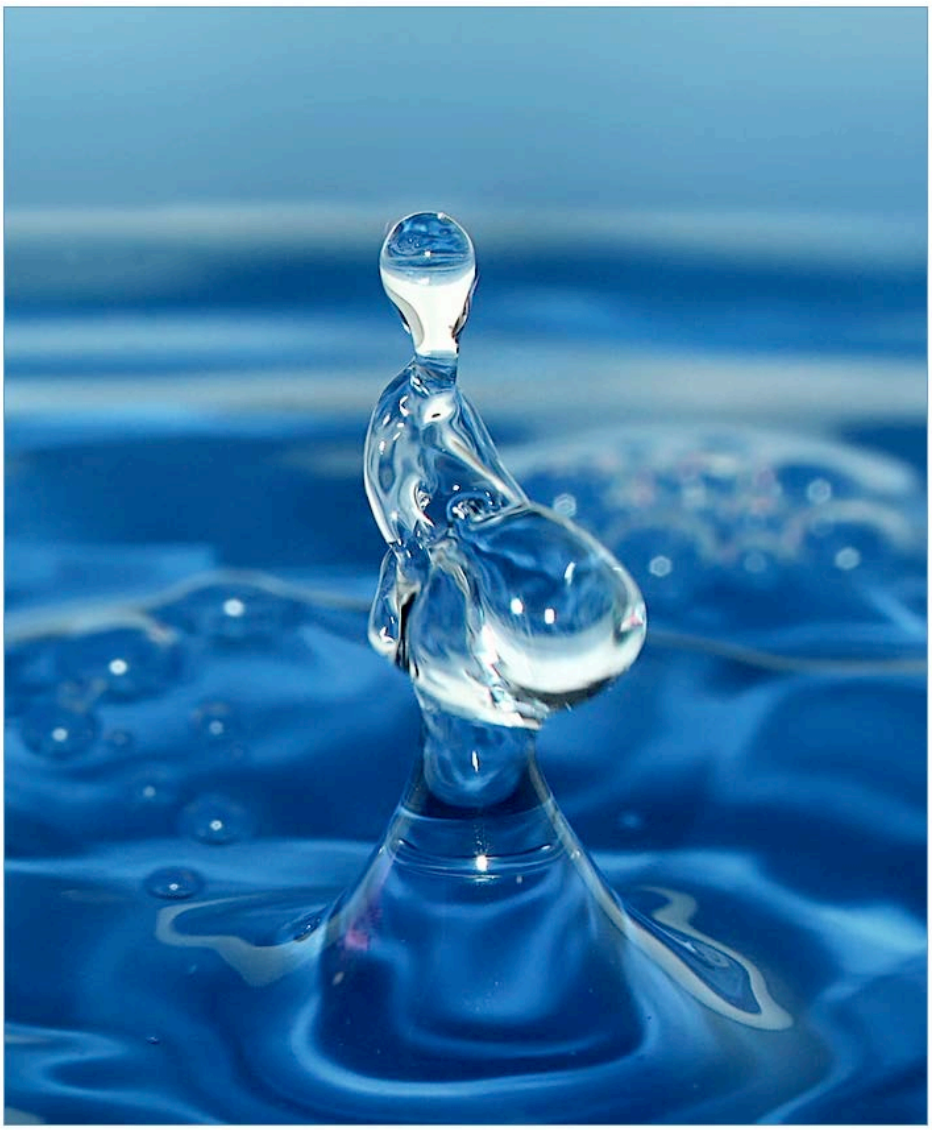
EPIC Green Solutions
Design Manual



EPIC Design Manual

Preface.

The information in this document is of an illustrative nature and is supplied without charge. It does not form part of any contract or intended contract with the user. Final determination of the suitability of any information or material for the use contemplated and the manner of use is the sole responsibility of the user and the user must assume all risk and liability in connection therewith.

This manual provides the general procedural process for designing EPIC system installations and the new thought process needed during the planning and design phases. It is not intended to cover all aspects or site specific applications of the installation process which can vary from project to project, but will provide the designer new options on how 100% efficient irrigation and true storm water management can be accomplished in landscape design plans.

L.A.C.E. Landscape Architecture Civil Engineering

Landscape Architecture

Civil Engineering

Traditional professions involved in site development, besides the overall architect and contractor are the frequently sublet professions of the civil engineer that plans infrastructure design for storm water removal off site, and the landscape architect that plans the aesthetic plant pallet selection and look of the complimentary landscape.

The EPIC system is a tool where the landscape architect simultaneously provides the civil engineer's function of storm water management, and the civil engineer achieves his goals of hydrologic responsibility by providing the irrigation and drainage aspects required for the landscape architect. Thus a new acronym profession is coined as Landscape Architect – Civil Engineer , LACE.

Background Philosophy

Two outdated yet ingrained philosophies of infrastructure design that greatly affect water use inefficiency are:

1. Domestic water supplies for indoor and outdoor use must be of drinking water quality

2. Storm water is a waste product that must be shed off the property as quickly as possible.

Both philosophies evolved to extensive regulation and construction standards for an expensive infrastructure procedure and system structure.

In the last century water management practices for water supplies and waste water disposal have changed very little in the form of philosophy or approach in design. In summary centralized filtration and treatment systems procured water from locally available sources be it surface or underground aquifers, polished it to drinking water standards, and through pressurized piping systems provided "running" water at the consumer end.

Pressurized domestic water supplies have a historical rationale based in sound Public Health Policies and indirectly have been adapted to support the technical shortcomings of conventional sprinkler delivery systems. In drier western states climates, however, 2/3 of the domestic water supply use is consumed for outdoor applications. The irrationality is that we clean and polish water sources to impeccable EPA drinking water standards and then post-contaminate 2/3 of this water with fertilizers so the plants can grow. The many contaminants we have removed are nothing more than nutrients needed by plants and already present in raw water.

At the other end used and "dirty" water was channeled into larger low pressure piping systems and channeled either as a direct discharge, or to treatment facilities to "clean" the water before it was discharged. For the most part the systems were hidden underground or located in remote areas of the community, and the average consumer knew little of the dynamics or structure. As long as water flowed when the faucet was turned on and the "toilet flushed", life was good, and there was no need to fix something that is not broken.

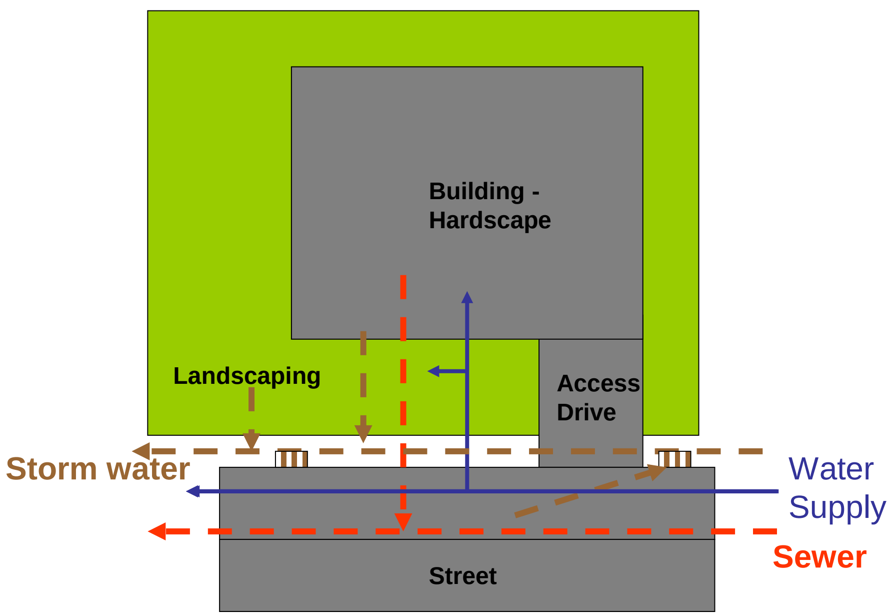
Population increases, migration shifts to live in "sunny" desert environments, drought, and higher volume and quality demands have provided supply pressures on existing water supplies. In many locations supply shortages are reaching a critical level. On the waste water side - pollution, environmental degradation, treatment costs, increased discharge regulations, and public awareness have increased pressures on improving the disposal of waste water.

Though intended for storm water relocation, conventional "curb and gutter" designs are also by nature street litter and pollution drains. Litter, animal droppings, automobile wash water, engine drippings, eroded soil etc. are simply intentionally or naturally washed away into the storm drain system to be dumped (or occasionally treated) somewhere downstream into larger bodies of water (rivers, bays, oceans).

CONVENTIONAL DESIGN

While physical buildings and surrounding areas have an infinite variation in form, size, occupancy and function; in terms of water management all community structural developments can be summarized in the following diagram of Fig.A

Fig. A – Conventional Infrastructure For Water Management



Any development whether it is a single family house, a high rise building, a shopping mall or sports complex must have access by a driveway from the street. The erected structure on the developed lot along with the traditionally impervious surfaces of streets, parking lots and access driveways form a water shedding surface. In most developments the cumulative total of hardscape (grey areas) often exceeds the pre-development hydrology of the vegetative areas (green areas).

Buildings are often surrounded by variable sizes and designs of landscape areas for functional and aesthetic purposes. Landscape areas may be small landscape gardens, small turf areas or large athletic fields on specific developments. Although absorptive landscape areas can traditionally absorb some of the water from rain events, the current practices of using traditional soils with a compacted clay content combined with code driven surface slopes of 1% or larger cause rain water simply to shed to low points of the property. Thereby to manage the overall cumulative storm events shed by all the hardscape and partially by landscape areas, the common wisdom was and is to construct a curb and gutter system at street level. These systems, though mathematically functional on the initial design plans are frequently overwhelmed by real life storm events due to plugged debris at catch basin openings, sediment accumulations in the transfer pipes, or downstream cumulative back-up. The net result is temporary flooding events.

Just as a storm event is composed of many individual rain-droplets, localized flooding is caused by the bulk accumulation of storm water run-off from many individual lots. While many perceive this as a necessary evil imposed by Mother Nature in an urban setting – the common events are not only a public safety hazard, an environmental pollutant, but sadly a total waste of a precious resource – free distilled water!


The **current challenge** in storm water management practices has been on **how to reduce and mitigate pollutants** that are discharged to the final recipient bodies of lakes, bays, streams, and ground water formations during storm events. Three general categories of pollutants are of concern and can be summarizes as follows:

1. The broad introduction of **nitrates** and **phosphates** that stimulate algal growth in the readily visible areas of surface water systems.

2. The visible **floating gross pollutants** of aesthetic concern in the form of visible floating debris, paper products, pet waste, agricultural litter and human refuse.

3. **Suspended** and **dissolved solids** of various chemical makeup including automobile crankcase drippings, fuel spills, soaps and detergents from vehicle washings, landscape fertilizers and pesticides, and accumulated fine dust particles from roads and roofs.

The centuries old historical philosophy and model for storm water management was the physical establishment of “slope” and the simultaneous construction of “curb and gutter” systems having the sole purpose of moving water quickly to its final dumping ground. **“We have traditionally created not a storm water management system but a storm water movement system.”** Unfortunately water in motion increases its kinetic energy which then translates to a growing erosive force that not only moves particulate material from the initial surface but creates a downhill destructive power.

The first picture illustrates how the sloped surfaces of a house, driveway, road, landscape surface all terminate in the curb and gutter structure. The crystal clear water that fell as a light rain event has already turned a brown color as road pollutants and landscape erosion are now in suspension as storm water is now in motion.

Particulates and debris moving towards the catch basin initially enter the below ground pipe and then start to restrict the catch basin openings reducing the open area. Diversionary devices merely stage the pollutants for entry during subsequent higher flow events or through bi-pass move the water mass with increasing energy to a lower collection device. However eventual plugged piping or miscalculations as to volume leads to system collapse and failure.

The answer to storm water management is not the creation of bigger and more expensive storm water movement systems, but **changing our philosophy and methods** to true water management systems that actually prevent and treat storm water pollutants.

When pollution issues were not in the forefront, the "curb and gutter" systems were convenient conduits to clean the immediate environment. Driveways and walkways were routinely hosed down, street traffic accident spills and debris were flushed to the nearest catch basins, street washers sprayed the streets, and the rain itself washed things "away". In the process of cleaning the immediate environment we transferred pollutants to the larger bodies of water and assumed that someone else is going to take care of it.

Increases in population densities increased impermeable surfaces, and while engineering reconstruction kept up with water movement strategies, water pollutant dumping overwhelmed natural cleaning cycles and pollution issues came to the forefront.

Current initial BMP's (Best Management Practices) evolved towards devises that filter and capture gross visible pollutants (floating debris). They include catch basin inserts, traps, filters, vortex cyclone flow devises, in line diversion screens, manhole baffles, and capture screens and floating barriers at final discharge points. **While gross pollutants account for the largest volume of contaminants from storm events, this pollutant category has the least amount of biological impact on the final receiving bodies of water**. The devices in general are efficient debris removers in light storm water flows, but are overwhelmed in larger flows and have to rely on the built in bi-pass features. This group of BMP's was an "add on" improvement to existing "curb and gutter" systems, but did not change the philosophy and structure of a "curb and gutter" system. A higher maintenance schedule to clean and service these devices has to be implemented. The eventual collection and disposal of these wastes improves aesthetics but does little to prevent the inflow of phosphates or nitrates.

Storm water detention and retention structures in the form of pits and basins became a BMP alternative to address the collection of sediment pollutants which were the primary source of soil phosphates. The theory was to slow the incoming water down into manmade ponds and allow some of the particulate matter to settle to the bottom of the pond and only allow slower and less contaminated surface flows to continue to the major receiving waters. Surface debris could be skimmed off while the soil sediments settle.

While this BMP has become, mostly by regulation, a current "state of the art" requirement for storm water mitigation, the model by nature creates a long list of other spin off problems, and it is questionable that this BMP actually adds to the environmental equation of improving the quality of the terminal receiving bodies of water.

1. Retention pits require the acquisition of considerable real estate acreage, in some localities at great expense. In Texas 20 acres of development require 1 acre of detention ponds, areas that now have no revenue base for tax collection or rentable space for developers.

2. The construction of detention pits in itself loosens considerable locked phosphate material in the soil, suspends the material into muddy water which during overflow storm events passes on the phosphate laden water to the final receiving waters.

3. Retention pits become a safety and liability issue and as such are frequently fenced as an added preventative expense. The fences in turn become wind blown filters for flying paper and debris.

4. The pits become mosquito breeding areas with associated disease vectors for horses and humans in residential areas.

5. In some areas the pits attract nuisance geese which in turn add to the deposition of soluble phosphates and nitrates.

6. The first incursion of silted muddy water seals the bottom infiltrative interface of the pit, and as such the pits do not recharge ground water as theorized.

7. The steep, soft inner embankments and water line areas are not conducive to support maintenance equipment that could clean or service the pits, and post construction

budgets never account for routine maintenance of these structures. The steep side walls continue to erode during every rain event.

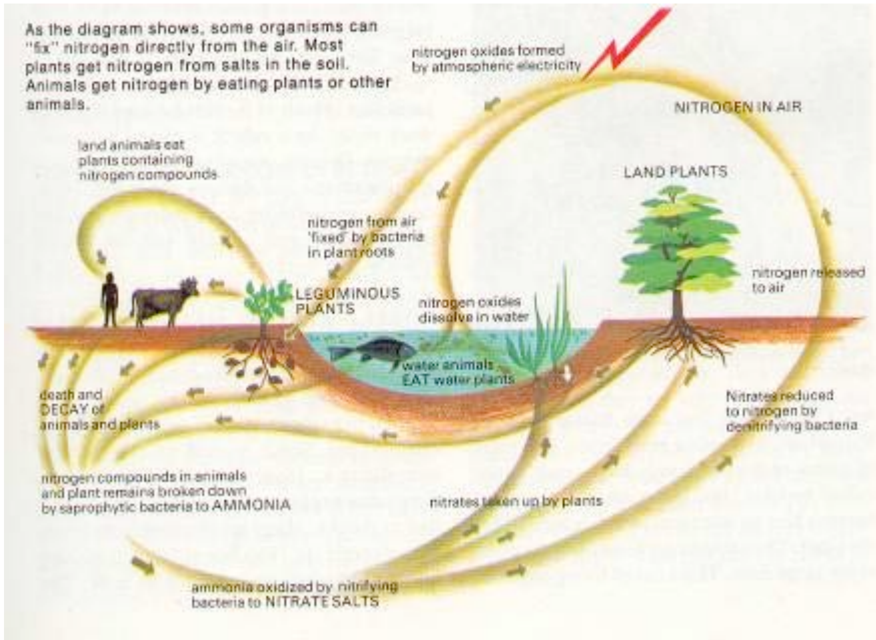
8. In wet climates the pits remain in a steady state of muddy water as phosphates and pollutants are in suspension with ongoing transfer of cloudy water to downstream water formations. In dry climates, storm events evaporate creating the conditions for the germination and proliferation of weeds. Desirable biological ecosystems rarely develop in pits due to extreme fluctuating water levels in a short time line. The "wetland" may have been created on paper but not in function.

9. Accumulation of leaves and other organic debris in the pits settles to the bottom and initiates an anaerobic environment which depletes oxygen and produces methane and hydrogen sulfide gas emissions.

10. The perceived client value is zero.

If the ecological goal in storm water management is the reduction of pollutants that initiate algae blooms and consequential oxygen deprivation in the final recipient bodies of water, then the focus in storm water management must be the reduction of **nitrates** and **phosphate** sources. Unfortunately BMP's that tend to augment conventional "curb and gutter" water movement systems cannot mitigate the reduction of these contaminants and in some cases actually contribute to the increase of these contaminants.

Nitrates: Nitrates (or $NO3^-$) are the negative anions of a broad spectrum of basic chemical compounds commonly identified as sodium nitrate, ammonium nitrate, potassium nitrate, calcium nitrate, nitric acid etc. Most nitrate compounds are soluble in water and as such will travel anywhere that water goes. Holding a net negative charge, they can travel great distances in soil which by nature also carries a net negative charge. As such the dissolved compounds can relocate to ground water formations or larger bodies of water great distances away from its point of origin. Once formed there is no non-biological chemical reaction in soil that can precipitate or neutralize the compounds. Nitrate movement and biological absorption become part of the planet's nitrogen cycle.



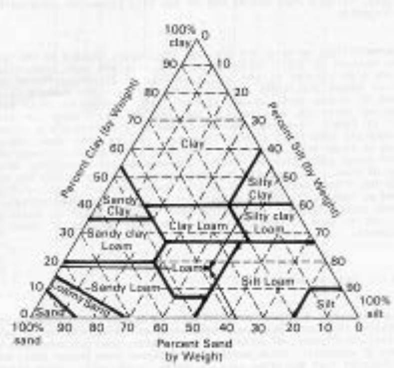
Nitrate production is ubiquitous and always present in storm water runoff not only from the wash out of excessive fertilizer applications, but also from the natural presence in thunderstorm rain events, and washings of surfaces exposed to automobile exhaust. Because nitrates are so highly soluble and negatively charged, an effort to control nitrate pollution by conventional "curb and gutter" systems can not happen because one must actually stop water movement itself to prevent nitrate transfer.

<u>Phosphates</u>: The primary source of this group of nutrients is a natural rock mineral called phosphorite. It consists largely of calcium phosphate and is used as a raw material for the subsequent manufacture of phosphate fertilizers, phosphoric acid, phosphorus and animal feeds. Some level of phosphate is universally present in all soils of agricultural quality. (Soils with the ability to grow plants whether they are weeds, turf or commercial crops).

The planet's soils can be categorized as a percentage and combination of three particle size primary components – **sand, silt, and clay**.

FIGURE A-2

TEXTURAL TRIANGLE DEFINING TWELVE TEXTURAL CLASSES OF THE USDA (ILLUSTRATED FOR A SAMPLE CONTAINING 37% SAND, 45% SILT, AND 18% CLAY)



All three particle components are derived from weathered rock and reflect the chemical characteristics of the many rock composition minerals including the phosphorus bearing molecules. Phosphorus molecules, unlike the negatively charged nitrate molecules have a net positive charge, and as such bind themselves quickly to the negatively charged soil particles. While nitrates readily move with water as compounds in solution, phosphates generally only move as "riders" on soil particles.

Sands (0.05-2.00 mm) by nature are larger particles and primarily composed of quartz crystals. As such there is less surface area or physical affinity for phosphates to attach as compared to the larger surface area and negative charges available on silt (0.002-0.05 mm) and clay (<0.002 mm) particles. Effective BMP's for Phosphate pollution control must integrate three source areas as **phosphate control equates to the control of erosion and relocation of soil particles:**

1. Prevention of soil erosion
2. Sedimentation and removal of settle able solids formed as sands and silts.
3. Prevention of movement of suspended solids in the form of clay particulates, generally known as "muddy" or "turbid" water.

Some current BMP's can effectively settle sands and silts but cannot handle "brown muddy" water where the majority of phosphates reside. Specialized high volume pump activated mechanical filters can make an attempt on "muddy water" in limited volumes, but high operating expense, frequent service and breakdown makes these systems not a viable solution to storm water pollution problems.

EMERGENCE OF THE EPIC SYSTEM

In **EPIC™** designs the use of low fertility sands, large particle sizes, and flat non-erosive terrain also means that nutrients that are available in the growing media do not move offsite. Additionally as indicated in the second column of Table 3. **EPIC**™systems can absorb and treat (through plant growth) **80 pounds of Nitrogen and 40 pounds of Phosphorus** per acre if these nutrients are deposited in **EPIC**™ systems from outside sources **(Treatment Capacity).**

EMERGENCE OF THE EPIC SYSTEM

In 1999 breakthrough technology identified as the EPIC™ system turned the world of irrigation upside down. Using a sand based rootzone, capillary physics for vertical water distribution and gravity for horizontal and drainage distribution, the passive system achieved 100% efficiency in irrigation, better turf quality and affordable low maintenance construction. Direct comparative studies demonstrated 58% less water needs as compared to sprinklers, and overnight the 2/3 water allocation in outdoor use for desert climates could be reduced significantly, without a change in landscape area, plant species or cultural habits.

	Sprinklered lot	EPIC™ lot
Domestic indoor use	107,500 gal.	**107,500 gal.**
Outdoor irrigation needs	217,500 gal.	**91,350 gal.**
Total water allocation	325,000 gal. (1 acre foot)	**198,850 gal. (0.6 acre foot)**
Adding storm water capture	**325,000 gal.(1 acre foot)**	**107,500 (**0.3 acre foot**)**

The non-pressurized system changed the first cardinal rule that irrigation water has to be pressurized and of drinking water quality. Irrigation could now be achieved with a number of water sources without any public health concerns. Domestic water, shower water reuse, and reclaimed water from sewage treatment plants could all be blended and be reused even in residential settings without any public health issues. However easier and more importantly, **the EPIC™ system opened the doors for efficient capture and reuse of storm water directly**. The system acted as a pre-filter for runoff sources prior to storage and then flipped as an efficient irrigation system during dry periods.

The above EPIC™ backyard provides 100% efficient irrigation and total storm water capture by collecting roof and hardscape runoff into system for irrigation reuse..

This changed the second cardinal rule in development design – Storm water has to viewed as a waste product and be removed from the property as quickly as possible. In recent years storm water capture and sub ground storage was made possible by a number of products from many different companies. Inexpensive void spaces can be created by fiberglass tanks, arched polymer structures, bladder systems and concrete voids. Unobtrusively placed under driveways, road side edges, or landscaped areas, the structurally sound storage voids could now store water indefinitely for future use not only for irrigation but also for fire reservoirs or heat exchangers for geothermal heating and cooling systems.

Landscape design and irrigation can become part of storm water capture and management. Landscape architects and civil engineers can directly team up to provide hydrological responsibility in the design phase of any new or restructured project. Lots could be custom tailored with climatic events and cycles to be totally self-sufficient for water irrigation needs with free water that came out of the sky. This is even possible in the driest parts of the country with less than 7” annual rainfall. Roof, driveway, and street runoff can become integrated into collection systems where water was pre-filtered, stored and then reused when needed. In wet climates the EPIC systems integrated sand filtration retention and absorption of contaminants to eliminate erosion, and cool the water prior to a clean discharge into existing infrastructure systems and destinations.

Table 2. PHILOSOPHICAL CHANGES OF EPIC™ SYSTEMS

CONVENTIONAL "CURB & GUTTER" SYSTEMS	PHILOSOPHICAL CHANGE IN EPIC™ WATER MANAGEMENT SYSTEMS
Allows substantial surface flow prior to catch basins. A process which picks up pollutants, debris and initiates soil erosion.	**Picks up water close to origin, filters it and moves it quickly below ground for a non erosive controlled flow.**
Provides no intermediate storage as water volumes increase with downhill flow transferred by ever growing structural pipe.	EPIC™ **systems provide immediate pre-filtered subsurface storage at 2.5 gallons per square foot or larger.**
Storm water is dumped to a downhill receiving body of water	**Storm water is reused for irrigation, and only excess cleaned water is optionally discharged to a final body of water.**
Expensive infrastructure serves single purpose of shedding water quickly	**Inexpensive infrastructure serves multiple purpose of drainage, irrigation, pollutant management and treatment.**

The distinguishing structural changes in EPIC™ designs are differentiated from conventional practices in the following ways:

PLANTING MEDIA.

Conventional landscaping practices deal with the available native soils, frequently "fluffed" and augmented with mulch, "top soil", fertilizers and imported sod.
EPIC™ growing media consists of washed, highly porous sands, and fine gravel for infiltration structures.

SLOPE.

Almost all conventional landscape areas have a surface slope in order to shed water. Slopes are designed to prevent standing water situations as native soils do not provide adequate infiltration rates to move the water below ground. The establishment of slope however also means that water will now move horizontally in paths of least resistance and initiate a scouring or surface erosion of the profile. Pollutants are now in suspension and move towards the nearest collection basin.
In **EPIC™** systems, due to the high porosity of sands, landscaping can be perfectly flat and still allow surface water to move down through the profile. As such erosion is never initiated because the sand particles are too large to go into suspension, there is no erosive surface flow, and storm water is automatically being pre-filtered by sand before it leaves the system. Nitrates, phosphates and other pollutants are retained within the system as nutrients and only clean excess water is transferred to receiving bodies of water.

DETENTION.

Conventional landscaping designs and "curb and gutter" systems are designed for quick water movement strategies. Speed does not allow for pollutant absorption and treatment, and worse as previously mentioned contributes in adding to the pollutant load through erosion. All agricultural soils contain within their matrix a number of nutrients that are available to the growing plants. Nutrient absorption by plants is a relatively slow process of assimilation as the plants grow. Soil and its nutrients must be retained in the growing profile for eventual absorption into the plant physiology and not lost with run-off water.

Table 3. NUTRIENT AVAILABILITY AND REMOVAL BY TURF*

NUTRIENT	SOIL CONTENT RANGE IN POUNDS/ACRE	TURF ABSORPTION IN POUNDS/ACRE FOR EVERY 2 TONS DRY PLANT MATTER
Nitrogen (N)	400-8,000	**80**
Potassium (K)	800-60,000	**40**
Phosphorus (P)	400-10,000	**12**
Calcium	14,000-1,000,000	**16**
Magnesium	1,200-12,000	**8**
Sulfur	60-20,000	**6**
Iron	14,000-1,100,000	**1**
Manganese	40-6,000	**0.8**
Copper	4-200	**0.08**
Zinc	20-600	**0.6**
Boron	4-200	**0.08**
Chlorine	40-1,800	**4**
Molybdenum	**0.4-10**	**0.0008**

* From Chemical Equilibria in Soils. W.L.Lindsay, 1979. Wiley & Sons.

What the above table illustrates is that **control of erosion is paramount** if we are to address nutrient pollution to terminal bodies of water. A significant amount of nutrients are available in fertile soils whether they are naturally present or artificially added. If soils get eroded by runoff so is the “tag along” nutrient.

In **EPIC™** designs the use of low fertility sands, large particle sizes, and flat non-erosive terrain also means that nutrients that are available in the growing media do not move offsite. Additionally as indicated in the second column of Table 3. **EPIC™**systems can absorb and treat (through plant growth) **80 pounds of Nitrogen and 40 pounds of Phosphorus** per acre if these nutrients are deposited in **EPIC™** systems from outside sources **(Treatment Capacity).**

CASE STUDIES:

On a small scale a number of installations reduced run-off issues by a paradigm shift of storm water capture and reuse as irrigation water. The following installation changed a direct roof drain discharge to an urban street collection system to an aesthetic grass parking area that acted as a sand filter during storm events. The small roof area provided adequate seasonal irrigation water to sustain the grass.

The following car dealership installed an EPIC landscaping in front of the building. Storm water sheet flow is directed for absorption into the EPIC profile and reused as irrigation water. While irrigation requirements were reduced by 60% the pollutant control benefit was - as the new cars are washed just above or over the profile, soap solutions and wash contaminants are absorbed into the profile, converted to plant nutrients and contaminated water never reaches the storm drain system.

This town house in Willermie, MN installed the EPIC profile near a wetland area as storm water capture system directly from the roof and hardscape areas. The system provided direct sand filtration, and landscape irrigation for grass and planting boxes. Independent monitoring by the Rice Creek water shed reported overall runoff volume reduction by **56%** and a phosphate removal efficiency of **85%.**

On a larger scale, the Cambria Elementary School on the central California coast captures and stores storm runoff during the rainy winter months off a 12 acre site to be reused as irrigation water for the rest of the year. A community with limited water resources! Sound familiar? The challenge was to provide 130,000 sq. ft. of an all season, durable, multi use grass play fields at a community school site where water volume, delivery pressures, and logistics were not feasible to deliver the water resources for conventional irrigation systems. The unique solution provides a water conservation system that utilizes the harvest and storage of rainwater runoff, and efficient non-pressurized subsurface irrigation.

Cambria, California a small coastal community in 2002 was at a crossroads to expand a planned expansion of an Elementary school and grounds. Prohibitive and unavailable land costs in the community proper were not available, and the only available land was in the outskirts of the town where steep coastal foothills presented site development and erosion challenges and the added elevation rise prevented the delivery of adequate volume and pressure of irrigation water to the site. The Coast Unified School District under a bond measure and assistance by the California State Allocation Board for Proposition 47 contracted services with RRM Design Group (Architect/Civil Engineer), Earth Systems Pacific (Soil Engineer) to provide plans to solve the development objectives and satisfy the stringent water quality and erosion mitigation demands of the California Coastal Commission.

The main player in this conservation game was the EPIC™ system. The system is a versatile player as it acts as a collector, water distributor, filtration system and irrigation system all in one.

As irrigation requirements in this system are reduced by better than 50% over conventional practices, so is the required volume of storage. In the Cambria School, all of the stormwater runoff from the 12 acre campus's hardscape is collected and stored in a subsurface detention basin (2.0 million gallons) in linear pipe underneath the main 87,000 sq. ft. playfield. Sufficient water is collected during seasonal rains (Average 17" per year) to supply all of the campus's irrigation needs for the rest of the year.

Cambria Elementary School, Storm water collection and Storage system under primary play field. (RRM design)

The best part of this design solution is the functional simplicity, low-tech/low maintenance components, reduced water usage, storm water management and saving the community's potable water supply for drinking – not landscaping. This is a sustainable project that harvests free rain water (during the rainy winter months) and stores it in an underground chamber system till when it is needed for irrigation. The storage system does not use up additional land space, is not subject to evaporation, nor does it promote algae growth to compromise water quality. Pre-filtration through the EPIC™ profile prior to storage minimizes sediment accumulations in the reservoir in the long term.

This Innovative Low Impact Development design shows how large institutional facilities can be self-sustainable by changing the way they look at storm water. Capturing every last drop provides sufficient irrigation water for their landscaping needs for the entire campus. Not just for a week or month but for year, after year, after year. This avoids all runoff issues and truly promotes a Green Bottom line.

Comple

Cambria School runoff filtration and water harvesting strip at mid section.(Sipaila)

Cambria School Primary Soccer field over sub-ground reservoir storage. Fall, 2006 (Sipaila)

Imagine, now that water sustainability is a reality on such a large scale for school campuses, this design concept being replicated across the country. Imagine the impact that this new EPIC™ system technology will have on the water resources of this country. Imagine if every new school ball field is actually self-sustainable. Imagine if every new residential or commercial development implements this to become self-sustainable in terms of water usage for all landscaping.

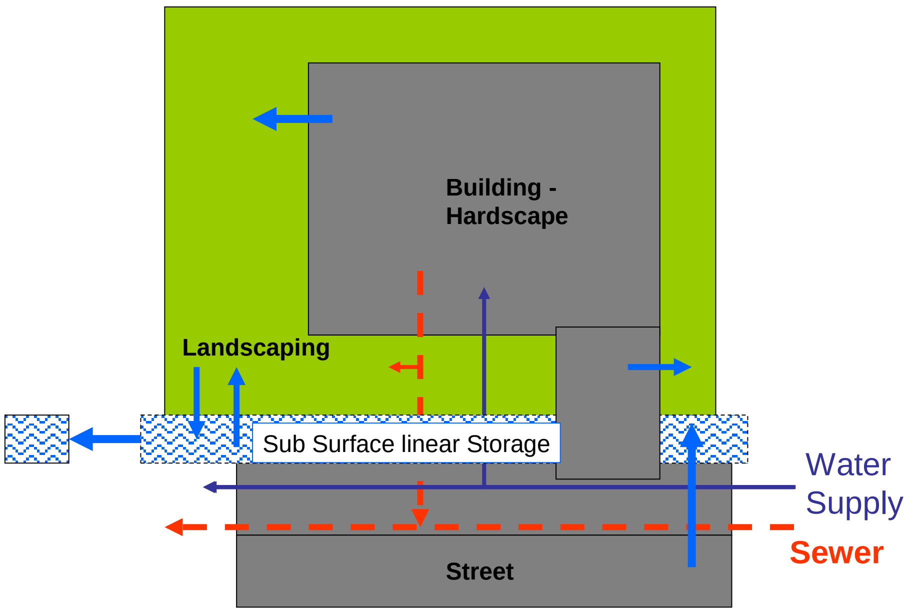
The ability to effectively control storm water movement through biological sand profiles provides opportunities to pre-filter, collect, store and reuse valuable and free rain water for secondary uses and benefits. Modifying this versatile EPIC™ BMP to many applications changes both the philosophical approach and desired outcome in many designs.

The paradigm shift in infrastructure design does not necessarily have to change the accustomed look and layout of familiar conventional design. A second look at the previously presented conventional infrastructure concept structure shows that we have no change in designated areas but what has changed in the EPIC Infrastructure is that:

- Storm water runoff passes through a sand profile for filtration to prevent erosion and pollutant transfer
- Storm water is linearly stored below ground to be reused as needed to provide irrigation, thus, depending on design, run-off is drastically reduced or eliminated totally.

- Domestic water supplies are not used for irrigation needs.
- Selected waste water sources can be integrated as irrigation water to reduce waste water treatment downstream.
- A natural reduction on all three existing infrastructure demands of water supply, storm water volume, and waste water treatment.

Fig. B – EPIC Infrastructure For Water Management



Water sources:

Where in conventional landscape designs the irrigation water was in general strictly supplied by the domestic pressurized water supply, EPIC systems provide a significant exception where irrigation water can be used and blended from multiple sources.

Waste water sources can be classified into four general categories of “Black water”, “gray water”, “reclaimed water” and “industrial waste water”. Although all of the above may be usable in EPIC systems a refinement of definition has to be evaluated.

Category	Examples	Required pretreatment	Comments
Black Water	Toilet waste Kitchen Sink Bathroom sinks Utility sink Combination of above	Septic tank Followed by Alternating EPIC fields (see leach field options)	**High potential of bacterial contamination. Disposal regulated by Health Departments.**
Gray water	Water fountain waste Air conditioner waste Shower water Laundry waste Storm water runoff Combination of above	None None None Pre-filtration Pre-filtration (auto) Pre-filtration	**Laundry waste contains a number of fibers including polyester which have to be filtered out as they are not biodegradable. May or not be regulated by Health Departments.**
Reclaimed water	Treated municipal Waste water. Clear water from a post Septic tank individual sewage treatment system	None	**Low bacterial contamination but must be contained unpressurized underground**
Industrial waste water	**Many sources may or may not be regulated**	**Analysis required and reviewed as to post discharge treatment**	**Analysis required to determine suitability as irrigation water.**

Begin part II

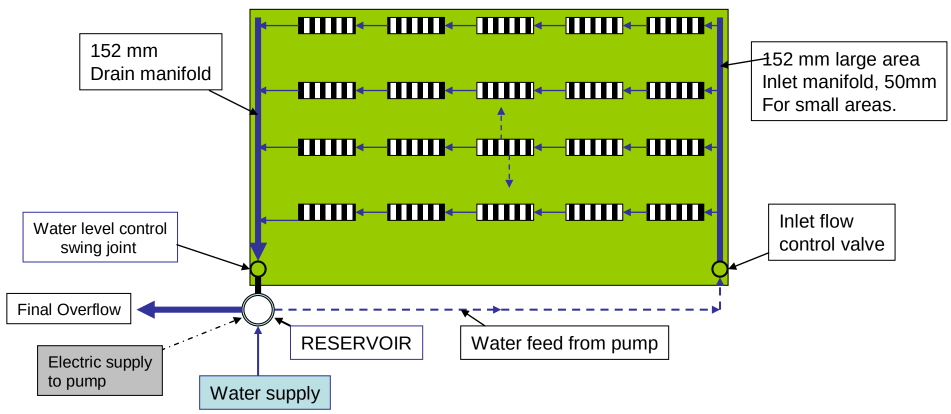
DESIGN Approaches:

There are two basic approaches for the construction of EPIC cells. One we have a broad area of a flat design where water introduction occurs through a manifold as shown below.

EPIC CONSTRUCTION PROCEDURE – Water flow flat System

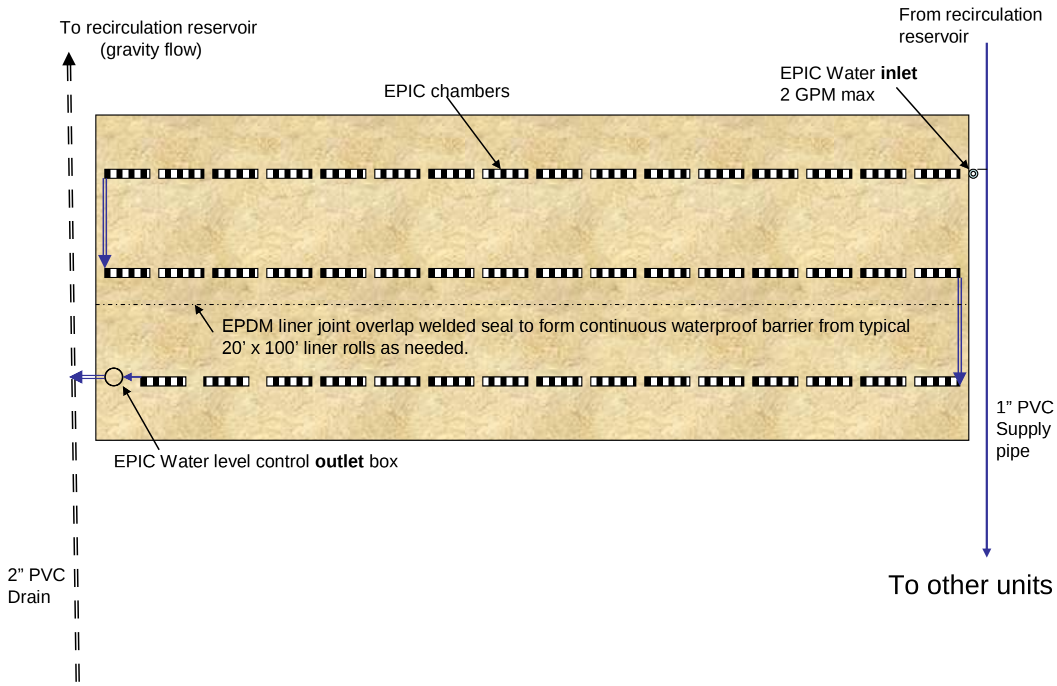
The principles of water flow in flat EPIC installations are as follows:

1. A pressured water supply keeps the reservoir partially full by a float valve
2. A submersible pump when activated by a timer (or manually) pumps water to the inlet control valve which then feeds the inlet manifold.
3. Flow (by gravity) from the manifold goes to the EPIC chambers, the field, and is collected by the drain manifold.
4. Water level in the field is controlled by the swing joint, and excess water returns to the reservoir and is recirculated if the pump is running and the field at capacity.
5. Excess storm water leaves reservoir overflow pipe.



On narrow and smaller areas a serpentine connection flow is used. The serpentine flow concept is also used on desired surface slope accommodations where individual level underground steps and cells are separated by an 8” subsurface wall between the level benches.

EPIC Concept layout for Serpentine flow



As shown above in the two diagrams EPIC systems are based on a flat and level plane that creates an EPIC cell. An EPIC cell can be as narrow as 24" or linked side by side encompass a flat soccer field.

In the following sequence a flat broad area consisted of a single cell, which then was divided at the surface to create three grass areas separated by a sidewalk. The EPIC cell provided the foundation and open pallet, and surface hardscape and amendments provided the look. The upper level plane incorporated small EPIC pans and tree growth.

  (Add picture of TCF trees)

Since the EPIC foundation provides a firm non-settling base, a number of different options become available to surface treat the sand surface either by plant material, porous surface structures or impermeable surfaces that allow surface sheet flow to the nearest EPIC cell for absorption. In the same EPIC foundation we provide surface runoff absorption and filtration, water storage and sub-irrigation on a passive basis.


The use of EPDM liner membrane allows the creation of irregular cells. As such EPIC does not necessarily restrict landscape layouts but enhances landscaping in a three dimensional arena. In the following two pictures tiered and raised garden beds provided a three dimensional look to landscaping but a common interconnected water flow between garden sections provides irrigation and drainage.


In the project of the above picture on the right the final destination point of all the surface runoff that goes through the project is filtered through the EPIC profile and ends up in a an underground storage cistern for reuse when needed to provide irrigation. Stored water as it was pre-filtered can be stored indefinitely underground with the advantages of no water loss due to evaporation and no algae growth due the absence of sunlight.

Underground reservoirs under the landscaping or adjoining hardscape areas including driveways can be the strategy for water storage. For EPIC applications these reservoirs also become the recirculation vault applied in the water distribution system as shown previously. In some small or large applications water features themselves can become the EPIC reservoir. In the following pictures the coy pond is the reservoir that not only provides the water feature flow but also provides passive irrigation of the EPIC garden beds surrounding the water feature. As the water feature water is recirculated through the EPIC garden profiles nutrient produced by the fish are absorbed by the plants and having some water in recirculation below ground prevents sunlight stimulation for algae growth.

Since homes and buildings are level, EPIC landscaping is for the most part an extension of the level plane to the landscaping features. The use of the impermeable EPDM liner wall that extends to the surface also means that soil environments can be placed near building walls without moisture penetration issues. In the picture on the left the narrow EPIC cell is along the building wall and also receives the roof downspout directly into the profile. The raised grass area on the right is built along a wooden back fence and this system is irrigated by shower water when storm water is insufficient.

Flat landscaping strategies possible with EPIC makes yards more functional and appealing for play. Even though level, the exceptional drainage capabilities of an EPIC profile absorbs water downward through the sand profile and then directs it even distribution underground and a designated discharge point anywhere in the flat profile.

The following pictures illustrate how the EPIC profile is even with the plane of the house and the plane of the adjoining pool.

As the EPIC profile is preferred by all plants, different plant species can be incorporated in the same system by strategically altering the sand depths that occur in the same profile. In the following the EPIC profile is slightly deeper in the tufts of ornamental grass and at normal nominal depths for turf grass. Additionally this installation was constructed on top of a parking area garage roof adding a familiar and usable plant pallet making the conventional barren roof pallet a park like area.

On a more dramatic scale different plants and plant depths can be accommodated over the EPIC drainage and irrigation base by altering the sand containment depths through the construction of retaining walls. These walls can be built right over the EPIC profile base and be added at any time in the future to complement existing turf areas with flowers, bushes and shade trees.

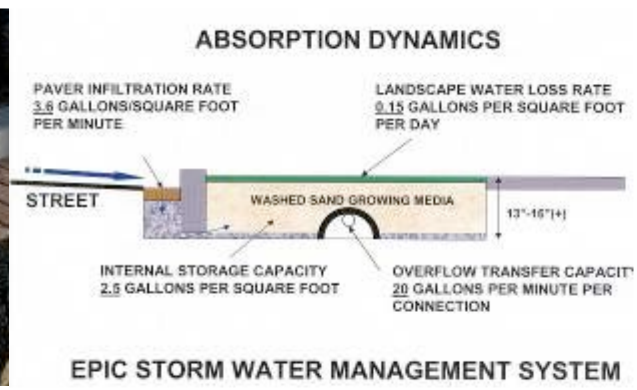
The conceptual diagram of EPIC transition below ground in conjunction with tree profiles is shown below.

(insert diagram of turf – tree well cross section)

EPIC systems are essentially sand based garden beds made in different sizes to accommodate landscape irrigation needs with the secondary function of water capture from surrounding hardscape areas. They may be below ground and invisible or above ground with various sand containment structures and materials to provide a three dimensional accent to the flat landscape or a functional sitting area

along the walking area. Even in large commercial retail outlets raised garden beds along buildings can be within the drip line of roof water collection, provide a sitting area, and discourage human or pet activity into the landscape plantings.

in the picture on the left roof runoff can be directly captured into a sand profile to provide irrigation reuse. In the picture on the right additional strategies of street runoff absorption directly into EPIC profiles provides substantial free water source for irrigation but also provide passive filtration and surge control from rain events while eliminating traditional infrastructure of catch basins and storm drains.



Strategic landscaping designs with EPIC systems can achieve net zero water needs from domestic water supplies for all landscaping in all climates. Net zero is achieved by balancing the water needs required by the plants with free available water sources. Free water sources in order of preference are storm water, ice machine waste water, air-conditioning waste water, buildings shower water. The above four combined are usually sufficient to achieve the irrigation needs in desert climates. Storm water alone is usually sufficient in moderate and wet climates by balancing average rain events with hardscape harvesting surfaces and strategic non-rainy day secondary storage systems.

Figure I

Begin Part III

A useful tool to calculate water needs is the creation of a climate table. An example of this tool is shown below along with directions of how it is used.

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
High ° F	30	34	45	58	70	79	83	81	74	61	47	**35**
Low ° F	17	19	27	37	48	58	62	61	53	42	32	**22**
Rain (in.)	2.2	2.0	2.8	3.4	3.0	3.4	3.2	3.7	3.4	2.5	3.0	**2.8**
Snow (in.x 0.1)	1.4	1.0	0.8	0.2							0.4	**1.4**
Estimated ET loss/SF	2.48	2.48	2.48	2.48	7.44 4.3	7.20 4.2	7.44 4.3	7.20 4.2	7.20 4.2	7.44 4.3	2.48	**2.48**
Field Storage/SF*	3.7	4.0	4.0	4.0	-0.4 2.7	-3.8 1.9	-4.2 0.8	-3.5 0.2	-3.8 -0.6	-4.9 -1.8	0.9	**2.6**
Field Drainage in.		0.22	1.12	1.12								
Water need gal/SF**					0.3	2.4	2.6	2.2	2.4 0.4	3.0 1.1		
Project –435,600 SF												
Output in gal***		59K	302K	302K								
Irrigation need/mo.					131K	1045K	1133K	958K	1045K 174K	1306K 479K		
Weekly Irrigation cycle (max)										326K 120K		
Weekly well production@35GPM										352K		
Stabilization reservoir storage										300K 700K		
Hardscape–SF												
Filtered Discharge+												
Irrigation need												
Sustainability Storage												

Table 1: Ann Harbor, MI Average Climate and EPIC Field Water Storage Dynamics

* Rain + Snow – ET loss, Normal Field Storage 4”/SF (2.5 gal/SF)

** Field Storage in inches x 0.62 gal/in.

*** Field drainage (in.) x Project SF x 0.62

+ Hardscape area x Rain x 0.62 plus Output of Field, minus irrigation need

Understanding, reading and manipulating

An EPIC climate water usage table

Although initially confusing an EPIC climate is a calculation tool in estimating a project's sustainability potential in terms of storm water capture, water use and storage requirements. Specific explanations to the ANN Harbor, MI table is as follows:

- Line #1 and #2 are the average monthly climate Temperature Data for the area obtained from weather internet sites.
- Line #3 and #4 are the precipitation averages for the month expressed in inches of rain or in the case of snow, the snow amount is multiplied by 0.10 to enter the rain equivalent of the reported snow depth. For example 10" of snow depth would be roughly equivalent to 1" of rain.
- Line five is the estimated total **E**vaporation and **T**ranspiration water loss in an EPIC system. EPIC systems are 100% efficient in that water loss in an EPIC system is actually the area's ET rate and EPIC systems can be used as an accurate gauge of a project's ET rate if water consumption is metered. During the winter months when plant growth is minimal by plant transpiration, there still is a water loss from an EPIC profile through evaporation or sublimation from snow. Calculations and observations have recorded a water loss of about 0.05 gallons per square foot per day. This number divided by 0.62 gallons per inch per square foot gives us a loss value of 0.08 inches per day. The 0.08 multiplied by 31 days gives us a water loss of **2.48** inches per square foot per month. This conservative number is then applied in the table in all winter months when grass growth is dormant or at best minimal due to unfavorable temperature for photosynthesis to occur. Months that have fewer than 31 days can be calculated with a slightly lower numbers, but for conservative simplicity the 2.48 inch number is applied in all of the non-growth months.
- When lows are above freezing and the average highs are above 55°F plant growth initiates a higher ET rate primarily due to transpiration activities. As such during the warmer months on line five higher ET losses are tabulated. ET losses are greatest in climates with low humidity, high temperatures and above average winds. Highest ET rates have been measured in high desert climates like Nevada where ET losses average about 0.15 gallons per square foot per day. This number divided by 0.62 gallons per inch per square foot gives us a value of 0.24 inches and this number multiplied by 31 days gives us **7.44** inches of water per month (**7.20** in a 30 day month). Thus the red numbers on line five are the expected maximums of water loss in an EPIC system in climates with a high ET rate.
- Since EPIC system capture, filter, and store all rain events, line six depicts the amount of water in inches that is stored in an EPIC profile. EPIC profiles store approximately **4.0** inches or 2.5 gallons per square foot of profile depth. Under normal operation settings if the 4.0 inch storage capacity is exceeded, filtered water leaves the system, and if under 4.0 it is retained in the profile. For example if you look at the November red numbers we see that it rained 3.0", and snowed 0.4" for a total precipitation gain and

capture of 3.4”. From this number we subtract the evaporation loss of 2.48” giving us balance remaining in the field of **0.9”.** In December we add the inches stored in November to the rain (2.8”) and the snow (1.4”) gained in December for a total of 0.9”+2.8”+1.4” for a total of 5.1” from which we subtract the Evaporation loss of 2.48” and the field storage in December now increased to **2.6”.**

- In February we add the storage balance of **3.7”** from January, add the 2.0” rain and 1.0” snow equivalent for a total of 6.7” from which we subtract the 2.48” Evaporation loss and have a balance of 4.22”. However since the maximum storage in the field is 4.0” the excess **0.22”** leaves the profile as filtered drainage and is reported on line seven.
- In May we carry over the 4.0” of April’s storage, add the 3.0” rain for a total of 7.0”, however by subtracting the higher ET rate of 7.44 we actually get a deficit of -0.4” which is placed as a negative on line 6 the storage line.
- Line 8 converts the negative integral units from line 6 into gallons per square foot by multiplying the integral value by 0.62 gallons per inch to obtain an irrigation need number of gallons per square foot per month. For example June showed a negative field storage number of 3.8”. Multiplying 3.8”per month by 0.62 gallons per sq.ft. per inch we get **2.4** gallons per square foot per month.
- Lines 1-8 complete the calculations for the square foot basis and the remaining chart lines now address total water needs for the project.
- Line 10 depicts a hypothetical EPIC project covering 10 acres or 43,560 square feet.
- Line 11 depicts the total gallons of “output” the EPIC project fields that will drain that month. This for example the April number is arrived by multiplying the 1.12” of drainage from line 7 by 0.62 gallons per inch per square foot and then by 435,560 SF for a total of 302,000 gallons and enter that number as **302K**.
- Line 12 depicts the irrigation need by simply multiplying the gallons per square foot need from line 8 by the project area. For June 2.4 from line 8 is multiplied by 435,600 to obtain 1,045,000 gallons entered as **1045K** in the table.
- From an observation of numbers placed in the table in red we note that the maximum irrigation need from Line 12 is in October with 1306K gallons. Since EPIC system are normally recharged once per week the number is divided by 4 weeks to determine the recharge volume needed per week for the fields. This number is entered as **326K** on Line 13.
- Line 14 depicts the maximum volume the 35 GPM well pump can produce in a weeks time and we can see that the production is greater than the demand so the on site well capacity can supply the irrigation requirements in a worse case scenario.
- Line 15 depicts the underground storage reservoir volume recommended to be filled by the well pump. The weekly recharge rate of the 10 acre project occurs in 24 hours and would be performed by pumps larger than 35 GPM, as such the 35GPM pipe would continually refill a reservoir from which the EPIC field pumps would draw from.

Now let's look at the numbers in blue ink.

- In humid climates that are not as hot or windy as high desert climates, the ET rate is expected to be substantially less . The more realistic ET rates for Ann Harbor, MI have been entered in blue in line 5.
- This change then alters the subsequent figures in the table, and on Line 6 we note that field storage continues through August and irrigation need is not arrived at until September and October.
- The irrigation need of **174K** in September and **479K** in October are easily achieved by a low capacity supplemental pump of 35 GPM.
- However if 700,000 gallon total capacity subsurface tanks are installed and strategically distributed in the project, the drainage rains in February, March and April (663K total) can be diverted to storage for use in September and October and the project becomes sustainable without any supplemental water need.
- The hardscape area calculations in this example were left blank. Hardscape drainage from planned parking areas, sidewalks etc. can be incorporated in to the system which then changes the dynamics of water availability, thus further decreasing the need of supplemental water sources for irrigation.

The versatility of the EPIC system for designers becomes a valuable and preferred tool for application once the simple concepts are understood. It is the only system that provides 100% efficient irrigation, provides exceptional drainage characteristics through the profile such that sloped surfaces become optional, a system that has built in sand filtration, significant water capture, and a profile that does not compact and can support a variety of hardscape surface treatments.

For landscape architects the desired "look" of the finished product does not necessarily change, but the underlying foundation that supports the desired look is different. It is also where this new foundation that automatically provides the civil engineering goals of hydrologic responsibility.

This guidance design manual cannot possibly exemplify the millions of variations of site plan design and options. However the manual can provide the basics of function and typical cross sections of installed installations are exemplified in the Appendix pages. EPIC systems are very basic cellular building blocks that are linked together to accomplish multiple functions. It offers many advantages over traditional conventional designs.

Technology use and benefits for Athletic Fields

The unique and proven drainage and irrigation properties of EPIC technology will become the eventual standard in Athletic Field construction once the technology becomes more widely known and tried with an expanding consumer base. The simplicity of design, the reliance on gravity and capillary physics as the operating forces, low water demands, and cost savings in installation and maintenance will make EPIC the product of choice by architects, owners, and superintendents.

PROVIDING AN EFFICIENT IRRRIGATION SYSTEM

"Head to Head" EPIC irrigation systems use on average 58% less water than conventional irrigation. Incorporation of stadium roof runoff and storm runoff from surrounding tracks can improve efficiency even more during rain events.

RECLAIMED WATER USE

Because EPIC systems are not pressurized and are completely underground with no surface access, reclaimed water use even during play eliminates Public Health Exposure issues to the athletes. No mud, no puddles, no surprises.

SOLVING DRAINAGE PROBLEMS

- EPIC systems can keep up with rain events up to 23" of rain per 24 hour period. There is no need for tarps, squeegee brigades or helicopters to dry out the field prior to an event.

REDUCED COSTS

Construction on a large scale is less expensive than conventional systems. Water supply rates are as low as 12 gallons per minute per acre with no pressure requirements. As such supply lines and meters can be reduced from 4" diameters to 1.5" diameters. No need to purchase booster pumps or expensive controllers. Systems have also been implemented to harvest and store free rain water to meet all irrigation demands.

SIMPLICITY OF DESIGN

Simple and very few moving parts makes maintenance issues reduced to grass management and not irrigation repair. Single point water control access provides total flexibility to control desired moisture levels. No exposed surface parts to damage during mowing or aerating operations.

SAFE PLAYING SURFACE

The combination of a 13" sand base and a long root structure makes it the most shock absorbing surface around. Natural grass is still preferred by 88.8% of poled athletes over synthetic turf, and 95.7% of NFL players believe that artificial surfaces are more likely to contribute to injury. The absence of midfield sprinkler heads reduces the chance of obstacle injury during falls.

SOLVES ENVIRONMENTAL ISSUES

EPIC designs resolve all current environmental issues by providing 0% water waste, total runoff and fertilizer control, no nitrate migration to ground water formations, subsurface fertilization and treatment options in management practices. The perfect landfill cap!

Technology use and benefits for Subdivisions

The unique and proven drainage and irrigation properties of EPIC technology will become the eventual new construction standard as to how Subdivisions are built, once the first subdivision applies and builds with the technology. The simplicity of design, the reliance on gravity and capillary physics as the operating forces, and cost savings in installation and subsequent maintenance will make EPIC the product of choice by architects, owners, and superintendents.

STORMWATER MANAGEMENT

Incorporating EPIC technology on a large scale can eliminate or greatly reduce storm water drainage and infrastructure in the Subdivision. Storm runoff is captured early and put into storage for subsequent irrigation use. Issues of off site runoff and erosion are eliminated. Street runoff is captured for additional irrigation efficient, and provided with passive biological treatment for urban runoff pollution.

PROVIDING AN EFFICIENT IRRRIGATION SYSTEM

Head to Head EPIC irrigation systems use on average 58% less water than conventional irrigation. Incorporation of roof runoff can reduce efficiency even more during rain events.

RECLAIMED WATER USE

Because EPIC systems are not pressurized and are completely underground with no surface access, reclaimed water use even in residential settings becomes a feasibility. There are no Public Health Exposure issues.

REDUCED COSTS

- Construction on a large scale is less expensive to the builder than conventional systems. Since the system is in place by the time the home is finished, capital improvement costs for irrigation are incorporated with the mortgage at a lower cost. Surface preparation preferences and plantings can be left to the homeowner for individual taste requirements.

SIMPLICITY OF DESIGN

- Simple and very few moving part points makes management of common areas simple for eventual association, thus association maintenance fees can be reduced for the residents.

SOLVES ENVIRONMENTAL ISSUES –

- EPIC designs resolve all current environmental issues by providing 0% water waste, total runoff and fertilizer control, no nitrate migration to ground water formations, subsurface fertilization and treatment options in management practices.

IMPROVED PROPERTY VALUES –

- The absence of spray eliminates mineral staining of property fences, stucco damage, outside mold growth in structures, etched glass doors and windows. Use of yard not dependent on irrigation times.

Technology use and benefits for the Golf Industry

The unique and proven drainage and irrigation properties of EPIC technology will become the eventual standard in Golf construction once the technology becomes more widely known and tried with an expanding consumer base. The simplicity of design, the reliance on gravity and capillary physics as the operating forces, and cost savings in installation and subsequent maintenance will make EPIC the product of choice by architects, owners, and superintendents.

BUNKER DRAINAGE –

- The unique properties of EPIC chambers provides an inexpensive drainage repair system that is 24 times more efficient than the best current USGA standard in getting water from the surface to a drainage structure with no plugging issues ever! Typical bunkers can be repaired with EPIC parts totaling less than $300. For full scale implementation results contact Sonoma National Golf Club, the former capital of poor bunker drainage.

SOLVING DRAINAGE PROBLEMS IN PROBLEM LOCATIONS

- Fairway low areas, along cart path sections, mushy areas along green edges, and areas around existing conventional “drainage” grates. The quick to construct and invisible structure provides a permanent drainage solution regardless of water source be it surface water or ground water flows. The surface can be seeded and the structure is not vulnerable to damage from vehicle traffic.

GREEN RENOVATION

- – Finally a permanent green renovation procedure that can be implemented without shutting down the golf course, loosing membership fees or members, redoing existing infrastructure or going bankrupt with traditional methods that are doomed to failure.

NEW GREEN CONSTRUCTION

- – A unique system that provides exceptional drainage and irrigation in the same package. Independent USGA sponsored tests at NMSU showed EPIC systems to produce a better turf quality than the best current standard with only about half the water requirements. A former USGA agronomist gave EPIC a 100% efficiency rating. For articles and study reprints, contact EPIC directly or visit the research page at http://turf.nmsu.edu .

CONSTRUCT THE PERFECT TEE BOX –

- EPIC systems can provide drainage and efficient irrigation in the same package. Tee boxes can be laser level for the perfect consistent stance, underground watering during use assures a dry surface, seed divots with sand without further overhead watering.

SOLVES ENVIRONMENTAL ISSUES –

- EPIC designs resolve all current environmental issues by providing 0% water waste, total runoff and fertilizer control, no nitrate migration to ground water formations, subsurface fertilization and treatment options in management practices.

Technology use and benefits for Individual Sewage Disposal Industry

The unique and proven properties of EPIC technology will become the eventual new standard in Leach Line Construction once the technology becomes more widely known by Health Department Regulators and tried with an expanding consumer base. The simplicity of design, the reliance on gravity and capillary physics as the operating forces, and cost savings in installation and subsequent maintenance will make EPIC the product of choice by design engineers, owners, and installers.

AEROBIC LEACH LINE STRUCTURE –

- The unique properties of the EPIC design converts septic water from the septic tank to usable nutrient water for plant roots. Odorous liquid becomes non odorous and natural biological activity starts the decomposition process of dissolved and suspended solids.

ABSENCE OF SILTATION PROBLEMS –

- Conventional leach line designs are doomed to eventual failure, because the use of stone allows the gradual infiltration of soil particles into the structure to diminish the absorptive area. The use of sand in EPIC systems prevents siltation.

ABSENCE OF SEDIMENTATION PROBLEMS –

- Conventional leach line designs are doomed to eventual failure, because the use of stone allows anaerobic septic liquid to accumulate in the lower voids created by the stone. Anaerobic sludge by products seal off soil pores as more liquid accumulates and even the side walls of the leach line become plugged. The use of sand in EPIC designs reverses water movement upward towards the root zone environment. Transpiration rates in EPIC designs are 11 times greater than conventional leach lines.

NITRATE REMOVAL

- EPIC designs can affectively address groundwater contamination issues caused by nitrate pollution from leach fields. The use of sand and directing sewage upward for absorption by plants also redirects nitrate flow from groundwater formations to plants as a nutrient.

COST REDUCTION –

- Simple EPIC designs are less expensive to construct, maintain, and never need replacement. Sewage can also be incorporated as supplementary water for lawn or shrub irrigation. Nitrate removal is accomplished naturally without mechanical parts or expensive treatment systems that do not work.

SOLVES ENVIRONMENTAL ISSUES –

- EPIC designs resolve all current environmental issues by providing 0% water waste, total runoff and fertilizer control, no nitrate migration to ground water formations, subsurface fertilization and treatment options in management practices.