

Influent Constituent Characteristics of the Modern Waste Stream from Single Sources

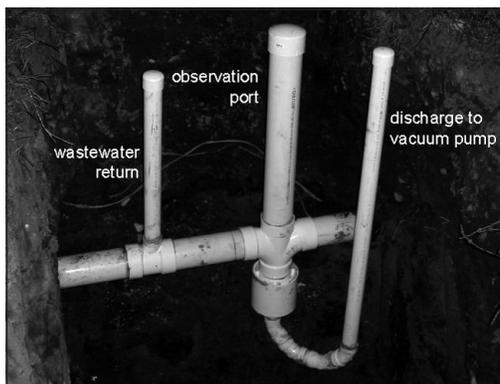
Decentralized wastewater management with onsite wastewater systems (OWS) are a necessary and appropriate component of a sustainable wastewater infrastructure. OWS serve over 21% of the U.S. population and about 28% of all new residential development. Proper OWS design, installation, operation, and management are essential to protect water quality and the public served by the local water source. Conventional OWS rely on septic tanks for primary digestion of raw wastewater followed by discharge of septic tank effluent (STE) to subsurface soils for eventual recharge to underlying groundwater. However, increasing uses of alternative OWS rely on additional treatment of the STE prior to discharge to the environment in sensitive areas or may eliminate use of a septic tank altogether. Waste streams treated by OWS have changed during recent years due to changing lifestyles including the increasing use of personal care and home cleaning products and lower water use due to water conservation efforts.

This two-phase project addressed the need for a thorough literature review to assess the state of knowledge related to the composition of single source raw wastewater (Phase 1: 04DEC1a). This Phase 2 report identified key parameters affecting wastewater composition, addressed information gaps, and summarized findings from actual raw wastewater and septic tank effluent field monitoring at three regional locations in the U.S.

Results of Field Investigations

Seasonal monitoring at a total of 17 sites from three regions (Colorado, Florida, and Minnesota) helped ensure that the results and information gained had broad applicability to management and design of OWS. A tiered monitoring approach was used to focus on conventional constituents, microbial constituents, and organic chemicals. Daily and weekly variability within the raw wastewater and STE was monitored. Information obtained was tabulated and graphically displayed to enable assessment and comparison of parameters that affect single-source waste stream composition. Households monitored during this project had OWS that were less than 25 years old with concrete chambered septic tanks serving households with two to six occupants ranging in age from small children to seniors. One site served an eight-unit apartment building with 18 occupants.

The results were compiled and statistical evaluations conducted to identify general trends. Further data analyses included variations attributed to regional location, season, age of occupants, and household water use. Relationships were established between a constituent in raw wastewater and STE as well as between different constituents in the waste stream. Finally, mass loading rates were estimated. Graphical tools were prepared including summary tables, cumulative frequency distribution graphs, box and whisker plots, and correlations.



Collection vessel with access ports.

BENEFITS

- Comprehensive field monitoring provides an explanation of modern raw wastewater and septic tank effluent (STE) composition from single residential sources.
- Presents variations in weekly and daily raw wastewater and STE composition from single residential sources due to types of indoor water use.
- Presents cumulative frequency distributions to enable users to assess raw wastewater and STE constituent concentrations and mass loadings to a treatment unit or the environment.
- Presents data in various formats (location, age of occupants, in statistical tables, and compared to literature values) so users can select representative constituent values with an understanding of data limitations and potential uncertainty.

RELATED PRODUCTS

Influent Constituent Characteristics of the Modern Waste Stream from Single Sources: Literature Review: Phase 1 (04DEC1a)

Factors Affecting the Performance of Primary Treatment in Decentralized Wastewater Systems (04DEC7)

Performance Dynamics of Trace Organics in Onsite Treatment Units and Systems (DEC14U06)

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Table 1. Summary of Tier 1 Constituents from This Study and Previously Reported (in mg/L).

		Median	This Study		U.S. EPA (2002)	Crites and Tchobanoglous (1998)
			Range ¹	Lit. Review		
Alkalinity (as CaCO ₃)	Raw	260	65-575	NR	NR	NR
	STE	411	172-862	NR	NR	60-20
TS	Raw	1,028	252-3,320	NR	500-880	350-1,200
	STE	623	290-3,665	NR	NR	NR
TSS	Raw	232	22-1,690	18-2,230	155-330	100-350
	STE	61	28-192	22-276	50-100	40-140
cBOD ₅	Raw	420	112-1,101	30-1,147	155-286	110-400
	STE	216	44-833	38-861	140-200	150-250
COD	Raw	849	139-4,584	540-2,404	500-660	250-1,000
	STE	389	201-944	157-1,931	NR	250-500
TOC	Raw	184	35-738	NR	NR	80-290
	STE	105	50-243	NR	31-68	NR
DOC	Raw	110	29-679	NR	NR	NR
	STE	66	22-140	NR	NR	NR
Total nitrogen	Raw	60	9-240	44-189	26-75	20-85
	STE	63	27-119	26-24	40-100	NR
TKN (as N)	Raw	57	16-248	43-124	NR	NR
	STE	60	33-171	27-94	19-53	50-90
Ammonium-nitrogen (as N)	Raw	14	2-94	9-154	4-13	12-50
	STE	53	25-112	0-96	NR	30-50
Nitrate-nitrogen (as N)	Raw	1.9	BDL-9	0.05-1.1	<1	0
	STE	0.7	BDL-7	0-10.3	0.01-0.16	NR
Total phosphorus	Raw	10.4	0.2-32	13-26	6-12	4-15
	STE	9.8	0.2-33	3-40	7.2-17	12-20

¹ All data included, outliers were not removed. NR = not reported BDL = below detection limits

The following conclusions can be made from this research:

- The median indoor water use was ~25% lower than previous studies conducted nearly 10 years ago.
- The range of constituent concentrations was higher for raw wastewater compared to STE.
- The consumer product chemicals – caffeine, ethylenediaminetetraacetic acid (EDTA), 4-nonylphenolmonoethoxylate (NP1EO) and triclosan – and the pharmaceutical residues – ibuprofen, naproxen, and salicylic acid – were detected in raw wastewater and STE.
- Significant regional variations in raw wastewater and STE concentrations were observed.
- Significant variations in water use and concentrations due to the age of the household occupants (either over 65 or under 65) were observed, but no significant seasonal variation was observed.
- Weekly and daily variations were observed in the raw wastewater attributed to the specific water use activities with little variability observed in STE concentrations.
- Relationships between raw wastewater and STE concentrations, and between different constituent concentrations in raw wastewater and STE combined were established. How the difference between individual systems may have affected constituent concentrations remains unclear with insufficient replicates to further evaluate concentration relationships.
- Mass loading rates for constituents from raw wastewater into the septic tank and from STE out of the septic tank suggest regional differences, age of occupant differences, and better relationships between raw wastewater and STE mass loading rates as well as between different constituents ($R^2 > 0.50$).

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The research on which this report is based was funded in part by the U.S. Environmental Protection Agency (U.S. EPA) through Cooperative Agreement No. X-830851-01 with the Water Environment Research Foundation (WERF). Unless an U.S. EPA logo appears on the cover, this report is a publication of WERF, not U.S. EPA. Funds awarded under the agreement cited above were not used for editorial services, reproduction, printing, or distribution.