



## Innovative Solutions to Global Water Shortages

### CURRENT LIST & BRIEF DESCRIPTION OF U.S. AND INTERNATIONAL PATENTS

The 13 granted Canadian, U.S. and International patents include:

1. **Canadian Patent 2,186,963 (1999):** A comprehensive Canadian patent that contains 75 claims that represent 12 different processes that treats surface water, brackish (well water) and city water and produces RO product water that can be used by industry for boilers, production, cooling tower make-up, etc., as well as capability to produce demineralized water for pharmaceuticals and electronic industry. The patent employs both a single stage RO (i.e. PT-RO-IX or PT-RO-CP where PT is pretreatment and CP is chemical precipitation softening) and a 2-stage RO membrane system (i.e. PT-RO-RO-IX or PT-RO-RO-CP). The process may also deploy a polishing RO and ion exchange if it is desired to produce ultrapure water for pharmaceutical, electronics industry or power generation, while also maintaining high recovery. This was the first comprehensive high recovery patent since all these processes can produce product water at recoveries in the range 90-99%, i.e. A waste as low as 1-2%, compared to typical 25-40% waste.
2. **U.S. Patent 6,113,797 (2000):** A comprehensive U.S. patent based on the Canadian Patent in 1 above, that contains 40 claims that represent 8 different processes using 2-stage RO membrane systems and achieves 90-99% RO product recovery from surface water, brackish (well water) and city water. As in the Canadian patent, this U.S. Patent (i.e. PT-RO-RO-IX or PT-RO-RO-CP) produces RO product water that can be used by industry for boilers, chemical and cosmetic product manufacturing (e.g. Tanner Industries), cooling tower make-up (Colgate Palmolive), etc., as well as capability to produce demineralized water for pharmaceuticals and electronic industry.
3. **U.S. Patent 6,416,668 (2002):** A comprehensive process patent that teaches novel pretreatment methods tailored to prepare contaminated surface water and brackish water containing colloidal matter for fine filtration through inexpensive spirally-wound microfiltration, ultrafiltration, nanofiltration and reverse osmosis membranes (i.e. PT-SPMF, PT-SPUF, PT-SPNF or PT-SPRO) thus producing clean potable water or NF or RO permeate at low cost. The patent includes 49 claims and four process configurations.
4. **U.S. Patent 6,461,514 (2002):** A simple, low cost single-stage high recovery RO U.S. patent based on the Canadian Patent in 1 above, that contains 16 claims that represent 4 different processes and achieves 90-99% RO product recovery from surface water, brackish (well water) and city water. As in the Canadian patent, this U.S. Patent (i.e. P-RO-IX or PT-RO-CP) produces RO product water that can be used by industry for boilers, chemical and cosmetic product manufacturing (e.g. Tanner Industries), cooling tower make-up (Colgate Palmolive), etc., as well as capability to produce demineralized water for pharmaceuticals and electronic industry.
5. **U.S. Patent 7,981,295 (2011):** The first of three strong high recovery wastewater treatment U.S. Patents that can treat and reclaim industrial and municipal effluents and achieve more than 95% recovery of recycled high quality water. It uses RO, CP, IX and RO in a unique configuration (RO-CP-IX-RO). In the U.S. PTO, it is difficult to get the Examiner to examine several different process configurations, so the Examiner splits the Claims into several "Divisional Patents". This granted patent includes three unique claims that represent two process configurations.

6. **U.S. Patent 8,241,503 (2012):** The second of three strong high recovery wastewater treatment Divisional U.S. Patents that can treat and reclaim industrial effluents, in this case uniquely suited to cooling tower blowdown waste, and achieve more than 95% recovery of recycled high quality water. It uses RO, CP, IX and RO in a unique configuration (CP-RO-IX-RO) to achieve very high recovery of good quality water from wastewater.
7. **U.S. Patent 8,506,817 (2013):** The last of three strong high recovery wastewater treatment Divisional U.S. Patents that can treat and reclaim industrial effluents, in this case tailored to treat biologically or organically contaminated wastewater and achieve more than 95% recovery of recycled high quality water. It uses RO, CP, IX and RO in another unique configuration (PT-CP-IX-RO) to achieve very high recovery of good quality water from wastewater.
8. **U.S. Patent 8,679,347 B2 (2014):** This patent teaches a versatile multi-use high water recovery process that integrates pretreatment, RO or NF membranes and ion exchange resins in several novel configurations that are selectively deployed depending on the raw water quality. The net result is process flexibility and easy customization to enable treatment of different raw water sources. This unique design also enables reuse of RO reject (brine) to regenerate the IX resin, thus ensuring a minimum waste while reducing use of chemicals. This patented design can be fabricated such that it fits inside a 20-ft mobile ISO Container that can be readily transported to the treatment site and easily connected to the raw water source, which can be surface, water, ground water, brackish water or wastewater, thereby producing good quality drinking water or purified water for process use, in a timely and cost-effective manner. This design comprises several configurations including: PT-RO, PT-IX-RO, PT-IX-RO-IX, PT-NF-IX, etc., where PT is pretreatment which can include simple, fine media filtration and antiscalant addition and/or MBR plus antiscalant addition.
9. **U.S. Patent 9,199,866 B2 (Dec. 1, 2015)** This High Water Recovery Drinking Water Process patent has been granted recently by the U.S. patent office (Dec. 2015) and is pending in Canada. This patent addresses the design of a purified water system that operates at high recoveries in the range 90% to 99%, resulting in minimum waste to drain, while prolonging the service life of the RO or NF membranes and a minimum use of chemicals.

A 1-gpm high recovery whole home drinking water system installed at a private residence in Ontario, Canada since November 2011. The system has maintained constant RO membrane flux during the past 8-9 years, operating in the permeate recovery range: 95%-97%, with no membrane replacement or cleaning and a minimum of chemical use.

This patented high recovery whole home drinking water RO process is currently being marketed as **ZERO** Drinking Water system with Trademark: **ZDW-RO**<sup>™</sup>


#### **International Patents:**

1. **Chinese Patent CN ZL201080036024.2 (2014):** This is a comprehensive wastewater high recovery patent that was granted by the Chinese Patent Office. It consists of 15 different wastewater process configurations and 17 Claims that teach treatment of different wastewater types, including but not limited to the processes granted under U.S. Patents 7,981,295, 8,241,503 and 8,506,817.
2. **Singapore Patent 178,334 (2014):** This is identical to the Chinese Patent, a comprehensive wastewater high recovery patent that includes 15 different wastewater process configurations and 17


Claims, teaching treatment of different wastewater types, including but not limited to the processes granted under U.S. Patents 7,981,295, 8,241,503 and 8,506,817.

3. **Mexican Patent Application MX/a/2012/001949 (2014):** This is also identical to the Chinese Patent, a comprehensive wastewater high recovery patent that includes 15 different wastewater process configurations and 17 Claims, teaching treatment of different wastewater types, including but not limited to the processes granted under U.S. Patents 7,981,295, 8,241,503 and 8,506,817. This patent has been allowed and is awaiting issue.
4. **Chinese Patent CN 103827043 B (Feb. 24, 2016):** This patent is based on U.S. Patent 9,199,866 B2 (Dec. 1, 2015) and teaches a High Water Recovery Drinking Water Process patent that purifies water and achieves high recoveries in the range 90% to 99%, resulting in minimum waste to drain, while prolonging the service life of the RO or NF membranes and uses a minimum of chemicals.

#### **TRADE MARKS (PUBLISHED, REGISTERED AND PENDING APPLICATIONS AT USPTO)**

1.  Advanced Water Solutions trademark approved and published in Trademark Official Gazette (OG) in June 2012. Serial No.: 85-195,345.
2. **ARROW**<sup>®</sup> approved and published in Trademark Official Gazette (OG) on Nov. 22, 2011. Serial Number: 85-195,414. Notice of Registration issued on Sept. 7, 2012.
3. **ZERO**<sup>®</sup> approved and published in Trademark Official Gazette (OG) on Dec. 13, 2011. Serial Number: 85-195,467. Notice of Allowance issued on Feb. 7, 2012.
4. **ZDW-RO**<sup>™</sup> Trademark application is in progress. Serial Number: 85-504,120  
No objections other than to clarify description of Goods/Services.

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