Engaging Irrigation Design for Long Term Ownership
Newport Center (Corporate HQ)
Who We Are

- 153 year old privately held company
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- One of the largest diversified real estate investment and development enterprises in the United States
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- Over 4,200 employees
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- 153 year old privately held company
- One of the largest diversified real estate investment and development enterprises in the United States
- Over 4,200 employees
- Offices in Newport Beach, Irvine, San Diego, Los Angeles and Silicon Valley
Three Operating Groups

- Irvine Company Community Development
Three Operating Groups

- Irvine Company Community Development
- Irvine Pacific
Three Operating Groups

- Irvine Company Community Development
- Irvine Pacific
- Investment Properties Group
  - ICOP-Office Properties
  - ICRP-Retail Properties
  - ICAC-Apartment Communities
  - ICRP-Resort Properties
What We Do

• Plan and develop “best of class”:
  ➢ Residential villages
  ➢ Business districts
  ➢ Apartment communities
  ➢ Regional, community and neighborhood retail centers
  ➢ Resort properties including hotels, golf courses and marinas
What We Do

- Lease and manage high-quality, income-producing properties
- Retain ownership of real estate investment assets for long-term appreciation
THE IRVINE COMPANY HEADQUARTERS
(Photograph by Jim England Photography, Los Angeles)
The Irvine Ranch

Orange County

22 M/35Km long and 9 M/15Km wide
90,000 Ac/31,422Ha
187 Sq M/484 Sq Km

History and Context
Boston Massachusetts
32,198 ac | 13,030 ha | 32% Irvine Ranch

Manhattan New York
14,319 ac | 5,795 ha | 14% Irvine Ranch

The Irvine Ranch
1947-1959 • Orange County population increased from 200,000 to 700,000, creating pressure for residential and industrial development.

The Irvine Ranch

Pressure of Urbanization
Coastal Hills

Valley

Inland Hills

Master Plan Influences

Rail Line

Freeways

Airports

Freeways

Ridge Lines

Ranch Boundary

The Irvine Ranch

Coastal Hills
The Irvine Ranch

Ranch Master Plan

Freeways
Airports
Rail Line

Inland Hills
Valley
Coastal Hills
What is Master Planning?

- Its function is to guide development, to set standards and to enlarge rather than inhibit the potential...

- A basic land use plan has been drawn, fully cognizant of what exists at present, what is being planned in surrounding areas and what is likely to evolve in the foreseeable future.”
  - William Pereira
Ranch Master Plan Objectives:

• Orderly transition from agriculture to urbanized land uses
• Retain the unique character of the place
• Plan for infrastructure to support build-out of ranch
• Establish boundaries for the City of Irvine, incorporated in 1971, 47,500 Acres
• Establish University of California, Irvine on 1,500 Acres
• Preserve 50,000 Acres of parks and open space
• Flexible enough to allow for social or economic change
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• Preserve 50,000 Acres of parks and open space
• Flexible enough to allow for social or economic change
Guiding Principles

- Maintain the land under a single owner.
- Establish a Master Plan for all 93,000 acres to guide land use and infrastructure decisions, ensuring that the whole would be greater than the sum of its parts.
- Create an internal planning group to guide the evolution and implementation of the Master Plan.
Guiding Principles

- Establish three major planning sectors on The Ranch to help break the master-planning work into manageable areas: Coastal Sector, Valley Sector and Mountain Sector.
- Continually reinvest in the land.
Guiding Principles

- Ensure that the three planning sectors adhere to topography and jurisdiction constraints.
- Continue the tradition of land stewardship, with an eye on the long-term view.
- Contribute to the quality of the cities on The Irvine Ranch.
- Make sound, realistic economic and political decisions.
Three fundamental principles are followed in designing all residential, office, retail and resort structures on The Irvine Ranch

- Design integrity: Assuring that the design of the architecture has integrity, that the structures are pleasing as well as appropriate to the area in which they exist and that they always communicate a sense of place.
Timeless architecture: Applying the principles of classical architecture to create a sense of timelessness and ensure that communities on The Irvine Ranch will age gracefully.
Four-sided architecture: Using the same material on all four sides of a structure so that, no matter what vantage point it is viewed from, the design is never interrupted and all the parts are perceived as part of a unified whole.
City of Irvine Planning Objectives:

- Alternative to sprawl
- Balance development and open space
- Full range of land uses
- Economically self-sufficient
- Residential areas organized in villages
- Provide work, shopping, learning, and recreational opportunities near housing
- Infrastructure to support ultimate build-out
- Planned for an ultimate population of 214,000 residents

The City of Irvine

A Complete Range of Land Uses
The City of Irvine

- Consistently ranked as one of the safest cities of its size in the U.S.
- World renowned educational institutions – University of California, Irvine and Irvine Unified School District
- 66 square miles of well maintained neighborhoods, world class dining, shopping, recreation and cutting edge workplaces
What We Manage

- Square feet of Landscape – 84,000,000
- Square feet of Turf – 20,000,000
- Number of trees – 144,000
- Number of Irrigation controllers – 1,550
- Number of Maintenance contractors – 31
- Number of Tree pruning contractors – 14
- Total number IC landscape maintenance employees - 17
Landscaping Awards

- McCarthy Center CLCA First Place Large Commercial Maintenance 2009 Gachina The Plaza at La Jolla CLCA Landscape Beautification Judges Award 2011 Brickman 20/40 Pacifica PLANET Grand Award 2011 ValleyCrest 8001 Irvine Center Drive CLCA Landscape Beautification - Outstanding Achievement 2011 Vandergeest Jamboree Center CLCA Landscape Beautification - Winner 2012 Vandergeest The Plaza at La Jolla PLANET Merit Award 2012 Brickman Discovery Business Center CLCA Landscape Beautification - Winner 2012 Bemus McCarthy Center PLANET Distinction Award 2012 Gachina Westwood Gateway CLCA statewide Achievement Award 2012 ValleyCrest McCarthy Center CLCA statewide First Place Large Commercial Maintenance 2012 Gachina The Plaza at La Jolla CLCA First Place Judges Award 2013 Brickman Pacific Arts Plaza CLCA large commercial landscape renovation 2013 Mission The Plaza at La Jolla CLCA statewide John Redmond Memorial Award for Best entry from all maintenance categories in California 2013 Brickman Jamboree Center CLCA Landscape Beautification - Winner 2014 Vandergeest 8001 Irvine Center Drive CLCA Achievement Award 2014 Vandergeest 8105 Irvine Center Drive CLCA First Place Large Commercial Maintenance 2014 Vandergeest MacArthur Court PLANET Grand Award 2014 CEI Market Place Center CLCA Landscape Beautification - Winner 2015 Bemus Newport Center - Block 500 CLCA 1st place Beautification Award 2015 Vandergeest Jamboree Center CLCA 2nd place - Outstanding Achievement Award 2015 Vandergeest 100 Spectrum Center Drive CLCA 1st place Beautification Award 2015 Vandergeest 300 Spectrum Center Drive CLCA 2nd place - Outstanding Achievement Award 2015 Vandergeest Jamboree Center CLCA statewide 1st place - Unlimited Commercial Maintenance Award 2015 Vandergeest Newport Center - Block 500 CLCA statewide John Redmond Memorial Award for Best entry from all maintenance categories in California 2015 Vandergeest McCarthy Center CLCA Achievement Award for Commercial Installation 2016 Gachina Block 500 at Newport Center CLCA 1st Place Award "Retail/Office/Industiral" 2016 Vandergeest 100 Spectrum Center Drive CLCA 1st Place Award "Landscape Maintenance Project Over 30yrs Old & Over $3k/month" 2016 Vandergeest Discovery Business Center CLCA Landscape Beautification - Winner 2016 Bemus
Landscaping is the Slowest of the Performing Arts
TIC Landscape Architecture • Why doesn't ours look like this?
TIC Landscape Architecture • Historic Influences
“Place legibility” is a term used to describe the ease with which people can understand the layout of a place. Lynch identified a network of five key elements:

- paths
- edges
- districts
- nodes
- landmarks
1. HISTORIC PRECEDENT
   • Influences
2. RANCH CONTEXT
   • Geography
   • Topography
3. MEDITERRANEAN CLIMATE
4. SITE PLANNING and LANDSCAPE DESIGN
   • The City of Irvine

• Architecture
• Landscape Architecture and Site Planning
• Interior Design

TIC Landscape Architecture • Key Influences
Planning and Design Influences
TIC Landscape Architecture • Ranch Geography
Landscape Architecture has two distinct disciplines: site planning and landscape design.
**Site Planning** - the art of organizing program elements on a site such as structures, driveways, parking lots, landscaping and utilities. Considerations include:

- Respond to context
- Positive arrival experience
- Clear auto and pedestrian circulation system
- Buildings create desirable exterior spaces
- Care in grading the site
- Minimize visual impact of site utilities
- Space for landscape
Planning and Design Influences

Landscape Architecture

- Reinforces site plan
- Creates space
- System of trees, shrubs, ground cover, paving and site furniture
- Establishes character
- Regionally influenced
- Classically inspired
- Small plant palette
- Evergreen
TIC Landscape Architecture • Visual Site Plan Cues
TIC Landscape Architecture  •  More than plants
Classical Architecture

• Derived from ancient Greek and Roman buildings
• Symmetrical, axial, ordered and hierarchical relationships in plan and elevation
• Scale and proportion based on mathematic formulas and scale of human body
• Create architectural “orders”, a repetitive system for organizing architectural elements including columns, capitals, entablature, architrave, frieze and cornice
• Stone and masonry construction

Planning and Design Influences

TIC Architecture

• Regionally inspired
• Traditional forms
IRRIGATION DESIGN GUIDELINES
FOR
IRVINE COMPANY OFFICE PROPERTIES

PREPARED FOR:
IRVINE COMPANY OFFICE PROPERTIES
550 NEWPORT CENTER DRIVE
NEWPORT BEACH, CALIFORNIA

UPDATED April 15, 2015

PREPARED BY:
d.d. PAGANO, INC.
IRRIGATION CONSULTANTS
4705 EAST CHAPMAN AVENUE
ORANGE, CA 92869
(714) 771-9200
IT IS ONE OF MAN'S CURIOUS IDIOSYNCRASIES TO CREATE DIFFICULTIES FOR THE PLEASURE OF RESOLVING THEM.

JOSEPH DE MAISTRE

PICTUREQUOTES.com
What Do We Want?
What Do We Want?

- To be able to apply the precise amount of water needed by each landscape zone with perfect coverage and zero runoff or overspray
What Do We Want?

- To be able to apply the precise amount of water needed by each landscape zone with perfect coverage and zero runoff or overspray
- For our maintenance vendors to be able to maintain the system to work as well as it did on day one
What We Don’t Want
Don’t Want
Challenges

- Irrigation design and maintenance are one of the most crucial components of a landscape
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- Typically new irrigation systems start deteriorating the day after installation.
Challenges

- Irrigation design and maintenance are one of the most crucial components of a landscape.
- Typically new irrigation systems start deteriorating the day after installation.
- There is a serious shortage of knowledgeable, experienced irrigation managers in landscape maintenance.
IC Water Management Best Practices

- Require written proof of monthly irrigation inspections
IC Water Management Best Practices

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- Partner with your vendor and share water bills and allocations. Hold them financially accountable for water penalties due to overwatering
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- Upgrade irrigation systems with smart controllers, low flow sprinklers, drip irrigation and master valves with flow sensors where appropriate
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- Re-landscape with low water use plants
- Reduce your turf footprint
Irvine Company Water Savings

- We have converted 603 irrigation controllers to “smart controllers” (Savings of approximately 100,800 gallons annually per 24 station controller)
Irvine Company Water Savings

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- We have converted 1,300 valves to drip irrigation (water savings approximately 25,700 gallons annually per valve)
Irvine Company Water Savings

- We have converted 474 irrigation controllers to “smart controllers” (Savings of approximately 100,800 gallons annually per 24 station controller)
- We have converted 1,400 valves to drip irrigation (water savings approximately 25,700 gallons annually per valve)
- We have converted about 70,000 sprinklers to low flow, high efficiency nozzles (water savings approximately 1,303 gallons annually)
How Have These Investments Changed Actual Water Use?

Allocations have steadily increased, but actual usage has either declined or stayed flat, resulting in more water saved annually and less water penalties over time. **Average percentage used is 70% of allocation.**

**Estimated Annual Office Portfolio Savings-**

- $112,000
- 82,000,000 Gallons
900% Savings vs. 2008 water penalties
Irrigation Principles

- Design for ownership
  - Equipment standardization
  - Effective after landscape matures and evolves
  - Allow for expansion
  - Durability
  - Precise application and hydrozoning
Irrigation Principles

- Facilitate maintenance
  - Simplify repairs
  - Fertigation
  - POC assemblies
Irrigation Principles

- Integration of irrigation with our amenities
  - Hardscape
  - Signage
  - Windows
  - Trees
  - Lighting
Irrigation Principles

- Drip Irrigation highly utilized
  - Shrub and ground cover areas
  - Small turf areas
  - Turf areas around signage
  - Areas where water staining can occur
Irrigation Principles
Irrigation Principles
Irrigation Principles

- Weather based centralized irrigation control
- Flow monitoring and management
Santa Clara Square
<table>
<thead>
<tr>
<th></th>
<th>Redwood Limits</th>
<th>Recycled Source</th>
<th>Potable Source</th>
<th>50% Blend</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>pH</strong></td>
<td></td>
<td>7.38</td>
<td>7.74</td>
<td>7.56</td>
</tr>
<tr>
<td><strong>Salinity</strong></td>
<td>3</td>
<td>1.00</td>
<td>0.66</td>
<td>0.83</td>
</tr>
<tr>
<td><strong>Sodium</strong></td>
<td>70</td>
<td>117</td>
<td>30</td>
<td>73</td>
</tr>
<tr>
<td><strong>Adjusted SAR</strong></td>
<td>3</td>
<td>5.1</td>
<td>1.6</td>
<td>3.7</td>
</tr>
<tr>
<td><strong>Chloride</strong></td>
<td>150</td>
<td>180</td>
<td>16</td>
<td>113</td>
</tr>
<tr>
<td><strong>Bicarbonate</strong></td>
<td>100</td>
<td>99</td>
<td>233</td>
<td>166</td>
</tr>
<tr>
<td><strong>Boron</strong></td>
<td>0.70</td>
<td>0.29</td>
<td>0.09</td>
<td>0.19</td>
</tr>
</tbody>
</table>
Santa Clara Square
Selecting a Contractor
Selecting a Contractor

- The work speaks for itself
Selecting a Contractor

- The work speaks for itself
- Length of time in the industry
Selecting a Contractor

- The work speaks for itself
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- Communication
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- The work speaks for itself
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- Reputation
- Size
- Communication
- Location
- Appearance of employees and trucks
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- Willingness to innovate
Selecting a Contractor

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- Length of time in the industry
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- Size
- Communication
- Location
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- Willingness to innovate
- Proactive
Irvine Company Best Practices – Landscape Maintenance
Irvine Company Best Practices – Landscape Maintenance

- Planning and Design team – Gatekeepers
Irvine Company Best Practices – Landscape Maintenance

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- Walk every square inch of every property every month
Irvine Company Best Practices – Landscape Maintenance

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Irvine Company Best Practices – Landscape Maintenance

- Planning and Design team – Gatekeepers
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- Create comprehensive punch list with completion dates
- Score the quality of the landscape maintenance with a judging sheet each month
Irvine Company Best Practices – Landscape Maintenance

- Planning and Design team – Gatekeepers
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- Create comprehensive punch list with completion dates
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- Drive-by two weeks after walkthrough
Irvine Company Best Practices – Landscape Maintenance

- Planning and Design team – Gatekeepers
- Walk every square inch of every property every month
- Create comprehensive punch list with completion dates
- Score the quality of the landscape maintenance with a judging sheet each month
- Drive-by two weeks after walkthrough
- Partnering with our vendors
Any questions?
On a “Lighter” Note: UV Disinfection 101

Dan Shaver
Strategic Account Manager, Aquionics Inc.
Aquionics Background

HALMA

**Process Safety**
- Castell Safety
- Crowcon
- Elfab
- Fortress Interlocks
- Kirk Key
- Netherlocks
- Oseco
- Cosasco
- SERV Trayvou
- Smith Flow Control

**Infrastructure Safety**
- Advanced Electronics
- Apollo Group
- Avire
- BEA Group
- FFE
- Firetrace
- Texecom

**Medical**
- Accudynamics
- Accutome
- Bio-Chem Fluidics
- Cen Trak
- Diba
- Keeler
- Longer Precision Pump
- Medical
- MicroSurgical Technology
- Riester
- SunTech Medical
- Visionmetrics
- Volk Optical

**Environmental & Analysis**
- Alicat Scientific
- Avo Photonics
- Fiberguide
- HWM-Water
- Hydreka
- Labsphere
- Ocean Optics
- Palintest
- Perma Pure
- Sensorex
- Hanovia
- Berson
- Aquionics

Aquionics Background

2018 NATIONAL CONFERENCE
Aquionics Background

- **Est. 1983**
  - Charlotte, NC
  - AMERICAS Municipal & Industrial Applications

- **Est. 1924**
  - Slough, UK
  - EMEA & ASIA Industrial Applications

- **Est. 1972**
  - Eindhoven, Holland
  - EMEA & ASIA Municipal Applications
#1 - What is UV Disinfection and why do I need it?
What is UV disinfection?

- Mercury vapor lamps produce UV-C light at a wavelength of 253.7nm
- DNA of many common bacteria & virus have a peak absorption around 260-265nm
- Exposure to UV-C destructs part of the DNA, preventing reproduction
- UV-C is the only effective treatment for many chlorine resistant organisms such as cryptosporidium and giardia
Medium Pressure (MP) lamps are also called polychromatic lamps, as they emit multiple wavelengths. MP lamps provide a higher output, but for usually a shorter amount of time, allowing for a smaller footprint and less lamps.

Low Pressure (LP) or Low Pressure Amalgam (LPHO) lamps are called monochromatic, as they emit only one wavelength. LP lamps are usually longer, and more are required to treat the same amount of flow as a MP lamp, however they consume less energy and typically last longer.
### LP vs. MP Applications

There is not one place where one technology is used over another, as each have their positive and negative attributes.

<table>
<thead>
<tr>
<th>Low Pressure (LP)</th>
<th>Medium Pressure (MP)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Where space is not limited.</td>
<td>Limited space.</td>
</tr>
<tr>
<td>Typically in lower flow situations.</td>
<td>When a high DOSE/level of disinfection is required.</td>
</tr>
<tr>
<td>Where power costs are high.</td>
<td>With continuous flows.</td>
</tr>
<tr>
<td>In batch processing.</td>
<td>Low maintenance requirement due to low number of lamps.</td>
</tr>
</tbody>
</table>

---

**ASIC**

2018 NATIONAL CONFERENCE
UV System Examples

- Full range of low-pressure and medium pressure UV systems
- Inline, U-shape and S-shape design (medium pressure)
- Single lamp horizontal or vertical installation (low pressure)
Maintenance Expectations

UV Lamps
- Works best with no more than 4 on/off cycles in 24 hours of operation
- MP Lamps – 8,000 hours of run time
- LP Lamps – 12,000 – 16,000 hours of run time

Quartz Sleeve
- Solarizes over time
- Replace every 2 years

Intensity Sensor
- Ages/drifts over time
- Calibration check against NIST standard every 12 months
- In-field sensor verification monthly a good practice

Auto-Wiper
- Keeps sleeve surface clean and reduces the effects of fouling
- Replace wiper rings every 12 months
#2 - What is UV Dose and how much do I really need?
UV Fluence or commonly referred to as **Dose**, is the energy required to inactivate a microorganism and is measured in mW sec/cm² or mJ/cm².

It is important to understand that actual equations used by UV systems are more complex than this and vary from UV system to UV system to account for UV reactor design differences.
Understanding UV Dose

- While there is some regulation that drives the level of DOSE required, many facilities look to UV manufacturers to make recommendations.

- Studies have been conducted to prove the DOSE required for most common bacteria, protozoa, molds & spores and virus.

<table>
<thead>
<tr>
<th>Organism</th>
<th>UV DOSE (mJ/cm²) for a given Log Reduction</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Legionella pneumophila (ATCC 43660)</td>
<td>3.1 5 6.9 9.4</td>
<td>Wilson et al. 1992</td>
</tr>
<tr>
<td>Salmonella spp.</td>
<td>&lt;2 2 3.5 7 15 29</td>
<td>Yaun et al. 2003</td>
</tr>
<tr>
<td>Streptococcus faecalis (ATCC29212)</td>
<td>6.6 8.8 9.9 11.2</td>
<td>Chang et al. 1985</td>
</tr>
<tr>
<td>Cryptosporidium hominis</td>
<td>3 5.8</td>
<td>Johnson et al. 2005</td>
</tr>
<tr>
<td>Giardia lamblia</td>
<td>&lt;2 &lt;2 &lt;4</td>
<td>Mofidi et al. 2002</td>
</tr>
<tr>
<td>Adenovirus (type 15)</td>
<td>40 80 122 165 210</td>
<td>Thompson et al. 2005</td>
</tr>
<tr>
<td>Bacillus subtilis (ATCC6633)</td>
<td>36 48.6 61 78</td>
<td>Chang et al. 1985</td>
</tr>
</tbody>
</table>
### Theoretical Dose Calculation (Average)

<table>
<thead>
<tr>
<th>Particle (microbe) flow pattern</th>
<th>Dose (mJ/cm²)</th>
<th>Microbe Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Track 1 Dark Blue</td>
<td>20</td>
<td>Still Activate</td>
</tr>
<tr>
<td>Track 2 Purple</td>
<td>40</td>
<td>Inactivated</td>
</tr>
<tr>
<td>Track 3 Yellow</td>
<td>60</td>
<td>Inactivated</td>
</tr>
</tbody>
</table>

![Diagram showing particle flow and dose distribution](image)
Theoretical Dose Calculation (CFD model)

CFD (Computational Fluid Dynamics) can be used to predict:

- Path of an organism through the system
- Path of flow through the system
- The RED (reduction equivalent dose) DOSE delivered by the system

Medium level of biosecurity, good for primary disinfection as part of multi-barrier treatment approach.
Introducing a test microorganism into a UV reactor and taking sample counts before and after the reactor.

Proves the system will disinfect the target organism at a certain UV Dose under a certain set of operating conditions (flow rate, UVT, UV intensity)

Provides a fully calibrated UV dose

Validated equipment is often referred to as 3rd party validated

Maximum level of biosecurity, guaranteed disinfection for critical applications.
## What Level of Security is Required?

<table>
<thead>
<tr>
<th>Biosecurity Level</th>
<th>Product Design</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum</td>
<td>Average Dose – simple numerical calculation.</td>
<td>Theoretical model. Supplementary disinfection</td>
</tr>
<tr>
<td>Medium</td>
<td>CFD calculated Reduction Equivalent Dose (RED)</td>
<td>Theoretical model. Primary disinfection as part of multi-barrier treatment.</td>
</tr>
<tr>
<td>Maximum</td>
<td>Bio-Assay based RED according to UVDGM</td>
<td>Calibrated model. Guaranteed disinfection for critical processes</td>
</tr>
</tbody>
</table>
Validation Protocols & Regulation

- **US EPA Drinking Water (UVDGM) – Municipal Drinking Water Applications:**
  - 2006 guideline written for standardization on UV disinfection, specifically for chlorine resistant organisms such as Cryptosporidium and Giardia

- **FDA Pasteurized Milk Ordinance (PMO) – Dairy Applications:**
  - 2009 regulation follows US EPA UVDGM, but uses 120 mJ/cm² Validated UV Dose for 4-log reduction of Adenovirus.
  - Includes instrumentation, controls, monitoring and reporting software requirements

- **National Water Research Institute (NWRI) – Reuse Applications:**
  - Minimum UV Dose 80 mJ/cm² RED MS2
  - N+1 System Redundancy
#3 - What can affect UV Dose?
**Turbidity (NTU)**

Measurement of UV light which scatters due to suspended materials, color and other matter found in the liquid which is to be treated by the UV system.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Influence / Effect</th>
<th>Typical Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turbidity</td>
<td>Measure of light scattering</td>
<td>&lt; 5 NTU recommended</td>
</tr>
<tr>
<td></td>
<td>Effects disinfection performance</td>
<td></td>
</tr>
</tbody>
</table>

![Diagram showing light scattering and suspension material with percentages]
More commonly found in wastewater, solids block the UV-C, reducing disinfection. Particles can “shadow” bacteria, keeping them from being deactivated.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Influence / Effect</th>
<th>Typical Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Suspended Solids</td>
<td>Absorbs UV light &amp; shields bacteria</td>
<td>&lt; 30mg/l recommended</td>
</tr>
<tr>
<td></td>
<td>Effects disinfection performance</td>
<td></td>
</tr>
</tbody>
</table>
UV Transmittance (UVT)

- Measurement of UV light which passes through one (1) cm of the liquid to be treated. One of the most important factors that affect UV system sizing and performance.
- Different than Turbidity (NTU) or Suspended Solids (TSS) as UVT also takes into consideration dissolved organic matter.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Influence / Effect</th>
<th>Typical Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>UV Transmittance</td>
<td>Measure of UV absorption</td>
<td>50 – 70 %</td>
</tr>
<tr>
<td>(UV-T)</td>
<td>Effects system sizing requirements</td>
<td></td>
</tr>
</tbody>
</table>

![DISSOLVED MATERIAL](image)

- 10 mm: 90%
- 20 mm: 81%
- 30 mm: 73%
- 40 mm: 65%
- 50 mm: 60%

60%
UV Transmittance (UVT)

100% UVT  70% UVT  40% UVT  20% UVT  5% UVT

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More commonly found in wastewater/reuse, minerals can have an effect on a UV systems performance. Minerals such as iron or manganese will adhere to the quartz sleeve, and causing fouling and poor system performance.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Influence / Effect</th>
<th>Typical Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minerals</td>
<td>Can cause scaling on quartz sleeves</td>
<td>Fe &lt;0.1 mg/l</td>
</tr>
<tr>
<td>(Coagulants)</td>
<td>Effects UV transmission</td>
<td>Mn &lt;0.1 mg/l</td>
</tr>
</tbody>
</table>
Iron & Manganese Fouling

If you can visibly see any fouling, it is major fouling in the eyes of the UV system!

This is why a wiper is recommended for lower UVT applications!
Iron & Manganese Fouling

If you can visibly see any fouling, it is major fouling in the eyes of the UV system!

This is why a wiper is recommended for lower UVT applications!
#4 - Where would I use a UV Disinfection System?
<table>
<thead>
<tr>
<th>Application</th>
<th>Description &amp; Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Source Protection, UV as a Firewall</td>
<td>Source water protection, <a href="#">FSMA compliance</a>, quality assurance, brand safeguarding</td>
</tr>
<tr>
<td>Pre-treatment, Filtration Stage</td>
<td>Disinfection after GAC or UF/NF, protects process from potential contamination from bacteria in filtration effluent</td>
</tr>
<tr>
<td>Dechlorination/Disinfection, RO Stage</td>
<td>Disinfection and Dechlorination (replace GAC or SMBS), reduced maintenance &amp; CIP, added protection ahead of RO</td>
</tr>
<tr>
<td>Pasteurized Equivalent Water</td>
<td>Meets FDA PMO requirements for creating pasteurized equivalent water, substantial energy savings for dairies</td>
</tr>
<tr>
<td>Sugar Syrup Disinfection</td>
<td>Inline disinfection of <a href="#">liquid sucrose</a>, alternative to heat pasteurization, target heat resistant molds (HRMs)</td>
</tr>
<tr>
<td>Brine Disinfection</td>
<td>Disinfection of <a href="#">meat brines</a> by recirculation, extends brine life and reduces disposal frequency</td>
</tr>
</tbody>
</table>
### Other Industrial Applications

<table>
<thead>
<tr>
<th>Aquaculture</th>
<th>Pharmaceutical Water</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chemical-free treatment prevents spread of disease in fish farming facilities especially during early rearing.</td>
<td>Enhanced hygienic system design for disinfection of pre-treatment or high-purity pharmaceutical water loop.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Deozonation</th>
<th>Irrigation Reuse</th>
</tr>
</thead>
<tbody>
<tr>
<td>Removal of ozone from process water after storage tanks to prevent it from entering final product.</td>
<td>Disinfection of harvested rainwater or other source water for irrigation supply and wastewater reuse applications.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cooling Tower</th>
<th>Industrial Wastewater</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disinfect make-up water or cooling tower loop. Reduce dependence on chemical biocide and eliminate risk of Legionella.</td>
<td>Control final effluent quality, reduce risk of exceeding bacteria limits and incurring municipal fines.</td>
</tr>
</tbody>
</table>
New Inquiries – What Do I Need to Know?

“I have an application.....what information do you need?”

**Application/Process –**
- General overview of the process flow and proposed location
- What is happening upstream of the UV System?

**Flow Rate –**
- Minimum/maximum flow rates
- Intermittent flow, batch process

**Water Quality –**
- UVT (transmittance) – take a sample or make conservative assumptions based on pre-treatment
- Other elements that could affect performance (TSS, Fe, Mn, etc.)

**Other Considerations:**
- Validation requirements, regulatory issues, corporate water quality specifications
- QA/QC performance goals (log reduction, etc.)
- Installation requirements (connections, materials, NEMA ratings, temperature, etc.)
#5 - Wow this presentation was the most amazing thing I’ve ever sat through, how do I contact Dan?
Dan Shaver
Strategic Account Manager
Aquionics, Inc.
dan.shaver@aquionics.com
613-929-8499