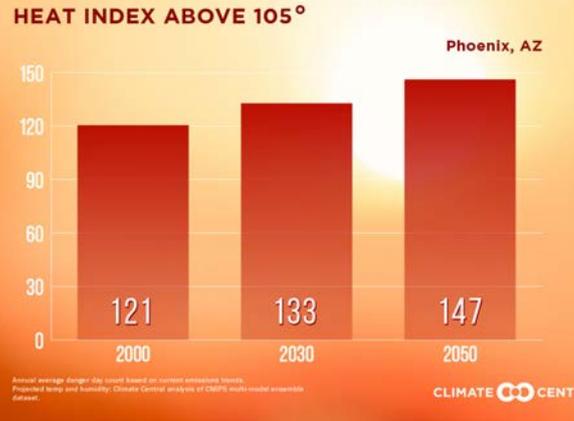
# THE CONCERNS FOR PHOENIX, ARIZONA

Arizona experiences the effects of climate change from deadly heatwaves, increased temperatures, wildfires, droughts, and decreased precipitation. Phoenix is one of the fastest warming states in the U.S., and for over 20 years, Arizona has been in a drought, surpassing the worst drought in more than 110 years of record. Climate change will lead to more frequent, severe and longer heatwaves. In 2020 at least 494 deaths were heat-related.

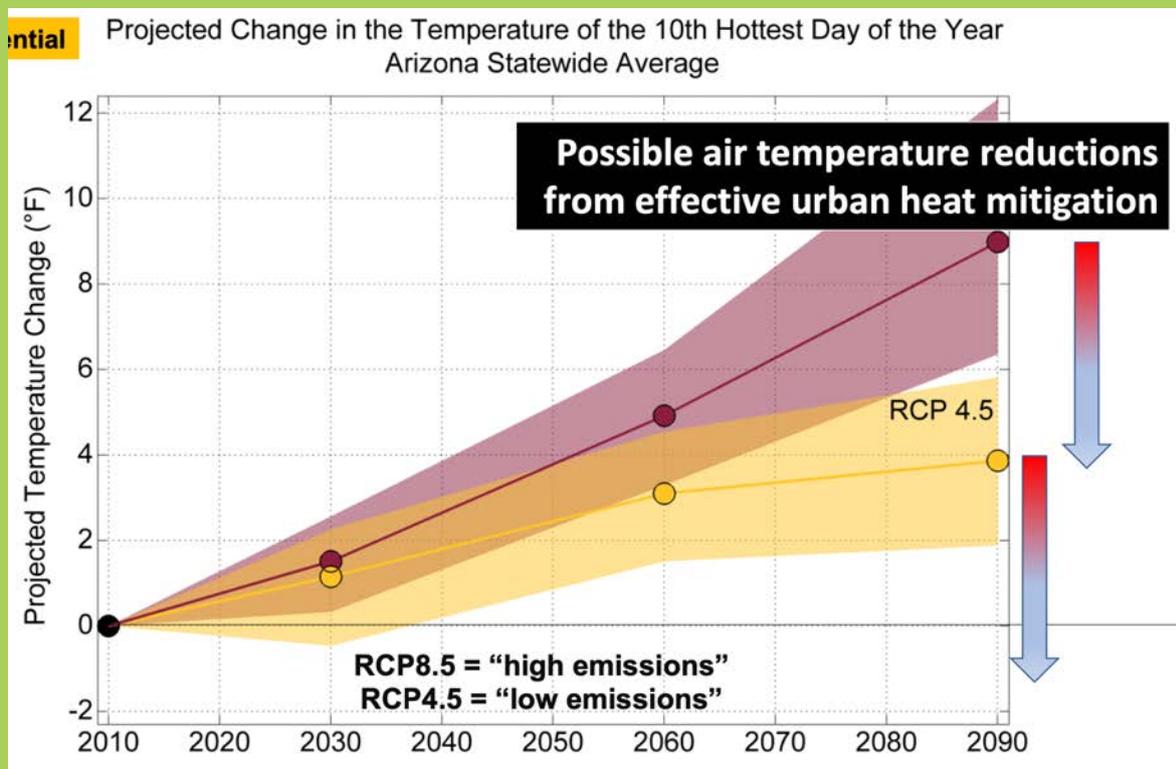
## Heat-associated deaths by zip code (MCDPH)



## MORE DANGER DAYS

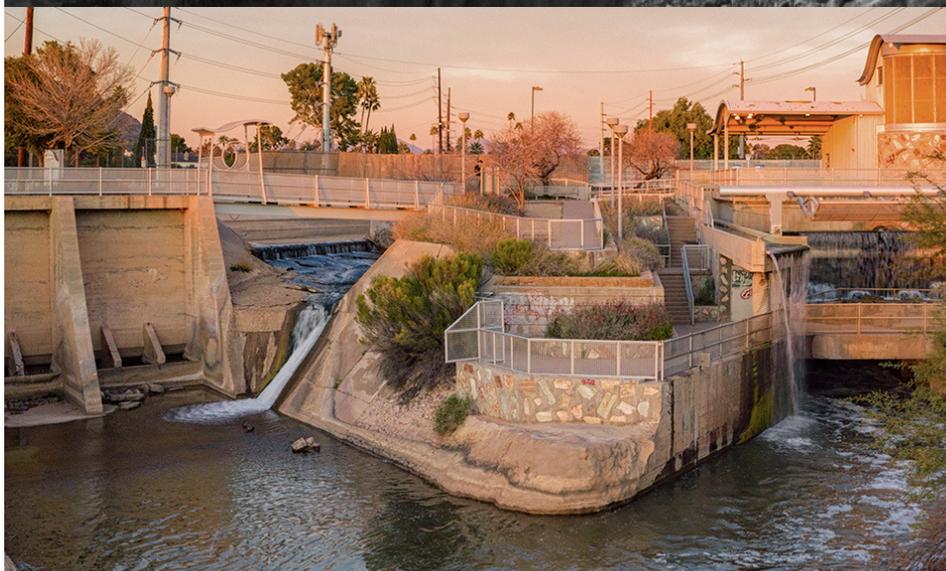
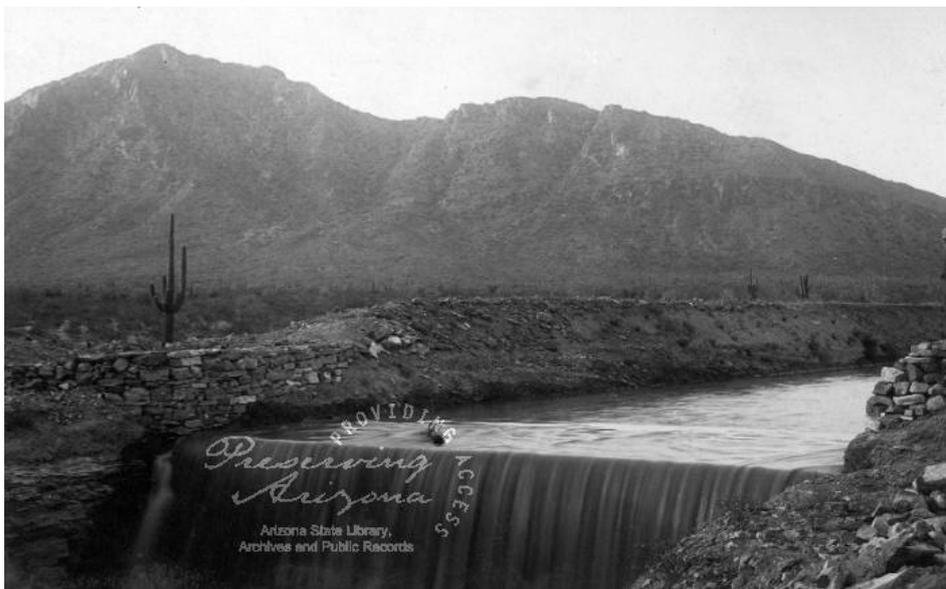


Other detrimental effects include crop losses, higher electricity bills, increased pollution, and a significant decrease in the Colorado River's water supply, which provides millions of people water. The majority of it is used for agriculture, posing a risk to an industry that contributes \$23 billion to the state's economy and provides over 130,000 jobs. Arizona has high evaporation rates, low soil permeability, and an average of approximately 7 inches of rain annually. The lack of water is becoming a more concerning issue; therefore, alternate water conservation methods are essential.



# THE CONCERNS FOR PHOENIX, ARIZONA CONTINUED

Although Phoenix is regarded as a new city, it is built on the remains of an ancient civilization as the Hohokam constructed the Salt River Valley canals From A.D. 600 to 1450. Today, Phoenix has 9 canals, with the canal system extending to about 180 miles, which is longer than the Venice (26 miles) and Amsterdam (60 miles) canals combined. Although and Amsterdam and Venice have taken advantage of their canal system, Phoenix has done the opposite as The Salt River Project removed every aesthetic element lining the canals. Phoenix is experiencing the urban heat island effect, partly due to the canals reconstruction, which consisted of removing thousands of trees and replacing the area with concrete and power lines. Although the reconstruction was in the 1950s, over the past several years, the city has seen the effects such as increased air pollution and energy usage for air conditioning. The Arizona Grand canal has much potential, and the city should consider the opportunity to consider implementing green infrastructure along the canal and throughout the city.



**Escalating effects:**

Higher temperatures amplified by the urban heat island effect lead to more frequent and intense heat waves

**Preparedness and response options:**

Use of white roofs, shade tree planting, and increased shading

## DRIVERS OF URBAN HEAT

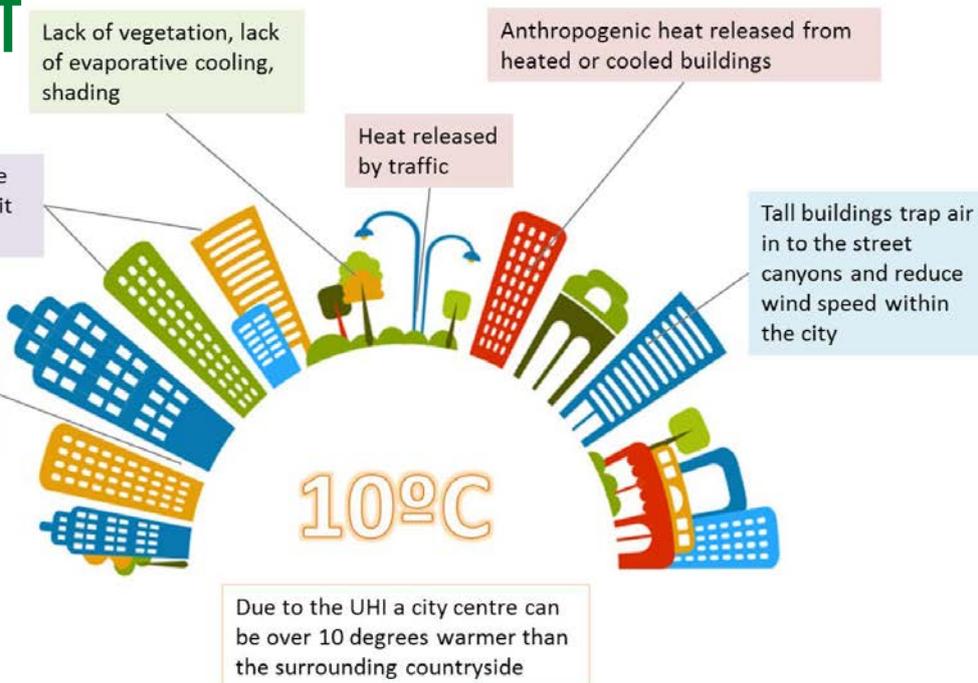
**Waste Heat**

Building materials store solar heat and release it at night

**Impervious Surfaces**

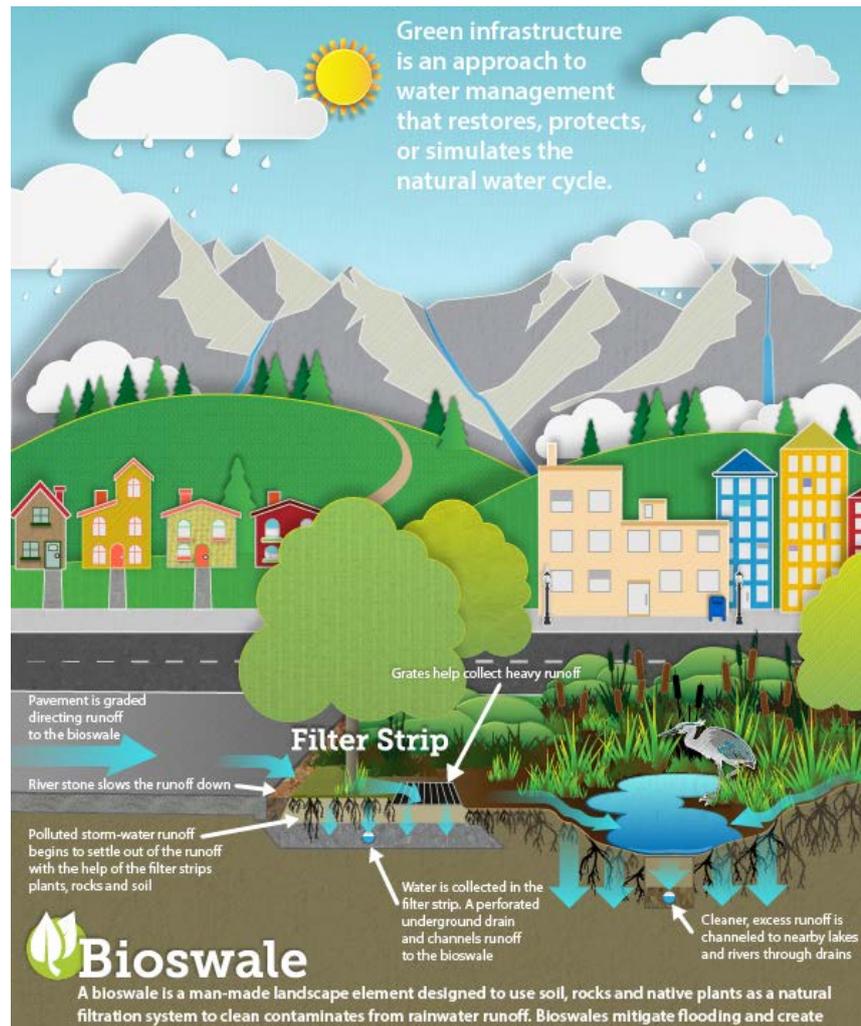
Long-wave radiation is reflected from walls back to street level

**Urban Geometry**



## WHAT IS GREEN INFRASTRUCTURE (GI)

Green infrastructure uses vegetation, soils, and natural processes to manage water, filter pollutants from stormwater, and develop healthier urban environments. Green infrastructure practices protect, restore, or mimic the natural water cycle so that stormwater runoff is captured, absorbed, infiltrated, allowed to evaporate, and retained on site. Green Infrastructure (GI) integrates natural processes into the built environment to help improve community resiliency and build adaptable infrastructure as different parts of the country become hotter, drier, or wetter. Green infrastructure is a cost-effective, resilient, sustainable design approach to managing the impacts of climate change while also providing many environmental, social, and economic benefits.



**GI consists of various stormwater management practices, such as:**

Figure 4: Types of Green Infrastructure Illustrated on the Environmental Protection Agency's Website



Urban tree canopy



Bioswale



Permeable pavement



Land conservation



Green parking



Downspout disconnection



Rainwater harvesting



Rain garden



Green street



Planter box



Green roof

# GREEN INFRASTRUCTURE BENEFITS

Green Infrastructure helps communities build resilience, which is the ability to prepare for and adapt to changing conditions and withstand / recover rapidly from disruptions such as naturally occurring threats. Community resilience encompasses the entire community, including its physical infrastructure, economic and social capital, natural environment, and systems that provide essential services. GI as an approach to managing rainwater is an integral component of sustainable communities because they benefit the environment and human health while offering social and economic benefits. In addition to reducing polluted stormwater runoff, GI practices provide various community benefits such as improved water and air quality, reduced urban heat island effect, and aesthetic and recreational value, contributing to a city's livability. GI provides habitat, can reduce erosion, preserve nature and wildlife and positively impact energy consumption, air quality, carbon reduction and sequestration, property prices, recreation, and other community health and vitality elements.

## THE HEALTH BENEFITS OF NATURAL SPACES

### ADULTS

- STRESS REDUCTION
- IMPROVED LIFE EXPECTANCY
- IMPROVED COGNITIVE PERFORMANCE
- BETTER GENERAL MENTAL / PHYSICAL HEALTH
- IMPROVED SLEEP QUALITY
- REDUCTION IN CANCER RISK

### CHILDREN (improvements in):

- EMOTIONAL / BEHAVIORAL DEVELOPMENT
- CONCENTRATION
- SELF CONFIDENCE
- SELF DISCIPLINE
- COORDINATION
- ATTENTION CAPACITY
- SOCIAL SKILLS
- BALANCE
- AGILITY
- WEIGHT OF NEWBORNS

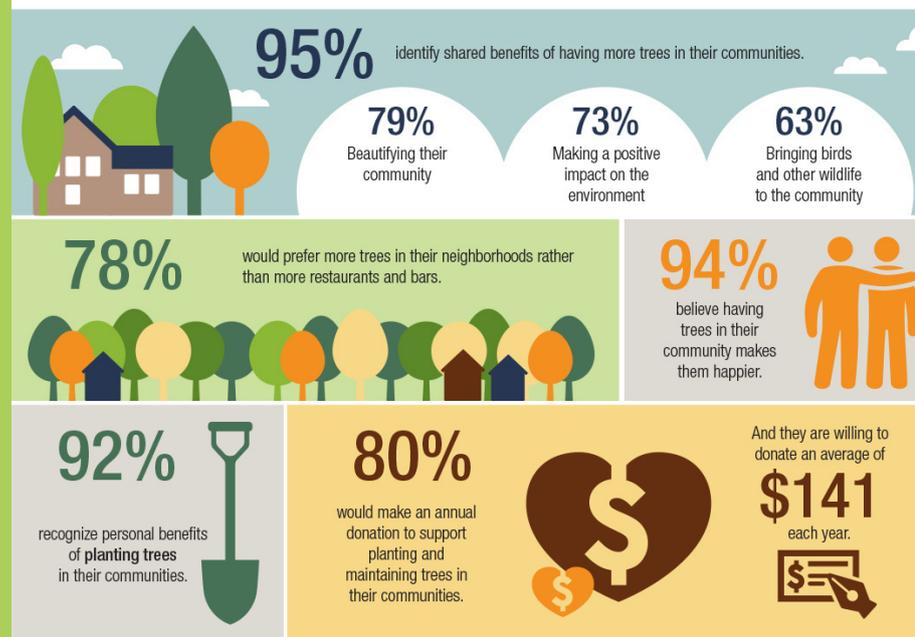
## GREEN INFRASTRUCTURE HAS THE ABILITY TO PRODUCE MULTIPLE BENEFITS WITH MINIMAL FUNDS. SOME INCLUDE:

- Improved water quality.
- Reduced municipal water use.
- Groundwater recharge.
- Flood risk mitigation for small storms.
- Increased resilience to climate change impacts such as heavier rainfalls and hotter temperatures.
- Reduced ground-level ozone.
- reduced erosion
- Reduced particulate pollution.
- Reduced air temperatures
- Reduced energy use and associated greenhouse gas emissions.
- Increased or improved wildlife habitat.
- Improved public health from reduced air pollution and increased physical activity.
- Increased recreation space.
- Improved community aesthetics.
- Cost savings.
- Green jobs.
- Increased property values.

## Trees are Growing Happier, Healthier Communities



**WE DID THE RESEARCH.** It turns out trees are improving neighborhoods and communities across the country. Here's what Americans have to say about trees.



Did You Know

**73%**

of Americans are interested in volunteering to plant or care for trees in their community. **SO LET'S GET TO WORK!**

# CURRENT POLICIES / PLANS

The City of Phoenix has already implemented many Green Infrastructure related practices such as community-level plans, redevelopment regulations for urban development, and vegetation preservation.

- The **Greater Phoenix Green Infrastructure Handbook: Low Impact Development (LID)** includes details for alternative Stormwater Management and provides guidance and technical standard details for LID techniques, so local design, planning, and development professionals can more efficiently integrate (GI) and LID in new and/or retrofit projects.
- The **Phoenix Tree and Shade Master Plan** attempts to create a more sustainable, livable, and thriving city through necessary investment in care and maintenance of the urban forest and shade.
- On May 20, 2019, Arizona and the other Colorado River Basin States signed agreements for **The Drought Contingency Plan** to take less water from Lake Mead over the next seven years.
- In 2011, **The Watershed Management Group** started a partnership with the City of Phoenix and community members to plan and implement green infrastructure on both private and public sites.
- Phoenix's' **Climate Action Plan** includes goals and specific actions for reducing GHG emissions from various activities, including air quality, heat, water, food systems, stationary energy, transportation, and waste.
- The 2011 **Water Resources Plan** indicates the possible challenges that Phoenix will encounter as a leader in water management. Phoenix's water supply and the threat of drought create a higher motivation to initiate proactive actions.
- The vision of **The City of Phoenix Comprehensive Bicycle Master Plan** includes "In the next 20 years, Phoenix will be a Platinum-level Bicycle Friendly Community. It will be safe and easy to bike anywhere in the city. A well-connected infrastructure network will link people and places, making bicycling a preferred option for daily transportation, recreation, and healthy lifestyles." (phoenix.gov)
- My proposal reflects sustainable urban development policies such as the "Bridging the Green and Brown Agendas" and "Linking Spatial Planning to Urban Infrastructure."

## 2050 Sustainability Goals

In 2016 Phoenix City Council adopted **2050 Environmental Sustainability goals** that articulate the community's desired long term environmental outcomes that would fulfill the General Plan aspirations of a **Sustainable Desert City**.

**Transportation:** Make walking, cycling, and transit commonly used, enjoyed, and accessible for every Phoenix neighborhood, including our disabled community

**Waste:** Create zero waste through participation in the Circular Economy

**Water Stewardship:** Maintain a clean and reliable 100-year supply of water

**Building & Land Use:** Reduce community carbon pollution by 80%-90% with the longer term 2060 goals of becoming a carbon-neutral city

**Parks, Preserves, and Open Spaces:** All residents live within a five-minute walk of a park or open space

**Clean Air:** Achieve a level of air quality that is healthy for humans and the natural environment

**Local Food Systems:** Maintain a sustainable, healthy, equitable, thriving local food system

## Tree + Shade Master Plan



The **Tree and Shade Master Plan** is the product of the Tree and Shade Task Force a multi-department committee led by the Parks and Recreation Department. The task force met for a year and a half to evaluate the causes of Phoenix's declining urban forest. The task force also looked at regulatory hurdles that prevent the construction of shade structures over public sidewalks. The Master Plan was adopted by the City Council on January 5, 2010.

The Tree and Shade Master Plan strives to create a **healthier, more livable and prosperous Phoenix** through the strategic investment in **care and maintenance** of the urban forest and engineered shade. **Trees and shade structures** are critical components of the infrastructure and over the long-term can save the city millions of dollars. The Master Plan provides a detailed roadmap to achieve an **average 25% shade canopy** coverage for the entire city.

[Learn more about Trees in Phoenix](#)

## 2020 Actions

### Reduce Urban Heat Island:

- Developing an **Urban Heat Mitigation and Adaptation Plan**
- Developing a **"HeatReady"** certification for Cities (pilot testing to begin in Phoenix in 2020)
- Building a **"WalkShed"** tool to identify priority areas to add shade in vulnerable neighborhoods.
- Accelerating the **Tree and Shade Master Plan** with a goal to plant **5000 trees** in 2020

### Air Quality:

- Building a **state and regional network** with dozens of stakeholders to address reduce pollutants. Possible strategies may include supporting programs to **increase EV adoption** and reduce miles traveled per capita through employer trip reduction programs and incentives.

## Recent Accomplishments

### \$110M in climate-related investments (\$910M with T2050)

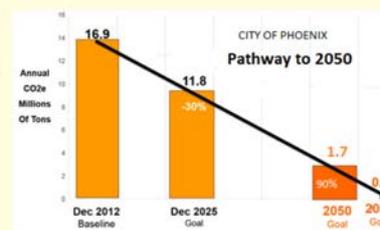
1. \$30M **LED Streetlight project** replacing 100,000 streetlights - completed in 2019
2. \$25M **biogas facility** capturing waste gas and selling to California (and 90% wastewater reuse) - 2019
3. \$30M in retrofits underway to **reduce energy use in City buildings by 20%**
4. \$15M state-of-the-art **compost facility**
5. \$4.5M in **Recycling Equipment Upgrades** (North Gateway)
6. \$5M annually in **tree planting and maintenance** (4500 trees planted in 2019 on City land)
7. **Joined C40** in 2020 – an international network of nearly 100 cities  
+ \$800M in **transportation improvement** in last 3 years

## City of Phoenix Climate Goals

- A **carbon-neutral city** by 2060 operating on 100% clean energy
- All new buildings are **"net positive"** by 2050 in both energy use and materials

### Greenhouse Gas (GHG) emission reduction targets:

- **15%** by 2015 for City Operations achieved
- **30%** by 2025 community-wide (Paris-compliant) on track
- **40%** by 2025 (City Operations only) on track
- **90%** by 2050 community-wide by 2050



- **Clean Air** – outperforming federal standards by 2050
- **Zero waste** through the circular economy
- A **100-year supply** of clean and reliable water
- Create a **vibrant healthy food system** by 2050 with **zero food deserts**

## Transportation 2050

On Aug. 25, 2015, Phoenix voters **approved Transportation 2050** and made a strong statement about the importance of expanding investment in Phoenix for **bus service, light rail construction, and street improvements**.



The previous transit plan, known as T2000, was a voter-approved tax that primarily funded transit service in Phoenix. Now broader and more comprehensive, the Transportation 2050 plan places additional emphasis on street needs including: **street maintenance, new pavement, bike lanes, sidewalks and ADA accessibility** which will all complement the **increase in transit services**.



The Transportation 2050 plan was developed by a **citizen-led committee of transportation experts and community advocates** and addresses a wide array of concerns expressed by residents who drive, bike, walk and ride transit service. The 35-year citywide street and transit improvement plan, which **became effective Jan. 1, 2016**, will **triple the number of light rail miles** in Phoenix by adding 42 miles of across the city, provide **late-night bus and Dial-a-Ride service citywide**, and will directly and indirectly **benefit every street in Phoenix**.

[Learn more and view progress updates](#)

# CITY OF PHOENIX LONG TERM GOALS



**A Carbon Neutral City**  
by 2060



New buildings are **Net Positive**  
in energy & materials



**15** vibrant compact  
complete centers



**Zero Waste** through participation  
in the circular economy



**Parks or Greenways**  
in every neighborhood



**40%** waste diversion  
by 2020



**Clean Air.** Excellent or  
good visibility on 90% of days



**Clean Air.** Out-performing  
federal standards



**25%** tree and shade  
canopy



**40%** of commutes by walking,  
biking, transit & car-share



**Zero Waste**



**300 Miles** of pathways and  
walkable vibrant canals



**100-year** clean &  
reliable supply of water



Everyone within a **5-Minute**  
**Walk** of a park or pathway



**15%** renewables  
by 2025



**80-90%** reduction in  
GHG emissions



A thriving vibrant  
**Food System**



Eliminate  
**Food Deserts**



**90%** of residents within  
10-minute walk of transit



**Transit** in every Phoenix  
neighborhood

# MY PROPOSAL IN RELATION TO CURRENT POLICIES / PLANS

Although Phoenix places a high value on tree preservation and currently has plans that incorporate UN sustainable goals and is dedicated to achieving a more resilient and prosperous future, not much progress has been made. My master plan design proposal will expand upon the current plans previously mentioned and are included below.

TARGET	11-1 TARGET	11-2 TARGET	11-3 TARGET	11-4 TARGET	11-5 TARGET	11-6 TARGET	11-7 TARGET	11-A TARGET	11-B TARGET	11-C TARGET
SAFE AND AFFORDABLE HOUSING	AFFORDABLE AND SUSTAINABLE TRANSPORT SYSTEMS	INCLUSIVE AND SUSTAINABLE URBANIZATION	PROTECT THE WORLD'S CULTURAL AND NATURAL HERITAGE	REDUCE THE ADVERSE EFFECTS OF NATURAL DISASTERS	REDUCE THE ENVIRONMENTAL IMPACT OF CITIES	PROVIDE ACCESS TO SAFE AND INCLUSIVE GREEN AND PUBLIC SPACES	STRONG NATIONAL AND REGIONAL DEVELOPMENT PLANNING	IMPLEMENT POLICIES FOR INCLUSION, RESOURCE EFFICIENCY AND DISASTER RISK REDUCTION	SUPPORT LEAST DEVELOPED COUNTRIES IN SUSTAINABLE AND RESILIENT FINANCING	SUPPORT LEAST DEVELOPED COUNTRIES IN SUSTAINABLE AND RESILIENT FINANCING

My design proposal addresses Sustainable Development Goal 11, Sustainable Cities and Communities, to make Phoenix a more inclusive, sustainable, resilient, and safe city. My design approach promotes efficient solutions to Phoenix's exponentially growing detrimental problems that can be efficiently resisted through green infrastructure along the canal.

## COMMENTS FROM CITIZENS

Which actions in the Framework would you like to see accomplished by 2025?

"Plant more trees"

"ALL! Let's get more ambitious, be a climate leader in the country. Prioritize air and water."

"improve the sustainability and resilience of the surrounding community's electricity grid"

"Specifically target vulnerable communities with climate relief actions."

"Just make sure any action plans you do are sustainable."

## RECENT IMPROVEMENTS

In February 2020, The Grand Canalscape, a \$22.5 million improvement plan along 12 miles of the canal from Interstate 17 to Tempe, was completed. The Grand Canal scape consists of a concrete pathway, pedestrian lighting, seating, and signalized crossings at major intersections. Although city planners have put effort into reviving Phoenix's canals, the reconstruction of the area lacks all green infrastructure elements, including the easy addition of trees and plants.



# MY PROPOSAL IN RELATION TO CURRENT POLICIES / PLANS

My proposal implements key aspects of the International Guidelines on Urban and Territorial Planning. The Guidelines include 12 principles and several action-oriented recommendations for an integrated planning approach that is beneficial across various scales and adaptable to different regional, national, and local settings. The guidelines provide inspiration and direction to help build more socially inclusive and connected cities that foster sustainable urban development and are resilient to climate change. The Guidelines provide national governments, local authorities, civil society organizations, and planning professionals with a reference framework for improving global policies, plans, designs, implementation, and processes. The Guidelines emphasize urban policy and governance, sustainable urban development, and implementation and monitoring mechanisms. Incorporating the design into Phoenix's infrastructure will promote a wide range of sustainable support and protection of Phoenix.

## The Guidelines:

### 12 Key Planning Principles with 114 Recommendations

To orient and guide decision-makers in developing or reviewing urban and territorial policies, plans and designs through an integrated planning approach, the Guidelines are structured along [12 key planning principles](#) and [114 recommendations](#) in [5 main sections](#) and [addressed to the 4 stakeholder groups](#). An abridged version of the 12 guiding principles can be found below.

URBAN POLICY AND GOVERNANCE	
1	Urban and Territorial Planning is an integrative and participatory decision-making process that addresses competing interests and is linked to a shared vision, an overall development strategy and national, regional and local urban policies.
2	Urban and Territorial Planning promotes local democracy, participation and inclusion, transparency and accountability.
URBAN AND TERRITORIAL PLANNING FOR SUSTAINABLE DEVELOPMENT	
Urban and Territorial Planning and Social Development	
3	Urban and Territorial Planning primarily aims to realize adequate standards of living and working conditions for all through social inclusion and cohesion, recognizing the distinct needs of various groups.
4	Urban and Territorial Planning is a precondition for a better quality of life and successful globalization processes that respect cultural heritages and cultural diversity.
Urban and Territorial Planning and Sustained Economic Growth	
5	Urban and Territorial Planning provides an enabling framework for new economic opportunities, regulation of land and housing markets and timely provision of adequate infrastructure and basic services.
6	Urban and Territorial Planning provides a mechanism to ensure that sustained economic growth, social development and environmental sustainability go hand in hand to promote better connectivity at all territorial levels.
Urban and Territorial Planning and the Environment	
7	Urban and Territorial Planning provides a spatial framework to protect and manage the natural and built environment of cities and territories, including their biodiversity, land and natural resources.
8	Urban and Territorial Planning contributes to increased human security by strengthening environmental and socioeconomic resilience, enhancing mitigation of, and adaptation to, climate change.
URBAN AND TERRITORIAL PLANNING COMPONENTS	
9	Urban and Territorial Planning is a continuous and iterative process, grounded in enforceable regulations, that aims to promote more compact cities and synergies between territories.
10	Urban and Territorial Planning aims to facilitate and articulate political decisions based on different scenarios. It translates those decisions into actions that will transform the physical and social space and will support the development of integrated cities and territories.
IMPLEMENTATION AND MONITORING URBAN AND TERRITORIAL PLANNING	
11	Implementation of spatial policies and plans requires political leadership, appropriate legal and institutional frameworks, efficient urban management, and improved coordination, consensus-building approaches to respond coherently and effectively to current and future challenges.
12	Effective implementation and evaluation of Urban and Territorial planning requires continuous monitoring, periodic adjustments and sufficient capacities at all levels, as well as sustainable financial mechanisms and technologies.

# METHOD OF SOLUTION: GREEN INFRASTRUCTURE

01

Designing a specific GI method for the canal that benefits many components in Phoenix's existing environment.

- Green Infrastructure design elements

02

Green Infrastructure master plan for the canal.

03

The structure of the process will include project governance and participatory design.

## HOW HIGH POINT DRAINAGE WORKS TO RECHARGE OUR GROUNDWATER AND PROTECT THE CREEK

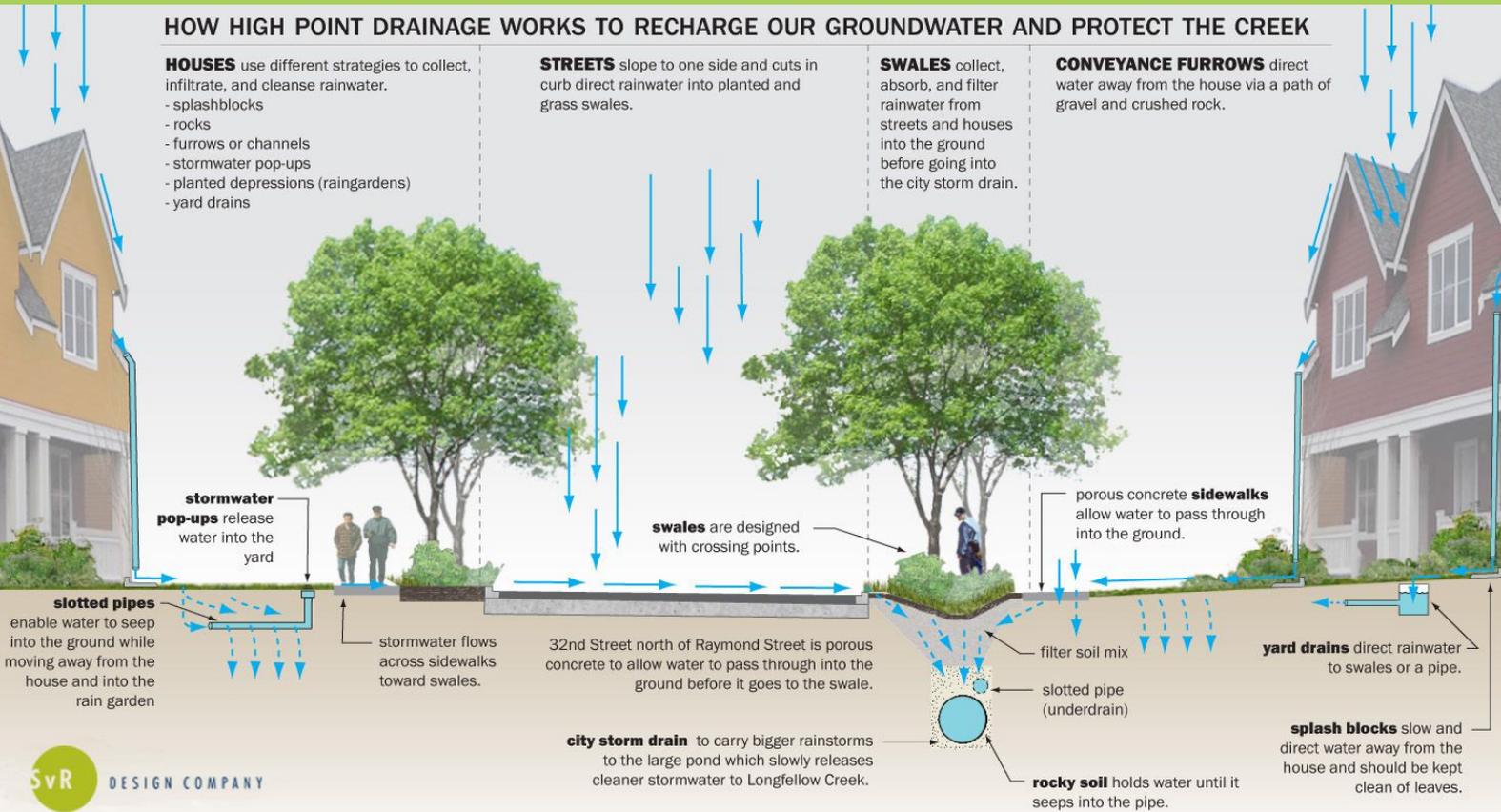
**HOUSES** use different strategies to collect, infiltrate, and cleanse rainwater.

- splashblocks
- rocks
- furrows or channels
- stormwater pop-ups
- planted depressions (raingardens)
- yard drains

**STREETS** slope to one side and cuts in curb direct rainwater into planted and grass swales.

**SWALES** collect, absorb, and filter rainwater from streets and houses into the ground before going into the city storm drain.

**CONVEYANCE FURROWS** direct water away from the house via a path of gravel and crushed rock.



## NEW Green Stormwater Infrastructure Program Offers Trees, Shade, Flood Reduction, and More

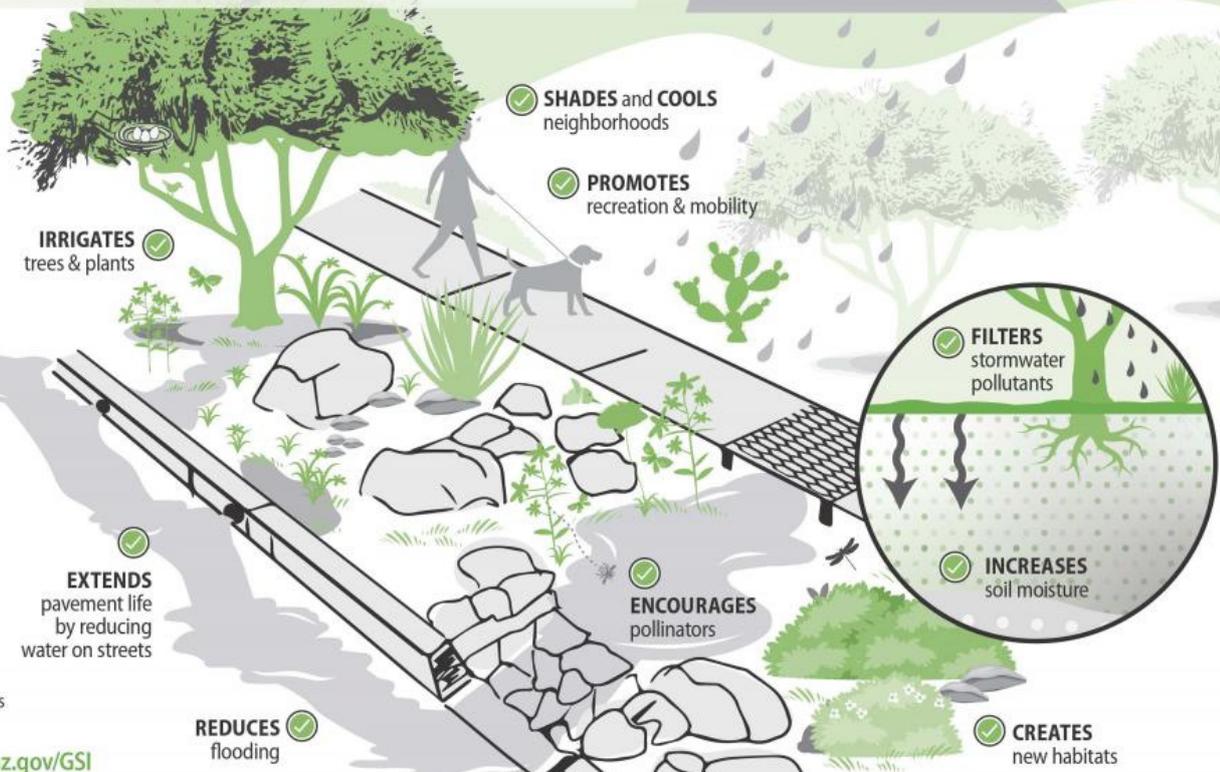
The City of Tucson has created a pilot program to build and maintain public projects that capture stormwater runoff from streets and parking lots, and divert it into vegetated water harvesting areas. These kinds of projects are called **green stormwater infrastructure (GSI)**. The new GSI program will:

- Provide a funding source for maintaining hundreds of existing GSI features in city neighborhoods
- Support growing more trees and plants along streets, and in parks and public areas using stormwater as a primary irrigation source
- Help reduce nuisance flooding issues on neighborhood streets

### Future Green Infrastructure Sites

- ✓ Neighborhood streets
- ✓ Greenways
- ✓ Bike Boulevards
- ✓ Parks
- ✓ Public parking lots

FIND OUT MORE Go to [Tucsonaz.gov/GSI](http://Tucsonaz.gov/GSI)



# METHOD OF SOLUTION: GREEN INFRASTRUCTURE

## 01 GREEN INFRASTRUCTURE ELEMENTS

### NATIVE AZ, DROUGHT RESISTANT VEGETATION

see next page

### PLANTER BOXES

### RAINWATER HARVESTING

Collects / Stores water - Helps build resilience to droughts by water conservation and water management

### PERMEABLE PAVEMENT

Where- For Bicycle / Walking path

porous concrete- light colored surface good for walking path

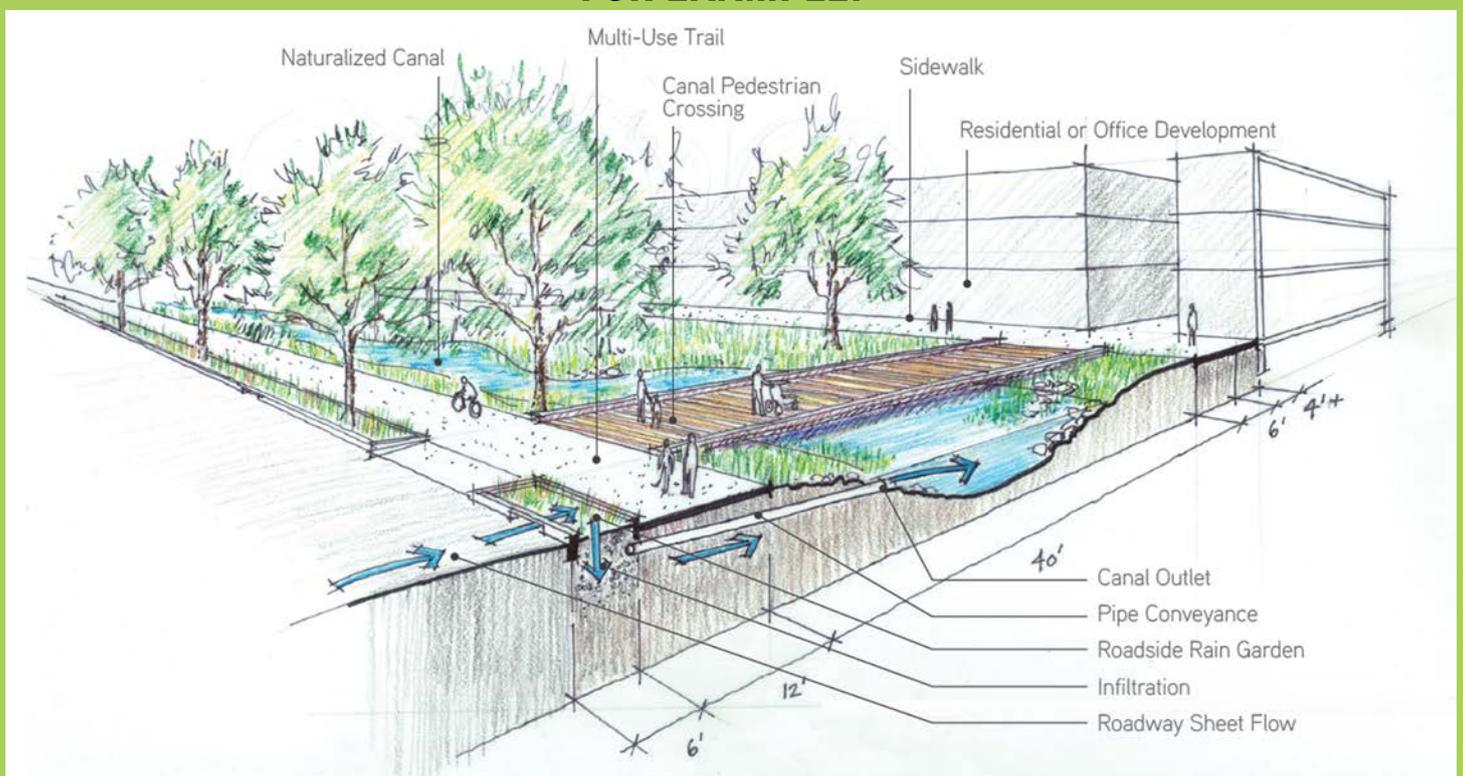
reflective pavement

Benefits- cooling surface temperatures / surrounding air temperatures, reduce runoff, improve water quality

### BIOSWALES ALONG THE PATH

Bioswales, vegetated swales, and bioretention areas are important GI features in an arid region. Phoenix receives higher pollutant and sediment loads in a given storm event with greater impact to groundwater quality and therefore, vegetated drainage features can help to slow, filter and infiltrate this storm water volume

## FOR EXAMPLE:



## POTENTIAL TYPES OF VEGETATION ALONG CANAL

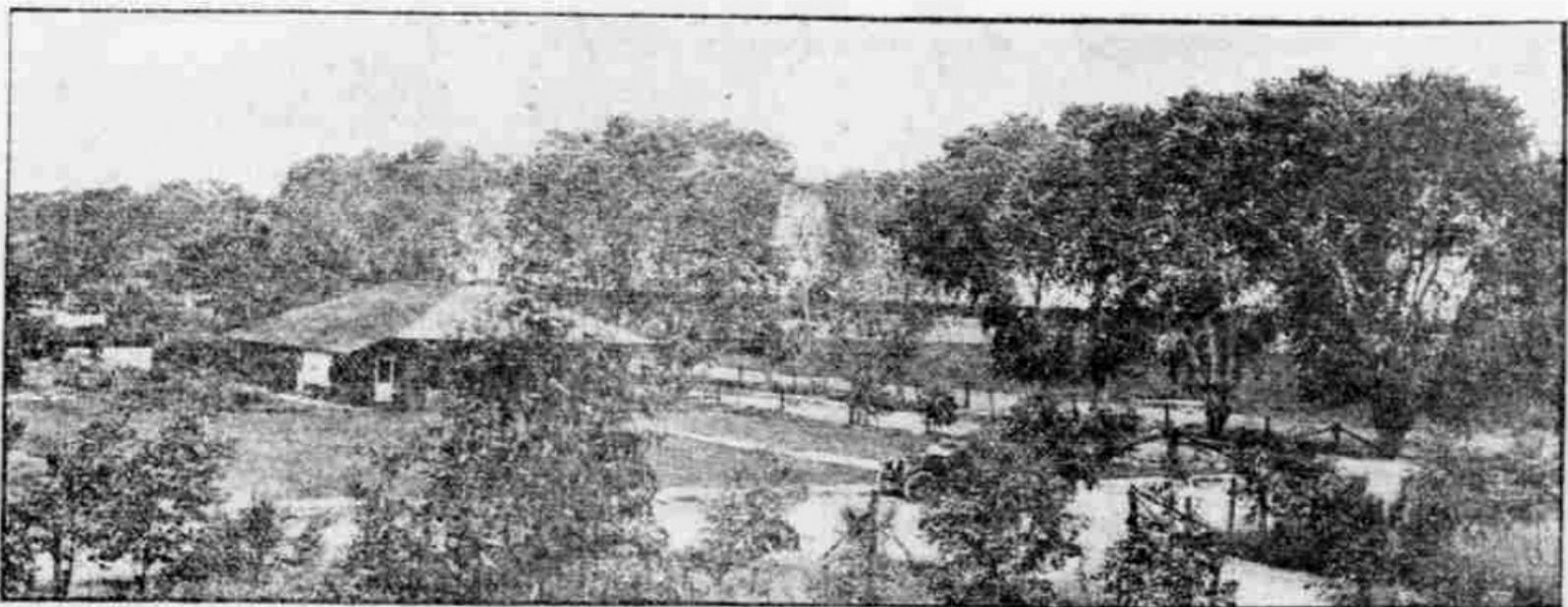
### NATIVE ARIZONA PLANTS

- COTTONWOODS
- WILLOW TREES
- ASH TREE
- BLUE PALO VERDE
- FOOTHILLS PALO VERDE
- ANGELITA DAISY
- ARIZONA ROSEWOOD
- ARIZONA YELLOW BELLS
- BEAVERTAIL PRICKLY PEAR
- BRITTLEBUSH
- BUCKHORN CHOLLA
- BUSH DALEA
- CHOCOLATE FLOWER
- CHUPAROSA
- CREOSOTE BUSH
- DEER GRASS
- DESERT MARIGOLD
- DESERT MILKWEED
- FEATHER BUSH
- GLOBE MALLOW
- GOLDEN EYE
- GRAPE IVY
- IRONWOOD
- KIDNEYWOOD
- OCOTILLO
- PALO BLANCO
- PARRY'S PENSTEMON
- PINK FAIRY DUSTER
- SAGUARO
- SAN MARCOS HIBISCOUS
- SWEET ACACIA
- TUFTED EVENING PRIMROSE
- WHITE THORN ACACIA
- VELVET MESQUITE
- FIRECRACKER PENSTEMON



FIND MORE INFO : [HTTP://WWW.AMWUA.ORG/PLANTS/COMBINATIONS](http://www.amwua.org/plants/combinations)

Before the reconstruction, the canals were lined with cottonwoods, ashes, willows, tall grasses, and other shade trees and consisted of corridors creating a lush habitat throughout the city. Today Arizona's major canal system follows many of the original paths, but the evidence of many Hohokam villages lies buried under the urban development of Phoenix and Tucson. Therefore it is essential to implement these historical elements into the redesign of the canal.



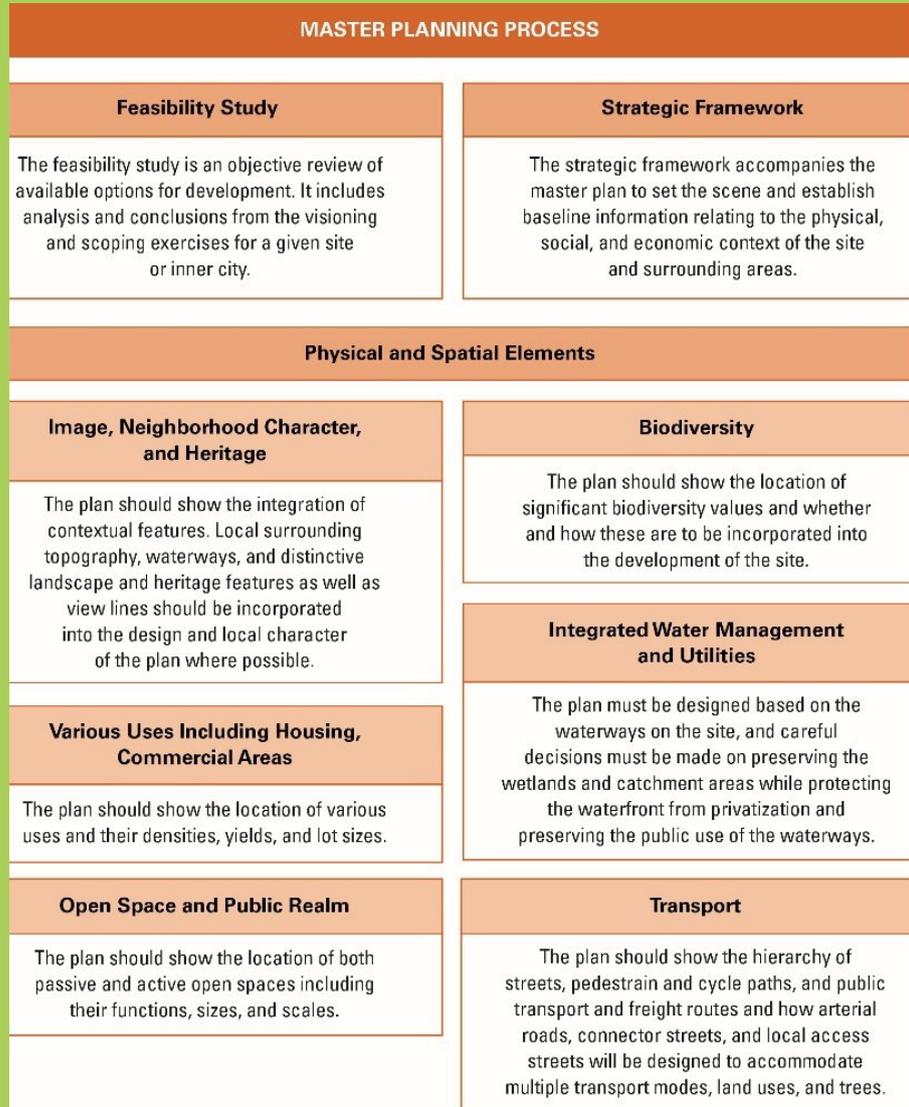
### IN THE SHADE OF THE COTTONWOODS

Wherever one goes in the Valley there are trees—along the city streets, lining the country roads, guarding the canals, patrolling ranch and orchard, are the lovely shade trees—ash, olive, cottonwood, eucalyptus, pepper and palm.

# METHOD OF SOLUTION: GREEN INFRASTRUCTURE

## 02 WHAT IS MASTER PLANNING

Master planning is a discipline that connects buildings with their surrounding environments and consists of public input, surveys, existing and future development, physical characteristics, and social and economic conditions. As a master plan for the Arizona canal, green infrastructure will guide future development and generate a multidisciplinary solution to different problems that Phoenix encounters. Green infrastructure along the canal requires inclusive planning and design processes that will guide decision-makers in maintaining a balance between protection and conservation and growth and development to help accomplish the design vision.



## 02 WHAT IS PROJECT GOVERNANCE

Urban project governance is a network of informal to formal connected associations of public, private, and nonprofit communities linked to a shared vision and overall development strategy to achieve the desired goal. Governance promotes local participation, inclusion, transparency, and accountability, creating a better quality of life for all. Governance ensures equal distribution of the costs, opportunities, and benefits of urban development, promoting and respecting social inclusion and place attachment, cultural heritage, and various human needs.



# METHOD OF SOLUTION: GREEN INFRASTRUCTURE

## WHO CAN PARTICIPATE - ANYONE

The goals of the master plan are to design according to the citizens' needs while introducing an efficient and sustainable way for Phoenix to combat current and future challenges. Including a wide range of people in the design process is significant because inviting all to share their opinion will promote participatory design. The project will promote participatory design, including a wide range of people to share their opinion in the design process. This encouragement will involve all stakeholders and ensure that the design's result meets their needs, is usable, and advocates for a healthier environment. Customers, employees, partners, citizens, local authorities will create a realm where people are actively caring about the city's future and their health and generations to come. Exploring the opinions of all who live near or have a general concern about Phoenix will increase the plan's success, which is crucial because this plan may set a precedent for future master plans, green infrastructure-oriented goals, and other sustainable approaches.

## WHAT WILL THE PROCESS LOOK LIKE

- volunteer workshops, tree plantings, and GI construction from citizens creating additional jobs for the city
- it will be a community-led process that is educational, fun and builds community connections

## WHO SHOULD BE INVOLVED IN THE PROCESS :

Local residents, neighborhoods, businesses, and institutions like schools and churches. Involvement should also include the City's Office of Environmental Programs, City's Finance Department, Treasury and Debt Management Division, Parks and Recreation, Water Services, Planning and Development, and Street Transportation Departments, Arizona State University, local consultants, and EPA.



## FINANCING

I am submitting my sustainable design project to The Finance Department of Phoenix to request the issuance of a green bond. "The development of the green bond market is attributed to municipalities issuing bonds used to finance projects with positive environmental impacts and a growing interest by investors to support environmentally sustainable efforts." (phoenix.gov). I believe this project is eligible for a green bond as Sustainable Development Goals are the basis of the project, and chosen projects are reviewed based on green projects such as; renewable energy, energy efficiency, pollution prevention and control, eco-efficient and/or circular economy adapted products, production technologies, and processes, green buildings, terrestrial and aquatic biodiversity conservation, clean transportation, etc.

# METHOD OF SOLUTION: GREEN INFRASTRUCTURE EXAMPLE



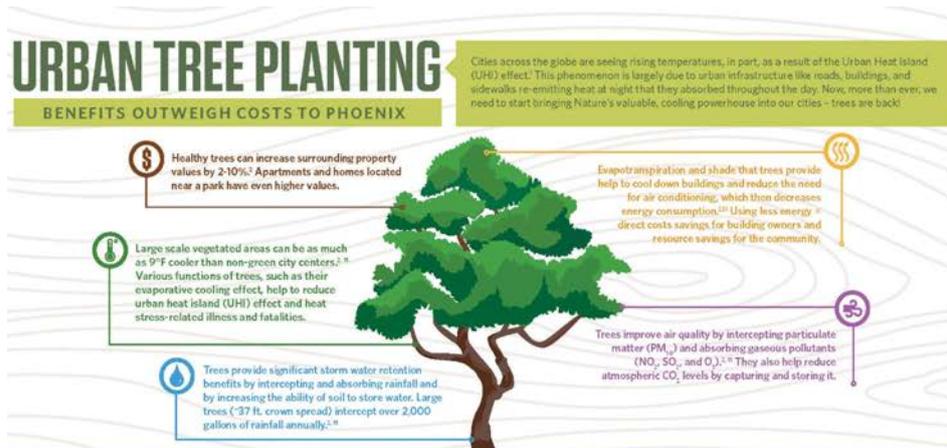
← N Arcadia Dr Phoenix, Arizona



# OVERALL BENEFITS OF GREEN INFRASTRUCTURE

A system that once brought water to thousands is now being used to help supply the water needs of millions in Phoenix. Green Infrastructure not only benefits the environment but is a way to link the city back to its origins. The redevelopment opportunities along the canal will benefit the environment and significantly enhance the quality of life in Phoenix. Green infrastructure can help communities become more resilient to the impacts of climate change and contribute to occupants' health and well-being and improve the environment's climatic adaptation. All of the restaurants, residential neighborhoods, schools, shops, and open spaces along or near the canal, would likely benefit for several reasons. Restaurants, in particular, would gain many additional customers as residents would have easier accessibility to ride their bike to lunch and dine on an outdoor patio that looks out to the canal and Camelback mountain. In addition, retrofitting the canal through the implementation of green infrastructure will reduce the Phoenix's temperatures and serve as a way of sustainably linking communities through natural pedestrian paths that wind along the canal and connect with pathways through buildings and properties.

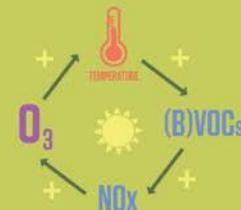
These improvements will encourage more individuals to interact with nature and nearby businesses, shops, and restaurants because planting trees will provide shade, reduce the temperature of the sidewalk, limit cooling, and promote improved physical activity and mental health. Green Infrastructure can provide a sense of place attachment which emerges from various experiences and situations, such as parks, green spaces, and natural areas, and increases in proportion to its proximity to one's home and frequency of use. Implementing Green Infrastructure along the canal will increase an individual's attachment to Phoenix and all of the history behind the canals. Phoenix, the 6th largest city in the US, has the potential to serve as a model for implementing green infrastructure into an arid environment, as a cost-effective and resilient approach, with a range of benefits.



## Trees and the Importance of BVOCs

Biogenic Volatile Organic Compounds (BVOCs)

- Ground level ozone forms when oxides of nitrogen (NO<sub>x</sub>) and volatile organic compounds (VOCs) react in the presence of strong sunlight. Ozone is an air pollutant and contributes to increased temperatures. The highest levels of ozone are recorded during summer months. NO<sub>x</sub> and VOCs are created by vehicles, industrial facilities, commercial products and solvents.<sup>1</sup>
- Less than 10 percent of VOCs originate from natural sources called BVOCs, biogenic volatile organic compounds. BVOCs are compounds emitted by all photosynthetic plants, including grasses and shrubs, as part of their metabolic processes.<sup>2,3</sup>
- Tree and shade can help decrease temperatures and reduce ozone formation.
- Locally adapted, low BVOC-emitting trees can provide positive ecological services and benefits – contributing to better air quality and community health.



**Examples of Low-emitting Trees for Phoenix:**

- Acacia
- Ironwood
- Ash
- Palo Verde
- Evergreen Elm
- Pistache
- Desert Willow
- Pine

We have a choice. **Be Smart... Design Sustainably... Plant Wisely.**

## TREES CAN BE TRUSTED

Green spaces help to reduce stress and improve mental concentration. Researchers have confirmed, through an EEG brain-wave study, that green spaces can actually **lessen brain fatigue**, making you feel more calm and focused.<sup>1</sup>

### OTHER CITIES THAT VALUE TREES

**New York City** struggled with poor air quality due to harmful carbon emissions from vehicles and fossil fuel based power plants.<sup>1</sup>

In 2006, the City of **Los Angeles** only had 21% tree canopy coverage.<sup>2</sup> The national average is 27%.

In recent decades, **Philadelphia** has lost a significant number of trees to development and sprawl.<sup>3</sup>

**New York** has increased its urban forests by 20%, extensively cutting down on harmful air pollutants and saving them an astounding \$220,000.<sup>4</sup>

When **Los Angeles** started planting more trees, it saw improvements in mental health, lower energy costs, and increased consumer spending in tree-filled commercial areas.<sup>5</sup>

As a counter to high pollution levels, **Pennsylvania Horticultural Society** has pledged to restore lost canopy coverage by adding about 30% more trees.<sup>6</sup>

### ANNUAL BENEFITS TO PHOENIX

**91.7**  
Million cubic feet of storm runoff avoided<sup>1</sup>

**89,200**  
Tons of oxygen produced<sup>2</sup>

**1,700**  
Tons of air pollution removed<sup>3</sup>

**35,400**  
Tons of carbon sequestered in addition to the 305,000 tons already stored in existing trees<sup>4</sup>

### VALUE OF PHOENIX'S URBAN FOREST

#### RETURN ON INVESTMENT

**\$2.23** PER TREE

A medium-sized tree at maturity.<sup>5</sup>

#### TOTAL BENEFITS

**\$40.25** MILLION

Annual combined benefits of existing Phoenix urban forest.<sup>6</sup>

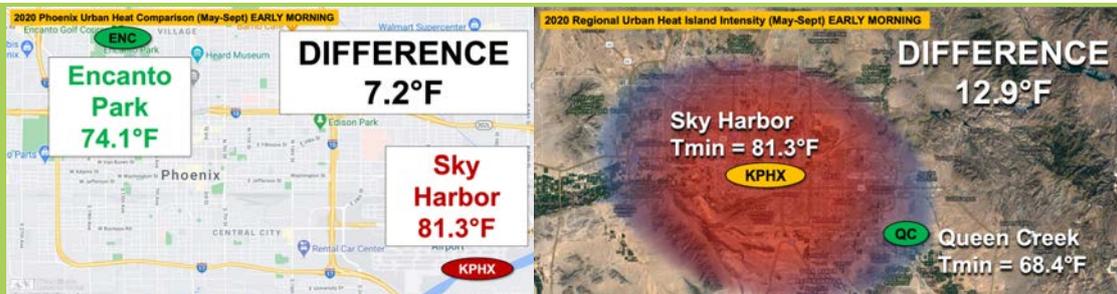
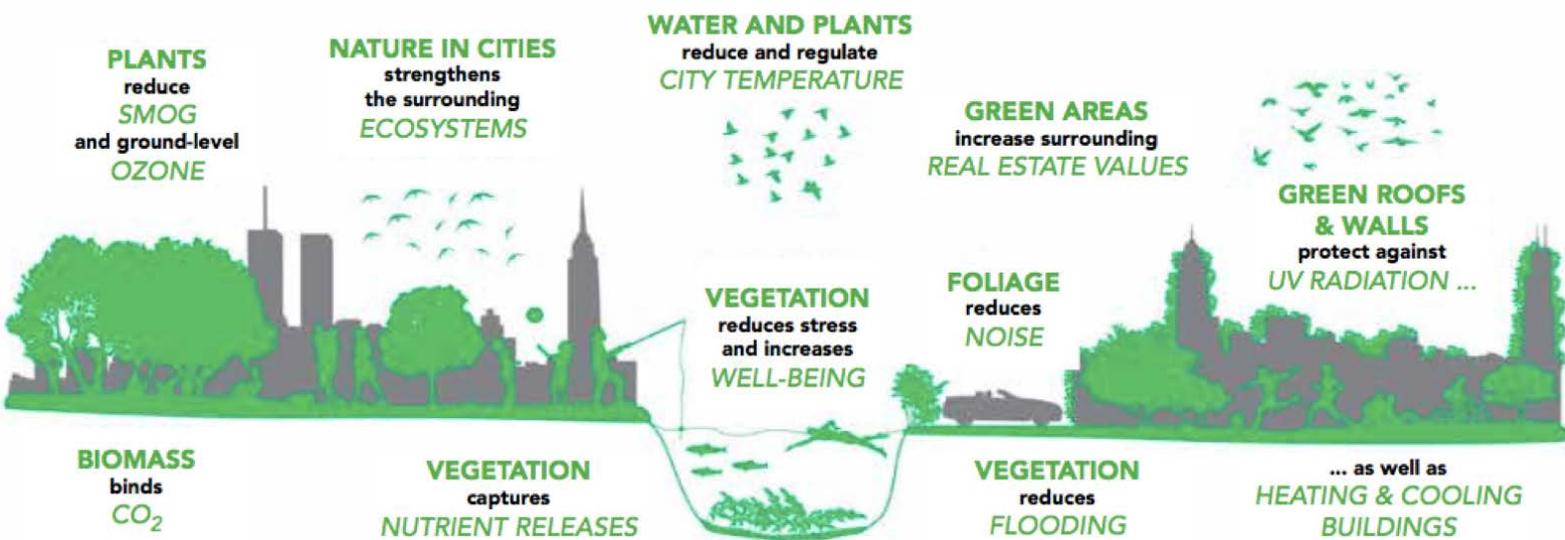
#### REPLACEMENT COST

**\$3.84** BILLION

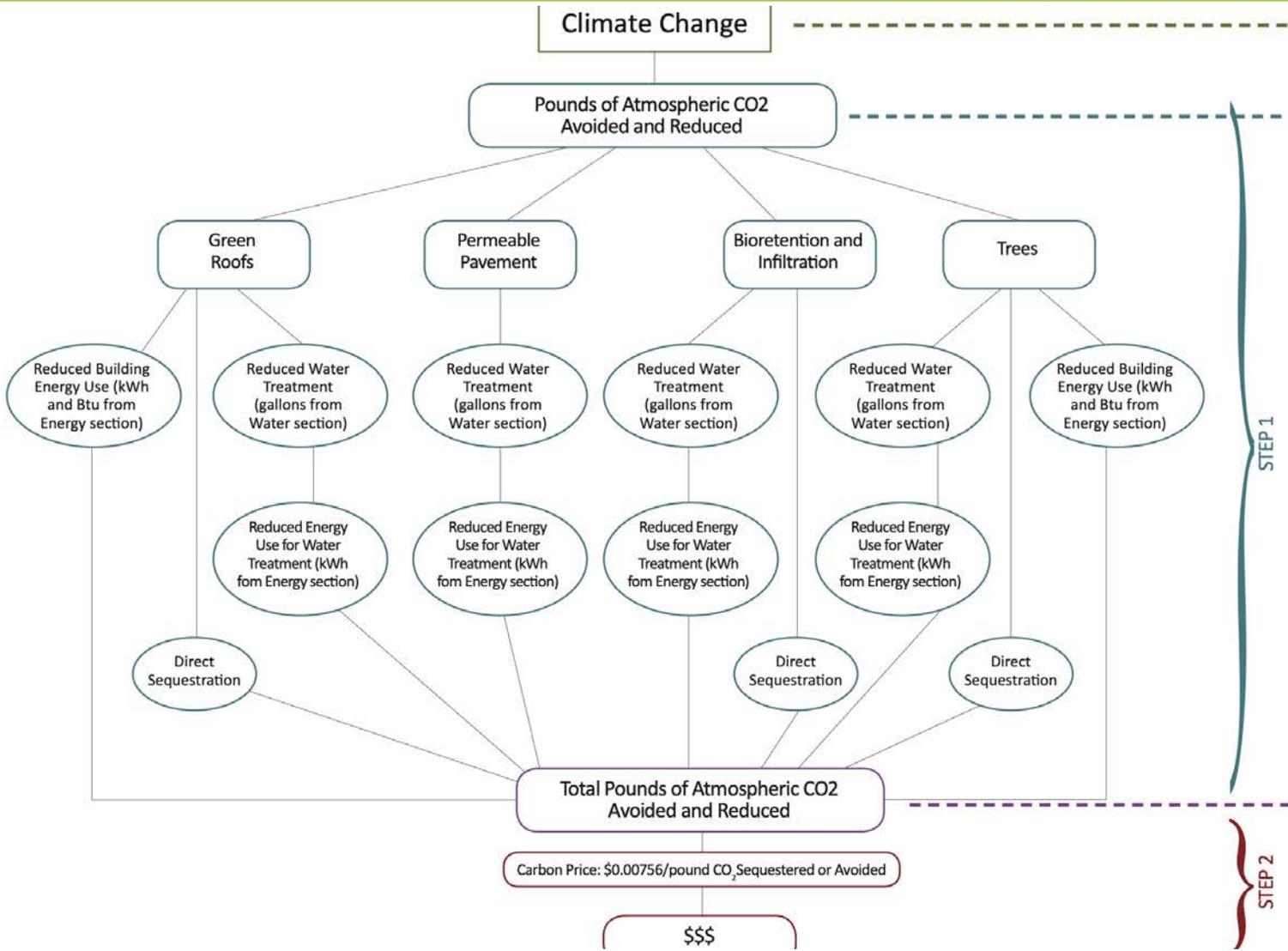
Cost to replace Phoenix urban forest.<sup>7</sup>

# OVERALL BENEFITS OF GREEN INFRASTRUCTURE

## BENEFITS OF PLANTING TREES / VEGETATION



- Reduce the urban heat island by shading building surfaces, deflecting the radiation from the sun, and releasing moisture into the atmosphere.
- reduces energy use- tree shade cools the air and reduces the amount of energy needed to cool buildings, which reduces the amount of greenhouse gases
- improves air quality- Trees absorb air pollutants (e.g. NO<sub>2</sub>, SO<sub>2</sub>, and O<sub>3</sub>) and intercept particulate matter (PM<sub>10</sub>).
- reduces CO<sub>2</sub>- Through direct sequestration
- vegetation reduces smog by reducing air temperatures, power plant emissions from AC, and removing air pollution
- Habitat improvement - Vegetation in the urban environment provides habitat for birds, mammals, amphibians, reptiles, and insects. By reducing erosion and sedimentation, green infrastructure can improve the habitat in the canal.
- Habitat connectivity - green infrastructures along the canal and connecting to other parks can help to facilitate wildlife movement and connect wildlife populations.
- Reduces stormwater runoff
- Increases Groundwater Recharge
- creates educational opportunities - Green infrastructure along the canal provides an opportunity to develop community awareness and understanding of the historical roots of the canal and the importance of sustainable water resource management.
- improve community livability
  - Trees improve community aesthetics and increase recreational opportunities by improving pathways, creating places to gather, and providing shade.
  - Native trees can help provide a sense of place and well-being in Phoenix, strengthening place attachment.
- Green Jobs: Green infrastructure along the canal can reduce Phoenix's infrastructure costs, promote economic growth, and create construction and maintenance jobs.
- Health Benefits: More green space and parks encourage outdoor physical activity, which reduces obesity and prevents associated chronic diseases.
- Recreation Space: Vegetation and trees throughout the city and connecting to the canal can increase recreation areas, allowing residents to enjoy greenery while biking or walking to other destinations.
- Property Values: Using green infrastructure in development and increasing vegetation and tree cover can enhance property values, benefiting both developers and homeowners.
- Increase Phoenix's biophilia which has many benefits and can be described as an emotional affiliation and identity, an ecoliteracy, beauty, simulation and delight, a way of healing,

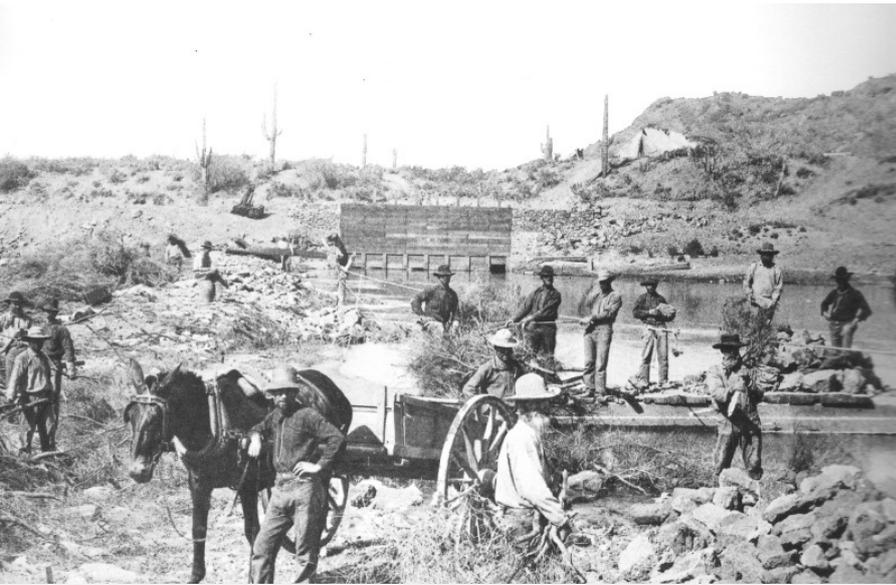


## Green Infrastructure Benefits and Practices

This section, while not providing a comprehensive list of green infrastructure practices, describes the five GI practices that are the focus of this guide and examines the breadth of benefits this type of infrastructure can offer. The following matrix is an illustrative summary of how these practices can produce different combinations of benefits. Please note that these benefits accrue at varying scales according to local factors such as climate and population.

Benefit	Reduces Stormwater Runoff					Improves Community Livability												
	Reduces Water Treatment Needs	Improves Water Quality	Reduces Grey Infrastructure Needs	Reduces Flooding	Increases Available Water Supply	Increases Groundwater Recharge	Reduces Salt Use	Reduces Energy Use	Improves Air Quality	Reduces Atmospheric CO <sub>2</sub>	Reduces Urban Heat Island	Improves Aesthetics	Increases Recreational Opportunity	Reduces Noise Pollution	Improves Community Cohesion	Urban Agriculture	Improves Habitat	Cultivates Public Education Opportunities
<b>Practice</b>																		
<b>Green Roofs</b>	●	●	●	●	○	○	○	●	●	●	●	●	○	○	○	○	○	○
<b>Tree Planting</b>	●	●	●	●	○	○	○	●	●	●	●	●	●	●	●	○	○	○
<b>Bioretention &amp; Infiltration</b>	●	●	●	●	○	○	○	●	●	●	●	●	○	○	○	○	○	○
<b>Permeable Pavement</b>	●	●	●	●	○	○	○	●	●	●	●	○	○	○	○	○	○	○
<b>Water Harvesting</b>	●	●	●	●	●	○	○	○	○	○	○	○	○	○	○	○	○	○

● Yes      ○ Maybe      ○ No



CAMEL BACK MOUNTAIN PHOENIX, ARIZONA C-438



## WORKS CITED

- "Ancient Engineering Lays Groundwork for Major Canal System in Arizona." WEF Highlights, March 20, 2019. <https://news.wef.org/ancient-engineering-lays-groundwork-for-major-canal-system-in-arizona/>.
- "Arizona Climate and Health Adaptation Plan 2017." Arizona Climate and Health Adaptation Plan 2017 | Adaptation Clearinghouse. Accessed May 10, 2021. <https://www.adaptationclearinghouse.org/resources/arizona-climate-and-health-adaptation-plan-2017.html>.
- "Arizona: Crosscut Powerplant (U.S. National Park Service)." National Parks Service. U.S. Department of the Interior. Accessed May 10, 2021. <https://www.nps.gov/articles/arizona-crosscut-powerplant.htm>.
- "Arizona's Climate Threats." Back to the map, November 7, 2016. <https://statesatrisk.org/arizona/all>.
- Beatley, Timothy. "Oslo The Biophilic City." Green Oslo: Visions, Planning and Discourse, edited by Per Gunnar Røe, Routledge, 2016.
- Benedict, Mark A., and Edward T. McMahon. "Green Infrastructure: Smart Conservation for the 21st Century." Renewable Resources Journal, vol. 20, no. 3, Renewable Natural Resources Foundation, 2002, pp. 12–17.
- "Bikeway Provision and Bicycle Commuting: City-Level ..." Accessed May 10, 2021. [https://www.researchgate.net/publication/350069924\\_Bikeway\\_Provision\\_and\\_Bicycle\\_Commuting\\_City-Level\\_Empirical\\_Findings\\_from\\_the\\_US](https://www.researchgate.net/publication/350069924_Bikeway_Provision_and_Bicycle_Commuting_City-Level_Empirical_Findings_from_the_US).
- Blufish. "The Canalscape Project Envisions Beautifying The Phoenix-Area's Many Canals." AZ Big Media, August 20, 2017. <https://azbigmedia.com/business/environment/canalscape-envisions-beautifying-phoenix-canals/>.
- "Board Board Members Board Meetings Notifications 45 Day Look Ahead Joint Appearances Board Background Board Committees Customer Service Task Force Excess Water Task Force Power Task Force Water Quality Standards Task Force Strategic Plan Board Policies Board Member History." Climate Adaptation Plan. Accessed May 10, 2021. <https://www.cap-az.com/departments/planning/climate-adaptation-plan>.
- Bosselmann, Peter, et al. "Livable Streets Revisited." Journal of the American Planning Association, vol. 65, no. 2, Taylor & Francis, 1999, pp. 168–80.
- "City of Phoenix Code Review to Promote Green Infrastructure: Case Study." wrrc.arizona.edu, May 28, 2019. <https://wrrc.arizona.edu/publications/water-harvesting/city-phoenix-code-review-promote-green-infrastructure-case-study>.
- "City of Phoenix Sustainability Goals." City of Phoenix. Accessed May 10, 2021. <https://www.phoenix.gov/sustainability>.
- "City of Phoenix, Arizona Tree and Shade Master Plan." City of Phoenix, Arizona Tree and Shade Master Plan | Adaptation Clearinghouse. Accessed May 10, 2021. <https://www.adaptationclearinghouse.org/resources/city-of-phoenix-arizona-tree-and-shade-master-plan.html>.
- "CLIMATE AND HEALTH STRATEGIC PLAN FOR MARICOPA COUNTY 2016 ..." Accessed May 10, 2021. <https://www.maricopa.gov/DocumentCenter/View/38688/Climate-and-Health-Strategic-Plan-2016-2021-PDF>.
- "Climate Costs Will Strain Arizonans' Health and Economy." Environmental Defense Fund. Accessed May 10, 2021. <https://www.edf.org/climate/costofinaction/arizona>.
- "Environmental Programs About-EQSC." City of Phoenix. Accessed May 10, 2021. <https://www.phoenix.gov/oep/EQSC>.
- "Environmental Programs climate\_homepage." City of Phoenix. Accessed May 10, 2021. <https://www.phoenix.gov/oep/climate>.
- "Environmental Programs UHI-Tree-Shade-Subcommittee." City of Phoenix. Accessed May 10, 2021. <https://www.phoenix.gov/oep/EQSC/UHI-tree-shade-subcommittee>.
- "Environmental Programs." City of Phoenix. Accessed May 10, 2021. <https://www.phoenix.gov/oep/cap>.
- "Environmental Sustainability Goals." City of Phoenix. Accessed May 10, 2021. <https://www.phoenix.gov/sustainability/goal>.
- "Everything You Need to Know about Canal Trails." SRP. Accessed May 10, 2021. <https://www.srpnet.com/water/canals/trails.aspx>.
- Ganz, Marshall. "Public Narrative, Collective Action, and Power." Accountability through Public Opinion: From Inertia to Public Action, The World Bank Washington, DC, 2011, pp. 273–89.
- Gardiner, Dustin. "Lifeblood of Phoenix: 7 Things to Know about Canals." The Arizona Republic. The Republic | azcentral.com, May 24, 2017. <https://www.azcentral.com/story/news/local/phoenix/2017/01/20/phoenix-canals-history-7-things-to-know/96695158/>.
- "Grand Canalscape Multi-Use Trail." City of Phoenix. Accessed May 10, 2021. <https://www.phoenix.gov/streets/grandcanalscape>.
- "Green Infrastructure (GI)." City of Phoenix. Accessed May 10, 2021. <https://www.phoenix.gov/waterservices/envservices/stormwater-program/green-infrastructure>.
- "Green Infrastructure for Southwestern Neighborhoods." Accessed May 10, 2021. [https://wrrc.arizona.edu/sites/wrrc.arizona.edu/files/WMG\\_Green%20Infrastructure%20for%20Southwestern%20Neighborhoods.pdf](https://wrrc.arizona.edu/sites/wrrc.arizona.edu/files/WMG_Green%20Infrastructure%20for%20Southwestern%20Neighborhoods.pdf).
- "Green Infrastructure: P2." ADEQ Arizona Department of Environmental Quality. Accessed May 10, 2021. <https://azdeq.gov/green-infrastructure-p2>.
- "History of the Phoenix Canal System." Canal history. Accessed May 10, 2021. <https://www.srpnet.com/water/canals/history.aspx>.
- "Incorporating the Green Infrastructure Handbook." Dibble Engineering, October 1, 2020. <https://www.dibblecorp.com/insights/incorporating-the-green-infrastructure-handbook/>.
- "International Guidelines on Urban and Territorial Planning: UN-Habitat." UN. Accessed May 10, 2021. <https://unhabitat.org/international-guidelines-on-urban-and-territorial-planning>.
- Kim, Annette M. 2015. Critical cartography 2.0: From "participatory mapping" to authored visualizations of power and people. Landscape and Urban Planning, 142, 215-225
- Manzo, Lynne C., and Douglas D. Perkins. "Finding Common Ground: The Importance of Place Attachment to Community Participation and Planning." Journal of Planning Literature, vol. 20, no. 4, Sage Publications Sage CA: Thousand Oaks, CA, 2006, pp. 335–50.
- Melissa Denchak. "Green Infrastructure: How to Manage Water in a Sustainable Way." NRDC, March 4, 2019, February 5, 2020. <https://www.nrdc.org/stories/green-infrastructure-how-manage-water-sustainable-way>.
- Nature's Cooling Systems Project for Heat Action Planning in Greater Phoenix. Accessed May 10, 2021. [https://repository.asu.edu/attachments/220971/content/HeatActionPlan\\_ExecSummary\\_highRes.pdf](https://repository.asu.edu/attachments/220971/content/HeatActionPlan_ExecSummary_highRes.pdf).
- "Overview of Arizona's Climate Change Preparations - Georgetown Climate Center." georgetownclimatecenter.org. Accessed May 10, 2021. <https://www.georgetownclimate.org/adaptation/state-information/arizona/overview.html>.
- "Phoenix 101: Canals." Rogue Columnist. Accessed May 10, 2021. [https://www.roguecolumnist.com/rogue\\_columnist/2018/06/phoenix-101-canals.html](https://www.roguecolumnist.com/rogue_columnist/2018/06/phoenix-101-canals.html).
- "Plants." AMWUA. Accessed May 10, 2021. <http://www.amwua.org/plant/white-thorn-acacia>.
- Posted by Longreads on February 5, and Longreads. "The Ancient Waterways of Phoenix, Arizona." Longreads, December 21, 2019. <https://longreads.com/2020/02/05/the-ancient-waterways-of-phoenix-arizona/>.
- "Preliminary Study of Climate Adaptation for the Statewide Transportation System in Arizona." Preliminary Study of Climate Adaptation for the Statewide Transportation System in Arizona | Adaptation Clearinghouse. Accessed May 10, 2021. <https://www.adaptationclearinghouse.org/resources/preliminary-study-of-climate-adaptation-for-the-statewide-transportation-system-in-arizona.html>.
- Project, The Climate Reality. "How the Climate Crisis Is Affecting Arizona." Climate Reality, November 25, 2019. <https://www.climateRealityproject.org/blog/how-climate-crisis-affecting-arizona>.
- "Recommendations for Integrating Green ... - Epa.gov." Accessed May 10, 2021. [https://www.epa.gov/sites/production/files/2020-09/documents/maricopa\\_gi\\_in\\_hmp\\_final\\_report\\_3-23-2020\\_final\\_1.pdf](https://www.epa.gov/sites/production/files/2020-09/documents/maricopa_gi_in_hmp_final_report_3-23-2020_final_1.pdf).
- Ruggeri, Deni, "Storytelling as a Catalyst for Democratic Landscape Change in a Modernist Utopia." Defining Landscape Democracy, Edward Elgar Publishing, 2018.
- Ruggeri, Deni. "The Agency of Place Attachment in the Contemporary Co-Production of Community Landscapes." Place Attachment: Advances in Theory, Methods and Applications, Routledge, 2020, p.243.
- Southworth, Michael. "Measuring the Liveable City." Built Environment, 2003, pp. 343–54
- Spirn, Whiston Anne. "Ecological Urbanism: A Framework for the Design of Resilient Cities." Resilience in Ecology and Urban Design, 2012.
- SRPconnect, and About The Author SRPconnect For more than a century. "The Grand Canalscape Is Now Complete, Here's the Details." SRPconnect Blog, August 19, 2020. <https://blog.srpnet.com/grand-canalscape-recreational-paths/>.
- "Sustainability City of Phoenix - Sustainability." City of Phoenix. Accessed May 10, 2021. <https://www.phoenix.gov/sustainability/highlights>.
- "THE 17 GOALS | Sustainable Development." United Nations. United Nations. Accessed May 10, 2021. <https://sdgs.un.org/goals>.
- "What Is Green Infrastructure?" EPA. Environmental Protection Agency, November 2, 2020. <https://www.epa.gov/green-infrastructure/what-green-infrastructure>.
- "Whatever Happened to the Historic Canals of Phoenix?" History Adventuring. Accessed May 10, 2021. <http://www.historyadventuring.com/2015/07/whatever-happened-to-historic-canals-of.html>.