

Innovative Conservation Practices for Aquaculture Operations

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Executive Summary

The goals and objectives of this project were to install innovative aquaculture best management practices and educate the aquaculture industry of the technical and financial assistance available from soil and water conservation districts and the NRCS. The BMP's installed addressed nutrient and sediment transport to surface water as well as alternative water reuse strategies.

There were 5 participating landowners; 3 striped bass operations, 1 tilapia operation and 1 prawn operation. Each had unique water quality and quantity concerns as it related to the management of the specific species. Practices that were installed included water control structures, solid separation system, irrigation systems and waste storage ponds.

The grant was extended due to initial engineering and design delays on the tilapia waste system. Once these were issues were resolved, the project was implemented on time and for a fraction of the original estimated cost. Due to engineers from partnering agencies working together the implementation costs were reduced drastically, however there was not enough time or match to plan additional projects with the remaining grant funds.

Now that the first projects of this type have been implemented, the Division has a better understanding of design and installation concerns and estimated costs. This will assist in appropriate conservation planning on future sites. These projects will continue to be showcased and used as demonstration pilots for others to replicate. The data and experience gained while implementing these projects will also assist the division in the development of adequate training for field staff. The Division is continuing to promote conservation practices and technical assistance to the aquaculture industry.

Introduction

Project Objectives

The primary goal of this project was to implement innovative best management practices on aquaculture operations to address their water quality concerns. These bmp's will focus on removing sediments and nutrients through waste management. Although, not the priority, water reuse and aquifer recharge concerns were also considered during the implementation of this grant.

The Division of Soil and Water Conservation worked with local soil and water conservation districts (SWCDs) to target a particular niche of aquaculture producers. Because many of these producers are not familiar with SWCDs and conservation programs, a major objective of the outreach was to increase awareness of aquaculture best management practices (BMPs) and the availability of financial and technical assistance for implementing BMPs. The Division and partners described the practices, their applicability to a particular operation, the water quality benefits, the design standards, and the average cost of implementation at producer meetings.

Funding

The Conservation Innovation Grant funded 39% of the total cost of the project installation cost based on the approved average cost list or actual receipts. The remaining funds were provided through the Agriculture Cost Share Program, landowner contribution and division engineering and administration cost.

The Soil and Water Conservation Commission approves practices, average costs and county allocations for the Agriculture Cost Share Program (ACSP). The Commission approved the practices and costs for this project if components were not currently on the approved cost list. The Commission also established an Aquaculture BMP Workgroup of its Technical Review Committee to evaluate such practices and to recommend practices for inclusion in the Agriculture Cost Share Program. In the fall of 2006, the Solid Separation from Tank Based Aquaculture Production practice was included in the program. This is also referenced as the Geotube practice.

Following the pattern of the NC Agriculture Cost Share Program, this project required individual contracts to be signed with each participating aquaculture producer. The length of the contract was determined by the life expectancy of the BMP, usually 10 years. This requires the landowner to keep and maintain a practice through the contract length of 10 years. The participating SWCDs conduct annual spot checks on 25% of the installed BMPs through this project for the entire contract length. This checking system insures that the BMPs receiving cost share funds are functioning properly throughout their lifespan.

Background

There are 330 licensed aquaculture operations currently operating in North Carolina. Because of the unique landscape of our state we also have a wide variety of aquaculture species being produced, ranging from hybrid striped bass farms in the lowlands of the coastal plains to the trout farms in the mountain region. However, many other species such as catfish, tilapia, crawfish, eels, and sturgeon are located throughout North Carolina. Eighty-five of the 100 counties are host to such operations.

The farming landscape is changing from the historical tobacco fields in North Carolina to a more diverse operation. Aquaculture has played a vital role in providing a variety of opportunities for small farmers to diversify their operations. The aquaculture industry in North Carolina is growing rapidly. In 2005, North Carolina ranked second in the nation for trout sales, producing 4.5 million pounds. Catfish production has increased to approximately 2100 acres.

Thus far, federal and state regulations regarding water quality and aquaculture operations have been limited. One obstacle was the fact that there was limited technology and science available to implement the most effective management practices on these operations. However, research has yielded innovative new and adapted practices that farmers can apply to cost-effectively reduce the amount of water being discharged and reduce the particulate matter and nutrients from entering the surface water. The Division of Soil and Water Conservation (DSWC) and its partners feel confident that, through education and financial and technical assistance, locally led conservation will encourage voluntary adoption to improve water quality ahead of any regulatory requirements.

This project dealt primarily with the striped bass, tilapia and prawn operations. The water quality concerns that were addressed were decreasing the nutrients and particulate materials from being discharged from the farm. For the striped bass farmers in Beaufort County in particular have been operating under a Special Order of Consent (SOC) by the Division of Water Quality due to complaints of the status of nearby streams. The SOC's allow these farms to continue to operate however they must demonstrate management methods to decrease the water quality degradation. Although each species sector that would fall under the definition of aquaculture is not being regulated like the bass farms, they see the need to voluntarily implement management practices.

In addition to the water quality improvements, water quantity is also a concern for North Carolina. This grant created an avenue for some of these operations to recycle their water instead of releasing it. Continuing to provide engineering and technical support as well as cost share assistance will contribute in decreasing concerns with agriculture withdrawing groundwater from the aquifers.

Review of Methods

Many of the practices installed by this project have historically been implemented on more traditional agriculture operations, such as row crop, swine or poultry operations. The purposes of the practices are the same; however the innovative approach of how to incorporate them within an aquaculture landscape was more of a challenge. The following sections describe which practices were implemented or considered for this project and how they were integrated in the management of these operations.

Solid Separator – Dr. Tom Losordo and staff from NC State University designed a system for treating water from Tilapia operations, known as the Geotube system. The system removes solid waste from Tilapia operations and stores it in a geosynthetic tube that encourages dewatering of the waste. The dried waste matter could then be available for composting or land application.



Irrigation System – As a component of the complete waste management system installed on the tilapia operation, the irrigation system functioned as normal for any typical farming operation. Effluent from the waste storage pond is irrigated on row crops based on the water needs of the plant. This system hydrologically limited not nutrient limited, so application by agronomic rates is not necessary.

Additional irrigation options were explored however never implemented. Partnering agency staff had conversations with striped bass producers to see if irrigating existing forest area was an option to treat their effluent instead of discharging. This could have been a viable option however the SWCC policies required the landowner to treat all of the resource concern if receiving cost share funds. The landowners only wanted to pilot this option, treating only a portion of the effluent. The other concern was the amount of water that needed to be irrigated verses the shallow depth of the water table.

Waste Storage Pond – Prawn producers are able to utilize the waste storage pond practice to create a holding area for their effluent instead of discharging. As part of their harvest practice they must drain their ponds. However, they do not have the concerns like some of the other species regarding recycled water. Therefore, through this grant we were able to design and install a waste storage pond that enables the producer to create a cyclical harvest plan such that one pond is emptied as another is filled. In addition to water quality concerns, water conservation and aquifer depletion is an ongoing concern for this area of the state. This practice meets both the objectives of the program and the landowner.

The NC General Assembly provided the Division of Soil and Water Conservation funding to create the Agricultural Resource Assistance Program (AgWRAP). Unlike the Ag Cost Share Program, AgWRAP will focus on the water quantity issues facing the NC agricultural producers. This practice will be continued to be offered for the aquaculture producers as a mechanism to eliminate discharges and recycle available water.



Water Control Structures – Hybrid striped bass farmers are experiencing pressure from the NC Division of Water Quality and neighbors to find alternative ways to reduce nutrient, chlorophyll a and particulate discharges into the nutrient sensitive waters in the Tar-Pamlico River Basin. Water control structures are commonly employed in the coastal plain of North Carolina to control drainage and provide water quality protection for cropland. Water control structures can also be applied to increase retention time for aquaculture discharges to allow particulate matter and nutrients to settle out or denitrify prior to being released into the stream. This practice may

also hold the water long enough such that the farmers could recycle the discharged water back into their ponds.



Producers that installed the water control structures had to also modify the management of their discharge. Instead of releasing the water from their ponds quickly after harvest, the producers are releasing their water at a much slower rate. This will optimize the retention time for denitrification.

Schedule of Events

Below is a schedule of events that shows when practices were designed and installed as well as when outreach efforts were completed.

Soil and Water Conservation Commission adopted the <i>Solid Separation from Tank Based Aquaculture Production</i> practice into the Ag Cost Share Program	Fall 2006
Presentation at NC Aquaculture Conference <i>NC Ag Cost Share Program & Aquaculture</i>	February 2007
Met with NC Cooperative Extension regarding design of mortality composter for aquaculture	July 2007
Toured two striped bass farms with representatives from DENR, NRCS and NCDA.	February 2008
Presented Accomplishments of CIG Grant at the NRCS Interagency Meeting	April 2009
Water Control Structure Installed on Striped Bass Operation (Contract #07-2009-712) Met with NC Cooperative Extension, NC Department of Agriculture and Consumer Services and Edgecombe Soil and Water Conservation District regarding management and treatment of prawn effluents.	March 2010
Presented accomplishments and challenges to the Technical Review Committee. Entire committee and	May 2010

attendees toured Tilapia project in Pitt County while under construction	
<p>Waste Management System for Tilapia Operation Completed (included Geotube, Waste Storage Pond, and Irrigation)</p> <p>Water Control Structure Installed on Striped Bass Operation (Contract #07-2009-713)</p> <p>Area 5 District Issues meeting (15 counties represented) toured completed Tilapia project in Pitt County</p>	August 2010
<p>Water Control Structure Installed on Striped Bass Operation (Contract #07-2009-711)</p> <p>Water Control Structure Installed on Striped Bass Operation (Contract #07-2010-732)</p>	September 2010
Waste Storage Pond Installed for Prawn Operation	September 2011
<p>Ongoing efforts:</p> <p>Assisting in NC Association of SWCD Annual Meeting Breakout Session <i>Business Decisions and Customers</i> <i>Go Hand In Hand</i> Focusing on Diversifying services to Non-traditional agriculture sectors</p> <p>Presentation at NC Aquaculture Conference regarding Ag Water Resources Assistance Program</p>	<p>January 9th, 2012</p> <p>February 10th, 2012</p>

Challenges

The Division and partnering staff encountered many obstacles when implementing this project. The below sections explain the challenges faced and how each were overcome in order to meet the objectives of the project.

Standards and Specifications

The standards and specification for some of the practices utilized in this project became a challenge with design and estimating cost. Due to these concerns it was difficult for District staff to assist with the design or contracting with these initial projects because many of the decisions had to be determined by Professional Engineers. The best example of this would be the Waste Storage Pond practice when used in conjunction with the Geotube practice. These practices were installed on a Tilapia operation to replace an inadequate waste treatment system.

The current NRCS standard for a waste storage pond requires that no design be developed with less than 60 days storage volume without a detailed, site specific water and nutrient budget. The engineers were able to obtain sufficient waste water analysis provided by NC State University Fish Barn and approval from NC Division of Water Quality to allow the storage volume to be reduced to 30 days. Their results indicated that once the solids were removed by the solid separator there was approximately 1 pound of nitrogen available in the wastewater per month. Even though this system is not nutrient limiting, the NC Division of Water Quality still maintained that this was waste water and must follow the standards. Once this decision was made the pond design could be completed.

The material to line the bottom of the waste storage pond became a concern. It was recommended that a synthetic liner be used instead of a clay bottom. Due to many maintenance concerns by the landowner and by legal counsel regarding the required contract for installation, the soil and water conservation district staff began to seek out alternatives. It was determined that there was a clay source on the property but an analysis had to be completed to ensure it met the NRCS engineering requirements. The District staff was able to get an initial analysis complete by TERRACON Soils Engineering with no cost to the grant. Once the analysis was approved by NRCS Engineering staff construction of the waste storage pond was underway.

There was concern as to how to account for the rain water that would enter the system from the geotube and rock bed. The initial recommendation from NRCS was to design a wooden structure over the geotube. This structure alone would have cost approximately \$40,000, if built to meet standard. By the time a quote was received and additional engineering requirements were communicated, the contractor went out of business. However, through many discussions the engineers determined that it would be most cost effective to increase the storage volume of the waste storage pond to account for the rainwater. This design change saved approximately \$35,000 and did not change the integrity of the BMP.

The water control structures that were installed on the striped bass farms also required engineering assistance. Typically one would design the water control structure based on the watershed size. However, these operations were discharging large volumes of water a various times of the year. So the design for the structure had to ensure that water would not be placed on adjacent landowners and that the landowners would slow the rate in which the discharge would occur so that adequate treatment could occur.

It was a challenge making the current standards and specifications from NRCS and Division of Water Quality applicable to aquaculture operations. Budgeting projects and obtaining commitments from other landowners was difficult with the cost of installation fluctuating with the engineering changes. Flexibility was essential when estimating cost and adhering to an implementation schedule. Fortunately, our participating landowners were willing to work with the changes; ensuring a cost effective and efficient product that could be replicated to others in the industry.

Landowner Knowledge of Conservation Programs and Agencies

Many of the aquaculture farmers have not been exposed to the services available from Division of Soil and Water Conservation, the Soil and Water Conservation Districts, or the Natural Resource Conservation Service. Because of not knowing the dynamics of our agencies many of the aquaculture farmers shied away from participating in the opportunities offered. There were several interested but wanted to wait to see the BMP installed on someone else's farm first. So it was a challenge to find the farmer that was willing to set the example for the others. Also, some of the striped bass farmers had been scrutinized by the public and were being monitored by the Division of Water Quality. This posed a challenge to convince them that we offered voluntary programs and technical assistance, we were not regulatory.

Our outreach and education efforts will continue to inform landowners and agency staff of these non-traditional farming entities in their counties. The Division is committed to work with soil and water conservation districts and the aquaculture industry to promote awareness of the technical assistance services available to this sector of agriculture.

Defining Aquaculture

As we have learned aquaculture is a broad term that encompasses many types of operations such as flow through, tank based and pond operations. Within each type of operation there are several different species raised in NC and each has their own management plan to optimize production. Some of these management plans has a greater impact on water quality than others. If this project were started today, the recommendation would be to focus on one type of aquaculture operation or species at a time. Therefore, technical resources, training for landowners and field staff could be more targeted and defined.

Conclusions and Recommendations

The best management practices that were implemented by this project can easily be incorporated in Division cost share programs as well as federal programs. Most of the basic principles that has been implemented on traditional agriculture operations would apply to the aquaculture operations. However, the design criteria for certain practices is not always applicable. For example, the waste storage pond standards for NRCS and Division of Water Quality are designed based on high nutrient content. The tilapia effluent was determined to have approximately 1 pound of nitrogen available per month after being processed through the Geotube. It would be beneficial if additional considerations could be incorporated in policies such that field staff could easily reference them as technical assistance requests are received.

The Division is continuing to educate the aquaculture industry on the technical assistance available through the soil and water conservation districts and NRCS. The information we have learned through the practices installed by this project will assist in future planning. Design standards and cost estimates decreased dramatically from the original proposal due to re-engineering designs and working through the questions and concerns as they arose. This data and experience will provide assistance in determining adequate processes to provide such assistance through the NC Ag Cost Share Program and the Agriculture Water Resource Assistance Program, provide pilot projects for neighboring producers to visit, and develop adequate training for district field staff.

Appendices

SOLID WASTE CAPTURE FROM INTENSIVE TANK-BASED AQUACULTURE PRODUCTION USING GEOTEXTILE BAGS

Definition

A facility for the removal, storage and dewatering of solid waste from the effluent of intensive tank-based aquaculture production systems.

Purpose

To capture organic solids from the effluent stream of intensive fish production systems that would otherwise flow to effluent ponds for storage and further treatment. This waste comes from uneaten feed and feces generated by fish while being fed within a tank-or raceway based fish farm.

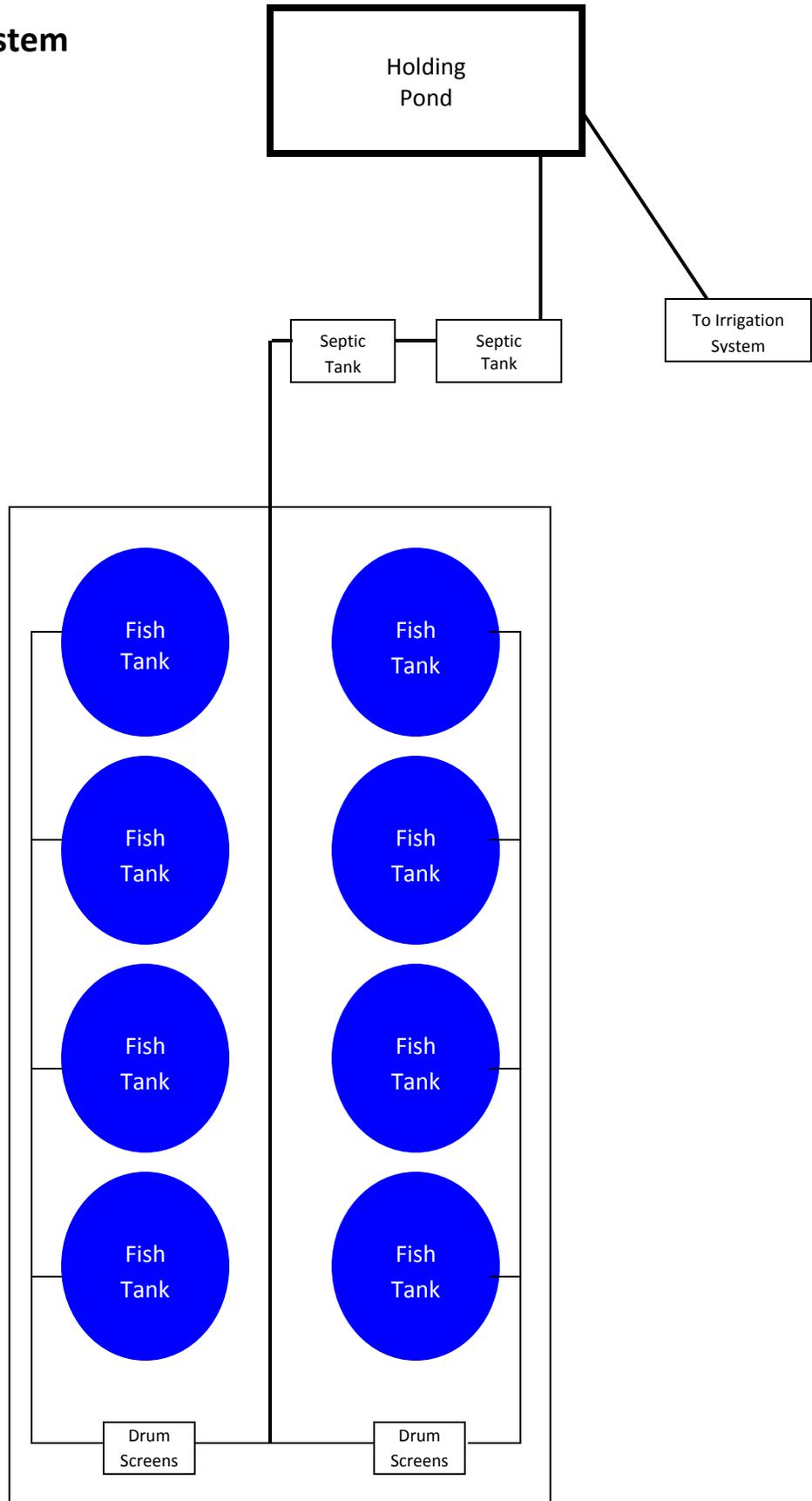
Policies

1. By signing the Cost Share Agreement (NC-ACSP-2), the cooperators and/or landowner acknowledges and agrees that they are responsible for the maintenance or replacement of all equipment cost shared as a component of waste management measure(s) at their expense and that any cost shared component will not be sold or used as collateral for the life of the practice must be included in the CPO.
2. Items for reimbursement under the maximum are all equipment, materials, construction, installation, vegetation, and pumps. A maximum of two 90' geotubes and a year supply of polymer per system will be eligible for reimbursement.
3. For all operations, cost share payments are limited to a \$15,000 lifetime cap.
4. Receipts must support reimbursable items.
5. Waste Management Plan Statement (NC-ACSP-WMP) is required
6. Cost share will not pay for any motorized vehicles used in transporting/applying waste.
7. BMP soil impact is not required. Include the amount of fresh manure in nitrogen and phosphorous units that will be generated and properly managed under the waste management system.
8. Minimum life of the BMP is 10 years.

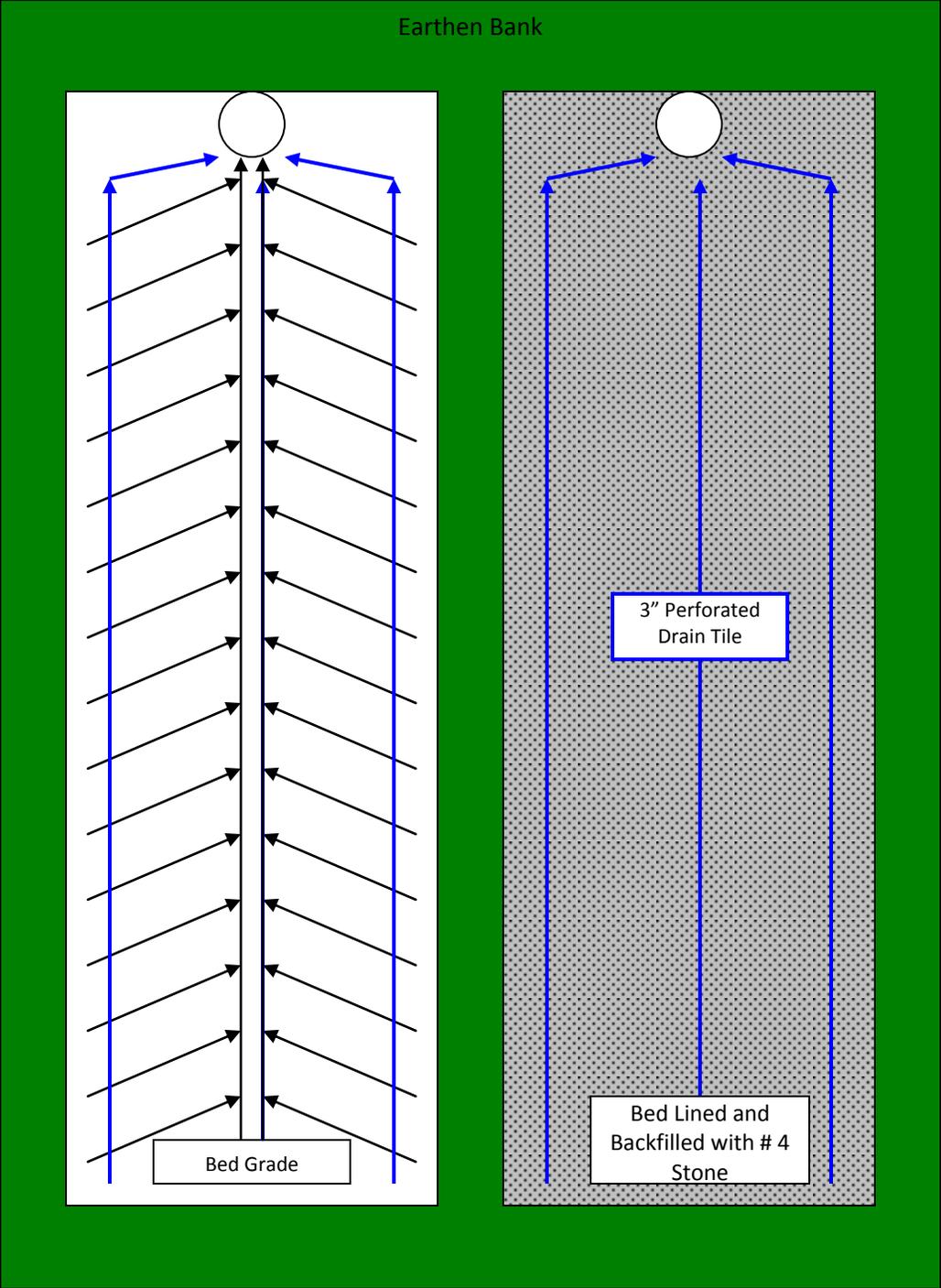
Specifications

N.C. NRCS Technical Guide, Section IV, Specifications #312 (Waste Management System); #633 (Waste Utilization)

Tilapia Waste System Original Design



Tilapia Waste System – Geotextile Bed Design



Tilapia Waste System - New Design

