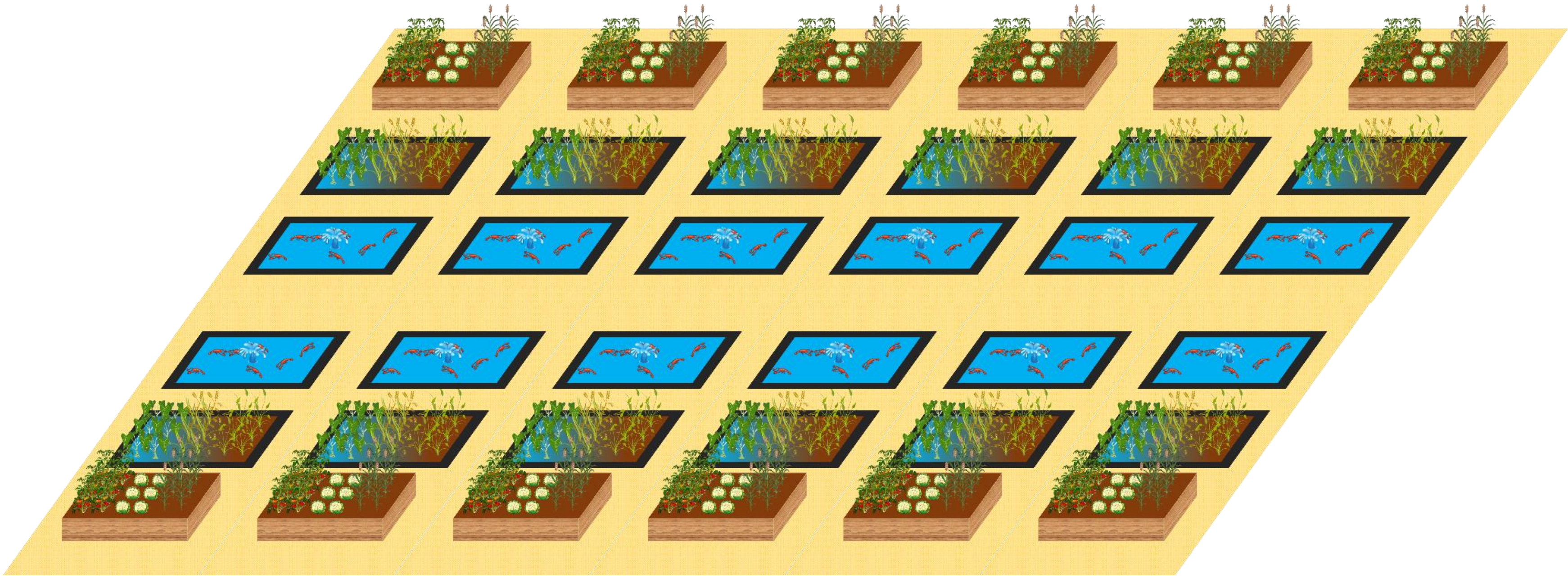
Project CRAWFISH: a water-smart, integrated vegetable garden and aquaculture system maintained with harvested rainwater and HVAC condensate



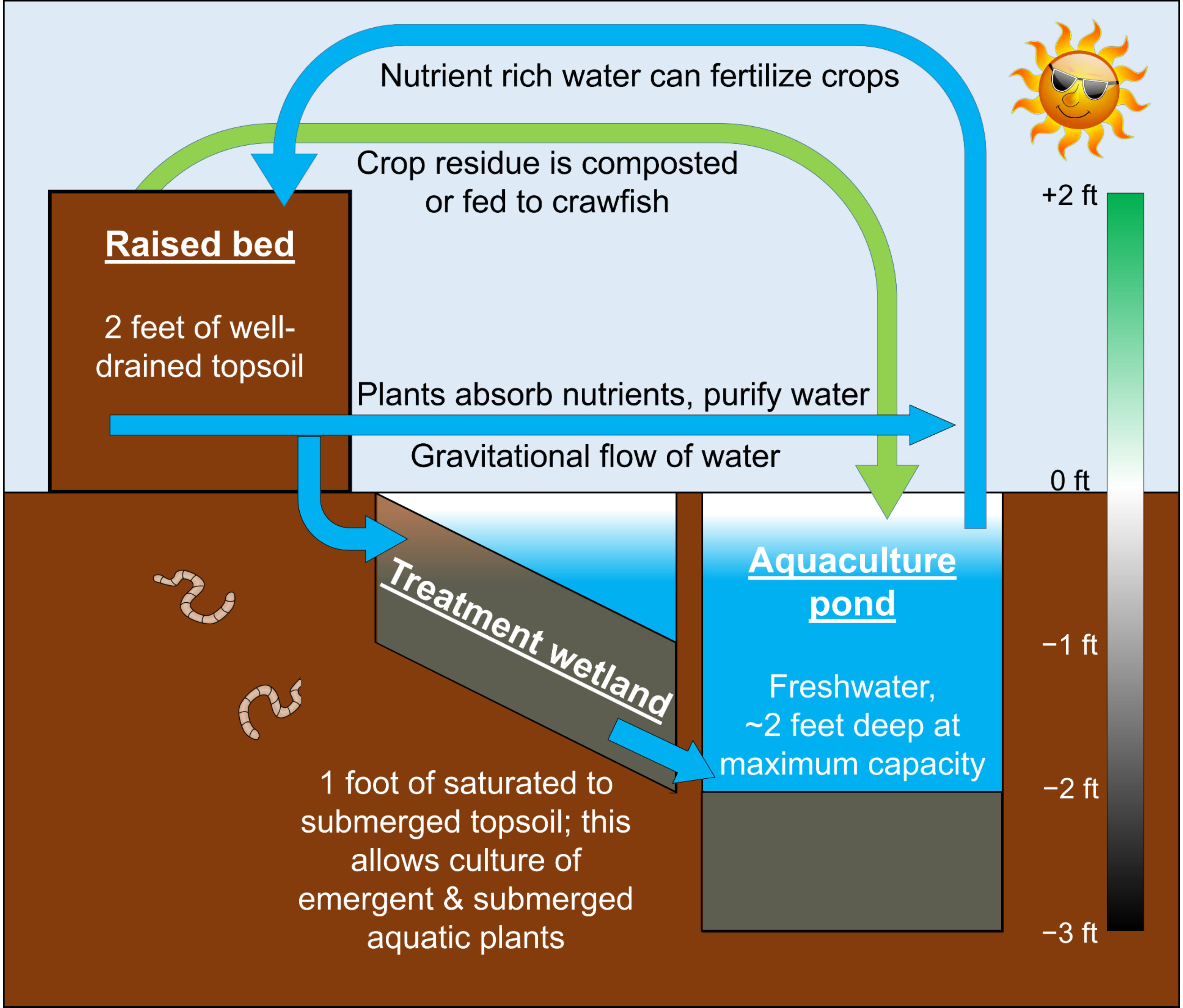
Christopher A. Gabler, Ph.D.
Assistant Professor
School of Earth, Environmental, and Marine Sciences & Dept. Biology
University of Texas Rio Grande Valley

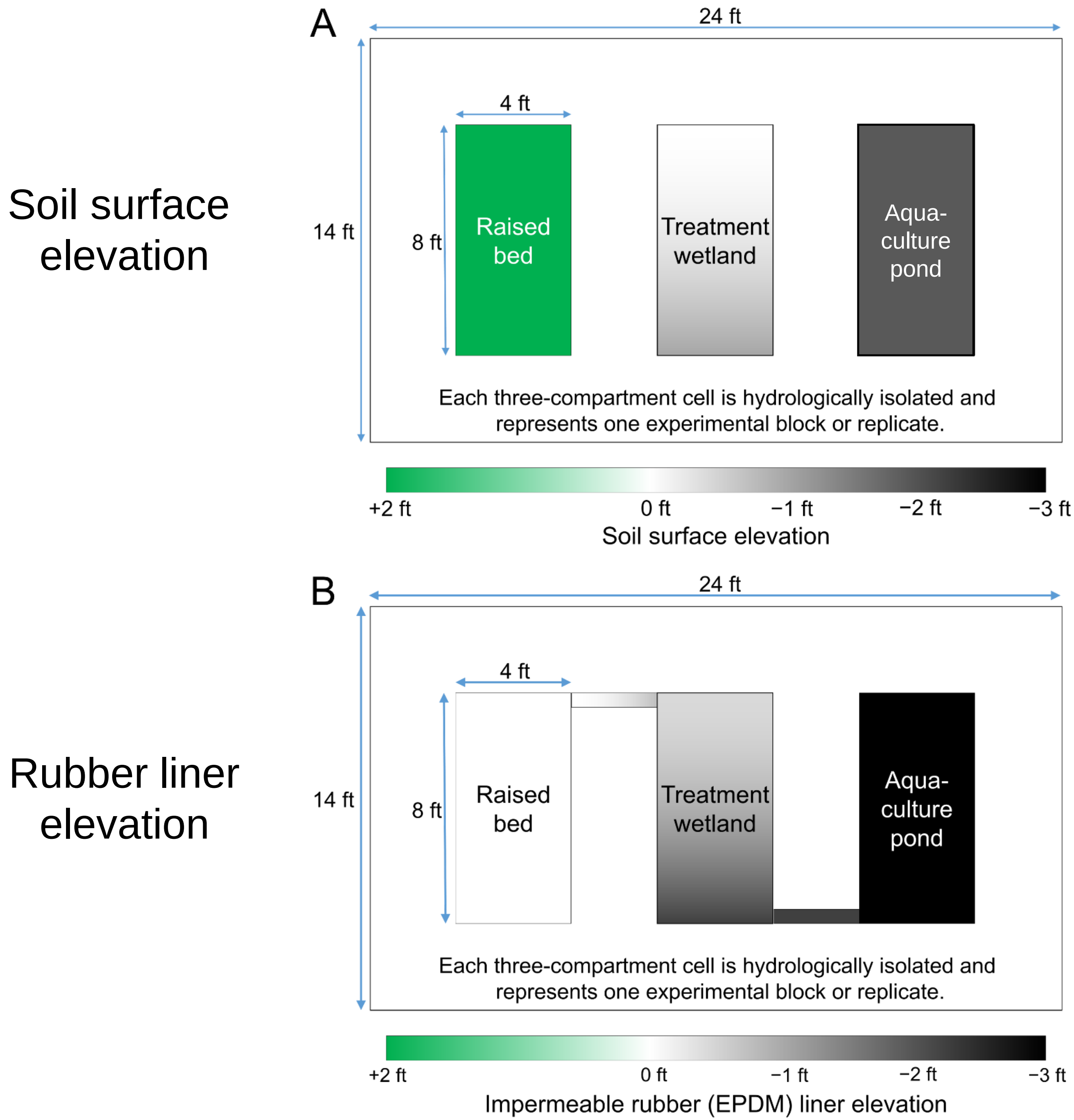
LRGV Water Quality Management & Planning Conference
South Padre Island – 24 May 2017

Dissecting the CRAWFISH

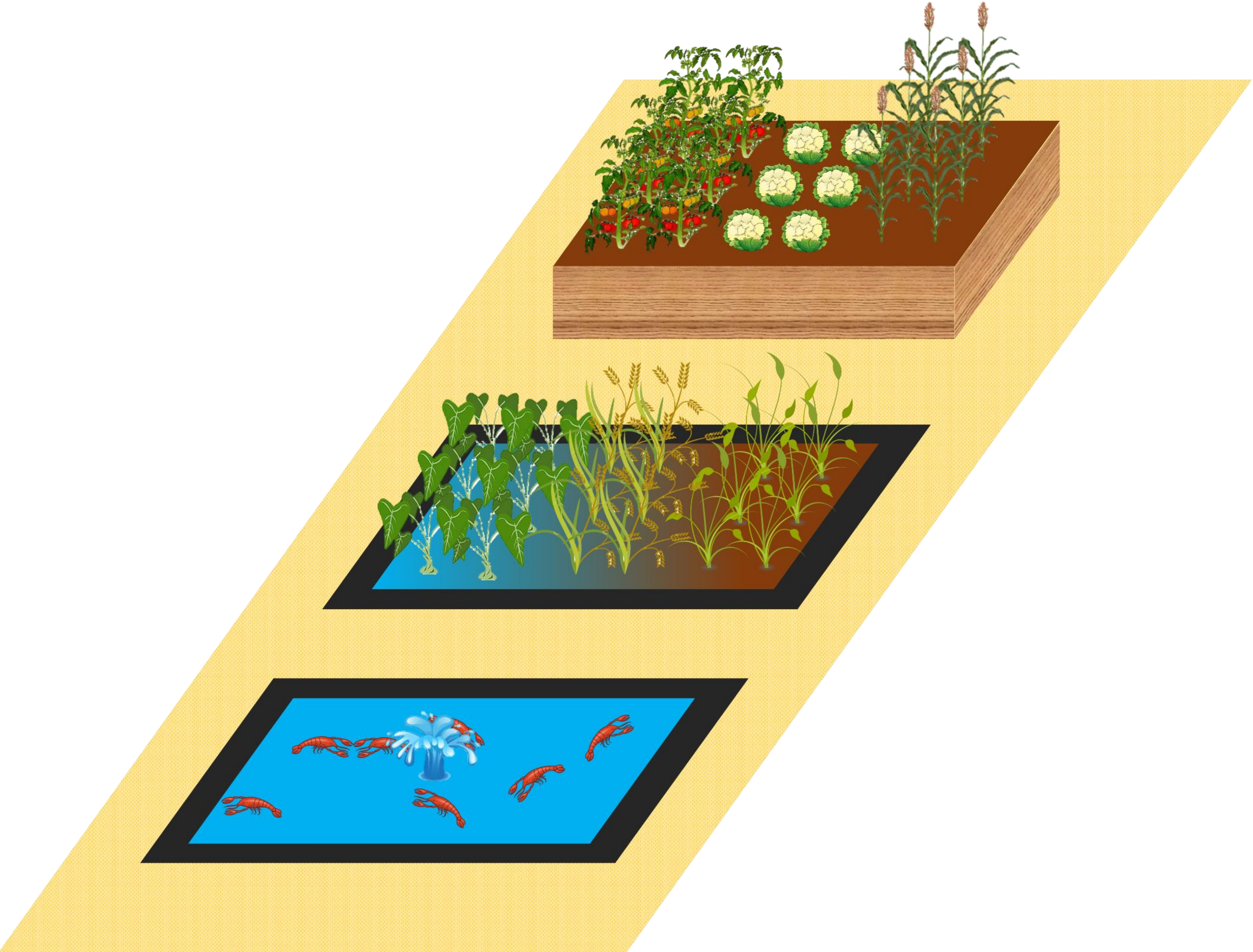
C
R
A
W
F
I
S
H

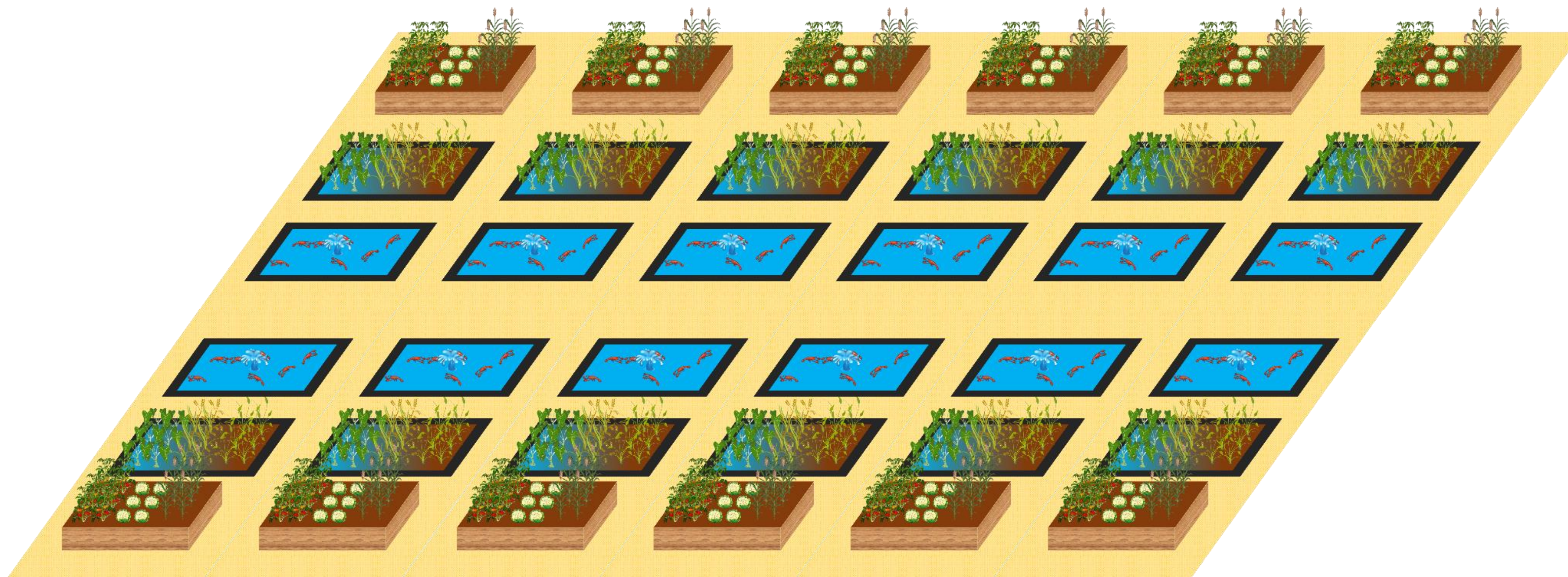
- **S**ystem for **H**usbandry – A way to produce food with several connected parts. Our system will act as a **community garden**.
- **W**atershed-**F**ood **I**ntegration – Food is produced in three compartments: raised beds, treatment wetlands, and aquaculture ponds. Compartments are hydrologically connected in that order to create ***model watersheds***. This system will uniquely demonstrate farm-wetland-fisheries linkages, and allow us to study these linkages and address watershed-scale research questions.
- **C**limate-**R**esilient – A key theme is **water scarcity**. Freshwater availability in the RGV is expected to decrease as our climate warms, and as conflict increases over water use for agricultural, municipal, and wildlife purposes. We will harvest rainwater and HVAC condensate for irrigation and emphasize husbandry of drought tolerant species (including crawfish).
- **A**groecological – We will be use only **organic, sustainable agricultural methods** based on ecological principles (e.g., biological control of pests, companion plants, etc.)


Nutrient rich water can fertilize crops
Crop residue is composted
or fed to crawfish
Raised bed
2 feet of well-
drained topsoil
Plants absorb nutrients, purify water
Gravitational flow of water
+2 ft
0 ft
−1 ft
−2 ft
−3 ft
Treatment wetland
Aquaculture pond
Freshwater,
~2 feet deep at
maximum capacity
1 foot of saturated to
submerged topsoil; this
allows culture of
emergent & submerged
aquatic plants



Soil surface elevation
A
24 ft
14 ft
4 ft
8 ft
Raised bed
Treatment wetland
Aqua-culture pond
Each three-compartment cell is hydrologically isolated and represents one experimental block or replicate.
+2 ft
0 ft
−1 ft
−2 ft
−3 ft
Soil surface elevation
Rubber liner elevation
B
24 ft
14 ft
4 ft
8 ft
Raised bed
Treatment wetland
Aqua-culture pond
Each three-compartment cell is hydrologically isolated and represents one experimental block or replicate.
+2 ft
0 ft
−1 ft
−2 ft
−3 ft
Impermeable rubber (EPDM) liner elevation





Four Broad Project Goals

1. To produce free and nutritious food for students and the local community
2. To create research capabilities in agricultural and environmental sciences
3. To create teaching resources for K12, undergraduate, and graduate students
4. **To engage the broader community through public outreach and extension services**

   Demonstrate municipal uses for stormwater management, sewage treatment, food production, and community recreation

Meta Goal: Promote Sustainability

Directly addressed by Project CRAWFISH

Indirectly addressed by Project CRAWFISH

Project CRAWFISH infrastructure design & construction

Objective 1 – **COMPLETE**

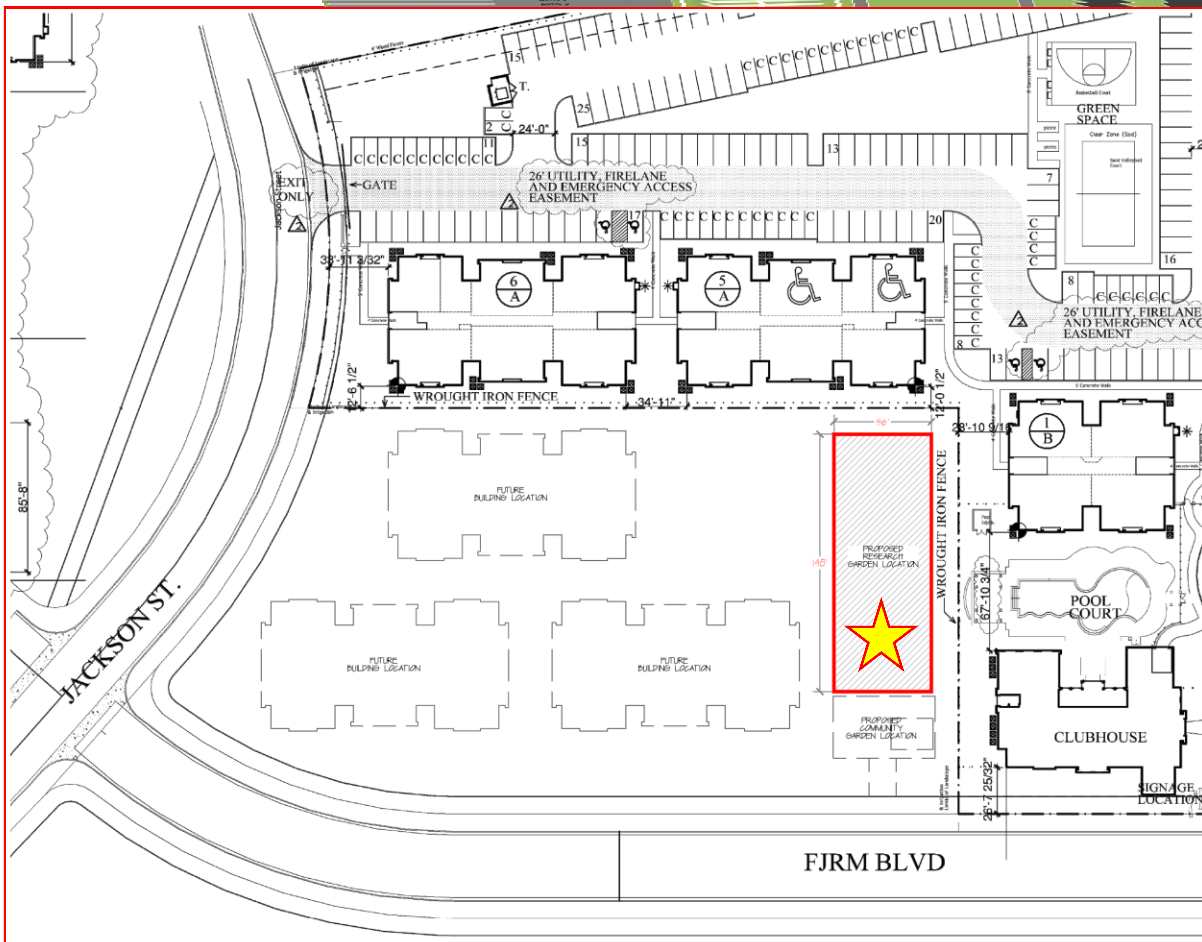
Create a community & research garden comprised of **<u>12 replicated model watersheds</u>**, each model watershed contains:

- **1 raised soil bed**
- **1 treatment wetland**
- **1 aquaculture pond**
- Each watershed is plumbed so water flows through all 3 parts in that order

- We built an earthen berm around the perimeter to control surface water flow

Garden Location

Approved Dec 2016



Garden Construction

Jan 2017 – Area surveyed, plots delineated

Jan 2017 – We removed sod from wetland and pond plots & used it to cover the berm.

Jan 2017 – Campus Facilities Operations donated a backhoe and operator time.

Jan 2017 – Students shape the earthen berm and arrange sod to reduce erosion.

Jan 2017 – Our Winter Break construction crew poses with Rodney the operator.

Jan 2017 – Rough holes had to be shaped by hand to exact dimensions.

Jan 2017 – Digging complete

Jan 2017 – Plumbing began by cutting 60 mil rubber liners to size; each roll weighed 180 lbs.

Jan 2017 – Students have been generous with both their time and their vehicles.

Feb 2017 – Geotextile fabric is pinned in place first, then the EPDM rubber liners.

Feb 2017 – With wetlands and ponds lined, we began building the raised beds.

Feb 2017 – All cutting complete; ready to assemble beds

Feb 2017 – Raised beds were lined with rubber to capture water and move it to wetlands.

Feb 2017 – Construction complete. Next step: move 60 cubic yards of soil (4 dump trucks).

Mar 2017 – We planted the raised beds once filled; the rest of the soil is in the background.

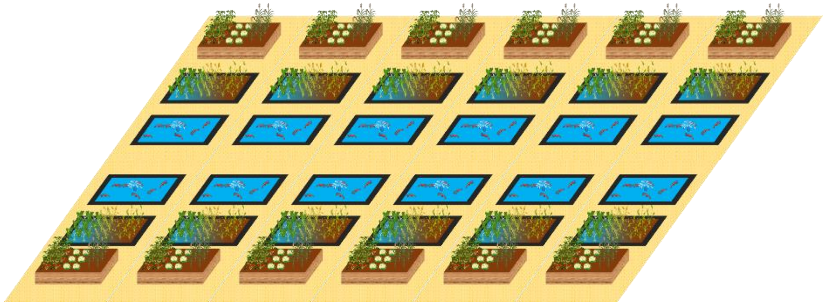
May 2017 – Ribbon-cutting ceremony to signify public grand opening.


CRAWFISH


SIX FLAGS


CRAWFISH
Rio Grande Valley
College of Sciences
FIESTA TEXAS
MBB
34


CRAWFISH
Rio Grande Valley
College of Sciences

What are we growing (now)?

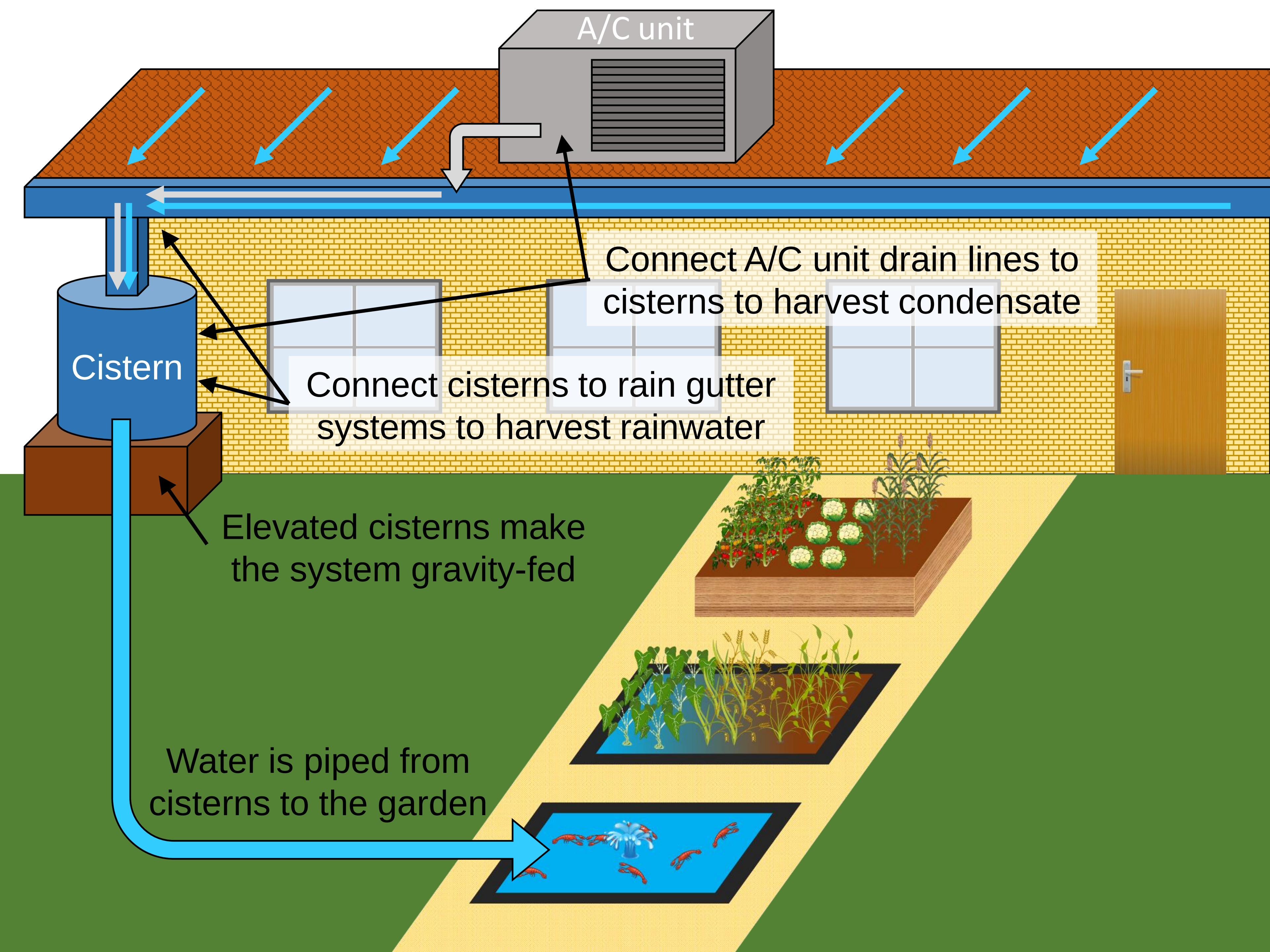
- **Raised beds** – will vary by year & season
  - Spring 2017: Chard (2 varieties), green beans, peppers (4 varieties), sorghum, sunflowers, & tomatoes (4 varieties)
- **Wetlands** – will vary by year
  - Rice (var. Presidio)
  - Lotus (*Nelumbo nucifera*)
  - Taro (*Colocasia esculenta*)
- **Ponds** – may vary by year
  - Red swamp crawfish (*Procambarus clarkii*)
  - Texas natives; can survive droughts by creating water-filled burrows with mud "chimneys", even if their ponds dry up

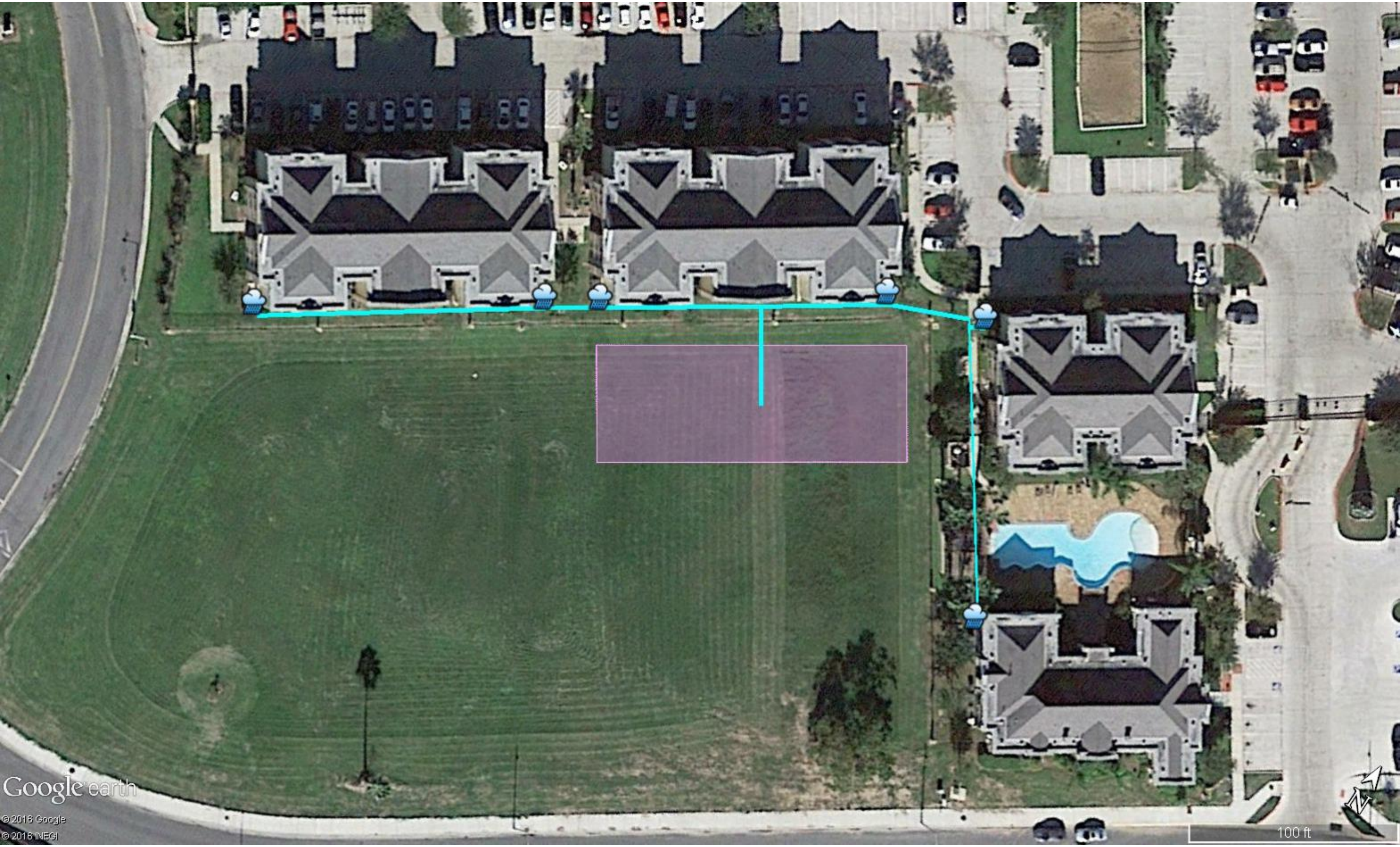
Future Project Plans

Objective 2: Create and integrate **rainwater & HVAC condensate harvesting and storage systems** to provide water for the garden.

Goal: ZERO municipal water

Objective 3: Create and integrate a **system to compost organic waste from UTRGV Brownsville campus** and the local community to provide compost for the garden.


A/C unit
Connect A/C unit drain lines to cisterns to harvest condensate
Cistern
Connect cisterns to rain gutter systems to harvest rainwater
Elevated cisterns make the system gravity-fed
Water is piped from cisterns to the garden


Google earth
© 2016 Google
© 2016 INEGI
100 ft
N

Relevant Experiments

- Current experiment is testing which wetland species are the best for various functions
  - Treatments: rice, taro, lotus, or rice+taro+lotus
  - Response variables: water quality, crop production, carbon sequestration, N & P assimilation
- Future experiments will deal with minimization of water loss due to evaporation and transpiration
  - For example: test efficacy of different types of covers, examine impacts on production
  - Test new tech like floating surface covers

Application of Project CRAWFISH design and principles for municipal use

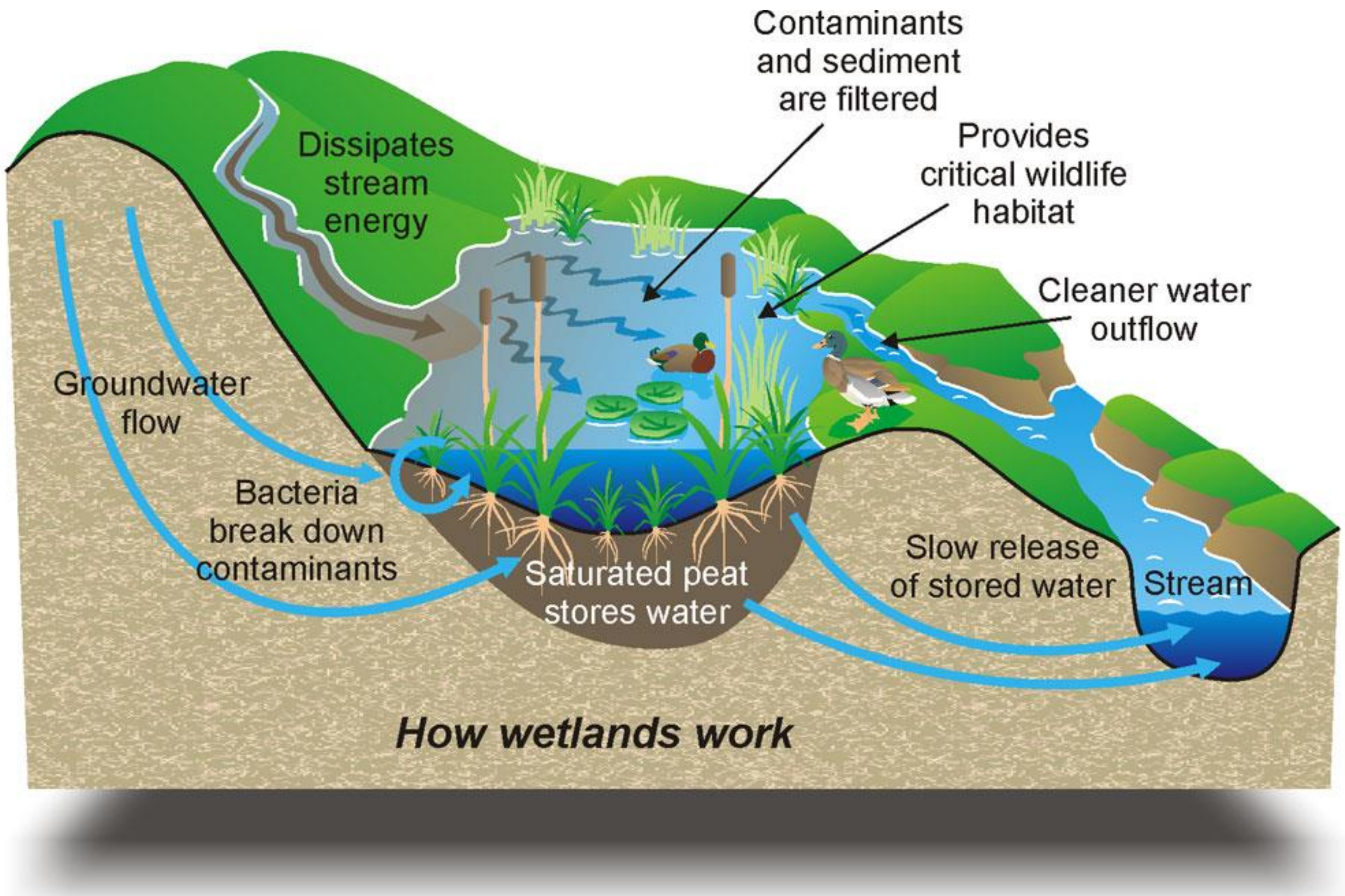
Application for municipal use

- Scalability
- Water treatment & retention
  - Storm water and/or sewage
- Food production
  - Role in public health
- Wildlife habitat
- Community recreation
- Integrated role in urban development

Scalability

- Project CRAWFISH was designed to be scalable
  - Apartment balcony
  - Suburban back yard
  - Small business
  - Commercial operations
- If employed for municipal use, especially for stormwater or sewage management, major design modifications will be required, but the same key principles apply

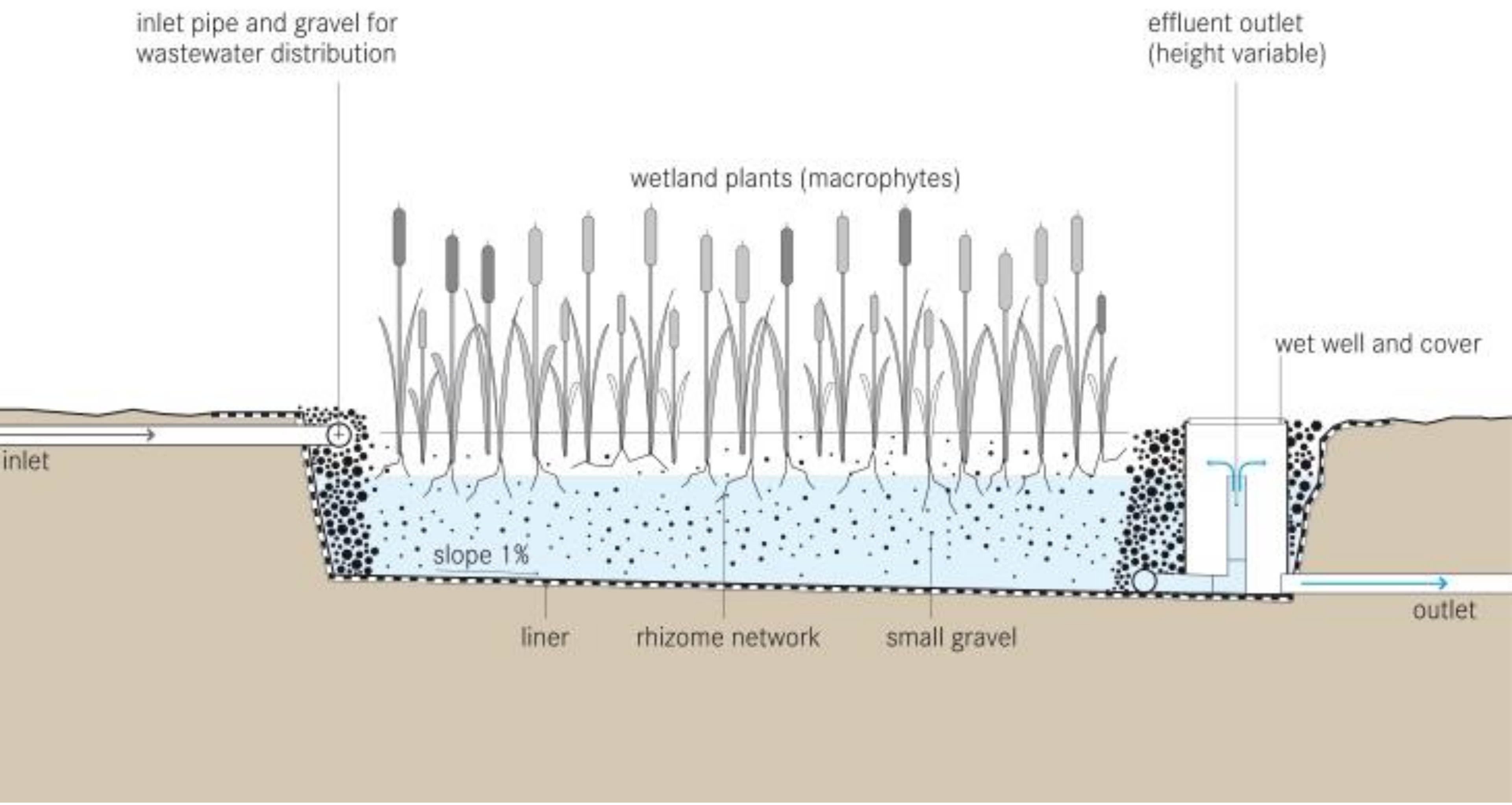
Water treatment & retention



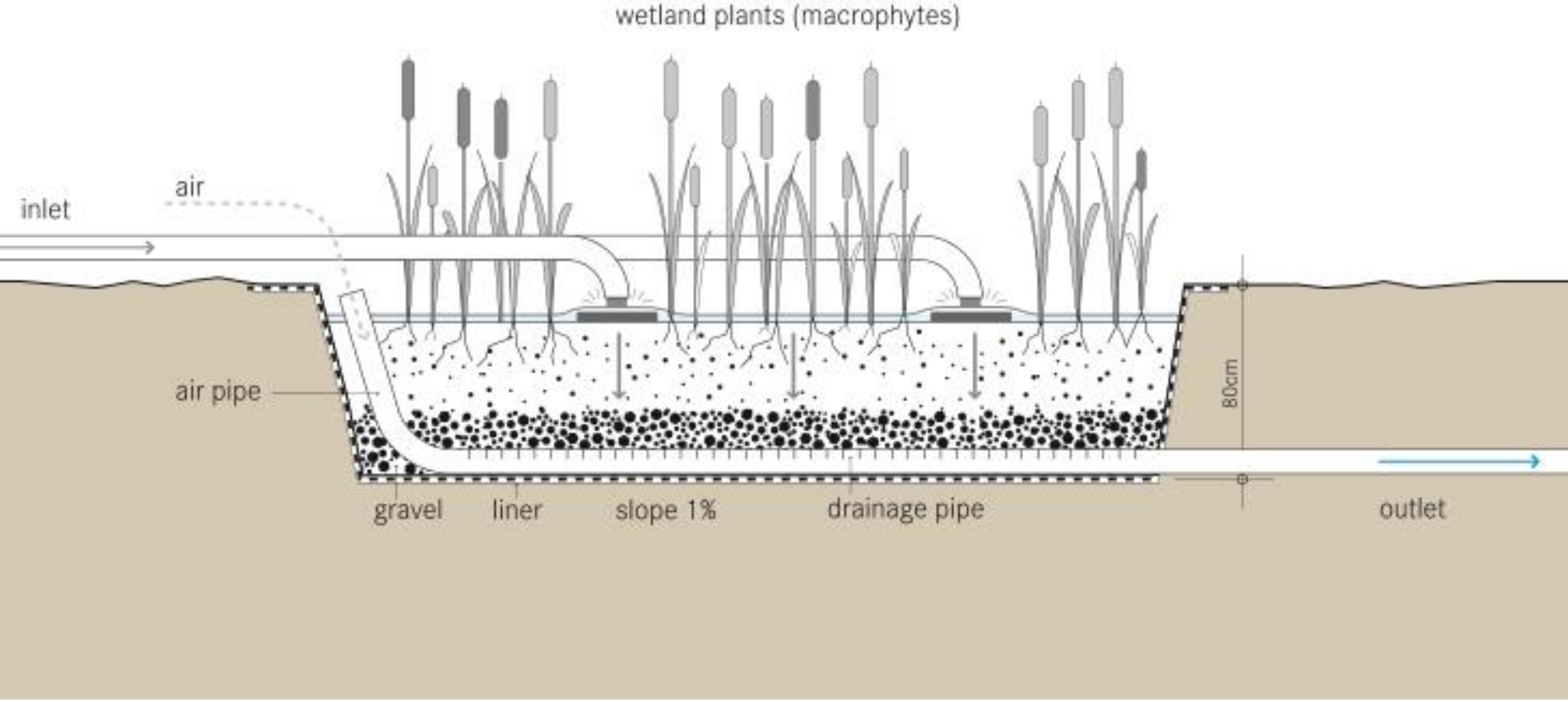
Water treatment & retention

- Constructed wetlands
  - Engineered sequence of water bodies designed to filter and treat waterborne pollutants found in sewage, industrial effluent or stormwater runoff
  - Commonly used for wastewater treatment or for greywater treatment
  - Can be incorporated into an ecological sanitation approach, or used after a septic tank for primary treatment
  - 2 basic types: **subsurface flow** and **surface flow wetlands**
- Vegetation in a wetland provides substrate (roots, stems, and leaves) for microorganisms that break down organic materials.
  - Microorganisms provide the bulk of pollutant removal and waste breakdown, and convert N and P compounds into forms plants can assimilate
  - Plants remove some pollutants, act as a carbon source for the microbes when they decay, and take up N and P
  - Many aquatic plants can assimilate heavy metals.
- Many regulatory agencies list treatment wetlands as one of their recommended "best management practices" for controlling urban runoff.

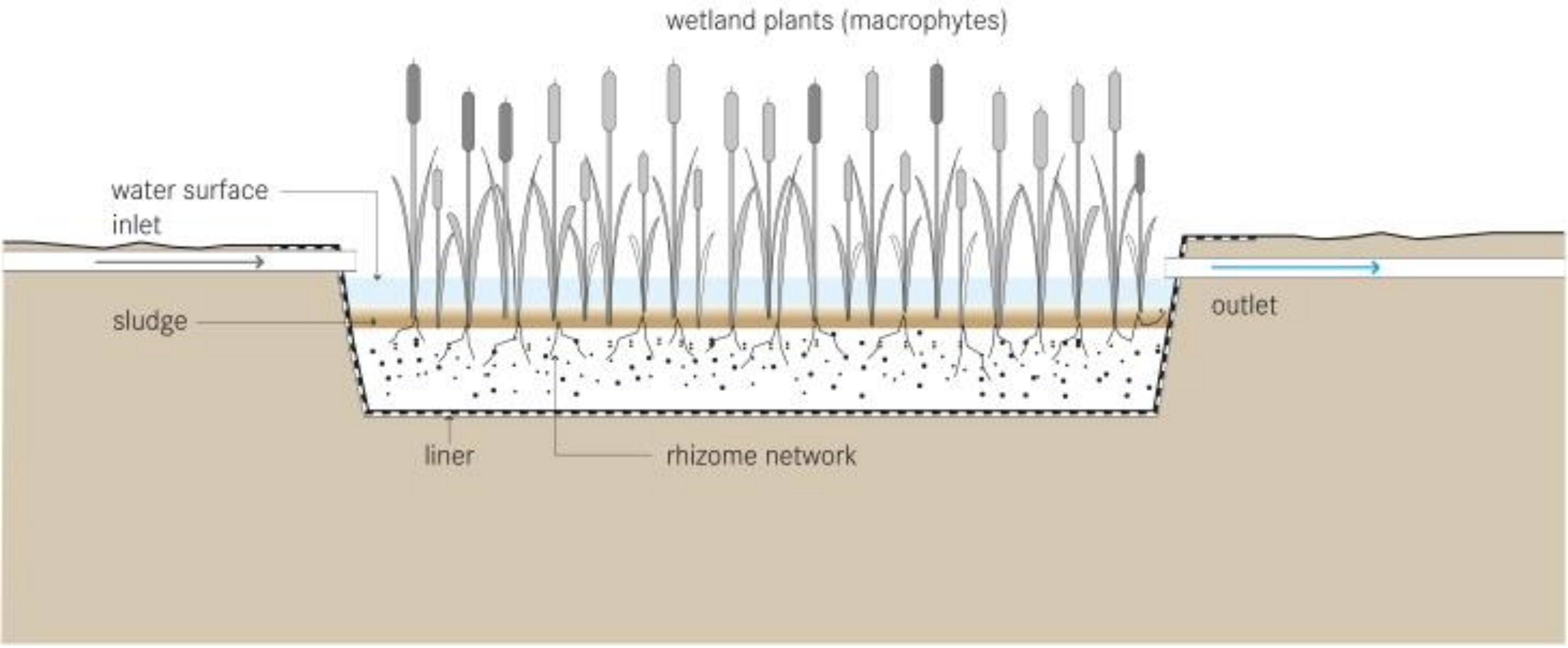
Subsurface flow (horizontal)



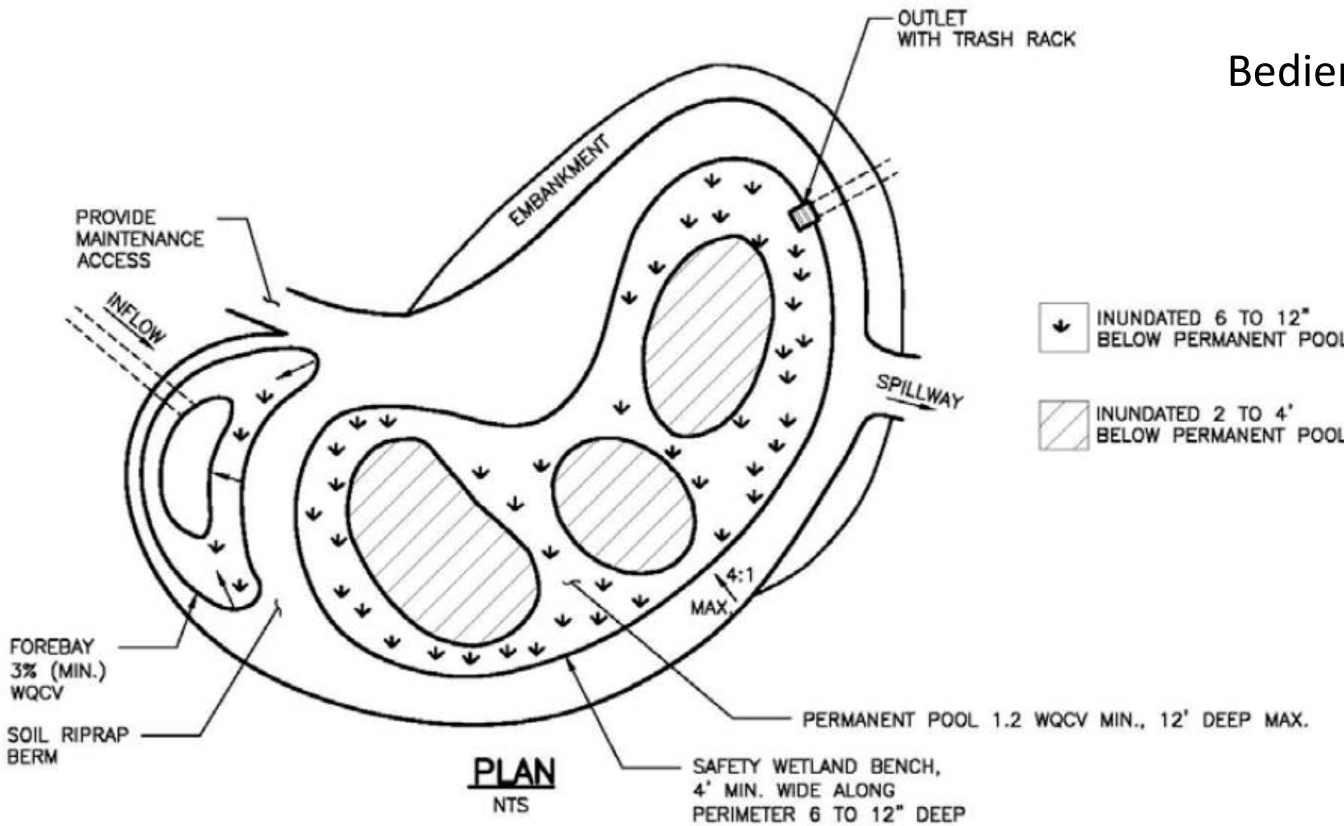
Subsurface flow (vertical)

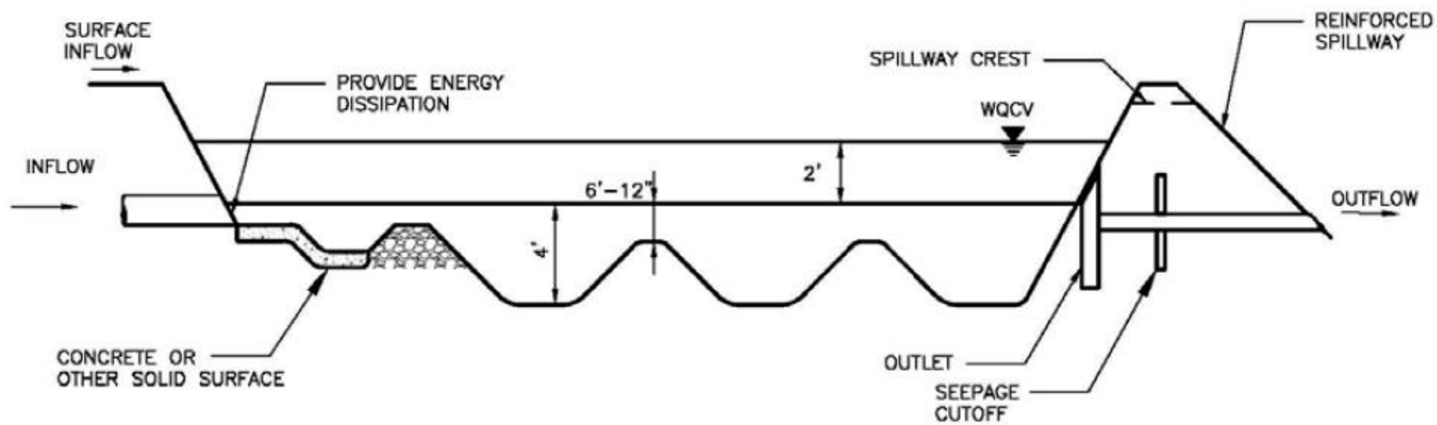


Surface flow



Bedient & Huber, 1992





Clayton County Water Authority (GA)

Sewage treatment constructed wetland (IN)

Wildlife, food, recreation, and sustainable urban development