Gannett Fleming

DATE: December 1, 2004

TO: Project File

FROM: Aaron Keno

RE: Concept Development – Dredging the South Fork Rivanna Reservoir (SFRR)

BACKGROUND AND CURRENT CONDITIONS

Rivanna Water and Sewer Authority (RWSA) is engaged in studies related to the selection of a preferred alternative for water supply expansion. Gannett Fleming Inc. of Fairfax, Virginia (GF) completed a Water Supply Alternatives Supplemental Evaluation in July 2004 supplemented by Technical Memoranda on the Beaver Creek Reservoir in October 2004 and concluded that four water supply options have the most potential to provide the future raw water supply for the RWSA Urban System through the 2055 planning period. These four options include: a withdrawal intake on the James River, raising the Ragged Mountain Reservoir Dam; adding a crest gate to the South Fork Rivanna Reservoir (SFRR), and dredging the SFRR. The purpose of this technical memorandum is to provide discussion on the dredging option for the SFRR. It is presented in four sections: Background and Current Conditions, Dredging Parameters, Dredging Cost, and Environmental Impacts.

This evaluation of the dredging concept will be used for comparison with the other options under review.

South Fork Rivanna Reservoir Description

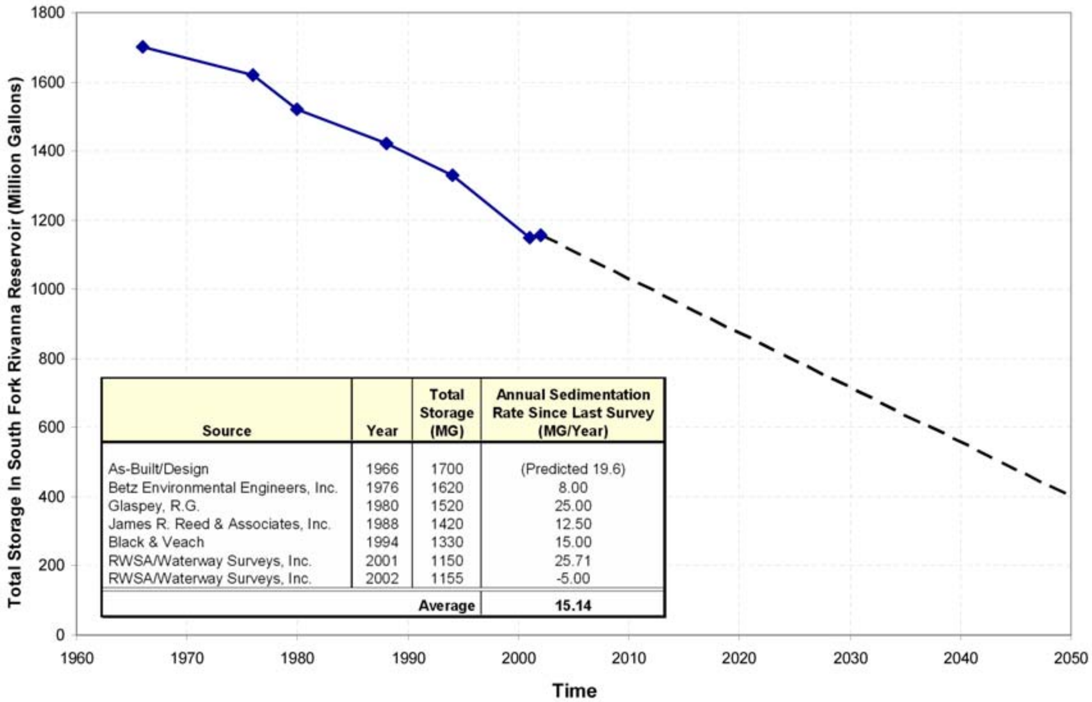
The SFRR, located north of Charlottesville on the South Fork Rivanna River, was constructed and impounded in 1966. The reservoir has a drainage area of 259.1 mi^2 and a surface area of 366 acres at the permanent pool elevation of 382 feet. Two major streams, Mechums River and Moormans River, are tributaries to the SFRR.

The design volume of the SFRR in 1966 was 1,700 million gallons (MG) of total storage: 1,250 MG of useable storage is located above the lowest intake elevation of 367 feet while 450 MG of dead storage is below the lowest intake elevation and inaccessible under normal operating conditions. Reservoirs are usually designed to provide dead storage below the intake to isolate lower quality water and provide a location for normal accumulation of sediments and silts.

Sedimentation accumulation in the SFRR has resulted in a steady decrease in the storage available in the SFRR, both in useable and dead storage volumes. Approximately 545 MG of sediment has been deposited in the SFRR since 1966 based on comparisons of current volumes with those reported when the reservoir was constructed. The current volume in the SFRR is based on the most recent bathymetric survey conducted in March 2002. The survey estimates that the total volume has been reduced to 1,155 MG, with the useable storage estimated at 800 MG and dead storage at 355 MG.

SFRR Sedimentation Rates

Over the 38-year life of the SFRR, six bathymetric surveys have been conducted. Volume losses of between 8 million gallons per year (mg/yr) and 25.71 mg/yr were observed in five of the studies. The 2002 survey showed an increase in storage volume by 5 mg, however, it is uncertain if this survey indicated a true change in conditions or simply an anomaly due to survey techniques. Viewed over the 38-year life of the reservoir the average storage loss based on sedimentation is just over 15 mg/yr. Sedimentation rates have fluctuated from year to year and are highly dependent upon the number and severity of storms for any given year. Figure 1 is a graphical representation of the storage volumes indicated by the bathymetric surveys and a projection of total storage available based on the average sedimentation rate previously identified. Future sedimentation in the SFRR will be projected based on the historical average storage loss of 15.14 mg/yr.



Source	Year	Total Storage (MG)	Annual Sedimentation Rate Since Last Survey (MG/Year)
As-Built/Design	1966	1700	(Predicted 19.6)
Betz Environmental Engineers, Inc.	1976	1620	8.00
Glaspey, R.G.	1980	1520	25.00
James R. Reed & Associates, Inc.	1988	1420	12.50
Black & Veach	1994	1330	15.00
RWSA/Waterway Surveys, Inc.	2001	1150	25.71
RWSA/Waterway Surveys, Inc.	2002	1155	-5.00
		Average	**15.14**

Figure 1: Plot Showing Change in Total Storage Over Time Due to Sedimentation at SFRR

Sediment Location

Based on previous bathymetric studies, it appears that the majority of the sedimentation has occurred in the upper two thirds of the SFRR. Figure 2 is assembled from data collected during the 2002 bathymetric survey. The data points in the figure are the lowest point measured from each of the 47 SFRR cross sections. Additional investigations may be necessary to more accurately locate and map the accumulated sediment.

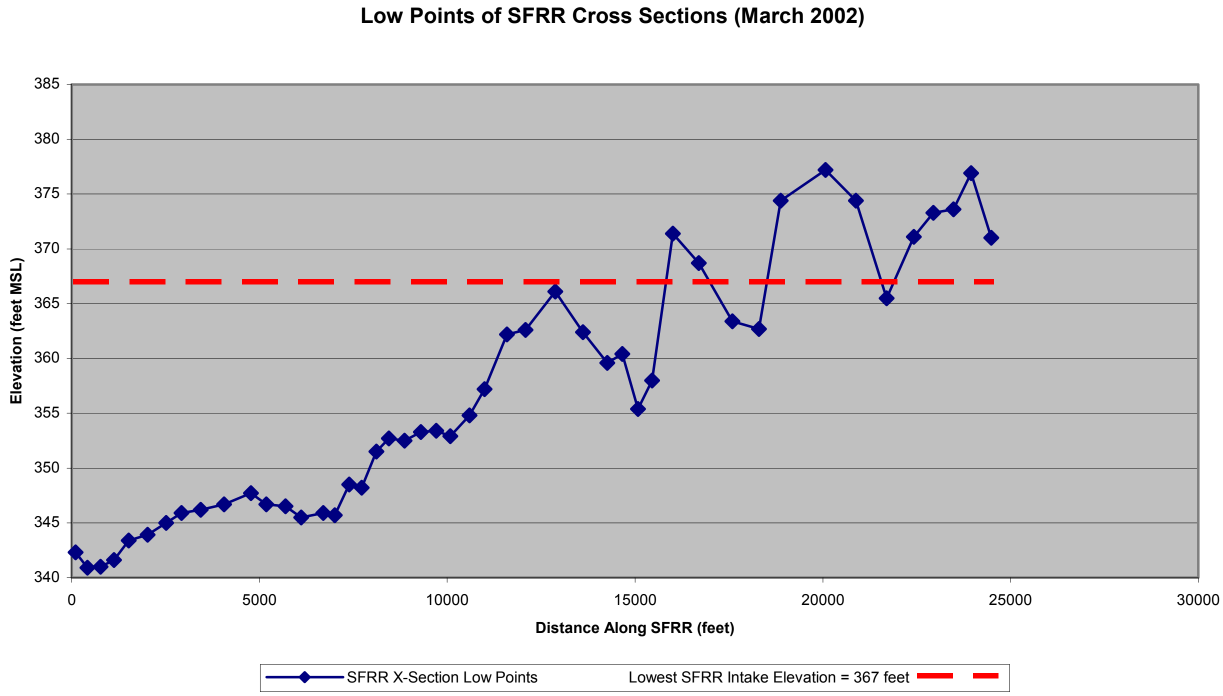


Figure 2: SFRR Bottom Elevation Profile (Data from 2002 Bathymetric Survey)

As seen in Figure 2, there appears to be significant sediment deposits within the useable storage of the upper reaches of the SFRR. The depth of sediments at specific locations of the reservoir was not estimated because the original topography of the SFRR was not available.

Sediment Composition

Sediment sampling was documented in a December 4, 2002 report prepared by Froehling & Robertson, Inc. (FR) entitled "Sediment Sampling South Rivanna River Reservoir at Panorama Farms". The sampling plan included three samples taken at various depths below the sediment surface (1 foot, two feet, and two and a half feet). The samples were located in the vicinity of the Panorama Farms property, and covered less than 1,000 linear feet of the SFRR. Analyses were made in order to determine the physical and chemical characteristics of the sediments.

Additional sampling is recommended if dredging is pursued to more accurately determine the composition and characteristics of these sediments.

The 2002 FR report found a range of results for the physical characteristics of the sediments. Table 1 summarizes the findings.

Table 1: Summary of SFRR Sediment Physical Characteristics

Sample No.	Depth Below Sediment Surface (ft)	% Sand	% Silt/Clay
1	1	98.3	1.7
2	2	26.5	73.5
3	2.5	33.6	68.4

The three samples produce an average of 53% sand and 47% fines near Panorama Farms. Although the data is limited, it is the best information available at this time. Since the relative proportion of the sediments is almost equal, we recommend that an average of 50% sand and 50% fines be considered representative for the accumulated sediment in SFRR throughout this evaluation.

The chemical analyses on the sediments included measures of nutrients, extractable organic halides (EOX), mercury, metals regulated under the Resource Conservation and Recovery Act (RCRA), and pH. Table 2 lists the test results.

Table 2: Chemical Characteristics of SFRR Sediments

	Sample No. 1	Sample No.2	Sample No. 3	Quantization Limit
RCRA Metals (mg/kg)				
Arsenic	BQL	23	BQL	15
Barium	61	231	67	1
Cadmium	2	8	2	1
Chromium	10	27	10	1
Lead	17	48	11	10
Mercury	BQL	BQL	BQL	0.5
Selenium	BQL	37	BQL	15
Silver	BQL	BQL	BQL	5
Nutrients (ppm)				
Nitrogen	38	130	<15	
Phosphorus	75	50	75	
Potassium	60	120	<60	
EOX (mg/kg)	10.3	BQL	11.2	10.0
pH	5.7	6.5	5.9	

BQL = Below Quantization Limit

The chemical analyses indicate that the material sampled in this location is likely to be non-hazardous in nature and might be reused or disposed of as appropriate. However, additional chemical sampling in accordance with the RCRA Toxic Characteristics Leaching Procedure (TCLP) requirements will be necessary if dredging is pursued.

Projected Volume of Sediments

Estimates of dredge material quantities or water storage volumes are based on the best information available at this time. Assuming a sedimentation rate of 15.14 mg/yr, by the year 2055 there will be approximately 1,302 MG of accumulated sediment in the reservoir, leaving only 398 MG of total storage. Based on the assumption that a portion of the sediment will settle in both the useable and dead storage of the reservoir, it is estimated that only 200 MG of useable storage will be remaining in the year 2055.

Safe Yield

As presented in the Gannett Fleming (GF) reports Safe Yield Study (January 2004) and Safe Yield Study Supplement No. 1 (July 2004), the RWSA Urban Service Area safe yield will decrease annually as sedimentation continues. Based on the original useable storage at SFRR, the safe yield of the RWSA Urban Service Area was determined to be 15.1 MGD. Currently, as determined by GF, the RWSA Urban Service Area safe yield is approximately 12.8 MGD. Based on the results of the latest bathymetric survey, the safe yield models generated by GF in the two referenced reports, and the assumptions made regarding storage loss from sedimentation, the RWSA Urban Service Area safe yield will decrease from the current 12.8 MGD to approximately 8.8 MGD in 2055. The 4 MGD reduction in safe yield is due primarily to the projected sedimentation that will occur in the SFRR.

Any resultant safe yield benefit derived from dredging will be based on the useable volume reclaimed. After dredging evaluations are complete, the safe yield benefit will be estimated. The Projected Dredging Quantities section below provides discussion on reclaimed usable storage and the safe yield benefit of dredging.

DREDGING PARAMETERS

The dredging option consists of physically removing the accumulated sediment from the useable storage portion of the SFRR. A maximum benefit would occur if the original 1966 SFRR volume was restored. Once the previously lost volume is restored, regular and periodic maintenance dredging will be required to remove future sedimentation.

Dredging Method Selection

There are three common types of dredging: clearing and snagging, mechanical dredging, and hydraulic dredging. Clearing and snagging is used to clear debris and other impediments that can hinder navigation in waterways. Mechanical dredging includes many different methods such as dipper dredges and clam shell dredges, which remove materials/debris and place the materials into barges in order to deliver the materials to a final destination. Mechanical dredges often have difficulty handling and containing loose or fine materials in their buckets and cannot dredge continuously along the bottom of a waterway. Hydraulic dredging involves a cutter head that loosens the material while a pump creates a vacuum that removes the material/water slurry through the pipeline and booster pump(s) to an upland containment area.

Table 3 below presents a brief comparison of dredging techniques:

Table 3: Comparison of Dredging Techniques

Dredging Technology	**Description**	**Technical Advantages**	**Technical Disadvantages**
Enclosed Clamshell Bucket	Use of an enclosed (watertight) clamshell bucket to remove sediment	1. Reduces water column turbidity 2. Operation can be controlled to reduce sediment resuspension	1. High unit costs are associated with this technique. 2. "Controlled" operation results in lower production rates. 3. Sediment disposal site required. 4. Biota are affected.
Cable-Arm Clamshell Bucket	Cable arms control the operation (including ascent, descent, opening and closing) of the bucket that excavated the sediment	1. Results in greater precision due to cable arm control 2. Improved design includes a venting system and an inner defection plate which aid in minimizing sediment resuspension.	1. Low production rate due to slow operation required for environmental dredging. 2. High dredging costs. 3. Sediment disposal site required. 4. Biota are affected.
Hydraulic	Use of a horizontal cutterhead equipped with knives and spiral augers that can cut the material and move it laterally toward the center of the augers where it is picked up by suction	1. Dredge operates on anchors or cables, leaving the bottom flat and free of windows. 2. Low turbidity. 3. High production rates. 4. Minimal interference with reservoir operation. 5. Smaller dredges are road transportable.	1. Depth-restricted operation. 2. Sediment disposal site required. 3. Biota are affected. 4. Not effective for removing rocky sediments.
Mechanical (Excavation)	Sediment would be removed by standard excavation equipment under "dry" conditions (reservoir drawn down).	1. Reduces turbidity and suspended solids due to "dry" working conditions.	1. High capital expenditure. 2. Biota are impacted. 3. Available water supply storage is reduced during dredging.

The hydraulic dredging method was selected for further investigation based on research and conversations with several dredging contractors that indicated other types of dredging are not compatible with the conditions at SFRR. Additionally, the US Army Corps of Engineers (USACE), which will exercise permitting authority through the Nationwide Permitting process, has indicated that hydraulic dredging will be the only dredging method accepted.

Hydraulic dredging was deemed appropriate for several other reasons. The length of the reservoir where sediments have accumulated is approximately 14,000 linear feet and hydraulic dredging can be undertaken without extensive repositioning of land-based equipment. The useable portion of the reservoir is not more than approximately 15 feet deep which is conducive to efficient hydraulic dredging. The high production rate, low impacts on reservoir turbidity and minimal interference with reservoir operations are also important criteria in evaluating this dredging method.

A hydraulic dredging operation will consist of the following components:

1. Floating hydraulic dredge to remove material;
2. Pumps and pipeline to transfer the slurry to an upland containment area;
3. Single dewatering and materials handling site adjacent to the SFRR;
4. Permanent disposal sites for dewatered sediment.

Projected Dredging Quantities

The maximum benefit from dredging could be achieved if the entire 1966 original useable storage volume (1,250 MG) was reclaimed. The total dredging volume can be determined based upon the original useable storage volume (1,250 MG) less the projected useable volume in 2055 with no dredging (200 MG). Therefore, 1,050 MG of sediment must be removed during the restoration phase of the program to fully restore the original useable storage. It is expected that some portion of the useable volume cannot be dredged because the area is too shallow, the specific location of the sediment is unknown, or the dredge head cannot be precisely controlled. Therefore it is suggested that 85% of the useable volume is the maximum volume of deposited sediments that can be successfully removed (approximately 900 MG). A 10% allowance (approximately 100 MG) for dredging sediment located in the dead storage pool should also be added to account for unknowns discussed above resulting in a total volume of 1,000 MG of sediment to be dredged in order to obtain 900 MG in useable storage. This assumption is based on literature research and discussion with dredging contractors who confirm that hydraulic dredging can remove approximately 80% to 90% of the accumulated sediments.

Based on an 85% removal rate of sediment from the useable pool, the resulting useable storage after 50 years of dredging will be 1,100 MG, including the 900 MG gained volume plus 200 MG existing. With a useable storage of 1,100 MG at SFRR, the Safe Yield of the RWSA Urban Service area is estimated to be 14.3 MGD based on the current safe yield hydraulic model. This is an increase of 5.5 MGD over the predicted Safe Yield of the RWSA Urban System in 2055 (8.8 MGD) with no dredging program.

Increasing the storage volume by 1,000 MG would necessitate removal of approximately 5,000,000 cubic yards (CY) of sediment or 100,000 CY annually for 50 years.

Dredged and dewatered material that has no use in the immediate project area must be disposed off site. In estimating the number of truckloads necessary to transport the total amount of dredging material for disposal per year, the following assumptions have been made:

1. Transport will occur over the typical 250-day working year.
2. Transport units will have 6 CY capacity.
3. Some percentage of the dredge materials may be suitable for other uses once it is dewatered (e.g. construction fill or general fill); however, it is unlikely that a large percentage of the materials will be used for these alternative practices. In any event, it is likely that RWSA will have to haul the material.

Based on these assumptions and quantities, 67 truckloads of material must be hauled from the dewatering site. As perspective, this volume of material would cover the field portion of Scott Stadium at the University of Virginia to a depth of about 26’ every year.

Sediment Composition Affect on Dredging

The dredging process can be significantly affected by the characteristics of the dredged materials. Sediment that is made up of mostly silts or clays can be easily removed from a waterway via hydraulic dredging; however, they will require a much longer dewatering period compared to materials made up predominantly of sand. If the material is mostly sand, the dredging process will typically require larger pump horsepower to remove the same volume of sand from the bottom of the waterway and will take longer to remove from the waterway. Based on the analysis of existing reservoir sediment composition data (presented in the Sediment Composition section of this report), the dredging evaluation will be based on the assumption that there is a 50% sand and 50% fines and the material is not hazardous.

Projected Dredging Period

Ideally, the dredging process should be conducted during the summer months in order to avoid periods of icing in the reservoir and to facilitate the dewatering process. Assuming the predicted annual dredging volume of 100,000 cubic yards and sediments that are 50% fines and 50% sands, the USACE ADDAMS program model predicts that it will take approximately 120 days to dredge 100,000 CY, operating 7 hours/day, 5 days/week. The model also predicted that for sediments with either 100% fines or 100% sands, the dredging would take approximately 70 days and 150 days, respectively. Higher volumes of dredging can be obtained with larger dredges; however, this could result in dredges that cannot be delivered "over the road". An operational range of 70 to 150 days each year is anticipated.

Continued Dredging

Beyond the 50-year planning horizon of this study, further dredging must continue in order to maintain the useable storage volume in the SFRR. If the sedimentation rate of 15.14 MG/year continues beyond the 50-year planning period, the same amount of sediment will need to be removed annually to maintain the useable storage of the reservoir. This is a dredging volume of approximately 75,000 CY of sediment, which would be removed in the same manner as the 100,000 CY per year during the first 50 years of the program.

Dredging Equipment and Access to SFRR

Our research indicates a 12" discharge dredge similar to an Ellicott Series 370 "DRAGON™" dredge would typically be used for an application such as this. The dredge would be floating whereas the booster pump(s), if needed, could be land-based for easier fueling, maintenance, etc. Floating dredging equipment would be brought in on flat bed trucks and assembled at an appropriate launch site. Since there is no existing ramp, an access road would have to be constructed with an appropriate slope to the reservoir for truck access. Another alternative is to mobilize a large crane to lift and place the dredge in the reservoir.

Estimated Land Area for Dewatering

Land area requirements for dewatering will be based on the specific physical characteristics of the dredged sediments. It is assumed that gravity settling will be sufficient for the sediments removed. Sediments containing primarily sand will require less area because they will dewater faster and sediments containing primarily silt/clay will require more area because they will dewater slower. The required dewatering site size to adequately handle 100,000 CY of (50/50) sediment is 40 acres. This land area is used for the cost estimates presented in this document. If the actual sediment composition were other than the stated content, the required dewatering site size would vary. A range of between 20 acres (for 100% sand) and 65 acres (for 100% silt/clay) is required. The land areas indicated here include sufficient room for cell construction, embankments, material spreading, and material removal. The number of cells will be dependent on the characteristics of the dredged material, dewatering period needed, and topography of the available dewatering area. Additional land may be required for access roads, parking and administration areas depending on the site selected. Allowable land use and zoning issues must be confirmed for site selection. It is assumed that the dewatered sediment will be continuously be removed for permanent disposal elsewhere, thus allowing continuous use of this facility.

Post-Dewatering Uses of Materials

One major benefit of hydraulic dredging is that the material placement results in a uniform sorting of the dredge material in the placement site. The coarser-grained material accumulates near the discharge pipe whereas the finer material migrates across the area and settles out of suspension away from the point of discharge. Assuming that the placement site is accessible to trucks, the sandy material may be marketable for unclassified construction fill. After drying, some of the fine-grained material may be used for fill or other land application. For a multi-year dredging program, some fine-grained material would most likely be best utilized for dike construction at the placement site(s). Material that has no post-dewatering use or market use must be transported to a disposal site.

Conversations with contractors in the Charlottesville area have indicated that unless the material can be classified as a structural fill, it may not be marketable. Determining the acceptability as a structural fill will require laboratory analyses. Extensive sieve analyses, chemical composition and density and compaction testing of the accumulated sediment would be necessary to determine what portion, if any, is suitable for structural fill. If acceptable uses are identified for this material, a regular material testing program would be required based on each application. The contractors and vendors also indicated it is unlikely that the full volume of sediments dredged could be utilized. One local contractor indicated that even if all of the material is suitable as structural fill, the material would have to be hauled to the construction sites at the dredgers cost in order for it to be accepted. Based upon the uncertainty of potential sediment uses additional sampling is not suggested at this time. If the dredging concept emerges as favorable, additional composition and chemical testing should be performed to the extent that the range of costs presented in Tables 4 through 6 of this report need to be refined for decision making purposes.

Discussion with Charlottesville area fertilizer and compost suppliers indicate that there is little market for dredged material as a soils additive or conditioner. Anticipated chemical composition would require the material to be mixed with organic material to develop a marketable product. At best, a small portion of the dredged material may be accepted if delivered at no cost.

Estimated Land Area for Disposal

The amount of land area required for disposal of dredged materials is dependent on the volume of material that can be reused, the depth of the disposal piles, existing topography at the disposal site, stability of the dredged material and proximity to natural drainage or forest features. Many of these impacts are site specific and can impact the size of the disposal site. Disposal sites have not been specifically identified; however, a preliminary review of areas within 10 miles of the SFRR has been performed and it appears that there are sufficient suitable disposal sites within this range. Suitable sites were identified by review of land with minimal watercourses from USGS quad sheets. It is assumed that RWSA will be able to obtain the necessary property for disposal. Allowable land use and zoning issues must be confirmed for site selection.

It is possible that some material can be reused. Given the uncertainties associated with post-dewatering reuse, a range of reuse quantities is established for cost estimating purposes. For the purposes of estimating disposal land requirements, disposal has been estimated based on no reuse, 20% reuse and 50% reuse of the dredged materials. Further, the depth of disposed material has been assumed to be a relatively uniform 8 feet. Using these assumptions, the annual land requirement for disposal for no reuse, 20%, and 50% reuse of material are 9 acres, 7.2 acres, and 4.5 acres respectively (including area for sloping and workspace).

DREDGING COST

Assumptions and Derivation of Cost Estimates

Many factors must be considered to develop an accurate range of costs associated with the dredging component. The major factors considered in determining conceptual level cost estimates for dredging activities include: the composition of sediments in the SFRR in terms of sand/silt and hazardous materials, location of sediments in the usable pool of the SFRR, location for sediment dewatering, location for sediment disposal, and marketability of the removed sediment.

It is difficult to accurately predict the amount of dewatered sediment that may be useful to others over a 50 year period and beyond. While current research indicates there is very little market for this material, there may be some individuals or groups that would accept the material if provided to them at little or no cost. Through a reuse program, the disposal land area required can be reduced proportionately by the amount of material provided to others. Three cost estimate scenarios are prepared to provide for this variable. The following assumptions are made: no reuse of dredged material, 20% reuse of dredged material, and 50% reuse of dredged material.

In December 2003 GF issued a letter report on dredging. Previous investigations were based on an approach that required RWSA to buy and maintain the equipment for the dredging events. While it is possible for RWSA to pursue dredging in this manner, it is more likely that RWSA would pursue outside contractors for dredging. Outsourcing or contracting this program is a likely option because dredging, dewatering and disposal is an equipment and labor intensive operation. Each piece of equipment has its own useful life and many parts of the operation will require multiple purchases over the 50-year period considered. Maintenance costs are high and difficult to predict. RWSA would also be required to add staff and training for such an operation. It is more accurate at this level of study to determine the cost of completing the work based on known market conditions. In a best case internal scenario, RWSA is likely to save only the profit margin made by the contractor, provided they can conduct the work as efficiently, purchase equipment, and perform maintenance at similar costs. By pursuing outside contractors, the dredging work maintenance and operations would be competitively outsourced to a contractor; therefore, the costs applied to RWSA would be limited to land acquisition, some facility construction, and annual contractor costs.

The following assumptions were made to help determine the costs associated with dredging. Dredging parameters are documented above.

1. The sediment material is not contaminated and will not require special handling as hazardous material. If any sediment proves to contain hazardous material, the costs would substantially increase.
2. Approximately 100,000 CY of sediment will be removed from the SFRR annually. Continued dredging at an annual rate of approximately 75,000 CY will be required after the end of the projected 50 year life cycle to maintain the useable storage in the reservoir.
3. Hydraulic dredging will be used. Typically, hydraulic dredging costs approximately $5.00/CY of dredge material removed, which does not include costs associated with mobilization, demobilization, dewatering, and disposal based on discussion with dredging contractors and consultants.
4. There would be one dewatering site that will vary in size to accommodate the sediment characteristics listed above. A 40-acre dewatering site will be required based on the available sediment composition data for the purposes of cost estimating.
5. Dewatering will be performed on a property adjacent to the SFRR to enable proper drainage of liquids. A VPDES permit will be needed for discharge of liquid back to the SFRR. It has been assumed that the dewatering facility will discharge water of satisfactory characteristics that it can be returned to the SFRR without additional treatment.
6. Costs associated with purchasing land for a dewatering site will be based on a cost of $16,500 per acre. This value has been supplied to Gannett Fleming, Inc. by RWSA as an applicable estimate of the market value of land in the SFRR area.

   Costs associated with dewatering do not include costs associated with an access road, easements, excessive sloping of the dewatering site, any streams that may intersect the parcel, or any clearing of the land that may be attributed to trees and native vegetation. Until a specific site is identified, these costs can not be accurately determined. Should any of these issues present themselves once a site is selected, the cost for the land may increase.

7. Disposal of sediments is based on 0% reuse, 20% reuse and 50% reuse and will result in the need for approximately 9, 7.2, and 4.5 acres of land annually for disposal, respectively (including area for sloping and workspace). The disposal land cost is based on $16,500 as an estimated marked value of land.
8. A cost of $16/CY has been used for transportation and disposal of sediments. It includes loading at the dewatering site, transportation to the disposal site, dumping, spreading and tamping. It is based on R.S. Means Construction Cost Data for Load & Haul with unit costs of $14.22 per CY and Clay Backfill costs of $2.28 per CY Load and haul costs include a 1-1/2 CY loader and eight 6 CY dump trucks with a 3-mile round trip. Clay backfill costs utilize a 75 HP dozer and tamper. The additional travel cost would be up to approximately $1 per CY for a full 20 mile round trip. The total cost has been adjusted to reflect recommended location factors appropriate for Charlottesville.
9. A cost of $12 per cubic yard has been used for material to be reused. It is based on the same assumptions as number 8 (above) excluding spreading and tamping cost.
10. Costs for environmental mitigation have been assumed to include permitting for dewatering basin discharge, dewatering basin construction, and sediment handling. Also included in these costs are soil stabilization measures such as dikes and silt fencing. These costs have been assumed to be approximately $150,000 regardless of the sediment composition. Overall environmental impacts are expected to be very small and mitigation costs negligible considering the overall cost of the project. A discussion of likely environmental impacts is presented below.

Projected Cost Estimates

Tables 4 through 6 summarize the cost estimates for the three reuse scenarios. The costs are in 2004 dollars and provide the total cost for dredging and disposal or reuse of all 5,000,000 cubic yards of material.

Total project cost range from over $127 million, assuming 50% of the dredged material is reused, to near $145 million, assuming none of the dredged material is reused. It is assumed the initial restoration dredging and disposal work would be conducted over a 50 year period, therefore, the costs could be divided into initial (or one-time costs) and annual costs for the 50 year period.

One-time costs would include land acquisition, dewatering basin construction, environmental mitigation and permitting, and engineering. The remainder of the costs would occur annually and be proportional to the volume of sediment removed.

Table 7 summarizes the cost estimate for continued annual dredging after the 50 year period is complete. Since predicting the usefulness of dredged material for reuse during this period is difficult, only a no reuse scenario is shown. The total annual cost for continued dredging is $2.2 million. This work would continue in perpetuity.

Table 4

Cost Estimate for Dredging a 50/50% Mixture of Sand and Silt/Clay with 50% Reuse of Dredged Material

Item	Cost
Land Acquisition for Dewatering Facility (40 acres @ $16,500/acre)	$660,000
Dewatering Basins Construction	$450,000
Environmental Mitigation and Permitting	$150,000
Hydraulic Dredging ($5/CY)	$25,000,000
Land Acquisition for Disposal (4.5 acres per year, 225 acres total over 50 years @ $16,500/acre)	$3,712,500
Hauling Costs for Reused Dredged Material ($12/CY)	$30,000,000
Disposal Costs for Unusable Dredged Material ($16/CY)	$40,000,000
Mobilization/Demobilization ($40,000/year)	$2,000,000
Engineering/Permitting and CM (25% of Dewatering Basin Construction only)	$112,500
Subtotal	$102,085,000
Project Contingencies (25%)	$25,521,250
Total Project Cost	$127,606,250
Average Cost per MGD of Safe Yield (provides 5.5 MGD)	$23.2M/MGD

Table 5

Cost Estimate for Dredging a 50/50% Mixture of Sand and Silt/Clay with 20% Reuse of Dredged Material

Item	Cost
Land Acquisition for Dewatering Facility (40 acres @ $16,500/acre)	$660,000
Dewatering Basins Construction	$450,000
Environmental Mitigation and Permitting	$150,000
Hydraulic Dredging ($5/CY)	$25,000,000
Land Acquisition for Disposal (7.2 acres per year, 360 acres total over 50 years @ $16,500/acre)	$5,940,000
Hauling Costs for Reused Dredged Material ($12/CY)	$12,000,000
Disposal Costs for Unusable Dredged Material ($16/CY)	$64,000,000
Mobilization/Demobilization ($40,000/year)	$2,000,000
Engineering/Permitting and CM (25% of Dewatering Basin Construction only)	$112,500
Subtotal	$110,312,500
Project Contingencies (25%)	$27,578,125
Total Project Cost	$137,890,625
Average Cost per MGD of Safe Yield (provides 5.5 MGD)	$25.1M/MGD

Table 6

Cost Estimate for Dredging a 50/50% Mixture of Sand and Silt/Clay with No Reuse of Dredged Material

Item	Cost
Land Acquisition for Dewatering Facility (40 acres @ $16,500/acre)	$660,000
Dewatering Basins Construction	$450,000
Environmental Mitigation and Permitting	$150,000
Hydraulic Dredging ($5/CY)	$25,000,000
Land Acquisition for Disposal (9 acres per year, 450 acres total over 50 years @ $16,500/acre)	$7,425,000
Disposal Costs for Unusable Dredged Material ($16/CY)	$80,000,000
Mobilization/Demobilization ($40,000/year)	$2,000,000
Engineering/Permitting and CM (25% of Dewatering Basin Construction only)	$112,500
Subtotal	$115,797,500
Project Contingencies (25%)	$28,949,375
Total Project Cost	$144,746,875
Average Cost per MGD of Safe Yield (provides 5.5 MGD)	$***26.3M/MGD***

Table 7

Annual Estimated Cost Dredging Beyond 2055 of a 50/50% Mixture of Sand and Silt/Clay with No Reuse of Dredged Material

Item	Cost
Hydraulic Dredging ($5/CY)	$375,000
Land Acquisition for Disposal (6.75 acres per year @ $16,500/acre)	$111,375
Disposal Costs for Unusable Dredged Material ($16/CY)	$1,200,000
Mobilization/Demobilization ($40,000/year)	$40,000
Subtotal	$1,726,375
Project Contingencies (25%)	$431,594
Total Project Cost	$2,157,969

ENVIRONMENTAL IMPACTS

The primary environmental affects of dredging operations can be discussed with respect to four primary activities: Access/Pipeline Routing/Staging, Excavation, Dewatering and Disposal.

Based on the description of dredging operations outlined in previous sections of this document, it is assumed that dewatering and disposal of dredged material will be accomplished at an upland site, without direct impacts to wetlands or streams. Consequently, impacts resulting from clearing or placement of fill in these aquatic systems will be limited to stream crossings for access roads, portions of staging areas or booster pump sites, ramp construction and pipeline installation and are expected to be minimal. Similarly, costs associated with compensatory mitigation will be an insignificant fraction of the overall program costs.

Access/Pipeline Routing/Staging

A dredging operation such as the one contemplated for the SFRR will require considerable infrastructure, which can be considered permanent in light of the 50 year project life. The dredge must be brought to the reservoir and launched, a process that will likely involve improvements to existing access routes, or construction of a new route. The dredge will then either be placed in the water by a crane, or launched from a constructed ramp. Maneuvering this heavy equipment into position may require stream crossings, minor grading and clearing of vegetation and placement of gravel on roads and lay-down areas. Similarly, an above-ground pipeline will have to be constructed from the reservoir to the dewatering site. This process will result in minor clearing along the pipeline route and in select areas for booster pumps, if needed. The primary environmental affect of these activities will be in the removal of vegetation and the potential for sedimentation during minor grading. Such impacts can be mitigated through careful sedimentation and erosion control conducted in accordance with the Virginia Erosion and Sedimentation Control regulations.

Excavation

The actual dredging process has the potential to produce direct and indirect environmental affects. Direct impacts to organisms living in the substrate of the reservoir will occur as the dredge cuts and removes the accumulated sediments. It is generally accepted that benthic communities disturbed by dredging recover relatively quickly. Secondary affects may occur due to turbidity in the water column resulting from disturbance of fine sediments on the bed of the reservoir. Because of the suction action associated with hydraulic dredging, turbidity affects are generally minimal and can be further controlled through the use of a turbidity curtain installed around the perimeter of the work area to limit suspended sediment movement away from the cutterhead.

Dewatering

Development of the dewatering site will result in clearing and minor grading activities associated with construction of containment berms. Environmental affects are similar to basic land development activities and will involve removal of vegetation and an increased potential for sedimentation and erosion during the grading process. As with construction of accesses and staging areas, these impacts can be mitigated by strict adherence to sedimentation and erosion control policies. Discharges from the dewatering site can also have an affect on receiving waters if the channel is inadequate to receive outflow from the basin, or if there is a discharge of turbid waters. These issues are addressed through careful engineering design of the outflow channel and by sizing and configuring the basin to allow fine sediments to settle out of suspension prior to discharge. A system of baffles is often used to increase the travel distance between the point of entry of dredged material and the outfall pipe, allowing complete settling before release.

Disposal

It is anticipated that much of the dredge material will need to be disposed, following dewatering. Again, preparation of the disposal site may require removal of vegetation and will result in the placement and spreading of soils over relatively broad areas. Standard sedimentation and erosion control techniques will effectively control environmental impacts.