



City of Tampa
Wastewater Department

Howard F. Curren AWTP Biosolids Processing Assessment Report

FINAL

May 2012

Contract 10-D-00534
Fund No.: SS0442BDN-06305-SS5599- -PW808
NGIP Code: 925-33

HAZEN AND SAWYER
Environmental Engineers & Scientists



Executive Summary

ES.1 Introduction and Biosolids Production

The City of Tampa (City) owns and operates the Howard F. Curren AWTP (HFCAWTP). The HFCAWTP is permitted for 96 million gallons per day (MGD) average daily flow (ADF) and currently operates with ADF of approximately 56 MGD. The current digested sludge production is approximately 380,000 gallons per day (gpd).

The biosolids processing portion of the plant consists of digestion, dewatering, and drying facilities. The existing heat drying facility is a rotary drum thermal drying system consisting of two (2) separate trains. Each train is designed to process up to 29.5 dry tons per day of 18 to 20 percent anaerobically digested dewatered cake to produce a more than 90 percent dry solids product for disposal. The facility was constructed in 1990 and several of the equipment components are original. Due to the condition of some of the equipment, only one of the trains is currently operable. Additionally, the heat drying facility has not been operated since November of 2010 due to higher operational costs of producing a Class AA pelletized final product as compared with the costs associated with Class B dewatered cake land application. A significant contributor to these higher operational costs has been a dramatic reduction in the resale value of the Class A product in recent years.

A separate facility used to dewater sludge for both land application and heat drying is located adjacent to the heat drying facility. The dewatering facility contains eight (8) belt filter presses (BFPs). Each press has a design capacity of 140 gallons per minute (gpm). Typically, only two to three presses are needed at any given time to process the amount of sludge produced at the facility. The sludge processed by the belt presses is a blend of primary and thickened waste activated sludge with 1.8 to 2.0 percent solids. The belt presses are capable of producing dewatered sludge with 15 to 17 percent solids.

The objective of this report is to assess the current condition of the HFCAWTP pelletized heat drying facility and sludge dewatering facility and provide recommendations for process improvements, equipment upgrades and/or equipment replacements to increase system efficiency, reduce operating and sludge disposal costs, and restore system reliability. The results of the assessment and subsequent recommendations are expected to be used as the basis for planning future capital improvement projects (CIP).

Based on available historical data, the HFCAWTP is currently producing an average of approximately 380,000 gpd of sludge. Table ES.1 shows an estimation of the sludge

41077-001R1

production rates for flow rates in the ranges between the current and future treatment plant average flow rates.

Table ES.1
Biosolids Production Projections

Average Annual Flow (MGD)	Sludge Production Rate (lb/MG)	Average			AVG365 Sludge Production Rate (dT/week)	MAX30 Sludge Production Rate (dT/week)	MAX7 Sludge Production Rate (dT/week)
		Sludge Production Rate (lb/day)	Sludge Volume @ 1.80% (gal/day)	Sludge Volume @ 2.00% (gal/day)			
56.0	1,125	63,000	419,664	377,698	220.5	258.0	385.9
58.0	1,131	65,613	437,067	393,360	229.6	268.7	401.9
60.0	1,138	68,250	454,636	409,173	238.9	279.5	418.0
62.0	1,144	70,913	472,372	425,135	248.2	290.4	434.3
64.0	1,150	73,600	490,274	441,247	257.6	301.4	450.8
66.0	1,156	76,313	508,343	457,509	267.1	312.5	467.4
68.0	1,163	79,050	526,579	473,921	276.7	323.7	484.2
70.0	1,169	81,813	544,981	490,483	286.3	335.0	501.1
72.0	1,175	84,600	563,549	507,194	296.1	346.4	518.2
74.0	1,181	87,413	582,284	524,056	305.9	358.0	535.4
76.0	1,188	90,250	601,186	541,067	315.9	369.6	552.8
78.0	1,194	93,113	620,254	558,228	325.9	381.3	570.3
80.0	1,200	96,000	639,488	575,540	336.0	393.1	588.0
82.0	1,206	98,913	658,890	593,001	346.2	405.0	605.8
84.0	1,213	101,850	678,457	610,612	356.5	417.1	623.8
86.0	1,219	104,813	698,191	628,372	366.8	429.2	642.0
88.0	1,225	107,800	718,092	646,283	377.3	441.4	660.3
90.0	1,231	110,813	738,159	664,344	387.8	453.8	678.7
92.0	1,238	113,850	758,393	682,554	398.5	466.2	697.3
94.0	1,244	116,913	778,794	700,914	409.2	478.8	716.1
96.0	1,250	120,000	799,361	719,424	420.0	491.4	735.0

¹ It is assumed that as the loading to the anaerobic digesting increases (resulting in decreased retention times) the volatile solids reduction in the digesters will decrease resulting in higher sludge production rates.

ES.2 Biosolids Disposal Costs

Three options for biosolids disposal are available to the City. These include:

- Land application
- Landfilling

41077-001R1

- Heat Drying for Class AA Resale

Table ES.2 summarizes the current costs associated with the various disposal options for the HFCAWTP biosolids. Based on current conditions, continued land application of Class B (dewatering only) is recommended for the near term. However, with new regulations placing more stringent requirements on land application, the costs for this option are expected to increase in the next few years. In addition, a reliable backup treatment process is needed during heavy rain events that interrupt land application operations. Landfill disposal is the next lowest cost option but is not significantly lower than heat drying. Landfill disposal costs are predominantly impacted by fuel and tipping fee costs, cost factors that cannot be controlled by the City. As such, landfill disposal has inherent risks as a long term backup disposal method. If biosolids processing improvements can be identified and installed at the HFCAWTP to improve the efficiency of the dewatering and heat drying system, the cost for Class A heat drying may be closer to anticipated increased land application costs sometime in the future, and should be significantly less than land fill disposal. Therefore, the remaining portion of this report will investigate means of improving the current dewatering and drying process.

Table ES.2
Summary of Biosolids Disposal Option Costs

Disposal Option	Cost (\$/dry ton)	Cost Excluding Dewatering (\$/dry ton)
Class B Land Application	\$256	\$121
Landfill Disposal	\$412	\$277
Class AA Product for Resale	\$465	\$330

ES.3 Potential Treatment Process Improvements

In addition to sludge dewatering and heat drying improvements there are process improvements that could potentially benefit or impact biosolids processing.

ES.3.1 Sidestream Treatment

Improvements to the sludge dewatering system may impact the sidestream quantity and quality. Therefore, the City may wish to consider sidestream treatment at the facility to assist with nutrient removal. In order for sidestream treatment to be cost effective, it is generally accepted that the sidestreams should be contributing 15-20 percent of the nutrient loading to the head of the plant. It is also typical that treatment facilities with significant biological processing in the solids train (i.e., anaerobic digestion) can benefit from some form of sidestream treatment. Some of the advantages of sidestream treatment include improved capability of existing activated sludge system and may allow mining of resources from biosolids. Based on available data, the filtrate contributes about 17 per-

cent of the TKN influent loading to the plant; thereby suggesting that sidestream nitrogen removal process treatment of the filtrate may be a viable option.

ES.3.2 Anaerobic Digestion and Gas Production Improvements

A possible alternate to the use of digester gas for co-generation would be to utilize the digester gas as a supplemental fuel for the heat dryer. Some of the advantages of this approach are an efficient use of the energy contained in the gas and a reduced siloxane concern. However, the anaerobic digesters are located remotely from the existing dewatering and thermal drying unit process area making utilization of digester gas in the thermal dryer problematic unless a drying facility were located closer to the digesters. Furthermore, if the available digester gas is being fully utilized for production of on-site electricity and the excess heat from the engines (engine jacket and/or exhaust gas) is being utilized beneficially for digester heating, the energy contained in this resource is likely already being made effective use of and little benefit likely would be gained by providing another location for utilization of this energy resource. However, there are existing regulation compliance dates at the federal level that may soon cause the City to have to abandon the existing combined heat and power (CHP) system. If the CHP system is to be decommissioned in the near future, which City staff believes is a real possibility, and be replaced with a more conventional digester heating system resulting in surplus digester gas; then consideration can and should be given to routing this energy resource to a thermal drying facility.

ES.3.3 WAS Pretreatment

In addition to improvement of the digester gas utilization, biosolids minimization of waste activated sludge (WAS) through anaerobic digestion pretreatment may be considered by the City to reduce dewatering and drying operational costs and increase digester gas production. WAS pretreatment may be viable for the HFCAWTP because these systems are sometimes capable of being retrofitted to the existing anaerobic digestion process with minimal change or interruption to the overall plant process.

ES.4 Sludge Dewatering System Improvements

Biosolids disposal costs are directly related to the amount of water volume that must be handled, transported, or removed in drying operations. Therefore, reductions in sludge water content will impact cost beneficially.

ES.4.1 Belt Filter Presses

If the dewatered cake solids content (currently 15-17 percent) from the belt presses can be increased, the cake volume would be reduced for lower hauling costs. Additionally, lower water content biosolids will significantly decrease evaporation energy required when utilizing a dryer. There are two general approaches to increasing solids content in

41077-001R1

the cake – optimizing the existing belt press operation and consideration for alternate dewatering technologies.

Optimization of Existing Belt Press Operation

Optimization of belt filter press operation to increase percent solids concentration in the dewatered cake is typically achieved by one or more of the following actions:

- Adjusting Sludge Feed
- Belt Filter Upgrades
- Belt Filter Replacement
- Polymer System Optimization

Alternate Dewatering Technologies

In addition to belt filter presses, several other options could be considered for biosolids dewatering. Each of these options have advantages/disadvantages which are shown in Table ES.3. If the City were to consider any of these options, it is recommended that pilot testing be performed to assess the performance and throughput of the most current models available.

Table ES.3
Dewatering Technologies

Consideration Factors	Alternative Technologies			
	Belt Filter Press	Screw Press	Centrifuge	Rotary Press
Capital Effectiveness	Moderate	Moderate	High	Low
Footprint	Moderate	High	Low	High
O&M Requirements	High	Low	Moderate	Moderate
Capture Efficiency	95%	90-97%	95-97%	≥ 95%
Expected Solids Content ¹	15-18%	18-25%	20-25%	14-18%
Odor Potential	High	Moderate	Low	Moderate
Energy Consumption	Moderate	Low	High	Moderate
Re-growth Potential ²	Low	Unknown	Possible	Unknown
Throughput Capability	Moderate	Low	High	Very Low

¹ Pilot study work at the facility indicated centrifuges may be able to achieve up to 25 percent solids content. Previous polymer testing has indicated that the belt filter presses may be capable of achieving 18 percent or higher.

² Recent industry experience has indicated a potential for pathogen re-growth when land applying sludge cake dewatered using centrifuges from feed stock of anaerobically digested sludge.

ES.4.2 Other Individual Dewatering System Components Assessment

The conditions of all of the existing dewatering components were assessed. These include:

- Sludge feed pumps
- Polymer feed system
- Cake conveyance system
- Boost water pumps
- Sludge grinders
- Electrical and instrumentation components
- Dewatering building

A summary of the recommended improvements is included in Section ES.5.

ES.5 Sludge Drying System Improvements

Biosolids drying costs are most significantly affected by thermal energy costs. As a result, reducing the amount of thermal energy required to produce a Class AA product for resale will have the most impact on the viability of future heat drying at the HFCAWTP.

ES.5.1 Impact of Solids Content from Dewatering on Heat Drying Process

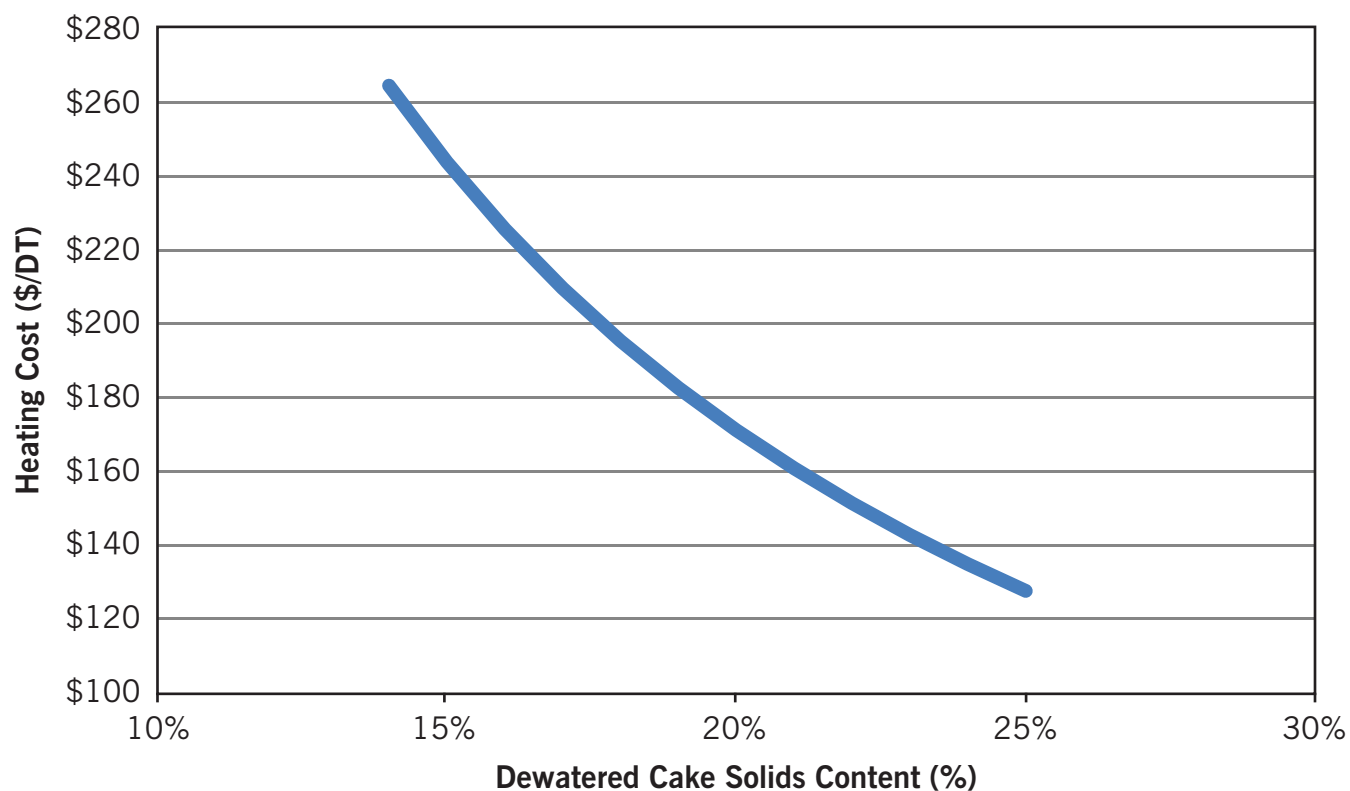
Lower than expected belt filter press dewatering performance results in increased evaporative loading rate loadings to the rotary drum drying system and results in reduced dry solids throughput for the system. The result of this differential performance is that:

- (1) an increased quantity of thermal energy is required to process a dry ton of solids in the thermal dryer; and
- (2) reduced throughput means that “fixed” costs which are a function of system run-time are distributed across a reduced dry solids production rate.

The net result is that the cost of processing a dry ton of material through the thermal dryer system is increased (\$/dry ton) above that which would be required if the cake solids content were greater. Figure ES-1 shows how the cake solids content has a significant impact on the thermal dryer operating costs.

ES.5.2 Impact on Thermal Efficiency of Heat Drying Process from Recycle of Exhaust Gas

The current dryer system exhausts all air from the process. This is a high heat air which can add significant value back to the drum dryer process if recycled. This results in higher energy costs and a higher oxygen content in the hot gas stream. In returning the ma-



Note: Thermal energy costs are based on the equation below assuming an estimated thermal dryer efficiency of 1,930 BTU per pound of water, a dried pellet total solids content of 93 percent, and a natural gas cost of \$11.30 per MMBTU.

$$\text{Estimated Thermal Efficiency} \left[\frac{\text{BTU}}{\text{lb water}} \right] * \left(\frac{2000}{\text{Cake TS}} - \frac{2000}{\text{Dried TS}} \right) \div 1,000,000 \frac{\text{BTU}}{\text{MMBTU}}$$

$$* \text{Thermal Energy Unit Cost} \left[\frac{\$}{\text{MMBTU}} \right] = \text{Thermal Energy Cost} \left[\frac{\$}{\text{dry ton}} \right]$$

Figure ES-1
Thermal Energy Costs for Drying Based on Dewatered Cake Solids Content

jority of this high heat air, bringing in only enough make-up air to support combustion, the following advantages can be realized:

- reduced fuel costs in making use of thermal energy already stored in the recycled hot gas (this has typically increased thermal efficiency of a dryer process by 20 percent)
- the volume of air processed by the regenerative thermal oxidizer (RTO) will be limited to the make-up air quantity, resulting in reduced energy use in the RTO.
- lower oxygen content in the gas loop (typically around 7%) increases the safety of the process and reduces the potential for fires

ES.5.3 Summary of Dryer Process Improvements

These two improvements, increasing solids content in the dewatered cake and including a hot gas recycle stream will make the heat drying system a more attractive alternate disposal method. Using the data presented in Figure ES-1 with a thermal efficiency reduced by 20 percent, the thermal energy cost to process a 22 percent dewatered cake would be reduced by \$30 to a total of \$121 per dry ton; thereby reducing the total cost for thermal drying from \$465 per dry ton as currently operated to around \$376 per dry ton (as summarized in Table ES.4), well below the current cost for land fill disposal. This is still much higher than the \$256 per dry ton for land application, so land application would still be considered the City's best option of disposal of biosolids. However, a modified heat drying system would be a good alternate disposal method should problems arise in the availability to send dewatered cake to land application sites.

Table ES.4
Summary of Thermal Dryer Costs

Thermal Dryer Costs as Presented in Section 2-3	(\$/Dry Ton)
Maintenance, Power and O&M Labor	\$145
Thermal Energy	\$210
Dewatering	\$135
Class AA Product Sale	-\$25
Current Total Cost	\$465
Thermal Dryer Costs Savings as Presented in Section 4-1	
Thermal Energy Savings Resulting from Dewatering to 22 Percent	-\$59
Thermal Energy Savings Resulting from Recycling Exhaust Gas with a 22 Percent Dewatered Cake	-\$30
Revised Thermal Energy Costs (\$210 - \$59 - \$30)	\$121
Potential Total Drying Cost (\$465 - \$59 - \$30)	\$376

41077-001R1

ES.5.4 Individual Dryer System Component Assessment

The conditions of all of the existing dryer components were assessed. These include:

- wet sludge storage bins
- pugmill mixers
- drum dryers
- settling chambers
- cyclones
- vibrating screens
- crushers
- recycle bins
- venture scrubbers
- after burners
- product storage silos
- odor control system
- dust control system
- truck loading conveyors
- pellet cooling system
- drying building
- electrical and instrumentation systems

A summary of the recommended improvements is included in Section ES.5.

ES.6 Recommendations

Several recommendations were investigated for the biosolids processing components as detailed in the previous sections. These included:

- Repair of existing components of dewatering and drying processes
- Sidestream treatment
- WAS pretreatment
- Polymer feed optimization
- Alternate dewatering technologies
- Conversion of the dryer system to include and exhaust recycle
- Construction of a new dryer train

The main objective in the evaluation of alternate dewatering technologies was to increase the solids content in the dewatering cake to reduce hauling costs due to lower product volume. Other benefits to improved dewatering would be reduced drying costs due to lower evaporation energy required and possible reduced operation and maintenance costs associated with alternate technologies. The comparison was made on a 20-year, net present worth (NPW) basis, using a 5 percent interest rate. Detailed break-

down of the NPW values for each option are provided under Appendix A, along with a list of assumptions made in developing the NPW values. The total initial capital cost for each option used in the NPW evaluations are provided under Appendix B with copies of equipment quotes included under Appendix C. A summary of the NPW values is listed in Table ES.4.

Table ES.5
Dewatering System Improvements for Land Application
Estimated Net Present Worth (NPW) Comparison for Dewatering Alternatives

Alternative	Baseline - BFP	1 BFP (optimized)	2 BFP (new)	3 Screw Press	4 Centrifuge
Capital Costs (in millions)	\$5.5	\$5.9	\$7.9	\$8.0	\$6.7
Annual Costs at Current Flows (in millions)	\$2.9	\$2.6	\$2.4	\$1.7	\$2.0
NPW at Current Flows (in millions)	\$42	\$39	\$38	\$30	\$31
Annual Costs at Future Flows(in millions) ¹	\$5.5	\$5.2	\$4.9	\$4.3	\$4.5
NPW At Future Flows (in millions)	\$74	\$70	\$69	\$61	\$63
Annual Costs at Current Flows (\$/DT) ²	\$256	\$228	\$208	\$151	\$172
Annual Costs at Future Flows (\$/DT) ²	\$251 ⁴	\$235	\$225	\$195	\$206

¹ Annual costs for future flows are derived by adding the annual cost for each alternative at current flows to the annual costs for optimized belt presses for additional WAS as presented in Appendix A Table A2.

² Biosolids at current flows is 11,500 DT/Yr (63,000 lb/D ÷ 2,000 x 365)
 Biosolids at future flows is 21,900 DT/Yr (120,000 lb/D ÷ 2,000 x 365)

³ Values in **BOLD** represent the most favorable net present worth.

⁴ Future annual costs are lower than current annual cost due to slightly lower daily run times for dewatering equipment.

Option #3, replacing the existing belt presses with screw presses, and Option #4, replacing the existing belt presses with centrifuges, both show a lower NPW over any of the belt press options. This is primarily due to the higher sludge solids concentration in the dewatered cake that can be achieved using screw presses or centrifuges over that of the belt press options. Option #3 has a slightly lower NPW than Option #4 due to lower polymer and power costs. As there is some concern for possible re-growth of bacteria in the dewatered cake using centrifuges for land application, it is recommended that Option

41077-001R1

#3 be implemented. However, Option #3 has the highest capital investment of all the options so it is imperative that the assumed dewatered cake solids concentration and polymer feed rate used in the NPW evaluation be verified through pilot testing.

The recommended improvements to the HFCAWTP biosolids facilities can be divided into near term and long term projects. In the near term, it is recommended that the City install a new or updated dewatering system and continue to dispose of biosolids through Class B land application due to the significant cost savings as compared with other disposal options. Short interruptions in availability of land application sites can be handled by one repaired train of the heat drying system.

Table ES.6
Recommended Near Term Capital Improvement Projects

Project	Fiscal Year	Opinion of Costs
Dewatering System Improvements		
<u>Repair Belt Presses</u> <ul style="list-style-type: none"> • Perform pilot testing of an existing belt press to identify key parameters to include in belt press optimization work • Upgrade, repair, and optimize the three existing belt presses that require the least amount of work 	2013/14	\$1,200,000
<u>Repair Existing Dewatering Building</u> <ul style="list-style-type: none"> • Recoat all structural steel members • Replace all metal piping • Repair/upgrade the ventilation system 	2013/14	\$400,000
<u>Replace Sludge Feed Pumps and Grinders</u> <ul style="list-style-type: none"> • Replace existing sludge feed pumps with seven new pumps (one dedicated to each refurbished belt press, one dedicated to each new screw press, one backup unit) • Rebuild grinders 	2013/14	\$300,000
<u>Replace Polymer Feed System</u> <ul style="list-style-type: none"> • Perform pilot testing of polymer feed systems to verify design parameters to optimize polymer efficiency • Replace existing feed units with seven new feed units (one dedicated to each refurbished belt press, one dedicated to each new screw press, one backup unit) 	2013/14	\$200,000
<u>New Screw Press Dewatering Truck Loading Station</u> <ul style="list-style-type: none"> • Perform pilot testing to verify design parameters for the screw press • Construct new elevated truck loading station with sufficient space for future expansion, covered roof, partially open sides, metal frame, corrosion resistant materials for roof and siding, three levels (truck weighing, distribution conveyors, and screw presses) 	2013/14	\$5,600,000

41077-001R1

Table ES.6
Recommended Near Term Capital Improvement Projects

Project	Fiscal Year	Opinion of Costs
<ul style="list-style-type: none"> • Install three screw presses with a minimum 10.6 dry ton per day per press capacity (3 duty, belt filter presses are backup) on the upper level, with a dedicated, forward/reverse distributing conveyor on the middle level to distribute dewatered cake uniformly in each truck in three individual truck loading bays. • Install platforms and access stairs for operation and maintenance of screw presses and conveyors • Install a bridge crane above the screw presses to facilitate removal of the press covers • Install feed piping from the sludge feed pumps and polymer feed system to the screw presses 		
Heat Drying Process Improvements		
<u>Repair Dryer Train 2</u> <ul style="list-style-type: none"> • Replace one influent belt conveyor to wet sludge storage bin with a screw conveyor and redesign and replace stairway • Replace pugmill mixer for Train 2 • Repair Train 2 drum dryer burner's internal wear and refractory work • Replace Train 2's settling chamber ceramic tile and screw • Replace Train 2's vibrating screen K conveyor and screen • Add automatic lubrication capability to Train 2's crusher • Replace recycle bin for Train 2 • Repair inlet and outlet conveyor for Train 2 recycle bin and replace liner • Replace Train 2's ID fan base and balance fan 	2014/15	\$1,360,000
<u>Repair Elements Common to Both Trains</u> <ul style="list-style-type: none"> • Replace dampers on after burners with slide gate valves • Replace exhaust fans on afterburners • Install inert interior liner for three of the product storage silos • Replace tops and inlet chutes the three product storage silos • Install temperature probes to detect hot spots in the three product storage silos • Install carbon monoxide analyzers to detect combustion in the three product storage silos • Install rubberized rotary valves and aspirators on discharges of the three product storage silos • Repair bleach system, spray nozzles, and fan for the odor control system 	2014/15	\$2,852,000

41077-001R1

Table ES.6
Recommended Near Term Capital Improvement Projects

Project	Fiscal Year	Opinion of Costs
<ul style="list-style-type: none"> • Perform dust control system maintenance for the dust control system • Replace liner for Conveyor SHD-TLSC-1A • Repair electrical issues for Conveyor SHD-TLSC-1B • Repair pellet cooling system controls • Replace siding on the dryer building with vinyl siding • Replace corroded motors, actuators, and instruments for Train 2, product silos, and truck discharge conveyors 		
Convert Dryer Train 2 to Exhaust Recycle	2014/15	\$750,000
Install screw conveyors from new truck loading station to Train 2	2014/15	\$770,000
Total Near Term Projects		\$13,432,000

In addition to these projects, the sidestream treatment and WAS pretreatment projects indentified previously should be considered and provisions included with the design of dewatering and drying process improvements.

For long term capital improvements, if the drying system starts to be used to process more than fifty percent of the total plant solids in a given year, or if land application disposal is known to become less available, a backup dryer train can be installed by refurbishing Train 3 at a cost of an estimated \$3,800,000.

41077-001R1