EPIC™
Water Management System

TOTAL WATER SOLUTIONS

EPIC Total Water Solutions

EPIC Total Water Solutions LLC, USA is a company specializing in highly efficient sub surface irrigation and drainage systems. The technology of EPIC TWS has been changing the face of water management for more than 20 years.

ETWS' patented core technology is based on the Environmental Passive Integrated Conveyance (EPIC) water management system, which combines the world's most efficient irrigation and drainage system through non-pressurized, gravity driven, capillary physics of washed sand via direct interface of the EPIC subsurface pipe that never clogs.

A **Game Changing** Technology

EPIC is the world's most efficient and most versatile system that can handle the following liquid Media:

- **TSE Water Irrigation**
- **Greywater Irrigation**
- **Blackwater Irrigation**
- **Seawater Irrigation**

EPIC™
TOTAL WATER SOLUTIONS

EPIC System

Multiple Sustainable Designs & Solutions

- **Subsurface Irrigation (SSI)**
- TSE, Grey, Blackwater, Seawater Irrigation
- Storm Water collection & management
- Rainwater Harvesting (National Scale)
- Park & Athletic Field Capabilities
- Intensive Green Roofs
- Environmental Remediation
- LEED Credit Contribution
- Major Return on Investment (ROI)

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TOTAL WATER SOLUTIONS

EPIC Chamber

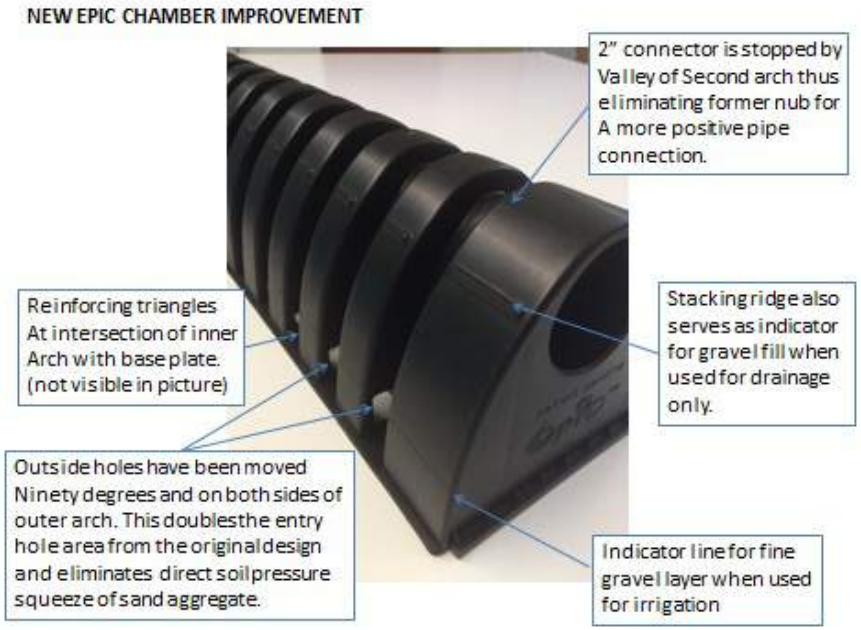
Environmental Passive Integrated Conveyance

TOTAL WATER SOLUTIONS

Environmental Passive Integrated Conveyance System

TOTAL WATER SOLUTIONS

Two EPIC chamber sizes



Two EPIC chamber sizes

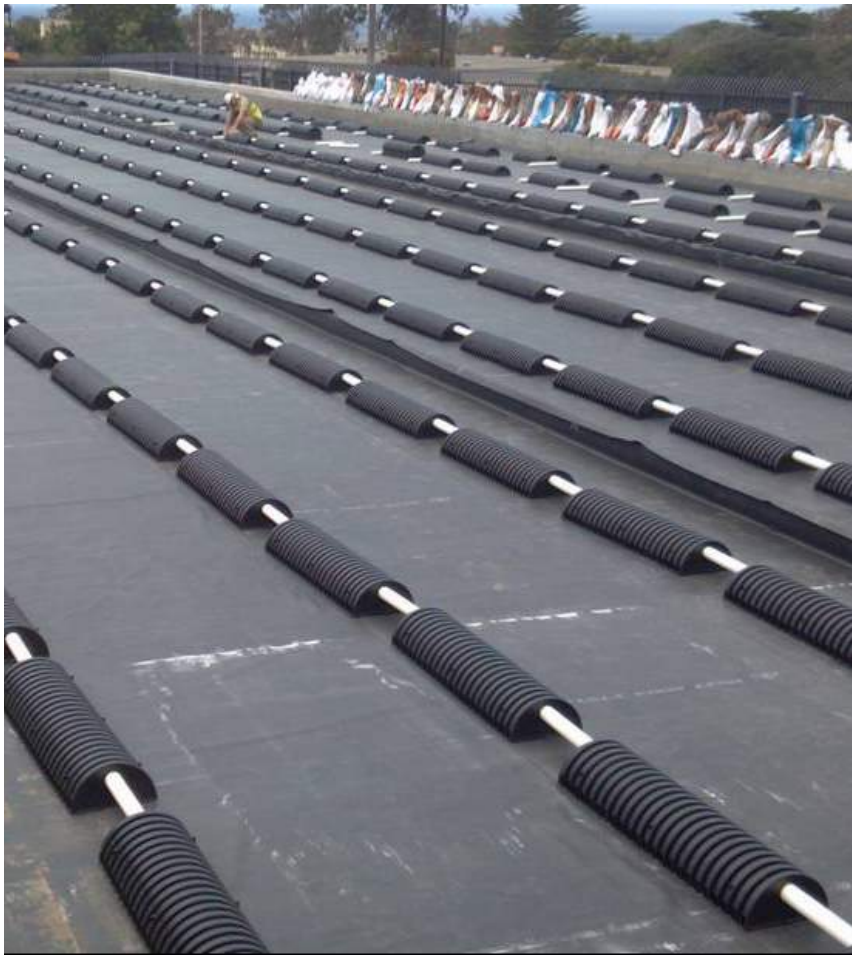
Environmentally **P**assive **I**ntegrated **C**onveyance (**EPIC™**) are single piece injection molded arched chambers. **EPIC™** is used individually or connected serially in preformed cells to provide **non-plugging and bi-directional movement** of fluids or gas in sand, gravel, grain or other imbedded porous matrixes.

The chambers are used to provide non-plugging drainage systems, sub-irrigation and underground storage applications, waste water soil injection, sand filtration, gas collection systems, pond bottom sludge air injection, oil/water separation, sand aeration, grain drying, water decanting applications, etc.

Patent #'s 5,921,711 and 7,517,172 others Pending

Product	Large Chamber	Small Chamber
Size	46" L x 13.25" W x 6.5" H	24"L x 6.5" W x 5.5" H
Color	Black	Black or custom
Weight	5.5 Pounds	1.7 Pounds
Polymer	Polypropylene	Polypropylene
Connection opening size	**2.375"**(nominal 2"Sch40 pipe)	**2.375"**(nominal 2"Sch40 pipe)
Side wall openings	46 - 0.75" x 1.30"(44.85 Sq.in.)	40 - 0.75"x 0.75" (22.5 Sq.in.)
Offset inner apertures	46 -0.875" circles (**27.66** Sq.in.)	22–1"x1.5"ovals (**25.92** Sq.in.)
Open Bottom area	45.5" x 10.25" (466 Sq. in.)	23.5" x 3.375" (79.31 Sq. in.)
Total internal volume	9.67 gallons (1.29 Cu. Ft.)	2.08 gallons (0.28 Cu. Ft)
Volume at Connection invert	6.02 gallons (0.80 Cu. ft.)	1.4 gallons (0.19 Cu. Ft.)
Connector stop distance	3.25" (to nub)	2" (to arch)
Base Pad support area	69.5 Sq. in.	30 Sq. in.
Packaging wt.	30/pallet (166 pounds)	16/box (28 pounds)(8-12bxs/plt)

20’x100’ Firestone EPDM liner EPIC system (large cells)

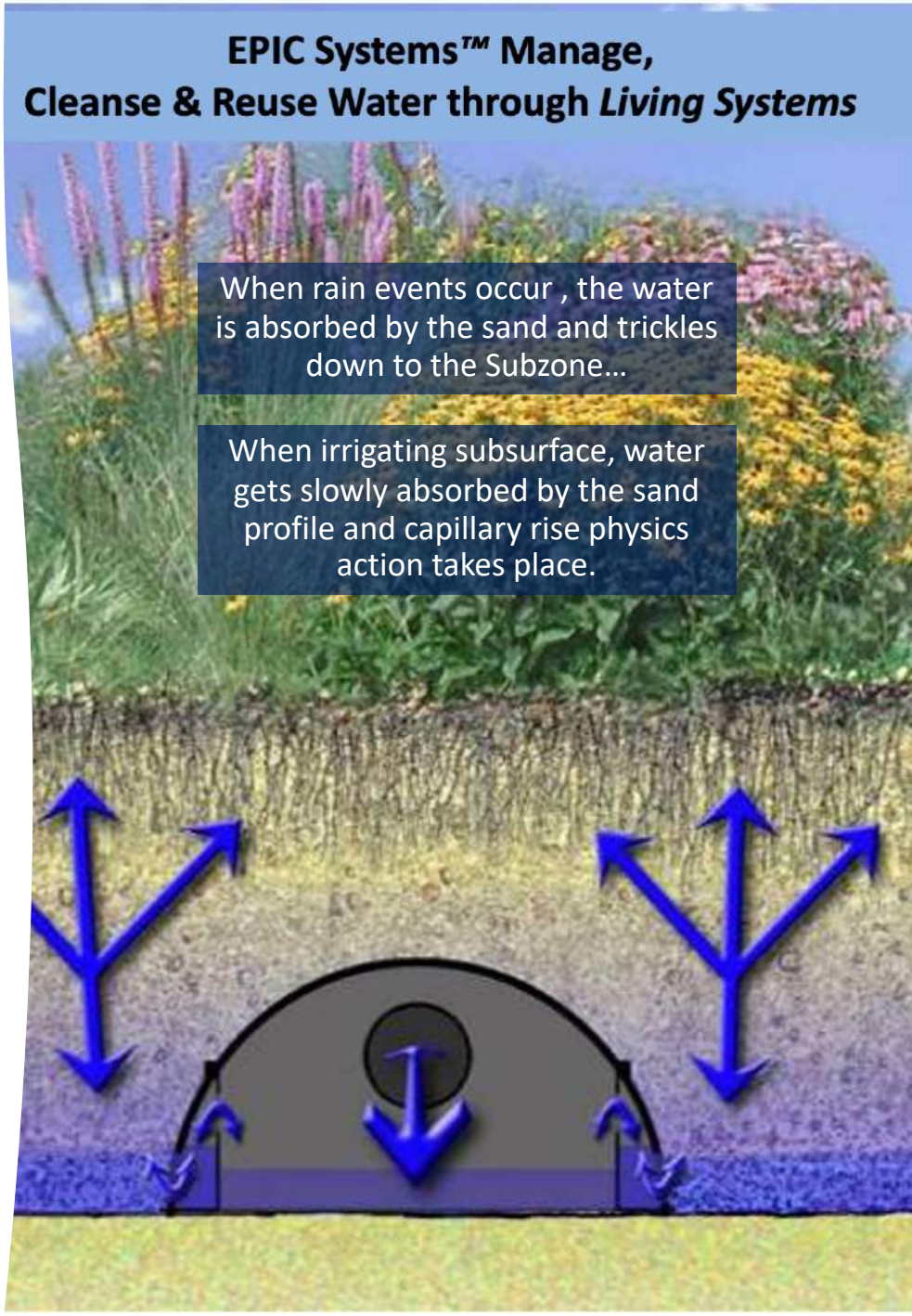


Firestone

EPIC Chamber

Environmental Passive Integrated Conveyance

- Patented, low tech, Low energy water delivery systems
- Saves Up to 85% Water Saving
- Anti Clogging
- Manages and re-uses rainwater
- Highly Economic drainage solution
- Grey Water & Black water re-use without human exposure
- Water harvesting of current impervious surfaces
- Improved yields by eliminating surface water evaporation
- The system uses sub fertilization (sand-based hydroponics)
- Less crop loss as plants use the water they require
- By using sand soil, there is decent aeration thus no ploughing
- Allows the growth of native plants in deserts without soil changes



epic™ TOTAL WATER SOLUTIONS

Double Wall Polypropylene Pipe

Functions as an Irrigation and Drainage System depending on purpose or condition

Uniquely Designed and Anti-clogging

Functions as a closed loop system with Zero Drain capabilities

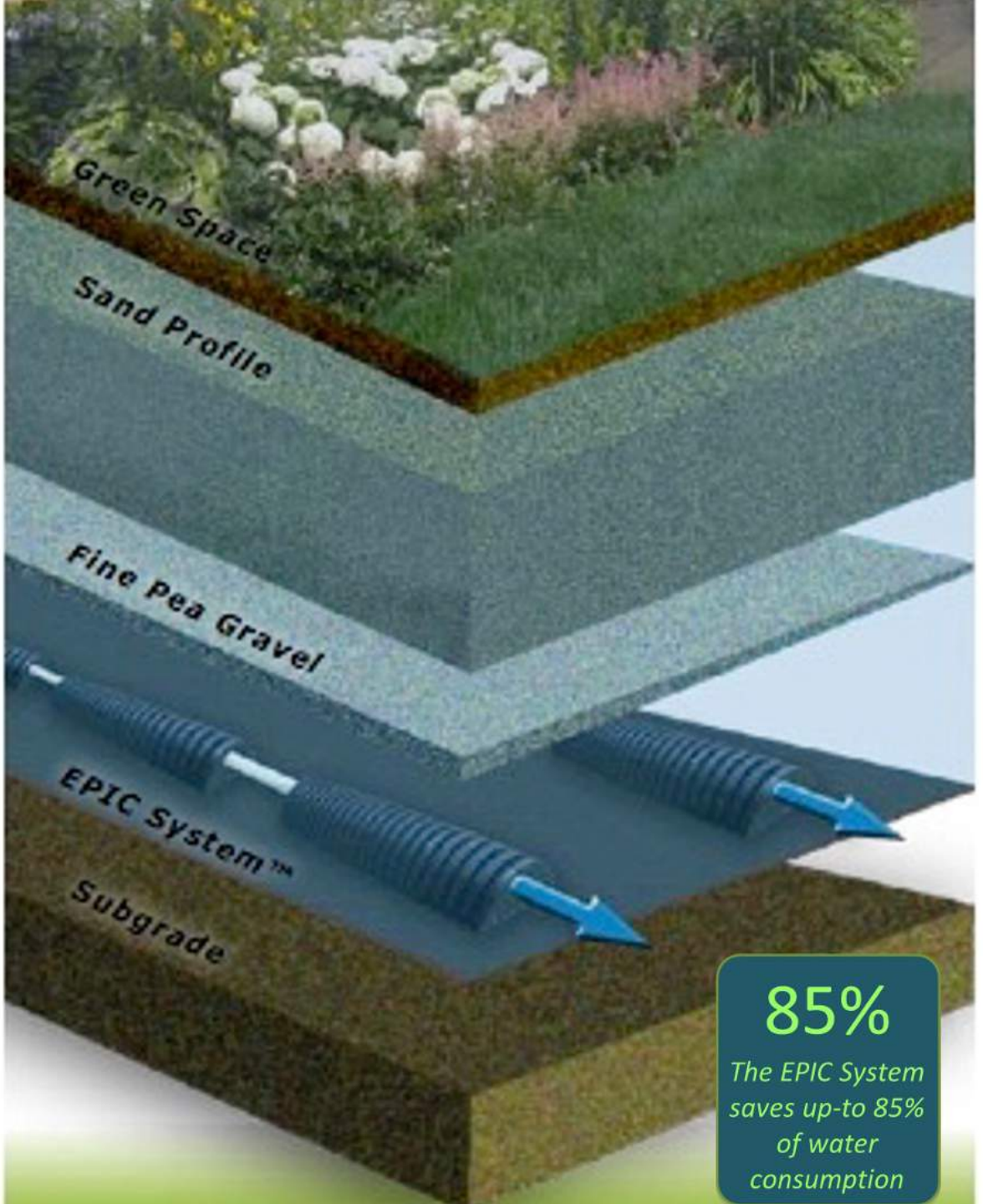
Connected together by Plastic Pipes

EPIC Chamber

Environmental **P**assive **I**ntegrated **C**onveyance

EPIC System Function

- A Living System with natural & Synthetic properties…
- Works via Capillary & Gravity action…
- Water is preserved by using an Epic Geomembrane Liner…
- A Fully Controllable System with Water tank/Reservoir Source with a low powered submersible tank with Shut-off Floats…
- Shut-off floats and a reservoir means the system is a closed loop to minimize any loss from the system and requiring very little maintenance….



epic™ TOTAL WATER SOLUTIONS

The Beauty of **Sand Hydroponics**

EPIC technology are sand hydroponic planting systems, where plants grow in SAND and not soil. Although sand generally has not been recognized as a planting media due to its fast drainage, sand is actually a preferred growing media for most plants. Adhesion and cohesion properties of water create surface tension and capillary rise within the sand growing profile.

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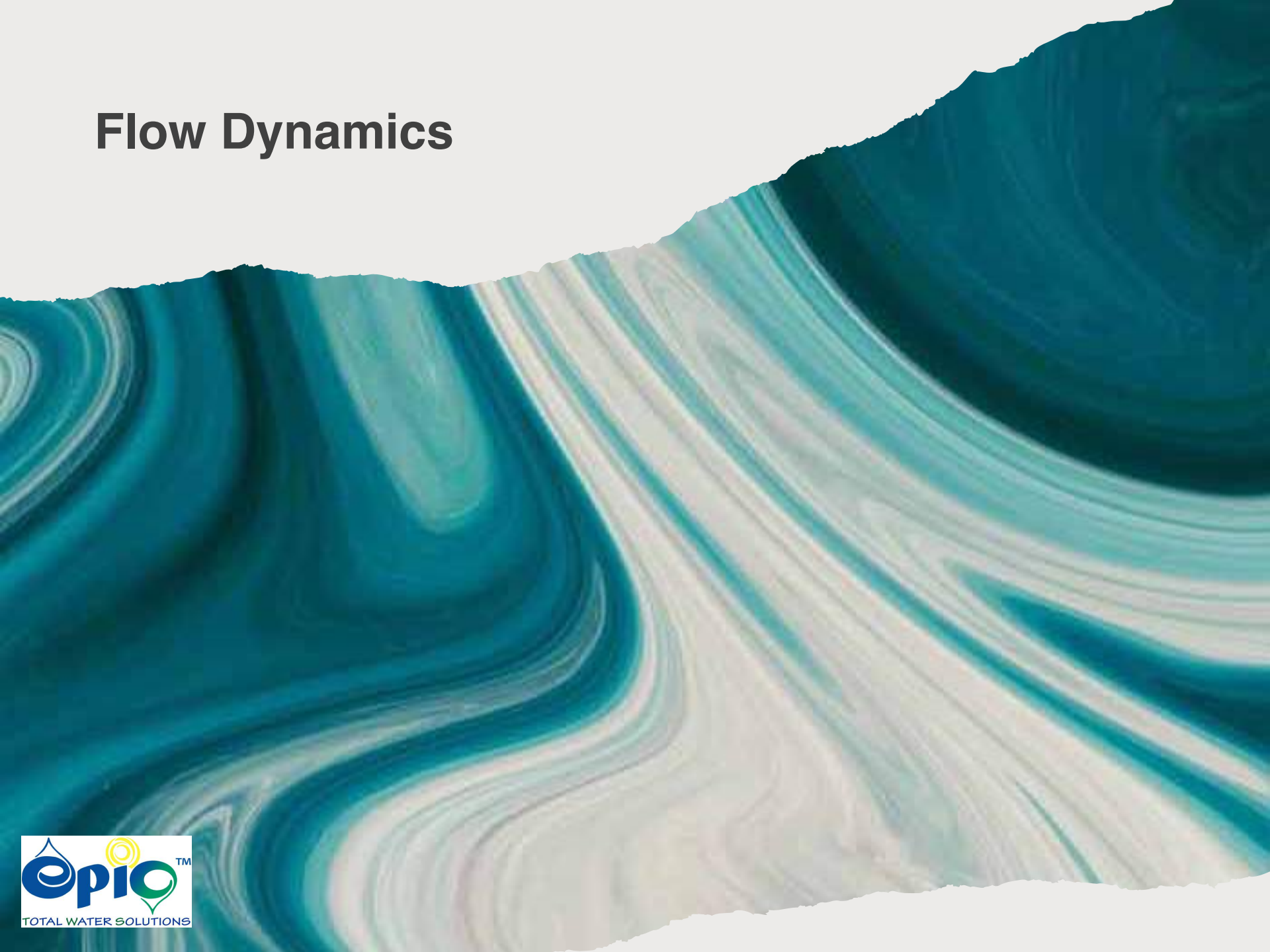
Flow Dynamics



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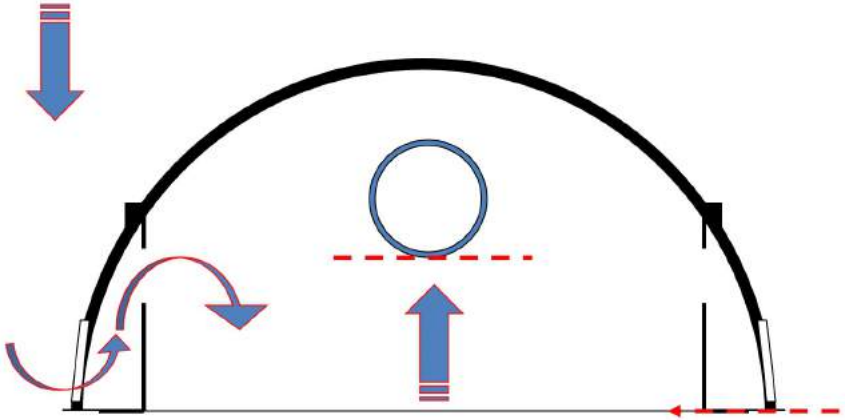
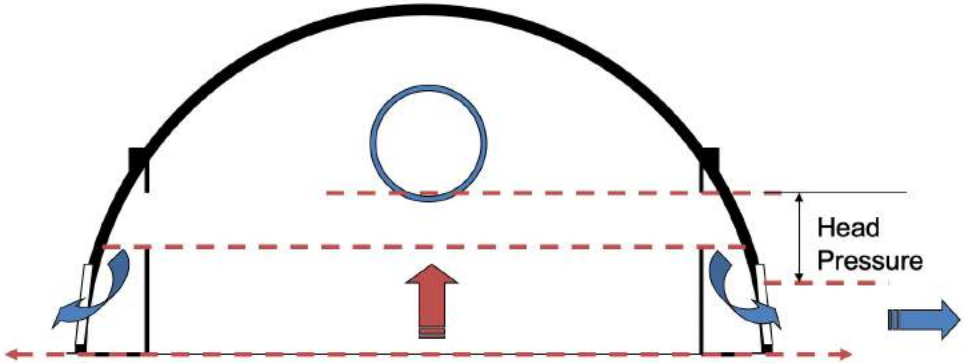
TOTAL WATER SOLUTIONS

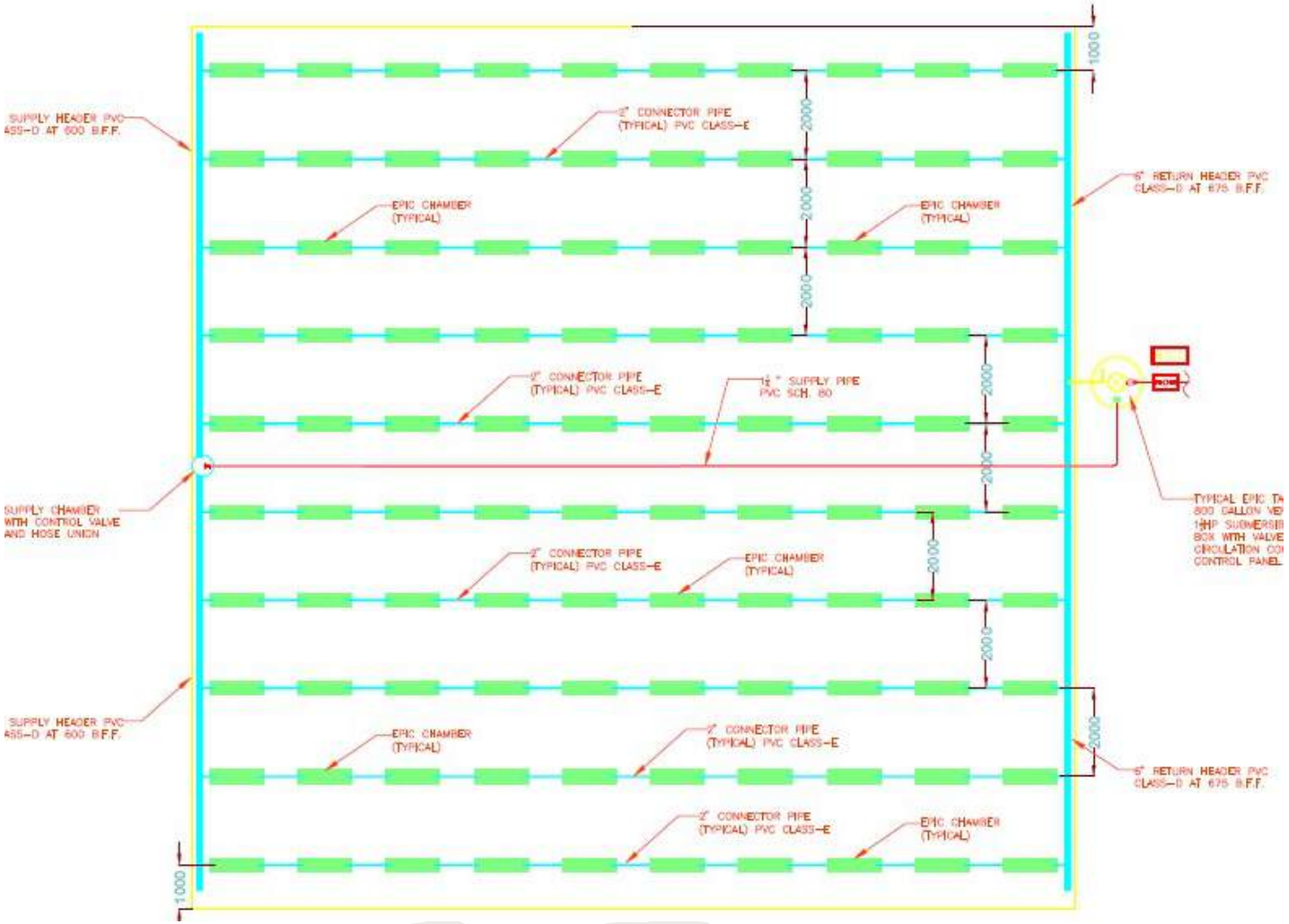


Drainage



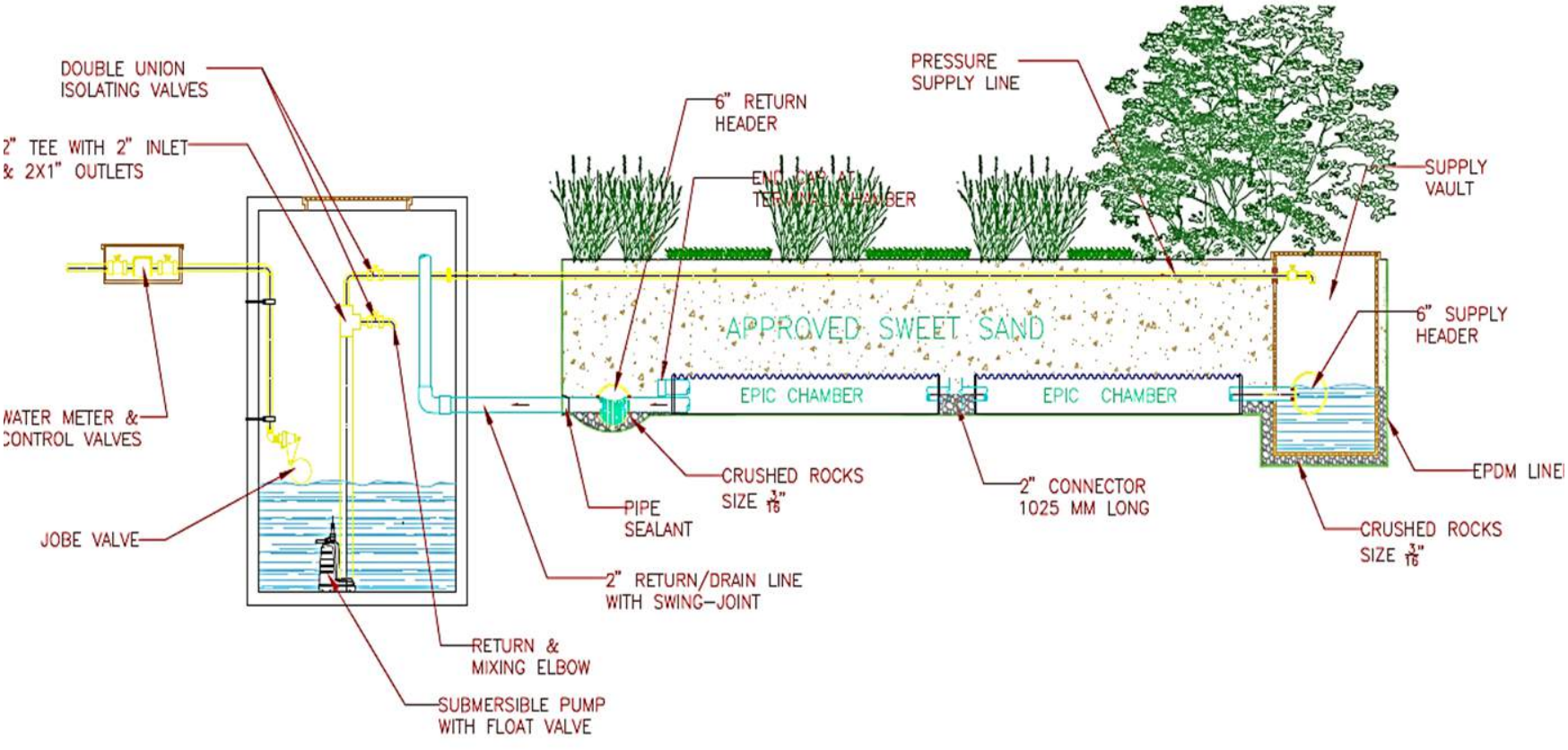
Irrigation

Flow Dynamics



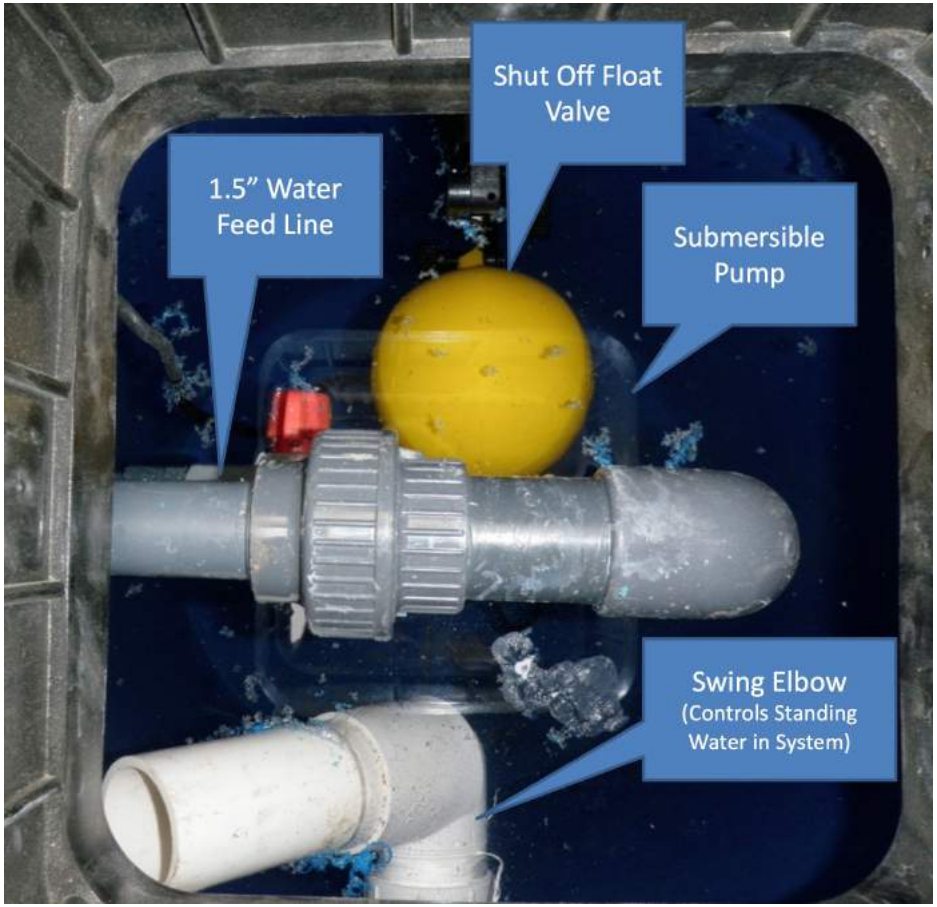
Typical EPIC System Cell

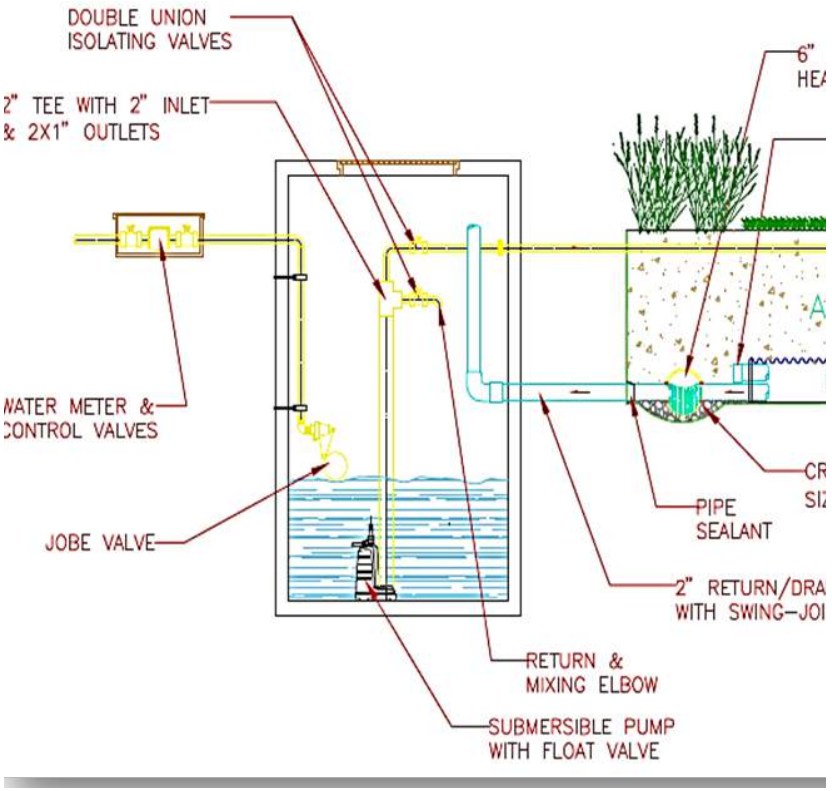
TOTAL WATER SOLUTIONS



Typical EPIC System Cell

TOTAL WATER SOLUTIONS



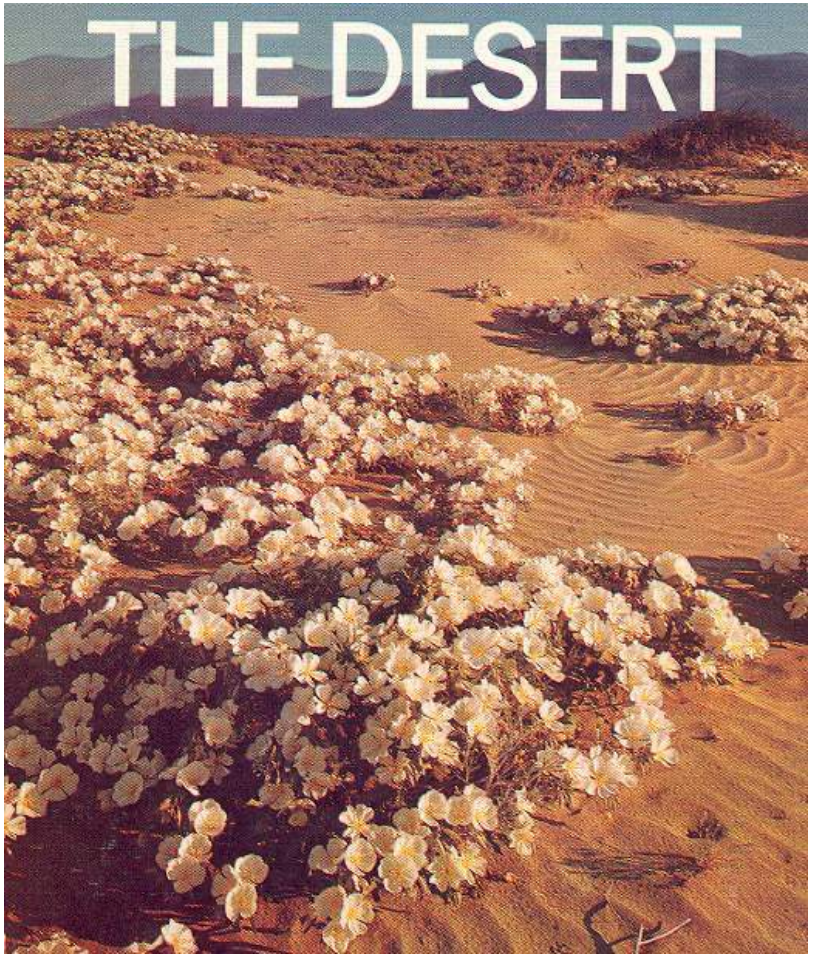


Typical EPIC System Cell

EPIC™ TOTAL WATER SOLUTIONS

All plants can grow in sand

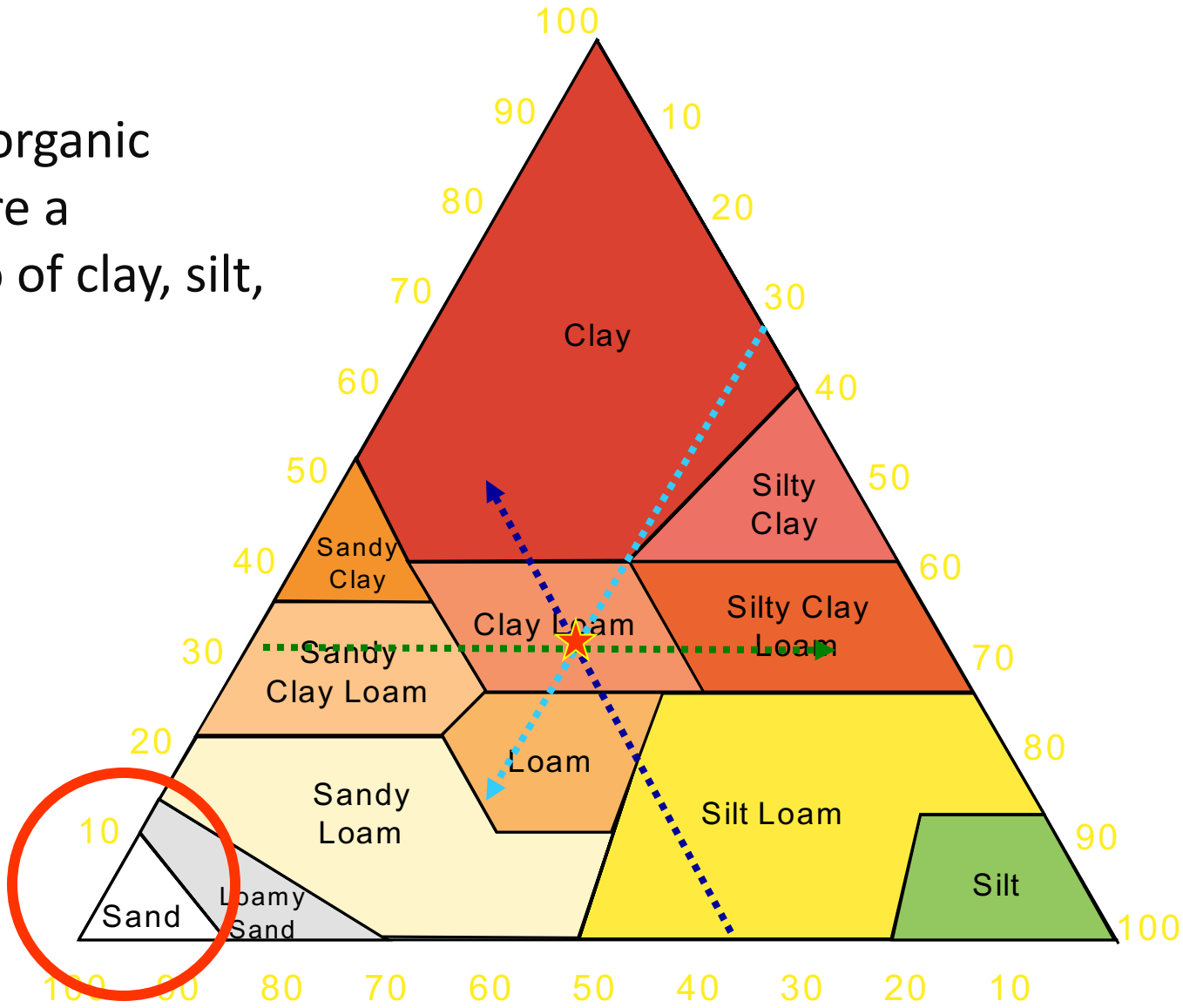
ALL plants do well in sand… so long as water is available



USDA Texture Triangle – 12 textural classes

Besides a variable organic content…all soils are a proportionate ratio of clay, silt, and sand particles.

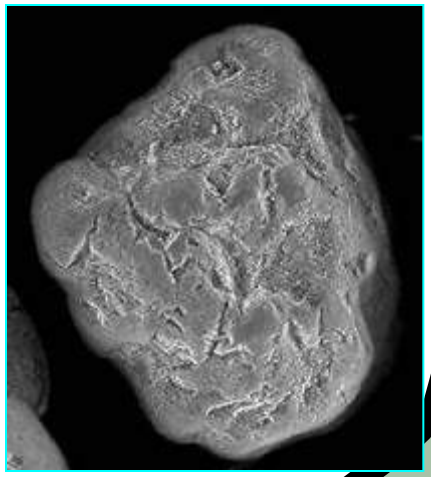
Sand = EPIC's exclusive choice!

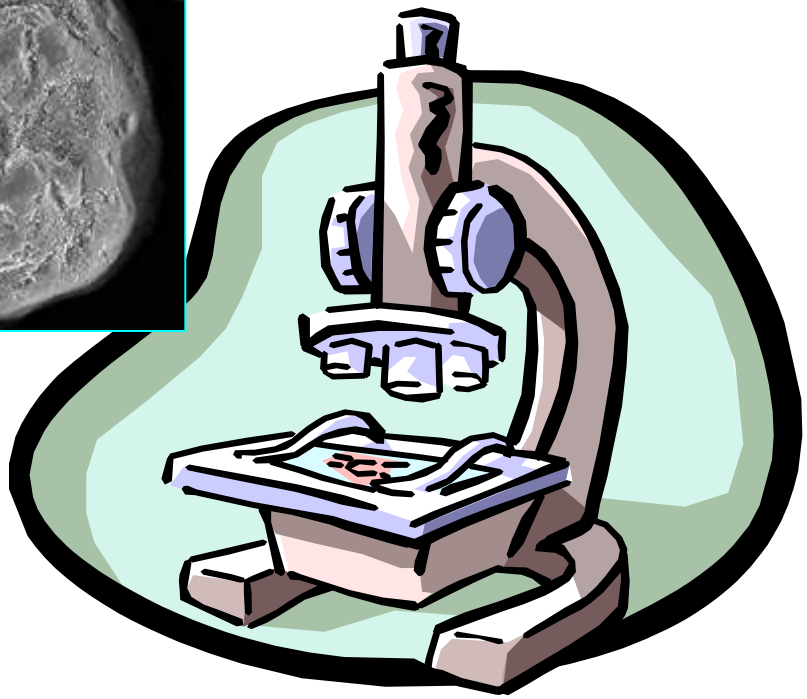


TOTAL WATER SOLUTIONS

The Properties of Sand VS Clay

- Crushed Rock
- 0.05-2.00 mm
  - 0.05-0.10=Very Fine
  - 0.10-0.25=Fine
  - 0.25-0.50=Medium
  - 0.50-1.00=Course
  - 1.0-2.0=Very Course
- Silicon Dioxide
- Void Spaces

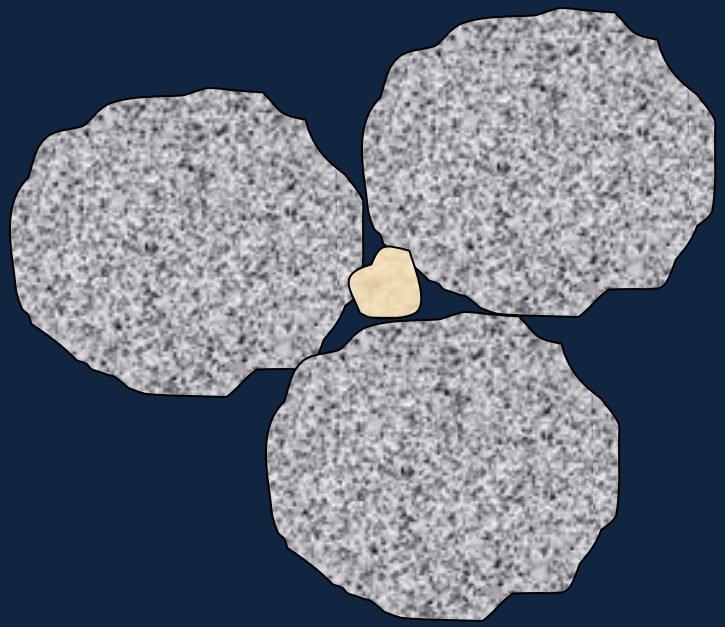




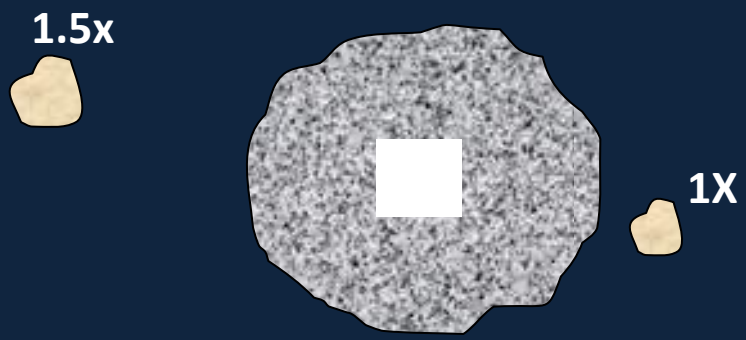
Clay particles are very small, mostly plate-shaped, crystal structures.

EPIC™ TOTAL WATER SOLUTIONS

Gravel Bridging Principle

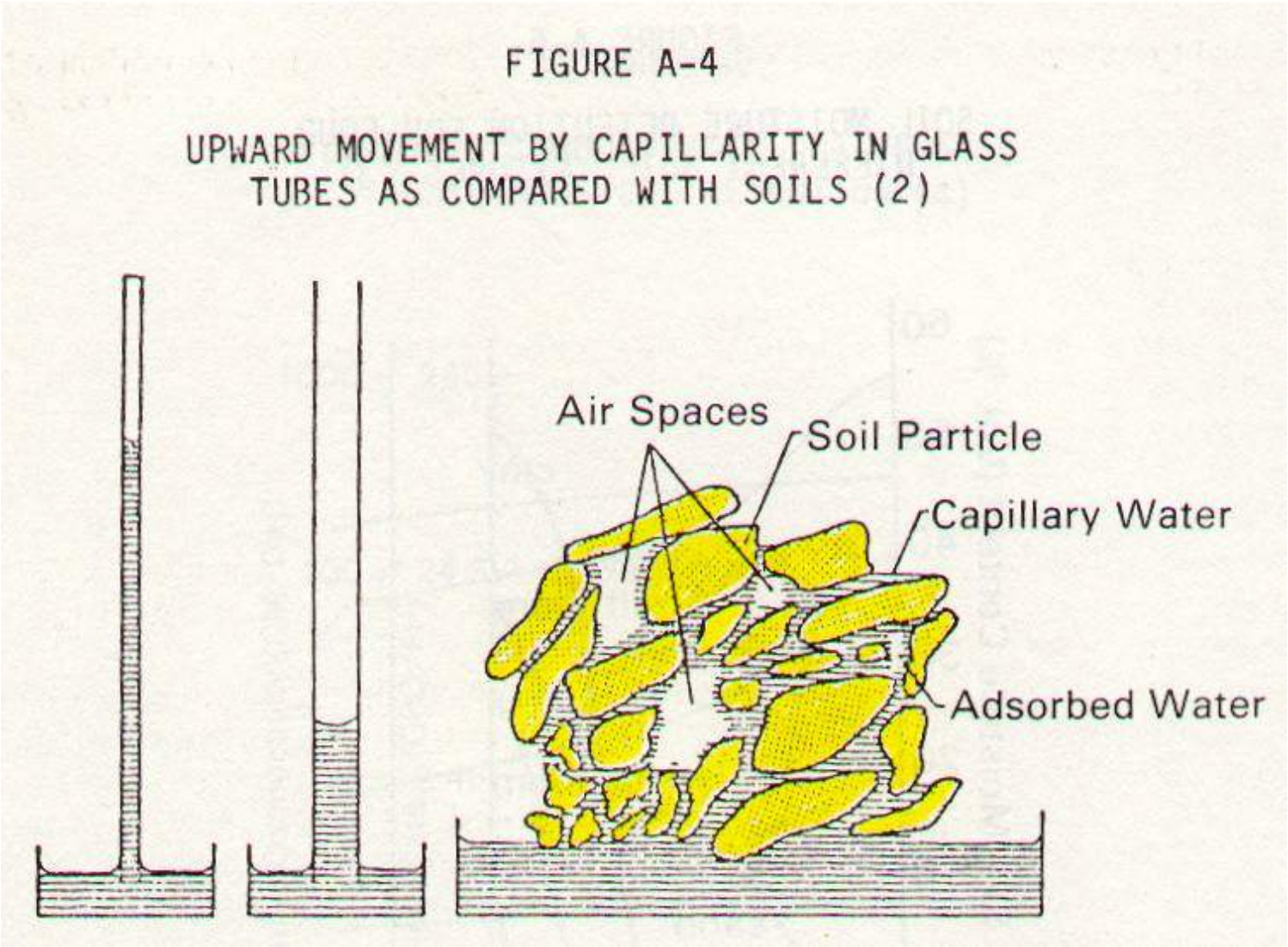


The average diameter of the larger aggregate has to be less than 8X the diameter of the smaller aggregate.



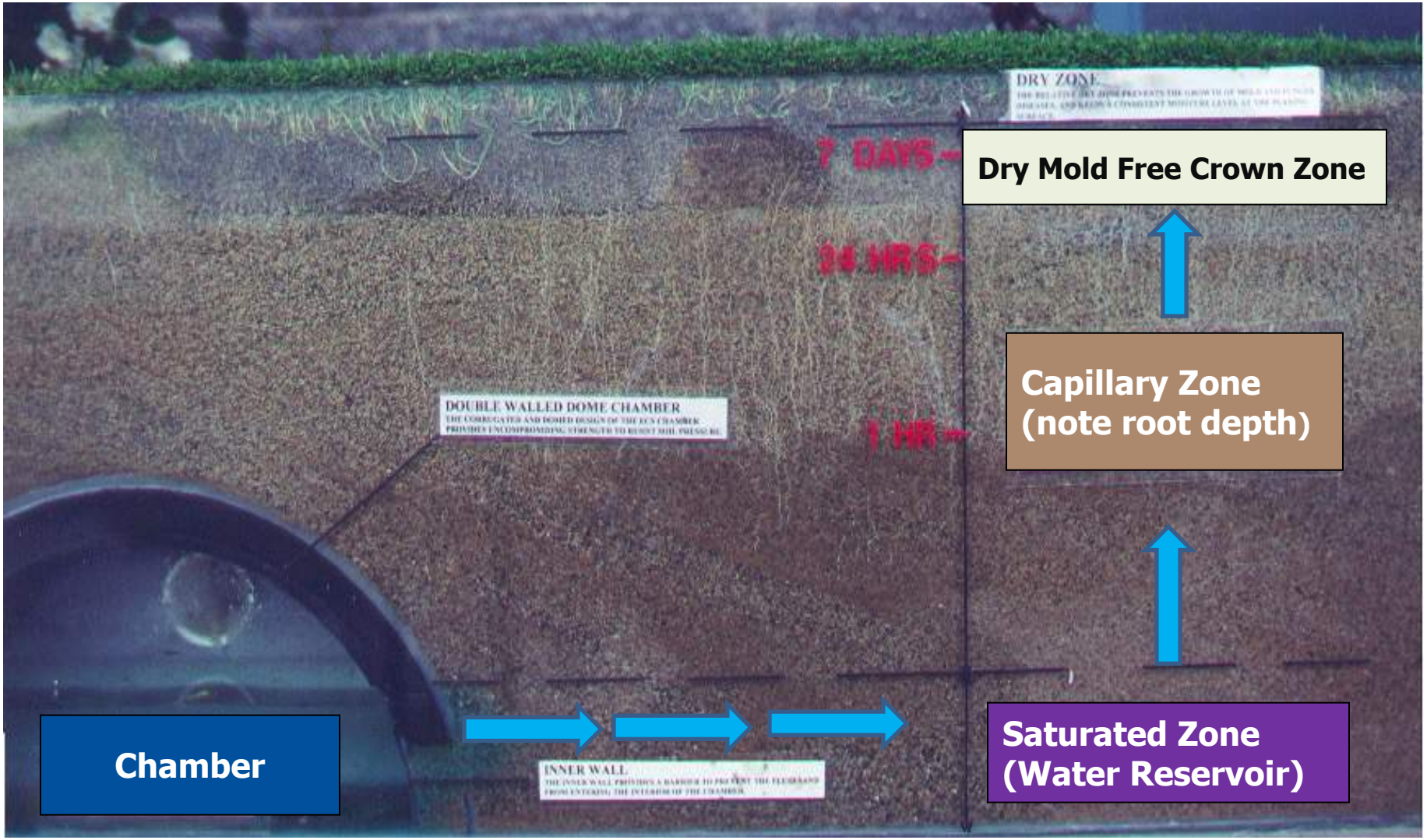
TOTAL WATER SOLUTIONS

The Physics of Capillary Rise



epic™ TOTAL WATER SOLUTIONS

Underground Cross Section

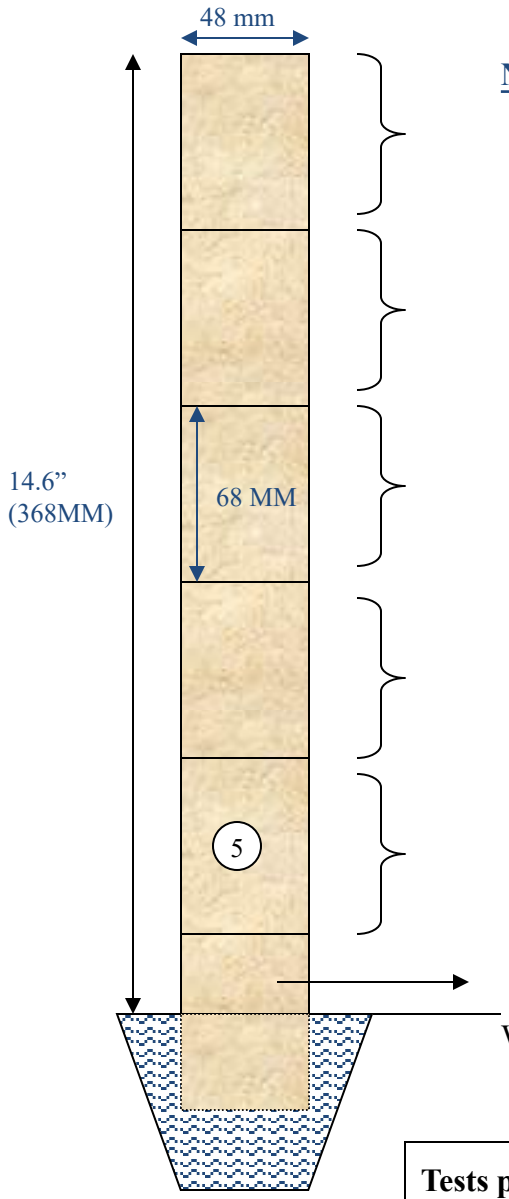


The EPIC System installed in sand demonstrating its capillary rise potential

Adhesion & Cohesion - Capillary Rise in sand


PASSIVE IRRIGATION ROOT GROWTH: EPIC PROFILE
01/01/2004
epic™
TOTAL WATER SOLUTIONS

SATURATION PROFILE IN EPIC SYSTEMS



Net Weight	Water Content	Air Volume
173.2 g	2.2 ml. **(3%)**	63.1 ml. **(97%)**
188.2 g	17.2 ml.**(26%)**	48.1 ml. **(74%)**
196.3 g	25.3 ml.**(39%)**	40.0 ml. **(61%)**
204.4 g	33.4 ml.**(51%)**	31.9 ml **.(49%)**
210.0 g	39.0 ml. **(60%)**	26.3 ml. **(40%)**
236.3 g	65.3 ml. **(100%)**	0.0 ml. **(0%)**

The capillary zone in EPIC systems provides a non-compacted soil profile and an ideal balance between moisture levels in the form of water coated sand grains, and additional void space occupied by air.

Constancy of the profile is assured by the physics of capillary rise from the bottom water reservoir, and air pressure infiltration from the surface.

During heavy rains a higher saturation occurs at the surface (i.e. column 5), however capillary adhesion forces can not maintain this saturated level against gravity. The water drains quickly into the reservoir and the EPIC profile is reestablished.

Tests performed on washed medium sized sand dominated by 0.25 – 0.50 mm particles, a mixture with 82 – 100% of the overall particles between 0.10 – 1.00 mm.
Visible capillary rise from water line = 12" in 48 hours (6" within the first hour)
Total volume per segment = 123 ml. with 57.7 ml (47%) occupied by sand solids.

Sand based sod root growth in only 3 months!

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Top Watered

Is slow watering from below better than fast watering from above?

Bean Roots grown in IDENTICAL sand

EPIC Bed

EPIC Performance Comparison Vs Traditional Irrigation Systems

The EPIC System™ consumes an average of **2-3 Liters** per square meter/per day, where a traditional system will consume anything ranging from **10 to 14 liters** per square meter / per day (and as stipulated by municipalities and planning bodies).

This leads to a yearly saving of approximately **4 cubic meters** of water per square meter per year.

Moreover a study conducted by the ROYAL COMMISSION FOR JUBAIL & YANBU has determined that Spray irrigation systems consume approximately 20 litres of water per square meter per day, whereas the EPIC System™ uses 2.5 Litres per square meter per day.

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EPIC System

Parks and Fields Irrigation & Drainage

Trees and turf grass installed in EPIC System TCF Stadium, University of Minnesota (2008

UNIVERSITY OF MINNESOTA

Tree and Turf growth 4 years later, July 18th 2012

UNIVERSITY OF MINNESOTA

EPIC™ System is buried in sand profile 2007

EPIC System Athletic Fields ™
Growth Capabilities (Grey Water)

EPIC™ System “charged”, 8-day germination (Grey water)

Vista Del Lago High School
Folsom, CA

20 day old grass from seed

Vista Del Lago High School
Folsom, CA

Vista Del Lago HS, Folsom, CA, 45 days old

Vista Del Lago High School 90 days

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Google Maps

Vista Del Lago High School

EPIC System soccer field installed 2007

Cancel Print

EPIC TOTAL WATER SOLUTIONS

Google Maps SMU Westcott Field installed 2006

SMU Soccer Fields, Dallas, TX

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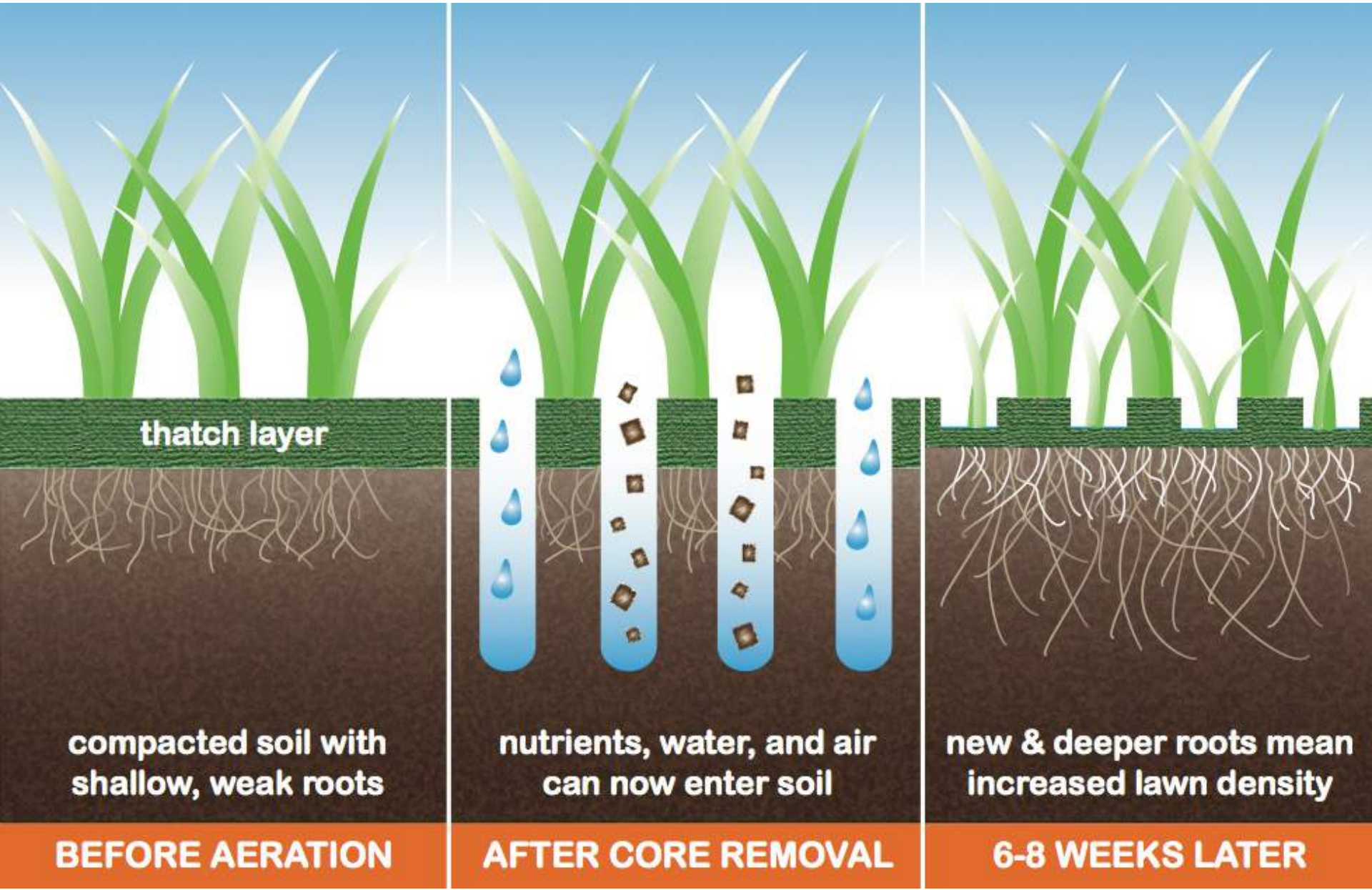
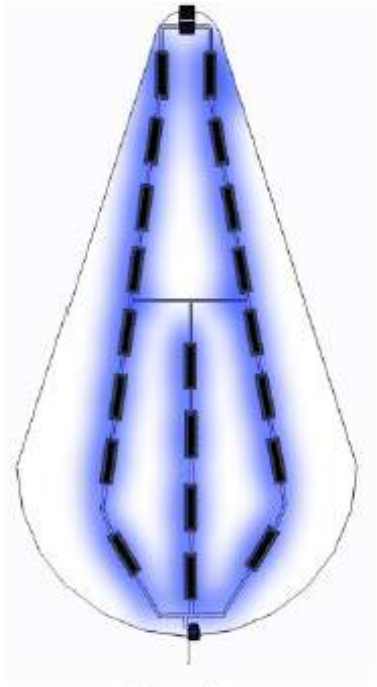
SMU after 100 straight days of +100* F Temperatures

Maintenance: Core Aeration and Gas Exchange



Consistent mowing with sharp blades prevents disease

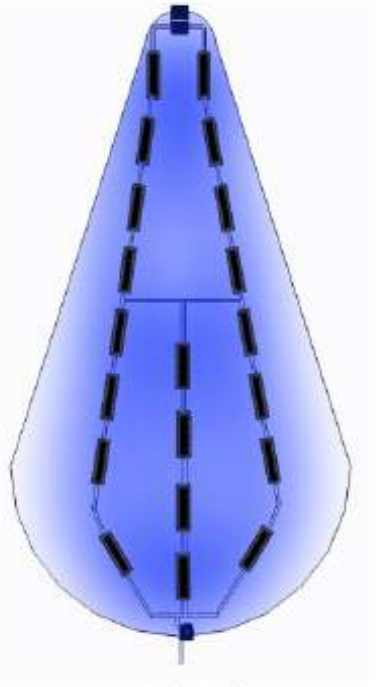
Dig. 1: Filling EPIC™ System too fast



Drain

EPIC is low flow and low energy.
A mimic of nature.

Dig. 2: Filling EPIC™ System correctly

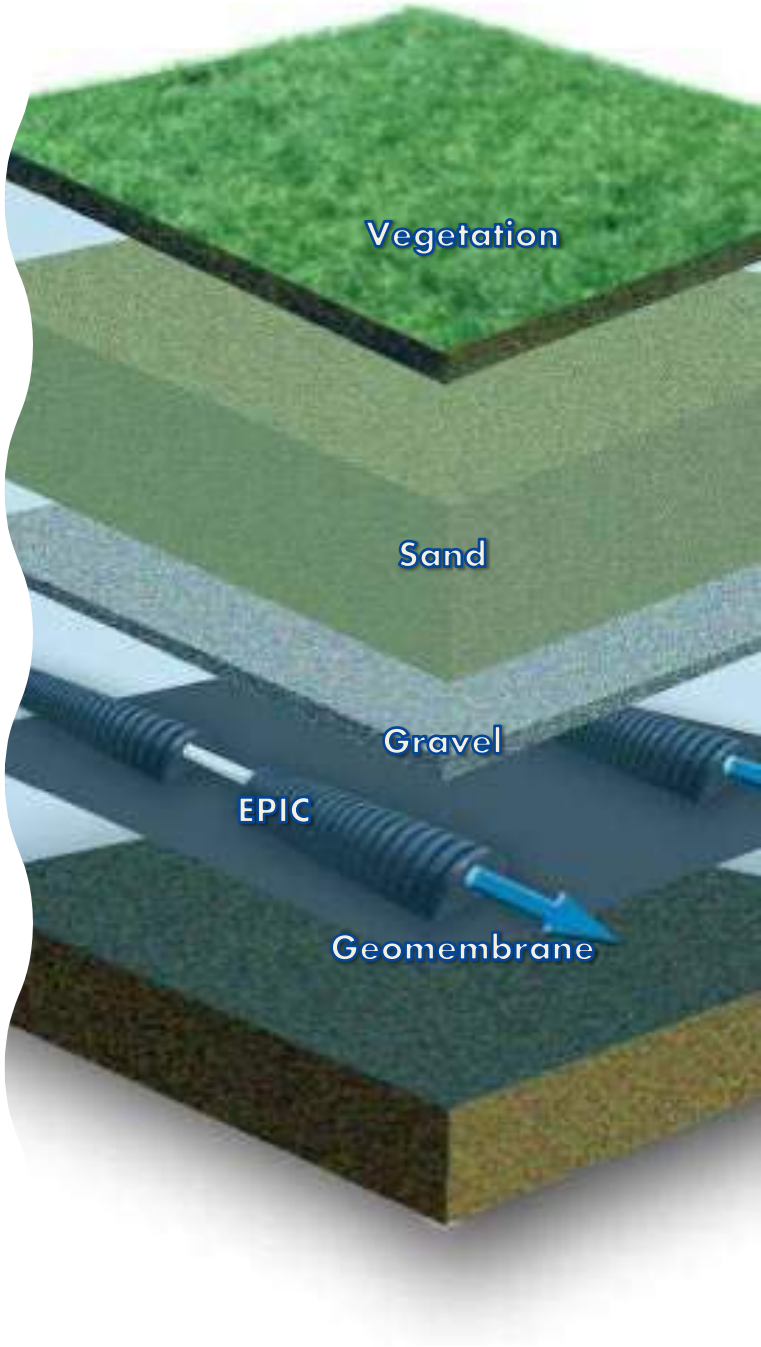


Drain

- **Running the submersible pump too <u>long</u> (+24-48 hrs.) will not create a problem.**
- **Running the submersible pump too <u>often / frequent</u> can cause a problem; too much water will not allow the system to fluctuate water levels which is good for the exchange of O_2 & CO_2.**

Water Treatment Capabilities

- Primary Discharge Approval (Minnesota PCA)
- "Living System" Treatment
- 90% Reduction of TSS
- (Total Suspended Solids)*
- 85% Phosphorous Removal*
- 60% Nitrate Removal**
- Enhanced Nutrient Uptake
- 3-5 Gallons/Sq. Ft.
- Sand Storage Capacity
- **Independent Research*
- ***PCA Research*



EPIC™ TOTAL WATER SOLUTIONS

Essential Element	Symbol	Plant usage
Calcium	Ca++	Calcium plays a prominent role in the absorption of other minerals from the soil. It neutralizes acids and has an antitoxic effect on other poisonous substances in the soil. Root hair cells contain calcium pectate, a colloid which enables it to imbibe water. This substance also forms the cementing material for holding all cells together, and is the first substance in the formation of new cell walls.
Iron	Fe+++	Iron is essential as part of the cytochrome oxidation system in respiration function. It is also essential for chlorophyll formation even though it is not part of the chlorophyll molecule. Many brown and reddish sands and soils may have an abundance of Iron, but it is not always in a form usable by the plant.
Magnesium	Mg++	Magnesium is a constituent of the chlorophyll molecule. Without chlorophyll there is no interaction with sunlight to produce plant tissue. However very high concentrations of magnesium are toxic to plants.
Manganese	Mn++	Manganese is thought to be necessary for the proper function of plant respiratory enzymes.
Nitrogen	NO_3^-	Nitrogen, only absorbed as a nitrate, is absolutely essential to growth, affecting particularly the growth of above ground parts. It is a constituent of chlorophyll, but is chiefly used for the production of proteins which are essential to every cell. A nitrogen deficiency quickly manifests itself as the yellowing of green foliage (chlorotic). Excess nitrogen may cause excessive vegetative growth which can result in weak and tender stems and foliage which are then susceptible to fungus and insect injury. Some nitrates are produced naturally through the interaction of lightning in thunderstorms; some is fixed by specialized soil bacteria living in nodules of specialized plants such as clover and alfalfa. Decomposition of dead organic material by soil organisms and their waste products (urea) may also provide nitrates through complex biological interactions. Urea → Ammonia→ Nitrites→ Nitrates. However, for lush thick turf, supplemental addition of nitrogen sources will almost always be necessary.
Potassium	K+	Potassium is necessary for the proper carbohydrate metabolism of the plant. When potassium is deficient, storage organs such as roots, tubers, and seeds are small and shriveled. Plants with ample supply of potassium have been reported to be more resistant to disease and insect injury.
Phosphorus	PO_4^{---}	Phosphorus in the soil is most likely absorbed as a phosphate ion. It is essential for the formation of many compounds such as phosphoproteins and phospholipids. Lack of this element interferes with normal cell division and checks growth. It is important for proper functioning of photosynthesis and respiration. Phosphorus also increases root development and as such is important in the early stages of sod or seed growth.
Sulfur	SO_4^{--}	Sulfur, absorbed as a sulfate ion, is a constituent of at least three amino acids that occur in proteins. Glutathione is an essential component in the respiration role of plants and the take up of oxygen.

Kentucky Blue Grass 30 days after seeding in ordinary sand.
(Left) No nutrients added (right) Addition of balanced nutrients

Plants need food, water, air and light to thrive.

These eight macro nutrients are essential for optimum plant growth. Other micro nutrients play their role, and annual lab testing is necessary to determine future nutrient application.


EPIC System
Rainwater Harvesting & Re-Use


Private Developments


Permeable Parking Lots

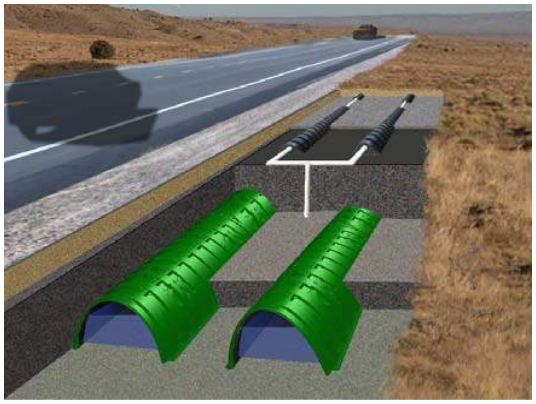

Corporate Offices

Storm Water Management Applications


Commercial Centers

Storm Water Management & Re-Use System

2 Million Gallon Storage & Re-use System
(Cambria School, CA)



Storage System Along
Highways (Nevada DOT)

5,000 Gallon Regulator
Tank (SMU, TX)

Park and Field Solutions

Cambria School Project, CA, USA

Cambria School in California was facing issues of low water pressure and volume available due to the elevation above the cities existing water system.

EPIC Green Solutions solved this issue on this 12 acre site by installing 130,000 sq ft turf and trees shrubs and plants which were irrigated using captured rain water and grey water to irrigate the plants. This run off was stored in customized storage systems, allowing for significant savings and reductions in required fresh water.

Cambria School Project

CAMBRIA SCHOOL, California, USA

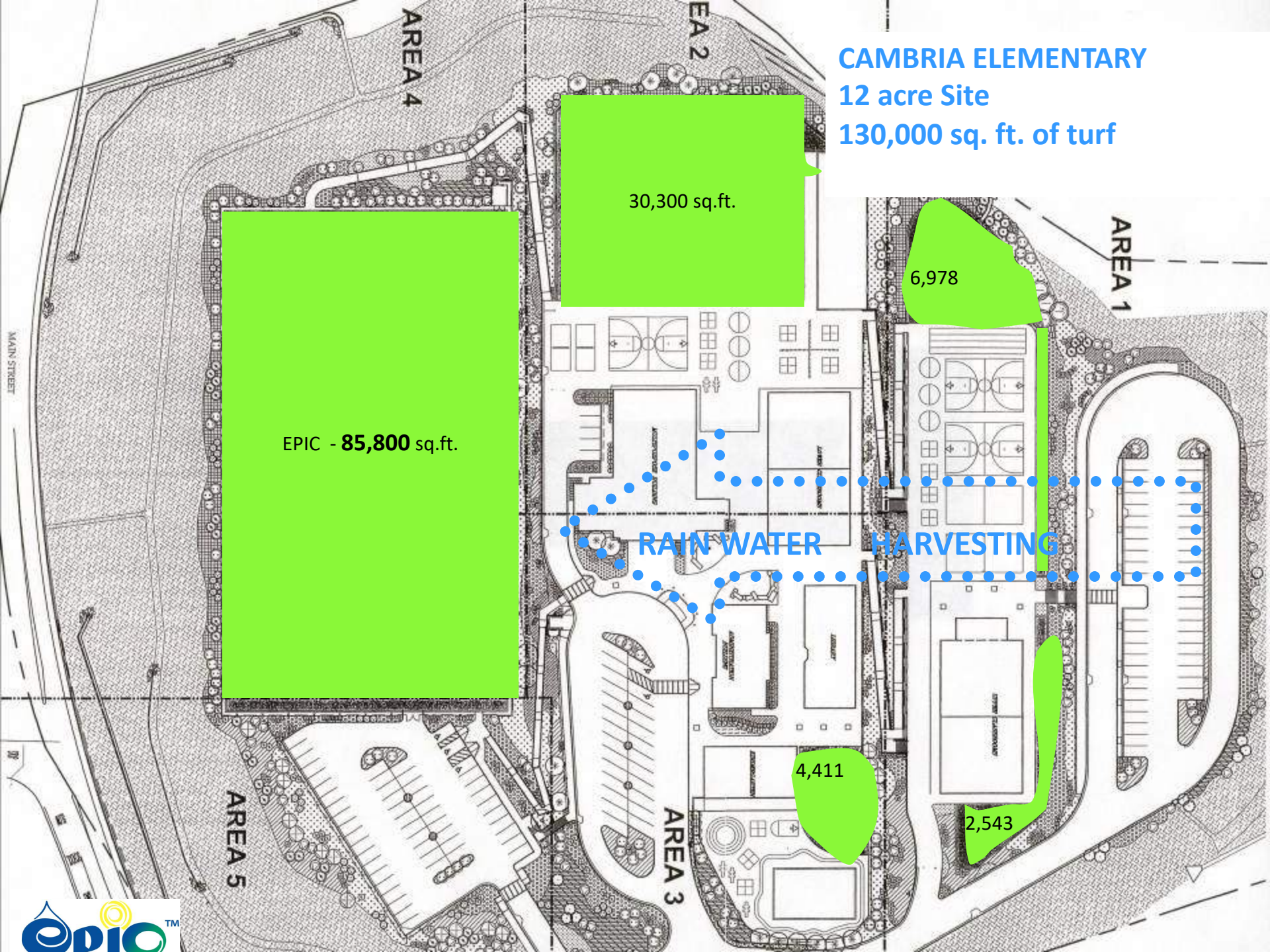
TOTAL SELF SUFFICIENT LANDSCAPING

NO EROSION OR STORM WATER POLLUTION ISSUES

epic™ TOTAL WATER SOLUTIONS

EPIC Construction aggregate import

STORMWATER CAPTURE AND REUSE


CAMBRIA ELEMENTARY
12 acre Site
130,000 sq. ft. of turf
30,300 sq.ft.
EPIC - 85,800 sq.ft.
6,978
4,411
2,543
RAIN WATER HARVESTING
AREA 1
AREA 2
AREA 3
AREA 4
AREA 5
MAIN STREET

BACKFILL OF RESERVOIR PIPES BECOMES BASE FOR SPORTS FIELD

ADS N-12 RESERVOIR

TRITON RESERVOIR


BRUNDAGE
CONVEYOR SYSTEM
5 MAN CREW
8 HOUR DAY
20,000 SQ. FT./DAY


FREE WATER
FOREVER !


EPIC System
Softscape Irrigation

Dammam Demonstration Project

For the Royal Commission for Jubail & Yanbu in Conjunction with KAUST

Turf irrigation

TOTAL WATER SOLUTIONS

KINGDOM OF SAUDI ARABIA


The project was composed of one self-contained plot each measuring 400 square meters. The planting was (carpet) Turf. The site took 5 days to install and landscape.
Saved over 80% of Water Use
vs
Spray Irrigation

Yas Island Demonstration Project

In conjunction with Aldar and Consultation with UPC

epic™ TOTAL WATER SOLUTIONS

ALDAR

مجلس أبوظبي للتخطيط العمراني
ABU DHABI URBAN PLANNING COUNCIL

Each of the plots on Yas Island contains a variety of flora which allowed for EPIC to demonstrate the ability of the system to effectively grow a range of species. Below is a list of the various plants that can be found in each plot.

Plot 1	Plot 2	Plot 3	Plot 4
Pennisetum Green	Agave	Atriplex Halimus	Platinum TE Paspulum Turf
Sesuvium Portulacastrum	Nerium Oleander	Atriplex Canenscens	
Bouganvilla	Ruellia	Caesalpinnia Pulcherrima	
Date Palm	Atriplex Halimus	Frangipani	
Cyprus Alternifoliu	Pennisetum Green	Ghoeodiscolor	
Caesalpinnia Pulcherrima	Pennisetum Red	Pennisetum Red	
Sesuvium Red	Spider Lily	Trees	
Ruellia	Trees	Trees	
Agave			

Award Winning Yas Island Pilot Project for Aldar PJSC

Saved 82% of Water Use
vs
Spray Irrigation/Drip

Average Consumption
2.46 Litres/M^2/Day

	Plot 1	Plot 2	Plot 3	Plot 4
Liters/Sq M/Day	3.63	1.80	1.99	2.44

Yas Island Image Snapshots










3 months from Seeding- Paspalum Vaginatum

USGBC LEED Credit Contribution

LEED v3.0

EPIC Green Solutions (EGS) is pleased to be a participant in your project. Our designs can aid in achieving over numerous points for the U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED) Program. In achieving LEED© New Construction (Version 2.2 & 3.0) Awards our products, systems and complete design services meet or aid in the following categories:

Sustainable Sites

Credit 2 Development Density & Community Connectivity **5**
Credit 3 Brownfi eld Redevelopment **1**
Credit 5.1 Site Development, Protect or Restore Habitat **1**
Credit 5.2 Site Development, Maximize Open Space 1
Credit 6.1 Stormwater Design, Quantity Control **1**
Credit 6.2 Stormwater Design, Quality Control **1**
Credit 7.1 Heat Island Effect, Non-Roof **1**
Credit 7.2 Heat Island Effect, Roof **1**

Innovation & Design Process

Credit 1.1 Innovation in Design **1**
Credit 2 LEED® Accredited Professional **1**

Regional Priority Credits

Credits 1.1 Regional Priority Credit **1**

Water Efficiency

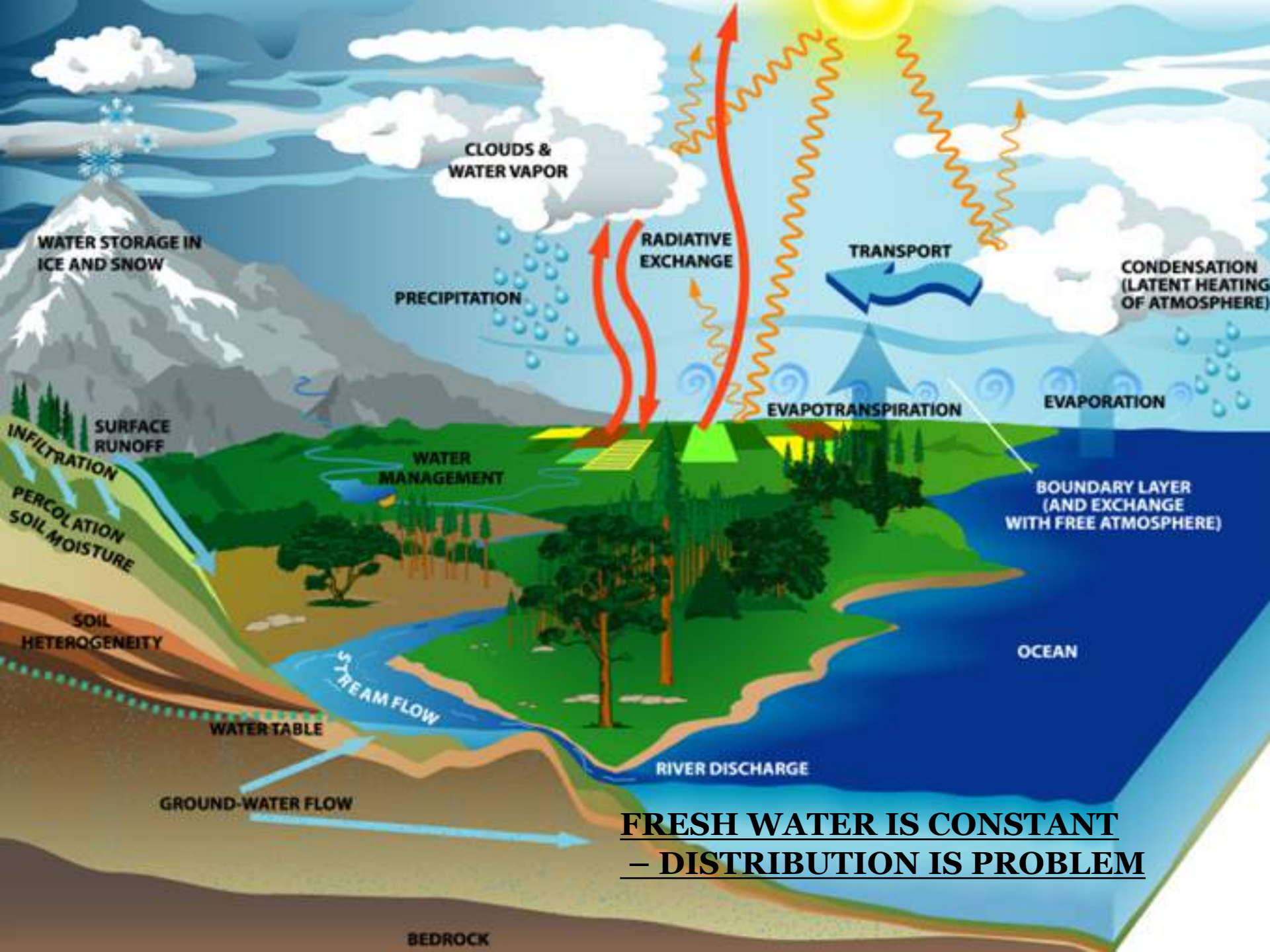
Credit 1.1 Water Efficient Landscaping, Reduce by 50% **2**
Credit 1.2 Water Efficient Landscaping, No Potable Use or No Irrigation **2**
Credit 2 Innovative Wastewater Technologies **2**
Credit 3 Water Use Reduction, 40% Reduction **4**

Materials & Resources

Credit 2.1 Construction Waste Management, Divert 50% from Disposal **1**
Credit 2.2 Construction Waste Management, Divert 75% from Disposal **1**
Credit 3.1 Materials Reuse, 5% **1**
Credit 3.2 Materials Reuse, 10% **1**
Credit 4.1 Recycled Content, 10% (post-consumer + ½ pre-consumer) **1**
Credit 4.2 Recycled Content, 20% (post-consumer + ½ pre-consumer) **1**
Credit 5.1 Regional Materials, 10% Extracted, Processed & Manufactured Regionally **1**
Credit 5.2 Regional Materials, 20% Extracted, Processed & Manufactured Regionally **1**

EPIC CREDIT CONTRIBUTION

33



FRESH WATER IS CONSTANT – DISTRIBUTION IS PROBLEM

There is NO water Crisis

…Only an inefficient water management- Infrastructure and philosophy.

epic™
TOTAL WATER SOLUTIONS

A Typical Installation

Excavation 600mm (Depending on Sand Soil)
Flat Leveling

Laying the Epic Geomembrane Liner (EPDM or LDPE)
Epic Recommends using Firestone EPDM Liner

Laying and securing the EPDM liner

Seaming the EPDM liner

TOTAL WATER SOLUTIONS

Installing the EPIC Chambers


EPIC Chambers and
Firestone EPDM Liner
is in place

Water Reservoir Tank

6” Supply Header

Attaching EPIC chambers to the supply vault and header pipe

Attaching EPIC chambers to the drain header pipe

Gravel
Filling

epic™
TOTAL WATER SOLUTIONS


epic™
TOTAL WATER SOLUTIONS
Gravel & Sand
Filling


epic™
TOTAL WATER SOLUTIONS
Gravel & Sand
Filling


epic™
TOTAL WATER SOLUTIONS
Sand
Filling

Installing the sand layer


TOTAL WATER SOLUTIONS
The area is now ready for planting

Open field Agriculture Irrigation
EPIC SSI System
Al Dahra Farms. Al Ain, UAE

3 Weeks after Planting

Fodder field

EPIC SSI System
Al Dahra Farms. Al Ain, UAE

3 Weeks after Planting

Cucumber Greenhouse

Epic SSI System

Aldahra UAE







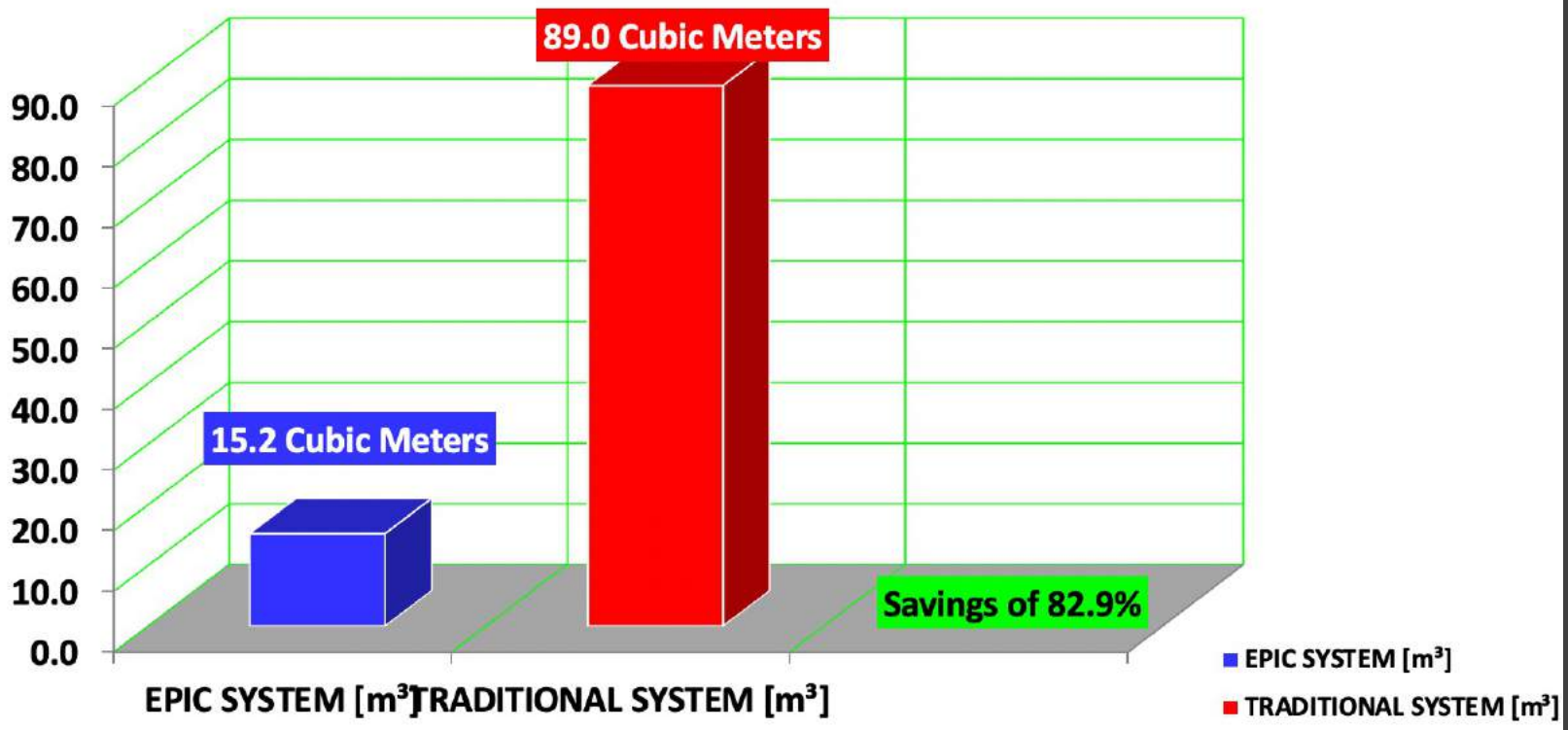





Cucumbers
3 Weeks after planting

Al Dahra Greenhouse Experiment

Recorded over 2 month Period



Experiment: 750 cucumber Plants over 5 rows (150 per row)


Grey Water Applications

Greywater Utilization

EPIC System™ Innovations

Rain/Greywater Re-use (Private Estate, CA)

Municipal Greywater (Folsom, CA)

Greywater Irrigation (Private Estate, NV)

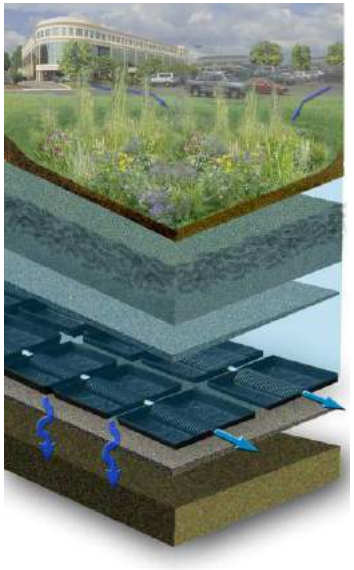
Blackwater Re-use (UC Davis, CA)

Greywater & Saline Designs
EPIC System™ Innovations

Saltwater Irrigation (Abu Dhabi, UAE)

Greywater Re-use (Dubai, UAE)

Rain Garden & Storage Infiltration

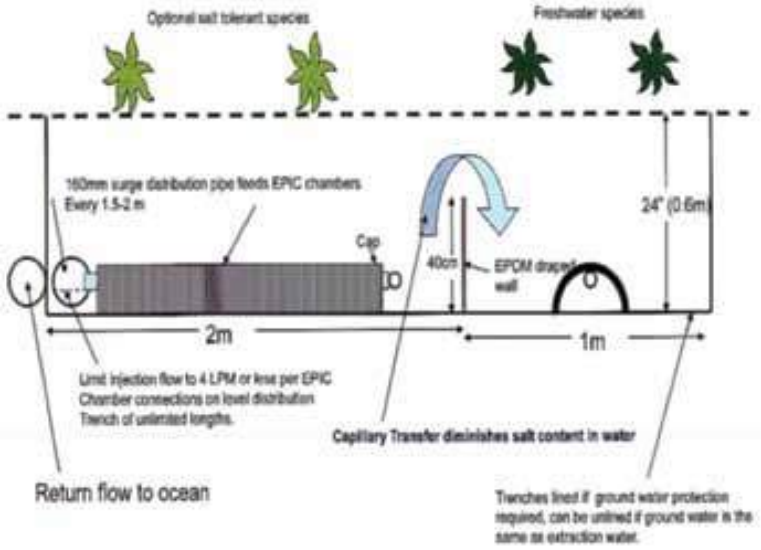


Sea Water Irrigation

Aldar Properties, Yas Island

Sea Water Irrigation
EPIC System™ Innovations

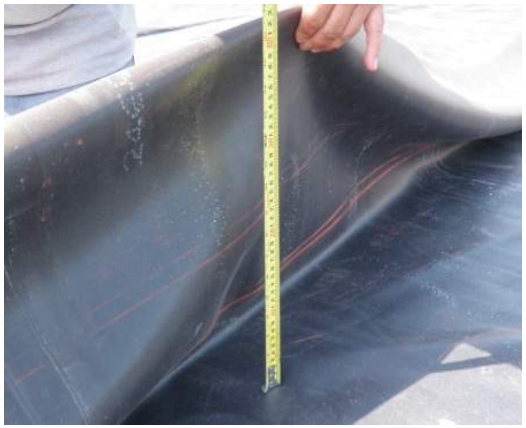
TOTAL WATER SOLUTIONS



The Yas Island Sea Water Cell demonstrates the ability to subsurface Irrigate with pure seawater in a highly controlled and efficient manner, using Photovoltaic Power. This makes ideal for coastal areas and inland seawater irrigation for landscaping or for Biofuel cultivation. The vegetation grown in the cell are halophyte plants.

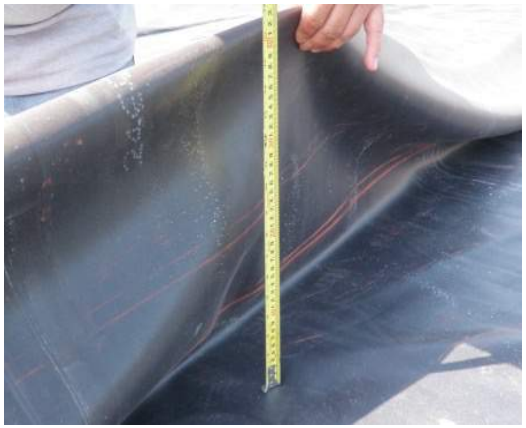
The EPIC geomembrane Liner prevents any Salt water to contaminate any groundwater sources. This particular EPIC cell has a return feed back to the sea, preventing salt accumulation. In event that the EC levels reach excess amounts, the cell can be leached by raising the swing elbow to 600mm (90 Deg) at the end of the drain line which floods the surface. Once flooding occurs the water is then allowed to drop and get drained out by putting the elbow at 180 degree invert.

Sea Water Irrigation
EPIC System™ Innovations



Sea Water Irrigation
EPIC System™ Innovations

TOTAL WATER SOLUTIONS

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TM
TOTAL WATER SOLUTIONS

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52,000 ppm Sea Water
Desalinated to 12,000ppm