

# Reverse Osmosis Reject Recovery

2013 Annual Pollution Prevention  
Conference



Paul Delor  
Environmental Specialist, TMMI  
[paul.delor@tema.toyota.com](mailto:paul.delor@tema.toyota.com)





# The American Toyota





# Historical Timeline

1996 1998 2000 2003 2007 2008 2009 2010 2013

Ground  
broken on  
Indiana  
truck plant



Sequoia  
line-off  
ceremony



Tundra  
(2<sup>nd</sup> generation)  
line-off

Sequoia  
(2<sup>nd</sup> generation)  
line-off



Tundra moved  
to TMMTX

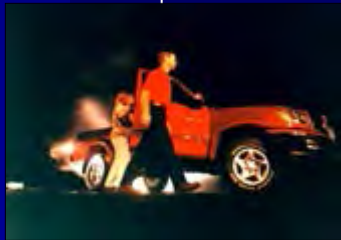
Highlander  
line-off



Highlander  
Hybrid  
line-off



Sienna  
(3<sup>rd</sup> generation)  
line-off



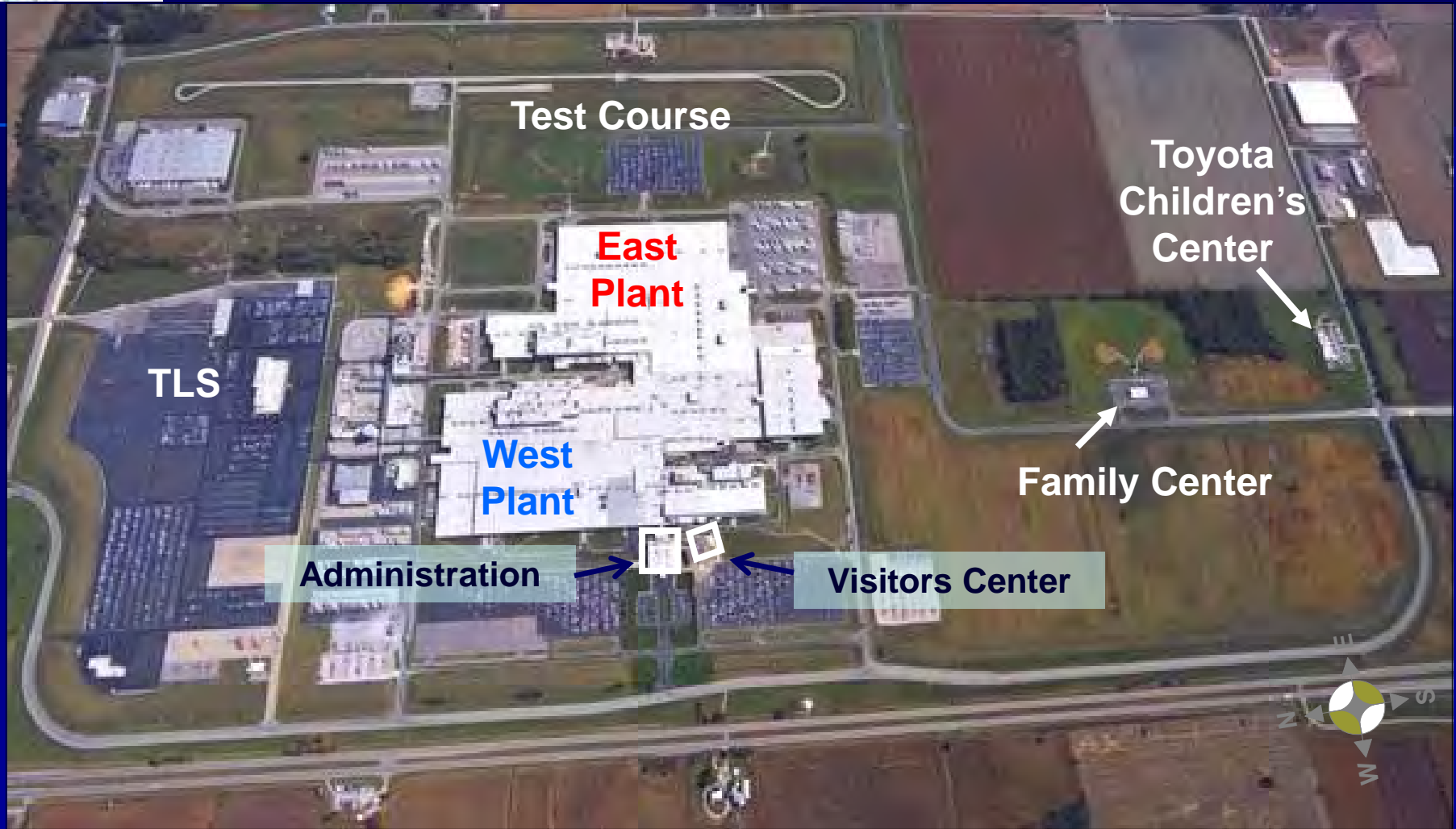
Tundra line-off  
ceremony



Sienna  
line-off  
ceremony



# Aerial View



**TMMI Property: 1,160 acres; 4 million square feet under roof  
(size of 70 football fields)**



# TMMI - Employment

4,500 talented & dedicated team members



Currently, 700-plus Aerotek variable workforce





# TMMI – Our Products

## West Plant



### Sequoia

- Full-size sport utility vehicle



### Highlander Gas and Hybrid

- Midsize sport utility vehicle

## East Plant

### Sienna

- Minivan





# Highlander Hybrid

**\$430 million investment**

**400 new jobs**

**Production start late 2013**





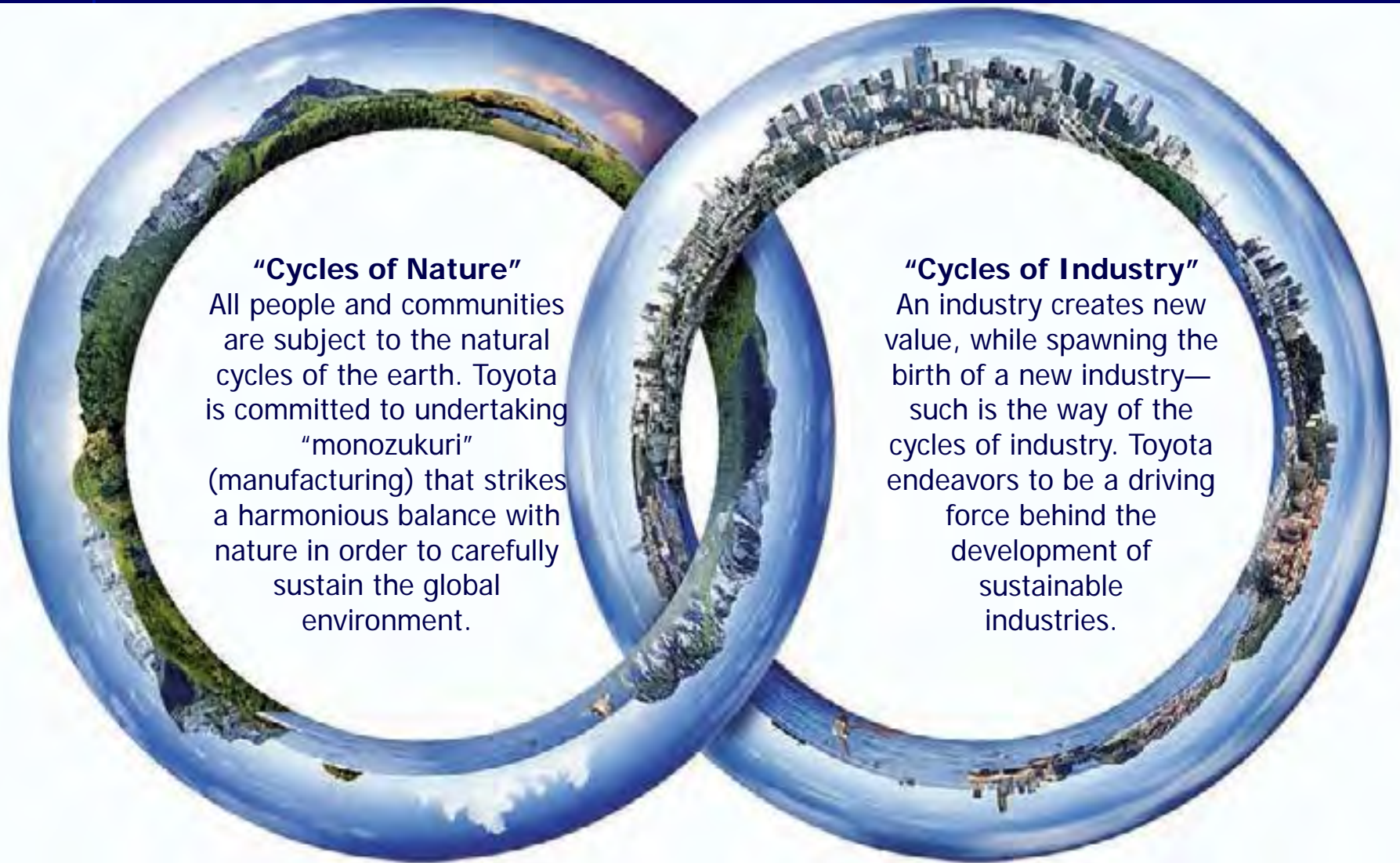
# Toyota Indiana Visitors Center



- More than 30,000 visitors
- Great for school groups, organizations, corporate outings and individuals
- Community conference rooms available



# Toyota Global Vision 2020





"When the well runs dry, we know the worth of water" – Benjamin Franklin



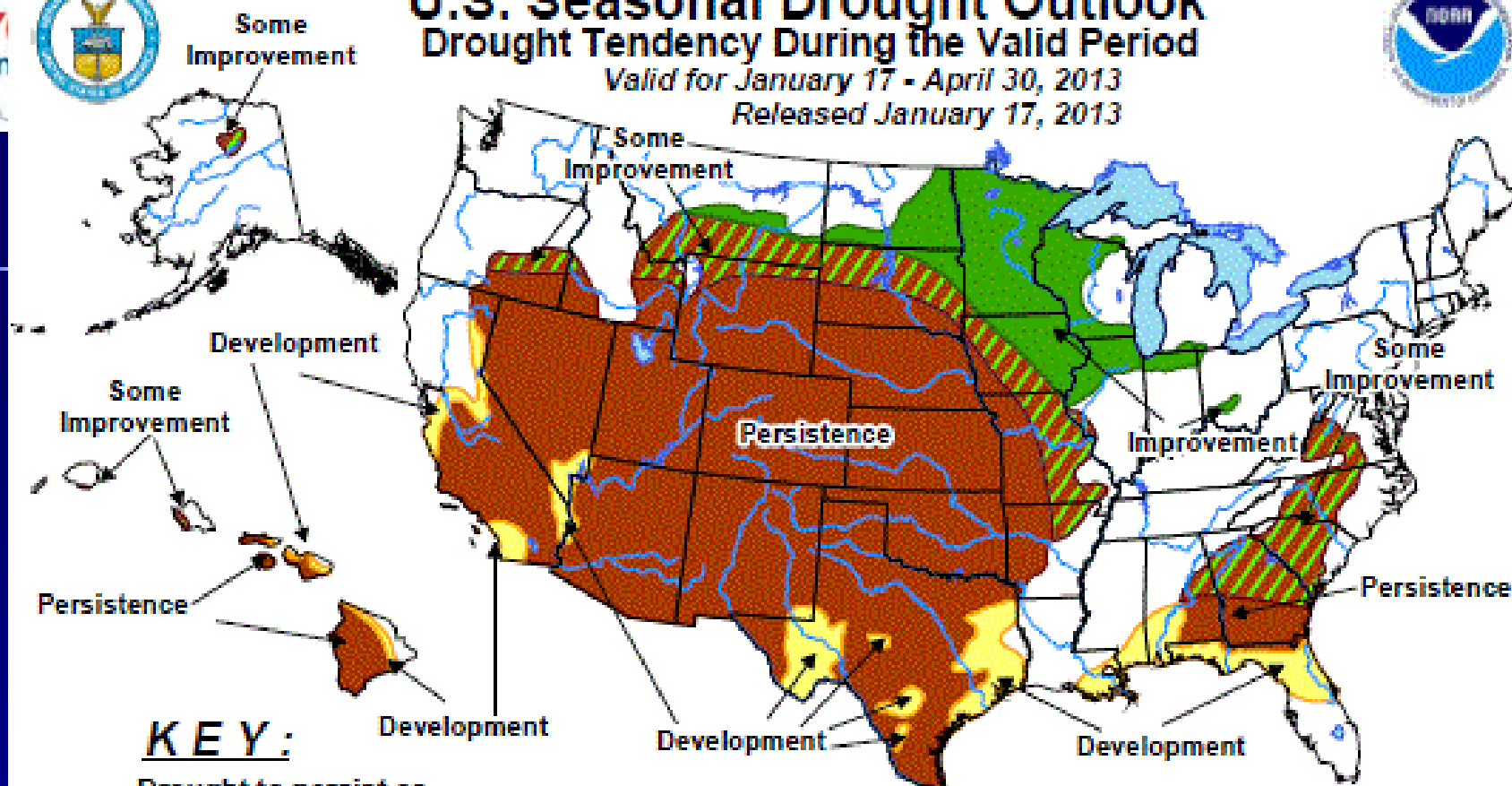


# U.S. Seasonal Drought Outlook





## Drought Tendency During the Valid Period

Valid for January 17 - April 30, 2013

Released January 17, 2013



### KEY:





-  Drought to persist or intensify
-  Drought ongoing, some improvement
-  Drought likely to improve, impacts ease
-  Drought development likely

No Drought  
Posted/Predicted

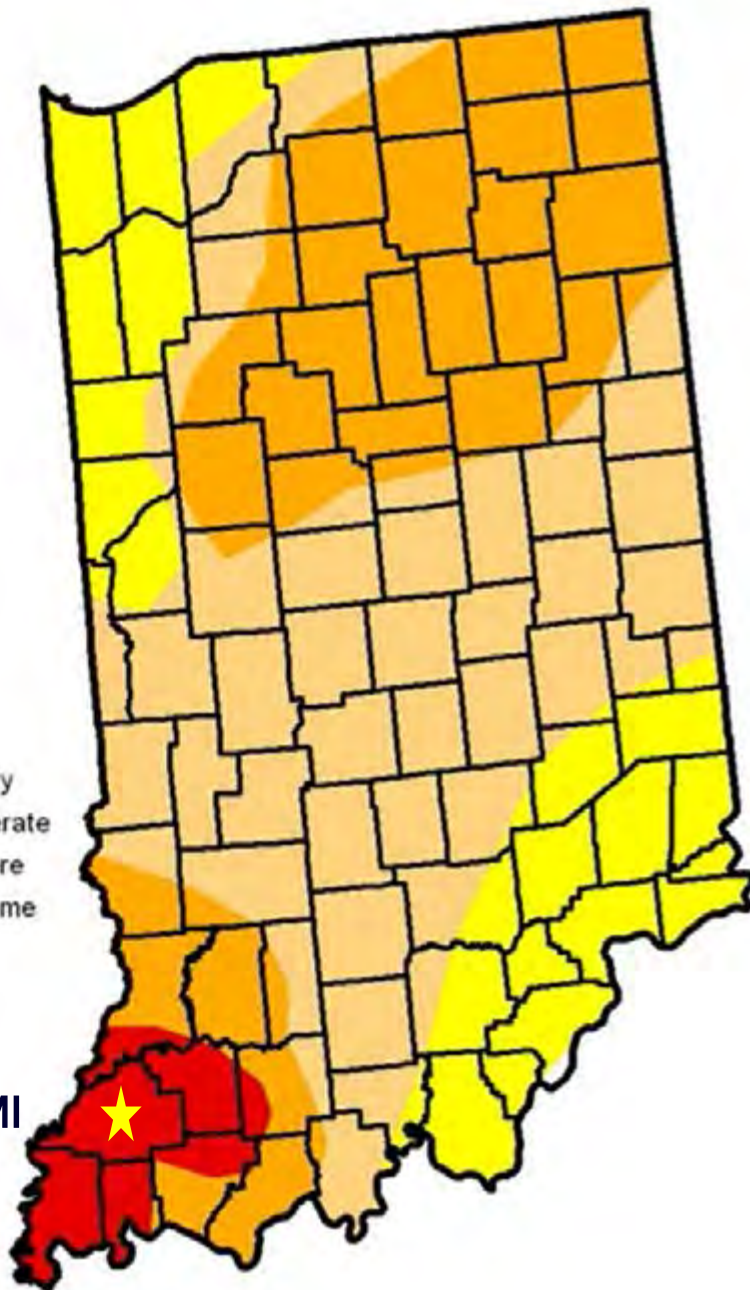


Depicts large-scale trends based on subjectively derived probabilities guided by short- and long-range statistical and dynamical forecasts. Short-term events – such as individual storms – cannot be accurately forecast more than a few days in advance. Use caution for applications – such as crops – that can be affected by such events. "Ongoing" drought areas are approximated from the Drought Monitor (D1 to D4 intensity). For weekly drought updates, see the latest U.S. Drought Monitor. NOTE: the green improvement areas imply at least a 1-category improvement in the Drought Monitor intensity levels, but do not necessarily imply drought elimination.

**Drought Severity**

-  D0 - Abnormally Dry
-  D1 Drought - Moderate
-  D2 Drought - Severe
-  D3 Drought - Extreme

**TMMI**





# DNR

Indiana Department of Natural Resources

Mitchell E. Daniels, Jr., Governor  
Robert E. Carter, Jr., Director  
Division of Water  
402 W. Washington Street  
Room W264  
Indianapolis, IN 46204  
Phone (317) 232-4160  
Toll-free (877) 928-3755  
Fax (317) 233-4579  
[www.in.gov/dnr/water/](http://www.in.gov/dnr/water/)

July 2, 2012

To: Owners/Operators of Significant Water Withdrawal Facilities

The Indiana Department of Natural Resources and the Indiana Department of Homeland Security have issued a **Water Shortage Warning** because of drought conditions for the following counties: Allen, Carroll, Cass, Daviess, Dekalb, Dubois, Elkhart, Fulton, Gibson, Grant, Greene, Howard, Huntington, Knox, Kosciusko, LaGrange, Marshall, Martin, Miami, Noble, Orange, Perry, Pike, Posey, Spencer, Steuben, Sullivan, Vanderburgh, Wabash, Warrick, Wells, and Whitley.

The objectives of the Water Shortage Warning stage are to prepare for a coordinated response to imminent water shortage conditions and potential water supply problems and to initiate concerted voluntary conservation measures in an effort to avoid or reduce shortages, relieve stressed sources, and if possible forestall the need for mandatory water use restrictions. A Water Shortage Watch is the lowest or mildest of three drought advisory phases; **a Water Shortage Warning is the second most severe stage**; and a Water Shortage Emergency is the most extreme condition.

The goal of water conservation efforts during the **Water Shortage Warning stage is a voluntary reduction in current water use of 10-15%**. Public water supply systems are advised to immediately develop and update water shortage contingency plans for their respective systems, where such plans are not already available for implementation. Indiana's



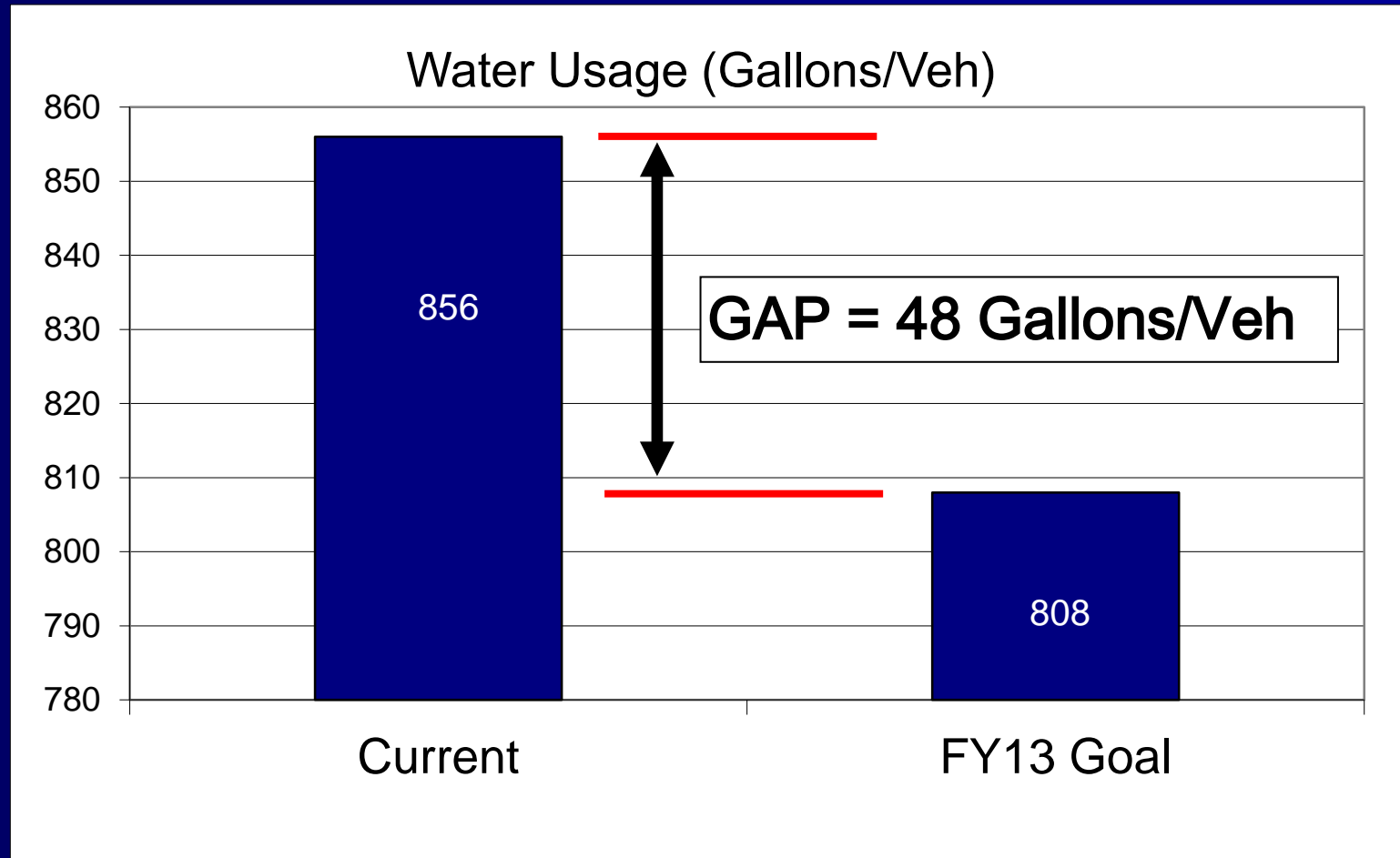
# Toyota Business Practices: 8 Step Problem Solving

1. Clarify the Problem
2. Break down the Problem
3. Set a Target
4. Root Cause Analysis
5. Develop Countermeasure
6. See Countermeasure Through
7. Confirm Results
8. Standardize Successful Process



# Water Usage Problem Solving

## Step 1: Clarify the Problem (Visualize)





# Water Usage Problem Solving

## Step 1: Clarify the Problem

### **Problem Statement:**

Current water consumption is above the FY13 water target.



# Toyota Business Practices: 8 Step Problem Solving

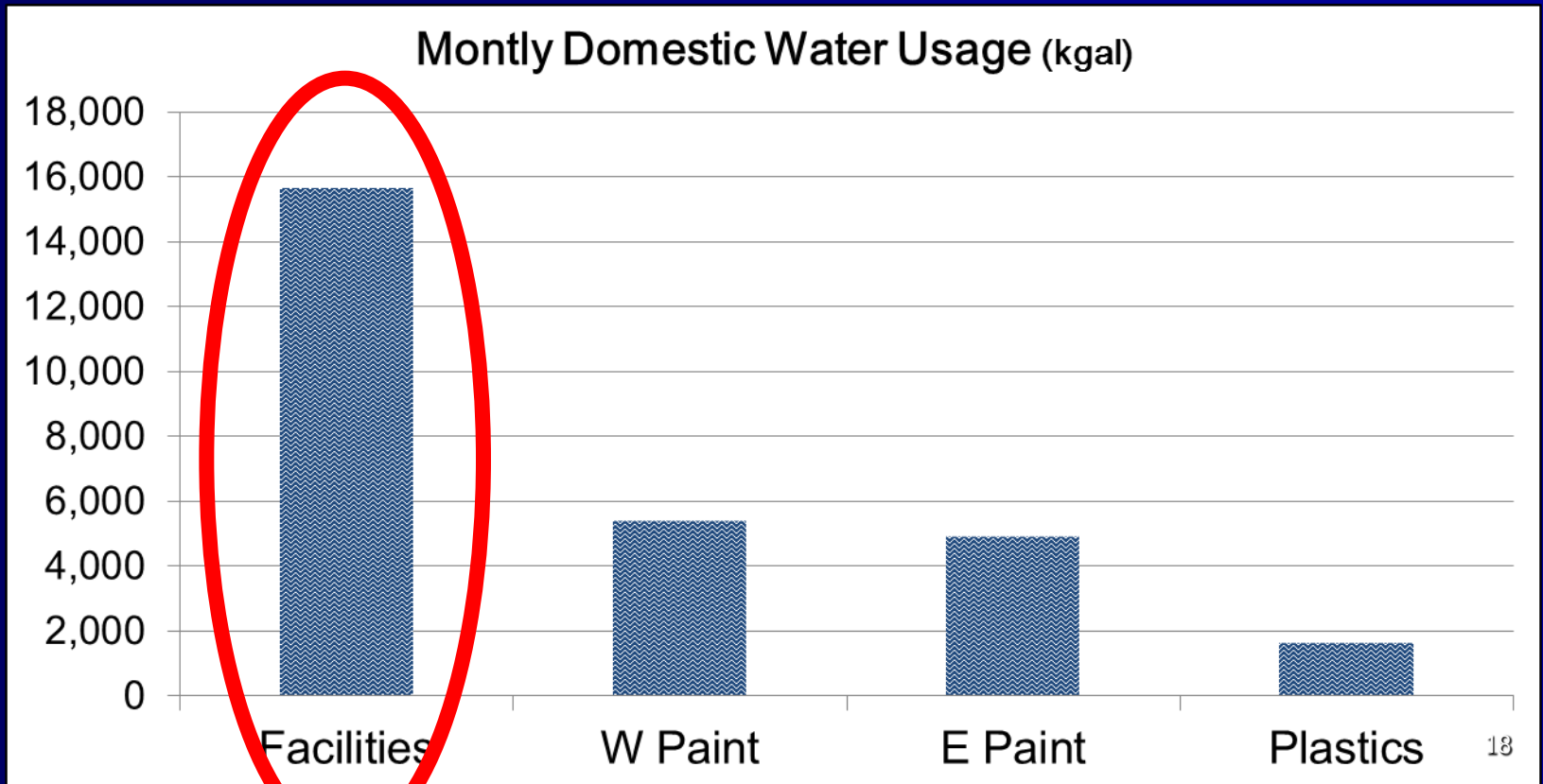
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## Step 2: Break Down the Problem

### Problem to Address:

Reverse Osmosis (RO) Filter  
is the highest water consumer in  
Facilities





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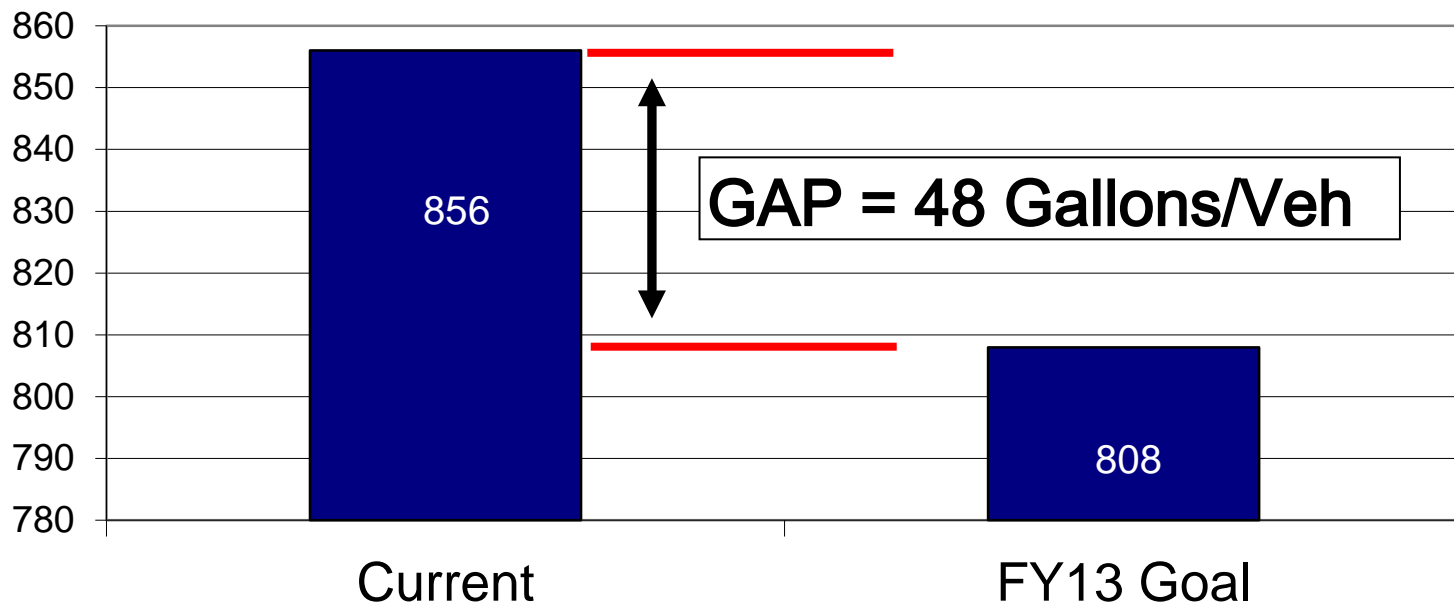


## Step 3: Set a Target

### Target:

Reduce water usage by 48 gallons per vehicle by end of FY13.

### Water Usage (Gallons/Veh)





# Additional Concern: RO water usage increase

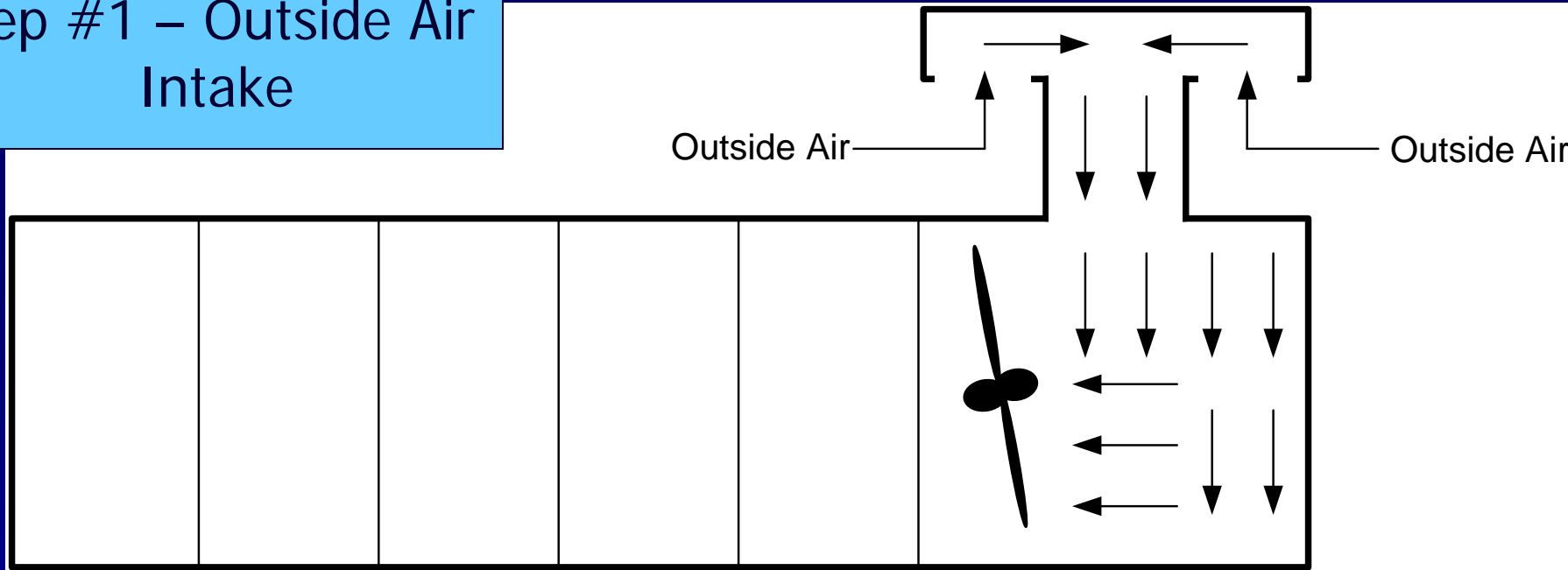
- Installing HPH system to eliminate steam in Paint Air Supply Houses
  - Huge Energy Savings
  - Replaces steam with high pressure RO water mist
- Even greater increase in RO water usage during dry months



# Air Supply House

## *Basic Operation*

Step #1 – Outside Air Intake

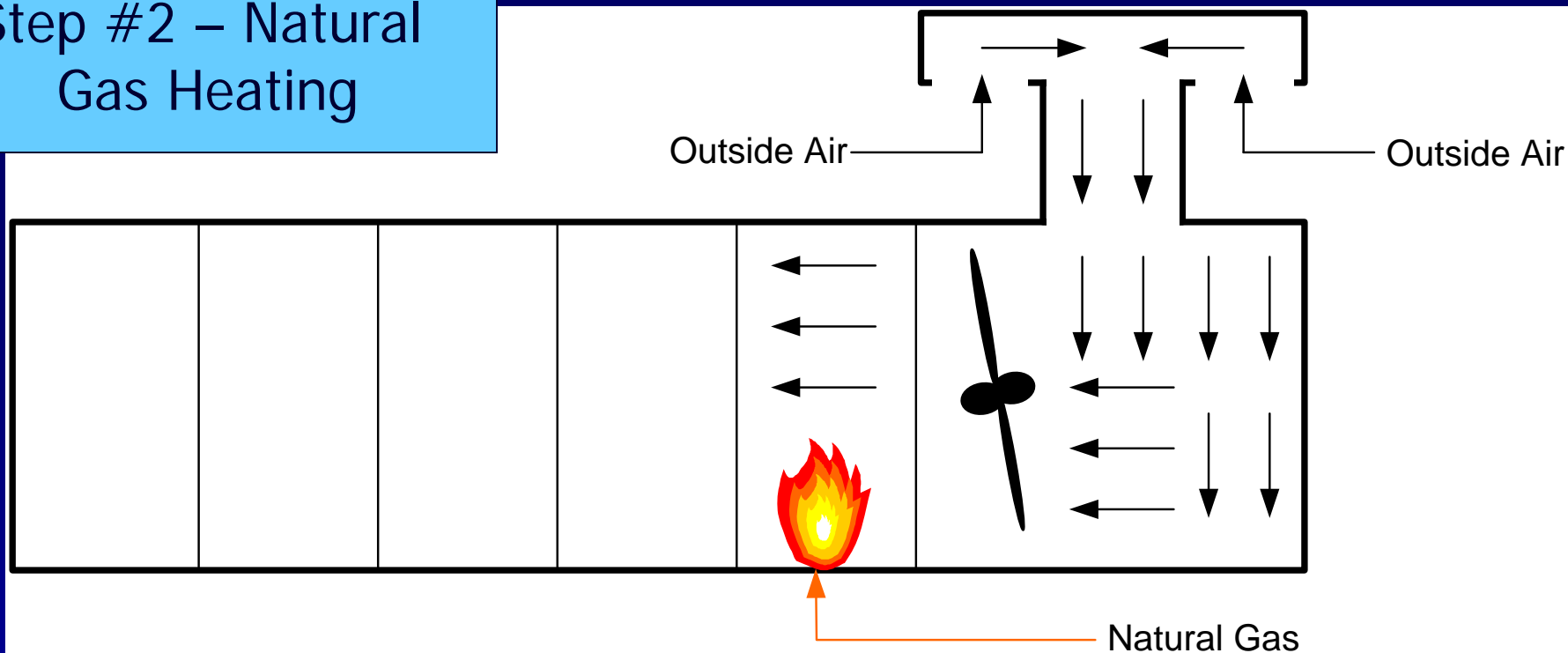




# Air Supply House

## *Basic Operation*

### Step #2 – Natural Gas Heating

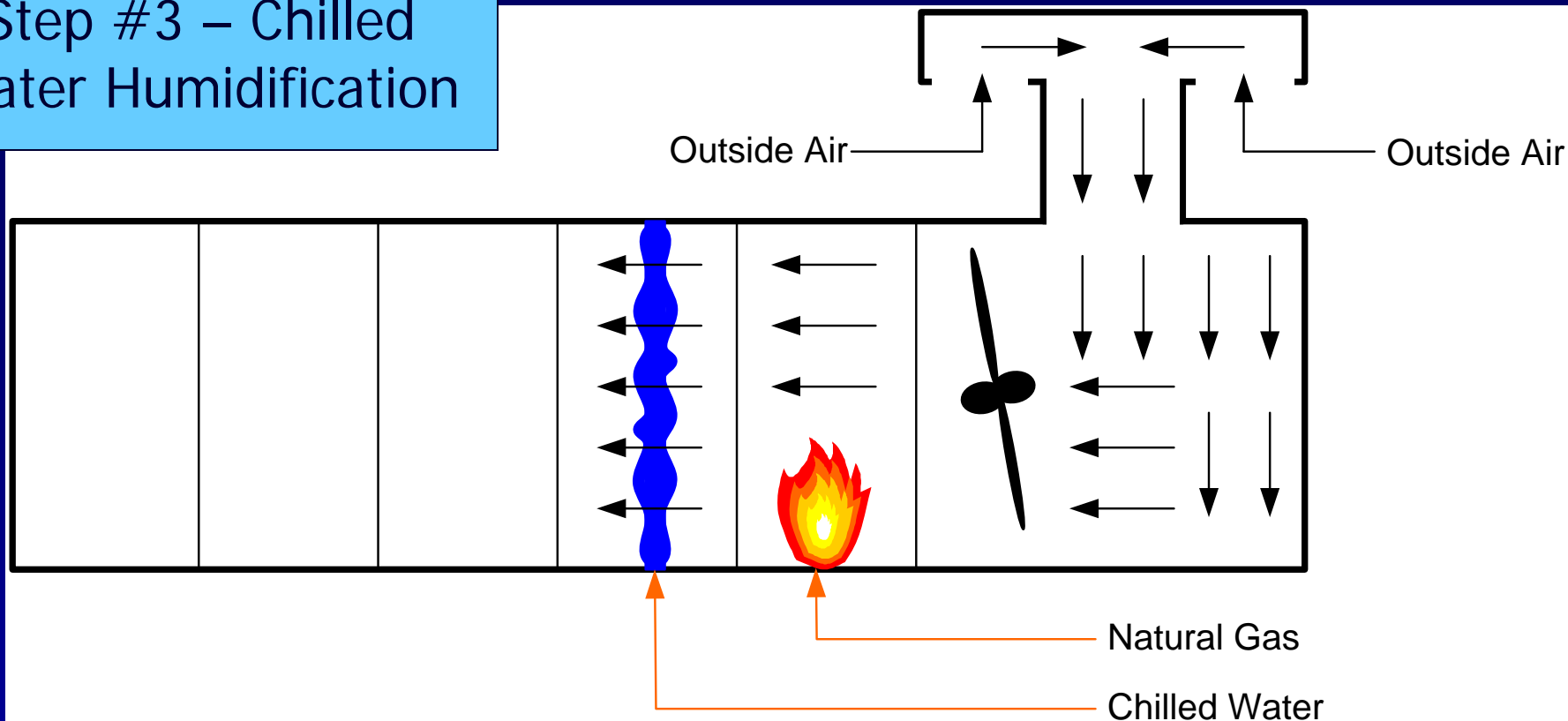




# Air Supply House

## *Basic Operation*

### Step #3 – Chilled Water Humidification

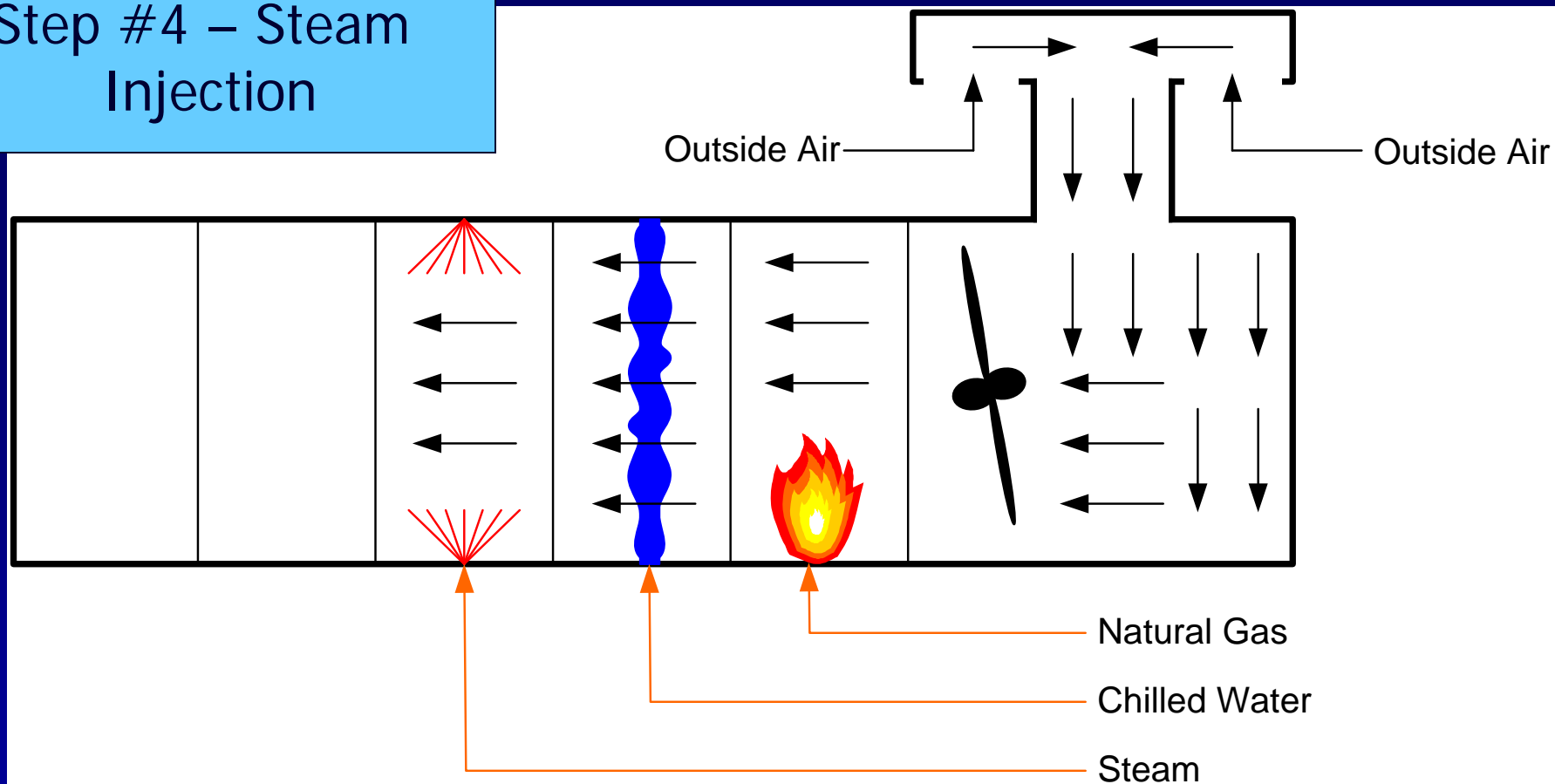




# Air Supply House

## *Basic Operation*

### Step #4 – Steam Injection

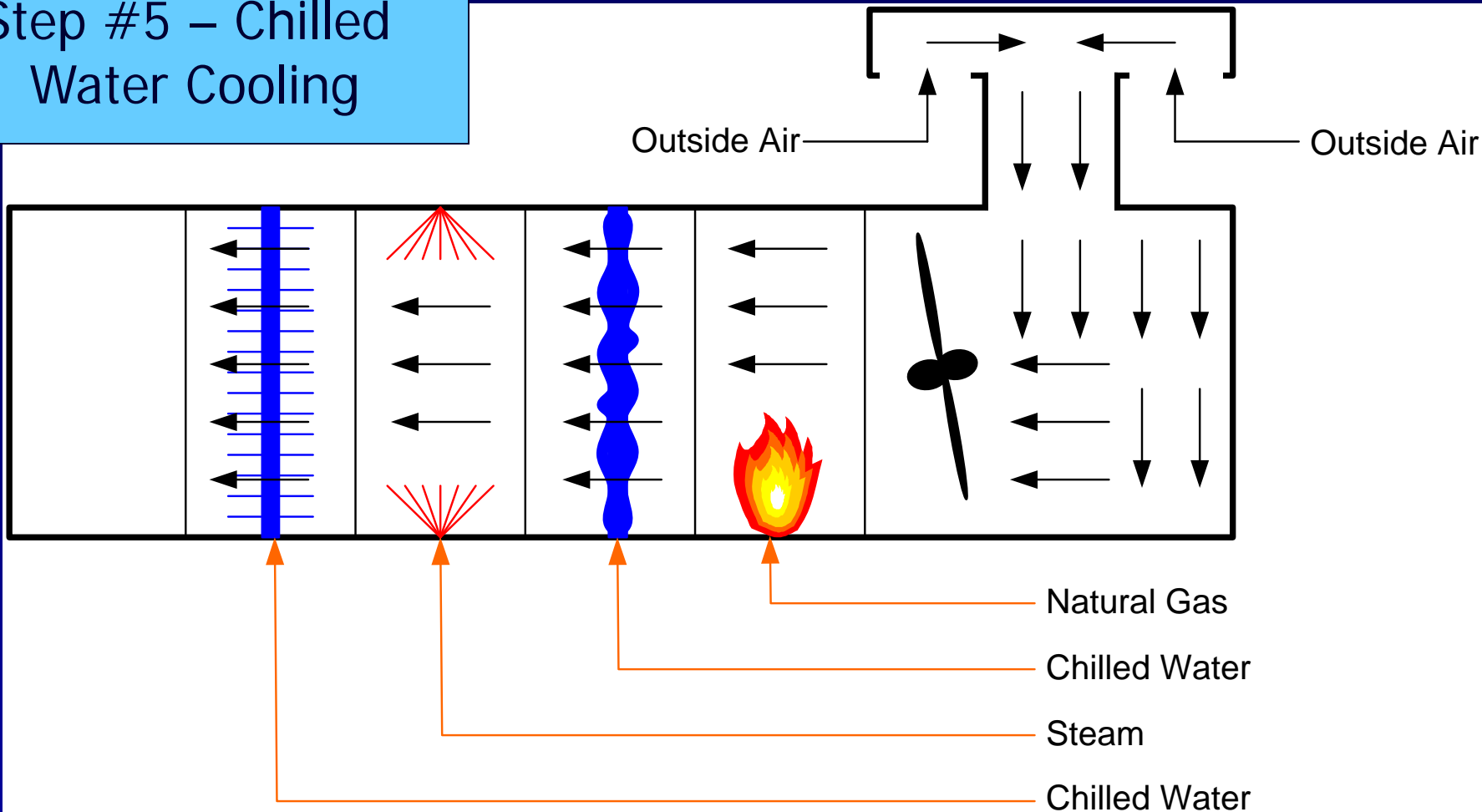




# Air Supply House

## *Basic Operation*

### Step #5 – Chilled Water Cooling

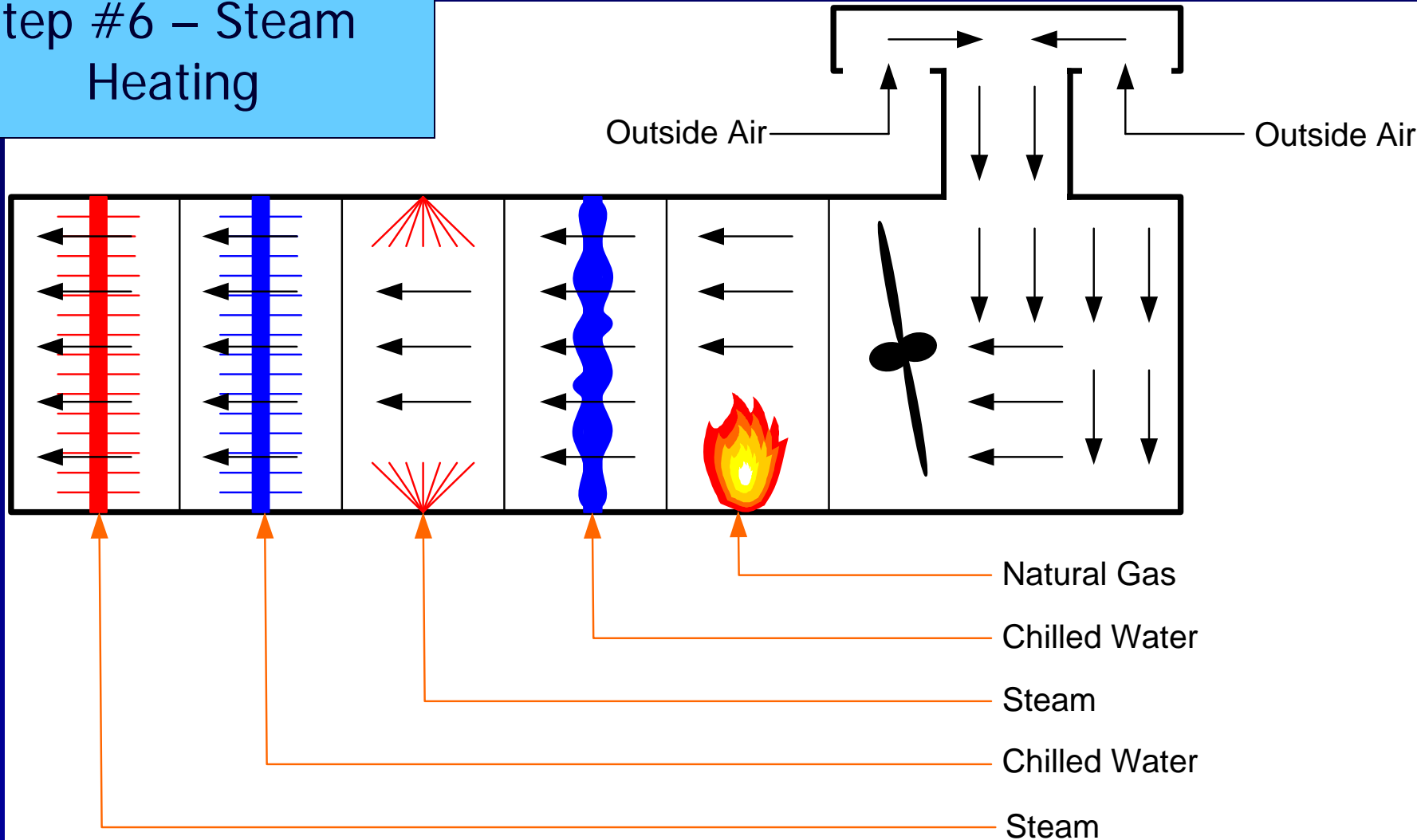




# Air Supply House

## *Basic Operation*

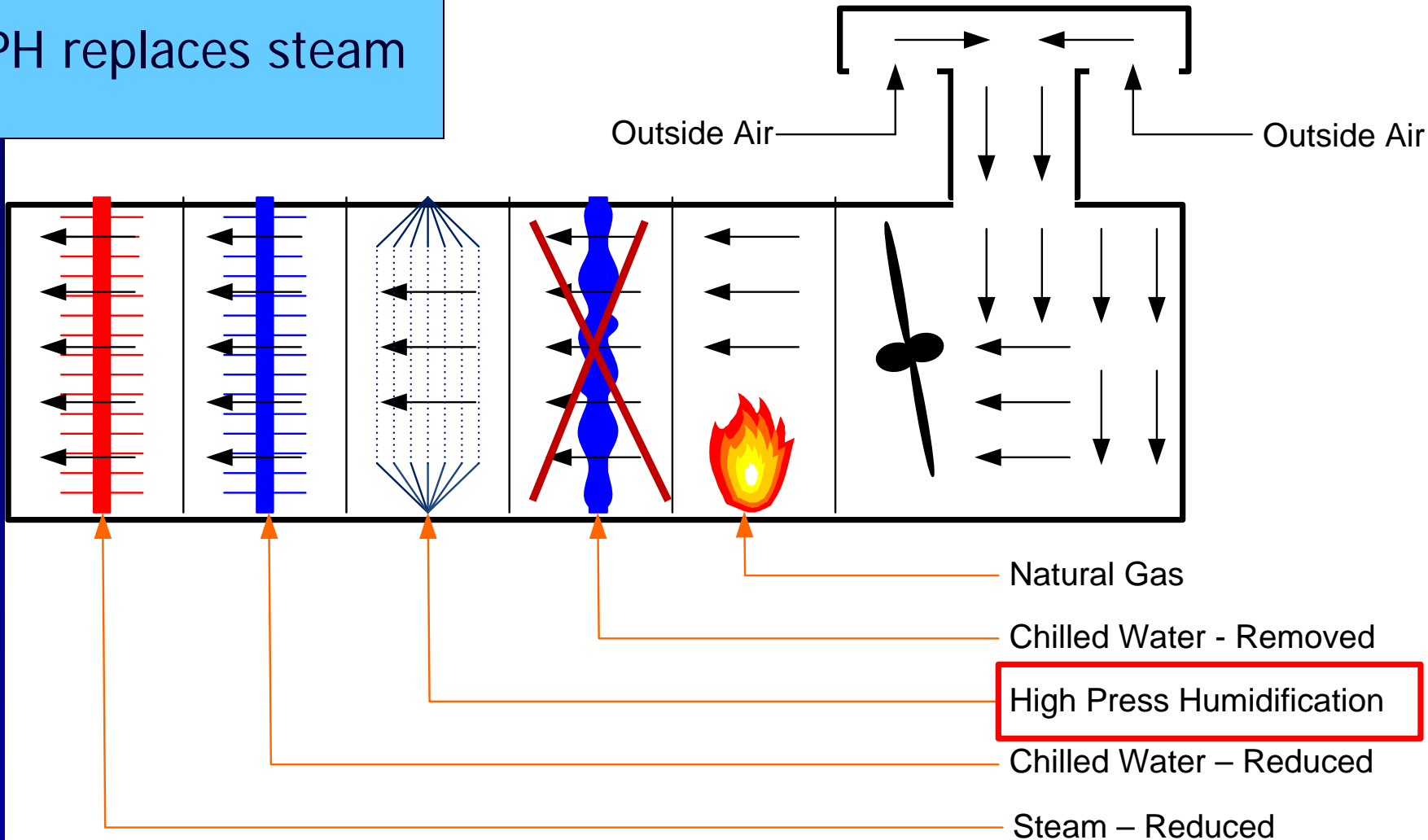
### Step #6 – Steam Heating





## Outside Air

- Outside Air



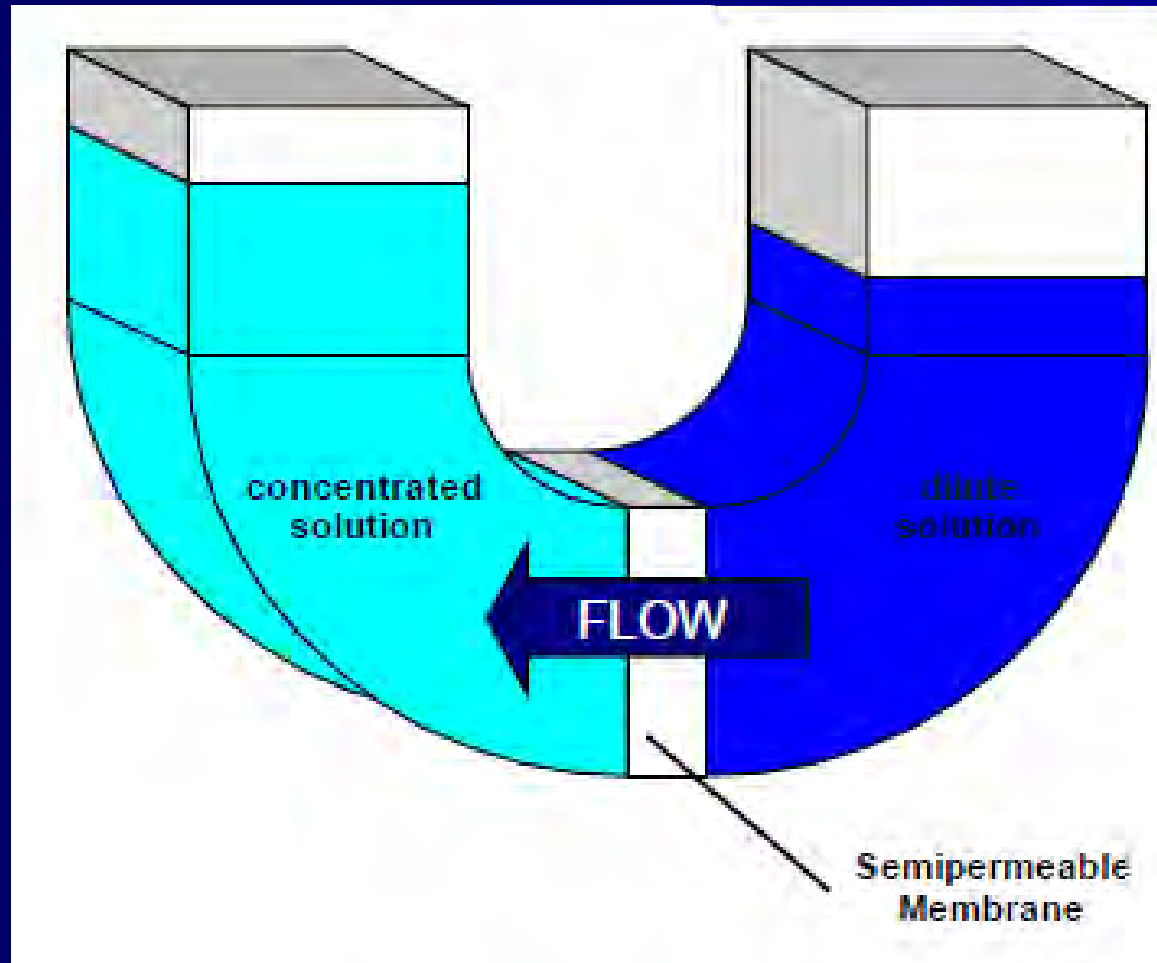
# Basic RO Principals



10 MGD Municipal RO System

# What is RO?

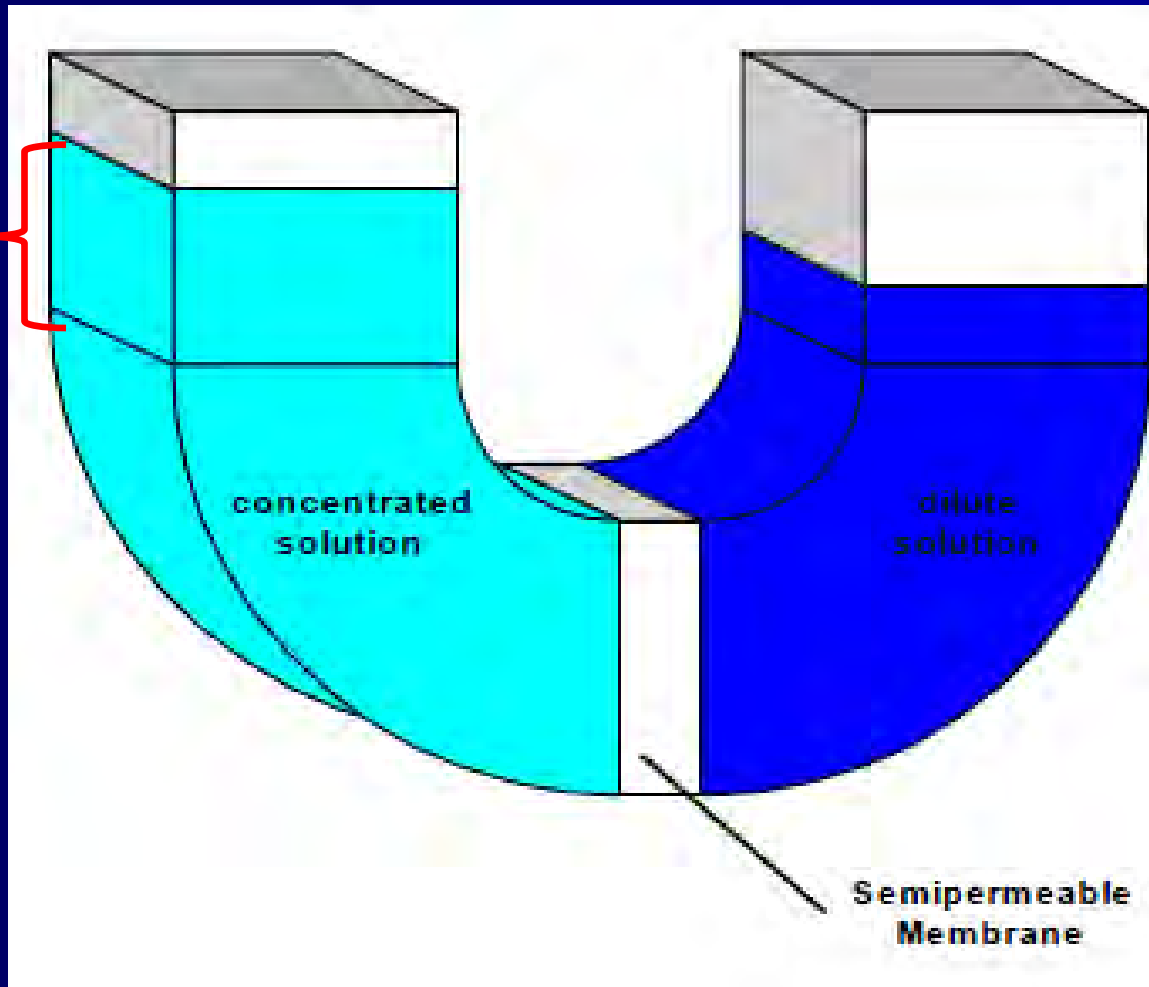
## Osmosis



The diffusion of solvent across a semi-permeable membrane that separates two solutions of different concentration

# What is RO?

## Osmotic Pressure

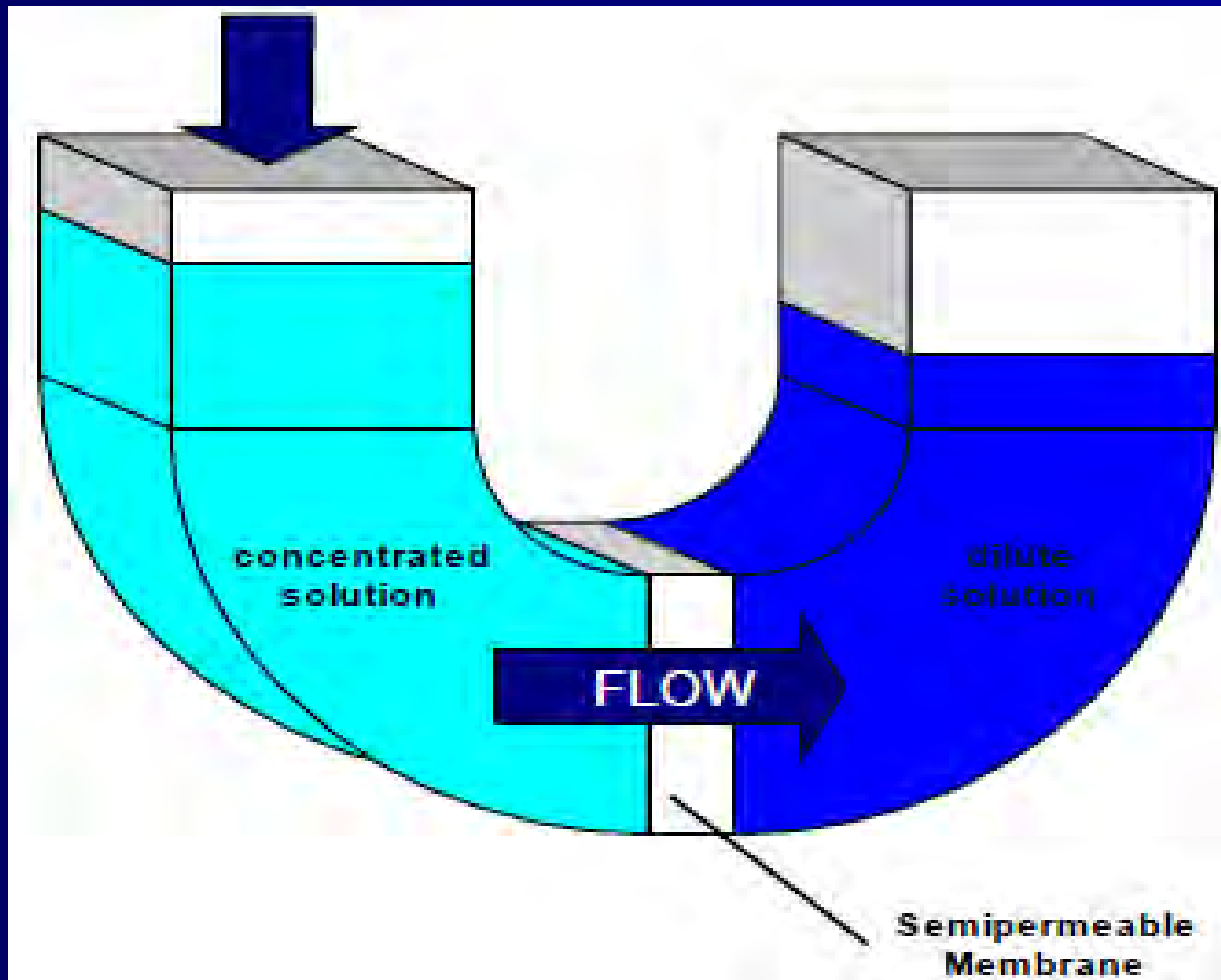


The pressure that must be applied to a concentrated solution to prevent osmosis

# What is RO?

Applied  
Pressure

Reverse Osmosis

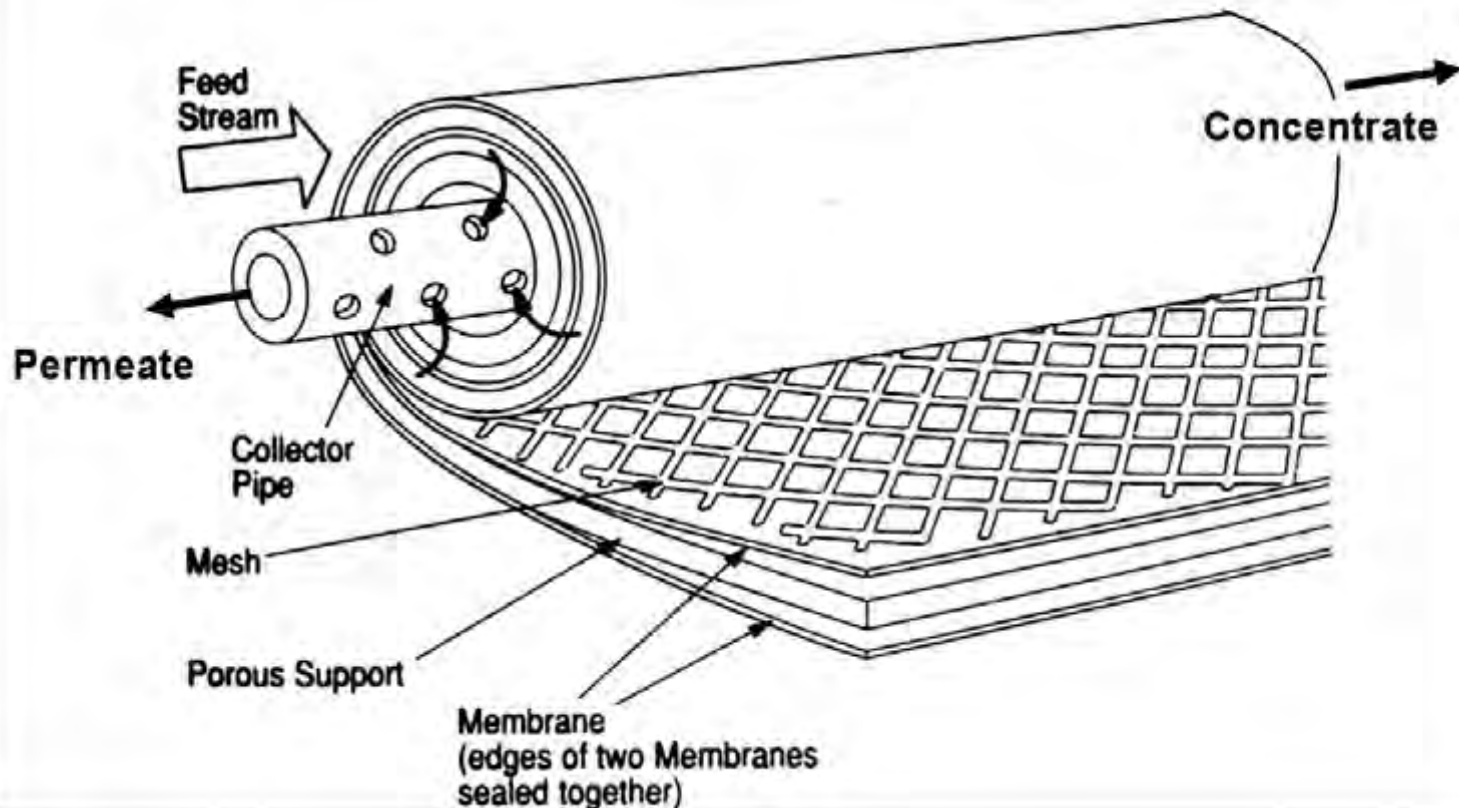


Reversing  
osmotic flow by  
applying a  
pressure in  
excess of the  
osmotic  
pressure

# What is RO?

## RO Membrane

### Inside A Spiral RO (Reverse Osmosis) Membrane Element



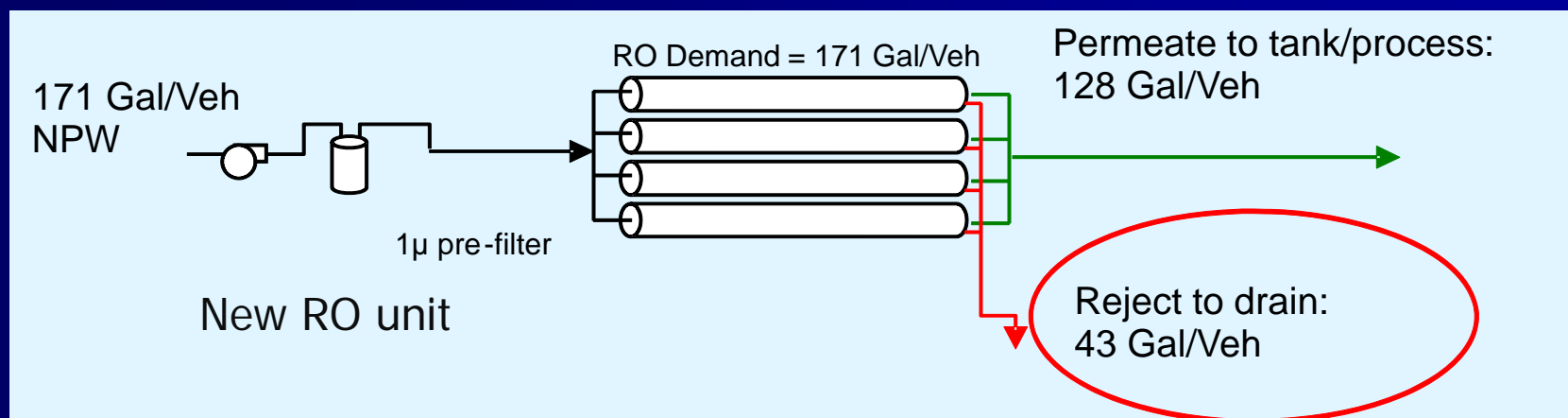
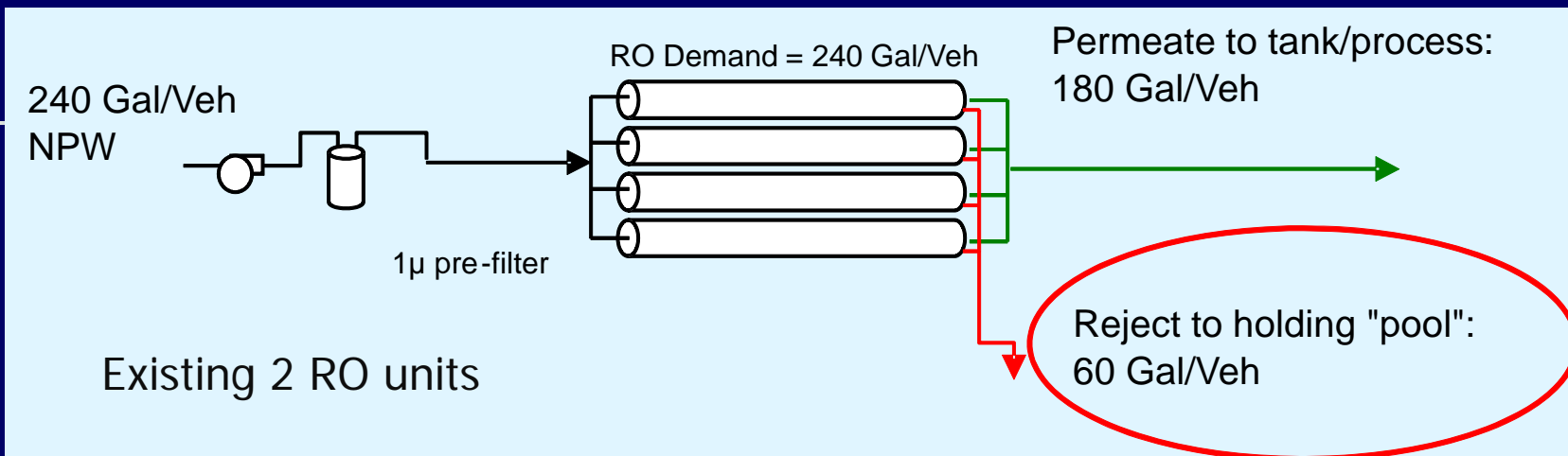


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# Original RO Design



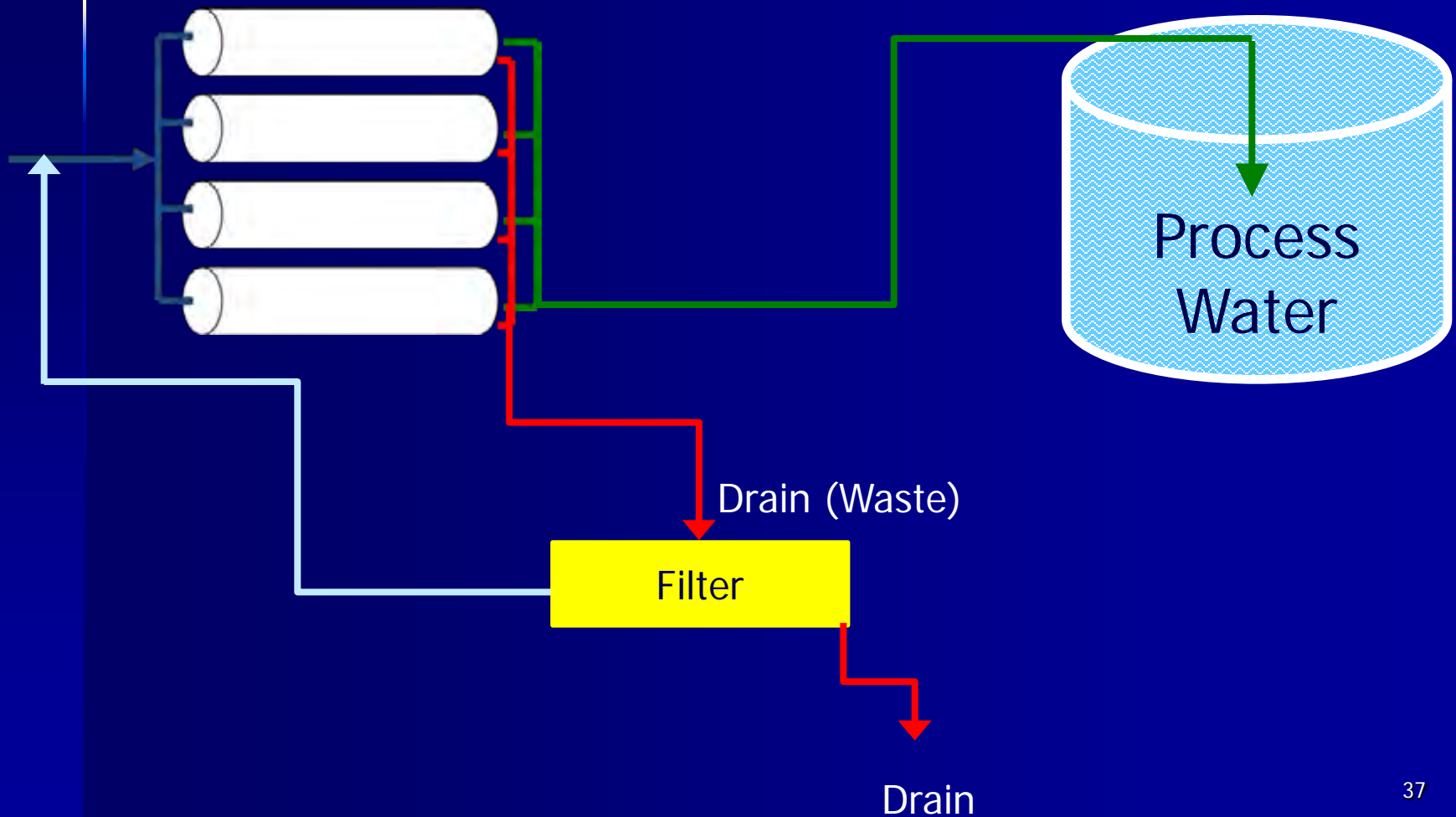
103 gallons of waste water generated per vehicle



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# Recovery Concept





# Possible Countermeasures

	Water Savings		Cost Savings	Cost	ROI	Rating
1) Install RO Reject Recovery unit on two current RO systems and on new system (3 units total)	51 gal/veh	14.5 Mgal/yr	\$ 91,000	\$ 195,000	25 months	○
2) Install New RO unit with tank to recycle reject (Yokoten TMMC project) *Requires additional pumps and piping	51 gal/veh	14.5 Mgal/yr	\$ 81,350	\$ 300,000	40 months	⊙
3) Do not install recovery units	0	0	\$ -	\$ -	n/a	×

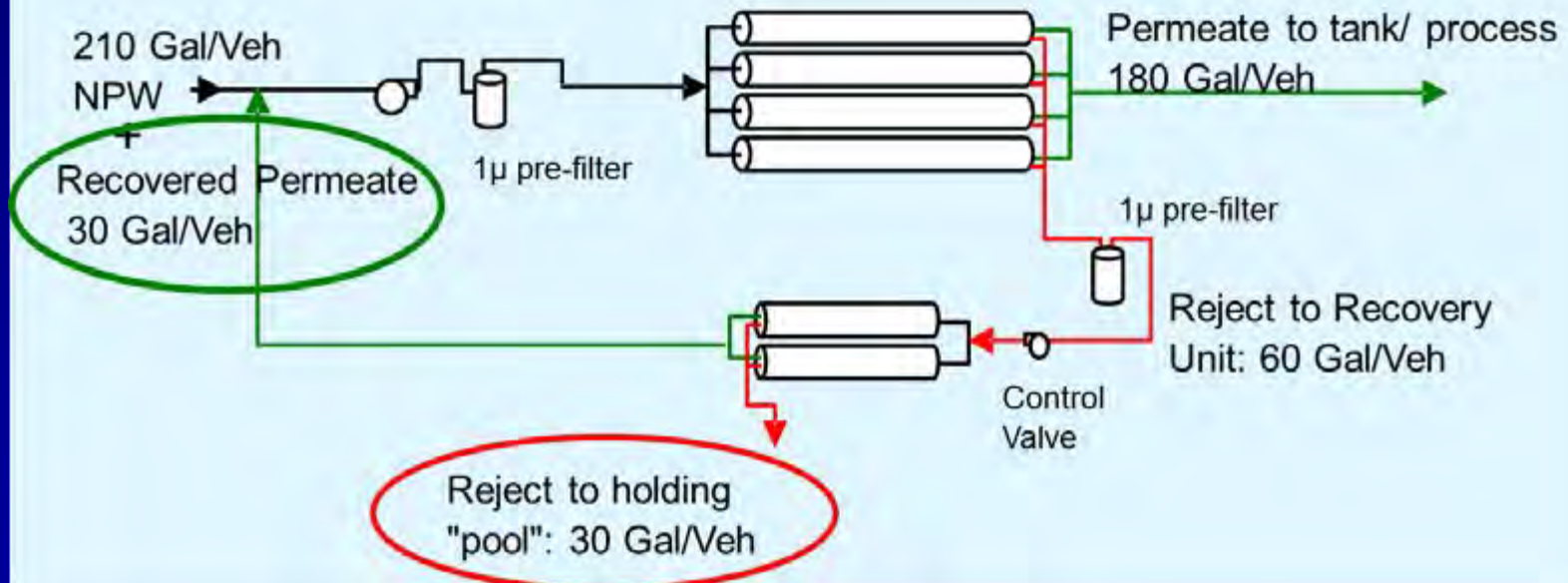
Exceeds target of  
48 gal/veh

# Recovery Set-up/Plan (Retrofit)

## Step 5: Develop Countermeasure

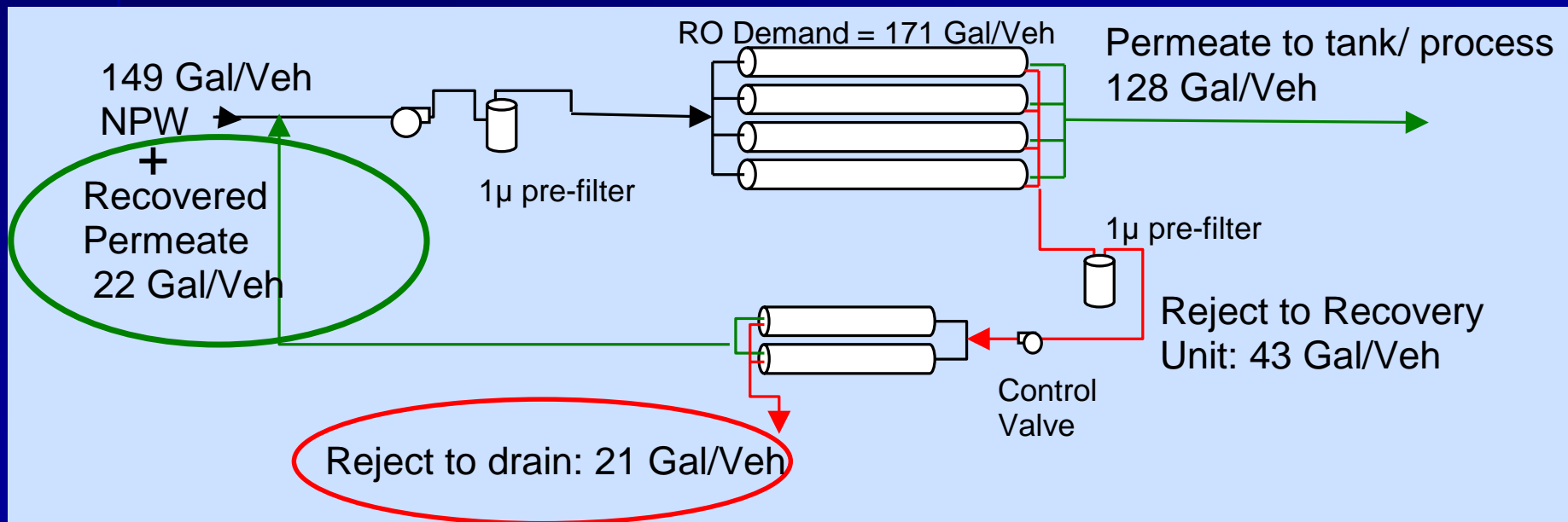
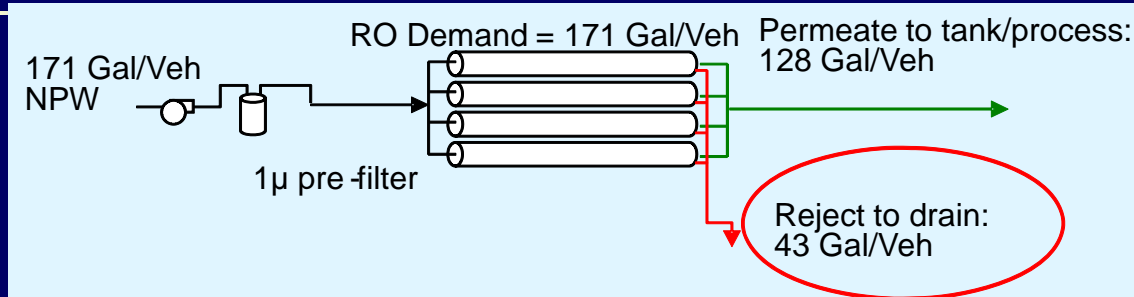


### EXISTING 2 RO UNITS



# Recovery Set-up/Plan (New Unit)

## Step 5: Develop Countermeasure





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# Install (Retrofit skid)





Recovery Unit (pre-installed)

**Install**  
(New Unit)





# Install (New Unit)



# Toyota Business Practices: 8 Step Problem Solving

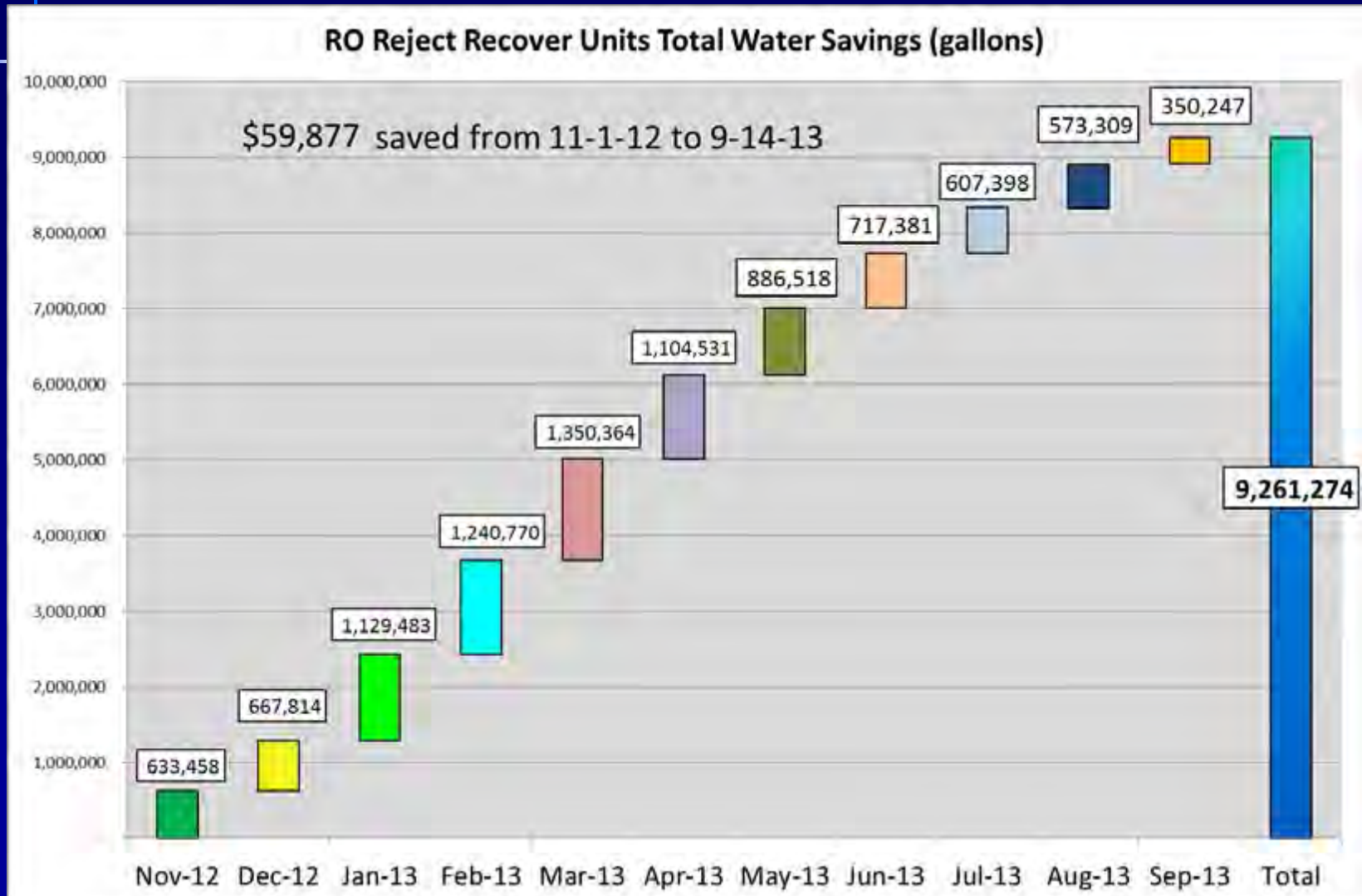
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# Recovery Data :

Step 7: Confirm Results

Actual to Date





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# Standardization of Success

- TMMK (Georgetown) installed Dec 2012
- TMMTX (San Antonio) investigating currently
- New TMMI Standard
  - Any new RO unit required to have recovery unit pre-installed



# ROI/Payback

**Cost Savings:** \$ 0.320 PER VEHICLE  
**Est. Annual Savings:** \$ 91,000  
**Yearly Water Savings:** 14,578,667 Gallons

New Equipment Costs:

~\$145,000 RO Recovery Equipment (all units)

~\$50,000 Install

**ROI = 24  
Months!**

[www.tourtoyotaindiana.com](http://www.tourtoyotaindiana.com)

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