SECTION V. WETLAND SYSTEM CONSTRUCTION COSTS, ALTERNATIVE COMPARISONS, SELECTION CRITERIA, AND ENERGY AND OPERATIONAL COSTS

Construction Costs and Alternative Cost Comparisons

Table 3 (pgs. 32-33) lists the engineering firms that have designed some of the wetland systems in Iowa. Listed in this table are some of the construction contractors and construction costs that were available for some locations. Table 4 (below) provides a list of estimated wetland costs for surface flow and subsurface flow systems in Iowa. These were costs at the time of construction and have not been adjusted to reflect up-to-date costs. A determination was also made of the cost per acre. Costs vary as indicated in this table. No indication is made as to why costs per acre were very low for the Agency and Lake Vista wetlands. Costs for entire wastewater treatment systems are provided in Table 5 (pg. 36). Systems are categorized according to pretreatment type that included lagoon, septic tank, or septic tank sand filter system. Surface flow systems appear to be more expensive than subsurface systems, excluding the sand filter system. However, the surface flow systems handle greater flows and serve populations greater than those for subsurface systems. The septic tank, sand filter, wetland system costs were by far greater than those for the septic tank, wetland system alone. The sand filter was added as an extra precaution because the effluent from this system is discharged to Silver Creek, which is a Class B trout stream.

Table 4. Construction costs for surface flow and subsurface flow wetlands.

Location	Wetland Cost	Wetland Acres	Cost/Acre	Year
Surface Flow Systems Wetland				
Agency	$30,000	3.5	$8,571	1994
Chelsea	$20,000	0.26	$76,923	1990
Dows	$53,201	2.3	$23,131	1991
Iowa City	*$25,000	0.55	$45,455	1998-99
			Ave.= $38,520	
			Range= $8,571-$76,923	
Lake Vista Motel	$23,000	0.88	$26,135	1997
Burr Oak	$38,000	0.24	$158,333	1993
IAMU	*$18,000	0.15	$120,000	1999
			Ave= $101,489	
			Range=$26,135-$158,333	

All costs are estimated except when actual costs were available and are indicated with *. These costs are to provide guidance only and don't reflect up-to-date costs.

Table 5. Construction costs for treatment systems that include surface flow and subsurface flow wetland systems.

Surface Flow Systems	System Cost	Wetland Acres	Year
Surface Flow Wetland Systems			
Dows: aerated lagoon and wetland	$495,000	2.3	1991
Granger: aerated lagoon and wetland	$775,000	3.6	1986
Laurel: aerated lagoon and wetland	$900,000	1.2	1991
LeGrand: Sludge removal and wetland	$298,528	10	1992
Subsurface Flow Septic Tank Systems			
Buchanan County Fontana Campground	*$19,000	0.7	1998
IAMU	*$40,000		1999
Neil Smith Wildlife Refuge	*$150,000	0.124	1997
Subsurface Flow Septic Tank Sand Filter System			
Burr Oak	$637,436	0.24	1993

All costs are estimated except when actual costs were available and are indicated with *. These costs are to provide guidance only and don't reflect up-to-date costs.

Information was obtained from Kadlec and Knight's book Treatment Wetlands that can be used for guidance when trying to estimate costs. A detailed study conducted by a consulting engineer or constructed wetland scientist, is needed by any community or facility that is considering this or any other treatment technology. The consultant would be able to provide more details on estimated costs for a constructed wetland within a certain region of Iowa

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Table 6. Estimated Surface Flow Wetland Costs (Kadlec and Knight, 1995).

Construction Item	Units	Unit Price	Total Cost	% of Total
Excavation/Compaction	yd^3	$1.80	$13,000	19.4
Soil	yd^3	$1.00	$2,800	4.2
Gravel	yd^3	$16.10		
Liner	acre	$15,000	$19,250	28.7
Plants	each	$0.60	$7,500	11.2
Plumbing	lump sum		$7,500	11.2
Control Structures	lump sum		$7,000	10.4
Other	lump sum		$10,000	14.9
Total			$67,050	

Table 7. Estimated Subsurface Flow Wetland Costs (Kadlec and Knight, 1995).

Construction Item	Units	Unit Price	Total Cost	% of Total
Excavation/Compaction	yd^3	$1.80	$13,000	10.7
Soil	yd^3	$1.00		
Gravel	yd^3	$16.10	$51,900	42.6
Liner	acre	$15,000	$19,250	15.8
Plants	each	$0.60	$13,330	10.9
Plumbing	lump sum		$7,500	6.1
Control Structures	lump sum		$7,000	5.7
Other	lump sum		$10,000	8.2
Total			$121,980	

Selection Criteria

Wetlands were selected as the primary land treatment system without considering alternatives at 33% of the wastewater treatment facilities. Buchanan County Fontana Campground, IAMU, Springbrook State Park and Neil Smith Wildlife Refuge facilities selected wetlands based solely on the premise that they are educational facilities that want to use an alternative to the typical drain field system. Most of these facilities conduct outdoor education programs and the wetlands are a treatment system that allows visual inspection compared to buried drain fields.

For other systems as shown in Table 5 (pg. 36) the wetland treatment system was the cost effective land treatment alternative. The exception was Burr Oak where the cost of the septic tank, sand filter, and wetland system was greater than the aerated lagoon system. This case is unique in that the Iowa Department of Natural Resources preferred the sand filter wetland system to the other system mainly due to the more polishing of effluent that would occur with this system and the water quality concerns over the receiving stream that is a Class B trout stream.

Table 8. Comparison of treatment systems that include wetlands costs to alternative treatment systems.

Location	**System**	**Treatment System with Wetlands Cost**	**Alternative**	**Alternative Costs**	**Cost of System with Wetland > or < than Alternative**
Burr Oak	Septic tank, sand filter, wetland	$637, 436	Aerated 3-cell lagoons	$222,200	>
Chelsea	Aerated lagoons and wetland	$20,000 wetland only	Quiescent 3rd lagoon	$25,000	<
Dows	Aerated lagoons and wetland	$495,000	Activated sludge expanded	$645,000	<

			New Activated sludge New lagoon system	$1,140,000 $1,910,000	< <
Granger	Aerated lagoon and wetland	$451,000	Aerated lagoons Controlled discharge lagoon Mechanical plant	$539,000 $1,860,000 $1,910,000	< < <
Lake Vista Motel	Septic tank and wetland	$23,000 wetland only	Pump to Chariton Controlled discharge lagoon	$66,000 $41,000	< <
LeGrand	Lagoon sludge removal and wetland	$298,528	Controlled discharge lagoon Aerated lagoons	$497,547 398,038	< <

These costs are to provide guidance only and don't reflect up-to-date costs.

Energy and Operational Costs

There are no energy costs for operation of the wetlands in Iowa that are included in this technical assessment. Flow to wetlands is by gravity so pumps are not required. Constructed wetlands that are designed for nitrogen removal will have aerators that require electrical energy. Such systems currently do not exist in Iowa. Pretreatment systems prior to wetlands may have energy costs. Aerated lagoons and activated sludge systems require electrical energy. A treatment system that includes wetlands may typically have energy expenditures that include lift stations, grinders, aerators in a lagoon, automatic samplers, and flow measurement and recording equipment. Operational costs for all wetlands are minimal. Some sites, as shown in Table 3 (pgs. 32-33), estimated their costs. The costs usually are associated with labor used for vegetation and water level management. Management of these systems is periodic compared to mechanical systems that require more constant maintenance of mechanical parts. For most systems, the pretreatment system required more management and used energy compared to the wetlands. This is especially true for systems that use aerated lagoons for pretreatment. A cost comparison of estimated operation and maintenance (O & M) costs between the proposed wetland system and other alternatives is provided for Granger as shown in Table 3 (pgs. 32-33). This information was obtained from engineering study reports used before the wetlands were constructed. The estimated O & M costs for using the existing system that consists of aerated lagoons (conversion to aerated lagoons) and wetlands was a few thousand dollars more than using a controlled discharge lagoon and several thousand dollars less than using only aerated lagoons or a mechanical plant.

Aerated lagoon and lagoon annual operation and energy costs are available for some of the wastewater systems that include wetlands and were obtained from a survey of wastewater treatment systems in Iowa that was conducted by the Iowa Association of Municipal Utilities based on 1999 annual operational costs.

Granger:

Aerated Lagoons and Surface Flow Wetland System	
Wastewater Treatment Annual Budget (excludes collection)	$38,000
Wastewater Treatment Energy Costs (excludes collection)	$7,500
Kilowatt hours Consumed per Year	Not Available

Blencoe:

Lagoons and Surface Flow Wetland System	
Wastewater Treatment Annual Budget (excludes collection)	$26,267
Wastewater Treatment Energy Costs (excludes collection)	$0
Kilowatt hours Consumed per Year	$0

Dows:

Aerated Lagoons and Surface Flow Wetland System	
Wastewater Treatment Annual Budget (excludes collection)	$33,600
Wastewater Treatment Energy Costs (excludes collection, includes main lift)	$11,595
Kilowatt hours Consumed per Year	Not Available

Middlebrooks et al., (1982) conducted a study that compared energy requirements of land treatment and conventional treatment systems. These studies focus on the pretreatment system when relating the results of this study to this assessment of wetlands. The following are typical energy requirements for ten treatment systems that are used by small treatment plants that have a 0.05 mgd, 0.1 mgd, and 0.5 mgd design capacities (Table 9 below). The results clearly show that facultative lagoon systems have lower energy requirements than mechanical treatment systems. Aerated lagoon with sand filters have higher costs compared to facultative lagoons, trickling filters, and RBCs. Energy is required to operate the aerators for the lagoon and it is not known if the sand filters require energy. Sand filters are not used after lagoons in Iowa. Energy costs also increase as the design flows increase.

Table 9. Comparison of energy requirements for conventional wastewater treatment systems that have design capacities of 0.05 mgd, 0.1 mgd, and 0.5 mgd (Middlebrooks et al., 1982).

Treatment System	Kilowatt Hours Consumed per Year	Kilowatt Hours Consumed per Year	Kilowatt Hours Consumed per Year
	0.05 mgd	0.1 mgd	0.5 mgd
Facultative Lagoon Overland Flow	5,700	10,700	50,070
Facultative Lagoon + Sand Filter	5,840	10,920	50,540
Facultative Lagoon + Microscreens	11,300	20,300	83,100

Aerated Lagoon + Sand Filter	20,800	39,500	184,800
Trickling Filter + granular gravity filtration	19,400	31,800	117,500
Trickling Filter + Ion Exchange	21,000	32,900	134,000
Rotating Biological Contact with Anaerobic Digestion (RBC)	18,200	29,700	111,000
Activated Sludge with Anaerobic Digestion	38,600	58,700	203,100
Activated Sludge with Sludge with Incineration	52,800	73,400	222,100
Activated Sludge with Advanced Treatment	131,690	244,560	1,029,400

References

Kadlec, R.H. and R.L. Knight. 1995. Treatment Wetlands. CRC Press, Lewis Publishers, Boca Ratan, Florida.

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