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SANITATION FACILITIES STUDY

CITY OF CHEFORNAK

PREPARED BY

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U.S. PUBLIC HEALTH SERVICE

DEPARTMENT OF HEALTH AND HUMAN SERVICES

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

SANITATION FACILITIES STUDY

CITY OF CHEFORNAK

INTRODUCTION AND HISTORY

The City of Chefornak requested Public Health Service (PHS) assistance to prepare a study for sanitation facility improvements for their community. The report request was in anticipation of planned community growth resulting from a Housing and Urban Development (HUD) mutual help home project, and new private home construction.

The need for the study resulted when Village Safe Water funds became available for sanitation facility improvements at Chefornak. A preliminary study and cost estimate was prepared for the state and was entitled "Preliminary Report, Village Safe Water Projects, 1980 Water and Sewer Bond Bill, Village Safe Water Program, January, 1981". In January 1981, the city of Chefornak contacted PHS regarding preparation of a sanitation facilities study. A presentation of various sanitation facility alternatives was made to the city council in May, 1981, and a Planning Agreement between the PHS and city was signed in June, 1981. In August, a city decision was made for the study to consider variations of a water distribution system utilizing watering points, and a sewage and solid waste haul system.

SCOPE OF STUDY

Per city direction, the scope of this study will consider a water distribution system with watering points, and a haul system using trailer mounted containers for sewage and solid waste. In addition, bunker system costs have been included as an option to consider and compare against the sewage haul system. The water distribution system will be considered for all-weather operation as well as summer only operation.

Resources and information utilized in this study include the following:

- -Bureau of Land Management (BLM) aerial photos
- -BLM survey plats
- -Existing well logs
- -Soils analysis reports
- -Analysis of the existing water sources
- -Discussions with the city council and residents
- -Cold Climate Utility Delivery Design Manual

The intent of this study will be to provide construction and operation costs for sanitation facilities. Costs will include serving the proposed new HUD subdivision, although initial on-site costs will be a HUD obligation. Recommendations will be provided where necessary so that the city can make choices and give direction for the final design of their sanitation facilities.

CITY CHARACTERISTICS

Chefornak's geographical information has been extensively covered in other documents prepared for the school (see "Lower Kuskokwim School Site Investigation for Chefornak, Alaska", prepared by R&M Consultants, Inc., 5024 Cordova Street, Anchorage, Alaska 99503), and for the state (see Alaska Department of Environmental Conservation report entitled "Preliminary Report, Village Safe Water Projects, 1980 Water and Sewer Bond Bill, Village Safe Water Program, January, 1981"). A third information source was a grant request made by the City of Chefornak entitled "Grant Proposal for Planning Sanitation Improvement Projects", prepared by Charlie Kairaiuak for Chefornak City Council, February 6, 1981. As a result, characteristics for Chefornak are shown below in abbreviated form.

Physical Characteristics

Location:
- 98 air miles west southwest of Bethel
- Adjacent to Kinia River
- Within Clarence Rode National Wildlife Refuge

Topography:
- Coastal delta; tundra with lakes, drainages on east and west side of village into Kinia River.
- City is from five to ten feet above river level.
- See Figure 1.

Geology:
- Alluvial and marine sediments characteristic of coastal delta deposits.
- City is built on a volcanic bank composed of large rocks and gray clays.
- Area underlain with permafrost. Active layer approximately 2 to 4 feet.
- Seismic zone 1

Climate:
- Temperature range: -50°F to 76°F.
- Freezing Degree Days: 2,800°F Days
- Thawing Degree Days: 1,800°F Days
- Heating Degree Days: 13,000°F Days
- Annual precipitation: 15 inches/year

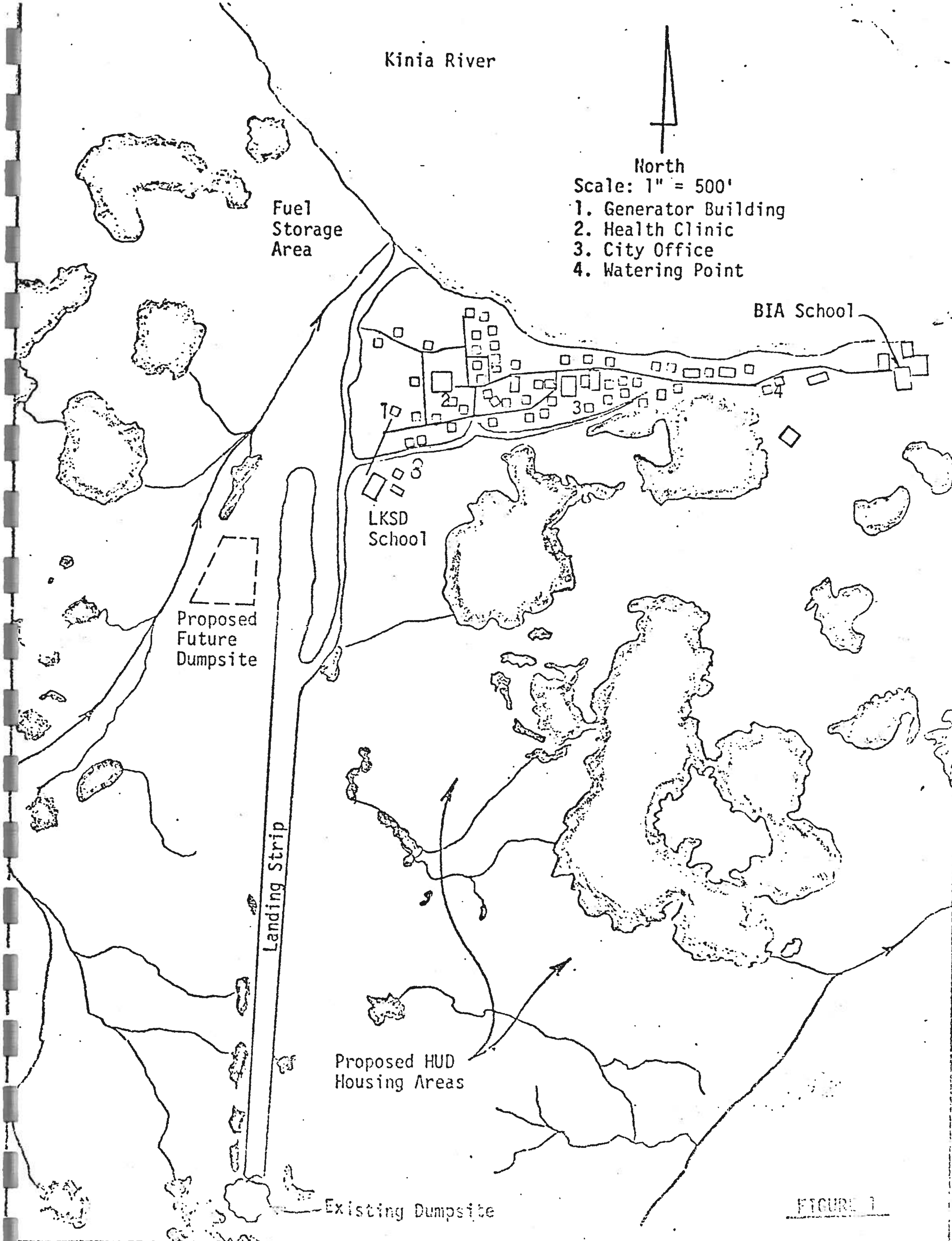
Village Characteristics

Population: U.S. Census Figures

1950	106
1960	133
1970	146
1980	221

- 1981 actual resident count 230
- Native type: Kaialigmuit Eskimo

Buildings:
- Residential Homes 54
- Proposed HUD homes 30
- Schools
  - LKSD High School
  - BIA Elementary School
- Other
  - Two stores (plus 1 under construction)
  - Catholic Church
  - Post Office
  - City Hall



Kinia River
North
Scale: 1" = 500'
1. Generator Building
2. Health Clinic
3. City Office
4. Watering Point
Fuel
Storage
Area
BIA School
LKSD
School
Proposed
Future
Dumpsite
Landing Strip
Proposed HUD
Housing Areas
Existing Dumpsite

FIGURE 1

Income: -Subsistence hunting and fishing
-Seasonal Commercial fishing
-Seasonal Cannery jobs
-Arts and Crafts
Government: -Five member traditional council
-Mayor, City Administrator

EXISTING SANITATION FACILITIES

Water Facilities

The existing water facilities now serving Chefornak consist of a 118 foot deep, 4-inch diameter drilled well, a watering point building containing the well, a jet pump, and two interconnected 600 gallon wood stave storage tanks. The jet pump operates continuously and excess water is returned to the well. Well water quality is good and has remained stable since it was put into use.

A more centrally located watering point is operated in the summer using city installed copper pipe. Pressure for the summer watering point is generated by special plumbing and valving on the jet pump.

The BIA and state schools have their own individual wells and hydropneumatic systems. The BIA school water quality approximates the community's well. The state school well has poorer quality water, and drinking water is obtained from the community watering point.

Sewage Disposal

Community sewage disposal consists of honey bucket dumping on the river bank. PHS constructed bunkers and privies (1964) have long been filled and are no longer used.

The BIA school has a small Bio-Pure aeration plant with treated effluent discharged to the river.

The state school has a lined, above ground pond for its sewage. There is no apparent means for dischange once the pond fills with sewage.

Solid Waste Disposal

Solid waste is burned in many instances, and individually hauled to a dumpsite located adjacent to the south end of the airstrip.

EVALUATION OF PROPOSED FACILITIES

As mentioned in the introduction and history section of this study, the city has made preliminary sanitation facility choices of a water distribution system with watering points, and a waste haul system. These choices were made after city review and discussion of different sanitation facility options.

This section will provide an evaluation of the proposed sanitation facilities. Capital plus operation and maintenance costs will be presented for the city's review and further consideration.

Water System

The city's desired water system improvements involve a distribution system with watering points. Two system options are available and include:

1. A combination pumphouse/watering point with summer only water distribution system serving several watering points.
2. A pumphouse and distribution system with multiple all-weather watering points. Distribution piping to be above ground per city's request

Differences between these two systems can best be explained by listing the particular items pertinent to each system. This has been done with estimated construction costs in Table I. The totals for each system show that the all-weather distribution system requires the most components and has a higher resultant construction cost.

The highest initial costs involve the pumphouse and water distribution system. Building costs involve foundation construction capable of supporting the water storage reservoir. Soil testing in the vicinity of a new pumphouse was done in October, 1981, and the results are shown in Figure 2. The soil log shows rock at an approximate 10 foot depth and a shallow pile foundation will probably be the best foundation choice.

Water distribution piping will consist of uninsulated polyethylene (PE) pipe if a summer distribution system is chosen, and insulated PE pipe with an outside aluminum jacket if an all-weather system is chosen. Lines would be placed parallel to the city boardwalks and above ground. Among other desireable properties of PE pipe is its ability to withstand water freezing in it with no damage to the pipe. An ideal situation exists for its implementation at Chefornak.

Because an all-weather system requires more equipment, operation and maintenance costs will also be higher as shown in Table II. As noted in this table, water heating costs could be reduced if waste heat from the village electrical generation system is utilized. An ideal situation for the water system would be to locate the new village generator next to the pumphouse so that pumphouse and water heating could be accomplished using waste heat. The present separation distance between the two utility buildings is approximately 1600 feet.

The final choice of water system type will have to be a city decision. The merits of not having to haul water greater distances during cold weather will have to be weighed against the increased costs to operate and maintain the system.

Current water use from the existing well is relatively low because of the single watering point. Upgrading the water system will result in higher usage and will require increased well water production. It is difficult to predict if increased water production will result in decreasing water quality over an extended period of time. Evaluation of chemical analyses from 1965 to 1981 shows no decrease in water quality, and only increased usage will determine if degrading water quality will occur.

TABLE I

CONSTRUCTION COSTS - CHEFORNAK WATER SYSTEM ALTERNATIVES

ITEM	SUMMER DISTRIBUTION SYSTEM			WATERING POINTS/ALL WEATHER DISTRIBUTION		
	Needed	Amount	Estimated Cost	Needed	Amount	Estimated Cost
1. Pumphouse Bldg.	X	24'x32	$150,000	X	24'x32'	$150,000
2. New Well Pump	X	1 Job	2,000	X	1 Job	2,000
3. Water Storage Tank	X	6,000 gallons	15,000	X	6,000 gallons	15,000
4. Water Treat. Equip.	X	1 Job	5,000	X	1 Job	5,000
5. Pressure Pumps	X	1 Job	5,000	X	1 Job	5,000
6. Pressure Tanks	X	1 Job	3,000	X	1 Job	3,000
7. Circulating Pumps				X	1 Job	4,000
8. Heating Equip	X	1 Job	1,500	X	1 Job	15,000
9. Electrical Work	X	1 Job	4,000	X	1 Job	5,000
10. P.E. line	X	5,300ft (3")	53,000			
11. P.E. line-Insulated				X	9,600ft.(3")	336,000
12. Summer Watering Points	X	13	6,500			
13. All Weather Watering Points				X	13	65,000
14. Fuel Storage	X	3,000 gal.	10,000	X	5,000 gal	15,000
TOTALS			$255,000			$620,000

FIGURE 2

SOIL TEST LOGS NEAR EXISTING PUMPHOUSE

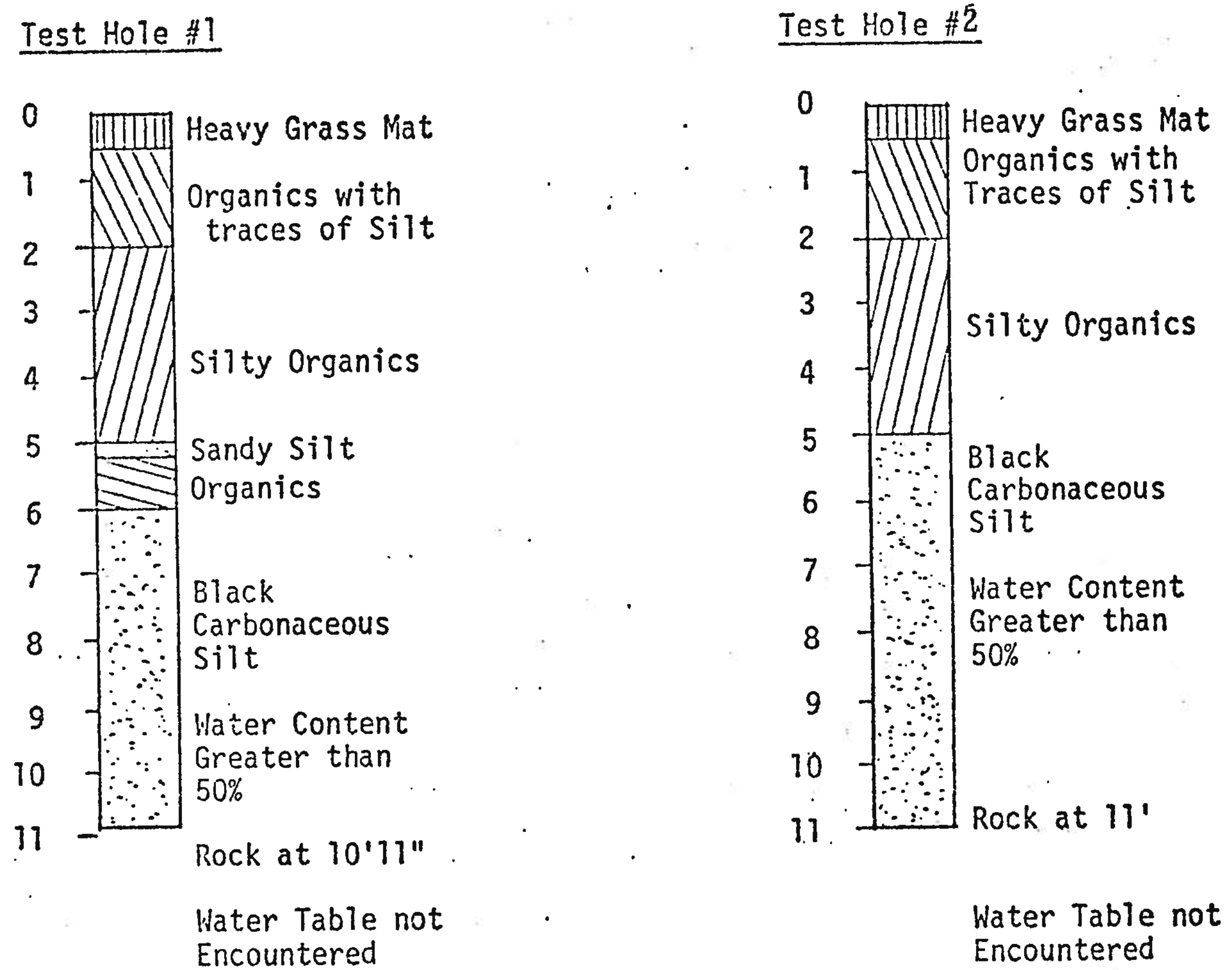


TABLE II

OPERATION AND MAINTENANCE COSTS
CHEFORNAK WATER SYSTEM ALTERNATIVES[1]

Item	Summer Distribution System Yearly Costs	Watering Points/All Weather Distribution
Pumping[2]		
Well Pump	$50	$50
Pressure Pumps	20	40
Circulating Pumps	N/A	280
Heating		
Pumphouse	1,200	1,200
Water	400	3,000[3]
Watering Points	N/A	1,200
Chemicals	200	250
Parts & Replacement	330	1,240
Labor	2,200	3,850
Total Yearly Cost	$4,400	$11,110

1. Costs for village owned generated electricity is $0.25/kw-hr. Assumed Fuel cost at $1.87/gallon (this is based on 1981 delivery costs of $1.56/gallon plus 20% inflation increase).
2. Based on a water usage rate of 1,150 gallons/day.
3. Assumed distribution line installed above ground. Also, the potential future use of waste heat from city's generator system could cut this cost by approximately $1,200 per year.

Figure 3 shows well logs of the existing community well, the BIA School well, and the new state school well. Approximately seven wells have been drilled in Chefornak, with most being abandoned due to low yield or poor water quality (salty). If the quality of the community well water decreases, the prospect of finding another well with good quality appears slim.

Alternate water supplies would include ponds or springs which result from snow melt and rain. In order to utilize these sources and provide a continuous supply of water to the community, water would have to be pumped during late spring and summer into a large water storage reservoir for use throughout the cold weather periods. Funds for construction of a large storage reservoir are currently not available, and it is best to consider this alternative as a future project if and when the existing well water quality starts to degrade.

Additional work in checking one or two water quality parameters of the area ponds should be done in the fall before freeze up. Easily measured parameters such as specific conductance will give the city some direction as to what areas could serve as future water sources and should not be disturbed by community activity.

Sewage Disposal System

Sewage disposal alternatives at Chefornak are limited unless large capital, and operation and maintenance funding is available. A full community sewer system would be difficult to install and maintain because of permafrost conditions and the potential need for one or more lift stations.

Other disposal alternatives include some form of haul system or honey bucket bunkers. Because bunkers have a limited life span, the city chose to evaluate a haul type system. Bunker system costs have also been included, as a reference and comparison to the haul system.

Bunker Disposal System. A bunker disposal system would consist of wooden bunkers having approximate dimensions of 4 foot wide by 5 foot deep by 16 feet. Approximately 16 bunkers would be installed throughout the community and the estimated construction costs have been shown in Table III.

Realizing that a bunker system is not maintenance free and that bunkers will have to be moved periodically, Table IV has been included showing anticipated maintenance costs. Work would include moving the above ground portion of the bunkers to new sites, digging new pits, and filling the abandoned pits. Using 16 bunkers with a fill life of two years, annual costs for this system would be approximately $15,500 per year. Using the bunkers for just honey bucket wastes could result in a longer life span. As a result, the table also shows maintenance costs for 3 and 4 year life spans.

Sewage Haul System. The haul system would consist of wheel mounted haul wagons which could be located throughout the community. Residents would empty honey bucket wastes into the wagons, and the wagons would be periodically pulled by a tracked vehicle to a waste disposal pit and dumped. Winter operations would require the use of disposable liners placed in the wagons to prohibit frozen wastes from sticking to the container walls.

FIGURE 3

WELL LOGS

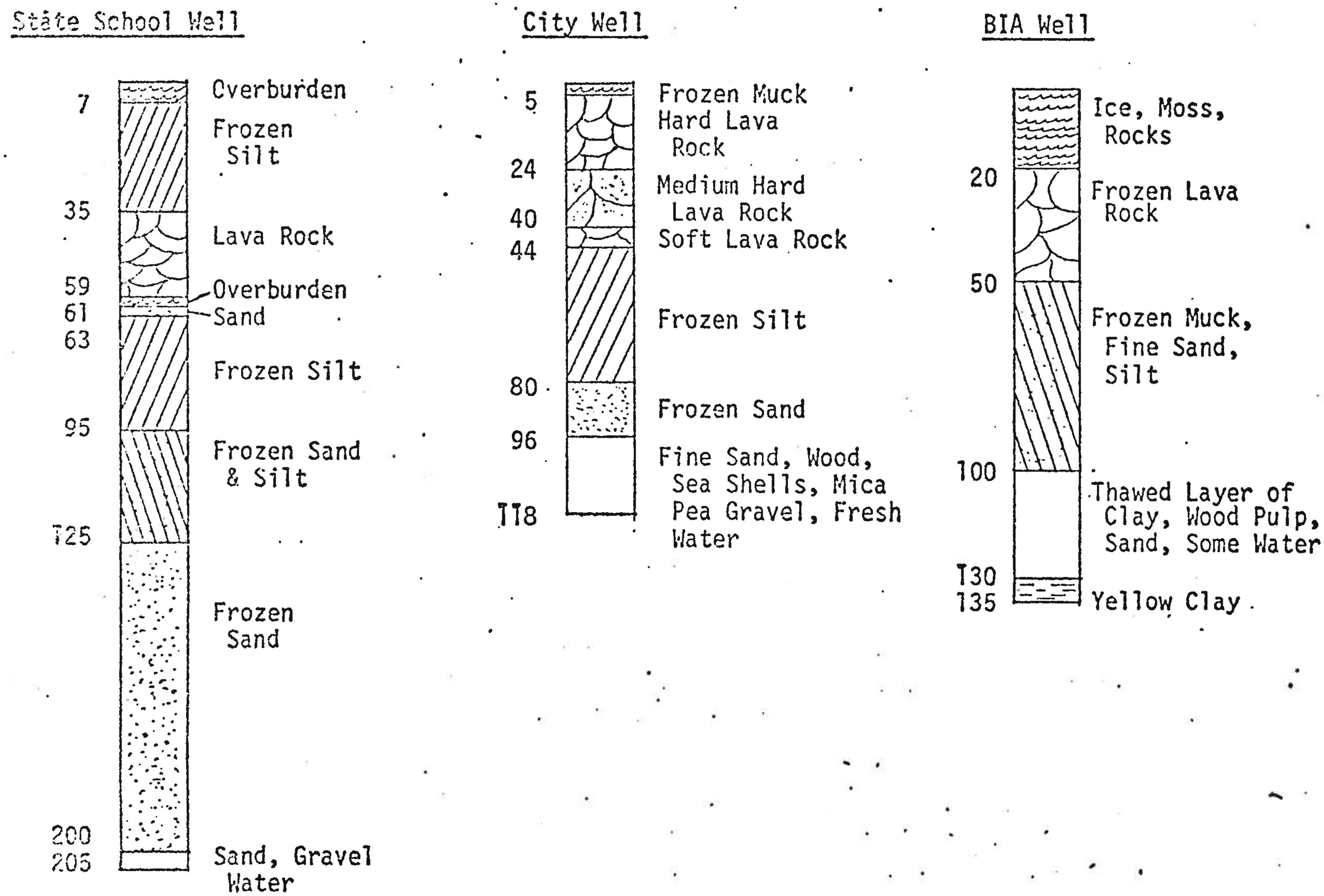


TABLE III

BUNKER CONSTRUCTION COSTS

Item	Description	Costs
1.	Materials Delivered	$1,600
2.	Labor	1,400
	Cost per Bunker	$3,000
	Cost for 16 Bunkers	$48,000

TABLE IV

ANNUAL BUNKER MAINTENANCE COSTS

Item	Annual Costs		
	2 Year Replacement	3 Year Replacement	4 Year Replacement
Materials Delivered	$9,100	$6,400	$5,000
Labor	6,400	4,500	3,600
Total Annual Cost	$15,500	$10,900	$8,600

Capital costs for initiating a honey bucket haul system are shown in Table V. Haul container sizes would be small, having approximate capacities of 125 gallons, and would be mounted on two wheeled trailers having low pressure flotation tires. The trailer design would incorporate a mechanism for a manual tilt-dump operation. Boardwalks would be installed from existing boardwalks to the wagon locations. Dumpsite construction would involve fencing and trenches for safe disposal of the wastes for present and future use. A garage would be constructed for storage of the haul vehicle and maintenance/repair work on the equipment. A city decision on garage location will be required.

Major transportation problems with a haul system may occur during late spring and summer. The lack of thaw stable roads and trails may lead to nearly impassible conditions during these periods, and costs have been included for haul system boardwalks to overcome this problem. The abundance of volcanic rock in the area provides a natural material resource which, when used with filter fabric, could produce good quality trails for the village if and when funds become available.

Operation and maintenance costs for a haul type system will vary considerably with haul distance and manpower needs. A cost sensitivity analysis utilizing guidelines put forth in Appendix D of the "Cold Climate Utility Delivery Design Manual" is shown in Table VI.

Condition C is the most practical condition for the city. Larger containers appear to reduce the operational costs for the city, but the larger loads may prohibit equipment use in the late spring and summer. An inoperative system is of no benefit to the city, and the 125 gallon size containers are recommended. This would allow each container to serve approximately 30 people.

The city may want to consider a dumpsite location closer to town than the existing site. Doubling the haul distance increases the costs to operate the system by approximately 20 per cent. A potential new dumpsite located closer to the city has been shown on Figure 1. Landing strip restrictions may limit use of this proposed area, however, and clearances will have to be obtained from the proper state authority before any dumping begins.

The design parameter having the largest impact on operation costs is the amount of wastes produced. Doubling the quantity of wastes produced will double the costs to operate the system. A value of 0.5 gallons per person per day was the chosen condition for this study. The amount produced by the city residents may vary, and the resultant operational costs will vary accordingly.

Finally, equipment replacement costs have been included separately at the bottom of the table. These values reflect the amount of money the city would need to set aside annually to replace the haul vehicle in 5 years, and the haul wagons in 7 years. They should be considered in the city's operating budget unless other sources of revenue can be depended upon to replace equipment when existing units wear out.

TABLE V

CAPITAL COSTS
HONEY BUCKET HAUL SYSTEM

Item	Description	Qty	Unit Cost	Total
1.	Haul Wagons	8	$4,000	$32,000
2.	Haul Vehicle	1	--	25,000
3.	Boardwalk Const.[1]	5,350 Ft.	15	80,250
4.	Dumpsite Const	1 Job	--	12,000
5.	Garage	640 Ft^2	100	64,000
6.	Fuel Storage	5,000gal	--	5,000
		TOTAL COST (to nearest $1,000)		$228,000

1. Cost includes constructing boardwalks to use for haul vehicle transportation throughout the existing and proposed new HUD home areas, and to the new dumpsite.

TABLE VI

OPERATION AND MAINTENANCE COST ANALYSIS
SEWAGE WASTE HAUL SYSTEM

Design Parameters	A	B	C	D	E
			Conditions[1]		
Wastes Produced Gal/Cap/Day	1		0.5	0.5	0.5
People Per Container	30				
Number of Containers	8				
Haul Container Size (gal)	100		125	125	150
Distance to/from Disposal (Mi.)	0.5		0.5	1	0.5
Vehicle Speed to Disposal (MPH)	10				
Rate of Dumping Wagon (GPM)	50				
Turn Around Time at Dump (Min.)	10				
Distance Between Wagons (Ft.)	300				
Speed between Stations (MPH)	5				
Hook up time to Wagons (Min.)	5				
Number of Helpers	1	0	0	0	0
Driver's Wage/Hour	$10.00				
Helper's Wage/Hour	7.00				
Labor Benefits Factor	1.25				
Results					
Circuit Time/Cycle	4.5	4.5	4.7	5.7	4.7
Operations/Year	128	128	52	52	43
Total Hours/Year	583	583	240	404	202
Number Vehicles Rqd.	0.27	0.27	0.2	0.2	0.1
Labor Costs/Year	12,400	7,370	3,000	3,660	2,500
Vehicle Costs/Year	5,800	5,800	2,400	2,940	2,000
Liner Costs/Year	5,450	5,450	2,250	3,800	1,900
Total Cost/Year	$23,650	$18,650	$7,650	$10,400	$6,400

Capital Replacement costs:
- Wagons $7,000/year – Replacement every 7 years.
- Haul Vehicle $7,000/year – Replacement every 5 years.

1. Conditions B thru E show parameters that were changed from condition A.

Solid Waste Disposal System

If the city choses the alternative of a sewage haul system, implementation of a solid waste haul type system should also be considered. The results of the sewage haul operation and maintenance cost analysis (see Table VI) shows that any haul vehicle would be used less than half the time for a normal work year. Also, the labor needs would be about 20 percent of full time for sewage haul. As a result, the same laborer and haul vehicle could be shared to do both sewage and solid waste haul systems.

Capital costs for a solid waste haul system are shown in Table VII. A haul wagon concept would be utilized in the same way as for sewage haul, but wagon capacity would be larger to accomodate the lighter but more bulky garbage. Solid waste dump stations could be at the same locations as the sewage dump stations.

An operation and maintenance cost sensitivity analysis for a solid waste program is shown in Table VIII. Results of this analysis confirm that a single laborer and haul vehicle can service both sewage and solid waste haul systems.

Operational costs will vary with distance to the dumpsite and amount of wastes produced in the same way as for the sewage haul system. For Cheforank's situation, trying to match condition C is recommended.

One operation and maintenance item included as a straight line cost for all conditions is the upkeep for the solid waste dumpsite. Periodic trench excavation and fill operations are necessary and would require the use of a backhoe/dozer. It is estimated that the equipment would be used one day per month, and at an operational cost of $50.00 per hour, costs would would run $200 per month, or $2,400 per year.

An alternative to the solid waste haul system is to reduce the amount of wastes hauled by continuing the present practice of burning refuse before hauling it to the dump. Burned trash pick-up could be scheduled on a monthly or quarterly basis at a much reduced operational cost to the city. By using this method and estimating total yearly hauling time to be 10 working days per year, costs to do the work would approach $3,000.

SUMMARY AND CONCLUSIONS

This study has presented construction, and operation and maintenance costs for proposed sanitation facilities for the city of Chefornak. Each system type was briefly described with elements highlighted that were necessary for city consideration.

Cost estimates and operating expenses have thus far been presented separately for water, sewage and solid waste. Although this study appears "tabled-to-death", two final tables have been included combining the different systems for total cost presentations.

Table IX shows estimated construction/capital costs for all systems discussed in this study except the bunker system which was included for