# AN EVOLVING CHECKLIST OF STRATEGIES TO BUILD A SUCCESSFUL GREEN INFRASTRUCTURE PROGRAM

**Prepared for the 2015 Border Green Infrastructure Forum**

**Longer Version with Resources and Links**

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May 2015

Last updated September 21, 2015

## PURPOSE

To promote the concept and practice of Green Infrastructure (GI) among local officials, developers, consultants, academics, non-profits, and the general public in communities on both sides of the US-Mexico border; to generate interest and build capacities in the various strategies, technologies, and policies involved in order to apply these concepts to public- and private-sector urban-infrastructure projects.

### What is Green Infrastructure?

Green infrastructure is *living* infrastructure. Living systems of vegetation, soil life, and infiltrated stormwaters are key to its function and effectiveness. It strives to align design principles and ecological-systems understanding. Thus it works *with* and demonstrates natural processes within our built environment.

### Why Green Infrastructure?

To improve and inform the design of living urban infrastructure so it contributes to larger, interconnected living systems in a way that enhances the health and wealth of communities, their environments, and the larger shared watershed.

The more effectively green infrastructure utilizes indigenous species and their unique role in the local ecosystem, the greater the potential for renewal and regeneration that taps the essence of a place. Communities are traditionally built at concentrations of natural abundance (climate, water, fertile soils, minerals, trade corridors) which is then degraded or enhanced. Well-designed GI has the potential to contribute to, rather than extract from, that natural abundance.

### Principles precede strategies

Principles are not strategies, they are guiding reminders of what potential strategies must do, and thereby help us select the appropriate strategy for each unique context.

Here are my eight principles you may want to start with. More GI principles can be found on p. 8 of Green Infrastructure for Southwestern Neighborhoods. But don't stop there. Evolve others as your growing experience deems appropriate.

# An evolving checklist of green-infrastructure capacities to develop and potential strategies to implement

(Note that the numbering of items is not intended to suggest the order in which they should be implemented)

## 1. INCREASE AWARENESS OF GREEN INFRASTRUCTURE'S VALUE TO PUBLIC, PROFESSIONALS, AND GOVERNMENT OFFICIALS AND STAFF

Awareness-building can be carried out by NGOs, business alliances, government, or collaborations between these entities.

Since GI requires new and evolving practices, it requires change. Change does not happen without will. So, to build will:

• **Create & maintain beautiful and effective demonstration sites / pilot projects** *(DIY, commercial, institutional)*
*People need to see and experience it to believe it.*

– Pima County, AZ: LID Case Studies Self Guided Tour (Scroll down on linked page. Geo-referenced when opened on a mobile device with app.)
– Portland, Oregon: Virtual tours

• **Organize and/or participate in forums and conferences**
*Great for cross-pollinating ideas and experience, challenging and evolving strategies, building networks, and growing community.*

– COLEF's 2013 Regional Green Infrastructure Forum: Tijuana (MX). See video here.

– BECC's Border Green Infrastructure Forums: 2014 Juárez (MX) and 2015 Tucson (AZ). See videos here.

– AridLID.org conferences 2012–2015

• **Generate or promote region- and climate-appropriate guidance manuals**
*Right plants (typically native plants) in right spot and right soils dramatically enhance success.*

– City of Tucson: Water Harvesting Guidance Manual
– Watershed Management Group (WMG): Green Infrastructure for Southwestern Neighborhoods
– WMG: Infraestructura Verde para Communidades del Desierto Sonorense

– New Mexico: Roof Reliant Landscaping
– California OAEC: Basins of Relations
– Tree People: Second Nature: Adapting L.A.'s Landscape for Sustainable Living

**• Books**

*Enable readers to learn at their own pace in the comfort of their own space. Often provide greater depth of information than other media.*

– *Rainwater Harvesting for Drylands and Beyond*
– *Water-Wise Home*
– *Eat Mesquite! A Cookbook*

**• Videos**

*Enable viewers to observe, learn, and share when it's convenient for them.*

– Tree People's Hall House news clip: Wonderful Example of an Inner-City Residence Retrofitted for Water-Harvesting in Los Angeles, California. This is a great example for cities everywhere, and beautiful street theater. L.A. nonprofit TreePeople put out a press release that a 1,500-year flood would hit a single residential property, but all would be okay due to a water-harvesting retrofit of cisterns, swales, infiltration basins, and dry wells. See this video for the TV coverage of the event when 4,000 gallons of water from fire hoses was dumped onto the property in 10 minutes. Not a drop of water left the property; all was beneficially harvested. Flood control and water security all in one go!

**• Presentations**

*Enable audience members to learn firsthand from experienced practitioners, and ask questions.*

– Water Smart, *part of Tucson's ongoing water-conservation course offerings*

– Tucson Water's 3-hour *required course for customers looking to receive Rainwater-Harvesting Rebate or Greywater-Harvesting Rebate. Education coupled with incentive to receive that education.*

– From 2006 through 2012 Brad Lancaster gave as many as 100 talks and workshops a year, throughout the southwest, nationwide, and internationally, as he also promoted his books "Rainwater Harvesting for Drylands and Beyond." This continues, but not with as many presentations per year.

**• Celebrations**
*Inform and shift public perception. Reward good practice with social affirmation. Lift the spirit and aspirations.*

– Desert Harvesters' annual Wild Food Fiesta & Mesquite Milling celebrating and demonstrating the planting, harvest, and enjoyment of native wild foods planted within and beside GI installations

**• Public database**
*Makes it easier to find and share otherwise difficult-to-access information.*

– University of Arizona Water Resources Research Center, Desert Water Harvesting Initiative

**2. GENERATE AND SHARE REPUTABLE DATA THAT CAN EVOLVE PRACTICES AND POLICY**
Good research can prove or disprove the effectiveness of certain approaches, or shed light on natural processes with which policy and practice can be better aligned.

– Study leading to legalizing rainwater harvesting in Colorado
Harvesting roof runoff in a tank used to be illegal throughout the state of Colorado, where it was assumed 100% of the precipitation falling on a site ultimately contributed to stream flows to which many had claimed water rights. These laws did not account for the fact that some of the precipitation was historically consumed by native vegetation and never made it back to the stream. This was proved with a 2007 study based on empirical methods using historical climate data for the study site in Douglas County, Colorado, which found that on average 97% of the precipitation falling on the undeveloped, naturally vegetated test site infiltrated the soil and was consumed by the native vegetation. Even in years of heaviest rainfall no more than 15% of the precipitation would leave the site as runoff. As a result, in 2009 two bills passed, allowing the limited harvest of residential roof and impermeable surface runoff in tanks within approved pilot-project housing developments—or from rooftops where the owner uses, or is legally entitled to, a well.

– Research in Tucson, AZ, found that within just a few years, the application of mulch, coupled with passively harvested water and newly planted multi-use perennial vegetation, has transformed once-degraded urban soils into rich soil ecologies equivalent to those found in healthy regional forests.

M.A. Pavao-Zuckerman and C. Sookhdeo, "Soil Ecological Knowledge Promotes the Ecosystem Services of Green Infrastructure," *Watershed Science Bulletin*, in review, 2012.

– Trees associated with mulched water-harvesting earthworks are able to grow 33% larger than those without, more than doubling the trees' potential sequestration of atmospheric carbon, passive cooling, and food production.

Watershed Management Group, "Soil's Role in Processing Pollutants for Air and Water: Case Studies of Green Infrastructure and Carbon Sequestration with Dr. Mitchell Pavao Zuckerman," webinar: 24 January 2013, http://watershedmg.org/webinars/soils

– The presence of more organic matter in the soil enables the soil itself to sequester additional carbon.

Alan Sundermeier, Randall Reeder, and Rattan Lal, Soil Carbon Sequestration Fundamentals, Ohio State University Extension Fact Sheet, AEX-510-05, http://ohioline.osu.edu/aex-fact/0510.html (accessed 2 February 2013).

– The natural pollutant-filtering/bioremediation ability of the soil mulched with organic material was ten times greater than that of rock- or gravel-mulched soil.

Pavao-Zuckerman and Sookhdeo, "Soil Ecological Knowledge."

-Research finds Decorative Landscaping Rock as a Source for Heavy Metal Contamination, Las Vegas, Nevada. Makes the case for reducing the use of such rock. Organic mulch could be a healthier substitute.

Decorative Landscaping Rock as a Source for Heavy Metal Contamination, Las Vegas, Nevada. Stephanie A. Mrozek, Brenda J. Buck, Patrick J. Drohan, and Amy L. Brock. Soil & Sediment Contamination , 15:471–480, 2006, Copyright © Taylor & Francis Group, LLC, ISSN: 1532-0383 print / 1549-7887 online DOI: 10.1080/15320380600847716

– Ann Audrey's work and spreadsheet on calculating ideal rainwater catchment-area ratios to plantings for various communities based on their rainfall and climate. This was done to prove the viability of City of Tucson's ordinance that commercial landscapes must provide at least 50% of their irrigation demand from harvested on-site rainwater. See water-harvesting assessment tool at WRRC (scroll down to the Tool 3 link).

– Research leading to legalization of residential greywater harvesting in Arizona

– "Solving Flooding Challenges with Green Stormwater Infrastructure in the Airport Wash Area," a study by WMG / Pima County modeling flood-reduction of GI systems retrofitting existing neighborhoods. *"For every $1 a community invests in rain gardens and green streets retrofits, over $2–$4 of value are created when accounting for direct and indirect economic values… GI scenarios showed peak-flow reductions of up to 24% during a 3-hour 100-year storm event."*

-Fred Lopez with the City of El Paso, Texas, reports that it is cheaper to install a landscape with native vegetation than it is to install just a hardscape of concrete.

– Research published by Tree People in "Second Nature"
This research made a great case for GI in Los Angeles by modeling examples on single- and multi-family residential scales, commercial scales, and school scales/contexts.

**3. DEVELOP IMPLEMENTATION CAPABILITY AND HANDS-ON EXPERIENCE OF CITIZENS AND PROFESSIONALS**

**Hands-on workshops**

GI systems rely primarily on freely/passively harvested on-site water irrigating vegetation. This is very different from the conventional practice of pumping and piping in off-site water to irrigate vegetation. Thus education and re-education are needed.

Nothing beats direct experience when learning a new way of doing things. Such workshops provide immediate feedback on understanding and performance. Important details are highlighted rather than overlooked. Such workshops can also create the public demonstration sites mentioned in the section above.

– Tucson, WMG Water Harvesting Certification course, www.watershedmg.org
– Tucson and Phoenix, WMG co-op program, www.watershedmg.org
– Tucson, Desert Harvesters workshops on planting native wild perennial food plants with water-harvesting earthworks, and how to harvest, process, and enjoy the bounty, www.DesertHarvesters.org
– Regional, Permaculture courses, www.sdsustainable.org, www.sonoranpermaculture.org
– Los Angeles, Greywater Action, www.GreywaterAction.org
– Los Angeles, Water LA, www.waterla.org
– Los Angeles, 3G, www.GreenGardensGroup.com
– La Paz, MX, Raiz de Fondo Jardines y Educación, www.raizdefondo.org
– Ciudad Obregón, MX, Ponguinguiola
– Tucson, LID Working Group workshop (every few years)

*The hands-on implementation component of these courses and programs is carried out throughout the community to increase the demonstration sites in the public eye.*

**4. INSPIRE AND GROW POLITICAL WILL**

GI requires changing current practices. Change requires will. Some ways to generate this will:

• Supporting the awareness and implementation-capability work listed above, as that will lead to calls and letters to policymakers, as well as citizens' speaking up at public meetings and campaign events

• Ensuring that GI advocates who represent the community gain seats on advisory boards

– Tucson, AZ: University of Arizona Stormwater Advisory Committee
– Tucson, AZ: Citizens Water Advisory Committee
– Pima Association of Governments (PAG): Stormwater Management Working Group
– Pima Association of Governments: Environmental Planning Advisory Committee

• Educating and/or recruiting candidates willing to put GI action on their platforms

- Rodney Glassman in Tucson, Arizona
- Ryan Anderson, Mayor's Aide

• Educating policymakers' aides first, as this can spark the invitation to engage with the elected policymaker him/herself

- Rodney's aide, Katie Bolger, was the "in" for getting Rodney involved with water harvesting efforts

University of Arizona students helped generate political will for GI at the college by working with Dr. Jim Riley to obtain a grant to get their own funding for a course on water harvesting that transforms the campus. Each semester they they assess different areas of the campus for water-harvesting opportunities, design the retrofit, and implement the design—all the while working with campus planners, facilities managers, and groundskeeping crews. Furthermore, Dr. Jim Riley and the students got positions on the campus stormwater advisory committee.
There had long been a desire among some university staff to incorporate GI on campus, but there was not enough will to make it happen as university policy and practice until the students stepped up and demanded it with their representation and example. After all, the college would not exist without the students. Groundskeeping staff have been so inspired they now regularly incorporate GI strategies, whether it has been requested or not.

## 5. CHANGE PRACTICES, LAWS, AND POLICIES TO INCENTIVIZE RATHER THAN DISINCENTIVIZE BEST PRACTICES

**Example:** In Tucson, AZ, it used to be illegal to cut street curbs to harvest street runoff in street-side tree basins. This was later legalized when done with a permit. Now it is mandated in new street construction, and qualifies for rainwater-harvesting rebates to retrofit existing infrastructure. See *Design Standards for Stormwater Detention and Retention in Pima County* for more.

Ways to support this kind of change:

**Find and work with allies within the system**

*See what they are trying to solve and if GI can help. Discuss collaborations and strategy.*

> ***Example:*** *Frank Souza was a flood-control engineer who validated and supported early GI work in Tucson, while fellow supporter and City landscape architect Gary Wittwer helped improve early development standards.*
>
> *– Pima County LID Working Group*

**Create and implement new incentivizing ordinances**

> – In Tucson, commercial landscapes must provide at least 50% of their irrigation demand from harvested rainwater.
>
> – In Tucson, required volume of tree canopy shading parking lots increased to one tree per 4 parking spaces.
>
> – In Tucson, all new homes must be built with greywater-harvesting stub-outs.
>
> – In Tucson, all new city streets or those being significantly rebuilt must harvest at least a ½-inch rainstorm's runoff within the public right-of-way of the street.
>
> – City of Tucson Department of Transportation Active Practice Guidelines for Green Streets

**Elevate awareness among all government staff who interact with the public in the context of GI—so they facilitate rather than discourage GI**

**Provide guidance documents**

> **–** *From Los Angeles, Melanie Winter of Water LA reports, "The neat thing is that the staff who oversee the LID counter are excited to have a guidance document that they can point developers (and residents who fall under the mandatory LID requirement) to as a more helpful resource."*
>
> **–** Pima Association of Governments (PAG) Regional Council Resolution Supporting Low Impact Development and Green Infrastructure (scroll down to 2012 Resolutions)

## 6. FOSTER A MARKET / ECONOMIC VIABILITY AROUND THE PRACTICE WITH INCENTIVES

- **Legalize the practice** *(see section above)*

• **Rebates**
*Rebates can create a financial carrot to encourage new practices. Rebates with requirements and education can enhance the quality of the rebated practice.*

– Tucson: Up to $2,000 rebate for rainwater-harvesting system. (*This should equally incentivize both active (tanks) and passive (earthworks) systems. Passive systems have a much greater capacity than active systems. We are currently working towards this.)*

– Tucson: Up to $1,000 rebate for greywater-harvesting system

– Soaps and detergents safe for greywater harvesting

– Evaluate municipal capital improvement bids using a return on investment calculator: Autocase – Cost Benefit Study for Arid Regions (calibrated by an effort in Pima County)

• **Stormwater utility fees or Green Infrastructure Fund**
*Makes more clear the community costs and benefits of certain practices. If a property helps reduce, rather than increase, downstream flooding, then the fee is less.*

– El Paso, NM: Stormwater Utility Fee
– Oro Valley, Arizona: Stormwater Utility Fee

## 7. GENERATE SITE ASSESSMENT PROTOCOL TO PLACE BEST PRACTICE IN BEST SITE

**Example:** It is often best to start higher in the watershed where it is easier to manage smaller volumes of water. This practice also minimizes flooding potential of DOWNSTREAM areas.

**Mapping**
*This can help identify ideal locations for successful GI and those locations to avoid.*

– Los Angeles, CA: *A number of NGOs, including Water LA, have collaborated (utilizing GIS shapefiles) to identify priority sub-subwatershed-level neighborhoods for GI. As Water LA's Melanie Winter reports, "Different funders want outcomes that tend to be weighted in one way or another (groundwater recharge, conservation, water quality, climate resilience, etc.), but we've pretty much broken it down to a tiered order of priorities:"*

*- Soil percolation/infiltration rates (prioritize areas with soils with good percolation rates over areas with soils with slow/poor percolation)*
*- Water-quality impairments (brownfield sites, etc.)*
*- Local patterns of flooding (place GI above, not within, these areas to reduce water*

*contributing to flooding)*
*- Slopes (avoid those that are too steep)*
*- Relationship to groundwater basin (where will GI strategies have greater likelihood of helping directly recharge aquifer?)*
*- Existing tree canopy (lack of canopy, which is often found in disadvantaged communities, can be mitigated lack with the planting of rain-irrigated trees)*
*- Parkway width (must be enough room for planting of water and vegetation)*
*- Volumes of street-side water flow on each side of a street (for better placement of in-street and street-side GI)*
*- Willingness of people/residents/businesses/institutions in an area to help maintain the systems once implemented*
*- Climate vulnerability (California has a method for quantifying this)*

*"There are myriad other factors, including habitat connectivity, that can be added into a weighted analysis, depending on the agency or funder objective, but I think those are the top tiers. In terms of moving towards a social tipping point, here in LA we also have to consider sites/neighborhoods with high visibility, and neighborhoods with high water use but perhaps no significant relationship to groundwater or WQ problems, just because we have to be mindful of building constituency and establishing a new normal for landscapes that is socially acceptable across all demographics."*

– Pima Association of Governments (PAG) in Arizona, has a Green Infrastructure Planning Tool which is an online, interactive mapping system that can identify environmental-justice opportunities for prioritization of limited resources. The map layers include level of surface heat, heat-vulnerable populations, flooding concern, flow paths, mobility issues (pedestrian zones, bike boulevards, and bus stops), canopy and surface vegetation, percent of impervious surface, and watersheds.

**8. PRODUCE / PROMOTE EVOLVING BEST MANAGEMENT PRACTICES (BMPs)**
These should continually evolve, as strategies and practices are improved based on experience and better understanding of natural processes.

– AZ Greywater Harvesting Guidelines/BMPs

– Recommended improvements to AZ and NM Greywater Harvesting Guidelines/BMPs

– Evolving Tucson BMPs for Rainwater Harvesting Systems
Building to (or exceeding) the standards of the Rainwater Harvesting BMPs might soon become mandatory for those seeking to receive rebate funds in Tucson, AZ. Water-harvesting businesses might soon need to go through a certified training to prove they understand the

BMPs and that the services they provide to the public meet those standards if they are to qualify for the rebates. Unfortunately, good GI designs are very often implemented incorrectly by landscaping contractors. Thus better education and oversight is needed.

**9. PRODUCE EVOLVING DEVELOPMENT STANDARDS FOR MULTIPLE CONTEXTS**

**Example:** In Tucson, AZ, the first standards for public right-of-way water harvesting were for areas perceived to be the most conducive to success. These areas required at least a 10-foot-wide public right-of-way on the side of the street. Now that the concept has been proven, new standards have been, or are now being, developed for in-street applications such as street medians and narrower traffic-calming rights-of-ways in the more-urban core.

– City of Tucson Standard Details for curb cuts, curb cores, and a whole lot more
– Water-harvesting parklets
– Pima County's *Low Impact Development and Green Infrastructure Guidance Manual*

**10. SHOW THE FLOW**

Passive surface strategies—ones that use only gravity and slope to move water, use soil and vegetation as the "tanks," and use plants and soil microorganisms as the "living pumps"—should be prioritized over subsurface infiltration galleries or active strategies—ones that require tanks as well as valves that must be actively turned on or off. This way everyone can see how things work, and how they could do the same. Passive strategies also tend to be the least expensive and require the least maintenance, thus they are often the more accessible strategies.

**11. CONTINUALLY EVOLVE IRRIGATION PRACTICES**

Where water conservation is a driver, GI should be designed and implemented to reduce water consumption.

– Gary Wittwer, Landscape Architect with the City of Tucson Transportation Department, has been contracting with a watering-truck service to get plantings in water-harvesting earthworks established. After the first year or two, the water truck is no longer needed. This way no conventional or drip irrigation system need be installed. There are no leaks to be repaired. And Gary finds this practice reduces weed growth. Gary has also implemented tree plantings in downtown Tucson on Alameda irrigated only with AC condensate (after establishment), and having dri-water in the soil—the plantings were hand watered (only twice) to get them established. Key to the success are planting in the fall, using trees grown in tall pots, dri-water, good winter rain, and great soil.

The ability to design the GI plantings to be in water-balance is key—plants' water needs at maturity must be met solely by the harvested on-site water.

Wisely selected and placed vegetation is key to success (see next section).

## 12. INITIATE LISTS-IN-PROGRESS OF MULTI-FUNCTIONAL RAIN-GARDEN / GI PLANTS BEST ADAPTED TO PLACE

Plants should be identified, listed, and placed according to their Rain Garden Zone (based on their water needs and tolerance).

The performance of the vegetation can be dramatically enhanced beyond ornamentation by also considering (and designing for) multiple functions such as food production, wildlife habitat, shade production, fragrance, carbon sequestration, nitrogen-fixing, natural bioremediation of toxins, and more. See plant charts here for examples.

Native plants are typically the best since they have adapted for millennia to local climate, soil, and wildlife conditions.

> – Southern Arizona: *Simple rain-garden zone classifications of plants are key to better ensure the right plant goes in the right place*. Rain Garden Zone classification.
>
> - Russ Buhrow's rain-garden list for Tucson, AZ

## 13. GATHER / CREATE RELIABLE SOURCES OF PLANTS & GUIDANCE ON HOW TO IRRIGATE THEM WITH HARVESTED ON-SITE WATER

As native plants are typically the best suited for GI, the availability of locally or commercially grown native plants must be developed in communities where it is lacking.

Additionally, most plant nurseries are accustomed to irrigating with piped-in water (and teaching the public to do likewise), rather than using passively harvested on-site water.

> **Propagation trainings**
> *Train public and professionals how to propagate native plants.*
>
> > – Tohono Chul Park's nursery, under the stewardship of Russ Buhrow, brought many native plants into the the market that were not previously available. As they are a non-profit with volunteer docents, they could afford to research and eventually perfect propagation methods for various plants.
>
> **Plant nurseries**

*Ideally, nurseries would group and label plants by their Rain Garden Zone and water needs/tolerance to make plant choice and placement easier for buyers.*

– Pima County, AZ, has its own plant nursery (irrigated with treated wastewater from the adjoining wastewater treatment plant) to better ensure it has plants for its county installations. *Longer nursery pots can encourage faster, deeper root establishment for more drought tolerance (see video) though it requires more and deeper digging.*

– Desert Survivors Nursery in Tucson, AZ, is a good example of a non-profit commercial nursery specializing in native plants. *Due to how some native plants such as mesquite (Prosopis) readily hybridize with the non-native varieties, this nursery has committed to collecting seed far from the city and non-native plantings to ensure they collect pure seed and grow true natives.*

– We need to influence what is carried, and what info is provided, in chain and big-box nurseries, too.

**Promote, contract with, and support local native-plant growers and native plant seed suppliers**
*This enhances supply, while building local jobs.*

## 14. ENACT CONTINUALLY DEVELOPING OVERSIGHT OF, AND EFFECTIVENESS OF, IMPLEMENTATION OF GI

**Common mistakes / oversights often not caught by implementation supervision, inspection, or the lack of both**

- Passive water-harvesting basins, bioswales, and such are under-excavated and/or over-filled with rock, gravel, or other material resulting in needlessly low capacity for harvestable water volume.

- Excessive amounts of rock or gravel are used (many courses high). This results in the purchase, cost, and transport of unnecessary material. It also inhibits the growth of beneficial vegetation between the rock (including native plant seed distributed by the contractor).

- Plant species on plan are randomly swapped out with other species during implementation. This hurts performance, and can cause other problems such as substituted street trees with shallow roots heaving pavement or the spread of exotic invasive plants via their planting in GI systems. (Potential remedies may include requiring installers to secure the plants earlier in the project, and giving installers acceptable substitutions to choose from.)

- Plant species are placed in the wrong Rain Garden Zone. For example, non-water tolerant plants are placed in the wet Bottom Zone of a basin, while water needy/tolerant plants are placed in the dry Top Zone. Both are likely to result in plant death.

- Inlets to GI basins and bioswales slow the flow of incoming water with slopes that are too gradual, inlets that are too small, inlets that are too rough, and/or inlets that are higher than the flow they are supposed to capture. This results in detritus dams forming at the inlet and the failure of the system to harvest the water it was meant to capture. (Creating at least a 2" drop from the bottom of a curb- cut or curb- core inlet to the spillway within the curbside basin / landscape helps speed up water flow slightly and reduce the chance of detritus dams forming at this location.)

- Three key elevation relationships of earthworks are not correct. 1. Basin bottom elevation (and the mulch covering it) must be well below inlet and overflow outlet elevation to actually hold water. 2. Common planting terrace elevations should not be above inlet elevation or plantings may be too dry (especially as they are getting established). 3. Path or other areas not to be flooded should be well above the elevation of the overflow outlet.

- Rockwork stabilizing banks of basins and bioswales is poorly done and/or done with rock that is too small resulting in rapid erosion of the rockwork and structure.
- More awareness of changing seasonal sun paths is needed when placing/planting trees so summer shade/cooling for buildings and hardscape is maximized, while the potential for passive winter heating of buildings is also maximized. Planting trees on the east, west, and north sides of buildings provides passive summer shading without shading out desired winter sun access from the south in winter.

**15. INSPIRE A CONTINUALLY EVOLVING CULTURE AND PRACTICE OF STEWARDSHIP MAINTENANCE**

GI systems rely on living soils and vegetation, thus unconscious or destructive "maintenance" that poisons, damages, or removes that life is often the biggest threat to GI systems. Well-established vegetation can be wiped out with one mass clearing or misguided application of herbicide. Soil-building and water-infiltrating organic mulch can be lost with one misinformed "clean up" job.

**Train and retrain landscapers and gardeners on how to best steward GI**
***Example:*** *On-site prunings can be cut up and used within GI basins to enhance the "living sponge" effect of healthy soil, rather than raking up and exporting this biomass and its fertility.*

**Train and retrain landscapers and maintenance crews on plant identification and the myriad benefits of the desired plants.**

***Example:*** *Pima county has created illustrated fact sheets for to help landscapers and maintenance crews identify the difference between native and non-native plants to help reduce the mistaken removal or poisoning of desired plants.*

**Set in place pre-construction maintenance agreements with City or County**

*To encourage better stewardship of GI installations in the public rights-of-way, residents, schools, and businesses sign agreements stating that they will help maintain the GI installations adjoining their property. This reduces the maintenance load on the municipality, while getting local residents to step up and better care for their neighborhood.*

*- These maintenance agreements are signed before GI locations are finalized to ensure the plantings, basins, etc will be maintained.*

*- Trees for Tucson requires this on a form for their Street Tree program; Conserve 2 Enhance requires it to be written into community grant applications; and the City of Tucson requires informal neighborhood agreements by individual neighbors before green streets are created (using curb cuts) with Tucson Water Conservation Funds.*

**Design and implement GI to reduce maintenance**

– Select the right plants and place them so that they will be in balance with available passively harvested water. See Rain Garden Zones above.

– Design systems that are more self-maintaining, such as backwater or eddy basins that accumulate rather than lose organic mulch.

– Design basin inlets with a slight drop to speed up water flow and minimize the formation of detritus berms at inlets.

– Design sediment traps just below basin/bioswale water inlets as needed.

**Create and continually develop public maintenance crews**

**–** WMG monsoon squad

*This works to enhance public's knowledge of best management practices while reducing costs to a municipality*

– Tucson Botanical Garden's Urban Foresters Program

– Tucson Clean and Beautiful's Adopt a Wash, Street, and Traffic Circle programs

**Create and distribute maintenance guides**

– *Watershed Management Group's Field Guide for Raingarden Care*

**LOOKING FORWARD**

– Where communities have turf-removal programs, look to getting the turf-removal rebates tied to rain grading (basin shapes rather than hill-like shapes), so new landscape will infiltrate rather than drain the rain

– Look to mandate passive rainwater harvesting in the front yards of all new planned housing developments with Home Owners' Associations (HOAs). HOA can be third party overseeing the maintenance of the rain gardens.

– Strive to evolve GI to increase potential (e.g., enhance perennial urban food production), rather than just solving a problem (e.g., flooding)

– Make rebate programs performance-based (e.g., passive and active rainwater- harvesting system rebates are based on realized water savings or flood reduction).

– Be ready for crisis/opportunity. According to Melanie Winter, due to the crisis of the current drought, the Los Angeles Mayor just helped Water LA's efforts by including a request in his recent Executive Directive for recommendations on what changes will be required to local codes and ordinances to facilitate water harvesting.

**HUGE THANKS TO ALL THOSE WHO HAVE PROVIDED FEEDBACK AND INPUT THUS FAR:**
Mead Mier (Pima Association of Governments), Ann Audrey, Ana Cordova, Melanie Winter (Water LA), Watershed Management Group staff