By Richard W. Elliott, P.E.

Evaluation of the Use of Crushed Recycled Glass as a Filter Medium: Part 1

The Sleepy Hollow Sewer District, in the Town of Oswego, NY, has provided wastewater collection, treatment and disposal for a residential subdivision of approximately 50 homes since 1965. The wastewater collection system included approximately 3,000 lineal feet of 8″-diameter gravity sewer. The treatment facilities included a steel tank and extended aeration package plant. The effluent was discharged to a facultative lagoon prior to discharge to Snake Creek Marsh and Lake Ontario. This treatment facility was operating very poorly due to age and neglect and the Town of Oswego was under a consent order to upgrade it.

The New York State Department of Environmental Conservation (NYSDEC) indicated that the new or upgraded facility would be required to produce an effluent meeting "Intermittent Stream Standards." These effluent standards include

Biochemical Oxygen Demand (BOD) . . . . . 5 mg/l
Total Suspended Solids (TSS) . . . 10 mg/l
Ammonia . . . . . 2 mg/l
Dissolved Oxygen (DO). . . . . 7 mg/l

However, the SPDES Permit issued by NYSDEC to the Town of Oswego did not include the dissolved oxygen parameter.

Upon recommendation of their Consulting Engineer[1] and approval by the NYSDEC, the Town of Oswego constructed, in late 1997, a 15,000-gallon-per-day recirculating intermittent sand filter to replace the existing treatment plant. The sand filter media consisted of crushed recycled container glass cullet rather than a natural or processed sand.

The treatment facility layout is shown in Figure 1 and consists of two 10,000 gallon septic tanks, a dosing pump station, three 2,000 square foot filters, a recirculation structure and a cascade reaeration channel. The septic tanks are designed to be operated in parallel or independently. The dosing pump station consists of a 4,500-gallon precast concrete wet well with three submersible sewage pumps, each dedicated to an individual filter and sized to discharge a 2″-deep dose of septic tank effluent/recycled filtrate to a filter. The filters are uncovered with a design application rate of 3.7 gallons per square foot per day, based on the plant flow excluding recycle.

The filter media is 30″-thick and is provided with an underdrain consisting of 4″-diameter perforated pipe embedded in No. 2 washed stone. The filters are sized so that the design flow can be treated with one filter out of service.

Distribution of septic tank effluent/recycled filtrate on the filters is by flooding from a center dosing pump discharge pipe provided with a 7′6″ by 7′6″ concrete pad to prevent erosion of the filter media. Figure 2 is a cross section view of the filter. The recirculation structure consists of a channel with a 60 degree "V" notch weir on the end to outfall and five similar V notch weirs on one side with discharge to a recycle wet well.

Figure 1: Treatment Facility Layout

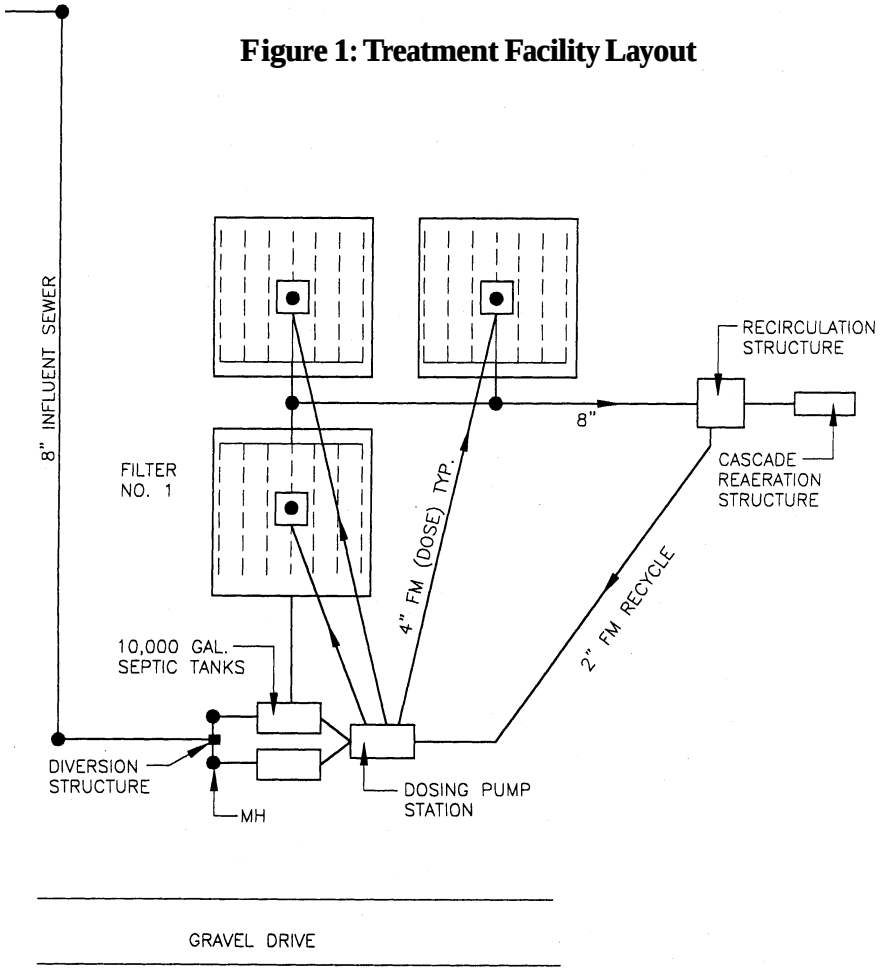
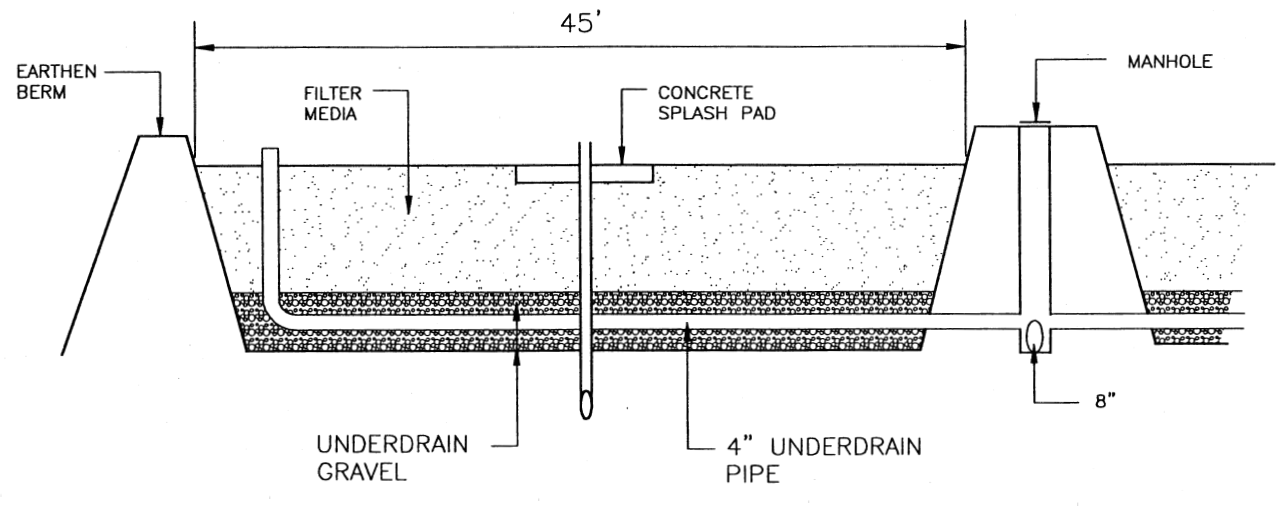


Figure 2: Filter Cross Section



Any number of the five recycle weirs can be blocked off to change the recycle rate incrementally from 5:1 to 1:1; or no recirculation at all. The recycle wet well is provided with a submersible pump (identical to the dosing pumps) that discharges to the dosing pump station. The cascade reaeration structure is a 20′-long precast concrete channel provided with four broad crested weirs with a 5″ drop at each weir.

Flow through the teatment facility is measured and recorded electronically by the dosing pump station control panel. The control panel is based on a programmable logic controller (PLC) that records the number of pump starts and converts that to gallons. The conversion from pump starts to gallons is accomplished by multiplying by the actual wet well volume from pump-on to pump-off then dividing by a constant that reflects the recycle rate (i.e., recycle rate of 5:1 or 5 returned to 1 outflow; divide by 6) and subtracting the average dosing pump station inflow from the septic tank for the duration of the pump cycle.

There are three operating variables available to the operator.

- The number of septic tanks in service (one or both).
- The number of filters in service (one, two or three).
- The recycle rate (5:1, 4:1, 3:1, 2:1, 1:1 or 0:1).

Table 1: Annual Operation and Maintenance Costs

Electric Power (9,525 KWH @ $0.15/KWH)	$1,450.00/year
Septic Tank Pumping	$500.00/year
Operator Salary	$6,150.00/year
Laboratory Fees	$550.00/year
Total Annual O & M Cost	**$8,650.00/year**

Table 2: Electric Power Cost

Bill Date	No. Days	KWH Usage	Total Bill
3/6/98	31	917	$135.19
5/6/98	61	1,856	$274.06
7/8/98	63	1,042	$171.27
9/4/98	58	1,196	$186.94
11/3/98	60	1,034	$164.56
1/7/99	65	1,239	$193.68
3/5/99	57	2,121	$300.78
4/8/99	34	1,253	$177.90
5/7/99	29	852	$125.91
Totals	**458**	**11,510**	**$1,730.29**

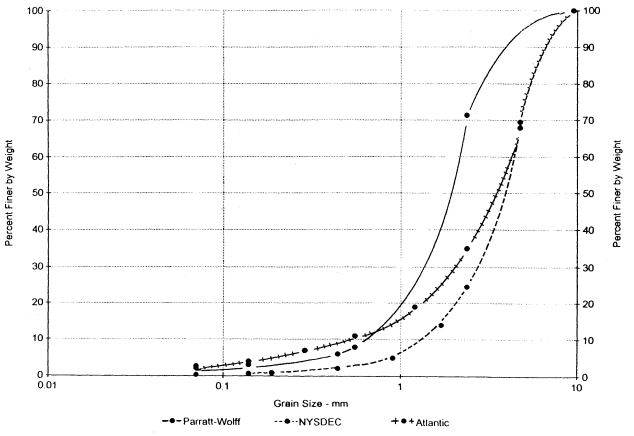
Capital and Annual Costs

The construction cost for the Sleepy Hollow Wastewater Treatment Facility was $154,490. The engineering fees for the project included $7,000 for a feasibility study and $16,000 for design, bidding and general construction review. The total project cost, therefore, was approximately $177,500. The annual operation and maintenance costs for the Sleepy Hollow WWTF include operators' salaries, electric power cost, laboratory cost and the cost for annual pumping and disposal of sludge from the septic tanks. Table 1 is a summary of those costs for the period from April 1998 to March 1999.

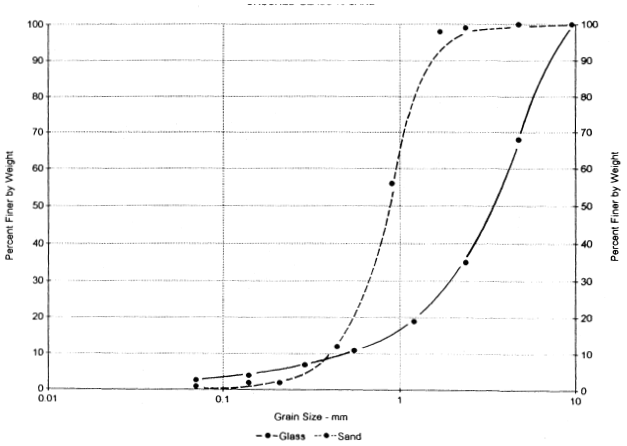
The electric power consumption (Table 2) varied dramatically over the

Figure 3: Grain Size Distribution

Crushed Glass Filter Media



Crushed Glass v. Sand



first year of operation. A comparison of the average daily flow by month with the power consumption indicates that significant increases in power consumption correlate well with seasonal increases in plant flow that result from collection system infiltration during periods of high groundwater surface water runoff.

Crushed Recycled Glass Filter Medium

The use of crushed recycled glass as a filter medium for intermittent sand filtration of wastewater has been described in published research supported by the Clean Washington Center[2]. This research was based on a once-through intermittent sand filter sized for an individual home. NYSERDA also published research on the use of recycled glass filter media for slow sand filtration of potable water on a laboratory scale.[3]

The filter media used in this project was made from mixed color, container glass cullet that was a waste product from the processing of returnable/recyclable glass containers for sale to various glass manufacturers. It was produced by Nexcycle Resources, Inc., Mattydale, N.Y.

The market for recycled glass requires that it be segregated by color, which generally is accomplished at the solid waste recycling centers. Therefore, the unprocessed glass is purchased by the processor in uniform color lots. During processing, substantial quantities of glass are lost with labels and tops that generally are disposed of in a landfill. In an effort to reduce the quantity of material to be landfilled, the labels and tops are reprocessed to remove additional glass to reduce the weight and volume.

The glass removed from this step is mixed color with little market value. However, it has found limited uses in landfill, highway and drainage construction. The waste mixed color material routinely generated by Nexcycle Resources, Inc., has a maximum particle size of ¾″ which is the size required by glass manufacturers who purchase the uniform color material. In order to produce material suitable for use as filter media, Nexcycle modified their crushing and screening process to produce material with a maximum particle size of ⅜″.

A grain size analysis was conducted by three different laboratories over the course of the design and construction of this project and preparation of this report. The crushed recycled glass filter media used in the above referenced grain size analyses came from the same source but from batches run on two different occasions. Figure 3 is a Grain Size Distribution Plot of the filter media prepared from sieve analyses conducted in accordance with ASTM C-136 and C-117. From that data, the range of effective size (ES) and uniformity coefficient (UC) was calculated. Specific approval to use this crushed glass filter media material was requested and received from NYSDEC. Recommendations for filter media specifications are published in several design manuals and standards of both New York State[4] and U.S. Environmental Protection Agency.[5] Table 3 summarizes those state and federal standards.

The Sleepy Hollow filters required 800 tons of crushed glass. The price charged by Nexcycle Resources for this

Table 3: State and Federal Design Standards

NYSDEC Design Standards for Wastewater Treatment Works - *1998 (Intermediate Sized Sewerage Facilities), page 41*	ES	0.3 to 1.5 mm
	UC	less than 4
USEPA Design Manual, Onsite Wastewater Treatment and Disposal	ES	0.3 to 1.5 mm
	UC	less than 4 (less than 3.5 preferred)
Crushed Glass Filter Medium	ES	0.55 to 1.2
	UC	3.6 to 5.6

ES - Efective Size UC - Uniform Coefficient

filter media material was $7.50 per ton FOB Mattydale, N.Y. The current average market price for uniform color material suitable for glass manufacturing is $25 to $30 per ton for clear glass, $20 to $25 per ton for amber glass and $5 to $10 per ton for green glass.[6] Natural sand meeting the required gradation is available in Central New York State at $20 per ton and currently is in use at municipal intermittent sand filters in Oriskany Falls, Remsen, Constableville, Glenfield and others. Oriskany Falls, Remsen and Constableville recently have replaced the media in some of their filters because of clogging after approximately 10 years of operation.

Part 2 of this article will cover system performance and physical characteristics and will appear in the August issue.

REFERENCES

1. *Report on Study of Proposed Upgrade of Sleepy Hollow Sewage Treatment Facilities,* Prepared for Town of Oswego, N.Y. by Richard W. Elliott, P.E., civil engineer, January 1997.

2. *Crushed Recycled Glass as a Filter Medium for the Onsite Treatment of Wastewater,* Clean Washington Center, Seattle, WA, by Aqua Test, Inc. and Stuth Co., Inc. December 1995, Report No. GI-95-5.

3. *Examination of Pulverized Waste Recycled Glass as Filter Media in Slow Sand Filtration,* New York State Energy Research and Development Authority, Syracuse University, Dept. of Civil and Environmental Engineering, by Dr. Raymond D. Letterman, et al, October 1997, Report No. 97-13.

4. *Design Standards for Wastewater Treatment Works, Intermediate Sized Sewerage Facilities.* New York State Department of Environmental Conservation, 1988.

5. *Design Manual—Onsite Wastewater Treatment and Disposal Systems,* U.S. Environmental Protection Agency, October 1980, EPA 625/1-80-012.

6. *Waste News Commodity Pricing Price,* a Crain publication. Volume 4, Issue 9, dated July 13, 1998.

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