

## Water Treatment Plant Residuals Management

### Summary

Water treatment plants produce a wide variety of waste products as well as safe drinking water. These residuals may be organic and inorganic compounds in liquid, solid, and gaseous forms depending on the source of raw water and the type of treatment processes, commonly, coagulation/filtration, precipitative softening plant, membrane separation, ion exchange, granular activated carbon.

The differences between the unit processes of the five plant types listed above characterize the type of residuals generated at a given facility. In the current regulatory climate, a complete management program for a water treatment facility should include the development of a cost-effective plan to remove and dispose of residuals. The following steps need to be considered when developing a comprehensive water treatment residuals management plan:

- Characterize form, quantity, and quality of the residuals;
- Determine appropriate regulatory requirements;
- Identify feasible disposal options;
- Select appropriate residuals processing/treatment technologies; and
- Develop a residuals management strategy that meets both the economic and noneconomic goals established for a water treatment facility.

### What are the residuals categories?

Water treatment plant residuals form when suspended solids in the raw water react with chemicals (e.g., coagulants) added in the treatment processes and associated process control chemicals (e.g., lime). Some potable water treatment processes generate residuals that are relatively easy to process and dispose of. For example, leaves, limbs, logs, plastic bottles, and other large floating debris separated from water during the initial screening process can be disposed of at conventional solid waste landfills. However, most other treatment processes produce more complex residual waste streams that may require advanced processing and disposal methods to protect human health and the environment.

The four major types of residuals produced from water treatment processes are:

- Sludges (i.e., water that contains suspended solids from the source water and the reaction products of chemicals added in the treatment process). Presedimentation, coagulation, filter backwashing operations, lime softening, iron and manganese removal, and slow sand and diatomaceous earth filtration all produce sludge.
- Concentrate (brines) from ion exchange regeneration and salt water conversion, membrane reject water and spent backwash, and activated alumina waste regenerant.
- Ion exchange resins, spent granular activated carbon (GAC), and spent filter media (including sand, coal, or diatomaceous earth from filtration plants).
- Air emissions (off-gases from air stripping, odor control units, or ozone destruction).

The chemical characteristics and contaminant concentration levels in these residual waste streams often impose the ultimate disposal options. Furthermore, it is reasonable to expect that as drinking water quality is increasingly regulated, higher removal efficiencies of more contaminants will be required. To achieve these higher efficiencies, water treatment plants (WTPs) will need to use more sophisticated treatment technologies. Of particular concern are cases in which residuals are characterized as either hazardous or radioactive waste. Depending on the raw water quality and treatment process removal efficiency, hazardous or radioactive characteristics could be exhibited in potentially any residual waste stream mentioned above.

# Water Treatment Plant Residuals Management

## Major Treatment Processes and Types of Residual Solids Treatment Processes (Robinson and Witko, 1991)

### Coagulation/Filtration

Typical Residual Waste Streams Generated	Typical Contaminant Categories	Typical Disposal Methods	Regulation Covering Disposal Method
Aluminum hydroxide, ferric hydroxide, or polyaluminum chloride sludge with raw water suspended solids, polymer and natural organic matter (sedimentation basin residuals)	Metals, suspended solids, organics, radionuclides, biological, inorganics	Landfilling Disposal to sanitary sewer/WWTP Land application Surface discharge	RCRA/CERCLA State and local regulations RCRA, DOT NPDES (CWA), state and local DOH
Spent backwash filter-to-waste	Metals, organics, suspended solids, biological, radionuclides, inorganics	Recycle Surface discharge (pumping, disinfection, dechlorination) Disposal to sanitary sewer/WWTP	State and local DOH NPDES (CWA), state and local regulations State and local regulations

### Precipitative Softening

Calcium carbonate and magnesium hydroxide sludge with raw water suspended solids and natural organic matter	Metals, suspended solids, organics, unreacted lime, radionuclides	Landfilling Disposal to sanitary sewer/WWTP Land application	RCRA/CERCLA, state and local regulations State and local regulations RCRA, state and local regulations, DOT
Spent backwash filter-to-waste	Metals, organics, suspended solids, biological, radionuclides, inorganics	Recycle Surface Discharge (pumping, disinfection, dechlorination) Disposal to sanitary sewer/WWTP	State and local DOH NPDES (CWA), state and local regulations State and local regulations

### Membrane Separation

Reject streams containing raw water suspended solids (microfiltration), raw water natural organics (nanofiltration), and brine (hyperfiltration, RO)	Metals, radionuclides, TDS, high molecular weight contaminants, nitrates	Surface discharge (pumping, etc.) Deep well injection Discharge to sanitary sewer/WWTP Radioactive storage	RCRA, NPDES, state and local regulations RCRA, NPDES, state and local regulations State and local regulations RCRA, DOT, DOE
--	--	---	---

## Ion Exchange

Typical Residual Waste Streams Generated	Typical Contaminant Categories	Typical Disposal Methods	Regulation Covering Disposal Method
Brine stream	Metals, TDS, hardness nitrates	Surface discharge	RCRA, NPDES, state and local regulations
		Evaporation ponds	RCRA, NPDES, state and local regulations
		Discharge to sanitary sewer/WWTP	State and local regulations

## Granular Activated Carbon

Spent GAC requiring disposal and/or reactivation, spent backwash, and gas-phase emissions in reactivation systems	VOCs, SOCs (nonvolatile pesticides), radionuclides, heavy metals	Landfill	RCRA, CERCLA, DOT
		Regeneration (on/off site)	State and local air quality regulations (CAA)
		Incineration	State and local air quality regulations (CAA)
		Radioactive storage Return spent GAC to supplier	DOT, DOE

## Stripping Process (mechanical or packed tower)

Gas phase emissions	VOCs, SOCs, radon	Discharge to atmosphere GAC adsorption of off-gas (contaminant type and concentration dependent)	State and local air quality regulations (CAA)
Spent GAC if used for gas-phase control	VOCs, SOCs radionuclides	GAC adsorption of off-gas (contaminant type and concentration dependent) Return spent to GAC to supplier	State and local air quality regulations (CAA)

### Key

<b>CAA</b> =Clean Air Act	<b>NPDES</b> =National Pollutant Discharge Elimination System
<b>CWA</b> =Clean Water Act	<b>RCRA</b> =Resource Conservation and Recovery Act
<b>CERCLA</b> =Comprehensive Environmental Response, Compensation and Liability Act	<b>RO</b> =Reverse Osmosis
<b>DOE</b> =Department of Energy	<b>SOC</b> =Synthetic Organic Chemical
<b>DOH</b> =Department of Health	<b>TDS</b> =Total Dissolved Solids
<b>DOT</b> =Department of Transportation	<b>VOC</b> =Volatile Organic Compound
<b>GAC</b> =Granular Activated Carbon	<b>WWTP</b> =Wastewater Treatment Plant



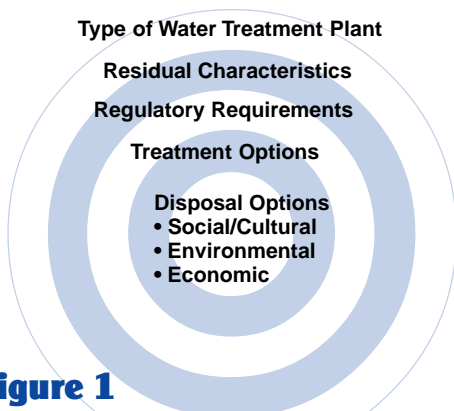
## What regulations govern management of water treatment plant residuals?

Identifying the regulations that affect various management practices may be difficult for water treatment utility managers. The difficulty is due to the many different types of wastes produced by WTPs and various types of waste disposal: direct discharge, discharge to wastewater treatment plants, disposal in landfills, land application, underground injection, disposal of radioactive waste, and treatment of air emissions.

At the federal level, the U.S. Environmental Protection Agency (EPA) has not established any regulations that are specifically directed at WTP residuals. Applicable regulations are those associated with the Clean Water Act (CWA); Criteria for Classification of Solid Waste Disposal Facilities and Practices (40 CFR, Part 257); the Resource Conservation and Recovery Act (RCRA); the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) or Superfund; and the Clean Air Act (CAA). The CWA limits direct discharges into a water course while the other legislation governs other methods of use and/or disposal of wastes. Most states are responsible for establishing and administering regulations that will meet the requirements of these acts. The regulation of wastes, therefore, is the responsibility of the states.

## How are residuals management plans selected?

To develop a residuals management plan, the WTP manager may start with a broad array of residuals processing and disposal options that can be narrowed through considering specific residuals characteristics and associated regulatory requirements. A focus on available disposal options further narrows the management alternatives.



**Figure 1**

*The primary target of a residuals management plan*

*Source: Management of Water-Plant Residuals*

Figure 1 illustrates the need for practical disposal options and treatment processes that will take into account economic and noneconomic factors of concerns to the community. The technical criteria used to select the final management plan differ from user to user; economic, cultural, social, and environmental factors are also site-specific, and are typically included in any final selection.

## Where can I find more information?

Information in this fact sheet was primarily obtained from:

- (1) *Management of Water Treatment Plant Residuals*. American Society of Civil Engineers (ASCE) Manuals and Reports on Engineering Practice No. 88, American Water Works Association (AWWA) Technology Transfer Handbook, and U.S. EPA 625/R-95/008.
- (2) *Handbook of Practice: Water Treatment Plant Waste Management*. American Water Works Association (1987). [This book is out of print but available in libraries.]
- (3) Robinson, M.P., and J.B. Wiko. 1991. "Overview of Issues and Current State-of-the Art Water Treatment Plant Waste Management Programs." *1991 Annual Conference Proceedings*. AWWA Quality for the New Decade, Philadelphia, PA. June 23–27. [This book is out of print; however, copies of the article are available for a fee from AWWA.]

*Management of Water Treatment Plant Residuals* can be ordered from the AWWA. For more information, write the AWWA at 6666 W. Quincy Ave., Denver, CO 80235, or call (800) 926-7337. You may also view a selection of AWWA literature on their Web site at <http://www.awwa.org/store.htm>.

*Additional copies of Tech Brief fact sheets are free; however, postal charges are added to orders. To order, call the NDWC at (800) 624-8301 or (304) 293-4191. You may also order online at [ndwc\\_orders@estd.wvu.edu](mailto:ndwc_orders@estd.wvu.edu), or download Tech Briefs from our Web site at <http://www.ndwc.wvu.edu> where they are available in the Products section.*

- Tech Brief: Disinfection, item #DWBLPE47;
- Tech Brief: Filtration, item #DWBLPE50;
- Tech Brief: Corrosion Control, item #DWBLPE52;
- Tech Brief: Ion Exchange and Demineralization, item #DWBLPE56;
- Tech Brief: Organics Removal, item #DWBLPE59;
- Tech Brief: Package Plants, item #DWBLPE63; and
- Tech Brief: Water Treatment Plant Residuals Management, item #DWBLPE65.