July 2005
(Update of May 2004 Draft)

Cost and Returns Analysis of Manure Management Systems Evaluated in 2004 under the North Carolina Attorney General Agreements with Smithfield Foods, Premium Standard Farms, and Front Line Farmers

TECHNOLOGY REPORT:SUPER SOILS ON-FARM

Prepared as Part of the Full Economic Assessment of Alternative Swine Waste Management Systems Under the Agreement Between the North Carolina Attorney General and Smithfield Foods

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Summary of Results

Retrofit Cost per 1,000 pounds Steady State Live Weight per year: $399.71
Standardized Feeder-to-Finish Farm with 4,320 head (Tables SS.30- SS.45)
10-Year Amortization, Pit-Recharge, N limited Irrigation onto Forage

Includes:	Manure Evacuation and Lift Station:	$ 12.02 / 1,000 lbs. SSLW / Yr.
	Strainer:	$ 0.42 / 1,000 lbs. SSLW / Yr.
	Homogenization Tank:	$ 27.25 / 1,000 lbs. SSLW / Yr.
	Separation Building:	$ 19.67 / 1,000 lbs. SSLW / Yr.
	Solids Separator:	$119.87 / 1,000 lbs. SSLW / Yr.
	Observation Deck:	$ 4.13 / 1,000 lbs. SSLW / Yr.
	Denitrification Tank:	$ 17.69 / 1,000 lbs. SSLW / Yr.
	Nitrification Tank:	$ 81.15 / 1,000 lbs. SSLW / Yr.
	Settling Tank:	$ 16.59 / 1,000 lbs. SSLW / Yr.
	Clean Water Tank:	$ 8.36 / 1,000 lbs. SSLW / Yr.
	Phosphorus Removal Module:	$ 39.71 / 1,000 lbs. SSLW / Yr.
	Return to Barns:	$ 2.04 / 1,000 lbs. SSLW / Yr.
	Royalty Fees:	$ 20.74 / 1,000 lbs. SSLW / Yr.
	Increased Land Application Cost:	$ 30.06 / 1,000 lbs. SSLW / Yr.

Range:	Across Farm Sizes and Types (Pit-Recharge):	$305.96 To 1,838.92 / 1,000 lbs. SSLW / Yr.
	Across Farm Sizes and Types (Flush):	$333.64 To 2,074.99 / 1,000 lbs. SSLW / Yr.

Confidence in Estimates:

Medium

Based on 11 months evaluation, real commercial setting data for solids and liquids collection, electricity and polymer use, electricity and polymer prices, construction and operating performance and expense

Costs by Category:

Direct Construction:	$195.39 / 1,000 lbs. SSLW / Yr.
Contractor Overhead	$ 68.40 / 1,000 lbs. SSLW / Yr.
Total Operating:	$105.87 / 1,000 lbs. SSLW / Yr.
Increased Land Application Cost:	$ 30.06 / 1,000 lbs. SSLW / Yr.

Sensitivity Analysis

Effect of Expected Economic Life, Interest Rate, and Overhead Rate on Predicted Annualized Construction and Overhead Cost ($ / 1,000 lbs. SSLW)

Capital Recovery Factor (CRF)		Overhead Rate	
		20 %	43.1 %
Low-Cost Projection (15-year economic life, 6 % interest rate)	0.1030	$157.80	$183.13
Baseline Cost Projection (10-year economic life, 8 % interest rate)	0.1490	$227.12	**$263.78***
High-Cost Projection (7-year economic life, 10 % interest rate)	0.2054	$311.94	$362.47

* This predicted cost was estimated using the assumptions that are applied throughout the report—10-year economic life, 8 % interest rate, and 43.1 % overhead rate.

Effect of Electricity Price on Predicted Annual Operating Cost ($ / 1,000 lbs. SSLW)

Electricity Price ($ / kWh)	Predicted Annual Operating Cost ($ / 1,000 lbs. SSLW)
Low-Cost Electricity ($0.06 / kWh)	$100.35
Baseline Cost of Electricity ($0.08 / kWh)	**$105.87***
High-Cost Electricity ($0.10 / kWh)	$110.93

* This predicted cost was estimated using the assumption that is applied throughout the report--$0.08 / kWh.

The sensitivity of predicted costs and returns to a few critical assumptions is illustrated above by recalculating **annualized construction and overhead cost** with lower and higher values for amortization rate (cost recovery factor) and for overhead rate. The number in bold face $263.78 is the actual predicted 2004 construction and overhead cost for the Super Soils on-farm system on a 4,320 head feeder to finish farm with pit recharge and nitrogen limited land application to forage. Numbers are recalculated using two overhead rates: 20% and 43.1%, and three combinations of interest rate and maximum expected economic life: 15 year life and 6% interest rate, 10 year life and 8% interest rate, and 7 year life and 10% interest rate. The range of selected parameter values has a significant effect on the predicted value of annual construction and overhead costs.

Similarly, predicted **annual operating costs** of the Super Soils on-farm system are recalculated using higher and lower prices for electricity. The 25% increase or decrease in electricity price has a moderate effect on the predicted annual cost per unit reflecting moderate use of electricity by the biofilter system.

Note that the sensitivity analysis is not intended to propose alternative costs and returns estimates. It is solely intended to illustrate the sensitivity of the results to changes in parameter values.

Break-even Analysis on By-product Prices

Breakeven analysis is conducted for systems that produce potentially marketable by-products in order to determine the by-product price required to cover the cost of the system. The Super Soils on-farm system produces separated solids and recovered phosphorus as well as liquid effluent. Breakeven analysis is conducted for the separated solids and the recovered phosphorus.

Break-even Analysis on Separated Solids: 4,320 Head Feeder to Finish Farm

Cost to be Recovered	($ / 1,000 lbs. SSLW / Year)	Breakeven Price @ 5.696 wet tons / 1,000 lbs. SSLW per Year*
		($ / wet ton)
Cost of lift station, strainer, homogenization tank, building, solid separator, installation and operation	$179.23	$31.46
Cost of solids separation plus liquid treatment and phosphorus recovery excluding solids land application	$351.32	$61.68

* Calculated based on separation of 6,643,396 pounds per year of wet solids @ 80% moisture.

Break-even Analysis on Recovered Phosphorus: 4,320 Head Feeder to Finish Farm

Cost to be Recovered	($ / 1,000 lbs. SSLW/Year)	Breakeven Price @ 15.75 dry lbs. / 1,000 lbs. SSLW per Year*
		($ / pound)
Cost of phosphorus removal module	$39.71	$2.52
Cost of Super Soils on-farm system	$399.71	$25.37

* Calculated based on 2,568 pounds of phosphorus plus 6,622 pounds of calcium recovered per year derived from the treated effluent and the additives applied in the phosphorus removal module.

The tables above present partial and total breakeven prices. The first row of numbers in each table presents the breakeven price of the additional technology necessary to produce the by-product (e.g. the solids separation system to produce separated solids or the phosphorus recovery module to recover phosphorus and calcium). The bottom line in each table is the price necessary to offset the incremental cost of the entire retrofitted manure management system.

To be economically viable, by-product prices must at least exceed their cost of production. Based on known markets, it does not appear that either solids separation or phosphorus recovery can produce sufficient revenue or savings to offset their cost. However, since they are part of a larger system that includes off-farm treatment of solids and since the solids removal is necessary to limit costs of liquid treatment, they are included in the systems analyzed here.

If more than one by-product is produced and they each generate revenue or savings greater than their cost, a set of breakeven prices for the total system can be calculated by assigning a fraction of the remaining cost to each by-product. For example, if separated solids and recovered phosphorus and calcium both generate revenue higher than their costs, then the remaining costs of the system (liquid treatment) could be assigned in some proportion (e.g. 90% to solids and 10% to phosphorus and calcium) and breakeven prices for each could be calculated. The resulting breakeven prices for each would be less than the bottom line estimates in the analysis above.

1. Overview of the Super Soil Systems Technology

1.1. Experimental Site Overview

This candidate technology, constructed and operated by Super Soil Systems USA, has an on-farm and off-farm component. The full-scale demonstration facility for on-farm treatment of swine manure is located on Goshen Ridge Farm at Duplin County. The separated solids from Goshen Ridge Farm receive further treatment at the off-farm solids treatment site located near Clinton, NC. Super Soil Systems also provided solids for the HSAD/ORBIT technology.

The Goshen Ridge Farm consists of three sites each containing a lagoon and 6 feeder–to-finish barns. The barn effluent from one site (six houses) is treated by the Super Soil Systems technology. The houses are naturally ventilated and equipped with fully slatted floors. Each house contains two shallow pits that are emptied once a week (Campbell, Worley-Davis). In total, the Super Soil Systems technology is treating manure from barns with capacity for 4,320 feeder-to-finisher pigs or 583,200 lbs. of SSLW.[1]

Prior to the construction of the Super Soil System, USA technology, all of the Goshen Ridge Farm swine manure was treated with three single-stage lagoons, each being 420' x 260' at the bank top. Each lagoon served a total of six houses. The total lagoon volume reported at maximum liquid level is 8,127,825 gallons (Worley-Davis).

This report only includes the on-farm component. It is assumed here that all separated solids and liquids produced by the technology are land applied. The solids processing component will be analyzed in a separate report to be released in late 2005. See the previous section on breakeven analysis for discussion of the effects on cost and returns estimates of shipping solids off the farm.

1.2. Technology Overview

The Super Soil Systems on-farm component uses polymer-enhanced liquid-solid separation, nitrification/denitrification, and soluble phosphorus removal modules to treat swine manure.

During the reporting period from March, 2003 to January, 2004, the pits in six barns were emptied and recharged once a week (typically half on Monday and half on Thursday) at the Goshen Ridge site. The effluent from the pits was pumped to a homogenization tank and kept well-mixed until solids separation occurred. The original estimate of pit volumes indicated that approximately 40,000 gallons of recycled liquid was required to recharge each pit (Worley-Davis).[2] Adding the manure, urine and excess water, Goshen

[1] Based on 135 lbs. of SSLW per head.

[2] Each house has two pits. There are six houses on the experimental site. The total volume needed for recharging is equal to 80,000 gallons / week / barn or 480,000 gallons / week / farm. The pits are recharged

Ridge Farm barn effluent would have measured approximately 76,000 gallons per day before the Super Soil Systems technology was installed. During the period from March 2003 to April 2004 the average inventory in the six barns on the Super Soil Systems experimental site was 3,437 animals (Vanotti). During the same period, the average daily volume of effluent from the six barns equaled 10,300 gallons / day which is substantially lower than the volume before the technology was installed. According to the SF and PSF estimates (as reported in Appendix A), average effluent volume for a 3,437-head finishing operation is approximately 22,500 gallons / day.

An estimate of the expected amount of manure, urine, and excess water produced by 3,437 feeder-to-finish pigs (7,905 gallons / day) can be obtained by multiplying the average inventory by the NRCS manure, urine, and excess water estimate. The implied volume used for recharging during the experiment can be calculated by subtracting the volume of manure, urine, and excess water from the total volume of barn effluent reported:

(1) Daily Volume used for Recharging = Average Daily Effluent Volume – Manure, Urine, and Excess Water Produced =10,300 – 7,905 = 2,395 gallons / day
(Note that this equation assumes that the volume of liquid evaporated in the barn is equal to the volume of effluent added by spilled and excreted solids.)

Differences in estimates of barn effluent and recycled liquid used for recharging suggest that a dramatic change in farm management practices occurred when the new technology was installed. The sharp reduction in pit recharge volume (e.g., 2,395 gallons per day versus 2 x 40,000 gallons per day) lowers the projected construction and operating cost of the technology, but also may have an impact on the environment inside the barns. The accumulation of undiluted manure in the shallow pits over a week could conceivably adversely affect air quality in the house and in air leaving the house. The cost model presented later in this document uses the reported experimental average barn effluent volume of 10,300 gallons / day to model the technology as actually built on the site (Tables SS.14–SS.29). All standardized models use the standard average barn effluent volume based on the estimate obtained from SF and PSF and published sources (Appendix A, Table A.5). The effect of assumed effluent volume is discussed in the summary.

Liquid effluent from the solids separation module is lifted into the nitrification/denitrification module. Effluent from the nitrification/denitrification tank is sent to a clean water storage tank and subsequently used to recharge the barn pits. Excess nitrification/denitrification tank effluent (not needed for pit recharging) gravity flows into the phosphorus removal module. Treated effluent from the phosphorus removal module is used to irrigate crops after first being stored in an existing lagoon. Separated solids were removed daily from the farm via trailers and transported to the solids processing

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once per week. Super Soil Systems measurements show that the pit volume is much lower (approximately 20,000 gallons / pit). Using the Super Soil Systems estimate, the total volume of effluent from each barn is approximately 50% of the Worley-Davis estimate.

facility or the HSAD treatment site. Separated solids from the phosphorus removal unit were dried on a concrete pad before being removed monthly from the farm in bags.

The Super Soil Systems on-farm treatment can be divided into the following unit processes:

(1) Lift Station and Manure Evacuation
(2) Strainer
(3) Homogenization Tank
(4) Solids Separation
(5) Tank 1: Denitrification
(6) Tank 2: Nitrification
(7) Tank 3: Denitrifcation
(8) Tank 4: Oxidation Tank
(9) Tank 5: Settling Tank
(10) Tank 6: Reservoir Tank
(11) Phosphorus Removal
(12) Clean Water Reservoir after Phosphorus Treatment (former Lagoon)
(13) Storage for Solids (Two trailers)
(14) Building and Shelters

The lift station at the site was designed to accommodate approximately 8,000 gallons of effluent at a time. Two 5-HP pumps were installed to move the effluent from the lift station to the homogenization tank. It is estimated that each pump is capable of pumping approximately 250 gallons/minute. Compared to lift stations built at other experimental sites, the Super Soil System lift station has similar components but its volume is larger.[3] The strainer is included in the system to capture hog hair and other larger objects that could clog pipes and damage the solids separator and the nitrification/denitrification (Biogreen) module. Solids separation uses polyacrylamides as a flocculating agent to enhance separation of solids from liquids in the swine manure. This reaction occurs in the main module, using a self-cleaning rotating screen to separate the solids. A dissolved air flotation unit (DAF) aids solids separation from the liquid effluent while a filter press is used to dewater the solids. Upon being dewatered, the solids fall to a trailer and are subsequently transported to the central processing plant in Sampson County or HSAD site. Upon removal of solids, the liquid still contains suspended organic material that must be treated via a nitrification/denitrification process. The Super Soils technology uses a Biogreen process to biologically remove the soluble ammonia in the liquid. The liquid is first sent to a denitrification tank to remove the nitrate using the manure's organic carbon (COD). Liquid next travels to a nitrification tank where polymer gel pellets are used to aid in the nitrification process. Liquid then flows to a second denitrification tank that used methanol injections to further reduce nitrate levels. From the second denitrification tank, the effluent temporarily resides in an oxic tank before moving on to a settling tank and ultimately an effluent storage tank. From the storage tank ("clean water tank"), the effluent is recycled for pit-recharging or gravity flows to the phosphorus removal module for further treatment.

[3] A typical lift station for a pit-recharge system is designed to hold 4,000 gallons of discharge.

In the phosphorus removal module, phosphorus is recovered in the form of calcium phosphate and pathogens are destroyed using an alkaline pH. Effluent is mixed with hydrated lime (linked to a pH controller) in a reaction chamber. Then, the mixture travels to a settling tank where the liquid and precipitate are separated. The precipitated calcium phosphate sludge is further dewatered (aided by the addition of a polymer) in filter bags holding about 50 pounds. Cleaned liquid is pumped to a nearby subsurface crop irrigation system.

The solids separation module became fully operational on March 1, 2003. On April 1, 2003, the nitrification/denitrification module became operational, followed finally by the phosphorus removal module on April 15, 2003. From that date forward, the Super Soils technology was continuously operated until January 15, 2004. Table SS.1 shows the amount of flushed manure that was being treated by the Super Soils technology during its 11-month operational evaluation period. Over the duration of this period, a total of 3.34 million gallons of flushed manure was processed (10,300 gallons per day). It also shows the number of pigs (the facility had a capacity of 4,400) and the weight of the pigs (1,000 lbs. SSLW) for every month in the evaluation period.

As indicated in the draft of the technology final report (Vanotti), the nitrification/denitrification module (Biogreen) was operated in three distinct configurations:

(1) Five-tank configuration with methanol injection
(2) Five-tank configuration without methanol injection
(3) Three-tank configuration with a by-pass of denitrification tank 2 and oxic tank

According to the report and e-mail communications with Dr. Vanotti, the three-tank nitrogen removal module performed optimally under the variety of treatment conditions and the average ammonia-nitrogen and nitrate contained in the treated effluent increased only slightly. The three-tank configuration was evaluated in all models presented later in this document.

2. Costs of the Super Soils Technology as Constructed at the Goshen Ridge Farms Demonstrational Facility (Tables SS.2-SS.12)

2.1 Invoiced Costs at Goshen Ridge Farms (Tables SS.2, SS.4-SS.11)

Table SS.2 shows the electrical power requirements necessary to operate the Super Soils technology as constructed at Goshen Ridge Farms including all components. The system uses an estimated 466.22 kilowatt-hours (kWh) of electricity per day, resulting in a daily operating cost of $37.30 (assuming $0.08 / kWh).[4] Annually, the cost of operating the Super Soils technology amounts to an estimated $13,622.95.

[4] The estimate is based on a conversion formula from horse power (HP) to kilowatt-hours (kWh) assuming 88 % motor and pump efficiency.

The second column of Tables SS.4-SS.9 shows the detailed invoiced cost summaries associated with the Super Soils technology unit processes. Specifically, the six unit processes described in these tables are: manure evacuation (Table SS.4), treated water return (Table SS.5), solids removal (Table SS.6), Biogreen nitrification/denitrification (Table SS.7), phosphorus removal (Table SS.8), and irrigation storage (Table SS.9). Tables SS.4-SS.9 separate the Super Soils technology's unit processes into individual cost components. For example, the Biogreen cost table (Table SS.7) shows the invoiced cost subtotals of the denitrification tank #1, nitrification tank, denitrification tank #2, oxic tank, settling tank, and clean water tank. These subtotals are then aggregated to provide a total for the unit process. Table SS.10 shows the general expenses associated with the Super Soils project. These include such costs as general design costs and an observation deck for overseeing the technology. The costs presented in the second column of Tables SS.4-SS.10 are actual (invoiced) costs, and represent the Super Soils technology as it was originally designed and constructed at Goshen Ridge Farms. Table SS.11 summarizes the total invoiced costs of the Super Soils technology by unit process. In total, the Super Soils technology has an invoiced cost of $1,041,621.98. The majority of Super Soils' costs (~84 %) in Table SS.11 are borne by its three main modules—solids removal, nitrification/denitrification, and phosphorus removal.

2.2 Modified Costs at Goshen Ridge Farms (Tables SS.3-SS.10, SS.12)

Table SS.3 shows the electrical power requirements necessary to operate the modified Super Soils technology. Because some motorized components were deemed unnecessary, the modified Super Soils technology required an estimated 425.30 kWh of electricity per day. Again assuming a rate of $0.08 / kWh, the modified technology would cost an estimated $34.02 to operate daily and $12,427.27 to operate annually. The third column in Tables SS.4-SS.10 summarizes the modified costs associated with the Super Soils technology. Generally, cost modifications are justified reductions associated with unnecessary expenses or unit processes. Appendix SS.A gives a complete list of Super Soils technology costs that have been modified or eliminated. Appendix SS.A was compiled by the technology provider and all modifications found in Appendix SS.A were agreed upon in a meeting between the technology provider and the modeling team with assistance from Cavanaugh and Associates. While invoiced costs (column 2 of Tables SS.4-SS.10) include all costs borne by the technology provider, modified costs only include those costs that were deemed necessary to construct and operate the technology. In the case of the Super Soils technology, components such as the second denitrification tank, the oxic tank, and the dissolved air floatation (DAF) unit were determined unnecessary upon operating and evaluating the system for a few months. Performance data have shown that the inclusion of the second denitrification tank and the oxic tank will result in only small changes in Super Soil's removal efficiency of ammonia-N. With the complete five-tank system, 97.9 % of ammonia-N was removed. With a three-tank system (minus the second denitrification tank and the oxic tank), the Super Soils technology removed 96.3 % the ammonia-N (Vanotti). Supported by the above results, the costs for these unit processes were eliminated. Other expenses such as relocation costs and costs associated with lightning damage have been eliminated in the modified cost tables. Again, the complete and detailed list of cost modifications is provided in

Appendix SS.A. Column 4 in Tables SS.4-SS.10 shows the item number in Appendix SS.A that corresponds to the modified cost shown in column 3 of these tables. For components that have the same invoiced and modified cost, there is no corresponding Appendix SS.A item number. For each component with a cost reduction, an item number in Appendix SS.A is documented to explain the cost modification.

Table SS.12 provides an analogue to Table SS.11. Instead of Table SS.11's invoice costs summary, Table SS.12 summarizes the modified costs associated with the Super Soils technology. In total, the modified Super Soils technology has a cost of $756,193.14—a 27.4 % reduction in cost from the invoiced total detailed in Table SS.11. As in Table SS.11, Super Soils' three primary modules (solids removal, nitrification/denitrification, phosphorus removal) are the bulk of the technology's total modified costs (82 %). Solids removal has replaced nitrification/denitrification (Biogreen) as the most costly unit process. This is because of Super Soils' decision to convert the Biogreen process from a 5-tank design to a 3-tank design via the removal of the second denitrification tank and the oxic tank.

2.3 Royalty Fees (Table SS.13)

Table SS.13 shows the royalty fees that are associated with this technology. Royalty fees are determined by production unit (e.g., sow or head capacity) and reported in Table SS.13 on an annual basis. Royalty fees are specified by the technology provider.

3. Cost Modeling (Tables SS.14-SS.93)

3.1 Introduction

Original invoice costs were reported detailing the construction costs of the Super Soils technology as it was built on the Goshen Ridge facility. These costs are reported by unit process in Tables SS.4-SS.10 (second column) and summarized in total in Table SS.11, where the original Super Soils technology costs summed to $1,041,621.98. Modified construction costs were also determined based on meetings between the technology providers and the economic modeling team. The modified costs are reported by unit process in Tables SS.4-SS.10 (third column) and summarized in Table SS.12. In the next step, the economic modeling team took the data reported in Tables SS.4-SS.10 and examined them for missing components and outdated prices. By doing so, the modeling team created a complete estimate of the construction cost. This estimate is intended to approximate adjusted invoiced cost that can be compared to those for other technologies analyzed under the Agreement. These approximated invoiced costs are summarized in Tables SS.14-SS.29. In the next step, estimates of costs that would occur on standard (representative) North Carolina farms were calculated. These costs are presented in Tables SS.30-SS.45 for a 4,320-head feeder-to-finish facility using a pit-recharge system of manure removal. Tables SS.46-SS.61 present the costs associated with a standard North Carolina feeder-to-finish operation with a head capacity of 4,320 using a flush system of waste removal. A representative NC 8,800-head feeder-to-finish facility with a

pit-recharge manure removal system is reported in Tables SS.62-SS.77. The final standard NC farm described in these cost tables is a 4,000-sow farrow-to-wean operation using a pit-recharge system of manure removal. Tables SS.78-SS.93 list the costs associated with using the Super Soils technology at this representative facility.

3.2 Estimated Adjusted Invoice Costs for Super Soils Technology at Goshen Ridge Farms (Tables SS.14-SS.29)

Table SS.14 provides the necessary assumptions (3,726-head finishing facility with pit-recharge system) for the cost estimate calculation and also summarizes annualized costs by land application scenario (nitrogen-based application to forages, nitrogen-based application to row crops, phosphorus-based application to forages, and phosphorus-based application to row crops).[5] Annualized costs for the whole farm and per 1,000 lbs. of SSLW (incremental cost) are reported. Table SS.14 presents incremental costs for each of the four land application scenarios range from $409.47 (phosphorus-based application to row crops) to $557.30 (phosphorus-based application to forages). Land application to forages is more costly than to row crops with the Super Soils technology. Tables SS.15-SS.26 summarize costs associated with individual unit processes of the Super Soils technology. Specifically, costs are reported for the following unit processes: manure evacuation and lift station (SS.15), strainer (SS.16), homogenization tank (SS.17), separation building (SS.18), solids separator (SS.19), observation deck (SS.20), denitrification tank (SS.21), nitrification tank (SS.22), settling tank (SS.23), clean water tank (SS.24), phosphorus removal module (SS.25), and return to barns (SS.26). Table SS.26 also reports the total costs associated with the unit processes listed above. Total construction costs are reported as $994,162.45, while operating costs are estimated as $48,475.03. The total annualized cost of the Super Soils technology before land application is estimated to be $198,708.47 for the 3,726-head feeder-to-finish facility at Goshen Ridge. Tables SS.27 (lagoon effluent) and SS.28 (solids) report land application costs associated with the Super Soils technology. Used in conjunction with the numbers reported at the end of Table SS.26, the total annualized and incremental cost estimates can be calculated. These numbers are reported in Table SS.14 for each of the four scenarios of land application. Table SS.29 details the mass balance of nutrients associated with the Super Soils technology. This table is necessary to derive the numbers found in Tables SS.27 and SS.28.

3.3 Standardized Costs for Super Soils Technology at a 4,320-Head Feeder-to-Finish Farm (Pit-Recharge System) (Tables SS.30-SS.45)

Tables SS.30- SS.45 provide estimates of the cost of constructing and operating the Super Soils technology on a standard (representative) North Carolina farm. The representative farm reported in this section is a 4,320-head feeder-to-finish facility using a pit-recharge system for waste removal. Table SS.30 provides total annualized and per unit ($ / 1,000 lbs. SSLW) costs for retrofitting the farm with standardized Super Soils technology. The standardized incremental costs range from $378.39 (nitrogen-based application to row

[5] For more on land application, see Appendix B.

crops) to $530.46 (phosphorus-based application to forages), with an average incremental cost of $423.84 per 1,000 lbs. SSLW per year across the four land application scenarios. In the standardized Super Soils model (as in the model estimating actual Super Soils costs), forages are more costly than row crops to land apply. Also, phosphorus-based land application is more costly than nitrogen-based land application in the standardized model. Tables SS.31-SS.42 are similar to Tables SS.15-SS.26. They report standardized costs for the same unit processes as listed in the above section (in the same order). Within certain unit processes (e.g., manure evacuation and lift station), there might be differences in individual components between the actual and standardized models. In these cases, the technology as it was constructed at Goshen Ridge was not indicative of how it would be constructed on a representative NC farm. Table SS.42 summarizes the total costs associated with the standardized Super Soils technology for a 4,320-head finishing facility with a pit-recharge system. Total construction costs are estimated at $1,025,643.92, while total operating costs are reported as $61,742.55. Total annualized costs before land application are estimated at $215,580.26 for this representative farm size and type. Tables SS.43 (lagoon effluent) and SS.44 (solids) summarize the land application costs associated with the standardized model for each of four scenarios. Table SS.45 provides an estimated mass balance of nutrients for this representative NC farm.

3.4 Standardized Costs for Super Soils Technology at a 4,320-Head Feeder-to-Finish Farm (Flush System) (Tables SS.46-SS.61)

Tables SS.46- SS.61 provide estimates of the cost of constructing and operating the Super Soils technology on a standard (representative) North Carolina 4,320-head feeder-to-finish facility using a flush system for manure removal. The only difference between the standard farm chosen to estimate the numbers in Tables SS.46-SS.61 versus the one chosen to estimate the numbers in Tables SS.30-SS.45 is the type of manure removal system used. Table SS.46 also provides total annualized and per unit ($ / 1,000 lbs. SSLW) costs for the standardized Super Soils technology. The standardized incremental costs of retrofitting the farm with the Super Soils system range from $492.42 (nitrogen-based application to row crops) to $644.60 (phosphorus-based application to forages), with an average incremental cost across the four scenarios of $537.96 per 1,000 lbs. SSLW per year. Forages are more costly than row crops for land application and phosphorus-based applications are more costly than nitrogen-based applications. The use of the flush system of manure removal increases average incremental cost estimates by about 27 % for a 4,320-head finishing facility as compared to using a pit-recharge system on the same facility. Tables SS.47-SS.58 detail the costs of individual unit processes in this standardized model. The set of unit processes and components are identical to those in Tables SS.31-SS.42, while some of the costs change between the two sets of tables. Table SS.58 also summarizes the total costs associated with the standardized Super Soils technology for a 4,320-head finishing facility with a flush system. Total construction costs are estimated at $1,382,864.73, while total operating costs are reported as $75,068.65. Total annualized costs before land application are estimated at $282,142.80 for this representative farm size and type. Tables SS.59 (lagoon effluent) and SS.60 (solids) summarize the land application costs associated with this standardized model for

each of four scenarios. Table SS.61 provides an estimated mass balance of nutrients for the representative farm modeled in these tables.

3.5 Standardized Costs for Super Soils Technology at an 8,800-Head Feeder-to-Finish Farm (Tables SS.62-SS.77)

Tables SS.62- SS.77 provide estimates of the cost of constructing and operating the Super Soils technology on a standard (representative) North Carolina 8,800-head feeder-to-finish facility using a pit-recharge system for manure removal. Table SS.62 provides total annualized and per unit ($ / 1,000 lbs. SSLW) costs for retrofitting a farm with the standardized Super Soils technology. The standardized incremental costs for the 8,800-head finishing facility range from $314.05 (nitrogen-based application to row crops) to $464.01 (phosphorus-based application to forages), with an average incremental cost of $358.40 per 1,000 lbs. SSLW per year across the four scenarios. This average incremental cost is about 15 % less than that of a standardized 4,320-head finishing facility with a pit-recharge system. Based on this finding, the model suggests that economies of scale are present for the Super Soils technology. Tables SS.63-SS.74 provide details of the costs of individual unit processes in this standardized model. The set of unit processes and components are identical to those in Tables SS.31-SS.42 and SS.47-SS.58 although some of the costs change between the sets of tables. Table SS.74 also summarizes the total costs associated with the standardized Super Soils technology for an 8,800-head finishing facility. Total construction costs are estimated at $1,712,410.11, while total operating costs are reported as $107,119.37. Total annualized costs before land application are estimated at $364,038.44 for this representative farm size and type. While these total construction costs are higher than in the standardized 4,320-head model, the costs per unit are lower. That is because the 8,800-head facility contains 1,188,000 pounds of steady-state live weight (SSLW) as compared to the 583,200 pounds of SSLW housed in the 4,320-head facility. Tables SS.75 (lagoon effluent) and SS.76 (solids) summarize the land application costs associated with this standardized model for each of four scenarios. Table SS.77 provides an estimated mass balance of nutrients for the representative farm modeled in these tables.

3.6 Standardized Costs for Super Soils Technology at a 4,000-Sow Farrow-to-Wean Farm (Tables SS.78-SS.93)

Tables SS.78- SS.93 provide estimates of the cost of constructing and operating the Super Soils technology on a standard (representative) North Carolina 4,000-sow farrow-to-wean operation using a pit-recharge system for manure removal. This representative farm contains 1,732,000 pounds of SSLW: the largest of any standard farm modeled for the Super Soils technology. Table SS.78 also provides total annualized and per unit ($ / 1,000 lbs. SSLW) costs for the standardized Super Soils technology. The standardized incremental costs range from $350.06 (nitrogen-based application to row crops) to $419.46 (phosphorus-based application to forages), with an average incremental cost of $369.91 per 1,000 lbs. SSLW per year across the four scenarios of land application. Forages were estimated as being more costly than row crops for land application and phosphorus-based applications were again modeled to be more costly than nitrogen-based

applications. These differences between application types were less pronounced for the standard farrow-to-wean facility than for the standard feeder-to-finish facilities, however. Tables SS.79-SS.90 provide details of the costs of individual unit processes in this standardized model. Table SS.90 summarizes the total costs of the standardized Super Soils technology for a 4,000-sow farrow-to-wean operation. Total construction costs are estimated at $2,725,786.36, while total operating costs are reported as $203,216.97. Total annualized costs before land application are estimated at $611,158.98 for this representative farm size and type. Tables SS.91 (lagoon effluent) and SS.92 (solids) summarize the land application costs associated with this standardized model for each of four scenarios. Table SS.93 provides an estimated mass balance of nutrients for the 4,000-sow farrow-to-wean operation modeled for the Super Soils technology.

3.7 Extrapolation to Other Farm Types and Sizes (Tables SS.94-SS.95)

Table SS.94 summarizes the per unit incremental costs ($ / 1,000 lbs. SSLW) of retrofitting the Super Soils technology onto each of the 25 size of farm / type of operation combinations. This table uses the representative farm size for a permitted North Carolina farm within a size / type combination. Incremental costs are shown for both pit-recharge and flush systems and Table SS.94's costs assume a nitrogen-based land application to forages is utilized. Table SS.95 is analogous to Table SS.94, but uses Smithfield Foods/Premium Standard Farms (SF/PSF) representative farm sizes and farm types only. Incremental costs are again shown for both pit-recharge and flush systems. As in Table SS.94, the costs in Table SS.95 assume that a nitrogen-based land application to forages is chosen. Tables SS.94 and SS.95 illustrate that predicted incremental costs decrease as the size of the farm increases. Within their farm size categories, wean-to-feeder operations are clearly the most expensive types of farms on which to construct and operate the Super Soils technology (on a $ / 1,000 lbs. SSLW / year basis). It is also apparent in Tables SS.94 and SS.95 that flush systems of manure removal are more costly than pit-recharge systems for any size of farm/type of operation category.

4. Summary and Conclusions

The on-farm portion of the Super Soils System technology was installed on an existing feeder to finish farm named Goshen Ridge. The original design included 14 components (listed in section 1.2 of this report). After experimentation, several components were deemed unnecessary and dropped from the recommended system. The experimental system treated effluent from six pit-recharge feeder-to-finish buildings with capacity for 4,320 pigs or 583,200 pounds SSLW. During the 11-month evaluation period (March, 2003 through January, 2004), the average inventory in the buildings was reported as 3,437 pigs. Tables SS.4 through SS.12 compare the retrofit installation costs of the original system with the modified system and show cost dropping from $1,041,621.98 to $756,193.14. One remarkable feature of the Super Soils System evaluation was that total barn effluent volume was reported at 10,300 gallons per day versus an expected 22,500 gallons per day that our standardized model predicts for an inventory of 3,437 finishing pigs. The reported effluent volume was used for modeling costs and returns of the actual

modified system (Tables SS.14 – SS.29) while standardized effluent volume was used for the standardized models (Tables SS.30 – SS.95) to allow comparison to other systems. The issue of how much effluent volume can be reduced and what productivity and environmental effects can be expected has been raised by several technology providers. The approximated cost of retrofitting the farm with the actual modified system was $994,162.45 in initial investment, $198,708.47 in annualized costs excluding land application costs, and total costs of $425.99 per 1,000 pounds SSLW per year when effluent is applied on a nitrogen basis to forage. Note that the Super Soils System is effective at separating solids and solids are assumed to be land applied in these models. As is the case for all technologies, overall costs of the system may fall should an outlet develop for separated solids that is less costly than land application. Excluding land application costs, the actual modified Super Soils System cost $395.04 per 1,000 pounds SSLW per year.

The standardized model produces a cost estimate of $399.71 per 1,000 pounds SSLW per year for the 4,320-head feeder to finish farm with pit-recharge and nitrogen-based land application using rates on forage. Economies of scale are evident in that predicted costs range from $305.96 (for the largest feeder-to-finish farm) to $2,074.99 (for a small wean-to-feeder farm) per 1,000 pounds SSLW per year.

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Tables SS.1 through SS.13: Actual Pig Inventory and Barn Effluent Volume at Goshen Ridge Farm, Estimated Electricity Use for Original and Modified Super Soils Systems, and Comparisons by Unit Process of Construction Costs for Original (Invoiced) and Modified Super Soils Systems

Table SS.1. Total Animal Weight and Amount of Flushed Manure Treated During the Super Soils Evaluation Period

Month	Number of Pigs	Total Weight (1,000 lbs. SSLW)	Flushed Manure (gallons / day)
March '03	3,978	454	8,100
April '03	3,975	697	8,600
May '03	3,441	764	9,600
June '03	978	270	9,500
July '03	2,787	191	11,400
August '03	4,115	436	11,900
September '03	4,015	671	14,600
October '03	3,749	805	12,700
November '03	2,831	328	8,800
December '03	4,120	410	9,500
January '04	3,814	520	9,000

Table SS.2. Original Super Soils Estimated Electric Power Requirements

Unit Process / Component	Motorized Component	HP (hp)	Power[1] (kw)	Capacity	Run-time (hrs. / day)	Daily power requirement (kWh / day)
Lift station	Lift station pump	5.00	4.25	100.0 %	0.32	1.36
Lift station	Lift station pump	5.00	4.25	100.0 %	0.32	1.36
					Lift station subtotal	**2.72**
Return to barns	Clean water pump	0.75	0.64	100.0 %	0.42	0.27
					Return to barns subtotal	**0.27**
Homogenization tank	Screen motor	0.75	0.64	100.0 %	5.97	3.82
Homogenization tank	Main module feeder	1.00	0.85	100.0 %	16.26	13.82
Homogenization tank	Homogenization tank mixer	2.99	2.54	100.0 %	23.13	58.82
					Homogenization tank subtotal	**76.46**
Solids separator	Polymer mixer	0.34	0.29	100.0 %	22.38	6.47
Solids separator	Main module	0.75	0.64	50.0 %	16.34	5.21
Solids separator	Polymer heater	0.41	0.35	100.0 %	22.39	7.81
Solids separator	Polymer heater	0.41	0.35	100.0 %	22.39	7.81
Solids separator	Polymer mixer	0.34	0.29	100.0 %	22.38	6.47
Solids separator	Polymer mixer	0.34	0.29	100.0 %	22.38	6.47
Solids separator	Polymer dosing	0.24	0.20	50.0 %	3.78	0.39
Solids separator	Filter drum	1.00	0.85	30.0 %	18.30	4.67
Solids separator	Reacting chamber agitator	1.00	0.85	40.0 %	18.88	6.42
Solids separator	Main module anti-foam	0.14	0.12	100.0 %	22.38	2.66
Solids separator	Belt filter motor	2.04	1.73	100.0 %	4.53	7.86
Solids separator	Belt filter pump	2.04	1.73	100.0 %	1.25	2.16
Solids separator	Effluent pump	1.63	1.39	100.0 %	4.71	6.55
Solids separator	DAF press pump	1.00	0.85	100.0 %	16.00	13.60
Solids separator	DAF self-clean	0.68	0.58	100.0 %	16.39	9.48
					Solids separator subtotal	**94.78**
Denitrification tank #1	DN1 mixer	2.04	1.73	100.0 %	23.00	39.79
					Denitrification tank #1 subtotal	**39.79**
Nitrification tank	BIOGREEN recirculating pump	4.08	3.47	25.0 %	23.14	20.07
Nitrification tank	BIOGREEN anti-foam	0.14	0.12	100.0 %	23.22	2.76
Nitrification tank	BIOGREEN blower	20.40	17.35	40.0 %	22.77	158.02
					Nitrification tank subtotal	**180.85**
Denitrification tank #2	DN2 mixer	2.04	1.73	100.0 %	23.22	40.17
					Denitrification tank #2 subtotal	**40.17**
Settling tank	Sludge retention pump	0.75	0.64	25.0 %	22.85	3.64
Settling tank	Scum return pump	2.04	1.73	100.0 %	1.00	1.73
					Settling tank subtotal	**5.37**
Phosphorus removal	Phosphorus reacting agitator	1.00	0.85	100.0 %	20.50	17.43
Phosphorus removal	Lime dosing	0.14	0.12	100.0 %	1.92	0.23
Phosphorus removal	Phos. removal polymer dosing	0.14	0.12	100.0 %	1.60	0.19
Phosphorus removal	Draimad feeding	0.75	0.64	100.0 %	1.60	1.02
Phosphorus removal	Lime mixer	0.34	0.29	100.0 %	24.00	6.94
					Phosphorus removal subtotal	**25.81**
					Total kWh / day	**466.22**
					Daily operating costs	**$37.30***
					Annual operating costs	**$13,622.95***

1. kw requirements are calculated as HP x 0.746 kw / HP x 1.14 motor efficiency adjustment.

* Operating costs calculations based on a rate of $0.08 / kWh

Table SS.3. Modified Super Soils Estimated Electric Power Requirements

Unit Process / Component	Motorized Component	HP (hp)	Power (kw)	Capacity	Run-time (hrs. / day)	Daily power requirement (kWh / day)
Lift station	Lift station pump	5.00	4.25	100.0 %	0.32	1.36
Lift station	Lift station pump	5.00	4.25	100.0 %	0.32	1.36
					Lift station subtotal	**2.72**
Return to barns	Clean water pump	0.75	0.64	100.0 %	0.42	0.27
					Return to barns subtotal	**0.27**
Homogenization tank	Screen motor	0.75	0.64	100.0 %	5.97	3.82
Homogenization tank	Main module feeder	1.00	0.85	100.0 %	16.26	13.82
Homogenization tank	Homogenization tank mixer	2.99	2.54	100.0 %	23.13	58.82
					Homogenization tank subtotal	**76.46**
Solids separator	Polymer mixer	0.34	0.29	100.0 %	22.38	6.47
Solids separator	Main module	0.75	0.64	50.0 %	16.34	5.21
Solids separator	Polymer heater	0.41	0.35	100.0 %	22.39	7.81
Solids separator	Polymer heater	0.41	0.35	100.0 %	22.39	7.81
Solids separator	Polymer mixer	0.34	0.29	100.0 %	22.38	6.47
Solids separator	Polymer mixer	0.34	0.29	100.0 %	22.38	6.47
Solids separator	Polymer dosing	0.24	0.20	50.0 %	3.78	0.39
Solids separator	Filter drum	1.00	0.85	30.0 %	18.30	4.67
Solids separator	Reacting chamber agitator	1.00	0.85	40.0 %	18.88	6.42
Solids separator	Main module anti-foam	0.14	0.12	100.0 %	22.38	2.66
Solids separator	Belt filter motor	2.04	1.73	100.0 %	4.53	7.86
Solids separator	Belt filter pump	2.04	1.73	100.0 %	1.25	2.16
Solids separator	Effluent pump	1.63	1.39	100.0 %	4.71	6.55
Solids separator	DAF press pump	1.00	0.85	100.0 %	16.00	13.60
Solids separator	DAF self-clean	0.68	0.58	100.0 %	16.39	9.48
					Solids separator subtotal	**94.03**
Denitrification tank #1	DN1 mixer	2.04	1.73	100.0 %	23.00	39.79
					Denitrification tank #1 subtotal	**39.79**
Nitrification tank	BIOGREEN recirculating pump	4.08	3.47	25.0 %	23.14	20.07
Nitrification tank	BIOGREEN anti-foam	0.14	0.12	100.0 %	23.22	2.76
Nitrification tank	BIOGREEN blower	20.40	17.35	40.0 %	22.77	158.02
					Nitrification tank subtotal	**180.85**
Settling tank	Sludge retention pump	0.75	0.64	25.0 %	22.85	3.64
Settling tank	Scum return pump	2.04	1.73	100.0 %	1.00	1.73
					Settling tank subtotal	**5.37**
Phosphorus removal	Phosphorus reacting agitator	1.00	0.85	100.0 %	20.50	17.43
Phosphorus removal	Lime dosing	0.14	0.12	100.0 %	1.92	0.23
Phosphorus removal	Phos. removal polymer dosing	0.14	0.12	100.0 %	1.60	0.19
Phosphorus removal	Draimad feeding	0.75	0.64	100.0 %	1.60	1.02
Phosphorus removal	Lime mixer	0.34	0.29	100.0 %	24.00	6.94
					Phosphorus removal subtotal	**25.81**
					Total kWh / day	**425.30**
					Daily operating costs	**$34.02***
					Annual operating costs	**$12,427.27***

* Operating costs calculations based on a rate of $0.08 / kWh

Table SS.4. Super Soils Technology Manure Evacuation Costs Summary

Project Component	Invoiced Cost	Modified Cost	Corresponding item # in Appendix SS.A
Barn modification			
Blocks/brixment	$668.40	-	2
Block labor	$960.00	-	2
Pipe/fittings	$4,272.31	$4,000.00	2
Sure-mix sealant	$94.61	-	2
Stone base	$370.38	$370.38	-
Concrete slabs	$660.00	-	2
Labor (pipe/pits)	$3,750.00	$3,000.00	2
Subtotal	**$10,775.70**	**$7,370.38**	
Strainer			
Pit	$140.00	$140.00	-
Purchase price of strainer	$250.00	$250.00	-
Pipe/fittings	$140.05	$140.05	-
Labor	$500.00	$500.00	-
Subtotal	**$1,030.05**	**$1,030.05**	
Lift station			
Evacuation tank	$14,730.00	$8,730.00	3
Pipe/fittings	$4,272.31	$4,272.31	-
Electrical panel	$1,565.38	$1,065.38	7
Lift pumps	$7,635.75	$7,635.75	-
Stone base	$370.38	$370.38	-
Crane rental	$900.00	$900.00	-
Labor (tank/pipe)	$5,275.00	$2,275.00	5
Labor (electrical)	$4,580.00	$3,080.00	6
Electrical materials	$2,877.60	$1,377.60	4
Subtotal	**$42,206.42**	**$29,706.42**	**-**
Manure Evacuation Costs Total	**$54,012.17**	**$38,106.85**	**-**

Table SS.5. Super Soils Technology Treated Water Return Costs Summary

Project Component	Invoiced Cost	Modified Cost	Corresponding item # in Appendix SS.A
Materials			
General	-	-	-
Mechanical	$601.14	$226.14	8
Electrical	$1,619.85	$1,619.85	-
Subtotal	**$2,220.99**	**$1,845.99**	**-**
Labor			
General	$500.00	$500.00	-
Mechanical	$1,250.00	$875.00	8
Electrical	$1,414.00	$1,414.00	-
Subtotal	**$3,164.00**	**$2,789.00**	**-**
Treated Water Return Costs Total	**$5,384.99**	**$4,634.99**	**-**

Table SS.6. Super Soils Technology Solids Removal Costs Summary

Project Component	Invoiced Cost	Modified Cost	Corresponding item # in Appendix SS.A
Homogenization tank			
Purchase price of tank	$19,612.00	$19,612.00	-
Mixer and controls	$5,680.00	$5,680.00	-
Screen	$10,000.00	$10,000.00	-
Labor (general)	$1,300.31	$1,300.31	-
Labor (mechanical)	$1,749.38	$1,749.38	-
Labor (electrical)	$9,686.81	$6,186.81	1,17
Materials and equipment	$15,609.70	$12,109.70	1,17
Subtotal	**$63,638.20**	**$56,638.20**	**-**
Separation building			
Materials (general)	$14,272.18	$8,772.18	33
Labor (general)	$22,934.69	$17,434.69	33
Crane	$1,650.00	$1,650.00	-
Steel structure	$11,666.00	$11,666.00	-
Steel stair	$2,500.00	$2,500.00	-
Labor (mechanical)	$1,058.60	$1,058.60	-
Labor (electrical)	$5,751.25	$3,251.25	17
Materials and equipment	$6,132.09	$3,632.09	17
Subtotal	**$65,964.81**	**$49,964.81**	**-**
Solids separation			
Main module	$130,000.00	$130,000.00	-
Dehydration system	$20,500.00	$20,500.00	-
Support belt filter	$1,900.00	$1,900.00	-
Shipping	$7,634.38	$7,634.38	-
Labor (mechanical)	$5,361.02	$3,311.02	9,10,25
Labor (electrical)	$29,125.94	$14,490.94	11,17,23,25
Materials and equipment	$31,054.65	$8,239.65	9,10,11,16,17,25
Subtotal	**$225,575.99**	**$186,075.99**	**-**
Solids Removal Costs Total	**$355,179.00**	**$292,679.00**	**-**

Table SS.7. Super Soils Technology Biogreen Costs Summary

Project Component	Invoiced Cost	Modified Cost	Corresponding item in Appendix SS.A
Denitrification tank #1			
Purchase price of tank	$15,945.00	$15,945.00	-
Mixer	$4,750.00	$4,750.00	-
Mixer controls	$700.00	$700.00	-
Materials and equipment	$16,947.56	$9,956.56	1,14,17,30
Labor	$12,736.50	$2,125.48	1,14,17,21,30
Probes/meters	$3,586.26	-	16,18,21
Subtotal	**$54,665.33**	**$33,477.04**	**-**
Nitrification tank			
Purchase price of tank	$11,687.00	$11,687.00	-
Screen housing	$5,861.27	$5,861.27	-
Screen	$1,701.74	$1,701.74	-
Diffusers	$1,979.37	$1,979.37	-
Tank floor	$560.00	$560.00	-
BIO-N cubes/engineering	$95,900.00	$95,900.00	-
Cranes	$2,025.00	$2,025.00	-
Materials and equipment	$16,947.56	$9,456.56	13,14,17,30
Labor	$18,421.50	$7,053.09	13,14,17,20,23,30
Probes/meters	$3,586.26	-	16,19,20
Subtotal	**$158,669.71**	**$136,224.03**	**-**
Denitrification tank #2			
Purchase price of tank	$11,529.00	-	31
Mixer	$4,430.00	-	31
Mixer controls	$700.00	-	31
Materials and equipment	$16,947.56	-	31
Labor	$12,736.50	-	31
Probes/meters	$3,586.26	-	31
Subtotal	**$49,929.33**	**$0.00**	**-**
Oxic tank			
Purchase price of tank	$5,544.00	-	32
Diffusers	$414.29	-	32
Materials and equipment	$16,947.56	-	32
Labor	$12,736.50	-	32
Probes/meters	$3,586.26	-	32
Subtotal	**$39,228.62**	**$0.00**	**-**
Settling tank			
Purchase price of tank	$31,863.62	$31,863.62	-
Sludge pit	$695.00	-	27
Crane	$600.00	$600.00	-
Materials and equipment	$17,087.18	$9,626.18	14,17,27,28,30
Labor	$13,800.40	$3,589.38	14,21,27,28,30
Probes/meters	$3,586.26	-	21,27
Subtotal	**$67,632.47**	**$45,679.18**	**-**
Cleanwater tank			
Purchase price of tank	$14,402.00	$14,402.00	-
Materials and equipment	$5,649.19	$4,649.19	17
Labor	$4,245.50	$1,338.15	22
Probes/meters	$1,195.42	-	21,22
Subtotal	**$25,492.11**	**$20,389.34**	**-**
Biogreen Costs Total	**$395,617.55**	**$235,769.59**	**-**

Table SS.8. Super Soils Technology Phosphorus Removal Module Costs Summary

Project Component	Invoiced Cost	Modified Cost	Corresponding item # in Appendix SS.A
Settling tank	$15,694.00	$15,694.00	-
Draimad system	$11,519.00	$11,519.00	-
Polymer preparatory	$5,935.00	$5,935.00	-
Polymer mixer	$564.00	$564.00	-
Shipping	$1,197.62	$1,197.62	-
Materials			
General	$961.56	$961.56	-
Mechanical	$5,000.00	$3,750.00	29
Electrical	$45,391.09	$29,780.09	14,17,24
Subtotal	**$51,352.65**	**$34,491.65**	**-**
Labor			
General	$10,565.00	$10,565.00	-
Mechanical	$4,125.00	$3,500.00	29
Electrical	$21,198.00	$5,073.00	14,17,24,29
Subtotal	**$35,888.00**	**$19,138.00**	**-**
Phosphorus Removal Costs Total	**$122,150.27**	**$88,539.27**	**-**

Table SS.9. Super Soils Technology Irrigation Storage Costs Summary

Project Component	Invoiced Cost	Modified Cost	Corresponding item # in Appendix SS.A
Storage tank	$7,215.00	$7,215.00	-
Crane rental	$300.00	$300.00	-
Tank move	$2,430.00	$2,430.00	-
Materials			
General	$718.36	$718.36	-
Mechanical	$120.00	$120.00	-
Electrical	$0.00	$0.00	-
Subtotal	**$838.36**	**$838.36**	**-**
Labor			
General	$800.00	$800.00	-
Mechanical	$500.00	$500.00	-
Electrical	$0.00	$0.00	-
Subtotal	**$1,300.00**	**$1,300.00**	**-**
Irrigation Storage Costs Total	**$12,083.36**	**$12,083.36**	**-**

Table SS.10. Super Soils Technology General Expenses Summary

Project Component	Invoiced Cost	Modified Cost	Corresponding item # in Appendix SS.A
Design	$62,000.00	$62,000.00	-
Site preparation	$11,766.00	$11,766.00	-
Miscellaneous	$12,814.56	-	35
Observation deck	$10,614.08	$10,614.08	-
General Expenses Total	**$97,194.64**	**$84,380.08**	**-**

Table SS.11. Super Soils Technology Total Invoiced Costs Summary

Project Component	Cost	% of Total Cost
Manure evacuation	$54,012.17	5.19 %
Treated water return	$5,384.99	0.52 %
Solids removal	$355,179.00	34.10 %
Biogreen	$395,617.55	37.98 %
Phosphorus removal	$122,150.27	11.72 %
Irrigation storage	$12,083.36	1.16 %
Design	$62,000.00	5.95 %
Site preparation	$11,766.00	1.13 %
Miscellaneous	$12,814.56	1.23 %
Observation deck	$10,614.08	1.02 %
Super Soils Total Costs	**$1,041,621.98**	**100.00 %**

Table SS.12. Super Soils Technology Total Modified Costs Summary

Project Component	Cost	% of Total Cost
Manure evacuation	$38,106.85	5.04 %
Treated water return	$4,634.99	0.61 %
Solids removal	$292,679.00	38.70 %
Biogreen	$235,769.59	31.18 %
Phosphorus removal	$88,539.27	11.71 %
Irrigation storage	$12,083.36	1.60 %
Design	$62,000.00	8.20 %
Site preparation	$11,766.00	1.56 %
Observation deck	$10,614.08	1.40 %
Super Soils Total Costs	**$756,193.14**	**100.00 %**

Table SS.13. Super Soils Technology Royalty Fees

Farm Type	Average Live Weight (SSLW) (lbs.)	Unit	Annual Royalty Fee / Unit
Farrow-wean	433	sow	$9.00
Farrow-feeder	522	sow	$10.95
Farrow-finish	1,417	sow	$29.60
Wean-finish	30	head capacity	$0.65
Feeder-finish	135	head capacity	$2.80

Tables SS.14 through SS.29: Costs and Returns Estimates Based on Actual Cost and Performance Data for Super Soils On-Farm System: 3,726-Head Feeder to Finish Operation with Pit-Recharge

Table SS.14. Super Soils Technology Assumptions and Total Annualized Costs—Actual Costs and Performance Data

Number of Animals	**3,726**		
Type of Operation	**Feeder-Finish**		
Barn Cleaning System	**Pit-Recharge System**		
Annualized Cost ($ / Year)			
Total Annualized Cost		Forages	Row Crops
	If Nitrogen-Based Application	**$ 214,277.86**	**$ 207,114.07**
	If Phosphorus-Based Application	**$ 280,325.74**	**$ 205,965.34**
Per Unit Cost ($ / 1,000 lbs. of SSLW)			
Total Annualized Cost per Unit		Forages	Row Crops
	If Nitrogen-Based Application	**$ 425.99**	**$ 411.75**
	If Phosphorus-Based Application	**$ 557.30**	**$ 409.47**

Note: Daily volume discharged from barns is 10,336 gallons / day including recharge liquid.
SSLW equals 503,010 pounds.

Table SS.15. Super Soils Technology Manure Evacuation and Lift Station Costs—Actual Costs and Performance Data

Component	Total Cost	Annualized Cost
Manure Evacuation		
Pipes/Fittings	$ 4,000.00	$ 596.12
Stone Base	$ 370.38	$ 55.20
Labor (Pipes/Fittings/Pits)	$ 3,000.00	$ 447.09
Lift Station		
Evacuation Tank	$ 8,730.00	$ 1,301.03
Pipe/Fittings	$ 4,272.31	$ 636.70
Electric Panel	$ 1,065.38	$ 158.77
Lift Pumps	$ 7,635.75	$ 2,751.53
Stone Base	$ 370.38	$ 55.20
Crane Rental	$ 900.00	$ 134.13
Labor (Tank/Pipe)	$ 2,275.00	$ 339.04
Labor (Electrical)	$ 3,080.00	$ 459.01
Electrical Materials	$ 1,377.60	$ 205.30
Contractor & Engineering Services & Overhead	$ 15,980.10	$ 2,381.51
Total Construction Cost	$ 53,056.90	$ 9,061.61
Electric Power Cost		$ 79.48
Maintenance Cost		$ 895.47
Property Taxes		$ 188.35
Total Operating Costs		$ 1,163.30
TOTAL ANNUALIZED COST OF MANURE EVACUATION AND LIFT STATION		**$ 10,224.91**

Table SS.16. Super Soils Technology Strainer Costs—Actual Costs and Performance Data

Component	Total Cost	Annualized Cost
Pit	$ 140.00	$ 20.86
Strainer	$ 250.00	$ 37.26
Fittings/Pipe	$ 140.05	$ 20.87
Labor	$ 500.00	$ 74.51
Contractor & Engineering Services & Overhead	$ 443.95	$ 66.16
Total Construction Cost	$ 1,474.00	$ 219.67
Maintenance Cost		$ 20.60
Property Taxes		$ 5.23
Total Operating Cost		$ 25.83
TOTAL ANNUALIZED COST OF STRAINER		**$ 245.50**

Table SS.17. Super Soils Technology Homogenization Tank Costs—Actual Costs and Performance Data

Component	Total Cost	Annualized Cost
Tank	$ 34,045.00	$ 5,073.71
Mixer & Controls	$ 5,680.00	$ 846.49
Screen	$ 10,000.00	$ 1,490.29
Materials & Equipment	$ 12,109.70	$ 1,804.70
Labor-General	$ 1,300.31	$ 193.78
Labor-Mechanical	$ 1,749.38	$ 260.71
Labor-Electrical	$ 6,186.81	$ 922.02
Contractor & Engineering Services & Overhead	$ 15,958.29	$ 2,378.26
Total Construction Cost		$ 12,969.96
Electric Power Cost		$ 2,234.16
Maintenance Cost		$ 1,236.69
Property Taxes		$ 308.95
Total Operating Cost		$ 3,779.81
TOTAL ANNUALIZED COST OF HOMOGENIZATION TANK		**$ 16,749.77**

Table SS.18. Super Soils Technology Separation Building Costs—Actual Costs and Performance Data

Component	Total Cost	Annualized Cost
Materials-General	$ 8,772.18	$ 1,307.31
Materials & Equipment	$ 5,282.09	$ 787.19
Labor-General	$ 17,434.69	$ 2,598.28
Steel Structure	$ 11,666.00	$ 1,738.58
Steel Stair	$ 2,500.00	$ 372.57
Labor-Mechanical	$ 1,058.60	$ 157.76
Labor-Electrical	$ 3,251.25	$ 484.53
Contractor & Engineering Services & Overhead	$ 21,534.83	$ 3,209.32
Total Construction Cost	$ 71,499.64	$ 10,655.55
Maintenance Cost		$ 564.41
Property Taxes		$ 253.82
Total Operating Cost		$ 818.23
TOTAL ANNUALIZED COST OF SEPARATION BUILDING		**$ 11,473.78**

Table SS.19. Super Soils Technology Solids Separator Costs—Actual Costs and Performance Data

Component	Total Cost	Annualized Cost
Storage	$ 10,000.00	$ 1,490.29
Main Module	$ 130,000.00	$ 19,373.83
Dehydration System	$ 20,500.00	$ 3,055.10
Support Belt Filter	$ 1,900.00	$ 283.16
Materials & Equipment	$ 8,239.65	$ 1,227.95
Shipping	$ 7,634.38	$ 1,137.75
Labor-Mechanical	$ 3,311.02	$ 493.44
Labor-Electrical	$ 14,490.94	$ 2,159.58
Contractor & Engineering Services & Overhead	$ 84,508.75	$ 12,594.30
Total Construction Cost	$ 280,584.74	$ 41,815.40
Electric Power Cost		$ 2,747.56
Polymer Cost		$ 5,945.98
Maintenance Cost		$ 8,031.98
Property Taxes		$ 996.08
Total Operating Cost		$ 17,721.59
TOTAL ANNUALIZED COST OF SOLIDS SEPARATOR		**$ 59,536.99**

Table SS.20. Super Soils Technology Observation Deck Costs—Actual Costs and Performance Data

Component	Total Cost	Annualized Cost
Material-General	$ 874.17	$ 130.28
Steel	$ 3,804.91	$ 567.04
Labor	$ 5,935.00	$ 884.49
Contractor & Engineering Services & Overhead	$ 4,574.67	$ 681.76
Total Construction Cost	$ 15,188.75	$ 2,263.57
Maintenance Cost		$ 93.58
Property Taxes		$ 53.92
Total Operating Cost		$ 147.50
TOTAL ANNUALIZED COST OF OBSERVATION DECK		**$ 2,411.07**

Table SS.21. Super Soils Technology Denitrification Tank Costs—Actual Costs and Performance Data

Component	Total Cost	Annualized Cost
Tank	$ 28,236.00	$ 4,208.00
Mixer	$ 4,750.00	$ 707.89
Mixer Controls	$ 700.00	$ 104.32
Material & Equipment	$ 9,956.56	$ 1,483.82
Labor	$ 2,125.48	$ 316.76
Probes/Meters	$ -	$ -
Contractor & Engineering Services & Overhead	$ 7,556.31	$ 1,126.11
Total Construction Cost	$ 53,324.35	$ 7,946.90
Electric Power Cost		$ 1,162.66
Maintenance Cost		$ 872.85
Property Taxes		$ 189.30
Total Operating Cost		$ 2,224.82
TOTAL ANNUALIZED COST OF DENITRIFICATION TANK		**$ 10,171.72**

Table SS.22. Super Soils Nitrification Tank Costs—Actual Costs and Performance Data

Component	Total Cost	Annualized Cost
Tank	$ 16,406.00	$ 2,444.98
Screen Housing	$ 5,861.27	$ 873.50
Screen	$ 1,701.74	$ 253.61
Diffusers	$ 1,979.37	$ 294.98
Tank Floor	$ 560.00	$ 83.46
BIO-N Cubes/Engineering	$ 106,812.76	$ 15,918.25
Material & Equipment	$ 11,481.56	$ 1,711.09
Labor	$ 7,053.09	$ 1,051.12
Probes/Meters	$ -	$ -
Contractor & Engineering Services & Overhead	$ 58,378.86	$ 8,700.17
Total Construction Cost	$ 210,234.65	$ 31,331.16
Electric Power Cost		$ 5,284.44
Maintenance Cost		$ 819.18
Property Taxes		$ 746.33
Total Operating Cost		$ 6,849.95
TOTAL ANNUALIZED COST OF NITRIFICATION TANK		**$ 38,181.11**

Table SS.23. Super Soils Technology Settling Tank Costs—Actual Costs and Performance Data

Component	Total Cost	Annualized Cost
Tank	$ 31,863.62	$ 4,748.62
Material & Equipment	$ 10,226.18	$ 1,524.00
Labor	$ 3,589.38	$ 534.92
Contractor & Engineering Services & Overhead	$ 5,954.51	$ 887.40
Total Construction Cost	$ 51,633.69	$ 7,694.94
Electric Power Cost		$ 156.91
Maintenance Cost		$ 841.80
Property Taxes		$ 183.30
Total Operating Cost		$ 1,182.01
TOTAL ANNUALIZED COST OF SETTLING TANK		**$ 8,876.95**

Table SS.24. Super Soils Technology Clean Water Tank Costs—Actual Costs and Performance Data

Component	Total Cost	Annualized Cost
Tank	$ 28,236.00	$ 4,208.00
Material & Equipment	$ 4,649.19	$ 692.87
Labor	$ 1,338.15	$ 199.42
Contractor & Engineering Services & Overhead	$ 2,580.54	$ 384.58
Total Construction Cost	$ 36,803.88	$ 5,484.86
Maintenance Cost		$ 657.70
Property Taxes		$ 130.65
Total Operating Cost		$ 788.36
TOTAL ANNUALIZED COST OF CLEAN WATER TANK		**$ 6,273.22**

Table SS.25. Super Soils Technology Phosphorus Removal Module Costs—Actual Costs and Performance Data

Component	Total Cost	Annualized Cost
Settling Tank	$ 15,694.00	$ 2,338.87
Draimad System	$ 11,519.00	$ 1,716.67
Polymer Preparer	$ 5,935.00	$ 884.49
Polymer Mixer	$ 564.00	$ 84.05
Shipping	$ 1,197.62	$ 178.48
Materials-General	$ 961.56	$ 143.30
Materials-Mechanical	$ 3,750.00	$ 558.86
Materials-Electrical	$ 29,780.09	$ 4,438.11
Labor-General	$ 10,565.00	$ 1,574.50
Labor-Mechanical	$ 3,500.00	$ 521.60
Labor-Electrical	$ 5,073.00	$ 756.03
Contractor & Engineering Services & Overhead	$ 38,160.43	$ 5,687.03
Total Construction Cost	$ 126,699.70	$ 18,881.99
Electric Power Cost		$ 754.17
Lime Slurry Cost		$ 2,050.85
Polymer Cost		$ 283.70
Phosphorus and Lime Cost Savings		$ (860.34)
Maintenance Cost		$ 1,364.07
Property Taxes		$ 449.78
Total Operating Cost		$ 4,042.24
TOTAL ANNUALIZED COST OF PHOSPHORUS REMOVAL		**$ 22,924.23**

Table SS.26. Super Soils Technology Return to Barns Costs—Actual Costs and Performance Data

Component	Total Cost	Annualized Cost
Materials-Mechanical	$ 226.14	$ 33.70
Materials-Electrical	$ 1,000.00	$ 149.03
Pump	$ 619.85	$ 223.36
Labor-General	$ 500.00	$ 74.51
Labor-Mechanical	$ 875.00	$ 130.40
Labor-Electrical	$ 1,414.00	$ 210.73
Contractor & Engineering Services & Overhead	$ 1,997.68	$ 297.71
Total Construction Cost	$ 6,632.67	$ 1,119.45
Electric Power Cost		$ 7.89
Maintenance Cost		$ 55.52
Property Tax		$ 23.55
Total Operating Cost		$ 86.95
TOTAL ANNUALIZED COST OF RETURN TO BARNS		**$ 1,206.40**

TECHNOLOGY ROYALTY FEES	**$ 10,432.80**

TOTAL CONSTRUCTION COST OF SUPER SOILS TECHNOLOGY	**$ 994,162.45**
TOTAL OPERATING COST INCLUDING ROYALTIES OF SUPER SOILS TECHNOLOGY	**$ 48,475.03**
TOTAL ANNUALIZED COSTS OF SUPER SOILS TECHNOLOGY WITHOUT LAND APPLICATION	**$ 198,708.47**

Table SS.27. Super Soils Technology Predicted Liquid Application Costs for Four Land Application Scenarios—Actual Costs and Performance Data

Annual Cost of Applying Lagoon Effluent		**Forages**		**Row Crops**
If Nitrogen-Based Application	$	5,844.24	$	7,108.58
If Phosphorus-Based Application	$	5,940.60	$	3,359.44
Acres Needed For Assimilation		**Forages**		**Row Crops**
If Nitrogen-Based Application		5.82		10.69
If Phosphorus-Based Application		5.82		12.14
Opportunity Cost of Land		**Forages**		**Row Crops**
If Nitrogen-Based Application	$	349.08		-
If Phosphorus-Based Application	$	349.08		-
Irrigation Costs		**Forages**		**Row Crops**
If Nitrogen-Based Application	$	5,495.16	$	7,331.66
If Phosphorus-Based Application	$	5,495.16	$	3,626.18
Savings From Not Having To Buy Fertilizer		**Forages**		**Row Crops**
If Nitrogen-Based Application		-	$	(223.08)
If Phosphorus-Based Application		-	$	(266.75)
Extra Fertilizer Purchase Costs		**Forages**		**Row Crops**
If Nitrogen-Based Application		-		-
If Phosphorus-Based Application	$	96.35		-

Note: 3,165,034 gallons / year of effluent land applied at Goshen Ridge.

Table SS.28. Super Soils Technology Predicted Solids Application Costs for Four Land Application Scenarios—Actual Costs and Performance Data

Annual Cost of Applying Solids		**Forages**		**Row Crops**
If Nitrogen-Based Application	$	25,164.50	$	14,267.47
If Phosphorus-Based Application	$	94,035.46	$	17,824.91
Acres Needed For Application		**Forages**		**Row Crops**
If Nitrogen-Based Application		72.79		235.92
If Phosphorus-Based Application		379.20		1,013.07
Opportunity Cost of Land		**Forages**		**Row Crops**
If Nitrogen-Based Application	$	4,367.43		-
If Phosphorus-Based Application	$	22,751.77		-
Application Costs		**Forages**		**Row Crops**
If Nitrogen-Based Application	$	17,006.20	$	19,079.75
If Phosphorus-Based Application	$	20,933.48	$	29,449.51
Savings From Not Having To Buy Fertilizer		**Forages**		**Row Crops**
If Nitrogen-Based Application		-	$	(4,812.28)
If Phosphorus-Based Application		-	$	(11,624.60)
Extra Fertilizer Purchase Costs		**Forages**		**Row Crops**
If Nitrogen-Based Application	$	3,790.87		-
If Phosphorus-Based Application	$	50,350.21		-

Note: 5,727,471 lbs. / year of solids land applied at Goshen Ridge.

Table SS.29. Summary and Mass Balance of Generated and Land Applied Nutrients—Actual Costs and Performance Data

Nutrient Balance	Nitrogen (lbs/ year)	Phosphorus (lbs / year)	Potassium (lbs / year)
Generated At Barn	75,414.24	21,610.80	37,073.70
Nutrient Reduction Due to Solids Separation	35,218.45	16,056.82	5,709.35
Entering Biogreen System	40,195.79	5,553.98	31,364.35
Removed in Biogreen	32,156.63	1,133.01	6,617.88
Remaining after Biogreen Treatment	8,039.16	4,420.96	24,746.47
Entering Phosphorus Removal Module	6,665.44	3,665.52	20,517.83
Removed by Phosphorus Removal Module	-	3,445.59	-
Remaining in Recycled Effluent	1,373.72	755.45	4,228.64
Entering Lagoon after Phosphorus Removal	6,665.44	219.93	20,517.83
Remaining for Land Application	1,914.31	219.93	20,517.83

Tables SS.30 through SS.45: Costs and Returns Estimates Based on Standardized Cost and Performance Data for Super Soils On-Farm System: 4,320-Head Feeder to Finish Operation with Pit-Recharge

Table SS.30. Super Soils Technology Assumptions and Predicted Total Annualized Costs—Standardized Quantities and Prices (4,320-Head Feeder-Finish with Pit-Recharge System)

Number of Animals	**4,320**		
Type of Operation	**Feeder-Finish**		
Barn Cleaning System	**Pit-Recharge System**		
Annualized Cost ($ / Year)			
Total Annualized Cost		Forages	Row Crops
	If Nitrogen-Based Application	**$ 233,108.64**	**$ 220,677.22**
	If Phosphorus-Based Application	**$ 309,362.42**	**$ 225,586.66**
Per Unit Cost ($ / 1,000 lbs. of SSLW)			
Total Annualized Cost per Unit		Forages	Row Crops
	If Nitrogen-Based Application	**$ 399.71**	**$ 378.39**
	If Phosphorus-Based Application	**$ 530.46**	**$ 386.81**

Note: Daily volume discharged from barns is 28,361 gallons / day including recharge liquid.
SSLW equals 583,200 pounds.

Table SS.31. Super Soils Technology Manure Evacuation and Lift Station Costs—Standardized Quantities and Prices (4,320-Head Feeder-Finish with Pit-Recharge System)

Component	Total Cost	Annualized Cost
Manure Evacuation	$ 4,555.00	$ 678.83
Lift Station		
Concrete Lift Station	$ 2,127.00	$ 316.99
Switches and Brackets	$ 126.50	$ 18.85
Pumps	$ 3,468.40	$ 1,249.83
Piping	$ 145.67	$ 21.71
Lift Station Accessories	$ 7,715.73	$ 1,149.87
Electric Panel	$ 1,065.38	$ 158.77
Labor (Electrical)	$ 3,080.00	$ 459.01
Electrical Materials	$ 2,877.60	$ 428.85
Contractor & Engineering Services & Overhead	$ 10,844.51	$ 1,616.15
Total Construction Cost	$ 36,005.79	$ 6,098.86
Electric Power Cost		$ 236.18
Maintenance Cost		$ 545.68
Property Taxes		$ 127.82
Total Operating Costs		$ 909.68
TOTAL ANNUALIZED COST OF MANURE EVACUATION AND LIFT STATION		**$ 7,008.54**

Table SS.32. Super Soils Technology Strainer Costs—Standardized Quantities and Prices (4,320-Head Feeder-Finish with Pit-Recharge System)

Component	Total Cost	Annualized Cost
Pit	$ 140.00	$ 20.86
Strainer	$ 250.00	$ 37.26
Fittings/Pipe	$ 140.05	$ 20.87
Labor	$ 500.00	$ 74.51
Contractor & Engineering Services & Overhead	$ 443.95	$ 66.16
Total Construction Cost	$ 1,474.00	$ 219.67
Maintenance Cost		$ 20.60
Property Taxes		$ 5.23
Total Operating Cost		$ 25.83
TOTAL ANNUALIZED COST OF STRAINER		**$ 245.50**

Table SS.33. Super Soils Technology Homogenization Tank Costs—Standardized Quantities and Prices (4,320-Head Feeder-Finish with Pit-Recharge System)

Component	Total Cost	Annualized Cost
Tank	$ 29,081.80	$ 4,334.05
Mixer & Controls	$ 5,680.00	$ 846.49
Screen	$ 10,000.00	$ 1,490.29
Materials & Equipment	$ 12,109.70	$ 1,804.70
Labor-General	$ 1,300.31	$ 193.78
Labor-Mechanical	$ 1,749.38	$ 260.71
Labor-Electrical	$ 6,186.81	$ 922.02
Contractor & Engineering Services & Overhead	$ 15,958.29	$ 2,378.26
Total Construction Cost	$ 82,066.29	$ 12,230.30
Electric Power Cost		$ 2,234.16
Maintenance Cost		$ 1,137.43
Property Taxes		$ 291.34
Total Operating Cost		$ 3,662.93
TOTAL ANNUALIZED COST OF HOMOGENIZATION TANK		**$ 15,893.22**

Table SS.34. Super Soils Technology Separation Building Costs—Standardized Quantities and Prices (4,320-Head Feeder-Finish with Pit-Recharge System)

Component	Total Cost	Annualized Cost
Materials-General	$ 8,772.18	$ 1,307.31
Materials & Equipment	$ 5,282.09	$ 787.19
Labor-General	$ 17,434.69	$ 2,598.28
Steel Structure	$ 11,666.00	$ 1,738.58
Steel Stair	$ 2,500.00	$ 372.57
Labor-Mechanical	$ 1,058.60	$ 157.76
Labor-Electrical	$ 3,251.25	$ 484.53
Contractor & Engineering Services & Overhead	$ 21,534.83	$ 3,209.32
Total Construction Cost	$ 71,499.64	$ 10,655.55
Maintenance Cost		$ 564.41
Property Taxes		$ 253.82
Total Operating Cost		$ 818.23
TOTAL ANNUALIZED COST OF SEPARATION BUILDING		**$ 11,473.78**

Table SS.35. Super Soils Technology Solids Separator Costs—Standardized Quantities and Prices (4,320-Head Feeder-Finish with Pit-Recharge System)

Component	Total Cost	Annualized Cost
Storage	$ 10,000.00	$ 1,490.29
Main Module	$ 130,000.00	$ 19,373.83
Dehydration System	$ 20,500.00	$ 3,055.10
Support Belt Filter	$ 1,900.00	$ 283.16
Materials & Equipment	$ 8,239.65	$ 1,227.95
Shipping	$ 7,634.38	$ 1,137.75
Labor-Mechanical	$ 3,311.02	$ 493.44
Labor-Electrical	$ 14,490.94	$ 2,159.58
Contractor & Engineering Services & Overhead	$ 84,508.75	$ 12,594.30
Total Construction Cost	$ 280,584.74	$ 41,815.40
Electric Power Cost		$ 2,747.56
Polymer Cost		$ 16,315.21
Maintenance Cost		$ 8,031.98
Property Taxes		$ 996.08
Total Operating Cost		$ 28,090.82
TOTAL ANNUALIZED COST OF SOLIDS SEPARATOR		**$ 69,906.22**

Table SS.36. Super Soils Technology Observation Deck Costs—Standardized Quantities and Prices (4,320-Head Feeder-Finish with Pit-Recharge System)

Component	Total Cost	Annualized Cost
Material-General	$ 874.17	$ 130.28
Steel	$ 3,804.91	$ 567.04
Labor	$ 5,935.00	$ 884.49
Contractor & Engineering Services & Overhead	$ 4,574.67	$ 681.76
Total Construction Cost	$ 15,188.75	$ 2,263.57
Maintenance Cost		$ 93.58
Property Taxes		$ 53.92
Total Operating Cost		$ 147.50
TOTAL ANNUALIZED COST OF OBSERVATION DECK		**$ 2,411.07**

Table SS.37. Super Soils Technology Denitrification Tank Costs—Standardized Quantities and Prices (4,320-Head Feeder-Finish with Pit-Recharge System)

Component	Total Cost	Annualized Cost
Tank	$ 29,081.80	$ 4,334.05
Mixer	$ 4,750.00	$ 707.89
Mixer Controls	$ 700.00	$ 104.32
Material & Equipment	$ 9,956.56	$ 1,483.82
Labor	$ 2,125.48	$ 316.76
Probes/Meters	$ -	$ -
Contractor & Engineering Services & Overhead	$ 7,556.31	$ 1,126.11
Total Construction Cost	$ 54,170.15	$ 8,072.95
Electric Power Cost		$ 1,162.66
Maintenance Cost		$ 889.77
Property Taxes		$ 192.30
Total Operating Cost		$ 2,244.74
TOTAL ANNUALIZED COST OF DENITRIFICATION TANK		**$ 10,317.69**

Table SS.38. Super Soils Nitrification Tank Costs—Standardized Quantities and Prices (4,320-Head Feeder-Finish with Pit-Recharge System)

Component	Total Cost	Annualized Cost
Tank	$ 22,182.92	$ 3,305.91
Screen Housing	$ 5,861.27	$ 873.50
Screen	$ 1,701.74	$ 253.61
Diffusers	$ 1,979.37	$ 294.98
Tank Floor	$ 560.00	$ 83.46
BIO-N Cubes/Engineering	$ 144,135.81	$ 21,480.49
Material & Equipment	$ 11,481.56	$ 1,711.09
Labor	$ 7,053.09	$ 1,051.12
Probes/Meters	$ -	$ -
Contractor & Engineering Services & Overhead	$ 74,465.10	$ 11,097.50
Total Construction Cost	$ 269,420.86	$ 40,151.65
Electric Power Cost		$ 5,284.44
Maintenance Cost		$ 934.72
Property Taxes		$ 956.44
Total Operating Cost		$ 7,175.60
TOTAL ANNUALIZED COST OF NITRIFICATION TANK		**$ 47,327.25**

Table SS.39. Super Soils Technology Settling Tank Costs—Standardized Quantities and Prices (4,320-Head Feeder-Finish with Pit-Recharge System)

Component	Total Cost	Annualized Cost
Tank	$ 36,493.55	$ 5,438.62
Material & Equipment	$ 10,226.18	$ 1,524.00
Labor	$ 3,589.38	$ 534.92
Contractor & Engineering Services & Overhead	$ 5,954.51	$ 887.40
Total Construction Cost	$ 56,263.62	$ 8,384.94
Electric Power Cost		$ 156.91
Maintenance Cost		$ 934.39
Property Taxes		$ 199.74
Total Operating Cost		$ 1,291.04
TOTAL ANNUALIZED COST OF SETTLING TANK		**$ 9,675.98**

Table SS.40. Super Soils Technology Clean Water Tank Costs—Standardized Quantities and Prices (4,320-Head Feeder-Finish with Pit-Recharge System)

Component	Total Cost	Annualized Cost
Tank	$ 20,125.00	$ 2,999.22
Material & Equipment	$ 4,649.19	$ 692.87
Labor	$ 1,338.15	$ 199.42
Contractor & Engineering Services & Overhead	$ 2,580.54	$ 384.58
Total Construction Cost	$ 28,692.88	$ 4,276.09
Maintenance Cost		$ 495.48
Property Taxes		$ 101.86
Total Operating Cost		$ 597.34
TOTAL ANNUALIZED COST OF CLEAN WATER TANK		**$ 4,873.43**

Table SS.41. Super Soils Technology Phosphorus Removal Module Costs—Standardized Quantities and Prices (4,320-Head Feeder-Finish with Pit-Recharge System)

Component	Total Cost	Annualized Cost
Settling Tank	$ 15,694.00	$ 2,338.87
Draimad System	$ 11,519.00	$ 1,716.67
Polymer Preparer	$ 5,935.00	$ 884.49
Polymer Mixer	$ 564.00	$ 84.05
Shipping	$ 1,197.62	$ 178.48
Materials-General	$ 961.56	$ 143.30
Materials-Mechanical	$ 3,750.00	$ 558.86
Materials-Electrical	$ 29,780.09	$ 4,438.11
Labor-General	$ 10,565.00	$ 1,574.50
Labor-Mechanical	$ 3,500.00	$ 521.60
Labor-Electrical	$ 5,073.00	$ 756.03
Contractor & Engineering Services & Overhead	$ 38,160.43	$ 5,687.03
Total Construction Cost	$ 126,699.70	$ 18,881.99
Electric Power Cost		$ 754.17
Lime Slurry Cost		$ 2,377.80
Polymer Cost		$ 328.93
Phosphorus and Lime Cost Savings		$ (997.49)
Maintenance Cost		$ 1,364.07
Property Taxes		$ 449.78
Total Operating Cost		$ 4,277.26
TOTAL ANNUALIZED COST OF PHOSPHORUS REMOVAL		**$ 23,159.25**

Table SS.42. Super Soils Technology Return to Barns Costs—Standardized Quantities and Prices (4,320-Head Feeder-Finish with Pit-Recharge System)

Component	Total Cost	Annualized Cost
Plumbing/Piping	$ 1,300.00	$ 193.74
Pumps	$ 1,200.00	$ 432.42
Contractor & Engineering Services & Overhead	$ 1,077.50	$ 160.58
Total Construction Cost	$ 3,577.50	$ 786.74
Electric Power Cost		$ 306.88
Maintenance Cost		$ 86.00
Property Tax		$ 12.70
Total Operating Cost		$ 405.58
TOTAL ANNUALIZED COST OF RETURN TO BARNS		**$ 1,192.31**
TECHNOLOGY ROYALTY FEES		**$ 12,096.00**
TOTAL CONSTRUCTION COST OF SUPER SOILS TECHNOLOGY		**$ 1,025,643.92**
TOTAL OPERATING COST INCLUDING ROYALTIES OF SUPER SOILS TECHNOLOGY		**$ 61,742.55**
TOTAL ANNUALIZED COSTS OF SUPER SOILS TECHNOLOGY WITHOUT LAND APPLICATION		**$ 215,580.26**

Table SS.43. Super Soils Technology Predicted Liquid Application Costs for Four Land Application Scenarios—Standardized Quantities and Prices (4,320-Head Feeder-Finish with Pit-Recharge System)

Annual Cost of Applying Lagoon Effluent		**Forages**		**Row Crops**
If Nitrogen-Based Application	$	6,124.27	$	3,753.40
If Phosphorus-Based Application	$	6,056.15	$	5,522.62
Acres Needed For Assimilation		**Forages**		**Row Crops**
If Nitrogen-Based Application		6.71		18.23
If Phosphorus-Based Application		6.71		6.71
Opportunity Cost of Land		**Forages**		**Row Crops**
If Nitrogen-Based Application	$	402.85		-
If Phosphorus-Based Application	$	402.85		-
Irrigation Costs		**Forages**		**Row Crops**
If Nitrogen-Based Application	$	5,653.30	$	4,065.12
If Phosphorus-Based Application	$	5,653.30	$	5,653.30
Savings From Not Having To Buy Fertilizer		**Forages**		**Row Crops**
If Nitrogen-Based Application		-	$	(311.72)
If Phosphorus-Based Application		-	$	(130.68)
Extra Fertilizer Purchase Costs		**Forages**		**Row Crops**
If Nitrogen-Based Application	$	68.13		-
If Phosphorus-Based Application		-		-

Note: 3,652,464 gallons / year of effluent modeled to be land applied.

Table SS.44. Super Soils Technology Predicted Solids Application Costs for Four Land Application Scenarios—Standardized Quantities and Prices (4,320-Head Feeder-Finish with Pit-Recharge System)

Annual Cost of Applying Solids		**Forages**		**Row Crops**
If Nitrogen-Based Application	$	28,222.34	$	15,589.65
If Phosphorus-Based Application	$	108,086.16	$	19,873.81
Acres Needed For Application		**Forages**		**Row Crops**
If Nitrogen-Based Application		84.39		273.53
If Phosphorus-Based Application		439.65		1,174.58
Opportunity Cost of Land		**Forages**		**Row Crops**
If Nitrogen-Based Application	$	5,063.68		-
If Phosphorus-Based Application	$	26,378.86		-
Application Costs		**Forages**		**Row Crops**
If Nitrogen-Based Application	$	18,763.45	$	21,169.11
If Phosphorus-Based Application	$	23,330.25	$	33,351.61
Savings From Not Having To Buy Fertilizer		**Forages**		**Row Crops**
If Nitrogen-Based Application		-	$	(5,579.46)
If Phosphorus-Based Application		-	$	(13,477.79)
Extra Fertilizer Purchase Costs		**Forages**		**Row Crops**
If Nitrogen-Based Application	$	4,395.21		-
If Phosphorus-Based Application	$	58,377.05		-

Note: 6,643,396 lbs. / year of solids modeled to be land applied

Table SS.45. Summary and Mass Balance of Generated and Land Applied Nutrients—Standardized Quantities and Prices (4,320-Head Feeder-Finish with Pit-Recharge System)

Nutrient Balance	Nitrogen (lbs/ year)	Phosphorus (lbs / year)	Potassium (lbs / year)
Generated At Barn	87,436.80	25,056.00	42,984.00
Nutrient Reduction Due to Solids Separation	40,832.99	18,616.61	6,619.54
Entering Biogreen System	46,603.81	6,439.39	36,364.46
Removed in Biogreen	37,283.05	1,313.64	7,672.90
Remaining after Biogreen Treatment	9,320.76	5,125.76	28,691.56
Entering P-Removal Module	3,265.44	1,795.76	10,051.80
Removed by P-Removal Module	-	1,688.01	-
Remaining in Recycled Effluent	6,055.33	3,330.00	18,639.76
Land Applied in Treated Effluent	3,265.44	107.75	10,051.80

Tables SS.46 through SS.61: Costs and Returns Estimates Based on Standardized Cost and Performance Data for Super Soils On-Farm System: 4,320-Head Feeder to Finish Operation with Flush System

Table SS.46. Super Soils Technology Assumptions and Total Annualized Costs—Standardized Quantities and Prices (4,320-Head Feeder-Finish with Flush System)

Number of Animals	**4,320**		
Type of Operation	**Feeder-Finish**		
Barn Cleaning System	**Flush System**		
Annualized Cost ($ / Year)			
Total Annualized Cost		Forages	Row Crops
	If Nitrogen-Based Application	**$ 299,663.60**	**$ 287,179.96**
	If Phosphorus-Based Application	**$ 375,927.85**	**$ 292,172.24**
Per Unit Cost ($ / 1,000 lbs. of SSLW)			
Total Annualized Cost per Unit		Forages	Row Crops
	If Nitrogen-Based Application	**$ 513.83**	**$ 492.42**
	If Phosphorus-Based Application	**$ 644.60**	**$ 500.98**

Note: Daily volume discharged from barns is 33,505 gallons / day including recharge liquid.
SSLW equals 583,200 pounds.

Table SS.47. Super Soils Technology Manure Evacuation and Lift Station Costs—Standardized Quantities and Prices (4,320-Head Feeder-Finish with Flush System)

Component	Total Cost	Annualized Cost
Manure Evacuation	$ 9,110.00	$ 1,357.66
Lift Station		
Concrete Lift Station	$ 2,127.00	$ 316.99
Switches and Brackets	$ 126.50	$ 18.85
Pumps	$ 3,468.40	$ 1,249.83
Piping	$ 145.67	$ 21.71
Lift Station Accessories	$ 7,715.73	$ 1,149.87
Electric Panel	$ 1,065.38	$ 158.77
Labor (Electrical)	$ 3,080.00	$ 459.01
Electrical Materials	$ 2,877.60	$ 428.85
Contractor & Engineering Services & Overhead	$ 12,807.72	$ 1,908.73
Total Construction Cost	$ 42,524.00	$ 7,070.27
Electric Power Cost		$ 279.02
Maintenance Cost		$ 636.78
Property Taxes		$ 150.96
Total Operating Costs		$ 1,066.76
TOTAL ANNUALIZED COST OF MANURE EVACUATION AND LIFT STATION		**$ 8,137.02**

Table SS.48. Super Soils Technology Strainer Costs—Standardized Quantities and Prices (4,320-Head Feeder-Finish with Flush System)

Component	Total Cost	Annualized Cost
Pit	$ 140.00	$ 20.86
Strainer	$ 250.00	$ 37.26
Fittings/Pipe	$ 140.05	$ 20.87
Labor	$ 500.00	$ 74.51
Contractor & Engineering Services & Overhead	$ 443.95	$ 66.16
Total Construction Cost	$ 1,474.00	$ 219.67
Maintenance Cost		$ 20.60
Property Taxes		$ 5.23
Total Operating Cost		$ 25.83
TOTAL ANNUALIZED COST OF STRAINER		**$ 245.50**

Table SS.49. Super Soils Technology Homogenization Tank Costs—Standardized Quantities and Prices (4,320-Head Feeder-Finish with Flush System)

Component	Total Cost	Annualized Cost
Tank	$ 36,821.77	$ 5,487.53
Mixer & Controls	$ 5,680.00	$ 846.49
Screen	$ 10,000.00	$ 1,490.29
Materials & Equipment	$ 12,109.70	$ 1,804.70
Labor-General	$ 1,300.31	$ 193.78
Labor-Mechanical	$ 1,749.38	$ 260.71
Labor-Electrical	$ 6,186.81	$ 922.02
Contractor & Engineering Services & Overhead	$ 15,958.29	$ 2,378.26
Total Construction Cost	$ 89,806.26	$ 13,383.78
Electric Power Cost		$ 2,234.16
Maintenance Cost		$ 1,292.23
Property Taxes		$ 318.81
Total Operating Cost		$ 3,845.20
TOTAL ANNUALIZED COST OF HOMOGENIZATION TANK		**$ 17,228.98**

Table SS.50. Super Soils Technology Separation Building Costs—Standardized Quantities and Prices (4,320-Head Feeder-Finish with Flush System)

Component	Total Cost	Annualized Cost
Materials-General	$ 16,667.14	$ 2,483.90
Materials & Equipment	$ 10,035.97	$ 1,495.66
Labor-General	$ 34,869.38	$ 5,196.57
Steel Structure	$ 22,165.40	$ 3,303.30
Steel Stair	$ 4,750.00	$ 707.89
Labor-Mechanical	$ 2,117.19	$ 315.52
Labor-Electrical	$ 6,502.50	$ 969.06
Contractor & Engineering Services & Overhead	$ 41,853.37	$ 6,237.39
Total Construction Cost	$ 138,960.95	$ 20,709.28
Maintenance Cost		$ 1,072.37
Property Taxes		$ 493.31
Total Operating Cost		$ 1,565.68
TOTAL ANNUALIZED COST OF SEPARATION BUILDING		**$ 22,274.96**

Table SS.51. Super Soils Technology Solids Separator Costs—Standardized Quantities and Prices (4,320-Head Feeder-Finish with Flush System)

Component	Total Cost	Annualized Cost
Storage	$ 10,000.00	$ 1,490.29
Main Module	$ 260,000.00	$ 38,747.67
Dehydration System	$ 41,000.00	$ 6,110.21
Support Belt Filter	$ 3,800.00	$ 566.31
Materials & Equipment	$ 16,479.30	$ 2,455.90
Shipping	$ 15,268.76	$ 2,275.50
Labor-Mechanical	$ 6,622.04	$ 986.88
Labor-Electrical	$ 28,981.88	$ 4,319.15
Contractor & Engineering Services & Overhead	$ 164,707.50	$ 24,546.28
Total Construction Cost	$ 546,859.48	$ 81,498.19
Electric Power Cost		$ 2,747.56
Polymer Cost		$ 19,274.29
Maintenance Cost		$ 16,063.97
Property Taxes		$ 1,941.35
Total Operating Cost		$ 40,027.16
TOTAL ANNUALIZED COST OF SOLIDS SEPARATOR		**$ 121,525.35**

Table SS.52. Super Soils Technology Observation Deck Costs—Standardized Quantities and Prices (4,320-Head Feeder-Finish with Flush System)

Component	Total Cost	Annualized Cost
Material-General	$ 874.17	$ 130.28
Steel	$ 3,804.91	$ 567.04
Labor	$ 5,935.00	$ 884.49
Contractor & Engineering Services & Overhead	$ 4,574.67	$ 681.76
Total Construction Cost	$ 15,188.75	$ 2,263.57
Maintenance Cost		$ 93.58
Property Taxes		$ 53.92
Total Operating Cost		$ 147.50
TOTAL ANNUALIZED COST OF OBSERVATION DECK		**$ 2,411.07**

Table SS.53. Super Soils Technology Denitrification Tank Costs—Standardized Quantities and Prices (4,320-Head Feeder-Finish with Flush System)

Component	Total Cost	Annualized Cost
Tank	$ 29,081.80	$ 4,334.05
Mixer	$ 4,750.00	$ 707.89
Mixer Controls	$ 700.00	$ 104.32
Material & Equipment	$ 9,956.56	$ 1,483.82
Labor	$ 2,125.48	$ 316.76
Probes/Meters	$ -	$ -
Contractor & Engineering Services & Overhead	$ 7,556.31	$ 1,126.11
Total Construction Cost	$ 54,170.15	$ 8,072.95
Electric Power Cost		$ 1,162.66
Maintenance Cost		$ 889.77
Property Taxes		$ 192.30
Total Operating Cost		$ 2,244.74
TOTAL ANNUALIZED COST OF DENITRIFICATION TANK		**$ 10,317.69**

Table SS.54. Super Soils Nitrification Tank Costs—Standardized Quantities and Prices (4,320-Head Feeder-Finish with Flush System)

Component	Total Cost	Annualized Cost
Tank	$ 22,182.92	$ 3,305.91
Screen Housing	$ 5,861.27	$ 873.50
Screen	$ 1,701.74	$ 253.61
Diffusers	$ 1,979.37	$ 294.98
Tank Floor	$ 560.00	$ 83.46
BIO-N Cubes/Engineering	$ 144,135.81	$ 21,480.49
Material & Equipment	$ 11,481.56	$ 1,711.09
Labor	$ 7,053.09	$ 1,051.12
Probes/Meters	$ -	$ -
Contractor & Engineering Services & Overhead	$ 74,465.10	$ 11,097.50
Total Construction Cost	$ 293,145.92	$ 40,151.65
Electric Power Cost		$ 5284.44
Maintenance Cost		$ 934.72
Property Taxes		$ 956.44
Total Operating Cost		$ 7,175.60
TOTAL ANNUALIZED COST OF NITRIFICATION TANK		**$ 47,327.25**

Table SS.55. Super Soils Technology Settling Tank Costs—Standardized Quantities and Prices (4,320-Head Feeder-Finish with Flush System)

Component	Total Cost	Annualized Cost
Tank	$ 43,662.21	$ 6,506.96
Material & Equipment	$ 10,226.18	$ 1,524.00
Labor	$ 3,589.38	$ 534.92
Contractor & Engineering Services & Overhead	$ 5,954.51	$ 887.40
Total Construction Cost	$ 63,432.28	$ 9,453.28
Electric Power Cost		$ 156.91
Maintenance Cost		$ 1,077.77
Property Taxes		$ 225.18
Total Operating Cost		$ 1,459.86
TOTAL ANNUALIZED COST OF SETTLING TANK		**$ 10,913.14**

Table SS.56. Super Soils Technology Clean Water Tank Costs—Standardized Quantities and Prices (4,320-Head Feeder-Finish with Flush System)

Component	Total Cost	Annualized Cost
Tank	$ 22,182.92	$ 3,305.91
Material & Equipment	$ 4,649.19	$ 692.87
Labor	$ 1,338.15	$ 199.42
Contractor & Engineering Services & Overhead	$ 2,580.54	$ 384.58
Total Construction Cost	$ 30,750.80	$ 4,582.78
Maintenance Cost		$ 536.64
Property Taxes		$ 109.17
Total Operating Cost		$ 645.81
TOTAL ANNUALIZED COST OF CLEAN WATER TANK		**$ 5,228.58**

Table SS.57. Super Soils Technology Phosphorus Removal Module Costs—Standardized Quantities and Prices (4,320-Head Feeder-Finish with Flush System)

Component	Total Cost	Annualized Cost
Settling Tank	$ 15,694.00	$ 2,338.87
Draimad System	$ 11,519.00	$ 1,716.67
Polymer Preparer	$ 5,935.00	$ 884.49
Polymer Mixer	$ 564.00	$ 84.05
Shipping	$ 1,197.62	$ 178.48
Materials-General	$ 961.56	$ 143.30
Materials-Mechanical	$ 3,750.00	$ 558.86
Materials-Electrical	$ 29,780.09	$ 4,438.11
Labor-General	$ 10,565.00	$ 1,574.50
Labor-Mechanical	$ 3,500.00	$ 521.60
Labor-Electrical	$ 5,073.00	$ 756.03
Contractor & Engineering Services & Overhead	$ 38,160.43	$ 5,687.03
Total Construction Cost		$ 18,881.99
Electric Power Cost		$ 754.17
Lime Slurry Cost		$ 2,377.80
Polymer Cost		$ 328.93
Phosphorus and Lime Cost Savings		$ (997.49)
Maintenance Cost		$ 1,364.07
Property Taxes		$ 449.78
Total Operating Cost		$ 4,277.26
TOTAL ANNUALIZED COST OF PHOSPHORUS REMOVAL		**$ 23,159.25**

Table SS.58. Super Soils Technology Return to Barns Costs—Standardized Quantities and Prices (4,320-Head Feeder-Finish with Flush System)

Component	Total Cost	Annualized Cost
Plumbing/Piping	$ 1,300.00	$ 193.74
Pumps	$ 1,200.00	$ 432.42
Contractor & Engineering Services & Overhead	$ 1,077.50	$ 160.58
Total Construction Cost	$ 3,577.50	$ 786.74
Electric Power Cost		$ 392.55
Maintenance Cost		$ 86.00
Property Tax		$ 12.70
Total Operating Cost		$ 491.25
TOTAL ANNUALIZED COST OF RETURN TO BARNS		**$ 1,277.98**

TECHNOLOGY ROYALTY FEES	**$ 12,096.00**

TOTAL CONSTRUCTION COST OF SUPER SOILS TECHNOLOGY	**$ 1,382,864.73**
TOTAL OPERATING COST INCLUDING ROYALTIES OF SUPER SOILS TECHNOLOGY	**$ 75,068.65**
TOTAL ANNUALIZED COSTS OF SUPER SOILS TECHNOLOGY WITHOUT LAND APPLICATION	**$ 282,142.80**

Table SS.59. Super Soils Technology Predicted Liquid Application Costs for Four Land Application Scenarios—Standardized Quantities and Prices (4,320-Head Feeder-Finish with Flush System)

Annual Cost of Applying Lagoon Effluent		**Forages**		**Row Crops**
If Nitrogen-Based Application	$	6,113.81	$	3,690.22
If Phosphorus-Based Application	$	6,056.15	$	5,542.68
Acres Needed For Assimilation		**Forages**		**Row Crops**
If Nitrogen-Based Application		6.71		15.43
If Phosphorus-Based Application		6.71		6.71
Opportunity Cost of Land		**Forages**		**Row Crops**
If Nitrogen-Based Application	$	402.85		-
If Phosphorus-Based Application	$	402.85		-
Irrigation Costs		**Forages**		**Row Crops**
If Nitrogen-Based Application	$	5,653.30	$	3,954.08
If Phosphorus-Based Application	$	5,653.30	$	5,653.30
Savings From Not Having To Buy Fertilizer		**Forages**		**Row Crops**
If Nitrogen-Based Application		-	$	(263.86)
If Phosphorus-Based Application		-	$	(110.62)
Extra Fertilizer Purchase Costs		**Forages**		**Row Crops**
If Nitrogen-Based Application	$	57.67		-
If Phosphorus-Based Application		-		-

Note: 3,652,464 gallons / year of effluent modeled to be land applied

Table SS.60. Super Soils Technology Predicted Solids Application Costs for Four Land Application Scenarios—Standardized Quantities and Prices (4,320-Head Feeder-Finish with Flush System)

Annual Cost of Applying Solids		**Forages**		**Row Crops**
If Nitrogen-Based Application	$	28,225.23	$	15,592.53
If Phosphorus-Based Application	$	108,089.05	$	19,876.79
Acres Needed For Application		**Forages**		**Row Crops**
If Nitrogen-Based Application		84.39		273.53
If Phosphorus-Based Application		439.65		1,174.58
Opportunity Cost of Land		**Forages**		**Row Crops**
If Nitrogen-Based Application	$	5,063.68		-
If Phosphorus-Based Application	$	26,378.86		-
Application Costs		**Forages**		**Row Crops**
If Nitrogen-Based Application	$	18,766.33	$	21,171.99
If Phosphorus-Based Application	$	23,333.13	$	33,354.58
Savings From Not Having To Buy Fertilizer		**Forages**		**Row Crops**
If Nitrogen-Based Application		-	$	(5,579.46)
If Phosphorus-Based Application		-	$	(13,477.79)
Extra Fertilizer Purchase Costs		**Forages**		**Row Crops**
If Nitrogen-Based Application	$	4,395.21		-
If Phosphorus-Based Application	$	58,377.05		-

Note: 6,645,040 lbs. / year of solids modeled to be land applied

Table SS.61. Summary and Mass Balance of Generated and Land Applied Nutrients—Standardized Quantities and Prices (4,320-Head Feeder-Finish with Flush System)

Nutrient Balance	Nitrogen (lbs/ year)	Phosphorus (lbs / year)	Potassium (lbs / year)
Generated At Barn	87,436.80	25,056.00	42,984.00
Nutrient Reduction Due to Solids Separation	40,832.99	18,616.61	6,619.54
Entering Biogreen System	46,603.81	6,439.39	36,364.46
Removed in Biogreen	37,283.05	1,313.64	7,672.90
Remaining after Biogreen Treatment	9,320.76	5,125.76	28,691.56
Entering P-Removal Module	2,764.11	1,520.06	8,508.60
Removed by P-Removal Module	-	1,428.86	-
Remaining in Recycled Effluent	6,556.65	3,605.69	20,182.96
Land Applied in Treated Effluent	2,764.11	91.20	8,508.60

Tables SS.62 through SS.77: Costs and Returns Estimates Based on Standardized Cost and Performance Data for Super Soils On-Farm System: 8,800-Head Feeder to Finish Operation with Pit-Recharge

Table SS.62. Super Soils Technology Assumptions and Total Annualized Costs—Standardized Quantities and Prices (8,800-Head Feeder-Finish)

Number of Animals	**8,800**		
Type of Operation	**Feeder-Finish**		
Barn Cleaning System	**Pit-Recharge System**		
Annualized Cost ($ / Year)			
Total Annualized Cost		Forages	Row Crops
	If Nitrogen-Based Application	**$ 396,148.96**	**$ 373,084.88**
	If Phosphorus-Based Application	**$ 551,247.75**	**$ 382,639.81**
Per Unit Cost ($ / 1,000 lbs. of SSLW)			
Total Annualized Cost per Unit		Forages	Row Crops
	If Nitrogen-Based Application	**$ 333.46**	**$ 314.05**
	If Phosphorus-Based Application	**$ 464.01**	**$ 322.09**

Note: Daily volume discharged from barns is 57,772 gallons / day including recharge liquid.
SSLW equals 1,188,000 pounds.

Table SS.63. Super Soils Technology Manure Evacuation and Lift Station Costs—Standardized Quantities and Prices (8,800-Head Feeder-Finish)

Component	Total Cost	Annualized Cost
Manure Evacuation	$ 9,110.00	$ 1,357.66
Lift Station		
Concrete Lift Station	$ 4,041.30	$ 602.27
Switches and Brackets	$ 253.00	$ 37.70
Pumps	$ 6,936.80	$ 2,499.67
Piping	$ 291.34	$ 43.42
Lift Station Accessories	$ 15,431.46	$ 2,299.74
Electric Panel	$ 2,130.76	$ 317.55
Labor (Electrical)	$ 5,852.00	$ 872.12
Electrical Materials	$ 5,755.20	$ 857.69
Contractor & Engineering Services & Overhead	$ 21,464.60	$ 3,198.86
Total Construction Cost	$ 71,266.46	$ 12,086.68
Electric Power Cost		$ 481.11
Maintenance Cost		$ 1,087.10
Property Taxes		$ 253.00
Total Operating Costs		$ 1,821.21
TOTAL ANNUALIZED COST OF MANURE EVACUATION AND LIFT STATION		**$ 13,907.89**

Table SS.64. Super Soils Technology Strainer Costs—Standardized Quantities and Prices (8,800-Head Feeder-Finish)

Component	Total Cost	Annualized Cost
Pit	$ 266.00	$ 39.64
Strainer	$ 475.00	$ 70.79
Fittings/Pipe	$ 266.10	$ 39.66
Labor	$ 950.00	$ 141.58
Contractor & Engineering Services & Overhead	$ 843.51	$ 125.71
Total Construction Cost	**$ 2,800.60**	**$ 417.37**
Maintenance Cost		$ 39.14
Property Taxes		$ 9.94
Total Operating Cost		$ 49.08
TOTAL ANNUALIZED COST OF STRAINER		**$ 466.46**

Table SS.65. Super Soils Technology Homogenization Tank Costs—Standardized Quantities and Prices (8,800-Head Feeder-Finish)

Component	Total Cost	Annualized Cost
Tank	$ 49,294.15	$ 7,346.28
Mixer & Controls	$ 5,680.00	$ 846.49
Screen	$ 10,000.00	$ 1,490.29
Materials & Equipment	$ 12,109.70	$ 1,804.70
Labor-General	$ 1,300.31	$ 193.78
Labor-Mechanical	$ 1,749.38	$ 260.71
Labor-Electrical	$ 6,186.81	$ 922.02
Contractor & Engineering Services & Overhead	$ 15,958.29	$ 2,378.26
Total Construction Cost	$ 102,278.65	$ 15,242.53
Electric Power Cost		$ 2,234.16
Maintenance Cost		$ 1,541.68
Property Taxes		$ 363.09
Total Operating Cost		$ 4,138.93
TOTAL ANNUALIZED COST OF HOMOGENIZATION TANK		**$ 19,381.46**

Table SS.66. Super Soils Technology Separation Building Costs—Standardized Quantities and Prices (8,800-Head Feeder-Finish)

Component	Total Cost	Annualized Cost
Materials-General	$ 16,667.14	$ 2,483.90
Materials & Equipment	$ 10,035.97	$ 1,495.66
Labor-General	$ 34,869.38	$ 5,196.57
Steel Structure	$ 22,165.40	$ 3,303.30
Steel Stair	$ 4,750.00	$ 707.89
Labor-Mechanical	$ 2,117.19	$ 315.52
Labor-Electrical	$ 6,502.50	$ 969.06
Contractor & Engineering Services & Overhead	$ 41,853.37	$ 6,237.39
Total Construction Cost	$ 138,960.95	$ 20,709.28
Maintenance Cost		$ 1,072.37
Property Taxes		$ 493.31
Total Operating Cost		$ 1,565.68
TOTAL ANNUALIZED COST OF SEPARATION BUILDING		**$ 22,274.96**

Table SS.67. Super Soils Technology Solids Separator Costs—Standardized Quantities and Prices (8,800-Head Feeder-Finish)

Component	Total Cost	Annualized Cost
Storage	$ 10,000.00	$ 1,490.29
Main Module	$ 260,000.00	$ 38,747.67
Dehydration System	$ 41,000.00	$ 6,110.21
Support Belt Filter	$ 3,800.00	$ 566.31
Materials & Equipment	$ 16,479.30	$ 2,455.90
Shipping	$ 15,268.76	$ 2,275.50
Labor-Mechanical	$ 6,622.04	$ 986.88
Labor-Electrical	$ 28,981.88	$ 4,319.15
Contractor & Engineering Services & Overhead	$ 164,707.50	$ 24,546.28
Total Construction Cost	$ 546,859.48	$ 81,498.19
Electric Power Cost		$ 2,747.56
Polymer Cost		$ 33,234.68
Maintenance Cost		$ 16,063.97
Property Taxes		$ 1,941.35
Total Operating Cost		$ 53,987.55
TOTAL ANNUALIZED COST OF SOLIDS SEPARATOR		**$ 135,485.74**

Table SS.68. Super Soils Technology Observation Deck Costs—Standardized Quantities and Prices (8,800-Head Feeder-Finish)

Component	Total Cost	Annualized Cost
Material-General	$ 874.17	$ 130.28
Steel	$ 3,804.91	$ 567.04
Labor	$ 5,935.00	$ 884.49
Contractor & Engineering Services & Overhead	$ 4,574.67	$ 681.76
Total Construction Cost	$ 15,188.75	$ 2,263.57
Maintenance Cost		$ 93.58
Property Taxes		$ 53.92
Total Operating Cost		$ 147.50
TOTAL ANNUALIZED COST OF OBSERVATION DECK		**$ 2,411.07**

Table SS.69. Super Soils Technology Denitrification Tank Costs—Standardized Quantities and Prices (8,800-Head Feeder-Finish)

Component	Total Cost	Annualized Cost
Tank	$ 55,853.61	$ 8,323.83
Mixer	$ 4,750.00	$ 707.89
Mixer Controls	$ 700.00	$ 104.32
Material & Equipment	$ 9,956.56	$ 1,483.82
Labor	$ 2,125.48	$ 316.76
Probes/Meters	$ -	$ -
Contractor & Engineering Services & Overhead	$ 7,556.31	$ 1,126.11
Total Construction Cost	$ 80,941.96	$ 12,062.74
Electric Power Cost		$ 1,162.66
Maintenance Cost		$ 1,425.20
Property Taxes		$ 287.34
Total Operating Cost		$ 2,875.21
TOTAL ANNUALIZED COST OF DENITRIFICATION TANK		**$ 14,937.95**

Table SS.70. Super Soils Nitrification Tank Costs—Standardized Quantities and Prices (8,800-Head Feeder-Finish)

Component	Total Cost	Annualized Cost
Tank	$ 29,081.80	$ 4,334.05
Screen Housing	$ 5,861.27	$ 873.50
Screen	$ 1,701.74	$ 253.61
Diffusers	$ 1,979.37	$ 294.98
Tank Floor	$ 560.00	$ 83.46
BIO-N Cubes/Engineering	$ 293,609.99	$ 43,756.55
Material & Equipment	$ 11,481.56	$ 1,711.09
Labor	$ 7,053.09	$ 1,051.12
Probes/Meters	$ -	$ -
Contractor & Engineering Services & Overhead	$ 138,888.47	$ 20,698.48
Total Construction Cost	$ 490,217.27	$ 81,154.24
Electric Power Cost		$ 5,284.44
Maintenance Cost		$ 1,072.70
Property Taxes		$ 1,740.27
Total Operating Cost		$ 8,097.40
TOTAL ANNUALIZED COST OF NITRIFICATION TANK		**$ 81,154.24**

Table SS.71. Super Soils Technology Settling Tank Costs—Standardized Quantities and Prices (8,800-Head Feeder-Finish)

Component	Total Cost	Annualized Cost
Tank	$ 74,338.72	$ 11,078.66
Material & Equipment	$ 10,226.18	$ 1,524.00
Labor	$ 3,589.38	$ 534.92
Contractor & Engineering Services & Overhead	$ 5,954.51	$ 887.40
Total Construction Cost	$ 94,108.79	$ 14,024.98
Electric Power Cost		$ 156.91
Maintenance Cost		$ 1,691.30
Property Taxes		$ 334.09
Total Operating Cost		$ 2,182.30
TOTAL ANNUALIZED COST OF SETTLING TANK		**$ 16,207.28**

Table SS.72. Super Soils Technology Clean Water Tank Costs—Standardized Quantities and Prices (8,800-Head Feeder-Finish)

Component	Total Cost	Annualized Cost
Tank	$ 29,081.80	$ 4,334.05
Material & Equipment	$ 4,649.19	$ 692.87
Labor	$ 1,338.15	$ 199.42
Contractor & Engineering Services & Overhead	$ 2,580.54	$ 384.58
Total Construction Cost	$ 37,649.69	$ 5,610.91
Maintenance Cost		$ 674.62
Property Taxes		$ 133.66
Total Operating Cost		$ 808.28
TOTAL ANNUALIZED COST OF CLEAN WATER TANK		**$ 6,419.19**

Table SS.73. Super Soils Technology Phosphorus Removal Module Costs—Standardized Quantities and Prices (8,800-Head Feeder-Finish)

Component	Total Cost	Annualized Cost
Settling Tank	$ 15,694.00	$ 2,338.87
Draimad System	$ 11,519.00	$ 1,716.67
Polymer Preparer	$ 5,935.00	$ 884.49
Polymer Mixer	$ 564.00	$ 84.05
Shipping	$ 1,197.62	$ 178.48
Materials-General	$ 961.56	$ 143.30
Materials-Mechanical	$ 3,750.00	$ 558.86
Materials-Electrical	$ 29,780.09	$ 4,438.11
Labor-General	$ 10,565.00	$ 1,574.50
Labor-Mechanical	$ 3,500.00	$ 521.60
Labor-Electrical	$ 5,073.00	$ 756.03
Contractor & Engineering Services & Overhead	$ 38,160.43	$ 5,687.03
Total Construction Cost	$ 126,699.70	$ 18,881.99
Electric Power Cost		$ 754.17
Lime Slurry Cost		$ 4,843.67
Polymer Cost		$ 670.04
Phosphorus and Lime Cost Savings		$ (2,031.93)
Maintenance Cost		$ 1,364.07
Property Taxes		$ 449.78
Total Operating Cost		$ 6,049.81
		$ 24,931.80

Table SS.74. Super Soils Technology Return to Barns Costs—Standardized Quantities and Prices (8,800-Head Feeder-Finish)

Component	Total Cost	Annualized Cost
Plumbing/Piping	$ 2,600.00	$ 387.48
Pumps	$ 1,200.00	$ 432.42
Contractor & Engineering Services & Overhead	$ 1,637.80	$ 244.08
Total Construction Cost		$ 1,063.98
Electric Power Cost		$ 625.12
Maintenance Cost		$ 112.00
Property Tax		$ 19.30
Total Operating Cost		$ 756.42
TOTAL ANNUALIZED COST OF RETURN TO BARNS		**$ 1,820.40**

TECHNOLOGY ROYALTY FEES	**$ 24,640.00**

TOTAL CONSTRUCTION COST OF SUPER SOILS TECHNOLOGY	**$ 1,712,410.11**
TOTAL OPERATING COST INCLUDING ROYALTIES OF SUPER SOILS TECHNOLOGY	**$ 107,119.37**
TOTAL ANNUALIZED COSTS OF SUPER SOILS TECHNOLOGY WITHOUT LAND APPLICATION	**$ 364,038.44**

Table SS.75. Super Soils Technology Predicted Liquid Application Costs for Four Land Application Scenarios—Standardized Quantities and Prices (8,800-Head Feeder-Finish)

Annual Cost of Applying Lagoon Effluent		**Forages**		**Row Crops**
If Nitrogen-Based Application	$	7,806.05	$	6,743.33
If Phosphorus-Based Application	$	7,667.27	$	6,589.48
Acres Needed For Assimilation		**Forages**		**Row Crops**
If Nitrogen-Based Application		13.53		37.13
If Phosphorus-Based Application		13.53		13.53
Opportunity Cost of Land		**Forages**		**Row Crops**
If Nitrogen-Based Application	$	811.59		-
If Phosphorus-Based Application	$	811.59		-
Irrigation Costs		**Forages**		**Row Crops**
If Nitrogen-Based Application	$	6,855.68	$	7,378.31
If Phosphorus-Based Application	$	6,855.68	$	6,855.68
Savings From Not Having To Buy Fertilizer		**Forages**		**Row Crops**
If Nitrogen-Based Application		-	$	(634.98)
If Phosphorus-Based Application		-	$	(266.20)
Extra Fertilizer Purchase Costs		**Forages**		**Row Crops**
If Nitrogen-Based Application	$	138.78		-
If Phosphorus-Based Application		-		-

Note: 7,358,454 gallons / year of effluent modeled to be land applied

Table SS.76. Super Soils Technology Predicted Solids Application Costs for Four Land Application Scenarios—Standardized Quantities and Prices (8,800-Head Feeder-Finish)

Annual Cost of Applying Solids		**Forages**		**Row Crops**
If Nitrogen-Based Application	$	51,546.26	$	26,184.56
If Phosphorus-Based Application	$	215,051.51	$	38,460.67
Acres Needed For Application		**Forages**		**Row Crops**
If Nitrogen-Based Application		171.92		557.18
If Phosphorus-Based Application		895.58		2,392.66
Opportunity Cost of Land		**Forages**		**Row Crops**
If Nitrogen-Based Application	$	10,314.91		-
If Phosphorus-Based Application	$	53,734.72		-
Application Costs		**Forages**		**Row Crops**
If Nitrogen-Based Application	$	32,278.15	$	37,550.12
If Phosphorus-Based Application	$	42,400.56	$	65,915.44
Savings From Not Having To Buy Fertilizer		**Forages**		**Row Crops**
If Nitrogen-Based Application		-	$	(11,365.56)
If Phosphorus-Based Application		-	$	(27,454.77)
Extra Fertilizer Purchase Costs		**Forages**		**Row Crops**
If Nitrogen-Based Application	$	8,953.20		-
If Phosphorus-Based Application	$	118,916.22		-

Note: 13,532,844 lbs. / year of solids modeled to be land applied

Table SS.77. Summary and Mass Balance of Generated and Land Applied Nutrients—Standardized Quantities and Prices (8,800-Head Feeder-Finish)

Nutrient Balance	Nitrogen (lbs/ year)	Phosphorus (lbs / year)	Potassium (lbs / year)
Generated At Barn	178,112.00	51,040.00	87,560.00
Nutrient Reduction Due to Solids Separation	83,178.30	37,922.72	13,484.24
Entering Biogreen System	94,933.70	13,117.28	74,075.76
Removed in Biogreen	75,946.96	2,675.93	15,629.99
Remaining after Biogreen Treatment	18,986.74	10,441.35	58,445.77
Entering P-Removal Module	6,651.82		20,475.90
Removed by P-Removal Module	-	3,438.54	-
Remaining in Recycled Effluent	12,334.92	6,783.33	37,969.88
Land Applied in Treated Effluent	6,651.82	219.48	20,475.90

Tables SS.78 through SS.93: Costs and Returns Estimates Based on Standardized Cost and Performance Data for Super Soils On-Farm System: 4,000-Sow Farrow to Wean Operation with Pit-Recharge

Table SS.78. Super Soils Technology Assumptions and Total Annualized Costs—Standardized Quantities and Prices (4,000-Sow Farrow-Wean)

Number of Animals	**4,000**		
Type of Operation	**Farrow-Wean**		
Barn Cleaning System	**Pit-Recharge System**		
Annualized Cost ($ / Year)			
Total Annualized Cost		Forages	Row Crops
	If Nitrogen-Based Application	**$ 620,638.48**	**$ 606,297.82**
	If Phosphorus-Based Application	**$ 726,511.64**	**$ 609,261.99**
Per Unit Cost ($ / 1,000 lbs. of SSLW)			
Total Annualized Cost per Unit		Forages	Row Crops
	If Nitrogen-Based Application	**$ 358.34**	**$ 350.06**
	If Phosphorus-Based Application	**$ 419.46**	**$ 351.77**

Note: Daily volume discharged from barns is 142,682 gallons / day including recharge liquid.
SSLW equals 1,732,000 pounds.

Table SS.79. Super Soils Technology Manure Evacuation and Lift Station Costs—Standardized Quantities and Prices (4,000-Sow Farrow-Wean)

Component	Total Cost	Annualized Cost
Manure Evacuation	$ 6,377.00	$ 950.36
Lift Station		
Concrete Lift Station	$ 4,041.30	$ 602.27
Switches and Brackets	$ 253.00	$ 37.70
Pumps	$ 6,936.80	$ 2,499.67
Piping	$ 291.34	$ 43.42
Lift Station Accessories	$ 15,431.46	$ 2,299.74
Electric Panel	$ 2,130.76	$ 317.55
Labor (Electrical)	$ 5,852.00	$ 872.12
Electrical Materials	$ 5,755.20	$ 857.69
Contractor & Engineering Services & Overhead	$ 20,286.68	$ 3,023.31
Total Construction Cost	$ 67,355.54	
Electric Power Cost		$ 1,188.21
Maintenance Cost		$ 1,032.44
Property Taxes		$ 239.11
Total Operating Costs		$ 2,459.77
TOTAL ANNUALIZED COST OF MANURE EVACUATION AND LIFT STATION		**$ 13,963.61**

Table SS.80. Super Soils Technology Strainer Costs—Standardized Quantities and Prices (4,000-Sow Farrow-Wean)

Component	Total Cost	Annualized Cost
Pit	$ 266.00	$ 39.64
Strainer	$ 475.00	$ 70.79
Fittings/Pipe	$ 266.10	$ 39.66
Labor	$ 950.00	$ 141.58
Contractor & Engineering Services & Overhead	$ 843.51	$ 125.71
Total Construction Cost	**$ 2,800.60**	
Maintenance Cost		$ 39.14
Property Taxes		$ 9.94
Total Operating Cost		
TOTAL ANNUALIZED COST OF STRAINER		**$ 466.46**

Table SS.81. Super Soils Technology Homogenization Tank Costs—Standardized Quantities and Prices (4,000-Sow Farrow-Wean)

Component	Total Cost	Annualized Cost
Tank	$ 91,407.80	$ 13,622.46
Mixer & Controls	$ 5,680.00	$ 846.49
Screen	$ 10,000.00	$ 1,490.29
Materials & Equipment	$ 12,109.70	$ 1,804.70
Labor-General	$ 1,300.31	$ 193.78
Labor-Mechanical	$ 1,749.38	$ 260.71
Labor-Electrical	$ 6,186.81	$ 922.02
Contractor & Engineering Services & Overhead	$ 15,958.29	$ 2,378.26
Total Construction Cost	$ 144,392.29	$ 21,518.71
Electric Power Cost		$ 2,234.16
Maintenance Cost		$ 2,383.95
Property Taxes		$ 512.59
Total Operating Cost		$ 5,130.70
TOTAL ANNUALIZED COST OF HOMOGENIZATION TANK		**$ 26,649.41**

Table SS.82. Super Soils Technology Separation Building Costs—Standardized Quantities and Prices (4,000-Sow Farrow-Wean)

Component	Total Cost	Annualized Cost
Materials-General	$ 37,720.37	$ 5,621.45
Materials & Equipment	$ 22,712.99	$ 3,384.90
Labor-General	$ 87,173.45	$ 12,991.41
Steel Structure	$ 50,163.80	$ 7,475.89
Steel Stair	$ 10,750.00	$ 1,602.07
Labor-Mechanical	$ 5,292.98	$ 788.81
Labor-Electrical	$ 16,256.25	$ 2,422.66
Contractor & Engineering Services & Overhead	$ 99,160.10	$ 14,777.78
Total Construction Cost		$ 49,064.97
Maintenance Cost		$ 2,426.94
Property Taxes		$ 1,168.77
Total Operating Cost		$ 3,595.71
TOTAL ANNUALIZED COST OF SEPARATION BUILDING		**$ 52,660.68**

Table SS.83. Super Soils Technology Solids Separator Costs—Standardized Quantities and Prices (4,000-Sow Farrow-Wean)

Component	Total Cost	Annualized Cost
Storage	$ 10,000.00	$ 1,490.29
Main Module	$ 650,000.00	$ 96,869.17
Dehydration System	$ 102,500.00	$ 15,275.52
Support Belt Filter	$ 9,500.00	$ 1,415.78
Materials & Equipment	$ 41,198.25	$ 6,139.75
Shipping	$ 38,171.90	$ 5,688.74
Labor-Mechanical	$ 16,555.10	$ 2,467.20
Labor-Electrical	$ 72,454.70	$ 10,797.89
Contractor & Engineering Services & Overhead	$ 405,303.76	$ 60,402.21
Total Construction Cost	$ 1,345,683.71	$ 200,546.56
Electric Power Cost		$ 2,747.56
Polymer Cost		$ 82,080.59
Maintenance Cost		$ 40,159.91
Property Taxes		$ 4,777.18
Total Operating Cost		
TOTAL ANNUALIZED COST OF SOLIDS SEPARATOR		**$ 330,311.79**

Table SS.84. Super Soils Technology Observation Deck Costs—Standardized Quantities and Prices (4,000-Sow Farrow-Wean)

Component	Total Cost	Annualized Cost
Material-General	$ 874.17	$ 130.28
Steel	$ 3,804.91	$ 567.04
Labor	$ 5,935.00	$ 884.49
Contractor & Engineering Services & Overhead	$ 4,574.67	$ 681.76
Total Construction Cost	$ 15,188.75	$ 2,263.57
Maintenance Cost		$ 93.58
Property Taxes		$ 53.92
Total Operating Cost		$ 147.50
TOTAL ANNUALIZED COST OF OBSERVATION DECK		**$ 2,411.07**

Table SS.85. Super Soils Technology Denitrification Tank Costs—Standardized Quantities and Prices (4,000-Sow Farrow-Wean)

Component	Total Cost	Annualized Cost
Tank	$ 46,307.75	$ 6,901.22
Mixer	$ 4,750.00	$ 707.89
Mixer Controls	$ 700.00	$ 104.32
Material & Equipment	$ 9,956.56	$ 1,483.82
Labor	$ 2,125.48	$ 316.76
Probes/Meters	$ -	$ -
Contractor & Engineering Services & Overhead	$ 7,556.31	$ 1,126.11
Total Construction Cost	$ 71,396.10	$ 10,640.12
Electric Power Cost		$ 1,162.66
Maintenance Cost		$ 1,234.29
Property Taxes		$ 253.46
Total Operating Cost		$ 2,650.41
		$ 13,290.53

Table SS.86. Super Soils Nitrification Tank Costs—Standardized Quantities and Prices (4,000-Sow Farrow-Wean)

Component	Total Cost	Annualized Cost
Tank	$ 25,179.42	$ 3,752.48
Screen Housing	$ 5,861.27	$ 873.50
Screen	$ 1,701.74	$ 253.61
Diffusers	$ 1,979.37	$ 294.98
Tank Floor	$ 560.00	$ 83.46
BIO-N Cubes/Engineering	$ 192,869.48	$ 28,743.24
Material & Equipment	$ 11,481.56	$ 1,711.09
Labor	$ 7,053.09	$ 1,051.12
Probes/Meters	$ -	$ -
Contractor & Engineering Services & Overhead	$ 95,469.31	$ 14,227.74
Total Construction Cost	$ 342,155.24	
Electric Power Cost		$ 5,284.44
Maintenance Cost		$ 994.65
Property Taxes		$ 1,214.65
Total Operating Cost		$ 7,493.74
TOTAL ANNUALIZED COST OF NITRIFICATION TANK		

Table SS.87. Super Soils Technology Settling Tank Costs—Standardized Quantities and Prices (4,000-Sow Farrow-Wean)

Component	Total Cost	Annualized Cost
Tank	$ 195,266.63	$ 29,100.49
Material & Equipment	$ 10,226.18	$ 1,524.00
Labor	$ 3,589.38	$ 534.92
Contractor & Engineering Services & Overhead	$ 5,954.51	$ 887.40
Total Construction Cost		$ 32,046.81
Electric Power Cost		$ 156.91
Maintenance Cost		$ 4,109.86
Property Taxes		$ 763.38
Total Operating Cost		$ 5,030.15
TOTAL ANNUALIZED COST OF SETTLING TANK		**$ 37,076.96**

Table SS.88. Super Soils Technology Clean Water Tank Costs—Standardized Quantities and Prices (4,000-Sow Farrow-Wean)

Component	Total Cost	Annualized Cost
Tank	$ 51,842.13	$ 7,726.01
Material & Equipment	$ 4,649.19	$ 692.87
Labor	$ 1,338.15	$ 199.42
Contractor & Engineering Services & Overhead	$ 2,580.54	$ 384.58
Total Construction Cost	$ 60,410.01	$ 9,002.87
Maintenance Cost		$ 1,129.83
Property Taxes		$ 214.46
Total Operating Cost		$ 1,344.28
TOTAL ANNUALIZED COST OF CLEAN WATER TANK		**$ 10,347.16**

Table SS.89. Super Soils Technology Phosphorus Removal Module Costs—Standardized Quantities and Prices (4,000-Sow Farrow-Wean)

Component	Total Cost	Annualized Cost
Settling Tank	$ 15,694.00	$ 2,338.87
Draimad System	$ 11,519.00	$ 1,716.67
Polymer Preparer	$ 5,935.00	$ 884.49
Polymer Mixer	$ 564.00	$ 84.05
Shipping	$ 1,197.62	$ 178.48
Materials-General	$ 961.56	$ 143.30
Materials-Mechanical	$ 3,750.00	$ 558.86
Materials-Electrical	$ 29,780.09	$ 4,438.11
Labor-General	$ 10,565.00	$ 1,574.50
Labor-Mechanical	$ 3,500.00	$ 521.60
Labor-Electrical	$ 5,073.00	$ 756.03
Contractor & Engineering Services & Overhead	$ 38,160.43	$ 5,687.03
Total Construction Cost	$ 126,699.70	$ 18,881.99
Electric Power Cost		$ 754.17
Lime Slurry Cost		$ 6,892.18
Polymer Cost		$ 953.42
Phosphorus and Lime Cost Savings		$ (2,891.28)
Maintenance Cost		$ 1,364.07
Property Taxes		$ 449.78
Total Operating Cost		$ 7,522.34
		$ 26,404.33

Table SS.90. Super Soils Technology Return to Barns Costs—Standardized Quantities and Prices (4,000-Sow Farrow-Wean)

Component	Total Cost	Annualized Cost
Plumbing/Piping	$ 2,600.00	$ 387.48
Pumps	$ 1,200.00	$ 432.42
Contractor & Engineering Services & Overhead	$ 1,637.80	$ 244.08
Total Construction Cost	$ 5,437.80	$ 1,063.98
Electric Power Cost		$ 1,896.75
Maintenance Cost		$ 112.00
Property Tax		$ 19.30
Total Operating Cost		$ 2,028.06
TOTAL ANNUALIZED COST OF RETURN TO BARNS		**$ 3,092.03**

TECHNOLOGY ROYALTY FEES	**$ 36,000.00**

TOTAL CONSTRUCTION COST OF SUPER SOILS TECHNOLOGY	**$ 2,725,786.36**
TOTAL OPERATING COST INCLUDING ROYALTIES OF SUPER SOILS TECHNOLOGY	**$ 203,216.97**
LAND APPLICATION	**$ 611,158.98**

Table SS.91. Super Soils Technology Predicted Liquid Application Costs for Four Land Application Scenarios—Standardized Quantities and Prices (4,000-Sow Farrow-Wean)

Annual Cost of Applying Lagoon Effluent		**Forages**		**Row Crops**
If Nitrogen-Based Application	$	9,411.39	$	7,876.91
If Phosphorus-Based Application	$	9,362.34	$	8,009.40
Acres Needed For Assimilation		**Forages**		**Row Crops**
If Nitrogen-Based Application		20.69		20.69
If Phosphorus-Based Application		20.69		20.69
Opportunity Cost of Land		**Forages**		**Row Crops**
If Nitrogen-Based Application	$	1,241.64		-
If Phosphorus-Based Application	$	1,241.64		-
Irrigation Costs		**Forages**		**Row Crops**
If Nitrogen-Based Application	$	8,120.70	$	8,120.70
If Phosphorus-Based Application	$	8,120.70	$	8,120.70
Savings From Not Having To Buy Fertilizer		**Forages**		**Row Crops**
If Nitrogen-Based Application		-	$	(243.79)
If Phosphorus-Based Application		-	$	(111.30)
Extra Fertilizer Purchase Costs		**Forages**		**Row Crops**
If Nitrogen-Based Application	$	49.05		-
If Phosphorus-Based Application		-		-

Note: 11,257,524 gallons / year of effluent modeled to be land applied

Table SS.92. Super Soils Technology Predicted Solids Application Costs for Four Land Application Scenarios—Standardized Quantities and Prices (4,000-Sow Farrow-Wean)

Annual Cost of Applying Solids		**Forages**		**Row Crops**
If Nitrogen-Based Application	$	33,352.68	$	16,586.02
If Phosphorus-Based Application	$	154,203.41	$	24,023.90
Acres Needed For Application		**Forages**		**Row Crops**
If Nitrogen-Based Application		112.93		366.01
If Phosphorus-Based Application		649.93		1,736.36
Opportunity Cost of Land		**Forages**		**Row Crops**
If Nitrogen-Based Application	$	6,775.76		-
If Phosphorus-Based Application	$	38,995.57		-
Application Costs		**Forages**		**Row Crops**
If Nitrogen-Based Application	$	21,295.72	$	24,549.94
If Phosphorus-Based Application	$	28,328.22	$	43,848.73
Savings From Not Having To Buy Fertilizer		**Forages**		**Row Crops**
If Nitrogen-Based Application		-	$	(7,963.92)
If Phosphorus-Based Application		-	$	(19,824.84)
Extra Fertilizer Purchase Costs		**Forages**		**Row Crops**
If Nitrogen-Based Application	$	5,281.20		-
If Phosphorus-Based Application	$	86,879.62		-

Note: 7,883,320 lbs. / year of solids modeled to be land applied

Table SS.93. Summary and Mass Balance of Generated and Land Applied Nutrients—Standardized Quantities and Prices (4,000-Sow Farrow-Wean)

Nutrient Balance	Nitrogen (lbs/ year)	Phosphorus (lbs / year)	Potassium (lbs / year)
Generated At Barn	117,000.00	37,040.00	77,000.00
Nutrient Reduction Due to Solids Separation	54,639.00	27,520.72	11,858.00
Entering Biogreen System	62,361.00	9,519.28	65,142.00
Removed in Biogreen	49,888.80	1,941.93	13,744.96
Remaining after Biogreen Treatment	12,472.20	7,577.35	51,397.04
Entering P-Removal Module	2,517.48	1,529.47	10,374.35
Removed by P-Removal Module	-	1,437.70	-
Remaining in Recycled Effluent	9,954.72	6,047.88	41,022.69
Land Applied in Treated Effluent	2,517.48	91.77	10,374.35

Tables SS.94 and SS.95: Predicted Costs of Retrofitting Various Representative Farm Sizes and Farm Types with the Super Soils On-Farm System: DWQ Permitted Farms and SF/PSF Owned Farms

Table SS.94. Predicted Costs ($ / 1,000 Pounds of Steady-State Live Weight (SSLW) per Year) of Retrofitting DWQ Permitted Representative Farm Type / Farm Size Combinations—Super Soils Technology

	Farm Size (1,000 pounds SSLW)				
	0-500	**500-1000**	**1000-1500**	**1500-2000**	**> 2000**
Farm Type					
Farrow-wean					
Rep. # of sows	752	1,540	2,400	4,000	6,000
Pit-recharge system	$565.32	$439.07	$388.45	$358.34	$329.81
Flush system	$579.36	$448.34	$453.83	$400.97	$361.40
Farrow-feeder					
Rep. # of sows	500	1,200	2,000	3,600	5,500
Pit-recharge system	$688.50	$474.88	$409.20	$361.14	$351.38
Flush system	$728.02	$605.91	$502.49	$490.46	$447.15
Farrow-finish					
Rep. # of sows	150	500	1,000	1,200	2,000
Pit-recharge system	$807.07	$443.57	$342.78	$346.33	$313.42
Flush system	$829.70	$463.71	$405.72	$401.16	$376.39
Wean-feeder					
Rep. head capacity	3,840	20,000	N/A	N/A	N/A
Pit-recharge system	$1,405.24	$551.59	N/A	N/A	N/A
Flush system	$1,639.58	$1,150.11	N/A	N/A	N/A
Feeder-finish					
Rep. head capacity	2,448	5,280	8,800	12,240	17,136
Pit-recharge system	$586.34	$440.89	$333.46	$323.63	$305.96
Flush system	$597.76	$453.86	$393.15	$333.73	$341.38

Table SS.95. Predicted Costs ($ / 1,000 Pounds of Steady-State Live Weight (SSLW) per Year) of Retrofitting Smithfield Foods/Premium Standard Farms Representative Farm Type / Farm Size Combinations—Super Soils Technology

	Farm Size (1,000 pounds SSLW)				
	0-500	**500-1000**	**1000-1500**	**1500-2000**	**> 2000**
Farm Type					
Farrow-wean					
Rep. # of sows	650	1,700	2,400	4,000	7,000
Pit-recharge system	$641.86	$414.96	$388.45	$358.34	$320.85
Flush system	$641.75	$499.48	$453.83	$400.97	$349.58
Farrow-feeder					
Rep. # of sows	675	1,200	2,000	3,419	5,500
Pit-recharge system	$554.47	$474.88	$409.20	$372.37	$351.38
Flush system	$754.69	$605.91	$502.49	$475.06	$447.15
Farrow-finish					
Rep. # of sows	N/A	500	1,000	1,200	2,000
Pit-recharge system	N/A	$443.57	$342.78	$346.33	$313.42
Flush system	N/A	$463.71	$405.72	$401.16	$376.39
Wean-feeder					
Rep. head capacity	2,808	N/A	N/A	N/A	N/A
Pit-recharge system	$1,838.92	N/A	N/A	N/A	N/A
Flush system	$2,074.99	N/A	N/A	N/A	N/A
Feeder-finish					
Rep. head capacity	1,240	5,100	8,800	12,246	17,136
Pit-recharge system	$986.39	$452.67	$333.46	$323.55	$305.96
Flush system	$1,000.57	$463.89	$393.15	$333.64	$341.38

APPENDIX SS.A

JUSTIFICATION OF COST REDUCTIONS IN ECONOMIC MODEL

ITEM

UNNECESSARY EXPENSES

1. **Mixing Solns-Hom, DN1, & DN2 Tanks.** Several mixing devices were tried in the tanks before the final solution was installed. These caused unnecessary expense in materials and particularly labor. We tried installation of recirculation pumps (two types) before purchasing the mixers being used currently. Both installations required piping and electrical work. One required purchase of pumps. Pump cost was approximately $1000.00 each for DN1 and DN2. Electrical and piping installation is estimated at $1000.00 each for three pumps.
2. **Modifications to Allow Return to Current Waste Handling System.** Modifications to the existing waste evacuation system were completed so that the drain system could be easily returned to the traditional permitted system. This resulted in significant expenditures beyond those needed to simply divert the waste to the new processing system. Examples include construction of 12 additional drain pits that divert the waste stream to the new lift station instead of the lagoon. Cost reductions included blocks/brixment ($668.00), block labor ($960.00), Pipe/fittings ($272.31), Sure Mix Seal ($94.61), Concrete Floors ($660.00), Labor (pipes/pits) ($750.00). Total is $3,405.00.
3. **Unused Portion of Waste evacuation Tank.** Due to groundwater level at the construction site and space restrictions, we could only dig deep enough to install one ring of the tank. The smaller tank size is acceptable for the application. The cost of one ring is approximately $6,000.
4. **Unused Conduit and wire to lift station.** A conduit was laid from the solids removal bldg. (control center) to the lift station in case communication/electrical wires are needed for additional automation of the lift system in the future. Cost of materials is estimated at $1,500.
5. **Excess Labor for Tank Installation.** An additional $3000 was paid to the installation contractor to cover additional labor and equipment required to bury the tank. The additional labor was required due to groundwater seepage and cave-in during the installation
6. **Excess Electrical Labor.** Labor associated with lightning problem and installation of additional conduit and wire to Lift Station. Estimated at $1,500.00.
7. **Lightning Damage to Control Panel.** Replacement equipment to control panel of Lift Station due to lightning damage. Lightning damaged the electrical circuit board and lightning protection equipment. Estimated cost of $500.
8. **Reversible Pit Recharge System.** Additional labor and materials to allow return to conventional system. Control valves were placed near the wash-down pump station. Two sets of control valves were required. Estimated cost is 750.00.
9. **Self-Clean System.** Unused materials, pump, filters, etc. for change to groundwater cleaning system. Additional materials and labor for groundwater

system. A pump and very expensive filter system were purchased before a decision was made to convert to a groundwater system. We could not return the pump ($1,500.00), filter system ($2,500.00), and filters ($50.00), Labor ($950.00; Total $5,000).

10. **Replacement Water Piping Materials.** Replacement of copper mixing and valve system due to concern over long-term corrosion. ($1,000 materials, $500 labor)
11. **Conversion of Electrical Circuits to US standards.** Many electrical components in the SELCO solids removal unit had to be replaced with US components so that the voltage feeding equipment would be acceptable. (Approx. $10,000 materials and $10,000 labor)
12. **Pump conversion to US standards.** The DAF pump impellers were modified to conform to US electrical standards. This was necessary to avoid overloading the motor that powered the pump. $500 machine shop and labor; $500 rewind motor.
13. **Airflow Meter Changes.** The airflow meters initially purchased were not sized appropriately to make the desired measurements. They could not be returned. Approximate cost was $1,500 for materials and $500 for labor; Total $2,000.
14. **Additional PLC for BIOGREEN and P-Removal Systems.** In the original design, the PLC for the SELCO solids removal unit was to be used to control all automation. We learned that the PLC in the SELCO unit was not sized properly to handle this load so an additional PLC and software was purchased. This was a design mistake. The larger PLC could have handled all of the control work. This also required purchase of a second screen and electrical protection equipment. The PLC is $9,581, the screen $3,800, and the protection/Associated equipment/software $6,842. Labor to make the changes is estimated at $15,000. Total $35,223 - $5,000 for larger SELCO PLC = $30,223.
15. **Relocation of Methanol Injection Pump.** A decision was made to relocate the methanol injection pump to avoid risk of fire. This was done after the initial installation was completed. (Estimated $500 materials and $500 labor)
16. **Level Probes not Providing Adequate Safeguard.** After initial installation, we learned that the level probes would not provide adequate protection against spills and loss of BIOGREEN pellets. As a result, additional floats were installed where needed (4 floats, wiring, and labor). The probes were not needed after the floats were installed. Their estimated cost is $1,000 each for materials and labor.
17. **General Electrical Layout and Changes**. Several significant electrical changes were made during construction that resulted in additional material and labor expenses.

COMPONENTS REQUIRED FOR EVALUATION

18. **ORP Meters in DN1 and DN2.** ORP meters were installed for use of the evaluation team. This resulted in a significant amount of additional materials and labor. Estimated $1,000 labor and $1,000 materials for each meter.
19. **pH Meter in Nitrification Tank**. This was installed for the Evaluation team and resulted in additional material and labor ($2,000).
20. **DO Meters in Nitrification and Oxic Tanks.** This was installed for the evaluation team and resulted in additional material and labor ($4,000).

21. **Air (3) & Liquid (3) Flow-meters.** These were installed according to original design to facilitate evaluation of the treatment system and provide precise control. $1,425 airflow and $2,750 + $2,915 liquid flow meters plus $7,000 labor.
22. **Level Probe in Clean-water Tank.** This was installed only for use by the evaluation team. Estimate $500 material and $500 labor.
23. **Additional Electric Circuits.** Additional Electric circuits were added to power equipment used by the Open and Verification Teams.
24. **Irrigation Storage.** A storage tank moved and set up to support studies to be conducted by USDA-ARS Florence. Studies are being conducted to verify that the treated water can be applied to crops in a trickle irrigation system. This tank was originally intended to serve as the settling tank in the BIOGREEN system. It was later determined that a cone could not be easily installed in the bottom of the tank as originally planned.

COMPONENTS TO BE ELIMINATED

25. **DAF Pit**. After initial start-up of the solids removal unit, it was determined that the DAF Pit is not required for the treatment process. Pit $600, Inst. Labor $600, Extra Piping $500, Float $100, Probes $500, Elect. Labor $1,135, Pump $1,565; Total $5,000.
26. **Methanol Injection System.** Over the past 6 months, evaluation studies have indicated that the Methanol Injection System is not required for the BIOGREEN treatment system. Pump $1,147, BLDG. $1,500, Piping $500, Elect. $1,000, Float $100; Total $4,247
27. **Sludge Pit.** During the past 6 months, evaluation studies have indicated that the Sludge Pit is not required for the BIOGREEN treatment system. Pit $600, Inst. Labor $600, Probe $500, Pump $1,565, Elect. Labor $1,500; Total $4,765
28. **Sludge weir on the settling tank.** During the past 6 months, evaluation studies have indicated that the sludge weir is not needed for proper function of the BIOGREEN system. Materials and Labor $2,000
29. **Lime Tank and Mixer.** During the last 6 months, evaluations indicate that the additional Lime tank and mixer are not needed for proper function of the P-removal system. Tank $650, Mixer $600, Inst. & Elect. Labor $1,250
30. **Electronic and Air Valves.** During the last 6 months, evaluations indicate that the valves are not necessary and may actually result in higher risk of improper function and spills. Valves and Labor $5,722.
31. **DN2 Tank.** During the last 6 months, evaluations indicate that the second denitrification tank is not necessary for thorough treatment of the waste. $47,453 - $48.94 = $42,557.
32. **Oxic Tank.** During the past 6 months, evaluations indicate that the Oxic tank is not needed for proper treatment of the waste. $37,610 - $4,080 = $34,531.
33. **Conversion to less expensive building.** The Solids Removal Bldg. was built using more expensive materials to provide additional protection for evaluation equipment. Experience since that time indicates that the cost of this facility can be reduced by at least one-third.

OTHER PROJECT COMPONENTS

34. **Compost facility.** The composting facility should not be considered part of the individual farm expenses. Total $18,452.
35. **Misl. Expenses.** Expenses for portable toilet and construction waste disposal should not be a part of individual farm expenses. $12,815.

Prepared by C. Ray Campbell 12/2/03; Revised 2/10/04