



# Transportable Solids Case Study

Northern Virginia

**The ETX Process**



Prepared by  
**Source Technologies, LLC**

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# Pilot Study

## Northern Virginia Advanced Water Reclamation Facility

**Background:** This northern Virginia AWRF processes on average 140,000 gallons of sludge per day producing roughly 8,000 pounds of transportable solids per hour. Sludge travels from the holding tanks through 1 of 4 pumps in the basement of the centrifuge building. After the pumps, the sludge goes up into the centrifuge and is processed into transportable solids. These solids can sit in storage for multiple days before being transported to a landfill or given to Synagro to produce fertilizer. The landfill and Synagro regularly refuse the product due to its foul smell, disrupting and limiting the production of solids. These foul odors come from a variety of reduced sulfur compounds that continually form in sludge due to the biological activity in anaerobic conditions.

**Goal:** Reduce and prevent the formation of malodorous compounds in Transportable Solids and increase acceptable landfill transported solids.

**Success defined as:** Total Reduced Sulfur (TRS) in the treated batches of transportable solids maintain an acceptably low to non-detectible level of odor development.

**Process:** Preliminary sulfide data was gathered by sampling the transportable solids to estimate feed rates for treatment. Based on that data and the desire to maintain low levels of malodorous off-gassing for multiple days, the ETX process was deemed the most likely product to provide success. The ETX process is a combination of Source Technologies' patented ETX catalyst and hydrogen peroxide that creates a chemical reaction resulting in the separation of volatile compounds on the atomic level. The process was injected before the centrifuge near the sludge pumps to ensure proper mixing and contact time (Picture 1 seen below).



Picture 1: (Left) 50% H<sub>2</sub>O<sub>2</sub> and (Right) ETX catalyst temporary chemical injection system.

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# ETX Process

## Northern Virginia AWRF

The ETX Process feed rates were calculated to test the effectiveness of treatment based on average and peak levels of total sulfide seen in the aforementioned sampling. Bench testing was conducted by injecting the ETX process into the sludge stream at the desired feed rates. Transportable solids were then contained in sealed 50-gallon plastic containers to mirror anaerobic conditions (seen in Picture 2 below). An untreated control sample was taken as well as two treated samples, labeled MinF (Minimum Feed Rate) and PeakF (Peak Feed Rate). The MinF for ETX was 2.12 gallons per hour (GPH) and 1.47 GPH for 50% hydrogen peroxide. The PeakF for ETX was 4.22 GPH and 2.94 GPH for 50% hydrogen peroxide.



Picture 2: Control, MinF-treated sample and PeakF-treated sample from left to right.

Sulfur analysis samples were taken utilizing 1.0 L Vacuum sealed containers. The samples were analyzed for twenty sulfur compounds using a gas chromatograph equipped with a sulfur chemiluminescence detector. All compounds except hydrogen sulfide and carbonyl sulfide were quantified against the initial calibration curve for methyl mercaptan. Vacuum canister samples were taken through  $\frac{1}{2}$ " ball valves (seen above in picture 2) after being sealed within the container, then again after 24 hours.

# Pilot Results

## Northern Virginia AWRP

### INSTANT Untreated vs Peak Feed Rate

| Compound           | Untreated $\mu\text{g}/\text{m}^3$ | PeakF $\mu\text{g}/\text{m}^3$ | Delta            |
|--------------------|------------------------------------|--------------------------------|------------------|
| Hydrogen Sulfide   | 24                                 | 0                              | 100.0% reduction |
| Carbonyl Sulfide   | 9,500                              | 29                             | 99.7% reduction  |
| Methyl Mercaptan   | 39                                 | 0                              | 100.0% reduction |
| Dimethyl Sulfide   | 30,000                             | 550                            | 98.2% reduction  |
| Dimethyl Disulfide | 72,000                             | 190                            | 99.7% reduction  |

### INSTANT Untreated vs Minimum Feed Rate

| Compound           | Untreated $\mu\text{g}/\text{m}^3$ | MinF $\mu\text{g}/\text{m}^3$ | Delta            |
|--------------------|------------------------------------|-------------------------------|------------------|
| Hydrogen Sulfide   | 24                                 | 16                            | 33.3% reduction  |
| Carbonyl Sulfide   | 9,500                              | 1,800                         | 81.1% reduction  |
| Methyl Mercaptan   | 39                                 | 0                             | 100.0% reduction |
| Dimethyl Sulfide   | 30,000                             | 1,400                         | 95.3% reduction  |
| Dimethyl Disulfide | 72,000                             | 4,100                         | 94.3% reduction  |



### 24 HOURS Untreated vs Peak Feed Rate

| Compound           | Untreated $\mu\text{g}/\text{m}^3$ | PeakF $\mu\text{g}/\text{m}^3$ | Delta           |
|--------------------|------------------------------------|--------------------------------|-----------------|
| Hydrogen Sulfide   | 220,000                            | 1,100                          | 99.5% reduction |
| Carbonyl Sulfide   | 7,800                              | 2,500                          | 67.9% reduction |
| Methyl Mercaptan   | 4,600,000                          | 130,000                        | 97.2% reduction |
| Dimethyl Sulfide   | 490,000                            | 1,700                          | 99.7% reduction |
| Dimethyl Disulfide | 1,800,000                          | 150,000                        | 91.7% reduction |

### 24 HOURS Untreated vs Minimum Feed Rate

| Compound           | Untreated $\mu\text{g}/\text{m}^3$ | MinF $\mu\text{g}/\text{m}^3$ | Delta           |
|--------------------|------------------------------------|-------------------------------|-----------------|
| Hydrogen Sulfide   | 220,000                            | 170,000                       | 22.7% reduction |
| Carbonyl Sulfide   | 7,800                              | 4,500                         | 42.3% reduction |
| Methyl Mercaptan   | 4,600,000                          | 5,600,000                     | 21.7% increase* |
| Dimethyl Sulfide   | 490,000                            | 43,000                        | 91.2% reduction |
| Dimethyl Disulfide | 1,800,000                          | 1,600,000                     | 11.1% reduction |

After 24 hours, PeakF continued to show excellent results. MinF was not able to maintain the same levels of control over an extended period of time. \*Most likely an outlier.

Detailed lab results found in Appendix A

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# Conclusion

## Northern Virginia AWRF

The successful pilot study at this Northern Virginia AWRF wrapped up with initial data proving very successful for both the Minimum Feed Rate and Peak Feed Rate. Injecting the ETX Process into the influent sludge line before the centrifuge allowed for rapid mixing to occur, which led to the successful control over reduced sulfur compounds. Data showed substantial reductions across the board. While the MinF was able to provide excellent immediate results treating the transportable solids, the PeakF was successful for up to 24 hours maintaining hydrogen sulfide, carbonyl sulfide, methyl mercaptan, dimethyl sulfide and dimethyl disulfide levels to a significant reduction from the control.

Both treatment options showed great value based on the desired control range.



# Appendix A

## Untreated

### Instant

| CAS #     | Compound              | Result<br>µg/m <sup>3</sup> | MRL<br>µg/m <sup>3</sup> | Result<br>ppbV | MRL<br>ppbV |
|-----------|-----------------------|-----------------------------|--------------------------|----------------|-------------|
| 7783-06-4 | Hydrogen Sulfide      | 24                          | 9.4                      | 17             | 6.8         |
| 463-58-1  | Carbonyl Sulfide      | 9,500                       | 17                       | 3,900          | 6.8         |
| 74-93-1   | Methyl Mercaptan      | 39                          | 13                       | 20             | 6.8         |
| 75-08-1   | Ethyl Mercaptan       | ND                          | 17                       | ND             | 6.8         |
| 75-18-3   | Dimethyl Sulfide      | 30,000                      | 17                       | 12,000         | 6.8         |
| 75-15-0   | Carbon Disulfide      | 840                         | 11                       | 270            | 3.4         |
| 75-33-2   | Isopropyl Mercaptan   | ND                          | 21                       | ND             | 6.8         |
| 75-66-1   | tert-Butyl Mercaptan  | ND                          | 25                       | ND             | 6.8         |
| 107-03-9  | n-Propyl Mercaptan    | 42                          | 21                       | 14             | 6.8         |
| 624-89-5  | Ethyl Methyl Sulfide  | 24                          | 21                       | 7.7            | 6.8         |
| 110-02-1  | Thiophene             | ND                          | 23                       | ND             | 6.8         |
| 513-44-0  | Isobutyl Mercaptan    | ND                          | 25                       | ND             | 6.8         |
| 352-93-2  | Diethyl Sulfide       | ND                          | 25                       | ND             | 6.8         |
| 109-79-5  | n-Butyl Mercaptan     | 32                          | 25                       | 8.8            | 6.8         |
| 624-92-0  | Dimethyl Disulfide    | 72,000                      | 13                       | 19,000         | 3.4         |
| 616-44-4  | 3-Methylthiophene     | ND                          | 27                       | ND             | 6.8         |
| 110-01-0  | Tetrahydrothiophene   | ND                          | 24                       | ND             | 6.8         |
| 638-02-8  | 2,5-Dimethylthiophene | ND                          | 31                       | ND             | 6.8         |
| 872-55-9  | 2-Ethylthiophene      | ND                          | 31                       | ND             | 6.8         |
| 110-81-6  | Diethyl Disulfide     | ND                          | 17                       | ND             | 3.4         |

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.

### 24 Hours

| CAS #     | Compound              | Result<br>µg/m <sup>3</sup> | MRL<br>µg/m <sup>3</sup> | Result<br>ppbV | MRL<br>ppbV |
|-----------|-----------------------|-----------------------------|--------------------------|----------------|-------------|
| 7783-06-4 | Hydrogen Sulfide      | 220,000                     | 1,900                    | 160,000        | 1,400       |
| 463-58-1  | Carbonyl Sulfide      | 7,800                       | 3,400                    | 3,200          | 1,400       |
| 74-93-1   | Methyl Mercaptan      | 4,600,000                   | 2,700                    | 2,400,000      | 1,400       |
| 75-08-1   | Ethyl Mercaptan       | ND                          | 3,500                    | ND             | 1,400       |
| 75-18-3   | Dimethyl Sulfide      | 490,000                     | 3,500                    | 190,000        | 1,400       |
| 75-15-0   | Carbon Disulfide      | ND                          | 2,200                    | ND             | 700         |
| 75-33-2   | Isopropyl Mercaptan   | ND                          | 4,300                    | ND             | 1,400       |
| 75-66-1   | tert-Butyl Mercaptan  | ND                          | 5,100                    | ND             | 1,400       |
| 107-03-9  | n-Propyl Mercaptan    | ND                          | 4,300                    | ND             | 1,400       |
| 624-89-5  | Ethyl Methyl Sulfide  | ND                          | 4,300                    | ND             | 1,400       |
| 110-02-1  | Thiophene             | ND                          | 4,800                    | ND             | 1,400       |
| 513-44-0  | Isobutyl Mercaptan    | ND                          | 5,100                    | ND             | 1,400       |
| 352-93-2  | Diethyl Sulfide       | ND                          | 5,100                    | ND             | 1,400       |
| 109-79-5  | n-Butyl Mercaptan     | ND                          | 5,100                    | ND             | 1,400       |
| 624-92-0  | Dimethyl Disulfide    | 1,800,000                   | 2,700                    | 470,000        | 700         |
| 616-44-4  | 3-Methylthiophene     | ND                          | 5,600                    | ND             | 1,400       |
| 110-01-0  | Tetrahydrothiophene   | ND                          | 5,000                    | ND             | 1,400       |
| 638-02-8  | 2,5-Dimethylthiophene | ND                          | 6,400                    | ND             | 1,400       |
| 872-55-9  | 2-Ethylthiophene      | ND                          | 6,400                    | ND             | 1,400       |
| 110-81-6  | Diethyl Disulfide     | ND                          | 3,500                    | ND             | 700         |

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.

## PeakF

### Instant

| CAS #     | Compound              | Result<br>µg/m <sup>3</sup> | MRL<br>µg/m <sup>3</sup> | Result<br>ppbV | MRL<br>ppbV |
|-----------|-----------------------|-----------------------------|--------------------------|----------------|-------------|
| 7783-06-4 | Hydrogen Sulfide      | ND                          | 10                       | ND             | 7.2         |
| 463-58-1  | Carbonyl Sulfide      | 29                          | 18                       | 12             | 7.2         |
| 74-93-1   | Methyl Mercaptan      | ND                          | 14                       | ND             | 7.2         |
| 75-08-1   | Ethyl Mercaptan       | ND                          | 18                       | ND             | 7.2         |
| 75-18-3   | Dimethyl Sulfide      | 550                         | 18                       | 220            | 7.2         |
| 75-15-0   | Carbon Disulfide      | 35                          | 11                       | 11             | 3.6         |
| 75-33-2   | Isopropyl Mercaptan   | ND                          | 22                       | ND             | 7.2         |
| 75-66-1   | tert-Butyl Mercaptan  | ND                          | 27                       | ND             | 7.2         |
| 107-03-9  | n-Propyl Mercaptan    | ND                          | 22                       | ND             | 7.2         |
| 624-89-5  | Ethyl Methyl Sulfide  | ND                          | 22                       | ND             | 7.2         |
| 110-02-1  | Thiophene             | ND                          | 25                       | ND             | 7.2         |
| 513-44-0  | Isobutyl Mercaptan    | ND                          | 27                       | ND             | 7.2         |
| 352-93-2  | Diethyl Sulfide       | ND                          | 27                       | ND             | 7.2         |
| 109-79-5  | n-Butyl Mercaptan     | 36                          | 27                       | 9.7            | 7.2         |
| 624-92-0  | Dimethyl Disulfide    | 190                         | 14                       | 49             | 3.6         |
| 616-44-4  | 3-Methylthiophene     | ND                          | 29                       | ND             | 7.2         |
| 110-01-0  | Tetrahydrothiophene   | ND                          | 26                       | ND             | 7.2         |
| 638-02-8  | 2,5-Dimethylthiophene | ND                          | 33                       | ND             | 7.2         |
| 872-55-9  | 2-Ethylthiophene      | ND                          | 33                       | ND             | 7.2         |
| 110-81-6  | Diethyl Disulfide     | ND                          | 18                       | ND             | 3.6         |

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.

### 24 Hours

| CAS #     | Compound              | Result<br>µg/m <sup>3</sup> | MRL<br>µg/m <sup>3</sup> | Result<br>ppbV | MRL<br>ppbV |
|-----------|-----------------------|-----------------------------|--------------------------|----------------|-------------|
| 7783-06-4 | Hydrogen Sulfide      | 1,100                       | 46                       | 790            | 33          |
| 463-58-1  | Carbonyl Sulfide      | 2,500                       | 82                       | 1,000          | 33          |
| 74-93-1   | Methyl Mercaptan      | 130,000                     | 65                       | 64,000         | 33          |
| 75-08-1   | Ethyl Mercaptan       | ND                          | 84                       | ND             | 33          |
| 75-18-3   | Dimethyl Sulfide      | 1,700                       | 84                       | 660            | 33          |
| 75-15-0   | Carbon Disulfide      | 1,200                       | 52                       | 380            | 17          |
| 75-33-2   | Isopropyl Mercaptan   | 160                         | 100                      | 50             | 33          |
| 75-66-1   | tert-Butyl Mercaptan  | ND                          | 120                      | ND             | 33          |
| 107-03-9  | n-Propyl Mercaptan    | ND                          | 100                      | ND             | 33          |
| 624-89-5  | Ethyl Methyl Sulfide  | ND                          | 100                      | ND             | 33          |
| 110-02-1  | Thiophene             | ND                          | 110                      | ND             | 33          |
| 513-44-0  | Isobutyl Mercaptan    | ND                          | 120                      | ND             | 33          |
| 352-93-2  | Diethyl Sulfide       | ND                          | 120                      | ND             | 33          |
| 109-79-5  | n-Butyl Mercaptan     | ND                          | 120                      | ND             | 33          |
| 624-92-0  | Dimethyl Disulfide    | 150,000                     | 64                       | 39,000         | 17          |
| 616-44-4  | 3-Methylthiophene     | ND                          | 130                      | ND             | 33          |
| 110-01-0  | Tetrahydrothiophene   | ND                          | 120                      | ND             | 33          |
| 638-02-8  | 2,5-Dimethylthiophene | ND                          | 150                      | ND             | 33          |
| 872-55-9  | 2-Ethylthiophene      | ND                          | 150                      | ND             | 33          |
| 110-81-6  | Diethyl Disulfide     | ND                          | 83                       | ND             | 17          |

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.

## MinF

### Instant

| CAS #     | Compound              | Result<br>µg/m <sup>3</sup> | MRL<br>µg/m <sup>3</sup> | Result<br>ppbV | MRL<br>ppbV |
|-----------|-----------------------|-----------------------------|--------------------------|----------------|-------------|
| 7783-06-4 | Hydrogen Sulfide      | 16                          | 9.4                      | 11             | 6.8         |
| 463-58-1  | Carbonyl Sulfide      | 1,800                       | 17                       | 720            | 6.8         |
| 74-93-1   | Methyl Mercaptan      | ND                          | 13                       | ND             | 6.8         |
| 75-08-1   | Ethyl Mercaptan       | ND                          | 17                       | ND             | 6.8         |
| 75-18-3   | Dimethyl Sulfide      | 1,400                       | 17                       | 560            | 6.8         |
| 75-15-0   | Carbon Disulfide      | 120                         | 11                       | 40             | 3.4         |
| 75-33-2   | Isopropyl Mercaptan   | ND                          | 21                       | ND             | 6.8         |
| 75-66-1   | tert-Butyl Mercaptan  | ND                          | 25                       | ND             | 6.8         |
| 107-03-9  | n-Propyl Mercaptan    | ND                          | 21                       | ND             | 6.8         |
| 624-89-5  | Ethyl Methyl Sulfide  | ND                          | 21                       | ND             | 6.8         |
| 110-02-1  | Thiophene             | ND                          | 23                       | ND             | 6.8         |
| 513-44-0  | Isobutyl Mercaptan    | ND                          | 25                       | ND             | 6.8         |
| 352-93-2  | Diethyl Sulfide       | ND                          | 25                       | ND             | 6.8         |
| 109-79-5  | n-Butyl Mercaptan     | ND                          | 25                       | ND             | 6.8         |
| 624-92-0  | Dimethyl Disulfide    | 4,100                       | 13                       | 1,100          | 3.4         |
| 616-44-4  | 3-Methylthiophene     | ND                          | 27                       | ND             | 6.8         |
| 110-01-0  | Tetrahydrothiophene   | ND                          | 24                       | ND             | 6.8         |
| 638-02-8  | 2,5-Dimethylthiophene | ND                          | 31                       | ND             | 6.8         |
| 872-55-9  | 2-Ethylthiophene      | ND                          | 31                       | ND             | 6.8         |
| 110-81-6  | Diethyl Disulfide     | ND                          | 17                       | ND             | 3.4         |

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.

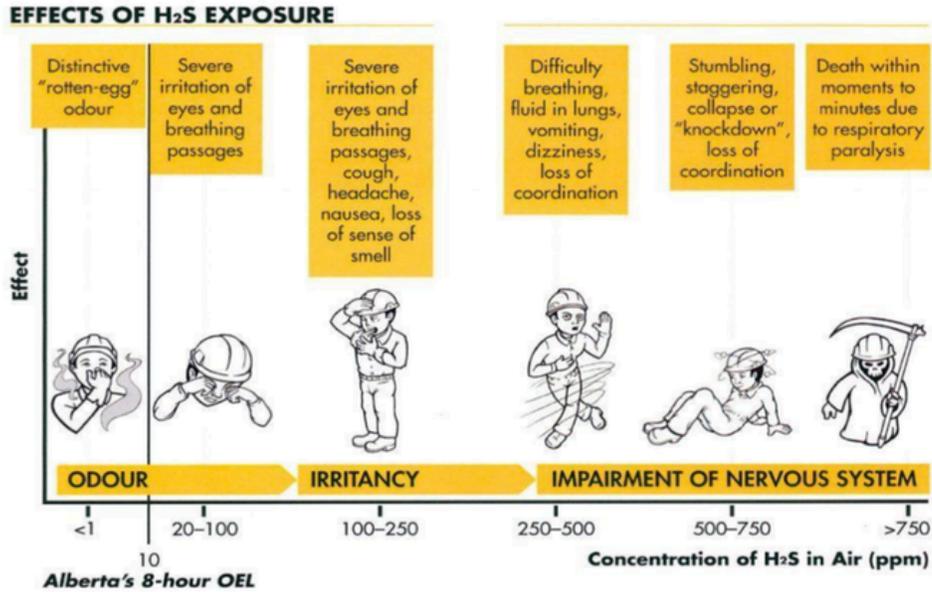
### 24 Hours

| CAS #     | Compound              | Result<br>µg/m <sup>3</sup> | MRL<br>µg/m <sup>3</sup> | Result<br>ppbV | MRL<br>ppbV |
|-----------|-----------------------|-----------------------------|--------------------------|----------------|-------------|
| 7783-06-4 | Hydrogen Sulfide      | 170,000                     | 970                      | 120,000        | 700         |
| 463-58-1  | Carbonyl Sulfide      | 4,500                       | 1,700                    | 1,800          | 700         |
| 74-93-1   | Methyl Mercaptan      | 5,600,000                   | 1,400                    | 2,900,000      | 700         |
| 75-08-1   | Ethyl Mercaptan       | ND                          | 1,800                    | ND             | 700         |
| 75-18-3   | Dimethyl Sulfide      | 43,000                      | 1,800                    | 17,000         | 700         |
| 75-15-0   | Carbon Disulfide      | 1,700                       | 1,100                    | 560            | 350         |
| 75-33-2   | Isopropyl Mercaptan   | 4,900                       | 2,200                    | 1,600          | 700         |
| 75-66-1   | tert-Butyl Mercaptan  | ND                          | 2,600                    | ND             | 700         |
| 107-03-9  | n-Propyl Mercaptan    | ND                          | 2,200                    | ND             | 700         |
| 624-89-5  | Ethyl Methyl Sulfide  | ND                          | 2,200                    | ND             | 700         |
| 110-02-1  | Thiophene             | ND                          | 2,400                    | ND             | 700         |
| 513-44-0  | Isobutyl Mercaptan    | ND                          | 2,600                    | ND             | 700         |
| 352-93-2  | Diethyl Sulfide       | ND                          | 2,600                    | ND             | 700         |
| 109-79-5  | n-Butyl Mercaptan     | ND                          | 2,600                    | ND             | 700         |
| 624-92-0  | Dimethyl Disulfide    | 1,600,000                   | 1,300                    | 410,000        | 350         |
| 616-44-4  | 3-Methylthiophene     | ND                          | 2,800                    | ND             | 700         |
| 110-01-0  | Tetrahydrothiophene   | ND                          | 2,500                    | ND             | 700         |
| 638-02-8  | 2,5-Dimethylthiophene | ND                          | 3,200                    | ND             | 700         |
| 872-55-9  | 2-Ethylthiophene      | ND                          | 3,200                    | ND             | 700         |
| 110-81-6  | Diethyl Disulfide     | ND                          | 1,700                    | ND             | 350         |

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.

# Appendix B

## Effects of H<sub>2</sub>S



One of the methods for determining sulfide loading in solution is to use a portable colorimeter device and the methylene blue method. This test helps identify how many milligrams per liter (mg/l) of sulfide are in solution. 1 mg/l of S= can form up to roughly 250 parts per million (PPM) H<sub>2</sub>S . Gas detection equipment can be deployed throughout the collection system to determine the concentrations of H<sub>2</sub>S in specific locations. Once H<sub>2</sub>S has formed, corrosion will occur.

Depending on turbulence and pH, understanding the concentrations of sulfide in solution can help determine the life expectancy of infrastructure.

## Effect of Sulfide on Infrastructure Life Expectancy

Target: 3' diameter concrete pipe (1" cover")  
 \*neutral pH scenario  
 \*Source of chart EPA website

**Effect of Sulfide on Infrastructure Life Expectancy**

| Sulfide (mg/L) | Life Expectancy |
|----------------|-----------------|
| 0.5            | >50 yrs         |
| 1.0            | 25-50 yrs       |
| 1.5            | 25 yrs          |
| 2.0            | 10-25 yrs       |
| 2.5            | 10 yrs          |
| 3.0            | 10yrs           |
| 4.0            | 5-10 yrs        |
| 7.0            | 5 yrs           |
| >7.0           | < 5 yrs         |

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# Source Technologies, LLC

Odor and corrosion from wastewater is problematical whether occurring at the treatment plant or in the collection system winding through neighborhoods. While most of the general public recognizes hydrogen sulfide (H<sub>2</sub>S) as the “rotten egg” smell associated with sewage treatment, facility managers know H<sub>2</sub>S is a far more destructive and corrosive compound for wastewater treatment facilities and the collection systems that feed them. Additionally, H<sub>2</sub>S is not only a costly nuisance, it can be a serious health and safety problem as well.

Source Technologies, whose principals have long been involved with environmental remediation and municipal wastewater treatment, formed the company to deploy the latest cutting edge technologies that apply to municipal wastewater treatment facilities, industrial pre-treatment activities and environmental restoration.



Under the leadership of CEO Suzie Richards, Source Technologies is proud to be a provider of one of the most powerful, comprehensive and cost-effective odor treatment technologies in the municipal wastewater market space. Our family of advanced oxidation and catalyzed oxygenation technologies are “green”, best-in-class, scalable and simple to operate.

## For additional information, contact us.

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