## **Appendix B: Residence Time Tests using Varying Depth Columns**

Optimizing contact time for pollutant removal can be performed in two ways. First, flow-through columns can be used as they would be in field applications and either outlet constrictions or media depth can be used to control the contact time (Appendix B). Second, batch kinetic testing can be used (Appendix C1). Because of outlet clogging concerns and because of the desire to minimize media costs with shallower beds if possible, the flow-through column tests used varying media depths to control contact time. Columns were approximately 1/3, 2/3 and full-depth of the media columns planned for field deployment. Tests were performed for three of the component media (GAC, Peat Moss [PM], and Surface Modified Zeolite [SMZ]) and three of the media mixtures (Rhyolite Sand [R] – SMZ, R-SMZ-GAC, R-SMZ-GAC-PM). These media were selected based on their performance in both the long-column and batch kinetics testing and based on literature performance values.

The graphs in this appendix show the results of the varying column depth tests. The lines on the graphs represent the spiked stormwater (labeled spiked influent), the 3 varying-depth columns that received spiked stormwater, the unspiked stormwater, and the 14-inch column that received the unspiked stormwater (labeled 14" Control). The control column was run to determine if any of the media released pollutants when the stormwater concentration was low. Each constituent has two pages of multiple miniature plots, with the exception of mercury, oil and grease, and perchlorate. The first page of the pair shows the results for the component media, while the second page shows the results for the media mixtures.

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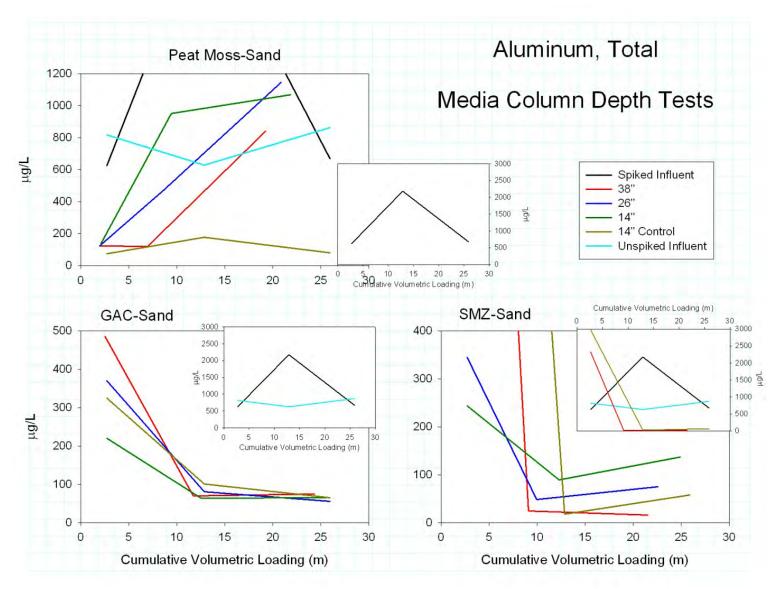


Figure B-1. Aluminum (Total) Removal for Component Media

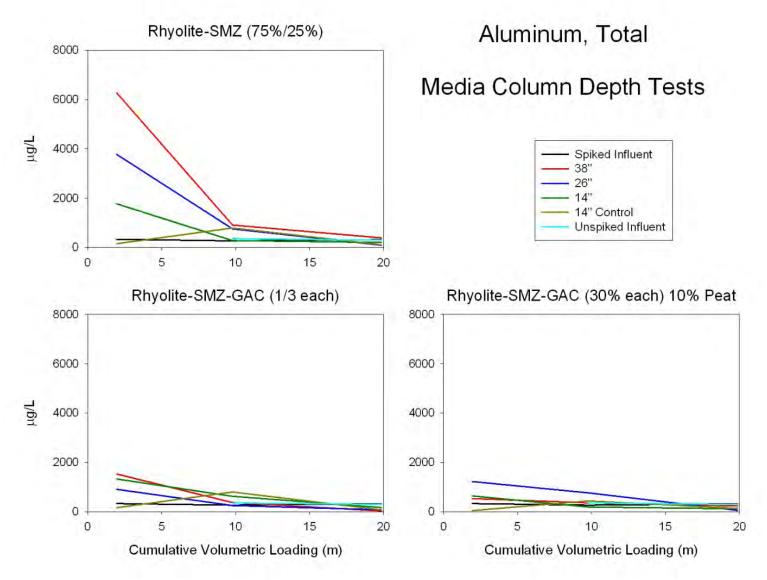


Figure B-2. Aluminum (Total) Removal for Media Mixtures

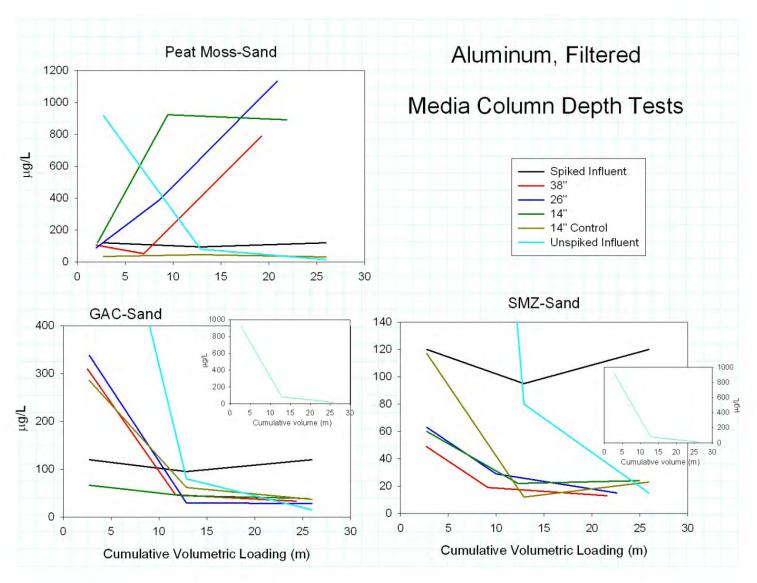


Figure B-3. Aluminum (Filtered) Removal for Component Media

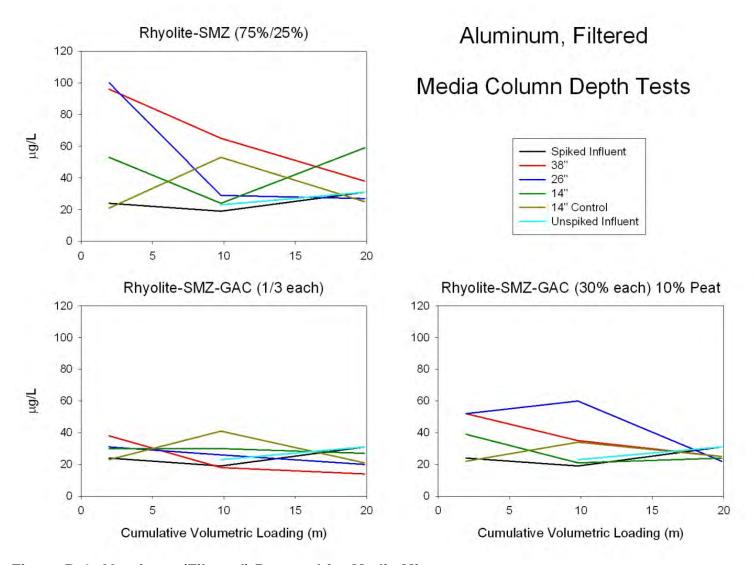


Figure B-4. Aluminum (Filtered) Removal for Media Mixtures

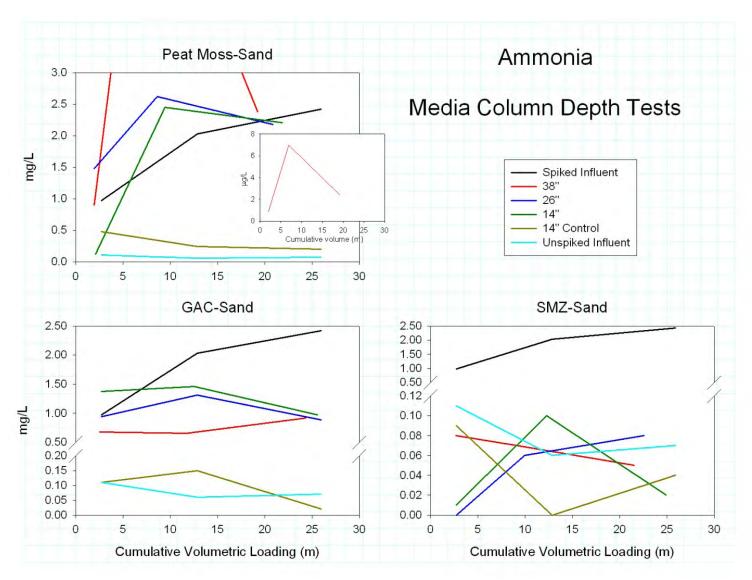


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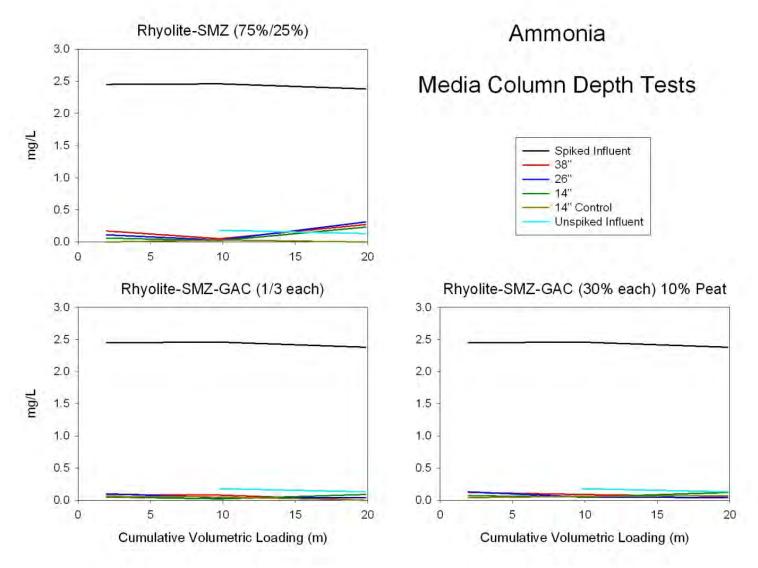


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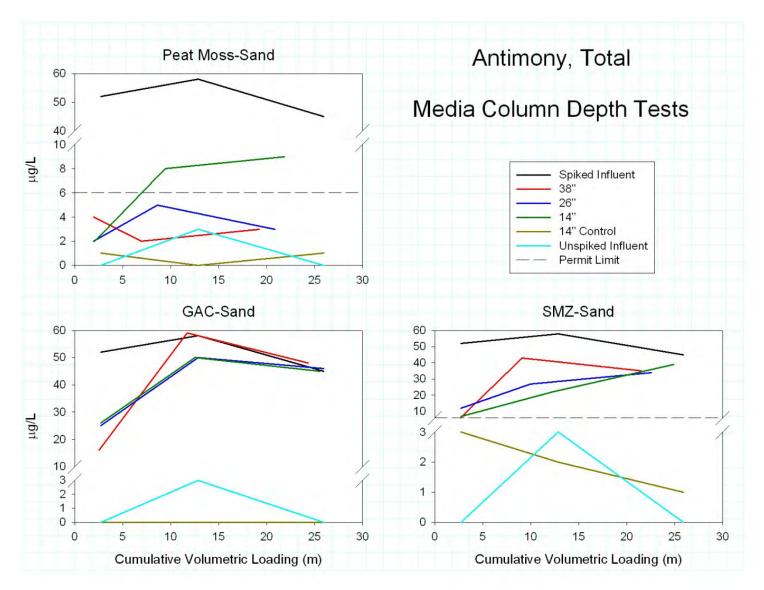


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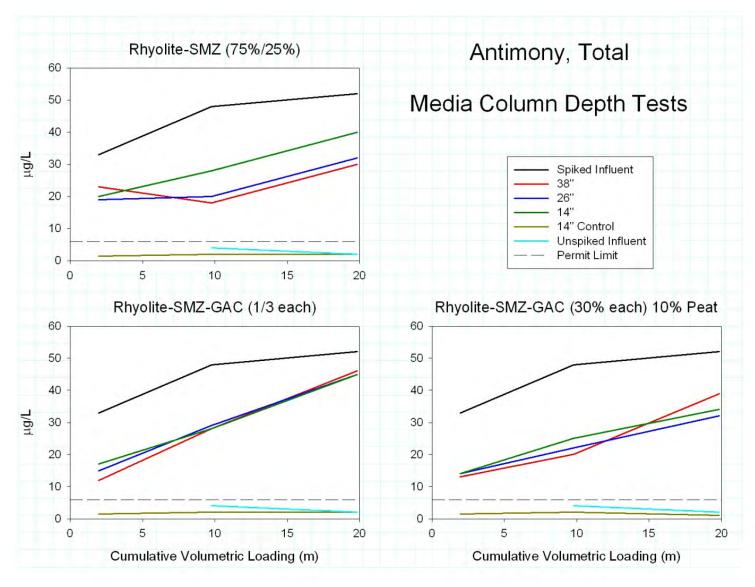


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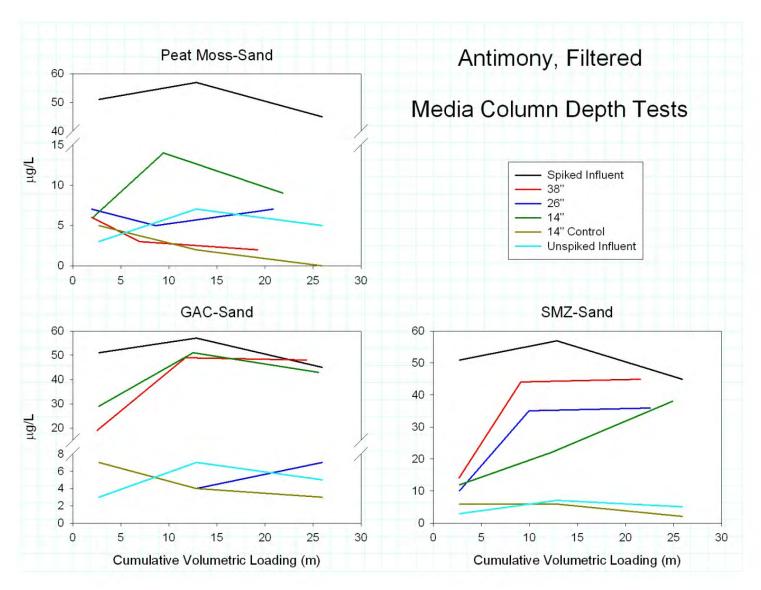


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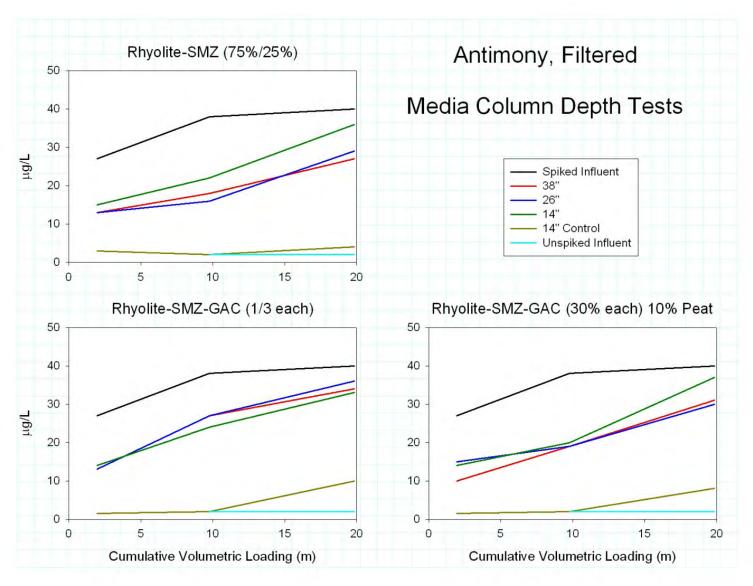


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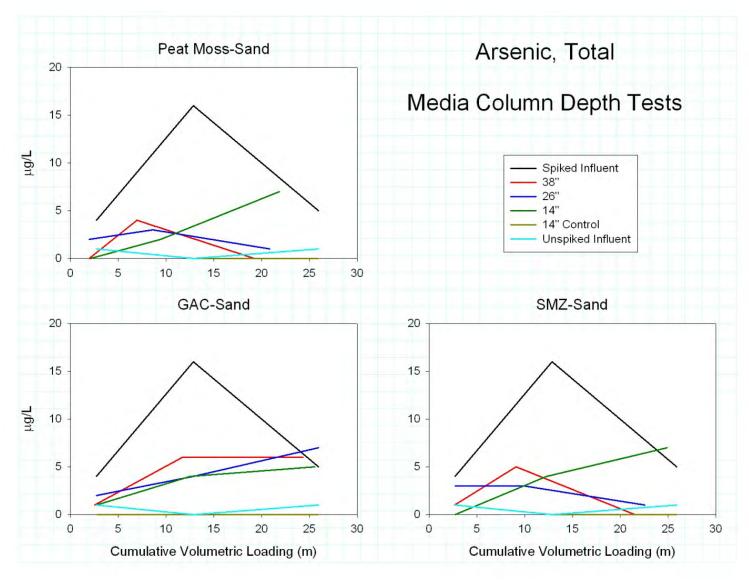


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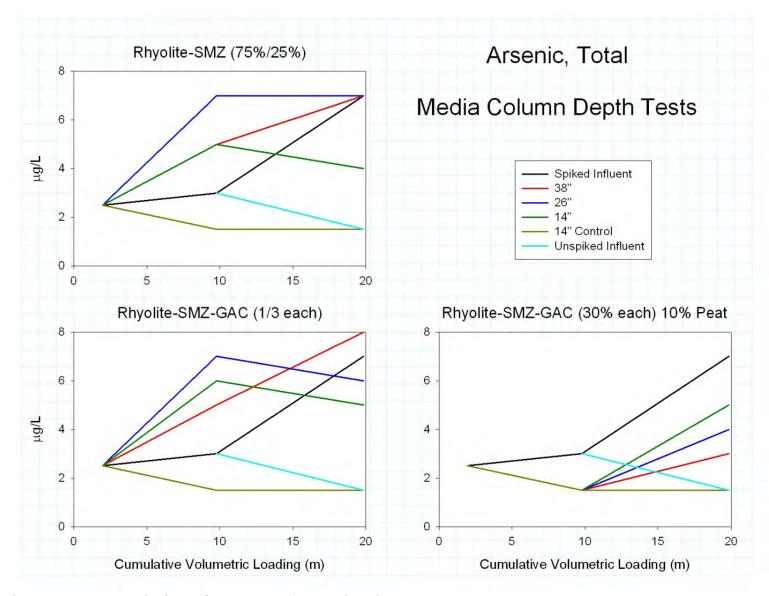


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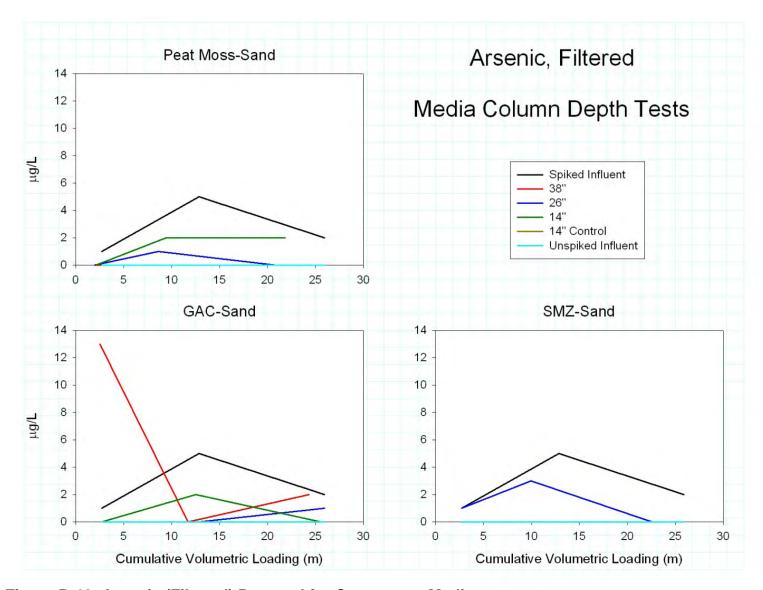


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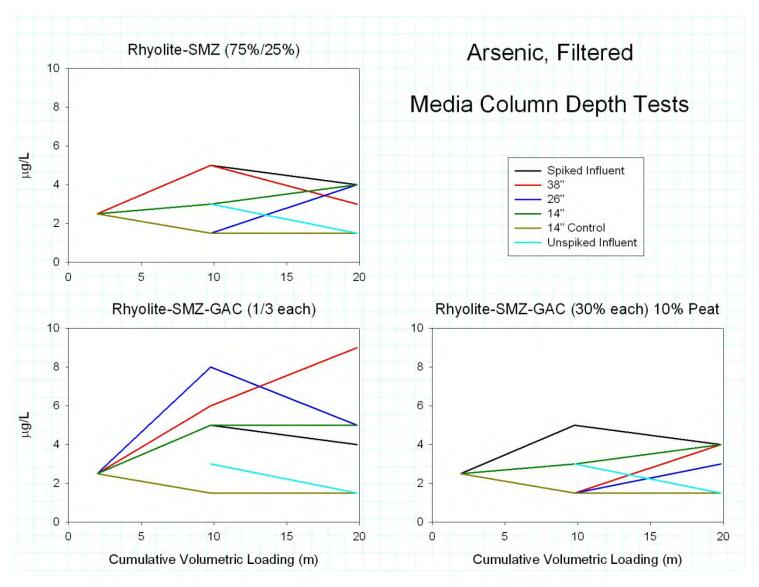


Figure B-14. Arsenic (Filtered) Removal for Media Mixtures

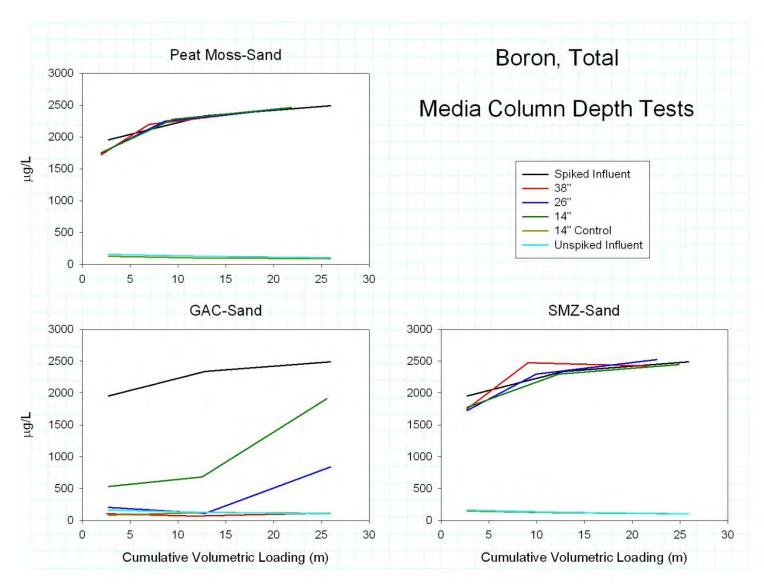


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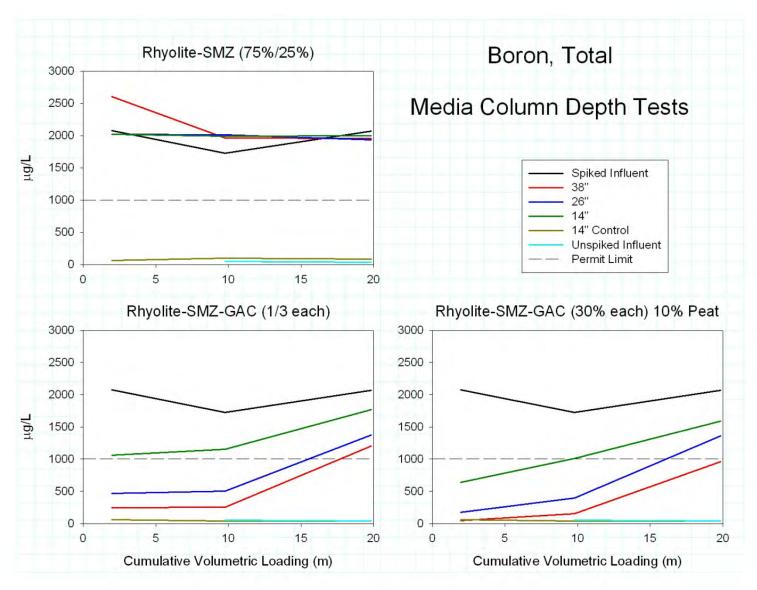


Figure B-16. Boron (Total) Removal for Media Mixtures

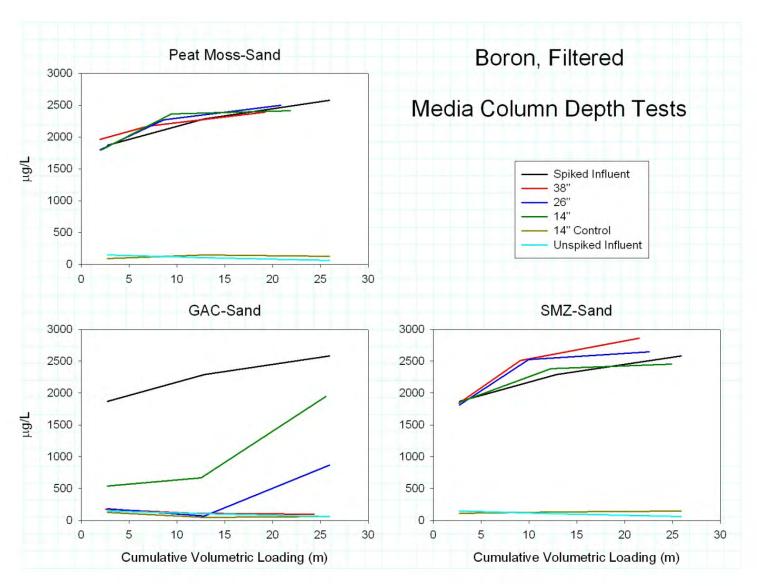


Figure B-17. Boron (Filtered) Removal for Component Media

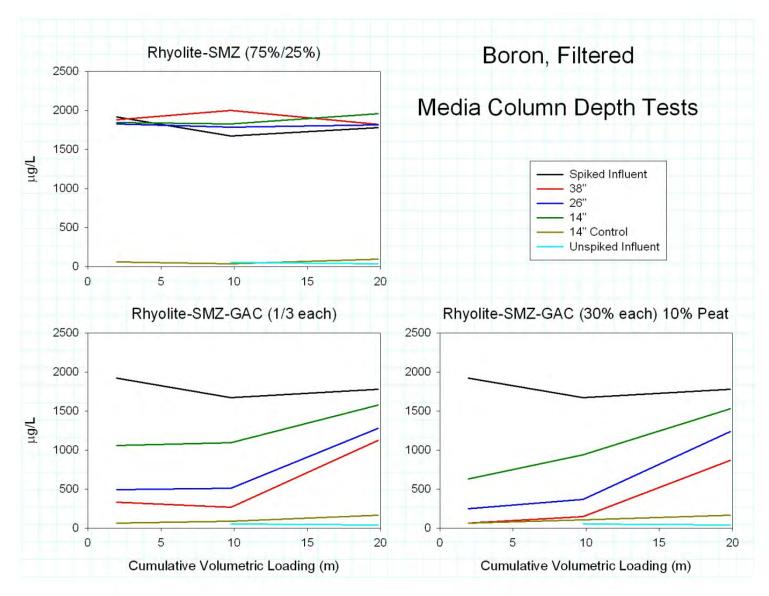


Figure B-18. Boron (Filtered) Removal for Media Mixtures

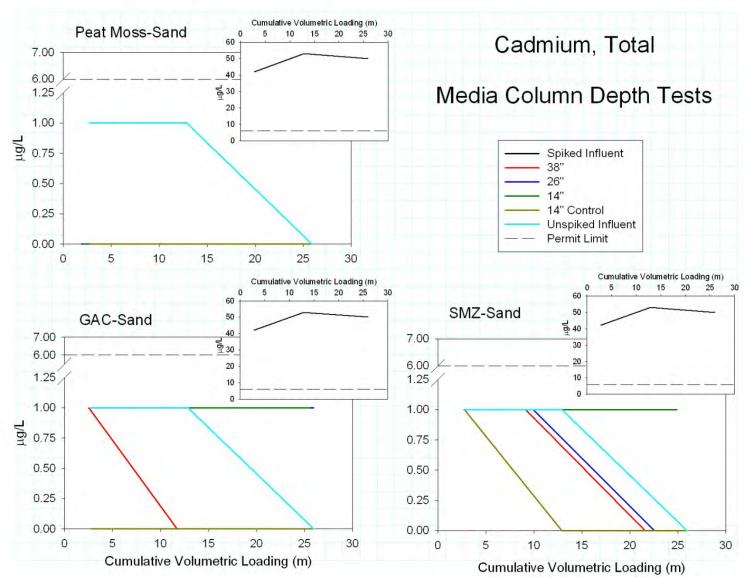


Figure B-19. Cadmium (Total) Removal for Component Media

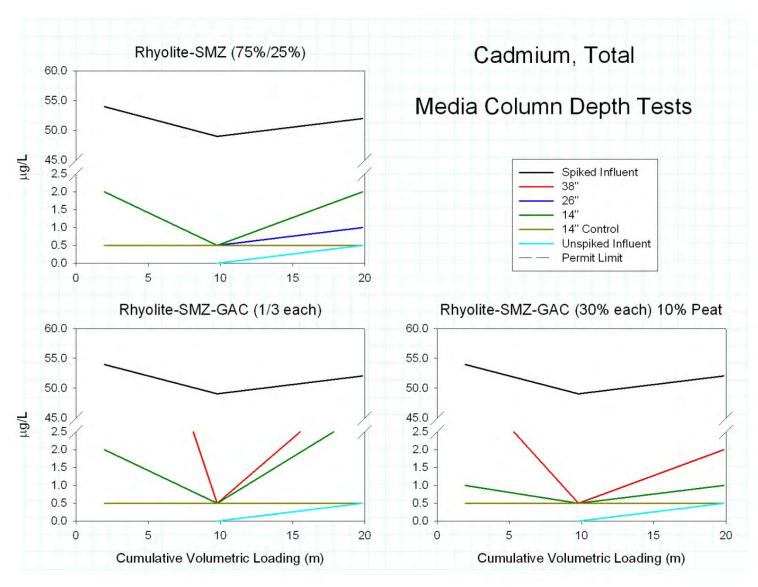


Figure B-20. Cadmium (Total) Removal for Media Mixtures

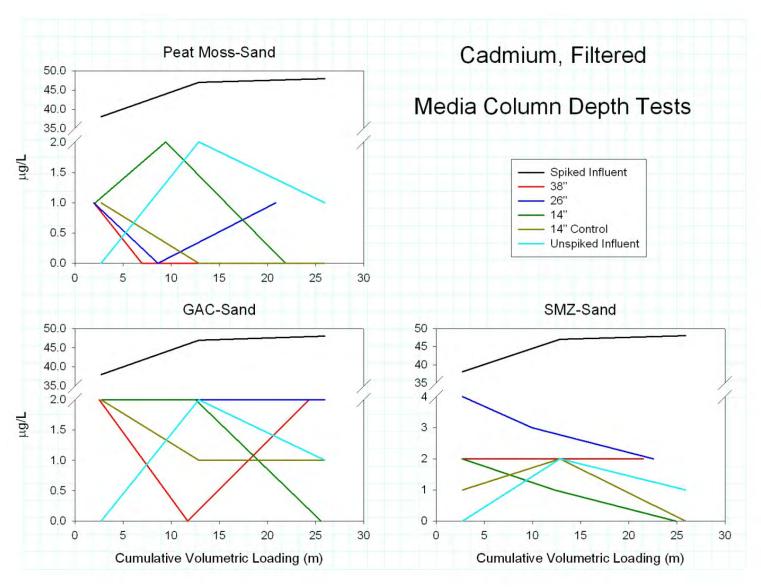


Figure B-21. Cadmium (Filtered) Removal for Component Media

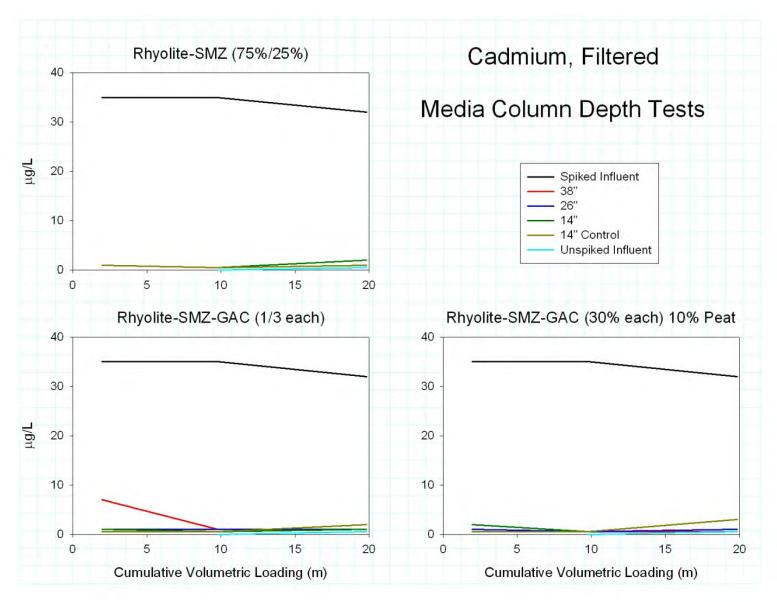


Figure B-22. Cadmium (Filtered) Removal for Media Mixtures

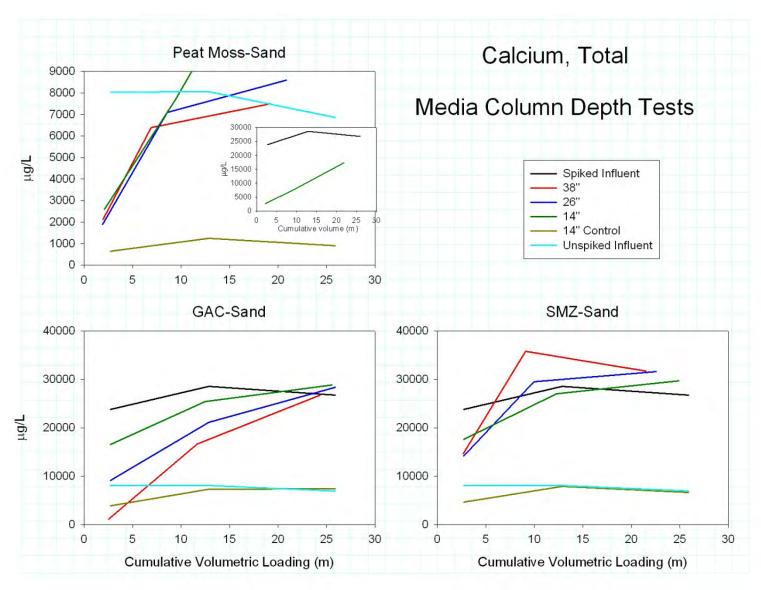


Figure B-23. Calcium (Total) Removal for Component Media

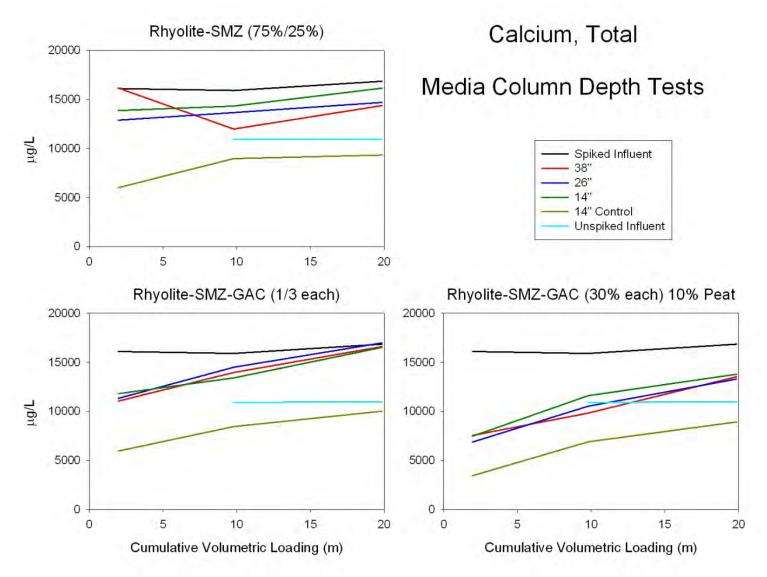


Figure B-24. Calcium (Total) Removal for Media Mixtures

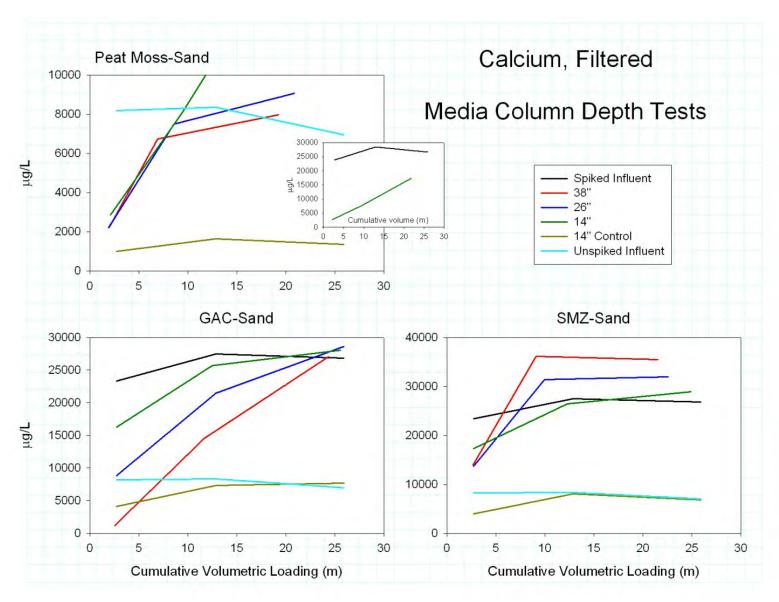


Figure B-25. Calcium (Filtered) Removal

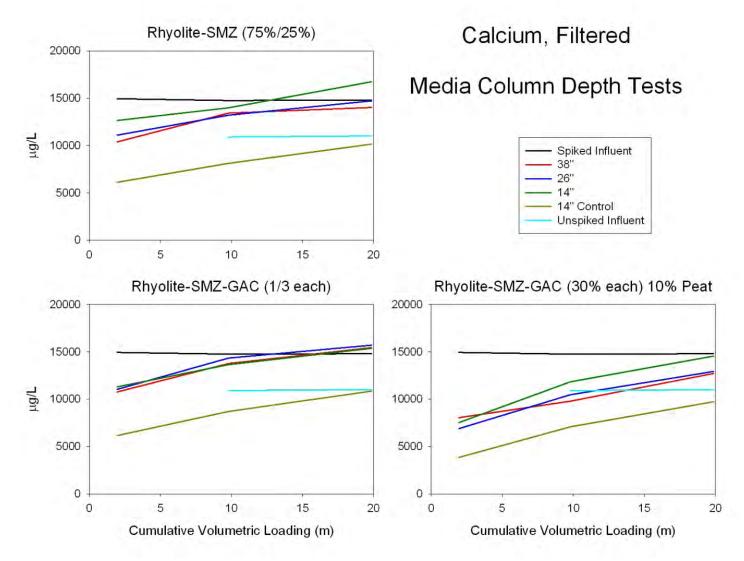


Figure B-26. Calcium (Filtered) Removal for Media Mixtures

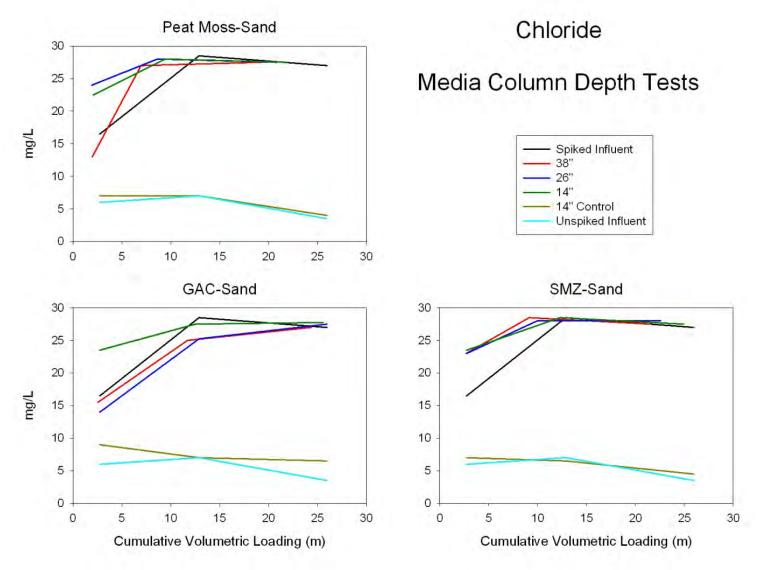


Figure B-27. Chloride Removal for Component Media

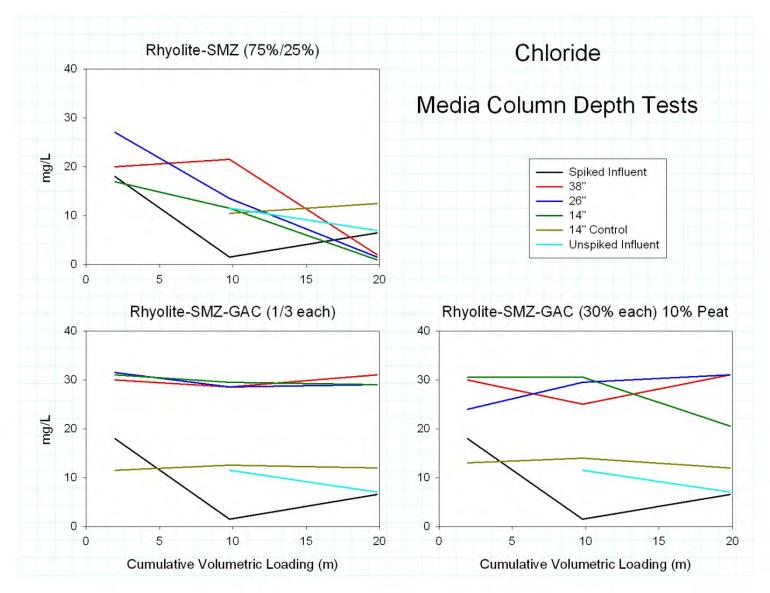


Figure B-28. Chloride Removal for Media Mixtures

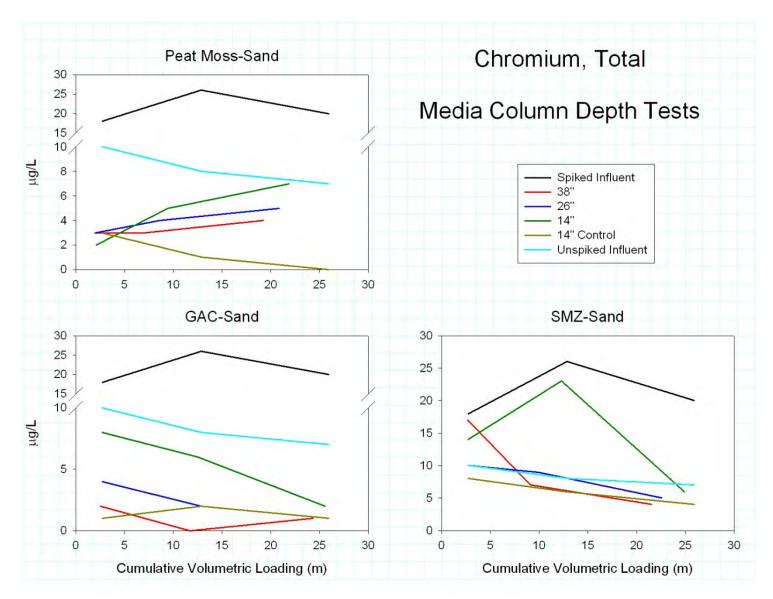


Figure B-29. Chromium (Total) Removal

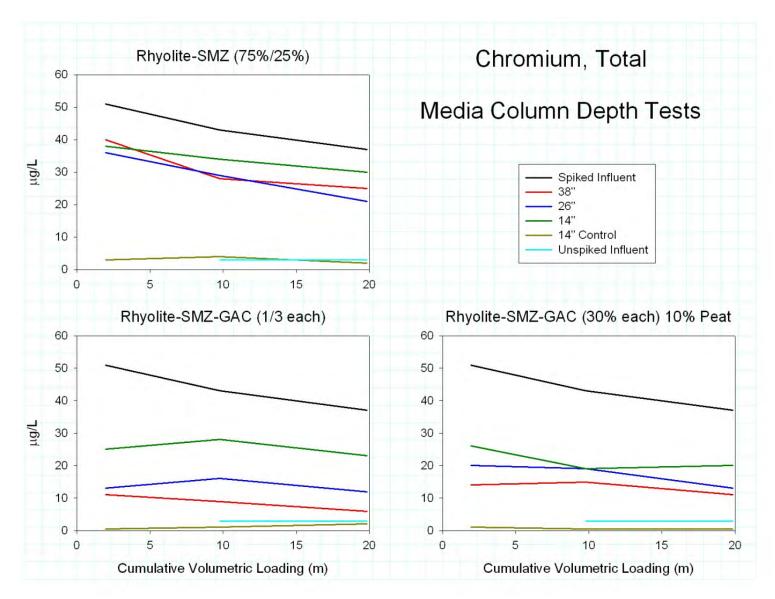


Figure B-30. Chromium (Total) Removal for Media Mixtures

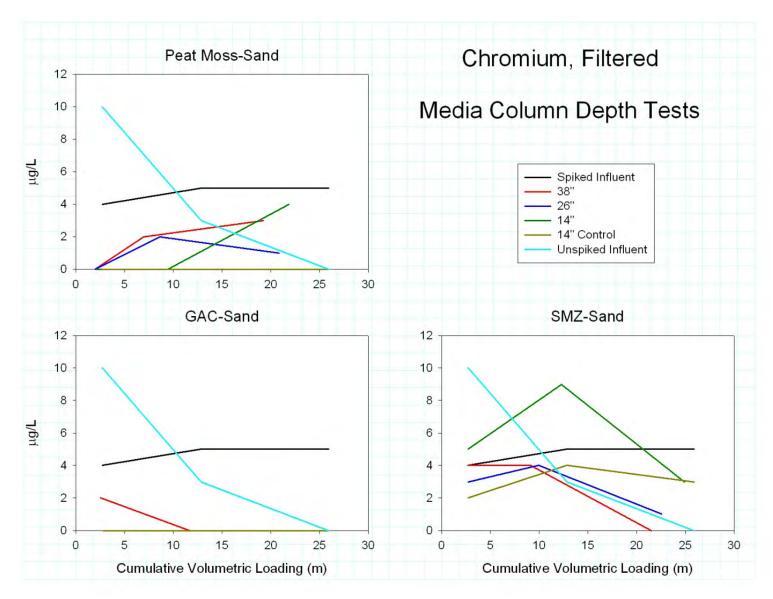


Figure B-31. Chromium (Filtered) Removal for Component Media

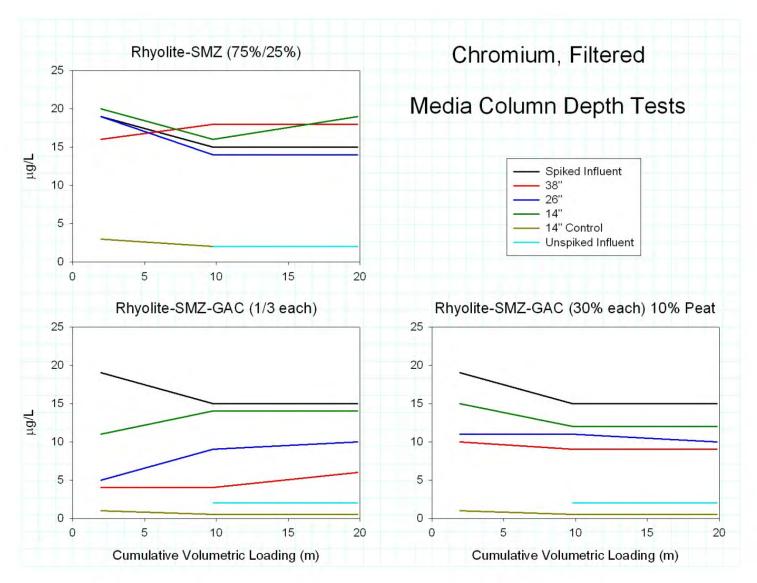


Figure B-32. Chromium (Filtered) Removal for Media Mixtures

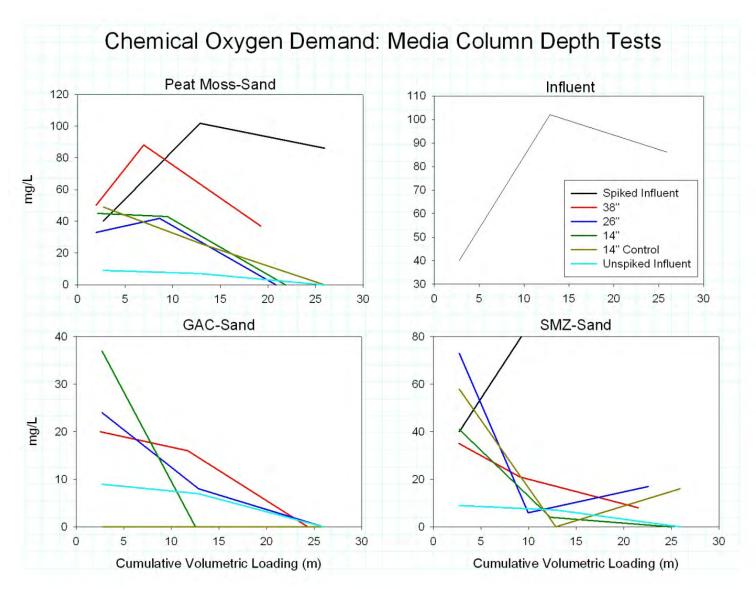


Figure B-33. Chemical Oxygen Demand Removal for Component Media

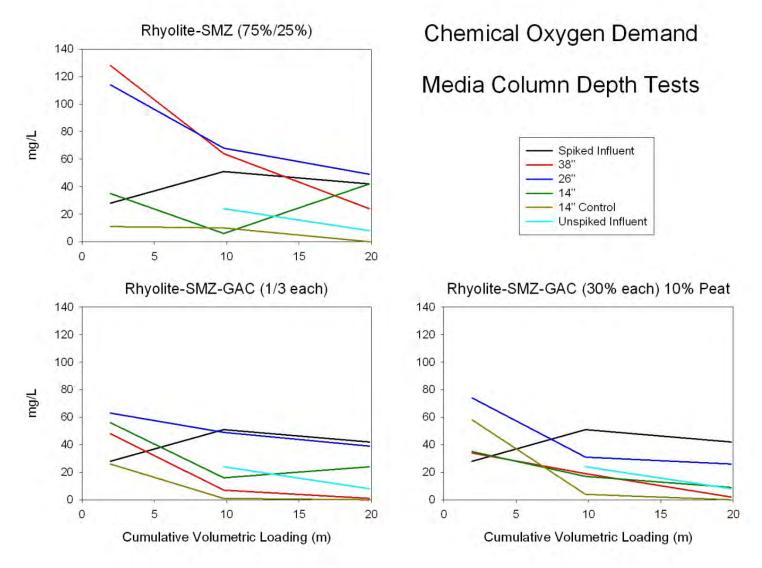


Figure B-34. Chemical Oxygen Demand Removal for Media Mixtures

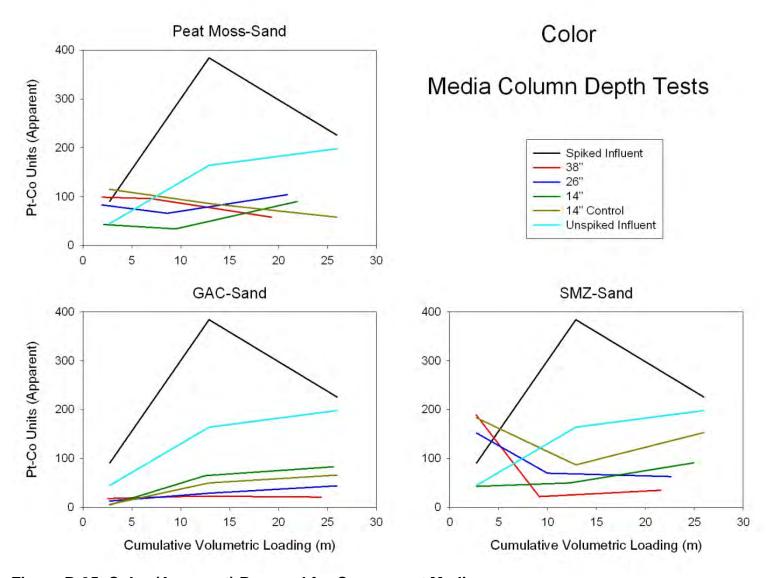


Figure B-35. Color (Apparent) Removal for Component Media

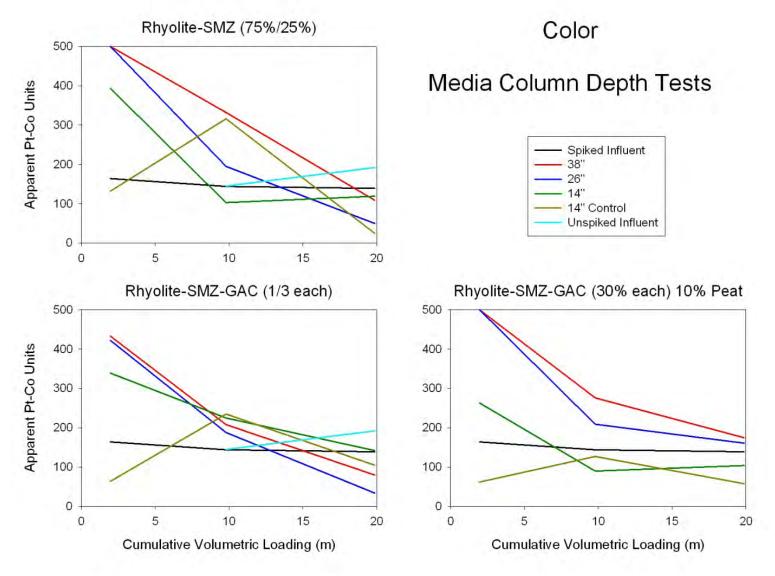


Figure B-36. Color (Apparent) Removal for Media Mixtures

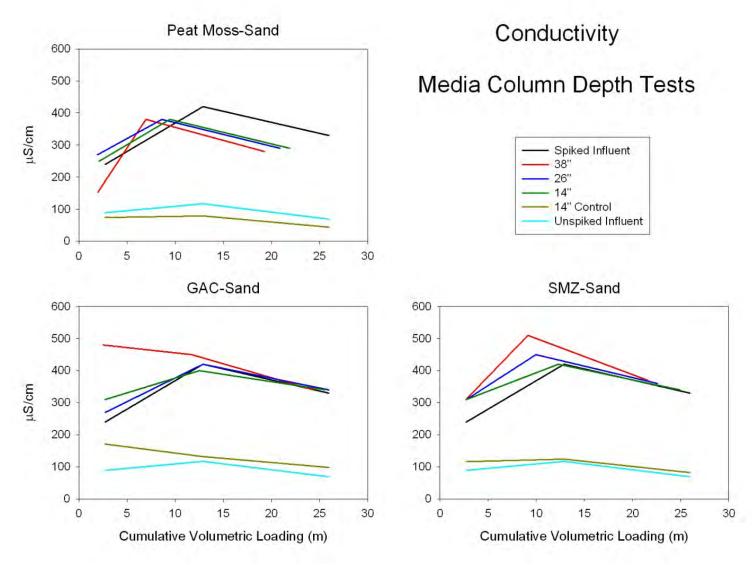


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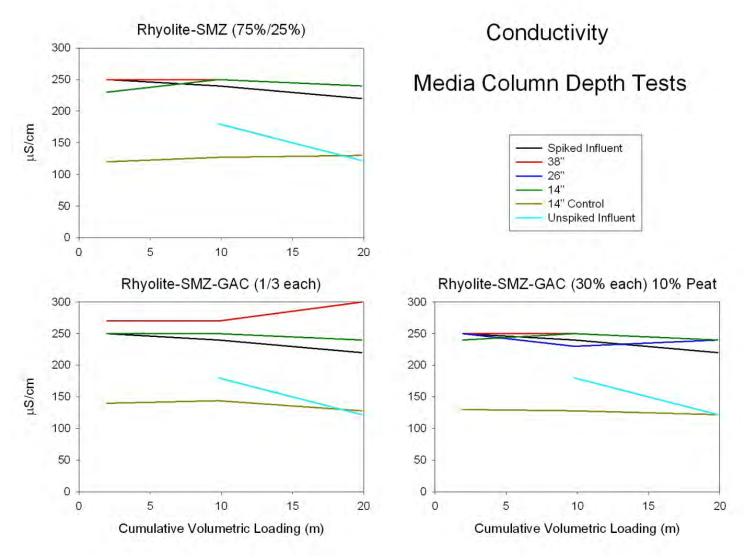


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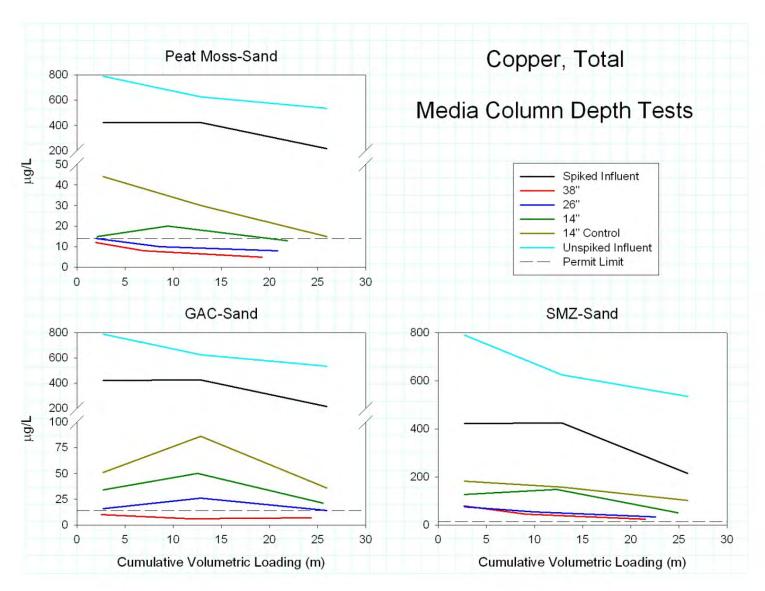


Figure B-39. Copper (Total) Removal for Component Media

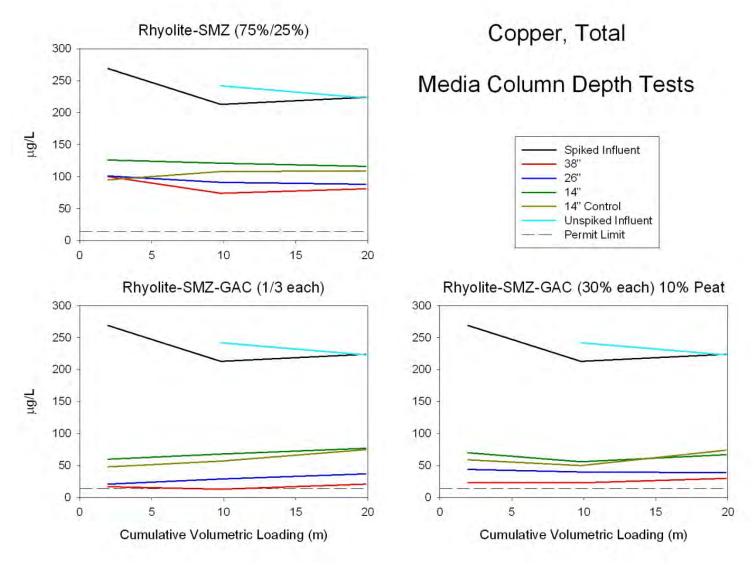


Figure B-40. Copper (Total) Removal for Media Mixtures

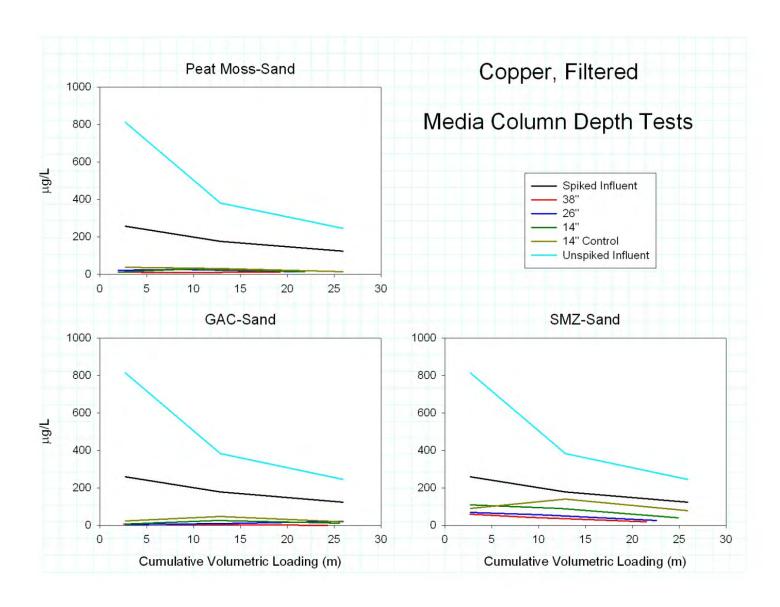


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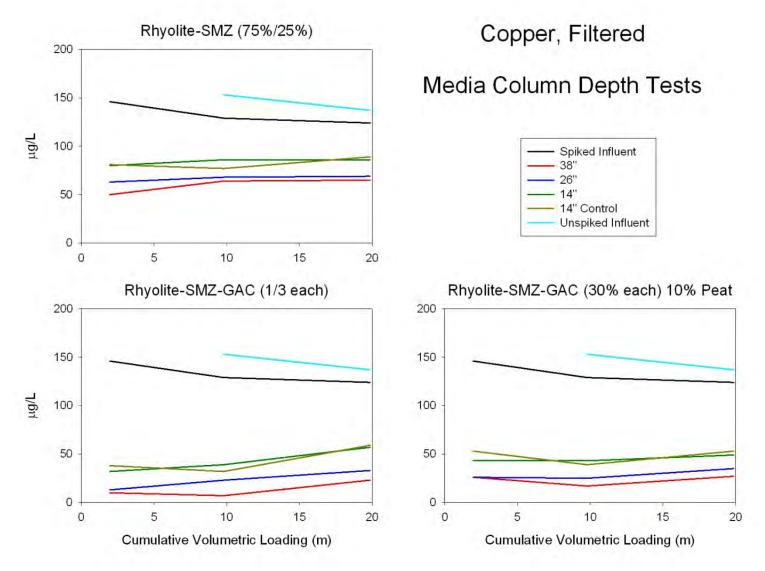


Figure B-42. Copper (Filtered) Removal

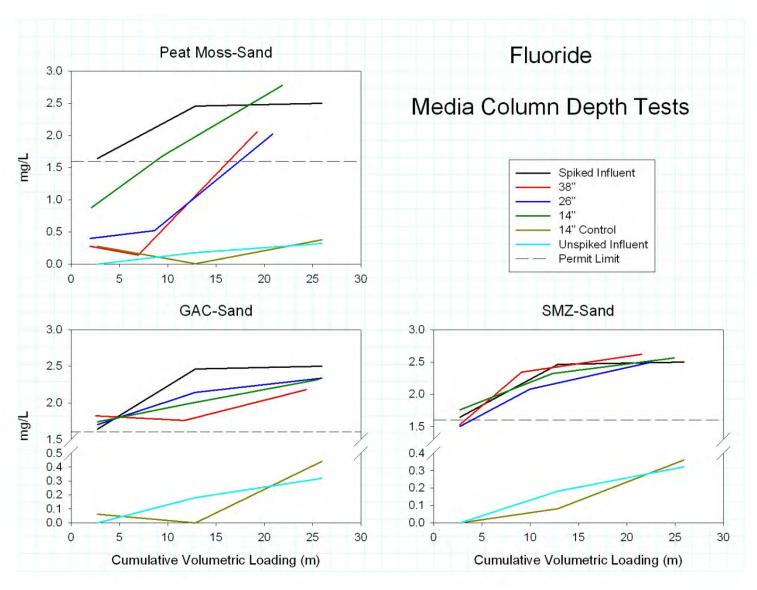


Figure B-43. Fluoride Removal for Component Media

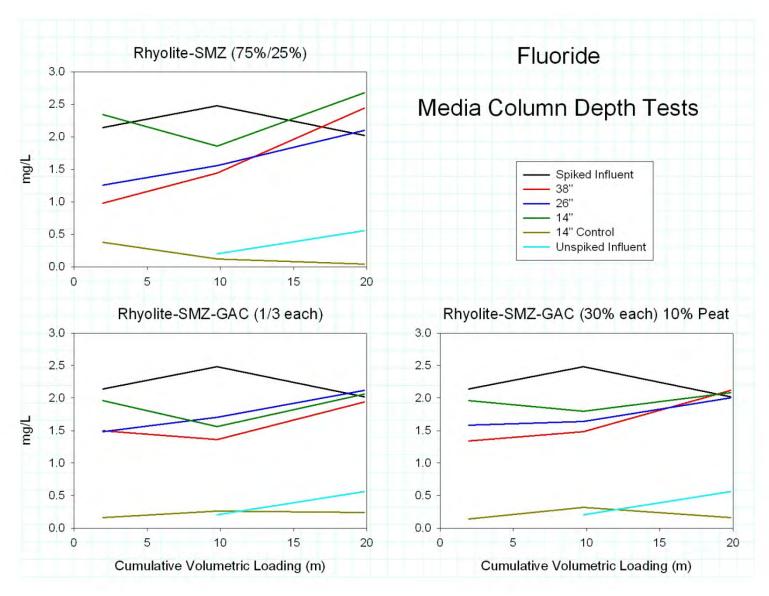


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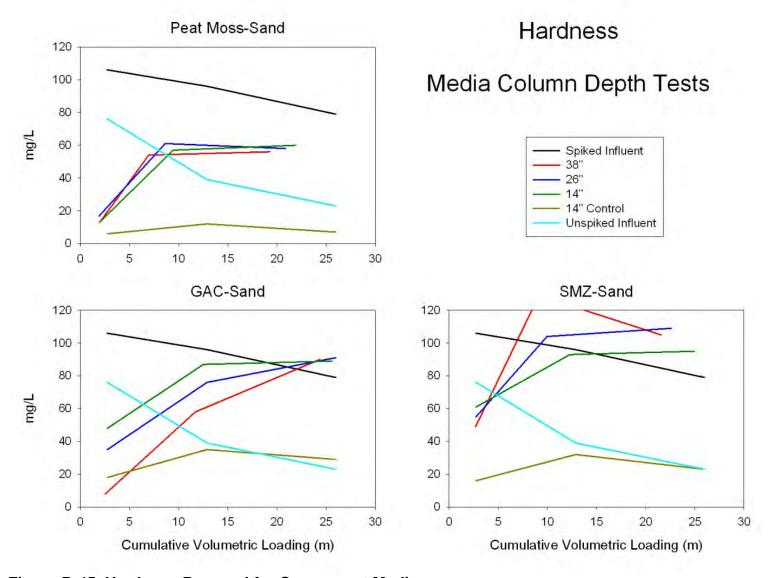


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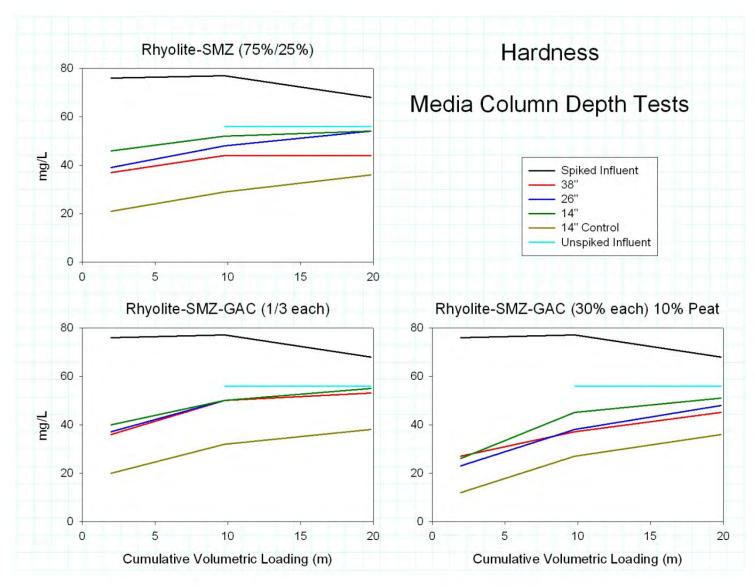


Figure B-46. Aluminum (Total) Removal for Media Mixtures

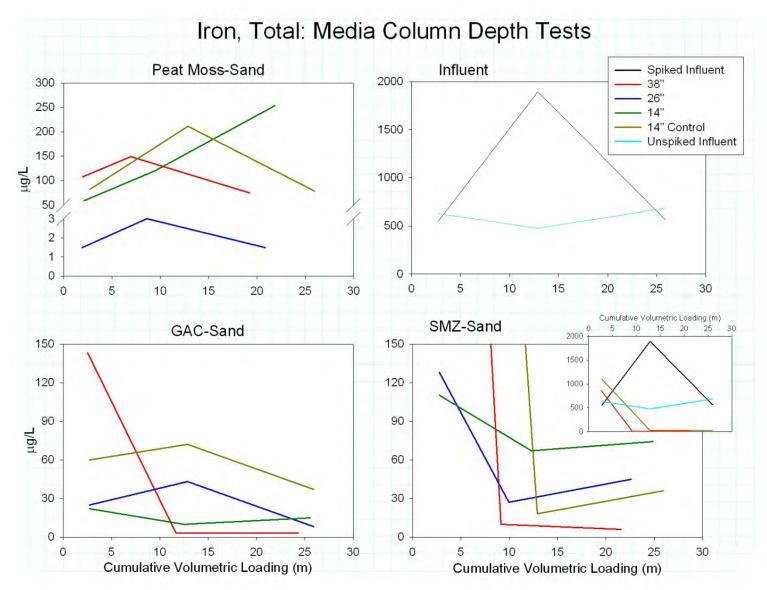


Figure B-47. Iron (Total) Removal for Component Media

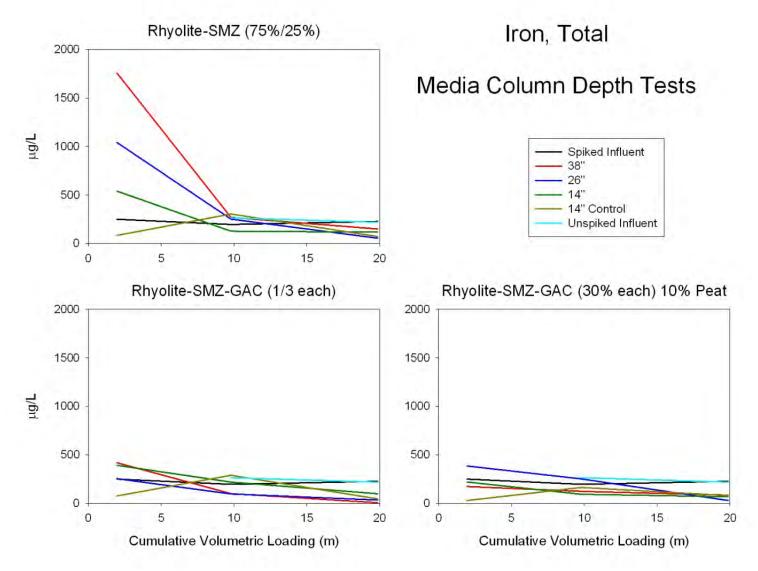


Figure B-48. Iron (Total) Removal for Media Mixtures

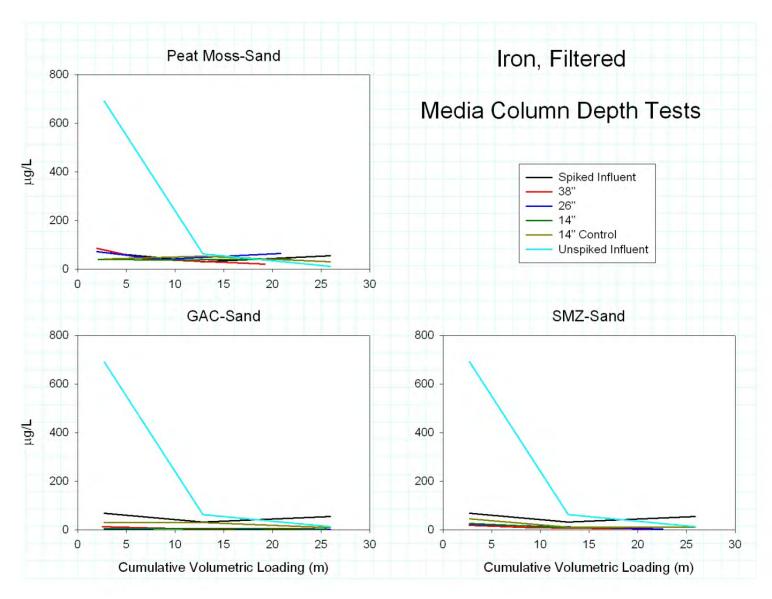


Figure B-49. Iron (Filtered) Removal for Component Media

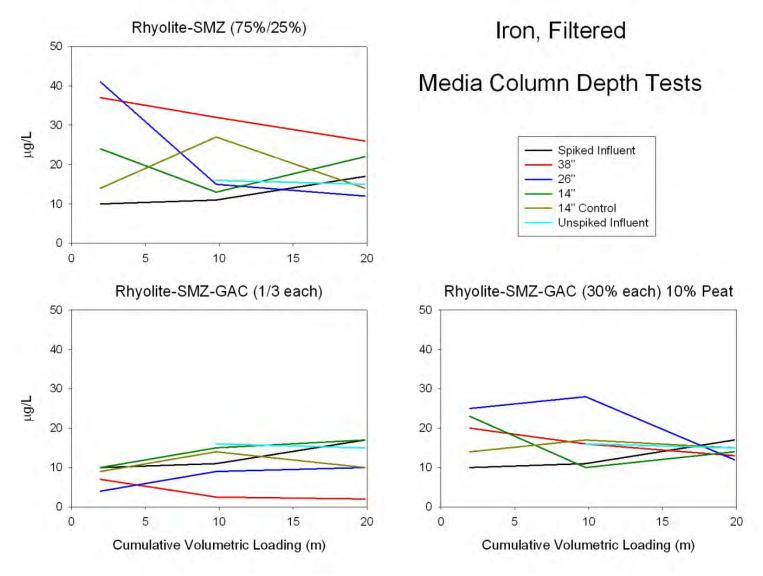


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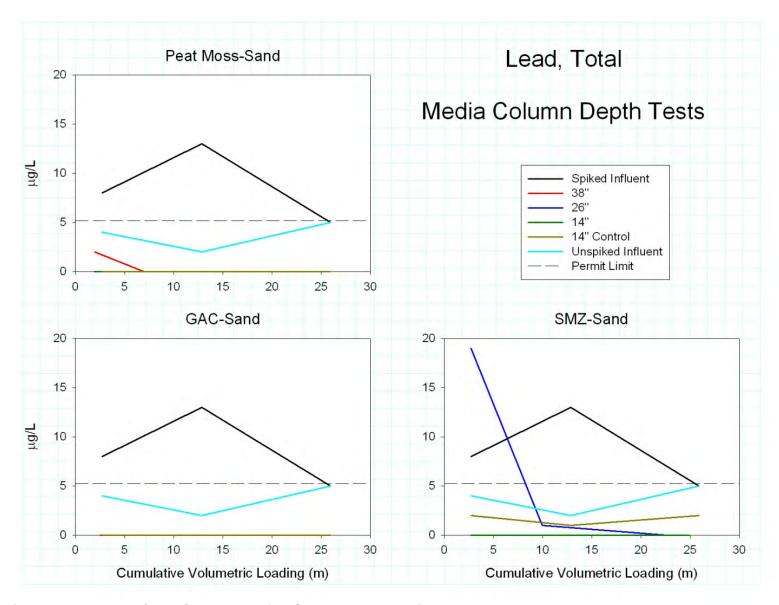


Figure B-51. Lead (Total) Removal for Component Media

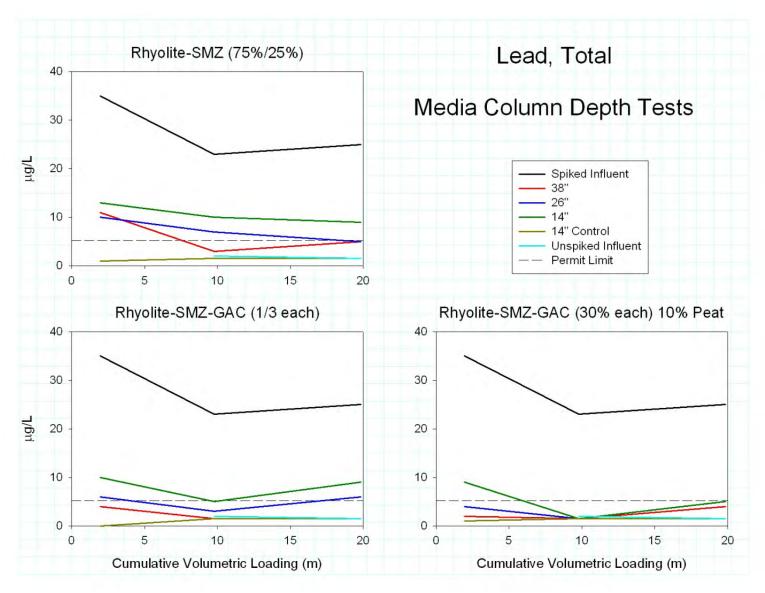


Figure B-52. Lead (Total) Removal for Media Mixtures

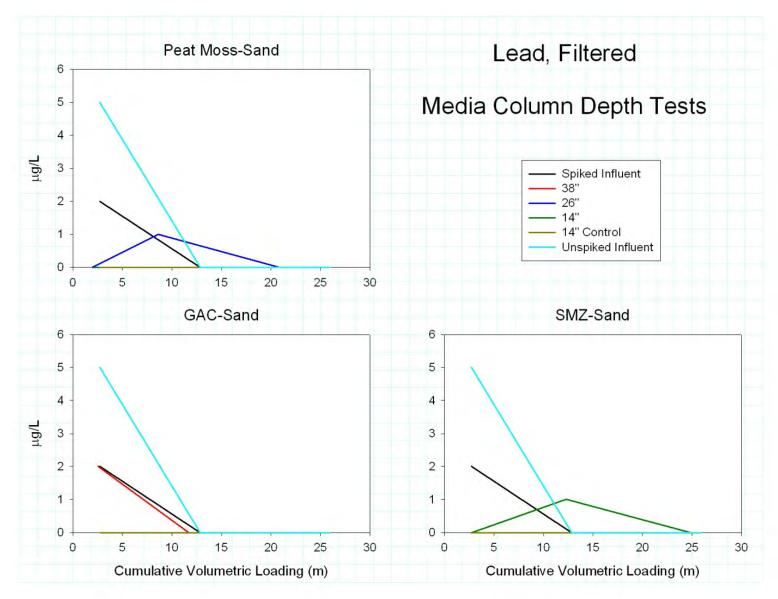


Figure B-53. Lead (Filtered) Removal for Component Media

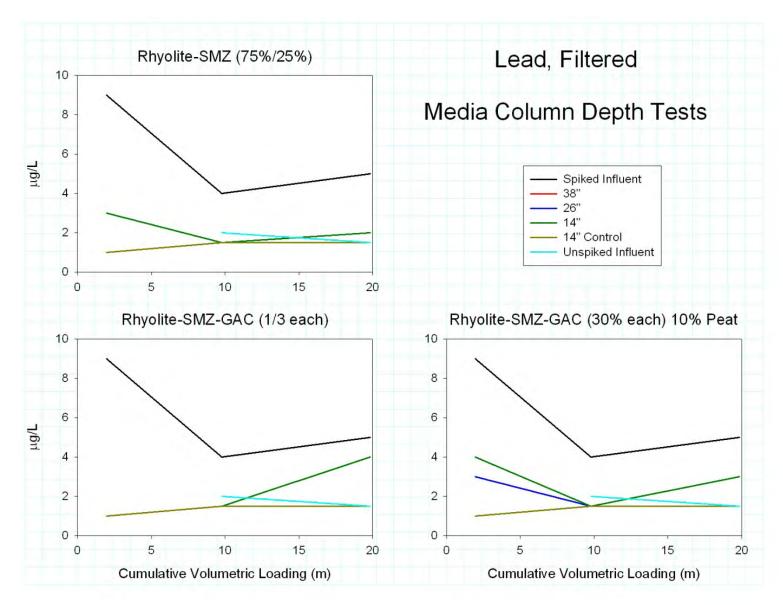


Figure B-54. Lead (Filtered) Removal for Media Mixtures

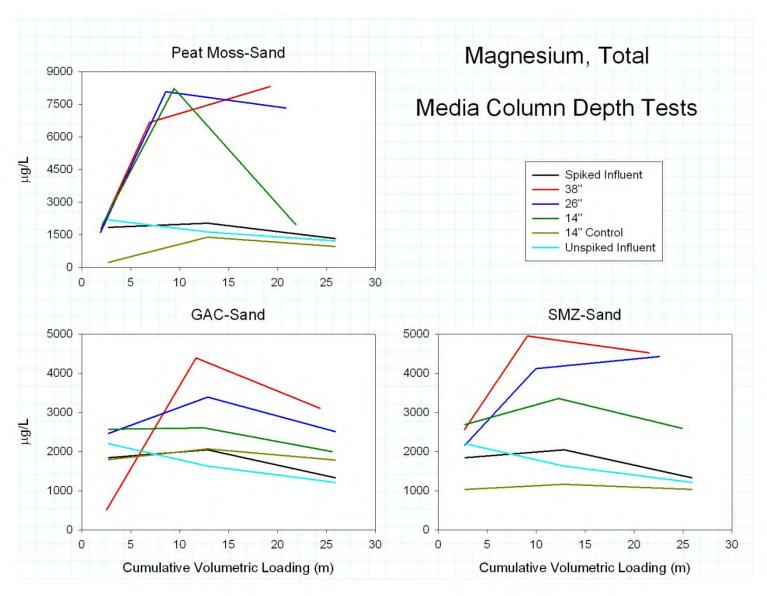


Figure B-55. Magnesium (Total) Removal for Component Media

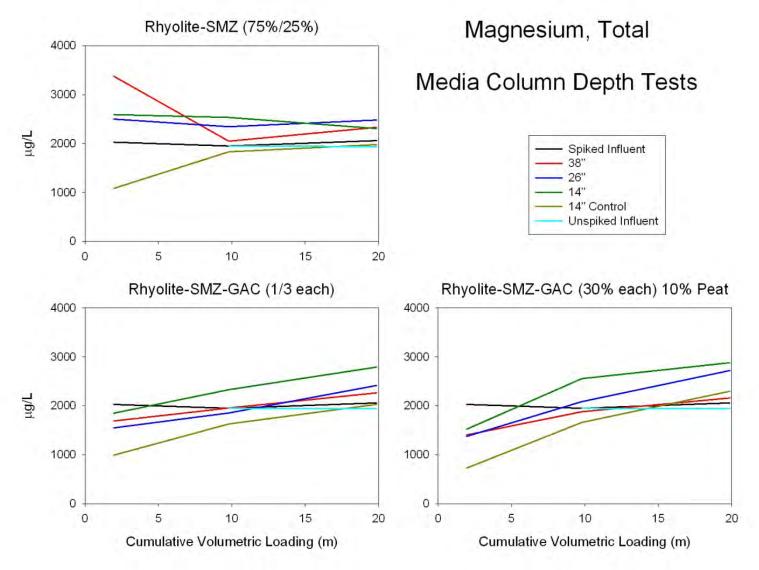


Figure B-56. Magnesium (Total) Removal for Media Mixtures

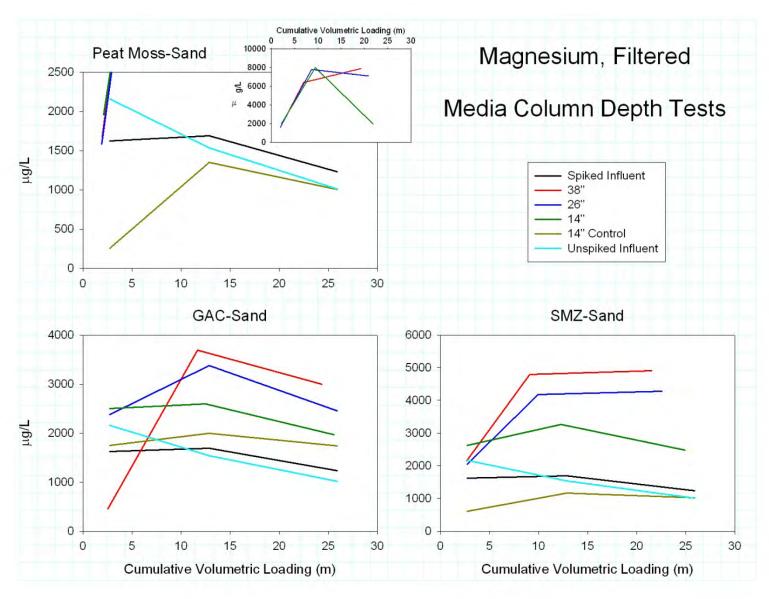


Figure B-57. Magnesium (Filtered) Removal for Component Media

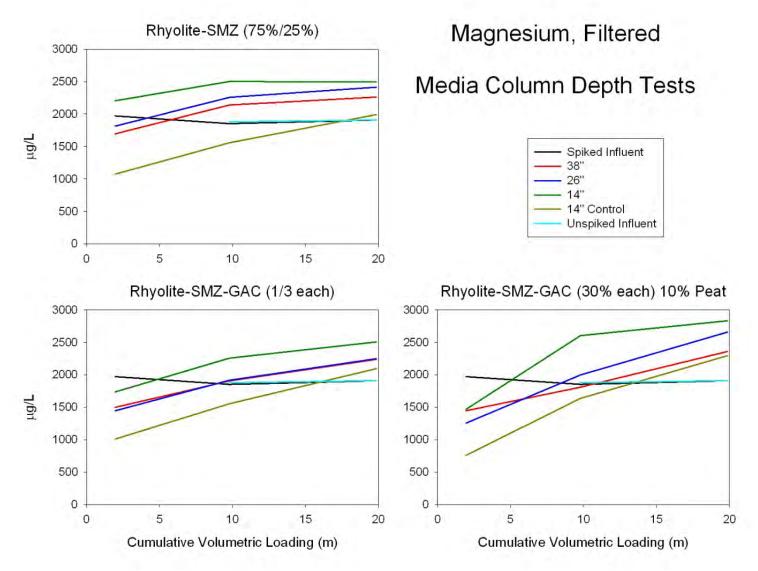


Figure B-58. Magnesium (Filtered) Removal for Media Mixtures

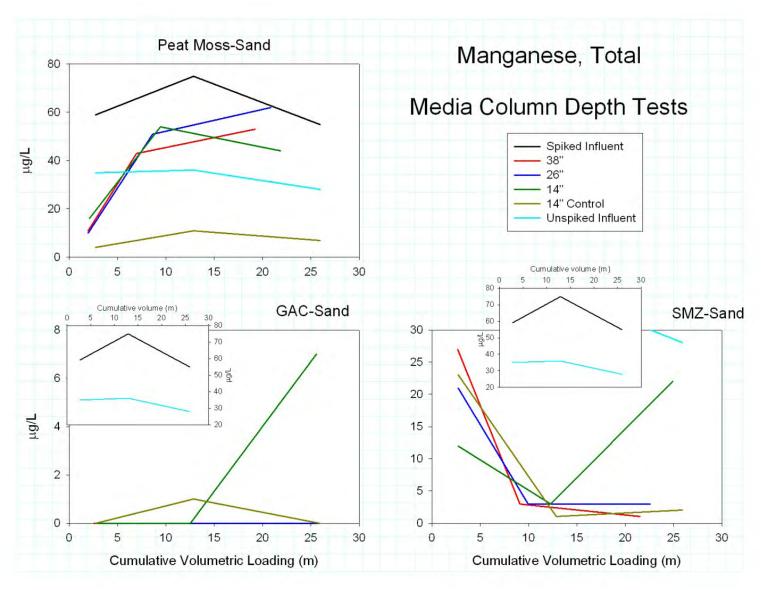


Figure B-59. Manganese (Total) Removal for Component Media

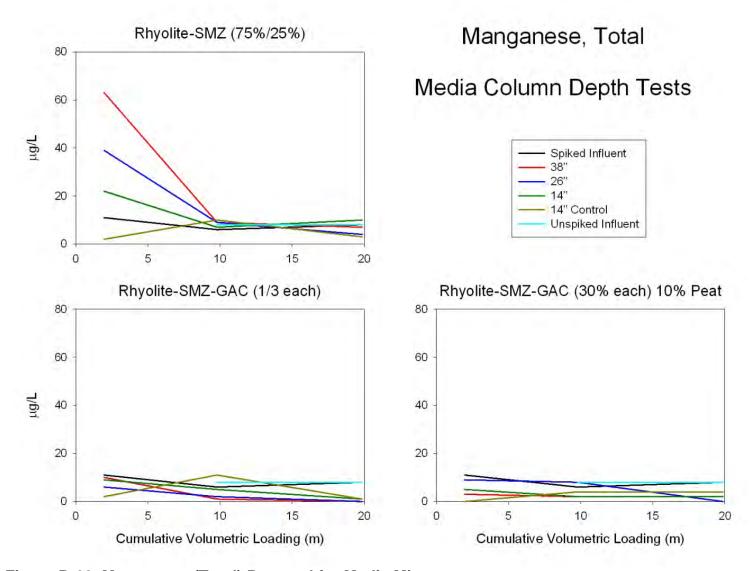


Figure B-60. Manganese (Total) Removal for Media Mixtures

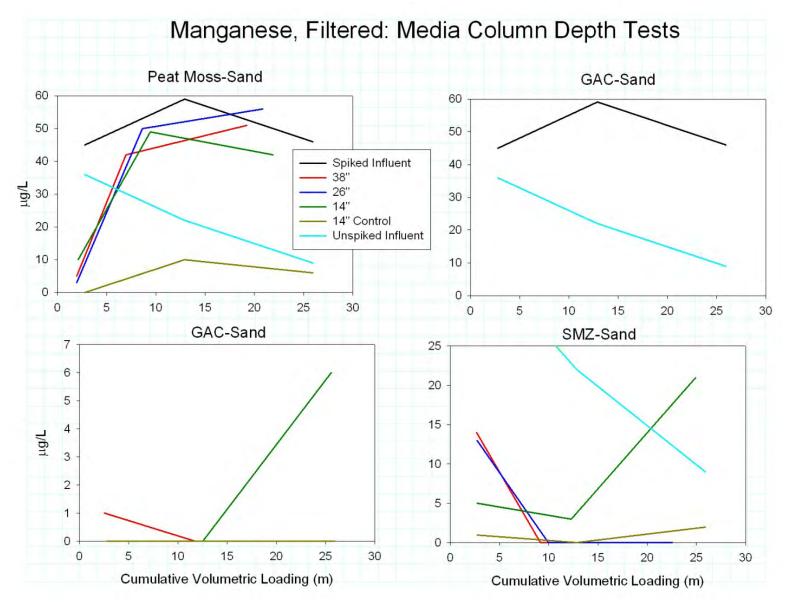


Figure B-61. Manganese (Filtered) Removal

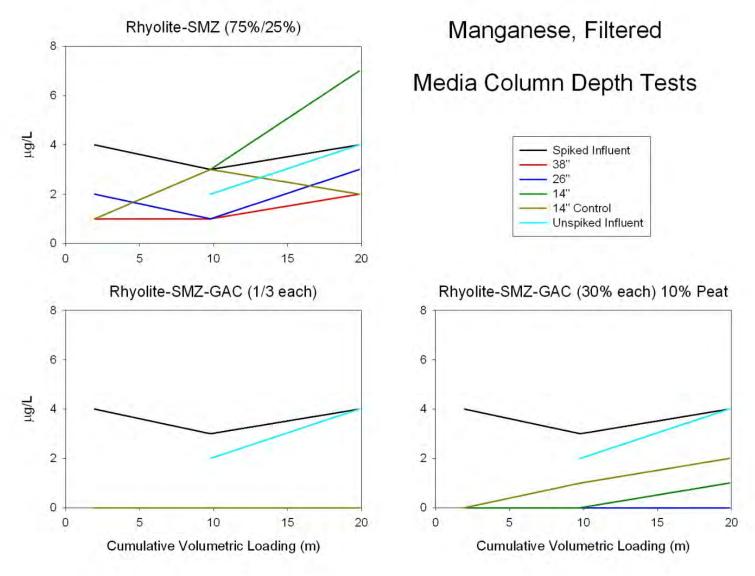


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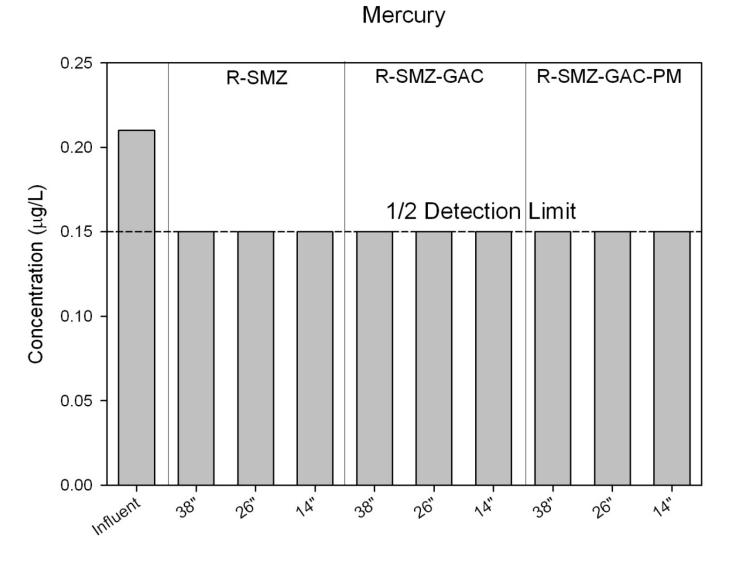


Figure B-63. Mercury (Total) Removal for Media Mixtures

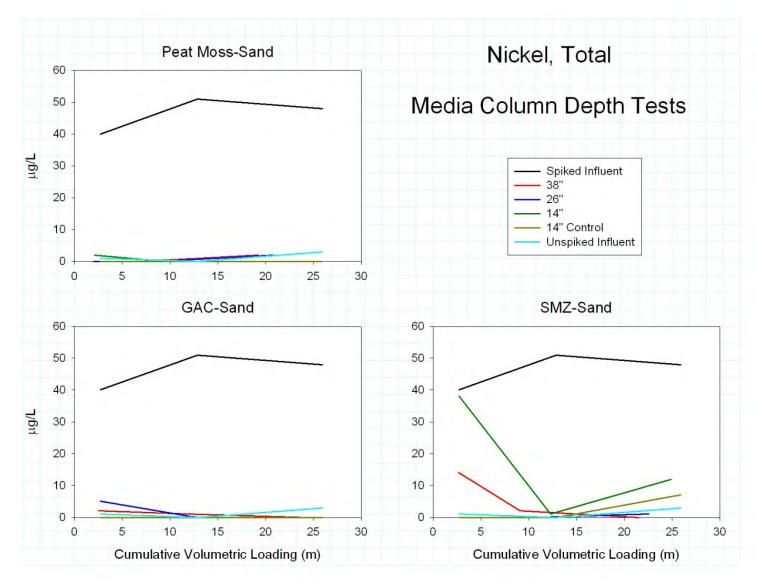


Figure B-64. Nickel (Total) Removal for Component Media

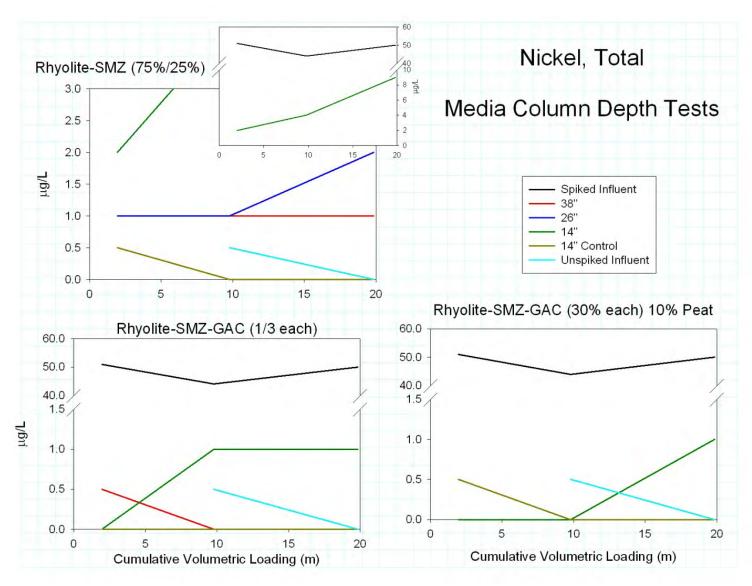


Figure B-65. Nickel (Total) Removal for Media Mixtures

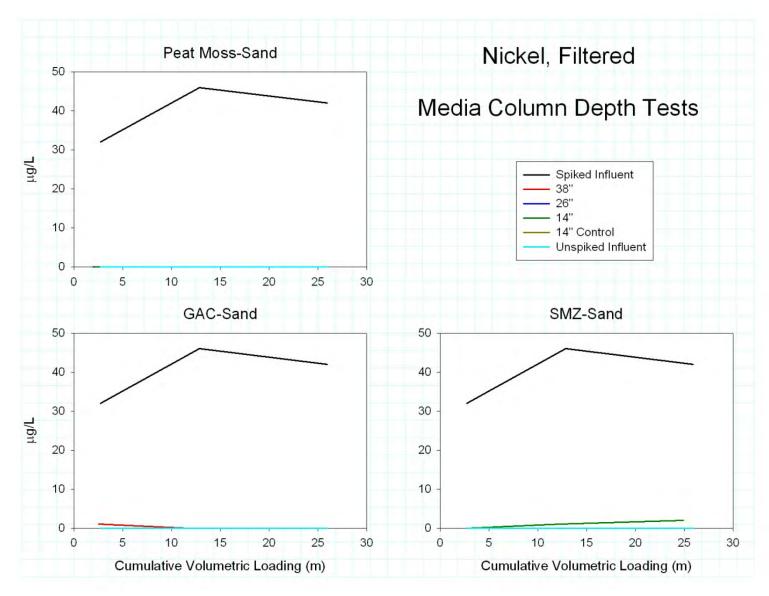


Figure B-66. Nickel (Filtered) Removal for Component Media

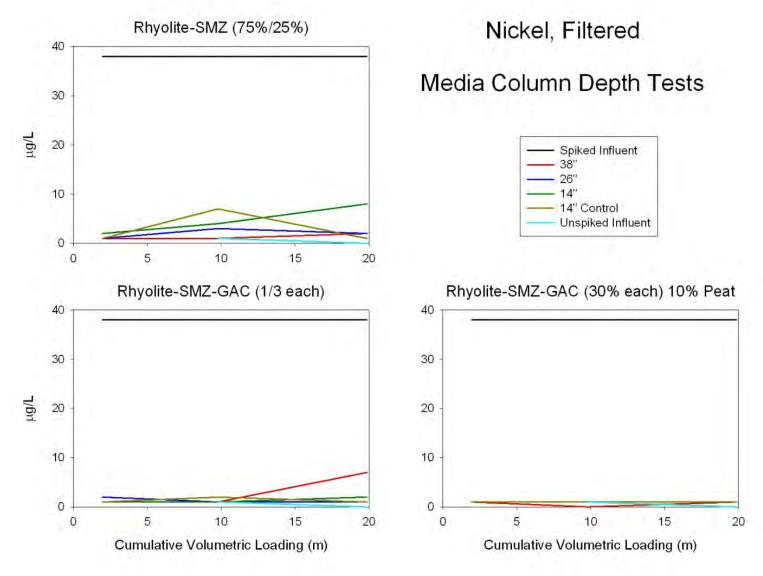


Figure B-67. Nickel (Filtered) Removal for Media Mixtures

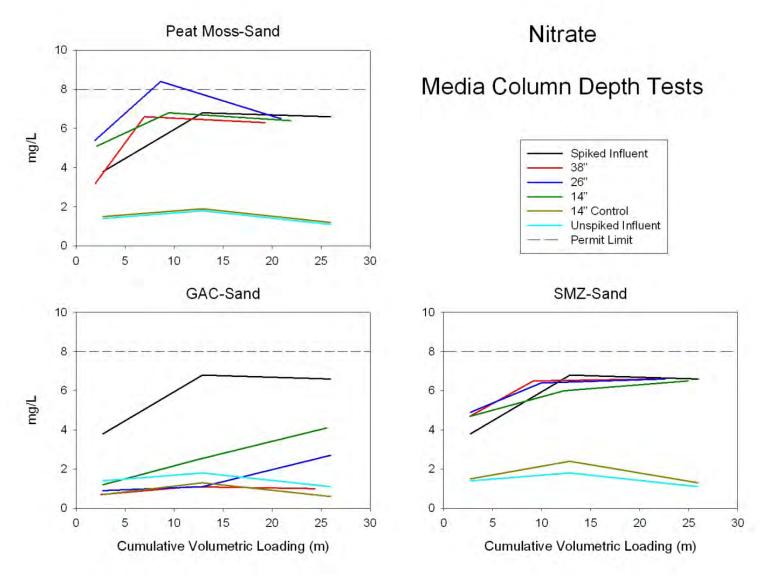


Figure B-68. Aluminum (Total) Removal for Component Media

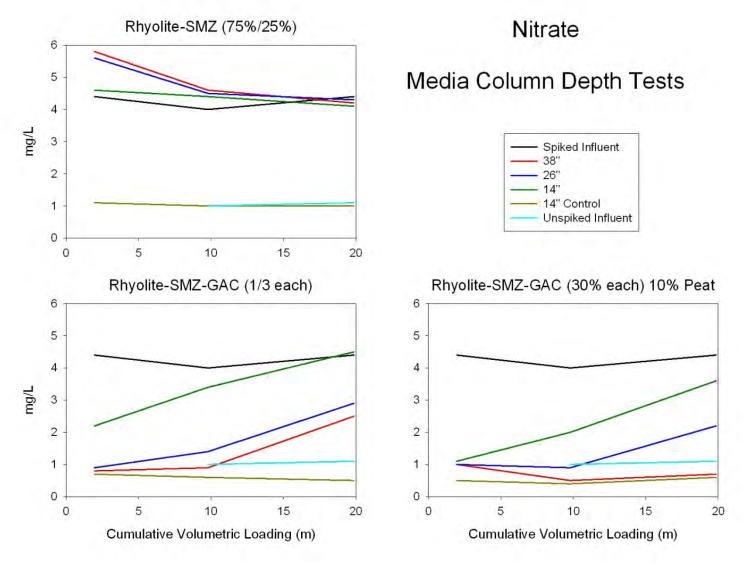


Figure B-69. Nitrate Removal for Media Mixtures

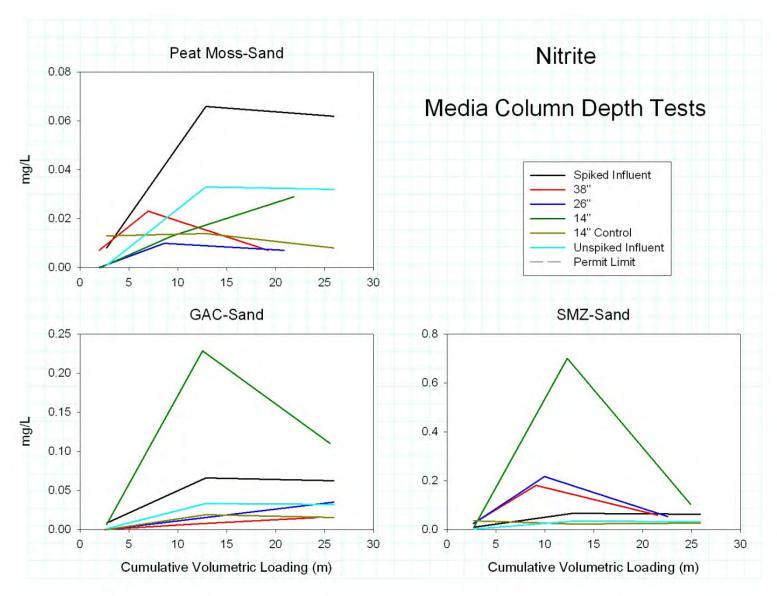


Figure B-70. Nitrite Removal for Component Media

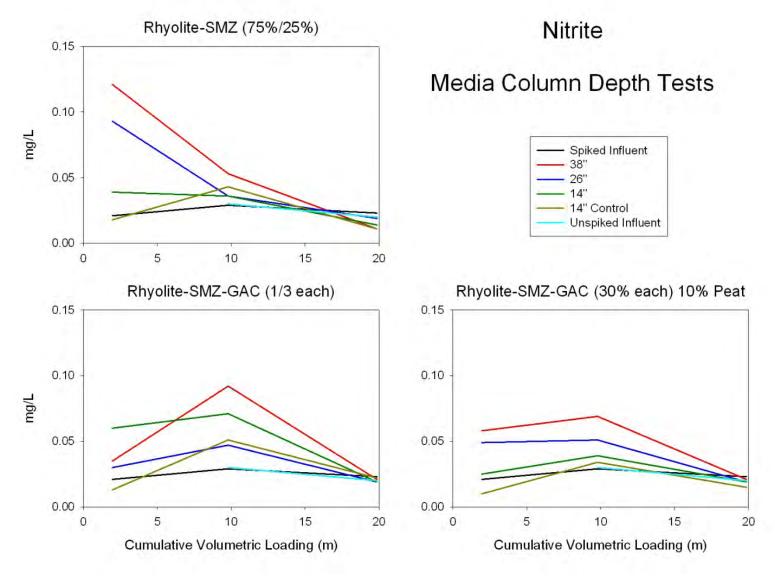


Figure B-71. Nitrite Removal for Media Mixtures

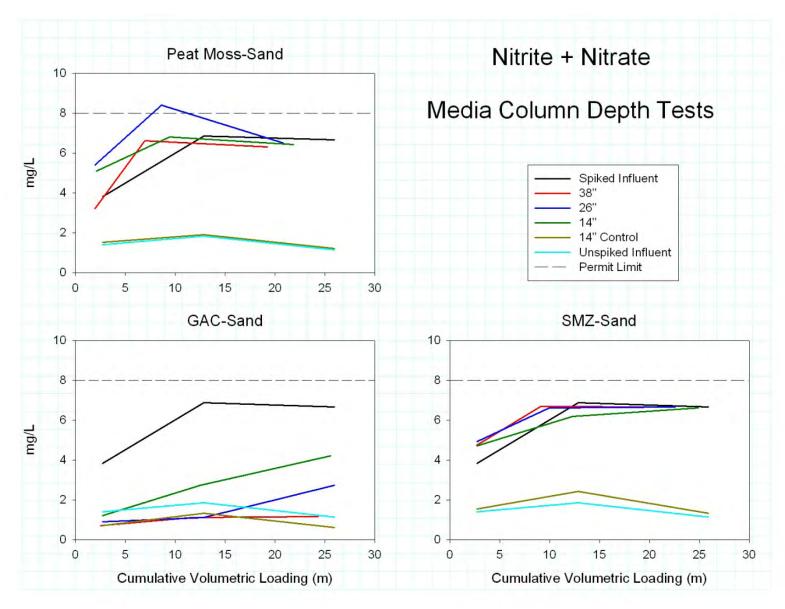


Figure B-72. Nitrite + Nitrate Removal for Component Media

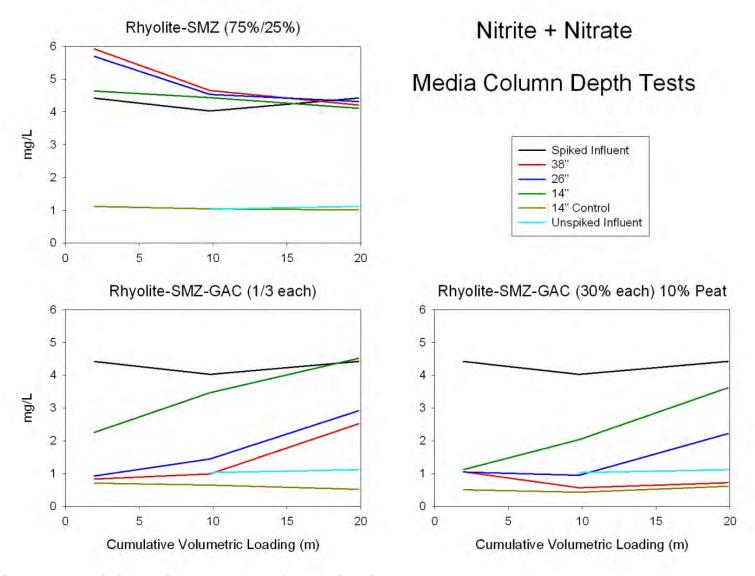


Figure B-73. Nitrite + Nitrate Removal for Media Mixtures

## Oil and Grease

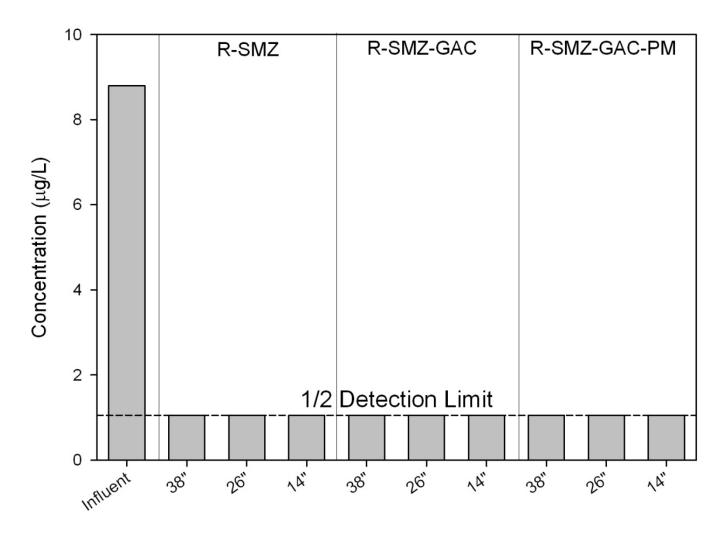


Figure B-74. Oil and Grease Removal for Media Mixtures

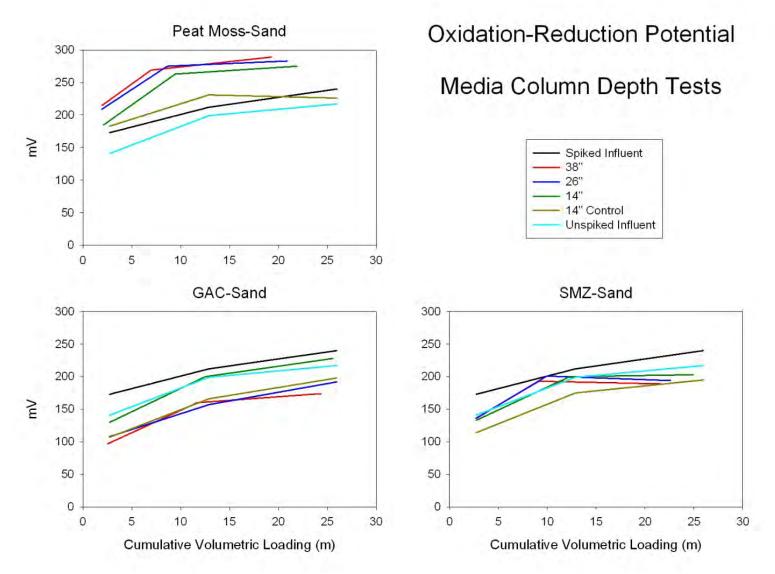


Figure B-75. Oxidation-Reduction Potential Behavior for Component Media

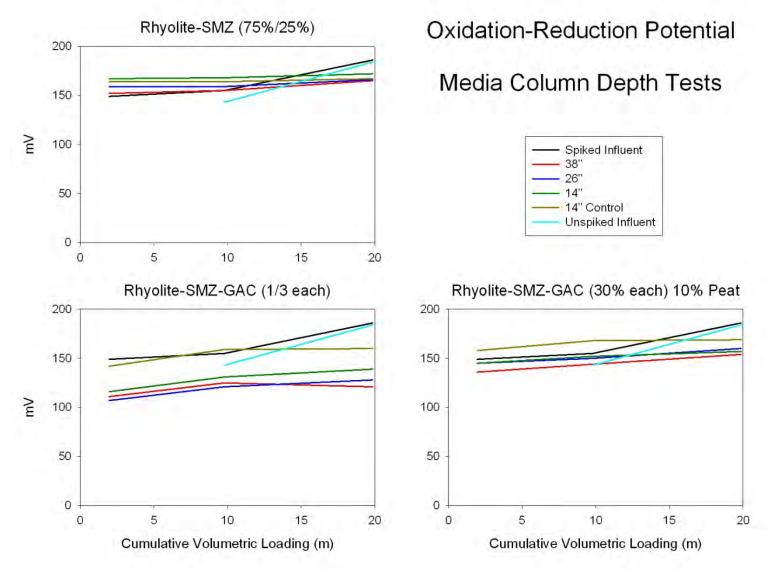


Figure B-76. Oxidation-Reduction Potential Behavior for Media Mixtures

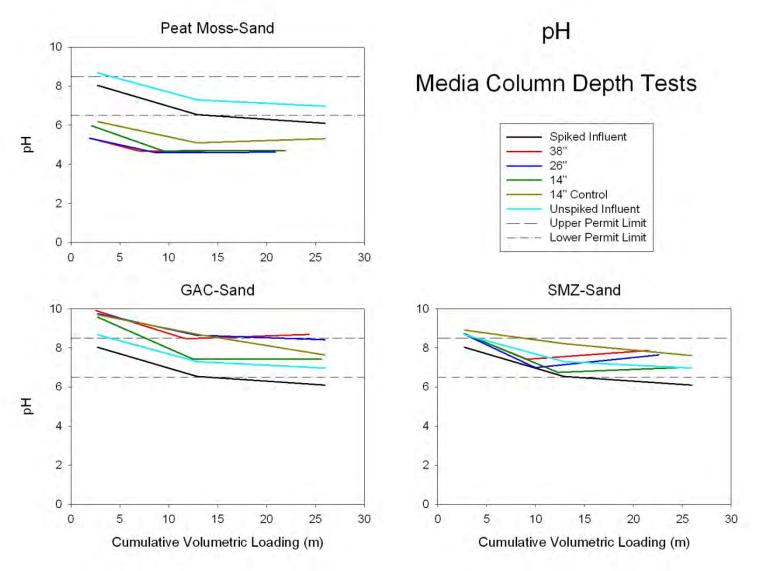


Figure B-77. pH Behavior for Component Media

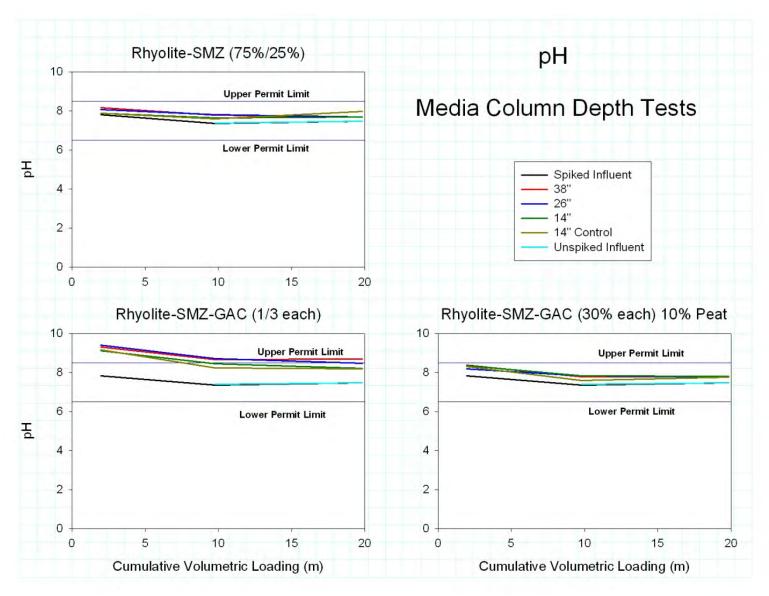


Figure B-78. pH Behavior for Media Mixtures

## Perchlorate

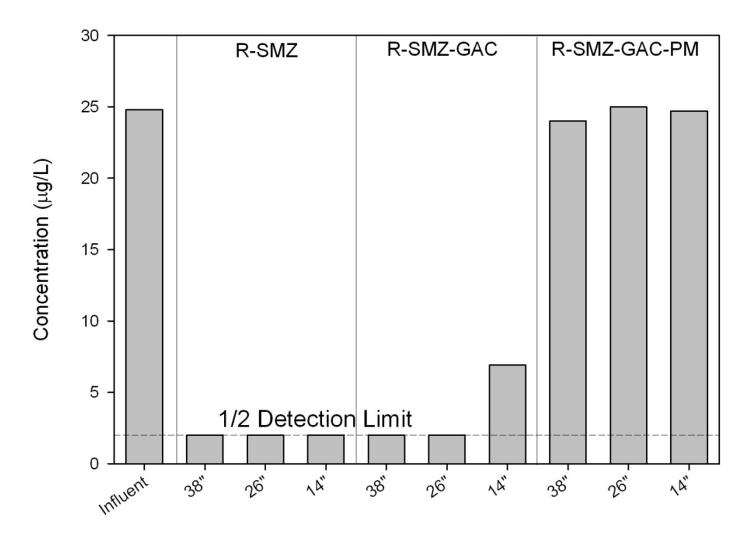


Figure B-79. Perchlorate Removal for Media Mixtures

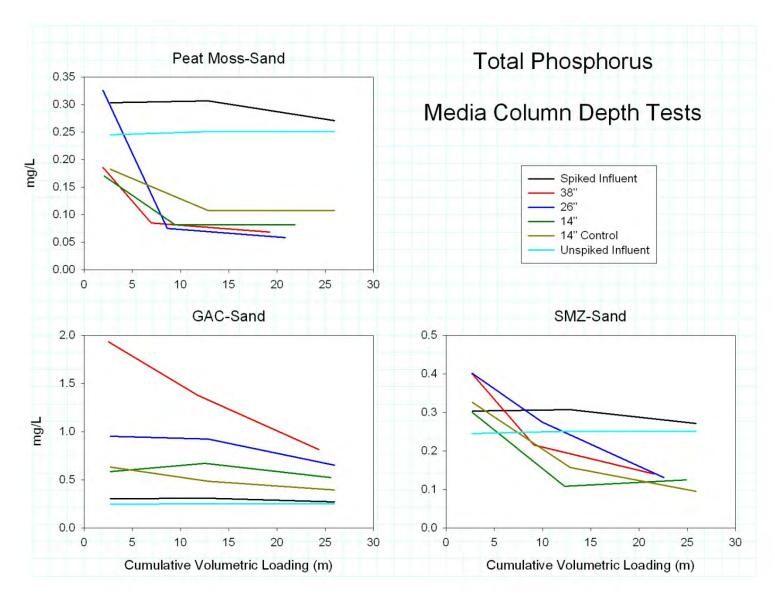


Figure B-80. Total Phosphorus Removal for Component Media

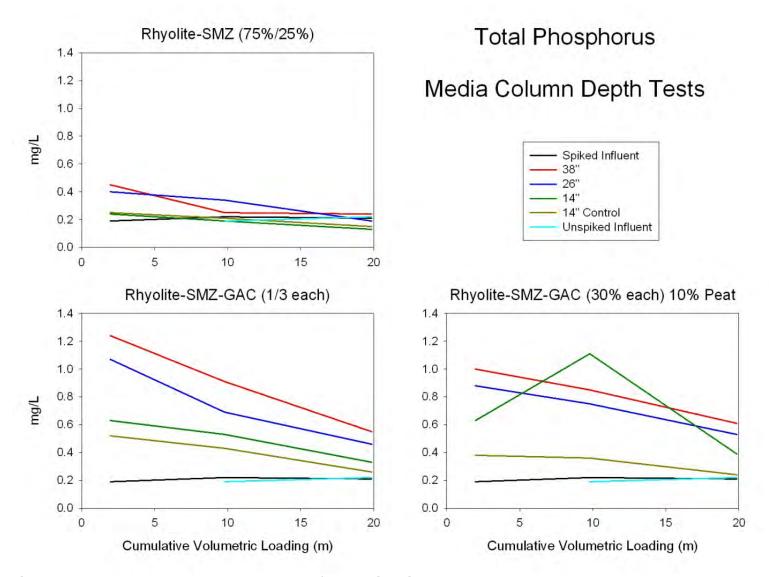


Figure B-81. Total Phosphorus Removal for Media Mixtures

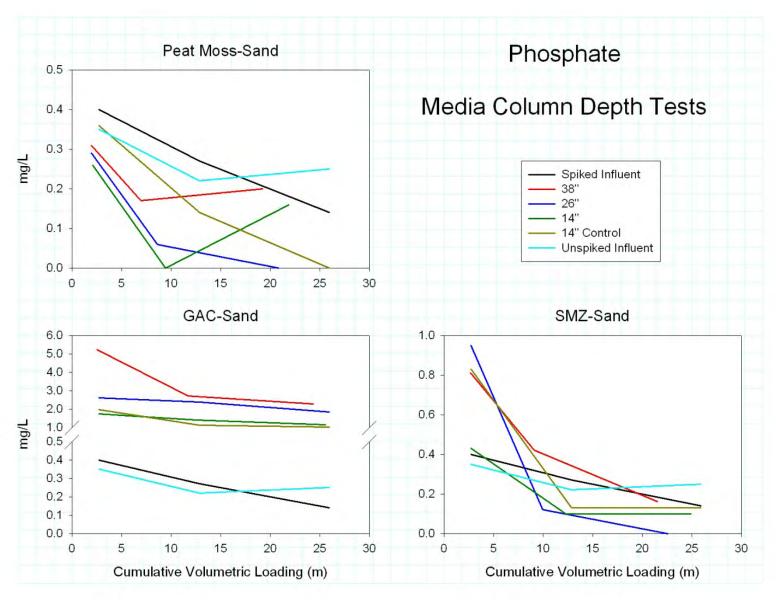


Figure B-82. Phosphate Removal for Component Media

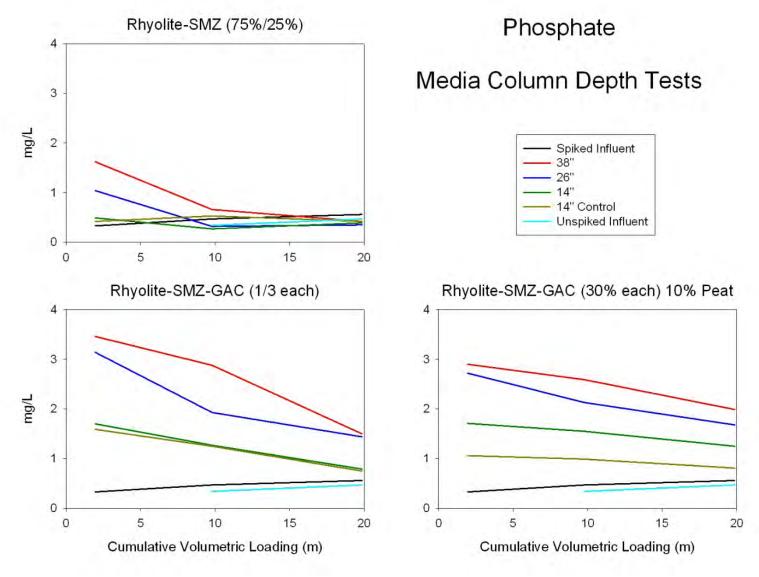


Figure B-83. Phosphate Removal for Media Mixtures

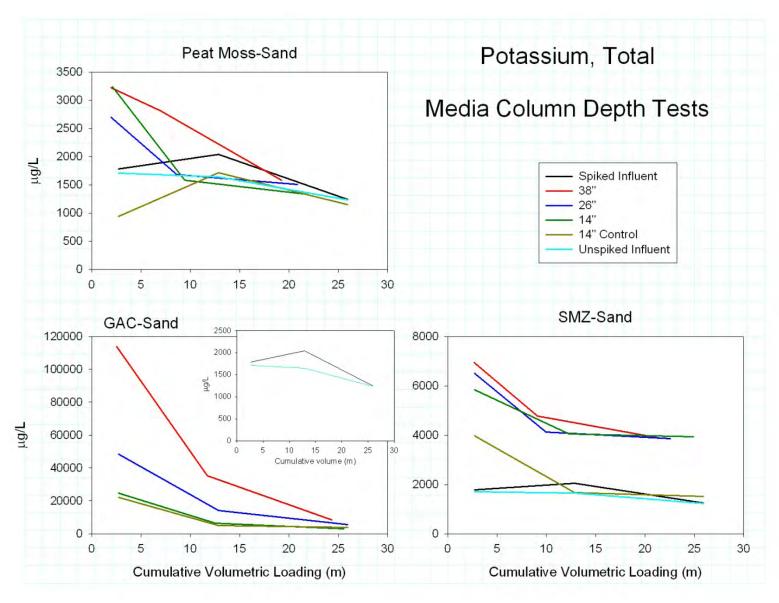


Figure B-84. Potassium (Total) Removal for Component Media

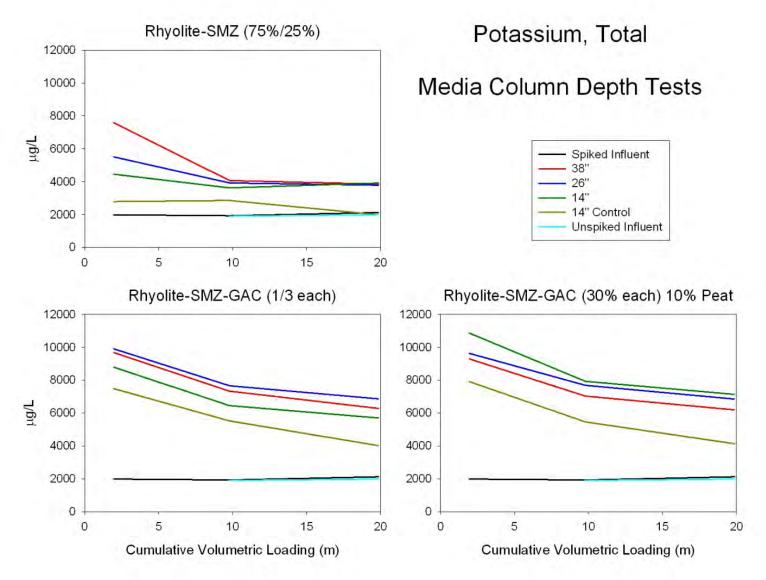


Figure B-85. Potassium (Total) Removal for Media Mixtures

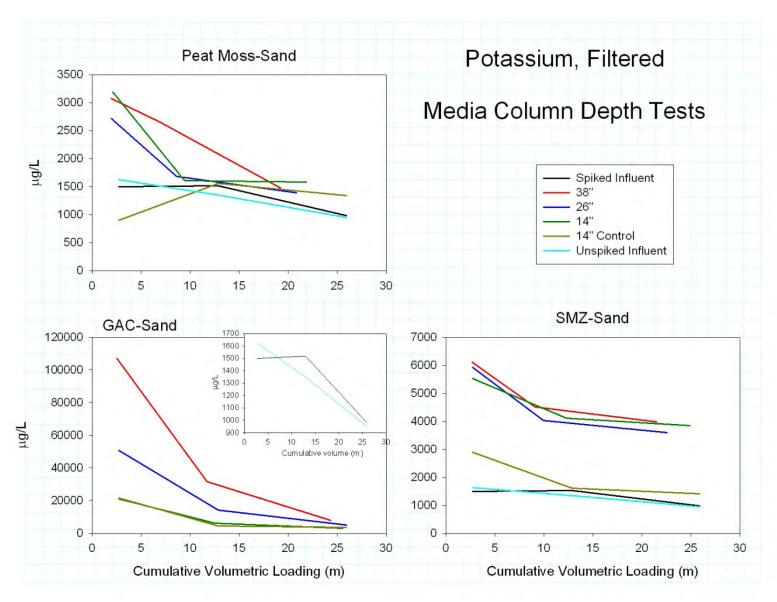


Figure B-86. Potassium (Filtered) Removal for Component Media

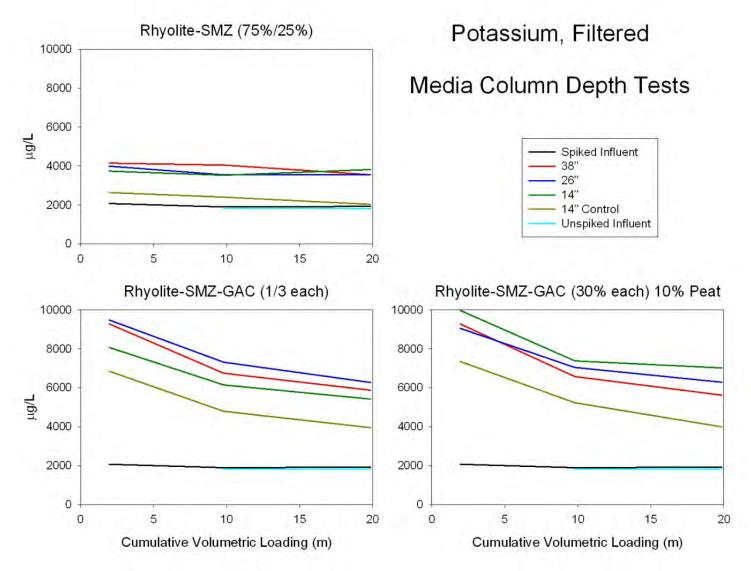


Figure B-87. Potassium (Filtered) Removal for Media Mixtures

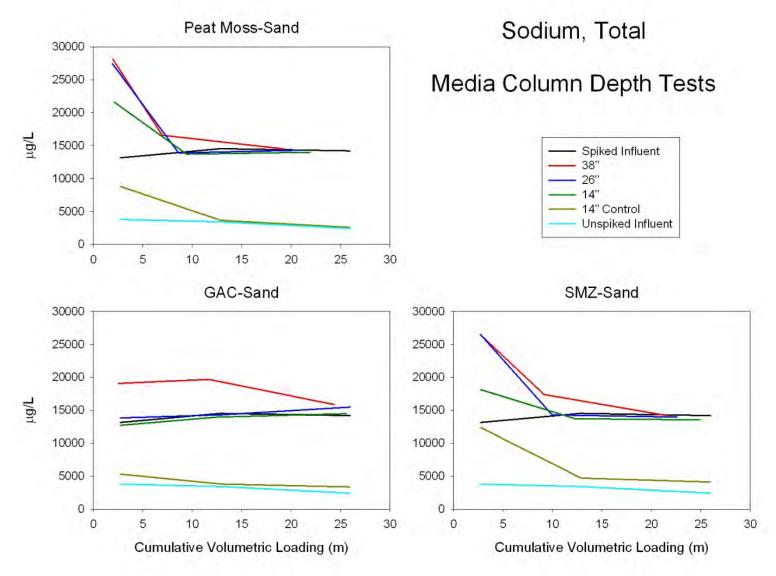


Figure B-88. Sodium (Total) Removal for Component Media

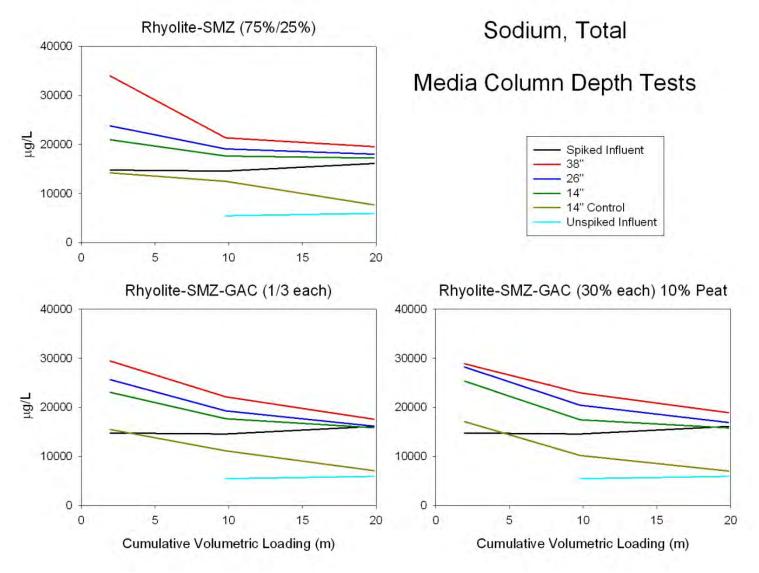


Figure B-89. Sodium (Total) Removal for Media Mixtures

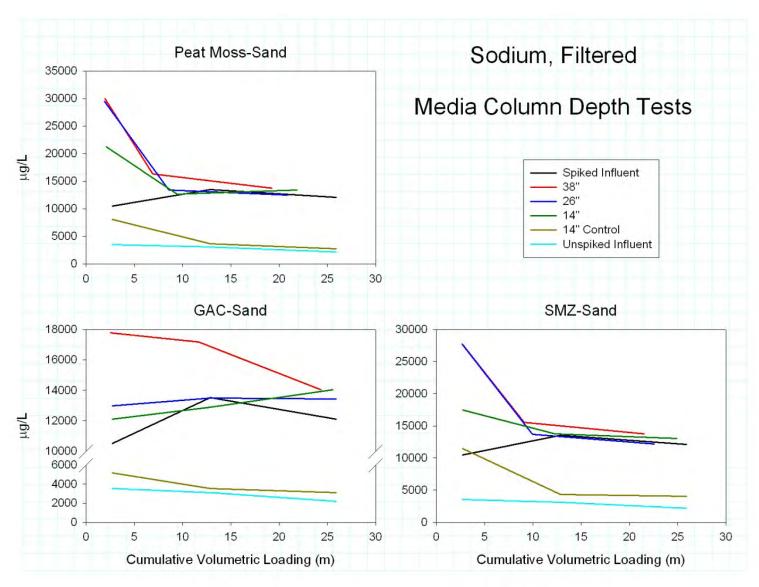


Figure B-90. Sodium (Filtered) Removal for Component Media

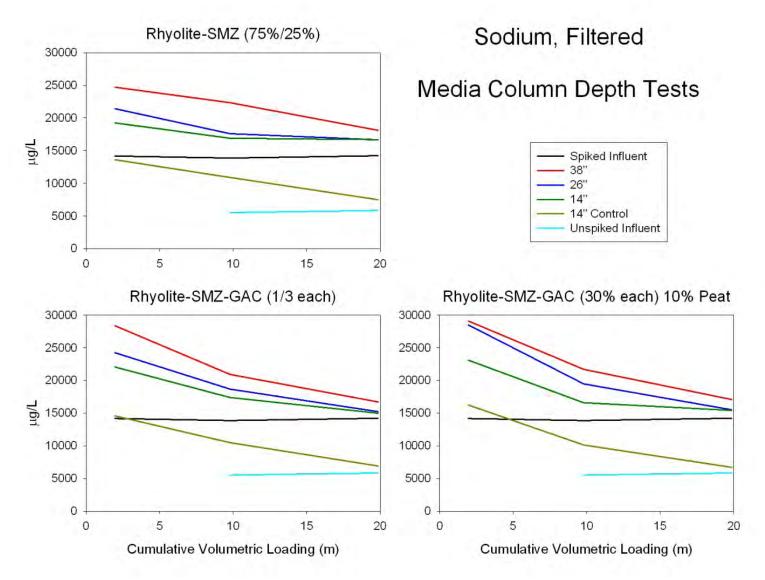


Figure B-91. Sodium (Filtered) Removal for Media Mixtures

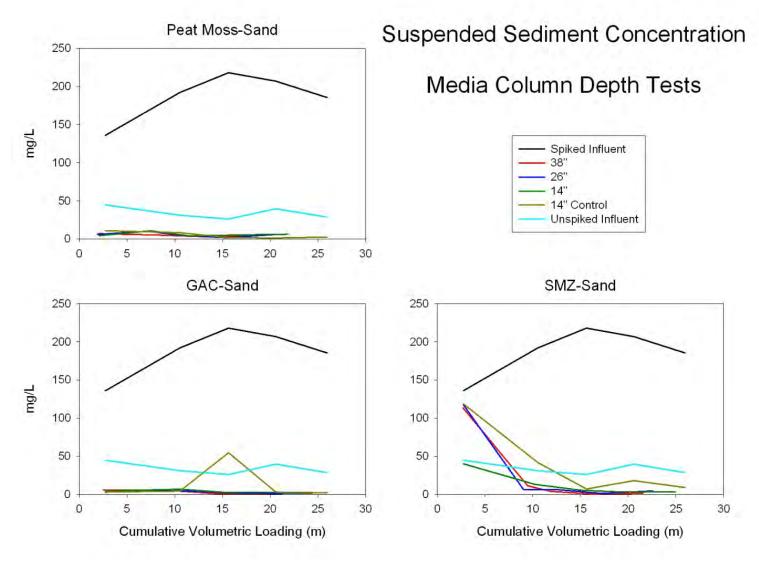


Figure B-92. Suspended Sediment Concentration (SSC) Removal for Component Media

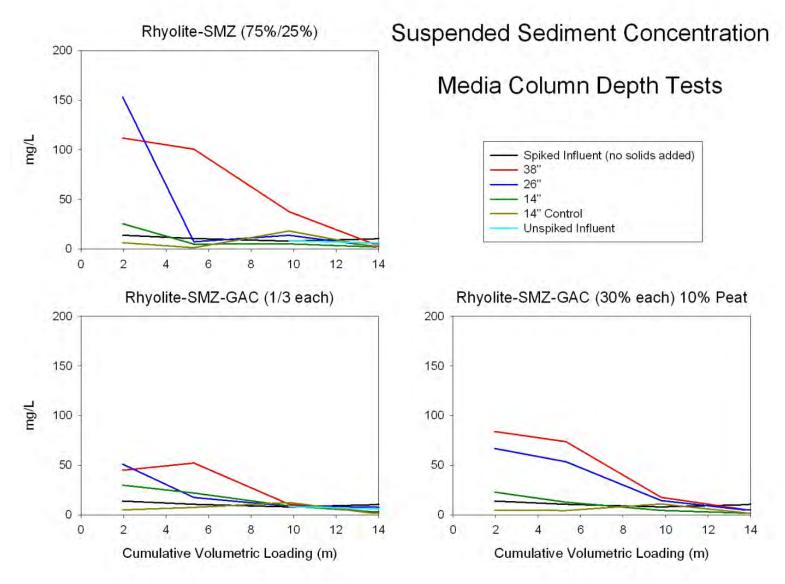


Figure B-93. Suspended Sediment Concentration (SSC) Removal for Media Mixtures

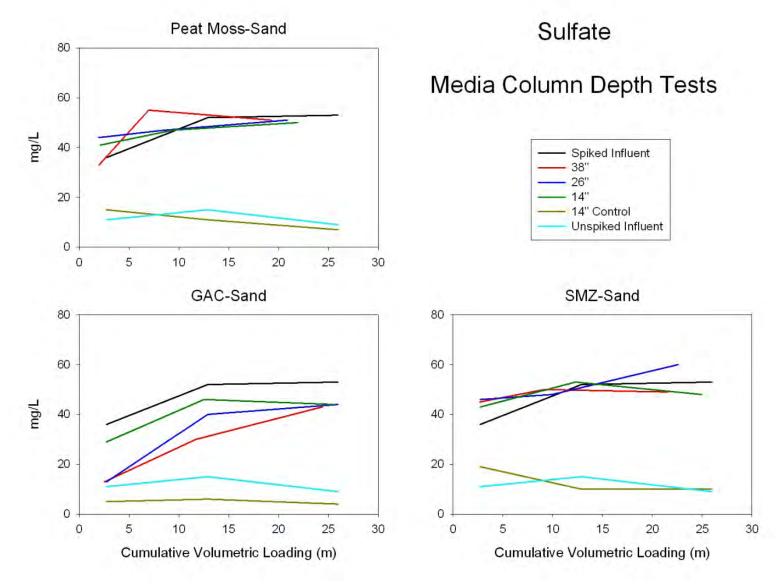


Figure B-94. Sulfate Removal for Component Media

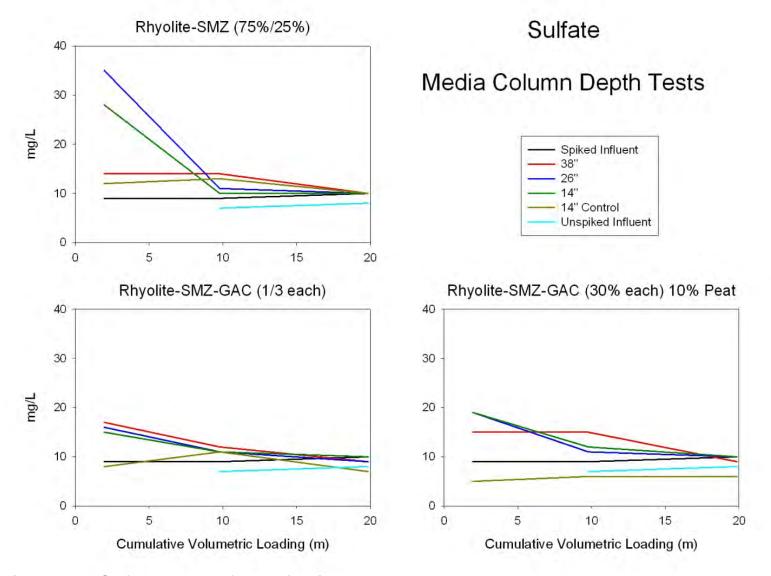


Figure B-95. Sulfate Removal for Media Mixtures

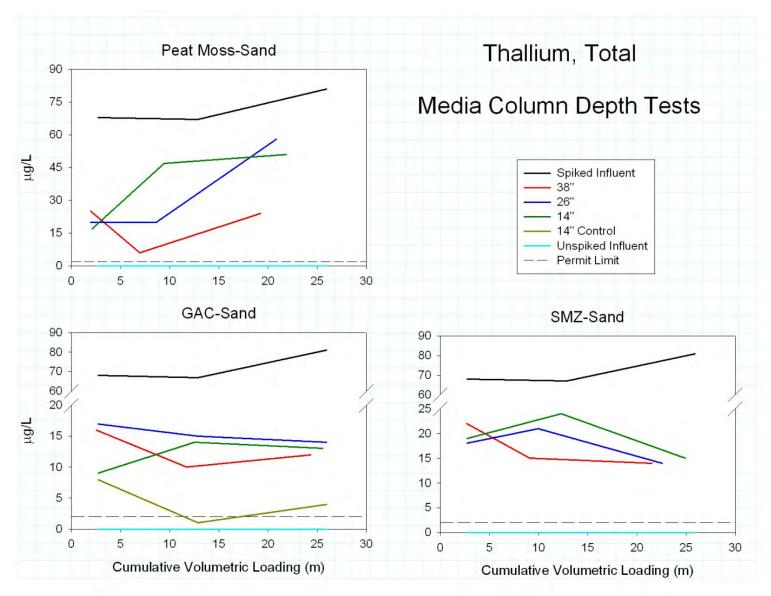


Figure B-96. Thallium (Total) Removal for Component Media

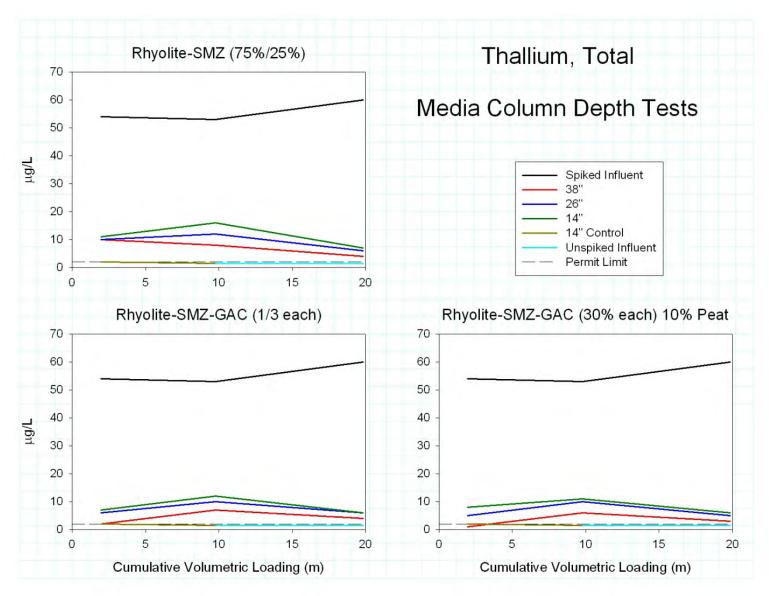


Figure B-97. Thallium (Total) Removal for Media Mixtures

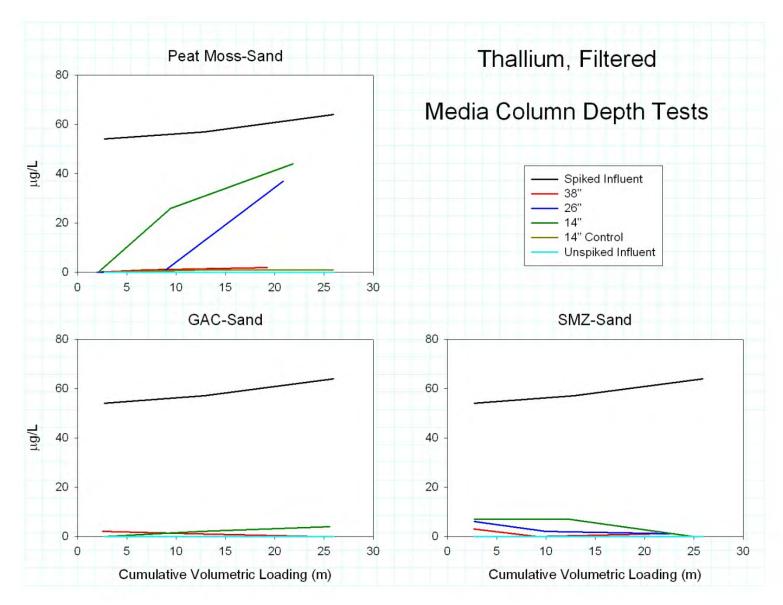


Figure B-98. Thallium (Filtered) Removal for Component Media

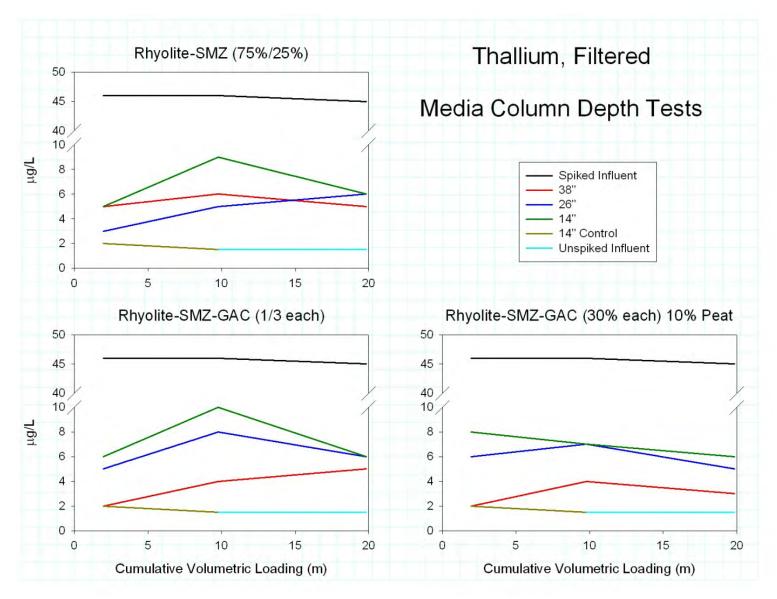


Figure B-99. Thallium (Filtered) Removal for Media Mixtures

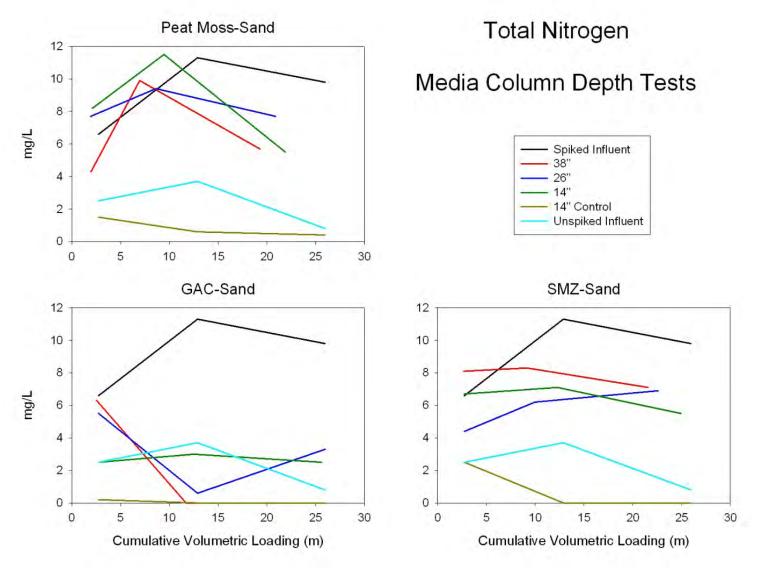


Figure B-100. Total Nitrogen Removal for Component Media

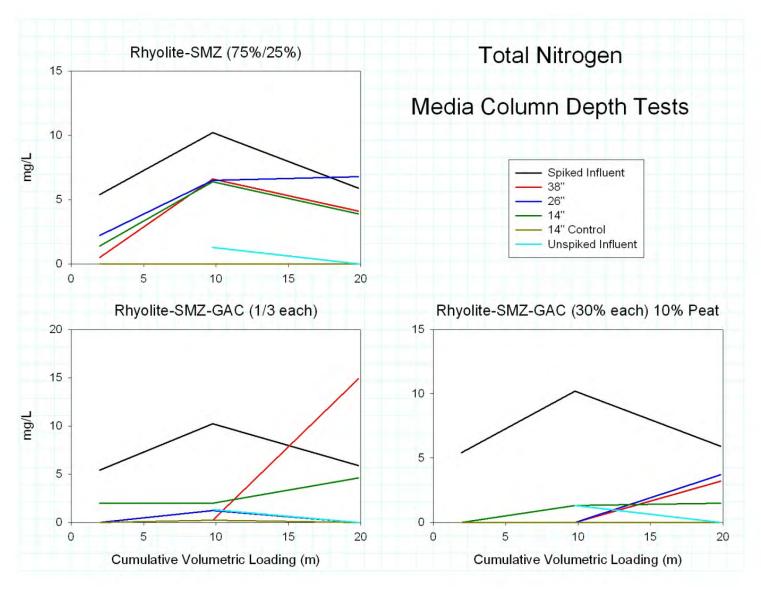


Figure B-101. Total Nitrogen Removal for Media Mixtures

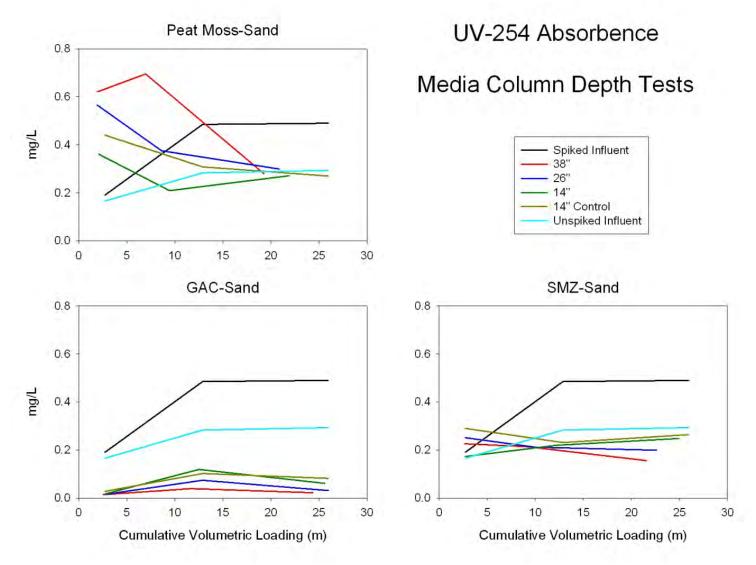


Figure B-102. UV-254 Absorbence Behavior for Component Media

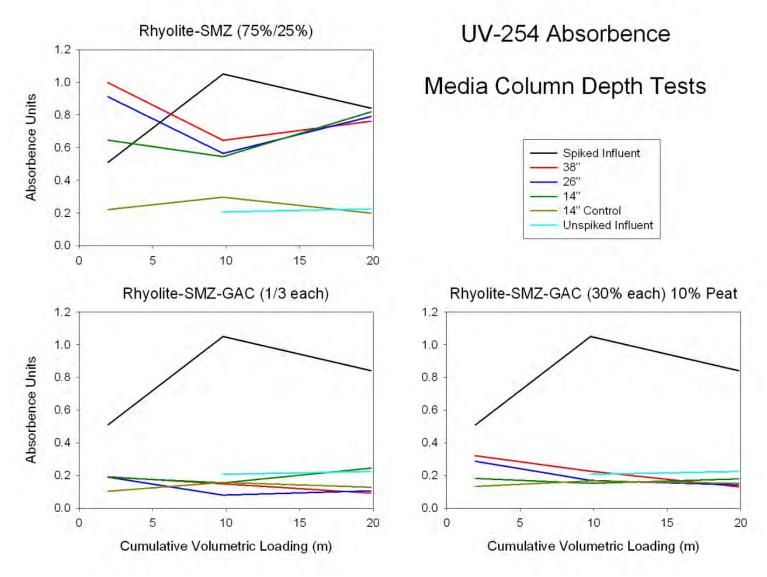


Figure B-103. UV-254 Absorbence Behavior for Media Mixtures

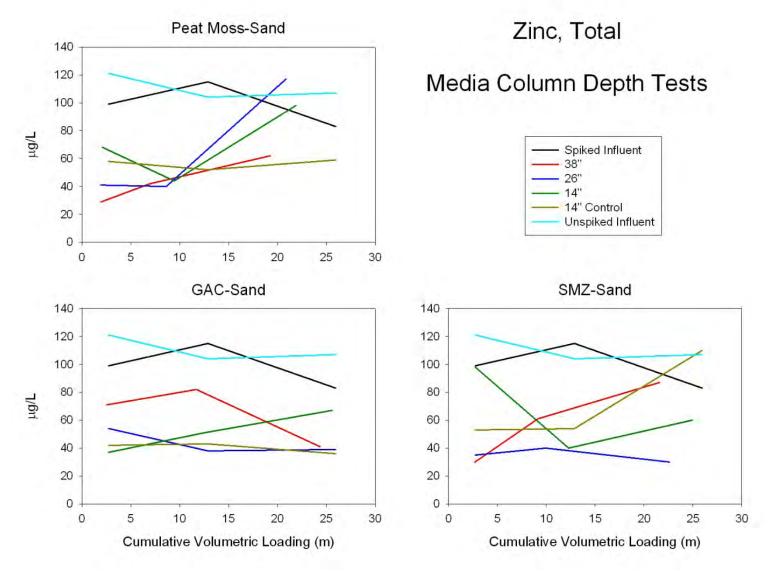


Figure B-104. Zinc (Total) Removal for Component Media

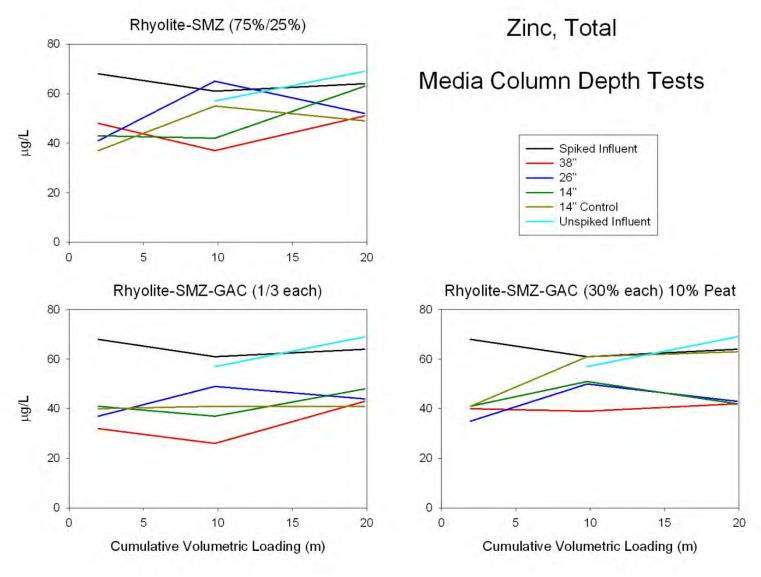


Figure B-105. Zinc (Total) Removal for Media Mixtures

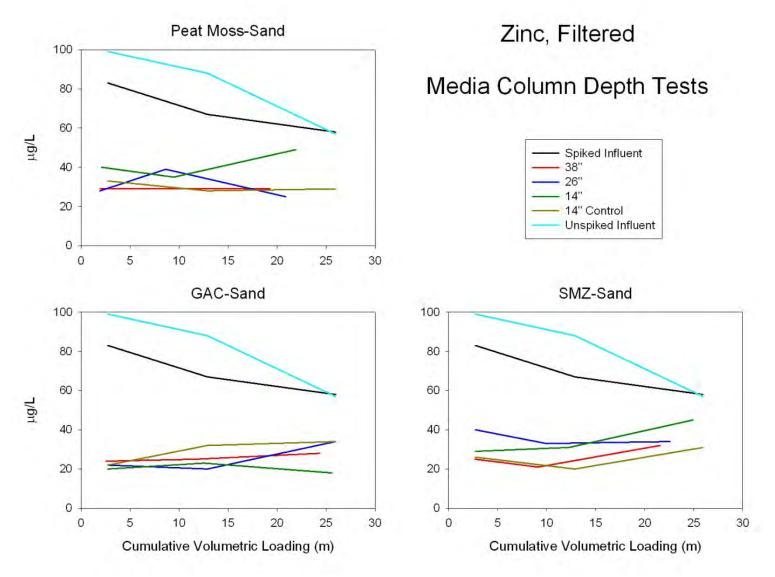


Figure B-106. Zinc (Filtered) Removal for Component Media

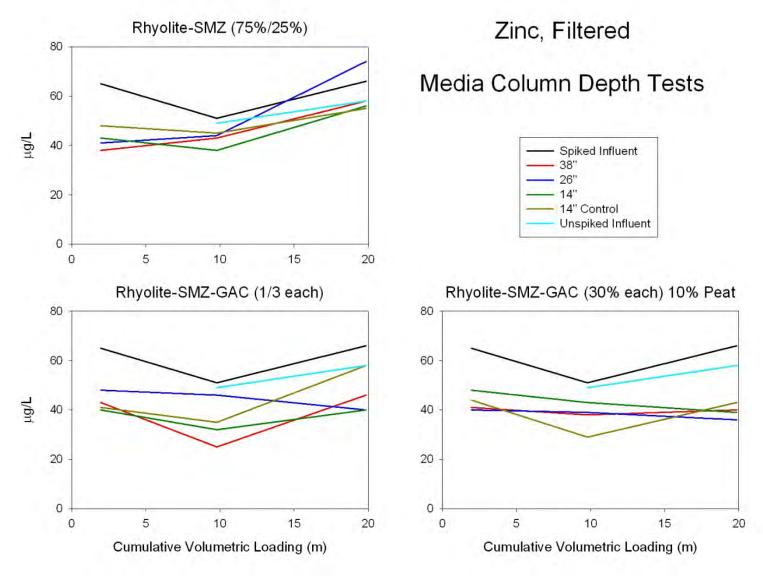


Figure B-107. Zinc (Filtered) Removal for Media Mixtures