

**SOUTH FORK RIVANNA RESERVOIR DREDGING FEASIBILITY STUDY
POTENTIAL BENEFICIAL REUSE OF DREDGED MATERIAL**

Prepared for



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Foreword

The purpose of the South Fork Rivanna Reservoir Dredging Feasibility Study is to evaluate the feasibility of restoring the water supply capacity of the South Fork Rivanna Reservoir (Reservoir) to as near its original contours and water storage volume as practical by removing accumulated sediment. This study evaluates dredging accumulated sediments both within the area of the available water supply volume (Reservoir areas above the water supply intake elevation) as well as areas below the water supply intake. This study does not involve dredging beyond the original contours or expanding the reservoir beyond its original configuration.

HDR Engineering, Inc. (HDR) has been tasked by Rivanna Water & Sewer Authority (RWSA) to evaluate the feasibility of dredging the Reservoir through completion of the following scope of services.

Phase I – Reservoir Characterization

Task 1 Wetlands Assessment

Task 2 Bathymetric Survey & Volume Analysis

Task 3 Pre-Dredge Survey

Task 4 Sediment Characterization

Task 5 Reservoir Characterization Public Meeting

Phase II – Dredging Alternatives Analysis

Task 6 Dredging Alternatives Evaluation

Task 7 Dewatering/Processing Alternatives Evaluation

Task 8 Dredging Analysis Public Meeting

Phase III – Dredging Feasibility Summary Report

Task 9 Summary Report

In addition, HDR was subsequently tasked with evaluating the potential beneficial reuse of dredged material from the Reservoir (Task 10 Beneficial Reuse Alternatives) as part of Phase II.

This report documents the activities and results of Task 10 Beneficial Reuse Alternatives.

Table of Contents

Summary	1
1.0 What is Beneficial Reuse?	3
2.0 How was Beneficial Reuse of the Sediment Assessed?.....	3
3.0 Sediment Characterization Summary	4
4.0 Beneficial Reuse Options for Reservoir Sediments.....	6
5.0 Local Opportunity for Beneficial Reuse	9
5.1 Engineered Use	9
5.1.1 Land Creation and Improvement	9
5.1.2 Capping.....	10
5.1.3 Replacement Fill.....	10
5.2 Agriculture/Product Uses.....	11
5.2.1 Topsoil	11
5.2.2 Construction Materials.....	12
5.2.3 Road Construction and Maintenance	12
5.3 Environmental.....	13
6.0 Cost/Benefit	14
6.1 Local Product Availability and Cost.....	14
6.2 Cost of Processing and Delivery of Dredged Material	14
6.3 Estimated Cost/Benefit of Reuse	16
7.0 Permits for Reuse.....	18
8.0 References.....	19

Appendix A: Potential Uses for Dredged Material

Summary

This report describes various potential beneficial reuse applications for dredged material from the South Fork Rivanna Reservoir. The Beneficial Reuse Assessment presents a framework for identifying a suitable application of Reservoir sediment within the Charlottesville and Albemarle County area.

The decision process for identifying the most appropriate application or reuse for dredged material involves analysis of project needs in the area, and included review of the following items during the decision process:

- Materials Characterization
- Technical Feasibility of Reuse
- Local Opportunity for Reuse
- Cost/Benefit
- Legal Constraints

The need to restore the capacity of South Fork Rivanna Reservoir and subsequent availability of valuable dredged material provides opportunity for creative partnerships to meet both environmental and economic objectives of the community.

If dredging the Reservoir moves forward, the dredged sediment would be suitable for most types of beneficial reuse. Reservoir sediment consists of a mixture of sand, clay and silt, without environmental contaminants. The sediment consists of a high percentage of sand in the upper reaches of the Reservoir.

The dredged material, once mechanically dewatered and processed, could be delivered at a favorable cost compared to retail costs for local topsoil material and sand (not counting the cost of dredging and dewatering the material). The cost difference of a given material is described as the difference in price between using dredged material and using the conventionally produced material at local retail pricing. Depending on local market conditions at the time of reuse, some or all of the cost difference could potentially be used to off-set the costs of producing the dredged material.

HDR's dredging and dewatering alternatives analyses (see respective reports) determined the most likely source for dredged material available for reuse would be a hydraulic dredging option with mechanical dewatering of sediment just upriver of Reas Ford Road Bridge. This option could produce approximately 189,097 cy of sand and 101,227 cy of sediment.

Sand is the most valuable component of the dredged sediments. Local retail pricing for sand is \$44 to \$54 per cy plus delivery. If 189,097 cy of sand are produced and accepted into the local market for reuse, the potential retail value ranges from \$8,320,268 to \$10,211,238. However, the sand produced from dredging may require some additional drying and processing at an off-site stockpile site to be competitive with local retail sand; therefore the actual return would likely be less. HDR estimates the added processing and transportation costs could reduce the actual net benefit from the sand reuse to \$4,774,699 to \$9,469,978. The net benefit is the difference between using the cost for using the dredged material and cost of purchasing similar material locally – that is, using the 189,097 cy of dredged sand (after drying and processing) would represent a cost savings of \$4,774,699 to \$9,469,978 over purchasing the same material on the local retail market.

If the remaining 101,227 cy of material is screened and reused as topsoil, the potential cost difference is \$126,534 to \$2,133,865 compared to purchasing topsoil on the local retail market – however; most topsoil on the local retail market has been processed to include additional organic matter. The dredged sediments, although suitable for topsoil, do not contain high quantities of organic matter and may not be as commercially attractive. Therefore, the upper end of the cost difference is unlikely to be achieved. If the remaining 101,227 cy of material is reused as fill (without additional screening) instead of topsoil, the potential cost difference is (-\$177,147) to \$1,222,822. Where a negative cost difference exists, the dredged material is unlikely to be selected for reuse on the basis of price alone.

1.0 What is Beneficial Reuse?

Beneficial reuse involves using dredged material or recovered sediment and soil material as a resource in a productive way. While the term “beneficial” indicates some benefit is gained by a particular use, the term has come to generally mean any reuse of dredged material. Beneficial reuse of dredged material can minimize, or eliminate, the treatment of dredged material as a waste requiring disposal. As part of overall sediment management, federal, state, and local regulatory agencies generally support the productive reuse of dredged material. Plus, in most cases, reuse is less expensive than disposal.

The potential uses for dredged material depend on the type and volume of dredged material, where the material is being dredged, how it is dredged and the overall suitability of the material for a particular use. Regulatory requirements and local conditions must also be considered. Beneficial reuse of dredged material generally falls into one of three broad categories: engineering uses, agricultural/product use and environmental uses. Typical beneficial reuses for these categories include, but are not limited to, the following examples:

- Agricultural/Product Uses
 - Topsoil, construction material, aquaculture, decorative landscaping products
- Engineered Uses
 - Berm creation, capping, land creation, land improvement, replacement fill, shore protection
- Environmental Enhancement
 - Fish and wildlife habitats, fisheries improvement, wetland restoration

The technical feasibility of connecting a dredging project to a beneficial reuse project requires overall project coordination, timing and physical location of activities. It is important to consider proximity of dredged material source to the ultimate reuse site, associated handling and trucking of material, and available access to the property. It is also necessary to ensure that the amount and type of dredged material is compatible with the specific reuse project requirements.

2.0 How was Beneficial Reuse of the Sediment Assessed?

HDR evaluated the beneficial reuse potential of the Reservoir sediment by

- Determining what the sediment is likely usable for, based on its chemical and physical characteristics;
- Determining if there may be a local demand for those uses that meet the sediment’s characteristics; and
- Determining the likely cost of the sediment delivered to its end use.

A conceptual level feasibility analysis was conducted where both suitability and a potential market were identified, as well as the likely costs to deliver the material to the identified local reuse project.

Cost estimates and estimates of volumes, distances, and materials have been used in developing comparative evaluations of various sediment transportation, and placement options. These estimates are intended for planning and comparison only, and are subject to change as the project components are

further developed, additional data becomes available, and final designs and decisions are completed. In addition, HDR has assumed some costs for materials, services, and use of private property. These costs are based on HDR's assumptions as described herein, and are subject to change based on market conditions and negotiations between parties.

3.0 Sediment Characterization Summary

The Reservoir sediment was characterized in Phase I of this study (see Sediment Characterization Report). HDR collected five sediment core samples from different areas of the Reservoir. These samples were then tested for various contaminants, as well as particle size, bulk density, and total nutrients.

The contaminant analyses did not identify any elevated concentrations of Toxicity Characteristic Leaching Procedure (TCLP) contaminants or Resource Conservation and Recovery Act (RCRA) heavy metals that would potentially restrict future dredging activities or reuse of the sediment. Results are provided in the Sediment Characterization Report.

The five sediment samples were also analyzed for physical characteristics, including particle size. The percentage of sand is highest in the far upper end of the Reservoir as exhibited in Sample 1 (see **Table 1**). The middle and lower portions of the Reservoir and the Ivy Creek tributary samples exhibit higher concentrations of silts and clays.

Table 1. Particle Size Summary			
Sediment Core Sample	Sand (%)	Silt (%)	Clay (%)
1 – Upper Mainstem Reservoir	77.2	19.6	3.2
2 – Mainstem Reservoir	23.2	57.6	19.2
3 – Mainstem Reservoir	20.0	59.2	20.8
4 – Lower Mainstem Reservoir	27.2	51.6	21.2
5 – Ivy Creek	21.2	53.6	25.2

Note: Particle size gradations: sand > 0.075 millimeters (mm); silt < 0.075 mm and >0.002 mm; clay < 0.002 mm

There is a clear distinction between the sediment size at the upper end of the Reservoir from the remainder of the Reservoir. This distribution of coarser material in the upper end of the Reservoir trending to finer grained particles in mid to lower Reservoir areas is typical for relatively narrow riverine reservoirs. Larger particle sizes tend to settle out rapidly due to energy dissipation at the river to reservoir interface. The transition of particle sizes between Samples 1 and 2 is likely gradual, although not entirely uniform, due to variances in the occurrences of storms and other high flow events.

In addition to the physical analyses described above, a standard soil fertility analysis was completed for each core sample. This standard test included a range of common agricultural nutrients that could affect potential beneficial reuse and/or land application of the sediment. The parameters included in the standard soil fertility test included: organic matter, phosphorus, potassium, magnesium, calcium, sodium, pH, acidity, Cation Exchange Capacity or C.E.C., percent base saturation, sulfur, zinc, manganese, iron,

copper, boron, and soluble salts. Nitrate is not typically included in a standard soil fertility test due to the variability of the nitrogen cycle and its propensity to change forms as a result of climatic conditions. Therefore, the analysis of nitrate and other forms of nitrogen in a standard fertility test is considered to be of limited value. However, the analysis of organic matter allowed an estimate of Estimated Nitrogen Release (ENR) to be completed.

Generally, the downstream samples (Samples 2, 3 and 4) and the Ivy Creek sample (Sample 5) contained higher nutrient levels than the coarse sand found in the upstream Sample 1 due to the presence of fine grained silts and clays. Although available phosphorus was low by agricultural standards, there were very desirable levels of potassium, magnesium, calcium, manganese, sodium and iron. Organic matter and estimated ENR was very low for the sandy material in Sample 1. The other sediment samples showed ranges of organic matter and ENR from low to medium, likely due to the presence of higher percentages of fine grained sediment. In addition, pH ranged from 5.7 to 6.1, which is considered to be acceptable for agricultural conditions. Based on these nutrient analyses, sediment from the areas represented by Samples 2 to 5 is suitable for agricultural applications.

The sediment (once dewatered) is estimated to weigh approximately 90 to 110 pounds per cubic foot, or 2,430 to 2,970 pounds per cubic yard (cy) [approximately 1.2 to 1.5 tons/cy].

Additional geotechnical analyses may be necessary to help predict the behavior of the sediment materials and relative effectiveness for certain applications. These analyses are important in determining the amount of Reservoir sediment that is suitable for engineered uses, including structural fill for construction use. The engineering behavior of soils is a function of a variety of factors including: the gradation, size and shape of the sediment particles, the mineral composition of fine-grained particles, and the water content of a soil mass (Maher, 2005).

If the dredged material is being considered for an engineering use that requires meeting specific agency criteria (such as Virginia Department of Transportation (VDOT), American Association of State Highway and Transportation Officials (AASHTO), and Federal Aviation Administration (FAA)), then HDR recommends additional sediment testing for ASTM grain size analysis, Atterburg limits, standard/modified Procter test, California Bearing Ratio test, pH, resistivity, chlorides, and sulfites. The geotechnical test results can be compared to criteria established by federal and state agencies for suitability of reuse. Samples could be collected from the depth of the sediment deposition, without moving or transporting the material. A vibrocore or similar sampling device mounted on a barge would be required to penetrate the full sediment core. Alternatively, the sediment could be sampled and analyzed after it is dredged and dewatered. Sampling after dredging would be substantially less costly and would better represent the actual sediment mix available for reuse.

HDR has assumed the material would generally meet the requirements for use by VDOT, AASHTO, and FAA for purposes of this evaluation of beneficial reuse, and as discussed below for specific uses. Further sediment testing per the above is recommended prior to any such application.

4.0 Beneficial Reuse Options for Reservoir Sediments

The sand, silt and clay found within the Reservoir originated from the upper reaches of the South Fork Rivanna Reservoir watershed – these sediments were once Albemarle County soils. Potential reuse options for these materials are based on their characteristics, and include:

Sand: VDOT quality standards refers to sand as either coarse (4.75mm to 2.0mm), medium (2.0mm to 0.425 mm) or fine (0.425mm to 0.075mm) grain material. Coarse sand (often referred to as granular) is considered to be valuable due to its suitability for most engineering uses without processing. Coarse sand can be used for parks, shoreline construction/protection, bird nesting islands, and wetlands restoration and establishment (VDOT, 2010). Medium to fine grained sands are typically used for recreation land development, habitat development, fill material, road construction/maintenance, children’s sand boxes and sand volleyball courts. Fine grain sand is used as a main ingredient in asphalt, an additive to cement used to make mortar for laying bricks, filling gaps in pavement and also as a base under materials such as geotextile liners (EPA USACE 2007). Sand of any grain size is generally easy to compact, affected little by moisture, and not subject to frost action (VDOT, 2010).

Silt: Silt grain size varies from silt < 0.075 mm and >0.002 mm and is typically used for agricultural purposes (topsoil), habitat restoration and development, recreation land development, pond construction, water control and containment and for berm strengthening. Silt can be unstable when moisture is increased, with a tendency to become quick (soft) when saturated. It is relatively impervious, difficult to compact, highly susceptible to frost heave, easily erodible and subject to piping (underground tunnels created by groundwater) and boiling (surface channels caused by sediment and water flow) (VDOT, 2010).

Clay: Clay generally consists of material < 0.002 mm grain size. It has good nutrient holding capability and is considered to be a valuable additive to topsoil in the correct proportion. It is also generally used for wetland/upland habitat restoration and development, shoreline construction, capping, and manufacturing of bricks and ceramic materials. The permeability of clay is very low; it is subject to frost heave, expansion and shrinkage with changes in moisture (VDOT, 2010).

In addition, combinations of the above materials have been found to have beneficial applications for agricultural and landscaping purposes, particularly when small percentages of sand, clay and leaf or other compost are blended with primarily silt grain-sized soil.

The U.S. Environmental Protection Agency and U.S. Army Corps of Engineers produced the manual *Identifying, Planning and Financing Beneficial Reuse Projects Using Dredged Material* (2007). This manual identifies typical users and types of use for dredged material and includes the following categories:

Commercial and Agricultural Industry

- Augment physical or chemical quality of topsoil or compost
- Construction materials: additives to concrete, asphalt, mortar and other materials
- Expanding or raising the height of land base
- Replace eroded topsoil

Local and State Parks Department

- Creation or improvement to community parks or trails
- Maintenance of recreation sites, athletic fields, picnicking, camping or boating areas

State Highway department

- Sanding roads
- Road construction or maintenance

State and Local Agencies

- Natural resource and habitat conservation or enhancement
- Wetland creation or enhancement
- Reclaim mines, waste landfills or brownfields

Private Party

- Additive to construction materials
- Commercial, residential, or other development projects
- Use as topsoil or fill for agriculture, habitat creation or landscaping, etc.

Table 2 identifies the beneficial reuse options associated with the type of sediment present in the South Fork Rivanna Reservoir.

Table 2. Beneficial Reuse Options by Sediment Type			
Use Type	Consolidated (Stiff) Clay	Silt	Sand (fine and coarse)
Engineered Uses			
Land creation	X	X	X
Land improvement	X	X	X
Capping	X		
Replacement Fill			X
Recreation Uses		X	X
Agriculture & Product Use			
Agriculture/Topsoil		X	
Construction materials	X	X	X
Road construction and maintenance			X
Environmental Enhancements			
Habitats Enhancement	X	X	X
Fisheries Improvement	X	X	X
Wetland/Shoreline Restoration	X	X	X

Source: U.S. EPA and USACE, Beneficial Reuse Planning Manual 2007, VDOT 2010

Although the upper portion of the Reservoir contains mainly sand (approximately 77%), the bulk of the accumulated sediments in the rest of the Reservoir are mainly silts (52 to 59%), with smaller percentages of sand (20 to 27%) and clay (19 to 25%) mixed in. These percentages are typical of both the conditions in the watershed and the Reservoir. While there are layers or lenses of largely one type of material in some locations within the Reservoir, most of the material is intermixed and inter-bedded. Both HDR's sampling and earlier sampling activity identified the ability of the varying materials to become consolidated, which would indicate that acceptable compaction can be achieved for beneficial use applications as fill. A good mix of particle sizes in soil allows for greater compaction, as the small particles fill the spaces between larger particles that would otherwise be empty if all were the same size.

5.0 Local Opportunity for Beneficial Reuse

There are multiple potential beneficial reuse options that have been identified for dredged material. However, few of the potential reuse options have the demand to absorb or use most or all of the potential volume of material that could be dredged from the Reservoir. Most of the specific reuse options would involve small quantities of material in comparison to targeted dredging volumes. The ability of many of the following reuse options to “mesh” with any Reservoir dredging project will require a balance of timing, cost, and need.

The results of the broad analysis of the potential uses and users of dredged sediment material are presented in Appendix A. This list includes transportation and development projects identified in the VDOT *Statewide Transportation Improvement Plan* (2009), and projects identified in the Village of Rivanna Master Plan (2009), and the Albemarle County Comprehensive Plan (1999).

Distance is another key factor in evaluating the feasibility of a particular reuse option; transporting sediment by truck is cost-prohibitive over long distances for most types of use. Final choices for sediment dewatering are not yet determined, so two points at each end of the Reservoir were selected as representative of potential starting points for transporting the dredged material for reuse. The Earlsville Road Bridge and the Reas Ford Road Bridge were used as representative starting points for distance estimates – all distances noted below are estimated road miles from these bridges.

The following is a discussion of alternatives for beneficial reuse projects in close proximity to the dredging activities.

5.1 Engineered Use

5.1.1 Land Creation and Improvement

Land creation or improvement involves filling, raising, and protecting an area that is otherwise periodically or permanently submerged. A mixture of dredged materials, either coarse or fine grain, may be used in land creation and/or improvement (see **Table 2**). The suitability of a particular dredged material will depend largely on the intended use of the land. Land created or improved using fine grain material is generally of lower strength than land improved using coarse-grained material. Suitable land creation/improvement projects include expanding or raising the height of land base, replacing eroded topsoil, or creating playing fields, golf course, parks and trails, light residential development or light commercial storage areas. Dredged material may also be used to improve slope and/or elevation of the land (USACE, 2006).

Albemarle County Planning Department (various locations): Staff at the Albemarle planning department indicated that there are no new parks planned within Albemarle County (MacCall, 2010). Smaller maintenance projects within recreational areas will continue to occur over the next few years; however, there is no anticipated need for a large amount of material. If dredged sediment is used for a recreation project it would be necessary to coordinate the timing of each individual project with the availability of the dredged sediment.

City of Charlottesville Parks and Recreation Department (various locations): Staff at the Parks and Recreation department identified a few parks that will have improvement projects occurring within the

next three to five years. Notably, the 1 acre dog park within Azalea Park (7 miles from Earlysville Road Bridge and 9 miles from Reas Ford Bridge Road) and general recreation facility improvements at McIntire Park (4 miles from Earlysville Road Bridge and 7 miles from Reas Ford Bridge Road) will likely require fill material and could be a reuse option (Ginter, 2010).

5.1.2 Capping

Capping involves the placement of clean dredged clay material over a landfill, mining site or contaminated site to isolate it from the surrounding environment. Due to the presence of numerous quarries in the area, upland capping of abandoned quarries would be a suitable reuse project. There are no capping projects for abandoned or underused industrial and commercial facilities, commonly referred to as Brownfields, within the City of Charlottesville or Albemarle County. In addition, there are no landfill sites in need of dredged sediment for capping purposes.

Virginia Department of Mines and Minerals and Energy (DMME) (various locations): Although many quarries exist within Albemarle, Nelson and Green counties, the DMME indicates that there is no anticipated need for dredge material to rehabilitate these areas. Many of the mines in the region have already been rehabilitated and revegetated. DMME indicated that there are two small quarries in the area that are currently operational, but the quarries currently do not have a need for the material (Cross, 2010).

5.1.3 Replacement Fill

Mixed dredge material may be used as a replacement fill when the physical qualities of dredged sediment are superior to soils in the surrounding area (see **Table 2**). Coarse grain material such as sand can be used to support construction of buildings, roadways, bridges or tunnels (USACE, 2006).

Charlottesville Airport Runway expansion (about 4 miles from Earlysville Road Bridge and 7 miles from Reas Ford Road Bridge): The Charlottesville Albemarle Airport is in the process of extending existing runway facilities. This project would involve a phased project to construct an 800 foot runway extension and construction of a 1,000 foot safety zone at the north end of the runway. The project is estimated to require 1.9 million cubic yards (cy) of fill. The material must be relatively clean and able to meet FAA standards for embankments, safety areas, runways, and other areas. Material used must be free of stumps, roots, and logs, as well as high concentrations of organic matter. The Airport has identified an on-site source for their fill needs, but would consider using dredged material if it (1) met FAA standards; (2) met project schedule needs; and (3) was the least cost option. The size of the airport project would allow for most of the dredged material to be utilized.

The Airport has also identified a possible future project involving development of a cargo terminal on the west side of the Airport. This project could require approximately 1 million cy of fill. However, at this time the cargo terminal project has not been approved, and no schedule exists for its development.

The Rivanna Solid Waste Authority (14 miles from Earlysville Road Bridge, 18 from Reas Ford Bridge Road): Rivanna Solid Waste Authority (RSWA) has a field in need of grading that could be a potential recipient of dredged material. A final grading plan has not been established, and the actual volume of fill material desired is not yet determined. The field is about one acre and would therefore require about 800 cy of dredged material to provide six inches of cover.

University of Virginia Research Park (7 miles from Earlysville Road Bridge, 9 miles from Reas Ford Bridge Road): The University of Virginia is currently expanding their research park. However, previous construction activities have created a stockpile of excavated material on the project site. Therefore, the University does not foresee a need to take on the dredged material for the project (Marshall, 2010).

5.2 Agriculture/Product Uses

Agriculture use projects involve the use of mixed dredge material to increase yields on eroded or low-yielding soils (see **Table 2**). Dredged material may also be used to improve the quality of agricultural lands or to address elevation issues to prevent occasional flooding. Additional options include land grading or filling of gullies and depressions, and construction of terraces, pond embankments, or other on-farm uses of clean fill.

5.2.1 Topsoil

Using Reservoir sediment for topsoil would likely involve a mixture of silt, sand, clay and organic matter, all important components of topsoil. Dewatering and conditioning of dredged material can result in a product that can be used in topsoil creation or improvement to soil structure. For horticultural use, Reservoir sediment would likely need to be mixed with organic material to develop a marketable product. Blending appropriate materials together in specific amounts will allow topsoil to better meet required specifications for a specific use. The Reservoir can provide large quantities of soil with consistent quality. However, Charlottesville area fertilizer and compost suppliers indicate there is not a major market for dredged material as a soils additive or conditioner.

The Thomas Jefferson Soil and Water Conservation District (TJSWCD) (various locations): The local division of the Virginia Soil and Water Conservation District coordinates conservation efforts within Albemarle County. As part of this coordination, TJSWCD manages erosion and sediment control programs, agricultural programs, stormwater programs, as well as conservation and education programs. Currently the TJSWCD does not have any large projects involving berm construction, bank stability improvement or other conservation projects that could use the Reservoir sediment. Because the sediment would likely not be available for approximately three to five years, it is difficult to identify and commit Reservoir sediment to conservation projects in the area. In addition, the projects managed by TJSWCD are typically small to medium scale and would not require use of large quantities of sediment. Therefore, logistical complications may arise from the need to coordinate with multiple end users.

Albemarle County Parks and Recreation Department and Public Schools Physical Services Department (various locations): The Albemarle County Parks and Recreation department manages about 2,000 acres of land and the Physical Services department maintains facilities for about 28 public schools in Albemarle County. Dredged material would be suitable for growing grass for recreational grounds and athletic fields. Both the Parks and Recreation Department and Albemarle County Public schools indicated interest in reusing the Reservoir sediment for top-dressing of athletic fields within the area (Smith, Rohm, 2010). Although a specific area is not identified for use, both departments have a regular need for top-dressing on their playgrounds and athletic fields and would likely utilize a substantial amount dredged material in close proximity to the dredging project. However, it is not known which fields will need top dressing at the time the Reservoir sediment is available and is therefore difficult to determine the amount of material that can be allocated to this use. Any such use must coordinate the timing of Reservoir

sediment availability, transportation to numerous locations, and application of the material to athletic fields.

5.2.2 Construction Materials

Construction materials can be created using mixed dredged material (see **Table 2**). In many cases, dredged material consists of a mixture of sand and clay fractions, which may require some type of separation and moisture control process.

Local Construction Companies (various locations): Depending on the sediment type and processing requirements, dredged material may be used as concrete aggregates (sand and gravel); backfill material or in the production of mortar (sand); raw material for brick manufacturing (clay with less than 30 percent sand); ceramics, such as tile (clay), pellets for insulation, aggregate, or lightweight backfill (clay) (USACE, 2006). Many construction companies make use of excavated material on their project site and do not have storage capacity to take on substantial quantities of the dredged material. Therefore, it is necessary to coordinate the availability of dredged material with local construction projects and associated need for material. Logistical complications may arise from the need to coordinate with multiple end users.

The Rivanna Solid Waste Authority (RSWA) (14 miles from Earlysville Road Bridge, 18 from Reas Ford Road Bridge): RSWA operates the Ivy Materials Utilization Center for residents of Charlottesville and Albemarle County. This center is located on State Route 637 and is available to residents of Charlottesville and Albemarle County. The center takes clean, unscreened fill material for a placement fee of \$8 per ton and allows residents of Charlottesville and Albemarle County to pick it up for personal land improvement projects. RSWA limits the amount of fill delivered to the facility to 300 to 500 tons per month. The amount of material RSWA would be able to take for their fill operations would depend on the compaction rate of the material and RSWA's supply of fill at the time the Reservoir sediment is available. For comparison, RSWA's \$8 per ton placement fee would be \$9.60 to \$12 per cy for the dredged material. The RSWA capacity of 300 to 500 tons per month would equate to 200 to 416 cy of dredged material per month.

Charlottesville Department of Public Works (various locations): The Department of Public Works generally works on small to medium projects that would not require large amounts of sediment or fill material. In addition the Department does not plan these projects as far out as three to five years and would therefore not be able to commit to using the material. The Department did indicate that if the material is still available in the future they would consider using it for their projects (Mollica, 2010).

5.2.3 Road Construction and Maintenance

Virginia Department of Transportation (various locations): VDOT local road projects would be a potential recipient of screened sand to use as an additive to construction material for road projects. The VDOT TIP identifies numerous small to medium size road projects within the Charlottesville and Albemarle County area. VDOT road construction projects typically make use of excavated materials on site (Sumpter, 2010). If it is determined that excess fill is needed, it would be difficult to estimate the required amount until the time of construction activity. In addition, the scale of these projects would not be large enough to take on all of the dredged sediment, resulting in a need to coordinate the availability of

dredged material and transporting material to numerous VDOT projects within the region. See **Appendix A** for a list of road development projects in the area.

VDOT (various locations) could also be a potential recipient of screened sand for road maintenance during winter months. However, VDOT indicated that the market for sand for road maintenance in the area is small. VDOT has on call contracts with local sanding companies for when sanding is needed. Contractors utilize their own supply of filtered sand that fits VDOT's specifications. Therefore, VDOT does not foresee a need to directly utilize dredged sediment (Sumpter, 2010).

5.3 Environmental

Habitat Enhancement: Reservoir sediment can be used to enhance or create various wildlife habitats and wetland areas. Native vegetation established in these areas then provides food and cover for wildlife. Nesting meadows and habitat for large and small mammals and songbirds can be developed on upland or floodplain (seasonally flooded) areas. Strategic placement of dredged material can replenish eroding natural wetland shorelines or nourish subsiding wetlands by serving as an erosion barrier or providing shoreline stabilization (Great Lakes Commission, 2001).

Dredged material sediment can also be used to stabilize eroding natural wetland shorelines or nourish subsiding wetlands. Dewatered dredged material can be used to construct erosion barriers and other structures that aid in restoring a degraded or impacted wetland (USACE, 2006).

Private Property Owner Habitat Enhancement (various locations, distance vary): Properties located along the Reservoir can be good candidates for small scale habitat enhancement projects. Habitat could be created or improved on property located within close proximity to the dewatering/storage site to minimize the need for hauling material. Coordination between willing property owners and agencies including Virginia DEQ, the Piedmont Environmental Council and the Rivanna Conservation Society would be necessary in order to define and implement these projects.

The Nature Conservancy (TNC) (various locations): TNC often conducts land rehabilitation and resource conservation projects. Current coordination with the NRCS has identified several potential projects that could be options for a beneficial reuse project. Because the dredged sediment would not likely be available for three to five years, it is difficult for TNC to determine if they can use the material or how much they would need. In addition, typical TNC projects would not be large enough to take on all of the dredged sediment, resulting in a need to coordinate the availability of dredged material and transporting material to numerous projects within the region.

Piedmont Environmental Council (PEC) (various locations): PEC is a local conservation organization operating in the Piedmont region, including the City of Charlottesville and Albemarle County. A representative at PEC indicated that there are no large scale land conservation projects that would require the use of fill or topsoil. Therefore, they do not anticipate a need for dredged material (Warner, 2010).

6.0 Cost/Benefit

HDR has estimated the costs for each particular use of dredged material. Local pricing estimates are used for identifying retail price of local materials for comparison with the beneficial reuse of dredged materials. The 2009 R.S. Means, an annually updated construction cost handbook, is used for estimating costs for handling and transporting the dredged material.

6.1 Local Product Availability and Cost

Products similar to the sediment from dredged material are available on the market within Charlottesville and Albemarle County area. Retail prices for topsoil, fill and sand vary depending on quality and availability. **Table 3** below indicates typical current retail prices for these products within the Charlottesville and Albemarle County area. Local delivery prices can vary by vendor, but typically run about \$8 per cy for delivery up to a 20 mile radius.

Table 3. Average Local Retail Prices			
Material	Local Material Price¹ (\$/cy)	Hauling (\$/cy)²	Delivered Price (\$/cy)
Topsoil - Screened	20 – 25	8	28 - 33
Topsoil - (unscreened)	10 - 15	8	18 - 23
Fill Material	8 - 10	8	16 - 18
Sand (used to grade or mix with topsoil) ³	44 – 54	8	52 - 62

¹Price includes loading.

² Delivery distance of up to 20 miles.

³Sand is priced at \$34/ton. The number of tons in a cy of sand varies from 1.3 to 1.6 depending on density and water content of material.

The local market price for sand is relatively high because there are no sand quarries in or near the City of Charlottesville or Albemarle County. Sand is typically shipped from the surrounding areas, with some sand shipped from Richmond and Williamsburg, Virginia. The closest supplier of sand to the area is about 40 miles (one way) from the Reservoir. Locations for other wholesale sand suppliers range from 75-112 miles (one-way) from the Reservoir and therefore long distance hauling costs are incorporated into local sand prices. For example, wholesale sand prices from a quarry in Montross, Virginia, are about \$10-12 per ton (\$13 to \$19 per cy) of high quality mason or concrete sand and about \$7-8 per ton (\$9 to \$13 per cy) for lower quality road sand. The VDOT Culpeper District, which includes Charlottesville and Albemarle County, purchases road sand from the Montross quarry, almost 120 miles from the Reservoir.

6.2 Cost of Processing and Delivery of Dredged Material

Dredged material available for reuse will likely come either from a mechanical dewatering set-up or from a confined dike facility after dewatering is complete. Dredged material from a mechanical dewatering set-up will already be screened of debris and may also be separated into sand and remaining sediment.

The material will be moist but not wet, and can be readily handled and transported. If the material has been stockpiled for some time prior to reuse, further drying will occur.

Dredged material from a confined dike facility will contain whatever material passed through the dredge cutterhead and pipeline, including small pieces of woody and other organic debris, gravel, etc. The material will be relatively dry. The dredged material undergoes a natural separation by size of particle during the settling process – this can be enhanced by the design and layout of the confined dike facility. Sand and larger particles settle out first, followed by silts and clays. A well designed confined dike facility will provide natural separation of sandy material from other sediments. However, for some reuse purposes, additional screening may be required.

Screening soil: The need for and degree of screening required for dredged material will depend on the end use of the material. A coarse screening may be necessary to remove rocks and debris from sediment. A fine screening may be necessary to separate topsoil, gravel and sand. Fine screening would use a screen with smaller holes resulting in a costlier, more time consuming process. The screening process would cost approximately \$6 to \$9 per cy, depending on the extent of coarse or fine screening that is necessary (R.S. Means, 2009).

Loading of Truck: A front end loader with standard 5 cy bucket would be required to load dump trucks for hauling sediment to the reuse site. Depending on the conditions at the dewatering/storage site, either a wheel mounted or crawler mounted front-end loader or excavator would be used. The estimated cost for loading sediment using a front end loader would be \$9.35 per 5 cy (\$1.87 per cy) for a track mounted loader or \$25.50 per 5 cy (\$5.10 per cy) for a wheel mounted loader. Cost of loading one 16.5 cy dump truck would cost about \$30 for a track mounted loader and \$82 for a wheel mounted loader (R.S. Means, 2009).

Hauling Sediment: Transportation or hauling costs are directly affected by distance. Hauling costs can vary depending on amount being hauled, and rates are adjusted to reflect permitted speed on roads and total trip distance. A 16.5 cy dump truck and speed limit of 35 miles per hour was assumed for cost estimate purposes, and average cost of hauling per cy were derived from R. S. Means (2009).

Table 4 below shows the estimated delivered cost for dewatered dredged material, both screened and unscreened.

Table 4. Estimated Delivered Cost of Dredged Material for Reuse				
Delivery Distance (miles)	Screening (\$/cy)	Loading (\$/cy)	Hauling (\$/cy)	Delivered Cost (\$/cy)
4	6.00 – 9.00	1.87 – 5.10	4.05	11.92 – 18.15
4	unscreened	1.87 – 5.10	4.05	5.92 – 9.15
10	6.00 – 9.00	1.87 – 5.10	7.05	14.92 – 21.15
10	unscreened	1.87 – 5.10	7.05	8.92 – 12.15
15	6.00 – 9.00	1.87 – 5.10	9.05	16.92 – 23.15
15	unscreened	1.87 – 5.10	9.05	10.92 – 14.15
20	6.00 – 9.00	1.87 – 5.10	12.65	20.52 – 26.75
20	unscreened	1.87 – 5.10	12.65	14.52 – 17.75

6.3 Estimated Cost/Benefit of Reuse

HDR’s dredging and dewatering alternatives analyses (see respective reports) determined the most likely source for dredged material available for reuse would be the hydraulic dredging option with mechanical dewatering of sediment at the S. Connelly site just upriver of Reas Ford Road Bridge. This option could produce approximately 189,097 cy of sand and 101,227 cy of sediment. This material would be partially screened by the dewatering process, but may require additional drying and screening depending on the end use. For example, sand and possibly topsoil would likely require additional screening and processing to be competitive with local materials, whereas fill material would not. Further testing may also be required for some reuses – for example, use of the sediment material as structural fill or Airport fill would require further testing for compaction, and possibly some additional drying.

Tables 5a and **5b** provide cost comparisons between purchase and delivery of local materials and delivery of screened (**Table 5a**) and unscreened (**Table 5b**) dredged material produced by mechanical dewatering. A positive cost difference means the delivered cost for dredged material is less than the delivered price for local materials. A negative cost difference means the delivered cost of dredged materials for reuse is greater than the delivered price of local materials. Note the cost of dredging and dewatering the material from the Reservoir is not included in this analysis.

Table 5a. Cost Comparison Local Materials & Screened Dredged Material			
Delivery Distance (miles one way)	Local Materials Delivered Price (\$/cy)	Screened Dredged Material Delivered Cost (\$/cy)	Cost Difference¹ (\$/cy)
Topsoil (Screened)			
4	28.00 – 33.00	11.92 – 18.15	9.85 – 21.08
10	28.00 – 33.00	14.92 – 21.15	6.85 – 13.08
15	28.00 – 33.00	16.92 – 23.15	4.85 – 16.08
20	28.00 – 33.00	20.52 – 26.75	1.25 – 6.25
Fill			
4	16.00 – 18.00	11.92 – 18.15	(2.15) – 6.08
10	16.00 – 18.00	14.92 – 21.15	(5.15) – 3.08
15	16.00 – 18.00	16.92 – 23.15	(7.15) – 1.08
20	16.00 – 18.00	20.52 – 26.75	(10.75) – (2.52)
Sand			
4	52.00 – 62.00	11.92 – 18.15	33.85 – 50.08
10	52.00 – 62.00	14.92 – 21.15	30.85 – 47.08
15	52.00 – 62.00	16.92 – 23.15	28.85 – 45.08
20	52.00 – 62.00	20.52 – 26.75	25.25 – 41.48

¹ Negative cost difference is shown in (_).

Table 5b. Cost Comparison Local Materials & Unscreened Dredged Material			
Delivery Distance (miles one way)	Local Materials Delivered Price (\$/cy)	Unscreened Dredged Material Delivered Cost (\$/cy)	Cost Difference¹ (\$/cy)
Topsoil (Unscreened)			
4	10.00 – 15.00	5.92 – 9.15	0.85 – 9.08
10	10.00 – 15.00	8.92 – 12.15	(2.15) – 6.08
15	10.00 – 15.00	10.92 – 14.15	(4.15) – 4.08
20	10.00 – 15.00	14.52 – 17.75	(7.75) – 0.48
Fill			
4	16.00 – 18.00	5.92 – 9.15	6.85 – 12.08
10	16.00 – 18.00	8.92 – 12.15	3.85 – 9.08
15	16.00 – 18.00	10.92 – 14.15	1.85 – 7.08
20	16.00 – 18.00	14.52 – 17.75	(1.75) – 3.48
Sand			
4	52.00 – 62.00	5.92 – 9.15	42.85 – 56.08
10	52.00 – 62.00	8.92 – 12.15	39.85 – 53.08
15	52.00 – 62.00	10.92 – 14.15	37.85 – 51.08
20	52.00 – 62.00	14.52 – 17.75	34.25 – 47.48

¹ Negative cost difference is shown in (_).

The cost comparisons provided in **Tables 5a & 5b** indicates the dredged material, once mechanically dewatered, could be delivered at a favorable cost compared to retail costs for local topsoil material and sand. Depending on local market conditions at the time of reuse, some or all of the cost difference could potentially be used to off-set the costs of producing the material. Sand and possibly topsoil would likely require screening and processing to be competitive with local materials – therefore the cost comparisons provided in **Table 5a** for these materials is likely the most suitable. If the sediment produced by mechanical dewatering is used as fill, additional screening would likely not be required, and the cost comparison provided in **Table 5b** is likely the most suitable. If 189,097 cy of screened sand are produced and made available for reuse, the potential cost difference is \$4,774,699 to \$9,469,978, depending on distance for delivery. If the remaining 101,227 cy of material is screened and reused as topsoil, the potential cost difference is \$126,534 to \$2,133,865 – however, most topsoil on the retail market has been processed to include additional organic matter. The dredged sediments, although suitable for topsoil, may not be as commercially attractive and therefore the upper end of the cost difference is unlikely to be achieved. If the remaining 101,227 cy of material is reused as fill (without screening), the potential cost difference is (-\$177,147) to \$1,222,822. Where a negative cost difference exists, the dredged material is unlikely to be selected for reuse.

7.0 Permits for Reuse

All activity associated with loading and hauling dredged sediment for beneficial reuse will be in compliance with the existing Special Use Permit and/or Erosion and Sediment Control Plan and associated conditions put in place for approval of a dewatering/storage site by Albemarle County (see Dewatering Alternatives Report). The Special Use Permit would cover construction equipment accessing the parcel(s) to load and haul sediment, access across adjacent parcels to and from the dewatering/storage site to roads and necessary mitigation to rehabilitate the site. Conditions set forward in the Special Use Permit and Erosion and Sediment Control Plan for the dewatering site would also apply to Beneficial Reuse operations at the dewatering site including possible limits on hours of equipment use and trucking operation activity and avoidance of areas for resource protection (Albemarle County Planning Department, 2010).

Permits for the beneficial reuse of sediment outside of the dewatering/storage area would be the responsibility of the project proponent or end user. HDR assumes that any beneficial reuse of the dredged materials would not adversely affect regulated wetlands and waters, and therefore would not require federal or state permits beyond those obtained for the dredging and dewatering operations. Local permits may be required, particularly where the placement of dredged material is part of a land disturbing project. Local permit requirements will be project specific.

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Appendix A

Potential Uses for Dredged Material

Use Category	Identified Project	Agency/ Responsible Party	Timeline of Project
Agricultural/Product Uses/Engineered Use	Route 250 Bypass interchange: The City of Charlottesville is developing the design of an interchange for the future intersection of the U.S. 250 bypass, McIntire Road and the proposed McIntire Road Extended. This project currently includes preliminary engineering (design) only.	VDOT <u>Greg Krystyniak</u> 540-829-7785 Project Managed by Charlottesville’s Neighborhood Development Services Department. Charlottesville City contact is Angela Tucker, 434-970-3993	Proposed – no timeline identified on website.
Agricultural/Product Uses/Engineered Use	Bridge Replacement Rte 677 Over Buckingham Branch RR	VDOT	(PE in 2014)
Agricultural/Product Uses/Engineered Use	Bridge Replacement Rte 637 Over Ivy Creek	VDOT	(PE 2014)
Agricultural/Product Uses/Engineered Use	I-64 at Shadwell Interchange improvements (FY08-FY12)	VDOT with developer contribution	FY08-FY12
Agricultural/Product Uses/Engineered Use	Intersection improvement US 250 and Route 729 (N. Milton Road) – add turning lane (FY08-FY12)	VDOT	FY08-FY12 or FY13-FY17
Agricultural/Product Uses/Engineered Use	Bridge over railroad at Route 22 (design/construct)	VDOT	FY08-FY12
Agricultural/Product Uses/Engineered Use	Meadowcreek Parkway	VDOT	February 2009-October 2011
Environmental Enhancement	Rivanna River Greenway – natural heritage sites/trails (FY08-FY12)	City of Charlottesville	
Agricultural/Product Uses	Community Park – In conjunction with first phase of Rivanna Village at Glenmore development.	City of Charlottesville	Under review
Agricultural/Product Uses	Azalea Park (located at 304 Lynchburg Road) – could be used for baseball diamond reconfiguration, concession stand/restroom project, trails,	City of Charlottesville	In planning stage

Use Category	Identified Project	Agency/ Responsible Party	Timeline of Project
Agricultural/Product Uses	Village of Rivanna Development (located east of the City of Charlottesville and south of Route 250 East)	Albemarle County/Glenmore Associates	Under Review (as of 2007)
Engineered Use	Rivanna Commercial Park (Request for preliminary site plan approval for two buildings totaling 59,600 square feet.)	Northside Drive LLC, Marcia Joseph and Blake Hurt	Project is deferred
Engineered Use	For planning and development (list of approved planning applications -- 434-296-5832 or email Esther Grace	Albemarle County	On going
Agricultural/Product Uses/Engineered Use	East Pantops Complex: PROPOSED: Special use permit request for an athletic facility with soccer fields, tennis courts, basketball courts, and parking for the facility and for a proposed greenway trailhead.	Mike Harding, developer	Ongoing
Engineered Use	South Fork to Ragged Mountain pipeline	Albemarle County/ Rivanna Water and Sewer Authority	Planning stage
Environmental Use	Chesapeake Bay Implementation Grant Projects	Virginia Department of Conservation and Recreation	Applications for projects were due February 1, 2010 – therefore the list of projects is not available online yet.
Agricultural/Product Uses	Lithic Construction – construction company, awarded for green projects	http://lithicconstruction.com/news/	Ongoing
Agricultural/Product Uses	Windridge Landscape supply: serve residential property owners, commercial and institutional organizations, and the contracting community of central Virginia	Jeff Howe (434) 361-1588 jhowe@windridgelandscape.com http://windridgelandscape.com/	Ongoing projects