



# 2014 International Emerging Technologies Seminar

Ultimate Water Conservation Methods



# Innovative Concepts Utilizing Storm water for Reuse

- **Why Water Conservation/Reuse**
- **Methods**
  - Storm
  - Rain
- **Definitions**
- **Water Quality/Risks**
  - Filtration/Disinfection Technologies
- **Codes and Standards**
- **Systems Design**
- **Applications/Obstacles**
  - Wash Water
  - Toilet Flushing



# Water Management Resource Center

<http://www.stormwatercenter.net>

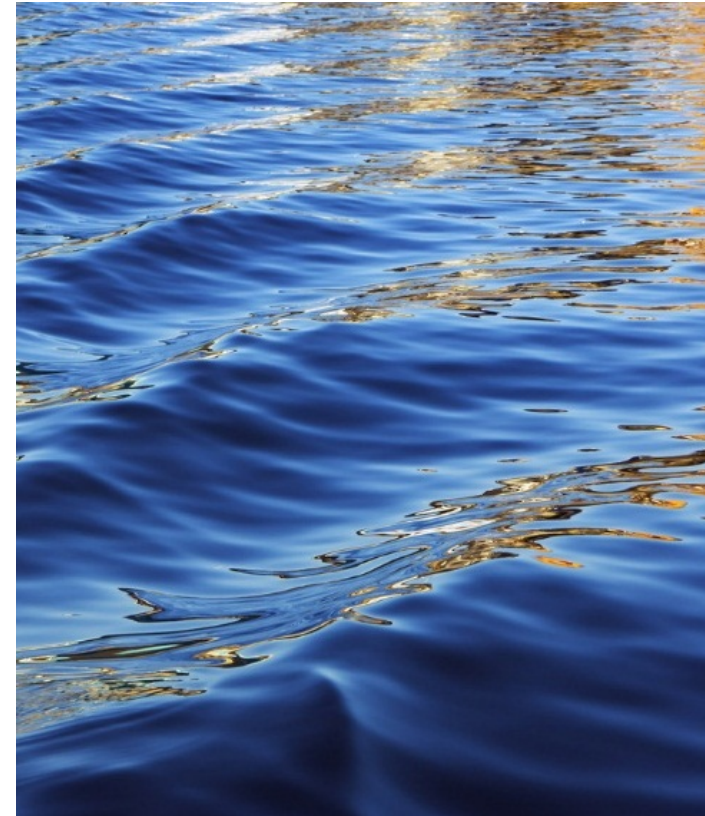
[Water Quality Association](#)

[How Safe Is Reuse | A Thirsty Planet](#)



# Water Conservation

What is Water Reuse?





# Driving Factors for Water Reuse

- **Water Availability**
- **Water Consumption**
- **Water Quality**



**Figure 2.3 Aerial Photo of Lake Lanier 2007**

DRAFT for Public Comment

# Storm Water Management –Rainwater Harvesting Benefits

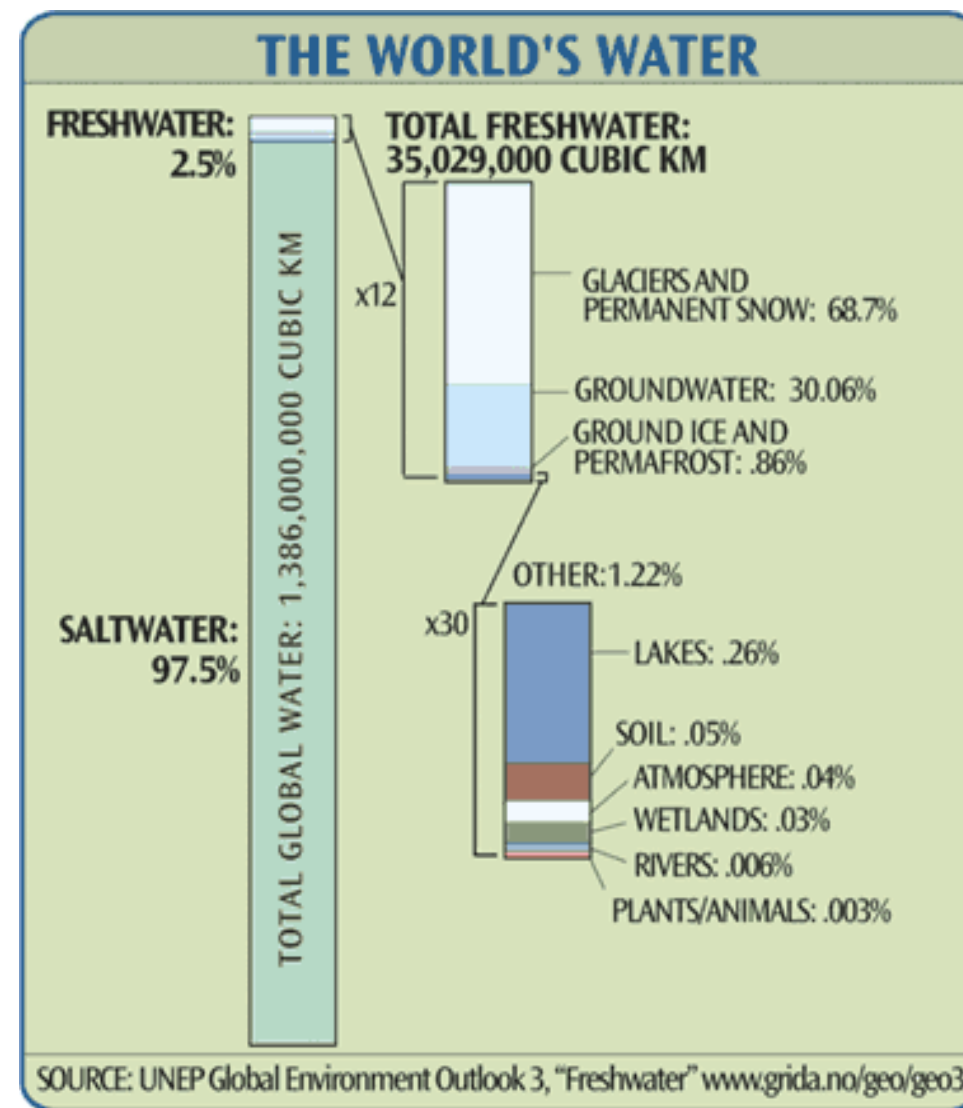
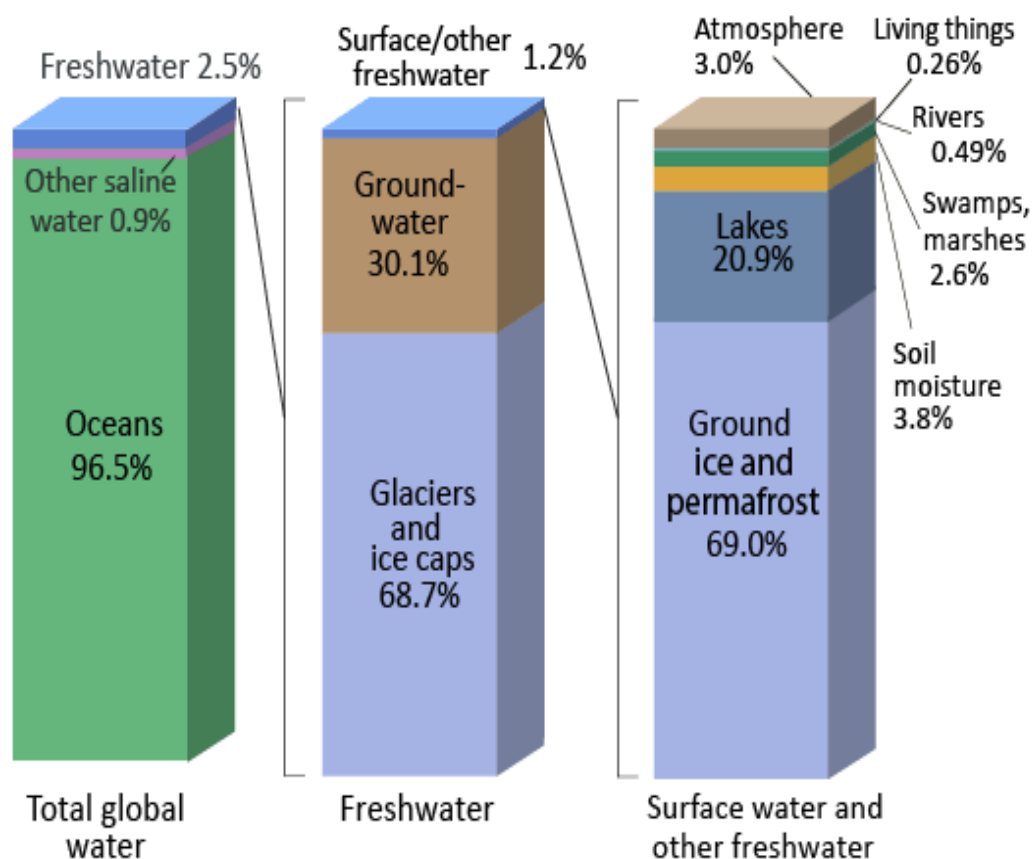
- **Decentralized Systems**
  - Non-Potable
  - Commercial/Industrial/Institutional
- **Rainwater Harvesting**
  - Storm Water Management
    - Zero Runoff
  - Unlimited Applications
- **Grey Water Recycling**
  - Known Quantity (source)
  - Small Footprint





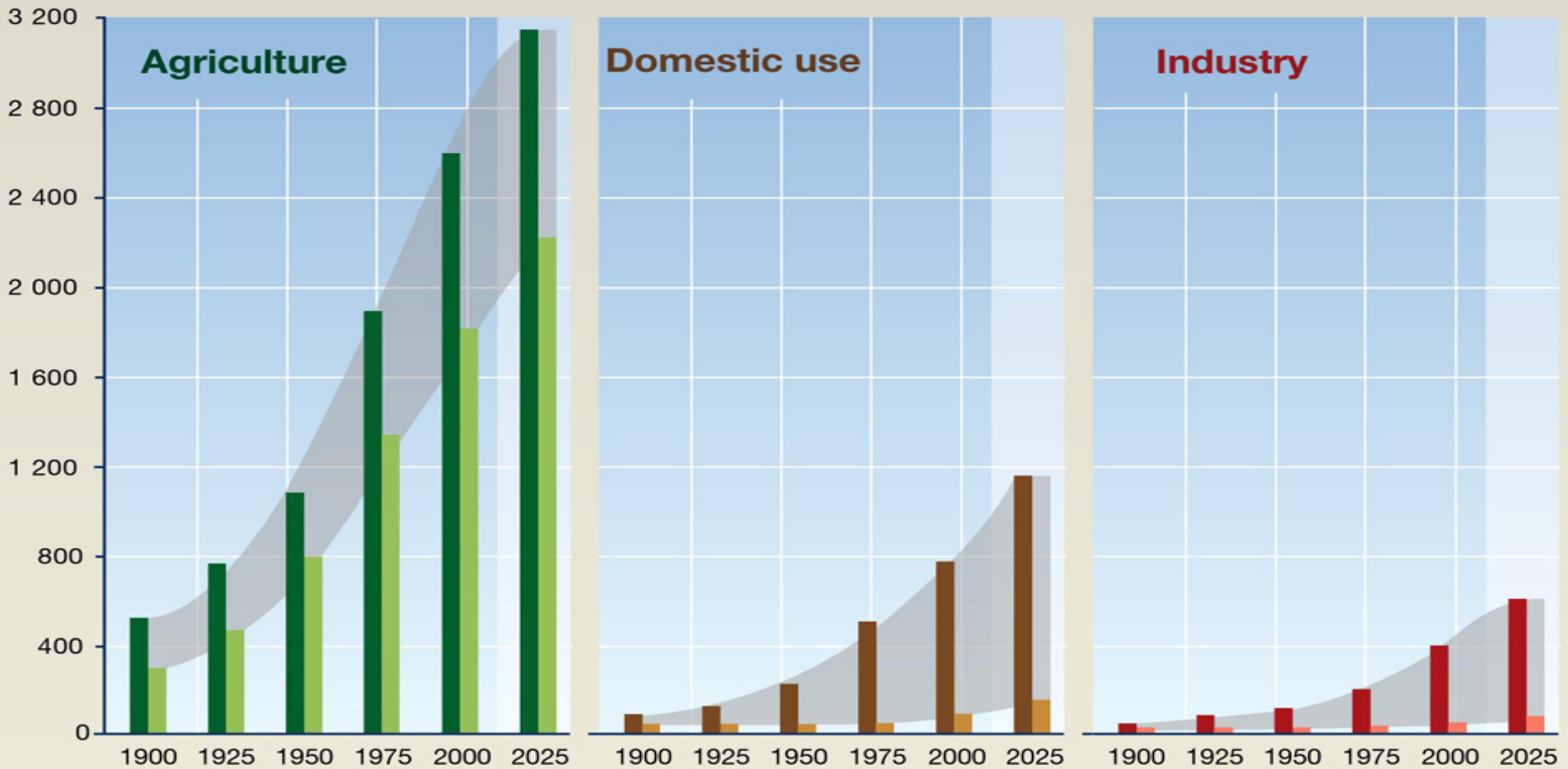
# Water Availability

## Where is Earth's Water?



Source: Igor Shiklomanov's chapter "World fresh water resources" in Peter H. Gleick (editor), 1993, *Water in Crisis: A Guide to the World's Fresh Water Resources*.  
 NOTE: Numbers are rounded, so percent summations may not add to 100.

Cubic km per year



Extraction

Consumption

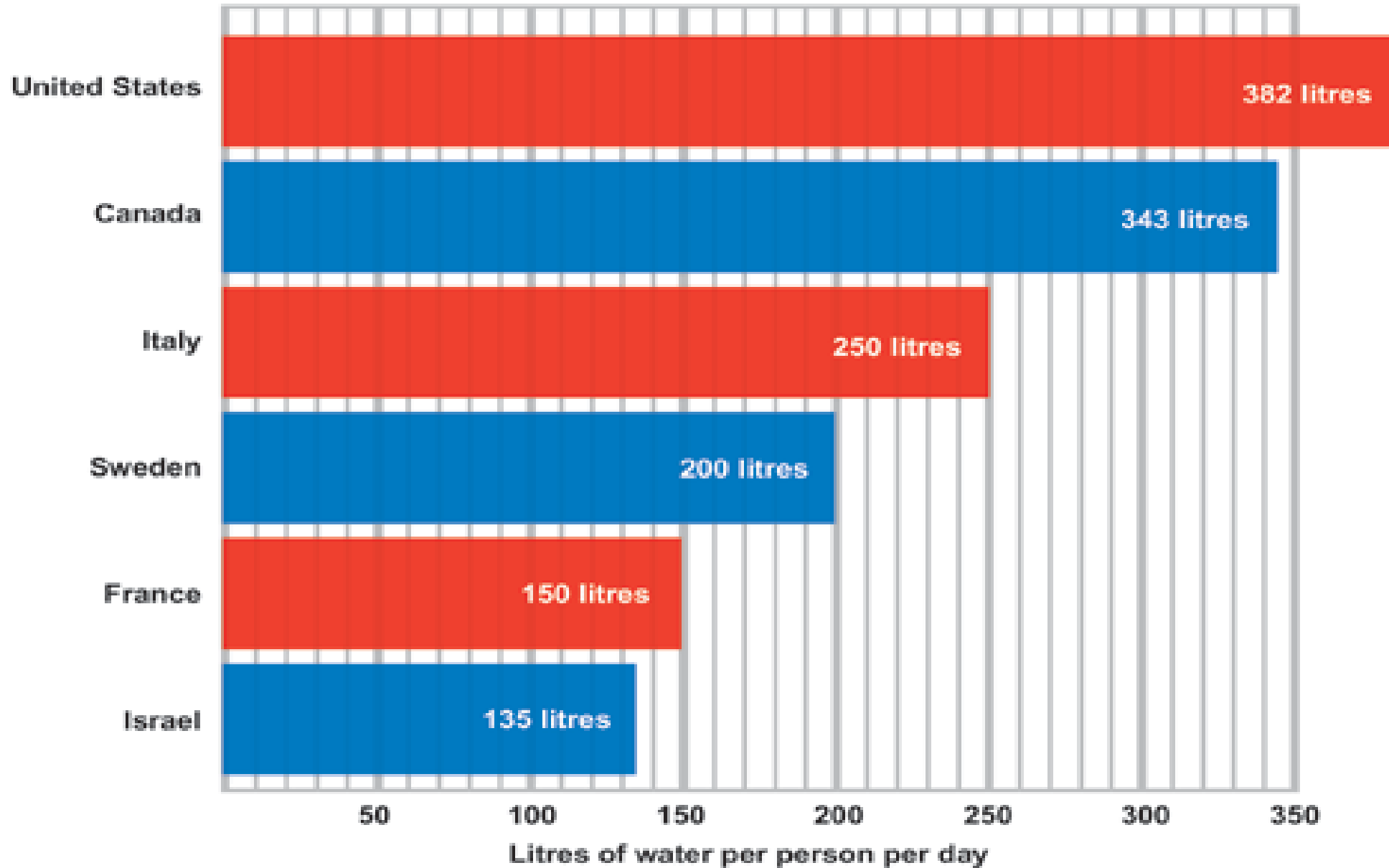


The grey band represents the difference between the amount of water extracted and that actually consumed. Water may be extracted, used, recycled (or returned to rivers or aquifers) and reused several times over. Consumption is final use of water, after which it can no longer be reused. That extractions have increased at a much faster rate is an indication of how much more intensively we can now exploit water. Only a fraction of water extracted is lost through evaporation.

Source: Igor A. Shiklomanov, State Hydrological Institute (SHI, St. Petersburg) and United Nations Educational, Scientific and Cultural Organisation (UNESCO, Paris), 1999.



# Average daily domestic water use (per capita)



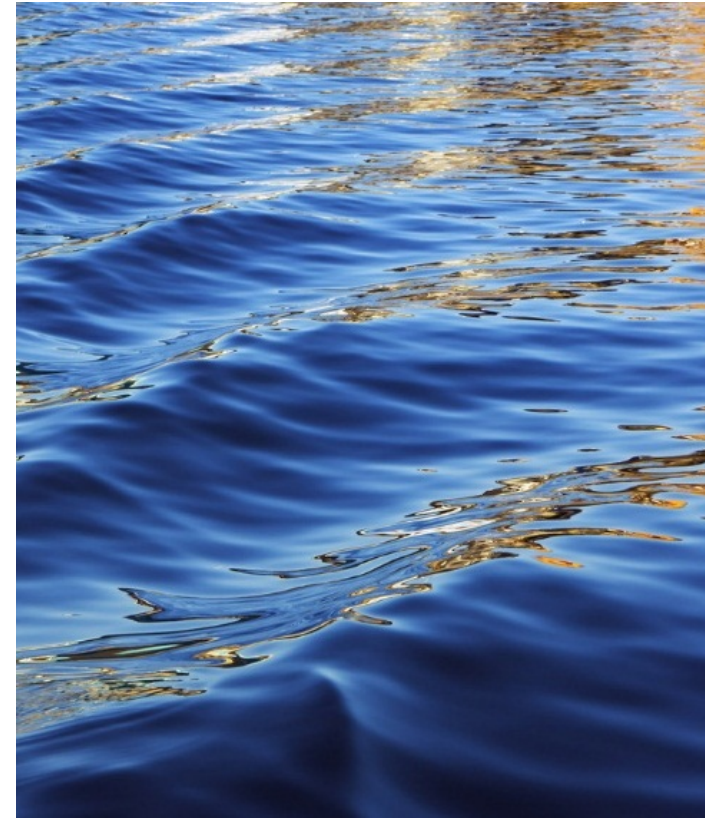
# Water Quality??





# Definitions

Universal Terminology



# What is Water Reuse?

- **Terminology**
- **Water Reuse**
  - The beneficial use of treated wastewater for agricultural, industrial commercial, institutional, etc.
- **Water Reclamation**
  - Reclamation involves all processes used to treat wastewater so that it can be beneficially reused.
- **Water Recycling**
  - Recycling generally means reuse of wastewater back in the same cycle where it is generated

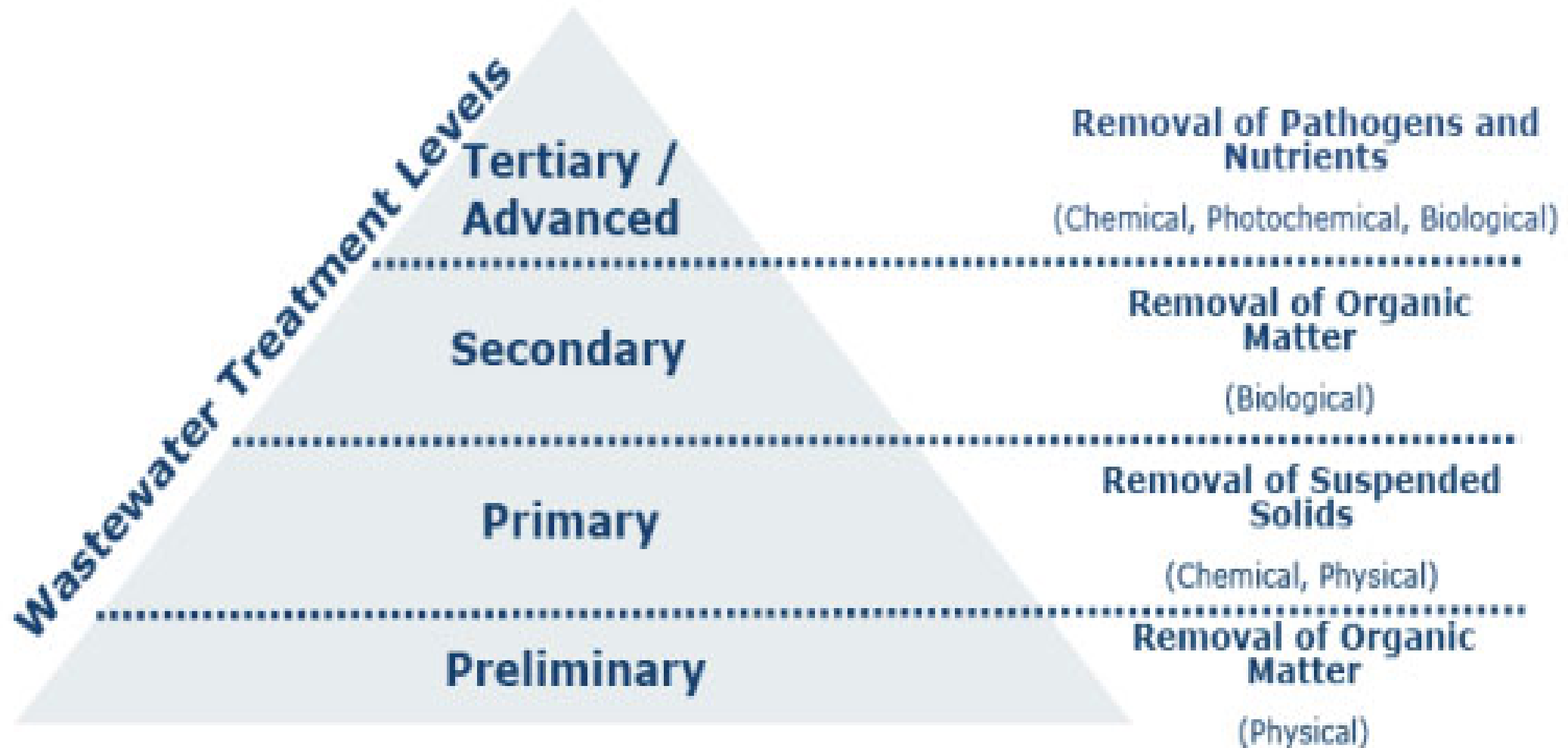


# Water Classifications

- **Black Water**- Toilet waste
- **Grey Water**-Untreated waste water that has not come in contact with toilet waste. Grey Water includes used water from bathtubs, showers, lavatories and washing machines. It does not include waste water from kitchen sinks or dishwasher.
- **Reclaimed Water**- Water which, as a result of tertiary treatment of domestic waste water by a public agency, is suitable for a controlled use. The controlled use can be the supply of reclaimed water to water closets, urinals, irrigation and trap seal primers for floor drains and floor sinks.
- **Harvested Rainwater**- Storm water that is conveyed from a building roof, stored in a cistern and filtered and disinfected before being used for toilet flushing, irrigation etc.
- *Taken from Plumbing Engineer Magazine 2007 Rainwater Harvesting and the Plumbing Codes*

# Treatment Train Terminology

Water and Wastewater Treatment Technologies: Levels of Wastewater Treatment

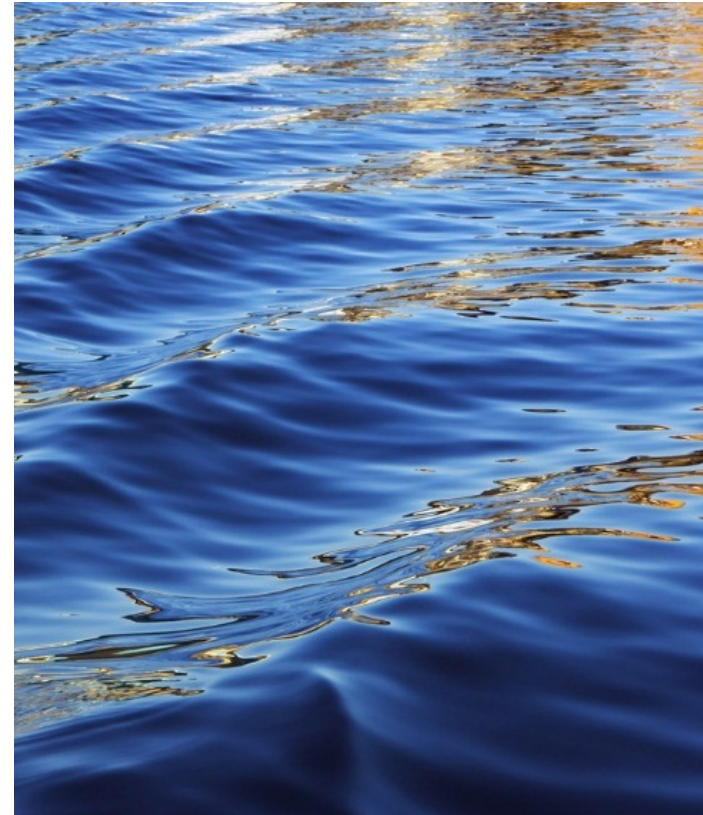


Source: Frost & Sullivan



# Reclamation Methods

Water Reuse Applications



# Progression of Stormwater Regulations





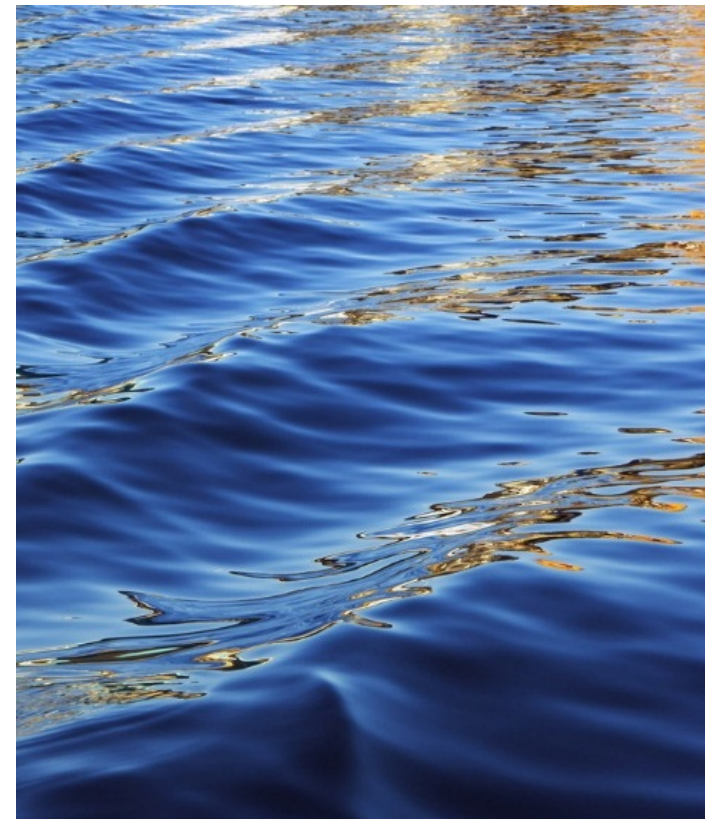






# Water Quality/Risks

Pollutants and Treatment Methods



# Sources of Contamination: Disease

Disease	Bacteria Name	Where it comes from	Method of water contamination
Listeriosis	Listeria monocytogenes	Fecal matter of infected animals, which can contaminate drinking water supplies and soil	Rodents leave droppings on roof or in catchment systems
Leptospirosis	Leptospira interrogans	Urine of infected mammals	Rodents urinate on roof or in catchment system
Campylobacteriosis	Campylobacter jejuni	Fecal matter of animals, domestic and feral; particularly carried by birds, domestic and wild	Birds or rats leave droppings on roof or in catchment system
Salmonellosis	Salmonella gastroenteriti	Fecal matter of animals, including birds and reptiles	Birds or geckos leave droppings on roof or in catchment system
Diarrhea	Escherichia coli	The fecal matter of all animals, but types pathogenic to humans are mostly found in human and cattle feces	Getting this disease via your water system is unlikely
Enteritis necroticans	Clostridium perfringens	Fecal matter of animals, domestic and feral	Animals leave droppings on roof or in catchment system

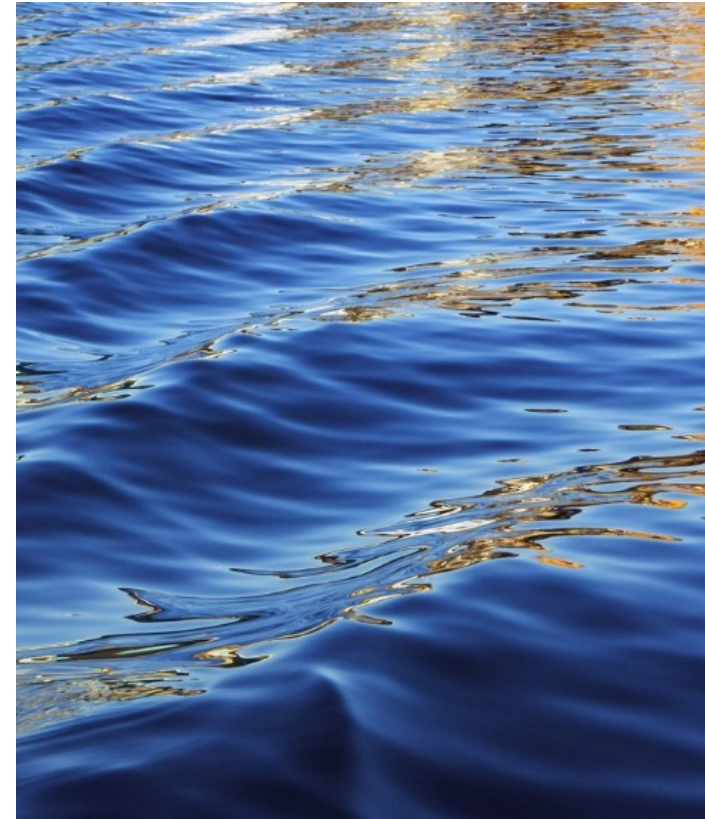
<b>Contamination in Tap Water</b>	<b>Health Damage</b>	<b>Method of Removal/Filtration</b>
Rust	Cause of liver cancer	PP Cotton
Dirt, Microorganisms, Sediment	Cause of various diseases	PP Cotton
Chlorine	Cause of rectal cancer, colon cancer and bladder cancer	Granulated Activated Carbon, KDF
Odour	Bad smell in water	Granulated Activated Carbon
Volatile Organic Chemicals (VOC)	Cause of various diseases	Granulated Activated Carbon
THMs: Total Trihalomethanes (THM)	Cause of kidney cancer and birth defects.	Granulated Activated Carbon, Ultrafiltration
Bacterial	Cause of various diseases	KDF / Calcium Sulfit
Algae	Cause of various diseases	KDF / Calcium Sulfit
Lead (Heavy Metal)	A poisonous metal that can damage nervous connections and cause blood and brain disorders	KDF / Calcium Sulfit
Mercury (Heavy Metal)	A cumulative heavy metal poison	KDF / Calcium Sulfit
Particles of 0.1 micron or larger	Cause of various diseases	Ultrafiltration
Bacteria and most viruses	Cause of various diseases	Ultrafiltration





# Codes and Standards

Current and Emerging





# What are the NPDES Phase II Stormwater Regulations?

- **National Pollutant Discharge Elimination System, established in 1987 under the Clean Water Act**
- **Phase I (1990) covers industrial sites, construction sites over 5 acres, and municipalities over 100,000**
- **Phase II (2003) covers industrial sites, construction sites over 1 acre, and ALL public entities (municipalities and institutions) operating separate storm sewer systems AND contained within the U.S. Census Urbanized Area**

# How does Phase II affect communities?

- Both permits require implementation of Best Management Practices (BMPs):

## Structural BMPs:

- detention ponds
- swales
- infiltration basins
- sand filters
- filter strips
- swirl concentrators

## Non-Structural BMPs:

- ordinances & zoning
- education & outreach
- maintenance activities (drain cleaning, street sweeping)

# What are the NPDES Phase II Stormwater Regulations?

- NPDES Phase II Goal:

To reduce the discharge of pollutants to the “maximum extent practicable” to protect water quality





# Water Reuse Standards

*NSF 350 Onsite residential and commercial reuse treatment systems*

*and*

*NSF 350-1 Onsite residential and commercial graywater treatment systems for subsurface discharge*

# Comparison of NSF 350 and 350-1

## Standard 350

- Residential and commercial treatment systems.
- Sources: graywater and combined wastewater.
  - Graywater: laundry, bathing or both.
  - Combined residential: black and gray.
  - Combined commercial: all potential sources.
- Effluent application.
  - Indoor; toilet and urinal flushing.
  - Outdoor; surface and subsurface irrigation.
  - Other comparable non-potable applications.

## Standard 350-1

- Residential and commercial treatment systems.
- Sources: graywater only; laundry, bathing or both.
- Effluent application: subsurface only

# System Sizes

- Residential wastewater; Up to 1500 gpd
  - Laboratory testing with actual wastewater.
- Graywater; Up to 1500 gpd
  - Laboratory testing with synthetic wastewater; bathing, laundry, or both
  - Exception; commercial laundry water
- Systems exceeding 1500 gpd, and commercial laundry
  - Field evaluation using actual building wastewater.

# Performance Evaluation: Complete Residential Wastewater

- Residential wastewater treatment system (combined wastewater); same as Standard 40/245.
  - Standard 40 Class I as prerequisite.
  - Same basic influent requirements.
  - Six month evaluation, stress testing, composite sampling
- Simultaneous testing to three standards
  - Standard 40: CBOD<sub>5</sub>, TSS, pH
  - Standard 245: Total Nitrogen
  - Standard 350: Turbidity, E. coli



# Standard 350 Effluent Criteria

Parameter	Class R	Class C
CBOD <sub>5</sub>	10 mg/L (25)	10 mg/L (25)
TSS	10 mg/L (30)	10 mg/L (30)
Turbidity	5 NTU (10)	2 NTU (5)
E. coli	14 MPN/100 mL (240)	2.2 MPN/100 mL (200)
pH	6.5-8.5	6.5-8.5

## Standard 350-1 Effluent Criteria

***Parameter***

***Criteria***

**CBOD<sub>5</sub>**

**25 mg/L**

**TSS**

**30 mg/L**

# Rainwater Collection Systems in the I-Codes



**"Irrigation of the land with seawater desalinated by fusion power is ancient. It's called rain."**

*Michael McClary*



Adopted in the  
City of Dallas

# Rainwater in the I-Codes

## 2012 International Green Construction Code (IgCC)

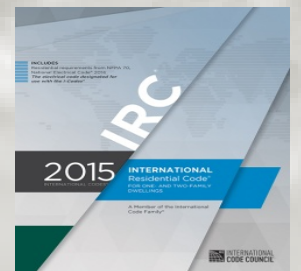
Ch. 7 – Water Resource Conservation, Quality and Efficiency  
Appendix A – Project Electives

## 2015 International Plumbing Code (IPC)

Chapter 6 – Water Supply & Distribution  
Chapter 7 – Sanitary Drainage  
Chapter 11 – Storm Drainage  
Chapter 13 – Nonpotable Water Systems

## 2015 International Residential Code (IRC)

Chapter 29– Water Supply and Distribution

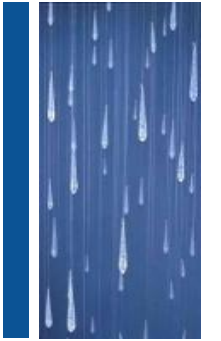


# P1303.1 General



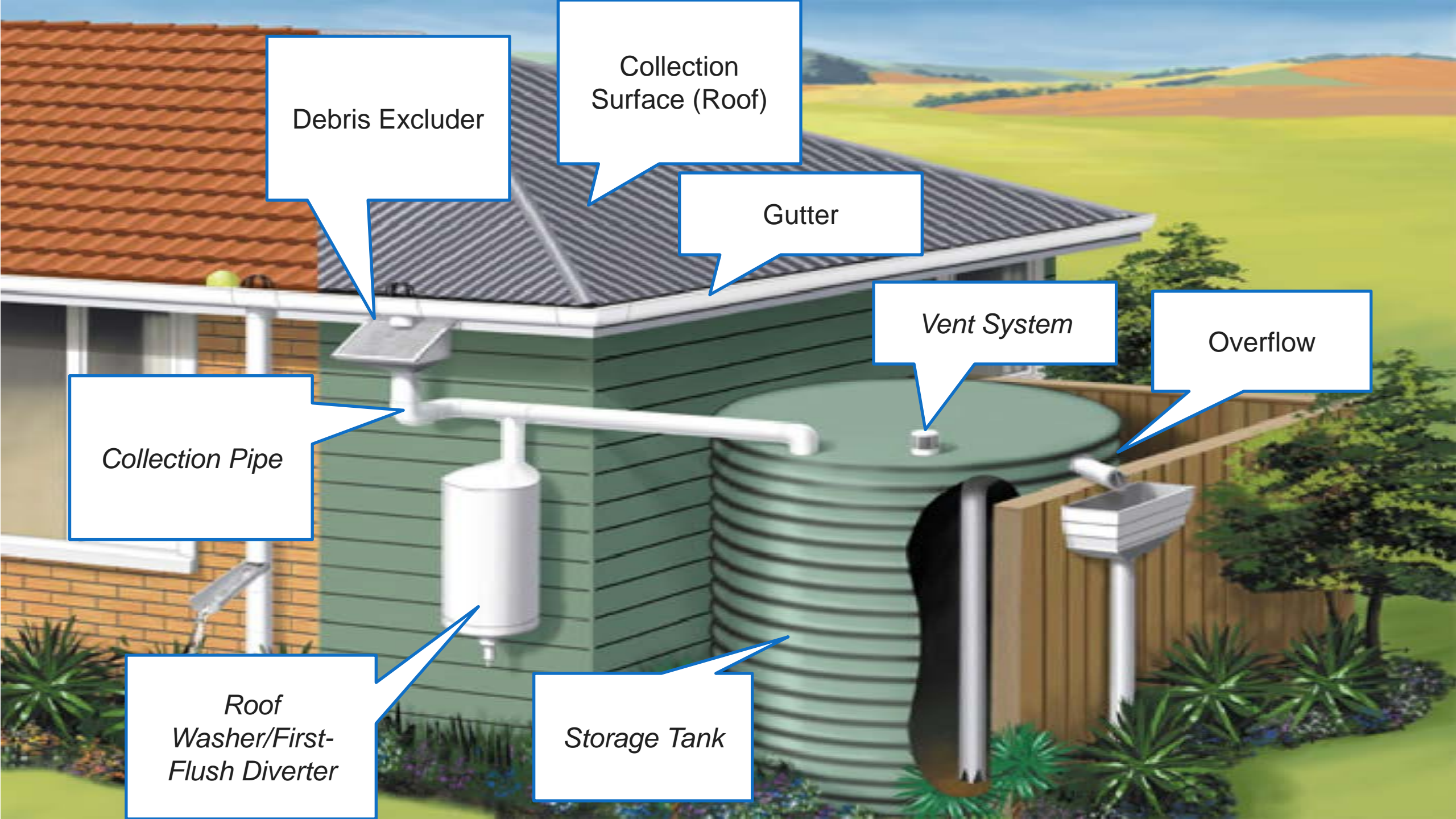
- **1303.1 General.** The provisions of Section 1303 shall govern the construction, installation, alteration and repair of rainwater collection and conveyance systems for the collection, storage, treatment and distribution of rainwater for nonpotable applications, as permitted by the jurisdiction.
  
- Plumbing and green code provisions must be considered in conjunction with local health codes.
  - Permissible non-potable use (e.g. flushing, irrigation, car washing, water features, etc)
  - Required disinfection and water quality
  - Periodic water quality and system inspections

# IgCC & IPC Section 202 Definitions



- **RAINWATER.** Water from natural precipitation.
- **RAINWATER COLLECTION AND CONVEYANCE SYSTEM.** *Rainwater collection system* components extending between the collection surface and the *storage tank* that convey collected *rainwater*, usually through a gravity system.
- *Roof Washer*
- *Potable, Nonpotable Water*
- *Storage tank*
- *Collection piping*
- *Backwater valves*
- *Leader*





Debris Excluder

Collection Surface (Roof)

Gutter

Vent System

Overflow

Collection Pipe

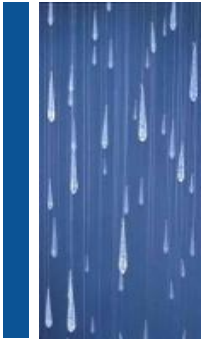
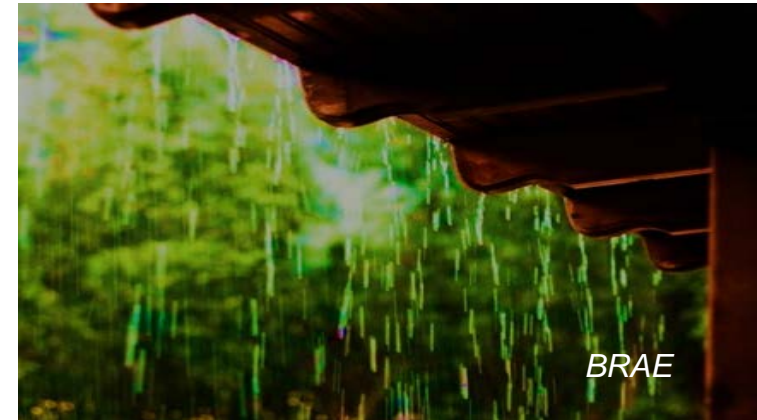
Roof Washer/First-Flush Diverter

Storage Tank



# P1303.1/G707.11 Collection Surfaces

- Collection of rainwater from above-ground impervious roofing surfaces using *approved* materials.
  - Exception: Vehicle and parking surfaces permitted for collection if water used exclusively for landscape irrigation.
- Overflow and bleed-off discharge from roof-mounted appliances may not discharge to collection surface



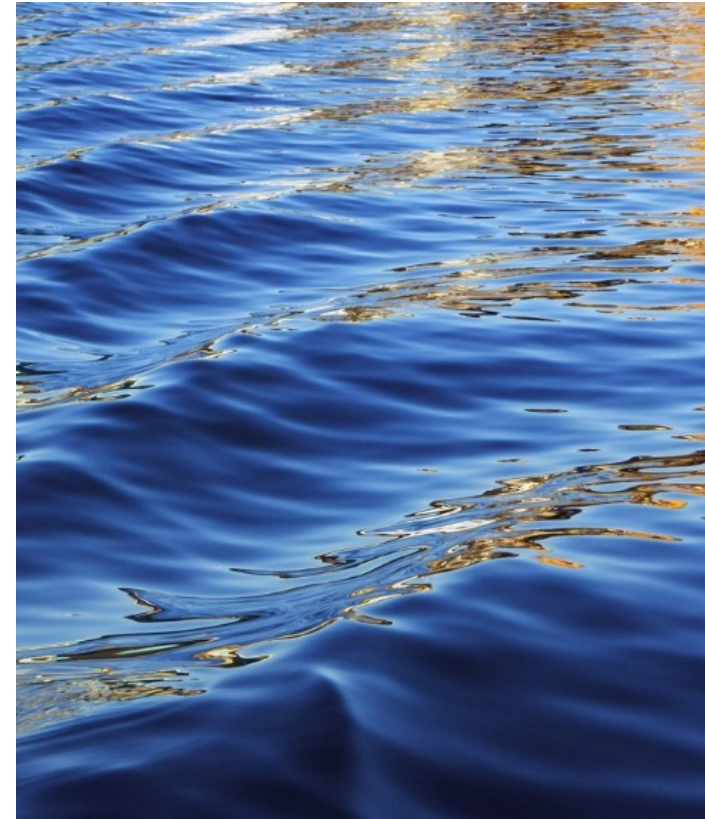




# Quality Control

## *Primary Treatment*

Innovative Technology



# Water Quality



# Common Pollutants

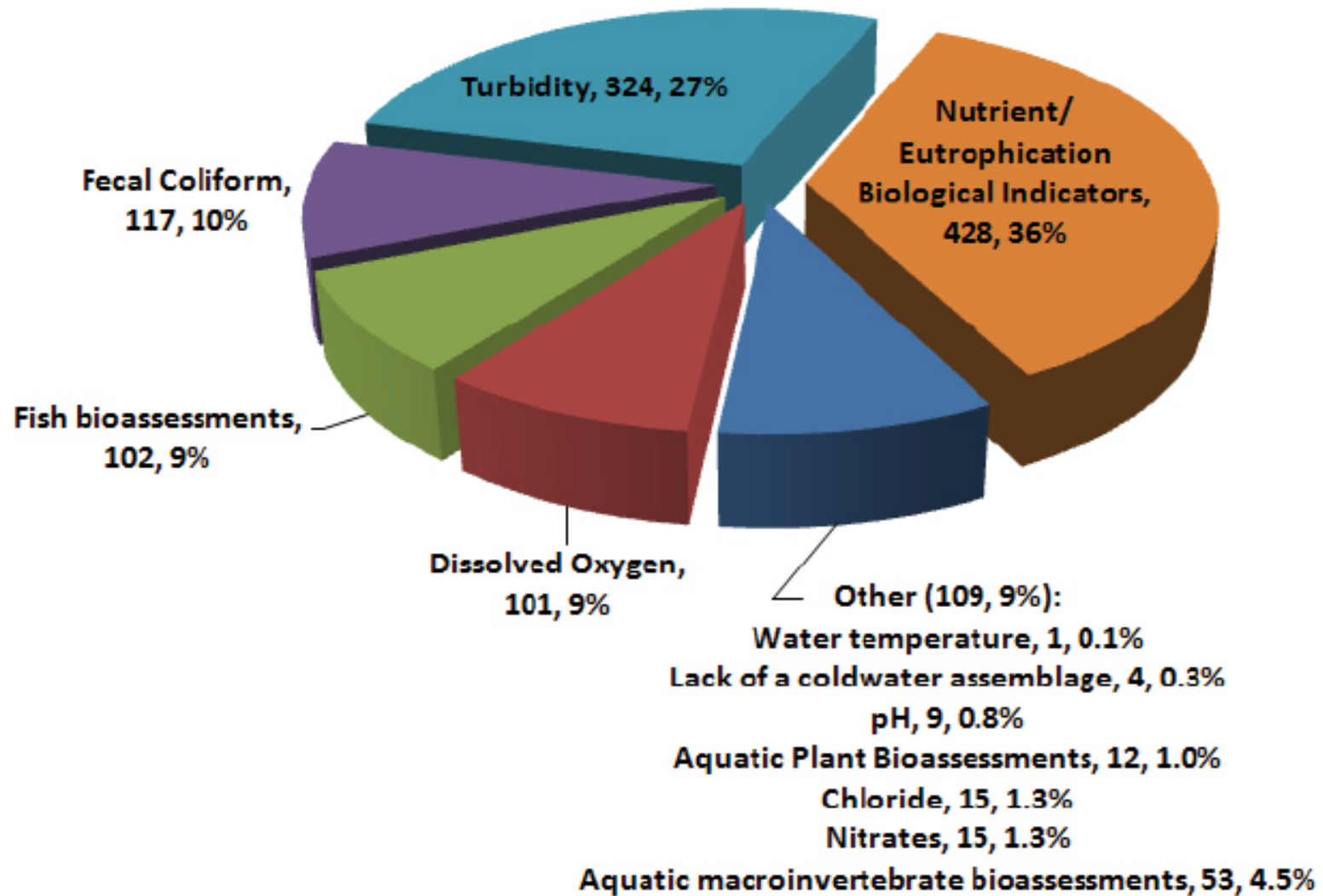
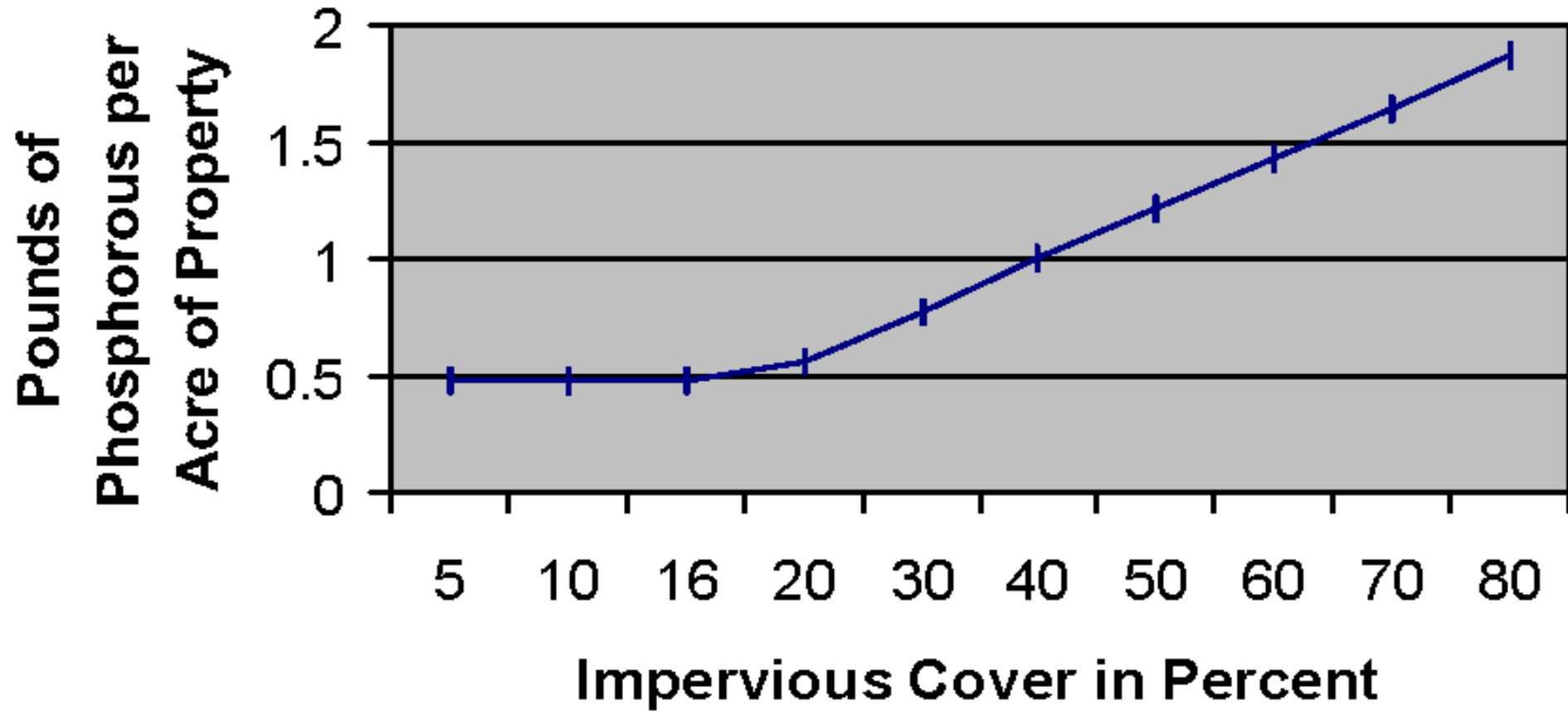


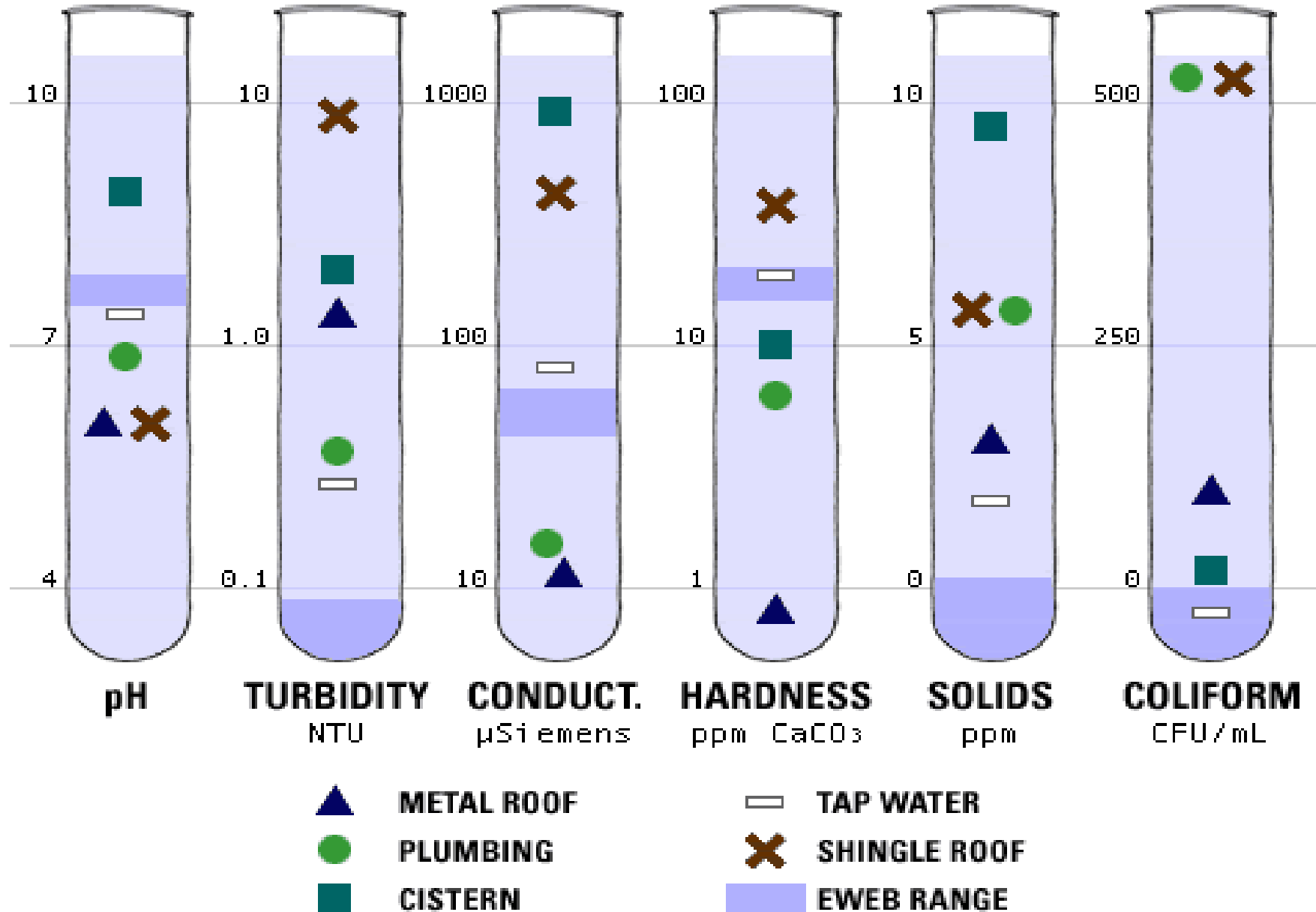
Figure 1.1: Water body impairments in Minnesota due to common stormwater pollutants (MPCA 2010)

# Impervious Cover vs. Pollutant Load

(Performance-based analysis:  $C=0.26$  mg/L, Avg. land cover = 16%)



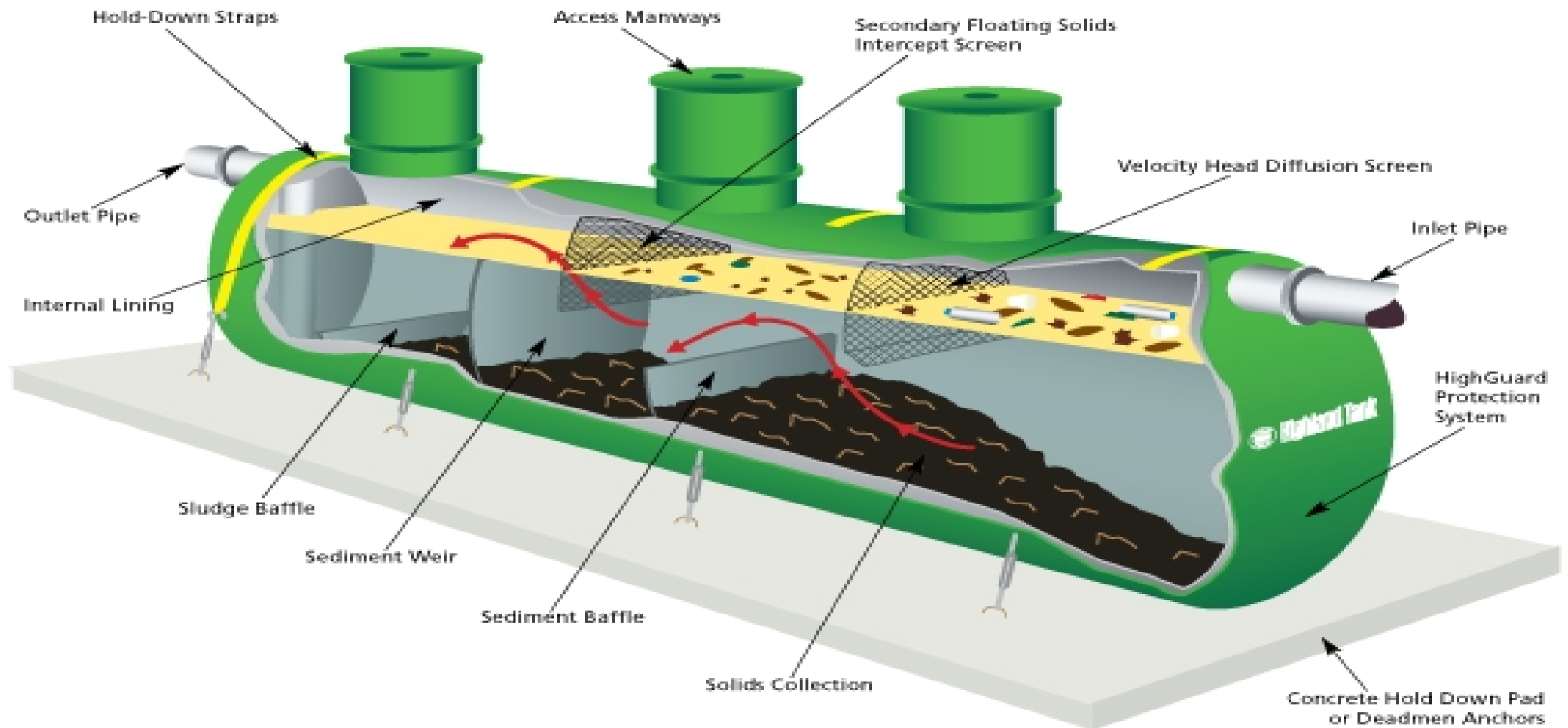
# Data & Analysis





# Sediment/Stormwater Interceptor

## How It Works





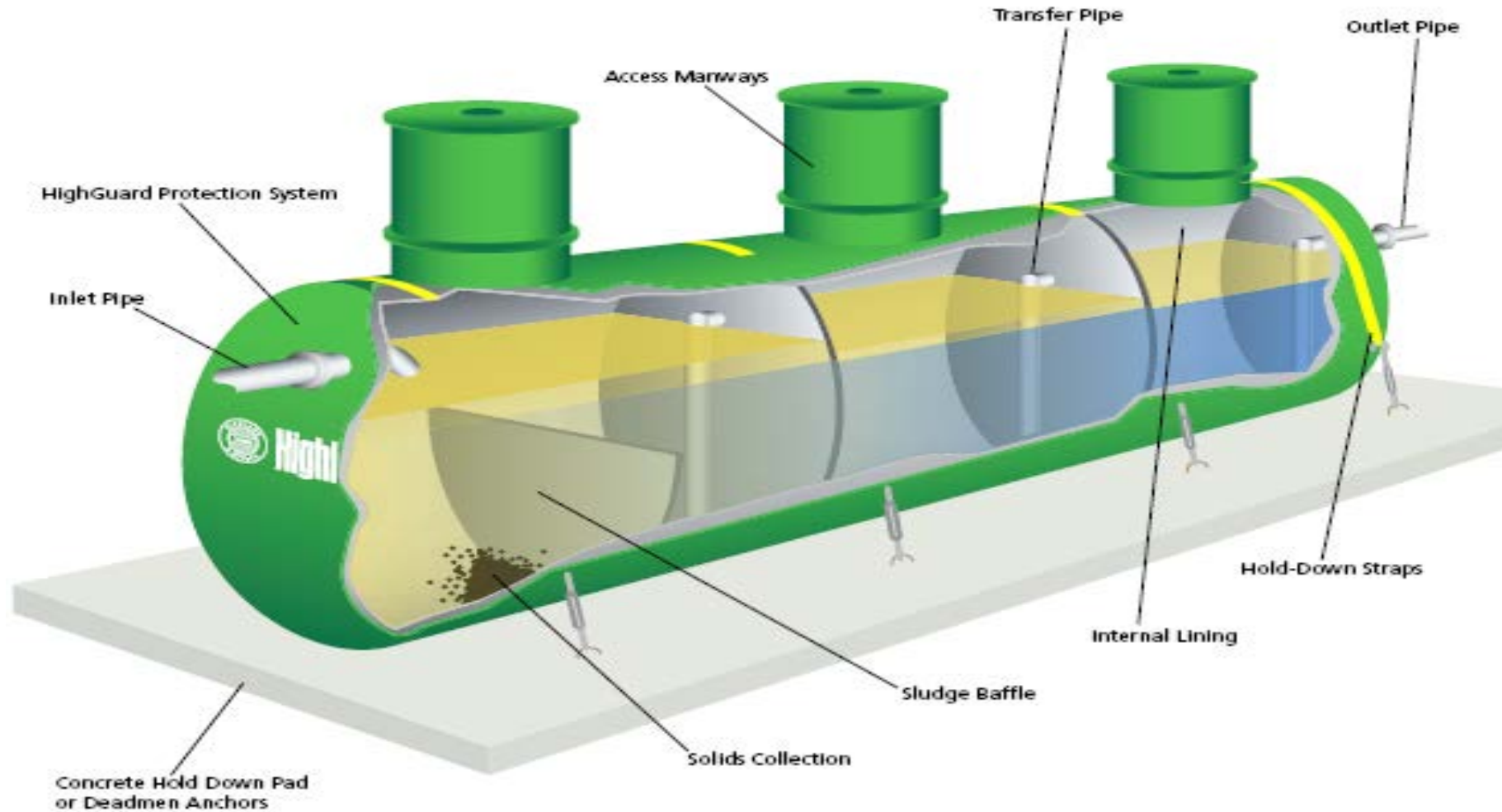


(1) 15,000 INTERCEPTOR/30,000 OWS  
STORMWATER MANAGEMENT SYSTEM  
AT AIRPORT RUNWAY

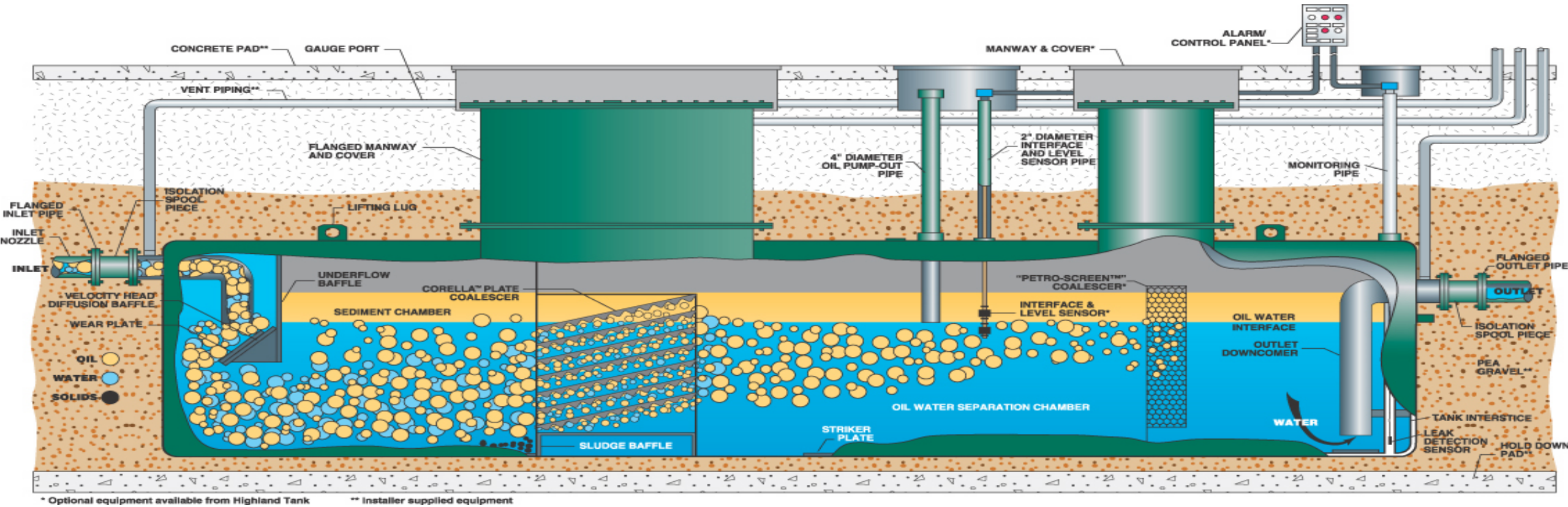


# Sand/Oil Interceptor

## How It Works



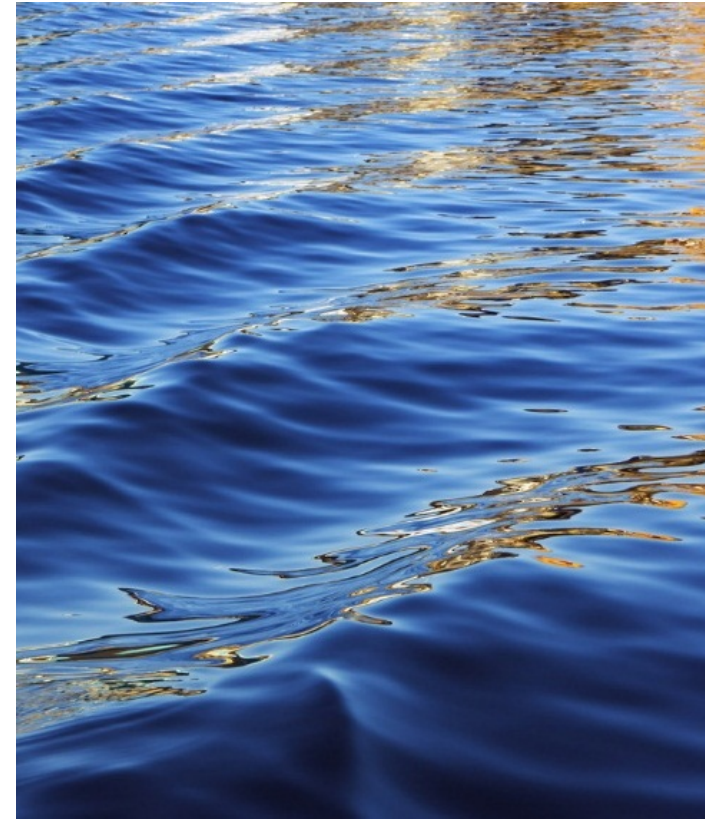
# Highland EZ-Access Oil/Water Separator with Corella® Plate Coalescer





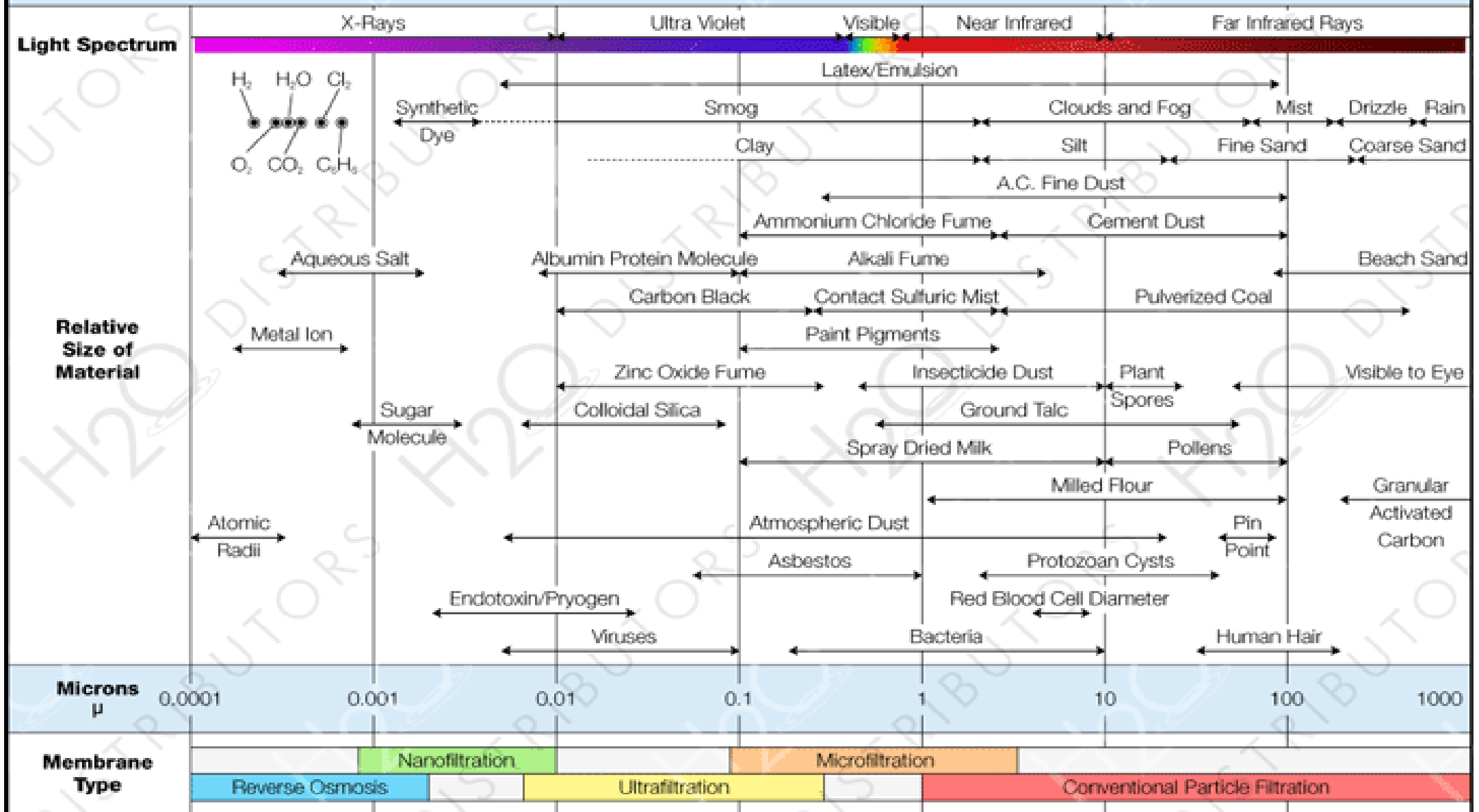
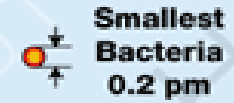
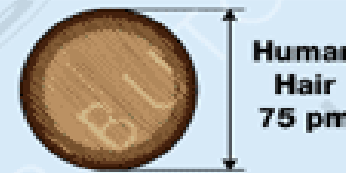
# Secondary Treatment

Filtration/Disinfection Technology



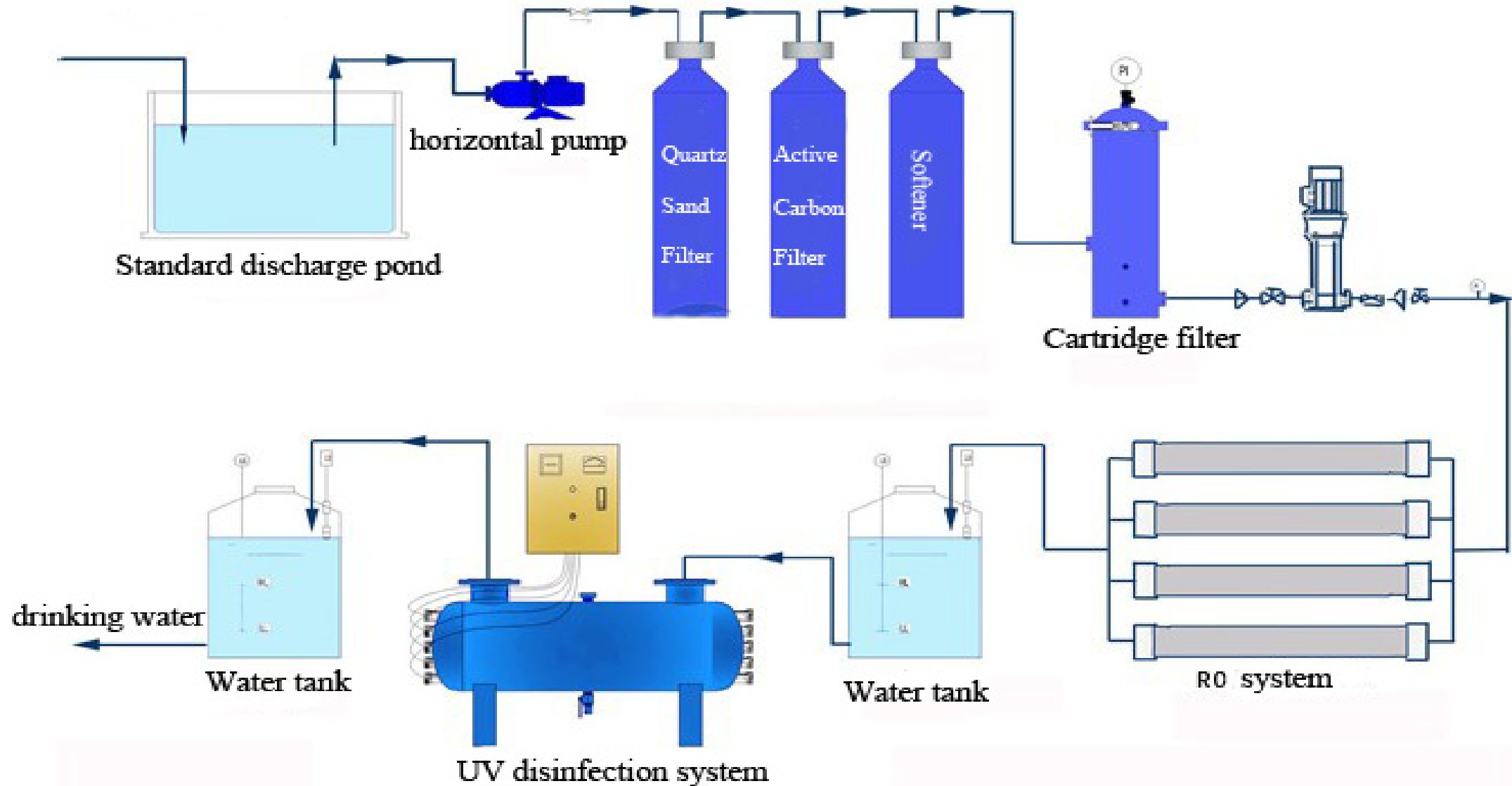


These sizes of well-known objects and particulates illustrate the size of the micrometer (or micron)



# Filtration/Disinfection Process

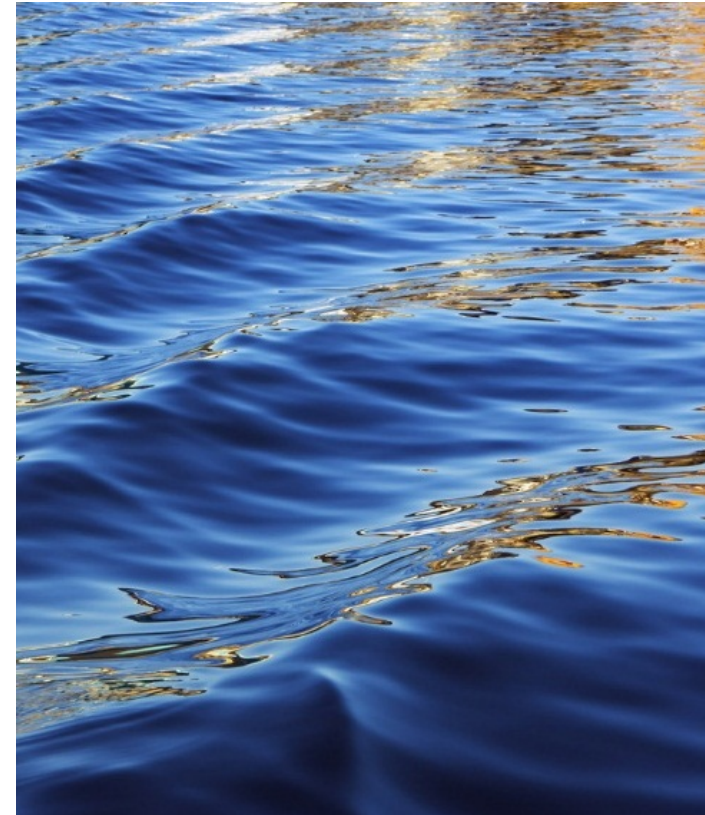
## Drinking Water Process Chart



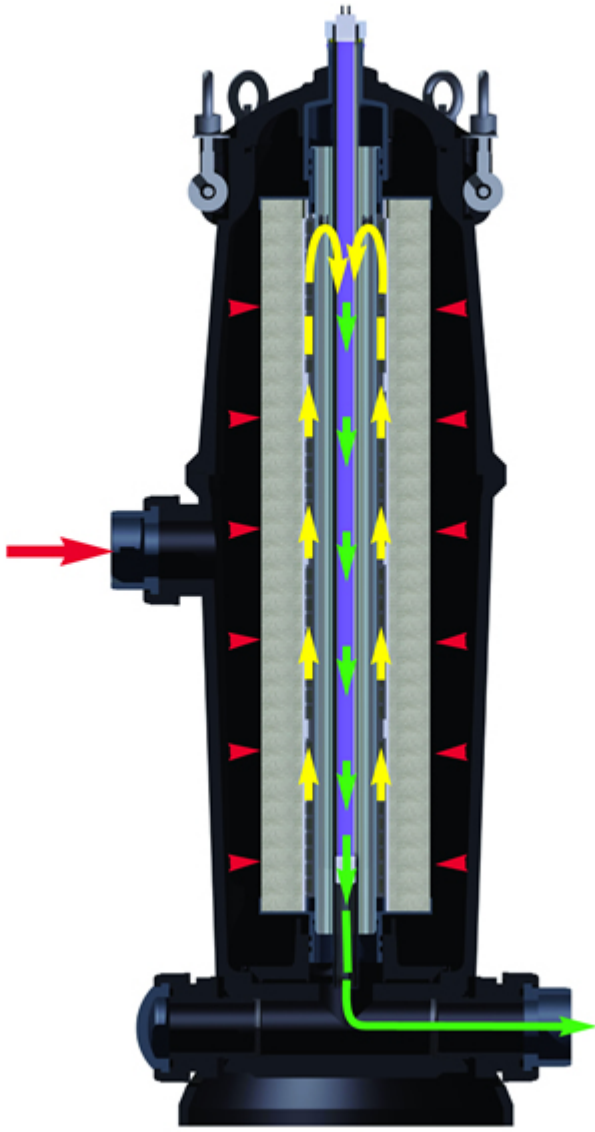
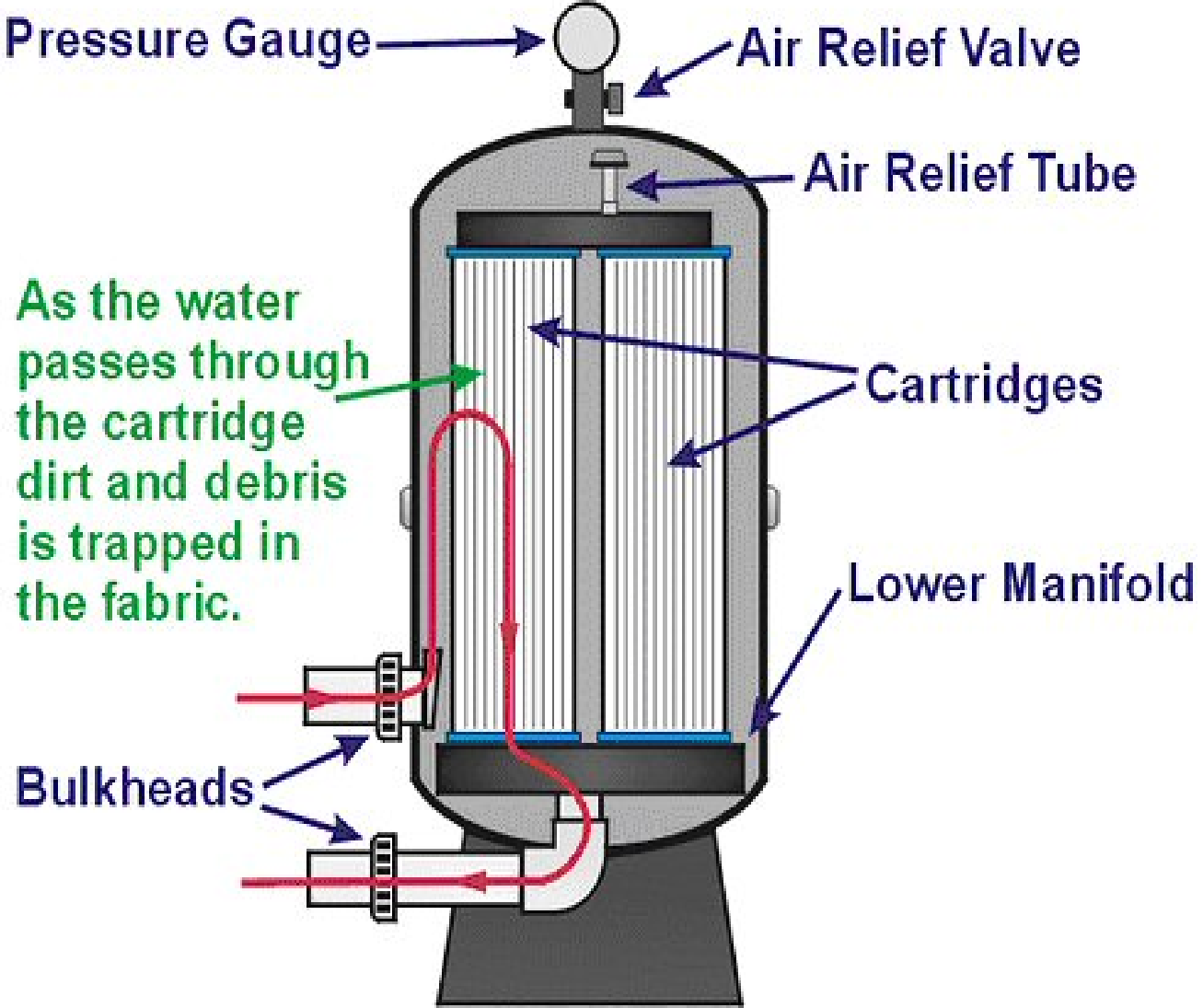


# Particulate Filtration

Types



# Cartridge Type Filters

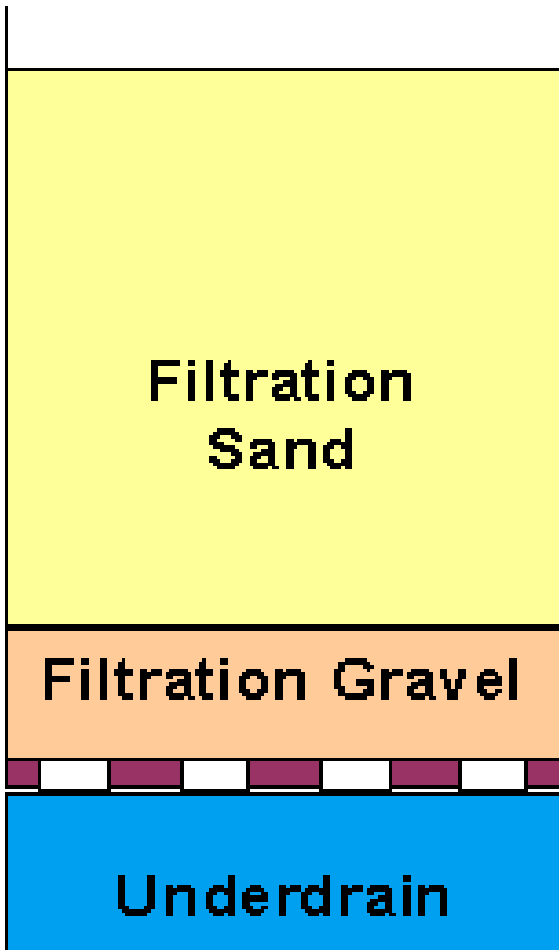


# Bag Filters

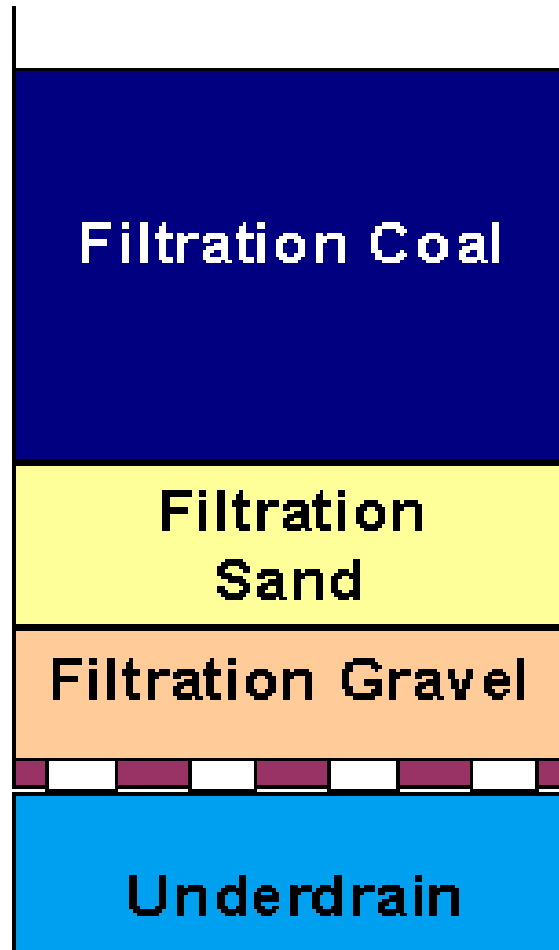




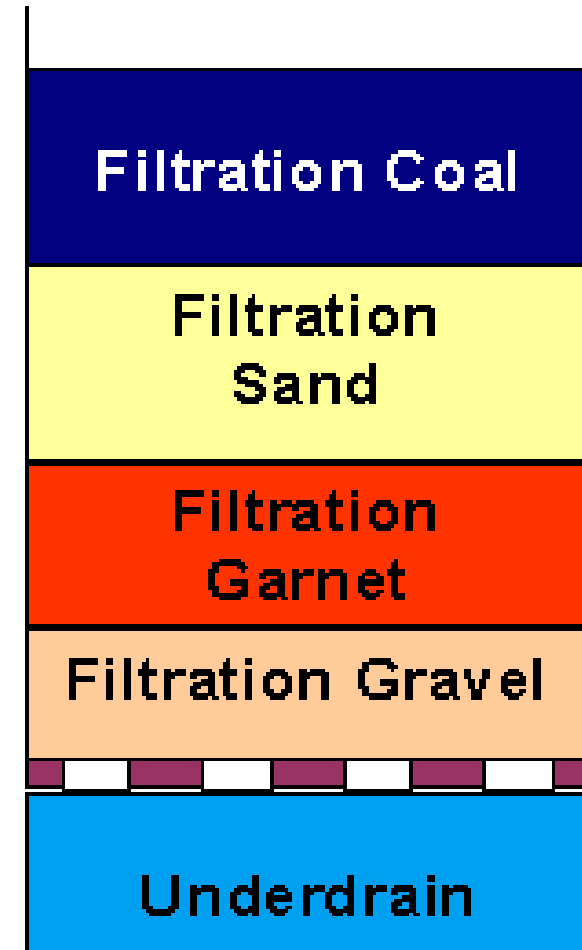
# Media Filters



**MONO-MEDIA**



**DUAL-MEDIA**



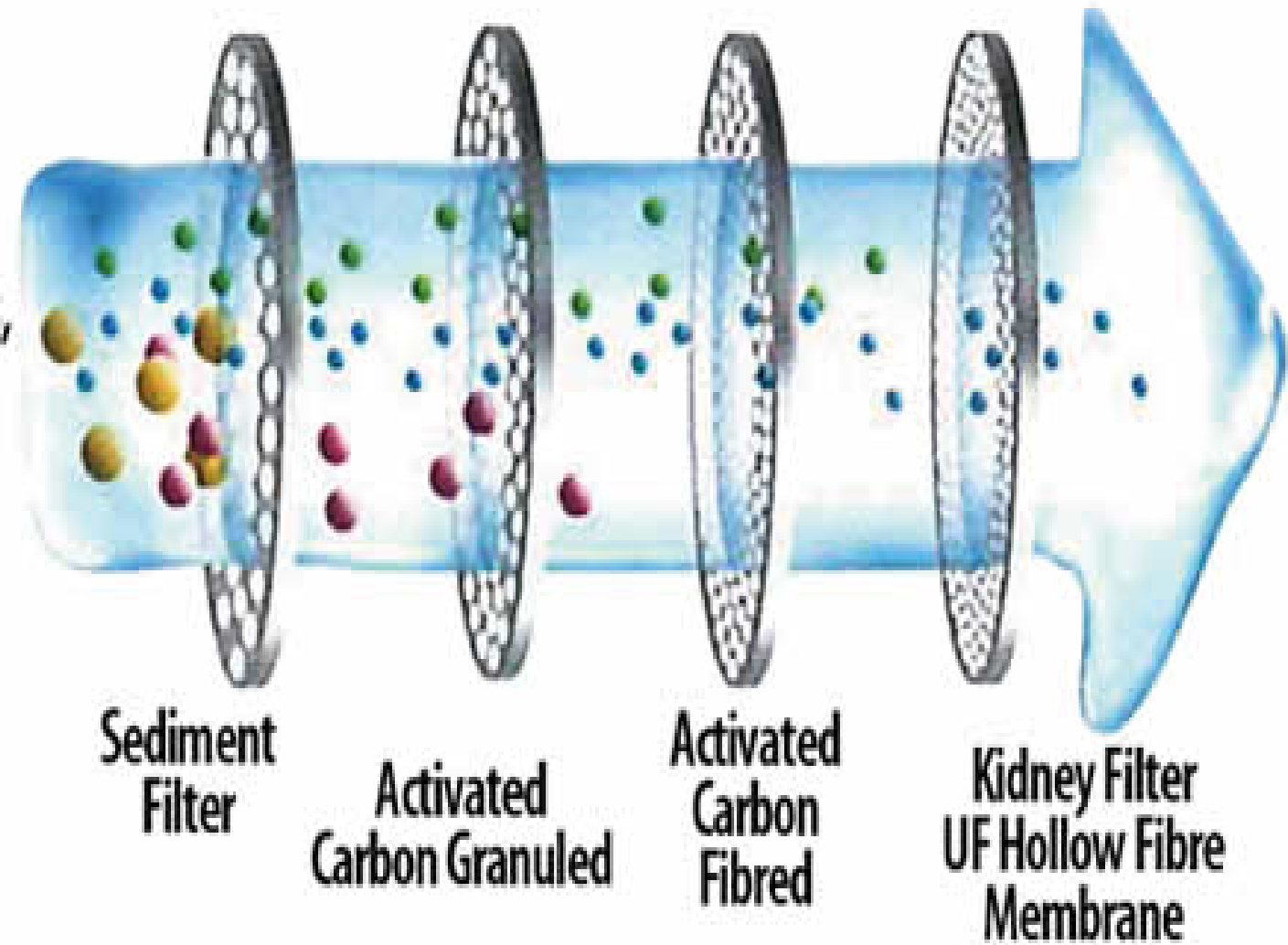
**MIXED-MEDIA**

● Minerals

● Mould, General Germs,  
Viruses, Bacteria

● Bad taste, Chlorine,  
Organic Substance

● Rust



# Polishing Filters

## Superior Design



Nutshell Media  
Particle Size:  
20–30 mesh

## Conventional Nutshell Filter



## Spectrum Micro Media Filter



Nutshell Media\*  
Particle Size:  
20–30 mesh



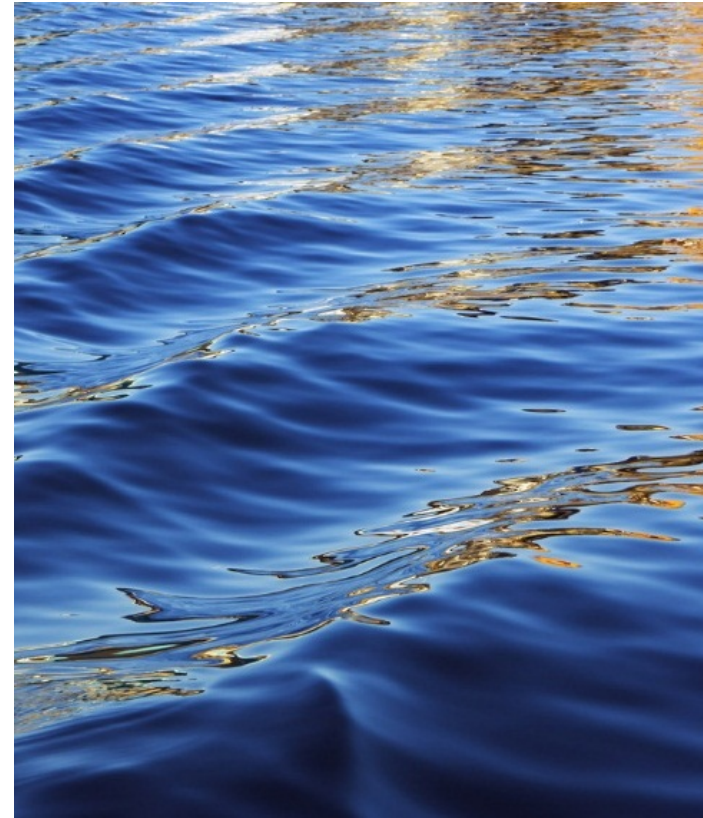
Spectrum Micro Media  
Particle Size:  
30–230 mesh

\*Spectrum Plus filter is used with oil water and has nutshell coarse media. When very little oil is present, a Spectrum Filter with anthracite as coarse media is used.



# Disinfection

Types of Oxidizers and there effectiveness





# Disinfection Oxidizers

- Chlorine

chlo·rine

*/ˈklôr, ēn/*

*noun*

1. the chemical element of atomic number 17, a toxic, irritant, pale green gas.

- Ozone

o·zone

*/ˈō,zōn/*

*noun*

1. a colorless unstable toxic gas with a pungent odor and powerful oxidizing properties, formed from oxygen by electrical discharges or ultraviolet light. It differs from normal oxygen (O<sub>2</sub>) in having three atoms in its molecule (O<sub>3</sub>).

- UV

**Ultraviolet** germicidal irradiation (UVGI) is a **disinfection** method that uses **ultraviolet** (UV) light at sufficiently short wavelength to kill microorganisms. It is used in a variety of applications, such as food, air and water purification.

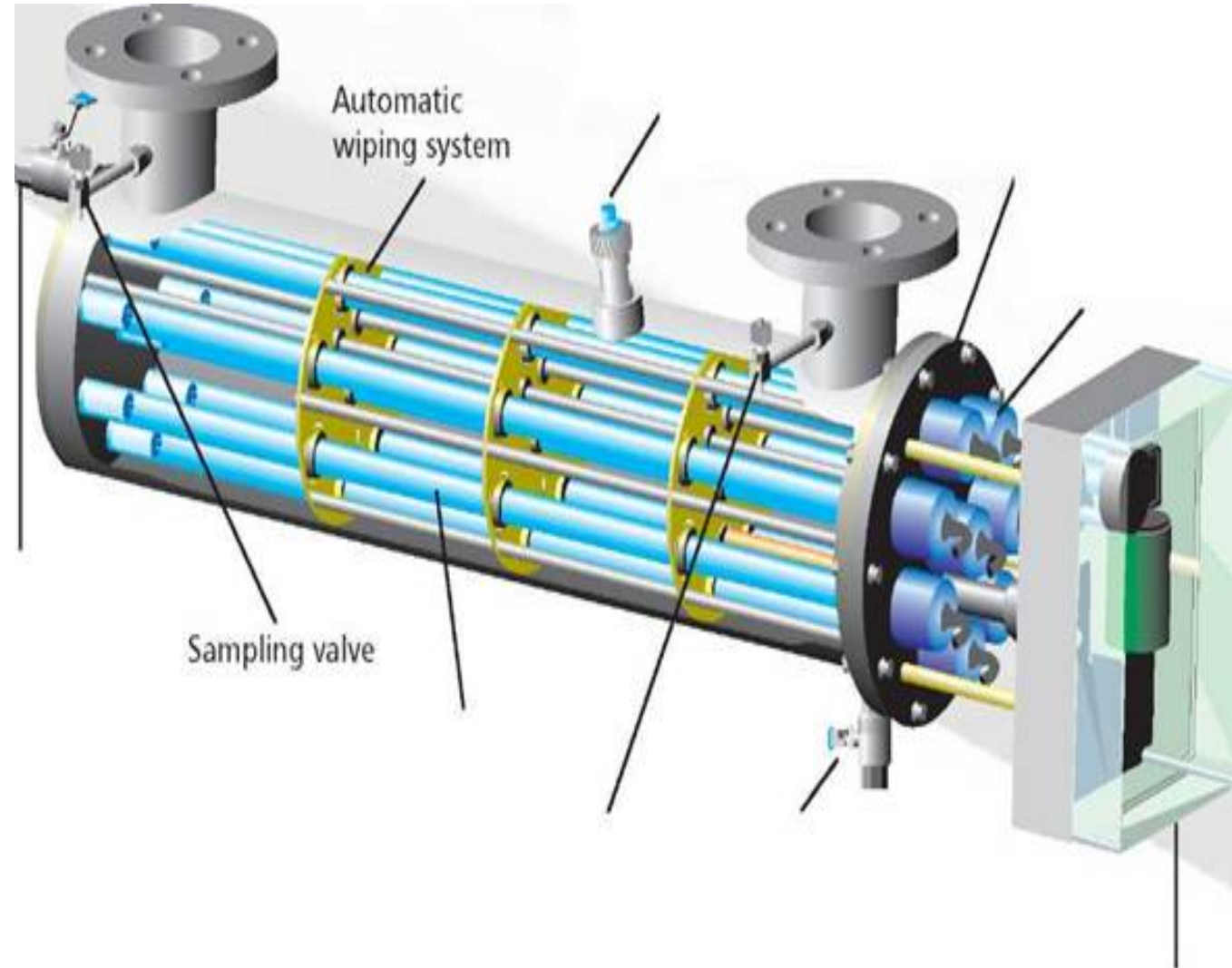


# Typical Chlorination





# UV Disinfection







MULTI  
PUMP

100 GUARDIAN  
ELECTRONIC  
CONTROL

SANTRON

ENHANCED  
VPIE CONTROLLER  
SELECT MODE  
Ashberry  
Commercial Water Treatment Experts  
1-800-422-5470

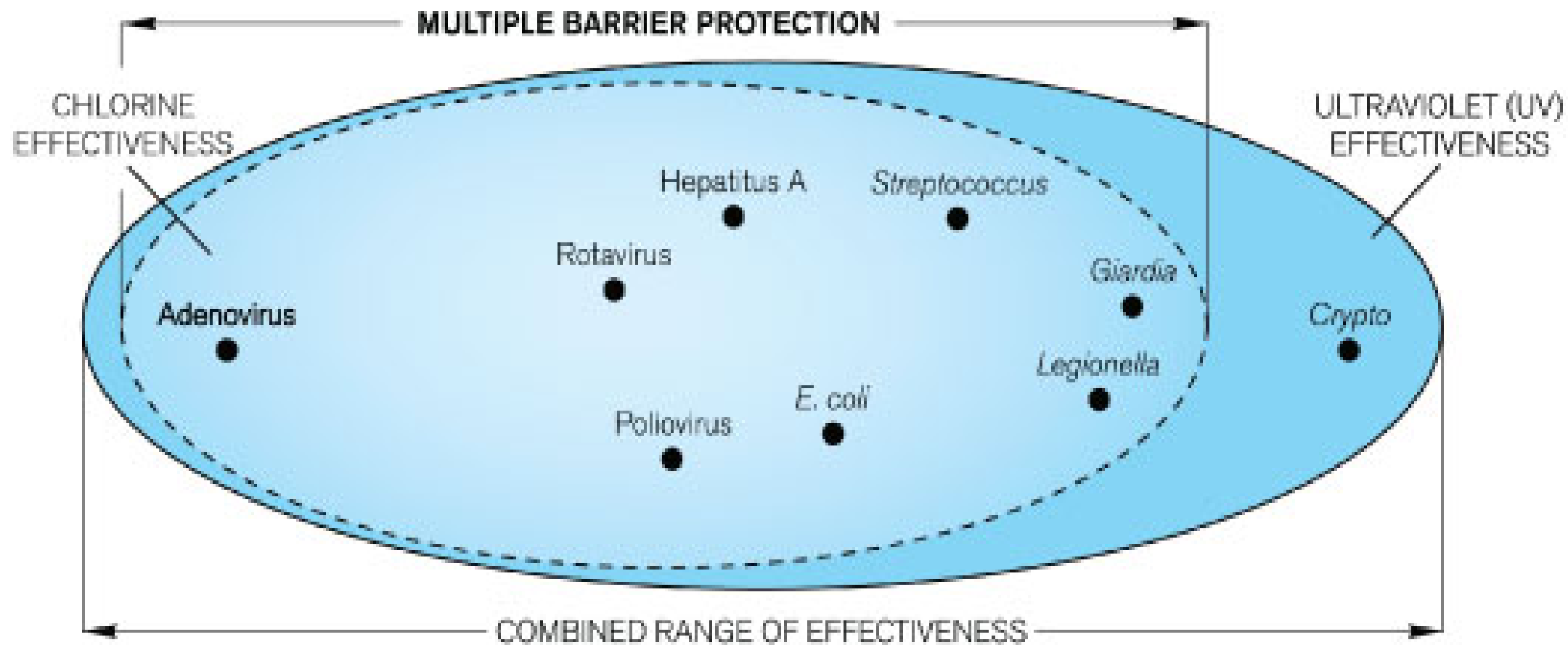
250V, 5A



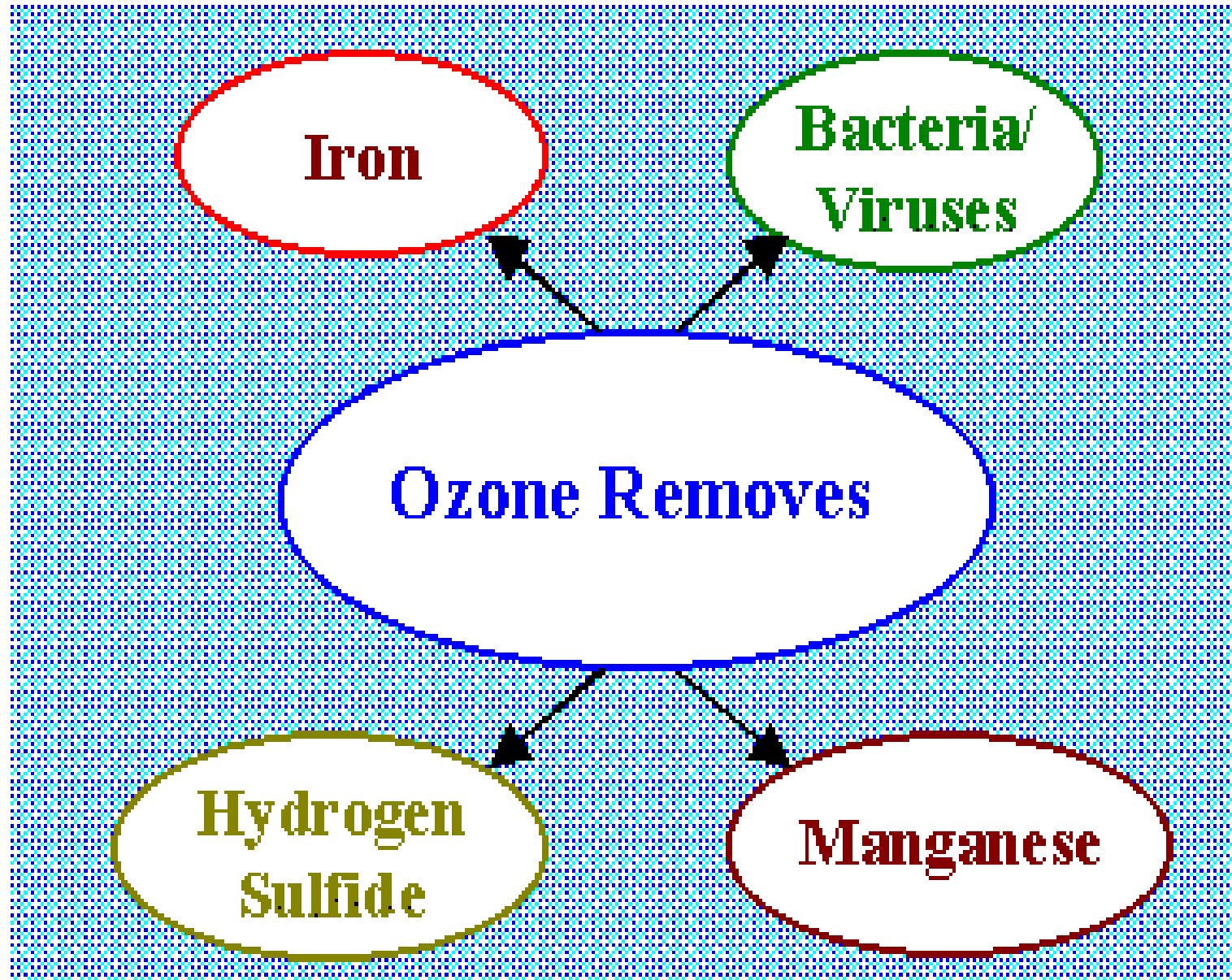
**HighDR**  
Rainwater Reuse System



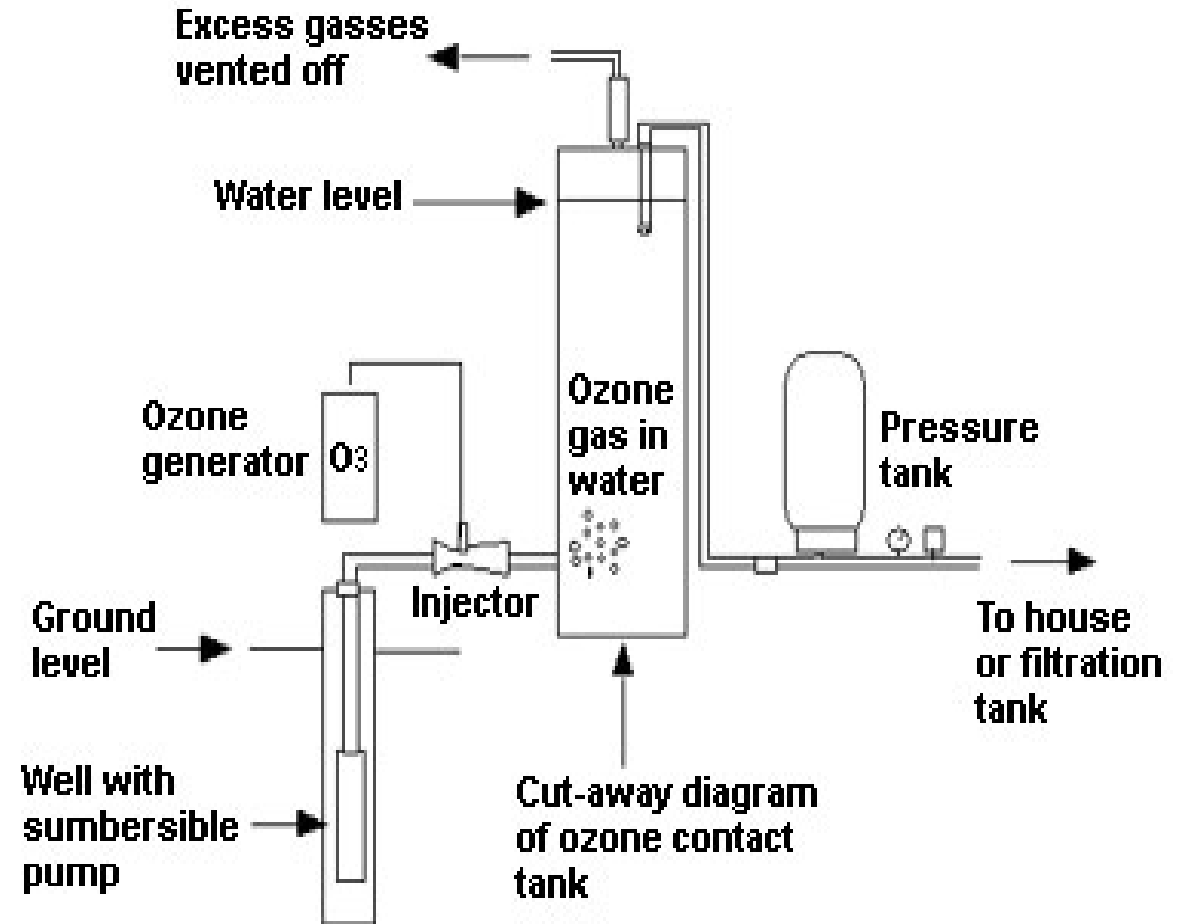
# Disinfection UV vs Chlorine



# Ozone



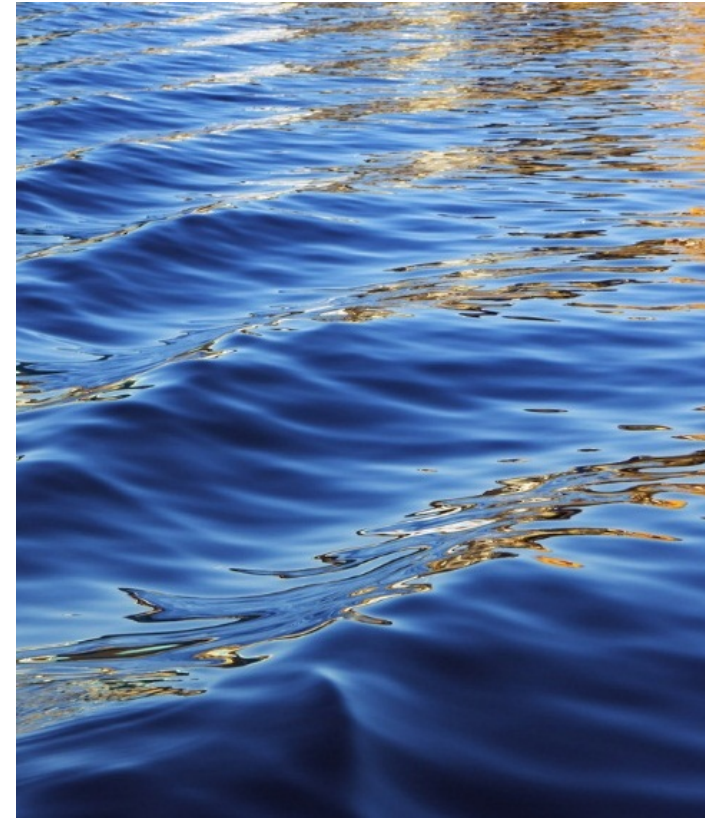
# Ozone Systems





# System Design

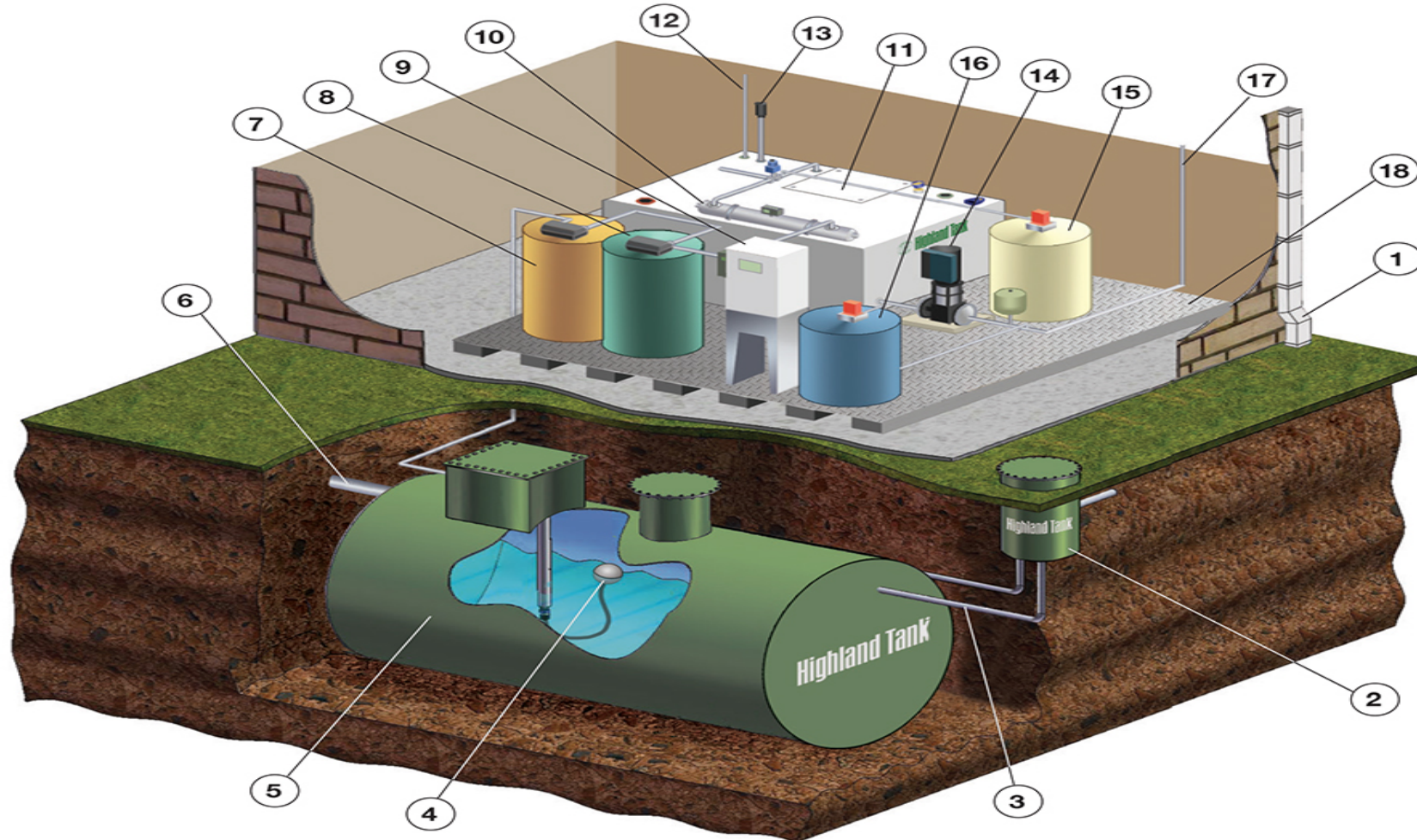
Reuse system components

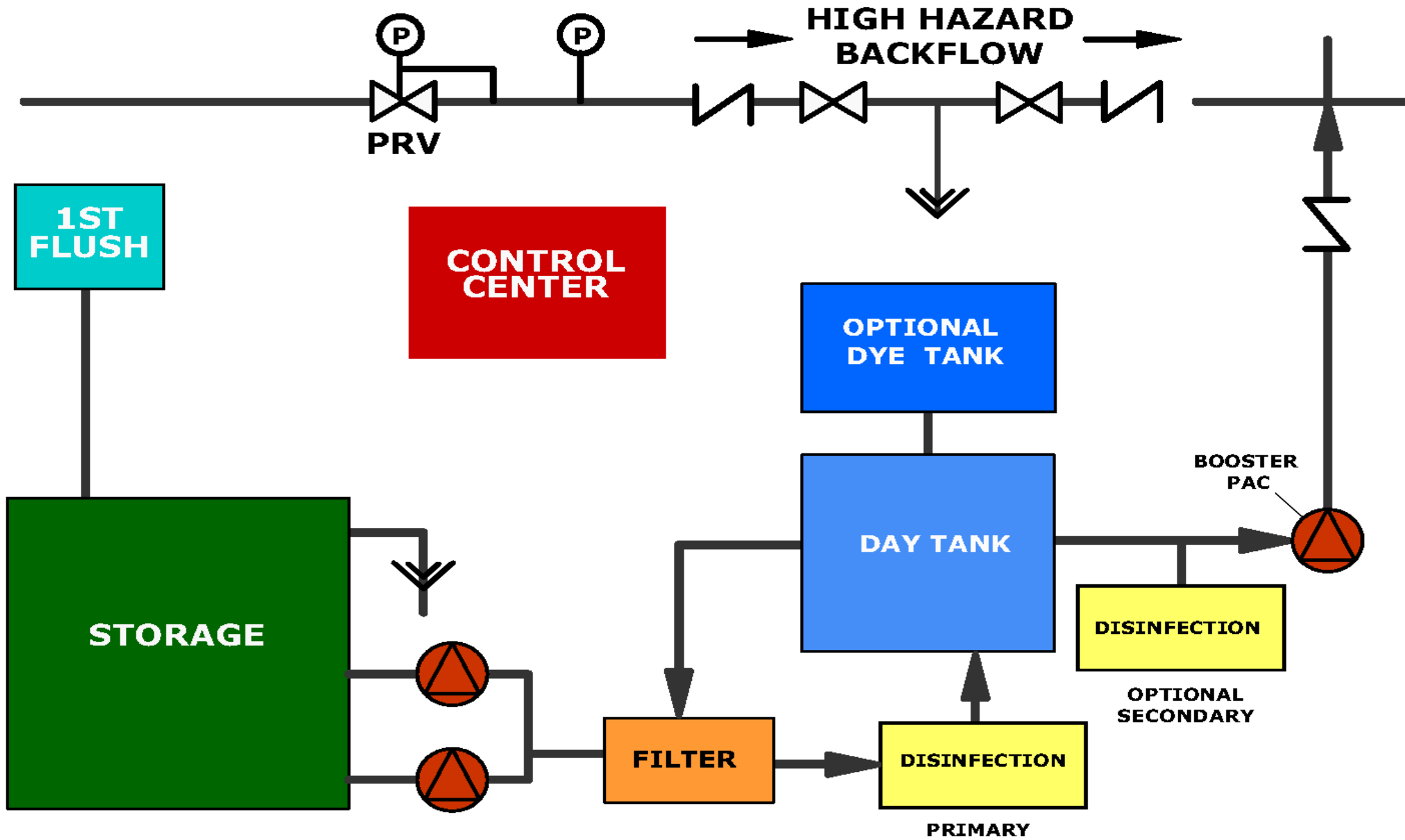




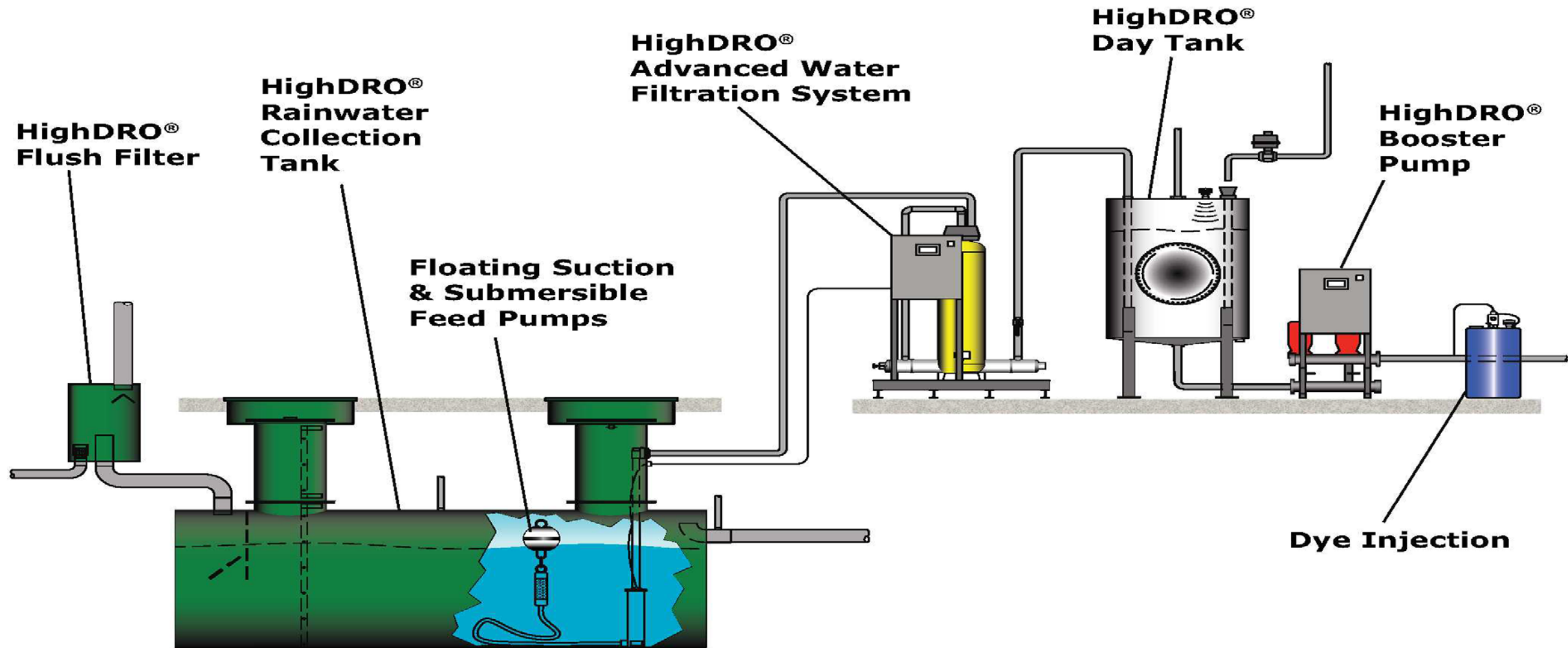
# HighDRO<sup>®</sup>-Pure Rainwater Harvesting Systems

1. Rainwater Source
2. Flush Filter (HD-FF)
3. Flush Filter Overflow to Storm Drain
4. Floating Suction & Submersible Feed Pumps
5. Rainwater Collection Tank (HD-RCT)
6. Collection Tank Overflow to Storm Drain
7. Carbon Filtration
8. Multimedia Filter
9. Control System (HD-CS)
10. UV Filter
11. Day Tank (HD-DT)
12. Make-up Water Connection
13. Carbon Vent
14. Booster Pump (HD-BP)
15. Chlorine Injection
16. Dye Injection
17. Water Supply to Building
18. Filtration Skid (50-60 ft<sup>2</sup>)

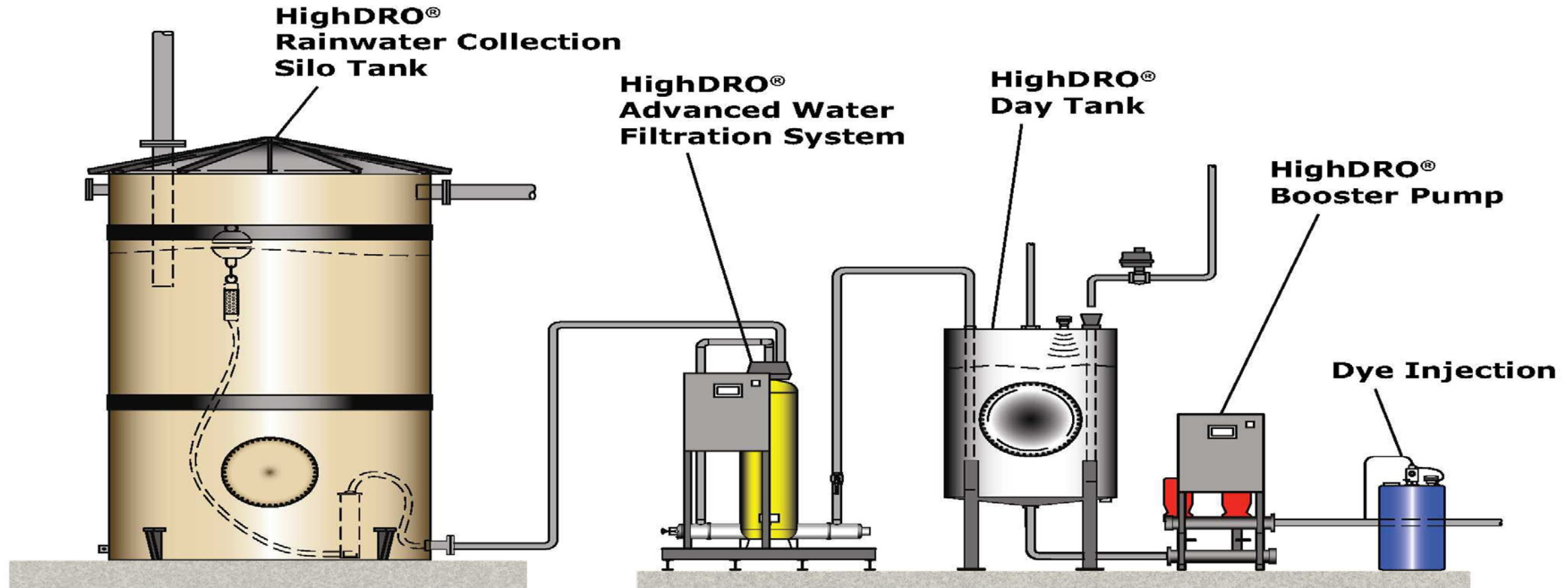




# Underground HighDRO®-Pure Rainwater Harvesting System



# Aboveground HighDRO®-Pure Rainwater Harvesting System





# Underground Cisterns



















08/15/2011 22:38





HighD89-Liner Plus  
**Highland Tank**  
www.highlandtank.com

MAIN DISCONNECT  
480 Volt 3 Phase

NON POTABLE WATER



# VCU School of Medicine















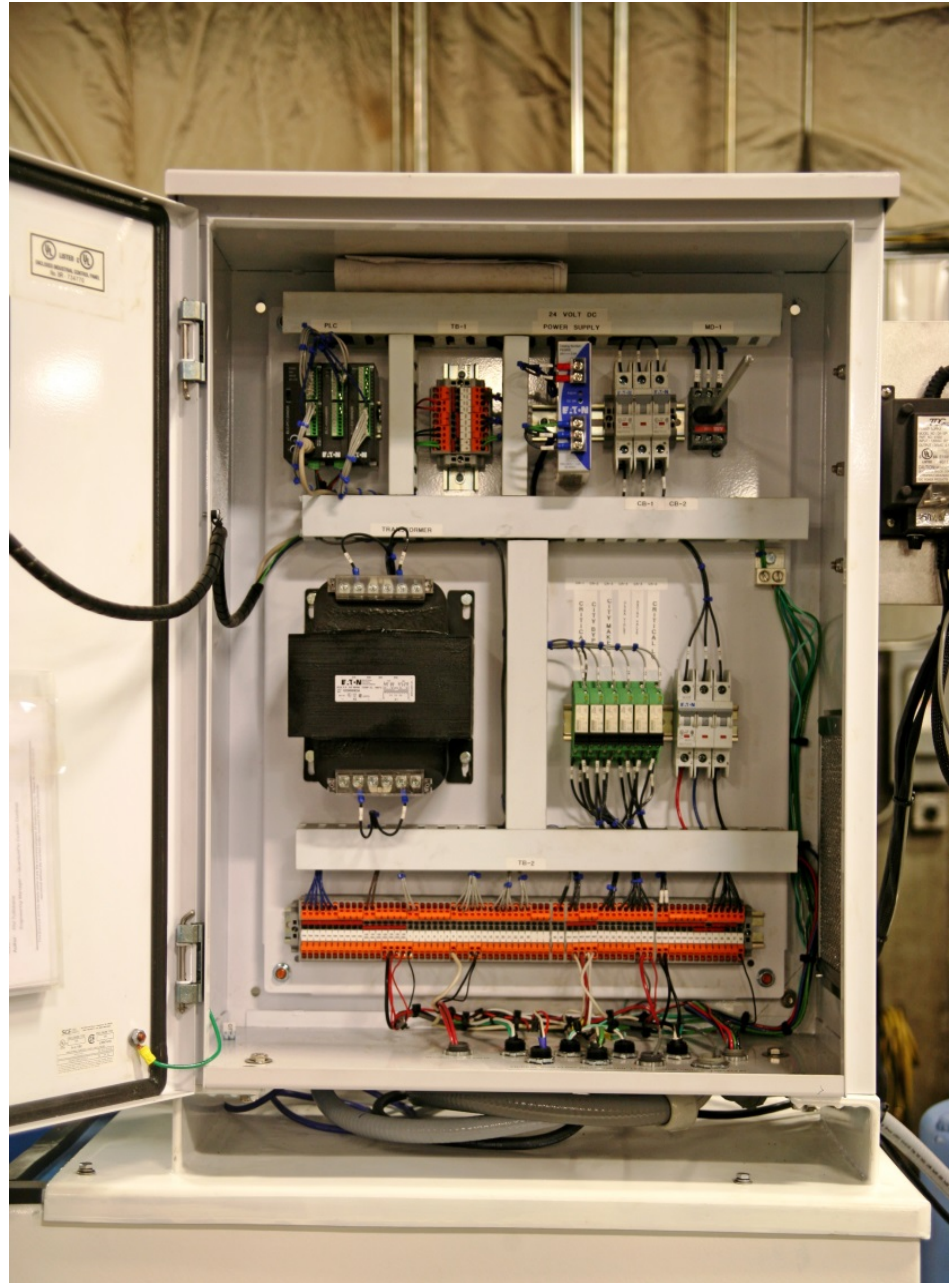




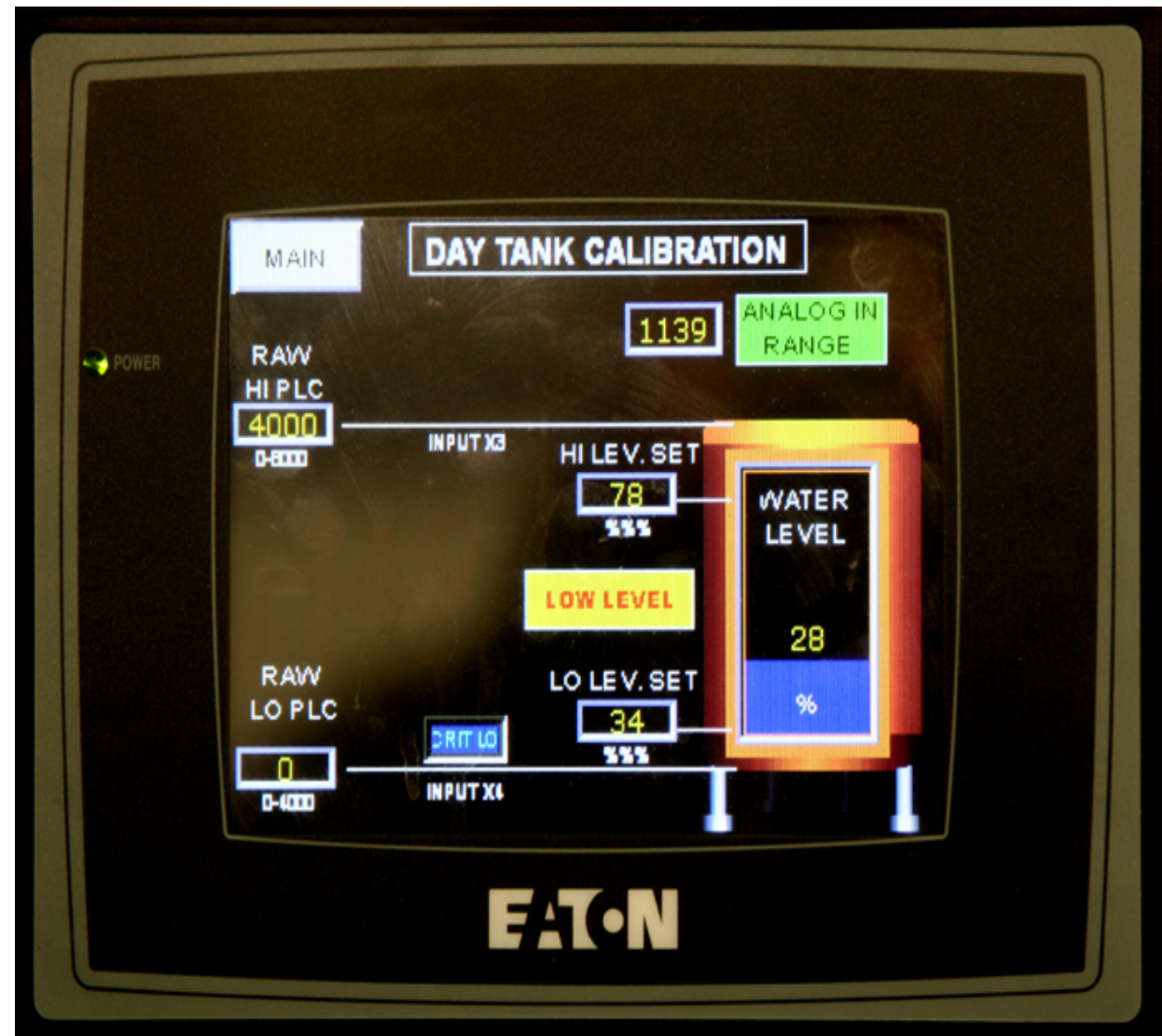
**HighDRG - Pure**  
Reverse Osmosis Systems for Highland Tank







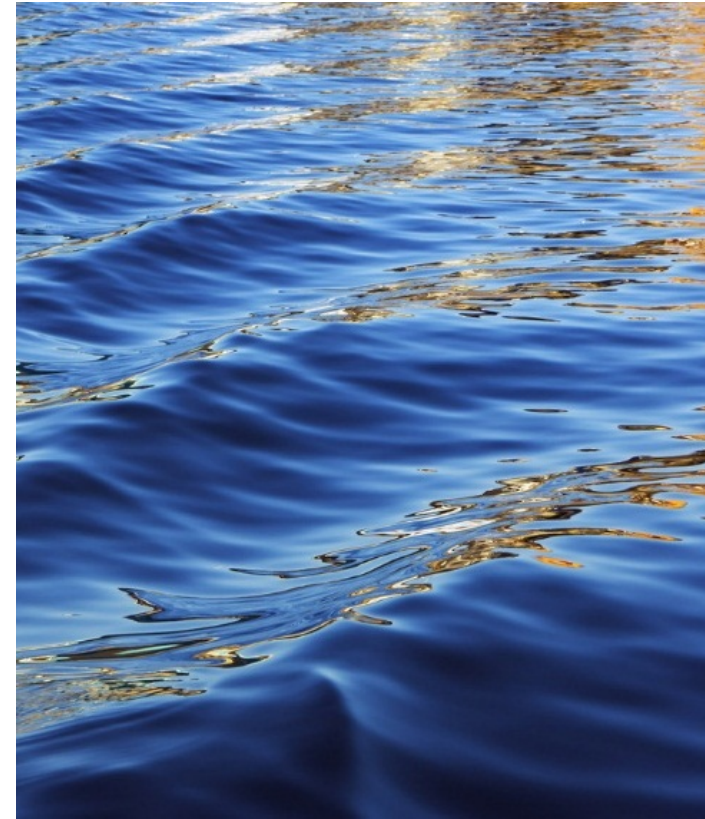






# Project Profiles

Storm Water Applications & Challenges





# Newington DVS Design

- Project Profile
- 91,000 sq/ft
  - 1831 Buses
- LEED Silver Design
  - Storm/Rain water reuse
- 25.4 acre site
- 1.7 acres Conservation Land



# Newington DVS Bus Facility-Wash Water

- **Scope of Equipment**
  - Sand/Oil Interceptor (First Flush Device)
  - Multiple Cisterns Manifold Header
    - Cistern Transfer Pumps
  - Filtration/Disinfection
    - Multi Media Filter
    - UV Disinfection
    - Pressure Tanks w/40-60 pressure switch(s)
    - Hose Bibs
    - Pressure Washers

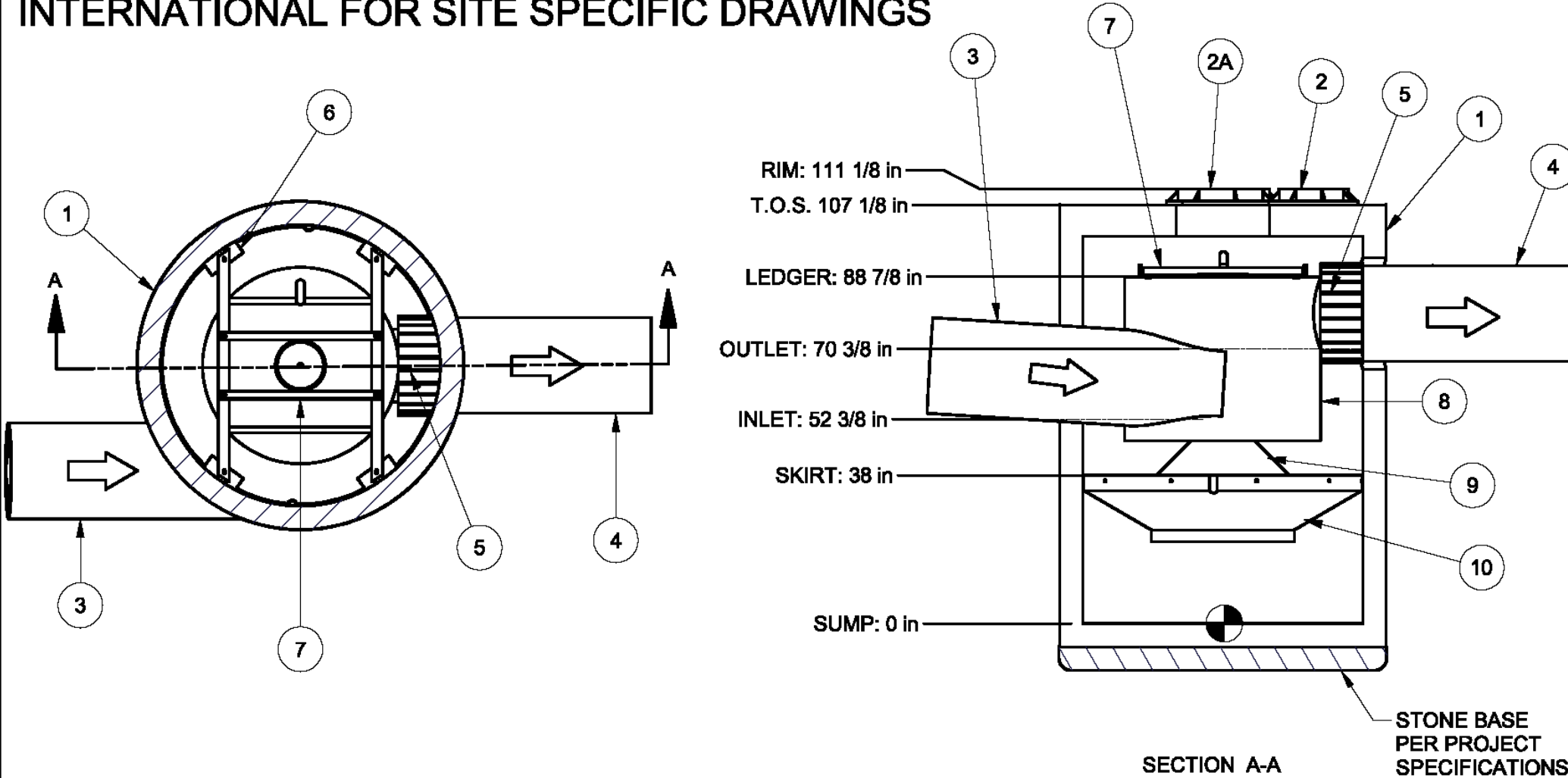








**NOT FOR CONSTRUCTION - CONTACT HYDRO INTERNATIONAL FOR SITE SPECIFIC DRAWINGS**



**Notes**  
 1. MANHOLE WALL AND SLAB THICKNESSES ARE NOT TO SCALE.  
 2. CONTACT HYDRO INTERNATIONAL FOR A BOTTOM OF STRUCTURE ELEVATION PRIOR TO SETTING DOWNSTREAM DEFENDER MANHOLE.

REVISION HISTORY		
REV BY	DATE	DESCRIPTION
Date	Scale	
9/14/2011	1/4" = 1'-0"	
Drawn	Checked	Approved
EMH	MRJ	MRJ

Title  
 6-FT DIAMETER  
 DOWNSTREAM DEFENDER

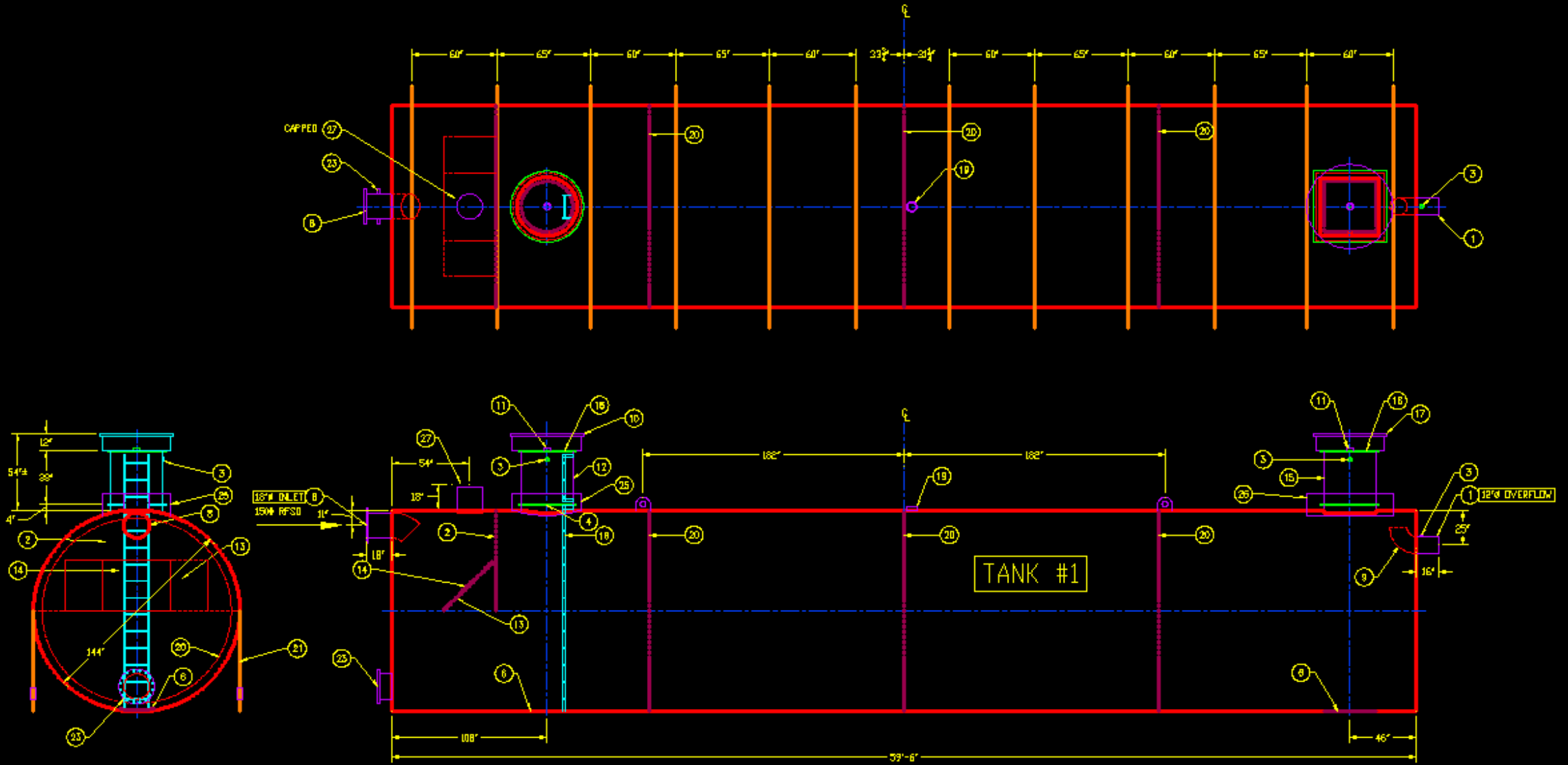
GENERAL ARRANGEMENT

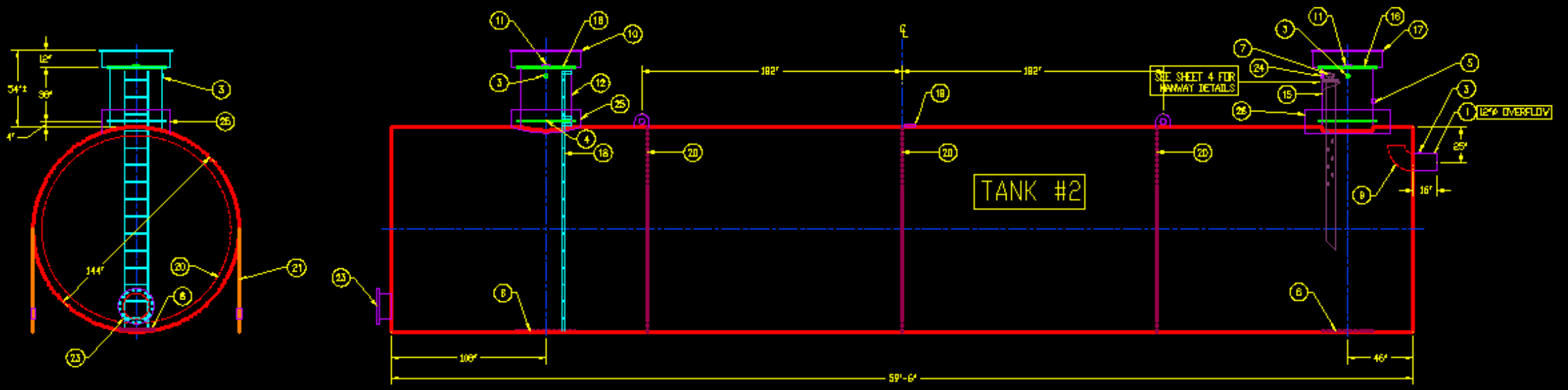
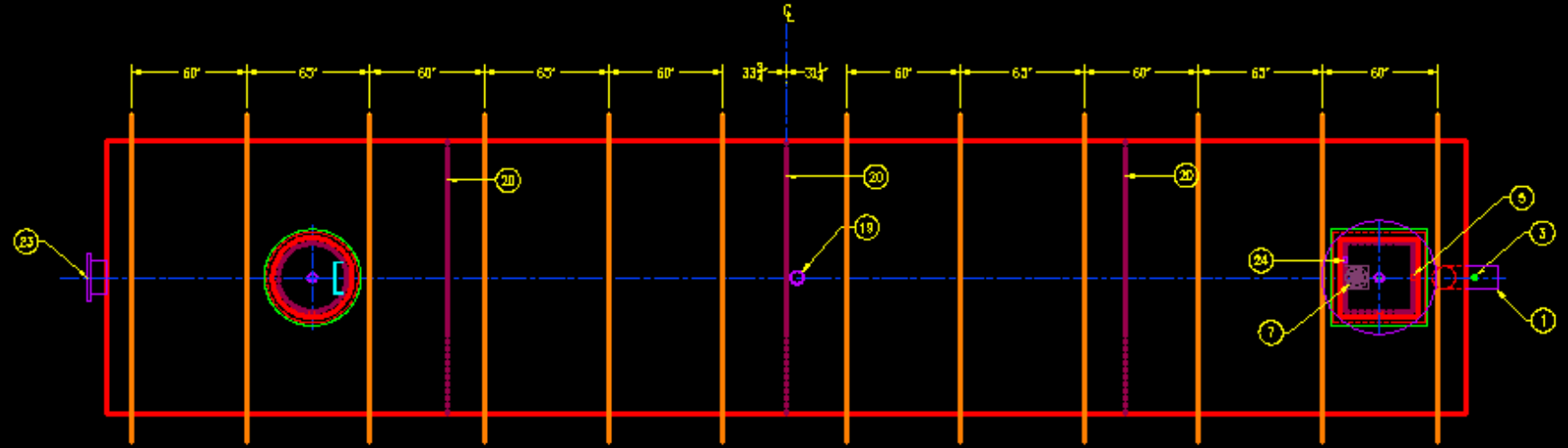
Parts List		
ITEM	DESCRIPTION	SIZE
1	PRECAST MANHOLE (BY HYDRO VIA PRECASTER)	72 in
2	FRAME AND COVER	18 in

**CAPACITIES:**

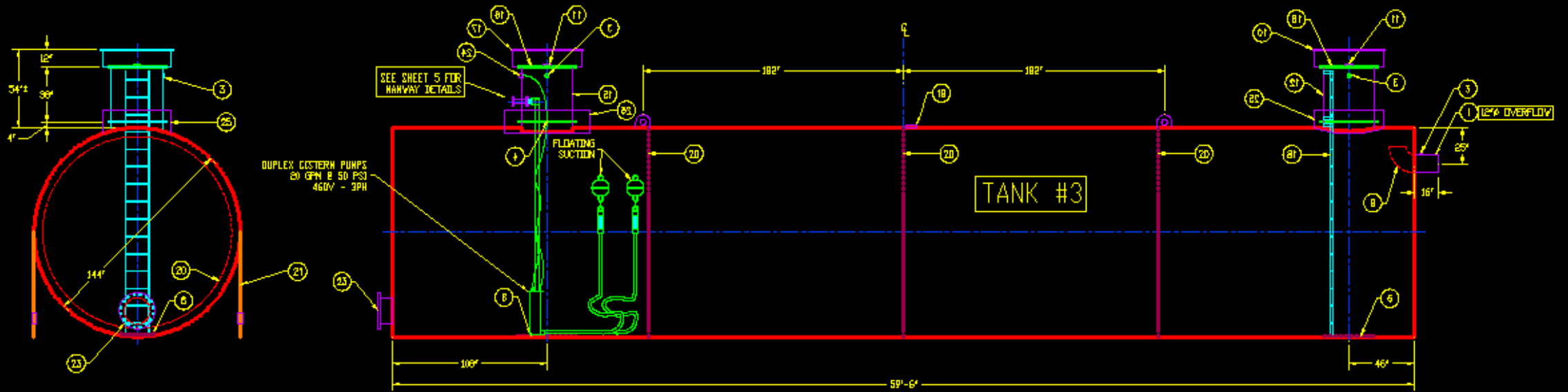
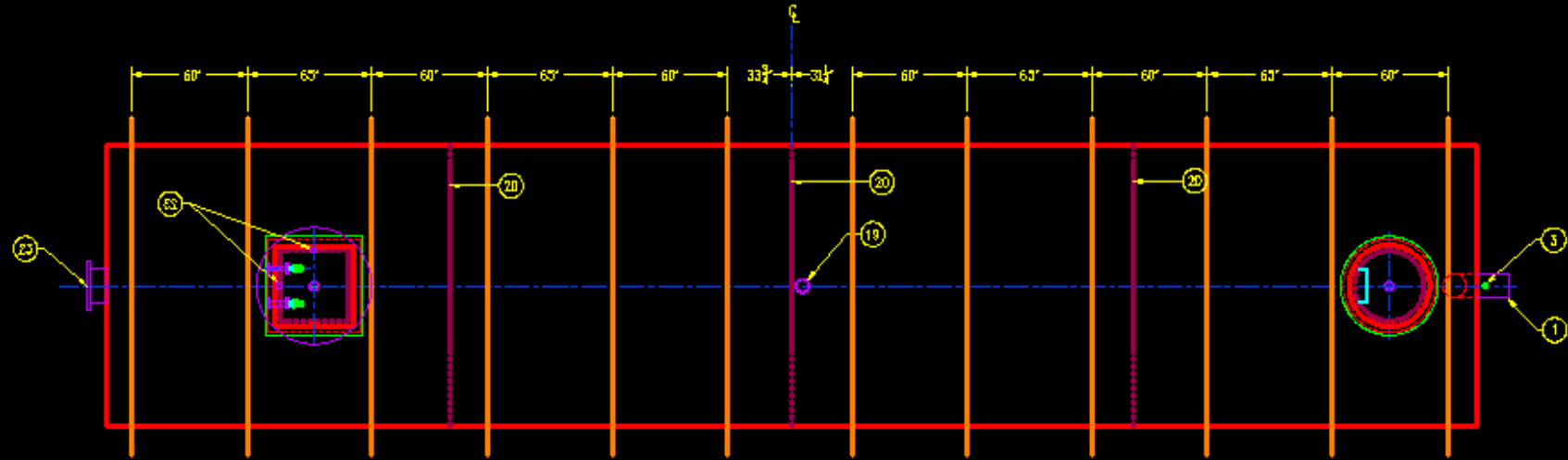
1. Peak treatment flow: 8.0 cfs (227 l/s)
2. Sediment storage capacity: 2.10 Cu. yd. (1.61 cu. m.)
3. Oil storage capacity: 216 Gal. (818 liters)

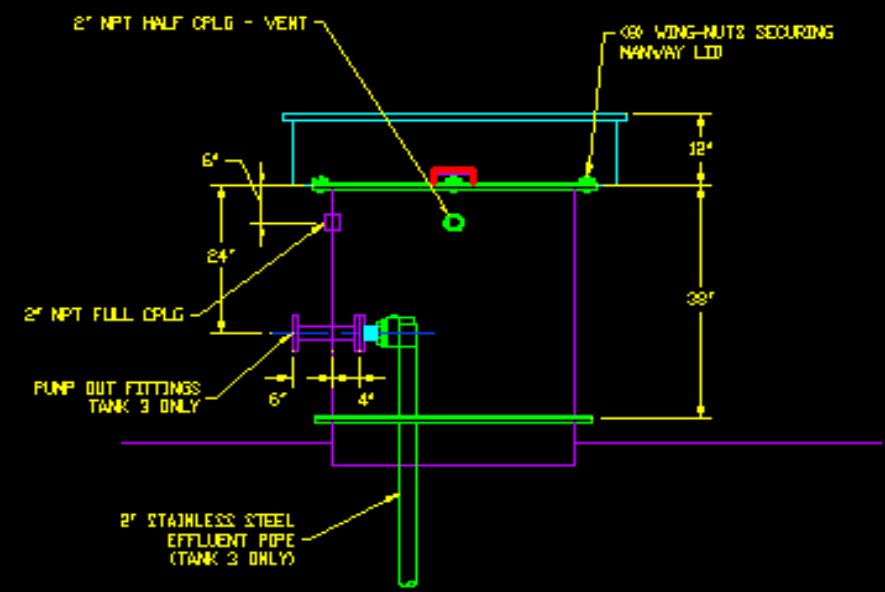
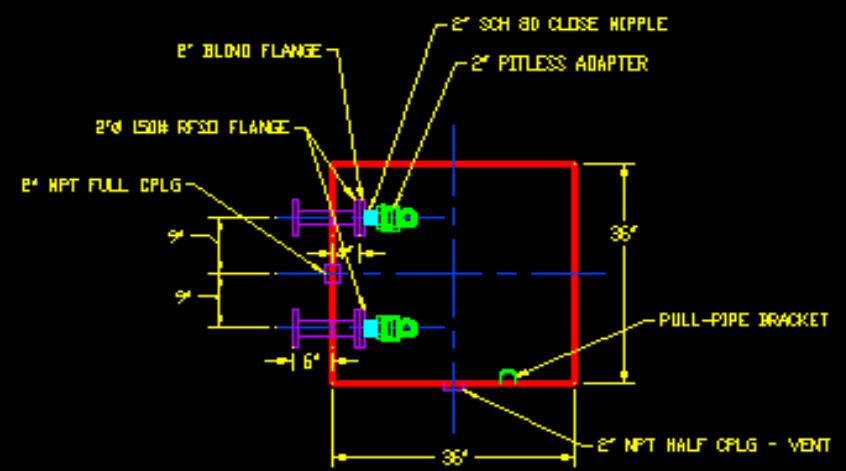
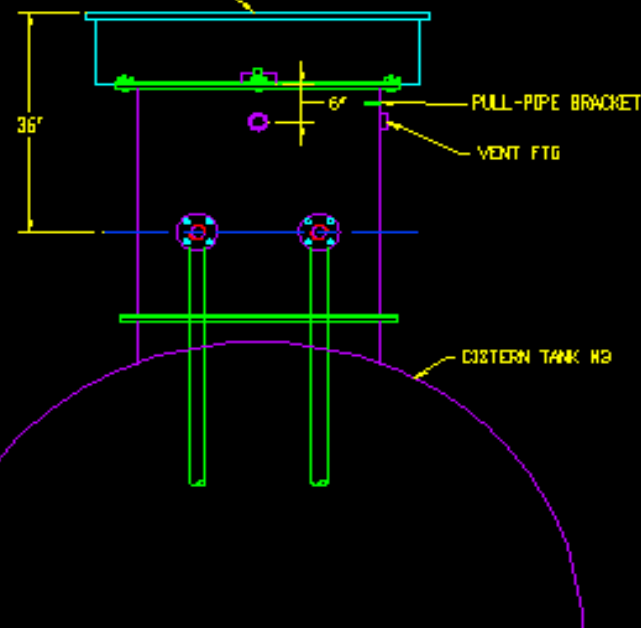
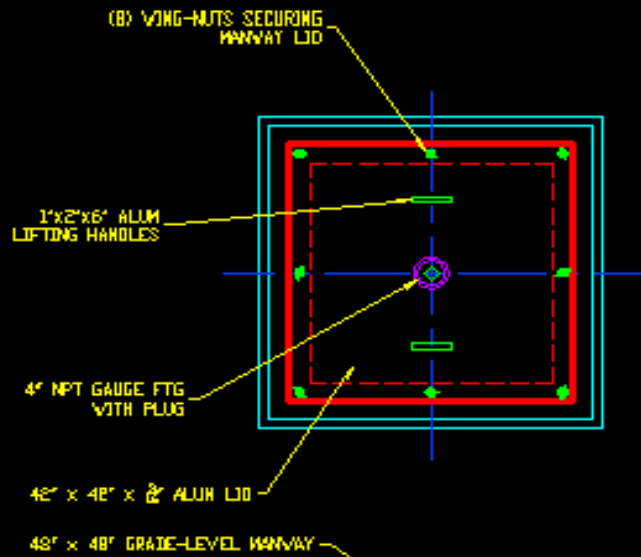


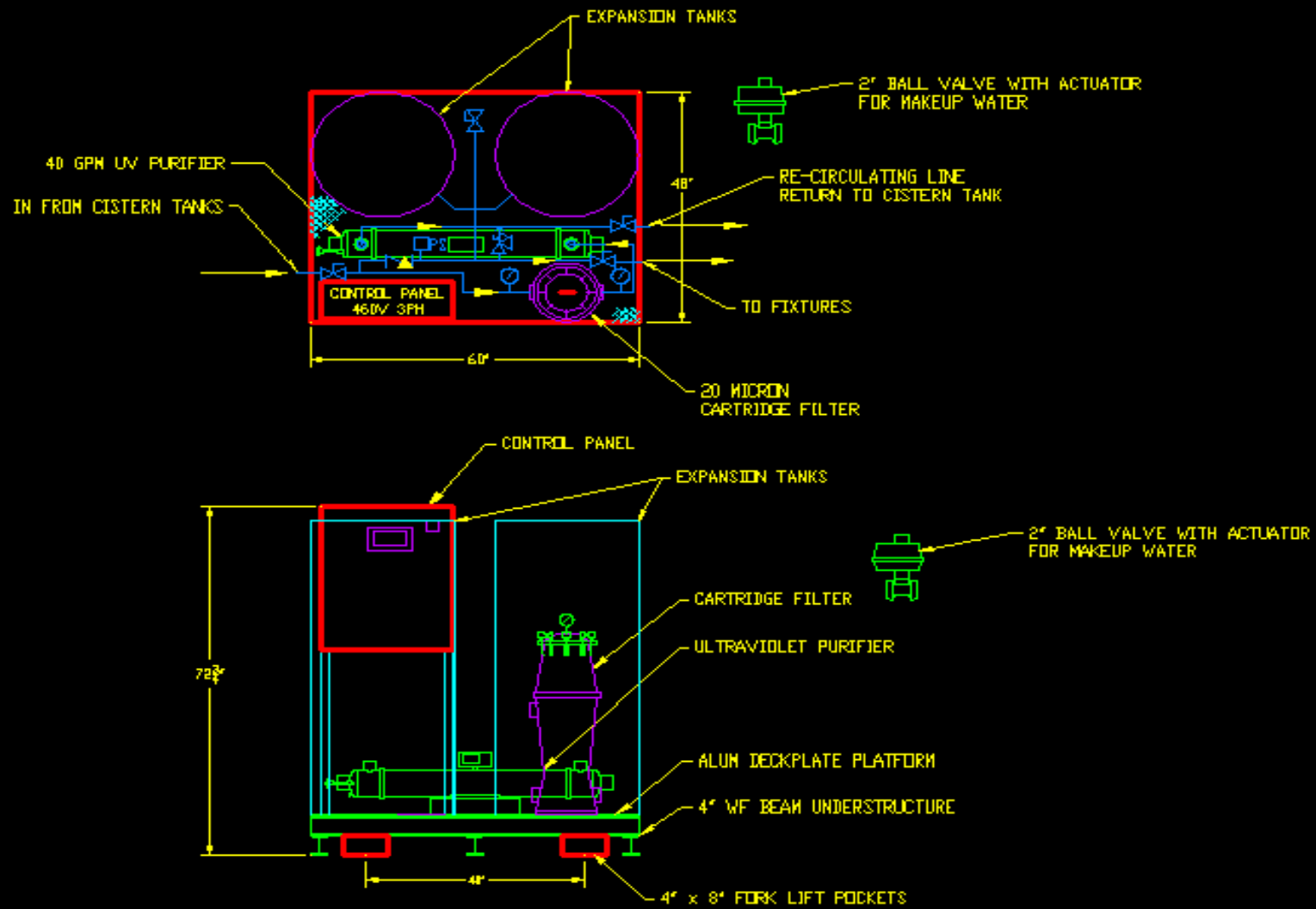


























# Challenges/Lessons Learned

# Factory Design

- **Project Profile**
  - **45,000 sq/ft**
    - **1/3<sup>rd</sup> used for water reclamation**
  - **80 ton Capacity**
  - **14'dia x 90'**
  - **Blast Booth**
  - **Paint Booth**
  - **Separate X-Ray Facility**
  - **LED Lighting and Radiant Heat**
  - **Hi-Def Plasma Table**
  - **Rain Water Harvesting System**
  - **Hydro Test Rig**



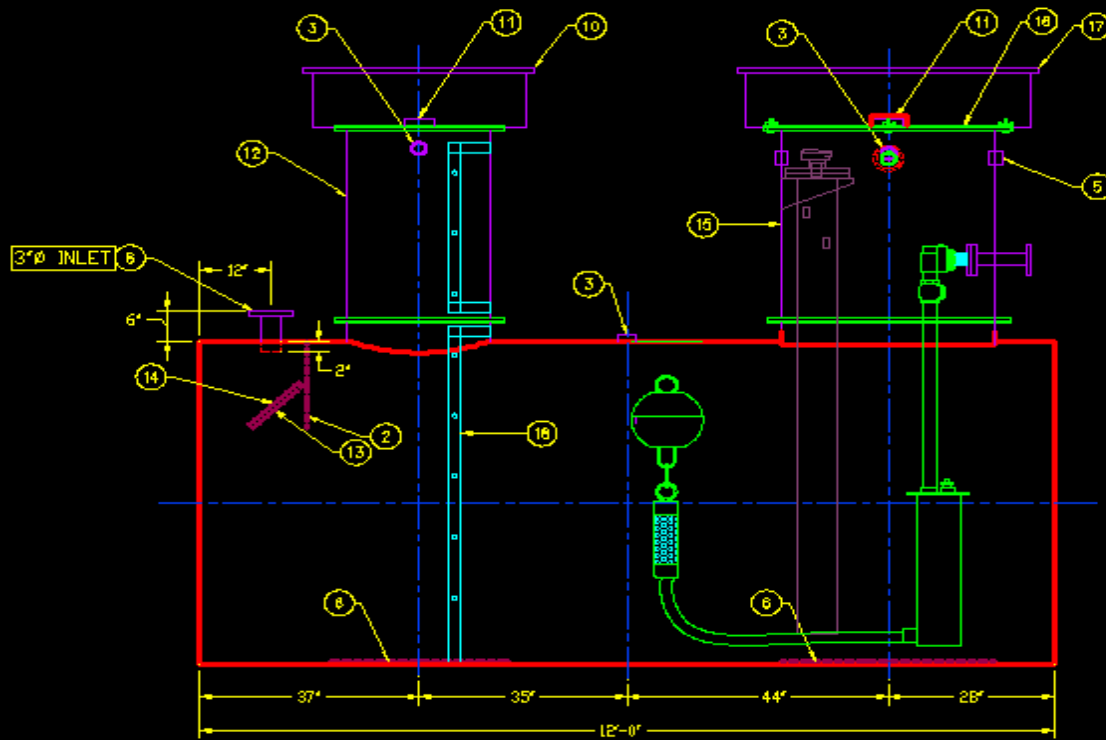
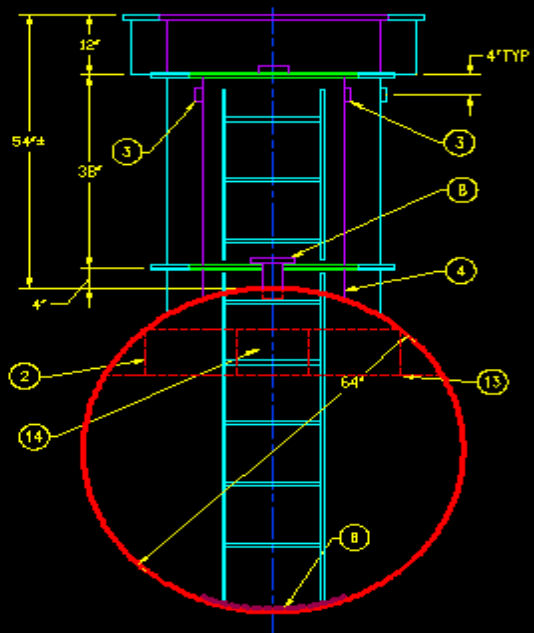
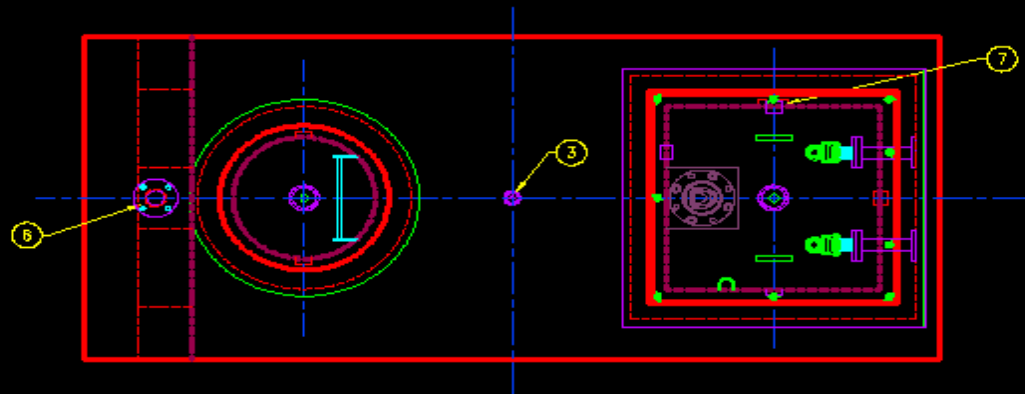


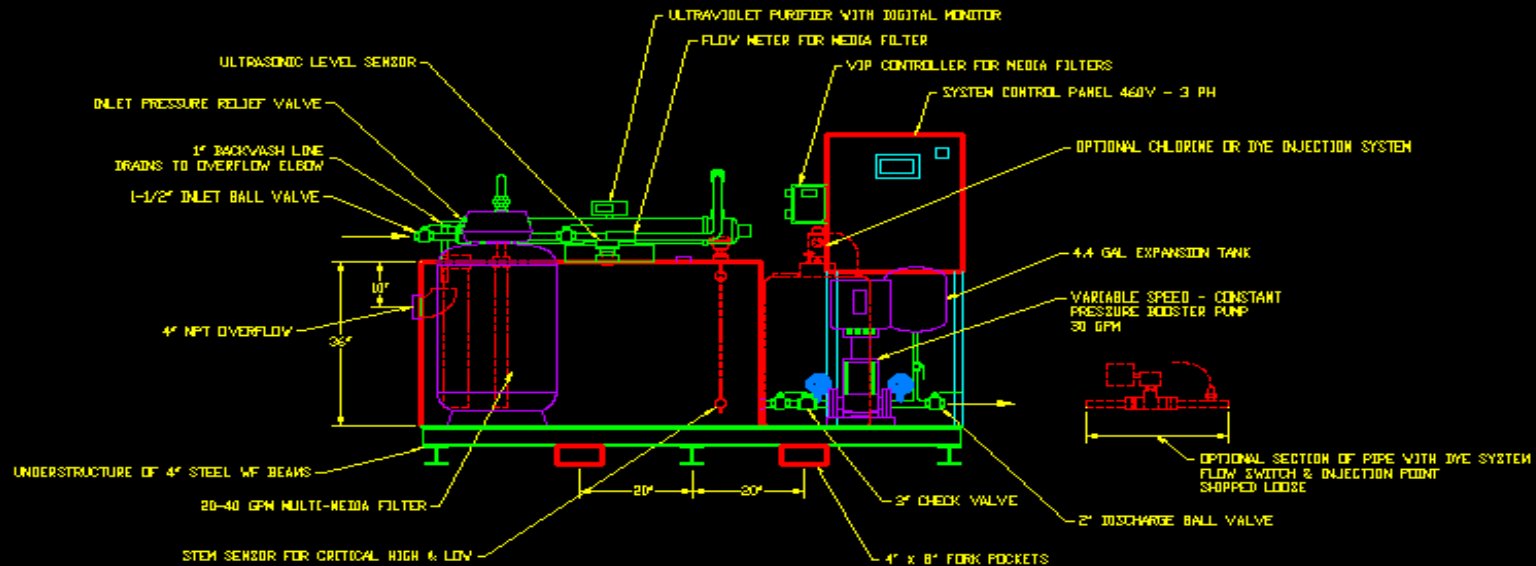
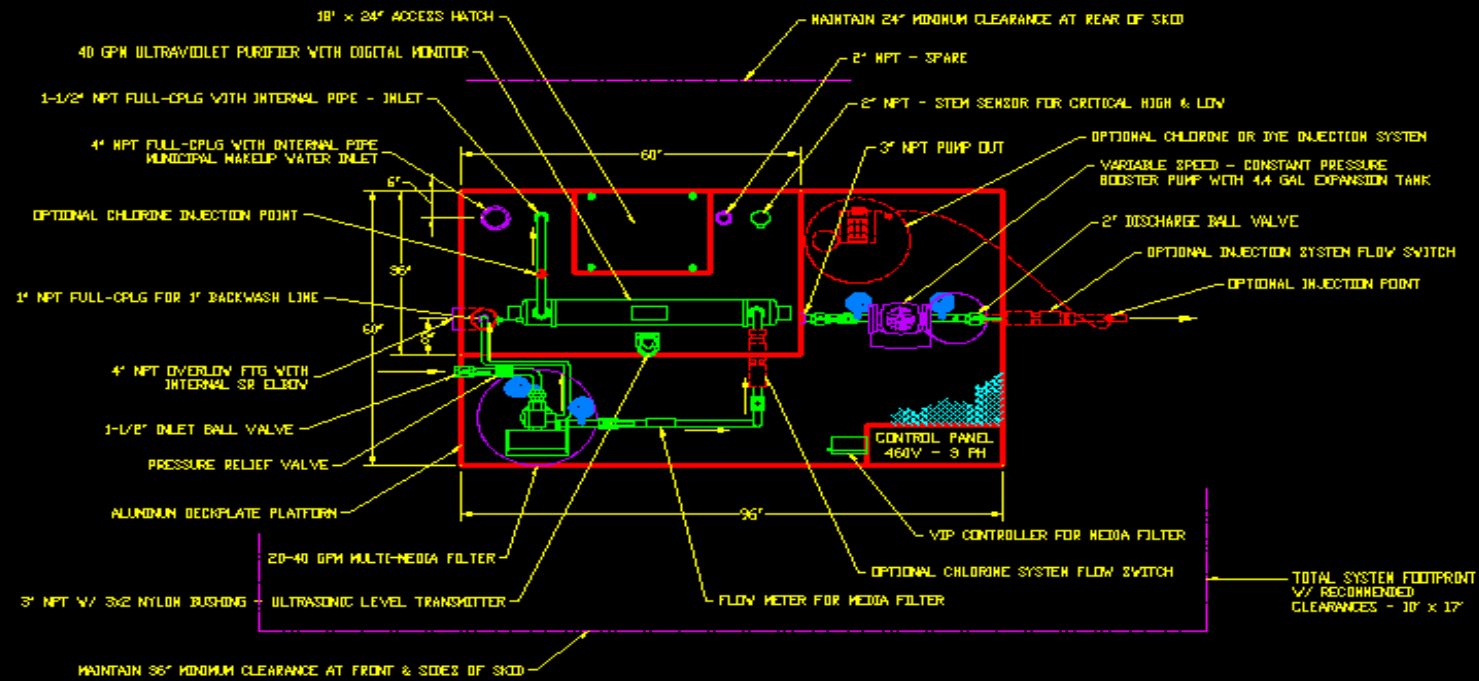
# Manheim- Toilet Flushing/Hydrostatic Testing

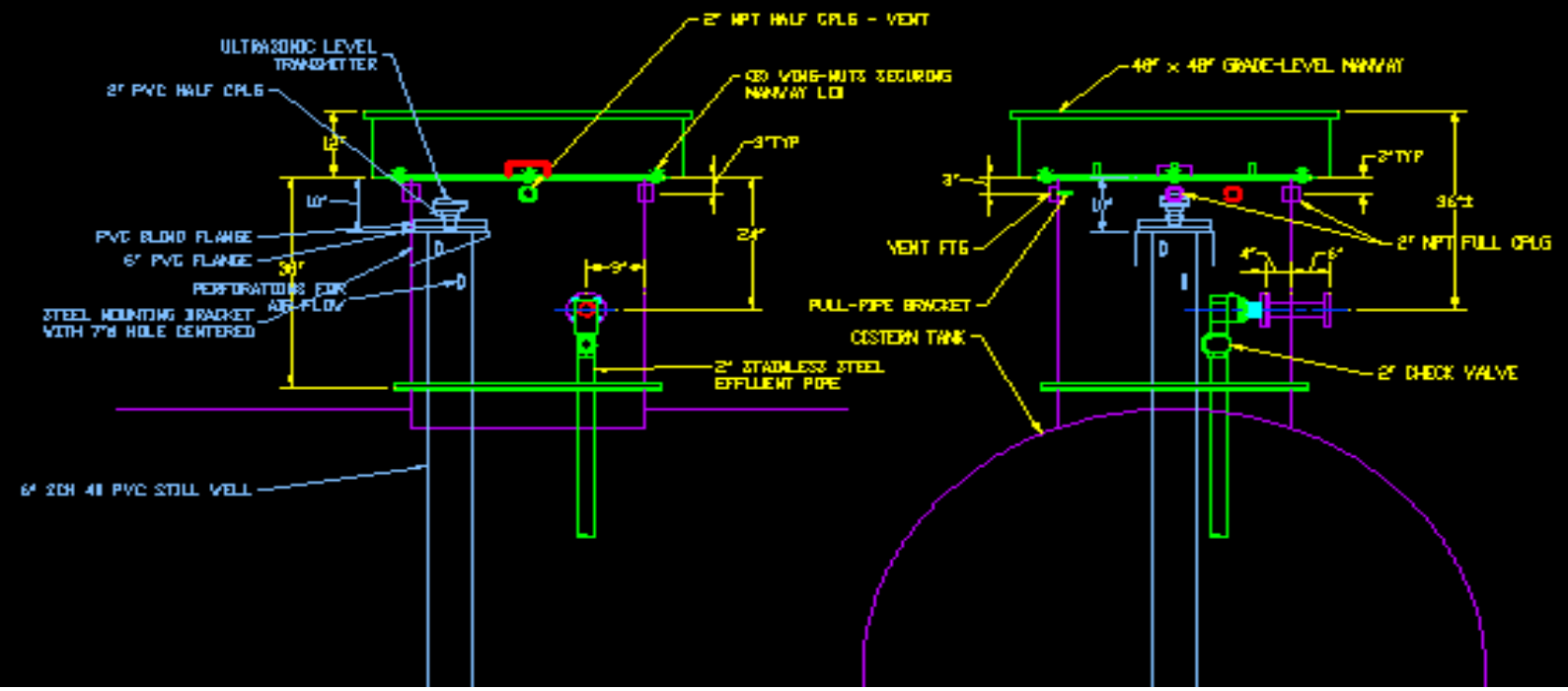
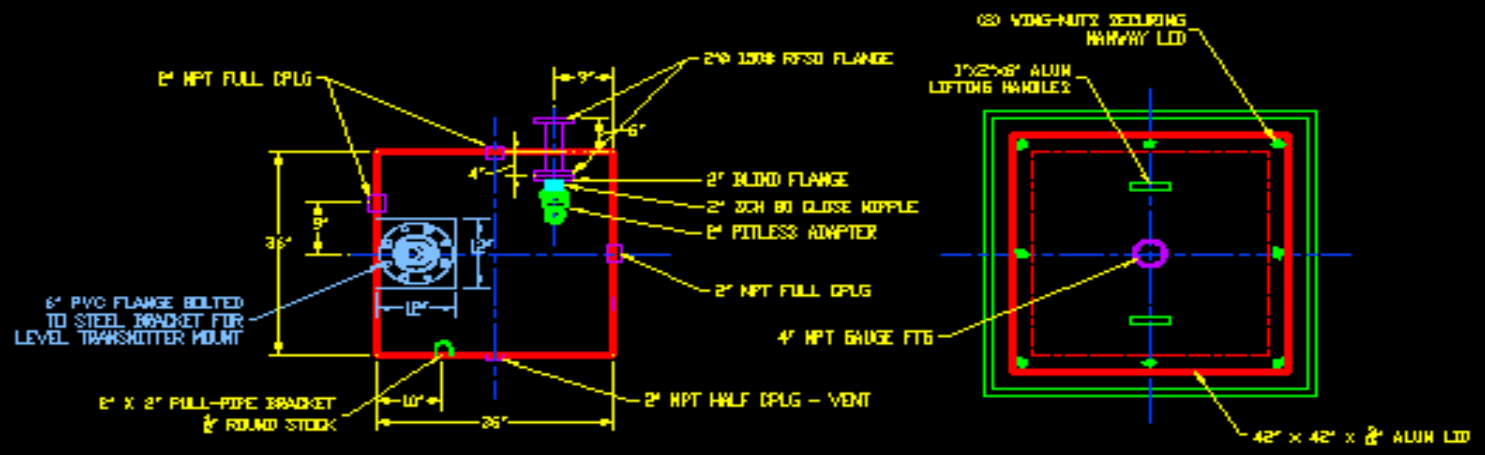
- **Scope of Equipment**
  - 3-WISY First Flush Diverters
  - 1-2000 UG PW Tank
  - 1-12,000 UG RCT
    - Duplex Pumps
  - **Filtration/Disinfection Skid**
    - MM Filter
    - UV
    - Control Panel
    - Grundfos CRE Booster Pump
  - 2-30,000 UG RCT w/dry compartments
    - Centrifugal Pumps
  - **Return Water filtration Skid**
    - Centrifugal Pumps
  - **Duplex Cartridge Filters**
  - **Chlorine Injection**
  - **Control**



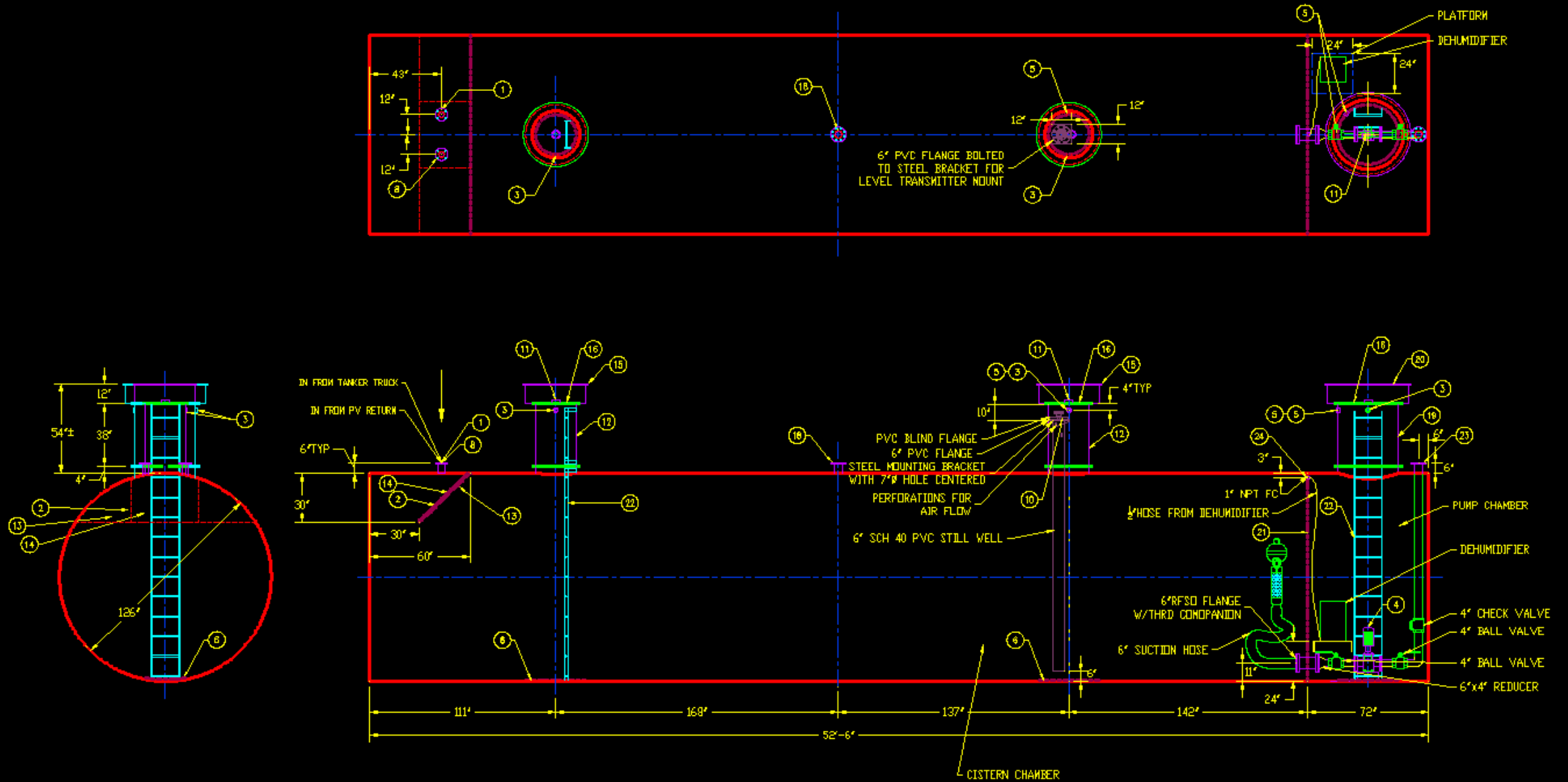


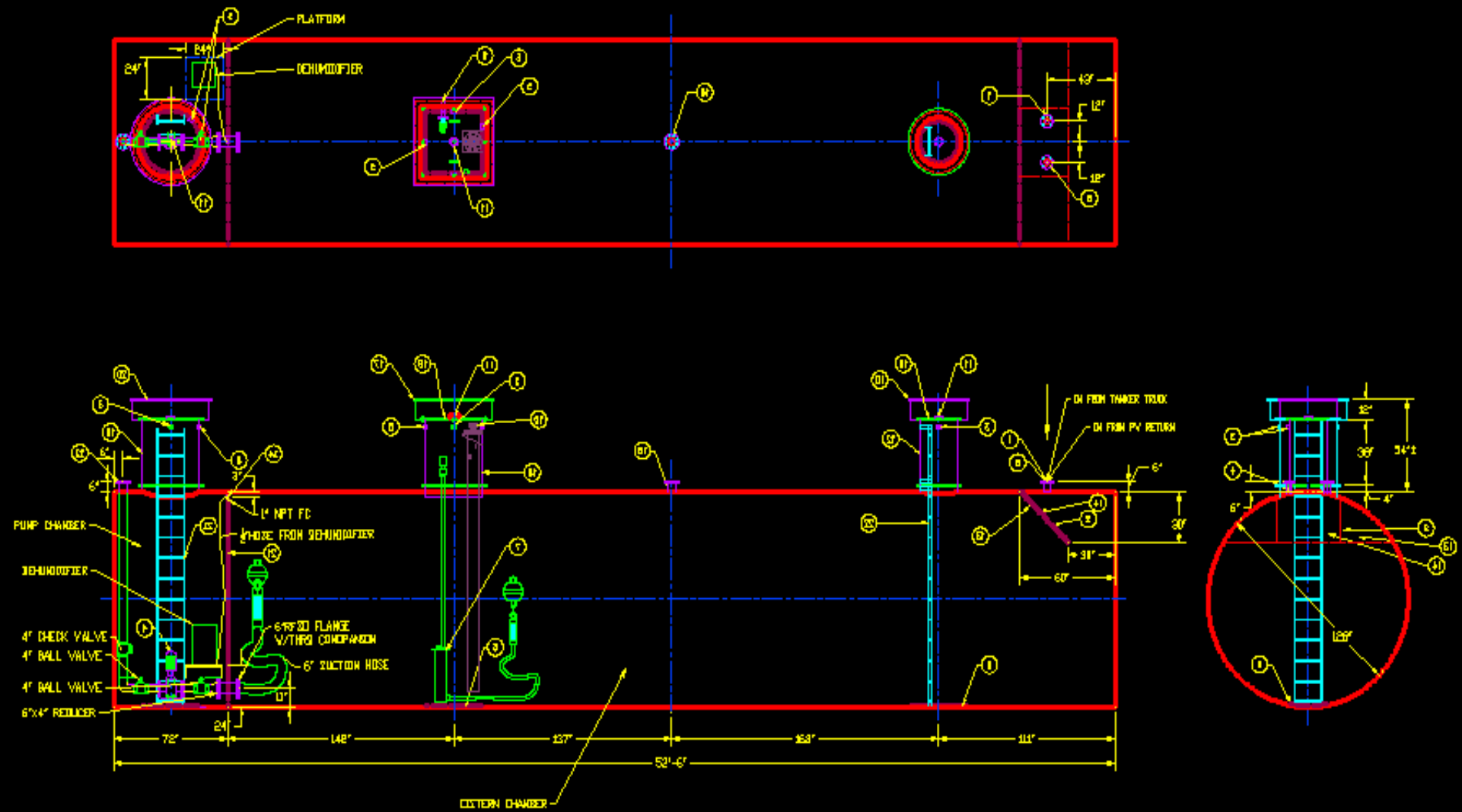
























# Challenges/Lessons Learned





# Questions

