Understanding Legal Indoor Cannabis Cultivation Facilities

Chris Wrenn

5/2024

AEssenseGrows.com

Learning Objectives

- Basic understanding of cultivating cannabis
- Styles of growing
- Equipment options and ramifications
- Potential dangers

Cannabis is a photoperiodic plant

- Long daylight hours means it grows “vegetatively”
- Once daylight hours drop to 12 hours then hormones are triggered to induce flowering
- Hardy mums are also photoperiodic plant that we use as a surrogate

Only females need apply

- The “bud” or “flower” is the most desired part of the plant
  - Although THC can be extracted from the fan leaves
- Only females produce bud
- Male plants will turn bud into seeds
  - Typically males are only required for breeding and are maintained in segregated areas
- Eliminating male plants from a grow will maximize the production of sticky, resinous bud

Only females need apply

- As female plants are desired there are three common ways of “guaranteeing” female plants
  1. Cloning: cuttings are taking from mature “mother” plants and using rooting hormones the cuttings are rooted
  2. Tissue Culture: small tissue cuttings are taken and grown aseptically until small rooted plants develop
  3. Feminized seeds

Understanding Cannabis Cultivation

- Cannabis cultivation can be broken down into three stages which typically take place in dedicated rooms
  1. Cloning: < 2 weeks
  2. Vegging: 2 to 6 weeks on average
  3. Blooming: approximately +/- 8 weeks driven by strain genetics

Cloning

- Photoperiod: 18/6 or 24/0
- Duration: 7-14 days

ÆssenseGrows

Vegging in hand-watered coco

- Photoperiod: 18/6 or 24/0
- Duration: 2-6 weeks on average

ÆssenseGrows

Blooming in hand-watered coco

- Photoperiod: 12/12
- Entering during lights off can be done with green lights
- “White” lights could throw off photoperiod or even cause some strains to hermaphrodite or “herm”
- Duration: ~8 weeks

ÆssenseGrows

Learning Objectives

- Basic understanding of cultivating cannabis
- Styles of growing
- Equipment options and ramifications
- Potential dangers

Plant density

- There are 31 flavors of ice cream at Baskin Robbins and there are at least 31 different ways to cultivate cannabis
- One of the big decisions is to determine how big one wants to grow their plants as this will affect velocity through the facility and plant counts
  - In “plant count” jurisdictions one will want to optimize their grow to get the most yield out of individual plants
  - In “canopy” jurisdictions one will want to optimize their grow by getting the most yield per square foot per year

Big plants

- This photo shows blue dream vegged to ~8’ tall and then bloomed
- Effectively this gives 3 harvests/year

ÆssenseGrows

SOG/SCROG

- Sea Of Green (SOG) and Screen Of Green (SCROG) are high density methods were lots of plants are illuminated under one light
  - Typically 20-24 plants per light
  - Reduces veg time to days (~2-14 days)
  - Effectively this can provide up to 6 harvests a year

Comparing Efficiencies

- If we get 4 lbs (1816 grams) from approximately 16 sq. ft., which is the approximate square footage of coverage of an average double-ended HPS light, then we have 1816g/16sq. Ft. = 113.5 g/sq. ft.
  - But with the much longer grow cycle required this method only gets 3 turns a year out of an 8 week strain so 113.5 x 3 = 340 g/sq. ft./yr. (of canopy)
- If we get 3 lbs (1362 grams) from an aeroponic SOG/SCROG system with 17 sq. ft. of grow plate/canopy then we have 1362g/17sq. Ft. = 80 g/sq. ft.
  - This system can get 6 turns a year out of an 8 week strain so 80 x 6 = 480 g/sq. ft./yr. (of canopy)

Styles of Growing

- Soil:
- Hydroponics:

Soil grow

- Soil: The upper, heavily weathered Layer of the earth's crust that supports plant life. It is a mixture of mineral and organic materials
  - Functions of Soil:
    - Contain/ deliver water to the roots
    - Contain/ deliver nutrients to the roots
    - Contain/ deliver air (oxygen) to the roots
    - Support
- True soil grows are rare in indoor cultivation
- Even those that appear to be soil are typically an inert media irrigated with a nutrient rich mixture (fertigated)

Hydroponics

The history of hydroponics can be traced back thousands of years

The hanging gardens in Babylon were believed to be a soil-less system.

Hydroponics

- Hydroponics (noun): the cultivation of plants by placing the roots in liquid nutrient solutions rather than in a solid matrix such as “soil”

- For commercial cannabis production, hydroponics can provide better consistency and greater efficiency than soil based grows allowing growers to push the plants to reach their highest potential

Hydroponics

In commercial cannabis cultivation choice of grow style can affect:

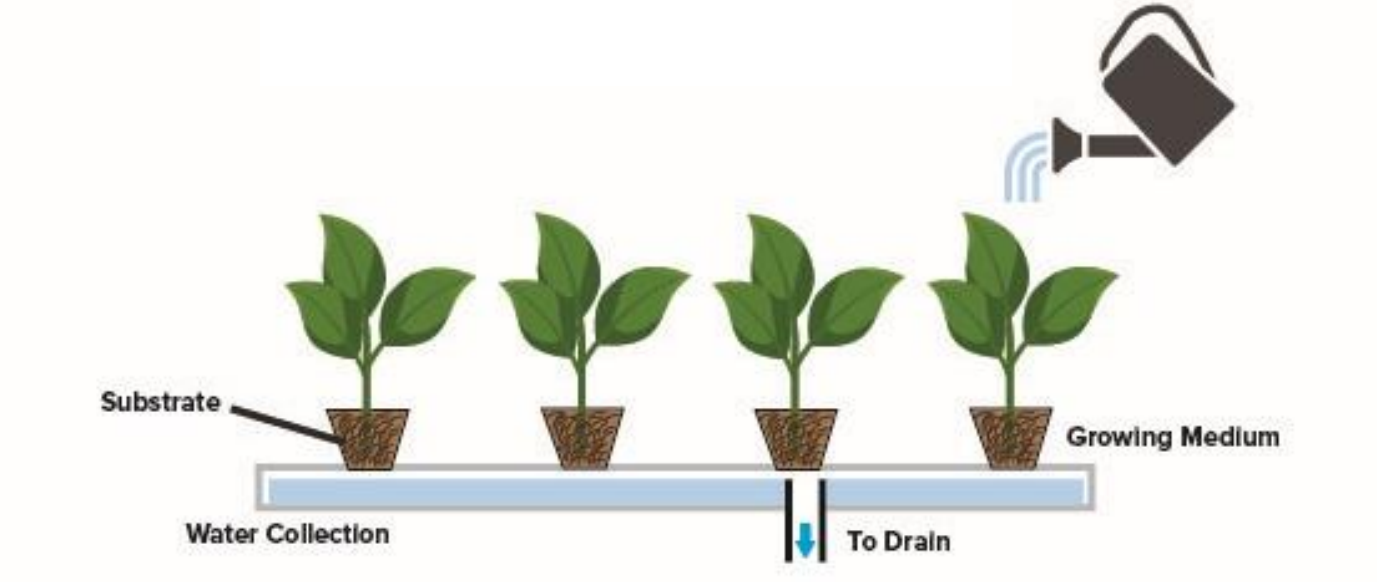
- Cost: Capital and Operational
- Labor:
- Room turnover rate: Number of Harvests per Year
- Pest/contamination management
- Yields:
- Taste…and many other things (Terpene Profile)

One can look at it as a continuum from soil to aeroponics (with many stops along the way):

Common Hydroponics Techniques

- Top water (drip)
- Ebb & Flow/Flood & Drain
- Deep Water Culture (DWC)
- Nutrient film technique (NFT)
- Aeroponics

Top Water (hand water/drain-dry)



Pros

- Low initial investment
- Simple to set up
- Forgiving: if you forget to water for a day or two the plants will still live

Cons

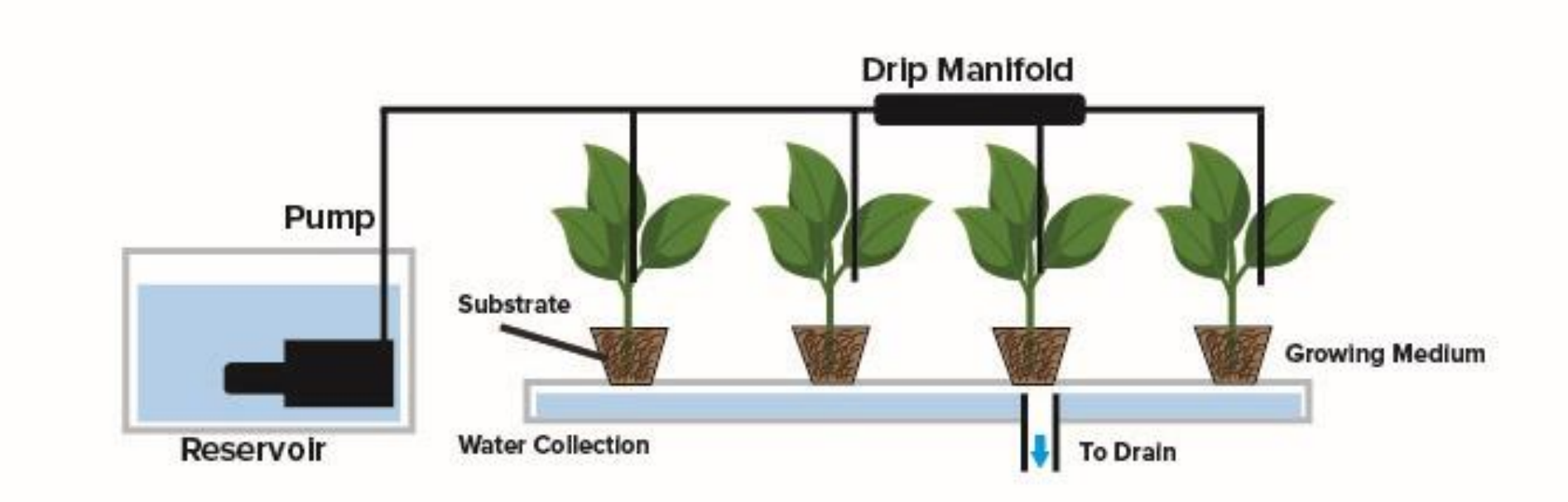
- Hand watering is labor intensive
- Multiple transplants typically required during vegging is labor intensive, messy and can stress plants
- Lots to dispose or disinfect at harvest
- 1 and done water usage not efficient

Top Water (hand water/drain-dry)

Top Water (hand water/drain-dry)

ÆssenseGrows

Top Water (automated drip/drain-dry)



Pros

- Low initial investment
- Less labor intensive than hand-watering

Cons

- Emitters in air can dry when not dripping
- Multiple transplants typically required during vegging is labor intensive, messy and can stress plants
- Lots to dispose or disinfect at harvest
- 1 and done water usage not efficient

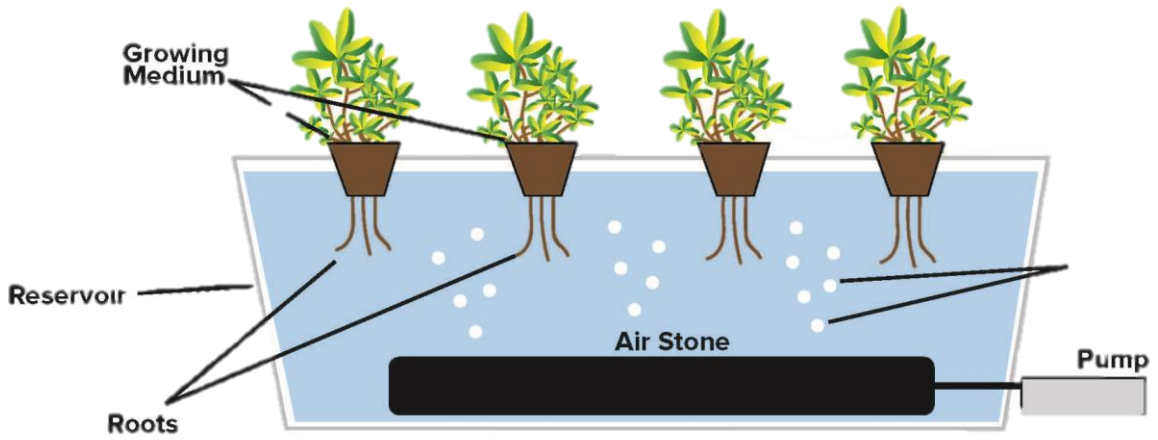
Top Water (automated drip/drain-dry)

ÆssenseGrows

Top Water (automated drip/drain-dry)

ÆssenseGrows

Deep Water Culture (DWC)



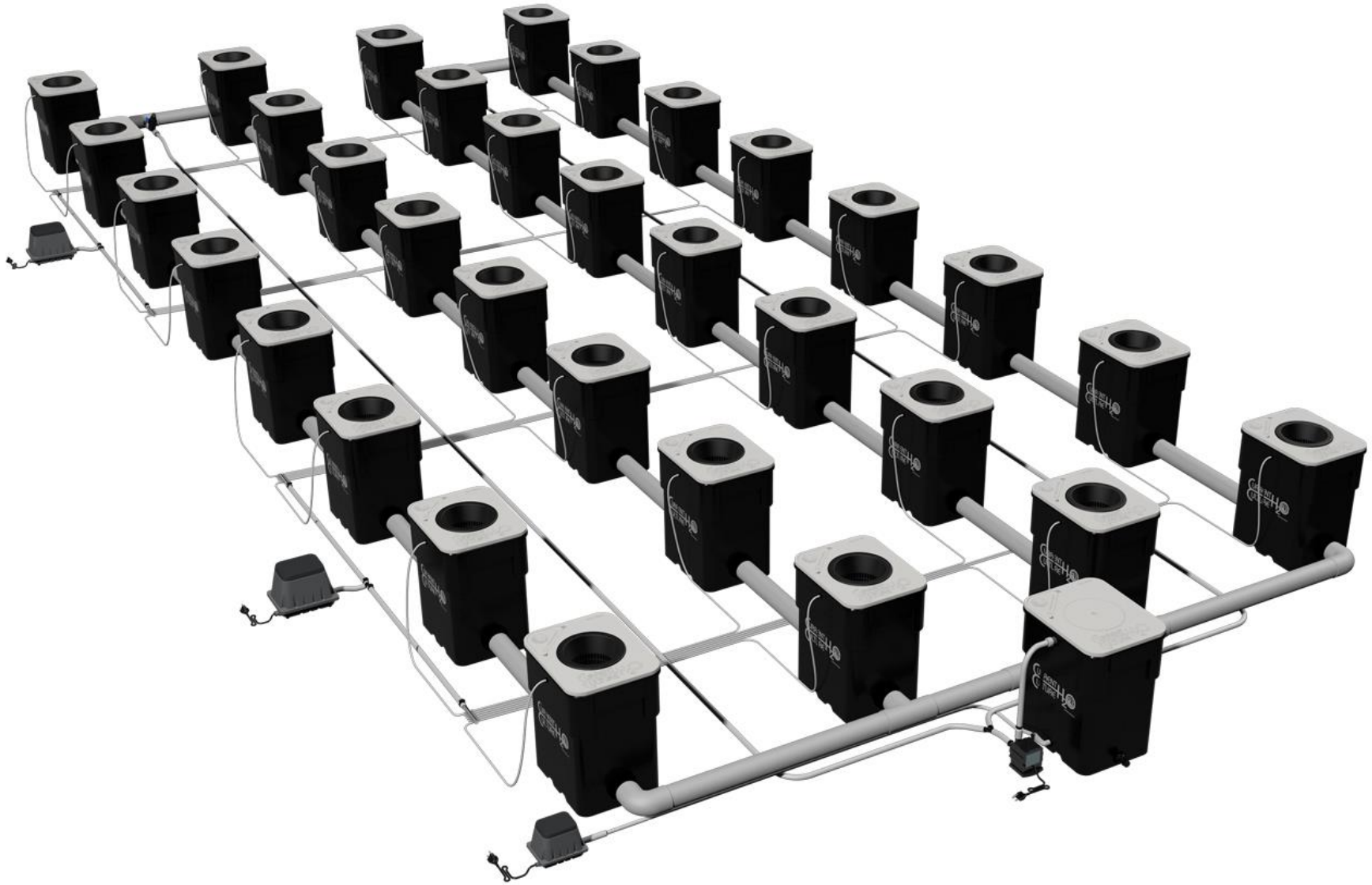
Pros

- Low-medium initial investment
- Simple setup
- Reliable

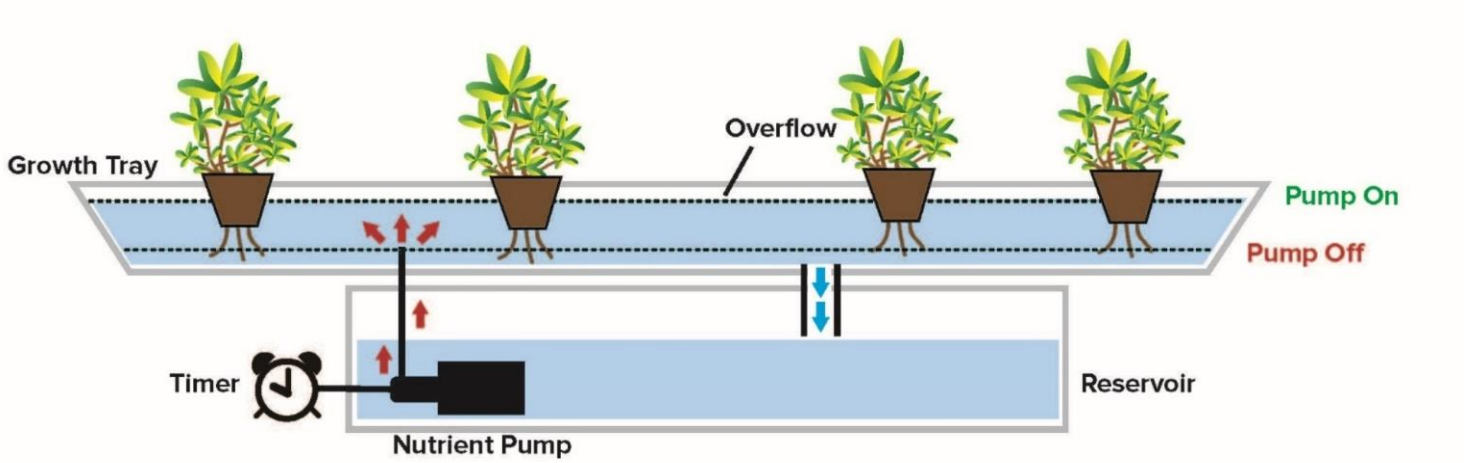
Cons

- Risk of bio-film formation if not kept clean
- Loss of bubblers/oxygenation could result in crop loss
- High volume of water & nutrients used
- Difficult to clean and turnaround after harvest

Deep Water Culture (DWC)



Ebb & Flow/Flood & Drain



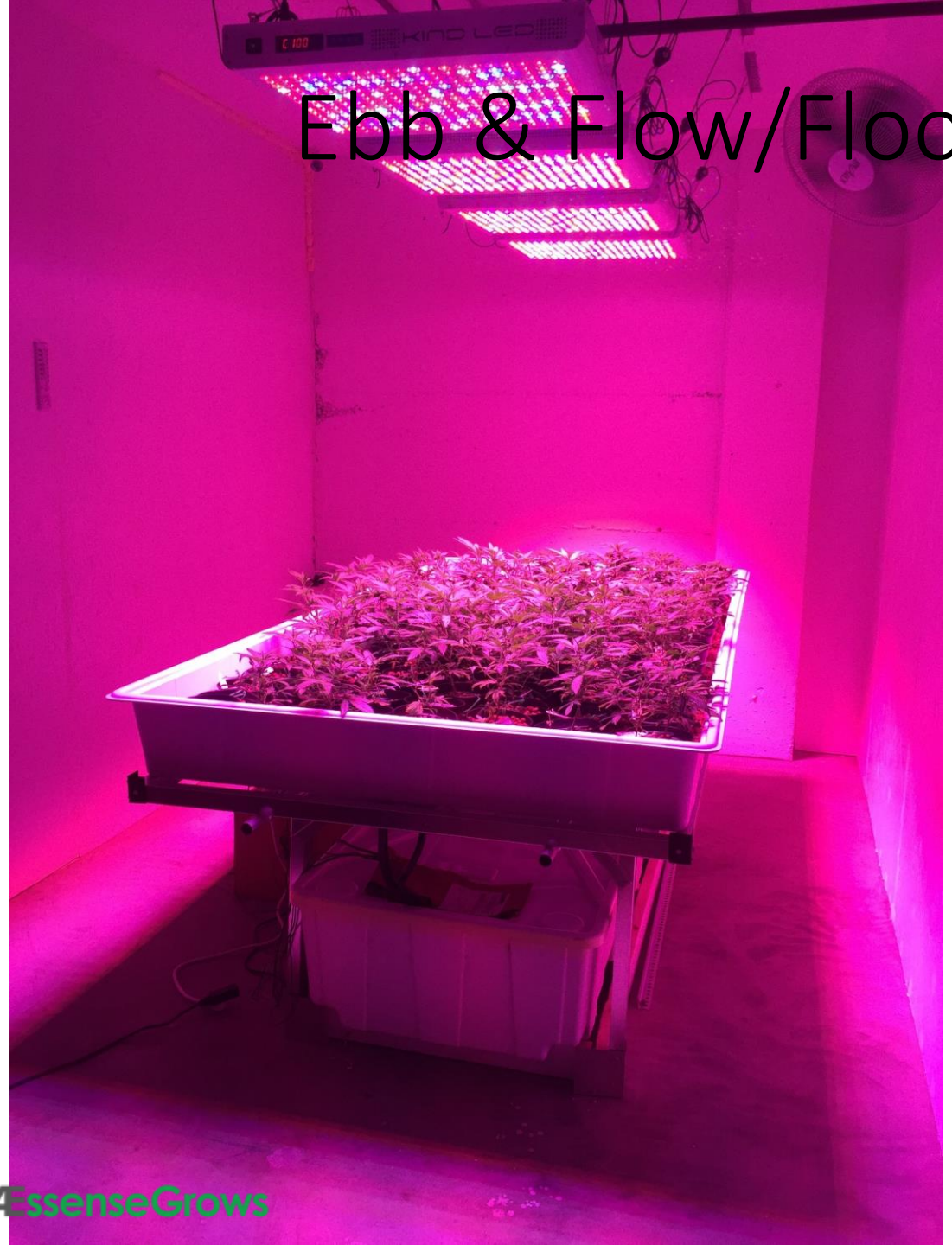
Pros

- Low-medium initial investment
- Low maintenance
- Nutrient solution recirculates, saves water

Cons

- Risk of bio-film formation if not kept clean
- Salt build-ups (during ebb it can dry and build up)
- Technical malfunctions could result in crop loss

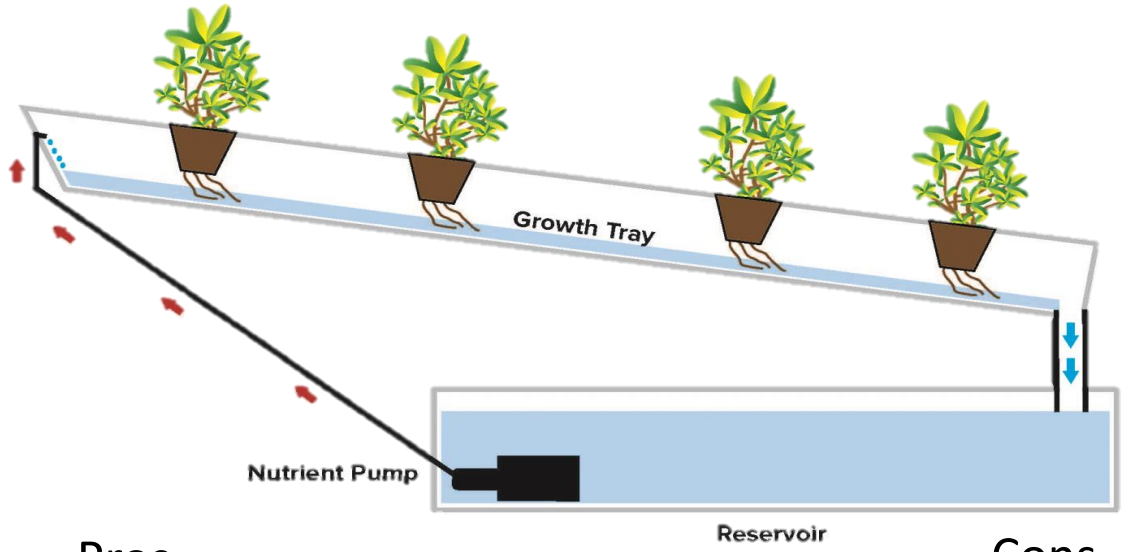
Ebb & Flow/Flood & Drain



Ebb & Flow/Flood & Drain

ÆssenseGrows

Nutrient Film Technique (NFT)



Pros

- Excess nutrient solution recirculates
- Plentiful oxygen
- Space efficient
- Low-Medium initial investments

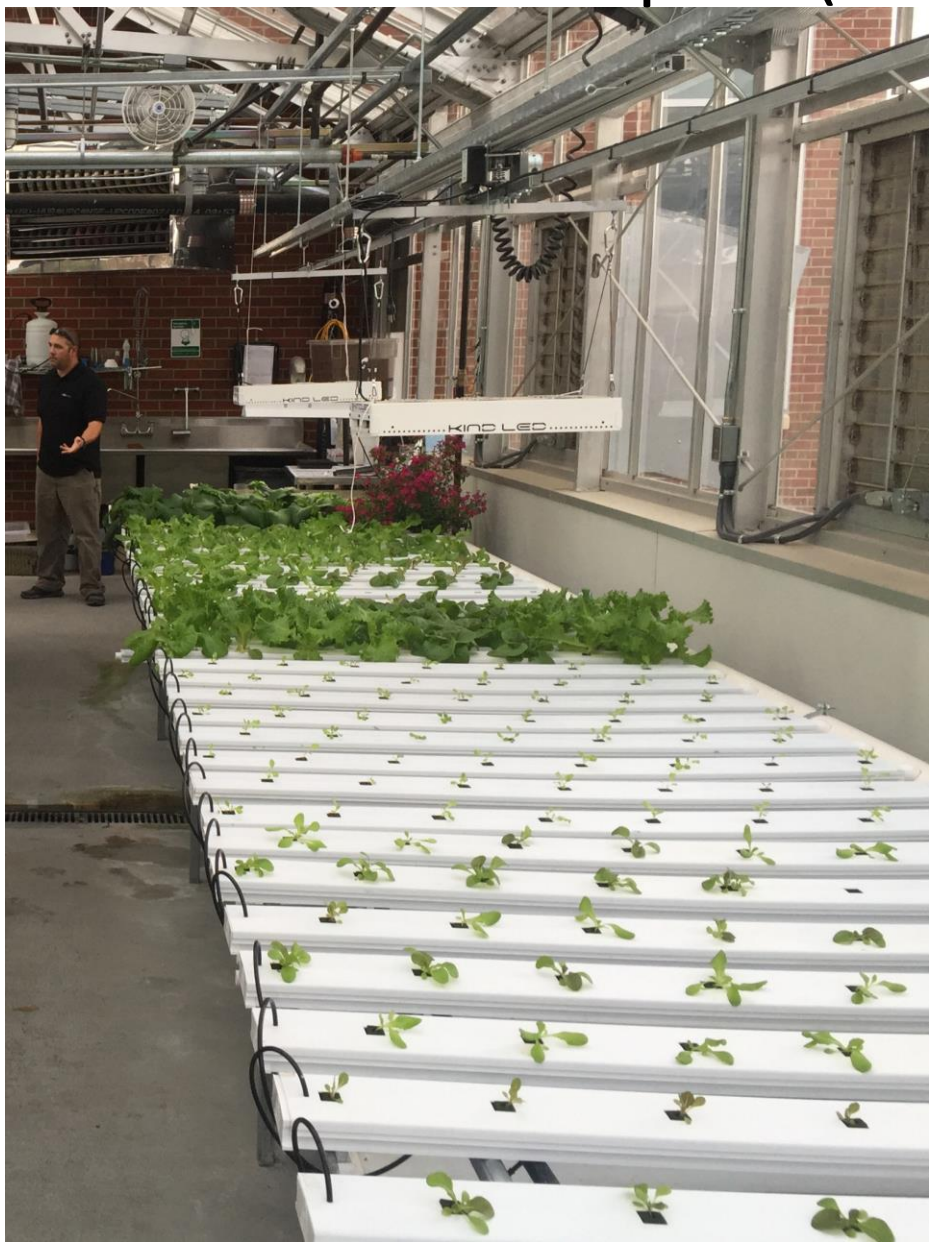
Cons

- Risk of bio-film formation if not kept clean
- Prone to clogging (if allowed to dry out)
- Technical malfunctions could result in crop loss
- In long grow trays plants at the end of the film may not get the same amount of nutrients as those at the beginning

Nutrient Film Technique (NFT)

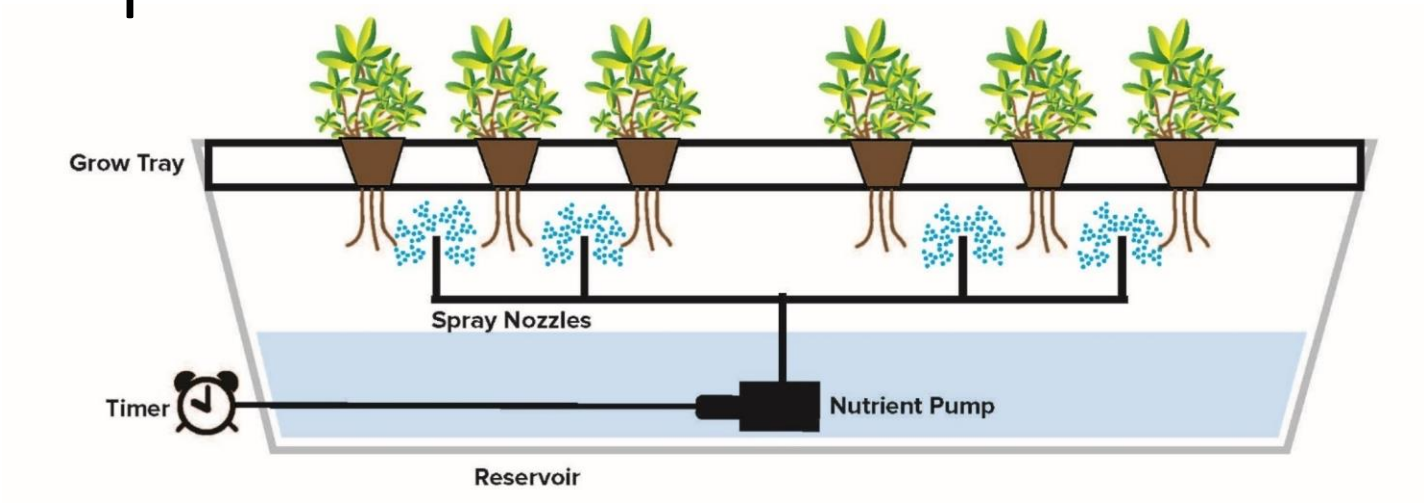
ÆssenseGrows

Nutrient Film Technique (NFT)



ÆssenseGrows

Aeroponics



Pros

- Maximum nutrient absorption
- Accelerated growth rates
- Excess nutrient solution recirculates
- Maximizes oxygen availability
- Relatively low water volume uses less nutrients
- Space efficient

Cons

- Risk of bio-film formation if not kept clean
- Technical malfunctions could result in crop loss
- Potentially labor intensive
- Poorly suited to thick organics nutrients and additives
- May not work with some organics
- Medium to high initial investment

Aeroponics

ÆssenseGrows

Aeroponics

ÆssenseGrows

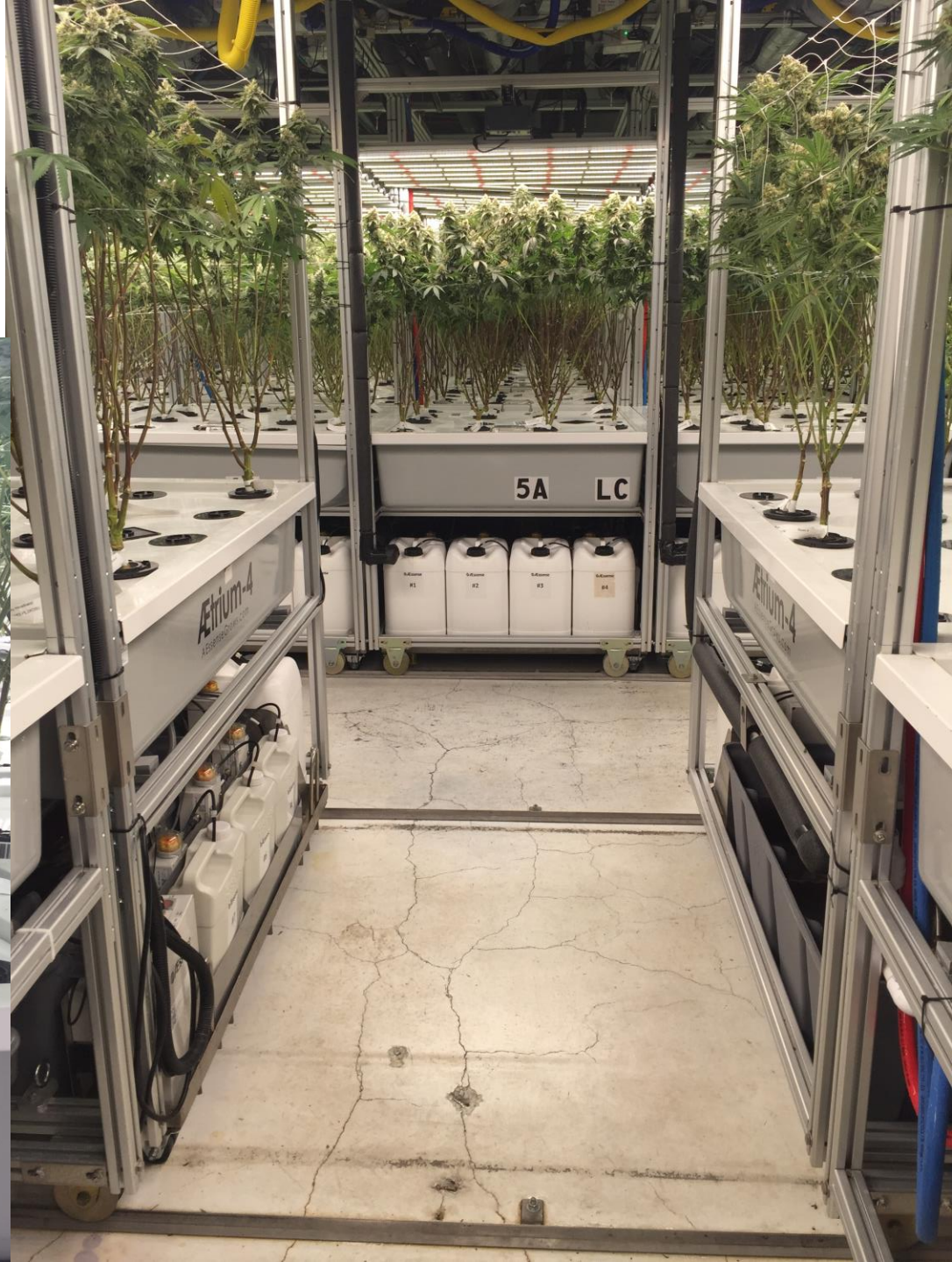
Aeroponics

ÆssenseGrows

Aeroponics

ÆssenseGrows

Aeroponics



Learning Objectives

- Basic understanding of cultivating cannabis
- Styles of growing
- Equipment options and ramifications
- Potential dangers

Lighting

- Light is required for photosynthesis
- Lighting style is one of the primary decisions in growing
  - It can impact bud weight
  - UV can positively induce stress which can influence terpene/THC profiles
  - It can impact power useage
    - LEDs use 2/3's of the power of HPS
    - LEDs for blooming can require 1/3rd the HVAC
- Different phases of growth may benefit from different lighting techniques
  - Cloning: low light requirements,
    - Fluorescents or LEDs
  - Vegging: low to medium lighting requirements
    - HID (High Intensity Discharge) lamps such as Metal Halide (MH) or High Pressure Sodium (HPS) dialed down
  - Blooming: full power
    - HPS (double ended 1000 watts)
    - CHM (ceramic metal halid)
    - LEDs (typically 600 watts)

Double ended HPS

- The most common for blooming
- Make the most heat and draw the most power
- Characterized by their red shifted light
- Try to not look directly into them!
- Run hot and can be a fire hazard!

100 HPS lights in a room

LEDs

- Many think Light Emitting Diodes (LEDs) are the future
- But some say that they don’t provide the same bud weight as HPS
- Try not to look directly into them!

Typically the grow buildings are unremarkable

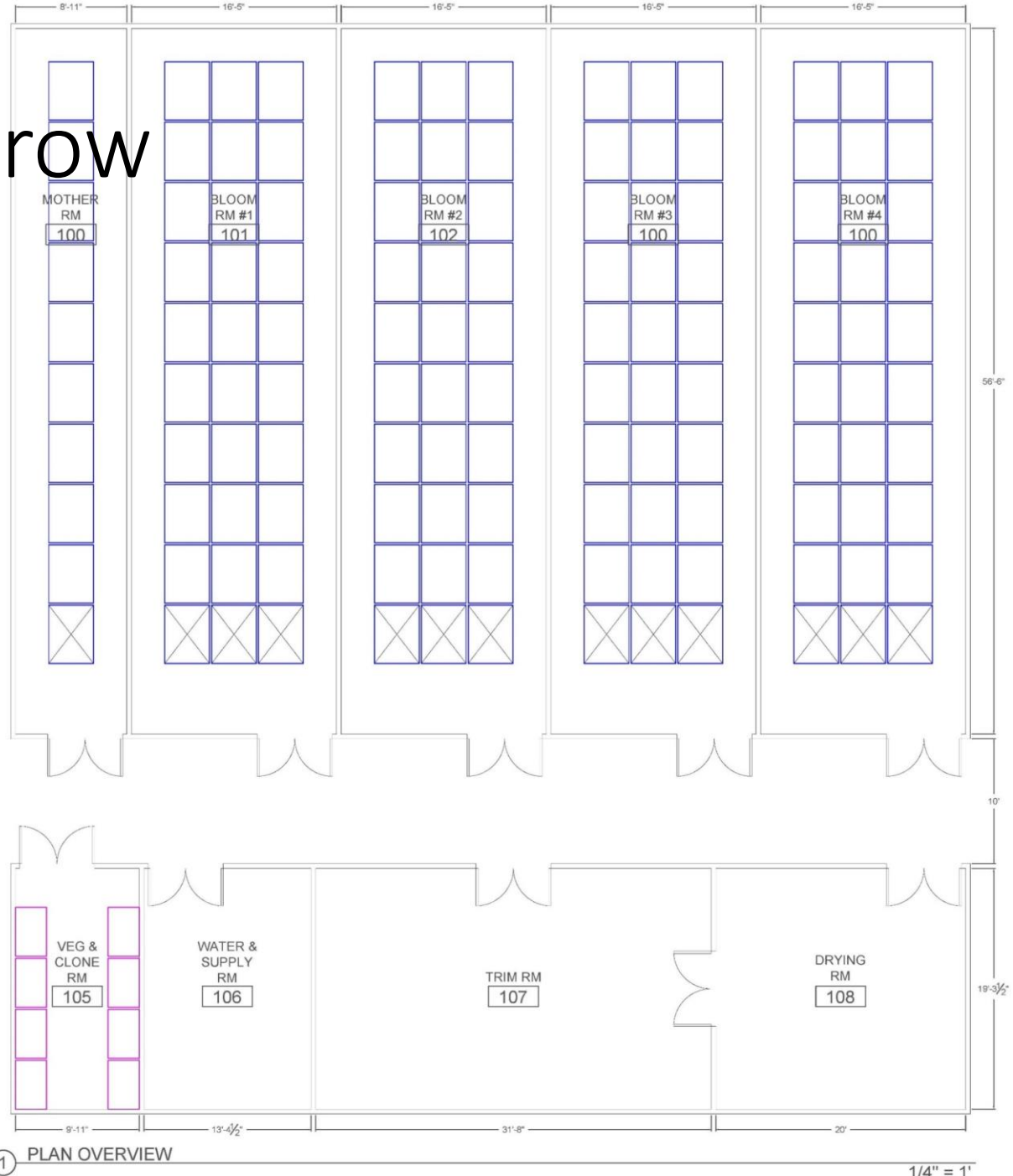
ÆssenseGrows

Typically the grow buildings are unremarkable

ÆssenseGrows

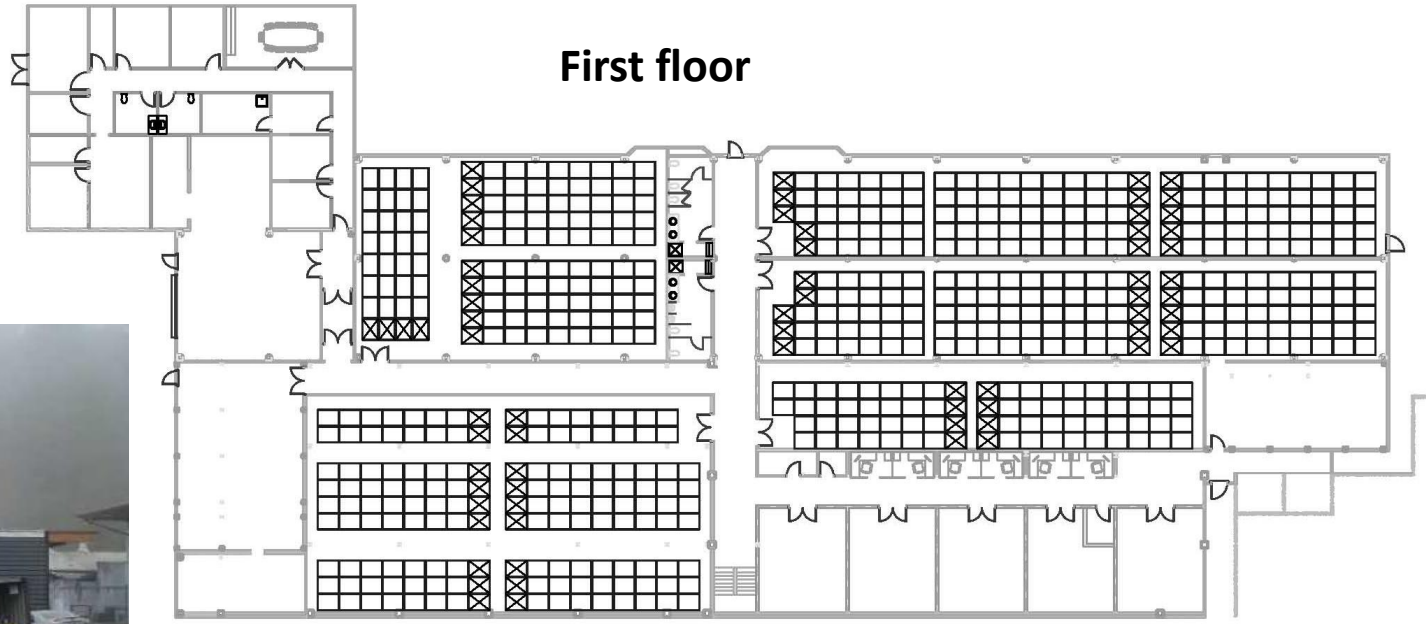
A Simple Layout of a Grow

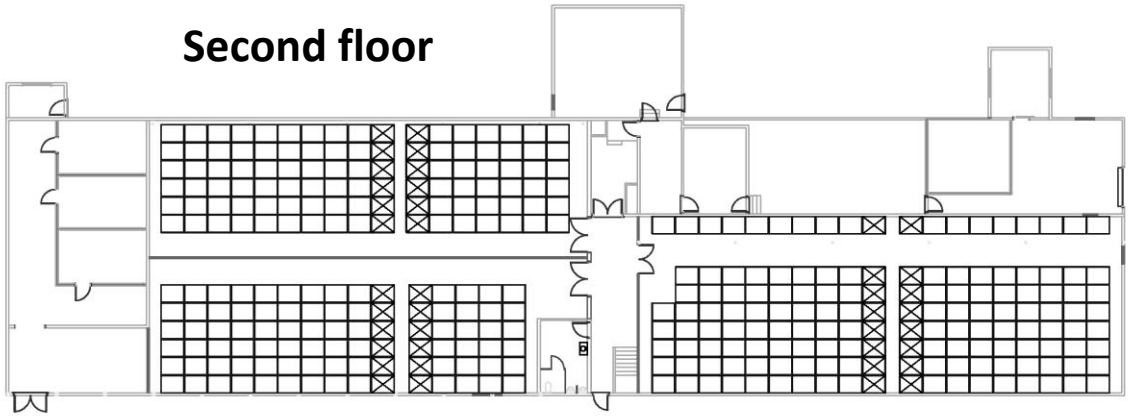
- Typically growers have rooms
  - Bloom
  - Mothers
  - Clone/Veg
  - Utilities
  - Trimming
  - Drying



ÆssenseGrows

30K of canopy grow





ÆssenseGrows

Big Power and HVAC are big clues

Big Power and HVAC are big clues

Dispensaries/Rec shops can be very clean & nice

ÆssenseGrows

Dispensaries/Rec shops can be very clean & nice

ÆssenseGrows

Learning Objectives

- Basic understanding of cultivating cannabis
- Styles of growing
- Equipment options and ramifications
- Potential dangers

Pesticides

- Indoor growers may embrace a “clean” pesticide free grow or not
- What follows are “The five most common banned pesticides seen in pot recalls issued by Denver's Department of Environmental Health”:
  - (according to The Cannabist 12/7/2015)

Pesticides

Chemical Name	Trade Name(s)	Use	Form	Risk to applier	Detection Method
Myclobutanil	Eagle 20, Systhane WSP,	Fungicide	Liquid in hydrocarbon matrix	Potential carcinogen	PID will detect hydrocarbons
Imidacloprid	Admire, Condifor, Gaucho, Premier, Premise, Provado, and Marathon	Insecticide	White powder	May be fatal if swallowed, harmful if inhaled	Solid
Abamectin	Affirm, Agri-Mek, Avermectin, Avid, MK 936, Vertimec, and Zephyr	Insecticide	Liquid in hydrocarbon matrix	Central nervous system affects, one carrier is a potential carcinogen	PID will detect hydrocarbons
Etoxazole	Borneo, Baroque, Secure, Tetrasan, Zoom	Spider mite insecticide	Liquid	Potential carcinogen	Unknown
Spiromesifen	Oberon, Judo and Forbid	Insecticide, miticide	Liquid in solution with gylcerine	Harmful if inhaled.Mists may cause respiratory tract irritation	PID will detect glycerine

Sulfur pots for fumigation

- They “cook” or heat elemental sulfur to disinfect a room
- Considered better than using pesticides
- Sulfur Dioxide (SO_2) threat to responders
  - IDLH: 100 ppm
  - TWA: 5 ppm (OSHA)

Sulfur pots for fumigation

- Measurement Options:
  - Tubes, best for high concentrations
  - Electrochemical sensors
    - SO_2
    - H_2S as cross-sensitivity
- Respect signage
  - Except when it’s not in place

Carbon Dioxide (CO_2) for enrichment

- The basic reaction of photosynthesis is CO_2 plus light gives creates sugars
  - Sugars are oxidized in the roots to create carbohydrates which builds the plants mass
- An effective way to build greater bud weight is to enrich the grow room to ~1200 ppm CO_2
  - IDLH = 4% (40,000 ppm)
  - TWA = 5,000 ppm
- Enrichment can be accomplished by:
  - Burning gas to create CO_2
    - Possibility of creating CO if not properly tuned
  - Cryogenic supply

Carbon Dioxide (CO_2) for enrichment

- Measurement Options:
  - Tubes, best for high concentrations
  - NDIR (Non-Dispersive InfraRed) sensors

ÆssenseGrows

Propylene Glycol

- Used as a heat transfer fluid rather than using air
- Much more efficient
- But when it breaks there can be 100’s or even 1000’s of gallons of propylene glycol spilled throughout a grow room
  - Detect with PIDs

Acids & Bases

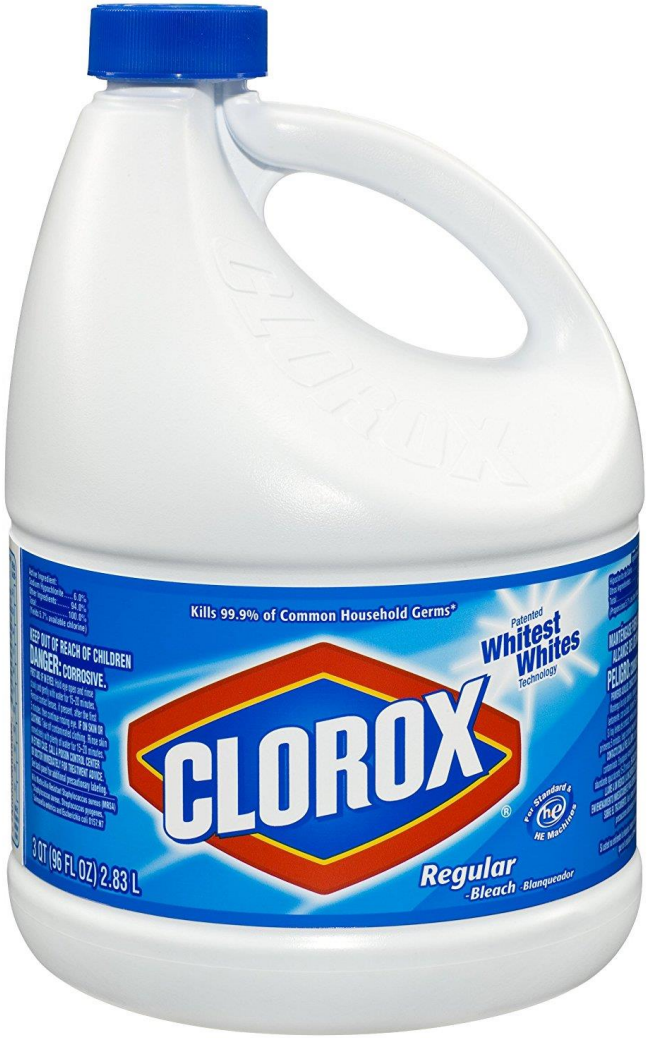
- pH down:
  - Used to balance pH of liquid nutrients
  - Phosphoric acid; pH of 1.2
- pH up:
  - Used to balance pH of liquid nutrients
  - Potassium Carbonate; pH of 12-12.3

Hydrogen peroxide

- Used for disinfection and purification (oxidizer)
- Highly concentrated ~36%
- Can burn/bleach your skin

Sodium hypochlorate (Household bleach)

- Used for purification and disinfection (oxidizer)
- Possibility of generation of Chlorine gas (Cl_2) when accidently mixed with pH down

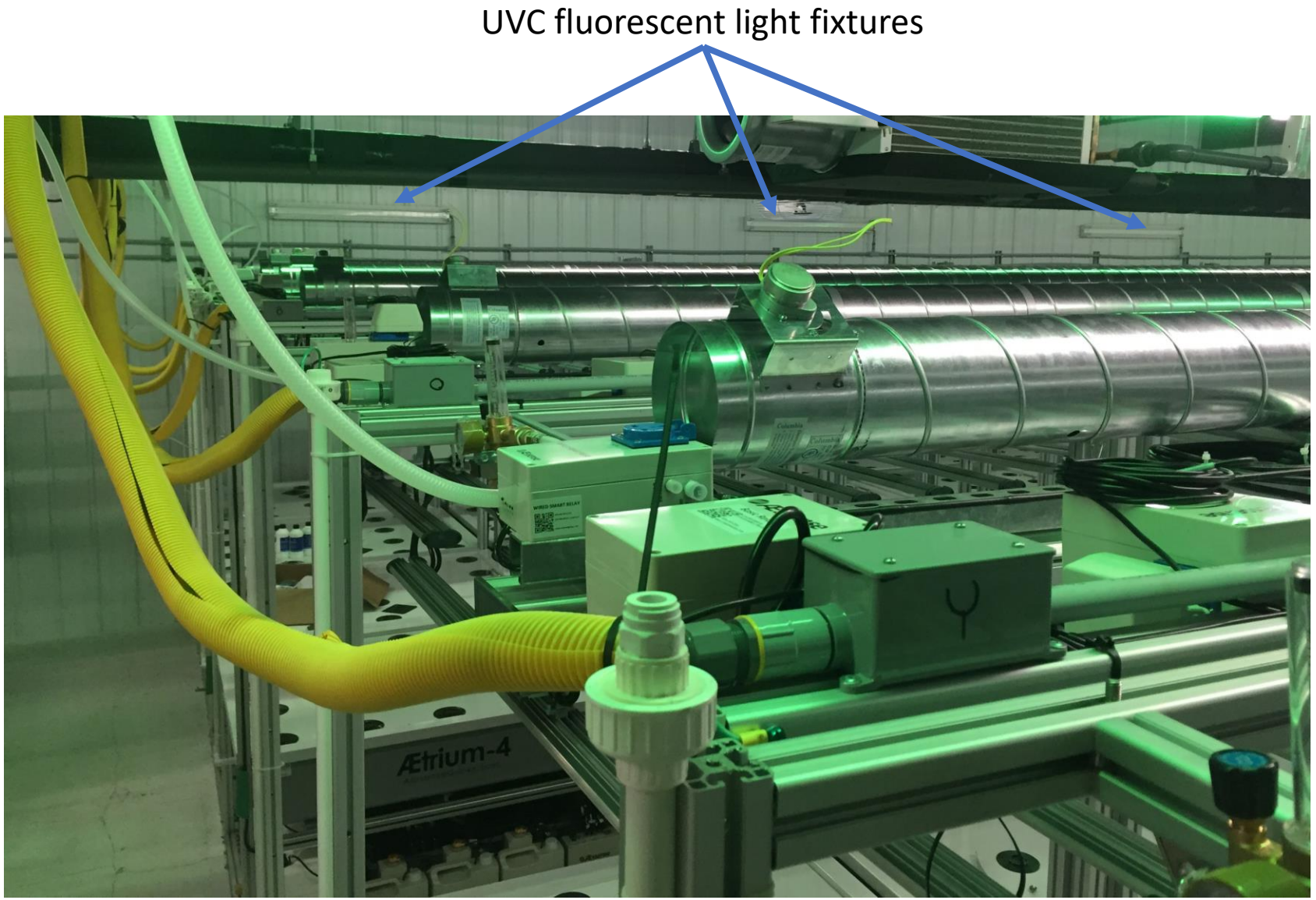


ÆssenseGrows

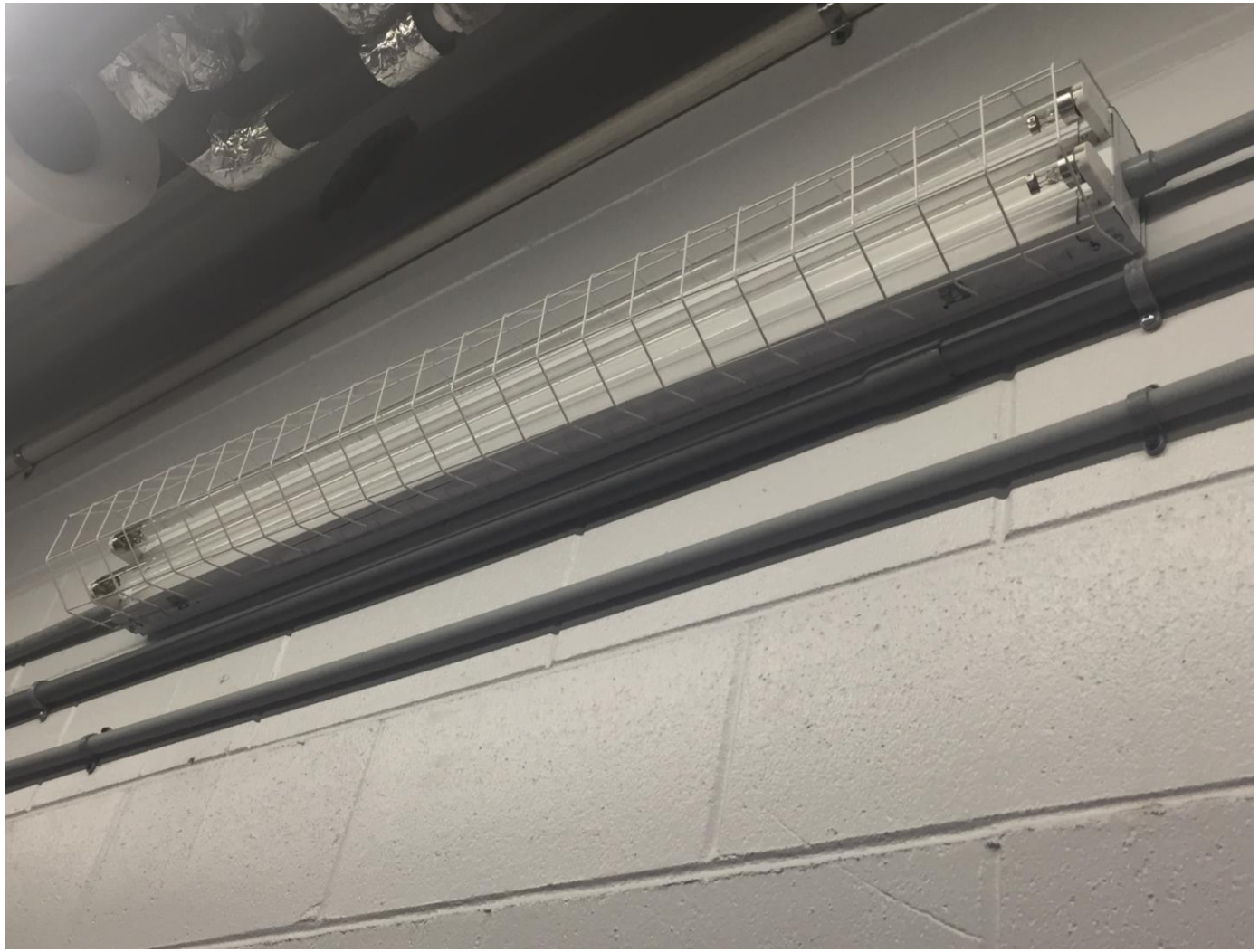
UVC

- UVC: short-wave (100–280nm) ultra-violet light
- Commonly found in hospitals for their germicidal properties but shielded from workers' eyes
- In nature it is completely absorbed by the ozone layer and atmosphere
- It can be readily generated by "fluorescent" style light fixtures to combat powdery mildew and pests
- In grow rooms to get maximum penetration no shields are affixed so personnel should be locked out of the room when in use

UVC



UVC



UVC: pay attention to warnings

UV LIGHT IN USE

Ozone for fumigation

- Facilities may use Ozone as a fumigant between grow cycles
- Concentrations as high as 800 ppm to kill bugs between harvests
  - IDLH = 5 ppm
  - TWA = 0.1 ppm
- Measurement Options:
  - Tubes, best for high concentrations
  - CO sensors possibly as a cross-sensitivity
- Watch for warning signs and locked out rooms!

High Temperatures for Fumigation

- Temperatures up to 120^{o}F (49^{o}C) can be used to kill off pests between grow cycles
- These temperatures can certainly lead to heat stress incidents
- Watch for warning signs and locked out rooms!

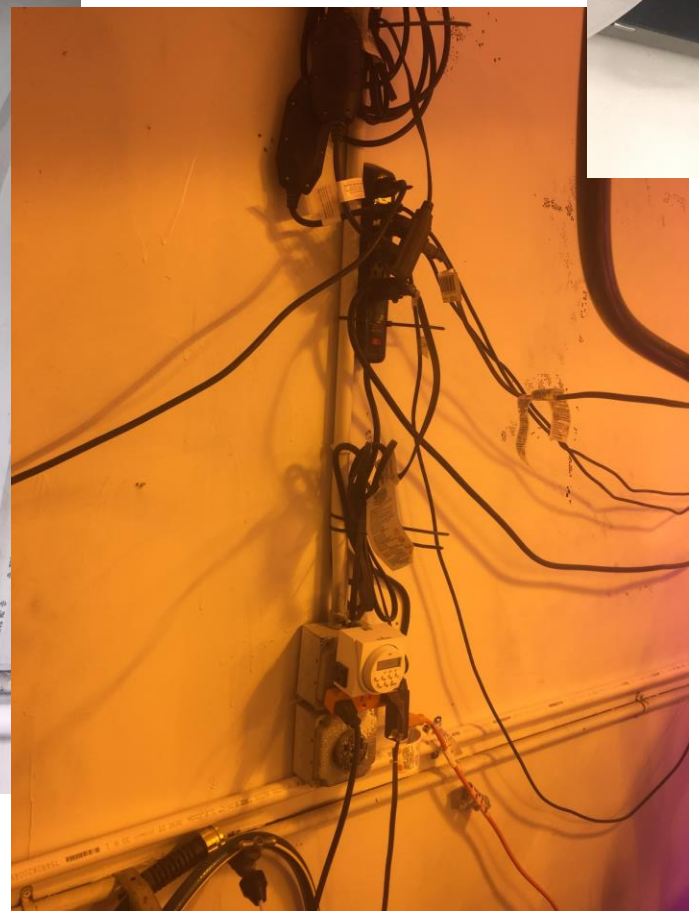
Water, water everywhere

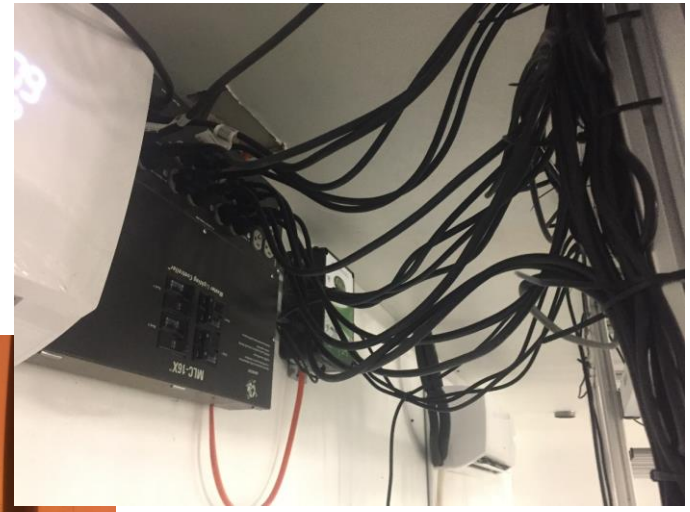
- Don’t slip!
- Be wary of mold & mildew

Electrical issues

- One of the top reasons for OSHA citations in legal grows
- With lights drawing as much as 1000w/light there is a lot of potential power
- Turning off lights at the wrong time could compromise the plants

Electrical issues





Lack of OSHA defined access

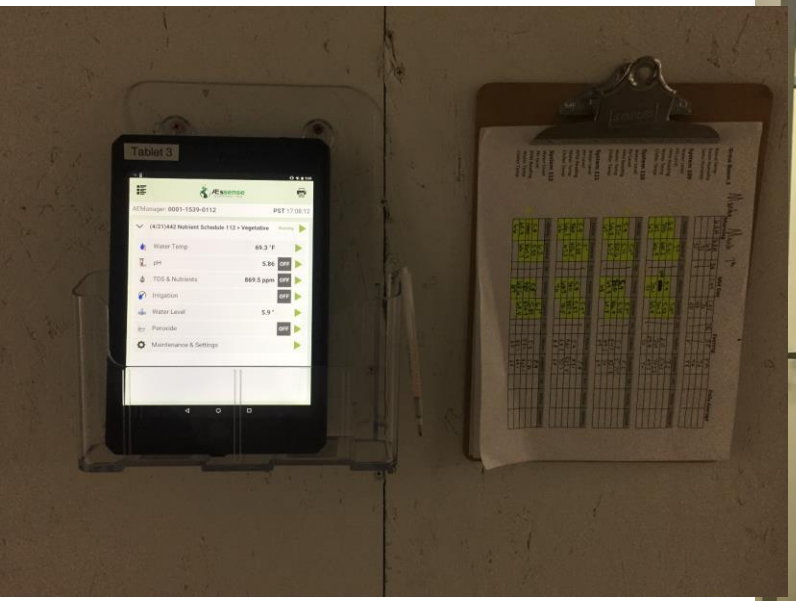
- OSHA requires 28” access which isn’t happening here!

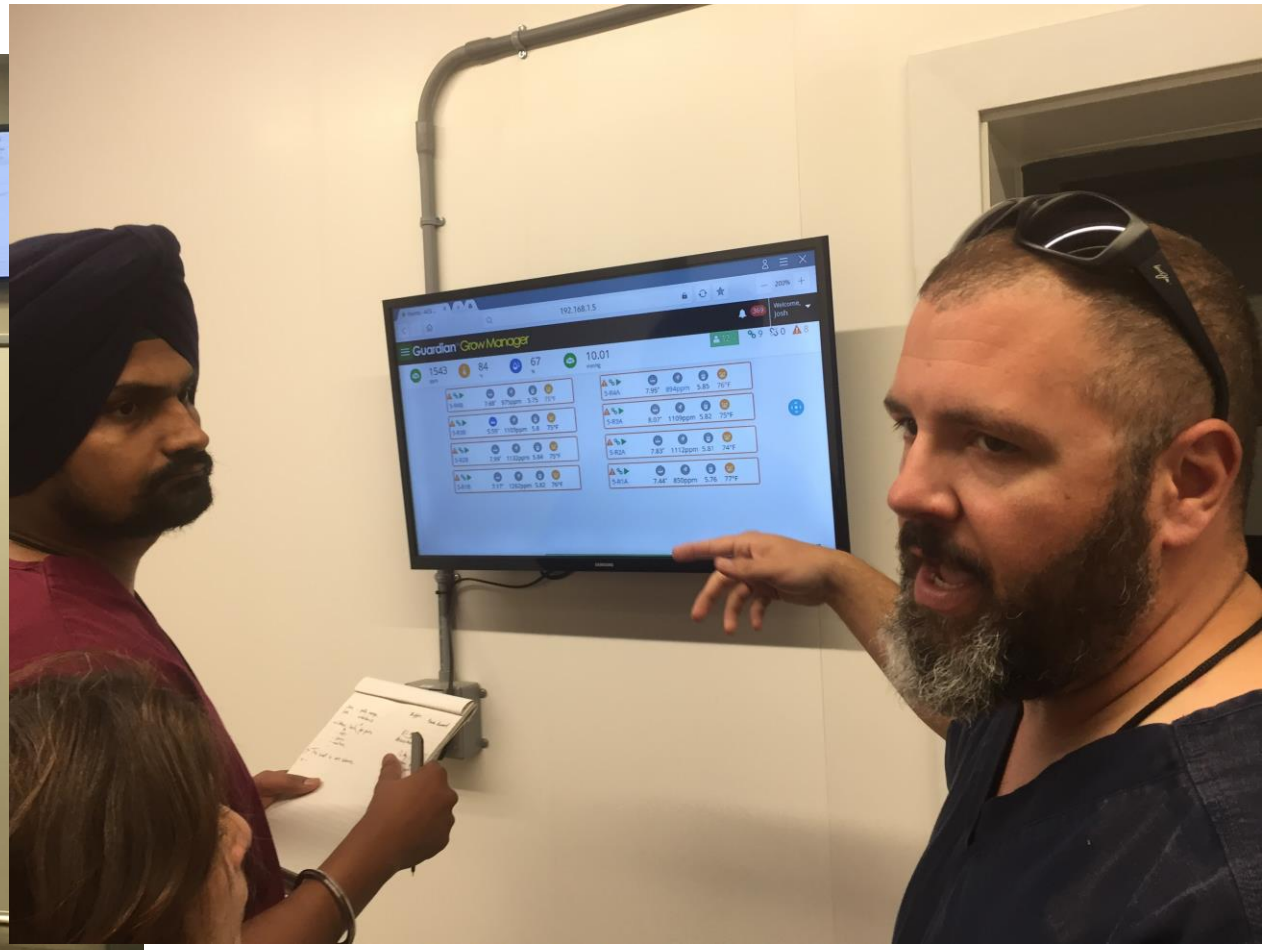
ÆssenseGrows

Lack of OSHA defined access

- These are 30 gallon pots
- Very little room between the plants for access
- Growers had to crawl between the plants for access

Some can have very sophisticated instrumentation and control





ÆssenseGrows

Some people build walls some prefab it

- Walls can be built out from drywall over wood studs
- Drywall over steel studs
- Plastic panels over steel studs
- Panel (clean room) construction
- Even shipping containers

Panel Construction

ÆEssenseGrows

Extraction

- Is becoming increasingly important in the cannabis community
  - More consumers require extracts
  - Some medical states prohibit smoking bud
- There are two common ways to extract
  - Super critical Carbon Dioxide
  - Hydrocarbons
    - Butane
    - Ethanol

Super Critical CO_2 Extraction

- Safer than using hydrocarbons because there is no explosion hazard
- May not extract as thoroughly as hydrocarbons because the desired compounds are all hydrocarbons
- Potential of CO_2 toxicity if there is a major release

ÆssenseGrows

Hydrocarbon Extraction

- Non-professional butane extraction has been proven to be dangerous
- But no properly designed and inspected facilities have blown up
- Note the use of explosion proof wiring

Questions?

chriswrenn@att.net

"Still confused but at a higher level"

If you'd like a copy of this presentation please email me or give me your information

If you are ever challenged with a gas detection problem, call or email me and we'll work through it

Check out www.DetectionGeek.com for downloads of slides and whitepapers

ÆssenseGrows