



SeaKlear[®]

Reliable & Effective

**The Swimming Pool Professional's
Guide to Recreational
Water Illness**

Second Edition

HaloSource, Inc.

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The Swimming Pool Professional's Guide to Recreational Water Illness

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Contents

An Introduction to Recreational Water Illness	3
<i>Cryptosporidium</i> : The Leading Cause of RWI Diseases	5
<i>Cryptosporidium</i> Defined	5
Risk of <i>Cryptosporidium</i> Infection	5
History of <i>Cryptosporidium</i>	6
Options for the Prevention of RWIs	7
Chlorine Sanitizer	7
Maintaining Proper Water Chemistry	7
Dilution	7
Ozone	8
UV	8
Oxidation	8
Circulation	9
Filtration	9
Swimmer Behavior & Facility Cleanliness	10
Enhanced Filtration	11
Enhanced Filtration with SeaKlear PRS	12
Application	14
Dosage Rates	14
ORP & the Role of Enhanced Filtration	14
Troubleshooting	15
Appendix A: Effectiveness Graphs	16
Particle Population Size Shift	16
Bentonite Particles	17
Superior Turbidity Reduction	17
Appendix B: Field Tests and Testimonials	18


An Introduction to Recreational Water Illness

According to the U.S. Bureau of the Census, more than 368 million people visit public recreational water facilities annually. Along with that influx of people comes a multitude of water contaminants that create sanitizer demand and lead to deterioration of water quality.

Use of public swimming pools can accurately be described as communal bathing. Each individual bather contributes substantial amounts of bacteria, and sometimes viruses and protozoa, to the water. In outdoor facilities, many microbes can be introduced to the water from wind, rain, source water and animals, such as birds and rats. The job of an aquatic facility operator is to keep the water within regulated standards for the safety and comfort of the facility's patrons.

Unfortunately, that challenge isn't always met. A 2002 study by the Centers for Disease Control and Prevention (CDC) showed that out of 22,131 pool inspections there were documented pool code violations in 21,561. More than 38 percent of the violations were pertaining to water chemistry (CDC, Morbidity and Mortality Weekly Report, 52, No. 22, June 6, 2003).

How Swimmers Affect Water Clarity



38,000 microorganisms released with "clearing" of nose

5 million organisms shed from a single hand washing

100 million to 1 billion organisms from 1 spit of saliva into the pool

2 pints of perspiration released in the pool per hour

One-tenth of a gram of fecal material containing millions of microbes such as chlorine-resistant *Cryptosporidium**

Every time we enter the water our bodies shed millions of small particles that affect the clarity of pool water.

*Dr. Charles Gerba, University of Arizona (Washington State Public Health Association 1987)

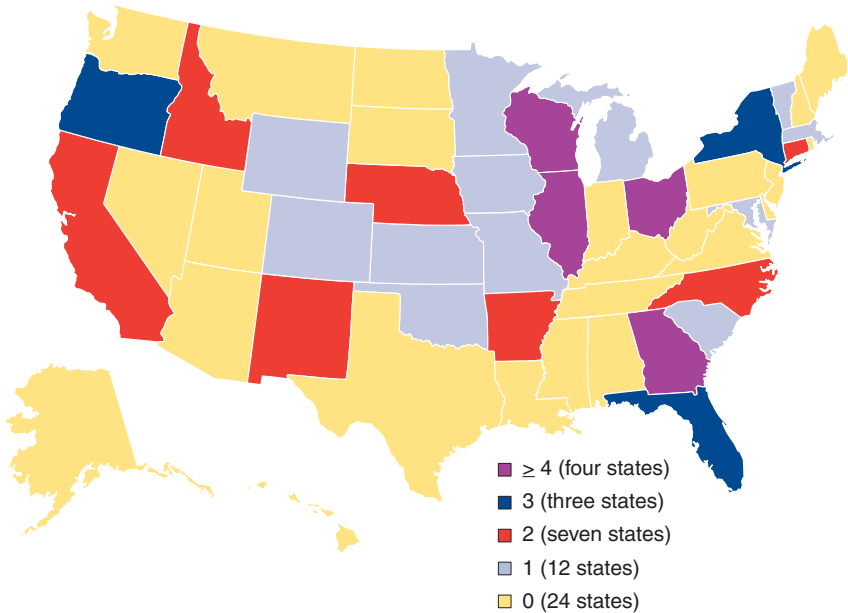
The significance of these violations is that the quality of pool water is directly related to recreational water illness (RWI). Recreational water illness is caused by pool water contaminated with bacteria or parasites—disease agents—that are released into the water by infected swimmers. In recent years there has been a rise in the occurrence of RWI outbreaks at public recreational aquatic facilities.

Why RWIs Are a Concern to Swimmers

- RWI outbreaks can occur even in chlorine-treated pools.
- High swimmer load can cause sanitizer residual to be inadequate.
- Most current filter technology is not sufficient for dealing with RWI outbreaks.

According to CDC statistics, RWI outbreaks rose from only two in 1986 to 21 in 2000 and then tripled to 62 in 2004 (see map below; CDC, “Surveillance for Waterborne Disease and Outbreaks Associated with Recreational Water—United States 2003–2004,” Morbidity and Mortality Weekly Report, Surveillance Summaries, December 22, 2006). It is important to note that a single outbreak has the potential to make thousands of people sick. Also, RWI diseases carry a risk of fatality for small children, the elderly and immunocompromised people. Moreover, it is likely that many other infections are acquired by exposure to contaminated pool water but are never recognized as being linked to that source.

Number of recreational water-associated outbreaks (n=62) in the United States, 2003-2004



* Note: these numbers are largely dependent on reporting and surveillance activities in individual states and do not necessarily indicate the true incidence in a given state.

‡ Guam also reported on recreational water-associated outbreak in 2004.

Cryptosporidium: **The Leading Cause of RWI Diseases**

Cryptosporidium, *E. coli*, *Giardia*, *Shigella* and *Pseudomonas* are just some of the contaminants present in pool water that can lead to an RWI outbreak. Most of these germs are killed by the proper use of chlorine and correct water balance, but some, such as *Cryptosporidium*, are highly chlorine resistant and require other means of treatment and prevention.

According to the CDC, *Cryptosporidium* is by far the leading cause of RWI outbreaks (“Preventing Recreational Water Illness Outbreaks,” *Recreation Management Magazine*, July 2006). From 2003 to 2004, *Cryptosporidium* was responsible for the largest number of RWI outbreaks, of which 99.97 percent were associated with chlorine-treated water facilities (CDC, Morbidity and Mortality Weekly Report, Surveillance Summaries, December 22, 2006). From 2004 to 2005, the CDC tracked a 111.4 percent increase in cryptosporidiosis cases in the United States (CDC, Morbidity and Mortality Weekly Report, Surveillance Summaries, September 7, 2007).

Cryptosporidium Defined

Cryptosporidium, commonly referred to as Crypto, is very difficult to detect and destroy. Crypto is a highly chlorine-resistant parasite that can be introduced



Cryptosporidium emerging from an oocyst

into swimming pool water from swimmers who release fecal material. Because it is transmitted through water in the form of a tough, microscopic, infectious stage—the oocyst—protected by a thick outer shell, Crypto can remain viable in properly chlorinated water for six to seven days.

When it is present in pool water swallowed by swimmers, Crypto can cause severe symptoms, such as diarrhea, stomach cramps, fever, nausea and vomiting, that usually last for a week and a half but can last for several weeks. In some people, a trickle of parasites continues to be shed in feces for months after an episode of disease.

Risk of Cryptosporidium Infection

Crypto is present in from 1 to 4 percent of the total population of North America (“*Cryptosporidium*,” Part 1, San Francisco Public Utilities Commission, September 26, 2006). This means that more than 12 million people in the United States alone could be carriers of Crypto. And according to microbiology studies at Arizona State University (Charles Gerba, PhD, “Preventing Waterborne Disease in Hot Water,” audio presentation, APSP 1999), even a clean, showered swimmer can introduce 0.1 gram of fecal material into pool water.

Recent studies conducted by the U.S. Environmental Protection Agency (EPA) have shown that the average adult swimmer swallows up to 1 ounce of water when swimming (“Water Ingestion During Swimming Activities in a Pool: A Pilot Study,” *Journal of Water and Health*, April 4, 2006). Children usually swallow twice that amount.

- One Crypto diarrhea “release” puts five oocysts per milliliter in pool water.
- For a 55,000-gallon pool, there would be about 20,000 oocysts per gallon.
- An infectious dose is probably in the range of 10 to 30 oocysts for adults (volunteer studies).
- Conclusion: an adult may take in about five infectious doses per swim.

With the possibility of billions of chlorine-resistant Crypto cysts present in pool water, it is easy to see how swimmers can become infected: one serious fecal accident can lead to almost every mouthful of water containing a fully infectious dose of the parasite.

What’s more, since the Crypto oocyst remains infectious in the water for six to seven days, pools with a high bather load always present a risk for potential outbreak, especially after the season is in full swing and the numbers of Crypto cysts in the water have risen to dangerous levels.

History of *Cryptosporidium*

The first human cases of *Cryptosporidium* infection were reported in 1976. The first reported outbreak of waterborne Crypto was in Texas in 1984. The most recent large outbreak occurred in the summer of 2005 at a spray park in New York. The outbreak infected as many as 4,000 people and spread to 36 New York counties, 26 states and two countries.

The summer of 2007 was one of the worst for outbreaks. Google news alerts reported 14 outbreaks between mid-July and late August 2007. The worst of these outbreaks occurred in the state of Utah. The Utah Department of Health declared pools in eight of the state’s counties off-limits to children under age 5 due to a diarrhea outbreak caused by *Cryptosporidium*. By the end of August 2007, there were 422 confirmed Crypto cases in the state of Utah alone, about 400 more than normal for the year. By mid-September the number had risen to more than 1,600 confirmed cases.

Risk of Crypto to Swimmers

- On average, adult swimmers swallow 1 ounce of pool water per swim, and children typically swallow twice that amount.
- Even clean, showered swimmers introduce fecal matter, which can contain Crypto.
- Crypto is prevalent in 1 to 4 percent of the total population. This equates to between 3 and 12 million people in the United States shedding oocysts.
- Since chlorine doesn’t effectively kill Crypto oocysts, and sand beds don’t efficiently remove them, cyst numbers can continually build up in the pool’s water throughout the season.

Options for the Prevention of RWIs

Chlorine Sanitizer

One of the most effective tools in preventing swimmer illness is still good, old-fashioned chlorine sanitizer.

When chlorine sanitizer is used against contaminants in pool water, varying periods of exposure—known as contact times—are needed to kill disease-causing microbes, depending on their chlorine sensitivity and the concentration of sanitizer in the water. The product of concentration (C) and time (T) that results in death (usually 99.9 percent) is a characteristic indicator of susceptibility of microbes and is called the CT value. A higher number, then, indicates more resistance, as either more time or more sanitizer is needed to reach the inactivation standard.

For example, *Giardia* has a CT value of 45. This means that a *Giardia* protozoan is inactivated to the level of 99.9% within 45 minutes of contact with pool water that is carrying a 1 part per million (ppm) residual of chlorine.

By contrast, Crypto has a contact time value of 9,600 (6.7 days), meaning it remains active for a week or longer in normally chlorinated pools. If a pool's chlorine is not maintained at 1 ppm or greater, the contact time required to kill Crypto increases.

As you can see, proper chlorine sanitization is merely the first step in protecting swimmers from the risk of RWIs.

Note: While residential pools and spas are not subject to the same health department regulations as public facilities are, they run the same risk of contamination from swimmers. Therefore, maintaining a proper level of chlorine sanitizer is just as important.

Maintaining Proper Water Chemistry

Maintaining proper water chemistry is vital in preventing an RWI outbreak. Water balance, pH, total alkalinity, calcium hardness and total dissolved solids (TDS) must all be kept within appropriate limits, in accordance with proper health department regulations, or the sanitizer's effectiveness against RWI diseases is decreased.

Dilution

Regular dilution of the pool water is another method for reducing the risk of RWI in pools. European regulations suggest the entire pool volume should be replaced over each 30-day period, by a routine of daily drawdown of a portion of the pool combined with fresh water replacement. This practice substantially reduces the buildup of organic chloramines and other organic material from swimmers. In some areas, particularly during times of drought, this method may not be practical.

Ozone

Ozone is a stronger oxidizer than chlorine or bromine and is able to destroy *E. coli* bacteria 25 times faster than hypochlorous acid (the killing agent of chlorine). Numerous data show ozone's effectiveness against *Cryptosporidium*; however, the ability of ozone to completely eradicate Crypto from pool water is strictly contingent upon concentration and contact time, and since the ozone contributes little or no residual to the water, the radiation has to happen very fast. That is, high concentrations of ozone are needed for there to be useful effectiveness.

Ultraviolet generators of ozone are not effective due to the low sanitizer output of these units. Corona discharge units that put out concentrations of 1 to 2 percent (dried-air units) or 3 to 5 percent (oxygen-enriched units) are recommended for producing effective amounts of measurable ozone. The proper level of ozone must be held for several minutes at a time to be effective. Since ozone is highly unstable and degrades within 22 minutes, it can be difficult to ensure that the proper contact time and measurable residual are sufficient to destroy all Crypto cysts.

UV

The use of ultraviolet (UV) light for disinfection and the reduction of Crypto cysts is becoming more prevalent. For example, the New York State Department of Health recently mandated the use of UV units for the treatment of water in all spray parks.

While UV can be an effective method of protection, its efficacy depends upon controlling the pool's turbidity and keeping the water clear enough for the UV rays to penetrate the flow of water. High turbidity in public facilities is a constant challenge due to high bather load. An effective flocculant system, such as **SeaKlear® PRS**, should therefore be used in conjunction with UV systems to properly control turbidity and ensure the success of UV in destroying Crypto.

Oxidation

Both chlorine and bromine are known as halogens. This simply means that they are sanitizers formed from the activation of these elements in salts (chlorides and bromides) and the end products of their actions on microbes and other organic substances are salts. A unique aspect of chlorine and bromine is that they act as both sanitizers and oxidizers.

The difference between a sanitizer and an oxidizer is that one kills, while the other oxidizes nonliving waste. Both of these actions are vital to water quality. When chlorine or bromine is introduced into water that is high in contaminant waste, up to 70 percent of the chemical can be consumed oxidizing organic waste. In spas this figure can be as high as 85 percent ("Ozone for Residential Swimming Pools and Spas," *Water Conditioning & Purification Magazine*, December 2004).

Chlorine or bromine can be readily consumed in oxidation when there are high amounts of oil from bathers and sunscreen, and other contaminants, such as skin cells, leaves, wind-borne dust, etc. When sanitizers are consumed in oxidation, very little is left behind for the sanitizing of bacteria and the destruction of other

pathogenic contaminants. This is what makes pool hygiene so challenging to maintain, and why so many pools end up without adequate levels of sanitizer in them, once the bather load gets high.

Circulation

This is the heartbeat of any properly functioning aquatic system. Without good circulation, the overall system is subject to a greater risk of algae growth or the persistence of disease-causing organisms. A majority of contamination is at the surface of the water, so effective skimming action is vital.

Obviously, the main component of a good circulation system is the pump. It is important that the pump be appropriately sized for the filtration equipment to ensure good water flow and effective removal of contaminants through the filter.

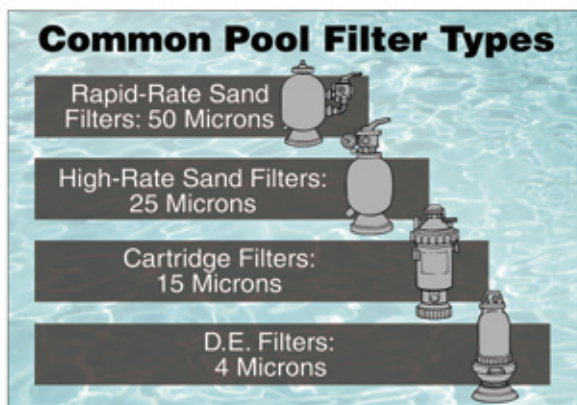
As pressure builds in filters, the flow rate through the medium is reduced. Weak flow rate leads to dead spots in the pool, reduced effectiveness of sanitation, insufficient oxidation and fewer filtration turnovers of the water. Regular backwashing, filter cleaning, and maintenance of pump seals and valves are all critical.

The use of an effective flocculant, such as **SeaKlear PRS**, enhances the filter's trapping efficiency, thus improving overall circulation.

Filtration

Filters are designed to remove suspended particulate matter to ensure cleansing and clarity of the water. Pool, spa and hot tub filters vary with regard to the size ranges of the particulate materials they are capable of removing. The following graphic identifies the capabilities of common filters, in terms of the limiting size, in microns, of the particles that they can remove.

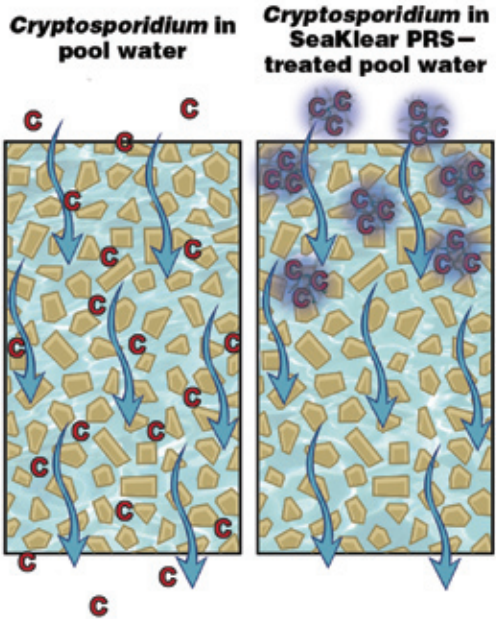
Most public aquatic facilities currently use sand filters as their primary means of filtration. A survey of water park owners conducted by *Aquatics International* showed 83 percent of respondents use sand filtration in their facility ("2006 Water Park Survey" *Aquatics International*, September 2006).



Crypto cysts are approximately 2 to 6 microns in size, depending on the strain, and can easily pass through most sand filters. Even in diatomaceous earth (D.E.) filters, which pick up material as small as 2 microns, Crypto cysts are flexible and can elongate and pass through the filter media pores. Use of **SeaKlear PRS** leads to stable flocs that are large enough to become entrapped in the filter media. This increases the filter's ability to trap particles that are as small as 0.5 microns.

Swimmer Behavior & Facility Cleanliness

Swimming behavior is another vital component of pool operation. Swimming is really communal bathing, so when sick people enter the pool and continue to swim while ill, the risk of an RWI outbreak is heightened.



When added to the pool water, **SeaKlear PRS** gathers Crypto into large, stable flocs that can then be removed by the filter.

Maintenance Practices That Can Help Reduce Crypto

- Proper sanitizer levels
- Correct water chemistry balance
- Regular system of water dilution
- Ozone
- UV
- Regular oxidation
- Good circulation
- Properly sized and maintained pumps and filters
- Appropriate hygienic swimmer behavior
- Enhanced filtration using an EPA-approved flocculant such as **SeaKlear PRS**

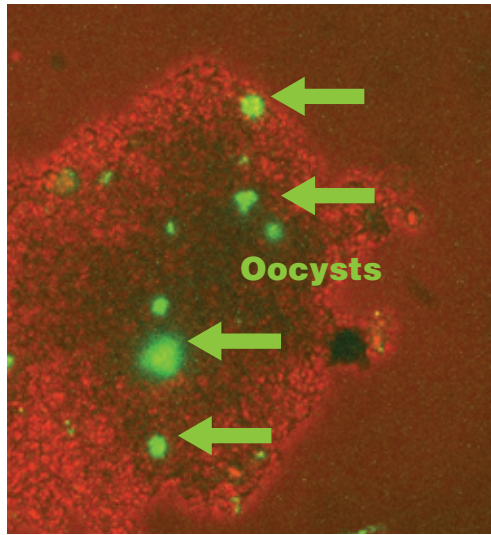
Improved facility hygiene is essential to ensure the cleanliness of swimmers entering pools. Clean restroom facilities and showers that provide hot water and soap are paramount. Swimmers should be encouraged to shower thoroughly (washing the area between the legs in particular) before entering the pool. Clean diaper-changing stations and hand-washing stations should be available to patrons. Signs should be placed in locker rooms and restrooms that educate swimmers about the risk involved if they swim when they are sick with diarrhea.

Enhanced Filtration

Another viable preventive method that any facility or pool operator can implement immediately is enhanced filtration with an EPA-approved flocculant. The CDC, along with many aquatic experts, has long promoted the concept of filter enhancement with the use of specialty clarifiers as an appropriate preventive measure. The technology in **SeaKlear PRS** depends upon two complementary biopolymers that, used in the right proportions and molecular forms, lead quickly to the formation of stable flocs and the effective entrapment of microorganisms such as algae, *E. coli*, *Giardia* and *Cryptosporidium* in standard-depth filter media.

This approach has been convincingly established through independent studies conducted at Auburn University and reported at the World Aquatic Health Conference in 2005 (Dr. Jennifer Spencer, "Flocculant-Polymer Combinations for Enhanced Removal of *Cryptosporidium* Cysts and Other Disease-Causing Agents with Conventional Filters"). The studies showed very stable flocs of Crypto were formed and trapped in sand filter media.

A recent presentation at the 2006 World Aquatic Health Conference, on work conducted at UNC Charlotte, showed a 99.99 percent removal of Crypto from pool water treated with the two-stage polymer system with the use of normal sand filtration media (James Amburgey, PhD, "*Cryptosporidium* Removal from Swimming Pools by Sand Filters").



Large floccules of Crypto oocysts formed after SeaKlear PRS treatment of suspension

In other presentations at the 2004 World Aquatic Health Conference, the CDC recommended enhanced filtration using clarifiers as an appropriate means of helping to reduce the risk of Crypto outbreaks (Dr. Michael Beach, "Recreational Water Illness Outbreaks and Lessons Learned"; Dr. Joan M. Shields, "Research Advances on the Inactivation of Chlorine-Resistant Pathogens like *Cryptosporidium*").



Enhanced Filtration with SeaKlear PRS

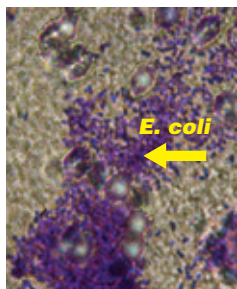
SeaKlear PRS is the only patented, EPA-approved technology that enhances filter entrapment of suspended Crypto in pools, spas and hot tubs. The treatment results in flocculation of both organic and inorganic particles down to 0.5 microns and makes them rapidly filterable without causing the filter system to clog.

SeaKlear PRS also provides superior turbidity reduction during peak bather load and quick recovery of standard water clarity after heavy use. Water clarity is important for disease outbreak prevention and swimmer safety. According to an EPA report, high turbidity can mean more disease agents are present (*Importance of Turbidity EPA Guidance Manual*, April 1999). This same report went on to say, "The particles of turbidity provide 'shelter' for microbes by reducing their exposure to attack by disinfectants."

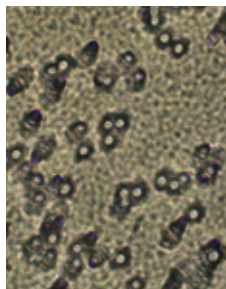
SeaKlear PRS is an advanced, two-stage biodegradable polymer system that effectively:

- Traps live and dead algae, *E. coli*, *Cryptosporidium* and *Giardia* in the pool's filter
- Reduces turbidity by flocculating and then enabling the trapping of particles as small as 0.5 microns
- Removes oil droplets from suspension better than the leading enzyme product does

Membrane filtration of *E. coli* after SeaKlear PRS treatment



SeaKlear PRS treated
E. coli suspension



Control membrane

Filterable flocs containing *Giardia* cysts



SeaKlear PRS is the only natural two-stage clarifier approved by the EPA for enhanced trapping of *Cryptosporidium*, algae, *E. coli* and *Giardia* in standard

swimming pool filter media. **SeaKlear PRS** is a filter enhancement product and is *not* a disinfectant. Correct water balance and sanitizer level, as recommended by local health agencies, must be maintained at all times.

Proven features and benefits of **SeaKlear PRS**:

- **SeaKlear PRS** effectively flocs oils and other inanimate particles measuring in the submicron range.
- **SeaKlear PRS** effectively flocs biological agents such as *E. coli*, algae, *Cryptosporidium*, *Giardia* and other contaminants in pool water after accidental fecal releases (AFRs).*

SeaKlear PRS effectively flocs live algae:

- Sand beds and other filter media will trap stable flocs for backwash removal.
- **SeaKlear PRS** biopolymers are safe, biodegradable (food grade) and potent (at parts per billion), and they pose no health risks for bathers.
- **SeaKlear PRS** water treatment is well suited for:
 - Enhancing pool water clarity.
 - A prophylactic approach to Crypto treatment.
 - Remediating pool water after AFR contamination.
 - Improving efficacy of UV sanitation measures for RWI prevention.



Additional benefits from **SeaKlear PRS**:

- Lower demand for manual removal of oil scum residues—efficient removal of suspended oil by filter
- Longer filter life—flocs remain near the surface of the medium for easier backwash and less fouling of the medium bed
- Lower demand for additives—effective filtration of algae
- No need for any other clarifier or additives

Accolades for **SeaKlear PRS**:

- EPA-approved for trapping of Crypto
- Tested and approved to National Science Foundation (NSF) 60 standards
- Water Quality Association (WQA) Gold Seal Certification
- Readers' Choice Award, *Pool & Spa News*, 2007
- *Aquatics International* Most Valuable Products Award, 2007



*SeaKlear PRS may be used along with the recommended AFR response from your local health agency or CDC.

Application

SeaKlear PRS consists of two proprietary, water-soluble, biodegradable, natural, food-grade polymers. When these polymers work simultaneously in the pool system, they create a powerful clarifier action in the water to trap live algae, *E. coli*, *Giardia* and *Cryptosporidium*. **SeaKlear PRS** also works to keep turbidity levels down even at times of peak bather load. This new technology is proven to be effective and reliable at keeping heavily used pools in pristine condition, improving overall water quality. Effective removal of *E. coli* from the water by enhancing filtration offers an additional means of removing *E. coli* and protozoa at times when the chlorine levels may have fallen below the required standard.

To ensure the best performance, **SeaKlear PRS Stage 1** must always be added before **SeaKlear PRS Stage 2**. A good practice is to start with **SeaKlear PRS Stage 1** early in the day, and then add **SeaKlear PRS Stage 2** in the afternoon or evening. **SeaKlear PRS** can be added to the pool water manually, or mechanically through the use of a metered pump that is set up on a timer. (Metered pump types will be covered in “ORP & the Role of Enhanced Filtration,” below.)

Dosage Rates

- **SeaKlear PRS Stage 1:** 1 ounce per 5,000 gallons
- **SeaKlear PRS Stage 2:** 1 ounce per 5,000 gallons added at least four hours after **SeaKlear PRS Stage 1**

When initially applying **SeaKlear PRS** or in cases of high turbidity, the dose for **SeaKlear PRS Stage 1** and **SeaKlear PRS Stage 2** should be tripled, but the proportion of **SeaKlear PRS Stage 1** to **SeaKlear PRS Stage 2** must always be maintained.

ORP & the Role of Enhanced Filtration

Many commercial facilities are using automated systems to standardize their chemical treatments as well as improve operator efficiency. Most automated systems use oxidation-reduction potential (ORP) or redox to measure the effectiveness of the sanitizer in the water.

Most health codes that address ORP state that a minimum level of 650 millivolts must be maintained at all times. However, because some codes only refer to parts per million levels, operators need to log both millivolts and parts per million. In addition, pH levels are often monitored and controlled.

Despite the different methods of measurement that operators are required to work with, it is clear that automated systems highly improve an operator's ability to maintain sanitizer effectiveness, preserve vessels and equipment, and better ensure bather comfort and healthy water.

For years, only larger commercial facilities invested in automation. Training and experience, however, are leading today's facility operators to understand the liability risks of having an outbreak of RWI.

While an automation system improves an operator's ability to maintain chemical

levels throughout the day, it is not self-sustaining and requires operator attention. Proper maintenance of a commercial pool also requires manually checking the chemical levels to verify calibration, oversee the operation of the filtration system and monitor potential safety hazards.

SeaKlear PRS, like automation, helps operators be more efficient. The automated systems help maintain chemical balances—higher-end systems even help with auto-backwashing—yet the filter system can only work as efficiently as the medium allows. **SeaKlear PRS** is engineered to enhance standard pool and spa filtration by trapping particles as small as 0.5 microns in size, making them into larger flocs that can be removed by the filter.

The best filters in the swimming pool market today can only filter particles larger than those in the 2- to 4-micron range.

Troubleshooting

Q: When SeaKlear PRS Stage 1 is added, my ORP drops 10 to 20 mv. Why?

A: The chlorine atoms will attach to the polymer when it is first added to the water. Because only a certain number of atoms can attach to the polymer, the ORP level will not continue to drop beyond the initial decline. Do not adjust your controllers to a lower set point; just allow the system to operate as normal. The oils that are introduced to most commercial pools on a regular basis are encapsulated in the **SeaKlear PRS** polymers, flocced to the filter and then removed through backwashing. Therefore, the amount of chlorine normally necessary to oxidize those oils can become available to kill pathogens or perform more important oxidizing needs.

Q: When I add SeaKlear PRS, why do I get an initial increase in the back pressure in the filter?

A: Some pool filter systems will show an initial, temporary increase in pressure due to the greater number of particles now arriving at the filter that can be trapped. In practice, noticeable pressure increases have not been seen after the first backwash, however. The new flocs along with oils embedded in the filter prior to treatment can now be removed during the backwash cycle to help reduce the flow pressure. These embedded oils slightly improve micron efficiency but hurt the flow rate. Removing the oils improves the turnover rates, which in turn helps eliminate “dead spots,” increases chemical uniformity throughout the entire body of water, and potentially reduces the demand on the chemical sanitizer.



Appendix A: Effectiveness Graphs

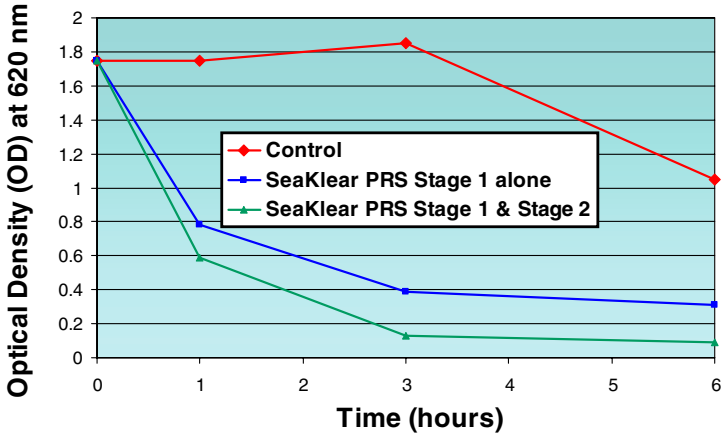


Figure 1: Flocculation of *E. coli* bacteria from suspension in water by *SeaKlear PRS*.

Particle Population Size Shift

The following charts show the effectiveness of **SeaKlear PRS** for gathering and removing submicron materials from swimming pool water to the filter. Particle population size shift is a means of showing that a majority of very small micron particles are made larger. The charts show that after the use of **SeaKlear PRS**, there is a significant shift from the submicron range into particles that are filterable. **SeaKlear PRS** is equally effective on both bentonite clay (dust) particles and oil droplets.

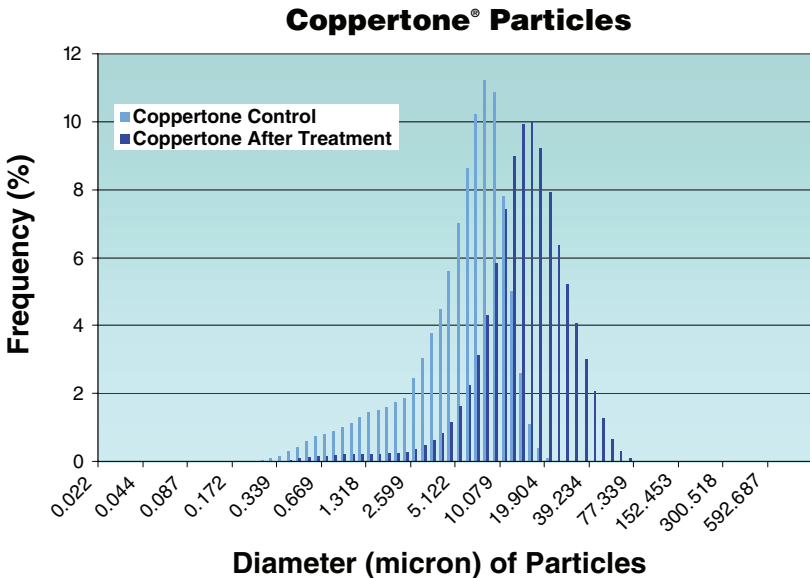


Figure 2: Biopolymer flocculation of Coppertone particles in pool water.

Bentonite Particles

SeaKlear PRS is also effective at removing small dirt particles and organic material that can consume chlorine and cause nuisance chloramines, which are responsible for odors and irritation to swimmers.

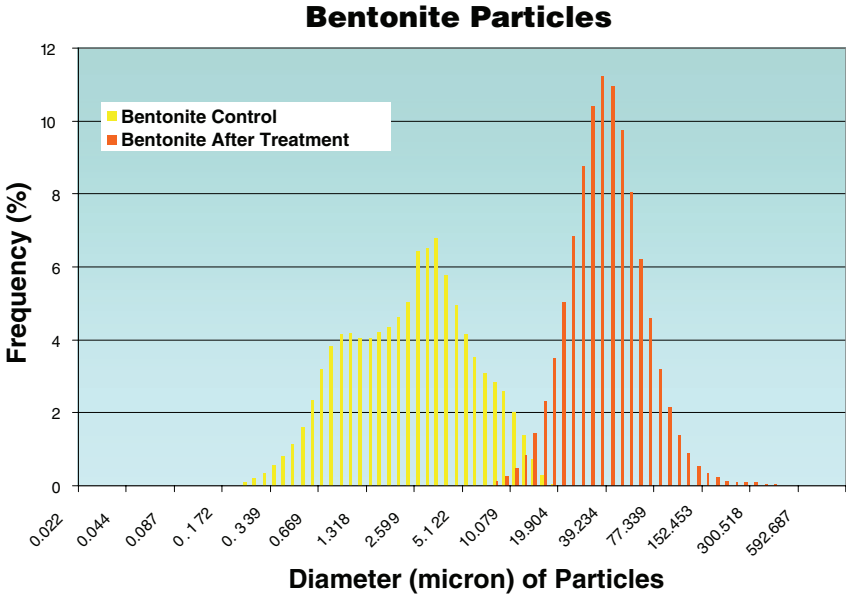


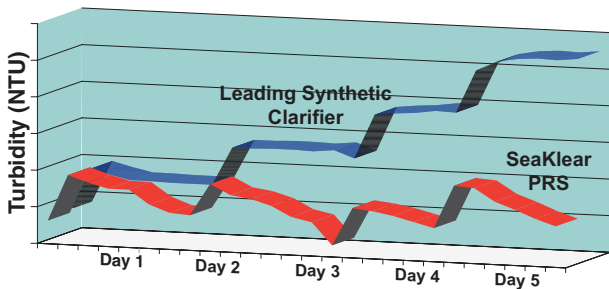
Figure 3: SeaKlear PRS shifts particle size from nonfilterable to filterable, resulting in continually clear water.

Superior Turbidity Reduction

In comparison to the leading one-stage clarifier, SeaKlear PRS is highly superior at removing oils and reducing turbidity. The leading petroleum-based clarifiers actually cause turbidity levels to climb. This is mainly because petroleum-based clarifiers cannot remove oils and can combine with dirt to form even more scum and oil. Studies show that advanced biopolymer systems, such as SeaKlear PRS, have several advantages over current synthetic clarifiers.

Turbidity Levels

SeaKlear PRS vs. Leading Synthetic Clarifier, Acting on a Daily Simulated Bather Load



Sand Filter Systems Suntan Lotion Experiments SeaKlear PRS vs. Leading Enzyme Product

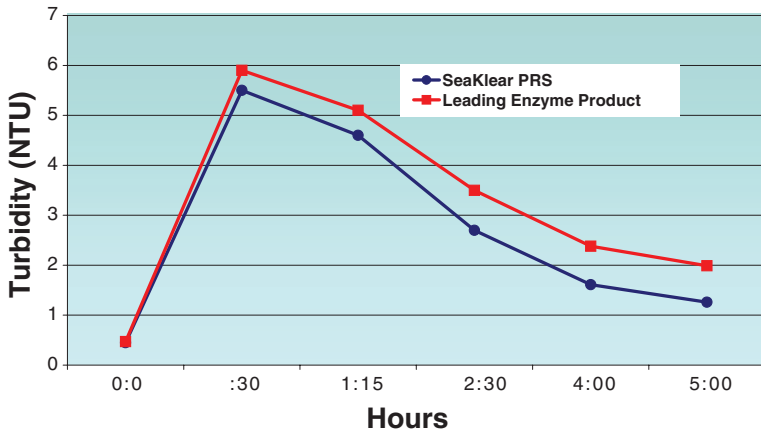


Figure 4: SeaKlear PRS also outperforms the leading enzyme products.

Appendix B: Field Tests and Testimonials

Fairwood Golf & Country Club

Fairwood Golf & Country Club is located outside Seattle, Wash. The chart below shows turbidity levels in Fairwood's 155,000-gallon pool during a three-week period in July 2005.

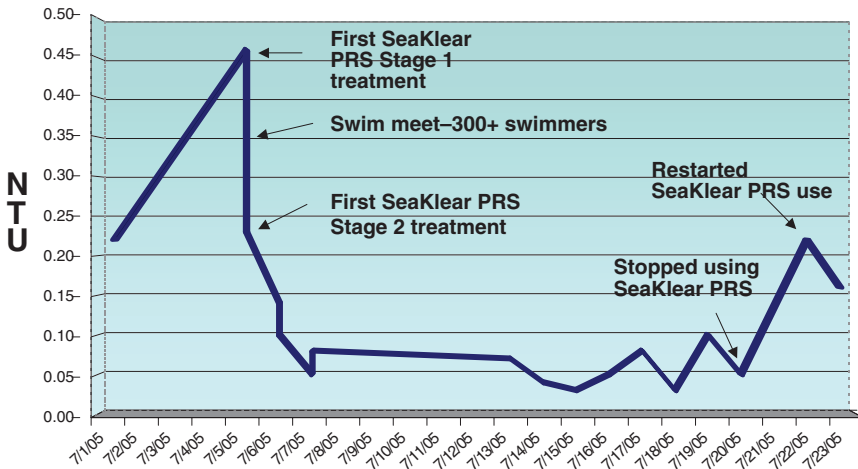


Figure 5: Regular dosages of SeaKlear PRS lower turbidity and keep it down even during peak bather loads.

First, Fairwood treated its pool with **SeaKlear PRS Stage 1**. A swim meet was

held six hours after the initial **SeaKlear PRS Stage 1** treatment. The bather load during the swim meet was approximately 300 swimmers over a three-hour period. After the swim meet, the pool was treated with **SeaKlear PRS Stage 2**.

The pool was treated daily with **SeaKlear PRS** for eight days and then treated twice a week for two weeks.

“We have seen remarkable results with **SeaKlear PRS**. Not only with water clarity, but with the overall function of our sand filters. We are backwashing less, and the pool has never looked so good,” said Aaron Whittecar, Fairwood Golf & Country Club Facility Maintenance Manager.

Keller Independent School District Natatorium

The Keller Independent School District Natatorium (KISDN) started using **SeaKlear PRS** in April 2007 as part of a closely monitored field study. During the study, the pool was initially dosed with **SeaKlear PRS Stage 1** and **SeaKlear PRS Stage 2** on a daily basis for a two-week period and then once per week for six months. Data collected from this study showed a particle shift from smaller to larger particles during the initial daily treatment. The shift became more dramatic with long-term use. This shift in particle size demonstrates the capabilities of **SeaKlear PRS** to floc small, submicron-sized particles into larger clumps that can then be removed by the filter.

Keller at a Glance

Facility:	Keller Independent School District Natatorium
Facility Manager:	Lee Feris
Location:	Keller, Texas
Gallons:	860,000
Dosage:	1.34 gallons each of SeaKlear PRS Stage 1 and SeaKlear PRS Stage 2 per week
Bather Load:	600–800 swimmers daily
Current System:	Chlorine and SeaKlear PRS
Cost to Implement SeaKlear PRS:	\$1,200-\$2,500
Estimated Cost for Alternate UV:	\$50,000-\$100,000
Estimated UV Maintenance Cost:	\$20,000 per 10,000 hours of use
Annual Cost of SeaKlear PRS:	\$5,000-\$6,000

Not only did the scientific findings support the product’s claims of enhanced filtration, but the facility manager, Lee Feris, also noticed the difference. Prior to using **SeaKlear PRS**, the KISDN facility had been on chlorine and filtration. Feris was interested in adding **SeaKlear PRS** to enhance filtration of Crypto and other RWIs. Feris said that **SeaKlear PRS** was appealing because, unlike other options, “**SeaKlear PRS** naturally uses the filter to remove contaminants from the pool instead of circulating them back in.”

Feris' initial concern was disease control and outbreak prevention. He had long questioned the efficiency of chlorine alone, asking, "When does chlorine become ineffective and has it always been this way?" Feris said he quickly did the math on adding **SeaKlear PRS** to his weekly maintenance and figured with the added drop in clarifier cost, he couldn't afford not to.

Feris has continued to use **SeaKlear PRS** at the KISDN facility for RWI prevention but notes improved water quality as an added benefit. Since starting the treatment in March 2007, Feris, along with his patrons, has noticed a difference in water clarity.

"We have had people comment expressly on the cleanliness of the pool and its appearance. Patrons comment on the quality of our water all the time," he said.



Photo courtesy of Brinkley Sargent Architects/Charles Davis Smith, AIA Photographer

Although improved water clarity is important to any public pool facility, Feris says his primary concern is always for the health and safety of his swimmers.

"There is always a need for safer, cleaner water. Unfortunately people don't see the big picture in being proactive," he said. "We have to start taking a proactive approach to the running and management of pools. Times are changing, and everyone will be forced to get onboard... It's not only time, but past time."

There is no doubt that the war against RWIs is far from over, but at least advances in the recreational water industry are being made to combat this ever-elusive enemy. Whether using **SeaKlear PRS** or any other system, the best approach is to incorporate these key elements: prevention, awareness and layered protection.

As this example shows, **SeaKlear PRS** is best used as an added layer to improve current facility methods. For more information on the results of this study or other testimonials please contact SeaKlear directly.

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