



Landfill Economics 101

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**Environmental Research
& Education Foundation**

Lighting a path to sustainable waste management practices

Landfill Series

Course Outline

- Full cost accounting principles
- Basic components of landfill costs
- Landfill revenues
- Factors influencing landfill economics

Full Cost Accounting

- Government Accounting Standards Bureau, Statement No. 18, Accounting for Municipal Solid Waste Landfill Closure and Postclosure care costs
- Financial Accounting Standards Board
- Fully account for actual expenditures, including depreciated and amortized expenses.

Accounting Approaches

- Cash Accounting
 - Looks at actual cash outlays
 - Used to evaluate investment performance
- Accrual Accounting
 - Accounts for non-cash expenses
 - Depreciation
 - Amortization
 - Accruals (new cell, closure, post-closure)
 - Tax calculations
 - Used in income/expense statements

Why Important

- Understand
 - Financial reports
 - Financial performance
 - Financial parameters
- Rate setting (municipal vs private)
- Benchmarking operations
- Performance optimization

Basic Principles

Cash vs Cost/Expense

- Cash Outlay – Actual cash paid during an accounting period
- Cost/Expense – dollar “value” of resource that is used

Example of a “Cost/Expense”

- Expense that is consumed or allocated during year:
 - Consumables (fuel and oil)
 - Materials and equipment
 - Labor
 - Insurance
 - Administrative costs
 - Depreciation, amortization, & accruals
 - Professional services
 - Utilities

Depreciation

- Purchase cost: \$800,000 (cash out)
- Service Life: 7 years
- Salvage Value = \$100,000
- Depreciation amount = \$700,000
- Yearly depreciation “cost/expense”
 $(\$800,000 - \$100,000)/7 = \$100,000/\text{year}$

Amortization

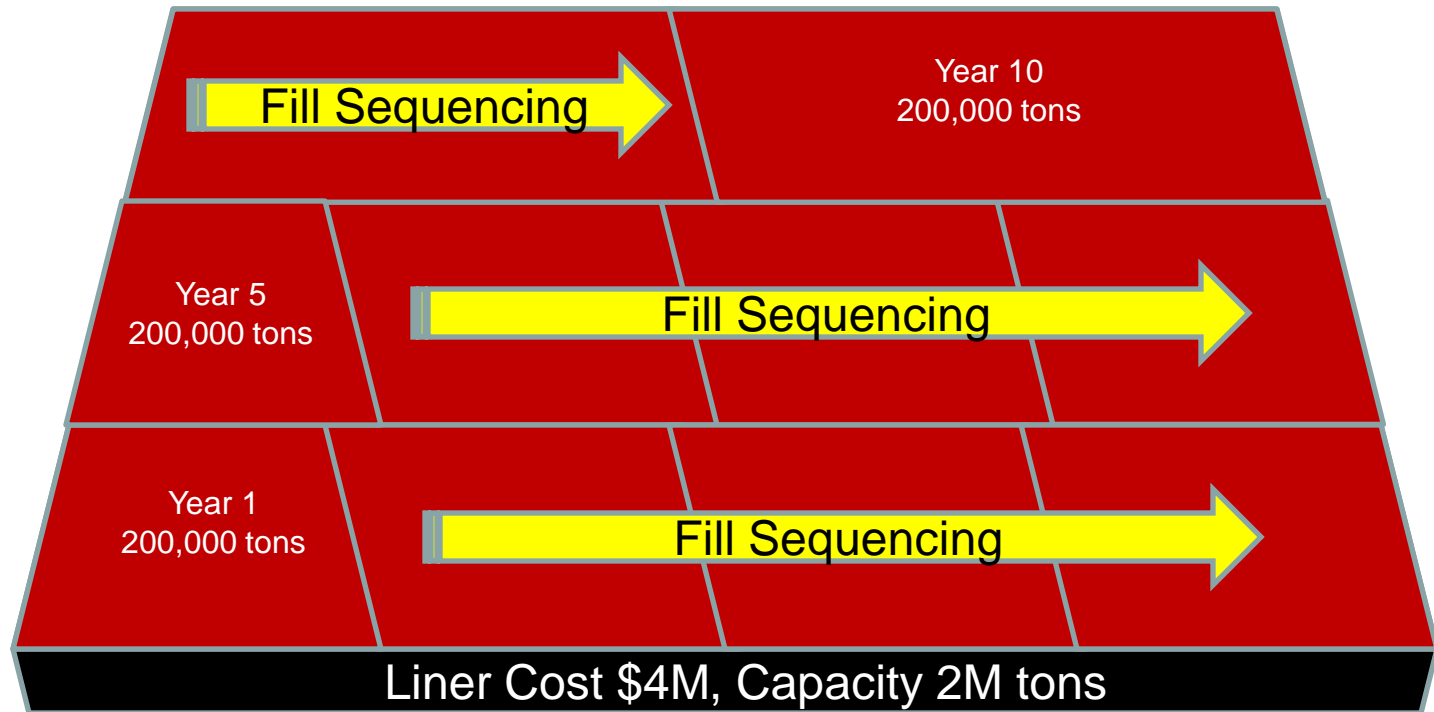
(non-depreciating asset)

- Purchase cost: \$1,000,000
- Term: 10 years
- Amortization: \$100,000/year

Accrual Expense

- Cell construction/depletion
 - Cell construction
 - Cell capacity = 2,000,000 tons
 - Cell cost = \$4,000,000
 - Depletion cost rate: \$2/ton (accrual)
 - Disposal rate in year: 200,000 tons
 - Depletion cost posted: \$400,000

Cell Sequencing and Depletion



Depletion rates for cell construction: \$2/ton
 $\$4,000,000/2,000,000$ tons

Accruals

- Closure

$$\text{Closure Accrual } \$/\text{year} = (C-A)/R \times D$$

In First Year Example

$$(\$3,000,000-0)/2,000,000 \text{ tons} \times 200,000 \text{ tons} = \\ \$300,000/\text{year}$$

Where:

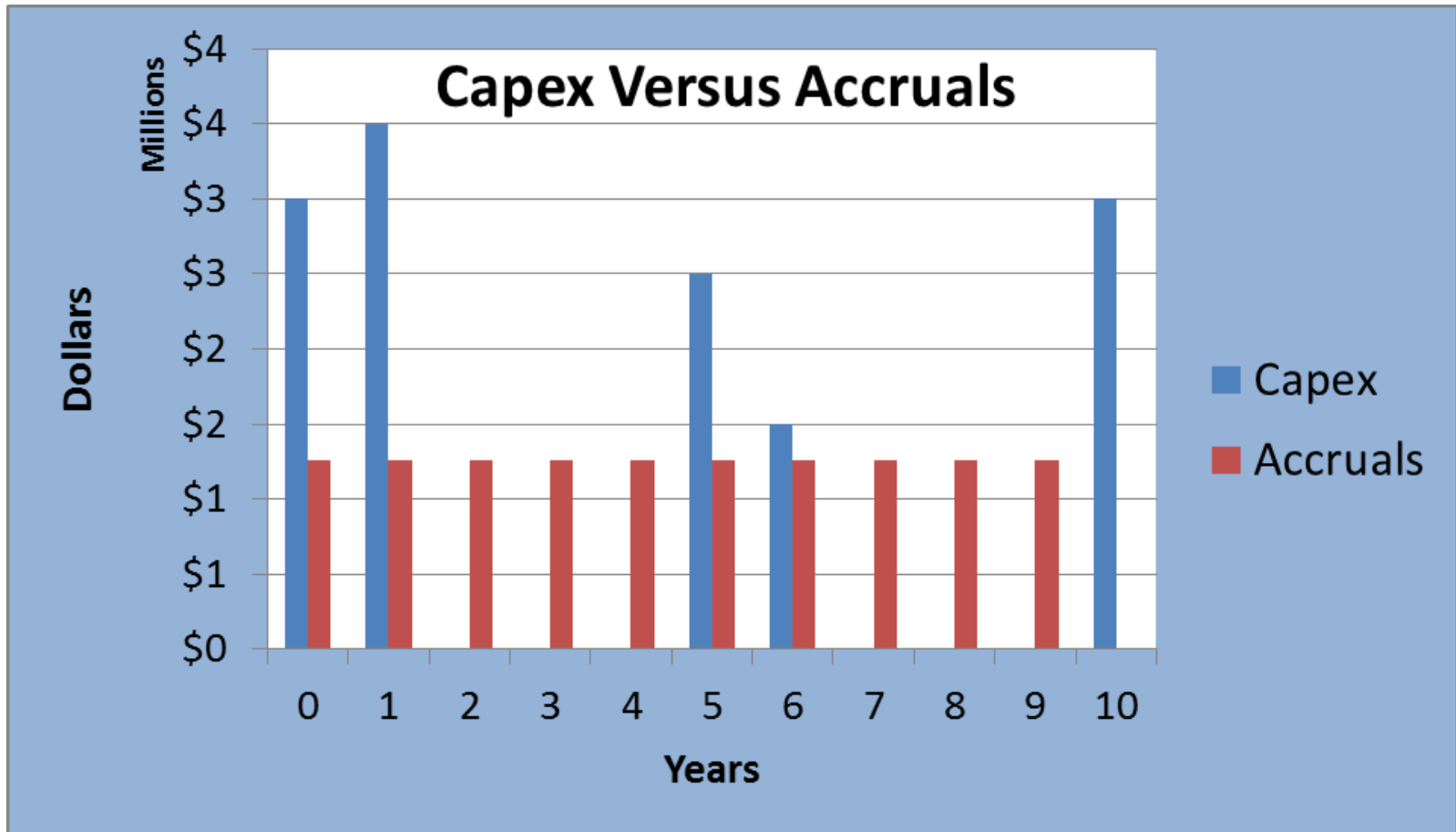
C = Future closure liability, \$

A = Previously accrued, \$

R = Remaining capacity beginning of period, tons

D= Disposal rate per year, tons/year

Cash versus Expense



Other Terms

- **EBITDA:** Earnings before interest, taxes, depreciation, amortization
- **Cash flow:** Earnings + Interest + Non-cash items – Capex
- **IRR =** Internal Rate of Return, or effective interest rate of cash flow, or discount cash flow rate of return.

Conceptual Income and Cash Flow Statements

Cost Item	Years					
	0	1	2	3	4	5
Revenue						
Tons Received		200,000	200,000	200,000	200,000	200,000
Tip Fee		\$ 30.00	\$ 30.00	\$ 30.00	\$ 30.00	\$ 30.00
Revenue		\$ 6,000,000	\$ 6,000,000	\$ 6,000,000	\$ 6,000,000	\$ 6,000,000
Expenses						
Cash						
Labor		800,000	800,000	800,000	800,000	800,000
Equipment O&M		1,000,000	1,000,000	1,000,000	1,000,000	1,000,000
Insurance		50,000	50,000	50,000	50,000	50,000
Closure/PCC Bond		150,000	150,000	150,000	150,000	150,000
Maintenance		200,000	200,000	200,000	200,000	200,000
Professional Services		150,000	150,000	150,000	150,000	150,000
Local Taxes		25,000	25,000	25,000	25,000	25,000
Utilities		50,000	50,000	50,000	50,000	50,000
G&A		500,000	500,000	500,000	500,000	500,000
Interest		250,000	230,000	209,000	187,000	164,000
Postclosure care		150,000	150,000	150,000	150,000	150,000
Subtotal Cash Outlays		3,325,000	3,305,000	3,284,000	3,262,000	3,239,000
Accruals						
Cell Development	} Non-Cash	400,000	400,000	400,000	400,000	400,000
LFG System		50,000	50,000	50,000	50,000	50,000
Closure		300,000	300,000	300,000	300,000	300,000
Depreciation		214,000	214,000	214,000	214,000	214,000
Amortization		500,000	500,000	500,000	500,000	500,000
Subtotal Accruals		1,464,000	1,464,000	1,464,000	1,464,000	1,464,000
Total, Expense		\$ 4,789,000	\$ 4,769,000	\$ 4,748,000	\$ 4,726,000	\$ 4,703,000
Operating Income		1,211,000	1,231,000	1,252,000	1,274,000	1,297,000
Taxes, 40%		484,400	492,400	500,800	509,600	518,800
Net Income		\$ 726,600	\$ 738,600	\$ 751,200	\$ 764,400	\$ 778,200

Conceptual Income and Cash Flow Statements

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	0	1	2	3	4	5
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Net Income		\$ 726,600	\$ 738,600	\$ 751,200	\$ 764,400	\$ 778,200
Break Even Tip Fee (Operating Income)		\$ 23.9	\$ 23.8	\$ 23.7	\$ 23.6	\$ 23.5
Break Even Tip Fee (Net Income)		\$ 26.4	\$ 26.3	\$ 26.2	\$ 26.2	\$ 26.1
Capex						
Development	5,000,000		-	-	-	-
New Cell	-	2,000,000	-	-	-	2,000,000
LFG System						500,000
Closure						
Equipment		1,500,000	-	-	-	-
	\$ 5,000,000	\$ 3,500,000	\$ -	\$ -	\$ -	\$ 2,500,000
EBITA	\$ -	\$ 2,925,000	\$ 2,925,000	\$ 2,925,000	\$ 2,925,000	\$ 2,925,000
Cash Flow	\$ (5,000,000)	\$ (575,000)	\$ 2,925,000	\$ 2,925,000	\$ 2,925,000	\$ 425,000
Sum of 10-year Cash Flow	\$ 13,750,000					
Sum of Capex	\$ 15,500,000					
IRR, 10 year	31%					

Pre-Development Costs

- Site selection
- Site investigations
- Engineering Design
- Permitting
- Public involvement

Site Selection

Item	Low (\$1,000)	High (\$1,000)
Fatal Flaw Analysis	\$30	\$100
Site Screening and Selection	\$500	\$2,000
Detailed Site Assessments	\$500	\$1,000
Final Selection	\$500	\$2,000
Public Involvement	\$100	\$500
Zoning	<u>\$50</u>	<u>\$200</u>
Totals	\$1,680	\$5,800

3 to 5+ year process. Costs can vary significantly beyond ranges shown depending on size of landfill, legal opposition, and environmental and permitting issues.

Mesquite Regional Landfill Development

- City of Los Angeles, Mesquite Landfill
 - Began permitting in 1992
 - Environmental Impact Statement/Report: 1992 – 1995
 - Fish & Wildlife/Historic Evaluations: 1993 – 1998
 - Air permit: 1998
 - Legal challenge: 2000 – 2002
 - City completes site purchase: 2002
 - Site development: 2003 - 2009

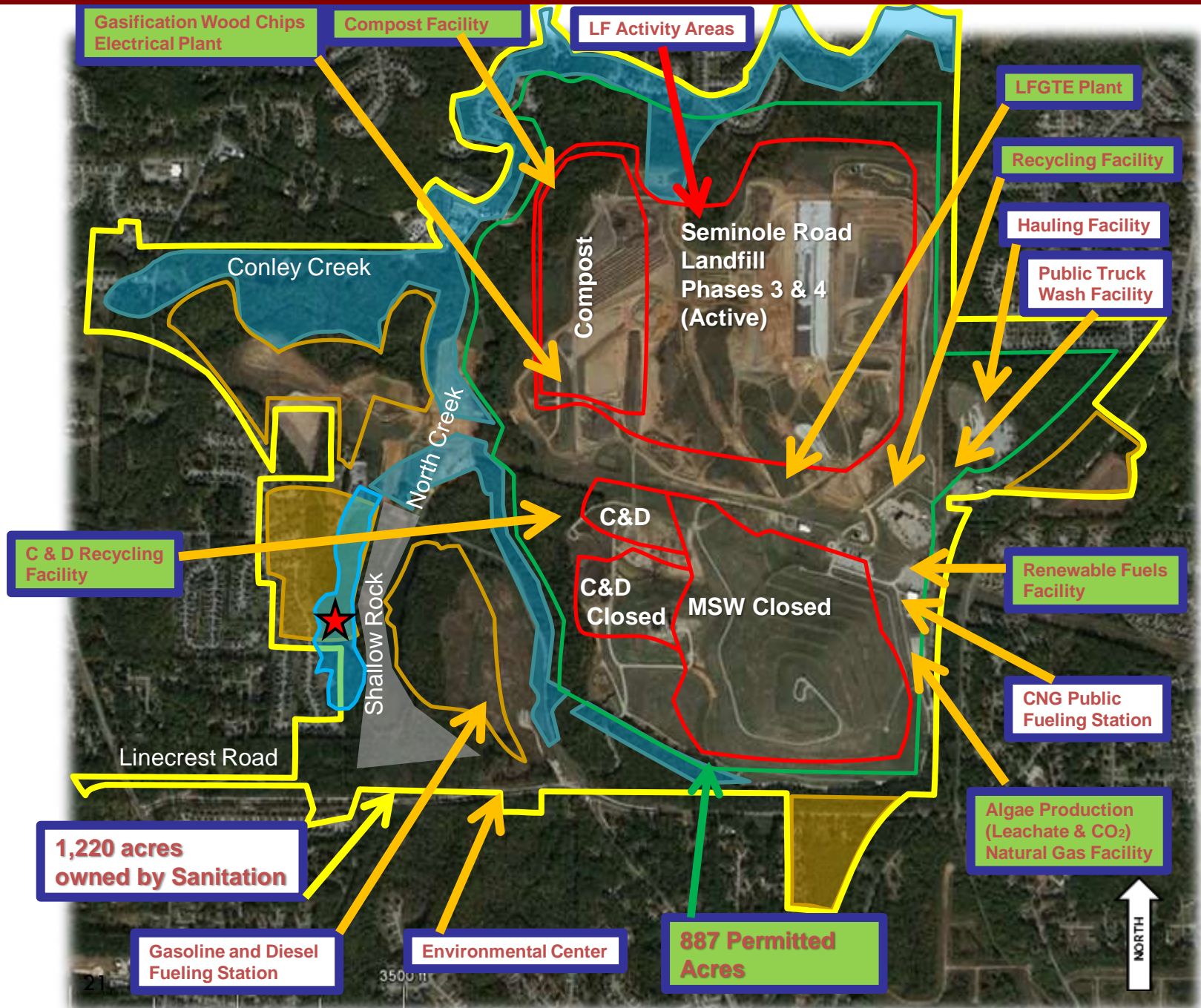
17
years

Site Investigations

Item	Low (\$1,000)	High (\$1,000)
Survey	\$50	\$200
Wetlands	\$50	\$300
Hydrogeological	\$500	\$1,500
Geotechnical	\$200	\$500
Flora & Fauna	\$100	\$200
Archeological	\$50	\$100
Traffic	\$50	\$200
Volume Analysis	<u>\$25</u>	<u>\$50</u>
Totals	\$1,025	\$3,050

Costs can vary significantly beyond ranges shown depending on size of landfill, site conditions and complexity, and regulatory requirements

Integrated SW Management Facility – Cost Centers



Capital Costs

- Site Development (varies)
 - Land
 - Buildings and Facilities
 - Entrance and Roadways
 - Fencing
 - Scales
 - Utilities
 - Other infrastructure

Capital Costs

Item	Low (\$1,000)	High (\$1,000)
Cell construction , \$/acre	\$250	\$350
Stormwater Systems	Varies	Varies
Leachate Management Systems	\$200	\$5,000
LFG Systems and Sequencing, \$/acre	\$30	\$40
Closure Systems, \$/acre	\$50	\$200
Environmental Monitoring Systems	Varies	Varies

Costs can vary significantly beyond ranges shown depending on size of landfill, site conditions and complexity, location and regulatory requirements

Engineering Design and Permitting

- Permitting
 - Drawings
 - Technical supporting documentation
- Construction level design/drawings
- Construction services
 - Resident engineering
 - CQA
 - Certification report

Operational Costs

Examples

- Labor
- Equipment
- Consumables (e.g., fuel, soil cover)
- Depreciation
- Professional Services
- Monitoring and Testing
- Accruals
- Cover Materials
- Leachate Management
- LFG Management
- Host Fees
- Taxes (If private)
- Transfers
- Other

Operational Costs

Labor

Labor Costs									
No.	Job Classification	Base Rate (\$/hr)		Overtime (%)	Hrs	OT Hrs	Hrs/Yr	2013 Salary (\$/Yr)	2014
1	General Manager	35.00	Salary	0%	2,080	-	2,080	73,000	75,000
0	Superintendent	30.00	Salary	0%	-	-	-	-	-
0	Sales Manager	0.00	Salary	0%	-	-	-	-	-
1	Operations Supervisor	25.00	Salary	0%	2,080	-	2,080	52,000	54,000
2	Gate House Operator	16.00	Non-Salary	5%	4,160	416	4,576	77,000	79,000
2	Office Clerk	16.00	Non-Salary	5%	4,160	416	4,576	77,000	79,000
1	Lead Mechanic	24.00	Non-Salary	5%	2,080	104	2,184	54,000	56,000
1	Mechanic	23.00	Non-Salary	5%	2,080	104	2,184	51,000	53,000
2	Lead Equipment Operator	22.00	Non-Salary	5%	4,160	416	4,576	105,000	108,000
3	Equipment Operator	20.00	Non-Salary	5%	6,240	936	7,176	153,000	158,000
1	Driver/Oiler	18.00	Non-Salary	5%	2,080	104	2,184	40,000	41,000
0	Parts Runner	12.00	Non-Salary	5%	-	-	-	-	-
2	Load Checker	12.00	Non-Salary	5%	4,160	416	4,576	57,000	59,000
3	Spotter	12.00	Non-Salary	5%	6,240	936	7,176	92,000	95,000
3	Laborer	10.00	Non-Salary	5%	6,240	936	7,176	76,000	78,000
0	Other1	10.00	Non-Salary	5%	-	-	-	-	-
0	Other2	10.00	Non-Salary	5%	-	-	-	-	-
22									
	Totals								
	Salary, \$							125,000	129,000
	Non-Salary							782,000	806,000
	Federal								
	Worker's Comp						15.000%	136,000	140,000
	FICA						6.200%	56,000	58,000
	Medicare						1.450%	13,000	13,000
	FUTA						0.200%	2,000	2,000
	SUI						0.135%	1,000	1,000
	Benefits							211,000	217,000
	Totals							\$ 1,326,000	\$ 1,809,000

Operational Costs

Equipment

No.	Equipment/Model	Estimated Capital Cost	Hours/Week/ Vehicle	Hours/Year/ Vehicle	Fuel Cost (\$/Year)	Oil Cost (\$/Year)	Total (\$/hr)	Total Repair & Maint. (\$/Year)	2013 Totals	2014
1	2-1/2 ton mechanic truck	111,000	8	416	\$9,000	\$200	4.75	\$2,000	\$11,200	12,000
1	Fuel & lube truck (2000 gal.)	111,000	8	416	\$9,000	\$200	4.40	\$1,800	\$11,000	11,000
1	3/4-ton pickup truck	37,000	8	416	\$6,000	\$0	1.40	\$600	\$6,600	7,000
1	1/2-ton pickup truck	30,000	8	416	\$3,000	\$0	1.25	\$500	\$3,500	4,000
2	D9 CAT dozer	368,000	44	2,282	\$208,000	\$26,000	25.50	\$58,200	\$292,200	301,000
2	D8 CAT dozer	294,000	44	2,282	\$191,000	\$13,000	19.00	\$43,400	\$247,400	255,000
1	D4 or D5 CAT dozer	184,000	44	2,282	\$52,000	\$4,300	21.50	\$49,100	\$105,400	109,000
2	Dump Truck	184,000	24	1,248	\$57,000	\$3,600	15.50	\$19,300	\$79,900	82,000
3	836 CAT compactor	331,000	88	4,565	\$989,000	\$19,500	16.50	\$75,300	\$1,083,800	1,116,000
2	Excavator	250,000	22	1,144	\$104,000	\$6,500	25.50	\$29,200	\$139,700	144,000
2	Loader	200,000	22	1,144	\$104,000	\$6,500	25.50	\$29,200	\$139,700	144,000
2	Water truck - 4000 gal.	89,000	12	624	\$24,000	\$2,400	10.90	\$6,800	\$33,200	34,000
2	Light Tower	23,000	18	936	\$28,000	\$1,800	4.75	\$4,400	\$34,200	35,000
0	Tipper	221,000	0	-	\$0	\$0	23.00	\$0	\$0	-
1	Irrigation pump & piping	30,000	16	832	\$6,000	\$400	1.50	\$1,200	\$7,600	8,000
2	Compressor	15,000	20	1040	\$16,000	\$1,000	1.50	\$1,600	\$18,600	19,000
					1,806,000	85,400		322,600	\$2,214,000	\$2,281,000

Environmental Monitoring

- Groundwater
 - Routine
 - Correction Action
- Surface water (NPDES)
- LFG/NSPS/Title V
- Leachate
- Odors

Professional Services

- Legal
- Accounting
- Environmental Sampling & Testing
- Engineering Design and Permitting
- Continuing Engineering Services

LFG Management

- Blower and flare stations
- LFGE facility (offsetting revenues)
- Wellfield maintenance
 - Routine repairs
 - Non-routine repairs
- Third-party contracts

Cover Management

- Site soil balance
- Soil borrow location and soil types
- Alternative daily covers
 - Foam
 - Tarps
 - Admixtures
 - Wood chips/compost

Find the least expensive that provides the regulatory and operational function required.

Host Fees

- \$/ton or periodic lump sum payment to municipality hosting the landfill.
- Usually applicable to private landfills in a host community
- Can be sizeable for regional and interstate landfills.

Host Fee Examples

Virginia Locality	Host Fee	Tons	\$/year
Brunswick	\$.40/ton	422,707	\$168,958
Charles City	\$6/ton	355,450	\$2,132,700
Gloucester	\$.7976/ton	280,000	\$223,076
Hampton	\$1.73/ton	553,887	\$960,051
King George	\$4.84/ton	1,240,724	\$6,008,370
Sussex	\$3.79/ton	1,749,404	\$6,630,241

Source: "Solid Waste Managed in Virginia During Calendar Year 2010" issued by the Virginia Department of Environmental Quality, June, 2011

Transfers

- Municipal Operations
 - Inter-department transfers
 - Accounting
 - Legal
 - Maintenance
 - General fund support
 - Special fund accounts (closure, pcc)

Transfers

- Private Operations
 - Inter-company transfers
 - Hauling division
 - Disposal division
 - Recycling division
 - Corporate support
 - Special fund accounts (closure, pcc)

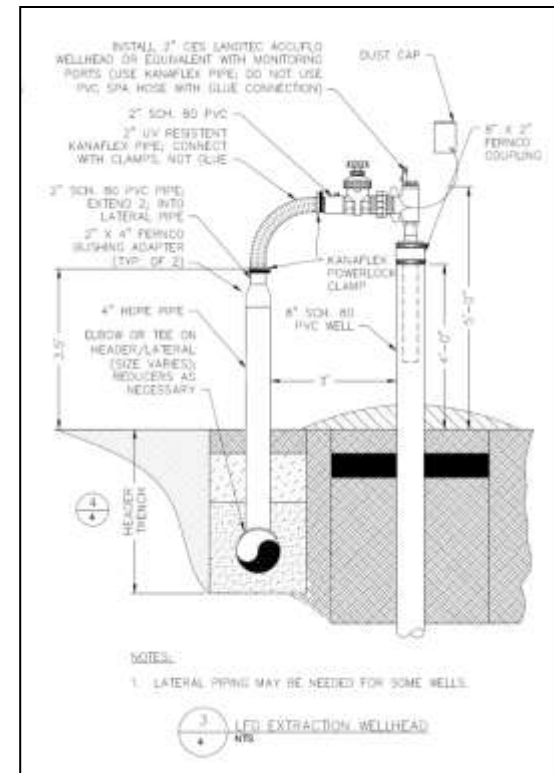
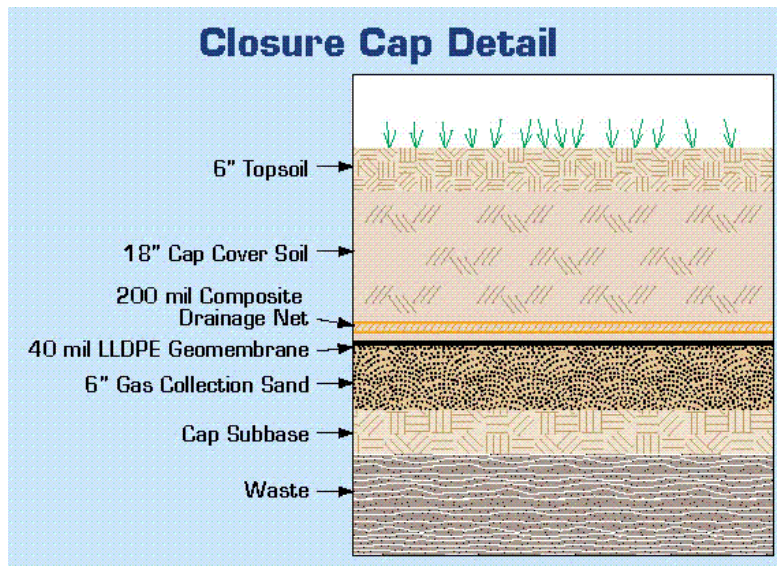
Fund transfers need to be fully understood and tracked properly.

Postclosure Costs

- Environmental Control Systems Operation & Maintenance
 - Stormwater Management
 - Leachate Management
 - LFG Management
 - Final Cover Integrity
 - Landfill Repairs (cap erosion repairs, drainage silt removal, replacement of LFG wells, etc.)
- Environmental Monitoring Costs
- Remedial Costs

Closure Costs

- Placement and establishment of landfill final cover
- Final LFG systems



Closure Costs

Item	Low (\$1,000)	High (\$1,000)
Cell construction , \$/acre	\$250	\$350
Stormwater Systems	Varies	Varies
Leachate Management Systems	\$200	\$5,000
LFG Systems and Sequencing, \$/acre	\$30	\$40
Closure Systems, \$/acre	\$50	\$200
Environmental Monitoring Systems	Varies	Varies

Costs can vary significantly beyond ranges shown depending on size of landfill, site conditions and complexity, location and regulatory requirements

Financial Assurance

- Mechanism to cover costs for closure and postclosure care if landfill operation fails.
- Financial Assurance Mechanisms
 - Trust
 - Escrow
 - Insurance
 - Letter of Credit
 - Bond

Financing Costs

- Financing

- Debt Financing (Public bonds, revenue bonds, borrow from a bank)
- Equity Financing (Private capital)
- Weighted Average Cost of Capital (WACC)

(Cost of Debt) x (1 – tax rate) x debt ratio + (cost of Equity) x (1-debt ratio)

Debt, 5%, 40% share

Equity, 16%, 60% share

$$\text{WACC} = 0.05 * (1 - 0.39) * 0.4 + 0.16 * (1 - 0.4) = 10.82\%$$

Interest Expense Example

Assumptions	
Principal	\$5,000,000
Term	10 years
Interest Rate	5%
PMT	(\$647,523)

Year	Prinical	Interest	Debt Service
1	(\$397,523)	(\$250,000)	(\$647,523)
2	(\$417,399)	(\$230,124)	(\$647,523)
3	(\$438,269)	(\$209,254)	(\$647,523)
4	(\$460,183)	(\$187,340)	(\$647,523)
5	(\$483,192)	(\$164,331)	(\$647,523)
6	(\$507,351)	(\$140,172)	(\$647,523)
7	(\$532,719)	(\$114,804)	(\$647,523)
8	(\$559,355)	(\$88,168)	(\$647,523)
9	(\$587,322)	(\$60,201)	(\$647,523)
10	(\$616,689)	(\$30,834)	(\$647,523)

Reserves

- Either Borrow or Fund Ahead
 - “Pay me now or pay more later”
- Escrow Funds
 - Contingency
 - New cell construction
 - Equipment purchase
 - Closure Escrow
 - Postclosure Escrow

Years	Starting	Deposit	Interest	Balance
1	-	780,190	-	780,190
2	780,190	780,190	31,208	1,591,588
3	1,591,588	780,190	63,664	2,435,442
4	2,435,442	780,190	97,418	3,313,050
5	3,313,050	780,190	132,522	4,225,763
6	4,225,763	780,190	169,031	5,174,983
7	5,174,983	780,190	206,999	6,162,173
8	6,162,173	780,190	246,487	7,188,850
9	7,188,850	780,190	287,554	8,256,595
10	8,256,595	780,190	330,264	9,367,049
11	9,367,049	780,190	374,682	10,521,921
12	10,521,921	780,190	420,877	11,722,988
13	11,722,988	780,190	468,920	12,972,098
14	12,972,098	780,190	518,884	14,271,173
15	14,271,173	780,190	570,847	15,622,210
16	15,622,210	780,190	624,888	17,027,289
17	17,027,289	780,190	681,092	18,488,570
18	18,488,570	780,190	739,543	20,008,304
19	20,008,304	780,190		
20	21,588,826	780,190	863,553	23,232,569
21	23,232,569	780,190	929,303	24,942,063
22	24,942,063	780,190	997,683	26,719,935
23	26,719,935			28,568,923
24	28,568,923			30,491,871
25	30,491,871		1,219,...	
26	32,491,736		1,299,...	
27	34,571,595		1,382,864	36,734,650
28	36,734,650		1,469,386	38,984,226
29	38,984,226		1,559,369	41,323,785
30	41,323,785		1,652,751	43,756,927
		23,405,710	20,351,217	

Example Pay It Forward Versus Borrowing

FV Closure = \$43.8M

Options:

- Borrow later
- Escrow now

Result: Save \$\$\$

PMT on \$47.8M @
4%, 30 years =
\$2.5M/year

*Privates would pay income
tax on earnings, use net
interest rate

Capital Invested

Interest Earned

Future Value

Revenues

- Sources
 - Tip fee (user fee)
 - General fund
 - Combination tip fee and general fund
 - Assessments
 - LFG-Energy recovery (Elec., Direct Use)
 - Mulch/compost sales
 - Recyclable sales (White goods, metals)

What Governs Tip Fee?

- Cost of service
- Investment goal (private)
- Market conditions
- Private versus public



**SOUTHEASTERN PUBLIC SERVICE AUTHORITY OF VIRGINIA
Fees and Charges for Solid Waste Management**

Effective June 1, 2012

Revenues

WASTE DISPOSAL - ALL LOCATIONS	
Waste Delivered to All Disposal Points:	Rate
Municipal Solid Waste (delivered by any SPSA Member Jurisdiction)	\$125.00 per ton
Contract Municipal Solid Waste (delivered on behalf of a SPSA Member Jurisdiction)	\$125.00 per ton
U.S. Navy Waste under contract with SPSA (Rate effective June 1, 2011 is \$35.35 per ton)	Per Contract
Residential Solid Waste Delivered in private automobile or low-side pick-up truck	No Charge
Weighting Charge Per Vehicle, Per Incident	\$20.00
Suffolk Municipal Solid Waste (delivered by the City of Suffolk)	No Charge
Suffolk Contract Municipal Solid Waste (delivered under contract with the City of Suffolk)	No Charge

****Regulated Medical Waste is Prohibited at all SPSA Facilities. A Penalty will be charged Per Occurrence of \$250, Plus any Costs Incurred/Revenues Lost****

WASTE DISPOSAL - LANDFILL ONLY	
Waste Delivered to SPSA's Regional Landfill:	Rate
Non-Processible Solid Waste (non-contract)	\$60.00 per ton
Industrial Process Waste (acceptable only with prior approval)	\$60.00 per ton
Dead Animals Bagged or Unbagged (household pets only, i.e. dogs and cats)	\$10.00 each
Water Treatment Plant Sludge from any Member Community Transported by SPSA	\$46.00 per ton
Construction and Demolition Waste	\$40.00 per ton
Special Handling Waste (accepted only with prior approval)	Handling Cost plus 25%

TIRES	
Whole Tires Accepted at Landfill Only:	Rate
Automobile and Light Truck	\$77.50 per ton
Truck and Light Industrial (up to 24.5" rim diameter)	\$140.00 per ton
Heavy Equipment and Off-the-Road	\$155.00 each
Tires with Rims	Add \$2.00 per tire

HOUSEHOLD HAZARDOUS WASTE	
User Fees:	Rate
Rate Per Resident Visit Charged to Customer's Local Government	\$35 per visit
Waste Accepted at SPSA's Regional Landfill (from Businesses)	
	Rate
Batteries (lead & rechargeable)	\$60.00 per ton
Cell Phone Batteries	\$60.00 per ton
Alkaline Batteries	\$0.75 / lb.
SPSA reserves the right to reject certain quantities of batteries dependent on storage availability.	

MISCELLANEOUS	
Appliances with CFC Disposed at SPSA's Regional Landfill:	
Member Communities or Residents (Billed to Customer's Local Government)	\$12.00 Each
Businesses	\$12.00 Each
White Goods Containers (Based upon Distance from the Suffolk Regional Landfill)	\$75.00 - \$125.00 per pull

GRAY SOILS FOR USE AS ALTERNATIVE DAILY COVER

Material Type	Disposal Rate Per Ton
ADC5	\$5.00
ADC10	\$10.00
ADC15	\$15.00
ADC20	\$20.00

General Rate Explanation
The \$10 rate would be appropriate for dry ADC of screened quality with the \$15 rate applying to material with manageable amounts of football sized debris. The \$20 rate would be applicable to material which requires SPSA to remove larger pieces of debris prior to its beneficial reuse. All materials must be gradable (sufficiently dry) and have the same basic characteristics and appearance of clean fill before SPSA will consider using the material as cover.

For any category of Waste Disposal which is based on weight, the Minimum Fee is \$15.00.

Cost of Service

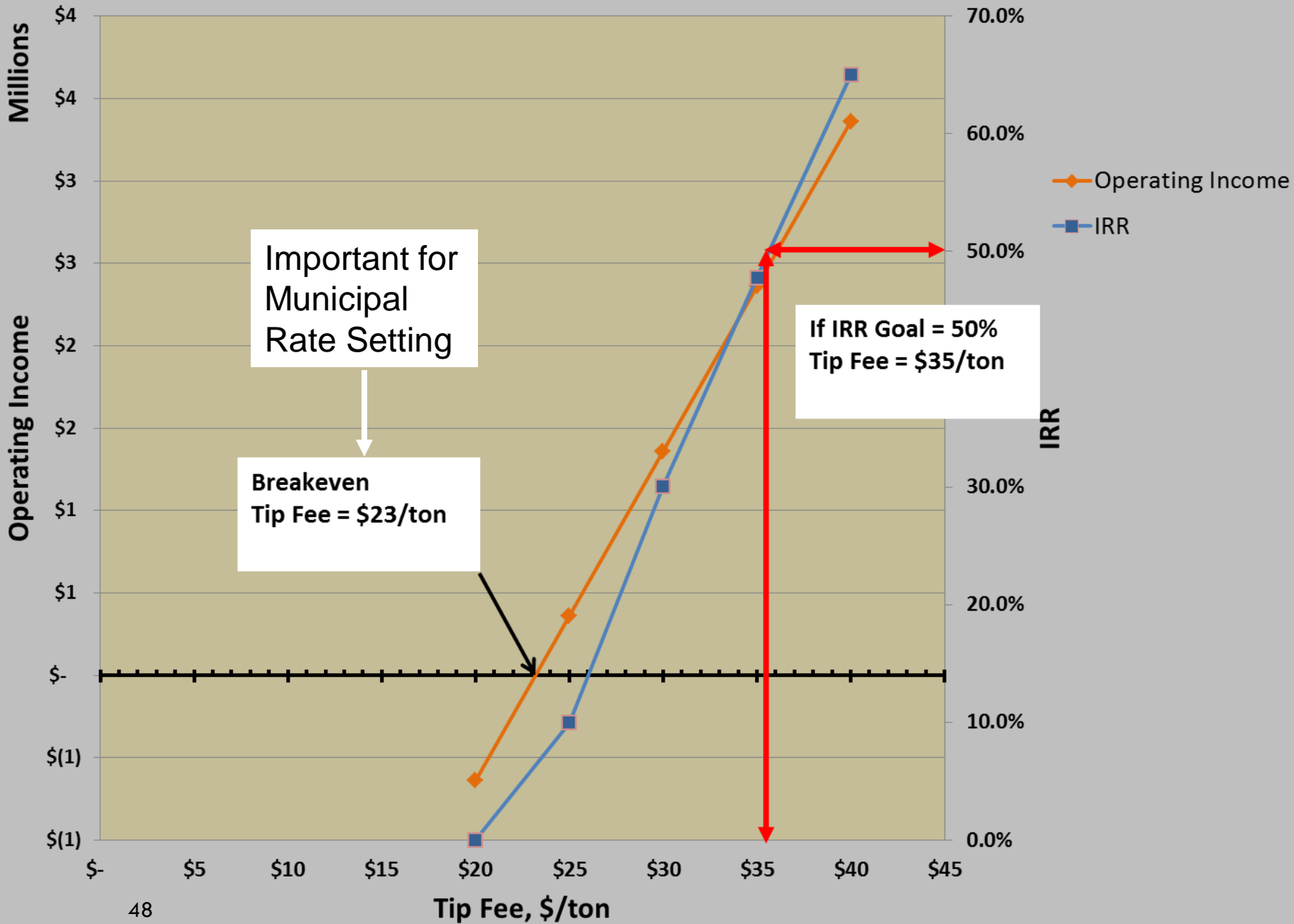
- Cost of service, breakeven analysis

Yearly Ops Costs (\$)/Disposal rate (tons)

Break Even Tip Fee = \$/ton

This tells you the tip fee required to make enough to cover your expenses

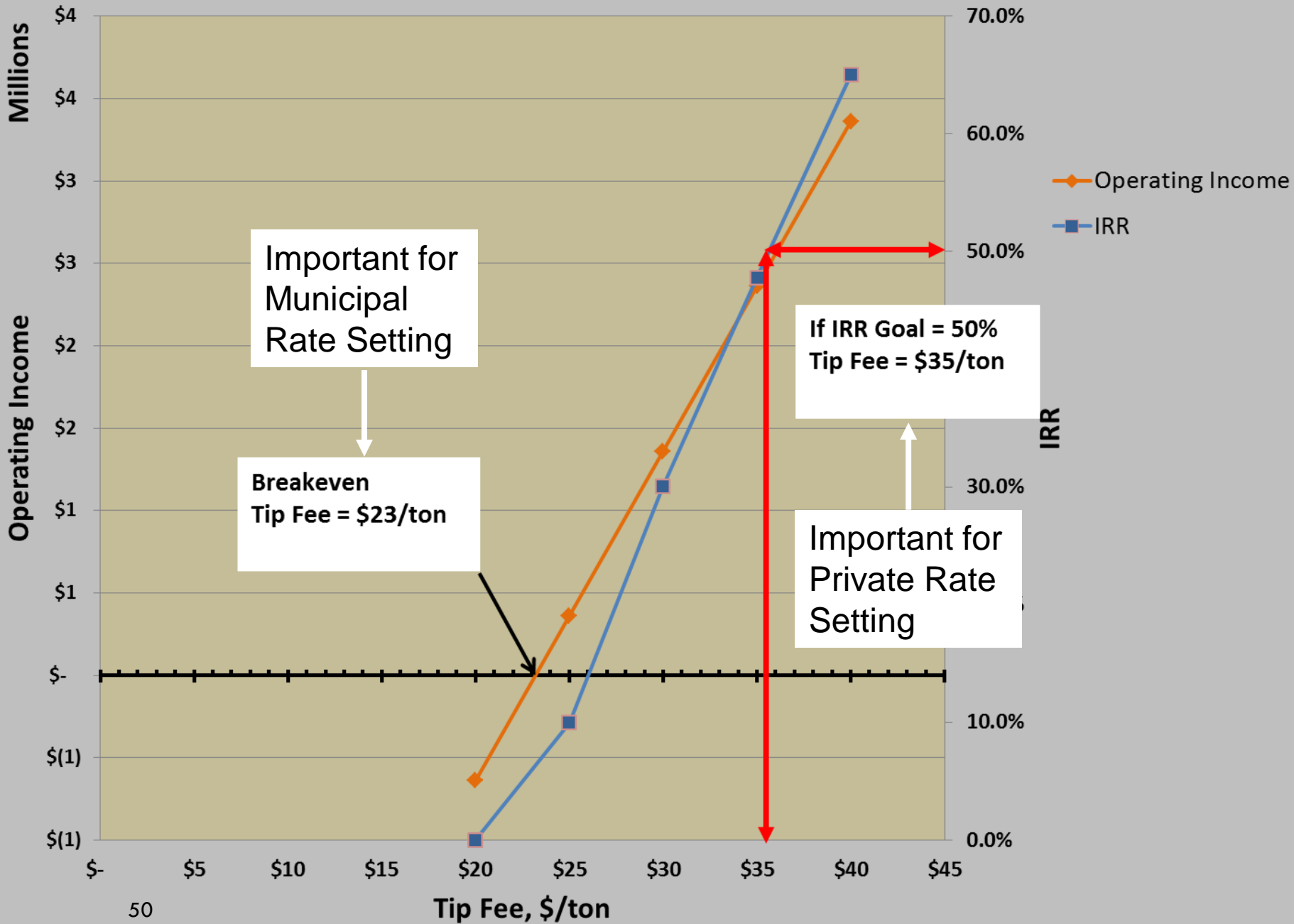
Breakeven Tip Fee/IRR Analysis



Investment Goals

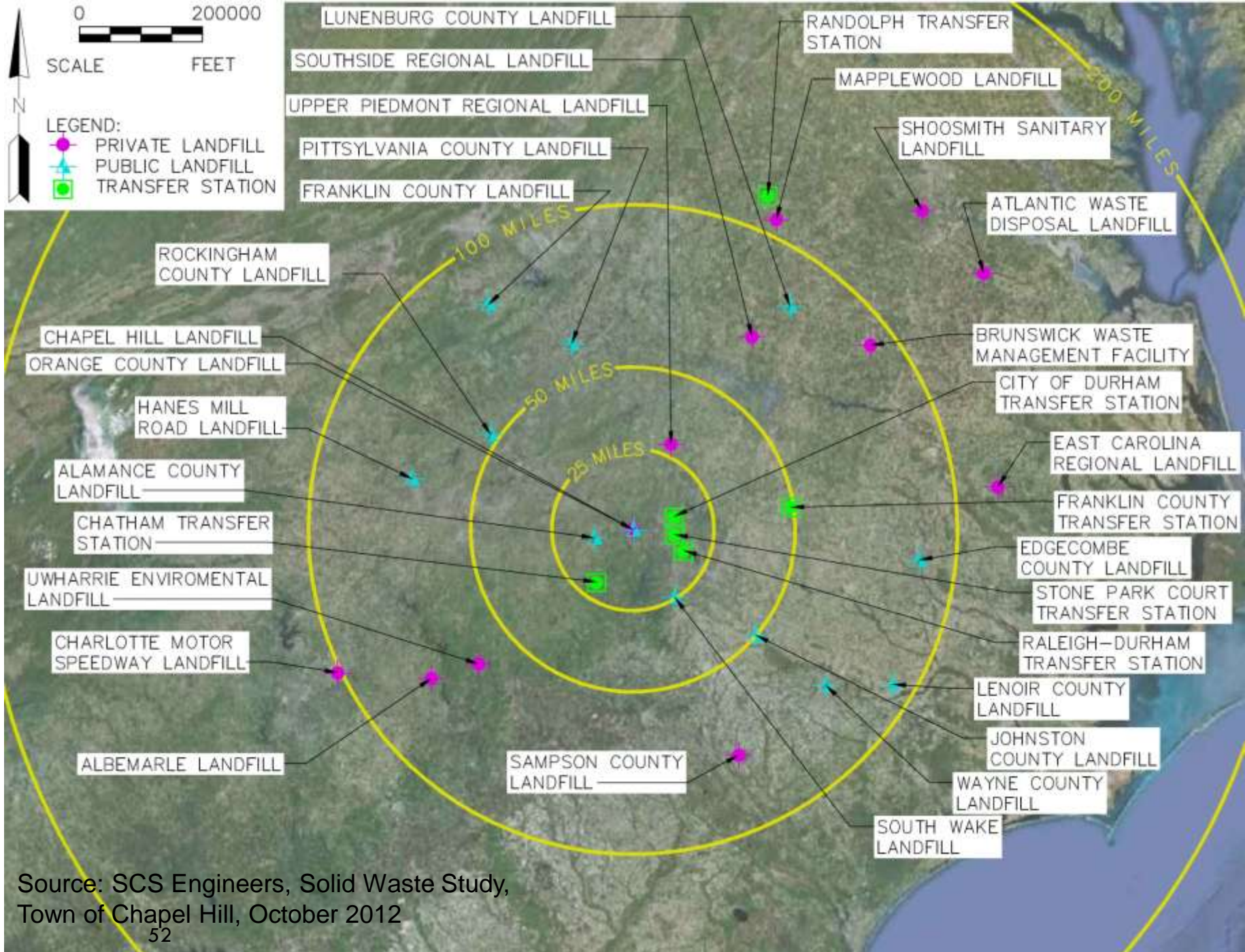
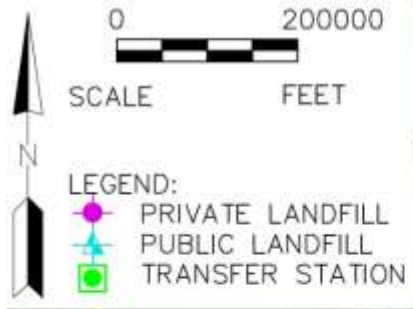
- Return on equity (IRR goal)
- Financing and tax strategies
- Deployment of capital

Breakeven Tip Fee/IRR Analysis



Landfill Economics Factors

- Proximity of competing landfills
- Market area tip fees
- Transportation costs
- Waste generation centroid



Source: SCS Engineers, Solid Waste Study,
 Town of Chapel Hill, October 2012

Rate Setting Example

1-Way Mile to Disposal

		Total Additional Cost (Labor and Fuel to Travel to Disposal Site), \$/ton					
		Fuel Price, \$/gallon					
		2.5	3	3.5	4	4.5	5
1		0.26	0.29	0.32	0.36	0.39	0.42
5		1.28	1.44	1.61	1.78	1.94	2.11
10		2.56	2.89	3.22	3.56	3.89	4.22
15		3.83	4.33	4.83	5.33	5.83	6.33
20		5.11	5.78	6.44	7.11	7.78	8.44
25		6.39	7.22	8.06	8.89	9.72	10.56
30		7.67	8.67	9.67	10.67	11.67	12.67
35		8.94	10.11	11.28	12.44	13.61	14.78

Situation I finish my route. I have two landfills to choose from.

Landfill A: 10 miles away, tip fee of \$20/ton

Landfill B: 25 miles away, tip fee of \$17/ton

Price of fuel = \$3.00/gal

Which one should I go to?

A: $\$20/\text{ton} + \$2.89/\text{ton} = \$22.89/\text{ton}$

B: $\$17/\text{ton} + \$7.22/\text{ton} = \$24.22/\text{ton}$

You might consider landfill A, even though higher tip fee

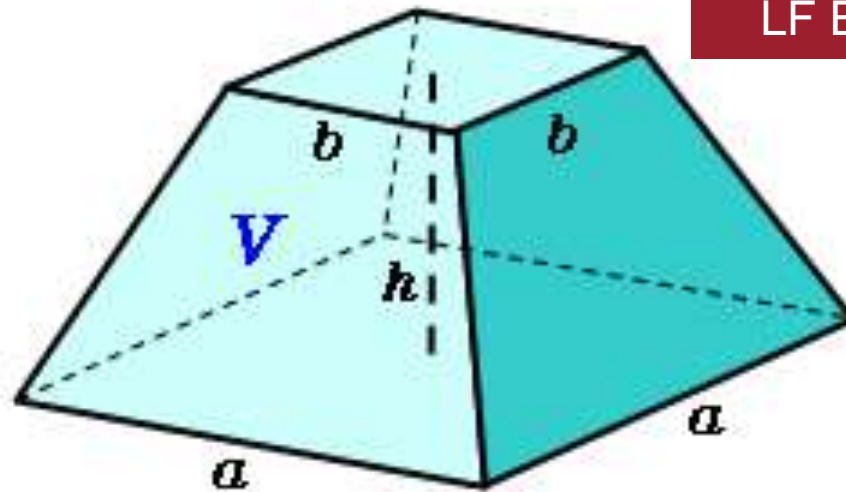
This assumes a 10-ton/vehicle load. Lower rates would apply to transfer trucks with higher capacity loads.

Landfill Configuration

- Maximize utilization of available airspace
 - Geometry
 - Operation optimization (compaction)

Landfill Slopes and Height Geometry





Truncated square pyramid

(1) *volume:* $V = \frac{1}{3}(a^2 + ab + b^2)h$

(2) *lateral area:* $F = 2(a+b)\sqrt{\left(\frac{a-b}{2}\right)^2 + h^2}$

(3) *surface area:* $S = F + a^2 + b^2$

a, feet	2,000	2,000	2,000	2,000
h, feet	100	100	150	200
b, feet	1,200	1,400	1,100	800
slope H:V	4	3	3	3
volume, CF	258,720,000	289,080,000	366,795,000	411,840,000
Volume, CY	9,582,222	10,706,667	13,585,000	15,253,333
% Increase		12%	42%	59%

Airspace Utilization Factor

- AUF: lbs/cubic yard achieved during period of time.

$$D/(VF2 - VF1)$$

Where:

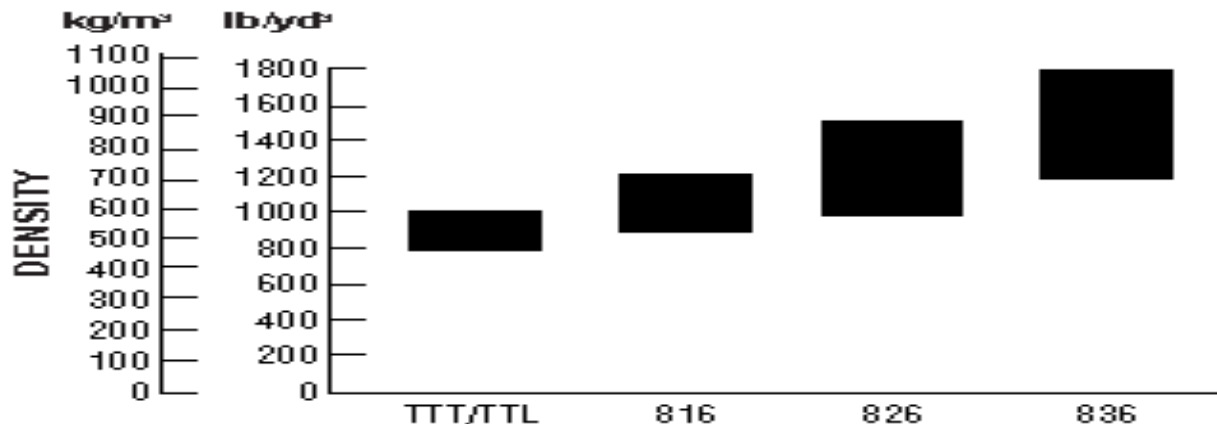
D = Disposal (tons) between time period 1 and period 2 (aerial survey)

VF2 = Volume Filled, Period 2, CY

VF1 = Volume Filled, Period 1, CY

COMPACTION COMPARISON ESTIMATE

The following graph may be used as a rule of thumb for the compactive ranges of various types of landfill machines if proper operating technique is employed.



EXAMPLE OF INCREASED COMPACTION ON POTENTIAL LANDFILL LIFE

Landfill refuse capacity	1 530 000 m³ (2,000,000 yd³)	
Operating days	260	
Daily volume	365 metric tons (400 tons)	
Yearly volume	94 328 metric tons (104,000 tons)	
Compaction	Landfill Life	Gain
590 kg/m³ 1000 lb/yd³	9.6 years	0
710 kg/m³ 1200 lb/yd³	11.5 years	1.9 years
830 kg/m³ 1400 lb/yd³	13.4 years	3.8 years
950 kg/m³ 1600 lb/yd³	15.3 years	5.7 years
1070 kg/m³ 1800 lb/yd³	17.2 years	7.6 years

Impact of AUF

AUF		Disposal Capacity (cy)	Disposal Capacity (tons)	Tip Fee (\$/ton)	Projected Revenue	% Change
lb/cy	tons/cy					
1200	0.60	10,000,000	6,000,000	35	210,000,000	0.0%
1300	0.65	10,000,000	6,500,000	35	227,500,000	8.3%
1400	0.70	10,000,000	7,000,000	35	245,000,000	16.7%
1500	0.75	10,000,000	7,500,000	35	262,500,000	25.0%
1600	0.80	10,000,000	8,000,000	35	280,000,000	33.3%
1700	0.85	10,000,000	8,500,000	35	297,500,000	41.7%

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