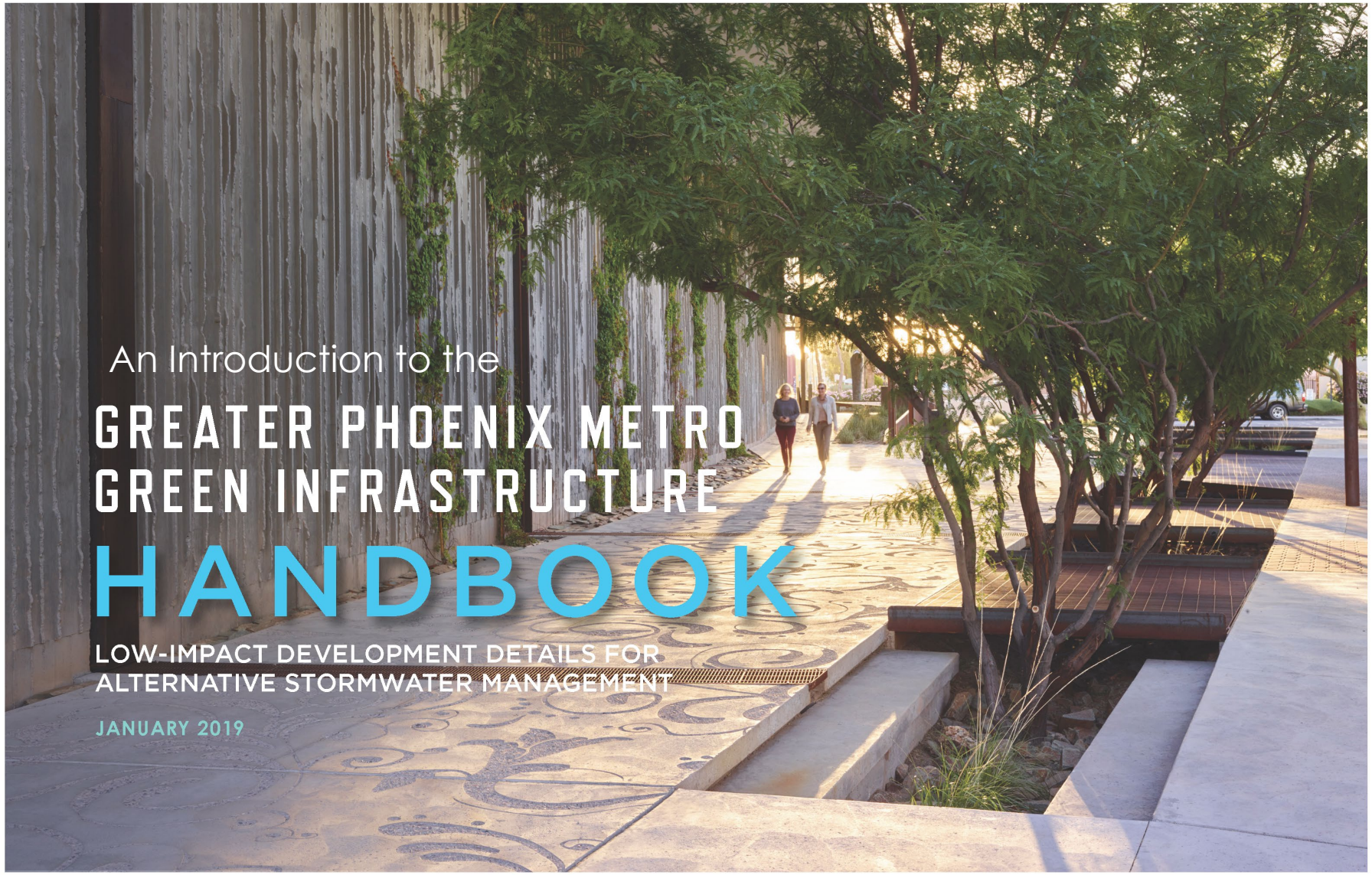


Prepared for CITY OF SCOTTSDALE in Collaboration with ASU Sustainable Cities Network Arizona State University and Member Communities

Photo credit: Marion Brenner. Scottsdale Museum of the West. Landscape architecture by Colwell Shelor

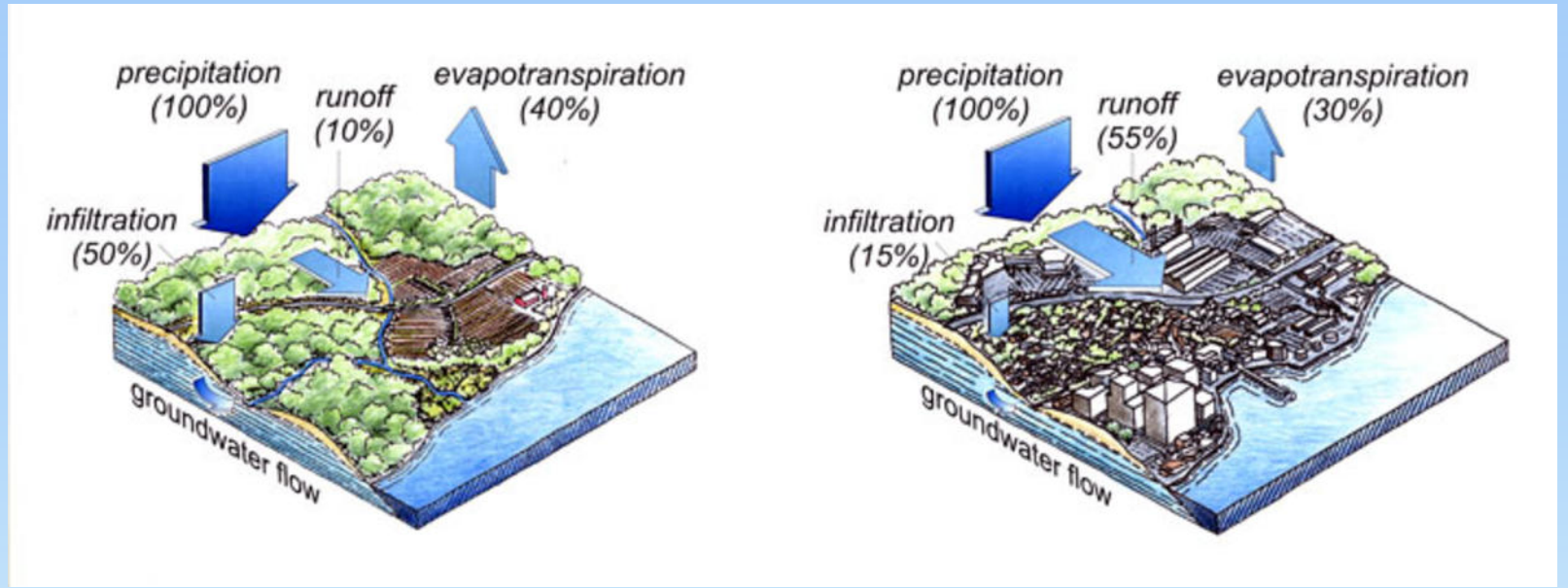
TRAINING AGENDA

- What is low-impact development (LID)/ green infrastructure (GI)?
- Background
- Benefits of LID
- Purpose of Handbook
- Hydrologic design standards
- Content
- Additional resources
- Questions

Image courtesy of Leigh Padgitt

WHAT IS LOW IMPACT DEVELOPMENT?

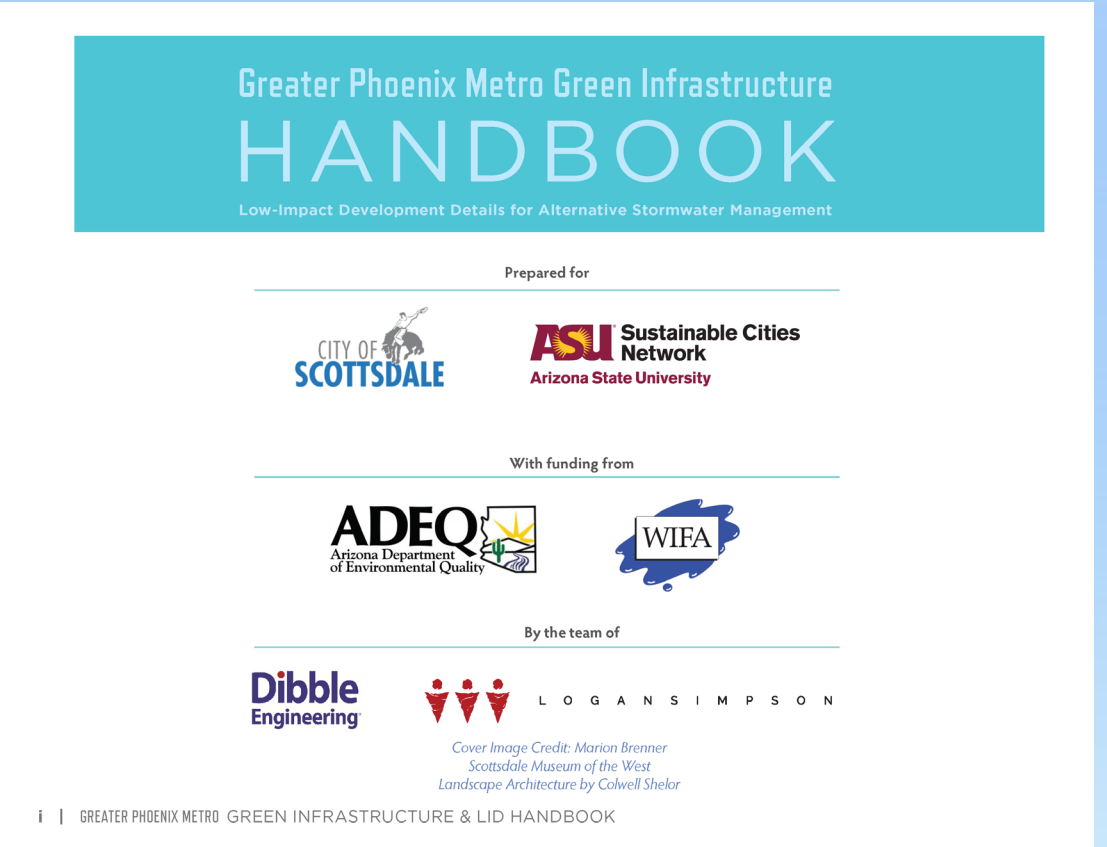
- GI is an approach to water management that protects, restores, or mimics the natural water cycle. LID is a low-cost GI technique that manages stormwater where it falls.
- LID/GI is a landscape-based practice that can help maintain pre-development hydrological conditions.
- LID/GI allows water to:
  - Be cleansed and infiltrate into the soil.
  - Evapotranspirate (be transferred to the atmosphere through evaporation or transpiration by plants).
  - Be used for beneficial purposes, such as landscape irrigation.



Courtesy of Mass.gov Smart Growth, Smart Energy Toolkit

BACKGROUND

- Arizona State University's Sustainable Cities Network (SCN) has fostered discussion about sustainability and GI in Arizona since 2009.
- LID is widely used in Pima County, but not in Maricopa County.
- With SCN guidance, the Specs & Standards Subgroup of SCN's GI Workgroup took up the challenge of creating a GI/LID handbook geared to the environment of the Phoenix Metropolitan Area. Core working team members include representatives of:
  - City of Scottsdale
  - City of Phoenix
  - Flood Control District of Maricopa County (FCDMC)
  - ASU Sustainable Cities Network (SCN)
  - In addition, a total of eight cities or local agencies provided review, comments, and input (see the Handbook for a list of participants)
- Funding came from Arizona Department of Environmental Quality (ADEQ) and Water Infrastructure Authority (WIFA) grants and the City of Scottsdale.
- The Handbook contains 10 technical standardized details and specifications (TSDS) selected by the core team and a stakeholder group of eight Phoenix Metropolitan Area municipal representatives.

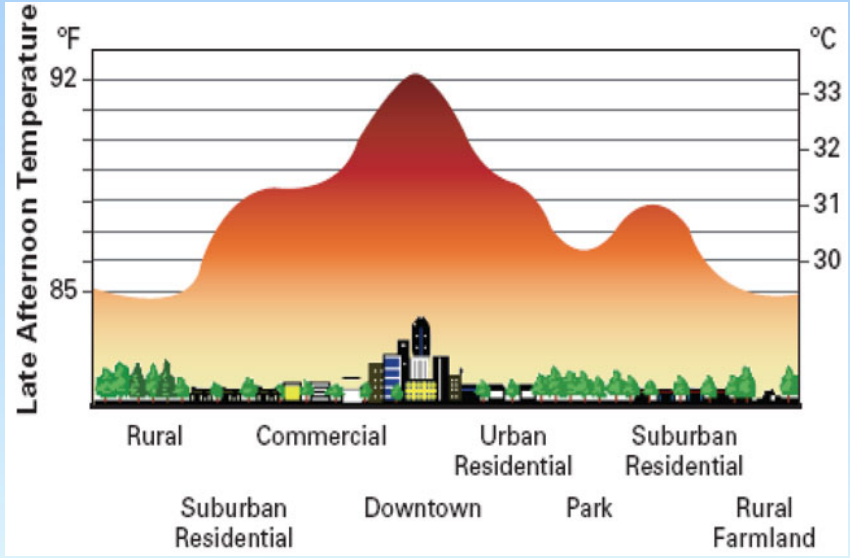


BENEFITS OF GI/LID

- Reduces water pollution by reducing nonpoint source pollutant loads.
- Helps conform with local first-flush requirements.
- Helps reduce stormwater peak flows and volume, helping mitigate flood hazards and improving water quality.
- Reduces the heat-island effect and quality of life by increasing vegetation and shade.
- Allows the use of stormwater as a supplemental source of irrigation water.
- Can help comply with MS4 and other general permit requirements, where the permit requires the use of sustainable stormwater practices.
- Sustainable practice that can help achieve goals for implementing green infrastructure.

Cause of Impairment	Cause of Impairment Group	Miles Threatened or Impaired
Escherichia Coli (E. Coli)	Pathogens	334.5
Copper	Metals (other than Mercury)	259.5
Selenium	Metals (other than Mercury)	254.7
Sedimentation/Siltation	Sediment	178.7
pH	pH/Acidity/Caustic Conditions	101.5
Chlordane	Pesticides	99.6
Toxaphene	Pesticides	99.6
DDT	Pesticides	99.6
Dissolved Oxygen	Organic Enrichment/Oxygen Depletion	97.4
Zinc	Metals (other than Mercury)	69.1
Mercury in Fish Tissue	Mercury	66.0
Boron	Toxic Inorganics	59.3
Cadmium	Metals (other than Mercury)	58.7
Ammonia, Un-ionized	Ammonia	58.5
Arsenic	Metals (other than Mercury)	35.6
Lead	Metals (other than Mercury)	35.6
Nitrogen, Total	Nutrients	24.1
Chlorine	Chlorine	20.3
Beryllium	Metals (other than Mercury)	15.8
Phosphorus, Elemental	Nutrients	8.0

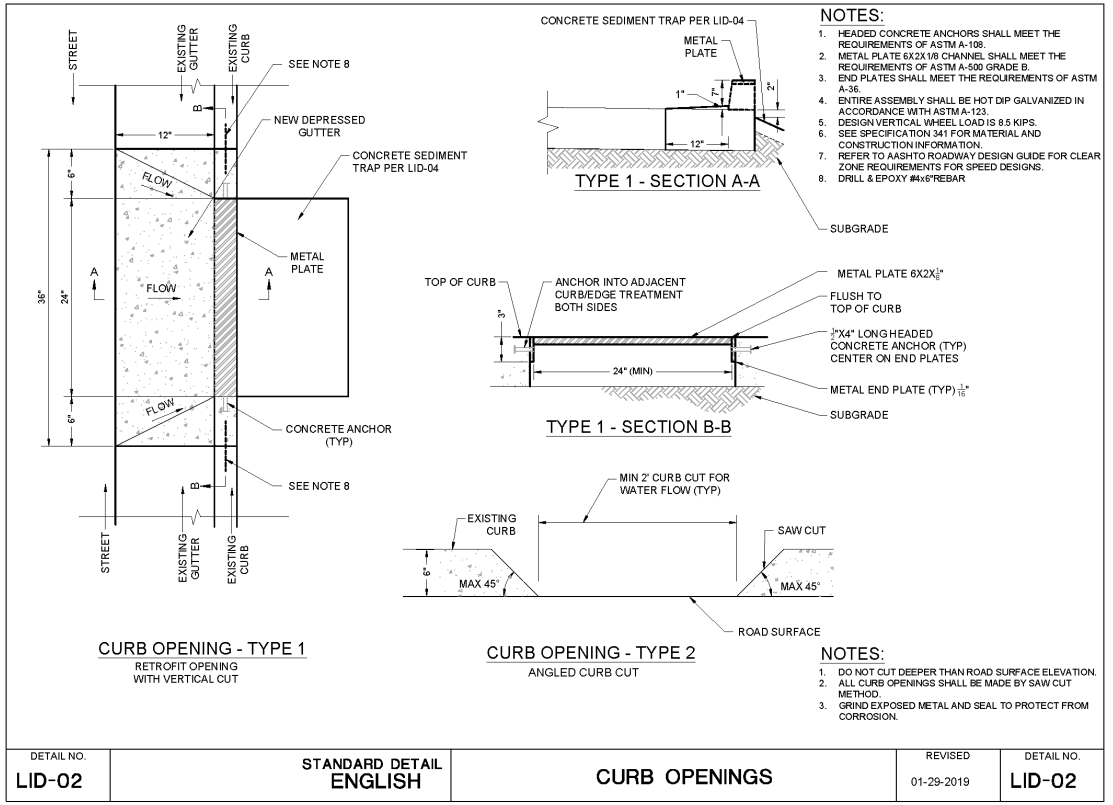
Courtesy of ADEQ



Courtesy of Southwest Urban Hydrology

PURPOSE OF THE HANDBOOK

- The Handbook encourages the use of LID techniques in the Phoenix Metropolitan Area by providing technical standardized details and specifications(TSDS) for 10 LID elements.
  - Elements were chosen with input from eight Phoenix Area municipal representatives.
  - Chosen elements were reviewed by a core team that included the Cities of Scottsdale and Phoenix; Flood Control District of Maricopa County (FCDMC); and Arizona State University (ASU) Sustainable Cities Network.



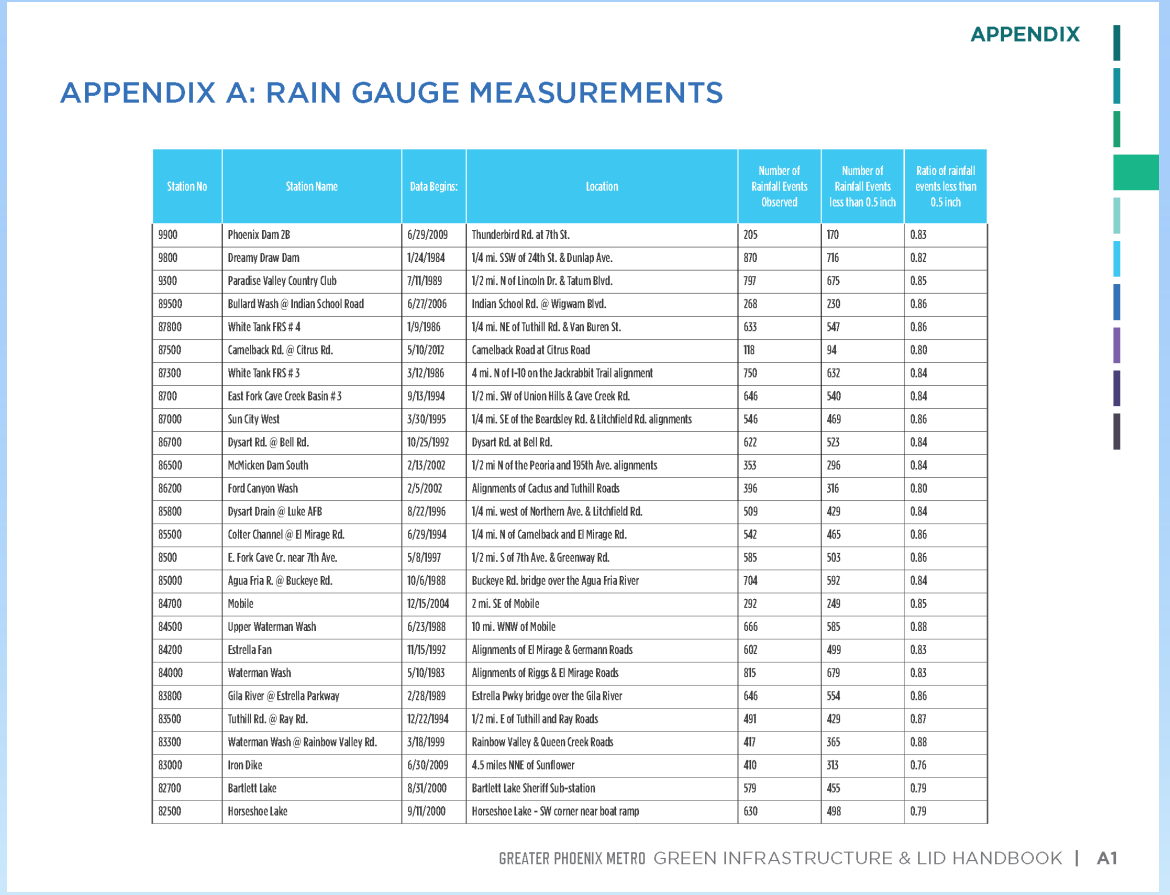
HYDROLOGIC DESIGN IN THE DESERT SOUTHWEST

- Rainfall patterns in the Desert Southwest are very different than elsewhere in the US.
  - High-intensity, short-duration thunderstorms occur during the monsoon (July – September).
  - Disintegrating tropical storms occur during the fall.
  - Lower-intensity frontal storms occur during the winter months.
  - Rainfall seasons are characterized by prolonged periods of dry conditions and low humidity.
  - A large majority of rain events in Maricopa County are less than 0.5 inches.

Image courtesy of AZFamily.com

HYDROLOGIC DESIGN CRITERIA USED IN THE HANDBOOK

- First-flush rainfall of 0.5 inches is the design criteria for this Handbook.
- Rainfall of 1.5 inches is used to determine the maximum storage capacity of LID facilities. Because these events cause floods, designing systems to accommodate these volumes can help mitigate flooding.
- Data is based on rainfall information collected by FCDMC across Maricopa County.
  - 90 – 95 percent of all storms are below 1.5 inches.
  - Rainfall events less than the first-flush rainfall occurred in 82 percent of storms.
- The design criteria for retention and detention basins requires that any storm event must drain within 36 hours.



APPENDIX

APPENDIX A: RAIN GAUGE MEASUREMENTS

Station No	Station Name	Data Begins:	Location	Number of Rainfall Events Observed	Number of Rainfall Events less than 0.5 inch	Ratio of rainfall events less than 0.5 inch
9900	Phoenix Dam 2B	6/29/2009	Thunderbird Rd. at 7th St.	205	170	0.83
9800	Dreamy Draw Dam	1/24/1984	1/4 mi. SSW of 24th St. & Dunlap Ave.	870	716	0.82
9300	Paradise Valley Country Club	7/11/1989	1/2 mi. N of Lincoln Dr. & Tatum Blvd.	797	675	0.85
89500	Bullard Wash @ Indian School Road	6/27/2006	Indian School Rd. @ Wigwam Blvd.	268	230	0.86
87800	White Tank FRS # 4	1/9/1986	1/4 mi. NE of Tuthill Rd. & Van Buren St.	633	547	0.86
87500	Camelback Rd. @ Citrus Rd.	5/10/2012	Camelback Road at Citrus Road	118	94	0.80
87300	White Tank FRS # 3	3/12/1986	4 mi. N of I-10 on the Jackrabbit Trail alignment	750	632	0.84
8700	East Fork Cave Creek Basin # 3	9/13/1994	1/2 mi. SW of Union Hills & Cave Creek Rd.	646	540	0.84
87000	Sun City West	3/30/1995	1/4 mi. SE of the Beardsley Rd. & Litchfield Rd. alignments	546	469	0.86
86700	Dysart Rd. @ Bell Rd.	10/25/1992	Dysart Rd. at Bell Rd.	622	523	0.84
86500	McMicken Dam South	2/13/2002	1/2 mi N of the Peoria and 195th Ave. alignments	353	296	0.84
86200	Ford Canyon Wash	2/5/2002	Alignments of Cactus and Tuthill Roads	396	316	0.80
85800	Dysart Drain @ Luke AFB	8/22/1996	1/4 mi. west of Northern Ave. & Litchfield Rd.	509	429	0.84
85500	Colter Channel @ El Mirage Rd.	6/29/1994	1/4 mi. N of Camelback and El Mirage Rd.	542	465	0.86
8500	E. Fork Cave Cr. near 7th Ave.	5/8/1997	1/2 mi. S of 7th Ave. & Greenway Rd.	585	503	0.86
85000	Agua Fria R. @ Buckeye Rd.	10/6/1988	Buckeye Rd. bridge over the Agua Fria River	704	592	0.84
84700	Mobile	12/15/2004	2 mi. SE of Mobile	292	249	0.85
84500	Upper Waterman Wash	6/23/1988	10 mi. WNW of Mobile	666	585	0.88
84200	Estrella Fan	11/15/1992	Alignments of El Mirage & Germann Roads	602	499	0.83
84000	Waterman Wash	5/10/1983	Alignments of Riggs & El Mirage Roads	815	679	0.83
83800	Gila River @ Estrella Parkway	2/28/1989	Estrella Pwky bridge over the Gila River	646	554	0.86
83500	Tuthill Rd. @ Ray Rd.	12/22/1994	1/2 mi. E of Tuthill and Ray Roads	491	429	0.87
83300	Waterman Wash @ Rainbow Valley Rd.	3/18/1999	Rainbow Valley & Queen Creek Roads	417	365	0.88
83000	Iron Dike	6/30/2009	4.5 miles NNE of Sunflower	410	313	0.76
82700	Bartlett Lake	8/31/2000	Bartlett Lake Sheriff Sub-station	579	455	0.79
82500	Horseshoe Lake	9/11/2000	Horseshoe Lake - SW corner near boat ramp	630	498	0.79

LID ELEMENTS COVERED IN THE HANDBOOK

- Permeable pavements
- Curb openings
- Sediment traps
- Stormwater harvesting basins
- Vegetated or rock bioswales
- Bioretention systems
- Curb extensions
- Bioretention planters
- Domed overflow structure
- Landscaping

TABLE OF CONTENTS

APPENDICES

LIST OF TABLES

PERMEABLE PAVEMENTS

- Allow streets, parking lots, and other typically impervious covers to utilize the infiltration capacity of underlying soils.
- Are suitable for low to moderate vehicular use areas.
- Are not suitable for high-speed (>30 mph) roadways or areas designed for high structural loads.
- Are not recommended where high pollutant loads are expected.
- Must be maintained regularly to remain effective.

Image courtesy of www.allpaving.com

Image courtesy of.advancedpavement.com

Courtesy of www.pavementinteractive.org/porous-on-purpose-permeable-pavements/

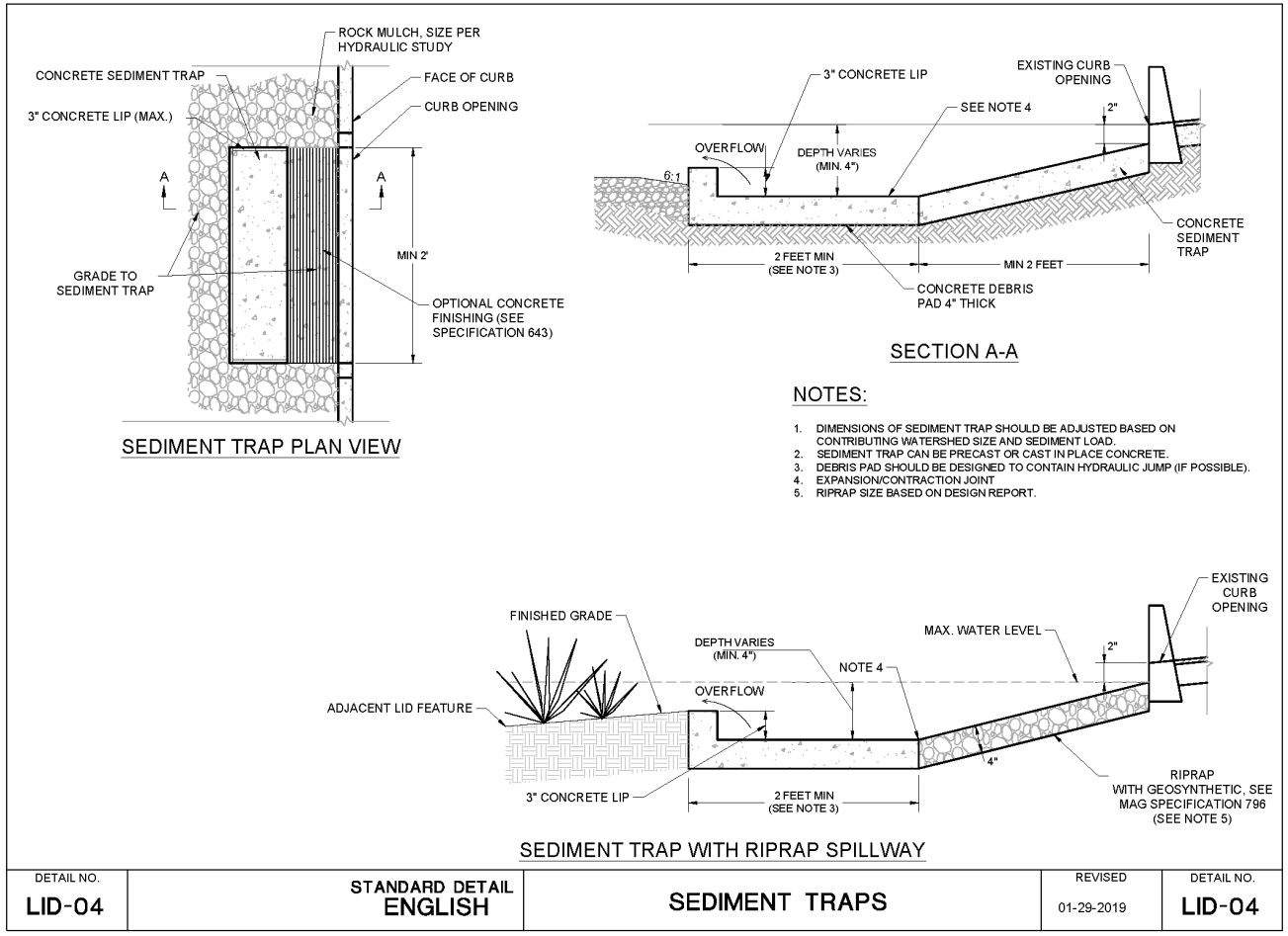
CURB OPENINGS

- Convey runoff into and out of LID features such as bioswales or biorentention areas.
- Can be new construction or retrofitted.
- Must be designed with roadway speeds and clear zone offsets in mind.
- Must be kept clear of debris and inspected after storms of ≥ 0.5 inches to ensure they are not clogged.
- Can be used in conjunction with vegetated/rock bioswales; stormwater harvesting basins; sediment traps; and bioretention systems.

Image courtesy of City of Mesa

SEDIMENT TRAPS

- Collect sediment and other debris in areas of concentrated stormwater flows before the water enters a stormwater capture or LID facility.
- Must be maintained by removing sediment and debris monthly and after storms of ≥ 0.5 inches.
- Serve as an accessory to other LID facilities or conveyance structures.
- Can be used in conjunction with curb openings and vegetated/rock bioswales.



STORMWATER HARVESTING BASINS

- Also referred to as rain gardens.
- Consist of shallow vegetated earthen depressions that collect stormwater and cleanse it before percolation into the subsurface.
- Provide subsurface storage within the constructed facility.
- Are typically landscaped and should be built adjacent to impervious areas like parking lots.
- Are scalable—can be built at any size.
- Must be checked for erosion, sediment, debris, and clogging semiannually and after storms of ≥ 0.5 inches. Underdrains must be cleaned when standing water is present.
- Serve as an accessory to other LID facilities or conveyance structures.
- Can be used in conjunction with curb openings, bioretention systems, and sediment traps.

Image courtesy of Craig Coronato

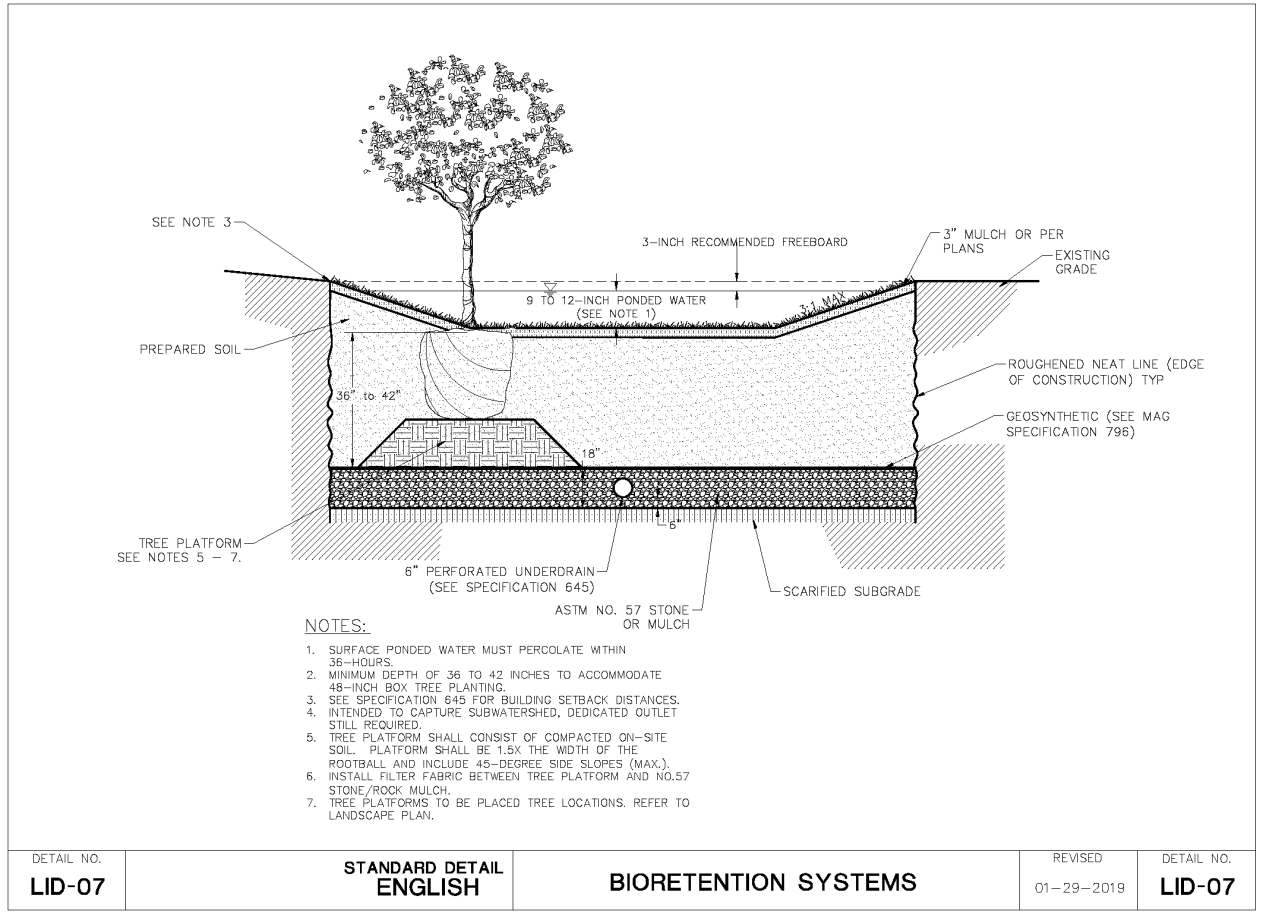
VEGETATED AND ROCK BIOSWALES

- Consist of open shallow channels with vegetation on the bottom and side slopes, in addition to pervious plating (i.e. decomposed granite, rock, or mulch).
- Are designed to slow runoff flows.
- May provide water harvesting opportunities and may allow percolation of cleansed stormwater into the ground.
- Must be checked for erosion, sediment, debris, and clogging semiannually and after storms of ≥ 0.5 inches. Sediment traps may be added to reduce maintenance requirements.
- Can be used in conjunction with curb openings, sediment traps, bioretention facilities, and permeable pavements. Overflow structures are required when the system is connected to a downstream drainage or bioretention facility.
- May require a series of checkdams to control speed/velocity of stormwater runoff in steeper, sloping instances.

Image courtesy of Wayne Colebank

BIORETENTION SYSTEMS

- Are primarily designed to remove pollutants through an engineered soil media.
- Are typically landscaped.
- Can be designed to allow water to percolate into the subsoil or to direct it to a downstream drainage system.
- Are well-suited to urban areas with highly impervious surfaces where space is limited.
- Should be constructed with a sediment trap at the inlet to prolong the facility's lifespan.
- Should be inspected quarterly and after storms of ≥ 0.5 inch and cleaned of sediment and debris.
- Can be used in conjunction with sediment traps and curb openings.



CURB EXTENSIONS

- Are designed to create an opportunity for the bioretention of street runoff and to provide a space for trees and plants.
- Are typically landscaped.
- Can be used along low-speed roadways, driveways, and parking lots.
- Can be used as a traffic-calming measure.
- Are easy to retrofit.
- Should be inspected quarterly and after storms of ≥ 0.5 inch and cleaned of sediment and debris.
- Can be used in conjunction with curb openings, sediment traps, permeable pavements, and overflow structures.

Image courtesy of Watershed Management Group

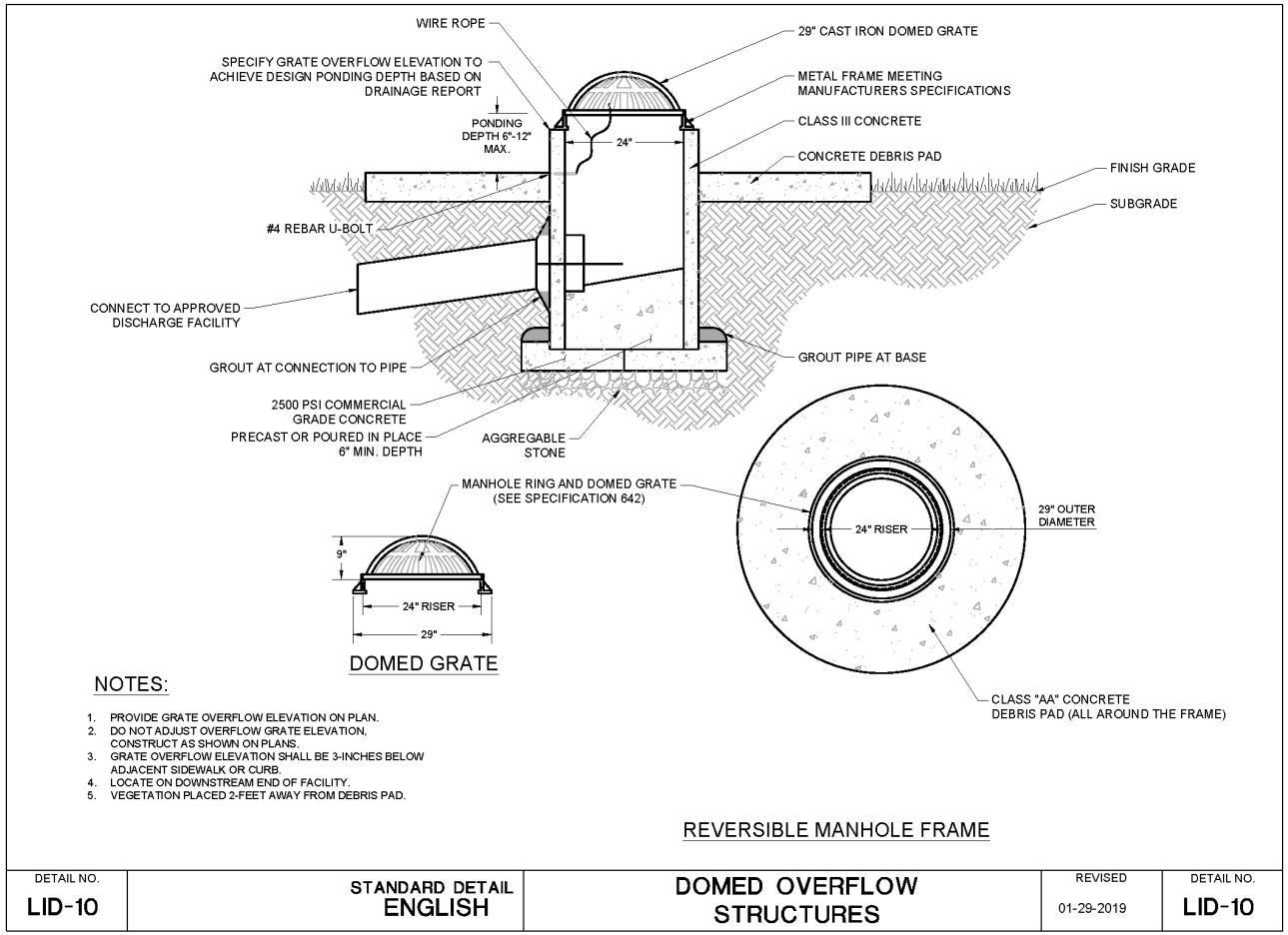
BIORETENTION PLANTERS

- Are small-scale bioretention cells typically located in hardscaped areas between the curb and sidewalk.
- Are typically landscaped.
- Do not connect to a downstream drainage facility.
- May require railings or curbs for pedestrian safety.
- Should be inspected quarterly and after storms of ≥ 0.5 inch and cleaned of sediment and debris. Cleanout risers should also be inspected.
- Can be used in conjunction with curb openings.

Image courtesy of Tim Conner

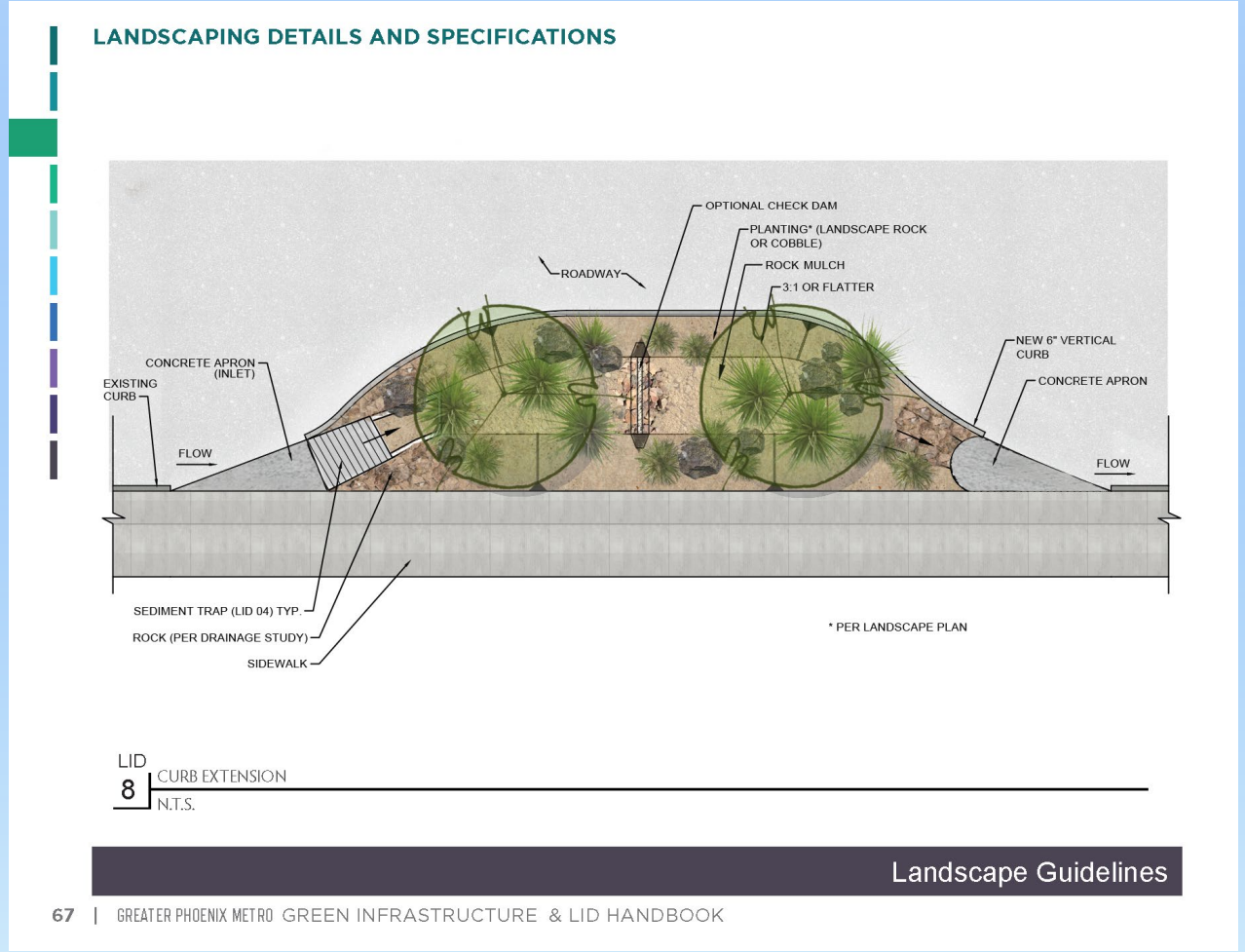
DOMED OVERFLOW STRUCTURES

- Allow ponding within multiple stormwater capture facilities and provide an outlet for larger storm events that exceed the capacity of each facility.
- Drain into a downstream collection facility.
- Should be inspected quarterly and after storms of ≥ 1.25 inch and cleaned of sediment and debris. Encroaching vegetation should be pruned or removed to maintain a landscape buffer.
- Can be used in conjunction with LID elements that involve surface water or ponding, such as vegetated or rock bioswales and stormwater harvesting basins.



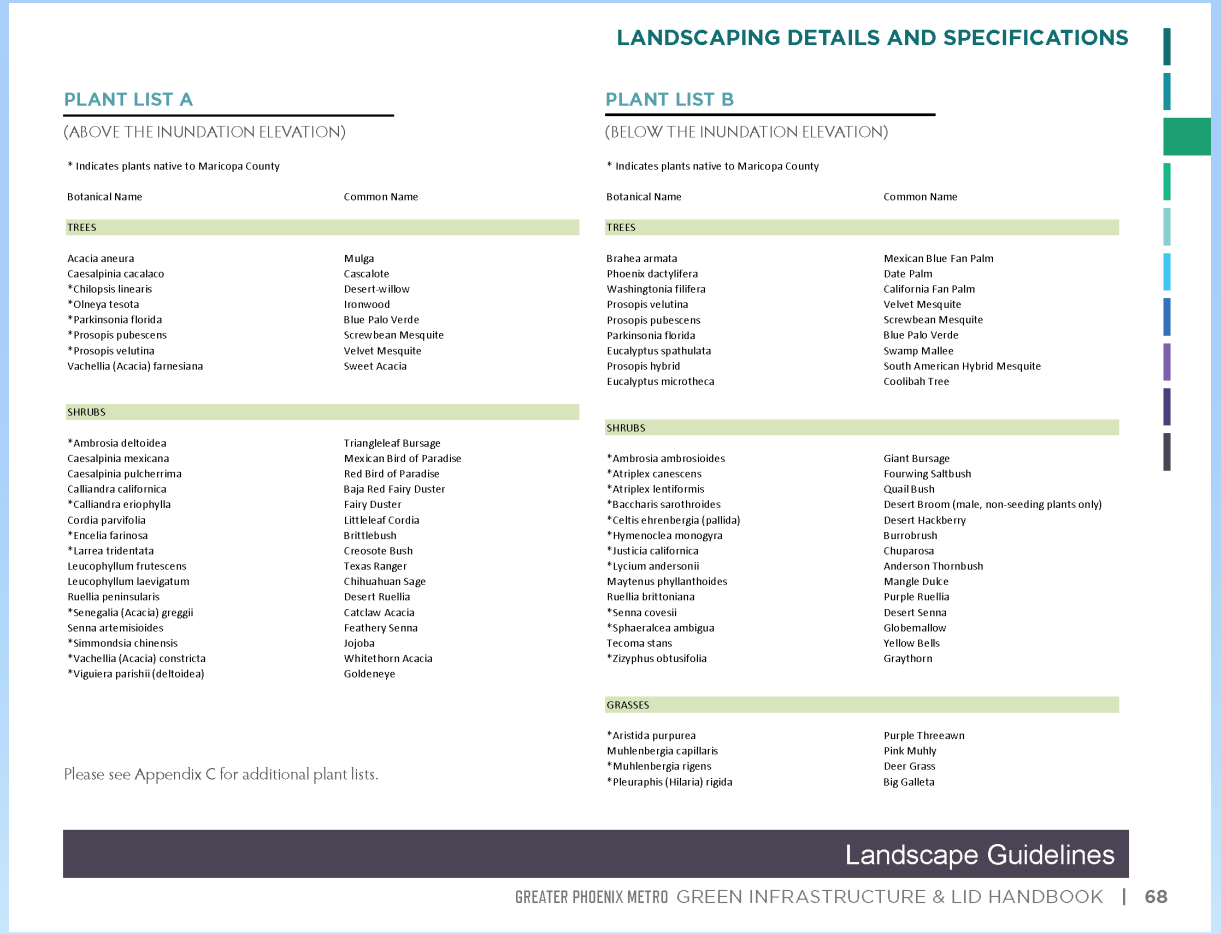
LANDSCAPING DETAILS

- LID/GI is a landscape-based technique.
- Native vegetation is sparse in Maricopa County, so purposely installed landscaping is needed to provide vegetative cover for most LID elements.
- LID/GI techniques must take into account the soils in Maricopa County, which:
  - Result from the disintegration of mountain ranges.
  - May have high a salt content.
  - Are generally alkaline.
  - May include impermeable layers like caliche.
  - Have low organic content.



LANDSCAPING DETAILS

- Plants best equipped to deal with conditions in Maricopa County are native or desert-adapted.
- Multiple agencies have produced plant lists, such as the Arizona Department of Water Resources Low Water Use Drought Tolerant Plant List.
- Many low water use/desert adapted plants can survive on rainwater after a 1 – 2 year establishment period; others require some supplemental watering.
- Plant size at maturity and planting locations should be carefully considered.



LANDSCAPING DETAILS AND SPECIFICATIONS

PLANT LIST A

(ABOVE THE INUNDATION ELEVATION)

* Indicates plants native to Maricopa County

Botanical Name	Common Name
TREES	
Acacia aneura	Mulga
Caesalpinia cacalaco	Cascalote
*Chilopsis linearis	Desert-willow
*Olneya tesota	Ironwood
*Parkinsonia florida	Blue Palo Verde
*Prosopis pubescens	Screwbean Mesquite
*Prosopis velutina	Velvet Mesquite
Vachellia (Acacia) farnesiana	Sweet Acacia
SHRUBS	
*Ambrosia deltoidea	Triangleleaf Bursage
Caesalpinia mexicana	Mexican Bird of Paradise
Caesalpinia pulcherrima	Red Bird of Paradise
Calliandra californica	Baja Red Fairy Duster
*Calliandra eriophylla	Fairy Duster
Cordia parvifolia	Littleleaf Cordia
*Encelia farinosa	Brittlebush
*Larrea tridentata	Creosote Bush
Leucophyllum frutescens	Texas Ranger
Leucophyllum laevigatum	Chihuahuan Sage
Ruellia peninsularis	Desert Ruellia
*Senegalia (Acacia) greggii	Catclaw Acacia
Senna artemisioides	Feathery Senna
*Simmondsia chinensis	Jojoba
*Vachellia (Acacia) constricta	Whitethorn Acacia
*Viguiera parishii (deltoidea)	Goldeneye

Please see Appendix C for additional plant lists.

PLANT LIST B

(BELOW THE INUNDATION ELEVATION)

* Indicates plants native to Maricopa County

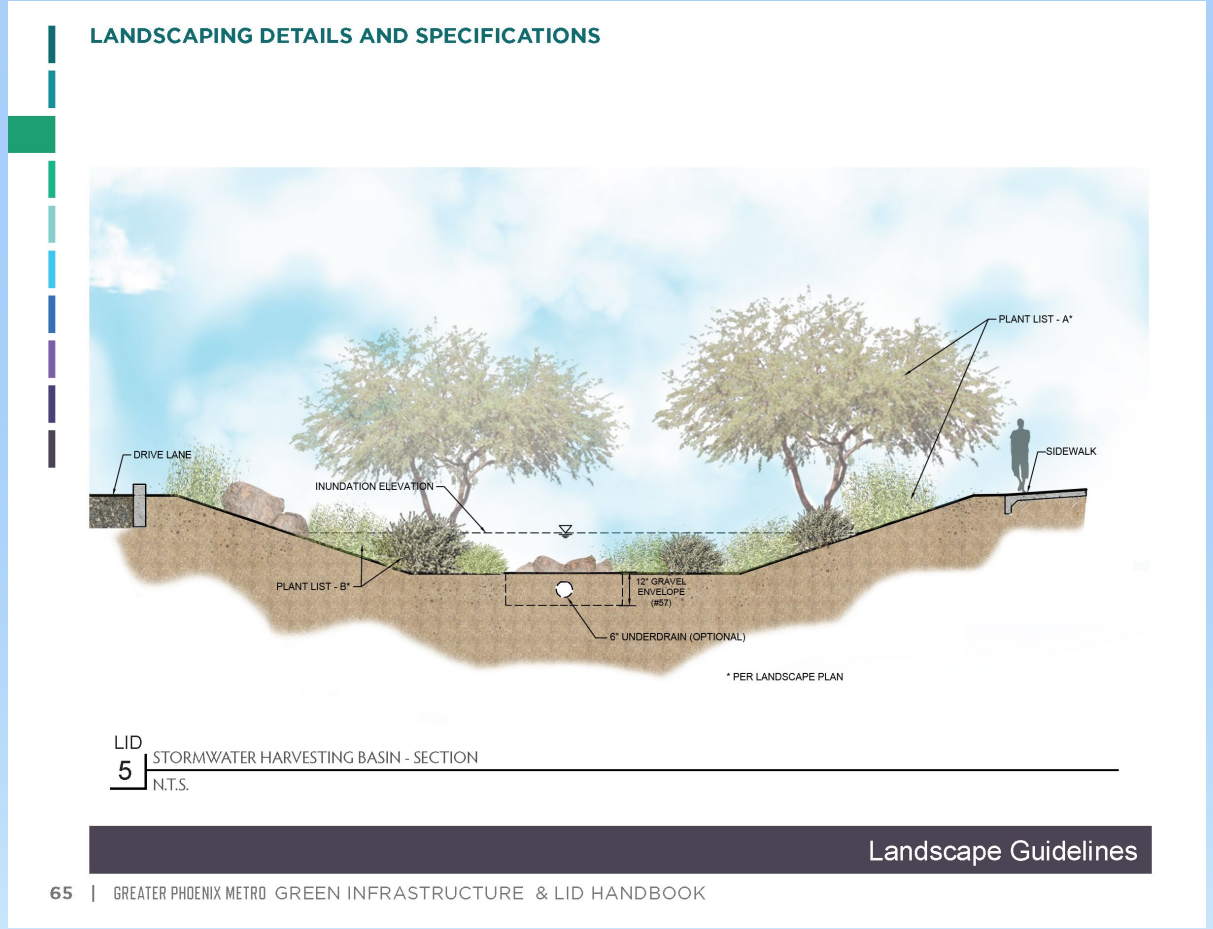
Botanical Name	Common Name
TREES	
Brahea armata	Mexican Blue Fan Palm
Phoenix dactylifera	Date Palm
Washingtonia filifera	California Fan Palm
Prosopis velutina	Velvet Mesquite
Prosopis pubescens	Screwbean Mesquite
Parkinsonia florida	Blue Palo Verde
Eucalyptus spathulata	Swamp Mallee
Prosopis hybrid	South American Hybrid Mesquite
Eucalyptus microtheca	Coolibah Tree
SHRUBS	
*Ambrosia ambrosioides	Giant Bursage
*Atriplex canescens	Fourwing Saltbush
*Atriplex lentiformis	Quail Bush
*Baccharis sarothroides	Desert Broom (male, non-seeding plants only)
*Celtis ehrenbergia (pallida)	Desert Hackberry
*Hymenoclea monogyra	Burrobrush
*Justicia californica	Chuparosa
*Lycium andersonii	Anderson Thornbush
Maytenus phyllanthoides	Mangle Dulce
Ruellia brittoniana	Purple Ruellia
*Senna covesii	Desert Senna
*Sphaeralcea ambigua	Globemallow
Tecoma stans	Yellow Bells
*Zizyphus obtusifolia	Graythorn
GRASSES	
*Aristida purpurea	Purple Threeawn
Muhlenbergia capillaris	Pink Muhly
*Muhlenbergia rigens	Deer Grass
*Pleuraphis (Hilaria) rigida	Big Galleta

Landscape Guidelines

GREATER PHOENIX METRO GREEN INFRASTRUCTURE & LID HANDBOOK | 68

LANDSCAPING DETAILS

- Plant maintenance requirements are of concern to those considering LID and have an effect on the efficiency of the techniques used.
- Plants should be allowed to grow into their natural shape; reduced pruning also reduces maintenance costs.
- See the Handbook for recommendations for landscaping, guidelines, details, Bioretention Soil Media (BSM), and maintenance.



ADDITIONAL RESOURCES

- An online version of the Greater Phoenix Metro Green Infrastructure Handbook is available at https://sustainability.asu.edu/sustainable-cities/resources/lid-handbook/.
- The Low Impact Development Toolkit prepared for the cities of Mesa and Glendale (available at https://www.mesaaz.gov/home/showdocument?id=14999)
- The Specifications and Standards Sub-Workgroup of the ASU Sustainable Cities Network Green Infrastructure Workgroup (https://sustainability.asu.edu/sustainable-cities/about/workgroups/green-infrastructure/)
- Pima County's 2015 Low Impact Development and Green Infrastructure Guidance Manual (http://webcms.pima.gov/UserFiles/Servers/Server_6/File/Government/Flood%20Control/Floodplain%20Management/Low%20Impact%20Development/li-gi-manual-20150311.pdf)
- Pima County LID Working Group (http://webcms.pima.gov/cms/one.aspx?portalId=169&pageId=65263)

THANK YOU!

- Reach out to us at:
  - *Presenter 1 name, email, phone number*
  - *Presenter 2 name, email, phone number*

Questions?