10.0 RECOMMENDED DESIGN CONSIDERATIONS FOR NEW PROJECTS

10.1 Community Values

The CAC developed a list of community values that was originally intended to be used by the technical team to evaluate and rank potential stormwater project alternatives. The community values identified by the committee are provided below:

1) Safety
   - Increase public safety in flood events; and
   - Reduce property damage to the extent possible.
2) Aesthetics
   - A natural, aesthetic look is preferred wherever possible, including a preference for the use of natural materials.
3) Dual Use
   - Allow for multi-functionality of structures, ponds, and channels to the extent possible for drainage, recreation, habitat, and aesthetics.
4) Natural Systems
   - Maximize the use of existing natural drainage paths and arroyos wherever possible;
   - Use natural vegetation for erosion control where possible;
   - Use greenbelts or materials such as porous concrete for stormwater absorption where possible; and
   - Maintain natural plants and trees as part of the stormwater system when possible.

10.1.1 Design Considerations

- Ease of maintenance is important throughout the system;
- Provide cost effective solutions;
- Allow for the long-term reliability of the system;
- Solve the drainage problems in low-lying areas; and
- Design/appearance of terminus of each facility is important.

As these community values were applied to the alternative evaluation process, it became apparent that all of these are excellent design considerations that should be used in the design process for all of the stormwater projects. It is recommended that these community values be incorporated in the design of all stormwater projects, to the extent possible.

10.2 Green Infrastructure Design Considerations

The CAC listed aesthetics and natural systems as two of the community values, both of which are benefits of Green Infrastructure Design (GID). In GID, the interconnected network of open spaces and natural areas such as greenways, wetlands, parks, forest preserves, and native plant vegetation is used to naturally manage stormwater, reduce the risk of floods, capture pollution, and improve water quality (America Planning Association [APA], January 2009).

GID utilizes natural materials, such as soil, vegetation and rocks, in the design and construction of stormwater infrastructure instead of, or in conjunction with, traditional impervious stormwater infrastructure. GID techniques help minimize impervious surfaces, absorb stormwater, and mimic the natural water cycle, which helps reduce or divert stormwater from the sewer system and direct it to areas where it can be infiltrated, reused or evapotranspirated (American Rivers, Inc. and Midwest Environmental Advocates [MEA], Inc., September 2008 and U.S. Environmental Protection Agency [EPA], April 2008). Media associated with many GIDs can provide a natural and open feel and "green" neighborhoods. These aesthetic benefits can contribute a sense of livability and value, thus enhancing property values and creating re-development potential and greater marketability. Other benefits are improved wildlife habitat, thermal pollution reduction, energy savings, smog reduction, enhanced wetlands protection, and decreased flooding. (Natural Resource Defense Council [NRDC], January 2009).

Traditional stormwater infrastructure typically uses concrete detention ponds and channels, which consume land and prevent infiltration. Increased runoff and higher stormwater velocities often result in serious erosion problems downstream, damage to property and public infrastructure, and/or increase public safety hazards. GID, however, typically uses more pervious area compared to traditional infrastructure, thereby reducing the amount of stormwater runoff and increasing groundwater recharge (American Rivers, Inc. and MEA, September 2008). Incorporating GID techniques, such as native vegetation, or naturally-lined or rock-lined basins and channels, will naturally slow down runoff velocities, therefore reducing erosion and creating a safer environment for the public. Since groundwater recharge is increased by infiltration, pollutants are often reduced. GID often results in wildlife habitat and generally promotes the overall health of the watershed.

Because of these benefits and the value to the community, the EPWU is including GID techniques as design considerations for the projects in this SMP. It is important to note that although there are many benefits associated with GID techniques, their use may require changes to existing ordinances.

10.3 Sample Green Infrastructure Design Techniques

The concept of GID is emerging as a highly effective and attractive approach to controlling stormwater pollution and protecting developing watersheds of urbanized communities throughout the country (NRDC, January 2009). GID concepts are rapidly evolving and new techniques are frequently introduced. Several GID techniques that may be applicable to the El Paso Region are summarized in the following subsections. However, engineers should not limit utilization of GID techniques to only those discussed herein. Numerous resources are available regarding GID and low impact design (LID), which is a similar concept to GID. References applicable to arid climates include:

- "Landscape Aesthetics & Multiple-Use Design Guidelines for Flood Control Basins, Channels and Flood Retarding Structures" from the Flood Control District of Maricopa County (FCDMC) (Phoenix, Arizona);
- "The Truckee Meadows Regional Stormwater Quality Management Program Low Impact Development Handbook" prepared by Kennedy/Jenks Consultants for the City of Reno, City of Sparks, Washoe County, Regional Water Planning Commission, and the Nevada Division of Environmental Protection (NDEP);
- "The Urban Storm Drainage Criteria Manual" from the Urban Drainage and Flood Control District (UDFCD) of Denver;
- "The Practical Streambank Bioengineering Guide" by the USDA NRCS Plant Materials Center; and
- The Best Management Practices Handbook from NDEP.

10.3.1 Vegetated Infiltration Systems

Vegetated stormwater infiltration systems, such as, rain gardens, bioretention, stormwater planters, and tree box filters are depressed vegetated areas that use native soils or porous engineered soils, plants, and their root systems to capture and treat urban runoff, and help infiltrate the water to the subsurface. Vegetated infiltration systems are effective at reducing the volume of runoff by soil retention, plant uptake, evapotranspiration, and infiltration. Additionally, pollutants are removed by physical filtering, ion exchange, adsorption, biological processing, and conversion (Kennedy/Jenks Consultants, August 2007). The need for large stormwater retention areas can be reduced and planted infiltration systems can be installed into existing soils or concrete enclosures (The American Institute of Architects [AIA], January 2009, Kennedy/Jenks Consultants, August 2007). A typical vegetated infiltration system design includes a depressed ponding area using native soils or an engineered soil mix. If existing soil has a slow infiltration rate, an underdrain system is also needed. These systems can be installed in new development and redevelopment projects where landscaping is to be incorporated. They can benefit the community by integrating stormwater management features into the landscaping, slowing runoff to help reduce downstream erosion, and infiltrating stormwater to recharge groundwater, while also creating wildlife habitat and landscape amenities.

10.3.2 Streambank Bioengineering

Streambank bioengineering consists of natural stream stabilization techniques by increasing the strength and structure of the soil with a combination of biological and mechanical elements. The USDA NRCS has developed basic design procedures for Streambank Engineering in arid climates, presented in *The Practical Streambank Bioengineering Guide - Users Guide for Natural Streambank Stabilization Techniques in the Arid and Semi-Arid Great Basin and Intermountain West* (USDA NRCS, May 1998). The reference includes recommendations for planning, detailed inventory, design, permitting, implementation, maintenance, and monitoring.

The multi-purpose effectiveness of streambank bioengineering is enhanced by designing configuration of the channel to mimic as closely as feasible within the established ROW the geomorphic shape of regional natural channels. This involves, again where feasible, the variance of channel side slopes, and allowance for meander in low flow channels. Guidelines in use in Maricopa County (Phoenix, Arizona) provide specific recommendations for channel perimeter area, set back, and buffers; channel overall configuration and shape, channel side slopes, channel bottom area, vegetation planting, and surface treatment (FCDMC, 2004).

10.3.3 Swales and Buffer Strips

Swales and buffer strips use vegetation and the subsoil matrix to filter pollutants from stormwater runoff, slow down stormwater runoff, and provide infiltration and groundwater recharge. They can be used as part of a storm drain system and provide pretreatment for other structural stormwater controls (Kennedy/Jenks Consultants, August 2007).

A grass swale is a drainage way with low-pitched sides and dense vegetation that collects and slowly conveys stormwater runoff. A grass swale can be used as an alternative to a curb-and-gutter system near impervious areas such as parking lots, buildings, residential yards, roadways, and grass buffer strips. The design facilitates sedimentation and limits erosion by forcing water flow to be slow and shallow. Grass swales are set below the adjacent ground surface and stormwater runoff enters the swale over grassy banks or rundowns. Berms or check dams can be added perpendicular to the flow to encourage settling and infiltration (UDFCD, June 2001). Additionally, if drainage is a problem due to poor infiltration of native soil or grades less than 0.5%, rock-lined low-flow channels or underdrain systems can be added. (Kennedy/Jenks Consultants, August 2007). Underdrains can also be utilized if the swale experiences standing water or if there is a base flow. Base flow may also be managed with an unlined trickle channel or as a wetland bottom channel (UDFCD, June

2001). The low flow channels and underdrain systems may also reduce potential for extended ponding or mosquito breeding (Kennedy/Jenks Consultants, August 2007).

Xeriscape swales (Figure 10-1) perform the same functions of decreasing velocity, trapping sediments, and reducing erosion as grass swales, but use native vegetation or low water use plants arranged among rock which have little or no water requirements once established. Sediments and pollutants are filtered through engineered subsoil and vegetation and by infiltration into the subsurface. Xeriscape swales are recommended to assist with water conservation (Kennedy/Jenks Consultants, August 2007).

Figure 10-1. Xeriscape Swale

Buffer strips, also known as vegetated buffer strips or filter strips, are gently sloping and uniformly graded vegetated strips that are used in relatively small drainage areas for stormwater runoff. Buffer strips are used to decrease velocity, trap sediments and pollutants, and promote infiltration into underlying soils (Kennedy/Jenks Consultants, August 2007). Buffer strips are different from swales as they are designed to handle sheet flow rather than channelized flow (UDFCD, June 2001). They require an evenly distributed sheet flow of runoff across the width of the buffer to function properly, which may require a flow spreader such as a porous pavement (PP) strip (Kennedy/Jenks Consultants, August 2007). Because the effectiveness of the buffer depends on the distribution of the sheet flow over the surface, the size of the contributing area and volume of runoff must be limited. Adjacent parking lots, roadways, and building roofs can contribute stormwater runoff as long as the flow is evenly distributed over the strip (UDFCD, June 2001).

Grass or vegetated buffers use densely vegetated, uniformly graded turf surfaces. Shrubs and trees may be mixed in to improve aesthetics and provide shade (UDFCD, June 2001). Grass buffers can be used in treating sheet flows and stabilizing channel banks adjacent to drainage ways by combining with riparian zones. Irrigation is required to maintain grass buffers in the arid climate of El Paso (UDFCD, June 2001).

Xeriscaped buffer strips perform similar to grass buffer strips except they utilize low water use plants and rock. Xeriscaped buffers are ideal for areas adjacent to sidewalks, driveways, streets and the edge of a lawn where areas are typically hotter and drier and require more water. By planting xeriscape buffer strips in these areas, water needs are reduced. Xeriscape buffers reduce runoff by capturing and infiltrating the water leaving the area (Kennedy/Jenks Consultants, August 2007).

10.3.4 Porous Paving Systems

PP covers a variety of stabilized surfaces that can be used for the movement and parking of vehicles (automobiles, trucks, construction equipment, light aircraft, etc.) and storage of materials and equipment. There are several different types of PP systems, including modular block pavement, cobblestone pavement, reinforced grass pavement, poured porous concrete pavement, and porous gravel pavement. PP differs from conventional pavement because it contains void spaces to provide infiltration of runoff into the underlying engineered porous materials and then into native soils. PP reduces the runoff and pollutant loads leaving the area by decreasing the imperviousness of an urban site, while also helping stormwater runoff hydrology return to pre-development conditions. Underdrains may or may not be needed in the design; however, when underdrains are required the infiltrated water will behave similarly to interflow and will surface at a reduced rate over extended periods of time (UDFCD, June 2001).

PP is a good substitute for conventional concrete and asphalt and can be used to preserve natural drainage patterns, enhance groundwater recharge and soil moisture, and help establish and maintain roadside vegetation (Kennedy/Jenks Consultants, August 2007). PP systems are not typically suitable for heavy traffic areas and a geotechnical engineer should be consulted as to the type of PP recommended for the loads and traffic of the area and the geologic conditions the PP will rest upon (UDFCD, June 2001).

10.3.5 Greenspace

Greenspace is privately or publicly owned corridors of open space which often follow natural land or water features and which are primarily managed to protect and enhance natural resources. Greenspace can serve the dual purpose of providing an area for recreation and stormwater management. As noted in the Green Infrastructure Plan for

Northeast El Paso, major regional detention areas that have been constructed by the City of El Paso and the Corps of Engineers in the northeast sector of the city are excellent opportunities for greenspace and wetlands. Portions of the detention area can be built up to create viewing and nesting islands. Perimeter trails and viewing areas can be developed to allow for wildlife observation. Trees and desert vegetation can be introduced along the edges of the ponds, and in some cases in the bottom of the ponds. If reconfigured correctly, vegetation should not unduly interfere with the flow and storage of floodwaters in the ponds (URS & Goodkin Consulting, July 2006).

10.3.6 Infiltration Systems

Infiltration systems, such as trenches or basins, allow stormwater to slowly percolate to the subsurface while sediments and pollutants are retained at the surface. An infiltration trench is a relatively small in size trench that has been lined with filter fabric and filled with a rock matrix to form a subsurface basin that captures, filters, and infiltrates stormwater runoff. Pollutants are removed by adsorption, precipitation, filtering, and bacterial degradation. The relatively small trenches fit easily along margins, perimeters, and unused sections of developed sites, including median strips and parking lot islands (Kennedy/Jenks Consultants, August 2007).

Infiltration basins are similar to trenches, but can serve larger drainage areas and use a wider variety of filter media. Basins can also be vegetated at the bottom. Infiltration basins promote infiltration by capturing runoff and the removal of pollutants such as suspended solids, metals, nutrients, and bacteria through sedimentation, adsorption, and physical filtration through permeable media. Areas adjacent to roadways and near interchanges are ideal spaces for infiltration basins (Kennedy/Jenks Consultants, August 2007).

10.3.7 Stormwater Ponds and Wetlands

This Debris Management Plan (DMP) includes recommendations for the construction of debris/sediment retention basins in locations where a geologic evaluation has estimated that there is significant risk of debris flows or sediment flows from an upstream watershed damaging lives and property within an urbanized area downstream. Typically, these recommended sites are located within undisturbed or marginally disturbed natural channels. The clear preference is that these sites be developed in a manner which provides the needed storage while mimicking the existing natural system. In particular, this may involve limiting the height and length of embankments, and engineering of needed embankments to provide less of an engineered (straight, uniform slope) appearance, and more of a natural (winding per topography, varied slopes) appearance. Guidelines in use in Maricopa County (Phoenix, Arizona) provide specific recommendations for a basin perimeter setback zone, basin configuration and shape, basin side slopes, basin bottom areas, siting of structural components, and vegetation planting and surface treatment (FCDMC, 2004).

The DMP also includes recommendations for stormwater ponds in the valley area adjacent to the Rio Grande (notably within the Mission Valley watershed). These ponds have the potential for sufficient baseflow duration to allow for establishment of wetland vegetation and aquatic wildlife habitat. The Truckee Meadows Low Impact Development Handbook (Kennedy/Jenks Consultants, August 2007) provides general guidelines for enhancement of stormwater ponds to incorporate these additional multiple uses.

10.3.8 Low-Flow Channels

Low-flow channels have the characteristics of a natural channel but are within an enlarged flood control channel that is designed to concentrate flows, increase channel velocity, and depth. Stabilization via structural measures such as bank protection, flow deflectors, and sills are required. These structural measures provide habitat diversity by providing diverse channel conditions (Fischenich, 2002).

Traditional channels modified for flood control and urban streams often have relatively uniform depths and velocities and limited habitat. The lack of habitat diversity negatively influences the aquatic ecosystem and promotes erosion (Fischenich, 2002).

10.3.9 Grade Control/Drop Structures

Grade control structures are installed to maintain a desired streambed elevation. These practices are used either to raise the stream invert (i.e., to reverse past channel erosion), or to maintain the channel invert at a current elevation (i.e., to prevent future channel erosion). Nearly all stream restoration projects incorporate some form of grade control practice in the project design. Grade control practices create a “hardpoint” along the channel, preventing the streambed from degrading below the top elevation of the structure. The two main types of grade control practices are those that utilize logs for construction materials and those that utilize rock.

Drop structures are a series of retaining walls and erosion control measures built in unstable riverbeds to prevent erosion, provide flood control, and to trap debris and silt. The main types of drop structures are basic vertical drop structures (vertical hard basin), riprap drop structures, "riffle" drop structures, and weirs. Other types include "baffle chutes" and "grouted sloping boulder.” Drop structures are sometimes built as retaining walls to stabilize a descent in the riverbed that is in danger of collapsing. In times of flood, drop structures slow the velocity of the water by turning fast-flowing rapids into a vertical descent.

10.3.10 Underground Detention/Retention

Underground stormwater retention/detention systems capture and store runoff in large pipes or other subsurface structures. Stormwater enters the system through a riser pipe connected to a catch basin or curb inlet and flows into a series of chambers or compartments for storage. Captured runoff is retained throughout the storm event, and can be released directly back into surface waters through an outlet pipe. Outlet pipes are sized to release stored runoff at predevelopment flow rates. This ensures that there is no net increase in peak runoff and that receiving waters are not adversely impacted by high flows from the site. Some systems are also designed to exfiltrate stored runoff into the surrounding soil, where it helps to recharge the groundwater table (EPA, September 2001).

10.4 Application of Green Infrastructure Design

As previously discussed, GID techniques can be applied in the design and construction of stormwater infrastructure instead of, or in conjunction with, traditional stormwater infrastructure. Table 10-1 indicates which GID techniques can be applied to the stormwater projects identified for improvement in this SMP. In most cases, GID techniques are utilized as a supplemental component of a traditional stormwater system.

Table 10-1. Green Infrastructure Design Techniques

GID Practice Reference Number	1	2	3	4	5	6	7	8	9	10
Green Improvement Design Practice	**Vegetated Infiltration Systems**	**Streambank Bioengineering**	**Swales And Buffer Strips**	**Porous Paving Systems**	**Greenways**	**Infiltration Systems**	**Stormwater Ponds .and Wetlands**	**Low-Flow Channels**	**Grade Control/Drop Structures**	**Underground Detention/Retention**
Source reference(s) for Design Guidance (see footnote)	1	2, 9	3	3	4	5	3, 9	6	7	8
Type of Improvement										
New/Expanded Channel		X			X			X	X	
Expanded Road Crossings (Bridges/Culverts)			X	X						
Stormwater Inlet Improvements	X		X	X		X				X
New/Expanded Storm Drains	X			X		X			X	
New Debris/Sediment Basin, Undeveloped Site	X	X			X		X			X
New/Expanded Detention/Retention Basin, Urban Site	X	X		X	X		X			
New/Expanded Pump Station					X					

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2. USDA NRCS, May 1998. The practical Streambank Bioengineering Guide - Users Guide for Natural Streambank Stabilization Techniques in the Arid and Semi-arid Great Basin and Intermountain West. http://plant-materials.nrcs.usda.gov/idpmc/streambank.html
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4. Green Values, January 2009. Stormwater Toolbox. http://greenvalues.cnt.org/greenways.
5. NDEP, 1994. Best Management Practices Handbook. http://ndep.nv.gov/bwqp/bmp05.htm.
6. Fischenich, C. (2002). "Design of Low-Flow Channels," *EMRRP Technical Notes Collection* (TN EMRRP-SR-19), U.S. Army Engineer Research and Development Center, Vicksburg, MS. el.erdc.usace.army.mil/elpubs/pdf/sr19.pdf.
7. The Stormwater Managers Resource Center, January 2009. Stream Restoration: Grade Control Practices. www.stormwatercenter.net/Assorted%20Fact%20Sheets/Restoration/grade_control.htm - 16k.
8. EPA, September 2001. Storm Water Technology Fact Sheet - On-Site Underground Retention/Detention. Office of Water. EPA 832-F-01-005. <http://www.epa.gov/owm/mtb/runoff.pdf>.
9. FCDMC, Phoenix, Arizona, 2004. Landscape Aesthetics and Multiple-Use Design Guidelines for Flood Control Basins, Channels, and Flood Retarding Structures.