Florida Onsite Sewage Nitrogen Reduction Strategies Study

Passive Nitrogen Reduction System Life Cycle Cost Analysis Tool (PNRS LCCA)

User Guide

Prepared for:

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Objective of Report

The passive nitrogen reduction system life cycle cost analysis (PNRS LCCA) tool is a computer spreadsheet tool that estimates the life cycle costs of passive nitrogen removal systems for onsite wastewater treatment as well as conventional onsite wastewater treatment and disposal systems (OSTDS). The user specifies a desired nitrogen removal efficiency range, and PNRS LCCA provides selections for treatment processes that achieve the selected nitrogen removal range and estimates the costs to meet the selected nitrogen removal efficiency. PNRS LCCA includes built in cost estimates for both conventional treatment systems (primary treatment + soil treatment and dispersal) as well as passive nitrogen removal systems (PNRS). PNRS LCCA also can provide cost estimates for the addition of saturated (Stage 2) biofilters to an existing nitrification treatment unit. This report summarizes the background of PNRS LCCA, describes the structure of the model, and provides a user guide for model application. Although the default system sizing and cost data in PNRS LCCA are based on the OSTDS code and costs in Florida, the tool allows user specific inputs which allow its use elsewhere, with some limitations.

PNRS LCCA Background

Passive nitrogen removal systems (PNRS) are 2-stage biofilter systems that enhance nitrogen removal from onsite wastewater through a combination of unsaturated biofilters for ammonia oxidation (Stage 1) and saturated biofilters with reactive media for denitrification (Stage 2). PNRS systems increase total nitrogen removal over conventional systems, which consist of primary treatment (i.e. septic tank) followed by a soil treatment unit. Passive two-stage nitrogen removal has been experimentally evaluated in the PNRS I bench-scale studies, PNRS II pilot studies, and in seven full-scale systems at individual home sites. PNRS LCCA was developed to provide planning level life cycle cost estimates for various passive two-stage nitrogen removal system options. The model includes capital and installation costs for new systems or the addition of PNRS components to an existing OSTDS system. The recurring annual costs for operation, maintenance, and compliance are also included in the model. The costs of conventional treatment as well as the total costs for conventional + PNRS treatment are provided.

Overall Model Structure

The PNRS LCCA is a spreadsheet consisting of a series of linked worksheets. The general flow of PNRS LCCA deployment is summarized here. The user first specifies the wastewater quantity based on building size and occupancy for the site, as per Florida code (FAC 64E-6.008 Table I). The next step is to choose one of three levels of nitrogen removal that are available for the site. Information is then entered on the characteristics of the existing conventional treatment system including primary treatment and soil treatment and dispersal systems, on general site characteristics that impact PNRS installation, on recurring costs for operation, maintenance, and compliance, and net discount rate for cost projections.

The user then specifies the specific PNRS system for which life cycle costs will be estimated.

PNRS LCCA then provides default cost estimates for conventional onsite treatment and conventional + PNRS. Default cost estimates include capital and recurring costs and are based on built-in algorithms. PNRS LCCA summarizes the default costs and presents the user with the option to override LCCA default costs with user specified costs. Present Worth analysis is applied to all costs, and PNRS LCCA provides a summary and breakout of life cycle costs for conventional treatment, and total system of conventional + PNRS. PNRS LCCA also calculates the dollar cost per mass of nitrogen removed. Results are presented in tables that include treatment technology characteristics, individual and summarized cost components, and corresponding pie chart cost distributions.

PNRS LCCA Worksheets

The individual PNRS LCCA worksheets are listed in Table 1. Some attributes of the PNRS LCCA model and worksheets are described here, as well as caveats for use.

1. ***LCCA Structure:*** A description of passive two-stage biofiltration processes is presented along with major design factors and example systems that have been evaluated at individual home sites. Conventional treatment (primary + soil treatment and dispersal) can reduce total nitrogen by 25-35%, and is assigned a total nitrogen removal of 30% (Low Level) in PNRS LCCA. Stage 1 systems alone will nitrify wastewater and if recirculation is provided can provide 50 to 70% total nitrogen removal (Medium Level). Also, several of the simple in-ground system designs can achieve similar reductions in total nitrogen. A 60% TN removal rate is thus assigned for Medium Level systems. Adding Stage 2 biofilter systems will denitrify wastewater further and can increase total nitrogen removal to a High Level (95%) provided that they are preceded by highly effective nitrification and include a soil treatment unit for effluent dispersal.

2. ***Table of LCCA Worksheets:*** A tabular summary is provided of the salient features of each PNRS LCCA worksheet.

3. ***Wastewater Quantity and System Parameters:*** The user specifies building area and number of bedrooms, which determine the design wastewater flowrate. For the conventional system (primary treatment + soil treatment and dispersal), the primary tank (and pump tank, if needed) is sized according to Florida Administrative Code (FAC 64E-6.008).

   The level of nitrogen treatment is selected from options of low, medium and high, with respective total nitrogen removals of 30, 60 and 95% used for calculations. Following the level of treatment selection, the applicable input fields are highlighted blue.

Data is then entered for usable pre-existing primary tankage, configuration of soil dispersal, surface loading rate, and depth to seasonal high water table. The soil treatment unit is sized according to the user defined configuration and surface loading rate (using FAC 64E-6.008 Table III for guidance). The depth to seasonal high water table determines if a mound system is needed.

Site data is entered which affect PNRS installation including: if the onsite sewage treatment and disposal system (OSTDS) is a new installation or retrofit to an existing system to enhance nitrogen removal, if an existing fully nitrifying aerobic process (Stage 1 biofilter or other nitrifying unit i.e. ATU, PBTS) is already present and usable, the construction complexity at the site (simple, moderate or complex), topography to determine the need for a pump, if primary effluent dispersal to a Stage 1 in-ground biofilter will use a drip system, and sophistication of the control panel (standard or complex).

Data is entered for all recurring annual operating costs including unit electrical cost, number of inspection visits per year by maintenance entity, the operating permit fee, and the number of water quality monitoring events per year. In addition, data is entered for all recurring maintenance costs including primary tank pump out frequency, media replacement frequency, and equipment replacement frequency. Project life and net interest rate are entered for life cycle costing. Additional guidance and/or typical values are provided in the column to the right of the input field.

4. ***PNRS Process Selection:*** PNRS process selection specifies the PNRS process for which life cycle costs will be estimated. All fields should be set to zero or blank before starting the selection process. Based on the level of nitrogen treatment the user selected in the ***WW Quantity & System Parameters*** worksheet (options of Low, Medium and High), the user selects from the drop down menu the desired processes: Stage 1 + Stage 2, Stage 1 only or Stage 2 only. The user selects Stage 1 only (60% total nitrogen removal or Medium Level), Stage 2 only (95% total nitrogen removal or High Level) which requires a fully nitrifying aerobic process be already present, or Stage 1 + Stage 2 (95% total nitrogen removal or High Level). Example PNRS system configurations are included in the *LCCA Structure* worksheet. Following the user defined processes selection, the applicable input fields are highlighted blue. PNRS system sub-selections are made for Stage 1 hydraulics (single pass or recirculation), for placement of Stage 1 in a tank or in-ground, for Stage 1 media (sand or expanded clay), and Stage 2 media (lignocellulosic material, elemental sulfur, or dual media). The option is offered to place lignocellulosic media underneath the Stage 1 media in a vertically stacked system. PNRS LCCA summarizes the PNRS system specified by the user in the ***PNRS Process Selection*** worksheet.

5. ***Default Design & Cost:*** PNRS LCCA determines the capital and operating costs for conventional treatment (primary treatment + soil treatment and dispersal), PNRS treatment, and conventional + PNRS treatment based on built-in data in the ***Design Data*** worksheet.

   The PNRS LCCA default costs have been developed for Florida conditions and are based on analysis of the costs of multiple conventional and PNRS systems. The default costs should be regarded as baseline estimates suitable for planning level cost analyses and for system comparisons.

6. ***Default Design Cost Summary:*** Capital and operating costs are summarized for conventional treatment (primary treatment + soil treatment and dispersal), PNRS treatment, and conventional + PNRS treatment. Costs are included for individual item costs, for system cost groupings, and for the overall systems.

7. ***User Specified Costs:*** The user has the option of entering capital and operating costs for specific cost items that override the LCCA default costs. All orange user specified cost entry fields should be set to zero or blank at the start of the PNRS LCCA application. PNRS LCCA presents the default design costs along with adjacent fields for entering user specified cost, along with the costs that will be used for life cycle cost analysis.

8. ***Life Cycle Cost Analysis, Conventional System:*** PNRS LCCA estimates life cycle cost for conventional treatment (primary + soil treatment and dispersal). Present Worth (PW) and Uniform Annual Costs (UAC) are shown. LCCA output for conventional treatment is shown in Figure 1. Results are summarized in tables that present the configuration of the system, individual cost components, cost groupings and total costs. Pie chart cost distributions are included. The conventional system LCCA results are incorporated into the life cycle costs of the total treatment system (conventional + PNRS).

9. ***Life Cycle Cost Analysis, Total System:*** PNRS LCCA estimates life cycle cost for the total treatment system of conventional treatment and PNRS. Present Worth (PW) and Uniform Annual Costs (UAC) are shown. LCCA output for conventional plus PNRS treatment is shown in Figure 2. Results are summarized in tables that present the configuration of the system, individual cost components, cost groupings and total costs. PNRS LCCA calculates the dollar cost per mass of nitrogen removed by the total treatment system. Pie chart cost distributions are included.

   The user can evaluate the overall cost of PNRS treatment versus conventional treatment only and the significance of individual treatment components to the overall system cost. The tabular and graphical results for a specific PNRS system can be saved and compared to the results for alternative PNRS systems. The dollar cost per mass of nitrogen removed by a PNRS can be compared to other PNRS systems or to other nitrogen removal options in a watershed, for example.

10. Design Data: Flow, sizing, energy utilization, and costs are compiled for generating the default costs of conventional and PNRS treatment systems. The worksheet includes the unit costs of materials, energy, site access and installation complexity. Under normal PNRS LCCA application this worksheet need not be accessed.

11. Example PNRS LCCAs: Example PNRS LCCAs are tabulated.

Table 1. PNRS LCCA Worksheets

Worksheet	Contents
1. LCCA Structure	Two-Stage PNRS Description ▪ Basic Model Structure ▪ Example PNRS Systems
2. Table of LCCA Worksheets	Summary Table of LCCA Worksheets
3. Wastewater Quantity & System Parameters	Determine design flowrate ▪ Specify conventional system parameters ▪ Select nitrogen removal level as high, medium or low @ 95%, 50-70%, or 25-30% ▪ Specify PNRS system parameters ▪ Specify recurring costs ▪ Specify net interest rate
4. PNRS Process Selection	Select specific PNRS system
5. Default Design & Cost	Summary of conventional system default design & cost ▪ Summary of PNRS design and default cost
6. Default Design Cost Summary	Default cost summary for conventional system, for PNRS system and for total system
7. User Specified Costs	User specified costs for conventional system ▪ User specified costs for PNRS
8. LCCA: Conventional	Characteristics of conventional system ▪ Life Cycle Cost Analysis of conventional system
9. LCCA: Total System	Characteristics of conventional system + PNRS ▪ Life Cycle Cost Analysis of conventional system + PNRS
10. Design Data	Compilation of flow and sizing criteria, unit cost factors for materials, energy, site access and installation complexity
11. Example LCCAs	Example Life Cycle Costs

PNRS LCCA Application

LCCA is applied as a discrete simulation for a specific case of wastewater flow, level of nitrogen removal required, and site characteristics. Therefore, there are two worksheets that require user input: 1) *WW Quantity & System Parameters* and 2) *PNRS Process Selection*. A third worksheet *User Specified Costs* allows the user to input capital and operating costs for specific cost items that override the PNRS LCCA default costs. The remaining model worksheets are for informational purposes only.

Wastewater Quantity and System Parameters

The user is first asked to provide nomenclature for PNRS LCCA identification which is referenced throughout the PNRS LCCA workbook.

Nomenclature for LCCA Identification

Next the number or bedrooms and building area are specified by the user to determine the design wastewater flowrate and must follow Florida statute (FAC 64E-6.008). PNRS LCCA includes this as a built-in feature.   For the conventional system of primary treatment + soil treatment and dispersal, the primary tank size and soil dispersal field area are determined by Florida statute (FAC 64E-6.008).

Wastewater Quantity

No. of Bedrooms

Building area, square feet

The user then specifies the level of treatment desired by selecting a nitrogen removal efficiency percentage range of greater than 95+ (**High**), 50-70 (**Medium**) or 25-35% (**Low**). The user should consider the environmental goals or regulatory requirements at the project site. Systems with a lower percent nitrogen removal will have lower capital, operating and life cycle costs. The user should select a higher nitrogen removal percent if there is uncertainty in the treatment requirements.

Level of Treatment

What level of nitrogen removal efficiency is needed for the site?

Low conventional (25 - 35%)

Medium (50 - 70%)

High (95+%)

Based on the level of treatment selected, additional user inputs are requested which are signaled by being highlighted blue.

The existing conventional system infrastructure (primary tank size, pump tank size and soil treatment unit infiltrative area) are input. Existing conventional infrastructure should only be considered if it can be verified as being truly usable. If the site requires a new system, 0 should be entered. In addition, the soil treatment unit configuration (trench or bed), surface loading rate and depth to seasonal high water table are input. The surface loading rate to the soil treatment unit is determined by the soil characteristics of the site and is specified in Florida code, as are procedures to determine the depth to seasonal high water table.

Conventional System Parameters

Existing system

Size of existing primary treatment tank, gallons	0
Size of existing pump treatment tank, gallons	0
Size of existing soil treatment unit, square feet	0

Soil treatment unit

Trench or bed configuration	
Infiltrative surface loading rate, gal/ft^2-day	
Depth to seasonal high water table (inches) at soil treatment unit	

If "medium" or "high" level of treatment are selected, the PNRS parameters need to be input. PNRS parameters include whether the nitrogen removal upgrade is to an existing onsite system (retrofit) or a new onsite wastewater treatment system. For existing systems, whether an existing Stage 1 biofilter or other fully nitrifying unit (ATU, PBTS) is usable. A construction complexity factor is input which considers site characteristics that determine if the installation is considered simple, moderate or complex. In addition, site topography to determine whether operation by gravity is possible (is there at least an 8 foot elevation drop from the house out 60 feet or more in the direction of the proposed system). For an in-ground Stage 1 biofilter installation, a cost factor for drip dispersal is applied if the primary effluent dispersal method is by a drip system rather than by gravity or low pressure distribution. The sophistication of the control panel (standard or complex) is also input. A complex control panel would provide remote monitoring ability.

PNRS Parameters

New OSTDS system installation or retrofit of existing system?	existing ▾
Will an existing Stage 1 biofilter or other nitrifying unit (i.e. ATU, PBTS) be used?	

Construction complexity: enter 1, 2 or 3

1 Simple (new undeveloped property) 2 Moderate (existing system, easy accessiblity to site) 3 Complex (existing system, difficult accessiblity to site)	
Is there at least an 8 foot elevation drop from the house out 60 feet in the direction of the proposed system?	
For an in-ground Stage 1 installation, is the primary effluent dispersal via a drip system?	
Standard or complex control panel?	

The annual operating costs included in the LCCA are local unit energy costs; required number of inspection visits and water quality monitoring events per year and associated costs; and permitting costs.

Annual operating costs

Energy Consumption

Electrical rate, $/kw-hour	0.100

Inspections, permit and monitoring

Number of inspection visits per year	2
Inspection & maintenance cost per visit, $	150
Operating permit fee, $	50
Number of water quality monitoring events per year	1
Water quality monitoring cost per sample event, $	120

The maintenance costs include primary tank pump out cost and frequency; media replacement cost and frequency; and equipment replacement cost and frequency.

Maintenance costs

Primary treatment tank pump out

Interval, years	5.0
Cost, $	300

Media Replacement

Stage 2 media replacement interval, years	15

Equipment Replacement

Pump replacement interval, years	10

Lastly, the cost parameters are input which include project life, recommended at 30 years, and net discounting rate.

Cost Analysis Parameters

Life Cycle Cost Analysis

Project life, years	30
Net Interest rate, %	1.500

PNRS Process Selection

The selection of a specific PNRS configuration is guided by technical factors, site factors, and experience. The *LCCA Structure* worksheet contains example PNRS configurations with varying levels of complexity.

All fields should be set to zero or blank before starting the selection process. Based on the level of nitrogen treatment and other parameters the user selected in the *WW Quantity & System Parameters* worksheet (options of low [25-35%], medium [50-70%] and high [95+%]), the user selects from the drop down menu the desired processes:

- Stage 1 + Stage 2 (*Stage1&2*),
- Stage 1 only (*Stage1*), or
- Stage 2 only (*Stage2*).

If "Low" level of treatment is specified, no additional inputs are required. The LCCA for a conventional system (primary tank + soil treatment unit) will be provided. If "Medium" level of treatment is specified, the user selects either *Stage1* or *Stage1&2*. If "High" level of treatment is specified, the user selects *Stage2* (which pertains only to where fully nitrifying systems are already present) or *Stage1&2*.

Following the user defined processes selection, the applicable input fields are highlighted blue. PNRS system sub-selections are made for placement of Stage 1 in a tank or in-ground, for Stage 1 hydraulics (single pass or recirculation), for Stage 1 media (sand or expanded clay), and Stage 2 media (lignocellulosic material, elemental sulfur, or dual media). The option is offered to place lignocellulosic media underneath the Stage 1 media in a vertically stacked system.

Stage 1&2 Biofilters System Selections

Stage 1 biofilter: in-tank or in-ground
Is the Stage 2 lignocellulosic media underlying the Stage 1 media?
Stage 1 biofilter mode of operation, single pass or recirculation?
Stage 1 biofilter type of media, expanded clay or sand?
Stage 2 biofilter type of media: lignocellulosic, sulfur or dual media?

Stage 1 Only Selections

Type of media expanded clay or sand?
Recirculation with recirc tank or no recirc tank?

Stage 2 Only Selections

Type of media: lignocellulosic, sulfur or dual media?
Both media in one tank or separate (two) tanks?

PNRS LCCA summarizes the PNRS system specified by the user in the **_PNRS Process Selection_** worksheet.

User Specified Costs

The user has the option to enter specific costs for individual cost factors in lieu of the default costs. The user should apply a reasonableness test to compare the user specified costs to PNRS LCCA default costs and the relative extent of deviation.

Figure 1 Results of LCCA for a Conventional Onsite Sewage Treatment and Disposal System (OSTDS)

PNRS LCCA: Life Cycle Cost Analysis Tool for Passive Nitrogen Reduction Systems
LCCA Identification: Stage 1 with recirculation, dual media Stage 2

Worksheet
1. LCCA Structure
2. Table of LCCA Worksheets
3. WW Quantity & System Parameters
4. PNRS Process Selection
5. Default Design & Cost
6. Default Design Cost Summary
7. User Specified Costs
8. LCCA Conventional
9. LCCA Total System
10. Design Data
11. Example LCCAs

8. LCCA Conventional

Present Worth (2015 dollars) — pie chart: Conventional Capital Cost, Conventional O&M

Conventional Capital Cost — pie chart: Primary tank, Pump tank, Pump, Soil treatment unit

Conventional System Summary

No. of Bedrooms	3
Building area, square feet	2,000
Depth to seasonal high water table (inches)	42
New OSTDS installation or retrofit of existing system	existing
Design wastewater flow, gallon/day	300

Life Cycle Cost Calculations

Project Life (PL), years	30
Interest Rate (IR), %	1.500
Primary tank pump out interval (TI), years	5.0
Pump out analysis life (PL), years	25.0
Equipment replacement interval (EI), years	10.0
Equipment replacement analysis life (EL), years	20.0
Compound Interest Factors	
P/A PL/IR	24.016
A/P PL/IR	0.04164
A/F TI	0.19409
P/A PL	20.720
A/F EI	0.09343
P/A EL	17.169
Nitrogen Removal	
Mass loading/year, lbs.	27.0
Removal efficiency, %	30.0
Mass removal/year, lbs.	8.1

Life Cycle Cost

Cost Item	Present Worth, $	Uniform Annual Cost, $	% of Total Life Cycle Cost
Conventional System Installation			
Primary treatment tank	1,400.00	58.29	26.8
Pump tank	0.00	0.00	0.0
Conventional system pump	0.00	0.00	0.0
Soil treatment unit	2,625.00	109.30	50.2
Subtotal	4,025.00	167.60	76.9
Operation and Maintenance			
Annual energy cost	0.00	0.00	0.0
Primary tank pump out	1,206.44	50.24	23.1
Equipment replacement	0.00	0.00	0.0
Subtotal	1,206.44	50.24	23.1
Total	5,231.44	217.83	100.0

Capital Cost

Installed Cost Item	Present Worth, $	Uniform Annual Cost, $	% of Installation Cost
Primary tank	1,400.00	58.29	34.8
Pump tank	0.00	0.00	0.0
Pump	0.00	0.00	0.0
Soil treatment unit	2,625.00	109.30	65.2
Total	4,025.00	167.60	100.0

Life Cycle Cost

Cost Item	Present Worth, $	Uniform Annual Cost, $	% of Total Life Cycle Cost
Conventional Capital Cost	4,025.00	167.60	76.9
Conventional O&M	1,206.44	50.24	23.1
Total	5,231.44	217.83	100.0
$/lb nitrogen removed	21.52	26.88	

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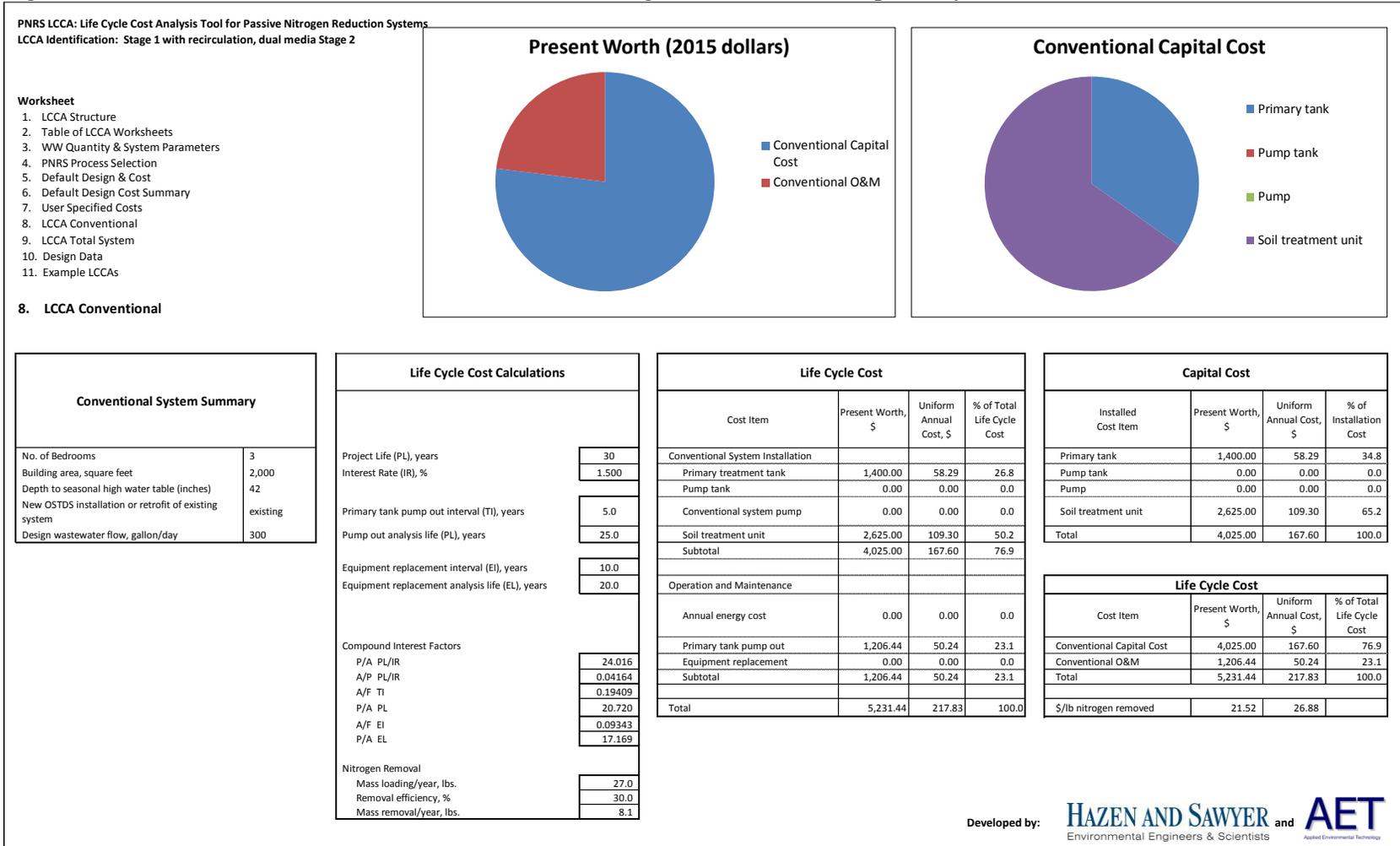
Figure 2 Results of LCCA for a Total System including Conventional OSTDS and Passive Nitrogen Removal

PNRS LCCA: Life Cycle Cost Analysis Tool for Passive Nitrogen Reduction Systems
LCCA Identification: Stage 1 with recirculation, dual media Stage 2

Worksheet
1. LCCA Structure
2. Table of LCCA Worksheets
3. WW Quantity & System Parameters
4. PNRS Process Selection
5. Default Design & Cost
6. Default Design Cost Summary
7. User Specified Costs
8. LCCA Conventional
9. LCCA Total System
10. Design Data
11. Example LCCAs

9. LCCA Total System

Present Worth (2015 dollars) — Capital Cost, Operation and Maintenance, Compliance

Capital Cost — Tankage, Soil Treatment Unit, Media, Pump(s), Control Panel, Misc. Appurtenance, Piping, Drip Dispersal, Liner, Contractor Fee

Conventional System Summary

No. of Bedrooms	3
Building area, square feet	2000
Depth to seasonal high water table (inches)	42
New OSTDS installation or retrofit of existing system	existing
Design wastewater flow, gallon/day	300

PNRS System Summary

PNRS System	9
Stage(s)	Stage 1&2
Stage 1 in-tank or in-ground	Tank
Stage 1 single pass or recirculation	Recirculation
Stage 1 media type	Expanded Clay
Ligno disposition	Tank
Stage 2 media type	Dual: Ligno & sulfur
Construction Complexity	Moderate
Level of nitrogen removal efficiency provided by system	High

Life Cycle Cost Calculations

Project Life (PL), years	30
Interest Rate (IR), %	1.500
Primary tank pump out interval (TI), years	5.0
Pump out analysis life (PL), years	25.0
Stage 2 media replacement interval (MI), years	15.0
Stage 2 media cost analysis life (ML), years	15.0
Equipment replacement interval (EI), years	10.0
Equipment replacement analysis life (EL), years	20.0

Compound Interest Factors

P/A PL/IR	24.016
A/P PL/IR	0.04164
A/F TI	0.19409
P/A PL	20.720
A/F MI	0.05994
P/A ML	13.343
A/F EI	0.09343
P/A EL	17.169

Nitrogen Removal

Mass loading/year, lbs.	27.0
Removal efficiency, %	95.0
Mass removal/year, lbs.	25.66

Life Cycle Cost

Cost Item	Present Worth, $	Uniform Annual Cost, $	% of Total Life Cycle Cost
Conventional System Installation			
Primary treatment tank	1,400.00	58.29	4.2
Pump tank	0.00	0.00	0.0
Conventional system pump	0.00	0.00	0.0
Soil treatment unit	2,625.00	109.30	7.8
Subtotal	4,025.00	167.60	12.0
PNRS Installation			
Tankage	4,609.29	191.93	13.8
Media	2,226.78	92.72	6.7
PNRS Pump	250.00	10.41	0.7
Control Panel	875.00	36.43	2.6
Piping	289.60	12.06	0.9
Misc. Appurtenance	1,693.00	70.50	5.1
Stage 1 Drip Dispersal System	0.00	0.00	0.0
Liner	0.00	0.00	0.0
Contractor Fee	5,000.00	208.20	14.9
Subtotal	14,943.67	622.24	44.7
Total System Installation	18,968.67	789.84	56.7
Operation and Maintenance			
Annual energy cost	789.46	32.87	2.4
Annual inspection & maintenance	7,204.75	300.00	21.5
Primary tank pump out	1,206.44	50.24	3.6
Stage 2 media replacement	794.01	33.06	2.4
Equipment replacement	401.03	16.70	1.2
Subtotal	10,395.69	432.87	31.1
Compliance			
Permit fee	1,200.79	50.00	3.6
Water quality monitoring	2,881.90	120.00	8.6
Subtotal	4,082.69	170.00	12.2
Total	33,447.06	1,392.71	100.00

Capital Cost

Installation Cost Item	Present Worth, $	Uniform Annual Cost, $	% of Installation Cost
Tankage	6,009.29	250.22	31.7
Soil Treatment Unit	2,625.00	109.30	13.8
Media	2,226.78	92.72	11.7
Pump(s)	250.00	10.41	1.3
Control Panel	875.00	36.43	4.6
Misc. Appurtenance	1,693.00	70.50	8.9
Piping	289.60	12.06	1.5
Drip Dispersal	0.00	0.00	0.0
Liner	0.00	0.00	0.0
Contractor Fee	5,000.00	208.20	26.4
Total System	18,968.67	789.84	100.0

Life Cycle Cost

Cost Item	Present Worth, $	Uniform Annual Cost, $	% of Total Life Cycle Cost
Capital Cost	18,968.67	789.84	56.7
Operation and Maintenance	10,395.69	432.87	31.1
Compliance	4,082.69	170.00	12.2
Total	33,447.06	1,392.71	100.0
$/lb nitrogen removed	43.44	54.27	