Environmental Services
Spotlight On:

Water Management Page 10

Water is a finite resource and rapidly shrinking in usable supply as the effects of population growth, urbanization, industrialization, and climate change limit access to safe and reliable water sources. Formidable challenges present opportunities in water treatment, water management, and water infrastructure, each of which are drivers of secular growth in the water industry.

In a roundtable on water management, industry professionals identify key issues in water, regulatory dynamics affecting change, and solutions to address challenges in the coming years.

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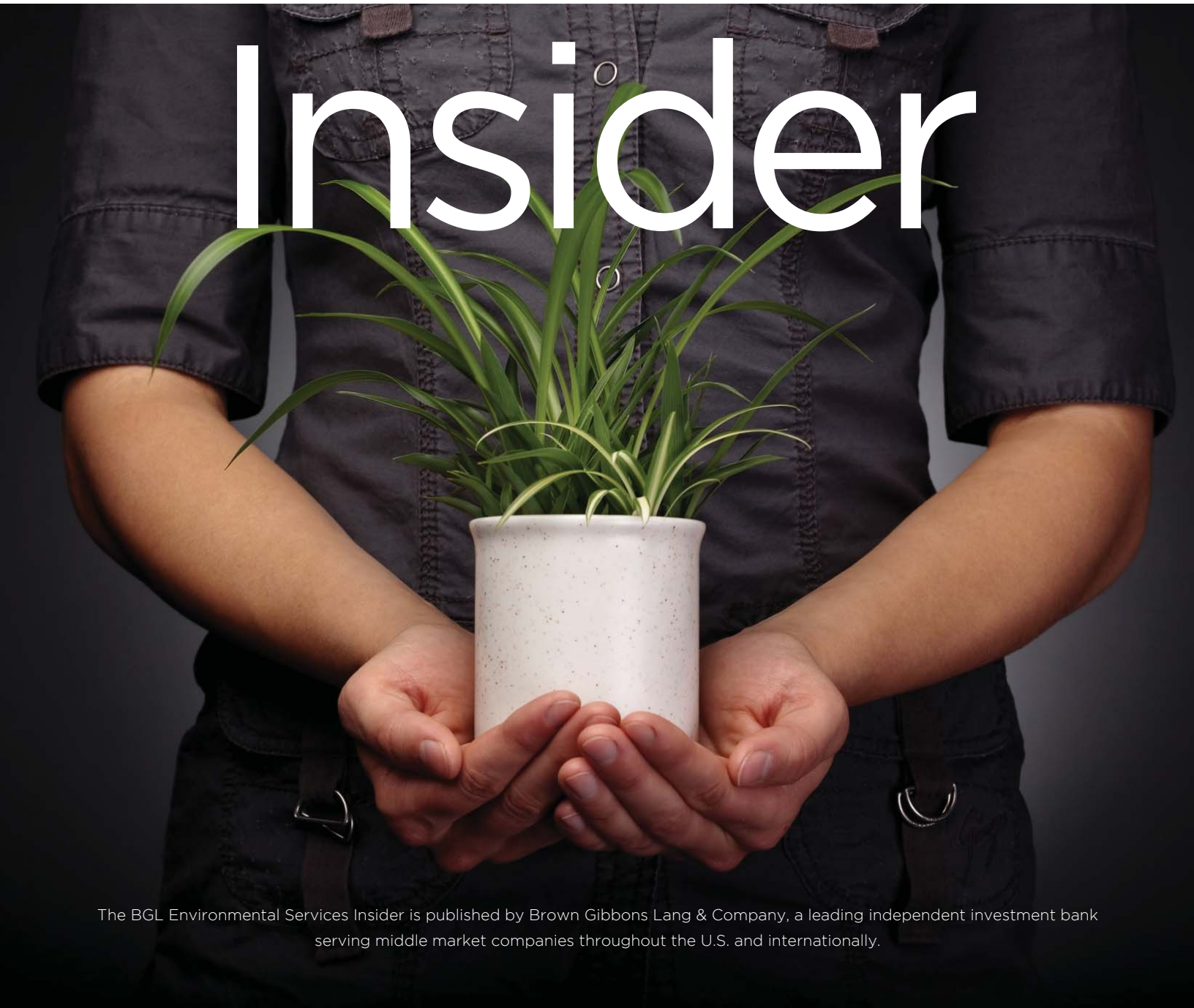

The BGL Environmental Services Insider is published by Brown Gibbons Lang & Company, a leading independent investment bank serving middle market companies throughout the U.S. and internationally.

The Environmental Services Insider discusses valuation metrics, recent mergers and acquisitions and capital markets activity, and select sector commentary for BGL's core focus areas within the environmental services industry:

- *Solid Waste (Non-Hazardous)*
- *Special Waste (Hazardous as well as other non-traditional waste streams)*
- *Environmental Engineering & Consulting (EE&C)*
- *E-Waste & Metals Recycling*
- *Reclamation & Remediation*
- *Waste-to-Energy (WtE)*
- *Energy Services*

Feature spotlights present our views and views of the market on certain sectors gathered through primary research and industry-focused transaction expertise.

M&A Activity

- Unlike the broader M&A market which saw disappointing volume trends in 2013, the middle market[1] saw deal flow rise modestly, with a 5.5 percent year-over-year increase in number of transactions and an 8.5 percent increase in deal value (Page 4). Strategic tuck-in acquisitions continue to be an important tool for acquirers. For private equity, add-on activity was robust during the year, accounting for 53 percent of transaction activity, surpassing buyout activity for the first time ever, reported PitchBook.

- Competition for deals continued unabated throughout 2013 pushing up deal multiples (Page 4):
  - Middle market[1] acquisition financing multiples eclipsed record highs observed in the 2007 peak, with senior leverage (senior debt to EBITDA) increasing to 4.6x in December. Aggressive financing structures and terms are expected to carry over into 2014 absent a material increase in M&A activity.
  - Purchase price multiples (enterprise value to EBITDA) reached their highest level since 2007, according to December data reported by *Standard & Poors Leveraged Commentary & Data*, increasing to 9.2x for strategic buyers and 8.1x for financial buyers.

- Environmental services M&A (Page 5) increased 8.6 percent year-over-year with EE&C reporting the highest level of activity at a 36 percent share, up from 32 percent in 2012. Solid Waste transaction activity also saw an uptick, accounting for 26 percent of deal flow, up from 20 percent the prior year. M&A activity in Solid Waste increased 43.6 percent year-over-year, followed by EE&C with an 18.8 percent increase.

1 Middle market defined as enterprise values between $25 million and $500 million.

Industry Valuations

The public equity markets rallied reaching record highs in 2013 with the S&P 500 and DJIA indices up 26 and 24 percent, respectively.* BGL Special Waste (Other) and EE&C composite indices outperformed the market, each up 29 percent over the same period. Equities retreated in recent weeks on news of slowing growth in China and the impact of Fed tapering on emerging economies. EBITDA valuation multiples have shown progressive expansion across all subsectors.

** As of December 31, 2013*

Operating Highlights

- Favorable MSW volume and pricing trends materialized in improved margin performance in 2013 with positive momentum expected to maintain in 2014.
- In used oil, re-refiners are continuing to take steps to reduce pay-for-oil prices. In January 2014, oil majors announced list price reductions ($.25 per gallon) for Group II base oil—the first price cut since last June.
- EE&C companies are reporting strength in industrial and infrastructure sectors. Industrial backlogs are growing on expansion in U.S. manufacturing activity. Sequestration and budget issues remain drags on federal sector business. Water represents a growth area in oil and gas and industrial markets given increased demand for specialized treatment and reuse.
- Scrap prices have been rising since October reflective of tight supply. Continued steady recovery in the U.S. economy, buoyed by strong auto sales and improving construction activity, remain positives for scrap end markets. Non-residential construction is poised for improvement in 2014.

For more information on how BGL's Global Energy and Environmental Services Practice can assist your company, please contact:

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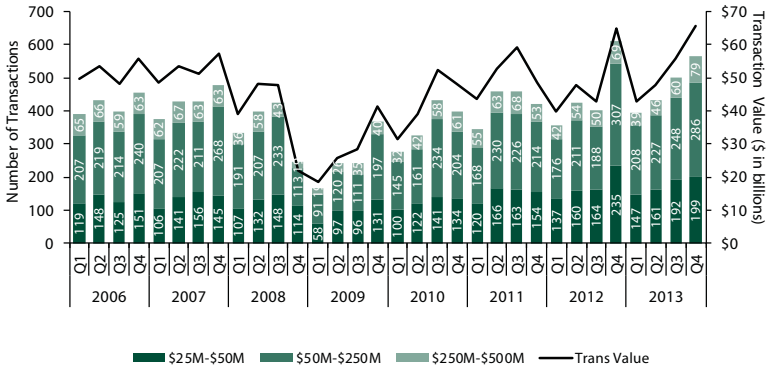
Overall M&A Activity

Mergers & Acquisitions Activity

Middle Market M&A Activity

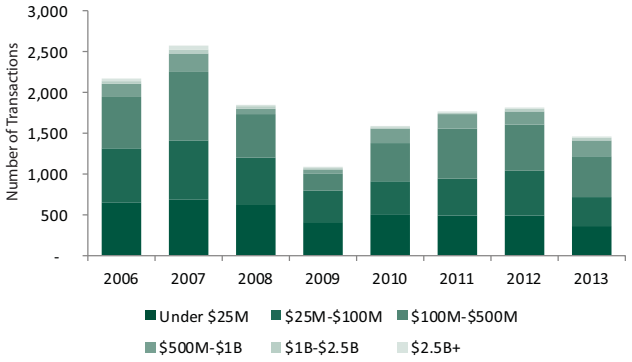


Based on announced deals, where the primary location of the target is in the United States. Middle market enterprise values between $25 million and $500 million.

SOURCE: S&P Capital IQ.

Private Equity Transaction Activity

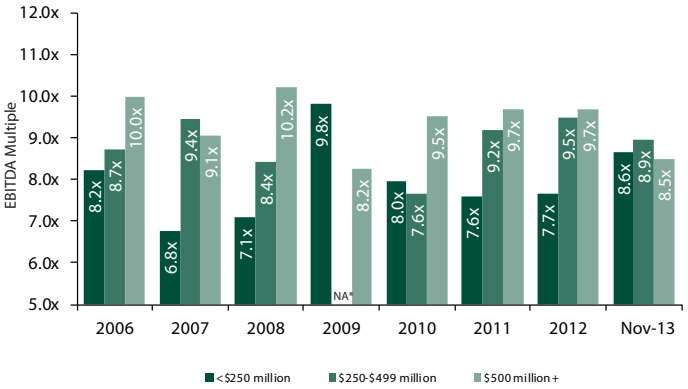
Transaction Count by Deal Size



SOURCE: PitchBook.

Trends in Valuation

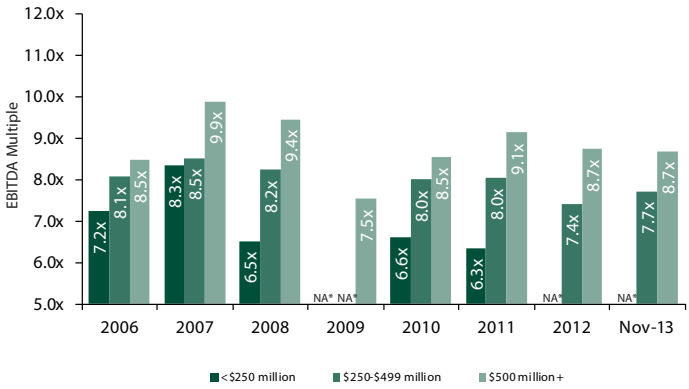
Transactions with Strategic Buyers



**NOTE: N/A Data not reported due to limited number of observations for period.*

SOURCE: Standard & Poors LCD.

Transactions with Financial Buyers

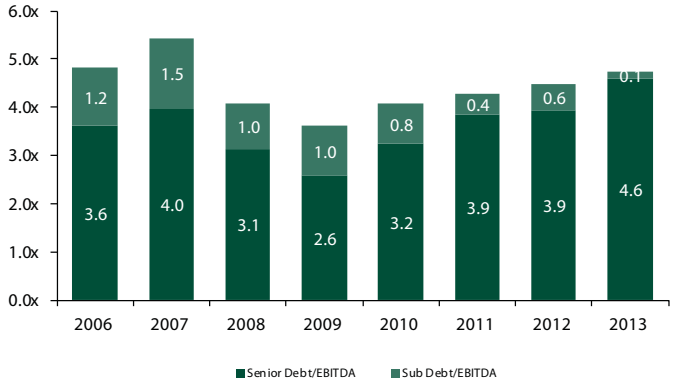


**NOTE: N/A Data not reported due to limited number of observations for period.*

SOURCE: Standard & Poors LCD.

Acquisition Financing Trends

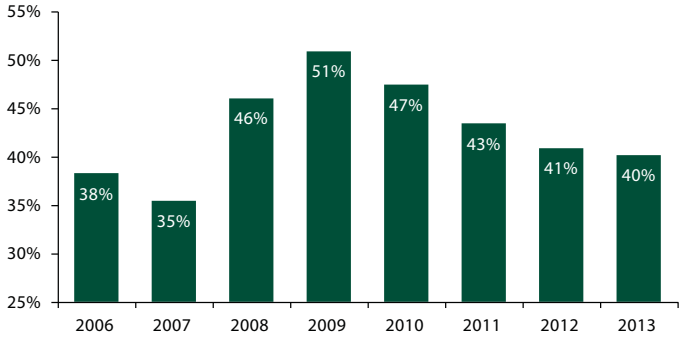
Leverage



Middle market enterprise values between $25 million and $500 million.

SOURCE: Standard & Poors LCD.

Equity Contribution



Middle market enterprise values between $25 million and $500 million.

SOURCE: Standard & Poors LCD.

Environmental Services M&A Activity

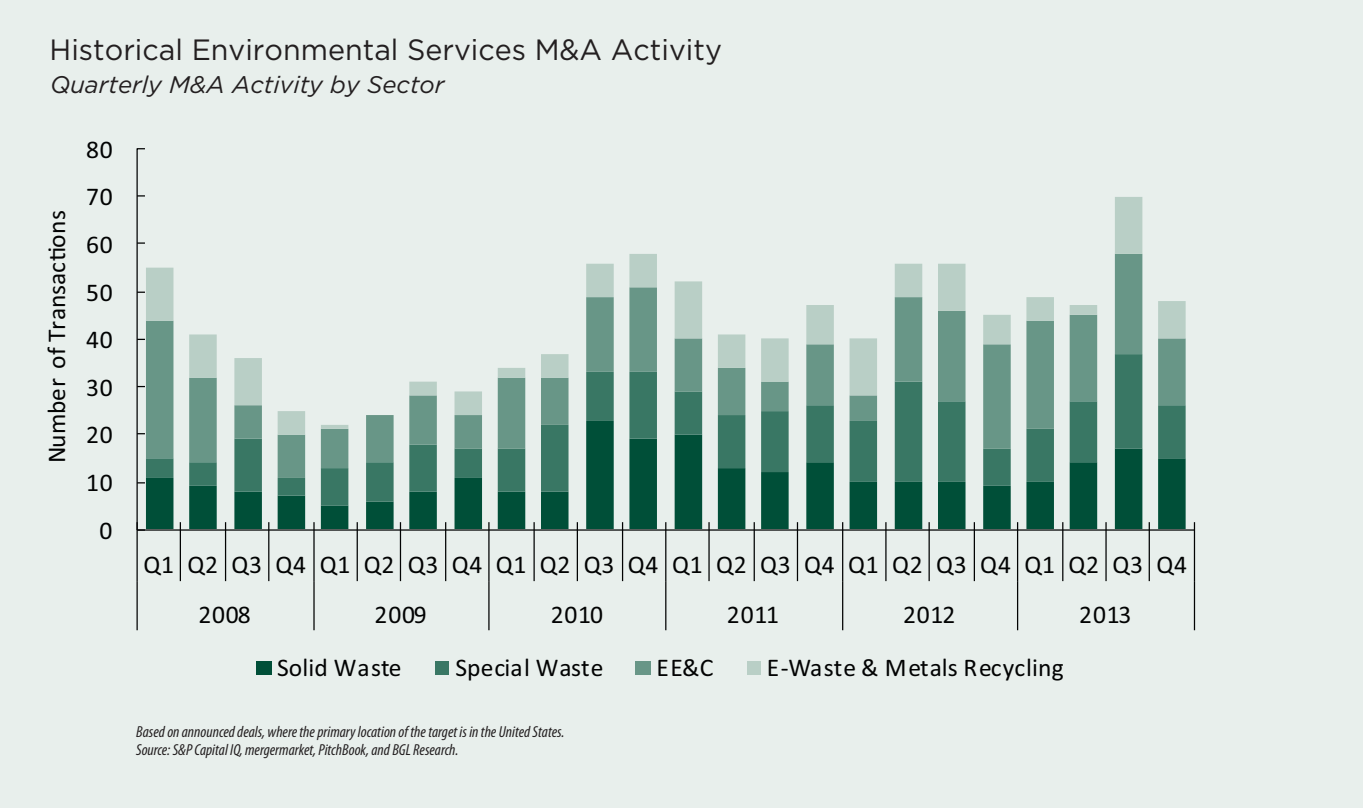
Notable M&A Activity in Solid Waste

SOLID WASTE

In January 2014, **Advanced Disposal Services, Inc.** (ADS) acquired certain assets from **M.A.S.S. Services Inc.** (dba **The Dumpster Company**), expanding its residential footprint in the greater Atlanta area with the addition of over 600 residential customers. ADS plans to utilize the Eagle Ford Landfill to dispose of waste from the newly acquired customers. In an interview, ADS regional vice president Charlie Gray said, "The Dumpster Company presented a unique opportunity to tuck in new residential customers into our existing collection operations; thus, increasing efficiencies and densities while growing our operations."

The transaction follows the December acquisitions of Janesville, Wisconsin-based **Sherman Sanitation Services, LLC** and **DC Disposal, Inc.** of Evansville, Indiana. The Sherman acquisition marks ADS's eighth acquisition in the Midwest, adding six commercial routes and expanding its Wisconsin footprint. The DC Disposal acquisition further expands ADS's Indiana footprint with the addition of 900 residential carts, 130 rear load containers, and three mixed residential and commercial routes that will be serviced by its Evansville, Indiana hauling location. The transaction is ADS's fifth acquisition in the East region. ADS completed a total of 17 acquisitions in 2013 according to a company press release.

In January 2014, **Roark Capital**-backed **GFL Environmental Corporation** (GFL) acquired Calgary, Alberta-based **The Garbage Company Inc.** The acquisition represents GFL's first solid waste operation in Western Canada and will serve as a platform for additional growth in the region. The acquisition will add 55 employees, increasing GFL's workforce to over 1,300 and customer base to over 875,000 households and 16,000 commercial customers. "By joining forces with The Garbage Company and its experienced and committed workforce, GFL can offer our customers more services in more locations than ever before," said GFL President and CEO Patrick Dovigi. In addition to solid waste collection and hauling, GFL provides a suite of special/liquid waste services, including industrial waste, grease trap, site excavation and remediation, and emergency response services.



SOURCE: S&P Capital IQ, PitchBook, Waste 360, Recycling Today, Equity Research, and Company Filings.

Environmental Services M&A Activity

Notable M&A Activity in Special Waste

SOLID WASTE (continued)

In December 2013, **Covanta Holding Corporation** (NYSE:CVA) acquired **two transfer stations** in Northern New Jersey from **Advanced Disposal Services**. The facilities accept 2,500 tons per day of municipal solid waste, construction and demolition waste, and recyclables. "This is an attractive acquisition that provides increased stability and flexibility of fuel supply to our Energy-from-Waste facilities in the region," said Derek Veenhof, Covanta Waste Solutions executive vice president.

In December 2013, Manassas, Virginia-based **EnviroSolutions, Inc.** (ESI) completed the acquisition of **Sajo Transport, Inc.** The transaction closing represents the completion of the second phase in its acquisition of Environmental Logistics Services' (ELS) New Jersey waste processing and rail operations. Through an agreement with the New Jersey Meadowlands Commission, Sajo operates the largest permitted solid waste transfer station in New Jersey. The facility is currently permitted for 2,750 tons per day and will add approximately $10 million in annualized revenues to EnviroSolutions. ESI provides solid waste collection, transfer, disposal and recycling services across 10 states in the Northeast and Mid-Atlantic. ESI President and CEO Eric Wallace said, "Our acquisition of ELS' Sajo Transfer Station assets represents another strategic growth opportunity within the greater New York City and Northern New Jersey waste-shed, providing us the opportunity to drive additional waste volumes through our waste-by-rail network and improve profitability through increased internalization of waste streams."

In November 2013, **Kinderhook Industries**-backed **Rizzo Environmental Services, Inc.** completed the acquisition of **V&M Corporation** (dba **Royal Oak Recycling**) for an undisclosed amount. Michigan-based Royal Oak Recycling provides paper, cardboard, metal, plastic, computer, and electronic products recycling services. The company handles more than 170,000 tons adding significant recycling operations to Rizzo. Commenting on the transaction, Rob Michalik, managing director of Kinderhook Industries, said, "The acquisition of Royal Oak will launch Rizzo into the recycling market with significant scale. We look forward to partnering with the Royal Oak management team and getting the opportunity to leverage their recycling industry expertise to help Rizzo expand its service offerings in the recycling sector." The acquisition marks the 15th environmental services transaction for Kinderhook.

In November 2013, **WCA Waste Corporation** completed the acquisition of **Sedalia Container Company Inc.** Sedalia's waste removal services and products include full service waste removal, wheeled containers, roll off containers, local bagged trash pick-up service, trash compactor rentals, commercial cardboard recycling, construction materials removal, and storage containers for rent. WCA Waste Corporation provides non-hazardous solid waste collection, transfer, processing, and disposal services in the United States. WCA was acquired by **Macquarie Infrastructure Partners Inc.** in March 2012 for approximately $530 million.

In November 2013, **Waste Management, Inc.** (NYSE:WM) completed the acquisition of **Alli Roloff Incorporated** for an undisclosed value. Alli Rolloff provides waste removal, recycling collection, and demolition services in Minnesota. The company offers rolloff dumpster; garbage collection and recycling services; and demolition services for various structures that include old and mobile homes, barns, and other buildings. The tuck-in acquisition included five trucks and adds more than 3,000 customers.

SPECIAL WASTE

In January 2014, **Curtis Bay Medical Waste Services LLC** announced the acquisition of the assets of Healthcare Solutions medical waste processing facility and customer service operation from **Waste Management Inc.** (NYSE:WM) Curtis Bay currently operates an established New England medical waste transfer station in Massachusetts and continues to expand its geographic footprint in the New England market. Services include the collection, transfer, transportation, recycling and waste reduction, sharps management, consulting, and sustainable medical waste processing services.

In December 2013, **REG Synthetic Fuels, LLC**, a subsidiary of **Renewable Energy Group, Inc.** (NasdaqGS:REGI), entered into a purchase agreement to acquire substantially all of the assets of **Syntroleum Corp.** (NasdaqCM:SYNM) for $40.3 million in stock. Syntroleum Corporation engages in the commercialization and licensing of its technologies for the production of synthetic liquid hydrocarbons. Syntroleum has pioneered Fischer-Tropsch gas-to-liquids and renewable diesel fuel technologies and has 101 patents issued or pending. Syntroleum also owns a 50 percent interest in Dynamic Fuels, LLC, a 75-million gallon renewable diesel production facility in Louisiana. REG owns and operates eight active biodiesel refineries in four states with a combined nameplate production capacity of 257 million gallons and distributes biodiesel through a national network of distribution terminals. **Transaction Multiple: 8.5x Revenue**

SOURCE: S&P Capital IQ, PitchBook, Waste 360, Recycling Today, Equity Research, and Company Filings.

Environmental Services M&A Activity

Notable M&A Activity in Environmental Engineering & Consulting

SPECIAL WASTE (continued)

In November 2013, **Aquilex Holdings LLC** (dba HydroChem), announced the acquisition of **Inland Industrial Services Group** from private equity firm Strength Capital Partners. Inland Industrial Services provides environmental and industrial cleaning services in the Midwest and Northeastern United States, including hydro-blasting, specialty line cleaning, vacuum, chemical cleaning/degassing, catalyst, hydro excavation, hydro cutting, hydro/precision blasting, tank cleaning, and turnaround services. The company is based in Detroit, Michigan and has branches in Kentucky, Louisiana, Ohio, and Texas. With the acquisition, the combined company will have annual revenues of approximately $400 million. HydroChem financed the acquisition with proceeds from a new credit facility underwritten by General Electric Capital Corporation. Aquilex Holdings LLC (dba Aquilex Hydrochem LLC), a leading provider of industrial cleaning solutions to the petrochemical production, oil refining, and other energy end-markets, is a portfolio company of **Centerbridge Partners**. Terms of the transactions were not disclosed.

In November 2013, British Columbia-based private equity firm **Stern Partners** announced the acquisition of a majority interest in **McRae's Environmental Services Ltd.**, a provider of pipeline inspection and drain cleaning services in Western Canada. The company offers monitoring well installation, liquid waste management and disposal, utility pole holes/anchor installation, pump station servicing, mainline pipe cleaning/video inspection/root-cutting, septic and holding tank pumping, tank rental and servicing, and industrial cleaning/hazardous material hauling; and drill mud pumping, hauling, and disposal services, as well as hydro-excavation and vacuum truck services. McRae's employs over 115 operators and has the largest equipment fleet in its core with over 80 specialized vehicles providing services to a broad range of governmental, heavy construction, oil & gas, commercial, industrial, utility, and institutional customers in the Greater Vancouver market. All existing investors retained a minority interest in the company. Additional terms of the transaction were not disclosed.

In November 2013, **National Response Corporation** (NRC) announced the acquisition of **RK Contractors** (dba RK Excavating) for an undisclosed value. RK Excavating operates as an environmental and industrial services contractor, providing emergency response services and equipment in the California and Nevada markets. NRC is a commercial provider of United States Oil Pollution Act of 1990 regulatory compliance and emergency response services, as well as a global provider of diversified environmental, industrial, and emergency response solutions. NRC was acquired in March 2012 by private equity firm **J.F. Lehman & Company**.

In September 2013, **Clean Harbors, Inc.** (NYSE:CLH) announced the acquisition of the assets of **Evergreen Oil, Inc.** for $60 million in cash. Evergreen is a collector, handler, and recycler of automotive and industrial waste. The company offers environmental hazardous waste services, such as used oil and fluids collection, vacuum, hazardous waste management, parts washer sales, parts washer rental and service, and waste oil re-refining services. In addition, it collects, transports, and recycles used motor oil, used oil filters, oily water, used antifreeze, and other solid and toxic waste. Evergreen is the second largest collector of waste-oil in California. The acquisition is expected to expand Clean Harbors' re-refining footprint into the Western United States, complementing its Indiana and Eastern Canada facilities. "While we plan to invest some capital into the re-refinery to enhance its layout and productivity, the plant is relatively new, with major portions of it having been rebuilt following a fire at the facility in 2011. In addition to the re-refinery, the purchase includes rolling stock and equipment, a diverse roster of West Coast customer accounts, an ancillary hazardous waste business and a permitted Treatment, Storage and Disposal Facility (TSDF) in Carson, California—a state where stringent permitting requirements create barriers to entry," said Clean Harbors CEO Alan McKim. The deal marks Clean Harbors' second major waste-oil acquisition in the last year after completing the purchase of Safety-Kleen, Inc. for approximately $1.5 billion in December 2012.

ENVIRONMENTAL ENGINEERING & CONSULTING

In December 2013, **Stantec, Inc.** (TSX:STN) submitted a letter of intent to acquire environmental consulting and engineering services company **Williamsburg Environmental Group, Inc.** Based in Williamsburg, Virginia with additional offices in Richmond, Glen Allen, and Fredericksburg, Virginia, Williamsburg Environmental provides specialized services in ecology, environmental restoration, water resources, and regulatory support for public and private clients in the power, transportation, and energy and resources sectors. Alberta-based Stantec provides professional consulting services in planning, engineering, architecture, interior design, landscape architecture, surveying, environmental sciences,

SOURCE: S&P Capital IQ, PitchBook, Waste 360, Recycling Today, Equity Research, and Company Filings.

Environmental Services M&A Activity

Notable M&A Activity in E-Waste & Metals Recycling

ENVIRONMENTAL ENGINEERING & CONSULTING
(continued)

project management, and project economics for infrastructure and facilities projects in North America and internationally.

In November 2013, **Yukon Capital**-backed **Montrose Environmental Corporation** completed the acquisition of **Air Compliance Testing, Inc.**, a provider of stack testing and air emission monitoring services for industrial, commercial, and government institutions in the United States. The company offers source emission testing, including manual, instrumental, and specialized emissions testing, as well as air pollution control equipment testing and optimization; Fourier transform infrared spectroscopy services; and CEMS services, which include maintenance programs, relative accuracy testing audits, calibration gas audit, and absolute calibration audits, and CEMS performance pre-test services. The company was founded in 1993 and is based in Cleveland, Ohio with an additional office in Gainesville, Florida. Montrose Environmental has completed six acquisitions with private equity backer Yukon Capital.

In October 2013, **Tata & Howard, Inc.** announced the acquisition of Vermont-based **Leach Engineering Consultants, P.A.** Leach Engineering provides civil and environmental engineering consulting services, including wastewater engineering, water system engineering, site engineering and construction, and project management services. "Leach Engineering Consultants' exemplary service to the northern New England water, wastewater, and stormwater market, with key focus on delivering cost-effective and innovative solutions, fits the Tata & Howard philosophy perfectly," said Donald J. Tata, P.E., co-founder and President of Tata & Howard. Tata & Howard is a specialized water, wastewater, stormwater, and hazardous waste consulting engineering firm with offices in Massachusetts, New Hampshire, Connecticut, Maine, and Arizona.

In July 2013, **Trinity Consultants, Inc.** announced the acquisition of **Insight Environmental Consultants, Inc.**, a provider of air quality consultancy services. Insight Environmental offers air quality impact analysis services that include reviewing the proposed project, such as phasing, planned equipment use, current land uses, any projected demolition activities, and traffic study data; identifying potential emissions; selecting and specifying mitigation measures; conducting emissions modeling to predict impacts to ambient air quality and health and potential CO "hotspots"; and conducting cumulative impact analysis. In addition, the company offers hazardous materials business plans that include conducting site inspection, preparing business plans, submitting to regulatory agency, and preparing emergency response plans. Insight also provides Phase I/II environmental site assessments. Trinity offers services in the areas of regulatory and sustainability consulting, environmental modeling software products and services, EH&S staffing assistance, and EH&S data management solutions. Trinity was acquired by private equity firm **Gryphon Investors** in November 2011.

E-WASTE AND METALS RECYCLING

In December 2013, **Alter Trading Corporation** announced the acquisition of the assets of **All Metals Recycling LLC**, an operator of a scrap metal recycling facility in Iowa. The transaction follows on the October purchase of Columbus, Nebraska-based metal recycler **CMI-TMC Holdings Inc.** The acquisition added six facilities, including two Nebraska shredders in Columbus and Kearney, and two auto parts facilities, making Alter the largest metal recycling company in Nebraska said Jay Robinovitz, Alter president and chief operating officer, in a press release announcing the transaction. Terms of the transaction were not disclosed. Alter, a privately held fourth-generation family firm, was founded in 1898. The company operates approximately 52 metal recycling facilities. Alter has 1,220 employees and a presence in eight states and one office in Hong Kong.

In October 2013, **United Milwaukee Scrap LLC** announced the merger with scrap recycler **Schulz's Recycling, Inc.**, expanding geographic footprint as well as broadening the availability of resources for both company's customers. Schulz is a provider of ferrous and non-ferrous scrap processing and has two scrap yards in Wisconsin. The newly merged company will operate from eight locations across Wisconsin, with additional offices in Minnesota and Massachusetts.

SOURCE: S&P Capital IQ, PitchBook, Waste 360, Recycling Today, Equity Research, and Company Filings.

Environmental Services M&A Activity

Notable M&A Activity in E-Waste & Metals Recycling

E-WASTE AND METALS RECYCLING (continued)

In September 2013, **Ingram Micro Inc.** (NYSE: IM), distributor and a leader in supply-chain and mobile device lifecycle services, announced the acquisition of Georgia-based **CloudBlue Technologies, Inc.** CloudBlue is a provider of enterprise IT asset disposition, onsite data destruction, and e-waste recycling services to large enterprise customers, retail customers, and OEMs. The company was founded in 2008 and provides reverse logistics solutions to over 1,000 customers. "The addition of CloudBlue to Ingram Micro allows us to meaningfully expand our supply chain solutions portfolio with a full suite of in-demand services that reduce the risk, cost and complexity associated with securely managing IT assets and consumer electronics throughout their lifecycle in compliance with environmental and data security regulations," said Ingram Micro president and CEO Alain Monié. **Riverwood Capital Management** was a former venture investor in CloudBlue. Terms of the transaction were not disclosed.

In September 2013, **Magnolia Environmental Solutions, LLC** announced the acquisition of Mississippi-based **Advantage Destruction Services, Inc.** (dba Advantage E-Cycling), a provider of on-site and off-site electronic and document destruction services. The company engages in dismantling and recycling computers, monitors, and related electronic equipment; and destructing and shredding computer hard drives, CDs, backup tapes, and other magnetic media. Magnolia is the only R2 certified electronic recycler in the state of Mississippi and serves all of the Mississippi, Alabama, Louisiana, Tennessee, Texas, and Arkansas markets.

SOURCE: S&P Capital IQ, PitchBook, Waste 360, Recycling Today, Equity Research, and Company Filings.

Spotlight On: Water Management

In this edition, we share the perspectives of industry professionals in a "roundtable" on water management. Through a series of interviews, we asked market participants to identify key issues in water, regulatory dynamics affecting change, and solutions to address challenges in the coming years.

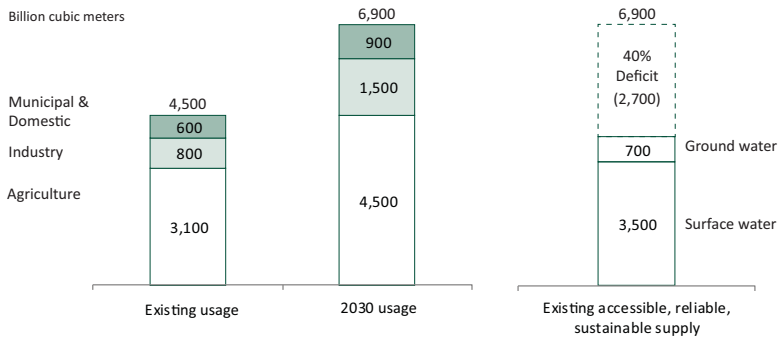
Water is a finite resource and rapidly shrinking in usable supply as the effects of population growth, urbanization, industrialization, and climate change limit access to safe and reliable water sources. The statistics tell a sobering story:

- World population is projected to grow from 6.1 billion in 2000 to 8.9 billion in 2050, increasing by 47 percent.[1]
- Global energy consumption will increase 50 percent by 2035, increasing water consumption by 85 percent.[2]
- By 2030, half of the world's population will be subject to severe water stress. By 2050, the need for water will increase by 60 to 90 percent, with demand outstripping supply in most parts of the world.[3]
- Aging infrastructure is contributing to water loss and increased pollution through untreated overflows to rivers and streams. Stormwater control and nutrient reductions represent growing problems.[4]
- Economic growth hinges on sustainable water practices, with an estimated 45 percent of projected 2050 global GDP at risk, the equivalent of $63 trillion.[5]

Formidable challenges present opportunities in water treatment, water management, and water infrastructure, each of which are drivers of secular growth in the water industry. Bank of America Merrill Lynch, in a study *A Blue Revolution - Global Water*, estimates the water services market will double by 2020 to $1 trillion.[5] A study released by SAM, a global asset manager specializing in sustainability investing, titled *Water: A Market of the Future*, sizes the market for water-related equipment and services at $480 billion.[6]

Global Water Demand

By 2030, demand for water is expected to outstrip suppy by 40 percent creating a "water gap."



Source: Charting our Water Future, 2030 Water Resources Group.

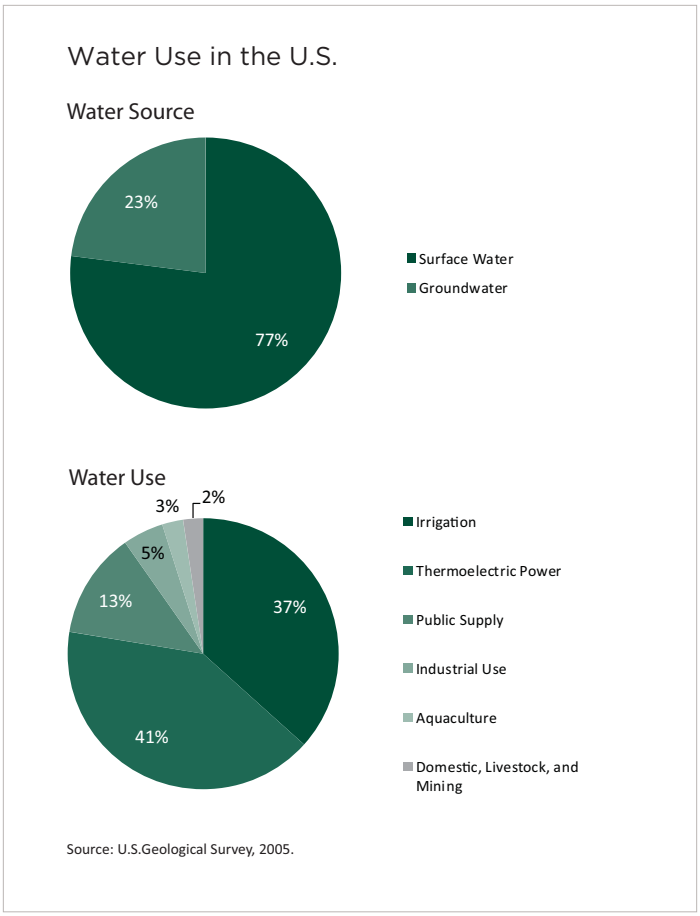
- New technologies such as fracking place a greater strain on sustainable water supply
- Wastewater technology and recycling bridge the gap between supply and demand
- Desalination and reuse provide additional water sources

"Water is ultimately more important than oil – it's an absolute of life and it has no substitute."
California American Water

"Every place on the global map will need to spend money on water," said Simon Gottelier, an investment manager at Impax Asset Management in London, who predicts that the water industry will grow 5 to 7 percent each year, on average.[7] According to Clean WaterNet, global investment in water solutions such as technology, infrastructure, pollution control, management and treatment is expected to double every four to six years. The water industry is "in its infancy", says Marc Robert, an investment portfolio manager for Water Asset Management, who estimates that $500 billion will need to be invested over the next 30 years to keep basic U.S. water infrastructure viable due to a "massive underinvestment" over the past few decades. EPA estimates start at $300 billion to more than $1 trillion.[8]

"Water has been a front and center issue for many regions around the world for some time, but there are more areas facing crises today than ten years ago for a variety of reasons," offered Ebie Holst at Clean WaterNet. China is currently one of the biggest spenders on water, Holst said, and will have invested about $80 billion on water infrastructure and technology between the years 2011 and 2014. "China isn't a traditional water-scarce country the way you would think of the Middle East, but their water challenges have expanded rapidly alongside industrialization. When the U.S. started exporting manufacturing to China, frankly we exported a lot of our water contamination issues, and China hasn't really had the regulatory infrastructure that we've had here in the United States. That's changing."

With a background in information technology, Holst formed Clean WaterNet to bring together buyers and sellers of water solutions across the globe to accelerate innovation. "The basis for Clean WaterNet is to explore how IT can better enable industry players to connect with one another and tap expertise and technologies globally for solving problems. A market participant in the Middle East, for example, is likely dealing with issues similar to someone in the U.S. Southwest, so there may be opportunities to collaborate around how problems are getting solved." Holst, who tracks meta trends, told us that water landed on her radar about five years ago with the apparent acceleration of investment in the water industry. "With the increase in investment activity, there has also been an increased effort to bring different sectors together around some of the challenges the industry is facing." The need for more efficient ways to tap, share, and collaborate around industry information is increasing as necessity dictates an urgent need for better management of water resources said Holst. "In speaking with a range of industry participants, we learned that solving water-related challenges involves some very slow and isolated processes that are similar almost regardless of industry or sector on the front lines of water management. We're looking to help."



"What we are seeing in North America is representative of what we are seeing around the world," commented Tom Pankratz at Global Water Intelligence. Pankratz focuses on desalination and other advanced membrane or thermal technologies in both municipal and industrial water and wastewater applications. "Traditional water supplies are being stretched. Aquifers are being drawn down. In the United States, there is growing concern about a number of areas in the West and Northeast where snowmelts are down and river water is being used to the point that flows are being reduced to dangerously low levels. At the same time, there is increased concern about maintaining environmental flows in rivers. Lower flow means that the pollutants that exist are becoming more concentrated and require a higher level of treatment. They have to look at alternative supplies."

Spotlight On: Water Management

Climate Change

Climate change is contributing to water management challenges as extreme weather events threaten water supplies, also presenting stresses on water infrastructure that require unique approaches to wet weather and stormwater management.

"Climate change is challenging traditional assumptions," observed Dianne Sumego, a client director at Black & Veatch. "Our water resources experts are helping utilities and local governments reassess what has been considered a 100-year flood. We are helping them forecast and plan for contingencies as we are now seeing storms with those characteristics happening with much greater frequency."

"Proliferating industrialization, increased nutrient loads with agricultural runoff, exponential growth in population, and amplified needs for power all over the world contribute to unprecedented stresses on global water resources. Adding climate change scenarios into the mix alongside the droughts and catastrophic storms we've been seeing these last several years, and it starts to look kind of scary," commented Ebie Holst at Clean WaterNet. "Water is starting to hit the radars of a lot of people who never paid it much mind before, and there will likely be more reasons to pay attention in the years ahead."

Regional pressures on U.S. water resources

Survey participants spoke to regional differences in water availability which are accelerating investment in water infrastructure and technology.

There is less water, and the water that is available is requiring more treatment. "That is true all over the country," commented Tom Pankratz at Global Water Intelligence. "The issues are different depending upon where you are, whether the problem is reducing and treating the volume of industrial frackwater or other industrial waters or just finding an alternative water supply." Pankratz continued, "In certain areas being exploited for shale gas development, Ohio and Pennsylvania for example, the challenge is not sourcing the water but preventing the flowback or produced water from polluting the fresh water that is available. In the Southwest U.S, reserves are being drawn down due to severe drought and low snow pack. As that occurs, shortfalls are being replenished by drawing down reservoirs. That is a big issue."

"How much water is available to begin with drives almost everything else. In some regions, there are extreme issues of scarcity so every drop becomes precious. This can drive prices as well as policy to make sure that any drop that is used is reused or cleaned up," said Holst. "Texas, Arizona, and other regions across the American West and Southwest are facing significant water management issues," said Sumego. "Utilities are having to make the most of existing supplies while identifying future sources. In the Midwest, our clients are paying close attention to regulatory developments, particularly involving nutrients, which is a current focus area for regulators."

"The biggest issue for the water and wastewater sector is infrastructure because it has been ignored for such a long time. We went through an era of cutbacks at the municipal level, during which time cities lost track of their asset management. In areas east of the Mississippi, our infrastructure is now at a critical aging point," offered Lorraine Koss, a senior vice president at the U.S. Water Alliance. "West of the Mississippi, infrastructure issues center on managing water resources to meet demand. It is newer infrastructure because much of the population growth has been more recent. You are making the most of limited water resources for a growing population. As we are looking forward and planning, land management issues come into play as well. We have a lot to turn around at this point in time."

"In Ohio, water quality is affected by a number of factors. We have aging infrastructure and combined sewer designs that were created when storm frequencies were lower. An increase in storms and overflows can have a significant impact on water quality. An increase in chemicals used for agriculture are creating algae issues in the Great Lakes that we haven't seen before which, in turn, affects some of the commerce that comes through the region. It is all ultimately related, but today these challenges are still generally handled agency by agency, one snapshot at a time," added Holst.

Improving water portfolio management

"The water sector has grown up in these regulatory silos. You have the Clean Water Act, the Safe Drinking Water Act—regulations that were put in place without consideration of the water cycle and water's use for energy," commented Lorraine Koss at the U.S. Water Alliance. "We talk a lot about "one water management."

We need to look holistically at these different elements of water—source water, drinking water, wastewater, storm water. In the past, these have all been viewed separately with no communication between the various players."

Cities are looking at diversifying their water portfolios said Tom Pankratz at Global Water Intelligence. "A portion of their water may be reused, a portion of their water requirements can be recovered through conservation, a portion they can get by storing more in storage tanks or reservoirs, and a portion through advanced treatment through new sources like seawater or brackish water desalination," offered Pankratz.

Pankratz continued, "Industrial facilities are often developing their own independent water supply rather than being dependent upon a municipality. This is happening all over the United States. In some cases they are buying wastewater from cities and treating it and using it. In other cases they are just tightening up their own recycling program at their facility. Every drop of water they reuse reduces the amount of water they have to purchase and discharge."

"One issue that is starting to come into play is if an industry has a dependency on a certain level of water quality or availability, and there is risk of that level no longer being dependably viable. Take an extreme example like an electric power-generation utility in the U.S. Southwest that is facing scarcity issues and competition from industries and communities all vying for the same water resources. A shortage of water for cooling towers could translate to power outages that affect huge populations. Issues like these will get more visibility as drought conditions in the U.S. West and South continue," observed Ebie Holst at Clean WaterNet. "One player to watch is Waterfund, which has been tracking these trends as they may relate to insurance and risk management. In 2013, Waterfund established a partnership with IBM big data to track water project profiles globally to better inform and enable more types of investment in water projects all over the world. In a fragmented industry like water it will take awhile before that information is available."

"I am optimistic about the future. Three words that come to mind are integration, innovation, and collaboration," observed Lorraine Koss at the U.S. Water Alliance. "The water sector has historically been risk averse and slow to change. Now we are starting to see real innovation. Climate change is driving industry players to take some risk. There is a real move on the part of the more progressive municipalities that are trying to build resilience for these extreme weather conditions and limited resources by bringing together the different water elements and foster more communication as they make investments."

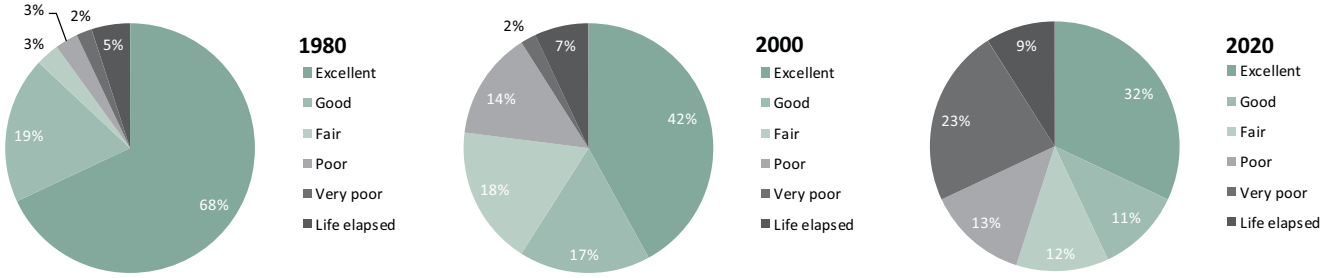
Infrastructure

The nation's aging infrastructure is an area of water management that is getting the most visibility, cited survey participants. Substantial investment will be needed over the next several decades to upgrade drinking water and wastewater infrastructure systems to ensure safe, reliable supplies.

U.S. drinking water infrastructure earned a D Grade from the American Society of Engineers in its 2013 Report Card for America's Infrastructure, estimating the cost to repair at more than $1 trillion over the next 25 years, according to the American Water Works Association.[9] California alone will need to spend an estimated $39 billion in drinking water infrastructure upgrades and New York State $27 billion over the next 20 years.[9,10]

State of the U.S. Water Supply System

In 1980, 68% of U.S. pipes were in excellent condition while only 32% are expected to be in the same condition by 2020. The number of pipes in poor, very poor, or life elapsed condition will swell from 10% to 45% over the same period.



Source: U.S. EPA: Clean Water and Drinking Water Infrastructure Gap Analysis Report, 2002.

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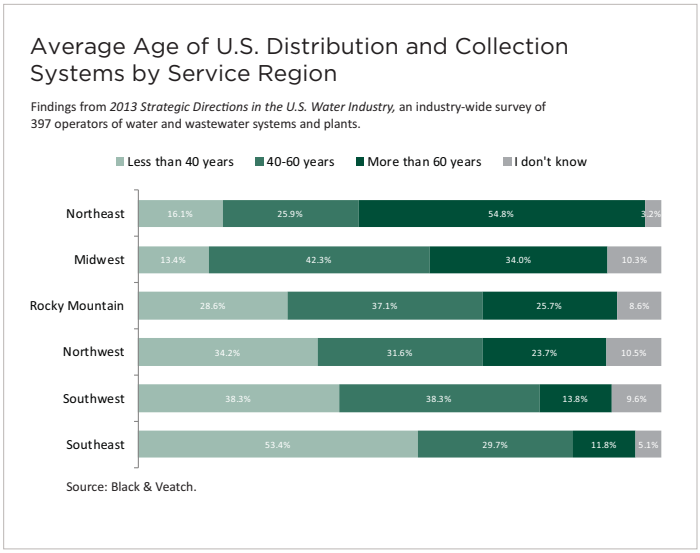
In the same study, U.S. wastewater infrastructure also earned a D Grade with an estimated $298 billion in capital investment required over the next 20 years to rebuild the country's wastewater and stormwater systems. Pipes will account for the largest capital need at about 75 percent of required spending with funds being deployed to fix and expand pipes to address sanitary sewer overflows (SSOs), combined sewer overflows (CSOs), and other pipe-related issues.[9]

A 2008 Clean Watershed Needs Survey estimates $134 billion will be needed for wastewater treatment and collection systems, $55 billion for combined sewer overflow corrections, and $9 billion for storm water management.[9]

Aging pipes are contributing to large volumes of "wasted" water. Water loss through leakage and unaccounted-for-water represents an area of focus and a large opportunity, according to Tom Pankratz at Global Water Intelligence. "If you look at the best run city in the United States, it probably has at least 15 and closer to 20 percent unaccounted-for-water; either it is not metered or it is lost due to leakage. In many cities in the Northeast and in the Midwest, the infrastructure is 80 or 90 years old. Even if you take a city with a relatively new infrastructure, they are still losing 15 percent of their water."

Black and Veatch, in its *2013 Strategic Directions in the U.S. Water Industry Report*, reported leakage levels between 8 and 12 percent for well-run utilities based on its own client experience. This contrasts with utilities with aging infrastructure, particularly in the Northeast and Midwest, which could have levels exceeding 30 percent. Nationally, the figure averages just over 20 percent.[11] The American Water Works Association's *2007 State of the Industry Report* estimated losses at 10 to 20 percent in water distribution systems throughout the nation.[12]

Cities are looking at ways to prevent water loss through the use of advanced metering, flow controls and sensors, and pipe rehabilitation and relining.



Urban Sewer Overflows

According to the U.S. Environmental Protection Agency (EPA), annually about 850 billion gallons of raw sewage and storm water is discharged into surface waters from combined sewer overflows (CSOs) and another 3 to 10 billion gallons from sanitary sewer overflows (SSOs), presenting a major pollution concern. Combined sewer systems serve approximately 772 communities containing about 40 million people. CSO communities are largely concentrated in the Northeast, Great Lakes, and Pacific Northwest regions of the country.

EPA estimates put the cost to fully control CSOs and SSOs at $50.6 billion and $88.0 billion, respectively, over the next 20 years, according to Ken Kirk, Executive Director of the National Association of Clean Water Agencies (NACWA).[13] Since 2007, the federal government has required cities to invest more than $15 billion in new pipes, plants, and equipment to eliminate combined sewer overflows.[9]

Tackling these issues will require a holistic approach to drinking water, wastewater, and stormwater challenges, examined within the context of sustainable cities and climate change.[14]

Perspective on Urban Sewer Overflows

"Historically, major municipalities across the Midwest and Northeast have used combined sewer overflow systems (CSOs). CSOs are generally effective unless you have a large volume of stormwater," observed Ebie Holst at Clean WaterNet. "Over the last five to ten years, many of these municipalities have seen a significant increase in storm size or frequency and the overflows that can occur as a result increase the risks of contamination to other surface and groundwater sources."

Older cities across the country including Philadelphia, New York, Washington D.C., among others, are spending billions of dollars on infrastructure improvements. These cities are either under a consent decree that was negotiated with U.S. EPA and the Department of Justice or they are under a permit condition from their state regulator that is requiring them to deal with the combined sewer problem. Just within Ohio, major cities like Cincinnati, Cleveland, Columbus, and Toledo will be spending billions of dollars over the next 30 years to deal with combined sewer overflows.

Kyle Dreyfuss-Wells, Manager of Watershed Programs at the Northeast Ohio Regional Sewer District (NEORSD), works with an integrated team of engineers, stormwater experts, and watershed planners responsible for green infrastructure as part of the sewer district's combined sewer overflow control plan. NEORSD will be required to spend approximately $3 billion over the next 25 years under its consent decree which will consist of seven new tunnels and at least $80 million in green infrastructure projects.[15]

"Since the Clean Water Act was passed we have been peeling the onion in terms of the layers of issues," offered Dreyfuss-Wells. "We have old systems that were intentionally designed to combine sewage and stormwater, which, as development has proceeded, pose a problem as wet weather events cause untreated discharges to the environment. Not only do we have the legacy systems, we are also now realizing that land use matters. The way that we use the land—impervious surface, poor zoning, overparking, urban sprawl—manifests itself in water quality problems and infrastructure costs. Those are the big issues."

Dreyfuss-Wells continued, "I firmly believe that the regulation drives the market. The NEORSD, for example, is under a federal consent decree that requires us to deal with 126 points of CSO discharge over the next 25 years. You have several other cities in Ohio and across the country that are being driven by the Clean Water Act and U.S. EPA's CSO control policy that drive this. The investment community and private sector community are simply responding to the regulatory drivers on the public sector."

"It is going to require a massive amount of infrastructure. There are a number of cities, including us, that are trying to look for ways to integrate green infrastructure into the combined sewer overflow control programs, so that in addition to solving the water quality issue, you also leave an amenity for the community."

"A primary concern of utilities is compliance with unfunded mandates by federal and state regulators, particularly consent-related agreements regarding combined sewer overflow (CSO) and sanitary sewer overflow (SSO) systems. Often, these agreements call for green infrastructure as part of the overall solution," said Dianne Sumego of Black & Veatch.

"The ultimate concern of CSO and SSO programs is public health and safety," Sumego continued. "The best solutions typically result when the public and private sectors work cooperatively. Water knows no political boundaries. Protecting the public's health and safety requires a watershed plan that reaches beyond traditional, man-made borders, to get a clear picture of the impacts of stormwater and the best options for managing it."

Grey versus Green

While grey infrastructure is expected to capture the lion's share of total spending, communities are reaching out into green. Federal regulations alone are not the only motivator. Local governments are making investments in green infrastructure because of many other community, economic, and environmental benefits.

Grey infrastructure is usually referred to as the structural components of a sanitary sewer or a pump station. Green infrastructure typically involves the use of swales, bioretention facilities, green roofs, and live roofs; however, the definition has expanded, insiders say, to now include sewer separation. "It is called a green solution because of how it handles stormwater," said Sumego. "Keeping stormwater out of sewers allows for natural filtering to occur while reducing the amount of wastewater that must be heavily treated. This saves infrastructure-related costs as well as conserves water resources."

"The basic idea with green infrastructure as it is deployed for CSO control is to try to interrupt the path of the stormwater before it gets in combined sewer systems.

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So if you are building deep tunnels, you are dealing with the stormwater and sanitary water after it has already been combined. With green infrastructure you are trying to intercept it," said Kyle Dreyfuss-Wells at NEORSD. "If you look at our consent decree, we have a definition for green infrastructure which is basically the management of stormwater at its source or as close as possible to its source, as opposed to the traditional approach which is to pipe it away."

The landscape of an area will dictate use. In highly urban and commercial and industrial areas, there is often limited land available to put in green retention facilities. In those situations, sewer separation is employed as part of a green focus because it is reducing the amount of stormwater that has to be treated. "There is a push toward minimizing conveyance of stormwater far away from sites, meaning onsite stormwater management—porous pavement options, swales, and rain gardens—that will encourage infiltration of rainwater onsite as opposed to collecting and conveying water off to a treatment plant. It is better for overall groundwater recharge to keep it onsite if you can do it without flooding," offered a project development and engineering company we surveyed.

"I refer to the green infrastructure that many cities are trying to apply basically as stormwater management in the city. These are older urban areas that built out at a time when no one did onsite stormwater management. They just put it in a pipe and sent it away. We are trying to replumb, retool the urban area," added Dreyfuss-Wells. "There is a whole body of knowledge about stormwater management practices, how they work, and how they need to be designed. Now with green infrastructure, you have people trying to use those as part of a combined sewer overflow control solution. So you have these two worlds coming together."

"These fixes are incredibly expensive so communities are looking for cheaper alternatives. Green can be a lower cost solution, but it is really a homegrown solution given the land use, existing infrastructure, and governance issues of a particular community," said Dreyfuss-Wells. "There is a lot of mythology around green infrastructure right now that needs to be taken away. There is the myth that it is always cheaper, which is not necessarily true. There is the other myth that it is incredibly hard to maintain, and that is not necessarily true. It is just a different skillset."

"Consent decrees/orders may specify a certain percentage of a community's solution must involve green infrastructure solutions. Even though certain water quality standards must be met, the reality is that what constitutes green is going to vary, depending on where the community is," added Dianne Sumego at Black & Veatch. "It has to be tailored to the climate, needs, and interest of the community. We look at each situation individually and work closely with a community to determine the solution that will best protect public health and safety and conserve resources."

"Green infrastructure is an area in which we are heavily involved and is growing rapidly. It is really loved in the places where it is taking off like Philadelphia and Washington D.C. The communities get a lot of public support for it," commented Lorraine Koss at the U.S. Water Alliance. "We know it works. We know it is more efficient. We know it provides other community benefits. Regulation has to catch up to it because it doesn't have a long track record yet." Koss continued, "Utility managers overall are not really risk takers. When you are heading up a utility and you have a city council or you operate under a board, green infrastructure is a risk just because there isn't enough data and history on it. A lot of the issues are around maintenance and how extreme weather events will impact it."

"Over the years, green solutions have been identified as sustainable, and in most cases the maintenance of these facilities has not been considered in cost analysis. However, green solutions, like grey solutions, require maintenance, commented Sumego. "If green solutions are not maintained the benefits may diminish or even disappear. Successful green solutions have advocates to help maintain thier sustainability."

"Currently there is more investment being spent on grey infrastructure with defined measurable results. However, green solutions are supplementing and in some cases replacing or reducing the size of grey infrastructure. The current challenge with green is the level of information available on successfully measuring water quality improvements," Sumego said. "Currently the regulatory burden and the proof burden on green infrastructure are a little higher than they are on grey infrastructure because the EPA is less certain about it," added Dreyfuss-Wells.

"Green infrastructure by its very nature requires collaboration across sectors that have historically not worked together," offered Kyle Dreyfuss-Wells at NEORSD. "Helping clients tear down those barriers is really huge. It is a skillset as opposed to a product. It is important to have highly skilled consultants that can give the right answers at the right time and be able to help deal with these transaction costs."

Greening cities

"We are implementing a series of solutions," Dreyfuss-Wells said. "We are going to do 10 projects over the next 5 years which involve retooling certain sections of the city to manage stormwater before it gets into the combined system. We call these green giants because they are really big projects that are dealing with significant amounts of stormwater." Dreyfuss-Wells continued, "We are peeling back the legacy system that is one pipe, putting in separate pipes, and running that stormwater through some kind of green feature like a wetland or a bioretention area and then discharging it to the environment."

> "A reduction in traditional public funding sources and weakened economic conditions has created a need for experienced private capital to meet the massive need for global infrastructure investment."
>
> Source: Kohlberg Kravis Roberts.

The private sector will play a significant role in the implementation of the Philadelphia Water Department's (PWD) green infrastructure program. Through its Green City, Clean Waters program, the PWD is committing to "green" more than 34 percent of the combined sewer area's impervious cover in the coming 25 years at a total cost of over $2.4 billion, which includes funding for increased treatment and transmission capacity of the combined sewer system; watershed planning; the design, construction, operation and maintenance of green stormwater infrastructure; the review of private sector development plans for compliance with PWD's stormwater regulations stream restoration; and public outreach and education.[14]

Funding the gap

Capital constraints present a challenge for water service providers to fund needed infrastructure improvements. "Probably the biggest challenge is finding funding to implement long-term control plan (LTCP) programs developed by these combined sewer overflow communities. These LTCP programs are tied into best practices which tie into watershed use and stormwater management," Dianne Sumego at Black & Veatch said. "In addition to rate increases to customers, many communities are submitting for revolving loan funds at reduced rates to help with the financing cost. There is not much in the way of grants available for these programs, putting the burden on the communities."

Communities face resistance and are challenged to pass through rate increases. "Individual utilities are going to their constituencies and raising rates. It is not always going over well," commented Dreyfuss-Wells. "We are still in a time of economic recovery. The approach needs to be reasonable, which is why the EPA is starting to work with communities on the issue of affordability," remarked Sumego.

"Utilities have no choice but to address the funding shortfall through rate increases or innovative financing options in order to maintain the level of service provided to customers," said Ahmad Habibian, a technical specialist for Black & Veatch's water business, in a company publication.[16]

Industry insiders assert that states should be given flexibility to pursue alternative financing sources—public-private partnerships (P3s), tolling and user fees, and low-cost borrowing through innovative credit and bond programs. Allowing use of tax-favored structures like master limited partnerships (MLPs) and real estate investment trusts (REITs) could also help attract private capital.[17]

Currently under review is the Water Infrastructure Finance and Innovation Act (WIFIA), the purpose of which is to enable utilities around the country to tap additional resources for investing in and upgrading their water infrastructure.

With public finances under pressure, the private sector will have to provide more funding, asserts Bank of America Merrill Lynch in a recent study *A Blue Revolution – Global Water*, which estimates that 30 percent of investment will come from private sources by 2016, compared with only 16 percent today.[5]

"One of the goals of the U.S. Water Alliance is to encourage public-private partnerships through our Business Advisory Council," offered Lorraine Koss. "I can recall when privatization

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within the water sector was very controversial. Now I believe it is generally accepted that it is going to be a significant portion. Not everyone is going to go private, but there are situations where it will be advantageous. Water and wastewater utility directors are now very open to creative financing."

"Public private partnerships are becoming more common," said Dianne Sumego at Black & Veatch. "However, states have different laws, even ordinances, on how utilities enter into these arrangements."

> Oil and gas companies spend $8 billion for water services in U.S. fracking regions. Spending on water management is expected to increase to $11.2 billion by 2022—a 40 percent increase.
>
> Source: IHS Global Insight.

One such agreement was announced in December 2012 by the city of Rialto, California, which through a newly-formed public-partnership, is securing the capital needed to rehabilitate and replace water mains and sewers and fund future water and wastewater system improvements. The City of Rialto and Rialto Water Services, a concession team comprised of Union Labor Life Insurance Co. and private equity investor Table Rock Capital, have hired Veolia Water North America to manage the city's water and wastewater systems. Through this partnership the City of Rialto will retain full ownership of Rialto's water and wastewater systems, water rights, and public authority for rate setting, while Veolia will upgrade, operate and maintain the city's water and wastewater system though a long-term contract.[18]

In December 2012, Kohlberg Kravis Roberts (KKR) and joint venture partner Suez Environment, through subsidiary United Water, entered into a 40-year concession agreement with the Bayonne Municipal Utilities Authority to run the water and wastewater systems for the city of Bayonne, New Jersey. It is the first investment into the U.S. P3 market for KKR. "We are slowly starting to see more cities looking at these partnerships given all the fiscal pressures they're facing," offered Brandon Freiman, a principal at KKR's energy and infrastructure team, in an interview with Reuters PE Hub. "But for every three cities that evaluate these options seriously, at least two ultimately can't get to the finish line. The one that gets to the finish line generally appreciates that these are win-win deals that are good for all constituents. So while we think that there should be more of these deals, progress has been very slow." Industry insiders believe the agreement holds promise as a template for future water and wastewater P3s.[19,20]

"Our communities understand the importance of improving the quality of our water bodies. The challenge they are facing is balancing the spending of millions of dollars they currently do not have to protect the health and safety of their community," commented Sumego. "As consultants, it is critical for us to provide the best alternatives available to improve the water quality with reasonable solutions. We need to be looking at how we sustain each solution by looking at integrated and affordable approaches to the utilities which ultimately affects the public. We are all here for the improvement of our environment, but the cost reward analysis has to be part of that evaluation. It is about prioritizing where the money is spent."

Fracking

Water demand in shale gas production is growing and the subject of increased scrutiny as drilling activities incite public concern over water withdrawals and water quality.

The shale gas boom in the U.S. is expected to play a substantial role in stimulating economic growth and advancing the nation's energy independence. Shale gas is projected to increase to 49 percent of total U.S. gas production by 2035, up from 23 percent in 2010.[21] Growth in the shale gas industry has already made a significant impact on the economy, contributing $76 billion to GDP in 2010, reported IHS Global Insight, and projects increasing to $118 billion by 2015 and tripling to $231 billion in 2035.[22] That growth will not be possible without water.

Hydraulic fracturing (fracking) is a water intensive process. On average, an estimated three to five million gallons of clean water are needed for just one unconventionally

drilled well, which can leave water resources in critical supply in areas that support drilling activity. An estimated 20 to 80 percent of water flows back to the surface as a by-product of the drilling process. Contaminated wastewater must be treated so that it can be either reused or properly discharged to the environment.

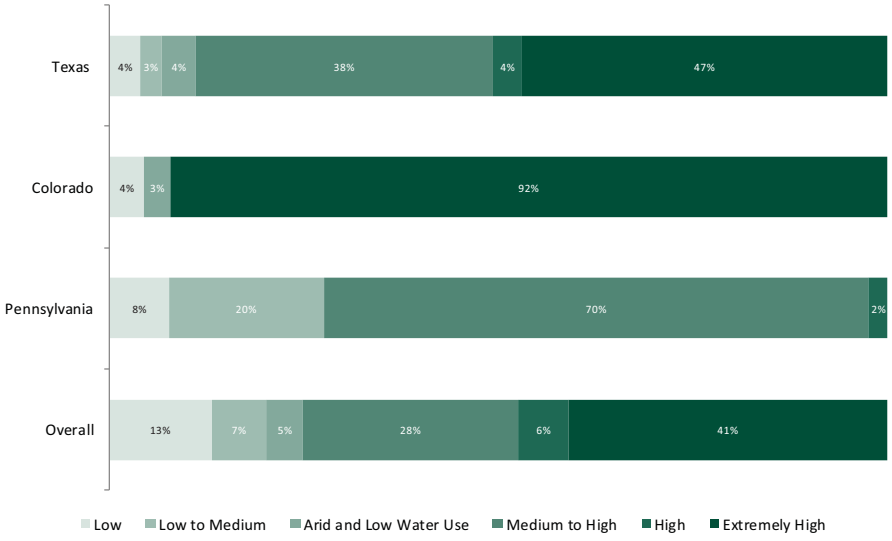
Fresh water costs (acquisition, transport, and disposal) can range from as low as $2/bbl of water (where water is sourced and disposed close to the well site) to more than $20/bbl. In the Marcellus basin, high water costs encourage greater recycling rates.[23] IHS Global Insight estimates oil and gas companies spend $8 billion for water services in U.S. fracking regions. Spending on water management is expected to increase to $11.2 billion by 2022—a 40 percent increase.[24]

Advancements in technology are enabling increased recycling/reuse and the use of alternative sources (e.g., wastewater, saline water, seawater) to reduce reliance on freshwater supplies. Recycling rates in the Marcellus are estimated to reach 40 percent. Saline water use in the Eagle Ford is about 20 percent.[25] Variability in water quality dictates different technologies with treatment and disposal cost central to the recycling/reuse decision. The problem is further complicated because regulations are more stringent in allowing the reuse or discharge of some wastewaters from oilfield operations indicated Tom Pankratz at Global Water Intelligence. "Even if you perform a high level of treatment and get the water down to a potable quality, in some cases you still can't even discharge it. You've got to pump it down a hole," said Pankratz. "It is unfortunate because people are more concerned about the water source than its quality. Public perception is still a factor, although it is slowly changing in many locations."

An increasing number of energy companies and service providers are exploring the use of alternative water sources to minimize fresh water used and innovative water treatment technologies to encourage recycling and reuse. Some examples include:[26]

- In 2012, Chesapeake Energy recycled and reused more than 235 million gallons of produced water. Chesapeake reuses 97 percent of the wastewater associated with its operations in the Marcellus North, 52 percent of the wastewater in the Marcellus South, and 89 percent of the wastewater in the Utica district.
- Antero Resources recycles over 95 percent of its flowback water with the remainder injected into disposal wells.
- Approximately 95 percent of Apache's total water withdrawals come from non-potable water sources such as saline aquifers or seawater.
- Halliburton is performing 70 percent of all fracturing treatments with produced water.

Percentage of Wells in Varying Water Stress Regions



Source: Ceres.

Ceres findings from FracFocus data collected for more than 25,000 tight oil and shale gas wells in operation between January 2011 and September 2012:

- An estimated 68.5 billion gallons of water was used in shale gas development representing the water use of 2.5 million Americans for a year.
- Nearly half of the wells were developed in water basins with high or extremely high water stress.
- Fifty-one percent of wells in Texas were in high or extremely high water stress areas, while 92 percent of Colorado wells were in extremely high water stress areas.
- Texas, Pennsylvania, and Arkansas were identified as the three states with the highest water use for oil and gas development, with a reported 26 billion gallons of water used in Texas.

While total water use for hydraulic fracturing is often less than 2 percent of a state's overall water use, water requirements at the local level can be much higher, highlighted by the Texas counties of Wise and Johnson where fracturing represented 19 and 29 percent of their overall county water use, respectively.

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- Nuverra Environmental Solutions announced a partnership with Halliburton in July 2013 to increase wastewater reuse and recycling in hydraulic fracturing operations in the Bakken Shale.
- Omni Water Solutions, a provider of mobile systems for water treatment and reuse, together with Dow Water & Process Solutions, have treated more than 245,000 barrels of flowback and produced water from Texas' Eagle Ford shale hydraulic fracturing operations.
- Fountain Quail Water Management, a subsidiary of Aqua-Pure Ventures, installed the first Eagle Ford water recycling facility in Kenedy, Texas in June 2011. The plant can now recycle up to 5,000 barrels per day of wastewater. Fountain Quail and Select Energy Services formed a joint venture in September 2013 to expand their oilfield and shale gas water treatment and recycling services.

Expected growth in water recycling will be driven by several factors including greater acceptance with "minimally treating" water, improved economics, and regulatory directives.[23]

Regulatory

Oversight of hydraulic fracturing is evolving, characterized by Accenture in a recent study *Water and Shale Gas Development* as a loose regulatory landscape that is beginning to change with growing state and federal attention. Regulation varies from state to state governing matters such as well casing, chemical disclosure, management of wastewater from flowback and produced water, and water storage and disposal, with standards that are typically more rigorous than federal laws.[21]

> "There needs to be across the board disclosure of the sources of water used for hydraulic fracturing, the amount withdrawn from each source, the amount used for each fracture, and the amount of flowback water (initial flows) and produced water (later flows) returned to the surface."
>
> Source: Ceres.

Recent developments

In 2014, the U.S. EPA is expected to release the final results of a national study assessing the impacts of hydraulic fracturing on drinking water resources, which is expected to provide states with greater clarity on what regulations are required to protect water resources.

In January 2014, California's first regulations on fracking will go into effect requiring oil companies to obtain permits for fracking as well as acidizing, public disclosure of chemicals used, as well as groundwater and air quality monitoring, among other standards.

Chemical disclosure has been the subjection of contention, with some states (Wyoming, Arkansas, and Texas) already implementing regulations requiring disclosure of materials used in fracking fluids. A new voluntary chemical registry, FracFocus, was launched in April 2011 by the Department of Energy and the Ground Water Protection Council for companies to report chemicals. Wyoming was the first state to adopt fracking chemical disclosure rules in 2010; in March 2014, new regulation for testing water wells near drilling sites will take effect.[27]

States are taking steps to encourage and mandate more recycling, including easing permitting requirements. Some examples include:[23]

- The Texas Railroad Commission changed permitting requirements in March 2013 making it easier to recycle.
- Pending legislation in Texas includes HB 2992, which would require that produced water can only be disposed of if it cannot be treated and HB 3249, which would add recycling to Natural Resources Code section on water protection.
- The Center for Sustainable Shale Development in Pennsylvania, launched in March 2013, is calling for 90 percent recycle rates.

Water management warrants greater attention from both industry and regulators asserts Ceres, which calls for better understanding of how water needs and impact are measured and managed. Recommendations include disclosure of water sources, amount of withdrawals, and amount of flowback and produced water.[25]

Perspective

What issues are you seeing in water use related to fracking activities?

Jeffrey Huntsberger, McDonald Hopkins. When people think about fracking, the first thing they think about is water. That is true in regions like the Midwest where there is a lot of water, and it is certainly true in the more arid parts of the country like the Southwest where they have very little and have experienced drought conditions.

> In the Marcellus, typical drilling and completion operations use approximately 4 million gallons of water (1,000 truckloads). Once stimulated, operators typically recover 350 truckloads of flowback water that will require disposal.
>
> Source: Halliburton.

Jeffrey Dick, Natural Gas and Water Resources Institute. The overarching issue is taking the available water and then using it in oil and gas processes, primarily hydraulic fracturing, where the majority of it is going to end up going into Class II injection wells. It is the removing of water that is usable by humans and locking it into the earth. Next come issues like water quantity—what is a safe withdrawal, what are the contamination issues for groundwater and surface water. In the western states it is all of that plus it is competition for the use of water, so farmers are looking at it and saying, will there be enough left for us. Municipalities are doing to same thing. It is a scarcity motif.

Huntsberger. Public perception is at the heart of it. I don't care how much water you have, people naturally are concerned that surface water is now put underground and arguably lost forever.

Ben Cowan, Locke Lord. Fracking has obviously created an energy boom in the country. It is this great untapped source of domestic oil and gas. But what it has really done is bring drilling closer to areas that have never before had any experience with it. Everyone likes the income it generates, but people are worried about the impacts on health and the environment.

Dick. At the end of the day, if we were better able to manage perception, water management wouldn't be nearly as much of an issue as it is perceived to be, if an issue at all.

Huntsberger. And the industry really isn't doing that. You don't hear much from the industry on what they are doing to conserve water other than recycling flowback. That is the only thing you hear about.

Sean Logan, Sean Logan & Associates LLC and former Chief of Conservation for the Muskingum Watershed Conservancy District. In Eastern Ohio, now more than ever, water owners and water users need to communicate and plan much better than we have. From identifying how much water is available to identifying ways of reducing its use or permanent consumption, we need help to make sure we leave a good legacy.

What dynamics have you observed in water sourcing?

Cowan. Fundamentally, water supply is a state law issue. You have to separate groundwater and surface water because they are regulated differently in most states. In Texas, groundwater is owned by the landowner above it, and surface water is owned by the state. You can't divert surface water in Texas, meaning take water from a lake or a stream, without obtaining a water right permit from the Texas Commission on Environmental Quality.

Water supply has become a much bigger concern, particularly in the last few years, and is certainly a bigger concern in the western states. When you are talking millions of gallons to frack a well, the big issues become, where do you get the water from and how do you get it to where you need it? There are fewer frack jobs taking place but they are bigger. The volume of water needed to frack a well actually seems to be increasing.

Dick. If the success of companies like Gulfport carries over to other parts of the Utica play, the volumes of water being used are going to be much greater. In their newer wells, they are using 13 to 15 million gallons of water instead of the traditional 5 million that you hear about all the time.

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Theodore Esborn, McDonald Hopkins. The key in Ohio is where you get the water. The Ohio Department of Natural Resources (ODNR) regulates overall use or quantity. The Ohio EPA regulates quality. If you are taking the water from the Lake Erie Basin or the Great Lakes Basin, you cannot divert it out of that basin. You can't truck it. You can't pipe it. You can't in any way convey it outside the boundaries of that basin for any purpose but specifically for any oil and gas exploration purpose. The regulators here are very vigilant on that point. All the Great Lakes states and the province of Ontario are very protective of the Great Lakes water resource.

Dick. In Ohio, there is not a supply issue. There is enough water that flows down the Muskingum River in one day to supply all the hydraulic fracturing needs for the next 20 years. And you are probably getting more water drawn up through a well than you are ever putting down into it because of the produced water over time. Whether that produced water is ever useful and is ever itself purified or put back down in a Class II injection well that is a question.

Project Development and Engineering Company. In Ohio, most of the operators have been able to find the volumes necessary. That is surface water, not typically much from groundwater wells. When I've seen groundwater used, they had constructed large impoundments and would pump the groundwater into those impoundments over a long period of time so that it is available when they need it. Another source is treated wastewater, buying water directly from a municipality or utility out of their distribution system. There is a lot of water there that could be used to frack wells. Zero revenue is being generated from that discharge now. There is a revenue stream there. It is an education.

Logan. The most vulnerable point we are in terms of water supply and where we really need to be thinking hard about sustainability is groundwater being used for hydraulic fracturing. It is not wise as a society to use groundwater for hydraulic fracturing. Ground water should be of the utmost priority of protection based upon use not just ownership.

> "In the Eagle Ford shale region, oil and gas exploration, development, and extraction and mining accounts for 6.5 percent of water demand; that demand is expected to increase by 26 percent from 2010 to 2060 for the region."
>
> Source: Luke Metzger, Environment Texas.

What are the standards and current practices in wastewater disposal?

Cowan. Water disposal is handled differently in different regions of the country, largely based on geology. Treatment facilities aren't equipped to handle this kind of wastewater, and the volumes are large so treatment prior to disposal is an issue. It becomes more complicated in regions where disposal wells aren't readily available.

There is not really a disposal well capacity issue in Texas. There is absolutely a capacity issue in Pennsylvania. Disposal wells are just not an option in some parts of the country so disposal becomes a major issue.

Project Development and Engineering Company. If there is flowback or produced water, the cheapest alternative for players in the Utica is to dispose of it in an injection well. When economics might change for operators is in the production phase when they are fracking multiple wells in a pad. When you can treat frack water onsite or at a centralized location, there is an immediate area that can reuse that water, so you'd be paying less to recycle and reuse than you would to dispose and secure fresh water. That only becomes feasible if there is a lot of concentrated activity in one area.
West Virginia and Pennsylvania have very few injection wells which has to do with the geology. There is plenty of potential capacity in Ohio. That is why there is more recycling going on in Pennsylvania. To dispose of the water, you have to truck it longer distances which makes it more expensive.

Huntsberger. Ohio does face a challenge in terms of being able to receive and dispose of all the wastewater from the

Marcellus and Utica plays in the injection wells we have here now. Pennsylvania, West Virginia, and New York ban any kind of surface water disposal even of treated waste fluids.

Logan. The Ohio Department of Natural Resources' injection well program is more stringent than the U.S. EPA regulatory program, so it is being handled the right way. But is there a better way besides deep well injection? The answer is there has to be.

What are the contamination risks?

Cowan. There is a lot of misinformation out there about the impacts of fracking on groundwater supplies. The process of fracking does not inherently present a risk; wells are being fracked at thousands of feet below the depth of groundwater supplies.

Dick. Scientific studies have proven that the fracking process itself will have no impact on groundwater. The risk in a shale well, as has been the risk since the 1880's, has been in a defective casing. The reality is that the science behind it and the process is so much more protective than it was just ten years ago that the odds of a well contaminating groundwater through a bad casing are far less than they have been. And with the cost to drill a well at $7 to $8 million, it is in the best interest of the oil and gas companies to avoid it for economic reasons not to mention liability reasons. If all you did is look at the media, you would think the shale gas industry is destroying our water resources, which isn't the case.

Esborn. You can almost name the sites where drilling-related accidents may have contaminated a water supply, but the exceptions almost prove the rule. If this were as dangerous a process as people claim, you would be hearing about a lot more of these sites, and you wouldn't be able to have the exceptions at the tip of your tongue.

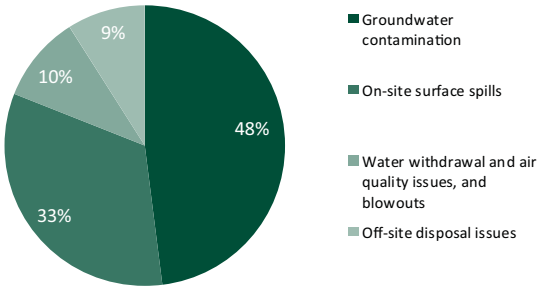
Dick. If there is going to be a risk of contamination of ground water, it is going to occur when the water is up above the surface when it is being handled. Fracking fluids are hazardous materials when brought up to the surface. History in the oil and gas industry of contamination of water and soil is really centered on spills.

How is the regulatory landscape evolving to keep pace with the industry's rapid growth?

Water Contamination Incidents Related to Gas Well Drilling

"According to the *Massachusetts Institute of Technology (MIT) 2011 Gas Report*, which reviewed three studies of publicly reported incidents related to gas well drilling, there were only 43 "widely reported" water contamination incidents related to gas well drilling in the past decade (to 2010), during which time there were about 20,000 shale gas wells drilled with almost all of them being hydraulically fractured."

"In the studies surveyed, no incidents are reported which conclusively demonstrate contamination of shallow water zones with fracture fluids."



Source: Accenture "Water and Shale Gas Development" from the Massachusetts Institute of Technology 2011 Gas Report

Cowan. There is really a patchwork approach to regulation of the industry, which is not unlike many other industries. With respect to wastewater, the Clean Water Act establishes the basic framework. Many states have been delegated authority by EPA to handle the permitting under the Clean Water Act. Those discharge permits are issued at the state level, but many localities also are imposing their own restrictions, so while it is principally on a state-by-state basis you have to be cognizant of local laws. Regulation is regionally diverse and very much a local issue.

Huntsberger. Colorado is among the most regulated states from a water use standpoint. There you basically can't use water without getting a permit. In Ohio, it is more liberal use.

Cowan. Chemical disclosure is another "hot" area of fracking regulation. The federal government came out with fracking chemical disclosure rules which apply when you are on federal land. Several states also have adopted laws that require certain levels of disclosure. It is becoming problematic because every state is implementing a slightly different regime. The trade secret aspect of that is really significant. It is definitely an area that is getting a lot of

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focus because of the concern about what is in the water, i.e., is it going to contaminate ground water supplies.

Some states have adopted legislation that either prohibits fracking within a certain distance from a drinking water well or requires a certain testing regime. Every state is handling that differently.

Logan. We still have a need for more regulatory authority on water withdrawals. In the region of northern Ohio that drains to Lake Erie, there is a comprehensive water withdrawal regulatory program subject to the Great Lakes Compact, which provides an effective foundation that not only respects downstream land owners and the ecology of a given watershed but also makes water available for progress. Conversely, in the Ohio River basin, there is very little regulation on withdrawing water, whether surface water or ground water. It is almost a first come, first serve approach.

The other need, regardless of the end use, is empirical data for how much water flows in a given area. For example, we know there is a lot of water in Eastern Ohio in the middle of the Utica play, but we need to know how much of a flow we have. We don't even know how much total volume is being withdrawn except for our public entities. We are in desperate need of more stream flow gauges.

Project Development and Engineering Company. Right now in Ohio, there is no coordination to know specifically when an operator is planning on using water out of a source. You can have a number of intakes up and down a given stream in Eastern Ohio. If each of the producers plan on using the stream and all of the well pads want to frack at the same time during the same week, there is no coordination to know that is going to happen. That would have an immediate impact on that source where it might affect the volumes of water available for other uses locally.

Logan. A solution would be to create a regional monitoring system to track where withdrawals are taking place, making it transparent enough for public entities yet protective of proprietary interests. When you get enough data to show how much excess surface water you have, you can very cautiously and prudently make that available for hydraulic fracturing. The additional revenue can help provide other public benefits such as improving wastewater treatment plants and/or extending drinking water lines so that more people have access to better drinking water so you can effectuate some change at both ends of the water use.

The industry appears to be very conscientious about how much they withdraw, which is why I believe there is more of a missed opportunity as it relates to infrastructure and legacy benefits than an environmental threat. I think with the support of both public and private financing, funding the infrastructure needs necessary to sustainably supply water in our region is very doable. I think that is a very real public private partnership that is further available.

Do you anticipate more stringent regulatory oversight in the future as production ramps up?

Esborn. I don't. The U.S. EPA was mandated by Congress in 2009 to perform a study of the impact of hydraulic fracturing on water resources. There doesn't seem to be any urgency even to get that study done; we aren't expected to see results until 2016. Insiders are saying that if there is going to be federal legislation, it will be based on that study. This Administration is not showing any urgency to be in a place to regulate or to have data to regulate.

The fact is we've been fracking in this country for 60 years. It is only recently that we've been doing it horizontally. Technology continues to improve, so I don't think there is a big rush to necessarily regulate the technology or even the disposal process. The EPA has had its injection well program in place since the mid 1980's, and there really is no history that it hasn't worked either. Despite the attention that fracking is getting, I don't see any rush to overly regulate.

Cowan. We are definitely keeping an eye on federal regulation, which up to this point has been limited to activities taking place on federal lands. I don't think it is going to get expanded beyond that, but there are certainly people lobbying for the EPA to regulate fracking. So much of the focus in the media is on groundwater contamination.

Water reuse is advancing and is an area where significant investment is being directed. What developments are you seeing in the market as it relates to recycling/reuse?

Dick. It is a matter of practicality that we look for alternatives. Obviously in the western areas where it is much drier, it is a much more pressing need to conserve and make better use of water and come up with alternatives to injection.

Esborn. Texas is doing away with requiring permits for water recycling operations. They almost want to deregulate it—make it easier to do.

Logan. The Ohio Department of Natural Resources (ODNR) appears to be stepping up to permit activities that lead to greater reuse or recycling. It is a heavy infrastructure process for the private sector and that would employ central impoundments. ODNR hopes to have a new set of rules to be considered by January 2014 dealing with impoundments. It is a hot debate.

Huntsberger. In Ohio, regulations are coming out for recycling facility permits. Most of the operators are very protective of their formulations. They will fight tooth and nail to have any kind of public analysis done of their fluids even for purposes of compliance. There will be a lot of resistance to that.

What solutions will be implemented to address water needs?

Cowan. There is an increasing focus on water recycling, water treatment, and reuse. Some of the oil majors that are involved are investing in water treatment facilities that will allow them to recycle. It is an area where there should be a lot of focus because reuse can obviously alleviate the pressure on water supply. The issue that all of the technologies face is that not all water is the same. Because water chemistry is different everywhere you go, you have to have a different treatment process for it. The challenge is finding a treatment process that is going to be effective in a wide range of shales. It makes it challenging to come up with a one-size-fits-all solution.

Logan. Solutions will be infrastructure-based, whether that means additional stream gauging to measure how much flow occurs in a particular stream or the transfer of water and how that water is recycled, not just reused. The oil and gas industry talks of recycling but really what they are doing is reusing. Recycling would be to return it to its previous state which is not threatening to environment or humans so that it is not deep well injected.

I believe there is a very solid marketplace-based solution, from water owners and water users working together to the build out of additional water infrastructure. That includes public water owners being responsible participants in the market of supplying water.

Cowan. Generally speaking, wastewater can be treated. It is a matter of setting up a treatment plant that can be nimble enough because you don't need a permanent wastewater treatment plant next to a well. It has to be somewhat modular or portable. You can put up a centrally located plant, but then you have to truck the water there from all the different wells, or lay pipelines so you need to have enough of a customer base in the area. Then you have to run the pipelines or trucks. The logistics of it are as challenging as the chemistry of it.

Dick. Fracking presents logistics challenges, even in regions like Ohio where there isn't a supply problem. As plays like the Utica mature, we will see less trucking of water and more construction of water impoundments with pipeline systems and pumps running out to the various well pads. Once producers can get enough midstream and collection lines in place, they will come back to pads where they've drilled one well and they'll start drilling more. Once they start doing that, they will need a lot more water, and they will start looking at building centralized containment ponds and then distributing the water from there to the various drill pads.

What is the current state of technology?

Huntsberger. Any company that is involved in recycling or cleaning water is interested in how they fit into this energy play. One of the challenges is everybody's fluid formulation is different. Coming up with one mousetrap that works for everybody is challenging.

Ebie Holst, Clean WaterNet. Produced water represents a big expense for the oil and gas industry in terms of disposal, but because it is so salty, it is very expensive to desalinate for reuse. An interesting area of innovation is in low energy desalination and onsite reuse technologies.

Logan. It is difficult to get your hands around which technology is going to be the best solution. It is not like treating surface water to make it potable. You have

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various treatment technologies to address the different physical and chemical components of the water. I think moving resources, whether public or private, into helping technology catch up would be one good way of making that happen. It would be worthy of our efforts.

Tom Pankratz, Global Water Intelligence. This is still very much an art as opposed to a science. In my opinion, there may never be a technology that is universal or at least not for the next 10 or 20 years. It may be that there are a couple of technologies that are used. The industry is complicated by the fact that the supply chain is so fragmented and poorly defined. The quality of produced water changes from well to well and from play to play and from region to region. Also, even within the same well, the water quality changes over time.

New technologies are more expensive and require more energy. Water from some of the shale formations, especially in the Marcellus shale, can be three to eight times saltier than seawater, which is an important factor in water treatment because energy requirements increase with salt concentration. Levels of treatment can be extremely high and cost a lot of money. It can be the determining cost whether an oil well is even viable to produce. In some cases, the cost of treating the water can be between $4 and $8 to $10 a barrel. If you've got a barrel of oil selling for $100 and you're producing 7 or 8 barrels of water, it is costing you $6 a barrel to treat that. You start looking at the numbers. That is a major issue.

Technology is changing rapidly which lends itself to more mobile and semi-permanent treatment facilities. It used to be that you drill one well from one pad. Now it is possible to drill ten or more wells from the same pad. The real solution is having mobile assets that can be called in short-term and treat the wells in a region or geographic area, whether it is a few miles or a few counties. Even with that, the quantity and quality of water changes. There isn't a one-size-fits-all solution.

Where do you see the opportunities for environmental services companies that are involved in water management?

Cowan. The water services industry is highly fragmented with low barriers to entry. There are a number of companies that have grown through acquisition and are focused on providing more comprehensive water management solutions from sourcing and distribution to treatment and disposal of the water. The M&A market was very active but has since slowed down as players digest their acquisitions.

There is a lot of pricing pressure on the service providers making the economics less attractive right now, but that will change with time and as technology improves. As environmental regulations become more stringent, barriers to success will go up. When you have rules to comply with in terms of water storage, management and disposal, it can start to get expensive. It requires more sophistication and better environmental compliance management systems. I think eventually you are going to see even more consolidation.

Tapping New Water Sources

Technology is bridging the "water gap" as water scarce regions are increasingly turning to desalination and reuse to meet supply needs.

Desalination

Proponents of desalination view the technology as a "drought-proof tool" and a new source of water essential to meeting supply needs. Bloomberg New Energy Finance (BNEF), in a 2011 study, forecasts the global desalination market will reach $30 billion by 2019, fueled by increasing demand for fresh water and technological improvements that have reduced costs and increased energy efficiency.[28]

Key research findings include:[28]

- The Middle East and Africa (MENA) will lead with 79 percent of global capacity, followed by the United States (8 percent), Australia (5 percent), Europe (4 percent). Collectively, India, Sub-Saharan Africa, and China will share about 5 percent.
- Advancements in technology will be key to growth, with further developments in membrane-based technologies expected to further reduce cost and make desalination more affordable.
- Forward osmosis and low-temperature desalination cited as the most promising disruptive technologies because they can efficiently use renewable energy sources and be used in smaller-scale plants.
- Small- and medium-scale plants expected in future.

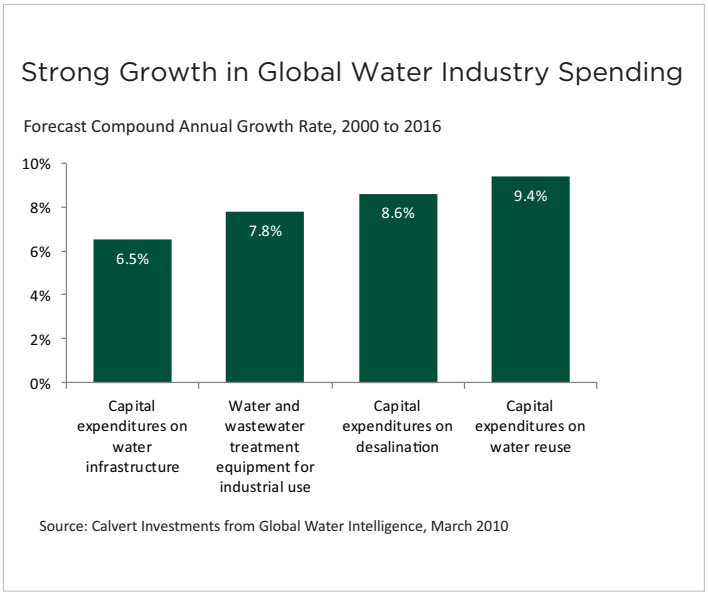
Bank of America Merrill Lynch, in an analysis of the global water market, *A Blue Revolution – Global Water* projects desalination could represent a $25 billion market by 2025.[5]

"The U.S. has been blessed compared to many other parts of the world in that it has had a lot of other freshwater supplies that were less expensive to provide to the public," said Rudy Truby, the International Desalination Association's comptroller, in an interview with *Engineering New Record*. "What's happening now is, as population has grown, many of the high-growth places in California, Texas, and Florida, where there isn't an excess of surface water or well water… are having to turn to the sea."[29]

"When people say desalination, most think of desalinating seawater. While that is a big part of desalination, it is unique to coastal areas. When you start getting in inland areas, there is also desalination of brackish water. You may even take water that is near potable quality in terms of salt content and run it through a reverse osmosis or other desalination process to remove some of the pollutants or produce a higher quality water for drinking," said Tom Pankratz at Global Water Intelligence.

Major criticisms of desalination are its high cost and energy requirements, with seawater more energy-intensive to treat than brackish water. Brackish water is more cost effective in inland areas when factoring in comparative cost to transport water. Disposal of salty waste is another area of concern. Insiders say desalination is most effective when used as part of an integrated water plan. Conservation and reuse come first with desalination supplementing these measures.

In high salinity industrial wastewaters or brines, operators usually are interested in volume reduction, where it may be necessary to turn to evaporation or other newer desalination processes like forward osmosis or membrane distillation, according to Pankratz. Desalination has application in water reclamation from hydraulic fracturing, indicated Ben Grumbles, president of the U.S. Water Alliance. "The big opportunity is to find affordable and environmentally protective ways to reclaim and reuse the large volumes of brackish frack water and other produced waters so they aren't simply discharged or buried as waste," said Grumbles in an interview with Water Law & Policy Monitor. "This journey of produced water going from waste to wealth is closely related to desalination research and practice. Much of it can be boiled down to removing large amounts of salt without spending large amounts of money and energy."[30]



Technology

Reverse osmosis and multi-stage flash distillation will lead desalination technology with an estimated 45 percent and 43 percent of the global market respectively. BNEF anticipates that developments in membrane-based technologies such as forward osmosis and membrane distillation and advancements in membrane technology like the use of ceramic membranes will further reduce the cost of desalination. Renewables is expected to gain traction in the future.[28]

"Desalination has been around for a long time, but has historically been very energy intensive. Where the innovation seems to be occurring in this area is around technologies that are less energy intensive," observed Ebie Holst at Clean WaterNet. "Not surprisingly, innovation in this area tends to show up where there is water scarcity such as the U.S. West and Southwest because that is where demand for 'new' water sources is on the rise. Some innovating companies are being opportunistic in recognizing that desalination is an issue being actively explored in oil and gas water reuse or recycling."

Forward osmosis (FO) has been recognized as one of the hottest topics in the water industry, according to Modern Water Executive Chairman Neil McDougall.[31] Modern Water owns, installs, and operates membrane technology and develops and supplies advanced systems for water monitoring. The company's FO process requires up to 40 percent less energy than traditional desalination. Modern Water designed and installed the world's first commercial

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FO desalination plant in Oman in 2012. The company raised capital from IP Group and other undisclosed investors through a PIPE in February 2013.[32]

Another emerging FO player is Oasys Water, whose patented forward osmosis technology platform offers up to an 80 percent reduction in cost when treating saline and impaired waters.[33] In October 2013, Oasys secured $15 million in Series B financing from a syndicate of strategic and existing investors including Flagship Ventures, Advanced Technology Partners, and Draper Fisher Jurvetson bringing cumulative capital raised to $25 million.[32, 34]

Desalination plants come with a high capital cost. The way that most large projects and even many smaller ones will have to get financed is through public-private partnerships, indicated Pankratz. "Communities in West Texas, for example, are not big enough and don't have enough tax revenue to justify building a brackish water desalination plant and the pipeline that is required to take the brine away and deep well inject it. They are looking at forming a joint venture or special purpose entity in which the city is a shareholder or the city enters into a long-term water purchase agreement with a private entity. That water purchase agreement is bankable and can be financed for 20 or 30 years," commented Tom Pankratz at Global Water Intelligence.

"In the United States, investments in desalination have historically been made on a very isolated basis with specific sub-regions and municipalities trying to address water supply issues," remarked Ebie Holst at Clean WaterNet. "Virtually anywhere in the world where you see significant investment in desalination, however, you will generally see investment shift from desalination to recycling and reuse over time, because it tends to be a lot cheaper."

The largest seawater desalination plant in the United States is under construction in Carlsbad, California. The facility will supply up to 54 million gallons a day of high quality water to San Diego County (representing 7 to 9 percent of the region's drinking water needs) under a 30-year off-take agreement with the San Diego County Water Authority—the first public-private partnership of its kind in the United States.[29,35] Once completed, the Carlsbad Desalination Plant will be the largest desalination plant in the Western Hemisphere. Orion Water Partners, a joint venture of Stonepeak Infrastructure Partners and Poseidon Resources (a subsidiary of Poseidon Water), is the developer and will operate the facility. Construction began December 2012 and is expected to be completed by 2015.[35]

Energy Recovery is supplying equipment for the $1 billion project. CEO Tom Rooney anticipates that the completion of the plant will help other similar projects to gain approval, indicating that at least 19 desalination plants are in various stages of development in California alone, according to an interview with *Forbes*. "It's breaking of the dam in terms of what's likely to be a cavalcade of desalination plants and projects all around the United States," Rooney said.[36] "It's being watched closely right now," said Peter MacLaggan, senior vice president of Poseidon Water, in an interview with *Engineering News Record*, adding, "We're very confident that this project will be a model when it's completed."[29]

Regulatory hurdles have the potential to limit U.S. growth insiders say. According to WateReuse President Wade Miller, California requires 27 permits to site a desalination plant and the time line could take years. The Carlsbad project "has provided a regulatory roadmap for streamlining the process," according to Scott Maloni, of Poseidon Resources, speaking to a smoother permitting process for future projects under development. Poseidon is constructing a second desalination plant in Huntington Beach, California. The 50-million-gallon-a-day facility is expected be operational in 2018.[30]

"Eventually the United States will need to tap new sources of water, and desalination will have to be one of the critical tools used," said Harold Fravel, executive director of the American Membrane Technology Association, in an interview with Water Law & Policy Monitor. "We're getting to a point where the sources have become more difficult to treat and conventional methods aren't going to work. As the population grows, and as we start seeing a shift in population location, I think they are going to rely heavily on technology to augment their water supplies."[30]

Reuse

Reuse is the fastest growing niche of the water industry, according to Matthew Sheldon, a portfolio manager for the Calvert Global Water Fund[7], and represents a new source of water supply, underlying a broader shift in attitude that no longer speaks of "wastewater" but rather "water that is wasted" according to G. Tracy Mehan III, a principal of The Cadmus Group.[4] Reclaimed supplies are becoming more attractive as population growth and climate change exert pressures on water availability, with wastewater reuse a means to reduce fresh water demand.

> "From the earliest of times, most wastewater has truly been wasted. However, it is a vast resource if we reclaim it properly, which includes the separation of municipal from industrial wastewater. Another way of envisioning the volume of the resource potentially available worldwide each year is to imagine 14 months watching the outflow from the Mississippi River into the Gulf of Mexico."
>
> Source: Zafar Adeel, UNU-INWEH.

Globally, municipal wastewater reuse rates vary widely, reports Blue Tech Research, which identifies Israel with the highest reuse rate at over 80 percent, followed by Singapore (35 percent), Australia (16 percent), China (9 percent), United States (6.5 percent), and Southern European Countries (3.5 percent). In the United States, Florida, Texas, and California account for over 85 percent of the U.S. wastewater reuse capacity and all have water reuse rates over 10 percent.[37] Similar global reuse statistics reported by GWI show Kuwait leading with 91 percent reuse of its wastewater, followed by Israel (85 percent), Singapore (35 percent), and Egypt (32 percent). Australia, China, and the United States are all recycling less than 20 percent.[38]

Types of water reuse include non-potable reuse and potable reuse (indirect potable reuse (IPR) and direct potable reuse (DPR)). Non potable reuse is dominant today, accounting for 87 percent of water reuse in the United States, 89 percent in Singapore, and over 99 percent in Europe. BlueTech forecasts that IPR is set for explosive growth as public acceptance grows.[37]

Pre-treatment with membranes, reverse osmosis, and advanced oxidation will soon become the standard form of urban water reuse, reports GWI. Capital expenditure on advanced water reuse is projected to grow at a CAGR of 19.5 percent between 2009 and 2016, with the global installed capacity of high quality water reuse plants increasing nearly three-fold, growing from 28 million m^3/day to 79 million m^3/day. China is projected to install additional capacity of 10.7 million m^3/day during the forecast period while the United States will install 5.9 million m^3/day making them the top growth markets for water reuse.[38]

Global barriers to reuse include public perception, pricing, and regulatory challenges.[39]

In 2012, the National Research Council released *Water Reuse: Potential for Expanding the Nation's Water Supply Through Reuse of Municipal Wastewater*, the findings of a three-year study which support that reclaimed water can contribute a growing portion of U.S. drinking water supplies and be as safe as conventional sources.[40] Jorg Drewes, a reuse expert and contributor to the study, calls reclaimed wastewater a "...supply that is as safe as the current drinking water supplies." Drewes is a Professor of Civil and Environmental Engineering and Director of Research for the NSF Engineering Research Center on Reinventing the Nation's Urban Water Infrastructure (ReNUWIt). He also serves as associate director of the Advanced Water Technology Center (AQWATEC) at the Colorado School of Mines. "Wastewater is a drought-proof supply. People are always generating wastewater," said Drewes in a water reuse panel discussion, adding that reclaimed water is cheaper than desalinated water. High quality reclaimed water can be repurposed for beneficial use including agricultural irrigation, groundwater recharge, and industrial uses, such as processing water and cooling water, among other uses.[41]

Worldwide, prominent reuse projects serve as industry models. One is Singapore's NEWater, which supplies 30 percent of the country's total water demand and is projected to meet 50 percent of future water demand by 2060.[42] California's Orange County Groundwater Replenishment System, operational since January 2008, can produce up to 70 million gallons daily—enough water to meet the needs of nearly 600,000 residents in north and central Orange County, California. The facility uses less than one-third the energy that it takes to desalinate ocean

Spotlight On: Water Management

water and is considered one of the most celebrated civil engineering and water reuse projects in the world.[43]

Recharging U.S. water supplies

Municipal wastewater reuse offers the potential to significantly increase the nation's total available water resources, according to the National Research Council (NRC). The NRC reports that approximately 12 billion gallons of municipal wastewater effluent is discharged each day out of the 32 billion gallons per day discharged nationwide. Reusing these coastal discharges would directly augment available water resources, equivalent to 6 percent of the estimated total U.S. water use or 27 percent of public supply. Over 90 percent of the nation's total wastewater reuse is located in four states—Arizona, California, Florida, and Texas.[33] Florida leads with a wastewater reuse rate of 67 percent and has the highest installed capacity with over 1,700 million gallons per day.[44] "Water reuse is a key issue in the United States, which is more prevalent in areas west of the Mississippi. There are a number of areas in the Northeast and Southeast that are also looking at implementing water reuse," observed Lorraine Koss at the U.S. Water Alliance. In addition to industrial and agriculture use, reuse can ultimately fulfill drinking water needs Koss said. "In some areas, that is going to be a necessity. Like Singapore where reuse is more pervasive, there are other places around the world that are going to be forced into that position too." Koss continued, "The technology is available but it is not cheap; however, reuse can be a less expensive, more efficient alternative to costly infrastructure improvements."

"We can reuse water safely, but what we don't have yet is public acceptance, certainly not at the level that we need for more widespread adoption. There needs to be an understanding that it is actually safe to do that," remarked Koss. Key to public acceptance is to combine recycled water with natural systems.[31]

"There is historically a reference to grey water which would be shower water or dishwasher water, but there the term purple water is being applied more and more to the recycling of water from one purpose to be used for another," commented Ebie Holst at Clean WaterNet. "Take wastewater from a mining site. It may not be easily made suitable for residential use, but it might be pragmatically applied for use in cooling towers for electric power generation." Holst continued, "In drier regions of the U.S., the power generation industry is under stress with water availability, and the purchasing of wastewater from the oil and gas industry to cool plants is being explored. We will see more thinking like this ahead as industries and communities explore their water priorities and requirements across applications."

Reuse and recycling will get more highly specialized over the next five years as a result, Holst said. "Reuse for oil and gas means something different than household reuse in a community under water restrictions," commented Holst. "Reuse in oil and gas might mean we use whatever flows back and then we buy more fresh water and add to it to dilute it, or we actually use both the flowback and produced water and clean it to a level high enough that we can reuse all of it. Those are different definitions and implied technologies than will be relevant to the residential market in which the influent is less variable and the effluent water quality standard is higher but a closed-cycle treatment system may be viable. With reuse at the well site however, the cycle is generally is finite because the total dissolved solids in the water accumulate with every reuse and eventually, disposal of that water becomes necessary."

"One of the options is stormwater," commented Tom Pankratz at Global Water Intelligence. "It certainly is a lot of water that could be used, but where are you going to store it, what is it going to cost to treat it, and can you really rely on it? The answer to those questions forces you in the direction of desalination." Pankratz continued, "It is the only weather independent water supply. Another source that some areas are considering is produced water that is treated and used for agricultural or industrial purposes. "There has to be a reshuffling of what we are doing with the available resources and making sure that we are matching the resource with the use for which it makes the most sense."

"In many locations, it is impossible to reuse or conserve your way our of a water supply problem," Pankratz said.

SELECTED INVESTMENT ACTIVITY IN WATER

Company	Investor	
212	Element Partners	PE GROWTH
ABS Materials	Harris+Harris Group	VENTURE CAPITAL
APTwater	True North Venture Partners, XPV Capital Corporation, KPCB (Kleiner Perkins Caufield Byers)	VENTURE CAPITAL
AquaMost	Keane D'Souza Venture Capital	VENTURE CAPITAL
AQUION	Mason Wells	PE BUYOUT
Armada	Undisclosed	VENTURE CAPITAL
Banyan Water (smart water management)	Catamount Ventures, Cue Ball	VENTURE CAPITAL
bcr	True North Venture Partners	VENTURE CAPITAL
Buckhorn Energy Services	OFS Energy Fund	VENTURE CAPITAL
Clean Runner (Clean Water Solutions)	Cate Street Capital	VENTURE CAPITAL
Desalitech	Liberation Capital, AquaGrofund	VENTURE CAPITAL
Evoqua Water Technologies	AEA	PE BUYOUT
FilterBoxx (Water and Environmental)	XPV Capital Corporation, EnerTech Capital	VENTURE CAPITAL
High Sierra Water	NGL Energy Partners LP	PE BUYOUT
HydroRecovery	Shaner Capital L.P.	VENTURE CAPITAL

Company	Investor	
Kaselco (Water Treatment Solutions)	Permira	PE BUYOUT
Nano H_2O	BASF Venture Capital GmbH, Total Energy Ventures Intl, Keytone Ventures	VENTURE CAPITAL
Oasys Water	Flagship Ventures, ATV (Advanced Technology Ventures), DFJ	VENTURE CAPITAL
Omni Water Solutions	AustinVentures	VENTURE CAPITAL
Pasteurization Technology Group	EIC Ventures, Kennington	VENTURE CAPITAL
Poseidon Water	Stonepeak Infrastructure Partners	PE GROWTH
SWD (Pyote Water Systems)	Altpoint Capital	VENTURE CAPITAL
pwa	OFS Energy Fund	VENTURE CAPITAL
r3fusion	Northwater Capital	VENTURE CAPITAL
RedZone Robotics	ABS Capital Partners, Meidlinger Partners	VENTURE CAPITAL
Rockwater Energy Solutions	SCF Partners	VENTURE CAPITAL
Scinor Water Technology	CLSA Capital Partners, KPCB (Kleiner Perkins Caufield Byers)	VENTURE CAPITAL
Stonybrook	BV Battery Ventures	VENTURE CAPITAL
U.S. Water Services	Excellere Partners	PE BUYOUT
AWT3	OFS Energy Fund	VENTURE CAPITAL

Insider Perspective

EXCELLERE PARTNERS

U.S. WATER SERVICES

Excellere Partners backs U.S. Water Services, a leading independent, fully-integrated, industrial/commercial water treatment company serving a wide range of industrial, commercial, and institutional accounts in the U.S. Patrick O' Keefe, a principal at Excellere who oversees the investment, shared with us his thoughts on the business and changing dynamics in the industry.

As an investor looking at the industry, you spent considerable time on formulating your investment thesis and finding the right platform. How did you arrive at the decision to invest in the water industry?

When we first began looking at the water space several years ago, the magnitude of the dollars being spent in and around water were just staggering. Where we were actually challenged was figuring out how do you play it? A lot of the investment is going into municipal infrastructure, which, from a private equity perspective, can be more difficult to play.

Our first investment in the space is U.S. Water Services, an integrated industrial water treatment company that offers chemical products and support services and engineered water treatment equipment (pretreatment systems, chemical feed systems, custom platform controls, and automation).

U.S Water Services works within the oil and gas production and midstream sectors treating wells and pipelines with corrosion inhibitors, scale inhibitors, and biocides. Oil and gas has been one of the growth areas for most of these companies.

The industry is highly fragmented, with the four largest companies holding a significant share of the market and several small, regional and even local players that have very strong relationships in their service footprint. Small and mid-sized companies have historically been an underserved market segment. U.S. Water brings engineering capability and expertise, acting as an outsourced water treatment expert for these companies.

We are pursuing a national expansion strategy so that we can serve companies with an integrated model of chemistry, service and engineering, and equipment, which is not something that is available in the middle market.

We have been very active with acquisitions of water treatment service companies as well as organic growth initiatives. When we closed on the acquisition of U.S. Water in January 2011, the company had $36 million in revenue. Revenue surpassed $100 million in 2013, making us one of the top 6 or 7 water treatment companies in the industry.

What are some of the developing themes that you are seeing in the water industry?

Water treatment is becoming increasingly important in severe environments. An example would be oil and gas. Food is another severe environment where the tolerances are going to be very low. You are seeing regulation around that as well.

There is going to be increasing regulation around food safety throughout the value chain, from the field all the way through processing. Most of our focus has been on the processing side—how water is being treated to avoid any contamination. It is still evolving, but it is only going to evolve towards more regulation versus less. Regulation provides opportunity for the service provider or technology provider. We typically like environments where compliance is becoming increasingly important.

Water reuse is gaining traction, dictated by regulatory mandates and as it becomes more attractive from an economic perspective to reuse water rather than discharge. That is both a chemical and an equipment play.

Scarcity is going to drive the demand for technologies that will allow for reuse. Through our investment in Integrated Petroleum Technologies, an oil and gas engineering company, we have observed water shortages in certain areas, particularly in the summer of 2012, when drilling activity had to slow down because the producers didn't have access to water supplies.

What are areas of investment opportunity in water?

We are actively looking at specialty chemicals that address water treatment end markets as well as the oil and gas markets. Green technologies are becoming an increasingly important area as well.

In municipal infrastructure, sensors and instrumentation used in combination with services around leak detection and pipe inspection.

Flow control and flow sensors.

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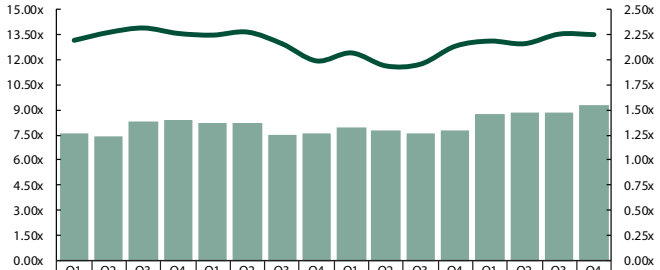
Relative Valuation Trends

Solid Waste - Vertically Integrated



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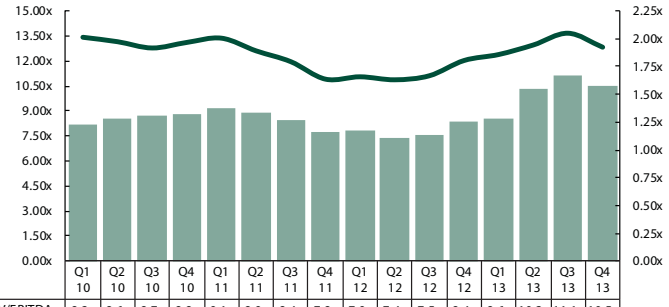
EV/EBITDA	7.6x	7.4x	8.3x	8.4x	8.2x	8.2x	7.5x	7.6x	7.9x	7.8x	7.6x	7.8x	8.7x	8.8x	8.9x	9.3x
EV/Revenue	2.2x	2.3x	2.3x	2.3x	2.2x	2.3x	2.2x	2.0x	2.1x	1.9x	2.0x	2.1x	2.2x	2.2x	2.3x	2.2x

Solid Waste - Waste-to-Energy



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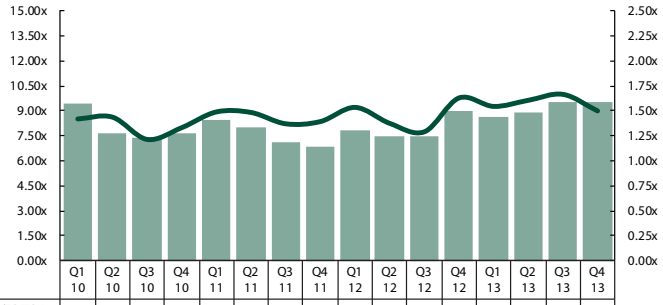
EV/EBITDA	8.2x	8.6x	8.7x	8.8x	9.1x	8.9x	8.4x	7.8x	7.9x	7.4x	7.5x	8.4x	8.6x	10.3x	11.1x	10.5x
EV/Revenue	2.0x	2.0x	1.9x	2.0x	2.0x	1.9x	1.8x	1.6x	1.7x	1.6x	1.7x	1.8x	1.9x	1.9x	2.0x	1.9x

Special Waste - Broadly Diversified



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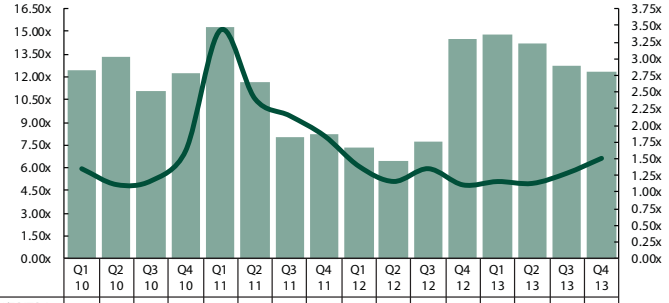
EV/EBITDA	9.4x	7.7x	7.4x	7.7x	8.4x	8.0x	7.1x	6.9x	7.8x	7.4x	7.5x	9.0x	8.6x	8.9x	9.6x	9.5x
EV/Revenue	1.4x	1.4x	1.2x	1.3x	1.5x	1.5x	1.4x	1.4x	1.5x	1.4x	1.3x	1.6x	1.5x	1.6x	1.7x	1.5x

Special Waste - Other



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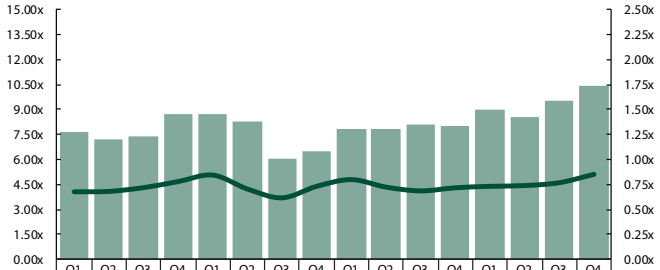
EV/EBITDA	12.5x	13.4x	11.1x	12.2x	15.3x	11.6x	8.0x	8.2x	7.4x	6.5x	7.7x	14.5x	14.8x	14.2x	12.7x	12.4x
EV/Revenue	1.4x	1.1x	1.2x	1.6x	3.4x	2.4x	2.1x	1.8x	1.4x	1.2x	1.4x	1.1x	1.2x	1.1x	1.3x	1.5x

Environmental Engineering & Consulting



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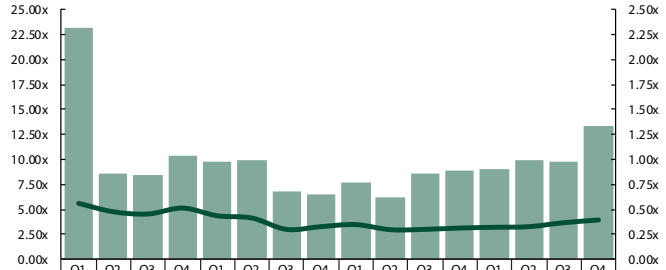
EV/EBITDA	7.7x	7.2x	7.4x	8.7x	8.7x	8.3x	6.0x	6.5x	7.9x	7.8x	8.1x	8.0x	8.9x	8.5x	9.6x	10.4x
EV/Revenue	0.7x	0.7x	0.7x	0.8x	0.8x	0.7x	0.6x	0.7x	0.8x	0.7x	0.7x	0.7x	0.7x	0.7x	0.8x	0.9x

E-Waste & Metals Recycling



	Q1 10	Q2 10	Q3 10	Q4 10	Q1 11	Q2 11	Q3 11	Q4 11	Q1 12	Q2 12	Q3 12	Q4 12	Q1 13	Q2 13	Q3 13	Q4 13
EV/EBITDA	23.2x	8.6x	8.4x	10.4x	9.8x	9.9x	6.8x	6.5x	7.7x	6.2x	8.6x	8.9x	9.0x	9.9x	9.7x	13.4x
EV/Revenue	0.6x	0.5x	0.5x	0.5x	0.4x	0.4x	0.3x	0.3x	0.3x	0.3x	0.3x	0.3x	0.3x	0.3x	0.4x	0.4x

BGL Environmental Services indices defined on Page 35.
SOURCE: S&P Capital IQ.

Relative Valuation Trends

($ in millions, except per share data) Company Name	Country	Ticker	Current Stock Price (1)	% of 52W High	Market Capitalization (2)	Enterprise Value (3)	Enterprise Value / TTM Revenue	EBITDA	Total Debt/ EBITDA	TTM Revenue	TTM Margins Gross	EBITDA
SOLID WASTE (VERTICALLY-INTEGRATED)												
Waste Management, Inc.	United States	NYSE:WM	$41.64	89.8%	$19,536.9	$29,776.9	2.1x	8.8x	3.0x	$13,917.0	34.8%	24.4%
Republic Services, Inc.	United States	NYSE:RSG	31.74	89.1%	11,429.4	18,373.7	2.2x	8.1x	3.1x	8,304.1	37.0%	27.2%
Waste Connections Inc.	United States	NYSE:WCN	40.80	87.8%	5,040.7	7,078.3	3.7x	11.2x	3.2x	1,891.7	44.4%	33.4%
Progressive Waste Solutions Ltd.	Canada	TSX:BIN	23.13	90.3%	2,647.2	4,131.1	2.2x	8.4x	3.1x	2,019.9	38.4%	26.4%
Casella Waste Systems Inc.	United States	NasdaqGS:CWST	5.38	86.8%	215.2	723.4	1.5x	9.1x	6.1x	481.7	29.7%	17.3%
Median			**$31.74**	**89.1%**	**$5,040.7**	**$7,078.3**	**2.2x**	**8.8x**	**3.1x**	**$2,019.9**	**37.0%**	**26.4%**
Mean			**$28.54**	**88.8%**	**$7,773.9**	**$12,016.7**	**2.4x**	**9.1x**	**3.7x**	**$5,322.9**	**36.9%**	**25.7%**
SOLID WASTE (WASTE-TO-ENERGY)												
Covanta Holding Corporation	United States	NYSE:CVA	$17.55	80.2%	$2,291.7	$4,496.7	2.7x	10.7x	5.9x	$1,643.0	39.7%	25.4%
Shanks Group plc	United Kingdom	LSE:SKS	1.91	95.9%	761.0	1,288.8	1.1x	10.6x	5.5x	1,111.1	14.7%	10.7%
Median			**$9.73**	**88.0%**	**$1,526.4**	**$2,892.7**	**1.9x**	**10.6x**	**5.7x**	**$1,377.1**	**27.2%**	**18.1%**
Mean			**$9.73**	**88.0%**	**$1,526.4**	**$2,892.7**	**1.9x**	**10.6x**	**5.7x**	**$1,377.1**	**27.2%**	**18.1%**
SPECIAL WASTE (BROADLY DIVERSIFIED)												
Veolia Environnement S.A.	France	ENXTPA:VIE	$16.42	86.1%	$8,779.5	$24,441.0	0.6x	6.1x	5.0x	37,782.3	16.2%	9.5%
Clean Harbors, Inc.	United States	NYSE:CLH	56.21	87.7%	3,409.7	4,552.9	1.4x	10.1x	3.1x	3,189.2	28.0%	14.1%
Newalta Corporation	Canada	TSX:NAL	15.10	93.7%	835.7	1,169.6	1.7x	9.3x	2.6x	756.3	23.3%	18.0%
Median			**$16.42**	**87.7%**	**$3,409.7**	**$4,552.9**	**1.4x**	**9.3x**	**3.1x**	**$3,189.2**	**23.3%**	**14.1%**
Mean			**$29.24**	**89.1%**	**$4,341.6**	**$10,054.5**	**1.2x**	**8.5x**	**3.6x**	**$13,909.2**	**22.5%**	**13.8%**
SPECIAL WASTE (OTHER)												
Stericycle, Inc.	United States	NasdaqGS:SRCL	$116.36	95.7%	$9,973.2	$11,329.6	5.5x	18.0x	2.2x	$2,078.5	47.5%	30.2%
Darling International Inc.	United States	NYSE:DAR	20.11	84.0%	3,181.7	3,423.9	2.0x	11.2x	0.8x	1,719.7	26.9%	17.4%
Secure Energy Services Inc.	Canada	TSX:SES	14.80	91.5%	1,726.9	1,922.3	1.5x	18.1x	1.9x	1,344.8	8.9%	8.5%
US Ecology, Inc.	United States	NasdaqGS:ECOL	37.02	93.1%	782.4	813.5	4.2x	12.3x	0.5x	192.2	38.6%	34.3%
Renewable Energy Group, Inc.	United States	NasdaqGS:REGI	10.30	62.4%	399.1	313.0	0.2x	1.9x	0.2x	1,339.5	15.1%	12.6%
Heritage-Crystal Clean, Inc	United States	NasdaqGS:HCCI	17.26	83.5%	318.4	309.9	1.2x	25.1x	1.7x	268.8	15.6%	4.6%
Vertex Energy, Inc.	United States	NasdaqCM:VTNR	3.37	80.2%	69.9	79.6	0.5x	12.3x	1.6x	147.5	9.4%	4.4%
Perma-Fix Environmental Services Inc.	United States	NasdaqCM:PESI	3.53	67.2%	40.2	57.1	0.6x	NM	NM	88.4	12.4%	-3.1%
Median			**$16.03**	**83.7%**	**$590.7**	**$563.3**	**1.3x**	**12.3x**	**1.6x**	**$804.2**	**15.4%**	**10.5%**
Mean			**$27.84**	**82.2%**	**$2,061.5**	**$2,281.1**	**2.0x**	**14.1x**	**1.3x**	**$897.4**	**21.8%**	**13.6%**
ENVIRONMENTAL ENGINEERING & CONSULTING												
Chicago Bridge & Iron Company N.V.	Netherlands	NYSE:CBI	$75.78	90.8%	$8,146.9	$9,671.1	1.0x	11.5x	2.4x	$9,631.7	11.0%	8.5%
AMEC plc	United Kingdom	LSE:AMEC	16.88	84.5%	5,023.2	4,986.9	0.7x	8.7x	0.6x	6,277.1	13.2%	8.3%
URS Corporation	United States	NYSE:URS	51.18	91.7%	3,832.8	5,662.2	0.5x	6.2x	2.4x	11,302.7	7.5%	7.3%
AECOM Technology Corporation	United States	NYSE:ACM	29.52	83.8%	2,921.7	3,547.0	0.4x	7.4x	2.6x	8,153.5	5.7%	5.6%
Arcadis NV	Netherlands	ENXTAM:ARCAD	35.58	93.7%	2,575.1	3,003.0	0.9x	10.6x	2.3x	3,444.8	21.1%	8.2%
Tetra Tech Inc.	United States	NasdaqGS:TTEK	29.35	93.2%	1,900.2	1,980.6	1.0x	14.5x	1.5x	2,024.8	13.5%	6.8%
Cardno Limited	Australia	ASX:CDD	5.63	85.6%	814.1	945.7	0.9x	8.0x	1.8x	1,094.3	15.1%	11.3%
Great Lakes Dredge & Dock Corporation	United States	NasdaqGS:GLDD	8.52	84.6%	506.7	762.5	1.0x	15.0x	5.9x	747.6	10.0%	6.7%
TRC Companies Inc.	United States	NYSE:TRR	6.98	74.3%	206.9	194.4	0.6x	22.0x	1.1x	326.4	13.2%	2.7%
Median			**$29.35**	**85.6%**	**$2,575.1**	**$3,003.0**	**0.9x**	**10.6x**	**2.3x**	**$3,444.8**	**13.2%**	**7.3%**
Mean			**$28.82**	**86.9%**	**$2,880.8**	**$3,417.0**	**0.8x**	**11.5x**	**2.3x**	**$4,778.1**	**12.3%**	**7.3%**
E-WASTE & METALS RECYCLING												
Commercial Metals Company	United States	NYSE:CMC	$18.94	89.3%	$2,221.9	$3,129.4	0.5x	9.3x	4.2x	$6,823.0	9.6%	4.9%
Sims Metal Management Limited	Australia	ASX:SGM	9.32	93.9%	1,906.4	2,034.1	0.3x	NM	NM	$6,594.1	7.6%	-0.1%
ALBA SE	Germany	DB:ABA	84.57	95.3%	832.2	917.2	0.4x	***34.4x***	3.9x	$2,279.0	8.1%	1.1%
Schnitzer Steel Industries, Inc.	United States	NasdaqGS:SCHN	28.11	84.4%	735.5	1,104.6	0.4x	13.4x	4.9x	$2,616.8	7.7%	3.1%
Metalico Inc.	United States	AMEX:MEA	2.05	76.5%	98.5	217.1	0.4x	13.3x	***7.5x***	$531.9	7.9%	3.1%
Industrial Services of America, Inc.	United States	NasdaqCM:IDSA	3.52	86.6%	24.9	45.8	0.3x	***NM***	***NM***	$145.2	3.5%	-1.0%
Median			**$14.13**	**88.0%**	**$783.8**	**$1,010.9**	**0.4x**	**13.3x**	**4.2x**	**$2,447.9**	**7.8%**	**2.1%**
Mean			**$24.42**	**87.6%**	**$969.9**	**$1,241.4**	**0.4x**	**12.0x**	**4.3x**	**$3,165.0**	**7.4%**	**1.8%**

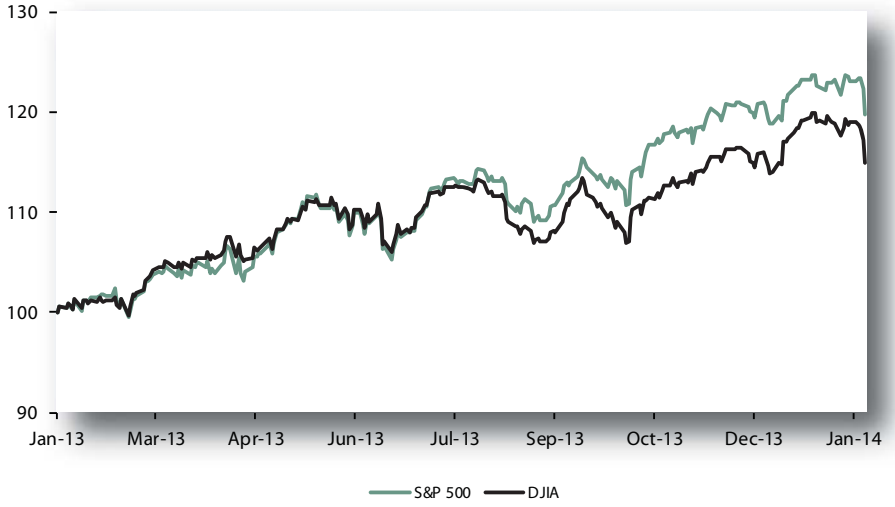
NOTE: Figures in bold and italic type were excluded from median and mean calculation.
(1) As of 1/24/2014.
(2) Market Capitalization is the aggregate value of a firm's outstanding common stock.
(3) Enterprise Value is the total value of a firm (including all debt and equity).
SOURCE: S&P Capital IQ.

Sector Performance

By Sector

	1 Year
Solid Waste - Vertically Integrated	11.7%
Solid Waste - Waste-to-Energy	-2.3%
Special Waste - Broadly Diversified	18.3%
Special Waste - Other	25.2%
Environmental Engineering & Consulting	18.4%
E-Waste & Metals Recycling	3.5%

Overall Market



	1 Year
S&P 500	19.8%
DJIA	14.9%

Index: January 24, 2013= 100.

SOURCE: S&P Capital IQ.

Who We Are

Leading Independent Firm

- Independent investment banking advisory firm focused on the middle market
- Senior bankers with significant experience and tenure; partners average over 20 years of experience
- Offices in Chicago, Cleveland, Miami, and Salt Lake City
- Founding member and exclusive U.S. partner of Global M&A Partners, Ltd., the world's leading partnership of investment banking firms focusing on middle market transactions
- Deep industry experience across core sectors of focus, including: Business Services, Consumer Products and Retail Services, Energy and Environmental Services, Healthcare and Life Sciences, Industrials, and Real Estate.

Comprehensive Capabilities

M&A Advisory	Private Placements	Financial Advisory
Sell-Side Advisory	All Tranches of Debt & Equity Capital for:	General Financial & Strategic Advice
General Financial & Strategic Advice	Growth	Balance Sheet Restructurings
Acquisitions & Divestitures	Acquisitions	Sales of Non-Core Assets or Businesses
Public & Private Mergers	Recapitalizations	§363 Auctions
Special Committee Advice	Dividends	
Strategic Partnerships & Joint Venture Formation		
Fairness Opinions & Fair Value Opinions		

Global Energy and Environmental Services Practice

Solid Waste

- Collection and Hauling
- Transfer Stations
- Material Recovery Facilities
- Landfills
- MSW, Commercial, and C&D

Special Waste

- General ES and IS and Emergency Response
- Vacuum Truck Services / Hydro-Excavation
- Liquids (e.g., Water/Wastewater, Oil, Grease)
- ODS and Other Hazardous Streams

EE&C

- Environmental Engineering and Consulting
- Auditing, Compliance, and Testing
- Reclamation and Remediation
- Health and Safety

E-Waste & Metals

- End-of-Life / Data Destruction
- Remanufacturing
- Asset Management
- Scrap Metal (Ferrous/Non-ferrous)

Energy/Resources

- Waste-to-Energy
- Renewables
- Oilfield Services
- Oil Collection/Re-Refining

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