

EPIC CASE STUDIES

THIRTEEN PROJECTS. ONE RECORD.

UNITED STATES · UNITED ARAB EMIRATES · SAUDI ARABIA

Greenhouses, open fields, island plots, parks, a school, two stadiums and a roof. Thirteen EPIC installations, each on its own sheet: headline figures, the project record, the measured results and dated photographs.

13	3	20
PROJECTS	COUNTRIES USA · UAE · KSA	YEARS, LONGEST photographic record

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Thirteen sheets, four pages each, five or six where the record runs to it. The evidence level on each sheet's cover is repeated here.

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MEASURED metered or monitored figures

CERTIFIED third-party certification; performance figures as published

DESIGNED & BUILT built and planted; the result is from the laboratory

MEASURED · PARTIAL laboratory analysis; no metered saving

MONITORED independent weekly inspection; no saving calculated

DOCUMENTED scope and installation recorded; no metered outcome



EPIC CASE STUDY

GREENHOUSE 5

AL DAHRA AGRICULTURAL COMPANY, AL AIN, UNITED ARAB EMIRATES

A greenhouse split down the middle. Same crop, same house, same climate: drip on one half, EPIC on the other, a water meter on each.

85%
LESS WATER
370 → 55 m³

102%
MORE CUCUMBER PER PLANT
3.57 → 7.22 kg

46%
LESS FERTILISER
92 → 50 kg

EVIDENCE LEVEL
MEASURED · Metered A/B trial · farm production records · daily meter log

Cucumber crop at Al Dahra, Al Ain, 26 January 2011.

PROJECT RECORD

CLIENT	Al Dahra Agricultural Company
LOCATION	Al Ain, United Arab Emirates
INSTALLED	Systems installed in two greenhouses at the farm: one completed December 2010, the other March 2011
CROP	Cucumber, grown for local markets
CONFIGURATION	Half of Greenhouse 5 converted to EPIC; half left on the existing drip system as the control. 10 rows of plants (2 rows across 5 sections), each section fitted with an EPIC chamber independent of the others; trenches excavated by hand.
WATER METERING	Both halves metered separately
FERTILISER METHOD	Fertigation: fertiliser dissolved in the EPIC reservoir and carried by the water through the system; trace elements applied foliar

THE PROBLEM

Al Dahra is one of the most prominent agricultural companies based in the UAE, producing locally distributed fruit and vegetables. The farm owner and the local municipality were looking to raise the efficiency of local food production, and were researching alternatives to the existing surface drip irrigation.

Two forces pull against each other in this region: more food has to be produced, and there is very little water with which to produce it. About 80% of water in the UAE is used for agricultural purposes.

Water was not the only concern. Under drip, fertiliser tends to seep down into the ground and away from the root zone, a cost to the farm and a contamination risk to groundwater.

WHAT EPIC BUILT

Half of Greenhouse 5 was converted. Trenches were excavated by hand, a Firestone EPDM waterproof liner laid, and EPIC chambers set on top of the liner and connected to the drain header pipe by 2 inch connector pipes to complete a closed loop. A fine gravel layer was placed over the chambers, then a sweet sand layer to finish grade.

Water is delivered from a reservoir tank with a submersible pump. A 90 degree elbow pipe on the drain header sets the water level in the system. The liner holds both water and dissolved fertiliser inside the profile, releasing them to the plant as it draws.

The other half of the house was not altered and continued on drip as the control. Both halves carried water meters.



5 Dec 2010 Trench installation. Liner and chamber pipe in place; the gravel layer goes in before the final sand.



The EPIC Chamber™ set on the Firestone EPDM waterproof liner.

85%
LESS WATER
370 → 55 M³

102%
MORE CUCUMBER PER PLANT
3.57 → 7.22 KG

46%
LESS FERTILISER
92 → 50 KG

THE RECORD

Results for the most recent of the two cucumber crops grown after conversion.

	TRADITIONAL DRIP	EPIC SYSTEM	DIFFERENCE
Water consumed	370 m³	55 m³	85% less
Water per kilo of cucumber	40 US gal	3 US gal	92.5% less
Cucumber per plant	3.57 kg	7.22 kg	102% more
Fertiliser used	92 kg	50 kg	46% less

Water per kilo in litres: 151.42 L on drip against 11.35 L on EPIC. Differences are calculated from the figures in each row.

DAILY METER LOG, 2011 CROP

Drip side planted 30 April 2011, EPIC side 3 May 2011. Readings from the farm's Greenhouse 5 data sheet.

	EPIC	TRADITIONAL DRIP	SAVING
Meter, 17 Apr 2011 (before planting)	50.1 m³	249.6 m³	
Meter, 3 Jul 2011	117.3 m³	652.8 m³	
Consumed over the crop	67.2 m³	403.2 m³	83%
Fertiliser, weeks 2 to 11	50.50 kg	116.25 kg	57%

Meters are cumulative: the consumed row is the difference between the two readings, and the saving is calculated from it. The daily saving ran from 94% early in the cycle to 82 to 83% at the last readings on 3 July.

FROM THE SAME DATA SHEET

- **Production.** On 3 July 2011, 414 plants were in production on the EPIC side against 679 on the drip side, at 0.373 and 0.244 boxes per plant respectively: EPIC at 153% of drip production per plant. A box is 16 kg.
- **Nematodes.** The fertiliser sheet records 170 plants lost to nematode. Pesticide for nematode was applied three times on the traditional side in week 2 and not applied on the EPIC side.

ALSO ON THE RECORD

Fourth crop cycle, January 2012. Drip crops were planted five days before the EPIC crops and the EPIC bed sits one foot higher; even so, the EPIC crop was taller and already flowering.

> **FARM FEEDBACK**
>
> "They have witnessed water savings of about 82% more than normal in the greenhouse, which is on par with what was predicted."
>
> Project brief, Al Dahra farm demonstration site



Lateral movement of water across the EPDM liner and through the gravel layer.



25 Jan 2011 Reservoir tank set in its trench with supply valves.



About three weeks after planting.



The comparison the trial was built for: wilting produce from the conventional drip system on the left, EPIC plants on the right.

RECORDS Al Dahra farm case study and results table; Greenhouse 5 data sheets, June and July 2011; crop cycle no. 4 report, January 2012; site reports, March and April 2011; project brief for the Al Dahra demonstration site.



EPIC CASE STUDY

OPEN FIELD DEMONSTRATION

AL DAHRA AGRICULTURAL COMPANY, AL AIN, UNITED ARAB EMIRATES

The same technology taken out of the greenhouse and laid across open desert field: one excavation, one liner, chambers in rows.

Nov 2010
OPEN-FIELD INSTALLATION
Data collection from end of January 2011

3
SEPARATE CELLS
Water levels tracked apart

0
EPIC PLANT LOSSES AT THE DEMO SITE
Against about 10% on drip

EVIDENCE LEVEL
DOCUMENTED · Project brief and installation record

EPIC chambers set out on the EPDM liner across the open field at Al Dahra, Al Ain.

PROJECT RECORD

CLIENT	Al Dahra Agricultural Company
LOCATION	Al Ain, United Arab Emirates
INSTALLED	Greenhouse and open-field demonstration sites installed late November 2010
DATA COLLECTION	Open field data collection began at the end of January 2011
PLANTED	A variety of vegetables, alfalfa grass and forage grass
CONFIGURATION	One large area excavated and covered by EPDM liner, with EPIC chambers fitted in rows over the area: three separate cells, each allowing water levels to be tracked independently
STATUS	Date palm plot installations were expected by the end of March 2011

THE PROBLEM

Al Dahra wanted the technology proven not just under glass but on open ground, across the mixed cropping the farm actually runs: vegetables, alfalfa and forage.

The open field is the harder case: there is no shelter from wind or sun, and the evaporative demand is far higher than under glass.

The farm was also carrying a fertiliser problem. In a conventional system fertiliser seeps into the ground; with the EPDM liner it is contained once applied and released as the plant uses it, which keeps it out of the groundwater.

WHAT EPIC BUILT

Where the greenhouse needed hand-dug trenches, the open field was done the normal way: one large area excavated, covered with the EPDM liner, EPIC chambers fitted in rows across it, then gravel and sand.

Three separate cells were used so that water levels could be tracked separately during the demonstration. Under normal operation the same area, or a larger one, could have been run from a single cell. Extra tanks, water meters and pumps were installed purely to collect and analyse data.

The brief also sets out, explicitly *“not necessarily for this project, but in general”*, that the system can use seawater and grey water. With the liner in place nothing below it is contaminated; and because the system is sub-surface, people do not come into contact with the irrigation water.



The EPDM liner laid over the excavated open-field area.



Chambers set in rows on the liner, connectors in place, before gravel.

Nov 2010	3	0
OPEN-FIELD INSTALLATION	SEPARATE CELLS, WATER LEVELS TRACKED APART	EPIC PLANT LOSSES AT THE DEMO SITE, AGAINST ABOUT 10% ON DRIP

WHAT THE RECORD SHOWS

The open-field demonstration is documented by its project brief and installation photographs rather than by meter readings. The observations below are those given in the brief.

OBSERVATION	AS RECORDED
Plant condition, demonstration site	Plants under EPIC were greener and healthier
Plant losses, first 4 to 6 weeks	Drip lost approximately 10% of plants, possibly to nematodes. EPIC lost none.
Greenhouse saving reported by the farm	About 82%, on par with what was predicted

> The 82% figure is the farm's feedback on the greenhouse installation, not the open field; the metered greenhouse record is set out in CS-01. The plant condition and plant loss rows describe the demonstration site as a whole, not the open field alone.



Header and connector pipe delivered to the open field.



Forage grass established on the open-field system.

ALSO ON THE RECORD

- **Seasonality.** Vegetables grown outside in the UAE tend to grow from September through to May and are out of season from June to August. The brief expected that EPIC may allow some vegetables to grow through the year, which could increase production. This is an expectation, not a result.
- **Root behaviour.** A site report from the Al Ain project, 16 April 2011, describes EPIC-side plants without the secondary root system seen on the farm side, and records that *some* plants matched the farm side at 4 m in length. In the report's words: "our plant root with out second root system it's like this because it's looking for fertilizer not like other side big and contain second roots because there's too much fertilizer."

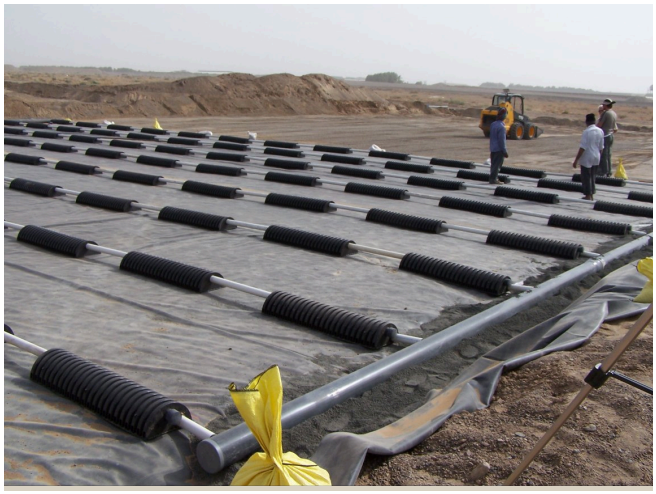
PROJECT AIM

"We want to make sure that any solution we provide to farmers is not only sustainable but is also simple, easy to use, and requires very little maintenance. Ultimately we are aiming for a turn-key system, with exact instructions based on what's going to be grown be it cucumbers, tomatoes, or any other agricultural produce."

Project brief, Al Dahra farm demonstration site



Sweet sand and gravel stockpiled on site.



The full open-field array: one excavation, chambers in rows across it.



Forage and alfalfa growing on the open-field installation.



The finished field in production.

RECORDS Project brief for the Al Dahra farm demonstration site; Al Ain project site report, 16 April 2011; installation photographs from the Al Dahra open field.

CS-03

LANDSCAPE · SEAWATER · ALTERNATIVE SOURCES

EPIC CASE STUDY

AL SAMMALEAH ISLAND

ABU DHABI, UNITED ARAB EMIRATES · 2007

Four EPIC plots on four different water sources, against a metered sprinkler control. One ran on seawater straight out of the Arabian Gulf, pumped by a solar panel.

78.91%	45,000+	Solar
METERED WATER SAVING	PPM GULF SEAWATER	PUMP
1 Aug to 9 Sep 2007	Irrigated directly	On the seawater plot

EVIDENCE LEVEL

MEASURED · Metered A/B turf trial, 1 Aug to 9 Sep 2007 · plus three source-demonstration plots

EPIC sub-surface fresh water irrigation system on Al Sammaleah Island, Abu Dhabi, developed for multi-use green parking and recreation.

PROJECT RECORD

LOCATION	Al Sammaleah Island, Abu Dhabi, UAE
YEAR	2007
TRIAL PERIOD	1 August to 9 September 2007
PLOT 1: EPIC	Bermuda grass, 126 m^2, sub-surface irrigation, metered
PLOT 2: CONTROL	Same turf, 138.75 m^2, traditional pop-up spray sprinklers, metered
SEAWATER PLOT	Sesuvium portulacastrum, irrigated on seawater direct from the Arabian Gulf at 45,000 to over 50,000 ppm, with a drain line back to the Gulf and a solar-powered pump
FURTHER PLOTS	One on air-conditioning condensate, one on grey water from an office building; the grey water introduced directly with no pre-filtering

THE PROBLEM

The question the island was set up to answer was a blunt one: how much water does a conventional landscape actually waste, and can a sub-surface system be run on water nobody else wants?

The Arabian Gulf carries a variable salt concentration of anywhere from 45,000 ppm to over 50,000 ppm, much higher than most ocean concentrations.

And on an island, electricity for a pressurised irrigation system is not a given.

WHAT EPIC BUILT

Several demonstration plots. Two of them, one EPIC and one on traditional pop-up spray sprinklers, same turf, both metered, formed the water-saving comparison.

The seawater plot was built like every other EPIC system with one addition: alongside the normal supply line, a drain line back to the Gulf, to stop salt building up in the soil. After a short hardening process the Sesuvium grew well.

The pump on that plot was powered by a small solar panel. A traditional irrigation system running at much higher water pressure would need a very large and expensive solar delivery system to do the same job.

Two further small plots ran on air-conditioning condensate and on grey water. Because the EPIC System does not clog, the grey water was introduced directly with no pre-filtering.



The seawater plot under construction: chambers ballasted on the liner beside the Gulf.



Sesuvium ground cover established on the same seawater plot.

78.91%
METERED WATER SAVING
1 AUG TO 9 SEP 2007

45,000+
PPM GULF SEAWATER
IRRIGATED DIRECTLY

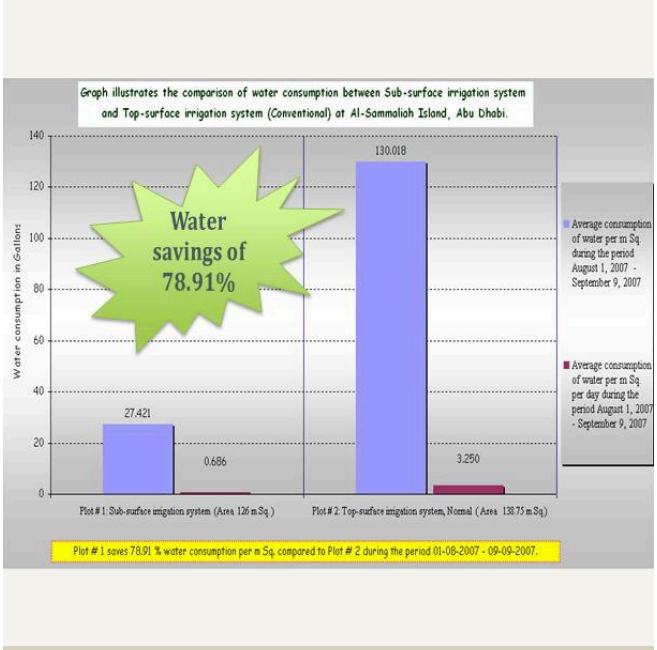
Solar
PUMP ON THE
SEAWATER PLOT

THE RECORD

Both turf plots were metered over the same 40-day period.

1 AUG TO 9 SEP 2007	PLOT 1: EPIC SUB-SURFACE	PLOT 2: POP-UP SPRINKLERS
Plot area	126 m²	138.75 m²
Average consumption per m²	27.421 US gal	130.018 US gal
Average per m² per day	0.686 US gal	3.250 US gal
Same, converted to litres	2.60 L/m²/day	12.30 L/m²/day
Water saving	78.91%	

Plot 1 saved 78.91% water consumption per m² compared with Plot 2 over the period; the written case study gives the result as over 78%. The two plots differ slightly in area, so the comparison is made per square metre. The litre row is a conversion at 3.785 L per US gallon, not a separate measurement.



The metered comparison chart from the time: 78.91% water saving, 1 Aug to 9 Sep 2007.



The conventional fresh water top-surface irrigation system: the metered control plot.

ALSO ON THE RECORD

- **Seawater.** The Sesuvium plot was irrigated on seawater taken straight from the Arabian Gulf, at 45,000 to over 50,000 ppm, and grew well after a short hardening process.
- **Salt control.** Salt build-up was prevented not by treatment but by plumbing: a drain line returning to the Gulf.
- **Solar.** The seawater plot's pump ran on a small solar panel, demonstrating irrigation supply where no electricity is available.
- **Grey water, unfiltered.** Grey water from an office building was introduced directly into the system with no pre-filtering required, because the system does not clog.



Pop-up spray in operation on the conventional control plot.



The seawater plot on Al Sammaleah Island.



The plot supplied with waste water and air-conditioner condensate.



Site signage: Environmentally Friendly Sub-Surface Irrigation.

RECORDS EPIC case study for Al Sammaleah Island, Abu Dhabi; Al Sammaleah Island presentation, with the metered comparison graph for 1 August to 9 September 2007 and site photographs.



EPIC CASE STUDY

YAS ISLAND LANDSCAPE PROJECT

ALDAR PROPERTIES & ABU DHABI URBAN PLANNING COUNCIL · YAS LINKS, ABU DHABI

Five plots at Yas Links, each with its own tank and meter, planted at the start of an Abu Dhabi summer: the worst time of year to establish anything.

2.46
L/M²/DAY AVERAGE
vs 12 to 14 typical

~80%
WATER SAVING
vs typical irrigation systems

4 of 5
PLOTS INDIVIDUALLY TANKED
and metered, 83 m² each

EVIDENCE LEVEL
MEASURED · Per-cell metering over 9 months · plot-by-plot planting schedule

Cell 3 planted with Oleander, Atriplex and Pennisetum, Yas Links, Abu Dhabi, 4 January 2012.

PROJECT RECORD

INVITED BY	Aldar and the Abu Dhabi Urban Planning Council
LOCATION	Yas Island Links, Abu Dhabi, UAE
INSTALLED	Installation began February 2011, completed by March 2011
SCOPE	Five self-contained plots of 83 m² each. Four have individual tanks and meters. Four smaller plots added for four trees, also with their own tanks and meters.
WATER SOURCES	Two plots on potable water, two on TSE (Treated Sewage Effluent), the fifth on sea water via a solar-operated pump
PLANTED	Three of the four plots with typical UAE landscape planting, 26 April 2011. The fourth with Platinum TE Paspalum turf, grown from seed, 15 May 2011.
REGIONAL BENCHMARK	Typical landscape areas of shrubbery or turf in this area require about 12 to 14 litres of water per square metre per day

THE PROBLEM

Abu Dhabi's master plans call for large areas of green space. The water to keep them alive is the constraint, not the design.

There is a second problem specific to Yas Island: a high water table and proximity to the sea mean sea water encroaches into traditionally landscaped areas by capillary action. The EPDM liner stops it; nothing can permeate into the EPIC profile from below.

The plots were planted at the beginning of summer. Turf grown from seed is rarely attempted in the UAE at all, because of the difficulty of applying enough water to germinate seed without the plant drying out before it establishes a self-sustaining root system.

WHAT EPIC BUILT

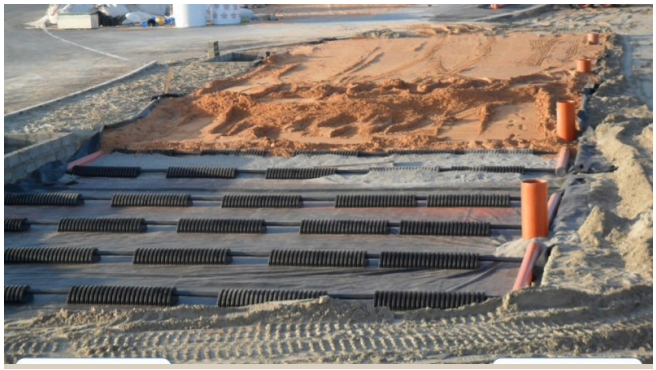
Five self-contained plots of 83 m² each at the Yas Links maintenance building. Four carried individual tanks and meters so that consumption could be monitored separately for different plant types and turf; four smaller tree plots were added on the same basis.

Two plots were supplied with potable water and two with TSE. Three were planted with typical UAE landscape species; the fourth was seeded with the Paspalum turf used on the adjoining golf course.

The fifth plot sits near the sea, supplied with sea water by a solar-operated pump. It is built as two interlinked sub-plots so that two things could be run at once: whether plants can survive on sea water alone, and whether a desalination effect occurs as sea water moves by capillary action from one compartment into the other.



Feb 2011 EPIC chambers and EPDM waterproof liner in place.



Laying the gravel and sand layers.

2.46
L/M²/DAY AVERAGE
VS 12 TO 14 TYPICAL

~80%
WATER SAVING
VS TYPICAL IRRIGATION

4 of 5
PLOTS INDIVIDUALLY TANKED
AND METERED, 83 M² EACH

THE RECORD

Metered water consumption of the four individually metered plots, in litres per square metre per day.

PER-CELL AVERAGE OVER TWO PERIODS, SUMMARISED 29 JANUARY 2012

PERIOD	CELL 1	CELL 2	CELL 3	CELL 4	4-CELL AVERAGE
26 Apr 2011 to 23 Jan 2012	3.66	2.00	2.33	3.10	2.77
2 Nov 2011 to 23 Jan 2012	2.38	1.62	1.81	2.95	2.19
Date palms, litres/tree/day					73.9 (Apr to Jan) · 11.67 (Nov to Jan)

The 4-cell average is the mean of cells 1 to 4. The date palms are in the separately tanked and metered tree plots and are given in litres per tree per day.

FIRST FIVE MONTHS OF THE PROJECT, PER PLOT, AS FIRST PUBLISHED

L / M² / DAY	PLOT 1	PLOT 2	PLOT 3	PLOT 4	AVERAGE
First 5 months of the project	3.63	1.80	1.99	2.44	2.46

Against the 12 to 14 L/m²/day typical for landscape areas here, this average was reported as “a savings of approximately 80% of typical irrigation systems”.



4 Jan 2012 Cell 1 with Pennisetum and Bougainvillea.



4 Jan 2012 Paspalum turf in Cell 4 at Yas Links, grown from seed inside the system.

ALSO ON THE RECORD

- **Turf from seed.** The Paspalum plot was grown from seed inside the system (rarely done in the UAE) and established through the summer.
- **Plot contents.** Plot 1: Pennisetum Green, Sesuvium Portulacastrum, Bougainvillea, Date Palm, Cyperus Alternifolius, Caesalpinia Pulcherrima, Sesuvium Red, Ruellia, Agave. Plot 2: Agave, Nerium Oleander, Ruellia, Atriplex Halimus, Pennisetum Green, Pennisetum Red, Spider Lily, Trees. Plot 3: Atriplex Halimus, Atriplex Canescens, Caesalpinia Pulcherrima, Frangipani, Rhoeo Discolor, Pennisetum Red, Trees. Plot 4: Platinum TE Paspalum Turf.
- **Media and government interest.** The case study records extensive requests from government, media and private organisations to view the site, with coverage in Arabic and English publications including Construction Weekly, AME Info, MEED, Al Fajr, Zawya and Gulf Today.
- **The original brief.** The December 2010 proposal to UPC and Aldar anticipated "water savings of the Epic System in the range of 50-80% less water used than other conventional irrigation systems" and asked that data gathering be set up so results "will meet the scrutiny of any third party".

  Proposal to UPC and Aldar, December 2010



26 Apr 2011 The first day of planting.



Four weeks later.



4 Oct 2011 Five months after planting.



The completed profile, ready for the April 2011 planting.

BUILDING IT, FEBRUARY TO APRIL 2011

Every frame on these two pages is dated. They run in the order they were taken, from bare ground to the planted trial.



3 February 2011 BEFORE

The graded lot beside the clubhouse before any work. Bare compacted sand, the villas behind.



27 February EXCAVATION

The excavation opened and brought to level, gravel base in, string lines set.



1 March CHAMBERS

EPIC chambers laid on the geomembrane liner, riser pipes standing at the connections.



2 March THE ARRAY

The array complete across the plot: rows of chambers on the liner, ready for cover.



2 March SAND

Sand spread over the gravel to form the profile the roots grow into.



3 March WATER TEST

The control chamber charged and standing full, tested before backfill.



26 April READY

The finished plots with the control panel in place, planting date on the record.

GROWING IT, MAY 2011 TO AUGUST 2012

The same plots over the following fifteen months. Elapsed time is counted from the 26 April 2011 planting date; the turf was sown separately on 15 May 2011.



22 May 2011 TURF SOWN
Turf establishing on raw sand a week after sowing, the chamber access cover at the edge of frame.



19 June 2011 8 WEEKS
Groundcover taking hold across the cell, drip lines still visible between the plants.



3 October 2011 5 MONTHS
The lawn cell fully established and closed over, edge to edge.



6 October 2011 5 MONTHS
The shrub and groundcover beds closed over in the same week, agave and yucca through.



12 February 2012 9 MONTHS
Mature planting: bougainvillea in flower, oleander and yucca established along the path.



12 March 2012 10 MONTHS
The plot in its setting, mown lawn and chamber lids, with the road and the buildings beyond.



1 August 2012 15 MONTHS
Frangipani and oleander over dense groundcover, through a second Gulf summer.

RECORDS Yas Island landscape project case study; summaries of water consumption at Yas Island, January 2012; plot contents schedule; EPIC installation report on Yas Island; proposal to UPC and Aldar, December 2010; dated site photographs, February 2011 to August 2012.



EPIC CASE STUDY

THE SEAWATER PLOT

YAS LINKS, ABU DHABI · THE DESALINATION-BY-CAPILLARY-RISE TRIAL

A plot built to test whether sand itself can take the salt out of seawater on the way up. The physics had already been demonstrated in the laboratory.

91%
TDS REDUCTION
Over the first capillary transfer

32,000 → 3,000
PPM TDS
Laboratory, January 2009

110 cm
LONGEST CAPILLARY PATH
Built in the companion cell

EVIDENCE LEVEL
DESIGNED & BUILT · Laboratory result, 2009 · field plot built and planted, 2012

Seawater plot at Yas Links, Abu Dhabi, 18 January 2012, 14 days after planting.

PROJECT RECORD

LOCATION	Yas Links, Abu Dhabi, UAE
PLANTED	4 January 2012
ESTABLISHMENT	Watered with fresh water for the first two weeks, then hardened on a combination of TSE and sea water. The plan recorded on 29 January 2012: “Over the next 4 weeks the TSE water will be reduced and the cell will be maintained with sea water only.”
CONFIGURATION	Sea water introduced into the EPIC cell, looped through the chambers and returned to the sea, creating a 75 mm deep saturated zone
TRAVEL DISTANCE	50 cm to the surface above the sea water section; up to 110 cm in the companion cell, up a 40 cm barrier wall, down the other side and up to the surface
PLANTED WITH	Sesuvium Portulacastrum, Atriplex Nummularia, Conocarpus, Atriplex Semibaccata, Pennisetum and Fountain Grass, Paspalum turf, Date Palm
PUMP	Solar operated

THE QUESTION

“The test plots were designed to determine if capillary salt water flow through sand has an influence on dissolved ion segregation.” If sand has a segregating influence, it may be related to travel distance, which is why the plot was built as two linked cells with very different path lengths.

The mechanism, as described by the system’s inventor: separation may occur in the capillary zone, where the water film is very tight in physical structure and squeezes out the larger molecules like a reverse-osmosis membrane. It may also be density stratification, sea water being heavier than fresh, with the slow movement EPIC provides working first with the lighter surface water at the source.

The laboratory work had already been done in 2009, and the result was substantial but bounded. That is why the field trial mattered.

WHAT EPIC BUILT

Sea water is introduced into the EPIC cell, loops through the chambers and returns to the sea, leaving a 75 mm deep saturated zone. Above it, water can only reach the surface by capillary rise through sand.

In the first cell, that rise is 50 cm. In the adjacent companion cell, the water must climb a 40 cm barrier wall, travel down the other side and then rise to the surface: a total travel distance of up to 110 cm.

A full sampling protocol was written for the plot: dry-sand and saturated-sand weight references, damp sand sampled 10 cm below the surface, three samples in the centre of the seawater cell and three in the “fresh” cell at 15 cm depth, extraction into 500 ml distilled water, and laboratory analysis for TDS, sodium, calcium, magnesium, chloride and potassium; to be repeated a month later 30 cm north of the original points, and south, east and west on the following three-month intervals.



The seawater cell at Yas Links, January 2012.



The cells beside the Gulf, as built.

91%
TDS REDUCTION OVER THE FIRST CAPILLARY TRANSFER

32,000 → 3,000
PPM TDS, LABORATORY JANUARY 2009

110 cm
LONGEST CAPILLARY PATH BUILT

THE LABORATORY RECORD

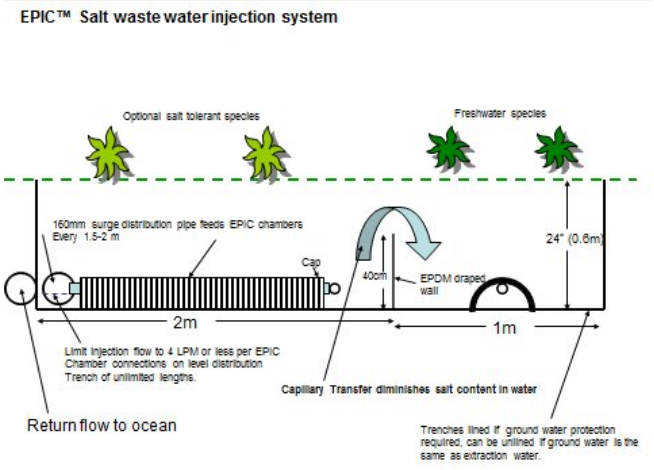
Anion and cation extraction levels in the root zone after capillary salt water movement. Values in ppm (mg/L).

	SALT WATER SOLUTION	SAND CONTROL	B · 17 TO 20 IN	C · 28 TO 31 IN	D · 57 TO 60 IN
TDS	32,000	81	3,000	3,800	3,300
Sodium	12,000	5.4	390	330	100
Chloride	20,000	2.4	2,200	2,400	2,200
Magnesium	1,400	8.7	210	250	270
Calcium	380	7.3	540	630	700
Potassium	340	3.0	7.4	7.6	7.0

Table 1 of the January 2009 laboratory paper on salt water irrigation with EPIC systems by Jonas Z. Sipaila, Director of Innovation, Rehbein Environmental Solutions Inc. Columns B, C and D are distances from the source, in inches. These are laboratory results, not Yas Island field results.



The seawater test plots on the Yas Links shoreline, as built.



The salt waste water injection schematic: limited injection flow, capillary transfer, return flow to ocean.

WHAT THIS MEANS

- **The bound matters as much as the result.** TDS falls from 32,000 to 3,000 ppm over the first transfer, a 91% reduction, and then does not fall further across the next two columns (3,800 and 3,300 ppm). A 97% reduction, to below 1,000 ppm, was not achieved. This is why the application is specified for salt-tolerant species and not for fresh-water species.
- **Laboratory, not field.** The 91% reduction is a January 2009 laboratory finding, over the first capillary transfer only, with no significant further change over subsequent transfers. It is not a Yas Island result.
- **The field plot.** The Yas Links plot was built, planted on 4 January 2012 and given a full sampling protocol. The salt water sample locations were recorded on 3 April 2012.



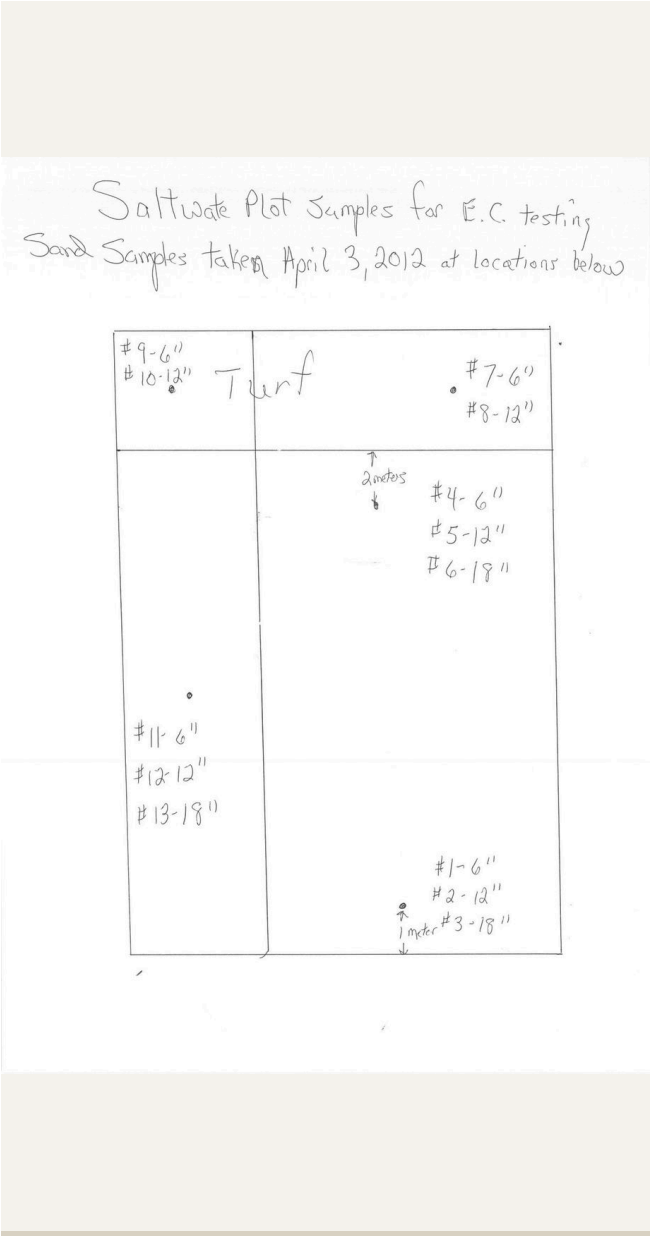
Salt-tolerant planting established in the cells.



The linked cells: the second carries the longer capillary path.



The seawater test plots as built at Yas Links.



3 Apr 2012 Sketch of the salt water sample locations.

RECORDS Laboratory paper on salt water irrigation with EPIC systems, January 2009; evaluation of the EPIC System for desalination and subsurface irrigation with seawater; Yas Island salt water sampling procedure; sketch of the salt water sample locations, 3 April 2012; records of the salt water plants, including as built; EPIC installation record for Yas Island; summary of water consumption at Yas Island.



EPIC CASE STUDY

AL FANATEER CORNICHE

ROYAL COMMISSION FOR JUBAIL & YANBU · JUBAIL INDUSTRIAL CITY, SAUDI ARABIA

A 400 m^2 plot the client asked to see monitored against a 50% saving target. The sand it was built with was too salty for turf, so the system flushed itself.

2.05	>80%	0.91 → <0.4
L/M²/DAY	SAVING DEMONSTRATED	SALINITY, FLUSHED
vs 20 on site	against a 50% target	by the system itself

EVIDENCE LEVEL

MEASURED · Jointly monitored, RCJY/SATCO with EPIC · daily water-meter log Dec 2011 to Mar 2012 · salinity readings

Turf growth after two months at the Al Fanateer Corniche plot, Jubail, February 2012.

PROJECT RECORD

CLIENT	Royal Commission for Jubail & Yanbu (RCJY)
LOCATION	Community Area, Danah Road × Danah 3, Jubail Industrial City, Saudi Arabia
MONITORING	Eng. Faisal Al Khatib, SATCO, designated main coordinator on behalf of the Royal Commission, with two Epic Green Solutions team members stationed in the eastern province
CONTRACT	SATCO Contract No. 951-S24
AREA AND WATER	400 m^2, planting type turf (carpet grass); water source TSE
INSTALLATION	10 to 17 December 2011; turf installed 17 December 2011
INITIAL CHARGE	19 m^3 from lorry tanker plus 19 m^3 from main supply line, to saturate the sand profile
INITIAL FERTILISER	100 kg slow release 15-15-15 plus 10 kg slow release 20-20-20
CLIENT'S TARGET	50% water saving, on which the Commission would look to award installation contracts

THE PROBLEM

In October 2011 Sheikh Faisal Al Rasheed, Director of Planning at RCJY, invited EPIC to carry out a pilot in Jubail, monitored by the Commission. The condition was explicit: achieve 50% water saving against existing systems, and RCJY would look to award installation contracts for environmental remediation and irrigation in areas under its control.

Two site conditions worked against the trial from day one. The soil condition at the time of landscaping is recorded as “Very Poor (High Salinity Content in Sand (Not Washed)”, the turf supplied was of poor quality, and the plot went in during the grass hibernating season.

There is also a structural problem at Al Fanateer that the liner solves incidentally: a high water table and proximity to the sea mean sea water permeates into traditionally landscaped areas run by the Commission. It cannot permeate into an EPIC profile.

WHAT EPIC BUILT

One self-contained 400 m^2 plot, turfed, with reservoir tank, float valve, inlet and 90° elbow, and an observation port through which the standing water level in the cell could be read daily.

On 28 December, eleven days after turfing, soil salinity was found above acceptable levels (0.91 on the soil probe scale against a recommended 0.1 to 0.4 for turf), caused by unwashed sand and excess fertiliser mix. Electrical conductivity readings in the tank and drain line were 9 and 16, translating to 5,760 ppm and 10,240 ppm TDS.

The system flushed itself. A hose is attached to the inlet valve at the supply vault and the pump turned on; the water level in the cell is raised enough to flood most of the depth of the profile in fresh water and is then drained, carrying the excess salinity out with it. “No modification to the system or special equipment is required to perform this flushing procedure.”



Dec 2011 Chambers and liner going in at Al Fanateer Corniche.



Chamber and connector before the sand layer.

2.05
L/M²/DAY
VS 20 ON SITE

>80%
SAVING DEMONSTRATED
AGAINST A 50% TARGET

0.91 → <0.4
SALINITY, FLUSHED
BY THE SYSTEM ITSELF

THE RECORD

Water consumption over 105 days from turfing on 17 December 2011.

JUBAIL CORNICHE PARK PLOT	LESS FLUSHING	LESS FLUSHING AND CHARGING
Water added, tanker	22.5 m³	22.5 m³
Water added, pump	79.5 m³	79.5 m³
Total	102 m³	102 m³
Removed for flushing	16 m³	16 m³
Used for charging the profile		38 m³
Water attributable to the plot	86 m³	48 m³
Days · plot area	105 days · 400 m²	105 days · 400 m²
Litres / m² / day	**2.05**	**1.14**

Readings are from the SATCO daily water meter log and run to 17 March 2012. The March 2012 project report to the Royal Commission states that no further water was added before 1 April 2012; the per day figures are calculated on that basis, as water attributable to the plot divided by 105 days and 400 m². Charging and flushing are one-time operations, not ongoing use. The comparison figure for the existing pop-up sprinkler system at Al Fanateer is 20 L/m²/day; industry averages for turf and landscaping in this part of the world are given as 12 to 18 L/m²/day.

SALINITY AND ROOTING

DATE	READING	NOTE
28 Dec 2011	0.91 at ~25 cm depth	Above the 0.1 to 0.4 recommended for turf; 7 m³ added for soil leaching
29 Dec to 3 Jan	Flushing	System flushed 29 Dec, 31 Dec (a further 9 m³ added) and 3 Jan
4 Jan 2012	below 0.4	Accepted as the optimum recommended level for turf
21 Feb 2012	Roots to at least 20 cm	Good progress on greening and rooting

Soil activity at depth against a normal sprinkler system, from the Royal Commission installation summary, December 2011: at 10, 15 and 25 cm, EPIC 0.22, 0.33 and 0.65 against sprinkler 0.04, 0.07 and 0.06.

ALSO ON THE RECORD

THE RESULT AGAINST THE TARGET

> "At this time we are demonstrating water savings in excess of 80% over normal water usage from typical irrigation systems for this climate."
>
> March 2012 project report to the Royal Commission. The client's target was a 50% saving.

- **Why there is a rest cycle.** "One of the reasons the Epic system has a rest cycle between adding water is to allow the sand profile to absorb oxygen as it dries out and the pore space opens up. When the water is periodically added carbon dioxide is pushed from the sand profile… This constant exchange of oxygen and carbon dioxide is very beneficial for the plants and sand profile."
  March 2012 project report to the Royal Commission

- **Operating rule.** The report records that someone at site inadvertently added 1 m^3 of water on 25 December which was not needed and should not have been added, and uses it to set the operating rule that water is added only at the direction of the EPIC representatives on site.

- **Brown spots.** Turf growth after two months showed some brown spots, attributed in the report to the poor quality turf supplied for installation.



New roots into the sand profile.



Root plug lifted from the plot after two months.



Conductivity and soil activity readings taken on site.



The plot, greening up as the weather warmed.

RECORDS Project report to the Royal Commission for Jubail & Yanbu, March 2012, with the SATCO daily water meter log (Contract No. 951-S24); Royal Commission installation summary, December 2011.



EPIC CASE STUDY

AL SALAMAT PARK

AL AIN MUNICIPALITY · AL AIN, UNITED ARAB EMIRATES · 2012

Nineteen weeks of independent municipal inspection through an Al Ain summer, side by side with the municipality's own irrigation, including a mid-season stress episode and its recovery.

19	45°C	96%
WEEKS OF INDEPENDENT municipal inspection	PEAK AVERAGE temperature recorded	GROWTH RECOVERY assessed at W19

EVIDENCE LEVEL

MONITORED · Independent weekly municipal inspection · dated photographic record · weekly meter readings for both halves

Al Salamat Park, Al Ain, August 2012, late in the monitoring period.

PROJECT RECORD

MONITORING BODY	Al Ain Municipality
LOCATION	Al Salamat Park, Al Ain, UAE
MONITORING PERIOD	23 April 2012 to 27 August 2012, weeks W1 to W19
CONFIGURATION	A turf area at Al Salamat Park split between the municipality's conventional irrigation and EPIC's sub-surface system, inspected side by side
RECORDED EACH WEEK	Al Ain municipality meter reading, EPIC Green Co. meter reading, average temperature, and written notes on plant condition and ground humidity
TEMPERATURE RANGE RECORDED	35°C in April rising to 45°C in May, 40 to 43°C through the summer, 39°C at the final inspection

THE SETTING

Al Ain Municipality inspected both halves of the same field each week, on its own forms and in Arabic, and wrote down what it saw.

The trial ran through the hardest part of an Al Ain summer, with recorded average temperatures reaching 45°C, and it included a mid-season stress episode on the EPIC side that the municipality documented week by week.

That episode and its recovery are set out week by week on the following pages.

HOW IT WAS MONITORED

Nineteen weekly inspections between 23 April and 27 August 2012. Thirteen carry meter readings; six weeks (W3, W4, W8, W14, W17 and W18) are recorded as “none”, W18 marked as the Eid holiday.

Each entry carries the municipality's own meter reading, EPIC's meter reading, the average temperature and free-text observations in Arabic on plant condition, weed presence and ground humidity, plus a dated photographic set of both halves of the field.

The municipality's notes are translated on the following page, including its criticisms and its one question, at W12.



Early in the monitoring period: both halves in condition.



Mid-June: the stress episode the municipality recorded from W9.

19
WEEKS OF INDEPENDENT MUNICIPAL INSPECTION

45°C
PEAK AVERAGE TEMPERATURE RECORDED

96%
GROWTH RECOVERY ASSESSED AT W19

THE MUNICIPALITY'S OWN NOTES, TRANSLATED

Observations as written in Al Ain Municipality's weekly monitoring table, 2012, translated from the Arabic.

WEEK	DATE	AVG TEMP	RECORDED OBSERVATION
W1	23 Apr	35°C	The turf on the company's side suffers pallor of colour.
W2	30 Apr	35°C	Same observation as the previous week. The reading was taken after the turf was mown.
W5	22 May	45°C	No harmful weeds at either trial site. The affected part of EPIC's section is the area that was patched. Some edges dry at both.
W7	4 Jun	43°C	Parasitic weeds appear in the municipality's plot, few or almost none in the company's. Dry edges in the company's trial.
W8	11 Jun		Mowing of the turf as part of routine maintenance work.
W9	19 Jun	40°C	Severe dryness appears on the company's section. Monitoring of growth rate after cutting begins.
W10	25 Jun	40°C	The dry part of the company's section begins to recover, very slowly; slight growth noted in some dry areas.
W11	2 Jul	40°C	Grass growth rate in the sub-surface system still weak.
W12	9 Jul	40°C	The company's turf begins to recover normal growth, 80% by observation. Parasitic plants in the municipality's part, absent in the company's. “To check with the company about the fertilising?”
W13	16 Jul	42°C	Turf recovered its natural growth; colour still slightly pale.
W15	30 Jul	43°C	Wilting present in the sub-surface irrigation part.
W16	6 Aug	41°C	Turf gradually recovering its natural colour. The dividing line between the two systems is noticeable.
W19	27 Aug	39°C	Parasitic plants (Euphorbia sp.) in the conventionally irrigated part. Turf recovered natural growth to 96%, held back by incomplete growth at the edges in EPIC's part; colour still pale. Possible mole-cricket larvae in the conventional part. Turf had not been mown up to the date of inspection.

METER READINGS AS RECORDED

WEEK	DATE	AL AIN MUNICIPALITY (M^3)	EPIC GREEN CO. READING
W1	23 Apr 2012	000047	0014581
W2	30 Apr 2012	000053	0019888
W5	22 May 2012	000072	00249729
W6	29 May 2012	000079	00249994
W7	4 Jun 2012	000085	00250002
W9	19 Jun 2012	000099	00279369
W10	25 Jun 2012	000105	00336237
W11	2 Jul 2012	000112	00359782
W12	9 Jul 2012	000119	00360372
W13	16 Jul 2012	000126	00380513
W15	30 Jul 2012	000140	0041981
W16	6 Aug 2012	000147	0044147
W19	27 Aug 2012	000163	00496488

Readings are as entered in Al Ain Municipality's weekly monitoring table. The municipality column is in m^3; the EPIC column carries no unit. The EPIC readings for W1, W2, W15 and W16 are entered with seven digits, the others with eight. Weeks W3, W4, W8, W14, W17 and W18 carry no readings (W18 Eid holiday). No irrigated area is given, so no saving is calculated from these readings.

WHAT THE PHOTOGRAPHIC RECORD SHOWS

- **April to May.** Both halves green and in condition, the EPIC side noted as paler.
- **Mid June to early July.** Extensive browning across the EPIC side, at recorded average temperatures of 40 to 43°C. This is the stress episode the municipality tracked from W9.
- **Late July to August.** Progressive recovery, reaching the municipality's assessed 96% of natural growth by 27 August, with colour still described as pale and edges incomplete.
- **Weeds.** In three separate weeks the municipality records parasitic weeds in its own conventionally irrigated half and few or none in the EPIC half, at W19 identifying them as *Euphorbia* sp. At W5 it records no harmful weeds at either site.

Monitoring table, W5, W7, W12, W19

THE RECORD IN PICTURES

The field through the monitoring period, from the dry period at its worst to the close on 27 August 2012.



The dry period at its worst.



Recovery beginning.



August: growth returned across the field.



The field at the close of the monitoring period.

RECORDS Al Ain Municipality weekly monitoring table for the Al Salamat Park trial, 23 April to 27 August 2012, in Arabic; dated photographic record of the park, 24 April to 27 August 2012; installation and post-installation photographs.



EPIC CASE STUDY

WESTSIDE PARK

CITY OF LOS ANGELES BUREAU OF ENGINEERING · PROPOSITION O · LOS ANGELES, CALIFORNIA

A city park designed to irrigate itself from the storm drain running underneath it, and to return what it does not use to the channel significantly cleaner.

3,700	$2.9m	2 acres
ACRES OF CATCHMENT	PROPOSITION O	OF EPIC PIPE
Targeted	Municipal project	In a sand profile

EVIDENCE LEVEL

MEASURED · PARTIAL · US$2.9m municipal project · laboratory water and soil analysis

EPIC chambers laid on the EPDM liner across the laser-levelled sub-grade benches, Westside Park, Los Angeles.

PROJECT RECORD

CLIENT	City of Los Angeles Bureau of Engineering; project manager Ahmed Iftekhar
FUNDING	Proposition O · US$2.9 million
CATCHMENT TARGETED	Runoff from 3,700 acres of land adjacent to South Fairfax Avenue
RECEIVING WATERS	Ballona Creek and Santa Monica Bay
SYSTEM	A two-acre network of EPIC sub-surface irrigation pipes in a sand profile
PROFILE	13 in sand over a 2 in gravel layer: 15 in total EPIC profile
CONFIGURATION	15 sections of 300 to 500 ft linear length on laser-levelled benches, each with one inlet and one outlet
FLOW	12 GPM per acre demand; 1 to 2 GPM per inlet
COMPLETION	Phase III as of mid-October 2010; scheduled to open February 2011; completion July 2011

THE PROBLEM

On 7 July 2010 the US EPA Administrator designated all of the Los Angeles River a Traditional Navigable Water, strengthening environmental regulation for the river and for the tributary streams and wetlands of its watershed. Developers and businesses along the mostly 82 km cement-lined river, and those affecting water across the 216,000 hectares of watershed, now have to consider compliance with the Clean Water Act.

Twenty-six million gallons of water flow into the Pacific Ocean daily from drainage channels like the one under Westside Park.

“In a drought year, using rainwater for irrigation will drastically reduce potable water use in the area and cut our expenses significantly.” Wing Tam, City of Los Angeles Stormwater Programme.

WHAT EPIC BUILT

The drainage channel runs underneath the park. Flow is intercepted and partially diverted into a pump lift station which supplies the EPIC system. It is a retrofit: normal drainage function continues whenever channel flow exceeds the park's irrigation demand.

Water is screened for floatable waste and heavy sediment, then delivered to the EPIC pipes in their sand profile, which feed the park's vegetation by root uptake. The system is non-pressurised and gravity driven, divided into laser-levelled sub-grade benches to suit the park's existing surface slope.

Chambers sit on Firestone EPDM liner with all sides folded upright to hold water in cells. Moisture reaches the finished surface by capillary influence between the level sub-grades and their serpentine flow pattern, inlet to outlet, high elevation to low.

Excess filtered stormwater is stored in underground chambers. By design, once they are at capacity the surplus “is discharged towards a dry creek and back into a storm drain significantly cleaner”. An existing tree was kept in place, its root mass buried to finish grade, irrigated by capillary movement up and over the liner side wall.



The drainage channel in flow: the park's irrigation source.



The pump lift station going in.

3,700
ACRES OF CATCHMENT TARGETED

$2.9m
PROPOSITION O MUNICIPAL PROJECT

2 acres
OF EPIC PIPE IN A SAND PROFILE

THE RECORD

Soil and water samples were taken on 24 August 2011 and analysed by Wallace Laboratories, El Segundo.

WATER, MG/KG (PPM)	INLET	OUTLET
Aluminium	10.72	< 0.05
Iron	19.29	2.58
Silicon	15.22	5.35
Barium	1.60	0.26
Titanium	1.51	0.08
Vanadium	0.83	0.18
Zinc	1.55	0.74
Lead	0.27	< 0.08
Phosphorus	36.45	2,376.40

Laboratory samples 11-237F-01 (outlet) and 11-237F-02 (inlet). These are baseline grab samples, not a measure of EPIC treatment efficiency. EPIC's September 2011 site report states: "This sample should not be interpreted as the treatment results of the EPIC field… the incoming water is not entering the bio-filter zone of the sand profile," and of the phosphorus result: "A single reading is not a pattern." The laboratory notes that the outlet has significantly lower levels of aluminium, barium, iron and silicon than the inlet since the turbidity is lower; however phosphorus is considerably higher in the outlet.

SOIL, AND THE OPERATING FINDING

MEASURE	VALUE	NOTE
Soil pH	7.77	Moderate alkalinity
Salinity, ECe	0.73 millimho/cm	Low
Estimated texture	Sand	Organic matter low; relative infiltration fair/good
Root depth at two months	4 to 5 in	From core samples
Root depth in a correctly cycled profile	over 10 in	Roots migrate deeper to seek moisture near the saturated zone

Soil values from the Wallace Laboratories soils report of 26 August 2011; root depths from EPIC's September 2011 site report. The report's diagnosis: continuous operation of the pump lift station gave the profile no resting period to breathe and exchange atmospheric gases, producing an abundance of moisture that does not encourage deep root growth. Recommendation: set the pump uplift irrigation duty cycle to a 36-hour cycle once per week.

ALSO ON THE RECORD

- **The two conclusions of the September 2011 report.** "1. There is no reason that the drainage ditch storm water cannot be used as irrigation water. 2. Nutrients present in the storm water are not sufficient to provide the nutrient needs for establishing vibrant and healthy turf grass in the park, and supplemental fertilization is required."
  EPIC site report, Westside Park, September 2011

- **No Black Plug Layer.** A sand sample profile cut revealed a thatch layer at the surface and no indication of anaerobic Black Plug Layer.
  Same report

- **Found on the August 2011 site visit.** All EPIC custom inlets found set incorrectly were corrected during the visit. Drain port "M" was left as a recommendation to label and verify. Section "D" showed evidence of previous surface pooling.
  Same report

- **The pollutants are nutrients.** The 2000 river study attributes nitrate, nitrite, ammonia and total phosphate to the three water reclamation plants (72% of the river's volume during that study) and bacteria including total coliform, E. coli and Enterococcus to the flowing storm drains and tributaries. In a sub-surface system, "all of these pollutants are nothing more than nutrients that can be used in the vegetative plant growth… without any public health exposure or concerns".
  EPIC sustainability case study, Westside Park

- **EPIC's efficiency claim in the project presentation.** "EPIC is 100% efficient irrigation using 60-80% less water than pressurized sprinkler and drip systems." This is EPIC's general figure for the system, not a Westside Park measurement.
  Westside Park study presentation

- **Community.** "It is multi-beneficial projects like this that make our communities better."
  Cynthia Ruiz, President, Board of Public Works



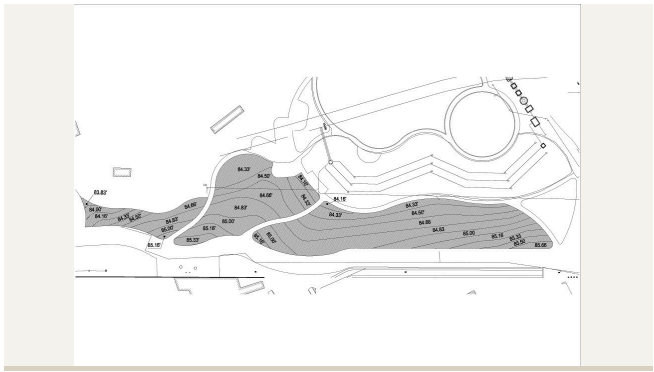
Laser-levelled benches, liner folded upright to hold water in cells.



An existing tree kept in place, the system built around it.



Sand fill over the chambers: 13 in of sand on 2 in of gravel.



Park layout: EPIC areas shaded, the level of each bench marked.

RECORDS EPIC sustainability case study and project presentation for Westside Park; EPIC site report, September 2011; Wallace Laboratories soil and water analysis and nutrient application recommendation, August 2011; EPIC maintenance manual for Westside Park.

CS-09

EDUCATION · SPORTS TURF · RAINWATER HARVESTING



EPIC CASE STUDY

CAMBRIA ELEMENTARY SCHOOL

CALIFORNIA COAST, USA · A WATER-INDEPENDENT PARK AND FIELD

A school on a steep coastal slope with no municipal water for irrigation, and a 2,200,000 gallon reservoir built below the soccer field.

130,000
SQ FT OF EPIC TURF
Across 12 acres

2,200,000
GALLONS RESERVOIR CAPACITY
40 pipes × 380 ft, below the field

Zero
FRESH-WATER IRRIGATION
Source required

EVIDENCE LEVEL

DOCUMENTED · Design scope, storage capacity and one-year photographic arc

The completed school grounds and fields, Cambria Elementary School, Cambria, California.

PROJECT RECORD

LOCATION	Cambria, California Coast, USA
CAMPUS	12 acres
EPIC TURF	130,000 sq ft across six strategic areas
FIELDS	An 85,000 sq ft community soccer field, as well as school athletic fields
RESERVOIR	40 pipes of 380 ft below the soccer field, with a total capacity of 2,200,000 gallons
COLLECTION	The entire campus, including the fields, designed to collect all available stormwater and hardscape runoff
SUMMER REPLENISHMENT	Effluent from the municipal sewage treatment facility
INSTALLATION METHOD	High-speed fill using a Brundage conveyor system

THE PROBLEM

Cambria Elementary School sits on the steep slopes of the California Coast, where access to municipal water for irrigation is not available.

The City of Cambria was unable to provide either the volume of water or the water pressure necessary to irrigate athletic fields using a traditional sprinkler system.

The school needed a way to take advantage of a short rainy season, storing water from the winter wet months for reuse in the dry summer, without negatively affecting an environmentally sensitive coastal area. Stormwater treatment and irrigation efficiency were both paramount.

WHAT EPIC BUILT

EPIC turf covers 130,000 sq ft in six strategic areas of the 12 acre campus. These include an 85,000 sq ft community soccer field, as well as school athletic fields, along with other park areas.

The entire campus, fields included, was designed to collect all available stormwater and hardscape runoff. Below the EPIC soccer field, a reservoir of 40 pipes of 380 ft has a total capacity of 2,200,000 gallons. The piped reservoir prevents both algae and evaporation.

The storage capacity gives the school a source of free irrigation water through the dry summer months, during which the system is also replenished with effluent from the municipal sewage treatment facility. This eliminates the need for a fresh water irrigation source entirely.

Because the design also mitigates runoff, the school gained multi-functional green space in a sensitive coastal setting where it would otherwise have been impossible.



Chamber installation across the field, with the Brundage conveyor system filling the EPIC pans.



Pipes for the below-field reservoir, with a person for scale.

130,000
SQ FT OF EPIC TURF ACROSS 12 ACRES

2,200,000
GALLONS RESERVOIR CAPACITY BELOW THE FIELD

Zero
FRESH-WATER IRRIGATION SOURCE REQUIRED

THE RECORD

This project is documented by its scope, its reservoir capacity and a photographic arc through to one year after completion.

	AS BUILT
Campus area	12 acres
EPIC turf installed	130,000 sq ft in six areas
Community soccer field	85,000 sq ft
Below-field reservoir	40 pipes × 380 ft
Total reservoir capacity	2,200,000 gallons
Fresh water irrigation source required	None



The 12 acre campus under construction.



Completed installation two weeks after sod was installed on the athletic field portion of the site.

ALSO ON THE RECORD

- **Why the reservoir is piped, not open.** “This system prevents any algae and evaporation.”
  Project record, Cambria Elementary School
- **The stated outcome.** “The EPIC System's storage capacity provides the school with a source of free irrigation water during the dry summer months, completely eliminating the need for a fresh water irrigation source.”
  EPIC project summary, Cambria Elementary School
- **The environmental case.** “EPIC designed and installed multi-functional green spaces that mitigate runoff issues and conserve water within the environmentally sensitive coastal area.”
  EPIC project summary, Cambria Elementary School
- **The photographic arc.** The 14-page project record runs from initial earthwork and design plans through chamber installation, conveyor fill, reservoir construction and sod laying to a page captioned “After one year”.
  Project record, Cambria Elementary School



Fill being placed in the chambers alongside a school building.



A piece of sod lifted by hand at the field edge, showing its roots.

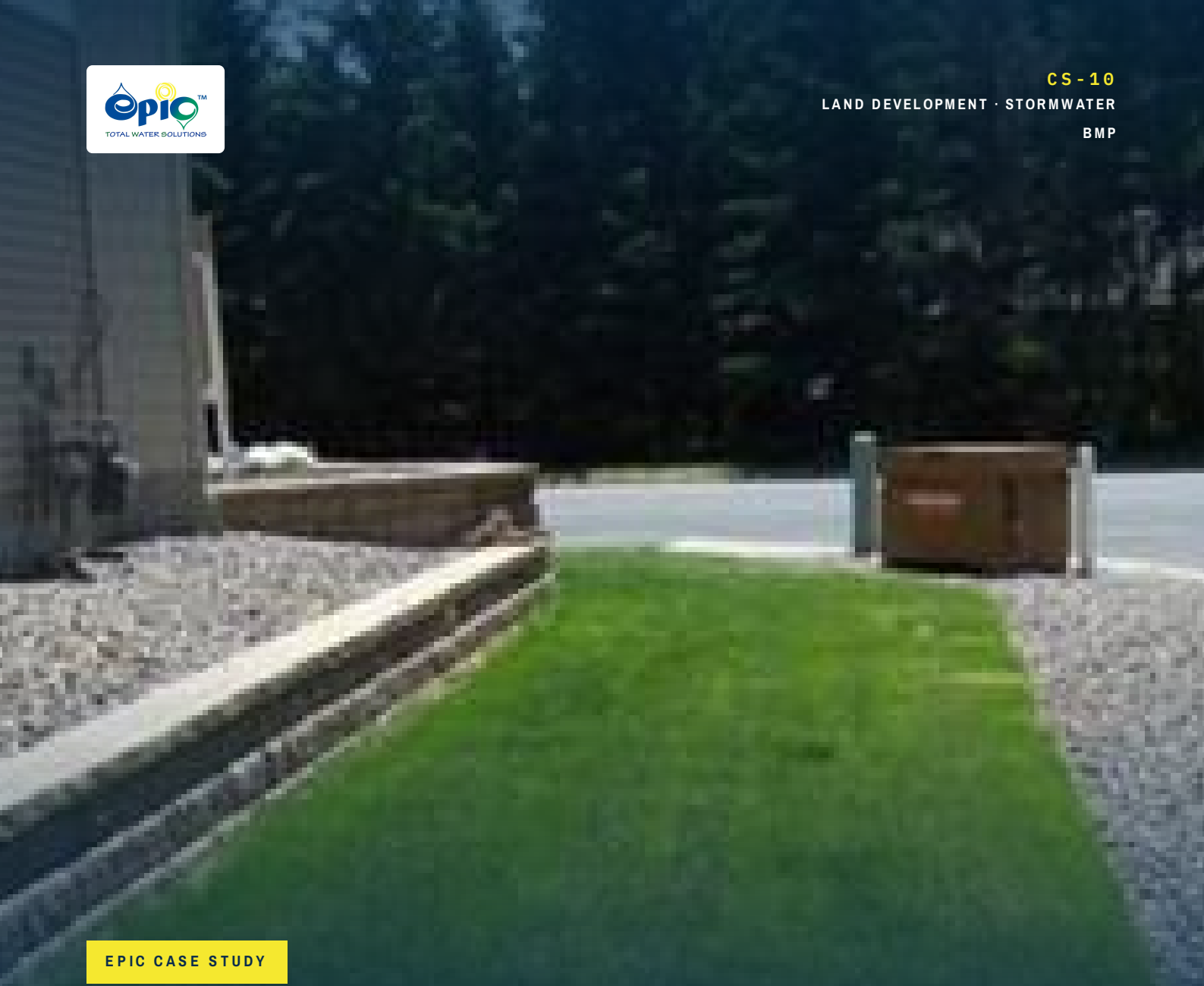


A finished turf strip between the planted bank and the play courts.



After one year.

RECORDS EPIC one-page project summary for Cambria Elementary School; 14-page project record with its photographic record from earthwork through to one year after completion; EPIC case study presentation for Cambria Elementary School.



EPIC CASE STUDY

WILDWOOD COMMONS

WHITEHORSE DEVELOPMENT CORPORATION · CITY OF WILLERNIE, MINNESOTA, USA · 2006

The first project in the seven-county Minnesota metro to rely on a single BMP for a whole site's stormwater, on a contaminated infill lot beside a wetland.

56%	85%	First
SITE RUNOFF REDUCTION	PHOSPHORUS LOAD REDUCTION	SINGLE-BMP SITE
16 Jun to 24 Sep 2007	11 Aug to 20 Sep	In the 7-county MN metro

EVIDENCE LEVEL

MEASURED · Modelled potential vs actual outflow, runoff and phosphorus · engineered and permitted by RESI

The finished EPIC green strip, Wildwood Commons, Willernie, Minnesota.

PROJECT RECORD

DEVELOPER	WhiteHorse Development Corporation; Mr Tim Jawor, President
LOCATION	McGregor Avenue × Stillwater Road (Wildwood / CSAH 12), City of Willernie, Minnesota
DEVELOPMENT	Two townhome buildings, nine units total; constructed 2006
SITE	A small vacant 30,000 sq ft lot, formerly a gas station and engine repair shop. Site plan label: "¾ Acre, 80% Impervious, Adjacent Wetlands"
JURISDICTIONS	City of Willernie, Willernie City Engineer Mr Les Mateffy, Rice Creek Watershed District, Washington County, MPCA
RECEIVING WATER	Drains toward White Bear Lake, Minnesota
ENGINEERING	"RESI then engineered the project and managed the approval process." Technical paper by William McCully PE, of RESI, the project engineer

THE PROBLEM

An infill development on a vacant lot, on a boundary between two cities, in a sensitive watershed with a popular recreational lake. It attracted significant opposition, and that opposition focused on how the developer would mitigate stormwater impacts and avoid the adjacent wetland.

A significant wetland wrapped tightly around the north-east property corner. There were reasonable environmental concerns that if the site was contaminated, infiltration practices would make things worse by carrying pollutants into the adjacent wetland water bodies.

Contamination was in fact found during the works, and was officially remediated with TetraTech, Inc. working with the MPCA.

The project fell below the Rice Creek Watershed District's one-acre threshold for a stormwater permit. The developer chose to meet the standard anyway.

WHAT EPIC BUILT

One stormwater management system for all site runoff. The EPIC system was installed in all green areas on the site, providing immediate biological and sand filtration and harvesting site runoff for irrigation.

Stormwater from the roofs, the impervious road surfaces and the rear driveways is sand-filtered and treated. Excess filtered stormwater discharges into a 4-inch PVC storm line to an existing street catch basin, via two lines entering from north and south of the buildings.

The irrigation is gravity fed. No pumps are part of the design; there is nothing to winterise or summerise and no moving parts to break or freeze. At its normal water level the system can provide the vegetation above with up to three weeks of irrigation water, delivered to the roots by capillary action.

By design on this project the EPDM liner prevents infiltration. On a remediated site, that is the point: the system caps the remediated soil against further leaching or plume movement toward the wetlands or groundwater.



Chambers and connectors on the EPDM liner, tight to the building.



Sand over the chambers: the green area is the stormwater system.

56%
SITE RUNOFF REDUCTION

85%
PHOSPHORUS LOAD REDUCTION

First
SINGLE-BMP SITE IN THE 7-COUNTY MN METRO

THE RECORD

Site performance from the project engineer's technical paper. Both tables compare a modelled *potential* baseline against the EPIC system's *actual* outflow.

SITE RUNOFF REDUCTION	PRECIPITATION	POTENTIAL RUNOFF	EPIC ACTUAL OUTFLOW	REDUCTION
16 Jun to 24 Sep 2007	13.55 in	32,181 cu ft	14,172 cu ft	56%

Potential runoff is the modelled runoff for Wildwood Commons; actual outflow is the outflow from the EPIC system over the same period. The reduction is calculated from the two volumes.

TOTAL PHOSPHORUS (TP) REDUCTION

PERIOD	POTENTIAL TP LOAD	EPIC SYSTEM TP LOAD OUTFLOW	REDUCTION
11 Aug to 20 Sep	0.2 lbs	0.019 lbs	85%

Total reduction as given in the engineer's paper. Calculated from the two rounded loads shown, the reduction is 90.5%.



22 May 2006 The infill site under construction.



The finished EPIC green strip along the driveway edge.

ALSO ON THE RECORD

- **A first for the region.** "This is the first project in the 7 county metro area of MN to solely rely upon one BMP for the entire sites stormwater management system."
  Technical paper, William McCully PE, RESI

- **Regulatory endorsement.** "Having the City Engineer, Mr. Les Mateffy comprehensively understand and approve the EPIC™ system, essentially endorsed the EPIC™ system for the City of Willernie. With their approval, all other issues with the MPCA, Washington Soil and Water Conservation District and RCWD were overcome."
  Same paper

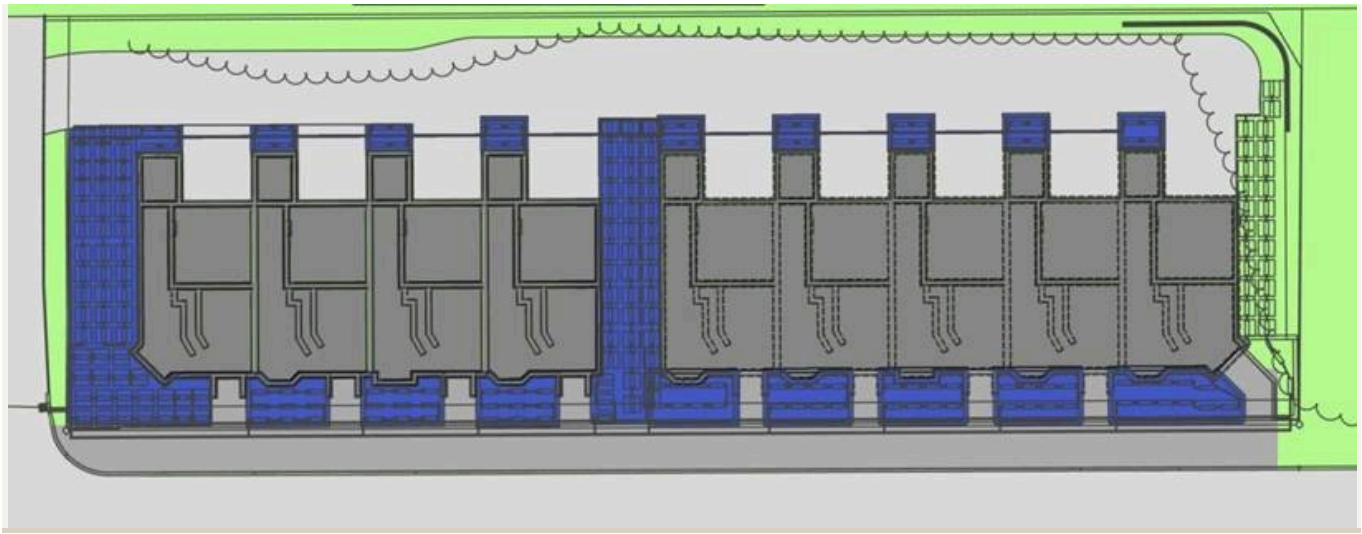
- **No mosquito habitat, as a design goal.** One of the developer's stated goals was "Allow effective stormwater management without producing a mosquito breeding habitat."
  Same paper

- **Provenance of the technology.** Jonas Sipaila received a patent in 1999 for the first pipe designed specifically for contact with sand, combining sub-surface irrigation, sub-surface drainage and capillary movement through sand. Other sub-surface systems had always had clogging problems; this invention eradicated them.
  Same paper

- **Irrigation water, in general.** The paper states that the system "saves the end user 50-85% over current irrigation water usage". This is a general statement about the EPIC system, not a measurement at Wildwood Commons.
  Same paper

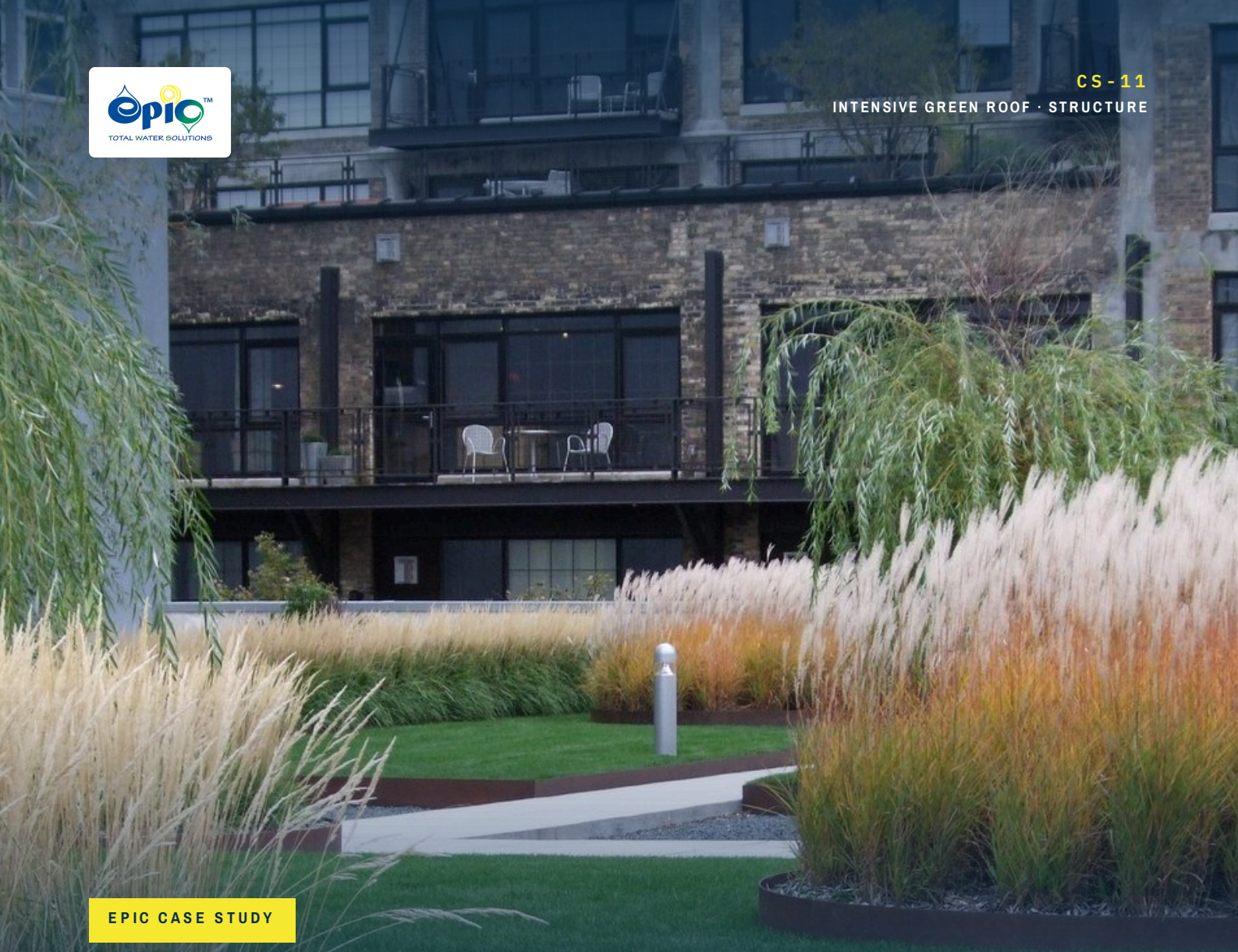


Planting over the system in a raised bed beside a brick building.



The site plan: the EPIC system, shown in blue, in the green areas around the two townhome buildings.

RECORDS Technical paper on Wildwood Commons by William McCully PE, RESI, with the site performance table for 2007; Wildwood Commons case study and testimonial sheet; construction photographs, May 2006.



EPIC CASE STUDY

BOOKMEN STACKS PARK PLAZA

MINNEAPOLIS, MINNESOTA, USA · A PARK-LIKE INTENSIVE GREEN ROOF

A park on top of a parking garage, inside a weight budget of 60 to 80 pounds per square foot saturated, and every apartment facing it sold.

60 to 80
LB/SQ FT SATURATED
Weight ceiling

10,000
GALLON STORMWATER
Detention, reused

2005 to 2016
DATED PHOTOGRAPHIC RECORD
2005 installation → October 2016

EVIDENCE LEVEL

DOCUMENTED · Design constraint, system spec and a 2005 to 2016 photographic arc · commercial outcome as stated by EPIC

The intensive green roof above the parking garage, Bookmen Stacks Park Plaza, Minneapolis, October 2016.

PROJECT RECORD

LOCATION	Urban core of Minneapolis, Minnesota, USA
BUILDING	A multi-storey development needing to maximise the use of any open space
LANDSCAPE ARCHITECT	Oslund and Associates
WEIGHT CONSTRAINT	The subsurface parking garage roof-weight capacity of 60 to 80 pounds per square foot, saturated
SYSTEM	The patented Muellner Green Roof™: an engineered profile using the EPIC System™ as passive irrigation and drainage
STORMWATER	Detained in a 10,000 gallon tank and reused safely
MATERIALS	Recyclable, made from local materials and post-consumer waste
PHOTOGRAPHIC RECORD	2005 installation · 2005 · 2007 · October 2016

THE PROBLEM

A multi-storey development in the urban core of Minneapolis needed to maximise the use of any open space it had. On this building, the open space available was the roof of the subsurface parking garage.

That set a hard structural ceiling: whatever went on top had to stay within a roof-weight capacity of 60 to 80 pounds per square foot when saturated. Saturated is the operative word; a green roof is heaviest exactly when it rains.

> "There was an extensive search to provide an intensive park-like green roof system that supports plant diversity, water management goals and has light weight characteristics."
>
> EPIC case study, Bookmen Stacks Park Plaza

WHAT EPIC BUILT

EPIC implemented its patented Muellner Green Roof™, an engineered profile that uses the EPIC System™ as a passive irrigation and drainage system, in collaboration with the landscape architecture firm Oslund and Associates.

The result is an intensive, park-like green roof: it increases usable structure space, provides water management opportunities, enhances roof membrane longevity and decreases site hard surfaces.

Stormwater is detained in a 10,000 gallon tank and reused safely. The Muellner Green Roof™ profile is recyclable and made from local materials and post-consumer waste.



2005 Installation: the EPIC profile going down on the roof membrane.



Growth in the first year.

60 to 80	10,000	2005 to 2016
LB/SQ FT SATURATED WEIGHT CEILING	GALLON STORMWATER DETENTION, REUSED	DATED PHOTOGRAPHIC RECORD

THE RECORD

The design constraint, the stormwater system and the outcome, as recorded for the project.

	AS RECORDED
Roof-weight capacity respected	60 to 80 lb/sq ft saturated
Stormwater detention	10,000 gallon tank, water reused
Commercial outcome	Every unit facing the green roof sold out; units facing elsewhere were 75% vacant
Photographic record	2005 installation → October 2016, eleven years

The commercial outcome is as stated in EPIC's case study for the project.

THE COMMERCIAL RESULT

“Additionally, Bookmen Stacks sold out every unit facing the green roof while units facing elsewhere were 75% vacant. The enhanced usability, function and aesthetics of this green space resulted in increased occupancy.”

EPIC case study, Bookmen Stacks Park Plaza



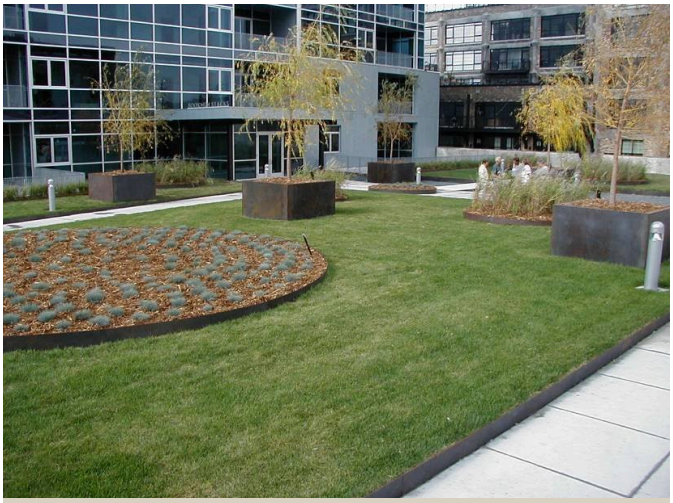
Oct 2016 The plaza over the parking garage.



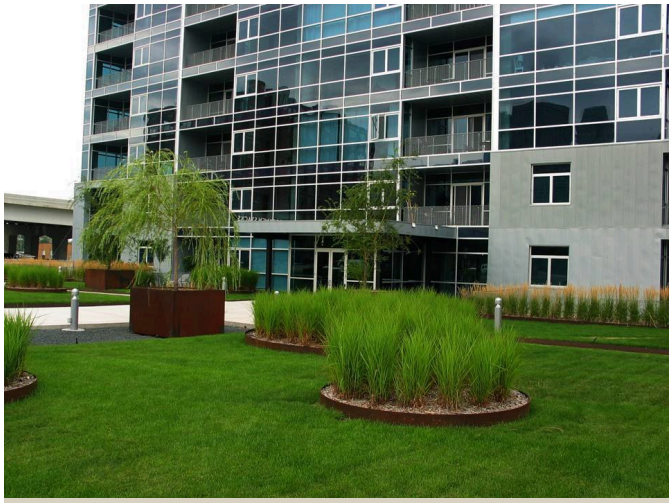
Intensive planting inside a 60 to 80 lb/sq ft budget.

ALSO ON THE RECORD

- **What an intensive roof buys.** “Our park-like, intensive green roof increases usable structure space, provides water management opportunities, enhances roof membrane longevity and decreases site hard surfaces.”
  EPIC case study, Bookmen Stacks Park Plaza
- **Eleven years.** Dated photographs of this roof run from the 2005 installation through 2005 and 2007 to October 2016, an unusually long visual record for a green roof.
- **Materials.** “Muellner Green Roofs™ are recyclable and made from local materials and post-consumer waste.”
  EPIC case study, Bookmen Stacks Park Plaza



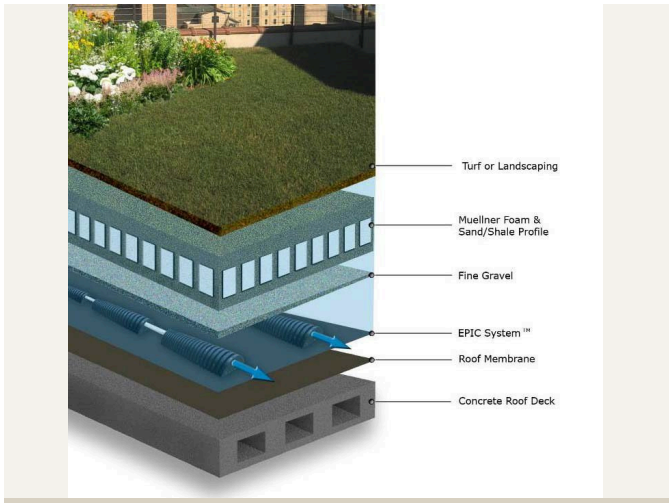
2005 The roof landscape.



2007 The same roof.



Oct 2016 Pathways through the plaza.



The green roof profile: turf or landscaping, Muellner foam and sand/shale profile, fine gravel, EPIC System™, roof membrane, concrete roof deck.

RECORDS EPIC case study for Bookmen Stacks Park Plaza; dated site photographs of the roof, 2005 installation to October 2016; EPIC green roof cross-section diagram.



EPIC CASE STUDY

TCF BANK STADIUM

UNIVERSITY OF MINNESOTA · MINNEAPOLIS, USA · OPENED 2009

The first collegiate or professional football stadium to earn LEED Silver. EPIC is the stormwater system inside the certification.

LEED	3.75	589
NEW CONSTRUCTION SILVER	ACRE WATERSHED	CHAMBERS
Certified by the USGBC	Stored and treated	One per 40 sq ft

EVIDENCE LEVEL

CERTIFIED · USGBC LEED-NC Silver, awarded to the stadium · two trade-press accounts · 2012 and 2016 photographic record

The landscaped plaza beside the stadium, Minneapolis, October 2016: half an acre of usable green space with the stormwater system beneath it.

PROJECT RECORD

PROJECT	TCF Bank Stadium, University of Minnesota East Bank campus, Minneapolis
OPENED	2009 · 50,000 seats · constructed by M.A. Mortenson Co.
CERTIFICATION	First collegiate or professional football stadium to earn Leadership in Energy and Environmental Design, New Construction Silver from the U.S. Green Building Council
DESIGN ENGINEERING	Rehbein Environmental Solutions Inc. (RESI), Minneapolis
INSTALLER	R&R Horn and Associates
GEOMEMBRANE	EPDM-R, 45-mil, Firestone Specialty Products
SITE	A half-acre landscaped plaza adjacent to the stadium, over a 0.54-acre underground system

THE PROBLEM

"At the stadium, space is at a premium," said Mark Apfelbacher, sustainability consultant at RESI. A 50,000-seat stadium was going up on a highly developed urban campus, and the stormwater had to be managed inside the confines of the limited usable green space that remained.

A conventional answer would have been a stormwater holding pond: land given over to infrastructure and nothing else, on a site with no land to spare.

The green space that did exist could not simply be lawn. On game days it has to carry broadcast trucks, emergency vehicles, maintenance vehicles and staging.

And the water leaving it drains to the Mississippi River.

WHAT EPIC BUILT

A multifunctional system beneath the landscaped plaza that removes the need for a holding pond altogether. It is non-pressurised and gravity-flow, relying on capillary water movement and evapotranspiration from a subsurface water supply, so it drains, treats and irrigates at the same time.

RESI excavated and prepared the watershed subsurface as a laser-level flat basin with 3:1 and 4:1 rising slopes. Approximately 100,000 sq ft of 45-mil Firestone EPDM geomembrane went down as an impervious barrier over the existing soil, in 20 ft × 100 ft panels overlapped 6 in, primed and secured with QuickSeam tape. A four-person crew completed the liner in about five days.

On top of the liner: the EPIC chambers and piping, fine aggregate, then the turf system with its sand profile, the whole covered with sod.

Above ground, ReFlex polypropylene mesh, the Netlon advanced turf system, is blended into the top 8 in of soil. It stabilises the soil, improves load-bearing capacity, reduces compaction and decreases rutting and deformation from vehicle parking. Liner and turf system were used in combination to minimise soil erosion and stabilise the slopes.



Chambers and connecting pipes installed on top of the geomembrane liner.



The plaza from above: the lawn strips between the sidewalks and the street sit over the system.

LEED
NEW CONSTRUCTION SILVER CERTIFIED BY THE USGBC

3.75
ACRE WATERSHED STORED AND TREATED

589
CHAMBERS, ONE PER 40 SQ FT

THE RECORD

Pollutant removal capability of the completed system, as stated by RESI.

POLLUTANT	STATED REMOVAL CAPABILITY
Phosphorus	more than 85%
Total suspended solids	90%
Nitrates	60%

> "The completed storm water system, according to Muellner, has the capability to remove more than 85% of phosphorous pollutants, 90% of total suspended solids and 60% of nitrates." Dave Muellner, senior project manager, RESI, in "Geomembrane Defense", Storm Water Solutions, July/August 2010.

CAPACITY AND CATCHMENT

	AS PUBLISHED	STATED IN
Drainage area	3.75 acres	Geosynthetics 2009; Storm Water Solutions 2010; EPIC site sheet
System footprint	0.54 acres, one seventh of the drainage area	Geosynthetics 2009
Chambers	589 total, one per 40 sq ft	Geosynthetics 2009
Below ground	more than 60,000 gal	Geosynthetics 2009; Storm Water Solutions 2010
Equivalent rainfall	a 0.50 in rainfall event, below ground	Geosynthetics 2009
Above ground	more than 72,000 gal	Geosynthetics 2009
Combined	more than 140,000 gal	Storm Water Solutions 2010
Rain event managed	all runoff from a 3.5 in event; over 3.50 in in 24 hours	Storm Water Solutions 2010; EPIC site sheet

> Geosynthetics 2009 gives the exact chamber count of 589 at one per 40 sq ft, and records that the 3.75-acre drainage area is seven times the 0.54-acre footprint of the system itself. Storm Water Solutions 2010 describes the same count as "nearly 600". Capacity figures are minimums.

ALSO ON THE RECORD

- **The stadium's wider sustainability result.** Potable water used for landscape irrigation was cut in half, and a 30% reduction in indoor potable water use was achieved. Alongside: 97% of the nearly 9,000 tons of steel came from recycled steel, and 98% of construction waste from the site was recycled.
  Storm Water Solutions, July/August 2010

- **Doug Lauer, landcare supervisor, University of Minnesota.** "From a sustainability standpoint, we're able to reduce our need, and related costs, for irrigation because the roots from the turf pull water up through the sand profile… We also save money by eliminating the disposal of water down the storm sewer."
  Storm Water Solutions, July/August 2010

- **And on how it came through the seasons.** "[The system] withstood the summer rains well, and there were no problems with any of the pipes throughout the winter… The turf is healthy, green and growing well, even though it gets a lot of student traffic."
  Doug Lauer, Storm Water Solutions, July/August 2010

- **The benchmark it was measured against.** Geosynthetics 2009 describes the water-treatment capability of the system as "similar to, but more effective than, sand-filter technology", and records that a major league sand filter was installed at the stadium as a prior component of the stormwater system, capable of removing up to 70 to 85% of total suspended solids and up to 35% of pathogens including coliform, streptococci and E. coli.
  Geosynthetics, February/March 2009

- **Dave Muellner, senior project manager, RESI.** "With limited space available at the stadium, this multifunctional system eliminates the need for a traditional storm water holding pond, while improving water quality… It also provides the university with an open green space that is strong enough to support heavy vehicles used by media, emergency personnel, maintenance staff and others during football games."
  Storm Water Solutions, July/August 2010



A RAINFALL OBSERVATION FROM SITE

About ten minutes after a thunderstorm. Runoff from the conventional grass in the foreground reaches the gutter; the EPIC sections beyond show none.

PUBLISHED ACCOUNTS

- **Storm Water Solutions, July/August 2010.** "Geomembrane Defense", by Chuck Pappas, chief executive officer, Rehbein Environmental Solutions Inc. © Scranton Gillette Communications, Inc., reprinted with permission.

- **Geosynthetics, February/March 2009.** By Ron Bygness, editor, and Mark Apfelbacher, sustainability consultant, Rehbein Environmental Solutions Inc. © Geosynthetics, reprinted with permission of IFAI.

Both articles expand EPIC as "Environmental Passive Integrated Chamber", the name in use at the time.



Jul 2012 **THREE YEARS AFTER OPENING**

The plaza turf.



Oct 2016 **SEVEN YEARS IN SERVICE**



Autumn 2016

The same lawn.

RECORDS EPIC site sheet for the University of Minnesota TCF Bank Stadium; Storm Water Solutions, July/August 2010; Geosynthetics, February/March 2009; site notes; dated site photographs, July 2012 and October 2016.



EPIC CASE STUDY

WASHBURNE STADIUM

SOUTHERN METHODIST UNIVERSITY · DALLAS, TEXAS, USA · INSTALLED 2006

A soccer field built on subsurface irrigation in 2006, photographed through construction, photographed playable in the middle of a four-inch rain, and photographed dense and green on 29 August 2026, with no measurable rain that month.

2006	0.00 in	2
INSTALLED 2006, IN PLAY 2026	RAINFALL AT DALLAS	12-VOLT PUMPS
Stadium rebuilt and reopened 2022	1 to 29 August 2026	The whole plant

EVIDENCE LEVEL

DOCUMENTED · 2006 construction photographic record · dated site photography January 2007, August 2011 and August 2026 · NOAA NCEI station record · account from the project's originator, September 2026

Washburne Stadium, Southern Methodist University, Dallas, 29 August 2026.

PROJECT RECORD

SITE	The soccer field at Westcott Field, Southern Methodist University, Dallas, Texas
INSTALLED	2006, ready for that autumn's competition
SURFACE AND DELIVERY	Natural grass on a flat field, laid as rolled sod on a sand profile over EPIC chambers and geomembrane. Water is delivered below grade, direct to the root zone: no sprinklers, no overhead spray, and no irrigation water reaching the playing surface.
PLANT	Two 12-volt sump pumps and an irrigation controller, with a solar panel at installation

THE PROBLEM

The playing surface sat inside the Morrison-Bell running track. Enclosed that way, it was difficult to drain and difficult to keep to a standard that would let the programme qualify to host playoff matches at home.

In 2006 the incoming soccer coach asked for help revising the surface. J.W. Davis, a former SMU letterman who had supported the soccer programme and sat on the hiring committee, went looking for a technology that would solve the drainage problem rather than manage it, and located EPIC for the university.

WHAT WAS BUILT

A flat field over a sealed subsurface system. A geomembrane liner went down over the prepared subgrade, EPIC chambers and connecting pipework were laid on the liner, then gravel, then the sand profile, then sod.

The turf is laid as rolled sod on a sand profile kept damp by capillary action from below, so from the day it goes down the grass draws from beneath it and the roots grow downward chasing that moisture. The plants take up only what they are calling for, and that uptake is what lowers the water level: plant demand governs how much water leaves the sand, not a timer.

Rain reverses the direction of flow rather than adding to it, moving down through the profile into the chambers beneath and overflowing to storage and then to the city storm system. The field drains as designed precisely because the profile is not already saturated from routine irrigation.

HOW IT WAS BUILT, 2006, IN ORDER



1 BEFORE
The old surface, boxed in by the track.



2 LINER
Geomembrane down in the excavation.



3 CHAMBERS
Chambers and pipework on the liner, sandbagged.



4 STORAGE
Storage and conveyance at the head of the field.



5 FLOOD TEST
The lined basin charged and standing full.



6 SAND PROFILE
Sand over the chambers, the layer capillary rise works through.



7 90 PER CENT
Graded out to the track edge, ready for sod.

2006
INSTALLED 2006,
IN PLAY 2026

0.00 in
RAINFALL AT DALLAS
1 TO 29 AUGUST 2026

2
12-VOLT PUMPS
THE WHOLE PLANT

THE RECORD

The site has no water meter and no control plot, so no water saving is measured here. What it carries instead is a dated photographic record at both ends of the water spectrum, from a four-inch rain in January 2007 to August 2026 with no measurable rain, set against a published station weather record.

DALLAS LOVE FIELD, 1 MARCH TO 29 AUGUST 2026	READING
Days in the period	182
Peak temperature	109°F, 22 July 2026
Days at or above 105°F	9
Rainfall, 1 to 29 August 2026	0.00 in, no measurable precipitation
Rainfall, July 2026	0.60 in on five days, four under 0.10 in

NOAA National Centers for Environmental Information (NCEI), daily summaries, Dallas Love Field station USW00013960.

THE FACILITY

1994	Opened as Westcott Field. Training venue during the 1994 FIFA World Cup, hosting the Netherlands, Germany, Bulgaria and Sweden.
2006	EPIC subsurface irrigation installed under the soccer field, ready for that autumn's competition.
2020	Gift from Heather and Ray Washburne.
2022	Stadium rebuilt and reopened as Washburne Soccer and Track Stadium, capacity 2,577, with new grandstands, locker rooms and an updated track on the retained footprint of the original field. According to J.W. Davis, the 2006 subsurface system was carried through that work unaltered.
2026	Selected again as a training site for the 2026 FIFA World Cup.

Facility history from SMU Athletics and KERA News, 19 May 2026. The carry-through of the 2006 system in 2022 as described by J.W. Davis, September 2026.

ALSO ON THE RECORD

- **The other end of the spectrum: 13 January 2007.** A photograph taken during the field's first winter is captioned in the original, in the photographer's own hand: “SMU Jan 13, 2007. Middle of 4″ Rain. Field is Playable”. The surface is uniformly green and shows no standing water. Draining a boxed-in field was the problem the system was installed to solve, and that photograph is the earliest dated evidence that it did.
- **The construction sequence was photographed.** Seven frames record the field before construction, the geomembrane down in the excavation, chambers and pipework laid and sandbagged against float, the storage tank, the flood test with the lined basin standing full, the sand profile and the field at ninety per cent. The field in service that January follows on page 5.

THE PLANT, AS DESCRIBED BY THE MAN WHO SPECIFIED IT

“The field is basically flat. The subsurface irrigation design that sits below grade and delivers water directly to the root zone, invisible below the sod. No sprinklers, no overhead spray, no wasted evaporation. The equipment operating it consists of two (2) 12-volt sump pumps, an irrigation controller (a small solar panel at install).”

J.W. Davis, September 2026



29 Aug 2026 Washburne Stadium. Subsurface irrigation, below grade: full, dense, uniform cover, with no dormancy, no thinning and no irrigation-pattern striping.



29 Aug 2026 Unirrigated ground a short walk away, photographed the same day: bare soil and desiccation cracking, the clay itself shrinking as it dries.



13 Jan 2007 **FIVE MONTHS IN**

Playable in the middle of a four-inch rain, which is the problem the field was rebuilt in 2006 to solve.



30 Aug 2011 **FIVE YEARS IN**

The last summer the operations staff were in regular contact with the installer.



29 Aug 2026 **TWENTY YEARS ON**

Dense and uniform after 29 days of August with no measurable rainfall.



29 Aug 2026 **NEARBY, SAME DAY**

Untreated turf gone dormant, green surviving only under the tree canopy.

RECORDS Account of the project by J.W. Davis, September 2026, with the 2006 construction sequence and the 29 August 2026 photography; site photographs: 2006 construction sequence, 13 January 2007, 30 August 2011 and 29 August 2026; NOAA NCEI daily summaries, Dallas Love Field station, 1 March to 29 August 2026; SMU Athletics facility history; KERA News, 19 May 2026.