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Anaerobic Compost Constructed Wetlands System (CWS) Technology

Innovative Technology Evaluation Report

National Risk Management Research Laboratory
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Notice

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Foreword

The U.S. Environmental Protection Agency is charged by Congress with protecting the Nation's land, air, and water resources. Under a mandate of national environmental laws, the Agency strives to formulate and implement actions leading to a compatible balance between human activities and the ability of natural systems to support and nurture life. To meet this mandate, EPA's research program is providing data and technical support for solving environmental problems today and building a science knowledge base necessary to manage our ecological resources wisely, understand how pollutants affect our health, and prevent or reduce environmental risks in the future.

The National Risk Management Research Laboratory is the Agency's center for investigation of technological and management approaches for reducing risks from threats to human health and the environment. The focus of the Laboratory's research program is on methods for the prevention and control of pollution to air, land, water and subsurface resources; protection of water quality in public water systems; remediation of contaminated sites and ground water; and prevention and control of indoor air pollution. The goal of this research effort is to catalyze development and implementation of innovative, cost-effective environmental technologies; develop scientific and engineering information needed by EPA to support regulatory and policy decisions; and provide technical support and information transfer to ensure effective implementation of environmental regulations and strategies.

This publication has been produced as part of the Laboratory's strategic long-term research plan. It is published and made available by EPA's Office of Research and Development to assist the user community and to link researchers with their clients.

Hugh W. McKinnon, Director
National Risk Management Research Laboratory

Abstract

As part of the Superfund Innovative Technology Evaluation (SITE) Program, the U.S. Environmental Protection Agency (EPA) evaluated constructed wetlands systems (CWS) for removing high concentrations of zinc from mine drainage at the Burleigh Tunnel in Silver Plume, Colorado.

Exploration geologists have known for many years that metals, most commonly copper, iron, manganese, uranium, and zinc, frequently accumulate in swamps and bogs located in mineralized areas. This understanding forms the basis for the design of CWS—essentially excavated pits filled with organic matter—that have been developed and constructed over the past 15 years to treat drainage from abandoned coal mines in the eastern United States. Mine drainage is routed through the organic material, where metals are removed through a combination of physical, chemical, and biological processes.

In fall 1994, anaerobic compost wetlands in both upflow and downflow configurations were constructed adjacent to and received drainage from the Burleigh Tunnel, which forms part of the Clear Creek/Central City Superfund site. The systems were operated over a 3-year period. The effectiveness of treatment by the CWS was evaluated by comparing the concentration of zinc and other metals from corresponding influent and effluent analyses. By far the dominant toxic metal present in the drainage was zinc. The upflow CWS removed an average of 93 percent of the zinc during the first year of operation, and 49 and 43 percent during the second and third years. The downflow CWS removed an average of 77 percent of zinc during the first year and 70 percent during the second year. (Flow was discontinued to the downflow system in the third year.)

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Acronyms, Abbreviations, and Symbols

ºC	Degrees Celsius
ºF	Degrees Fahrenheit
%C	Percent completeness
%R	Percent recovery
AA	Atomic absorption
ARAR	Applicable or relevant and appropriate requirement
ASTM	American Society for Testing and Materials
AVS	Acid volatile sulfide
BOD	Biochemical oxygen demand
CDPHE	Colorado Department of Public Health and Environment
CDM	Camp, Dresser, & McKee, Inc.
CFU	Colony forming units
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CWS	Constructed wetlands system
DQO	Data quality objective
Eh	Oxidation reduction potential
EPA	U.S. Environmental Protection Agency
FS	Feasibility study
gpm	Gallons per minute
H_2S	Hydrogen sulfide
HDPE	High-density polyethylene
HSWA	Hazardous and Solid Waste Amendments of 1984
ICP	Inductively coupled plasma
ITER	Innovative technology evaluation report
LC_{50}	Lethal concentration for 50 percent of the test organisms
MCAWW	Methods for Chemical Analysis of Water and Wastes
MCL	Maximum contaminant level
µg	Micrograms

Acronyms, Abbreviations, and Symbols (continued)

µS	Microsiemens
mg/kg	Milligrams per kilogram
mg/L	Milligrams per liter
MS	Matrix spike
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NIST	National Institute of Standards and Technology
NPDES	National Pollutant Discharge Elimination System
NRMRL	National Risk Management Research Laboratory
O&M	Operation and maintenance
ORD	Office of Research and Development
ORP	Oxidation/reduction potential
OSHA	Occupational Safety and Health Administration
OSWER	Office of Solid Waste and Emergency Response
PPE	Personal protective equipment
ppm	Parts per million
PRC	PRC Environmental Management, Inc.
PVC	Polyvinyl chloride
QAPP	Quality assurance project plan
QA/QC	Quality assurance/quality control
RCRA	Resource Conservation and Recovery Act
RI	Remedial investigation
RPD	Relative percent difference
SARA	Superfund Amendments and Reauthorization Act
SITE	Superfund Innovative Technology Evaluation
SDWA	Safe Drinking Water Act
SOP	Standard operating procedure
SRM	Standard reference material
SWDA	Solid Waste Disposal Act
TCLP	Toxicity characteristic leaching procedure
TOC	Total organic carbon
TDS	Total dissolved solids
TSS	Total suspended solids
yd^3	Cubic yards

Conversion Factors

	To Convert From	*To*	*Multiply By*
Length	inch	centimeter	2.54
	foot	meter	0.305
	mile	kilometer	1.61
Area:	square foot	square meter	0.0929
	acre	square meter	4,047
Volume:	gallon	liter	3.78
	cubic foot	cubic meter	0.0283
Mass:	pound	kilogram	0.454
Energy:	kilowatt-hour	megajoule	3.60
Power:	kilowatt	horsepower	1.34
Temperature:	(°Fahrenheit - 32)	°Celsius	0.556

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This project consisted of a demonstration conducted under the SITE program to evaluate the anaerobic compost Constructed Wetland System (CWS) technology developed by the Colorado Department of Public Health and Environment (CDPHE). The technology demonstration was conducted on mineral mine drainage at the Burleigh Tunnel in Silver Plume, Colorado, which is included in the Clear Creek/Central City Superfund site. Passive treatment was selected as the preferred treatment alternative for the Burleigh Tunnel drainage in a 1991 Record of Decision (ROD). This Innovative Technology Evaluation Report (ITER) interprets the data that was collected during the nearly four-year demonstration and discusses the potential applicability of the technology.

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