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United States
Environmental Protection
Agency

Region 10
1200 Sixth Avenue
Seattle WA 98101

November, 1982

Water

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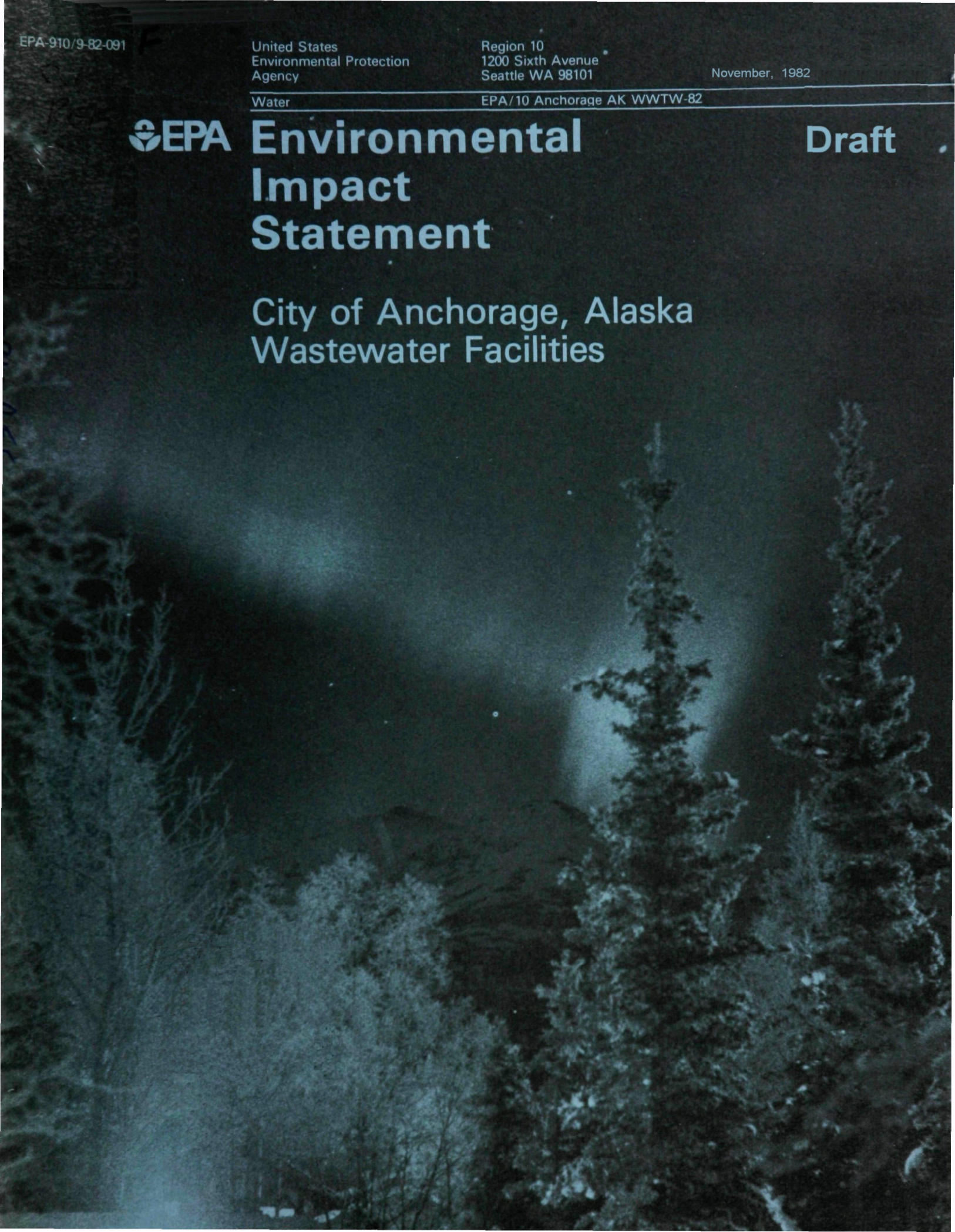
EPA

Environmental Impact Statement

Draft

City of Anchorage, Alaska Wastewater Facilities



U.S. ENVIRONMENTAL PROTECTION AGENCY

REGION X

1200 SIXTH AVENUE

SEATTLE, WASHINGTON 98101

REPLY TO ATTN OF: M/S 443

TO: All Interested Government Agencies, Public Groups and Citizens

Enclosed for your review and comment is the Draft Environmental Impact Statement (EIS) on the proposed City of Anchorage Wastewater Treatment Plant Expansion and Interceptor facilities. The Environmental Protection Agency (EPA) has given the grant for planning needed facilities for the transmission and treatment of wastewater from developed areas in the City of Anchorage. The City has an Environmental Protection Agency grant for planning the proposed facility which includes treatment plant expansion and interceptors under Section 201 of the Clean Water Act. The Environmental Protection Agency has prepared this Draft Environmental Impact Statement on its proposed approval of this action, pursuant to Section 102(2)(c) of the National Environmental Policy Act (NEPA) of 1969 and implementing Federal regulations.

EPA will announce the availability of this document in the Federal Register on Friday, January 21, 1983, which will begin a 45-day review period. If you have any comments on the Draft Environmental Impact Statement or wish to provide additional information for inclusion in the Final Environmental Impact Statement, we would appreciate hearing from you before the close of the comment period on March 7, 1983. All comments will be used by the Environmental Protection Agency in evaluating the effects of approving the proposed action.

Please send your comments to: Clark Smith
Environmental Evaluation Branch
Environmental Protection Agency, Region 10
1200 Sixth Avenue, M/S 443
Seattle, Washington 98101

DRAFT
ENVIRONMENTAL IMPACT STATEMENT

MUNICIPALITY OF ANCHORAGE
SEWERAGE FACILITIES EXPANSION

Prepared by:

U. S. Environmental Protection Agency
Region 10
1200 Sixth Avenue
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Clark Smith, Project Officer

With Technical Assistance from:

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Sacramento, CA 95816

November 1982

Responsible Official:

John R. Spencer
Regional Administrator
Environmental Protection Agency
Region 10

DRAFT ENVIRONMENTAL IMPACT STATEMENT

City of Anchorage, Alaska

Wastewater Facilities

Prepared By

United States Environmental Protection Agency

Region 10

Seattle, Washington, 98101

With Technical Assistance From

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DEC 3 1982

Date

TABLE OF CONTENTS

	Page
CHAPTER 1 - INTRODUCTION	
Organization of DEIS	1
Background and History of the Project	2
Objectives of the Facilities Plan	3
Necessity and Purpose of the Environmental Impact Statement	3
Issues of Concern	4
Legal, Policy and Regulatory Constraints	5
Federal Laws, Policies and Regulations	5
State Laws, Regulations and Policies	9
Local Laws, Rules and Regulations	10
Public and Agency Participation	11
Study Area Characteristics	11
Physical Location	11
Population	13
Past Growth	15
CHAPTER 2 - EFFLUENT LIMITATIONS, NPDES PERMIT, EXISTING SEWERAGE SYSTEM	19
Collection and Interceptor System	21
Service Areas	21
Pump Stations	21
Point Woronzof Wastewater Treatment Plant	24
Liquid Process	24
Solids Processing	26
Auxiliary Facilities	26
Effluent Characteristics	26
CHAPTER 3 - ALTERNATIVES FOR WASTEWATER COLLECTION, TREATMENT AND DISPOSAL	33
Introduction	33
Service Area	35
Planning Constraints	35
Recommended Plan	36
Solids Processing	39
Auxiliary Facilities	40
Ocean Outfall and Diffuser	41
West Bypass Interceptor Sewer	42
Southeast Interceptor	44
Interceptor Sizing	45
Hillside Wastewater Management Plan	50
Collection Sewer Improvement Projects	54
Range of Alternatives	56
Screening of Alternatives	58

Page

Description of Alternatives 58
"No-Action" Alternative 58
Land Application Treatment 58
Wastewater Renovation and Reuse 60
Point Woronzof Treatment Alternatives 60
Alternatives for Ocean Outfall and Diffuser 64
West Interceptor Extension Alternatives 65
Rabbit Creek/Potter Creek Collection and Treatment Alternatives 65
Individual Treatment Systems 66
Cost Summary 69
User Costs 69

CHAPTER 4 - WETLAND ISSUES 81
Legal, Regulatory and Policy Constraints 81
Issue Summary 83
Biological Setting of Nontidal Wetlands 84
Habitat Types 85
Aquatic Organisms 91
Birds 92
Mammals 96
Biological Setting of Potter Marsh 98
Biological Setting of Tidal Wetlands 100
Hydrologic Setting 101
Hydrologic Cycle 101
Surface Runoff and Groundwater 101
Surface/Groundwater/Wetland Complex 103
Human Use Setting 105
Wetland Impacts 106
Pipe Emplacement Impacts 106
Mitigation of Pipe Emplacement Impacts 121
Hydrologic Impacts 122
Mitigation of Hydrologic Impacts 130
Secondary Biological Impacts 130
Mitigation of Secondary (Growth-Related) Biological Impacts 131
Human Use Impacts 131
Impacts on Potter Marsh 132
Mitigation of Sedimentation Impacts on Potter Marsh 133
Pipe Emplacement Impacts on Tidal Wetlands 133

CHAPTER 5 - HILLSIDE ISSUES 135
Issue Summary 135
Legal, Regulatory and Policy Constraints 137
Planning Guidelines 137
On-Site Sewage System Inspections 137
On-Site Water Well Inspection 138
Human Use Setting 138

	Page
Hydrologic Setting	139
Surface Water	139
Groundwater	139
Domestic Water Supply	140
Impacts of Sewerage Decisions on Hillside Area	141
Impacts of Sewering Portions of Hillside Area	141
Impacts of Designating On-Site Sewerage for Portions of Hillside Area	143
CHAPTER 6 - CULTURAL RESOURCE IMPACTS	153
Archeological Resources	153
Historic Places	153
CHAPTER 7 - SECONDARY IMPACTS	155
Growth Inducement	155
Consequences of Growth	158
Water Supply	159
Solid Waste Disposal	160
Energy Resources	161
Education	163
Police Protection	163
Fire Protection	164
Recreation	164
Air Quality	165
Hydrology, Erosion, Seismicity	166
Perceived Quality of Life	170
CHAPTER 8 - EFFLUENT TREATMENT AND DISPOSAL IMPACTS	173
Introduction	173
Physical Oceanography	174
Tides	174
Tidal Currents	178
Flushing Rates of Knik Arm and Cook Inlet	178
Waste Assimilation Ability of Knik Arm	180
Biological Oceanography of Knik Arm, Cook Inlet	182
Chemical Oceanography and Bacteriology of Knik Arm, Cook Inlet	185
Alkalinity and pH	185
Dissolved Oxygen	185
Suspended Solids/Nutrients	186
Primary Pollutants	186
Coliform Bacteria	187
Conclusions	187
Wastewater Treatment Impacts	188
CHAPTER 9 - SLUDGE PROCESSING AND DISPOSAL IMPACTS	189
Air Quality	189
Energy Consumption	191
Knik Arm Impacts	191

Page

Landfill Capacity Impacts 192
Landfill Leachate Impacts 192
Groundwater Impacts of Ash Lagoons 192

CHAPTER 10 - SHORT-TERM CONSTRUCTION IMPACTS 195
Impacts Common to Most Activities 195
Special Case Impacts 195
Alaska Railroad 195

CHAPTER 11 - IMPACTS OF ALTERNATIVES 199
Land Application of Effluent 199
Wastewater Renovation and Reuse 200
Alternative PA: Primary Clarification With No Chlorination of Effluent 200
Secondary Treatment of Effluent 201
Sludge Disposal 202
West Bypass Interceptor 202
Rabbit Creek/Potter Creek Area 204
Rabbit Creek/Potter Creek Area Wastewater Collection Alternatives 205
No-Action Alternative 207

CHAPTER 12 - ISSUES UNRESOLVED BY ALTERNATIVES 209

CHAPTER 13 - COORDINATION 211
Scoping Meeting 211
Public Workshops and Meetings 211
Interagency Workshop - September 9, 1981 211
Facilities Plan Public Meeting - October 15, 1981 211
EIS Wetlands Workshop - October 16, 1982 213
Facilities Plan Public Meeting - January 20, 1982 213
EIS Wetlands and Hillside Workshop - April 14, 1982 213
Comments Received Through Distribution of the Preliminary Draft EIS 213

CHAPTER 14 - REFERENCES 215
Documents 215
Personal Communications 221

APPENDICES

LIST OF TABLES

Table		Page
1-1	Current and Projected Population: Municipality of Anchorage	14
2-1	NPDES Effluent Limitations for Point Woronzof, Based on Secondary Requirements	20
2-2	NPDES Effluent Requirements for Point Woronzof WWTP, Based on Primary Treatment	20
2-3	Summary of State of Alaska Water Quality Standards Applicable to Knik Arm	22
2-4	Summary of Existing O&M Staff at Point Woronzof WWTP	28
2-5	Yearly Average Effluent Concentrations	31
3-1	Peak Flow Projections Use for Interceptor Sizing - Subareas	48
3-2	Peak Flow Projections Used for West Bypass Interceptor Sizing - Composite Flows	49
3-3	Present-Worth Component Criteria	71
3-4	Present Worth Summary - Point Woronzof Primary Treatment Expansion Alternatives	72
3-5	Present Worth Summary - Point Woronzof Secondary Treatment Expansion Alternatives	73
3-6	Present Worth Summary - Incinerator Ash Disposal Alternatives	74
3-7	Present Worth Summary - West Bypass Interceptor Extension Alternatives	75
3-8	Present Worth Summary - Rabbit Creek/Potter Creek Collection Alternatives	76
3-9	Present Worth Summary - Rabbit Creek Treatment Alternatives	77

Table		Page
3-10	Present Worth Summary - Rabbit Creek/Potter Creek Collection and Treatment Alternatives	78
3-11	Estimated Changes in Single-Family Monthly Service Charge for Sewer Service	79
4-1	Habitats Identified in Inland Wetland Areas of the Anchorage Bowl	86
4-2	Birds Sighted in Connors Lake Bog and Campbell-Klatt Bog, September 10-17, 1981	93
4-3	Mammals Trapped by Specific Habitat Type and General Habitat Category; Connors Lake Bog and Campbell-Klatt Bog; September 10-17, 1981	97
4-4	Potential Impacts on Proposed Sewer Lines on Biological and Recreational Resources	107
4-5	Sections of Proposed Sewerage Interceptor Crossing Wetlands Undisturbed by Pipe Emplacement	111
4-6	Sections of Proposed Sewer Interceptor Adjacent to Nontidal Wetland Areas	114
4-7	Section of Proposed Sewer Interceptors Which Cross Streams or are in the Stream Floodplain	116
4-8	Precipitation (in inches) Summary for Periods Preceding Aerial Photography of Connors Lake Bog	129
5-1	Tabulation of Areas to be Served by Public Sewers and by On-Site Sewerage Systems in the Hillside Area	145
7-1	Residential Land Use Comparisons by Anchorage Bowl Areas for Current (1980) and Future (Saturation) Conditions	157
9-1	Average Daily Sludge Incinerator Emissions	190
10-1	Potential Short-Term Impacts Typically Associated With Construction Activities. Many are Relatively Minor in Effect and Magnitude and can be Effectively Mitigated as Outlined	196

LIST OF FIGURES

Figure		Page
1-1	Location Map	12
1-2	Population Projections for Anchorage	17
2-1	Sewer Service Areas	23
2-2	Schematic of Point Woronzof WWTP Liquid Process	25
2-3	Schematic of Point Woronzof WWTP Solids Process	27
2-4	Comparison of Effluent Quality to NPDES Permit Limits	30
3-1	Proposed Expansion of Point Woronzof WWTP - Site Layout	37
3-2	Proposed Expansion of Point Woronzof WWTP - Process Diagram	38
3-3	Proposed West Bypass and Southeast Interceptor Sewers	43
3-4	Adopted Hillside Area Sewerage Designations	51
3-5	Hillside Area Septic Tank Suitability	52
3-6	Proposed Sewer and Interceptor Sewer Construction, Repair and Rehabilitation Projects	55
3-7	Alternative Treatment Process Diagrams - Liquid Process - Point Woronzof WWTP	61
3-8	Alternative Treatment Process Diagrams - Solids Process - Point Woronzof WWTP	63
3-9	Rabbit Creek-Potter Creek Alternatives	67
3-10	Rabbit Creek-Potter Creek Alternative Treatment Process Diagrams	68
4-1	Wetlands	82
4-2	Campbell Klatt Bog	87
4-3	Connors Lake Bog	88

Figure		Page
4-4	Moose Corridors	99
4-5	The Hydrologic Cycle Related to Anchorage	102
4-6	1981 Photo of Connors Lake Bog	108
4-7	Comparative Photographs of Baxter Bog	109
4-8	1964 Photo of Connors Lake Bog	124
4-9	1970 Photo of Connors Lake Bog	125
4-10	1975 Photo of Connors Lake Bog	126
4-11	1978 Photo of Connors Lake Bog	127
4-12	1980 Photomosaic of Connors Lake Bog	128
7-1	Residential Land Use Impacts of Urban Runoff	167
7-2	Measures to Control Erosion and Sedimentation	171
7-3	Measures to Control Increases in Runoff and Decreases in Infiltration	171
8-1	Generalized Bathymetry of Cook Inlet, Alaska	175
8-2	Bathymetry of Knik Arm	176
8-3	Current Speed Measured 500 Meters off Point Woronzof Superimposed on Tide Heights for the Same Period	177
8-4	Point Woronzof Current Directions, August 16, 1979. Bearings are Degrees True.	179
8-5	Estuarine Waste Assimilation Diagram	181
8-6	Water Quality, Intertidal and Subtidal Sampling Stations in Knik Arm	183
13-1	Issues Identified for EIS Coverage and Priorities at July 9 and 10, 1982 Scoping Meetings	212

EXECUTIVE SUMMARY
ENVIRONMENTAL IMPACT STATEMENT

Draft (X)
Final ( )

Prepared by: U. S. Environmental Protection Agency
Region 10
1200 Sixth Avenue
Seattle, WA 98101

Type of Action: Administrative

Project Description

This Draft Environmental Impact Statement (DEIS) is prepared by the U. S. Environmental Protection Agency (EPA) to evaluate the impacts of expanding the Municipality of Anchorage (MOA) wastewater collection, treatment and disposal system. It emphasizes matters of particular concern, including wetlands, Hillside area sewerage decisions, growth inducement and impacts of growth, effects of disposing of effluent in Cook Inlet, and the impacts of sludge disposal.

The DEIS specifically evaluates the MOA facilities plan that proposes expansion of the sewerage system. That facilities plan consists of two related documents. The first is entitled Wastewater Facilities Plan for Anchorage, Alaska dated June 1982. This report was prepared for the MOA by a joint venture of Ott Water Engineers, Inc., Quadra Engineering, Inc., and Black and Veatch Consulting Engineers, and it comprises the majority of the MOA Section 201 facilities plan. The remainder of the Section 201 facilities plan is the Hillside Wastewater Management Plan developed by the MOA Planning Department, with contract assistance from Arctic Environmental Engineers and adopted by MOA in May 1982.

The Hillside Wastewater Management Plan, funded under Section 208 of the Clean Water Act, was prepared to address sewerage needs of the Hillside area of the Anchorage Bowl with an emphasis on continuing on-site sewage disposal and preserving a rural lifestyle in the study area. The plan identifies areas of the Hillside that are to be served by on-site treatment and disposal systems (such as septic tanks with drain fields), areas to be served by sewers, and areas unsuitable for on-site systems where no sewer systems are to be provided (although on-site systems may be allowed).

The Wastewater Facilities Plan for Anchorage, Alaska (MOA 1982) recognizes the determinations for these Hillside areas and proposes sewage collection, treatment and disposal systems serving the areas designated for sewerage in the Hillside plan. It also encompasses alternatives for expansion of sewage collection, treatment and disposal facilities for the rest of the Anchorage Bowl, outlined as follows:

- Alternatives for expansion of Point Woronzof wastewater treatment plant (WWTP) from a current design capacity of 34 MGD-58 MGD.
- Extension of the existing outfall by 1,500 feet.
- Adding a diffuser of undetermined length at the end of the extended outfall.
- Alternatives for disposal of sludge solids from the treatment process.
- Alternatives for construction of the West Bypass Interceptor sewer.
- Construction of the Southeast Interceptor sewer, including sewerage alternatives in the Rabbit Creek-Potter Creek area.
- Provisions for on-site sewerage of a portion of the Hillside area.
- Construction of about 70 sewer improvement projects through 1998.

The facilities plan also sets forth a MOA-Recommended Plan, suggesting implementation of specific alternatives.

For EIS purposes the above project alternatives, except for the 70 sewer improvement projects, are evaluated in detail in the EIS. The 70 sewer improvement projects are addressed only with specific reference to wetland impacts and in general terms relative to cumulative impacts.

Recommended Plan

The Point Woronzof WWTP would be expanded from its current effective capacity of 22 MGD to 58 MGD (average annual flow). Current design capacity is 34 MGD, although the plant cannot meet discharge requirements at a design flow rate over 22 MGD. This expansion would be achieved through construction of three additional primary clarifiers, modification

of other portions of the liquid processing to increase capacity, addition of another sludge incinerator to the solids process, and consideration of alternative disposal methods for incinerator ash. The facilities plan indicates a preference for discharging the ash into the Knik Arm of Cook Inlet through the outfall along with the effluent, although discharge to a landfill or to lagoons or a gravel pit in the area of Point Woronzof is also considered.

The facilities plan recommends that the outfall be extended by 1,500 feet, that an extensive design effort be undertaken, and that the diffuser requirements be further studied. Preliminary diffuser modeling prepared for a Section 301(h) waiver application determined that a 1,000-foot diffuser would enable the discharge of chlorinated effluent to meet all existing water quality standards.

A diffuser study is underway to evaluate outfall and diffuser requirements under the assumption that chlorination would be discontinued. Preliminary results indicate that a theoretical diffuser length of tens of miles would be needed to meet coliform standards applicable to Cook Inlet if chlorination is discontinued. All other standards, however, apparently could be met with a minimal (100-foot) diffuser.

The study also is evaluating the diffuser requirements under assumptions that certain state-designated beneficial uses of the waters of Cook Inlet would be deleted. This change would allow less strict Alaska state water quality standards to apply. If fecal coliform standards of 200 FC/100 ml were to apply (compared to current standards of 14 FC/100 ml), a diffuser length of 6,100 feet would enable the discharge to meet this standard. If designated uses were further relaxed to eliminate all coliform standards a minimal length (100-foot) diffuser would be adequate.

A major interceptor sewer, the West Bypass Interceptor, is proposed to connect existing interceptor sewers at the Alaska Railroad crossing over Campbell Creek to an existing downstream section of the West Bypass Interceptor sewer near the Minnesota Bypass-Raspberry Road intersection. The proposed completion of the interceptor between these points would bypass a deteriorated, undersized corrugated metal pipe sewer paralleling Campbell Creek and an occasionally overloaded pumping station at Campbell Creek. A 25 MGD pumping station and force main are recommended, with provision for future expansion to 60 MGD capacity.

The existing Southeast Interceptor is proposed to be extended south to provide service to areas of the Hillside that are designated for public sewerage in the Hillside plan, including the south Hillside areas near Potter Creek and Rabbit Creek.

The Hillside Wastewater Management Plan (MOA 1982) evaluated the suitability of the Hillside area of Anchorage to accommodate on-site disposal systems, and delineated areas for public sewers, unsewered areas for on-site systems and unsewered areas generally unsuitable for on-site disposal systems. It sets forth planning and design criteria, construction guidelines and operation and maintenance requirements for on-site systems.

The Hillside plan does not preclude on-site systems in generally unsuitable areas; rather it applies additional restrictions, including soil tests for each lot in a subdivision, requiring innovative systems unless conventional systems are shown to be acceptable, and requiring more detailed system reviews by MOA.

The existing Anchorage Bowl system of collector sewers is in need of expansion, replacement and renovation in certain areas. Additional capacity is required in some instances, as well as replacement of several miles of corrugated pipe. About 70 sewer construction, rehabilitation and replacement projects are recommended in the facilities plan.

Alternatives

The facilities planning process in Anchorage has evolved over many years. A relatively broad range of investigations has been completed, with many alternatives evaluated and some rejected. The current facilities plan is intended as the culmination of these, and it identifies most prior evaluation efforts, although it does not document all of the screening that went into the development of the current Recommended Plan.

"No-Action" Alternative. The no-action alternative assumes no rehabilitation, improvement, or expansion of the existing collection system, and no expansion of Point Woronzof WWTP.

No action was rejected because the MOA would be in violation of federal and state laws. Pollution of local streams would increase and be subject to local objections. Further, the state could impose a moratorium on new sewerage connections, adversely affecting growth of the Anchorage area. No action would be inconsistent with MOA desires.

Land Application Alternatives. Land application alternatives were considered during development of an earlier (1976) facilities plan. The potential of rapid infiltration at the Point Campbell Military Reservation appeared cost

effective at that time, due to the proximity of the lands to Point Woronzof, the presence of sand and gravel soils, and the apparent groundwater flow direction away from areas of groundwater extraction and toward Cook Inlet. This alternative is the land application alternative evaluated in the current facilities plan.

The Point Campbell land application alternative was rejected due to probable land use conflicts, lack of feasibility studies and probable adverse environmental impacts.

Wastewater Renovation and Reuse. Currently, little need for treated effluent has been identified in the Anchorage area, but the facilities plan recommends future review of this alternative. The economic benefits of reuse might outweigh the costs of additional treatment, depending on a variety of factors. The facilities plan concludes that this alternative cannot be seriously analyzed until a market for the wastewater is identified.

Point Woronzof Treatment Alternatives. The facilities plan considers two primary treatment and two secondary treatment alternatives. Alternative PA would be identical to the Recommended Plan, described earlier, with the exception that no chlorination would be employed in this alternative, and that the diffuser length may be different. Diffuser length would change as a function of fecal coliform limits at the perimeter of the discharge mixing zone. Changes in the designated uses of the waters of upper Cook Inlet would also be made as part of this alternative. This would apply different water quality standards, thus changing this coliform limit.

The MOA has sought to obtain a modification of NPDES requirements under Section 301(h) of the Clean Water Act to permit continued ocean discharge of less than secondary effluent from the existing Point Woronzof WWTP. EPA has tentatively decided to issue a 5-year permit modification under Section 301(h). Continued primary discharge beyond the expiration dates of any such modification is not assured in the Clean Water Act, and under the construction grant regulations, EPA must restrict its funding to projects with a 20-year planning horizon. Since EPA has no authority to consider an alternative involving ocean discharge of less than secondary-treated effluent 20 years in the future, the selected alternative must incorporate secondary treatment. Both secondary treatment alternatives could be added to the primary treatment alternatives, thus meeting this requirement. High-rate trickling filters and a complete mix activated sludge process are the two secondary treatment processes evaluated in the facilities plan.

No alternatives to the recommended 1,500-foot extension of the outfall are presented in the facilities plan. The diffuser length could vary from about 100 feet to 6,100 feet in length, depending on applicable water quality standards and whether chlorination is continued

Sludge Processing and Disposal Alternatives. As an alternative to incineration at the Point Woronzof WWTP, sludge could be dewatered, digested and landfilled; it could also be disposed of through co-incineration with municipal refuse, with the residual ash being landfilled. In the digestion alternative, either primary or secondary sludge would be dewatered by gravity thickeners, and then pumped to an anaerobic digester for stabilization. The stabilized dewatered sludge would be hauled to a sanitary landfill.

Primary or secondary sludge can be incinerated in combination with refuse, a process called co-incineration. Combustion is easily accomplished because of the fuel value of the refuse. The heat output can generate electricity, produce steam, and be applied to drive mechanical dewatering devices or other treatment plant equipment and provide heat. The ash would be landfilled. Total community solid waste volume could be reduced if co-incineration were used.

Interceptor Sewer Alernatives. West Bypass Interceptor sewer alternatives were considered, including a gravity interceptor with open trench construction, gravity interceptor with tunneling for deep excavation areas, and the recommended pump station and force main. The gravity alternatives were rejected due to potential significant adverse impacts from dewatering the trench area. Potential ground subsidence and loss of water from a high-yielding water supply well were major considerations.

Rabbit Creek-Potter Creek Sewerage Alternatives. The facilities plan presents a series of sewage collection, treatment and disposal alternatives to serve the southerly portion of the Hillside area designated for public sewers in the Hillside plan. One set of alternatives encompasses four treatment options that would be independent of the Point Woronzof plant and one pump station-force main option (the Recommended Plan) that would connect to the Southeast Interceptor, flowing to Point Woronzof. In addition, other alternatives describe alternative collection system patterns in the area.

Interceptor Sizing. Sizing of the West Bypass Interceptor and Southeast Interceptor sewers, both of which would serve the southeast area of Anchorage that encompasses the Hillside area, has been an identified issue due to controversy over sewer capacity to be provided to the Hillside area.

EPA has also raised questions regarding the fundable capacity of the interceptors (Appendix A to DEIS). The DEIS summarizes the flow computations of the facilities plan and explains how the interceptor capacities were recommended.

Hillside Area Alternatives. The Hillside Wastewater Management Plan element of the facilities plan does not evaluate alternative public sewer systems or alternative public sewer/on-site system area designations. The plan does allow alternative types of on-site sewerage systems, depending on individual needs on each parcel.

Environmental Impacts

The Recommended Plan as presented in the facilities plan would result in environmental impacts on many areas of the Anchorage Bowl. The DEIS addresses these impacts in major topic areas, including cost, wetlands, the Hillside area, cultural resources, secondary (growth-related) impacts, treatment and disposal impacts, sludge processing and disposal impacts, construction impacts, and impacts of alternatives.

User Costs

Costs to individual MOA sewer customers would increase as a result of expansion of the wastewater facilities in accordance with the Recommended Plan. Those customers served by sewers would sustain a rate increase estimated at from 22-34 percent in 1985, and 30-40 percent in 1999, depending on funding sources for construction.

The low range in these estimates assumes that EPA would provide 75 percent construction funding for the Point Woronzof WWTP improvements, and the state would provide an additional 12.5 percent; that the state would fund 50 percent of all other expansion; and that local funds would comprise the balance. The high range assumes no EPA funding, but rather that all construction cost funding would be 50 percent state and 50 percent local. Both ranges assume that user charges would support all local costs. No comparable estimates of user costs are available for the unsewered Hillside area.

Wetland Issues

The Anchorage Bowl contains numerous nontidal wetland areas that comprise an estimated 9,400 acres, or 15 percent of the 64,000-acre area of the Bowl bounded by the military

reservations and Chugach State Park. An additional 2,300 acres of tidal wetlands are incorporated into the Potter Point State Game Refuge. These wetlands provide fish and wildlife habitat, open space and hydrologic benefits, and recreational opportunities. They are potentially susceptible to significant impacts from sewerage facilities expansion, both directly from sewer interceptor construction, and indirectly from facilitation of urban growth through the provisions of new sewerage facilities.

A primary characteristic of a wetland is, obviously, the presence of water. The presence, characteristics, and movement of this water are termed hydrology. Hydrologic values of wetlands include retention of rainfall and snowmelt, runoff, augmentation of stream base flow, water quality benefits, and groundwater recharge. Loss of wetlands could result in elevated flood and erosion risks, and alteration of stream flow and water quality.

The construction of facilities within and adjacent to the wetlands may result in loss of more than half of all nontidal wetlands in the Anchorage Bowl.

Construction of sewers within wetlands as proposed in the facilities plan (about 26 sewer facilities in many of the area wetlands) will result in destruction of vegetation and loss of wildlife habitat along pipe alignments. Heavy equipment crushes or removes vegetation and compacts peat deposits. Areas of bog wetlands stripped of vegetation generally do not revert to the original habitat type, but instead are overgrown by ruderal vegetation or are kept barren by foot or off-road vehicle traffic. Long-term alteration of habitat is apparent in aerial photographs taken long after emplacement of pipe. In Campbell-Klatt Bog, for example, one sewer line is proposed to pass through an area used by Canada geese and other waterfowl as a nesting area.

Much more subtle, but perhaps more significant, is the delayed impact on hydrologic features of wetlands. Most peat bogs, such as those comprising the majority of wetlands in the study area, are natural water-retaining basins. In some ways, their character is analogous to a teacup filled with water and cotton. If a buried pipe were placed through a wetland and if a backfill material were used which did not impede water movement, the action would be approximately analogous to chipping the rim of the cup, allowing some of the water to drain away. To continue the analogy, water level in the cup (bog) will probably sink below the level of the damaged area because the cotton (peat) will act as a wick bringing moisture to the outlet area. This dewatering process will adversely change the biological and hydrologic values of wetlands.

Additional hydrologic impacts may result from the use of permeable material as backfill. Pipe corridors not only may act as corridors for water movement into or out of wetlands, but also may divert groundwater away from wetland areas when the pipe corridor is adjacent to a wetland and perpendicular to the path of groundwater movement. These impacts may be of diminished importance when the wetlands appear in a floodplain, but may be very important to isolated bogs.

The facilities plan will remove a major constraint on population growth in the Anchorage Bowl, particularly in the area south of Tudor Road. If population saturation is reached in 20 years and if all wetlands designated as developable by the MOA wetlands management plan are developed then a loss of about 55 percent of the remaining nontidal wetland habitat in the Anchorage Bowl would result. The major consequences of this overall loss are likely to be: 1) alternations in the hydrologic regimes of streams, 2) changes in groundwater movement, and 3) a major loss of bird nesting habitat including a well-established Canada goose nesting area at Heather Meadows (C Street and Tudor Road) and in southern Campbell-Klatt Bog.

Construction of sewers and growth in the Anchorage Bowl could result in the loss of more than half of the Anchorage Bowl wetlands and have adverse impacts on vegetation, wildlife and hydrology in many of the remaining wetlands. There would be a decrease in wildlife abundance (including moose and especially nesting waterfowl) because of increased recreational activities on remaining wetlands, and loss of wildlife and fish habitat because of alterations in hydrologic regime.

These impacts may be partly mitigated through special construction techniques to inhibit groundwater diversions caused by pipe construction and backfill; by rerouting sewers away from wetland areas that are to be preserved; by timing construction in streambeds to avoid sensitive times for migrating and spawning fish; and by providing protection for preservation of wetlands through the existing wetlands management plan.

Potter Marsh, a coastal wetland on lower Rabbit Creek between Old Seward Highway and the Alaska Railroad, is part of the Potter Point State Game Refuge. The facilities plan proposes sewer construction adjacent to the marsh, and the Hillside plan proposes development of the ajdacent area. Potter Marsh will be adversely affected by turbidity in waters entering the marsh from Rabbit and Little Rabbit Creeks as a result of sewer construction and development activities. Some of the extra sediment burden may be transported out of the marsh at the next "breakup" or heavy storm runoff, but a portion may remain permanently in the marsh.

Sewering of some tributary areas of the Hillside may provide benefits to Potter Marsh by preventing on-site system construction and thereby precluding water quality impacts due to system failure. Other portions of the watershed that will not be sewered may develop with on-site systems for sewage disposal. These areas will increase the threat of water quality standards violations in Rabbit Creek and in Potter Marsh.

The presence of sewers in and adjacent to Potter Marsh presents a threat of spills and seepage of untreated sewage to the marsh. If the pump station or force main near Rabbit Creek were to fail, sewage would overflow, reaching Potter Marsh.

Seismic activity and frost heaving can separate pipe joints, move manholes and allow infiltration as well as exfiltration, depending on groundwater depth as compared to pipe depth. Seismic activity in particular can cause catastrophic damage, and could disable the sewerage system for an extended period.

The potential impact of contamination of Potter Marsh can be partly mitigated by providing standby pumping and storage capacity at the Rabbit Creek pump station. Conservative design and construction practices can help reduce the susceptibility of sewers to frost heaving and seismic activity, lessening infiltration and exfiltration.

It has been suggested that a new water supply for the south Hillside would be developed from surface water in the area, and that inflow to Potter Marsh would be reduced. Potter Marsh is fed by Rabbit and Little Rabbit Creeks. The worst case impact that could occur would be for the entire water supply to be developed from Rabbit and Little Rabbit Creeks. If this occurs, water diversions could reduce inflow to Potter Marsh by more than 50 percent at certain times of the year, and by about 15 percent on an average annual basis. The wildlife values of Potter Marsh could be adversely affected by such a change in hydrologic regime. Fishery resources of the creeks could also be adversely affected.

Proposed sewer lines will cross streams throughout the Anchorage Bowl. Construction activities may adversely affect water quality and salmonid fish. Many species of fish use Campbell Creek and other streams for spawning. Construction may reduce spawning and rearing success.

Hillside Impacts

The Hillside area has been sparsely settled by residents who wish to live in a less crowded area than exists elsewhere in the Anchorage Bowl, and who wish to retain some flavor of rural Alaska in their residential setting. With the exception of a few areas close to New Seward Highway the Hillside does not have public water or sewers. Instead, the area relies on individual domestic water supply wells and individual on-site sewage disposal systems such as septic tanks with drain fields.

The U. S. Geological Survey in 1975 prepared a report documenting possible water quality and public health threats that could result from increased Hillside area development using on-site sewage disposal systems. They concluded that a high risk of groundwater pollution, surface water pollution and public health effects existed.

The MOA adopted the Hillside Wastewater Management Plan in 1982. The objectives in preparing the plan were to better define physical constraints to on-site sewage disposal, delineate areas that would be served by public sewers and areas that would be served by on-site sewage system, and to provide for proper and safe management of on-site systems to protect public health.

By adopting the "recommended maximum perimeter of public sewerage" the Municpality has excluded sewers from 79 percent of the Hillside area. In order to develop within this unsewered area each landowner must demonstrate that adequate land is available to support three drain fields and that other conditions are met. If a property is located on areas designated as generally unsuitable for on-site treatment systems (30 percent of the Hillside is so classified), approval is more difficult, but is still possible. Innovative (special technology) on-site systems are required unless it can be shown that the traditional system is acceptable.

Water Availability Impacts. The Hillside plan does not address the water supply issue. EIS analyses assume that individual wells will continue to be the source of domestic water for the Hillside. As U. S. Geological Survey points out, water availability is very limited in localized portions of the Hillside, even though sufficient water resources exist on an area-wide basis to support full development. Some development may be precluded by an inability to develop a well. It is also possible that numerous wells tapping the same limited aquifer could exceed the recharge of the aquifer, leaving upslope or shallower wells without water.

This impact can be mitigated by providing a public water supply system to the area, or by limiting development by water availability based on evaluation of local groundwater supplies.

Surface Drainage Problems. The Hillside area has certain unique surface drainage problems that may subject development to risk of damage, and which complicate the use of on-site disposal systems. With the exception of the major streams, much of the area lacks defined natural drainage channels; wetland areas are present on the Hilside, along with areas with shallow groundwater; flood hazard areas adjoin the major creeks; and winter icing and spring thaws complicate transportation and affect local drainage.

Development may increase total runoff and may inadvertently channel it toward existing downstream residences. The Hillside plan includes a requirement that surface water disposal plans be prepared covering "...erosion and sediment controls, water quality controls, surface water conveyance and disposal and on-site system operation." This requirement will help mitigate some of the risks to development related to the drainage problems of the Hillside.

Groundwater Quality and Public Health Impacts. The potential for localized groundwater pollution in the Hillside is relatively high, based on work by both U. S. Geological Survey (1975) and Arctic Environmental Engineers (1981). This high potential exists because most chemicals, detergents, and pathogens are not removed in the septic tank, but rather by contact with unsaturated soil particles in the drain fields. If this contact is inadequate, pollutants may remain untreated. In addition, certain pollutants such as nitrates are not readily removed, and may contaminate the underlying groundwater. In the Hillside area, bedrock outcrops, shallow bedrock, shallow groundwater, steep slopes, roadway excavations, building site excavations and freezing conditions increase the risks of inadequate treatment.

The large number of on-site systems will increase the risk of accumulations of conservative pollutants such as nitrates. Cumulative impacts of substantial groundwater recharge from nearly 9,000 on-site systems may be significant. Nitrate levels could exceed the EPA drinking water standards in localized areas, and could affect the artesian aquifer under the lower hillside and within the Anchorage Bowl.

As the number of on-site systems on the Hillside increases from 1,500 to nearly 9,000, the number of failures from all causes is likely to increase, even considering tighter design standards and pumping requirements. As existing systems age, failures will increase. Septic systems do not last forever; new drain fields will need to be provided as existing fields absorb pollutants and suspended solids, and eventually fail to meet adequacy testing on resale or simply fail to accept discharged wastes.

Surface Water Quality Impacts. Wherever septic tank effluent is allowed to surface, or where shallow groundwater recharges a surface water body, the potential for surface water pollution exists. There are many ways in which septic tank effluent can surface.

The growing number of roadway excavations and building site excavations poses a risk of intercepting percolating effluent. At a density of one unit per acre excavations frequently will be in close proximity to on-site sewerage systems. The potential for public health impacts would be magnified substantially by incompletely treated effluent surfacing and flowing in local drainage courses and roadside ditches.

Mitigation Measures. Mitigating the potential groundwater impacts on public health and water quality that result from the decision to preclude public sewers and allow a substantial increase in on-site systems in the Hillside presents many challenges. The Hillside Wastewater Management Plan incorporates certain mitigation measures that are discussed in greater depth in the DEIS. Additional mitigation methods could include groundwater monitoring, periodic certification of domestic wells, creation of a public septic system maintenance district, providing capacity in downstream interceptor sewers, providing a public water supply to the Hillside area, improving site inspection criteria, monitoring surface water quality, prohibiting the construction of drain fields upslope of excavations, and prohibiting excavations downslope of existing drain fields.

Cultural Resources

The Anchorage Bowl area is not noted for extensive use by prehistoric populations. A known archeological site occurs at Point Woronzof one-half mile from the WWTP.

Impacts to known or newly-discovered archeological sites can be minimized through avoidance where possible. The facilities plan does not threaten the site in the Point Woronzof area. A preconstruction survey of the expansion area at the WWTP should be conducted as a precautionary measure. Since watercourses are often places of high habitation probability, a brief reconnaissance at all stream crossings is recommended. During all construction activity, a localized work halt should occur and the State Historic Preservation Officer should be immediately notified if an archeological site is uncovered.

Secondary Impacts

The facilities plan is judged to indirectly allow population growth of about 134,500 persons as a consequence of expanded sewerage facilities and on-site sewerage decisions in the Hillside area. The facilities plan is also assumed to be a direct inducer of growth in the south Hillside areas from Little Rabbit Creek to Potter Creek, where development will depend on the sewerage extensions included in the facilities plan.

The most visible sign of population growth is the development of land. Unless there is a high vacancy rate or unused capacity in existing structures, residential, commercial and industrial developments will occur to fulfill the needs of the growing population.

The effects of growth, both beneficial and adverse, may be observed in environmental and socioeconomic areas, and may have regional and local consequences. Growth usually affects the following:

- Services and utilities
  - sewerage
  - water supply
  - solid waste disposal
  - energy
  - transportation
  - education
  - police and fire protection
  - parks and recreation
  - social services

- Resources
  - air quality
  - water quality
  - hydrology, erosion, seismicity
  - open space
  - wetlands
  - biological resources
  - aesthetics
  - noise

- Socioeconomic values
  - development-related economic activity
  - community cultural resources
  - social structure
  - fiscal strength
  - perceived quality of life

Water supply is of substantial concern, since existing supplies are currently barely able to meet demand in critical periods. In the summers of 1976 and 1977, during an extended dry period, both the Anchorage Water Utility and Central Alaska Utilities publicly requested that their customers curtail water use because demand exceeded production and a drop in water pressure was experienced in various areas. In 1980, the MOA retained a consultant to investigate the feasibility of obtaining a 70 MGD water supply from Eklutna Lake by pumping water from the tailrace below the Eklutna powerhouse. If this project is undertaken, the water supply will be adequate for the growth predicted by the 201 facilities plan.

In the meantime the MOA is investigating the drilling of additional wells to use groundwater supplies until the Eklutna project is constructed.

A relationship between water supply and sewerage exists, in that a portion of the water supply becomes wastewater. If the water supply available to Anchorage is not increased, water conservation and/or rationing could be imposed. This would tend to keep sewage flows lower than projected by the facilities plan. Lack of adequate water supplies could delay the need for part of the proposed expansion of sewerage facilities.

Solid waste is also of concern, since the MOA is running short on capacity at the existing Merrill Field landfill, and is expected to require a new landfill no later than mid-1986. No new landfill has been identified, although the Solid Waste Management Plan is expected to be updated in 1983.

The use of energy resources will increase with growth and it is expected that supplies will keep pace.

The increased population and automobile use will place additional demands on the existing roadway network and public transportation services. Roadways and services will need to be established in the new sewered residential and commercial areas. Certain secondary impacts are also generated by increased transportation use. These include increased energy consumption and higher levels of air pollution, particularly carbon monoxide.

Most of the urbanized area of the Anchorage Bowl has been formally designated as a carbon monoxide "nonattainment area" due to violations of federal air quality standards. The MOA is designated as being in attainment of other federal air quality standards (ozone, nitrogen dioxide, sulfur dioxide and suspended particulate matter).

MOA has adopted an air quality plan that focuses on attaining the Federal carbon monoxide standard by 1987. The facilities plan is considered consistent with the growth assumptions of the air quality plan since the facility plan does not accommodate growth levels beyond those anticipated in the air quality plan.

Demands for educational services, police protection, fire protection and other governmental services will increase. Additional facilities and staff will be needed to meet these demands.

The Anchorage Bowl has numerous and varied recreational resources. Population growth will put increasing pressure on these resources. Some existing resources may become more heavily used and seem overcrowded, particularly local and neighborhood park facilities and bike trails in greenbelt areas. Although growth may be accompanied by the provision of additional urban recreational facilities, the expansion is not possible in the case of finite resources such as beaches and greenbelt areas. Chugach State Park and other open land areas in south-central Alaska will also get heavier use.

Some benefits will also accrue from growth. Development will bring economic activity, including construction and accompanying employment. A larger population can support a greater diversity of cultural resources, such as plays, ballet, symphonies, art exhibits, popular entertainment, museums, and libraries.

Urban construction has wide ranging effects on surface and groundwater hydrology. Most of these impacts are caused by the reduction of naturally permeable soil surfaces with impermeable concrete, asphalt, and buildings. Percolation of rainwater and snowmelt to the groundwater is substantially reduced, and runoff to stream channels may become inadequate to contain the man-altered runoff regime.

Other development-related impacts can be controlled by proper land use planning and plan implementation, including specific plans for transportation, air quality, recreation, public services and facilities, and other elements.

Treatment and Disposal Impacts

Effluent leaving the Point Woronzof WWTP is chlorinated and discharged to the Knik Arm of Cook Inlet. The increase in discharge and improvement in treatment capability is not expected to noticeably affect the Inlet, even though discharge quality will be improved.

Knik Arm is one of the most dynamic water bodies in the world. The physical environment is so harsh, in fact, as to hinder the establishment of a benthic biological community. The only observable evidence that municipal wastes are injected into Knik Arm via an outfall at Point Woronzof is the accumulation of coliform bacteria on the beaches to the east of the discharge. The bacteria are brought ashore on the flood tide by an eddy along the north shore of Point Woronzof. The lengthening of the outfall by an additional 1,500 feet will ensure that wastes are injected outside of the system and thus not returned to shore.

The provision of a 1,000-foot diffuser should ensure that all water quality standards are met at the boundaries of the state designated mixing zone around the discharge point.

Treatment of additional quantities of wastewater at an expanded Point Woronzof WWTP will increase the use of chemicals (particularly chlorine) and energy (pumping of wastewater), will create about eight additional employment positions, and may increase the potential for odors near the plant.

Sludge Processing and Disposal Impacts

The Recommended Plan for sludge treatment and disposal involves dewatering, incineration and discharge of ash to the Knik Arm of Cook Inlet via the outfall, landfilling the ash, or discharging the ash to a lagoon or gravel pit near the plant as a slurry blended with wastewater.

Incineration of increased volumes of sludge is not expected to create any significant air quality impacts. Energy consumption will probably increase.

Discharge of sludge ash through the outfall pipe following incineration will increase the suspended solids concentration in plant effluent. The ash alone would increase total suspended solids by about 13 mg/l. Considering that the plant currently has difficulty meeting discharge requirements of 100 mg/l (monthly average), the addition of ash will make it increasingly difficult to avoid NPDES permit violations.

As a mitigation measure, the plant could be designed to achieve a consistent effluent quality of 85 mg/l suspended solids in the clarifier overflow, allowing for an additional 13 mg/l from incinerator ash.

There is a slight chance that discharge of ash in suspension with treated effluent could introduce toxic materials, such as heavy metals, to the Knik Arm of Cook Inlet. Without an analysis of constituents of the ash, evaluation of solubility of end products, particle size and volume of discharge, no further analysis is possible.

Landfilling the ash will use landfill volume that would otherwise be available for municipal refuse and other solid waste. At a rate of 1.8 tons per day, the incinerator would produce about 660 tons per year, representing 0.33 percent of total landfill volume. If a new landfill site is chosen that has a 20-year life, it would last 24 days longer without the ash.

If toxic substances are present in landfilled sludge ash, percolating rainwater could leach these substances into the groundwater, adversely affecting water quality and beneficial uses of the water resource. The potential for such impacts occurring is small.

There is a remote risk that discharging sludge ash to lagoons or gravel pits near Point Woronzof (within 0.25 mile of the WWTP) could lead to local pollution of groundwater, depending on constituents in the ash. Evaluations of land disposal of wastewater at nearby Point Campbell (U. S. Army Corps of Engineers 1979) indicated that groundwater flow was toward Cook Inlet in this general area. A more detailed review of both shallow and deep aquifers in this area is necessary to ascertain movement direction and potential interchange between aquifers.

Construction Impacts

Construction of wastewater facilities typically results in an assortment of short-term nuisance impacts. This type of impact typically lasts for the duration of the activity in a particular local area. These impacts include noise, dust, stream turbidity, access problems, traffic congestion, potential safety hazards and visual "eyesores". These impacts are usually judged insignificant unless someone is injured or a stream is severely damaged. In most cases, these impacts are readily mitigated to tolerable levels.

Impacts of Alternatives

The DEIS evaluates impacts of alternatives including land application of effluent; eliminating chlorination of the Point Woronzof effluent; sludge digestion rather than incineration; alternative concepts for the West Bypass Interceptor sewer; various collection, local treatment, and pumping alternatives for the Potter Creek area; and no action.

Land Application of Effluent. Land application of effluent was evaluated for the Point Campbell Military Reservation area. Land application would reduce or eliminate the discharge from the outfall into Cook Inlet. While wastewater percolates through soil, heavy metals, organic compounds, bacteria and viruses can be filtered, biologically degraded or bound to soil particles and probably not reach Cook Inlet in significant amounts. The Point Campbell Military Reservation is moose habitat, and nutrient enrichment of the soils may accelerate growth of forage species, particularly if appropriate forage management actions were undertaken.

Potential adverse environmental impacts relate to projected and existing human use of the disposal area. The MOA plans to develop a park in the Point Campbell area following transfer of the property from military to MOA jurisdiction.

Groundwater impacts could also result from land disposal of effluent in the Point Campbell area. As noted previously, prior study (U. S. Army Corps of Engineers 1979) indicated flow of groundwater was generally toward Cook Inlet. A more detailed review is needed of shallow and deep aquifers in this area to confirm movement direction and assess possible interchange between aquifers. Such an analysis should include consideration of the effects of increased MOA groundwater pumping on the direction of flow.

Treatment and Effluent Discharge Alternatives. Chlorination of effluent is a generally accepted technique for killing viruses and bacteria which may cause human disease. On the other hand, chlorination is known to result in the formation of potentially toxic halogenated organic compounds (e.g., chloramines) and free chlorine which are toxic to salmonids and other aquatic species. Partially in response to these toxicants, the Alaska Department of Environmental Conservation has recommended an extension of the outfall and elimination of the chlorination process as measures to minimize the potential for adverse impacts on migrating salmon.

Actual benefits to the salmon resource are unknown, primarily because the impact of the chlorinated effluent on the Knik Arm is unknown. Elimination of chlorination will result in elevated levels of bacteria and viruses in the discharge mixing zone, beyond the mixing zone, and in nearshore areas.

Two alternative changes in state-designated beneficial uses of the waters of upper Cook Inlet are proposed in studies undertaken following publication of the facilities plan. These changes would, in effect, ease or eliminate coliform standards applicable to the Knik Arm. These recent studies show that an unchlorinated effluent discharge would violate current receiving water quality standards.

One alternative would ease coliform standards to 200 FC/100 ml from the current 14 FC/100 ml, requiring a 6,100-foot diffuser to meet the relaxed standard. Certain beneficial uses of the waters of Cook Inlet, specifically, water supply for seafood processing, water contact recreation, and harvesting for consumption of raw mollusks or other raw aquatic life, would be deleted as designated uses. This change in standards would probably not significantly affect any existing uses, nor would it preclude any likely future uses. Water contact recreation, however, does occur to a small degree on Cook Inlet. Public use of the shoreline area occurs, and high coliform counts have historically been of concern.

The second alternative, with a minimal (about 100-foot) diffuser, would require deletion of all beneficial uses except growth and propagation of fish, shellfish, aquatic life, and wildlife, including seabirds, waterfowl and furbearers. This would result in no coliform standard being applicable, pursuant to state water quality standards. In addition to the uses foregone as described for the alternative above, water supply for aquaculture, water supply for industry, and secondary water recreation would no longer be protected (designated) uses.

High natural turbidity levels in Knik Arm preclude most of these uses as a practical matter. However, water quality standards coliform levels could be exceeded.

Secondary treatment would require a greater capital investment, greater energy consumption, more land at the plant, and would generate larger volumes of sludge.

Sludge Disposal Alternatives. An alternative to sludge incineration, namely digestion of the sludge and subsequent disposal in a landfill, is evaluated. This would hasten the reduction in available landfill capacity.

Another alternative discussed in the facilities plan is co-incineration of sludge and refuse. This alternative has the environmental advantage of reducing the amount of solid waste destined for a land fill and generating energy as a by-product. Adverse impacts on air quality may occur if steps are not taken to minimize the release of carbon monoxide and particulates.

West Bypass Interceptor Alternatives. Two alternatives for the West Bypass Interceptor, namely a gravity flow interceptor with open ditch construction, and a gravity flow option with a combination of open ditch and tunneling construction, would have potentially significant imapcts on the environment. A 50-foot excavation would be required along much of the alignment in C Street and the easterly portion in Raspberry Road. Shallow groundwater is prevalent in this area, with sand and gravel deposits predominating. Dewatering would be required in order to allow construction of either the open trench alternative or the tunnel alternative.

One of the highest yielding water wells in the Anchorage Bowl, operated by Central Alaska Utilities, Inc., for domestic water supply is located several hundred feet north of the

interceptor's route. The dewatering could decrease the Anchorage water supply for several months. Considering that the Anchorage water supply is currently barely adequate to meet demands at critical periods, loss of well production could cause a water shortage in Anchorage.

Several commercial buildings and residences are located near the interceptor alignment and could be affected by construction activities, especially dewatering. Dewatering may allow soil particles to compress, causing subsidence of the land surface. This may affect utilities and structures, particularly the Alaska Bank building and its sensitive computer system.

Rabbit Creek/Potter Creek Area Alternatives. The facilities plan describes a number of alternatives for providing sewerage service to those portions of the lower Hillside area requiring connection to the public system. Several alternatives provide for a small WWTP at the north edge of Potter Marsh that would discharge secondary treated effluent into Rabbit Creek. This method of disposal is likely to have adverse environmental impacts on Potter Marsh and the fishery resources in Rabbit Creek. Of major concern are the adverse impacts of an accidental discharge of raw or inadequately treated sewage, elevated water temperatures during winter, chlorine, and turbidity.

Alternatives in sewer alignments would have somewhat different impacts. One alternative was determined to have less potential impact on Potter Marsh.

No-Action Alternative. The long-term environmental consequences of no action appear more adverse than the long-term consequences of any of the alternatives or the Recommended Plan. The status quo would increasingly violate federal and state water quality laws and could result in a state-imposed moratorium on new sewer hookups in the Anchorage Bowl. Failure to expand or renovate the existing sewer system would increase the incidence of pollution of local streams and of local groundwater supplies. This situation would place severe constraints on local growth and the local economy, and sharply increase the hazard to public health.

Consistency With Federal Laws, Policies, and Regulations

Clean Water Act. The EPA is charged with overall administration of the Clean Water Act, as amended (33 USC 1251 et seq.), with certain responsibilities delegated to those states carrying out EPA-approved water quality programs.

Section 201 of the Clean Water Act establishes a construction grant funding program for publicly-owned municipal wastewater facilities. In order to receive grants under Section 201 of the Clean Water Act, the MOA must conduct its planning according to guidelines promulgated by the EPA and administered by the State of Alaska. The State of Alaska has not determined whether the MOA facilities plan is consistent with the state guidelines. EPA has raised several questions regarding the plan's consistency (see Appendix A to DEIS).

Section 402 of the Clean Water Act requires a NPDES permit for all discharges to waters of the United States. In the State of Alaska, EPA submits the draft NPDES permit to the Alaska Department of Environmental Conservation for certification that the permit meets state water quality criteria. The existing NPDES permit for the Point Woronzof treatment plant expires on December 30, 1982. The permit, AK-002255-1, actually refers to a discharge of secondary treatment effluent. Permission was granted in a letter by EPA to continue primary effluent discharge until July 1, 1982. The MOA has applied for a Section 301(h) waiver of the requirement for secondary treatment of the wastewater discharged to Knik Arm. Consistency between the facilities plan and the requirements of Section 402 cannot be determined until the new NPDES permit is issued.

Section 404 of the Clean Water Act establishes a permit program, administered by the Secretary of the Army, acting through the U. S. Army Corps of Engineers, to regulate the discharge of dredged material (including backfill) into waters of the United States. Interceptors and the outfall extension called for by the facilities plan which cross streams and wetlands may require 404 permits. Utility crossings of streams and wetlands are allowed under a nationwide 404 permit subject to certain criteria. Of these criteria, the following may not be met by the proposed facilities as described in Chapter 4 of the DEIS.

- No change in preconstruction bottom contours is to take place.
- Discharge (backfill) is not to disrupt the movement of indigenous aquatic species.
- Spawning areas are to be avoided to the maximum extent possible during spawning season.
- Discharge (backfill) is to be avoided to the maximum extent possible in migratory waterfowl breeding areas.

Heavy equipment in wetlands is to be placed on mats to the maximum extent possible.

Temporary fills are to be removed in their entirety.

If any single criterion is not met by certain elements of the proposed facility plan, those elements will require an individual Section 404 permit issued by the U. S. Army Corps of Engineers.

Coastal Zone Management Act. The act (16 USC 1451 et seq.) requires Federal activities to be consistent to the maximum extent practicable with approved state coastal zone management plans. Certain elements of the facilities plan may not be consistent with the state-approved MOA coastal zone management plan to the extent that they allow and encourage development in the southern half of Campbell-Klatt Bog. Campbell-Klatt Bog is a significant migratory waterfowl nesting area and is designated for preservation by the state-approved MOA coastal zone management plan. A formal coastal zone management consistency determination will be made by the State of Alaska.

Federal Policy on Floodplain and Wetlands Protection. The EPA is required to assess the impacts of its action on wetlands and floodplains and to avoid or minimize unavoidable adverse impacts. Insufficient information is available to adequately describe indirect impacts on wetlands resulting from emplacement of sewer pipes adjacent to wetland areas.

Endangered Species Act. The EPA is required by the Endangered Species Act (16 USC 1536 et seq.) to ensure that actions funded by the agency do not jeopardize the continued existence of any endangered or threatened species or result in the destruction or adverse modification of critical habitat for these species. There are no known endangered or threatened species in the study area, therefore te Endangered Species Act requirements are not relevant to the facilities plan.

Clean Air act. The Clean Air Act requires that Federal funding not support projects inconsistent with locally-developed state air quality plans. Consistency between the MOA facility plan and state air quality management plans is determined by comparing population growth forecasts and treatment activities such as sludge incineration which result

Chapter 1

INTRODUCTION

This Draft Environmental Impact Statement (DEIS) is prepared by the U. S. Environmental Protection Agency (U. S. EPA) to evaluate the impacts of expanding the Municipality of Anchorage (MOA) wastewater collection, treatment and disposal system. It emphasizes matters of particular concern, including wetlands, Hillside area sewerage decisions, growth inducement and impacts of growth, effects of disposing of effluent in Cook Inlet, and the impacts of sludge disposal.

Organization of DEIS

This DEIS is organized in 14 chapters. Chapter 1 provides background detail; Chapter 2 describes the existing sewerage situation; Chapter 3 describes the projects proposed by the MOA as the Recommended Plan, and also describes alternatives to that plan; Chapters 4 through 10 evaluate impacts of the Recommended Plan; Chapter 11 evaluates impacts of alternatives to that plan; Chapter 12 describes issues unresolved by alternatives; Chapter 13 describes coordination activities and public input; and Chapter 14 is a list of references used in compilation of the plan.

The text is set off into chapters, as noted above; within chapters a consistent system of subheadings is used to denote the relative rank of the discussions in outline style. The following key to the appearance of headings in terms of capitalization, centering, alignment with or indention from the left margin, underlining, and type face is provided to assist the reader.

INTRODUCTION	Rank 1 (Chapter title)
Background	Rank 2
Federal Laws	Rank 3
Clean Water Act.	Rank 4
Mitigation Measures.	Rank 5

In the case of Ranks 4 and 5 headings, text begins immediately following and on the same line as the headings. The Table of Contents provides additional assistance to the understanding of this system through Rank 3.

Background and History of the Project

The wastewater collection system in the Anchorage Bowl was developed in an uncoordinated, patchwork fashion between 1917 and the mid-1960s. A comprehensive wastewater plan was formulated in 1966, initiating the construction of the Greater Anchorage Area Borough trunk and interceptor system during the period 1970-1973. This period included development of the Point Woronzof wastewater treatment plant (WWTP) and an 84-inch ocean outfall extending 804 feet into the Knik Arm to a depth of 15 feet below MLLW. Since that time, extensive population growth and associated development throughout the Anchorage Bowl area resulted in overloading of the existing wastewater collection and treatment system. The Point Woronzof WWTP was designed as a primary treatment plant and put into operation in 1972 with a rated average daily flow capacity of 34 million gallons per day (MGD) for a design population of 221,000. Based on historical performance, a realized rating of 22 MGD is appropriate. Average flows in 1980 and 1981 were 26.5 MGD and 28 MGD, respectively. Under current National Pollutant Discharge Elimination System (NPDES) limits, the WWTP is overloaded.

The U. S. Army Corps of Engineers (U. S. COE) Alaska District started a facilities planning process in 1976. During preparation of the U. S. COE facilities plan, the Anchorage Water and Sewer Utility (AWSU) proceeded with an infiltration and inflow analysis, a sewer system evaluation survey, and a wastewater collection system study. An incomplete draft report was issued by the U. S. COE in 1979. Completion of the report was not possible for a number of reasons, including:

- The MOA had not adopted a wastewater collection system study.
- The sewer system evaluation survey was incapable of generating adequate wastewater flow projections.
- The issue of on-site disposal vs. sewerage in the Hillside area remained unresolved.
- The comprehensive development planning process was not completed, specifically the Hillside Wastewater Management Plan, the Wetlands Management Plan and the Comprehensive Development Plan were needed to adequately project population growth and define areas requiring new or additional service.

The MOA postponed development of a facilities plan until a revised community development program could be prepared.

On July 9, 1981, the MOA authorized a sanitary engineering consultant to begin work preparing draft and final facilities plans for expansion of sewage collection, treatment and disposal facilities. The MOA intends to use the facilities plan to apply for U. S. EPA construction funds under Section 201 of the Clean Water Act. Facilities plan work was initiated with the assumption that the Hillside Wastewater Management Plan and the Wetlands Management Plan would be sufficiently complete and not significantly affect planning, e.g., changes in these documents upon adoption would not have a major impact on the facilities plan, and adoption of these management plans as elements of the Comprehensive Development Plan would occur early in the 201 facilities planning process. The Wetlands and Hillside plans were adopted in the spring of 1982.

Objectives of the Facilities Plan

The facilities plan has the following objectives:

- Evaluate existing wastewater collection and treatment systems and their abilities to meet current and anticipated future sewage loads.
- Provide a long range plan for orderly development of sewage collection and treatment facilities in an environmentally-sound manner. Project wastewater loads and flow for treatment facilities to 2005. Design principal interceptors for peak flows expected in 2025.
- Evaluate alternative collection and treatment systems and recommend cost-effective improvement and expansion programs.
- Meet the requirements of the MOA's application for a grant of funds from U. S. EPA under Section 201 of the Clean Water Act.

Necessity and Purpose of the Environmental Impact Statement

The MOA has requested a grant from U. S. EPA under Section 201 of the Clean Water Act. Under terms of Section 201, local facilities construction projects are eligible to receive up to 75 percent federal funding for the planning, design, and construction of municipal wastewater treatment systems. Up to 85 percent funding can be received for innovative techniques. Eligibility is based largely on EPA regulations and guidance memoranda. As the lead agency for the

Clean Water Act, U. S. EPA is charged under terms of the National Environmental Protection Act (NEPA) with assessing the environmental impacts of proposed wastewater facility projects built with federal funds. A review of planning documents for the Anchorage area, meetings with U. S. EPA Region 10 staff, a review of the project area environment, and discussions with local officials resulted in the determination that significant environmental impacts are potentially associated with the Section 201-funded facilities plan. The issues of concern are identified in the following section of this chapter. If significant adverse impacts may occur the U. S. EPA is required by NEPA to prepare an Environmental Impact Statement (EIS).

The EIS is to be a "full disclosure" document and must follow specific regulations of the Council on Environmental Quality (CEQ), (as set forth in 40 CFR, Part 6 and published in the Federal Register, Volume 43, Number 230, November 29, 1978), and of the U. S. EPA, (as set forth in the Federal Register, Volume 44, Number 216, November 6, 1979). It is the intent of NEPA that alternatives identified during the scoping process be evaluated and a plan selected on the basis of all environmental, engineering, and economic considerations, not just monetary costs.

This EIS has been prepared to evaluate the environmental impacts of the MOA wastewater facilities expansion and to encourage public participation in the planning process through local meetings, workshops, and public hearings. It also provides input to the facilities planning firm and coordinates feedback between the facilities plan and environmental assessment during the EIS process.

Issues of Concern

Prior to and during the preparation of this EIS, a number of key issues were identified that warrant discussion and, if possible, resolution. The issues identified below are described in detail and evaluated in Chapters 4-11. Those issues that remain generally unresolved are identified and discussed in Chapter 12, ISSUES UNRESOLVABLE BY THE ALTERNATIVES. The issues of general concern to this wastewater collection, treatment, and disposal project are:

- The impacts of pipe emplacement through wetlands on wetland resources, including biological resources, hydrologic characteristics, and open space/aesthetic values.

- The impacts of facilities on growth and development in the Hillside area, and associated impacts on water quality in the Hillside area..

- Growth-inducing impacts, particularly effects of population growth on wetlands and community services, traffic and energy, and the perceived quality of life.

- The impacts of effluent disposal on fishery resources in Cook Inlet.

- The impacts of sludge disposal on the environment.

Legal, Policy and Regulatory Constraints

The following briefly discusses major federal, state and local laws, regulations and policies that affect the MOA's 201 facilities plan.

Federal Laws, Policies and Regulations

Clean Water Act. The U. S. EPA is charged with administration of the Clean Water Act, as amended (33 USC 1251 et seq.). The goals of the act are to achieve fishable, swimmable surface waters throughout the nation by 1983 and to achieve no discharge of pollutants by 1985. The act requires that all discharges to the United States waters be issued a permit under NPDES (Section 402). In the State of Alaska, the U. S. EPA submits the draft NPDES permit to the Alaska Department of Environmental Conservation (ADEC) for certification that the NPDES permit meets state water quality criteria.

All alternatives being considered for the 20-year facilities plan include a discharge to navigable surface waters and, therefore, the discharge must comply with an NPDES permit issued for the outfall. The existing permit for the Point Woronzof WWTP was issued on November 30, 1977, became effective on December 30, 1977, and is scheduled to expire on December 30, 1982. The permit, AK-002255-1, actually refers to a discharge of secondary treatment effluent. Permission was granted in a letter by the U. S. EPA to continue primary effluent discharge until July 1, 1982. The MOA has applied for a new NPDES permit which would authorize a continuation of the discharge of primary treated effluent under Section 301(h) of the Clean Water Act Amendments.

Section 201 establishes a construction grant funding program for publicly-owned municipal wastewater facilities (a federal funding of 75 percent with a maximum of 85 percent for "innovative" wastewater treatment and/or disposal concepts). In order to receive grants under Section 201 of the Clean Water Act, the MOA must conduct its planning according to strict guidelines administered by the State of Alaska and

enforced by the U. S. EPA. In order to comply with these mandates, the MOA prepared a facilities plan for the expansion and upgrading of the wastewater collection, treatment and disposal systems based on effluent quality limitations established by the U. S. EPA and the State of Alaska.

Section 404 establishes a permit program, administered by the Secretary of the Army, acting through the U. S. COE, to regulate the discharge of dredged material (including backfill) into waters of the United States. This term has been defined by regulations (Federal Register Volume 42, pages 37122-37164, July 19, 1977) such that all the streams in the study area up to their headwaters and the adjacent wetlands are subject to the 404 permit program. This comprises over 12 percent of the study area. Utility crossings of these streams and wetlands are permitted under a nationwide 404 permit, subject to the following criteria:

- No change in preconstruction bottom contours will occur.
- Discharge will not be located in the proximity of a public water supply intake.
- Discharge will not occur in areas of concentrated shellfish production.
- Discharge will not violate provisions of the Endangered Species Act.
- Discharge will not disrupt the movement of indigenous aquatic species.
- Discharge will be free of toxic pollutants in toxic amounts.
- Discharge will be maintained to prevent erosion and other nonpoint pollution.
- Discharge will not occur in a national or state wild and scenic river element.

Toxic Substances Control Act. The U. S. EPA is charged by the Toxic Substances Control Act (15 USC 2601 et seq.) to protect public health and the environment from harmful chemicals and mixtures. Among other provisions, the act authorizes the U. S. EPA to adopt regulations governing the manner of disposal of chemical substances. U. S. EPA has promulgated regulations which require an analysis of wastewater or effluent at the discharge to identify toxic pollutants. If toxic pollutants are identified, the discharger must develop a program for pretreatment of toxic

pollutants entering the wastewater stream from industrial sources, and must develop a nonindustrial source control program. MOA has developed a plan and incorporated it into its 301(h) application.

Coastal Zone Management Act. The act (16 USC 1451 et seq.) establishes funding and requirements for state coastal zone management programs. Under U. S. EPA procedures for implementing NEPA (40 CFR Part 6), a determination of consistency with applicable coastal zone management programs is required of U. S. EPA activities having significant coastal zone impacts. U. S. EPA has approved the Alaska Coastal Management Program as established by the Alaska State Coastal Zone Management Act of 1977. In Alaska, the state has designated specific local governments to implement coastal management controls. Anchorage's Coastal Zone Management Plan was certified by the Alaska Office of Coastal Zone Management. The existing treatment plant, discharge, and portions of the collection system fall within the area controlled by the MOA.

Potter Marsh, all tidal flats and coastal wetlands, Campbell-Klatt Bog, Turnagain Bog, and most of Potter, Little Rabbit, Rabbit, Furrow, Campbell, Fish, Chester, and Ship Creeks in the study area have been included in areas designated for preservation under the MOA Coastal Zone Management Plan (MOA 1980, map 12). Development in these areas, particularly as approved in Campbell-Klatt Bog by the MOA's Wetlands Management Plan, will require amendment of the coastal zone management plan. The coastal zone management plan also states that "public works activities . . . shall avoid or minimize adverse impacts upon coastal marsh systems."

The Point Woronzof WWTP is located in the coastal zone management area. The tidal area to the south of the treatment plant is designated a wetland of special concern. Extension of the outfall should not impact this area.

No marine or estuarine sanctuaries occur in the vicinity of the proposed discharge or other facilities.

Resource Conservation and Recovery Act. As part of its proposed nonindustrial source control program, MOA proposes to establish centrally located sites where the public may discard toxic pollutants or hazardous wastes, including grease and oil. Under provisions of the Resource Conservation and Recovery Act (42 USC 6921 et seq.), the U. S. EPA has authority to regulate this program.

Endangered Species Act. The central purpose of the Endangered Species Act, as amended (16 USC 1536 et seq.) is to halt and reverse the trend toward species extinction through limitations on the actions of federal agencies. By

enacting the Endangered Species Act, Congress made a conscious decision to give endangered species priority over the "primary missions" of federal agencies. The Endangered Species Act states that each federal agency shall " . . . ensure that any action authorized, funded or carried out by such agency does not jeopardize the continued existence of any endangered species or threatened species or result in the destruction or adverse modification of habitat of such species which is determined by the Secretary to be critical, unless such agency has been granted by exemption for such action by the Committee". The Endangered Species Act (Section 7) also requires that all federal agencies consult with the Secretary to achieve these ends and the Secretary must issue an opinion on how the agency action will affect the species and how the impacts could be avoided. If the opinion indicates that the agency action may jeopardize a listed species or critical habitat, the agency must either modify its action or apply for an exemption from the Endangered Species Act.

Nonfederal entities contracting with a federal agency may also be subject to the Endangered Species Act provisions as well. Provisions of the Endangered Species Act may apply even after a project has been built.

There are no known endangered or threatened species in the study area (Alaska DFG 1976). Arctic peregrine falcon are classified rare and endangered by the federal government and the State of Alaska. Any area in Cook Inlet could receive use by Arctic peregrines during spring and fall migration periods, but such use in the study area would be uncommon and has not yet been reported. There is a possibility that the Aleutian Canada goose may occur in lower Cook Inlet, but this use has not been verified either, and is highly unlikely in the study area.

Critical habitat areas have not been identified in upper Cook Inlet. Potter Marsh and the tide flats south of Campbell Point to Chugach State Park are included in the Potter Point State Game Refuge managed by Alaska DFG, but these areas are not covered by Endangered Species Act jurisdiction.

U. S. EPA Policy on Floodplain and Wetlands Protection. In January 1979, U. S. EPA issued a Statement of Procedures on floodplain and wetlands protection pursuant to Executive Order 11988 and Executive Order 11990. Under the procedures, U. S. EPA is required to assess the impacts of its action on wetlands and floodplains and to avoid or, if no practicable alternative exists, minimize adverse impacts.

U. S. EPA, Region 10 has determined that 201 grants may promote or support development in environmentally-sensitive areas such as wetlands and floodplains. This effect occurs

when facility designs provide capacity for a reasonable amount of future growth, thereby influencing the amount or location of future development within a planning area. Potential adverse impacts of the MOA's proposed projects are described in this EIS.

Clean Air Act. The Clean Air Act, as amended (42 USC 1857 et seq.) requires states to prepare plans to attain national ambient air quality standards (NAAQS) in regions where the standards are being violated. These standards are designed to protect human health from the effects of chronic air pollution. Any project that directly or indirectly creates local air pollution conditions in excess of NAAQS, or which conflicts with the strategy presented in an approved State Implementation Plan (SIP), may have federal funding withheld under Section 316 of the Clean Air Act. Because federal standards for carbon monoxide are periodically violated in the Anchorage Bowl, an air quality plan has been prepared and was adopted in June 1982 (MOA 1982).

Safe Drinking Water Act. The Safe Drinking Water Act (42 USC 300f et seq.) requires U. S. EPA to set standards for drinking water quality and to establish guidelines for state regulation and enforcement of these standards. It also gives U. S. EPA the responsibility of protecting underground sources of drinking water. National primary drinking water regulations were established by U. S. EPA in 1977 and secondary drinking water regulations were established in 1979. The facilities plan must be analyzed for its effects on local drinking water supplies.

Fish and Wildlife Coordination Act. Under this act (16 USC 661 et seq.), federal agencies involved in projects resulting in modifications of streams or other water bodies are required to protect fish and wildlife resources which may be affected by the project. U. S. EPA procedures for implementing NEPA require consultation with the U. S. Fish and Wildlife Service(USFWS) and appropriate state wildlife agencies to develop mitigation measures for adverse impacts.

National Historic Preservation Act. Under the National Historic Preservation Act (16 USC 470 et seq.), if federal agencies undertake activities affecting sites of historic, architectural, archeological, or cultural value that are listed on the National Register of Historic Places, then the Advisory Council on Historic Preservation must be consulted and mitigation measures must be developed.

State Laws, Regulations and Policies

Alaska Water Quality Standards. U. S. EPA has granted jurisdiction for preventing and abating water pollution in the state to ADEC. ADEC is responsible for issuing permits for

the discharge of liquid wastes into state waters and for the disposal of nondomestic liquid wastes into publicly operated sewer systems. ADEC has developed water quality standards (18 AAC 70) under the Alaska Water Pollution Control Program (ADEC 1979). It also has established mixing zone regulations which determine the size of mixing zones in receiving waters. The code requires that reports, plans and specifications for all proposed modifications or construction of new sewer systems must be submitted to ADEC and approved by ADEC in writing.

Alaska State Coastal Zone Management Act. See discussion of Coastal Zone Management Act under Federal Laws, Policies and Regulations

Local Laws, Rules and Regulations

Sewer Tariff. The MOA has a sewer tariff which prohibits the discharge of toxic substances at concentrations hazardous to humans or animals, which may interfere with the sewage treatment process, or create any hazard in the receiving waters. The sewer tariff also specifies upper limits of certain heavy metals and phenol which may be discharged into the sewer system.

Wetlands Management Plan. The MOA Wetlands Management Plan, adopted in April 1982, has been enacted to provide for the orderly control of development of wetland areas in the Anchorage Bowl. Under the plan, most of the wetland areas in greenbelt areas or adjacent to recreational sites are designated as preservation areas. The remaining wetlands are either available for complete urbanization and development to satisfy growth needs, or are available for development if identified resource values are maintained as much as practicable.

Hillside Wastewater Management Plan. Adopted in May 1982, the plan establishes guidelines for on-site sewerage in the Hillside area and identifies those areas unsuitable for on-site disposal systems. The plan seeks to minimize the public health hazards associated with on-site disposal system failures and subsequent contamination of groundwater and surface water, while minimizing the growth-inducement impact that could result from installing a wastewater collection system tied to the MOA system.

Comprehensive Development Plan. The MOA has developed a draft Comprehensive Development Plan (MOA 1982) to guide community development. It addresses land use and supporting services, including transportation, parks, trails, open space, energy, land use, and phasing of urban development. An adoption date is not currently scheduled. In the meantime the 1976 Comprehensive Development Plan Ordinance remains in effect.

Anchorage Coastal Management Plan. See discussion of Coastal Zone Management Act under Federal Laws, Policies and Regulations.

Public and Agency Participation

Data for this EIS were compiled from numerous existing studies of the Anchorage Bowl, wastewater facilities documents, field reconnaissance, literature review, and numerous contacts with governmental agencies and individuals. Some of the agencies providing information and assistance in preparation of this EIS include the U. S. EPA, USFWS, U. S. COE, Alaska DFG, ADEC, Arctic Environmental Information and Data Center, U. S. Geological Survey and various entities of the MOA.

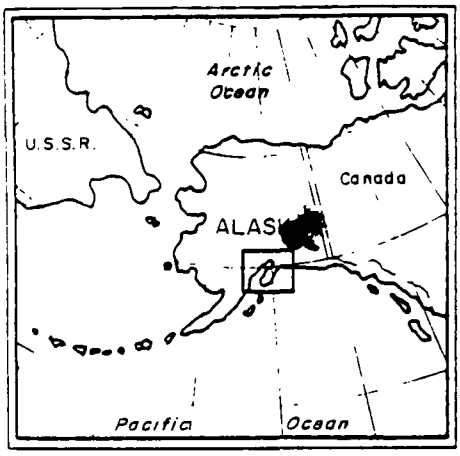
The EIS process encourages public input into the decision-making process. Scoping meetings were held in Anchorage on July 9 and 10, 1981; an interagency workshop was held on September 9, 1981 regarding wetlands work; a 201 facilities plan public meeting incorporating EIS topics was held on October 15, 1981; an EIS workshop on wetland issues was held on October 16, 1981; a 201 facilities plan public meeting, incorporating EIS topics, was held on January 19, 1982; and an EIS workshop emphasizing hillside and wetlands issues was conducted on April 14, 1982. Many agencies, interest groups and individuals were represented at the public meetings and workshops.

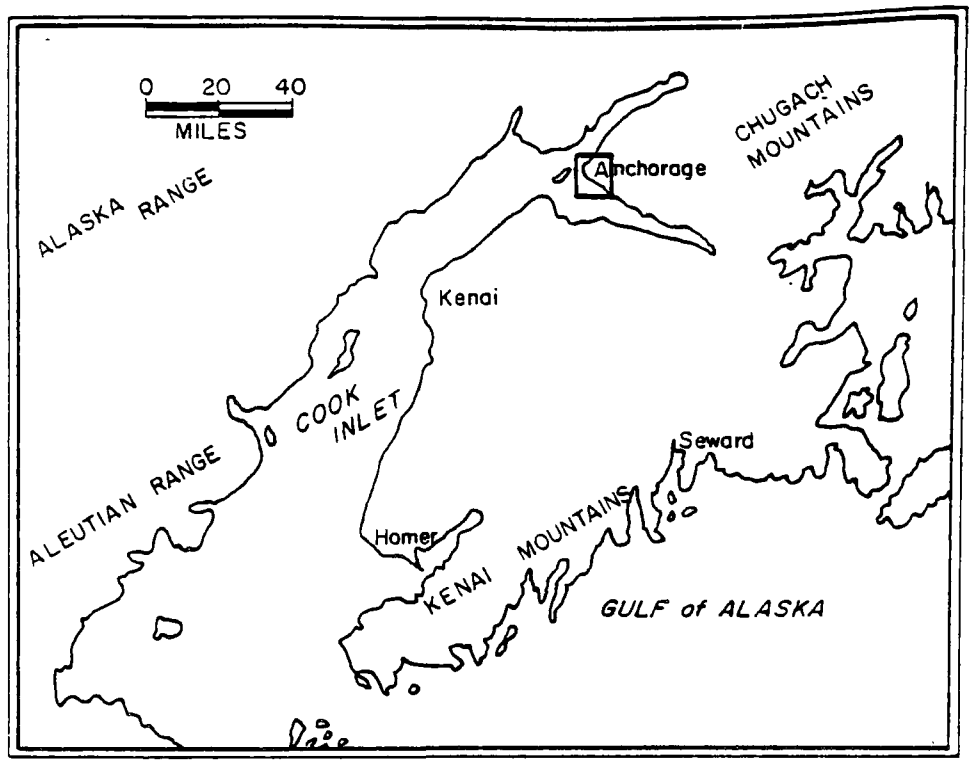
The Draft EIS will be widely circulated by U. S. EPA for public comment, and a public hearing will be held to solicit public response. The results of the public meetings and hearings and any written comments received will be presented in the Final EIS. Final U. S. EPA action concerning the grant award to the MOA will be made following the comment period on the Final EIS.

Study Area Characteristics

Physical Location

Anchorage is located in south central Alaska, at the head of Cook Inlet on a lowland shelf dividing the Knik Arm and the Turnagain Arm (Figure 1-1). The City of Anchorage and its immediate surrounding suburban area is referred to in this EIS as the Anchorage Bowl area, due to the presence of the Chugach Mountains on the east and marine waters on the south, west and north. The area, comprising approximately 240 square miles, slopes gently downward from the Chugach foothills immediately east of the city to a general elevation of 80 feet above sea level. The entire lowland is separated





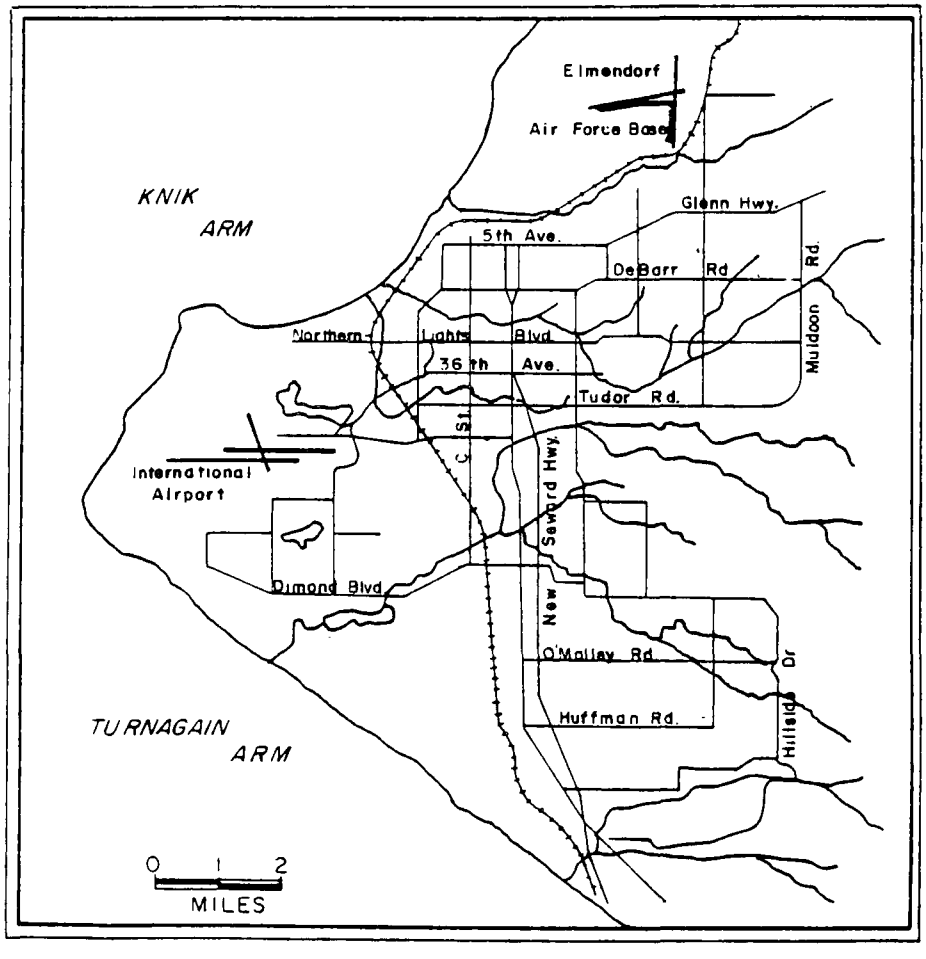


Figure 1-1. Location Map

from the sea by steep bluffs, and only along the valley of major streams does the land approach sea level with a gentle gradient. This topography is consistent in the Bowl area, except at the extreme west tip where a ridge of hills with elevations reaching 300 feet extends from Point Campbell to Point Woronzof.

The study area for this EIS is bounded by the northern limits of the military reservations (Elmendorf Air Force Base and Fort Richardson), Chugach State Park and Cook Inlet.

Climate in the Cook Inlet region is transitional between the maritime and continental regimes, and consequently is variable. Weather conditions may also vary substantially from point to point within the Anchorage Bowl area due to the many geographic factors in the local area. Temperatures average from 18°F during the winter to 65°F in summer, with occasional periods of more extreme temperatures. The maximum temperature ever recorded at Anchorage International Airport is 86°F; the lowest ever recorded is -38°F (Environmental Atlas 1972). Average annual precipitation at Anchorage International Airport is 14.7 inches with an annual average snowfall of 75.1 inches. The Anchorage Bowl area receives from 13-20 inches precipitation annually. Heaviest precipitation is in July and August when the wind direction is generally from the southwest. Prevailing winds are from the north, with an average velocity of 6.5 miles per hour.

Prior to the establishment of Anchorage in 1914 as a railroad camp, the Anchorage Bowl was characterized by birch forest and muskeg bogs around numerous small lakes and ponds. Moose were common, especially in winter, and salmon were abundant in Ship Creek, Fish Creek, Campbell Creek, and Rabbit Creek.

Population

According to the 1980 census, the population of the MOA was 174,431 (Table 1-1). Approximately 79 percent of the population lives in the Anchorage Bowl area. The balance of the population lives in Eagle River/Chugiak/Eklutna, Turnagain Arm areas or on Elmendorf Air Force Base and Fort Richardson Military Reservation. The Anchorage economy depends on wholesale and retail trades; transportation, construction and utility services; government employment; oil production; service industries; and tourism. The construction industry causes a seasonal flux in both the local economy and population.

Table 1-1

Current and Projected Population:
Municipality of Anchorage

	1980 Census	2000 Projection
Anchorage Bowl (includes Hillside)	143,451	258,501
Military	17,499	17,499
Eagle River/Chugiak/Eklutna	12,835	36,066
Turnagain Arm	656	6,300
Municipality of Anchorage	174,431[1]	318,366[2]

[1]Source: U.S. Bureau of Census
[2]Source: Institute of Social and Economic Research

SOURCE: Hillside Wastewater Management Plan Technical Report . . ., MOA 1982.

Past Growth

The MOA experienced rapid growth during the early and mid-1970s. According to Anchorage School District figures, the population peaked around 181,500 in 1978 and then sharply declined for a brief period during 1979 and 1980. The population is currently on the rise and is apparently at its highest (182,429 in 1981), based on school enrollment figures (Schaedel pers. comm.). The rapid growth of the early and mid-1970s reflected statewide growth trends, largely in response to the trans-Alaska pipeline project. Once the pipeline was completed many residents returned to the lower 48 states, causing the dip in population in the late 1970s.

Comprehensive development plans, zoning ordinances, capital facilities programming and other factors have served to direct and control past growth in the MOA to various degrees. The 1976 Comprehensive Development Plan Ordinance remains in effect, although a new Comprehensive Development Plan is currently in the approval process.

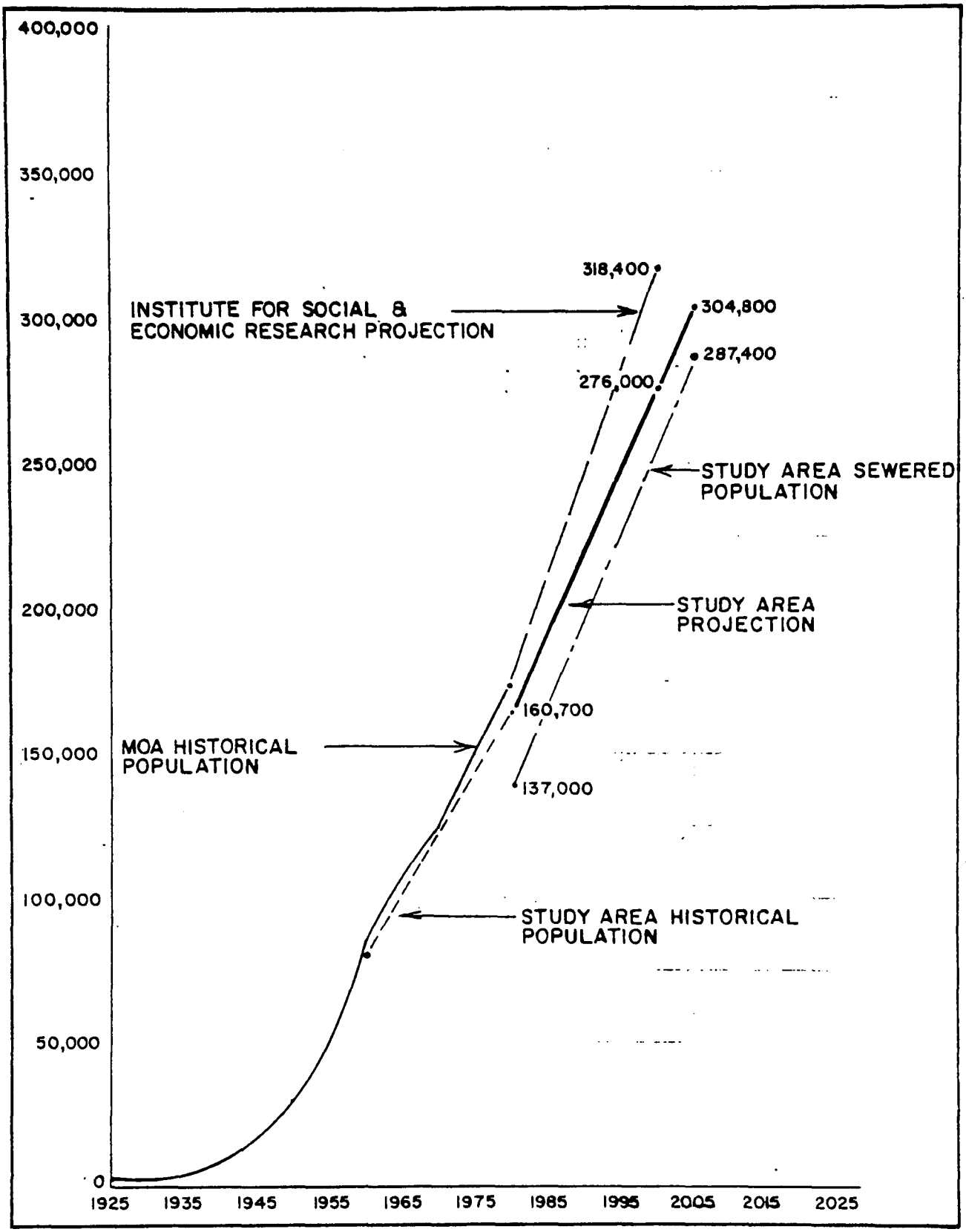
The new Draft MOA Comprehensive Development Plan focuses on the basic issue of growth: its pattern, density and quality (MOA 1982). The plan is intended to guide urban growth, while conserving natural resources and open spaces, reducing potentially harmful environmental conditions, and minimizing the overall costs of public services and facilities to the community. The Draft Comprehensive Development Plan's land use maps and the zoning ordinance will establish the use that may be made of the land within the MOA's boundaries. The uses designated reflect a general policy of concentrating urban growth in areas that have already seen some development and limiting of population density in more rural areas.

The adopted Wetlands Management Plan and Hillside Wastewater Management Plan also control growth. The wetlands plan designates development and preservation categories for most wetland areas of the Anchorage Bowl. The Hillside wastewater plan designates much of the Hillside area for on-site sewage disposal systems, thereby limiting development densities.

Capital facilities programming also influences urban growth patterns. The annual capital improvement program is intended to be consistent with the Comprehensive Development Plan. The latter identifies general areas of urban growth and the capital improvement program schedules those facilities and services necessary to support the land use patterns.

Coastal zone regulations enacted pursuant to the federal Coastal Zone Management Act of 1977 limit growth in the coastal areas.

Future Growth. The population of the MOA is projected to increase to 318,366 by the year 2000 (Figure 1-2). The additional growth from 1980 to the end of this century is anticipated to be over 143,935 people, nearly a doubling of the population. Most of this growth is predicated upon Anchorage's role as the transportation and service center for outlying areas in Alaska, especially as it relates to exploration and utilization of natural resources. It is difficult to predict what additional impact may result if the state capital and related services are relocated from Juneau to Willow.



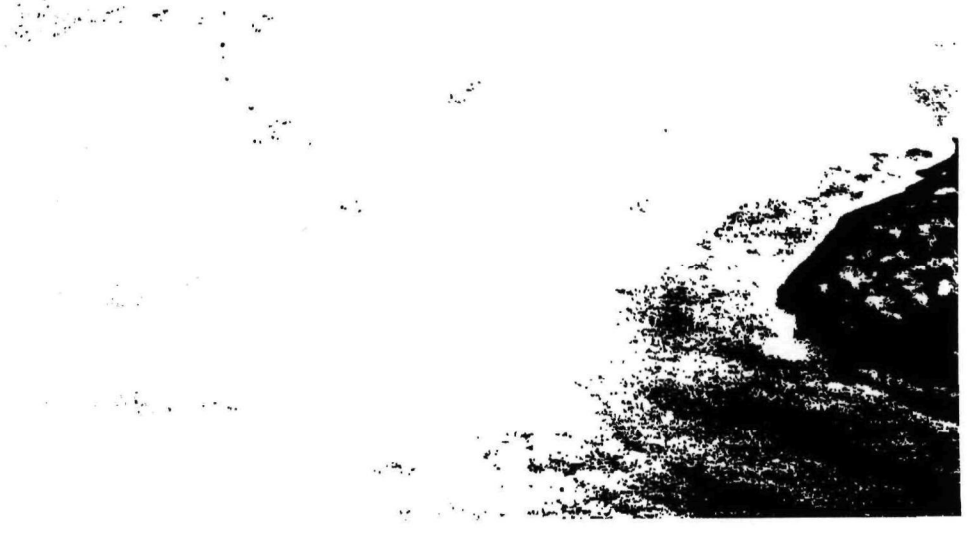
SOURCE: MOA, 1982

FIGURE 1-2. POPULATION PROJECTIONS FOR ANCHORAGE

Chapter 2

Effluent Limitation, the NPDES Permit, and the Existing Sewerage System

- Collection and Interceptor System
- Pump Stations
- Treatment Plant
- Effluent Characteristic



Chapter 2

EFFLUENT LIMITATIONS, THE NPDES PERMIT, AND THE EXISTING SEWERAGE SYSTEM

Public Law 92-500, the Clean Water Act, requires that a National Pollutant Discharge Elimination System (NPDES) permit be issued for each waste treatment facility that discharges to surface waters, fresh and marine. Effluent quality limitations are established for each discharge in its NPDES permit. The Clean Water Act also states that secondary treatment of wastewater is to be implemented by July 1977. The NPDES permit issued for the Point Woronzof Wastewater Treatment Plant (WWTP) requires effluent to meet secondary quality at the levels indicated in Table 2-1.

However, permission was granted by EPA by a letter attached to the NPDES permit (AK-002255-1) to continue the discharge of primary effluent. The allowed concentrations are presented in Table 2-2. The letter of permission also requires that discharge flow and pH limits be no different than those set forth in the original NPDES permit.

An amendment to the Clean Water Act (PL 95-217) was passed in 1977 which allows, under Section 301(h), a conditional waiver of the secondary treatment requirement. Waiver approval depends on the demonstration that: a) the existing receiving waters are either ocean or saline, with currents of sufficient strength to ensure rapid effluent dispersion; and b) the EPA must be satisfied that the discharge has no significant environmental impact. The MOA has applied for and received tentative approval of a waiver under Section 301(h), but as of October 1982 it had not been issued.

The effluent must not cause the receiving water to exceed the State water quality standards established in Chapter 70 of Title 18 (18 ACC70). These standards reflect known or potential beneficial uses of the Knik Arm and impose strict regulations on the quality of waters used publicly or privately. The Alaska Department of Environmental Conservation (ADEC) will allow criteria for effluent-receiving waters to be exceeded within a prescribed boundary known as the "mixing zone." However, these standards must be met outside the specified mixing zone boundaries.

The waters of the Knik Arm are designated as marine waters, supporting all protected marine uses. A summary of applicable water quality standards with requirements for

Table 2-1. NPDES Effluent Limitations for Point Woronzof, Based on Secondary Requirements[1]

Effluent Characteristics	Unit of Measurement	Monthly Average	Weekly Average
Effluent Concentrations			
Biochemical Oxygen Demand (5-day)	mg/l	30	45
Suspended Solids	mg/l	30	45
Effluent Loadings			
Biochemical Oxygen Demand (5-day)	kg/day (lb/day)	3,867 (8,500)	5,800 (12,760)
Suspended Solids	kg/day (lb/day)	3,867 (8,500)	5,800 (12,760)

[1] Conditions waived by U. S. EPA letter. See text. Table 202 applies.

Table 2-2. NPDES Effluent Requirements for Point Woronzof WWTP, Based on Primary Treatment

Effluent Characteristics	Unit of Measurement	Monthly Average	Weekly Average	Daily Maximum
Biochemical Oxygen Demand (5-day)	mg/l	120	130	140
Suspended Solids	mg/l	100	115	130
Fecal Coliform Bacteria	Number/100 ml	700	1,500	---

Source: MOA 1982

selected constituents is presented in Table 2-3. The strictest requirement in each column is the governing criterion. For a complete listing of constituents and standards, the reader is referred to the Alaska Water Quality Standards.

Collection and Interceptor System

The first sewers in Anchorage were constructed in 1917. This system, centered in what is now the northern portion of the business district, was expanded south to 16th Avenue by 1948. The earthquake of 1964 severely damaged the collection system, especially the Knik Service Area sewer lines.

Two years later, area-wide sewerage authority was granted to the former Greater Anchorage Borough, and by 1969, Sewer Service Area No. 40 was established. Major interceptors were constructed between 1967 and 1972 to collect the wastewater and transport it to the present location of the Point Woronzof WWTP. Prior to 1972, when the treatment plant became operational, raw sewage was discharged into the Knik and Turnagain Arms of the Cook Inlet.

When the City and Borough of Anchorage were consolidated in 1975 to form the Municipality of Anchorage, the sewer systems were consolidated under the new Anchorage Water and Wastewater Utility (AWWU). The AWWU administers sewerage system planning, construction, operation and maintenance in the Municipality.

Service Areas

The sewerage system is divided into five major drainage or service areas (Figure 2-1) that contain more than 400 miles of sanitary sewers, and 23 pumping stations that contribute flow to Point Woronzof WWTP. Elmendorf AFB and Fort Richardson are not included in these areas, but are tributary to them.

Elmendorf AFB contributes flow to the Municipality's system in the Knik Service Area. Fort Richardson contributes to the Northeast Service Area. Air Force Base flows reach Point Woronzof via the downtown area and the Chester Creek Pump Station, while Fort Richardson flows travel to the Campbell Creek Pump Station near Campbell Lake and are then pumped north to Point Woronzof WWTP.

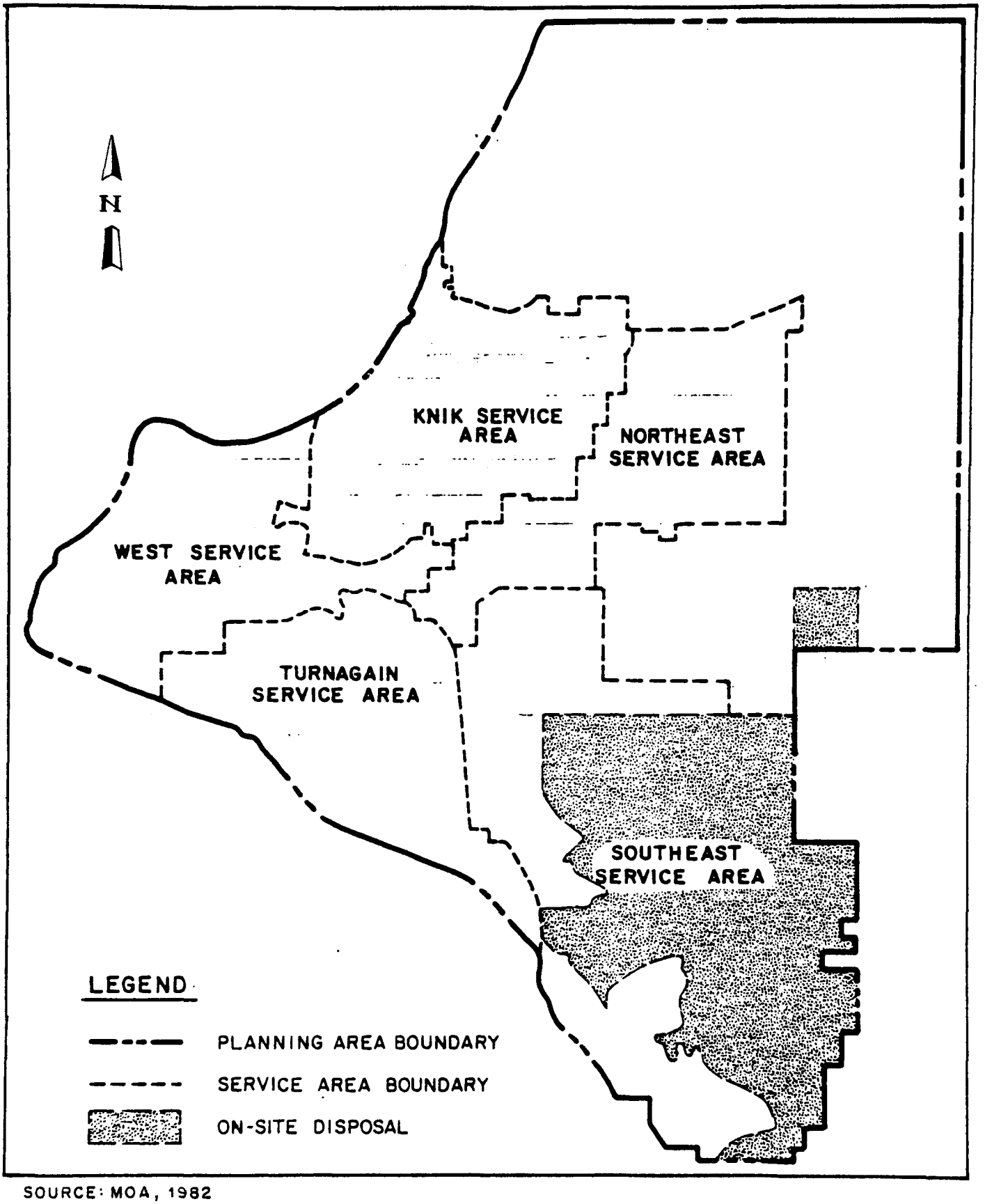
Pump Stations

The study area includes 23 pump stations. Only two of these stations will be described in further detail.

Table 2-3. Summary of State of Alaska Water Quality Standards Applicable to Knik Arm

WATER QUALITY PARAMETERS → / II MARINE WATER USES ↓	FECAL COLIFORM BACTERIA (FC) (See Note 1)	DISSOLVED GAS	pH (Variation of pH for waters naturally outside the specified range shall be towards the range)	TURBIDITY	SEDIMENT	RESIDUES FLOATING SOLIDS, DEBRIS, SLUDGE DEPOSITS FOAM, SCUM
(A) Water Supply (ii) aquaculture	For products normally cooked the mean based on a minimum of 5 samples taken in a period of 30 days shall not exceed 200 FC/100 ml and not more than 10% of the samples shall exceed 400 FC/100 ml For products not normally cooked the mean based on a minimum of 5 samples taken in a period of 30 days shall not exceed 20 FC/100 ml and not more than 10% of the samples shall exceed 40 FC/100 ml	Surface dissolved oxygen (D O) concentrations in coastal water shall not be less than 6 0 mg/l for a depth of 1 meter except when natural conditions cause this value to be depressed D O shall not be reduced below 4 mg/l at any point beneath the surface D O concentrations in estuaries and tidal tributaries shall not be less than 5 0 mg/l except where natural conditions cause this value to be depressed In no case shall D O levels above 17 mg/l be permitted The concentration of total dissolved gas shall not exceed 110% of saturation at any point of sample collection	Shall not be less than 6 5 or greater than 8 5 and shall not vary more than 0 1 pH units from natural condition	Shall not exceed 25 NTU.	No imposed loads that will interfere with established water supply treatment levels.	Shall not alone or in combination with other substances or wastes cause the water to be unfit or unsafe for the use Shall not cause detrimental effects on established water supply treatment levels.
(A) Water Supply (iii) seafood processing	Based on a minimum of 5 samples taken in a period of 30 days mean shall not exceed 20 FC/100 ml and not more than 10% of the samples shall exceed 40 FC/100 ml	D O shall be greater than or equal to 5 mg/l	Shall not be less than 6 0 or greater than 8 5 Shall not vary more than 0 5 pH unit from natural condition	Shall not interfere with disinfection	Below normally detectable amounts	Shall not alone of in combination with other substances make the water unfit or unsafe for use, cause a film, sheen, or discoloration on the surface of the water or adjoining shoreline, cause leaching of toxic or deleterious substances; or cause a sludge, solid, or emulsion to be deposited beneath or upon the surface of the water within the water column, on the bottom, or upon adjoining shorelines
(A) Water Supply (iv) industrial including any water supplies used in association with a manufacturing or production enterprise (other than food processing) including mining, placer mining energy production or development	Where worker contact is present the mean FC bacteria concentration based upon a minimum of 5 samples taken in a period of 30 days shall not exceed 200 FC/100 ml not more than 10% of the samples shall exceed 400 FC/100 ml	Not applicable	Shall not be less than 5 0 or greater than 9 0	Shall not cause detrimental effects on established levels of water supply treatment	No imposed loads that will interfere with established water supply treatment levels.	Shall not alone or in combination with other substances or wastes cause the water to be unfit or unsafe for the use
(B) Water Recreation (i) contact recreation	Based on a minimum of 5 samples taken in a 30 day period the mean shall not exceed 20 FC 100 ml and not more than 10% of the samples shall exceed 40 FC/100 ml	Same as (2)(A)(i)	Shall not be less than 6 5 or greater than 8 5 If the natural pH condition is outside this range substances shall not be added that cause a increase in buffering capacity of the water	Shall not exceed 25 NTU	No measurable increase in concentrations above natural conditions.	Shall not alone or in combination with other substances make the water unfit or unsafe for use; cause a film, sheen, or discoloration on the surface of the water or adjoining shoreline; cause leaching of toxic or deleterious substances, or cause a sludge, solid, or emulsion to be deposited beneath or upon the surface of the water, within the water column, on the bottom, or upon adjoining shorelines.
(B) Water Recreation (ii) secondary recreation	Based on a minimum of 5 samples taken in a 30 day period the mean shall not exceed 200 FC/100 ml, and not more than 10% of the samples shall exceed 400 FC/100 ml	Same as (2)(A)(i)	Shall not be less than 5 0 or greater than 9 0	Shall not exceed 25 NTU	Shall not pose hazards to incidental human contact or cause interference with the use.	Shall not alone or in combination with other substances make the water unfit or unsafe for use; cause a film, *sheen, or discoloration on the surface of the water or* adjoining shoreline, cause leaching of toxic or deleterious substances; or cause a sludge, solid, or emulsion to be deposited beneath or upon the surface of the water, within the water column, on the bottom, or upon adjoining shorelines.
(C) Growth and Propagation of Fish, Shellfish Aquatic Life, and Wildlife Including Seabirds, Waterfowl and Furbearers	Not applicable	Same as (2)(A)(i)	Shall not be less than 6 5 or greater than 8 5, and shall not vary more than 0 1 pH unit from natural condition	Shall not reduce the depth of the compensation point for photosynthetic activity by more than 10%. In addition, shall not reduce the maximum secchi disk depth by more than 10%	No measurable increase in concentrations above natural conditions	Shall not alone or in combination with other substances or wastes cause the water to be unfit, unsafe or cause acute or chronic problem levels as determined by bioassay or other appropriate methods. Shall not alone or in combination with other substances cause a film, sheen, or discoloration on the surface of the water or adjoining shorelines; cause leaching of toxic or deleterious substances, or cause a sludge, solid, or emulsion to be deposited beneath or upon the surface of the water, with the water column, on the bottom, or upon adjoining shorelines
(D) Harvesting for Consumption of Raw Mollusks or Other Raw Aquatic Life	Based on a 5 tube decimal dilution test the fecal coliform median MPN shall not exceed 14 FC/100 ml, not more than 10% of the samples shall exceed a FC MPN of 43 FC/100 ml (See Note 15)	Same as (2)(A)(i)	Shall not be less than 6 0 or greater than 8 5 Shall not vary more than 0 5 pH unit from natural condition	Same as (2)(C)	Not applicable	Shall not make the water unfit or unsafe for use, cause a film, sheen, or discoloration on the surface of the water or adjoining shoreline, cause leaching of toxic deleterious substances, or sludge, solid, or emulsion to be deposited beneath or upon the surface of the water, within the water column, on the bottom, or upon adjoining shorelines

Source: ADEC 1979



SOURCE: MOA, 1982

FIGURE 2-1. SEWER SERVICE AREAS

In 1972, the Chester Creek and Campbell Creek Pump Stations were put on-line. These stations, the largest in the system, transport between 70 and 90 percent of the wastewater flow received at the Point Woronzof WWTP. Sewage from nearly all of the Knik Arm Service Area, Elmendorf AFB, central business district and the Spenard area discharges to the Chester Creek Pump Station, located near the mouth of Chester Creek at the Alaska Railroad. The force main discharging from the Chester Creek Pump Station discharges to large-diameter gravity sewers near Northern Lights Boulevard and then flows west to Point Woronzof.

The Campbell Creek Pump Station serves the Northeast, Southeast and much of the Turnagain service areas. Most flows reach the pump station through an aging corrugated metal pipe that parallels Campbell Creek. This interceptor is overloaded, and occasionally spills raw sewage to Campbell Creek near the Alaska Railroad. The pump station is located near the mouth of Campbell Creek, and pumps sewage north and east to gravity sewers near the Minnesota Bypass and south of Raspberry Road. These gravity sewers flow north, joining flows from the rest of Anchorage and flowing west to the Point Woronzof WWTP.

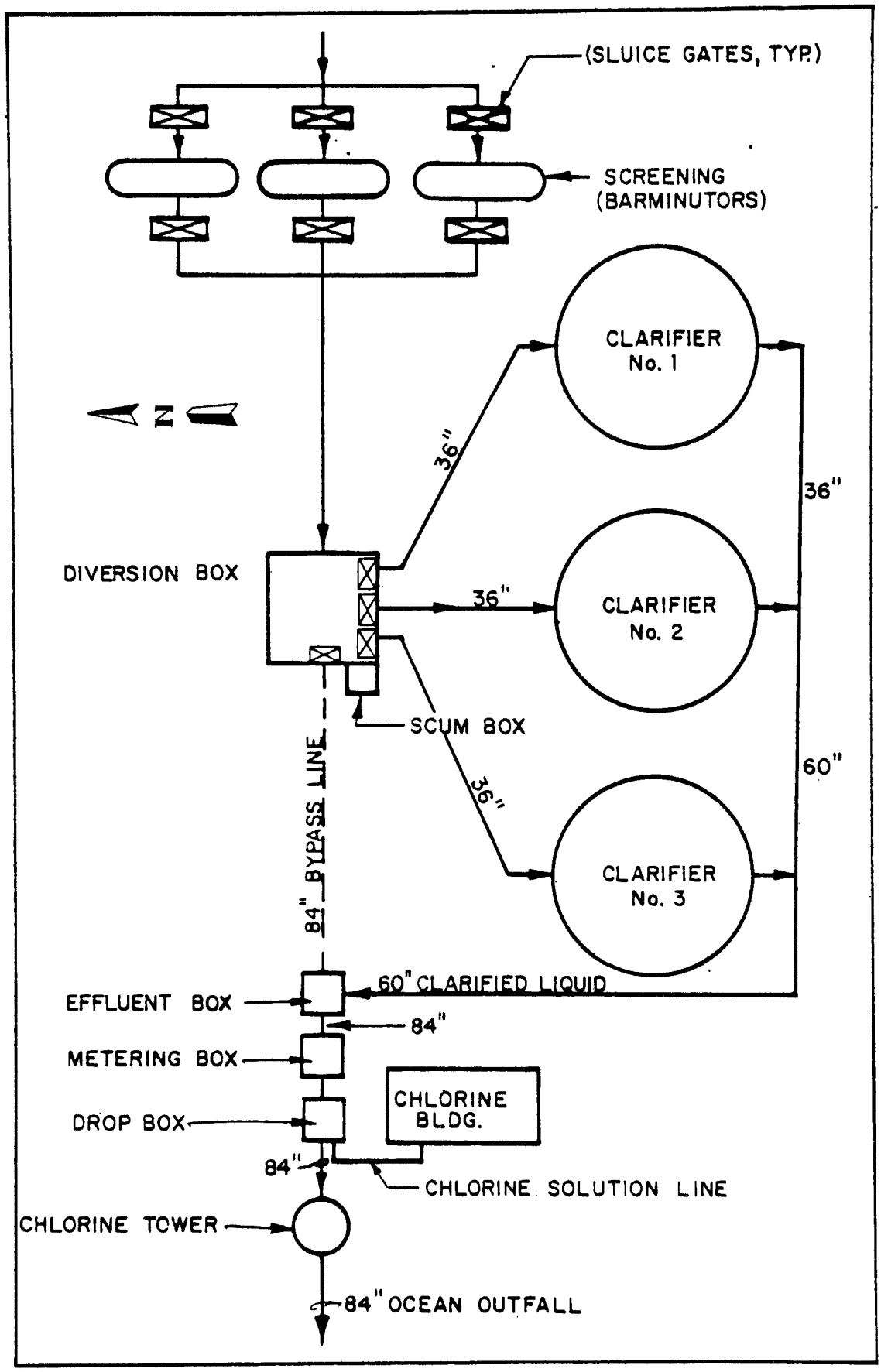
Point Woronzof Wastewater Treatment Plant

The John M. Asplund Wastewater Treatment Plant, commonly referred to as the Point Woronzof WWTP, has been in service since July 1972. The facility operates as a primary treatment plant and was designed for a population of approximately 221,000. Current population projections indicate that this design population will be exceeded before the year 1995, and evaluation of the plant operation indicates it is incapable of adequately treating sewage from that population.

A brief description of the Point Woronzof WWTP plant, including the improvements constructed in the summer of 1982, follows. The treatment process is discussed; the liquid and solid processes are discussed in separate subsections.

Liquid Process

A 96-inch influent pipeline enters the plant, and its flow is divided between three Barminutors which cut up the solids in the wastewater (Figure 2-2). These solids are then screened, mechanically removed, and sent to the hammermill for grinding, and then incinerated. The wastewater is cleaned of grit (sand, gravel), prechlorinated and distributed to three primary clarifiers. Here, the sludge is settled out, and the scum (greases and oils) are skimmed off. The wastewater then flows to a metering box, where flow amounts are recorded, and on to a drop box.



SOURCE MOA, 1982

FIGURE 2-2. SCHEMATIC OF POINT WORONZOF WWTP LIQUID PROCESS

Chlorine, which destroys fecal coliform and other microorganisms, is automatically injected into the drop box. The chlorinated effluent flows 3,200 feet through an 84-inch pipe to the control tower. The flow is surcharged, slowing the velocity and increasing contact time between the chlorine and the effluent (about 38 minutes at 34 mgd). The effluent is discharged into the Knik Arm of Cook Inlet through an 804-foot-long, 84-inch-diameter ocean-outfall pipe.

Solids Processing

The sludge and scum separated from the wastewater in the clarifiers are transferred to two thickeners by raw sludge pumps (Figure 2-3). Before entering the thickeners, grit is removed by the classifier and hydrocyclone, and is trucked off to the Merrill Field sanitary landfill. In the thickener, further gravity settling separates sludge from excess water. Sludge is then pumped to the dewatering facilities where more water is removed by a belt filter press. Dewatered sludge is conveyed into a multiple hearth incinerator and is burned. Ash from the incinerator is transported to a sanitary landfill. The water extracted from the sludge by the thickener enters the wastewater stream at the diversion box, while the wastewater from the dewatering process flows back to the screening room at the head of the plant.

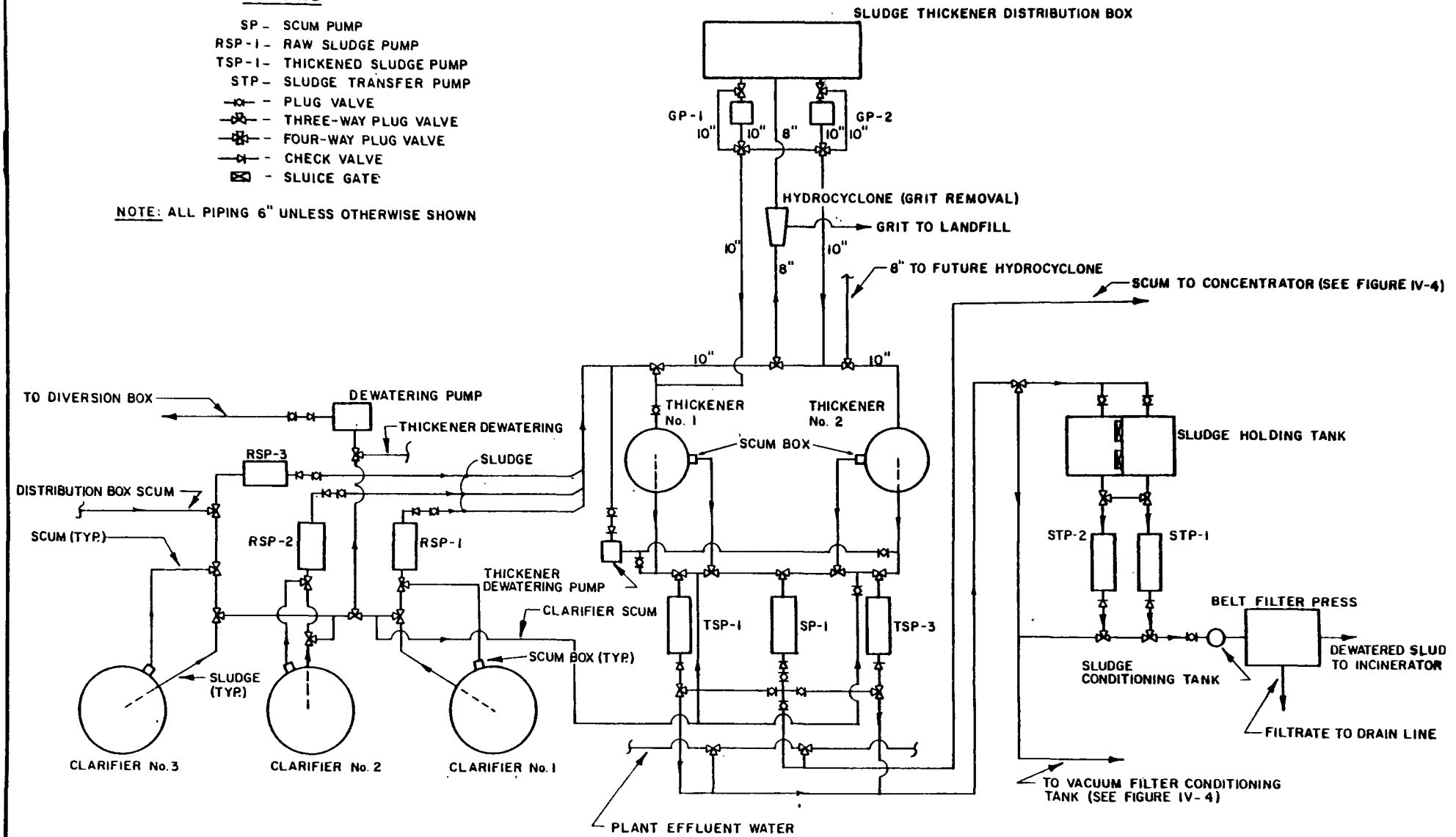
Scum from the clarifier can be pumped to the belt filter press for dewatering or to a screen incinerator contained in the incinerator building. Surplus is returned to the liquid process at the screening room.

Auxiliary Facilities

At this time, 51 employees, including operators and maintenance staff, oversee the operation of Point Woronzof WWTP (Table 2-4). A lab located in the administration building, a maintenance shop, and control room located in the solid processing building complement the wastewater treatment facilities.

Effluent Characteristics

The effluent flows through an 804-foot, 84-inch ocean outfall and is discharged into the Knik Arm of the Cook Inlet. Monthly characteristics of the effluent compared to current



SOURCE: MOA, 1982

FIGURE 2-3. SCHEMATIC OF POINT WORONZOF WWTP SOLIDS PROCESS

Table 2-4. Summary of Existing O&M Staff at Point Woronzof WWTP

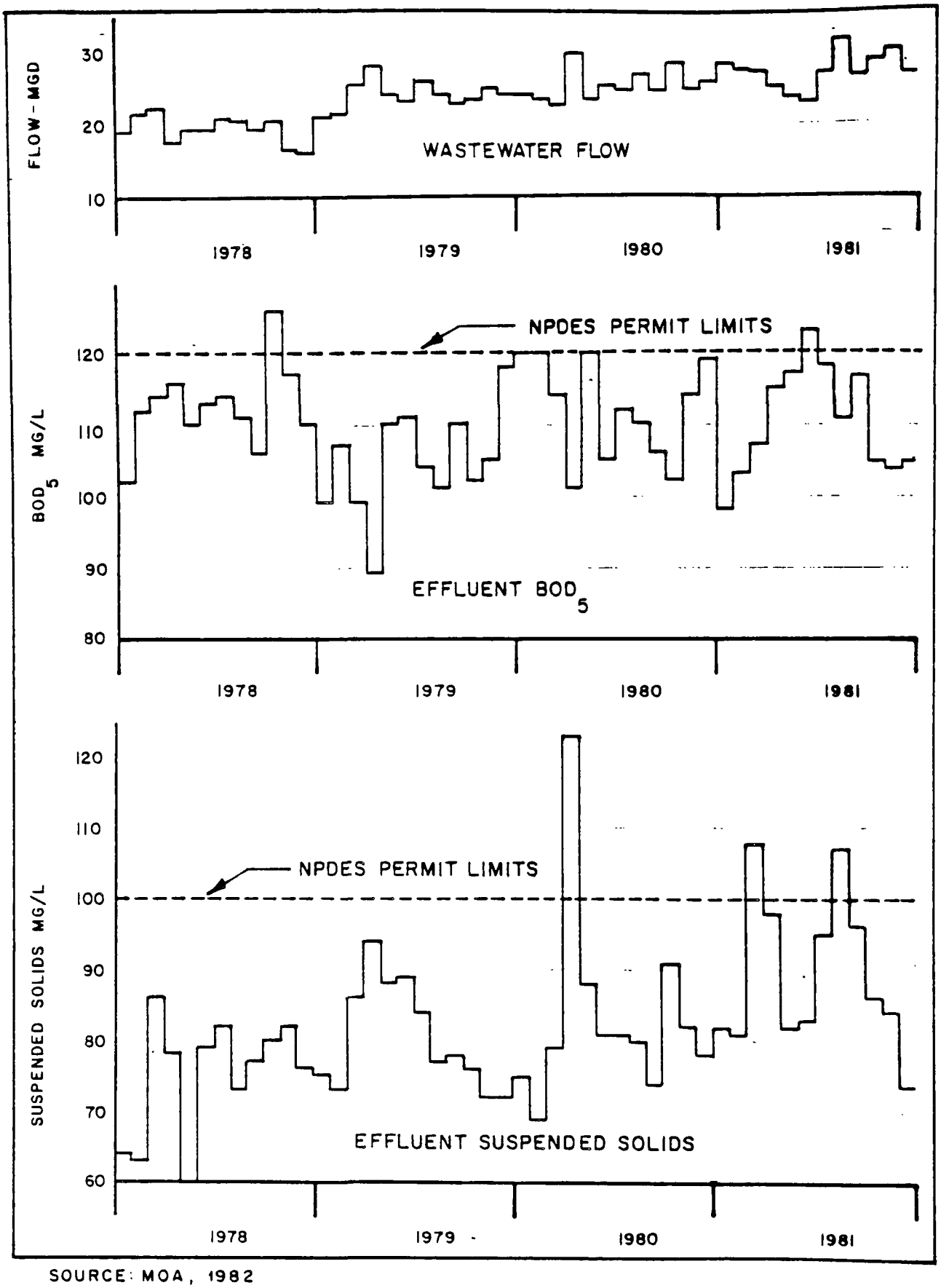
Classification	Number Employed
Superintendent	2
General Foreman	2
Maintenance Foreman	4
Operation Foreman	4
Senior Operator	4
Operator II	8
Operator I	5
Instrument Electrician	4
Machinist	1
Mechanic Welder	1
Mechanic Leadman	1
Journeymen Craftsman	1
Mechanic	1
Utility Man II	4
Building Superintendent	1
Lab Supervisor	1
Lab Analyst	1
Lab Assistant	1
W.Q. Tech. I/2	2
Clerical	1
Expediter	1
Warehouseman	1
TOTAL	51

NPDES limits are shown in Figure 2-4. BOD_5, TSS, and fecal coliform levels have at times exceeded NPDES limits. These occurrences are generally linked to seasonal flows as well as long-term increases in wastewater flows between 1978 and 1981. TSS concentrations typically exceed NPDES limits during spring breakup, while higher BOD_5 concentrations occur during low flow periods. NPDES fecal coliform violations generally occur when the residual chlorine content of the effluent falls below 1.0 mg/l.

Table 2-5 depicts average yearly effluent concentrations and removal efficiencies for BOD_5 and TSS. As wastewater flows have increased, removal efficiencies have declined. This is mostly due to the overloading of the clarifiers.

To determine the design requirements for future expansion, extensive evaluation of the primary clarifiers was undertaken. The clarifiers were designed for a maximum overflow rate (the rate at which water is drawn from clarifiers) of 1,000 gallons per day per square foot (gpd/sf) yielding a design flow of 34 million gallons per day (MGD). Past operation records indicate that current NPDES effluent limits can only be met if retention time of wastewater within the clarifiers is increased; the flow rate must be reduced to 660 gpd/sf, yielding a design flow on only 22.2 MGD.

It is apparent that violations will continue, depending on seasonal flows and population growth. The frequency of violations is expected to increase, although the 1982 modifications should provide some improvements in treatment. Obviously, in the event that Section 301(h) is not granted and the secondary treatment NPDES permit goes into effect, continual violations of the permit will occur until expansion and upgrading can occur.



SOURCE: MOA, 1982

FIGURE 2-4. COMPARISON OF EFFLUENT QUALITY TO NPDES PERMIT LIMITS

Table 2-5. Yearly Average Effluent Concentrations

Year	BOD_5		TSS	
	Concentration mg/l	Percent Removed	Concentration mg/l	Percent Removed
1972	110	30	78	60
1973	72	48	74	62
1974	58	41	69	53
1975	68	29	70	38
1976	98	20	62	45
1977	107	21	77	45
1978	113	25	77	47
1979	105	17	80	39
1980	112	20	83	39
1981	110	21	89	42

Source: Wastewater Facilities Plan for Anchorage, Alaska AWWU, June 1982

Chapter 3

Alternatives for Wastewater Collection, Treatment and Disposal

- Introduction
- Recommended Plan
- Range of Alternatives
- Description of Alternatives
- Cost Summary

Chapter 3

ALTERNATIVES FOR WASTEWATER COLLECTION, TREATMENT AND DISPOSAL

Introduction

The description and comparison of project alternatives in the preparation of an EIS must follow specific regulations of the CEQ as contained in 40 CFR, Part 6 as published in the Federal Register, Vol. 43, November 29, 1978 and of the EPA as contained in the Federal Register, Vol. 44, No. 216, November 6, 1979. The comparative evaluation should include an analysis of the environmental impacts, commitments of resources, costs and societal risks associated with each alternative. The reasons why a proposed alternative management system is finally selected must also be explained in detail. This section contains a description of the alternatives considered for the MOA wastewater facilities expansion and evaluations relative to cost and engineering considerations.

The information on which much of the following discussion is based is contained in the document entitled Wastewater Facilities Plan for Anchorage, Alaska dated June 1982. This report was prepared for the MOA by a joint venture of Ott Water Engineers, Inc., Quadra Engineering, Inc. and Black and Veatch Consulting Engineers, and it comprises the majority of the MOA Section 201 facilities plan. The remainder of the section 201 facilities plan is the Hillside Wastewater Management Plan developed by the MOA Planning Department, with contract assistance from Arctic Environmental Engineers. The two documents taken together comprise the combined facilities plan that is the subject of this EIS.

There are important differences between components of the plan. During initial planning, the service area was divided into two portions: the Hillside area, and the remainder of the Anchorage Bowl. The preparation of the Hillside Wastewater Management Plan (MOA 1982) was undertaken with Section 208 funding to address sewerage needs of the Hillside area with an emphasis on continuing on-site sewerage disposal and preserving a rural lifestyle in the study area.

The plan identifies areas of the Hillside that are to be served by on-site treatment and disposal systems (such as septic tanks with drain fields), areas to be served by sewers, and areas unsuitable for on-site systems where no

sewer systems are to be provided (although on-site systems may be allowed). The Wastewater Facilities Plan for Anchorage, Alaska (MOA, 1982) recognizes the determinations for these areas and proposes sewage collection, treatment and disposal systems serving the portion of the Hillside area designated for sewerage in the Hillside plan. It also encompasses expansion of sewage collection, treatment and disposal facilities for the rest of the Anchorage Bowl.

The combined facilities plan describes an areawide sewerage facilities expansion program serving the Anchorage Bowl and extending over a 20-year period. It encompasses:

- o Alternatives for expansion of Point Woronzof WWTP;
- o Extension of the existing outfall by 1,500 feet;
- o Study of adding a diffuser at the end of the extended outfall;
- o Alternatives for disposal of sludge solids from the treatment process;
- o Alternatives for construction of the West Bypass interceptor sewer;
- o Construction of the Southeast interceptor sewer, including sewerage alternatives in the Rabbit Creek-Potter Creek area;
- o Provisions for on-site sewerage of a portion of the Hillside area;
- o Construction of about 70 sewer improvement projects through 1998.

The facilities plan sets forth a MOA-recommended plan, suggesting implementation of specific alternatives.

For EIS purposes the above project alternatives, except for the 70 sewer improvement projects, are evaluated in detail in the EIS. The 70 sewer improvement projects are addressed only with specific reference to wetland impacts and in general terms relative to cumulative impacts. The Recommended Plan is presented and analyzed in greater depth, with alternatives analyzed in sufficient detail to provide a full perspective of the consequences of alternative actions.

Chapter 3 includes descriptions of the Recommended Plan and alternatives as summarized from the facilities plan. The Recommended Plan is described first; followed by a brief

overview of the range of alternatives considered in the planning process, a discussion of the screening of alternatives, and a description of all alternatives evaluated in the facilities plan. The chapter is concluded with cost-effectiveness evaluations of all alternatives.

Service Area

The area to be served by facilities proposed in the facilities plan consists of the Anchorage Bowl, including lands west of Chugach State Park, Elmendorf Air Force Base, and Fort Richardson (Figure 2-1). It excludes all portions of the MOA outside of this area, such as Eagle River, Chugiak and Eklutna. The area was selected as the area that can logically be served by the Point Woronzof wastewater treatment plant.

Planning Constraints

A variety of federal and state laws and regulations and local conditions impose constraints on the facilities planning process. Regulations promulgated by EPA pursuant to the Clean Water Act of 1977 are primary constraints. These regulations (40 CFR Part 35) set forth in detail requirements for obtaining federal funding for WWTPs. Other regulations and requirements in effect during development of the MOA facilities plan are summarized in the EPA publication Facilities Planning 1981, Municipal Wastewater Treatment.

EPA requires that the planning period for the facilities plan be 20 years, meaning that the alternatives proposed in the facilities plan must provide sufficient capacity to meet the needs for 20 years following project inception, although phased implementation is permissible. The alternatives must include the no-action alternative, and evaluation of all alternatives is required from economic, environmental, reliability and public interest aspects. Many other requirements apply and are outlined in the 1981 publication referenced above.

State laws and regulations govern effluent quality and discharge, establishing a minimum performance level for the treatment plant and outfall. Other state and local constraints described in Chapter 2 of this EIS influence the planning process and the allowable range of alternatives evaluated in the plan.

Recommended Plan

The Wastewater Facilities Plan for Anchorage, Alaska (MOA June 1982) and the Hillside Wastewater Management Plan (MOA May 1982) together set forth an area-wide Recommended Plan for wastewater collection, treatment and disposal in the Anchorage Bowl. The Hillside plan, which designates areas for sewerage, on-site sewage disposal systems, and no sewerage service (generally unsuitable for on-site systems), was adopted by the Municipal Assembly on May 18, 1982. This is considered a Recommended Plan in the context of EIS analyses. The Wastewater Facilities Plan for Anchorage, Alaska acknowledged the adopted Hillside plan and includes sewerage service to the areas so designated in that plan. The wastewater facilities plan also evaluates alternatives in the remainder of the Anchorage Bowl and presents a Recommended Plan selected from those alternatives.

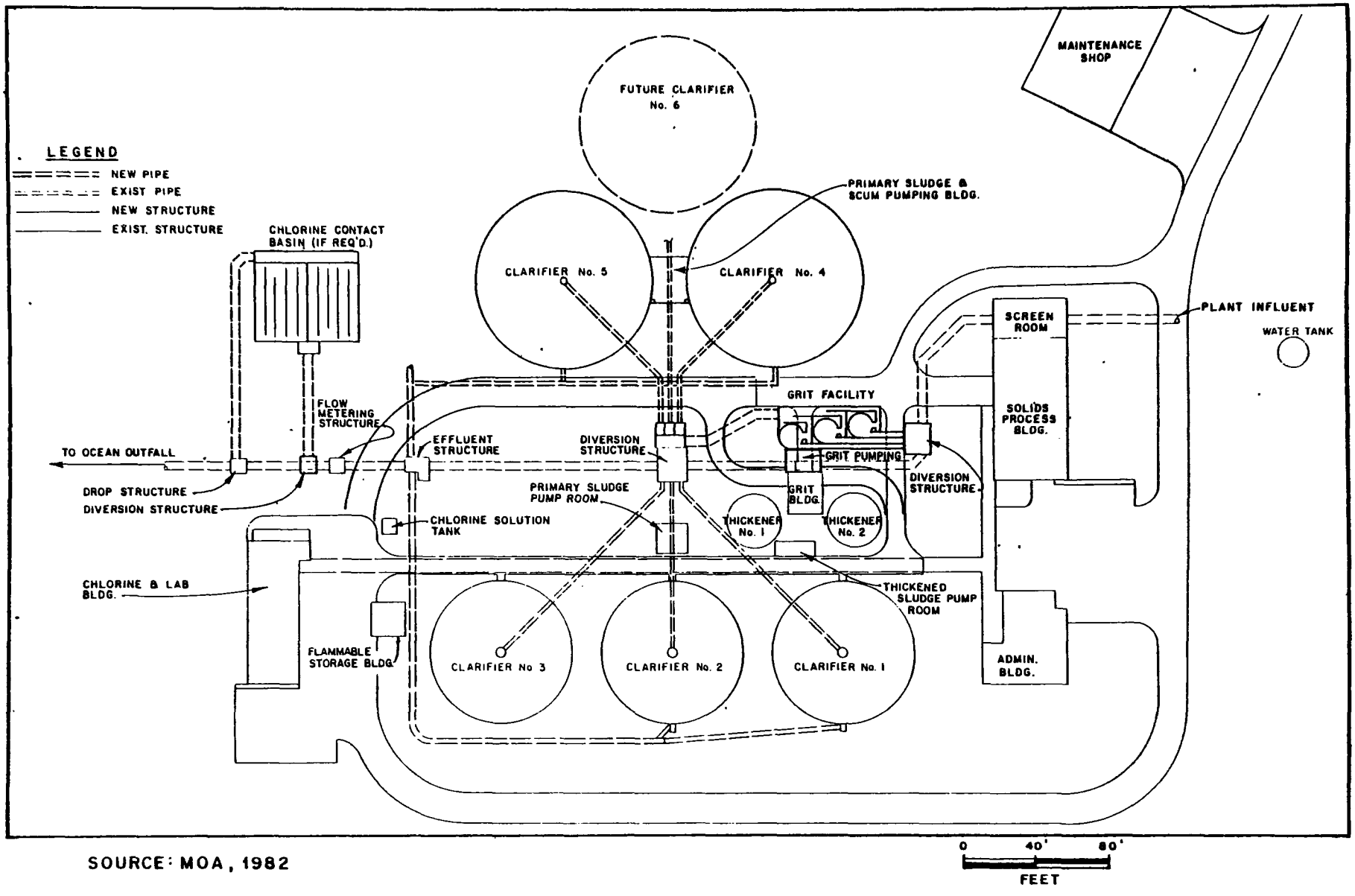
The Recommended Plan for providing wastewater collection, treatment and disposal is described in this section. The expansion of the Point Woronzof treatment plant is described first, followed by the outfall and diffuser, major interceptor sewers, the Hillside sewerage plans, and the remaining sewer improvement projects.

The Point Woronzof WWTP would be expanded from its current effective capacity of 22 MGD annually to 58 MGD (average annual flow). (Current design capacity is 34 MGD, although the plant cannot meet discharge requirements at a design flow rate over 22 MGD.) This expansion would be achieved through construction of three additional primary clarifiers, modification of other portions of the liquid processing to increase capacity (Figure 3-1), addition of another sludge incinerator to the solids process (Figure 3-2), and consideration of alternative disposal methods for incinerator ash. These improvements are described below in the order of the treatment process.

Liquid Processing

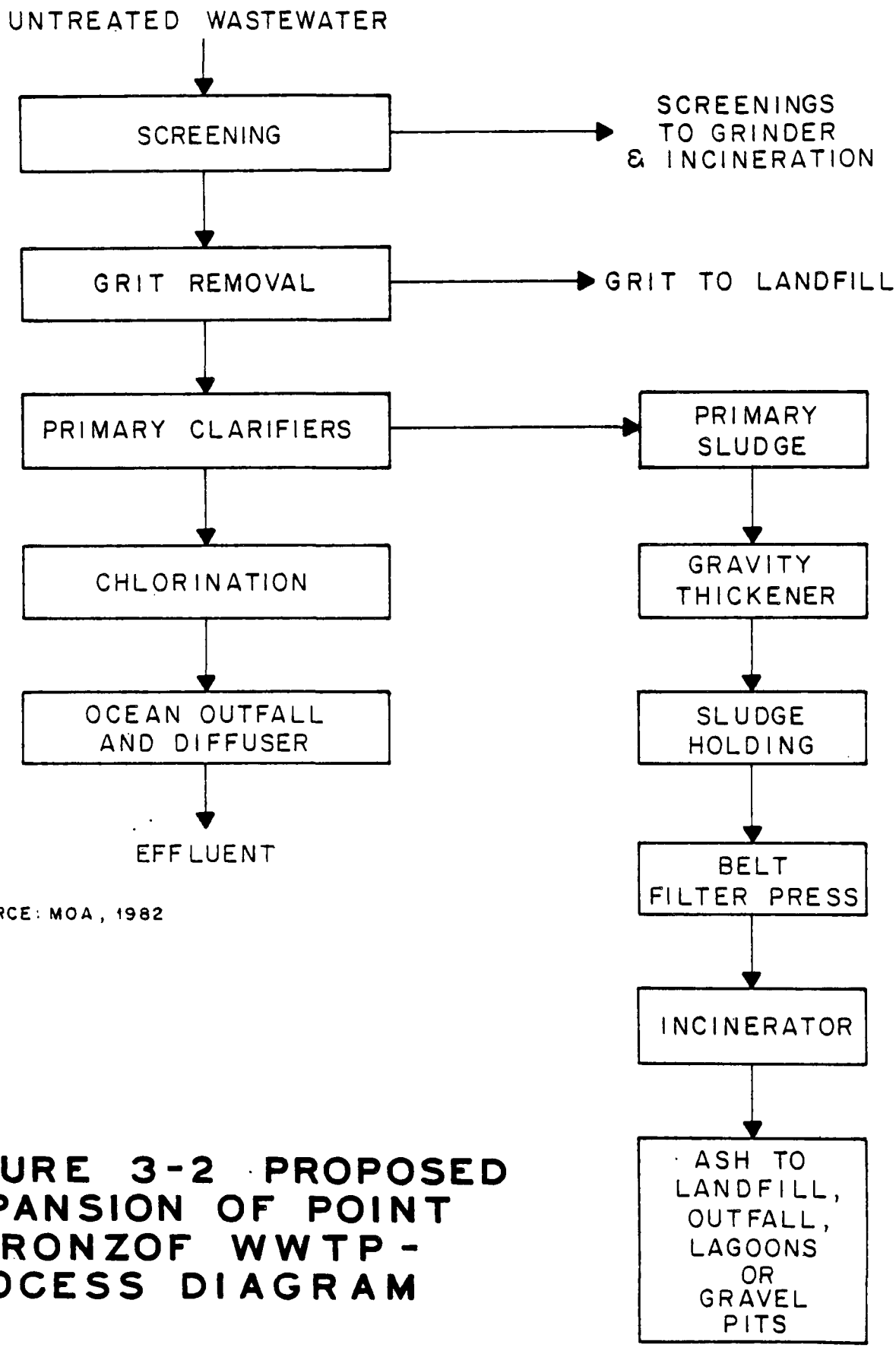
Minor construction in the headworks will be necessary for safe and efficient operation of the screen room. The door and window opening into the solids processing building will be replaced with a solid wall. Special electrical fixtures will be installed in areas where hazardous gasses accumulate, and the existing fixtures will be inspected to ensure compliance with the National Electrical Code.

During peak flow periods (usually spring breakup) grit is washed from the collection system into the clarifiers. The accumulated grit forms deposits on the sludge scraper rotors, interferes with scraper operation, and must be cleaned off manually. Clarifier effluent is adversely affected by



SOURCE: MOA, 1982

FIGURE 3-1. PROPOSED EXPANSION OF POINT WORONZOF WWTP - SITE LAYOUT



SOURCE: MOA, 1982

FIGURE 3-2 PROPOSED EXPANSION OF POINT WORONZOF WWTP - PROCESS DIAGRAM

excessive grit. A grit removal system will be installed prior to clarification to eliminate this problem. Three units (two functioning, one standby) and a diversion box will be installed.

As discussed in Chapter 2 and above, current effluent limits cannot be met consistently unless the overflow rate of the clarifier is limited to 660 gpd/sf. This overflow rate would yield only 22 MGD processing capacity. Three additional 150-foot clarifiers would provide an additional 35.5 MGD capacity. At this time, only two are necessary, but by 1995, the third clarifier may be required. Alterations in effluent permit limits, wastewater strength, or variations in the efficiency of treatment facilities may postpone or accelerate the need for the third clarifier. Modifications to the existing flow diversion box will be required to direct influent to the proposed clarifiers.

The propeller meter control section at the metering box may be enlarged to provide for increased flows. Replacement or overhaul of the propeller meter would be accomplished if necessary.

Four constant-speed raw sludge pumps will be added, three for the proposed clarifiers, and one as a standby to simplify sludge pumping and reduce costs.

Replacement of the existing chlorine feed system is recommended by the facilities plan. Pre-chlorination would require a 5,000 lb/day feeder, while combined pre- and post-chlorination require a 16,000 lb/day system. The combined feed system is recommended in the plan.

Solids Processing

Sludge thickener No. 1 will be renovated. The two thickeners will have sufficient capacity until 2005. Two additional belt filter presses for sludge dewatering would be installed to provide adequate sludge dewatering capacity past 1990.

A larger multiple-hearth incinerator will be installed to increase solids handling capacity and to provide needed standby capacity. A heat recovery system will be installed with the new incinerator that will be adapted to the present hot water recovery system. The system will provide heat for the treatment plant.

Two new scum pumps and solids grinders will be added to prevent plugging of scum processing equipment. Two scum concentrators are also recommended in the facilities plan. In both cases, one unit would serve as standby. A system to feed scum into the incinerator at a constant rate is required.

The facilities plan presents no recommended project for disposing of the residual ash following sludge incineration. Instead, it describes three alternatives and suggests an order of preference for their consideration. These alternatives are described as follows:

Alternative 1 - Continue hauling ash to a sanitary landfill, with an estimated haul distance of 20 miles per trip and current disposal charges. Ash is now hauled by covered truck approximately 7 miles to the landfill near Merrill Field. This landfill, which currently is the only facility serving civilian uses in the Anchorage Bowl, is expected to be filled within three to four years. No replacement site has been selected for the landfill, although it is recognized in the facilities plan that a new site could double haul distances.

This alternative is incompletely described since no site for the new landfill has been identified in the facilities plan or in other MOA planning documents.

Alternative 2 - Blend ash with plant effluent and dispose of through the ocean outfall. This alternative is identified as preferred, unless significant adverse environmental impacts are associated with the action.

Alternative 3 - Blend ash with plant effluent and discharge to a lagoon or gravel pit within 0.25 mile of treatment plant. This alternative is identified as the second choice if alternative 2 is not acceptable. If a lagoon is used, it would be drained and covered when full, or the ash removed to a landfill at that time, and the lagoon reused. If a gravel pit is used, no draining, covering or removal would be involved.

Auxiliary Facilities

Enlargement of the existing buildings and additions to the operational control centers are needed to properly handle the expanded treatment facilities. Currently, space in the maintenance building is limited, and equipment and parts must be stored elsewhere. A new, larger building, about 10,000 square feet in size, would be constructed to centralize maintenance services.

The laboratory would be relocated from the administration building to the existing maintenance building. Also, pretreatment facilities will require a sampling area complete with a mud room, and a room for equipment storage and washing equipment. Removal of the laboratory will free space in the administration building, providing room for additional office space and allowing expansion of the conference room for use as a lecture facility for educational and community services.

oom would be expanded or extensively modified, control panel and increased control capabili-led treatment plant.

acilities would require up to eight or sonnel:

el for operation of added equipment and tenance;

1 person to operate and maintain new pumping not be needed if other proposed improvements me existing stations;

- two operations personnel will be needed in the control room.

Ocean Outfall and Diffuser

To prevent shoreward movement of effluent, studies conducted by Kinnetic Laboratory, Inc. (1979) suggest that the existing outfall be extended by about 1,500 feet, and that a diffuser also may be necessary.

The facilities plan recommends that the outfall be extended by 1,500 feet, that an extensive design effort be undertaken, and that the diffuser requirements be further studied. Preliminary diffuser modeling prepared for the Section 301(h) waiver application determined that a 1,000-foot diffuser would enable the discharge of chlorinated effluent to meet all existing water quality standards.

The MOA has entered into a contract with Ott Water Engineers, Inc. to study the outfall and diffuser requirements under the assumption that chlorination would be discontinued. Preliminary results indicate that a theoretical diffuser length of tens of miles would be needed to meet coliform standards applicable to Cook Inlet. All other standards, however, apparently could be met with a minimal (100-foot) diffuser.

The Ott study also is evaluating the diffuser requirements under assumptions that certain beneficial users of the waters of Cook Inlet would no longer be considered designated uses. This change would allow less strict standards to apply (see Table 2-3). Assumptions are made by Ott whereby the only remaining designated uses would be industrial water supply; secondary water recreation; and growth and propagation of fish, shellfish, and wildlife, including seabirds, waterfowl and furbearers. The uses of water supply for aquaculture, seafood

ssing and water-contact recreation would be deleted as
ated uses, leaving the most stringent applicable coliform
rd as 200 FC/100 ml. Under these assumptions a diffuser
of 6,100 feet (1,860 meters) would meet water quality
ls.

notes that deleting all beneficial uses except
propagation of fish, shellfish, aquatic life,
fe including seabirds, waterfowl and furbearers
that carries no fecal coliform standard) would permit
very short diffuser, perhaps only 100 feet in length.

The preliminary results of the Ott study also indicate that the MOA should more accurately locate the limit of the gyre that causes shoreward movement of effluent. They indicate that a significantly shorter outfall extension than indicated in the 301(h) application may be possible.

The Recommended Plan for the ocean outfall and diffuser is defined, for EIS purposes, as a 1,500-foot outfall extension with a diffuser about 1,000 feet in length, discharging chlorinated effluent. It should be recognized that the ongoing studies may result in a different alternative becoming the Recommended Plan.

Alternatives are: 1) the construction of a 1,500-foot outfall extension with a 6,100-foot diffuser discharging unchlorinated effluent along with the deletion of water supply for aquaculture, seafood processing, and water-contact recreation as designated uses of the waters of Cook Inlet; and 2) the construction of a 1,500-foot outfall extension with a 100-foot diffuser discharging unchlorinated effluent together with the deletion of all designated uses of the waters of Cook Inlet, except growth and propagation of fish, shellfish, aquatic life, and wildlife including seabirds, waterfowl and furbearers.

West Bypass Interceptor Sewer

A major interceptor sewer is proposed to connect existing interceptor sewers at the Alaska Railroad crossing over Campbell Creek to an existing downstream section of the West Bypass interceptor sewer near the Minnesota Bypass - Raspberry Road intersection. The proposed completion of the interceptor between these points would bypass a deteriorated, undersized corrugated metal pipe sewer paralleling Campbell Creek and an occasionally overloaded pumping station at Campbell Creek (see Figure 3-3).

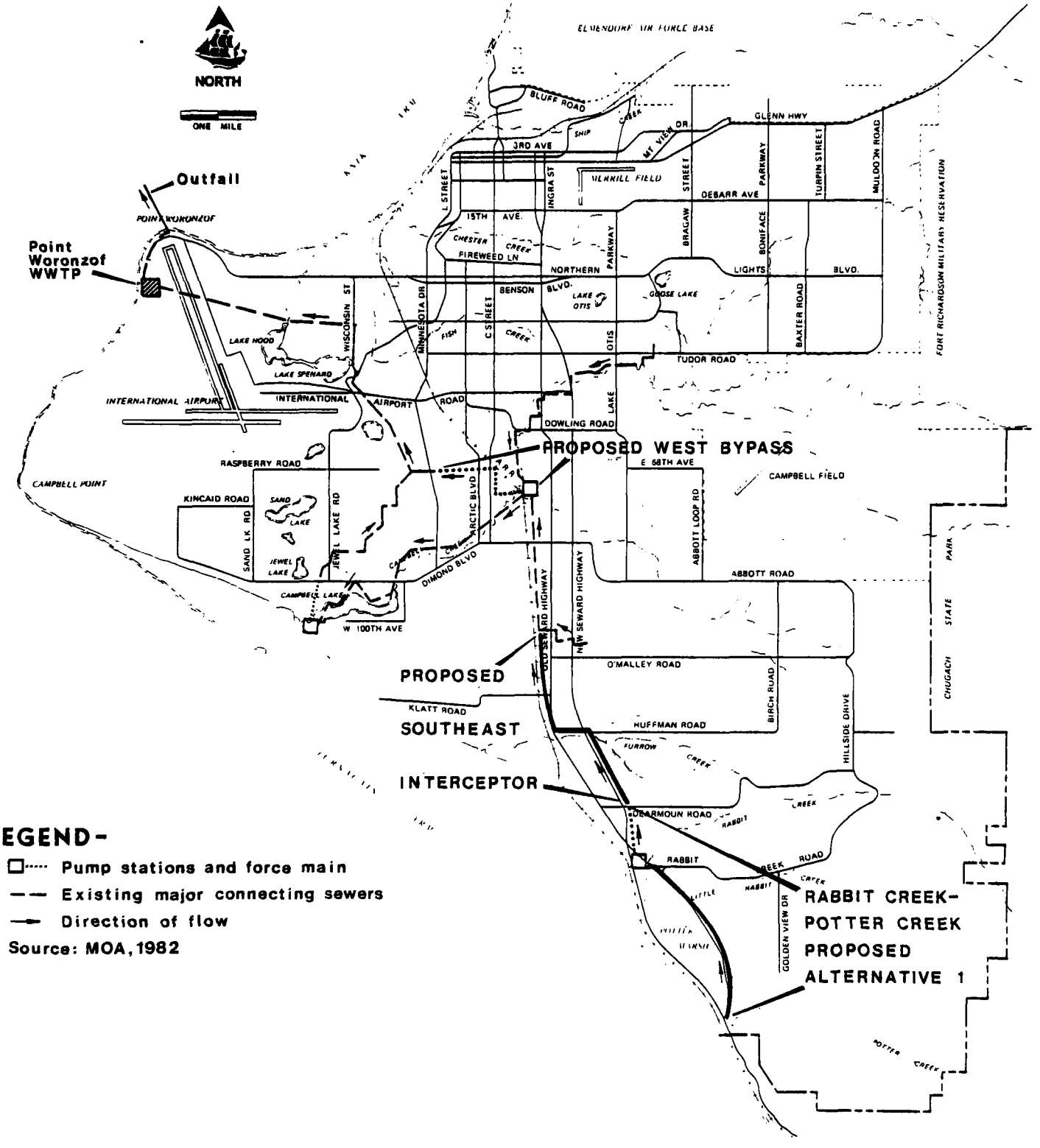


FIGURE 3-3. PROPOSED WEST BYPASS & SOUTHEAST INTERCEPTOR SEWERS

A pumping station and force main are recommended (Alternative 3). A 25 MGD pumping station (complete with standby electrical power) would be constructed immediately, followed by an expansion to about 60 MGD capacity.

- The recommended location for the pumping station is on the south bank of Campbell Creek, west of the Alaska Railroad.
- A 36-inch force main would be constructed southwest for about 270 feet, crossing Campbell Creek, and running west approximately 1,400 feet to C Street. The force main would turn north along C Street for 1,300 feet, turning west again to follow Raspberry Road for 3,700 feet, joining the existing 78-inch interceptor near the Minnesota Bypass.

The West Bypass Interceptor would serve a large portion of Anchorage, including the areas generally east of Old Seward Highway and south of Tudor Road, plus the area east of Goose Lake between Glenn Highway and Tudor Road. The service area includes all portions of the Hillside area that are to be served by sanitary sewers.

Southeast Interceptor

The southeast interceptor is proposed to be extended south to provide service to areas of the Hillside that are designated for public sewerage in the Hillside plan. The northerly terminus of the existing southeast interceptor is at the Alaska Railroad crossing of Campbell Creek (also the starting point for the West Bypass interceptor sewer). The interceptor currently ends about 1,500 feet south of Dimond Boulevard along the Alaska Railroad, and would be extended south from this point to De Armoun Road. Extension of the southeast interceptor to Potter is also recommended as the preferred plan for sewering the south Hillside areas near Potter Creek and Rabbit Creek.

Approximately 1,700 feet of the Southeast Interceptor is scheduled for construction from its terminus south of Dimond Boulevard to De Armoun Road by the summer of 1984. If it is decided to serve the Rabbit Creek/Potter Creek area with the Southeast Interceptor, certain portions of the existing pipe will be inadequate to carry projected flows, and capacity would be expanded as follows:

- A 600-foot section crossing Dimond Boulevard would be paralleled by a 42-inch pipe.

- Between 84th and 88th Avenues, approximately 12,000 feet of 36-inch pipe would be installed parallel to the existing 36-inch pipe.

- A 15-inch pipe would parallel a 400-foot section of interceptor north of 81st Avenue.

Southeast Interceptor and Force Main Extension to Rabbit Creek-Potter Creek. The facilities plan evaluates several alternatives for providing sewerage service to the southerly Hillside area near Little Rabbit and Potter Creeks. These alternatives include various sewer alignments with the option for a package treatment plant at either Rabbit Creek or Potter Creek, or a force main with flow to Point Woronzof via the Southeast Interceptor. This latter alternative has been recommended in the facilities plan. It would include:

- Gravity collectors and force mains sized for saturation population of the area designated to be sewered in the Hillside plan.

- A 24- to 30-inch gravity interceptor sewer with an above-grade crossing of Little Rabbit Creek following the bluff along Old Seward Highway from Potter Creek to the pump station.

- Construction of a pumping station near Rabbit Creek with a pumping head (lift) of about 200 feet. Two possible locations are considered: a) between Old and New Seward Highways, north of Potter Marsh; or b) adjacent to Old Seward Highway north of Rabbit Creek.

- A 14-inch force main along the New Seward Highway frontage road from the pump station to the Southeast Interceptor.

- Improvements to the existing interceptor sewer, which serves a small area between Huffman and De Armoun Roads.

Interceptor Sizing

Sizing of interceptor sewers serving the southeast area of Anchorage, including portions of the Hillside area, has been an identified issue due to controversy over sewer capacity to be provided to the Hillside area. The two proposed interceptor sewers that serve these areas are the Southeast Interceptor and the West Bypass Interceptor. This section describes the methodology used to determine the sizing of these facilities as proposed in the Recommended Plan.

The assumptions used in the sizing are summarized as follows:

- Population estimates: Planning Department estimates of maximum and minimum saturation populations in the year 2025.

- Wastewater flows: 80 gallons per day per capita (gpcd).

- Peaking factors: Derived as a function of population based on sanitary engineering literature (Fair and Geyer 1954, as reprinted in Committee of the Great Lakes and Upper Mississippi River Board of State Sanitary Engineers 1978). Peaking factors are read from a chart based on population and applied to average flows to determine peak flows for pipe capacity. Factors vary inversely with population.

- Infiltration/inflow: Data from Infiltration/Inflow Analysis and Sewer Evaluation Survey (MOA 1979). This study indicated that infiltration/inflow reduction was only cost effective in reducing infiltration inflow into the existing system to 4,000 gallons per inch diameter per mile (gpdim) in 1979. It was assumed that a similar level of infiltration/inflow would also be an appropriate basis for design of new sewers.

- Commercial and industrial flow: Calculated separately for Southeast service area; commercial and industrial flows for the Northeast area are included in current flow data used for projections.

Sizing of the West Bypass Interceptor is dependent on flows from the Northeast as well as Southeast areas (Figure 3-3). The Northeast area flow projections are discussed first, followed by Southeast flow projections.

Northeast Service Area. Peak flow data from the 1979 Infiltration/Inflow Analysis and Sewer Evaluation Survey were used to arrive at an average per capita peak flow of 300 gpcd from a population of 53,700. The population is expected to increase by 22,700-48,600 yielding an average peak flow increase of 6.8-14.6 MGD. Table 3-4 shows this projected flow added to the existing measured peak flow of 16 MGD. As mentioned above, commercial and industrial flows are included with residential peak flows.

Based on these calculations, the total projected peak flow from the Northeast service area would be between 22.8 and 30.6 MGD. Available capacity in the existing 48-inch Northeast Interceptor is 40.1 MGD, which should be adequate for saturation conditions in 2025.

Southeast Service Area. According to the Hillside Wastewater Management Plan, the Hillside area will require collection systems to serve a projected population of between 70,400 and 86,800 persons in an area of approximately 5,900 acres. This includes the Rabbit Creek-Potter Creek area. Applying the average flow of 80 gpcd yields a base flow of 5.6-6.9 MGD (Table 3-1).

An infiltration/inflow allowance of 7.2 MGD was calculated by using a value of 4,000 gpdim and assuming 200 feet of pipe per acre and 5,900 acres to be sewered.

The peaking factors were applied to the residential base flow and the infiltration/inflow allowance. (U. S. EPA has questioned the application of this peaking factor to the infiltration/inflow allowance. See Appendix A).

Flows for commercial and industrial lands identified in the September 1981 Draft Comprehensive Development Plan represent peak flows and include infiltration/inflow allowances. These flows, reflected in Table 3-1, total 10.9 MGD.

If the Potter Creek-Rabbit Creek area is not sewered to the Southeast Interceptor, but rather is sewered to a new treatment plant with a local discharge, then both the Southeast and West Bypass Interceptors could be designed for a slightly lower flow. The residential base flow for the Rabbit Creek-Potter Creek area was estimated using a projected population of 13,500 and per capita flows of 80 gpcd, plus assumed infiltration of 1,200 gpd per acre for 2,000 acres. The flow estimates, shown in Table 3-1, total 3.5 MGD from this portion of the Hillside area, equivalent to about 250 gpcd, which is a typical wastewater flow for low density developments.

Interceptor Sizing. The flow values at the bottom of Figure 3-1 are used for sizing the Southeast Interceptor. Separate calculations are necessary to estimate the sizing for the West Bypass Interceptor. Table 3-2 presents those calculations. Lesser peaking factors computed from the combined population of both service areas are used in this instance. The maximum and minimum flows from the total tributary area, including the Rabbit Creek-Potter Creek area, are estimated to average 91.2 cfs.

If the Rabbit Creek-Potter Creek area were to be excluded from service by these interceptors, flows would be as shown in the bottom portion of Table 3-2.

The facilities plan presents sizing recommendations based on gravity construction for the West Bypass Interceptor.

Table 3-1. Peak Flow Projections Used for Interceptor Sizing - Subareas

	Maximum Flow (MGD)	Minimum Flow (MGD)
Northeast Service Area		
Existing Peak Flow	16	16
Projected Peak Flow Increase	14.6	6.8
Total Projected Peak Flow	30.6	22.8
Rabbit Creek-Potter Creek at Saturation Development		
Residential Average Flow	1.1	1.1
Infiltration	2.4	2.4
Total Residential Average Flow	3.5	3.5
Southeast Service Area Including Rabbit Creek-Potter Creek[1]		
Residential Average Flow	6.9	5.6
Infiltration	7.2	7.2
Total Residential Average Flow	14.1	12.8
Peaking Factor	x2.0	x2.1
Residential Peak Flow	28.2	26.9
Commercial/Industrial Flow	10.9	10.9
Total	39.1	37.8
Equivalent Total	(60.5 cfs)	(58.5 cfs)

[1] Basis for sizing Southeast Interceptor.

SOURCE: Municipality of Anchorage Wastewater Facilities Plan for Anchorage, June 1982.

Table 3-2. Peak Flow Projections Used for West Bypass Interceptor Sizing - Composite Flows

	Maximum Flow (MGD)	Minimum Flow (MGD)
Northeast and Southeast Service Areas Including Rabbit Creek-Potter Creek Area		
Northeast Service Area Average Flow	15.3	11.4
Southeast Service Area Average Flow	14.1	12.8
	29.4	24.2
Peaking Factor	x1.76	x1.83
Residential Peak Flow	51.7	44.3
Southeast, Industrial/ Commercial	10.9	10.9
Total Peak Flow	62.6	55.2
Equivalent Total	(96.9 cfs)	(85.4 cfs)
The maximum and minimum flows average to 91.2 cfs.		
Northeast and Southeast Service Areas Excluding Rabbit Creek-Potter Creek Area		
Northeast Service Area Average Flow	15.3	12.4
Southeast Service Area Average Flow	10.6	9.3
Total Average Flow	25.9	21.7
Peaking Factor	x1.8	x1.9
Peak Flow	46.6	41.2
Southeast, Industrial/ Commercial	10.9	10.9
Total Peak Flow	57.5	52.1
Equivalent Total	(89.0 cfs)	(80.7 cfs)
The maximum and minimum flows average to 84.9 cfs.		

SOURCE: Municipality of Anchorage Wastewater Facilities Plan for Anchorage, June 1982.

It should be noted that the Recommended Plan proposes a pump station and force main, which would involve several smaller pipes under pressure that would discharge to the existing 78-inch interceptor sewer near Minnesota Drive. Under the Recommended Plan, little if any large diameter interceptor pipe would actually be constructed. The facilities plan discussion of sizing is included here, however, since gravity construction is an alternative.

Sewer pipe of the size required to handle large flows at relatively flat grades is generally available in 6-inch-diameter increments. The two candidate sizes for gravity flow for the West Bypass Interceptor are 72 inches and 78 inches. Since a 72-inch interceptor at the maximum available slope of 0.00035 foot of drop per foot of distance provides capacity for 78 cfs, a 78-inch line with a 96 cfs capacity is recommended by the facilities plan. With the exclusion of the Rabbit Creek-Potter Creek area, the West Bypass Interceptor would receive an average peak flow of 84.9 cfs, still above the 72-inch line capacity of 78 cfs.

Hillside Wastewater Management Plan

The Hillside Wastewater Management Plan (MOA 1982) adopted by the Municipal Assembly on May 18, 1982, evaluated the suitability of the Hillside area of Anchorage to accommodate on-site disposal systems, and delineated areas for public sewers, unsewered areas for on-site systems and unsewered areas generally unsuitable for on-site disposal systems. Figures 3-4 and 3-5 show the Hillside study area and the resulting designations. The areas suitable for on-site systems are classified as "generally suitable for individual on-site treatment systems" or "generally unsuitable. . .". Some of the area is also indicated as "marginal", and one area is classified as an "area recommended for use of privately-owned cluster system sewers (1 dwelling unit/acre)." A recommended maximum perimeter of public sewerage is delineated that excludes most of the Hillside in the northern half of the plan's study area and includes large areas in the southern half near Little Rabbit Creek and Potter Creek.

The plan text indicates that the area is subdivided into "1) areas suitable for on-site systems; 2) areas generally unsuitable for on-site systems; and 3) areas marginally suitable

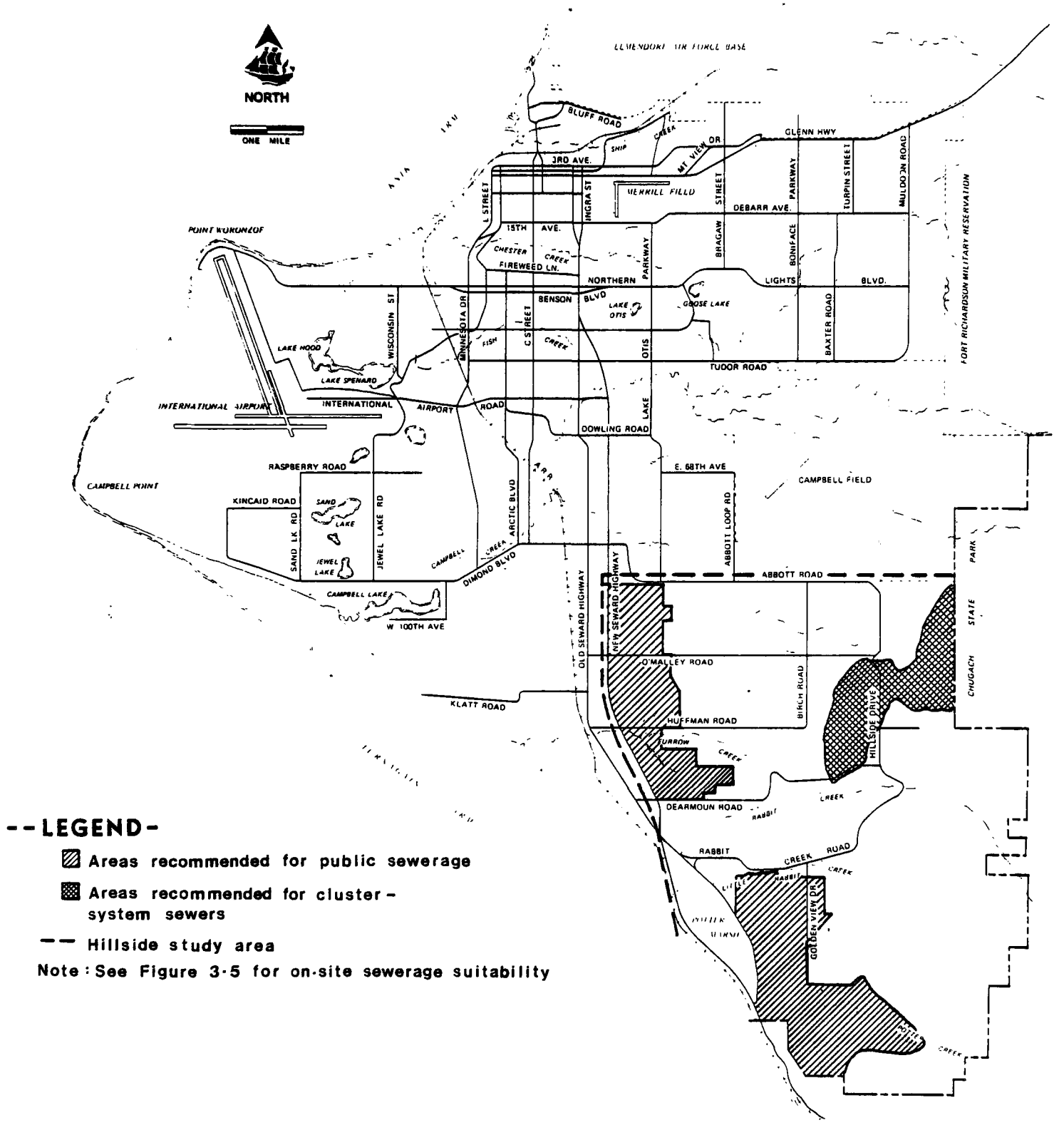
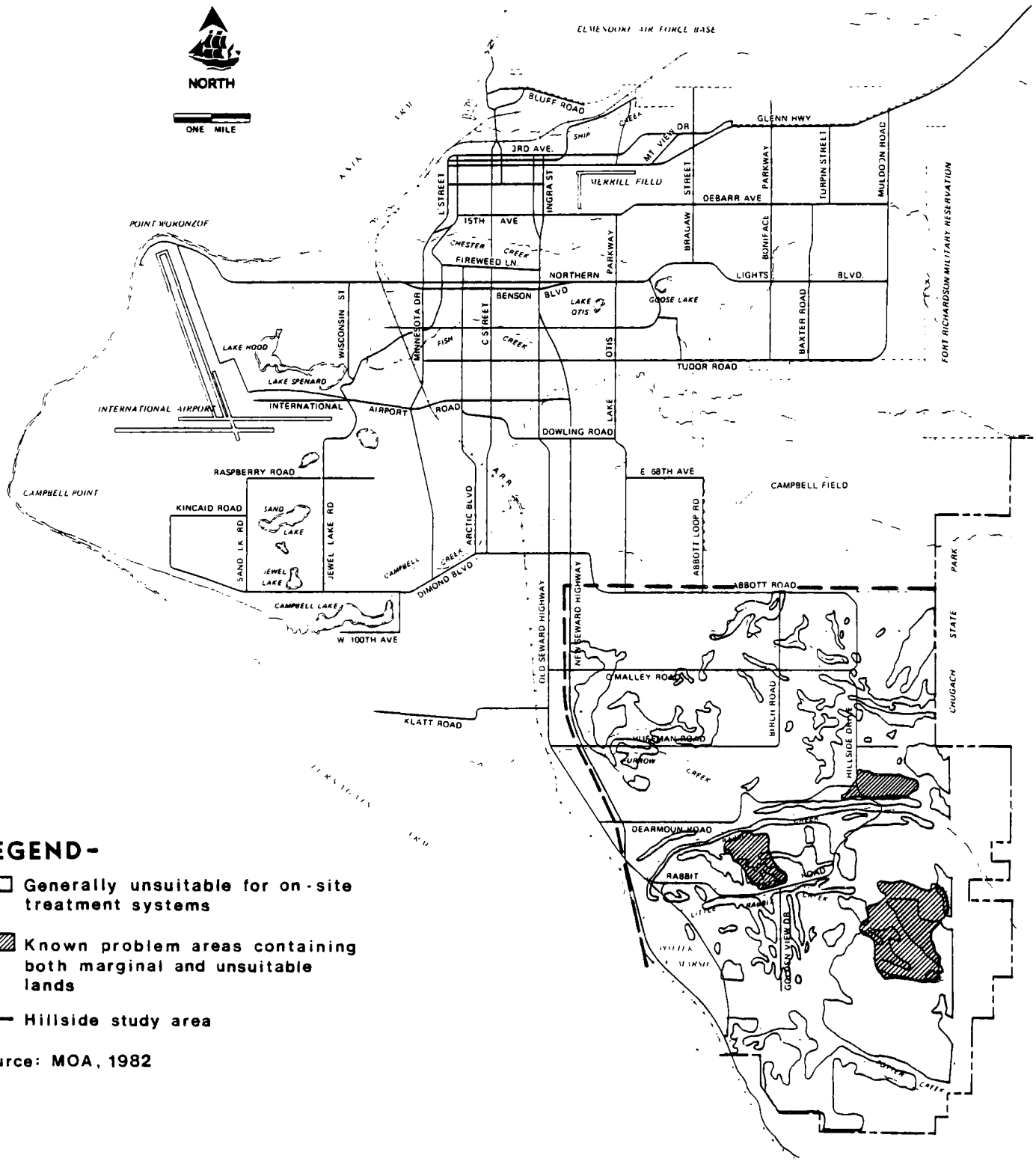


FIGURE 3-4. ADOPTED HILLSIDE AREA SEWERAGE DESIGNATIONS



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- ☐ Generally unsuitable for on-site treatment systems
- ▨ Known problem areas containing both marginal and unsuitable lands
- —— Hillside study area

Source: MOA, 1982

FIGURE 3-5. HILLSIDE AREA SEPTIC TANK SUITABILITY

for on-site systems using alternative systems." This last area is denoted on the map as "known problem areas containing both marginal and unsuitable lands." Unsuitable designations are delineated for portions of land within the shading for this category. It appears to be the intent of the plan to allow alternative systems within the marginal areas, including those portions of the marginal areas shaded as unsuitable for on-site systems, subject to "a more rigorous design and review process." Likewise, for areas classified as unsuitable for on-site systems, the plan states:

> "The scale of the mapping did not permit site-by-site investigations, so it must be emphasized that these areas are considered generally unsuitable. Any given site could have good conditions for on-site treatment, but if it lies within a generally unsuitable area, it will be subject to the same rigorous design and review process which will be used to evaluate individual lots in the marginally suitable areas. Even in the non-suitable areas, certain on-site systems may be used, based on the attributes of the particular site as well as certain developed lands.
>
> "It should be reemphasized that these area designations do not necessarily preclude the use of on-site system operation, but because of adverse environmental problems, requires a more rigorous design and review process. The innovative systems described earlier in this report may allow development in these areas."

The plan sets forth planning and design criteria, construction guidelines and operation and maintenance requirements for on-site systems.

Planning and design criteria encompass training for homeowners, engineers, contractors, septic tank pumpers and site evaluators, including an examination; review of drainfield locations by the Municipality Department of Health and Environmental Protection (DHEP); incorporation of a drainage plan with new plats; surface water disposal plans for on-site areas of the Hillside; testing of innovative on-site systems; and provision of four feet of insulating soil cover over all new drainfields.

Construction guidelines provide for training of contractors, certification of the job site installer under the training program, and insulation of septic tanks.

Operation and maintenance requirements include mandatory pumping of septic tanks every two to three years, with MOA recordkeeping and enforcement, and further training and MOA supervision of pumpers.

Additional restrictions are applied to marginal and unsuitable areas, including soil tests for each lot in a subdivision; requiring innovative systems unless conventional systems are shown to be acceptable; and more detailed system reviews by DHEP.

Collection Sewer Improvement Projects

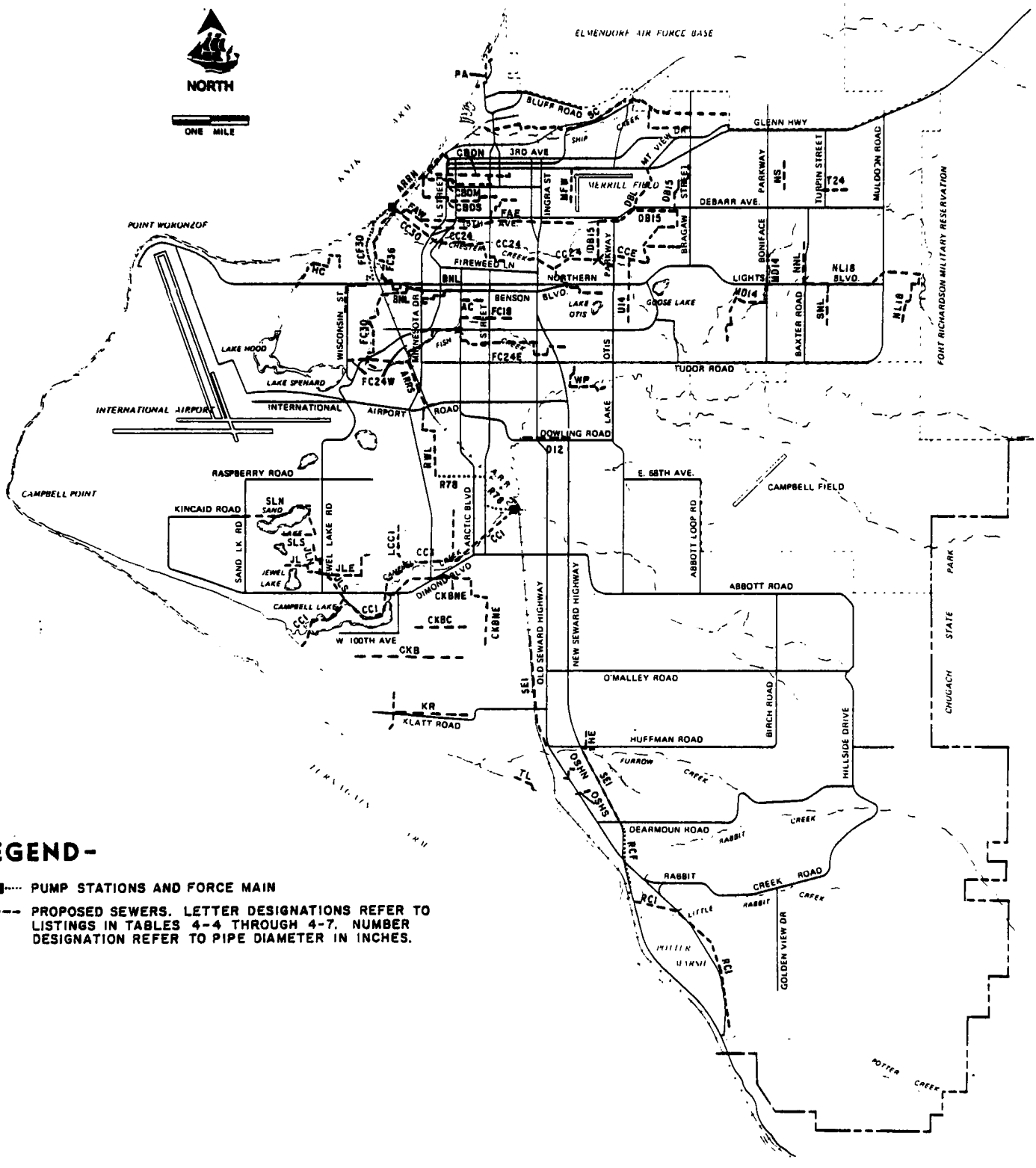
The existing collector system is in need of expansion, replacement and renovation in certain areas. Additional capacity is required in some instances, as well as replacement of several miles of corrugated pipe. About 70 sewer construction, rehabilitation and replacement projects (Figure 3-6) are recommended in the facilities plan. The more significant of these proposed projects are generally described in the following section. For a complete listing, the reader is referred to pages X-4 through X-12 and Figure IX-2 of the facilities plan.

Northeast Service Area.

- No replacement or development is recommended in this area.

Knik Service Area.

- Two interceptors along the Alaska Railroad near Nulbay Park are of corrugated metal pipe and are scheduled for replacement.
- Trunks following Chester Creek exceed capacity during peak flows. Enlargement of trunks is necessary.
- The trunk following Fish Creek overflows, and should be replaced.
- An additional trunk located near Fish Creek will be relocated to the Tudor Road right-of-way between the Alaska Railroad and Wisconsin Street. An adjacent trunk would also be reconstructed.
- Trunk B-2 needs improvement. Portions have already been replaced.
- University and hospital area trunks require additional capacity.
- The Chester Creek pumping station requires a fourth pump and a 36-inch force main to correct inadequate capacity.



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■···· PUMP STATIONS AND FORCE MAIN

--- PROPOSED SEWERS. LETTER DESIGNATIONS REFER TO LISTINGS IN TABLES 4-4 THROUGH 4-7. NUMBER DESIGNATION REFER TO PIPE DIAMETER IN INCHES.

FIGURE 3-6. PROPOSED SEWER AND INTERCEPTOR SEWER CONSTRUCTION, REPAIR AND REHABILITATION PROJECTS

Southeast Service Area.

- Existing reserve capacity is sufficient, but potential capacity increases in the northern portion of the service area may require development of trunks and interceptors. These facilities are not included in the facilities plan at this time.

Turnagain Service Area.

- Extensive construction is required on the Campbell Creek trunk. Internal inspection is recommended to determine required rehabilitation. Installation of the West Interceptor will allow inspection of the existing line and enable accurate construction recommendations for the Campbell Creek trunk.

- Trunks along 88th Avenue and crossing the Dimond-Mears High School grounds possibly need expansion. Construction of the West Bypass interceptor would postpone the enlargement.

- Development of the Klatt Bog area would overload the Turnagain interceptor; rigid inspection is required to control infiltration and inflow in this wetland.

Range of Alternatives

The range of alternatives considered in development of the facilities plan is partially documented in the two plan documents. The facilities planning process in Anchorage has evolved over many years with intermediate reports such as the incomplete Corps of Engineers facilities plan, the URS-Bomhoff study and other work as discussed in Chapter 1 of this EIS. A relatively broad range of investigations has been completed over the past several years, with many alternatives evaluated and some rejected. While the current facilities plan is intended as the culmination of these, it does not identify all prior evaluation efforts, nor does it document all of the screening that went into the development of the current Recommended Plan.

The range of alternatives evaluated in the Wastewater Facilities Plan for Anchorage, Alaska is outlined as follows:

- No action;

- Land application of treated wastewater;

- Wastewater renovation and reuse;

- Point Woronzof alternatives:

- Primary alternatives - expansion of primary clarifiers with and without chlorination;

- Secondary alternatives - high rate trickling filters or complete mix activated sludge process;

- Sludge treatment and disposal - incineration, anaerobic digestion, coincineration, with suboptions for incinerator ash disposal;

o Outfall and diffuser alternatives - outfall extension of 1,500 feet with various diffuser lengths depending on whether chlorination is employed and depending on whether designated uses of Cook Inlet waters are changed;

o West Interceptor alternatives - gravity with trench or tunnel construction, or pump station-force main; three alternative alignments are referenced, with only the preferred alignment described;

o Southeast Interceptor - no alternatives, except as influenced by Rabbit Creek-Potter Creek alternatives;

o Rabbit Creek-Potter Creek alternatives - various collection sewer alignments combined with a small treatment plant with alternative processes at one of two alternative locations, or pump station-force main to Southeast Interceptor.

The Hillside Wastewater Management Plan does not evaluate alternative public sewer systems or alternative public sewer/on-site system area designations. The plan does allow alternative types of on-site sewerage systems, depending on individual needs on each parcel.

Other sewerage alternatives considered for the Anchorage Bowl in prior reports include the following:

o Alternative sewer alignments, including sewering of major portions of the Hillside area (URS-Bomhoff 1979);

o Flow and waste reduction, covered in Infiltration-Inflow (MOA 1979) and Sewer System Evaluation Survey. Certain identified cost-effective rehabilitation work is complete, as addressed in the facilities plan;

o Point Woronzof treatment alternatives, including aerated lagoons and facultative lagoons (primary), and five additional variations of the activated sludge process (secondary);

- o Advanced primary treatment alternatives considered in the facilities planning process, but not documented in the June 1982 draft facilities plan;

- o Export of digested sludge to the Matanuska Valley, considered in the facilities planning process but not documented in the June 1982 draft facilities plan.

The foregoing list is not intended to be exhaustive, but rather to be illustrative of the wider range of alternatives considered by the MOA during the planning process.

The EIS description of alternatives and analysis of viable alternatives is limited to the alternatives described in the June 1982 facilities plan and in the Hillside Wastewater Management Plan.

Screening of Alternatives

The facilities plan documents do not describe the screening process used to identify the viable alternatives. It would be speculation on the part of the EIS to attempt to describe how the MOA and its facilities planners selected those alternatives described in Chapter VII of the Wastewater Facilities Plan for Anchorage, Alaska. That document does indicate how the Recommended Plan was selected from among the viable alternatives, and those reasons are given in the following section along with the discussion of each alternative.

Description of Alternatives

"No-Action" Alternative

The no-action alternative assumes no rehabilitation, improvement, or expansion of the existing collection system, and no expansion of Point Woronzof WWTP.

No action was rejected because the MOA would be in violation of federal and state laws. Further, the state could impose a moratorium on new sewerage connections, adversely affecting growth of the Anchorage area. It would increase pollution of local streams and be subject to local objections. No action would be inconsistent with MOA desires.

Land Application Treatment

Because land application satisfies the goals of "zero discharge" and "resource recovery" as stated in the 1972 Clean Water Act and its 1977 amendments, EPA requires that

land application be evaluated. The Act also allows preferential federal funding covering up to 85 percent of the installation cost of a land application system, compared to 75 percent for conventional facilities.

Land application wastewater treatment uses natural systems (i.e., vegetation and soil) to control organic pollutants. The nutrients contained in wastewater increase the fertility and productivity of terrestrial systems, making this treatment attractive to silvicultural and agricultural interests. The level of treatment may be superior in some cases to conventional treatment methods. Three methods of application are possible:

- Slow rate process - distribution of wastewater over the receiving land by sprinklers or ridge and furrow flooding. Rates range from 0.50-4 inches per week, depending on soil characteristics.

- Rapid infiltration - distribution over sand or loam soils. Rates range from 4-120 inches per week.

- Overland flow - wastewater is applied to the upper margins of a relatively impermeable and gently sloping watershed. Rates range from 6-16 inches per week.

Some treatment is necessary before land application. For slow rate and rapid infiltration, primary treatment is adequate. For overland flow, screening and grit removal may be sufficient.

Land application alternatives were considered during development of the 1976 facilities plan. The potential of rapid infiltration at the Point Campbell Military Reservation appeared cost effective at that time, due to the proximity of the lands to Point Woronzof, the presence of sand and gravels, and the apparent groundwater flow direction away from areas of use and towards Cook Inlet. The 1982 facilities plan cites this alternative as the land application alternative evaluated in the current facilities plan.

The Point Campbell land application alternative was rejected for the following reasons:

- The Point Campbell military reservation is being transferred to the MOA for park use.

- A pilot program to establish feasibility and design criteria has never been funded.

- Environmental concerns, including loss of a potential parkland resource, loss of existing public recreational use of the area, loss of existing moose habitat, visual impacts, the risk of groundwater contamination and the potential for strong public objections are also cited as reasons for rejection.

Wastewater Renovation and Reuse

Reduction of effluent discharge may be accomplished by reusing the treated wastewater for potable or nonpotable consumption. Various treatment facilities elsewhere in the United States have reclaimed wastewater for 1) crop irrigation; 2) cooling and boiler feed; 3) golf course and park irrigation; and 4) nonpotable domestic use, among others. Secondary treatment is generally the minimum required before wastewater can be reused for nonpotable purposes.

Currently, little need for this water has been identified in the Anchorage area, but the facilities plan recommends future review of this alternative. The economic benefits of reuse might outweigh the costs of additional treatment, depending on a variety of factors. The facilities plan concludes that this alternative cannot be seriously analyzed until a market for the wastewater is identified.

Point Woronzof Treatment Alternatives

The facilities plan considers two primary treatment and two secondary treatment alternatives. Alternative PB, one of the two primary treatment options, is the recommended process and is described in an earlier section of this chapter. The remaining primary alternative and the two secondary alternatives are described in the following section.

Primary Treatment. In the event that MOA is granted a waiver under Section 301(h) of the Clean Water Act, the Point Woronzof plant could continue discharging primary treated wastes to Cook Inlet. Expansion of the current primary clarifier system to provide increased capacity is the basic concept for both alternatives PA and PB. The Recommended Plan, alternative PB, retains effluent chlorination in the process. Alternative PA would discontinue chlorination consistent with the desires of ADEC.

Alternative PA would be identical to the Recommended Plan, presented earlier in this chapter, with the exception that no chlorination would be employed in this alternative, and that the diffuser length may be different. Diffuser length would change as a function of fecal coliform limits at the perimeter of the discharge mixing zone. Suggested changes in the designated uses of the waters of upper Cook Inlet would apply different water quality standards, thus changing this coliform limit.

A diagram of Alternative PA is shown in Figure 3-7.

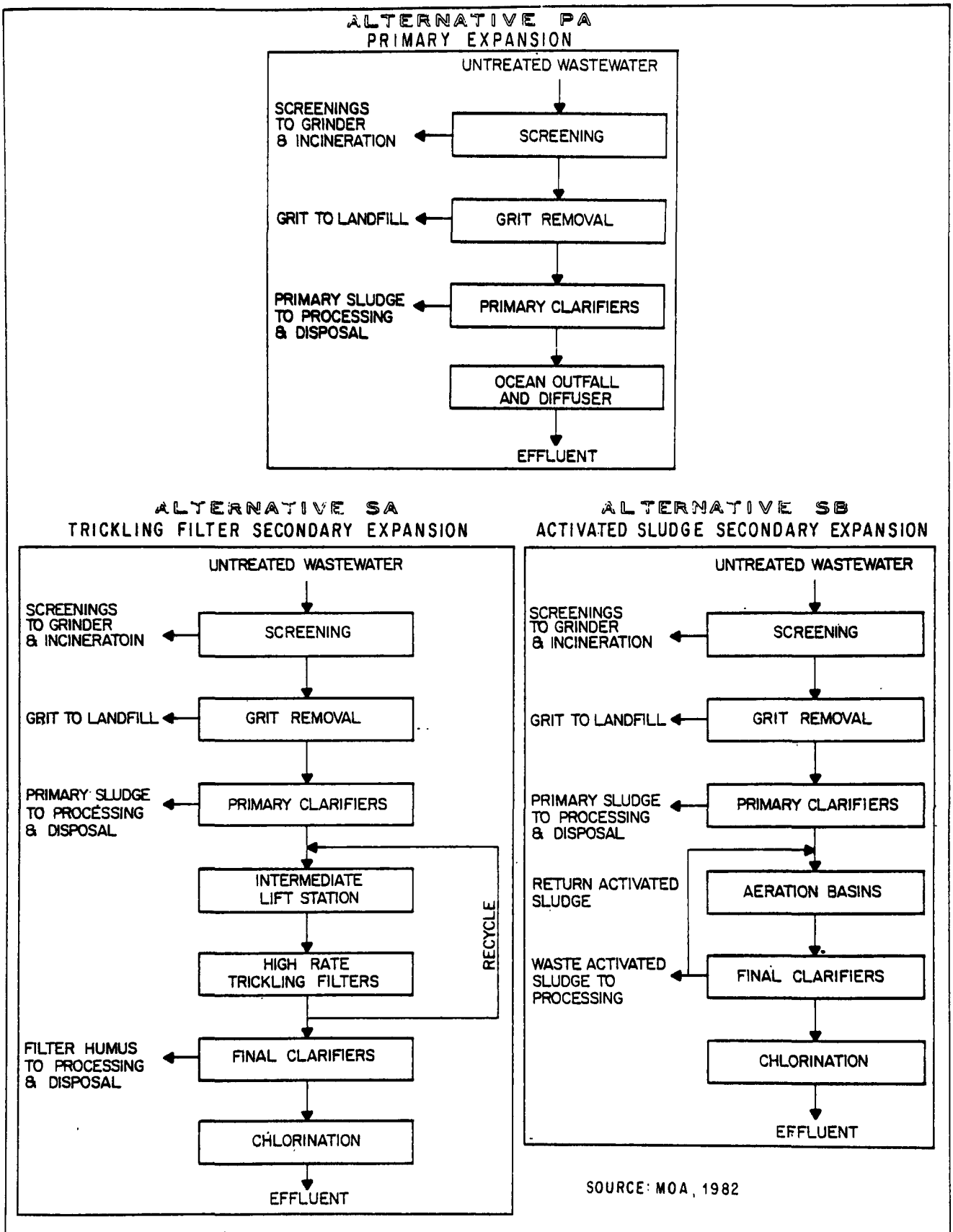


FIGURE 3-7. ALTERNATIVE TREATMENT PROCESS DIAGRAMS-LIQUID PROCESS-POINT WORONZOF WWTP

Secondary Treatment. The MOA has sought to obtain a modification of NPDES requirements under Section 301(h) of the Clean Water Act to permit continued ocean discharge of less than secondary effluent from the existing Point Woronzof WWTP. Issuance of a 5-year permit modification under Section 301(h) is expected in the fall of 1982. Continued primary discharge beyond the expiration dates of any such modification is not assured in the Clean Water Act, and under the construction grant regulations, EPA must restrict its funding to projects with a 20-year planning horizon. Since EPA has no authority to consider an alternative involving ocean discharge of less than secondary-treated effluent 20 years in the future, the selected alternative must incorporate secondary treatment. Both secondary treatment alternatives could be added to the primary treatment alternatives, thus meeting this requirement.

Secondary treatment (biological treatment) utilizes microorganisms to extract about 85 percent of the BOD and TSS. The two secondary treatment options evaluated in the facilities plan are described below. Both are practicable, but are not proposed for implementation due to pending approval of the 301(h) waiver.

Alternative SA - High-Rate Trickling Filters (Figure 3-2). After primary clarification, wastewater is distributed evenly over fixed redwood or plastic media. These trickling filters utilize microorganisms growing on the media surface to assimilate organic pollutants. A portion of the filtered effluent is recycled to increase contact time with the microorganisms on the substrate. Clusters of microorganisms sloughed off of the media are settled out in final clarifiers.

Because of the cold climate, an enclosed heated structure would be needed to provide for consistent micro-organism growth and adquate treatment.

Alternative SB - Complete Mix Activated Sludge Process. After primary treatment, wastewater enters an aeration basin which contains microorganisms in a "mixed liquor." The liquor is aerated by mechanical mixing or bubbling. After biological activity removes organic solids, the microorganisms are removed in final clarifiers where they settle as sludge. Portions of this activated sludge are pumped back into the aeration basins to seed incoming sewage. The liquid from the clarifiers is discharged through the outfall.

Alternatives for Sludge Solids Treatment and Disposal

Figure 3-8 presents the sludge treatment and disposal alternatives. Sludge solids removed from either primary or secondary treatment must be processed to ensure environmentally safe disposal.

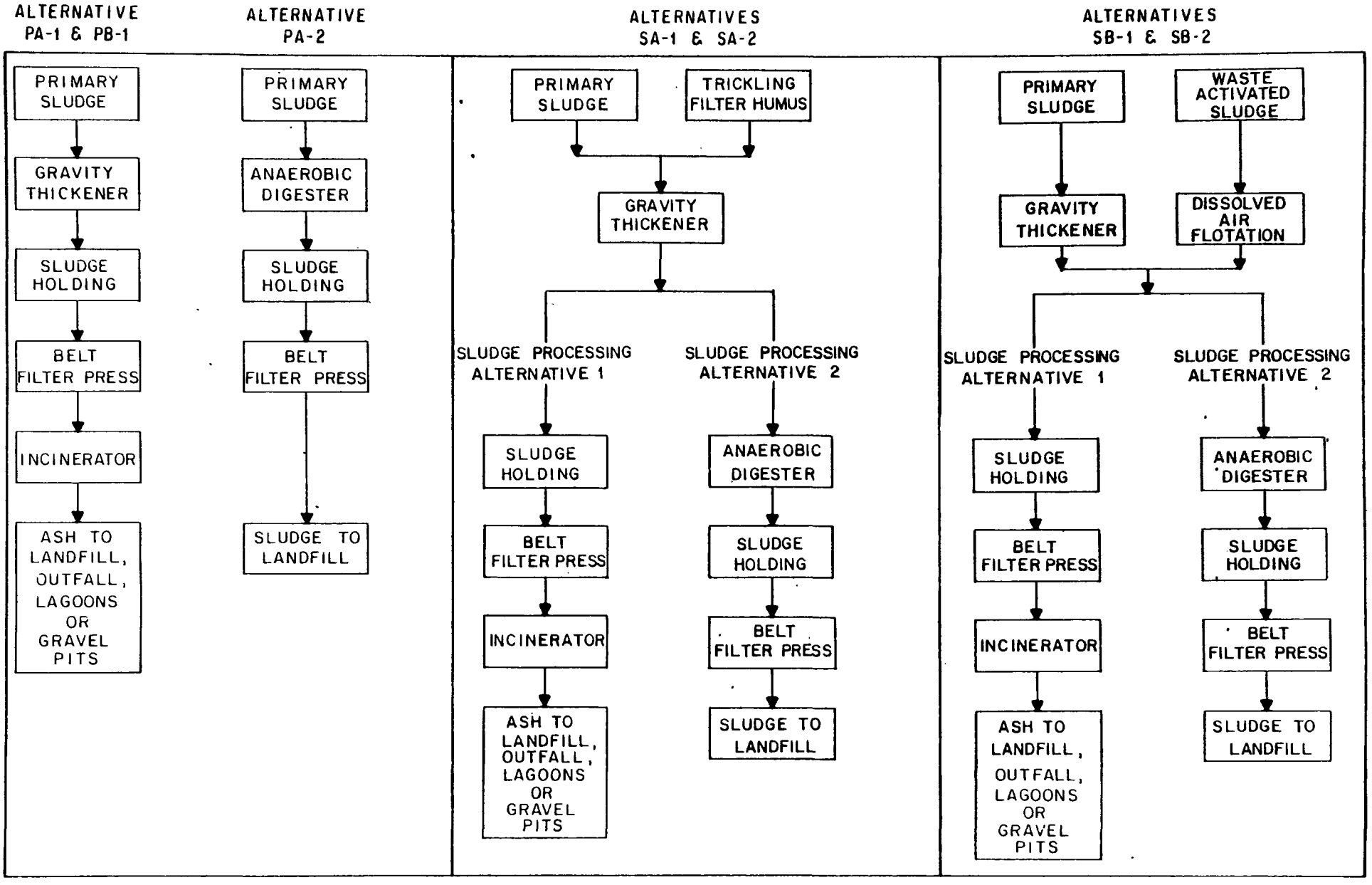


FIGURE 3-8. ALTERNATIVE TREATMENT PROCESS DIAGRAMS - SOLIDS PROCESS - POINT WORONZOF WWTP

Alternative 1: Incineration; Ash to Landfill, Outfall, Lagoons or Gravel Pits. Sludge would continue to be incinerated, with three possible disposal options identified. Land filling (the current method) could be continued; ash could be mixed with effluent and discharged through the outfall; or ash could be discharged as a slurry mixed with a small quantity of plant effluent and discharged to a lagoon or gravel pit near the Point Woronzof WWTP. The outfall discharge is identified as preferred, although not firmly recommended, in the facilities plan. The incineration alternative with all three disposal options is considered as part of the Recommended Plan, and the impacts are evaluated in Chapter 9.

Alternative 2: Dewatering, Digestion and Landfilling. In all cases except Alternative SB-2 either primary or secondary sludge would be dewatered by gravity thickeners, and then pumped to an anaerobic digester for stabilization. In Alternative SB-2, sludge would be dewatered by dissolved air flotation units (solids are removed by air bubbles) and then stabilized in the aerobic digester. The stabilized dewatered sludge would be hauled to a sanitary landfill.

Co-Incineration. Primary or secondary sludge can be incinerated in combination with refuse. Combustion is easily accomplished because of the fuel value of the refuse. The heat output can generate electricity, produce steam, and be applied to drive mechanical dewatering devices or other treatment plant equipment and provide heat. The ash would be landfilled. Total community solid waste volume could be reduced if co-incineration were used.

Alternatives for Ocean Outfall and Diffuser

Alternatives for the ocean outfall and diffuser are described in depth earlier in this chapter in the Recommended Plan discussions. The two alternatives for the Recommended Plan are repeated below.

Alternative 1. The construction of a 1,500-foot outfall extension with a 6,100-foot diffuser discharging unchlorinated effluent along with the deletion of water supply for aquaculture, seafood processing and water contact recreation as designated uses of the waters of Cook Inlet.

Alternative 2. The construction of a 1,500-foot outfall extension with a 100-foot diffuser discharging unchlorinated effluent together with the deletion of all designated uses of the waters of Cook Inlet, except growth and propagation of fish, shellfish, aquatic life, and wildlife, including seabirds, waterfowl and furbearers.

West Interceptor Extension Alternatives

The West Interceptor extension will serve the eastern portion of the Anchorage Bowl, north of Fort Richardson and south to the east fringe of Potter Marsh. Extension of the Interceptor will continue east along Raspberry Road to "C" Street. From this point, three routes had been considered, two of which were eliminated during preparation of the facilities plan and are not documented in the plan. The alternatives considered in this EIS are thus restricted to construction options along the recommended routing. The routing is described in the foregoing section on the Recommended Plan.

- o Alternative 1 - A gravity interceptor, with open ditch construction;
- o Alternative 2 - A gravity interceptor, constructed by both tunneling and open ditch;
- o Alternative 3 - Pump station and force main, described in Recommended Plan.

The first two alternatives are not recommended in the facilities plan due to extensive excavation (50-foot-deep trenching), difficult dewatering requirements, a nearby shallow well that provides a high yield of potable water, the potential for conflict with the Bank of Alaska computer facility from vibration and building settlement, and high construction cost. These factors are addressed in further detail in Chapter 11.

Rabbit Creek/Potter Creek Collection and Treatment Alternatives

The facilities plan presents a series of sewage collection, treatment and disposal alternatives for the southerly portion of the Hillside area designated for public sewers in the Hillside plan. Lettered alternatives A through E encompass four treatment options that would be independent of the Point Woronzof plant and one pump station-force main option (Alternative D, the Recommended Plan) that would connect to the Southeast Interceptor, flowing to Point Woronzof. In addition, numbered Alternatives 1-4 describe alternative collection system patterns in the area.

The Recommended Plan was selected from these alternatives based on cost effectiveness, least land requirements and environmental questions regarding a separate treatment plant and discharge.

Alternative A. An extended aeration package treatment plant would be located at Rabbit Creek, providing secondary treatment of wastewater. Effluent would be discharged into Rabbit Creek and the sludge hauled to Point Woronzof WWTP and processed (Figure 3-10).

Alternative B. An oxidation ditch wastewater treatment plant, providing secondary treatment, with effluent discharged to Rabbit Creek.

Alternative C. An aerated lagoon wastewater treatment plant, providing secondary treatment, with effluent discharged to Rabbit Creek.

Alternative D. Pumping station and force main discharging to the Southeast Interceptor as described in Recommended Plan.

Alternative E. An extended aeration package treatment plant identical to alternative A, but located at and discharging to Potter Creek.

Once the pumping or treatment facility is chosen, a system of interceptors, trunks and laterals must be selected. The four alternatives are shown in Figure 3-9 and described below:

Alternative 1: Gravity Flow Toward Rabbit Creek (Figure 3-9). A 24-inch gravity interceptor flowing north, 13,000 feet long, would roughly follow Old Seward Highway. Crossing Little Rabbit Creek, it would then proceed northwest, cross Old Seward Highway and flow into either the pumping station or treatment plant at Rabbit Creek. Further discussion is contained in the section on Recommended Plan.

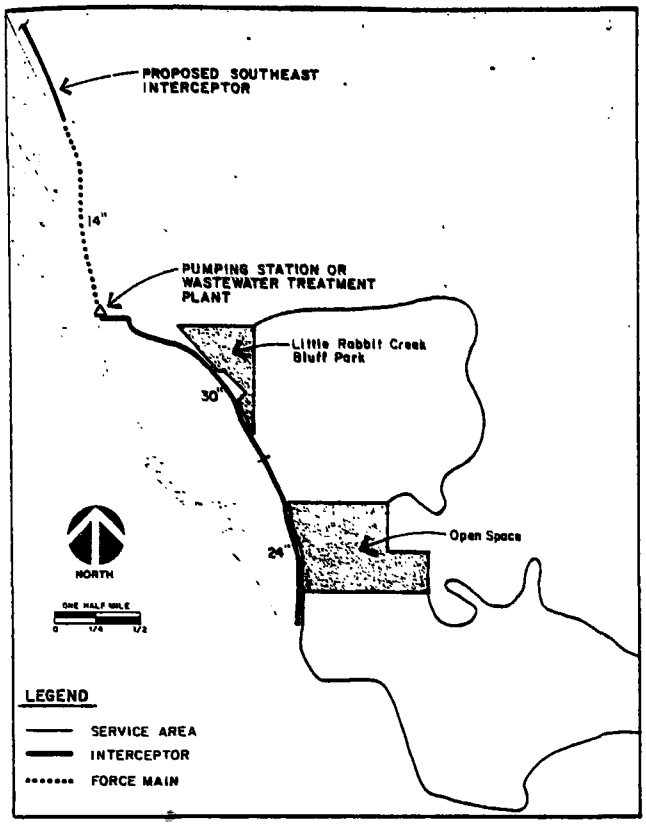
Alternative 2: Pumping Station and Force Main Toward Rabbit Creek. This alternative would consist of a pumping station north of Potter Creek, and a 14-inch force main toward Rabbit Creek along Old Seward Highway. A 12- to 18-inch interceptor would parallel this main and transport wastewater by gravity flow to the pumping station.

Alternative 3: Gravity Flow Toward Rabbit Creek. A 12- to 18-inch gravity interceptor would flow south to the Potter Creek weigh station. A 30-inch interceptor would then convey flow north toward Rabbit Creek on the west side of the Alaska Railroad embankment.

Alternative 4: Gravity Flow to Potter Creek. This alternative was designed specifically for treatment Alternative E. A 12- to 18-inch interceptor would be laid along Old Seward Highway, carrying the flow south to the Potter Creek Package Treatment Plant.

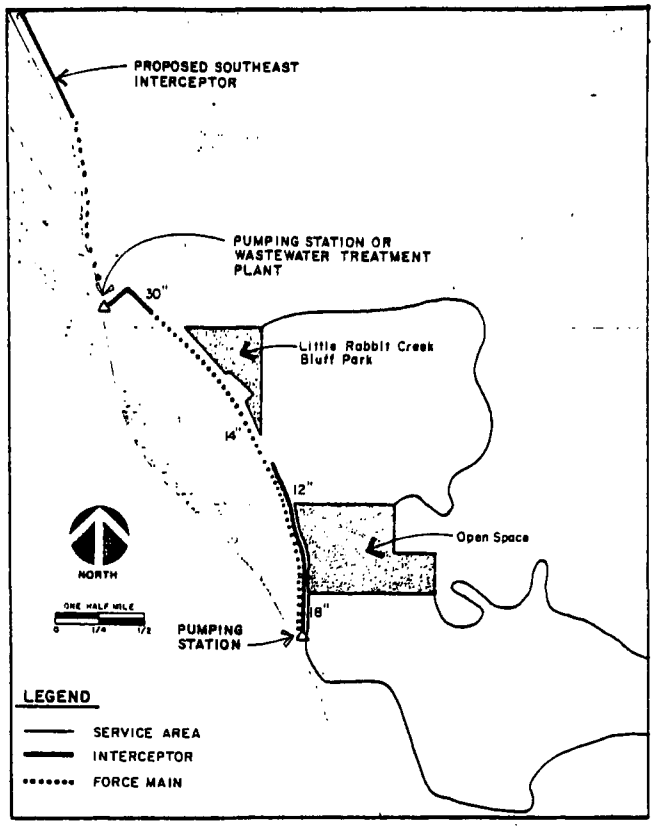
Individual Treatment Systems

On-site wastewater dispoal units, studied by the MOA Physical Planning Department and described in the Hillside Wastewater Management Plan, will be discussed in Chapter 4.



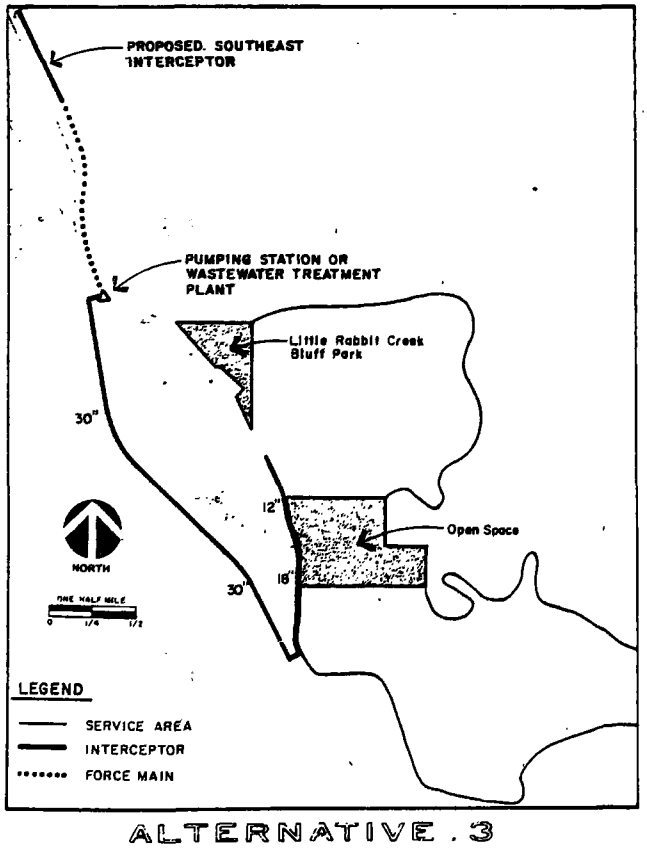
ALTERNATIVE 1

GRAVITY FLOW
TO RABBIT CREEK



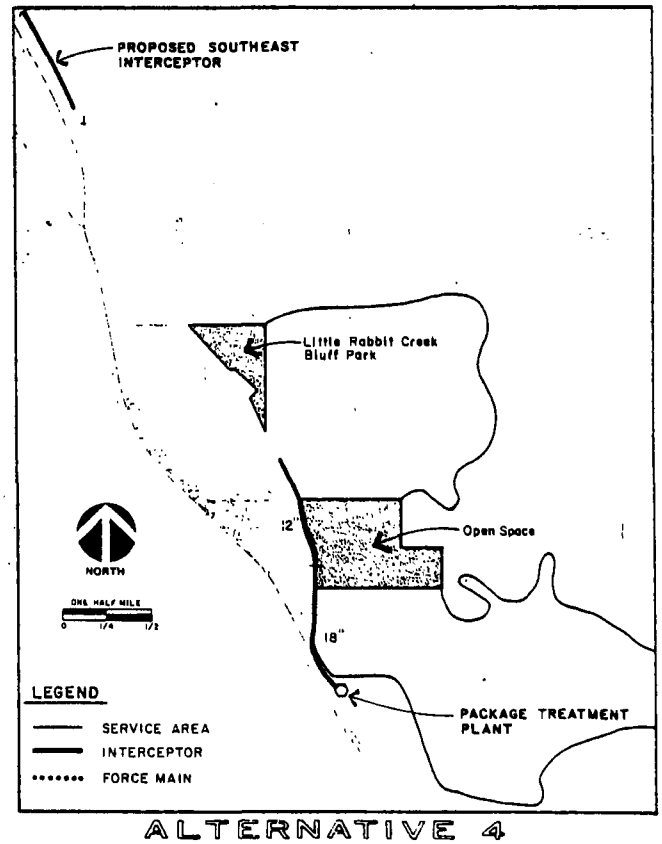
ALTERNATIVE 2

GRAVITY FLOW TO POTTER, PUMP STATION
AND FORCE MAIN TO RABBIT CREEK



ALTERNATIVE 3

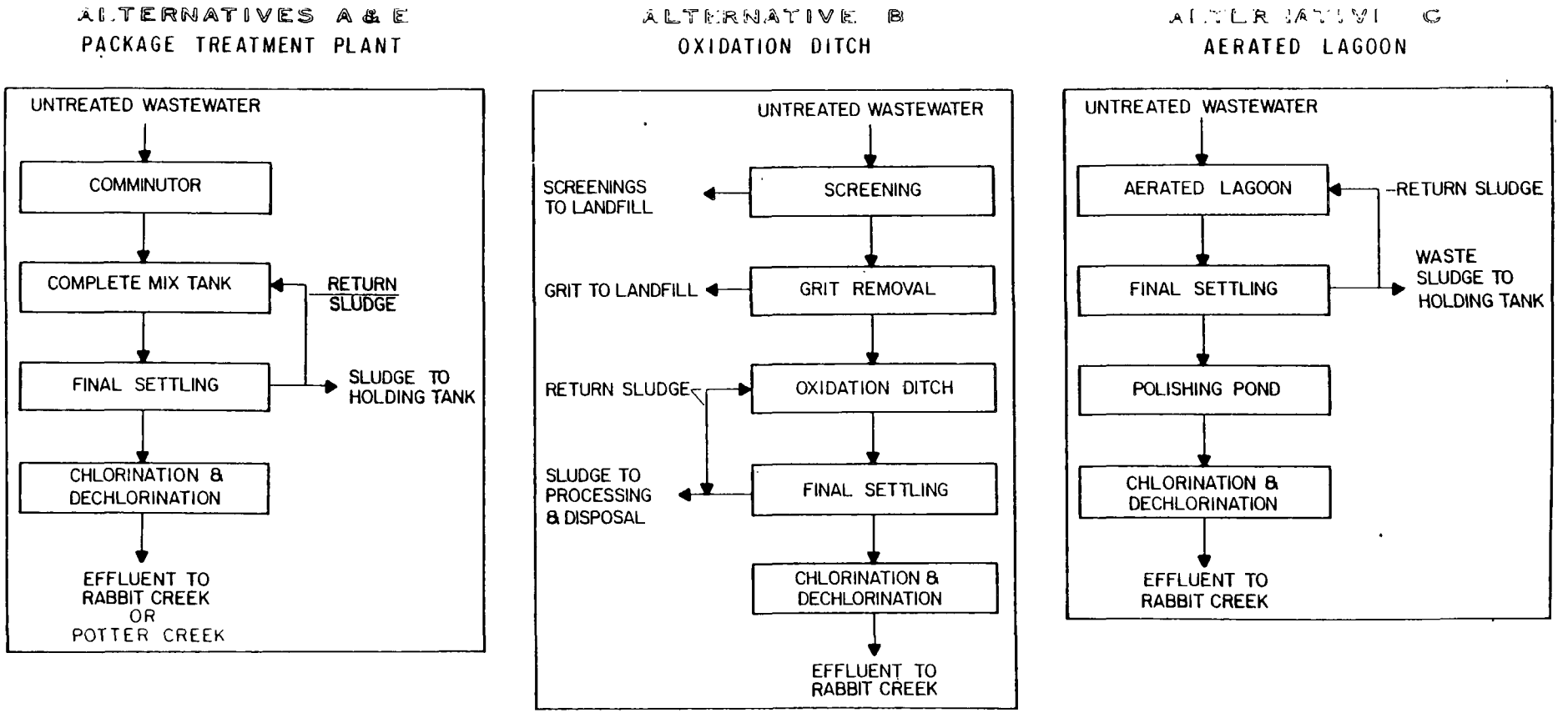
GRAVITY FLOW
TO RABBIT CREEK



ALTERNATIVE 4

GRAVITY FLOW
TO POTTER CREEK

FIGURE 3-9. RABBIT CREEK - POTTER CREEK ALTERNATIVES



SOURCE: MOA, 1982

FIGURE 3-10. RABBIT CREEK-POTTER CREEK ALTERNATIVE TREATMENT PROCESS DIAGRAMS

Cost Summary

Federal regulations require that a comprehensive cost analysis of all wastewater treatment plans be undertaken. The most cost-effective plan is defined as the lowest present-worth alternative that meets water quality standards in the absence of overriding non-monetary costs. Present-worth evaluation is the method most commonly applied to evaluate the cost of alternative facilities. Present-worth evaluations include:

- Probable construction costs: engineering, legal and administrative fees, contingencies and interest.
- Operation and maintenance: labor, materials, supplies, spare parts, chemicals and power, usually on an annual basis.
- Remaining value of improvements: Value of facilities at the end of the planning period.

Table 3-3 shows the criteria used to determine the costs of the above present-worth components. Tables 3-4 through 3-10 show present-worth alternatives described in this chapter.

Present-worth costs for the outfall extension and diffuser are not included in the tables. A 1,500-foot outfall extension is estimated to cost $5,660,000, and a 1,000-foot diffuser is estimated to cost $3,770,000 (MOA 1982).

User Costs

Costs to individual MOA sewer customers would increase as a result of expansion of the wastewater facilities (Table 3-11). Those customers served by sewers would sustain a rate increase estimated at from 22 percent to 34 percent in 1985, and 30 percent to 40 percent in 1999 as a result of the Recommended Plan, depending on funding sources for construction.

The low range in these estimates assumes that U. S. EPA would provide 75 percent construction funding for the Point Woronzof WWTP improvements, and the State would provide an additional 12.5 percent; that the State would fund 50 percent of all other expansion; and that local funds would comprise the balance. The high range assumes no U. S. EPA funding, but rather that all construction cost funding would be 50 percent State and 50 percent local. In both cases, all repair and rehabilitation work, as well as maintenance and operating costs, would be paid with 100 percent local funds.

The above estimates also assume that the rates for sewer service will be raised to reflect the actual local operating costs by 1985.

Comparable cost data are not available for the Hillside area.

Cost information has been excerpted from a preliminary draft of the Executive Summary of the facilities plan. U. S. EPA has expressed concerns that cost assumptions be consistent with U. S. EPA requirements (see Appendix A).

It should be noted that U. S. EPA may participate in funding certain interceptor sewers, depending on timing of the projects. Section 10(b) of PL 97-117 limits the eligible reserve capacity in an interceptor to 40 years if the interceptor was funded under a Step 3 grant awarded prior to December 29, 1981. For all interceptors subsequently funded under Step 3 grants awarded prior to October 1, 1984, the eligible reserve capacity would be limited to 20 years. After October 1, 1984, only that capacity for existing needs would be grant eligible.

The May 12, 1982 interim final construction grant regulations (40CFR 35.2123) reiterate the funding limitations contained under Section 10(b). They also allow Step 3 grant participation in reserve capacity up to 40 years for the remaining segments of an interceptor providing that an initial segment of the interceptor had received Step 3 funds prior to December 29, 1981. Where the first segment was awarded after December 29, 1981, but before October 1, 1984, the entire interceptor may be eligible up to the 20-year capacity.

Table 3-3. Present-Worth Component Criteria

• Planning Period (1985 - 2005)	20 years
• Service Life -	
Structures	50 years
Pipelines	50 years
Equipment	20 years
Basins	30 years
Package Treatment Plants	10 years
Package Pump Stations	20 years
• Land Costs	$75,000/acre
• Interest Rate	7.625%
• Inflation Rate (for land costs only)	3% per year
• All Costs Adjusted to	Dec. 1981 Price Levels
• Allowances for Engineering, Legal & Administrative Costs	15%
• Contingencies	15%
• Interest during Construction	(I)(P/2)(C)

I = Interest Rate
P = Construction Period in Years
C = Total Capital Costs

Source: Wastewater Facilities Plan for Anchorage, Alaska June 1982

Table 3-4. Present Worth Summary

Point Woronzof Primary Treatment
Expansion Alternatives

	Alternative PA-1 ($ x 10^3)	Alternative PB-1 ($ x 10^3)	Alternative PA-2 ($ x 10^3)
Probable Construction Cost	20,720	20,605	23,685
Engineering, Legal & Administrative Costs	3,108	3,091	3,553
Contingencies	3,574	3,554	4,086
Interest During Construction	1,045	1,039	1,194
TOTAL PROJECT COST	$28,447	$28,289	$32,518
Present Worth Remaining Value (-)	-2,252	-2,106	-2,870
Average Annual O&M Cost	(2,422)	(2,837)	(2,597)
Present Worth Average Annual O&M Cost	24,458	28,659	26,226
TOTAL PRESENT WORTH	$50,653	$54,842	$55,873
Average Annual Equivalent Cost	($ 5,016)	($ 5,431)	($ 5,533)

Source: Anchorage Wastewater Facilities Plan
June 1982

Table 3-5. Present Worth Summary

Point Woronzof Secondary Treatment
Expansion Alternatives

	Alternative SA-1 ($ x 10^3)	Alternative SA-2 ($ x 10^3)	Alternative SB-1 ($ x 10^3)
Probable Construction Cost	47,927	51,817	45,233
Engineering, Legal & Administrative Costs	7,189	7,772	6,785
Contingencies	8,267	8,938	7,803
Interest During Construction	4,833	5,225	4,561
TOTAL PROJECT COST	$ 68,216	$ 73,752	$ 64,382
Present Worth Remaining Value (-)	-1,257	-1,388	-1,006
Average Annual O&M Cost	(3,944)	(4,548)	(4,648)
Present Worth Average Annual O&M Cost	39,828	45,927	46,937
TOTAL PRESENT WORTH	$106,787	$118,291	$110,313
Average Annual Equivalent Cost	($ 10,575)	($ 11,714)	($ 10,924)

Source: Anchorage Wastewater Facilities Plan, June 1982

Table 3-6. Present Worth Summary

Incinerator Ash Disposal
Alternatives

	Alternative 1 Ash to Landfill	Alternative 2 Ash to Outfall	Alternative 3 Ash to Lagoon
Probable Construction Cost	$287,800	$134,100	$437,400
Engineering, Legal & Administrative Costs	43,200	20,100	65,600
Contingencies	49,700	23,100	75,500
Interest During Construction	7,300	3,400	11,000
TOTAL PROJECT COST	$388,000	$180,700	$589,500
Present Worth Remaining Value		--	
Average Annual O&M Cost	(80,300)	(39,000)	(39,000)
Present Worth Average Annual O&M Cost	810,900	394,200	394,200
TOTAL PRESENT WORTH	$1,198,900	$574,900	$983,700

Source: Anchorage Wastewater Facilities Plan
June 1982

Table 3-7. Present Worth Summary

West Bypass Interceptor Extension
Alternatives

	78-inch Interceptor Open Trench ($ x 10^3)	78-inch Interceptor Open Trench & Tunnel ($ x 10^3)	Pump Station and Force Main ($ x 10^3)
Probable Construction Cost	11,154	10,773	6,234
Engineering, Legal & Administrative Costs	1,673	1,616	935
Contingencies	1,924	1,858	1,075
Interest During Construction	562	543	314
TOTAL PROJECT COST	$15,313	$14,790	$8,558
Present Worth Remaining Value (-)	-1,805	-1,743	-905
Average Annual O&M Cost	(10)	(10)	(128)
Present Worth Average Annual O&M Cost	101	101	1,300
TOTAL PRESENT WORTH	$13,609	$13,148	$8,953
Average Annual Equivalent Cost	($ 1,348)	($ 1,302)	($ 887)

Source: Anchorage Wastewater Facilities Plan
June 1982

Table 3-8. Present Worth Summary

Rabbit Creek/Potter Creek
Collection Alternatives

	Alternative 1 ($ x 10^3)	Alternative 2 ($ x 10^3)	Alternative 3 ($ x 10^3	Alternative 4 ($ x 10^3)
Construction Cost	1,838	2,327	2,599	779
Engineering, Legal & Administrative Costs	276	349	390	117
Contingencies	317	401	448	134
Interest During Construction (6 mos.)	93	117	131	39
Right-of-Way Costs	1,100	-	-	-
TOTAL PROJECT COST	$3,624	$3,194	$3,568	$1,069
Present Worth Remaining Value (-)	-754	-377	-421	-126
Average Annual O&M Cost	-	(35)	-	-
Present Worth O&M Cost	-	353	-	-
TOTAL PRESENT WORTH	$2,870	$3,170	$3,147	$ 943
Average Annual Equivalent Cost	($ 284)	($ 314)	($ 312)	($ 93)

Source: Anchorage Wastewater Facilities Plan
June 1982

Table 3-9. Present Worth Summary

Rabbit Creek Treatment
Alternatives

	Alternative A Package Unit ($ x 10^3)	Alternative B Oxidation Ditch ($ x 10^3)	Alternative C Aerated Lagoon ($ x 10^3)	Alternative D Pump Station & Force Main ($ x 10^3)
Probable Construction Cost	1,458	2,452	2,511	986
Engineering, Legal & Administrative Costs	219	368	377	148
Contingencies	252	423	433	170
SUBTOTAL	$1,929	$3,243	$3,321	$1,304
Interest During Construction	74	124	127	50
TOTAL PROJECT COST	$2,003	$3,367	$3,448	$1,354
Present Worth of Expansion at 1995	1,321			
Present Worth Remaining Value (-)	-0	-219	-222	-122
Average Annual O&M Cost	(316)	(320)	(294)	(32)
Present Worth Average Annual O&M Cost	3,196	3,236	2,969	323
TOTAL PRESENT WORTH	$6,520	$6,384	$6,195	$1,555
Average Annual Equivalent Cost	$ (646)	$ (632)	$ (613)	$ (154)

Source: Anchorage Wastewater Facilities Plan
June 1982

Table 3-10. Present Worth Summary

Rabbit Creek/Potter Creek Collection and Treatment Alternatives

Alternatives	Treatment Cost ($ x 10^3)	Collection Cost ($ x 10^3)	Total Present Worth ($ x 10^3)	Ranking
A - 1	6,520	2,655	9,175	
A - 2	6,520	2,674	9,174	
A - 3	6,520	2,920	9,440	
A - 4	6,520	704	7,224	3
B - 1	6,384	2,655	9,039	
B - 2	6,384	2,674	9,058	
B - 3	6,384	2,920	9,304	
C - 1	6,213	2,655	8,868	
C - 2	6,213	2,674	8,887	
C - 3	6,213	2,920	9,133	
D - 1	1,320	3,975	3,975	1
D - 2	1,320	3,994	3,994	1
D - 3	1,320	4,240	4,240	2

Source: Anchorage Wastewater Facilities Plan, June 1982

Table 3-11. Estimated Changes in Single-Family Monthly Service Charge for Sewer Service

	Current Rates	Required 1985 Rates No Projects	1985 Rates with Projects	1990 Rates with Projects	1995 Rates with Projects	1999 Rates with Projects
Scenario 2[2]	$7.50	$12.68	$15.47	$15.75	$14.78	$13.95
Scenario 3[3]	7.50	12.68	17.03	17.03	15.09	15.00

[1] Additional revenues required to pay for status quo system.

[2] 75 percent, U. S. EPA, 12.5 percent funding of Point Woronzof; 50 percent funding of all other projects; remainder from local funds.

[3] 50 percent state funding for all projects; 50 percent local funding.

Chapter 4

Wetland Issues

- Legal, Regulatory and Policy Constraints
- Issue Summary
- Habitat Types
- Biological Setting of Potter's Marsh
- Biological Setting of Tidal Wetlands
- Hydrological Setting
- Human Use Setting
- Wetland Impacts

Chapter 4

WETLAND ISSUES

The Anchorage Bowl contains numerous nontidal wetland areas that comprise an estimated 9,400 acres, or 15 percent of the 64,000-acre area of the Bowl bounded by the military reservations and state park. An additional 2,300 acres of tidal wetlands are incorporated into the Potter Point State Game Refuge. These wetlands provide fish and wildlife habitat, open space and hydrologic benefits, and recreational opportunities. They are potentially susceptible to significant impacts from sewerage facilities expansion, both directly from sewer interceptor construction, and indirectly from facilitation of urban growth through the provision of new sewerage facilities. Wetlands are shown on Figure 4-1.

Legal, Regulatory and Policy Constraints

The nation's wetlands are of federal as well as local concern, as evidenced by Presidential and Congressional actions. U. S. EPA's federal interest in the wetlands through the EIS process stems from these federal statutes and policy directives.

Executive Order No. 11990, "Protection of Wetlands", issued May 24, 1977 directs that "Each agency shall provide leadership and shall take action to minimize the destruction, loss or degradation of wetlands and to preserve and enhance the natural and beneficial values of wetlands". It requires that "...each [federal] agency to the extent permitted by law shall avoid undertaking or providing assistance for new construction located in wetlands unless the head of the agency finds: 1) that there is no practicable alternative to such construction, and 2) that the proposed action includes all practicable measures to minimize harm to wetlands which may result from such use. In making this finding the head of the agency may take into account economic, environmental and other pertinent factors."

The U. S. COE has extensive responsibility for the protection of wetlands under Section 404 of the Clean Water Act. Any excavation or filling conducted in a wetland must be carried out under a permit issued by the U. S. COE. The U. S. Department of Interior, USFWS, under authority from Executive Order No. 11990, Migratory Bird Act, Fish and

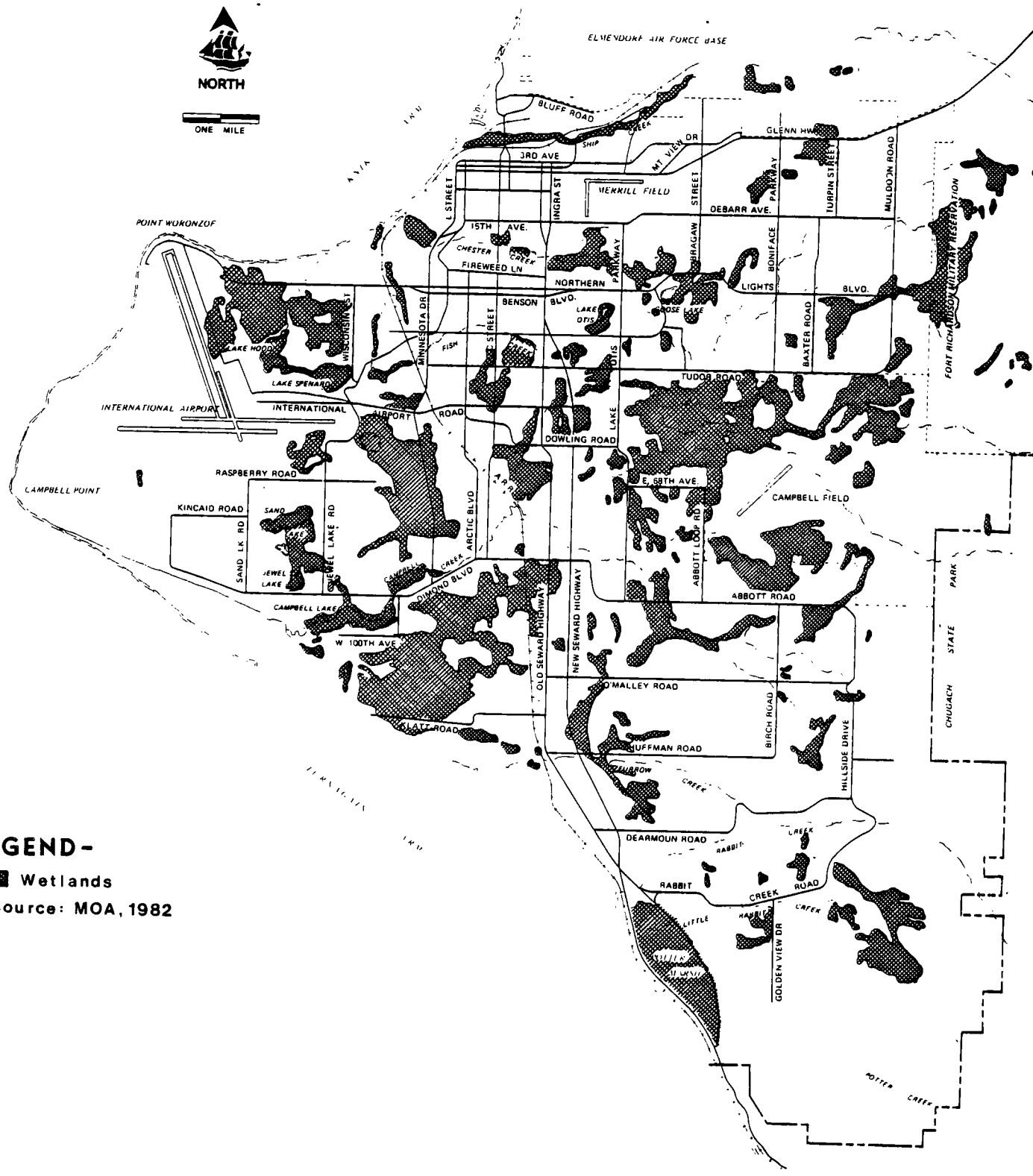


FIGURE 4-1. WETLANDS

Wildlife Coordination Act and 40 CFR 230, is given the responsibility for evaluating the impact a project will have on wetlands and providing comments and recommendations to the U. S. COE. The U. S. COE takes these recommendations and those of other agencies such as the Alaska DFG and ADEC under consideration to determine if a 404 permit will be granted.

Local concern about Municipality wetlands has been expressed in the development of a wetlands management plan by the MOA. The plan applies four classifications to the wetland areas: 1) wetland areas classified as "preservation" would be managed or protected in their natural conditions. Activities that would enhance, restore or preserve the natural character of wetlands would be allowed. (This category covers about 3,800 acres of nontidal wetland, or about 40 percent of the remaining nontidal wetland areas in the Anchorage Bowl.) 2) Wetland areas classified as "conservation" could be developed subject to conserving "their natural functions and values to the maximum extent practicable" (MOA 1982c). Development would be allowed on fringes and in "less critical wetland areas." (This category covers about 400 acres, or about 5 percent of the remaining nontidal wetlands.) 3) Wetland areas classified as "development" or "developable" could be urbanized. (This category covers about 5,200 acres of nontidal wetland, or about 55 percent of the remaining nontidal wetland areas in the Anchorage Bowl.) A subcategory of developable wetlands is the classification "mixed development." This refers to developable wetlands in low density zoned areas, specifically the Hillside area. 4) Wetland areas classified as "special study" cover a few areas where more information is required on environmental values. These would be studied and classified in one of the three foregoing categories.

The Municipality's plan was adopted by the Assembly on April 20, 1982. The plan constrains the use of wetlands by landowners, developers, public agencies, and citizens.

Issue Summary

The sewerage facilities plan includes installation of interceptor sewers that traverse wetland areas. The facilities plan also may facilitate population growth, thereby accelerating pressure to develop wetlands. These potential impacts of the facilities plan on wetlands are of concern because wetlands typically have hydrological, open space and biological values beneficial to the public at large. Wetland areas in Anchorage are under increasing development pressure as the available land supply decreases and population growth and urban development continue.

Hydrological values of wetlands include retention of rainfall and snowmelt runoff, augmentation of stream base flow, water quality benefits, and groundwater recharge. Loss of wetlands could result in elevated flood and erosion risks, and alteration of stream flow and water quality.

Wetlands are a valuable aesthetic and recreational resource to many citizens of Anchorage. Loss of open space and natural areas within the Municipality, including wetlands, will have an impact on the perception of quality of life.

Biological resources associated with wetland areas in Anchorage have not been studied or reported in detail. Concern has been expressed that sewerage decisions may precipitate losses of undefined wetland values, including the inadvertent loss of biological resources dependent on wetland habitats.

Biological Setting of Nontidal Wetlands

This section of the EIS describes the biological setting of freshwater wetlands within the Anchorage Bowl that are analyzed and evaluated in the EIS. The study area, methods of study, principal findings, and the biological resources of these wetlands are described based on extant data and 1981 field work.

Study Area and Methods

Anchorage is located in an area whose climate is transitional between maritime climatic and continental climatic zones (Hartman and Johnson 1978). Although forested areas in Anchorage are transitional, (i.e., contain some species found only in the maritime forests and other species found only in interior Alaska), open bog areas are generally similar to those found in interior Alaska.

Two wetland areas in the Anchorage Bowl were selected to receive special attention in describing existing conditions of wetlands potentially impacted by the facilities plan. Campbell-Klatt Bog, between Campbell Creek and Klatt Road, was studied as a large, representative wetland with relatively minimal impact by human activities. Connors Lake Bog, between Campbell Creek and International Airport Road, was studied as a large, representative wetland surrounded by development and currently crossed by sewer facilities and a road network.

Recent (1980) aerial photographs of these wetland areas were obtained, and habitats identified using photo-interpretation techniques. Preliminary maps of wetland habitats were prepared by vegetation type, and were ground checked as necessary. Field studies were done during September 10-18, 1981 to survey small mammal occurrence by habitat types. Sherman live traps (408 trap nights) were used

to ascertain small mammal occurrence; in addition, mammal signs (e.g., scat, evidence of feeding activity, tracks, burrows) were noted to augment other data. Incidental sightings of bird use by habitat type also were noted.

Based on available information, including the field work conducted during preparation of this EIS, a general description of the biological resources of wetland habitats in the Anchorage Bowl is presented.

Habitat Types

Wetlands in the Anchorage Bowl include: tidal marshes at the base of the bluffs along Turnagain Arm and Knik Arm; Potter Marsh, located between Old Seward Highway and the Alaska Railroad embankment and isolated from direct tidal influence by tidal gates; and inland black spruce and treeless bogs, which are not affected by tidal action. The vegetation of Potter Marsh and the coastal marshes between Campbell Point and Potter Marsh has been previously described (U. S. COE 1978b; Batten et al. 1978; Macdonald 1980; Alaska DFG 1981a). The vegetation of inland bogs (black spruce bogs and treeless bogs) in Anchorage has not been described prior to the current study.

A number of schemes have been devised to classify or characterize various wetland habitats, (e.g., U. S. COE 1978a; Cowardin et al. 1979; Batten 1980; Viereck and Dyrness 1980; Viereck et al. 1981). Differences in these schemes are based on their purposes and levels of division of vegetation types into component habitats. The classification scheme of Viereck et al. (1981) is used here, but an effort also is made to relate this scheme to the USFWS (Cowardin et al. 1979) classification system.

This survey of inland wetlands in the Anchorage Bowl identified 11 habitat types (Table 4-1) based on vegetation. (Nomenclature used in this report for the habitat types is that used at Level IV by Viereck et al. [1981].) Maps of the wetland habitats as delineated in 1981 in Campbell-Klatt Bog and Connors Lake Bog are presented (Figures 4-2 and 4-3). Three of the habitats mapped in Figures 4-2 and 4-3 combine certain of the habitat types identified in Table 4-1 for reasons described below. The 11 habitat types are discussed below.

Open Water. This habitat category is broadly defined, because it includes a range of open water habitat types in the Anchorage wetlands. It is not identified at Level IV of Viereck et al. (1981), but is nearly equivalent to pond and lake habitat at Level III (Table 4-1). Waterlily (Nymphaea spp.) and submerged forms of Ceratophyllum, Potamogeton and a few other aquatic plants grow in larger, deeper, more permanent

Table 4-1. Habitats Identified in Inland Wetland Areas of the Anchorage Bowl. Nomenclature of Habitats is that of Viereck et al. (1981). The Equivalent USFWS Designation (Cowardin et al. 1979). is also Presented.

Level I	Level II	Level III	Level IV	USFWS
Aquatic	Freshwater	Ponds and lakes	Open water*	L1OWH or POWF or PEM5
Herbaceous	Sedge-grass	Sedge-grass bog meadow	Subarctic lowland sedge bog meadow	PEM5
Shrubland	Low shrub	Open low shrub	Dwarf birch-ericaceous shrub-sphagnum bog	P $\frac{SSI}{EM5}$ B
Shrubland	Low shrub	Open low shrub	Sweetgale-sphagnum bog	P $\frac{SSI}{EM5}$ B
Forest	Conifer forest	Conifer woodland	Black spruce (woodland, canopy 10-25%)	P $\frac{SSI}{FO4}$ B
Forest	Conifer forest	Open conifer forest	Black spruce (open forest, canopy 25-60%)	PFO4B
Forest	Conifer forest	Closed conifer forest	Black spruce (closed forest, canopy 60-100%)	PFO4B
Forest	Mixed conifer and deciduous forest	Closed mixed forest	Spruce-birch (closed forest, canopy 60-100%)	P $\frac{FO4}{FO1}$ B
Forest	Deciduous forest	Closed deciduous forest	Paper birch (closed forest)	Not classified
Herbaceous	Tall grass	Bluejoint-herb	Bluejoint-fireweed	PEM5
Shrubland	Tall shrub	Closed tall shrub	Alder	PSS1

*Approximately equivalent to "ponds and lakes" habitat (Level III) of Viereck et al. (1981).

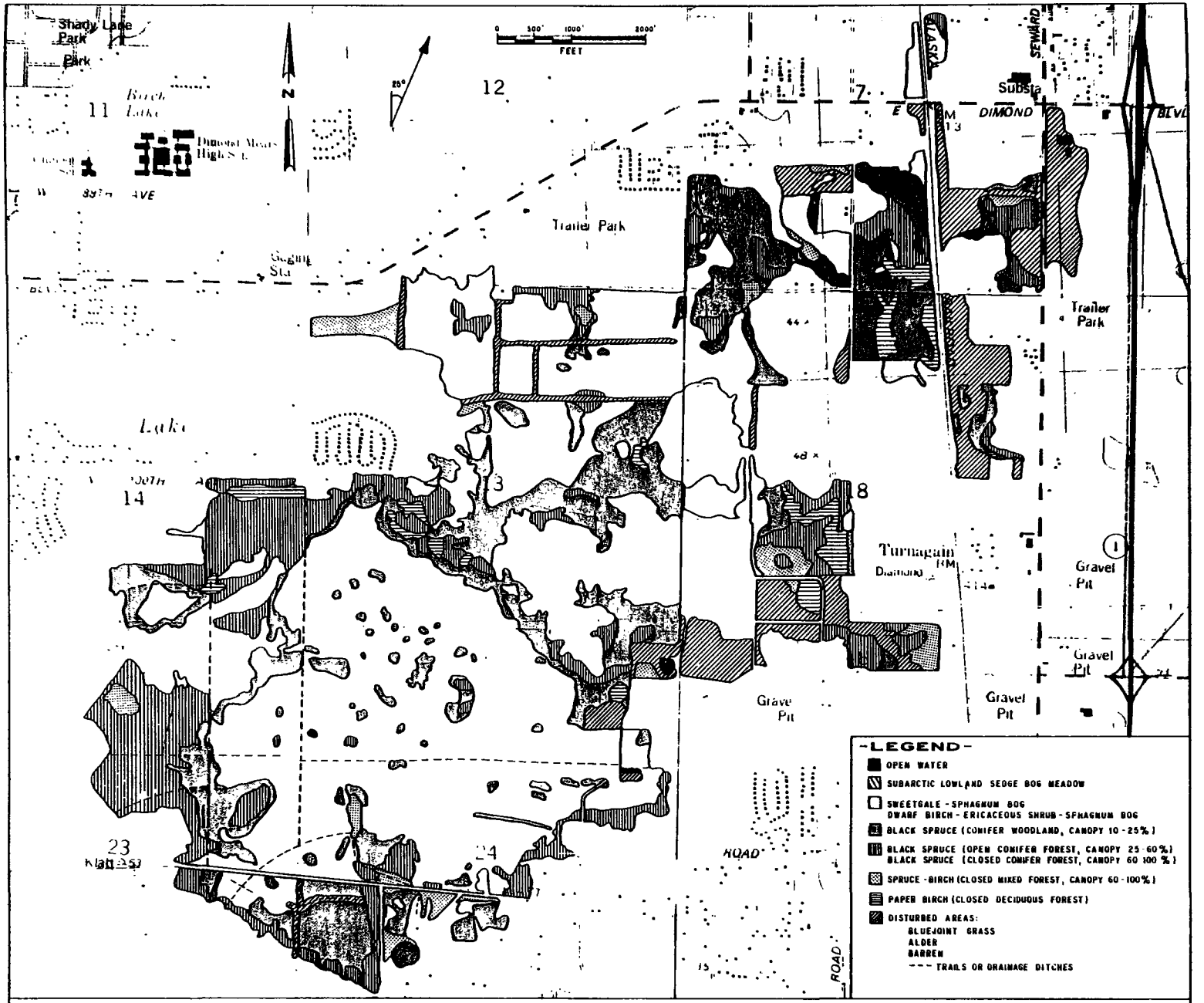


FIGURE 4-2. CAMPBELL KLATT BOG

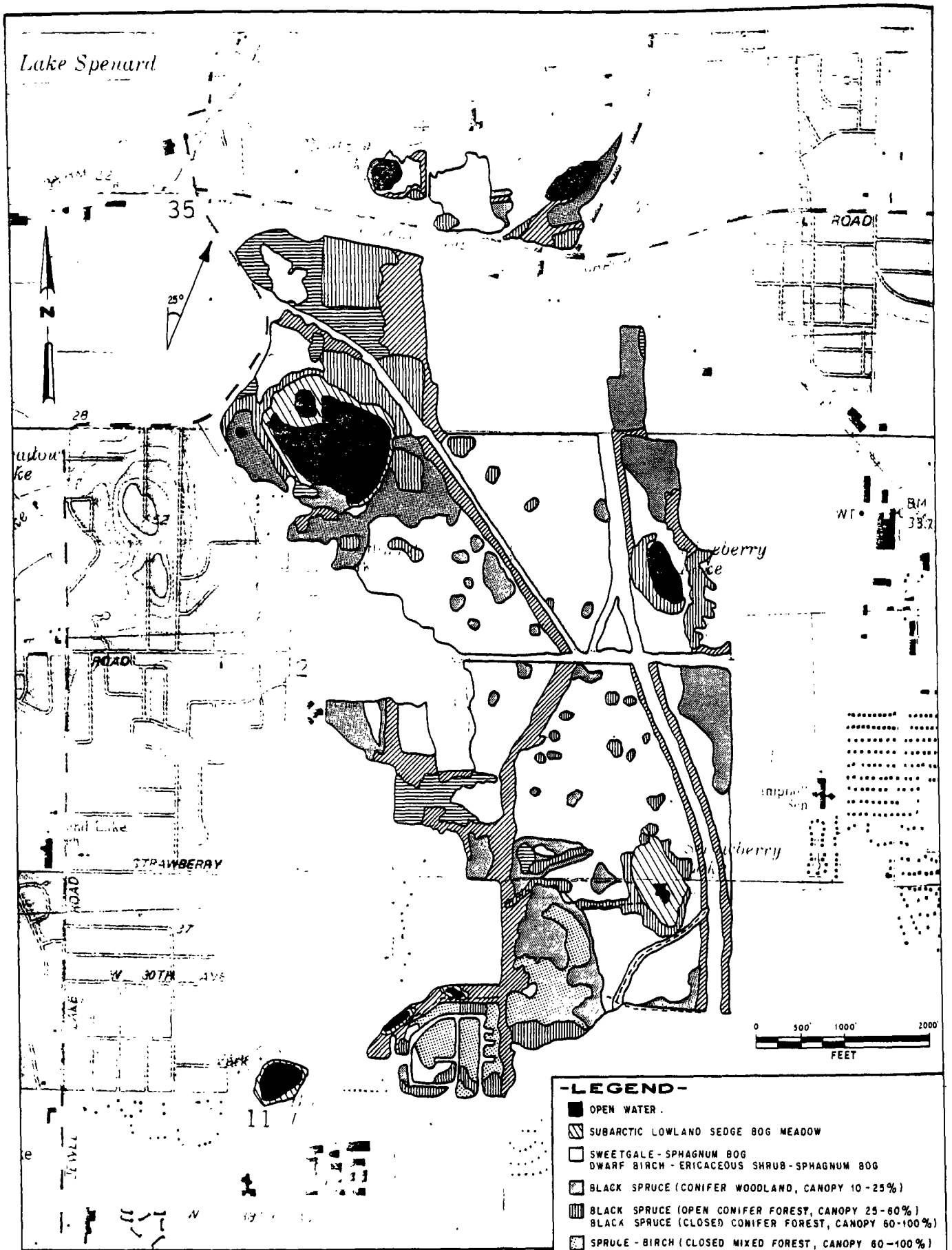


FIGURE 4-3. CONNORS LAKE BOG

bodies of water such as Connors Lake. Bladder wort (Utricularia sp.) and sedges frequently are found in small, shallow ponds, potholes and depressions. Cowardin et al. (1979) classify the former as permanent limnetic open water (L1OWH), and the latter as semipermanent palustrine open water (POWF) or emergent, palustrine, persistent, narrow-leaved vegetation (PEM5).

Subarctic Lowland Sedge Bog Meadow. This habitat type is usually found on very wet sedge peat, often with standing water present in areas of poor drainage. Sedge bog meadows can be found on quaking mats on the margins of open standing water. Carex spp. are very common; cottongrass (Eriophorum spp.) frequently is found in stands near the drier margins of the sedge meadow. Buckbean (Menyanthes trifoliata) and arrowgrass (Triglochin maritimum) also are common in this habitat. Cowardin et al. (1979) classify this habitat as palustrine, persistent, narrow-leaved emergent vegetation (PEM5).

Dwarf Birch-Ericaceous Shrub-Sphagnum Bog/Sweetgale-Sphagnum Bog. This habitat is a combination of two separate Level IV open low shrub bog habitats recognized by Viereck et al. (1981). Because of the topographic patterns characteristic of these bogs, i.e., linear peaty ridges separating wetter, often sedgy basins, these two habitat types are not easily distinguished or mapped at a scale of 1:12,000. Consequently, these two similar habitats, recognizable in the field, are combined on the vegetation maps of Connors Lake Bog and Campbell-Klatt Bog. Sphagnum spp. and other mosses form the ground cover and much of the peat, and often form hummocks or linear ridges. Dwarf birch (Betula nana), bog-rosemary (Andromeda polifolia), narrow-leaf Labrador-tea (Ledum decumbens), and bush cinquefoil (Potentilla fruticosa) account for much of the taller shrub species on hummocks and ridges. Additional species frequently observed are: crowberry (Empetrum nigrum); leatherleaf (Chamaedaphne calyculata); mountain cranberry or lingenberry (Vaccinium) vitis-idaea); bog blueberry (V. uliginosum); bog cranberry (V. oxycoccos); cloudberry (Rubus chamaemorus); alpine blueberry (Arctostaphylos alpina); and scattered black spruce (Picea mariana) displaying stunted growth forms less than 1 m high. Wetter sites have sweetgale (Myrica gale), marsh five-finger (Potentilla palustris), horsetail (Equisetum fluviatile), buckbean (Menyanthes trifoliata), and sedges. Cowardin et al. (1979) classify these habitats as saturated, palustrine, narrow-leaved, persistent emergent vegetation and broadleaved, deciduous shrub habitat ($P\frac{SSI}{EM5}B$)

Black Spruce (Conifer Woodland, Canopy 10-25 Percent). Many of the species in this habitat also are associated with the dwarf birch-ericaceous shrub-sphagnum bog habitat, but in this habitat stunted black spruce (Picea mariana) less than 2 m in height forms a distinct third canopy layer above the sphagnum moss and shrubs. Ericaceous shrubs are more common, and sweetgale (Myrica gale) is less common relative to the open low shrub bog habitat. Although stunted black spruce trees can be found in the open low shrub bog, they do not form a recognizable stand as they do in this habitat. The stunted black spruce in this habitat type are usually distinguishable from the taller growth forms of the open and closed black spruce forest. Under the Cowardin et al. (1979) classification system, this habitat is saturated, palustrine broad-leaved deciduous shrub and needle-leaved evergreen habitat $\left(P\frac{SSI}{F04}B\right)$.

Black Spruce (Open Forest, Canopy 25-60 Percent/Closed Forest, Canopy 60-100 Percent). These two habitat types, distinguished by Viereck et al. (1981), are not clearly delineated from each other in the wetlands of the Anchorage Bowl. Black spruce (Picea mariana) forms the overstory in both habitats to a height of about 5-12 m. Paper birch (Betula papyrifera) also may occur as part of the overstory. Dwarf birch (Betula nana) and Labrador-tea (Ledum groenlandicum) comprise a mid-level canopy over the moss understory. Additional species frequently observed are: bog blueberry (Vaccinium uliginosum), lingenberry (V. vitis-idaea); cloudberry (Rubus chamaemorus); crowberry (Empetrum nigrum); and bog-rosemary (Andromeda polifolia). Generally, the shrub understory displays a taller and more lush growth form relative to the open low shrub bog and black spruce woodland. These two habitats are classified as saturated, palustrine needle-leaved evergreen habitat (PFO4B) under the Cowardin et al. (1979) system.

Spruce-Birch (Closed Mixed Forest). In some areas of the wetlands, black spruce and paper birch form mixed stands. This habitat type is primarily a transition between the black spruce forest, which is characterized by poorly drained organic soils, and paper birch forest, which is characterized by well-drained organic or mineral soils. Under the Cowardin et al. (1979) classification, this habitat is a mixture of broad-leaved deciduous and narrow-leaved evergreen palustrine habitat on saturated soils $P\frac{FO4}{FOI}B$

Paper Birch (Closed Forest). Paper birch (Betula papyrifera occupies well-drained areas and upland areas bordering the bog. Paper birch predominates, but quaking aspen (Populus tremuloides) also occurs in thickets or small stands. Willows (Salix spp.) and alder (Alnus spp.) also may be present, particularly at edges of disturbed areas (e.g., along roads). The understory is characterized by shrubs such as Labrador-tea (Ledum groenlandicum), devilsclub (Oplopanax horridus), prickly rose (Rosa acicularis), American red currant (Ribes triste), and highbush cranberry (Viburnum edule). Woodland horsetail (Equisetum sylvaticum) forms a dense ground cover where the canopy is closed. Bluejoint grass (Calamagrostis canadensis) and sedges can be found in small open depressions where surface drainage is lacking. This habitat generally is not considered wetland habitat, and is not classified under the Cowardin et al. (1979) system.

Disturbed Areas (Bluejoint-Fireweed/Alder). Disturbed wetland areas include drainage ditches, road cuts and similar areas which have not been filled or developed. Bluejoint grass (Calamagrostis canadensis) and fireweed (Epilobium angustifolium) are common species in disturbed areas of the open low shrub bog. Alder (Alnus spp.) also is commonly associated with disturbed areas, especially in well drained sites along roads and on higher ridges of the disturbed areas.

Roads and trails cut through the bogs and allowed to lie fallow generally are colonized by bluejoint or alder. Bluejoint grass grows under a wide array of edaphic (soil) conditions, ranging from very wet to moderately dry and from organic to mineral soils. Bluejoint grass in wet areas usually indicates that the area experiences slow water movement. Sedges may grow in deep ruts or in areas where water collects. In most cases, peat excavated during construction of a drainage ditch was deposited as a "spoils ridge" to one side of the ditch. These "spoils ridges" generally remain barren at the top for long periods of time, but may be colonized by bluejoint grass near the base. Prickly rose (Rosa acicularis) and small shrubs occasionally grow on peat spoils. Shallowly excavated drainage ditches may be colonized by sedges. Because of the narrowly linear and patchy distribution of these disturbed areas, these habitat types have been generally mapped as disturbed areas in Figures 4-2 and 4-3.

Aquatic Organisms

No data are available which describe the kinds of aquatic organisms found in the shallow ponds and water-filled depressions of the nontidal wetlands in the Anchorage Bowl. Preliminary data obtained by Fugro Northwest, Inc. et al. (1980) on the

quality of surface water in several drainage ditches in Connors Lake Bog and Campbell-Klatt Bog indicate that water quality in many cases does not restrict the occurrence of aquatic organisms. Mosquito larvae probably form a major component of the aquatic invertebrates in bogs. Other insects, small crustaceans, and representatives of other taxa also may occur. The wood frog (Rana sylvaticus) occurs in wetlands in the Anchorage Bowl.

Use of wetlands in the Anchorage Bowl by fish is not well documented. Salmonid species use Campbell Creek, Rabbit Creek, and Ship Creek as spawning and rearing areas (Alaska DFG 1980), but the role of wetlands in these fisheries is poorly understood. Chester Creek is no longer considered a candidate stream for fishery management because of significant negative impacts of stream alteration resulting from development in the drainage basin (Alaska DFG 1974). Nevertheless, juvenile coho salmon have been found in the upper reaches of South Fork Chester Creek during studies by the USFWS (Nickles pers. comm.) and in field work for this EIS.

Threespine sticklebacks (Gasterosteus aculeatus) may occur in some wetland ponds and ditches. Alaska blackfish (Dallia pectoralis), not native to the Anchorage area, was accidentally introduced to Lake Hood in 1948. Since then, blackfish have appeared in Fish Creek and the city sewer system, and are thought to occur in other areas in Anchorage including possibly wetland ponds and ditches (Kubik pers. comm. 1981). Several lakes in the Anchorage area are stocked each year with catchable rainbow trout by the Alaska DFG (1977b). Records exist on the number of fish planted and the harvest and effort (Kubik pers. comm. 1981). Stocking of some of the lakes in the Anchorage Bowl is done primarily to establish a "put and take" fishery. Total harvest of the year's fish plant is desirable because of high winter mortality (Alaska DFG 1977). Experimental plants of grayling occurred in Connors Lake in three successive years, but the experiment was not successful and was discontinued (FAA 1976).

Birds

Wetlands in the Anchorage Bowl provide habitat for a number of bird species. To the casual observer, birds probably represent the most visible wildlife using wetland habitats. Kessel et al. (1967) briefly discuss migration, breeding and nesting activities of birds in the Anchorage area. Selkregg (1972) lists birds potentially or known to be using Anchorage area wetlands. A brief review of migratory activities is presented by Alaska DFG (1977a). Field observations made by Jones & Stokes Associates in September 1981 are summarized in Table 4-2.

Table 4-2. Birds Sighted in Conners Lake Bog and Campbell-Klatt Bog, September 10-17, 1981

Species (Common Name/ Scientific Name)	Location		Habitat Type						Remarks
	Campbell-Klatt Bog	Connors Lake Bog	Open Water and/or Sedge	Open Bog (Dominants <1 m High)	Dwarf Spruce Bog (Dominants 1-5m High)	Birch and/or Alder Thicket	Mature and/or Mixed Forest	Disturbed Areas	
Arctic loon Gavia arctica		x	x						
Mallard Anas platyrhynchos	x	x	x					x	Present in water-filled ruts formed by heavy equipment.
American green-winged teal Anas crecca carolinensis		x	x					x	Present in water-filled ruts formed by heavy equipment.
Greater scaup Aythya marila		x	x						
Marsh hawk Circus cyaneus	x		x	x	x				Foraging over bog; individual perched at edge of spruce/birch forest at south end of Klatt Bog.
Spruce grouse Canachites canadensis	x					x			
Sandhill crane Grus canadensis	x		x						
Killdeer Charadrius vociferus		x	x						
Common snipe Capella gallinago	x	x	x						
Belted kingfisher Megaceryle alcyon		x	x						
Gray jay Perisoreus canadensis	x	x			x	x	x		
Black-billed magpie Pica pica	x	x			x	x	x	x	
Common raven Corvus corax		x						x	
Black-capped chickadee Parus atricapillus	x				x				
Boreal chickadee Parus hudsonicus	x					x	x		

Table 4-2. Cont'd.

Species (Common Name/ Scientific Name)	Location: Campbell-Klatt Bog	Location: Connors Lake Bog	Habitat Type: Open Water and/or Sedge	Habitat Type: Open Bog (Dominants < 1 m High)	Habitat Type: Dwarf Spruce Bog (Dominants 1-5 m High)	Habitat Type: Birch and/or Alder Thicket	Habitat Type: Mature and/or Mixed Forest	Habitat Type: Disturbed Areas	Remarks
American robin *Turdus migratorius*	x							x	
Golden-crowned kinglet *Regulus satrapa*	x						x		
Ruby-crowned kinglet *Regulus calendula*	x	x				x	x		
Northern shrike *Larius excubitor*	x	x			x	x	x		
Common redpull *Carduelis flammea*	x	x				x	x		
Savannah sparrow *Passerculus sandwichensis*	x	x			x	x			
Dark-eyed junco *Junco hyemalis*	x	x			x	x	x		
Tree sparrow *Spizella arborea*	x	x				x	x		
Lapland longspur *Calcarius lapponicus*	x							x	

Waterfowl represent the group of birds most dependent on wetland habitats. Which species use inland wetland habitats for nesting purposes depends a great deal on the size and depth of open water habitat. For example, marsh and pond ducks (dabblers) may make extensive use of potholes in bog areas because they do not require large stretches of open water when initiating flight and forage in shallow water. Diving ducks (bay ducks and sea ducks) require larger and deeper water bodies because they run and patter along the surface when initiating flight and usually dive under water while foraging. Common snipe and sandhill cranes may require little open water habitat in a shrub bog.

Sellers (1979), Eldridge and Rosenberg (1981), and Ritchie et al. (1981) have studied wetland habitat utilization in the upper Cook Inlet area. A number of water birds, including red-throated loon, red-necked grebe, Canada goose, pintail, mallard, green-winged teal, sandhill crane, least sandpiper, northern phalarope, greater and lesser yellowlegs, long-billed dowitcher, common snipe, mew gull, and herring gulls, were found to nest in inland bog habitats. Loons, grebes, diving ducks and mergansers used deeper, larger ponds when these were available in the bog; otherwise, these species were more likely to occur in coastal marsh habitats or on marshes along lakes and creeks.

Potter Point State Game Refuge, southwest Campbell-Klatt Bog, lower Campbell Creek, Connors Lake Bog, Heather Meadows, Lake Spenard, Hood Lake and Turnagain Bog are major nesting and brood-rearing areas for waterfowl in the Anchorage area. Sandhill cranes utilize Campbell-Klatt Bog, and Canada geese nest in Potter Marsh, Campbell-Klatt Bog, and Heather Meadows (Nickles pers. comm.). Although concentrated in only a few wetland areas, nesting and brood-rearing occurs in many wetlands in the Anchorage Bowl. During field surveys in early July 1982, numerous small bogs with little or no open water habitat were noted for large numbers of white-crowned sparrows (Zonotrichia leucophrys), least sandpipers (Erolia minutilla) and yellowlegs (Totanus spp.). Although a few pairs of birds nesting in various ponds and bogs may seem insignificant relative to an area supporting many pairs (e.g., Potter Marsh), in cumulative numbers the nontidal wetlands of the Anchorage Bowl may support a significant proportion of the waterfowl occurring and nesting in the Anchorage area.

Mammals

Selkregg (1972) has listed the mammal species most likely to occur in the bogs and marshes of the Anchorage Bowl. Field surveys conducted in September 1981 by Jones & Stokes Associates have provided further information on the mammalian fauna of Anchorage Bowl wetlands. Prior to this recent effort, no studies had been undertaken either to verify the occurrence of the species listed by Selkregg (1972) or to identify specific wetland habitats used.

Field data collected by Jones & Stokes Associates in September 1981 confirmed the presence of 10 species of mammals in wetland habitats of the Anchorage Bowl. Redbacked vole (Clethrionomys rutilus), masked shrew (Sorex cinereus), dusky shrew (S. obscurus), shorttailed weasel (Mustela erminea) and house mouse (Mus musculus) were live-trapped in wetland habitats (Table 4-3). Scats of coyotes (Canis latrans), snow shoe hares (Lepus americanus), red fox (Vulpes fulva), and moose (Alces alces) were frequently encountered in wetland areas surveyed. A coyote was sighted in Campbell-Klatt Bog, and red squirrels (Tamiasciurus hudsonicus) were observed in birch forest and mixed birch-black spruce forest habitats.

Red-backed voles were trapped most often, and probably were the most abundant small mammals in the wetland habitats. Bangs (pers. comm.) found that red-backed voles and masked shrews were the most abundant small mammals in lowland forests of the Kenai National Wildlife Refuge, and that capture success was greater in mature forest than in stands of black spruce regrowth.

The field data collected during this study do not provide a clear picture of Level IV habitat preference by red-backed voles (Table 4-3). Many of the habitats as defined at Level IV especially disturbed areas along drainage ditches and sedge bog meadows, are very small and patchily distributed within the wetland. Traps set in these habitats frequently were within 1 m of an adjacent Level IV habitat type. A study of Level IV habitat preference was impractical. If all wetland habitat types were combined into four broad categories, as shown in the lower half of Table 4-3, the preliminary data suggest that red-backed voles were more likely to be trapped in forested areas than in open habitats (i.e., open bog or black spruce woodland). Red-backed voles also were present, however, in grassy areas along drainage ditches (disturbed areas) in the study area (Table 4-3). Bangs (pers. comm.) considers good cover from 1-12 inches above the moss or ground layer to be crucial to voles. The summer diet of voles at Kenai National Wildlife Refuge is 50 percent fungus and 30 percent low bush cranberry. A major fraction of the fungus is hypogeoid fungus, which is associated with underground tree roots (Bangs pers. comm.).

Table 4-3. Mammals Trapped by Specific Habitat Type and General Habitat Category; Connors Lake Bog and Campbell-Klatt Bog; September 10-17, 1981, by Jones & Stokes Associates Staff.

	Total Traps Set	Traps Sprung, No Sign of Visit [1]	Traps [1] Visited	Red-Backed Voles #	Red-Backed Voles % of Traps in Habitat	Dusky Shrews #	Masked Shrews #	Short-Tail Weasels #	House Mice #	Total Visits and Captures #	Total Visits and Captures % of Traps in Habitat
Specific Habitat Types [2]											
Subarctic lowland sedge bog meadow	3	0	0	0	0%	0	0	0	0	0	0%
Open low shrub bog	73	0	2	9	12%	0	0	0	0	11	15%
Black spruce woodland	131	0	5	8	6%	1	0	0	0	14	11%
Black spruce forest	87	0	16	11	13%	0	1	0	0	28	32%
Black spruce-birch mixed forest	20	0	0	1	5%	0	0	1	0	2	10%
Paper birch forest	21	1	4	1	5%	1	0	0	0	6	29%
Disturbed areas	73	0	5	8	11%	0	1	0	1	15	21%
TOTAL	408	1	32	38	-	2	2	1	1	76	-
General Habitat Categories											
Sedge	3	0	0	0	0%	0	0	0	0	0	0%
Open habitat	204	0	7	17	8%	1	0	0	0	25	12%
Forest	128	1	20	13	10%	1	1	1	0	36	28%
Disturbed	73	0	5	8	11%	0	1	0	1	15	21%
TOTAL	408	1	32	38	-	2	2	1	1	76	-

Footnote:

[1] A "visit" was recorded if a trap did not contain an animal, yet fecal pellets were observed on top of or within the trap. The visited trap may or may not have been sprung.

[2] Generally defined at Level IV of Table 1.

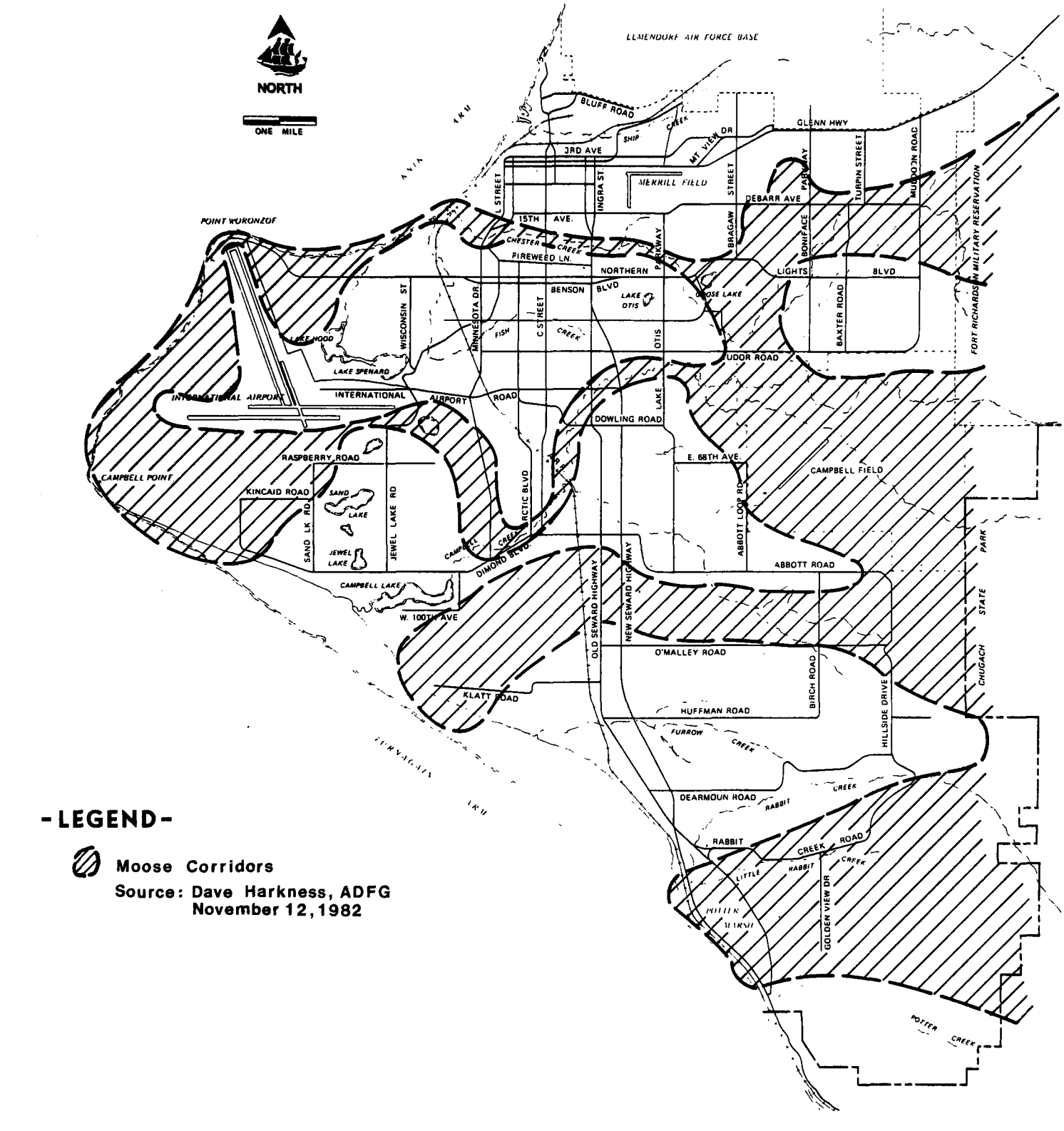
Prior to the urbanization of the Anchorage Bowl, moose used the area as a winter refuge from deep snow in the Chugach Range. In the late 1950s about 3,000 moose occurred in Game Management Unit 14c, which incorporates the Anchorage area, military bases north and east of Anchorage, and portions of the Chugach Range. Approximately 1,000 moose are now found in Game Management Unit 14c (Harkness pers. comm.). The reduction in numbers apparently is primarily a function of loss of winter habitat and forage in the Anchorage Bowl (Harkness pers. comm.). Very few moose now winter in west Anchorage because urbanization has reduced open space to a few narrow corridors (Figure 4-4). Winter forage of moose typically consists of shrub and deciduous tree communities (Cushwa and Coady 1976). Extensive development of upland habitats in the study area has greatly reduced the availability of winter forage.

Biological Setting of Potter Marsh

Potter Marsh is a coastal wetland situated on lower Rabbit Creek and Little Rabbit Creek between Old Seward Highway and the Alaska railroad embankment. It is part of the Potter Point State Game Refuge, managed by Alaska DFG. Although it is a coastal wetland, the railroad embankment and the associated tidal gates on the Rabbit Creek outlet have effectively removed tidal influences, leaving Rabbit Creek and Little Rabbit Creek as the major hydrologic influences.

Habitat types in Potter Marsh have been mapped by Alaska DFG (1981a) as part of the Potter Point State Game Refuge. A Puccinellia/Triglochin community (alkali grass, seaside arrowgrass) is located at the confluence of Rabbit Creek and Little Rabbit Creek, at the outlet of Rabbit Creek. A Carex community (sedge) surrounds it, and a Scirpus/Carex community (bulrush, sedge) extends along New Seward Highway south of the Rabbit Creek outlet. A deciduous tree forest (paper birch, poplar, alder, willow) is located north of Rabbit Creek and along Old Seward Highway on the east. A large shrub/bog community extends south of Rabbit Creek between the Scirpus/Carex community along New Seward Highway and the deciduous forest along Old Seward Highway.

Threespine stickleback (Gasterosteus aculeatus) is the most common resident fish in Potter Marsh (Wolf et al., in press), ninespine stickleback (Pungitius pungitius) and sculpins are also present. Rabbit Creek supports a small salmon run (Selkregg 1972). Alaska DFG (1981b) reports up to 500 pink salmon (Oncorhynchus gorbuscha), up to 100 coho (Oncorhynchus kisutch), 5-15 chinook (Oncorhynchus tshawytscha),



-LEGEND-

Moose Corridors

Source: Dave Harkness, ADFG
November 12, 1982

FIGURE 4-4. MOOSE CORRIDORS

500 Dolly Varden (Salvelinus malma), and about 100 whitefish (Coregonus nelsoni) can be found in Rabbit Creek as spawning adults.

Waterbird use of Potter Marsh during migration periods and summer nesting periods is perhaps the most valuable aspect of the marsh from the biological resource perspective. Potter Marsh is among the more productive marshes in the state for duck production (MOA undated). The nesting population of lesser Canada goose (Branta canadensis parvipes) is a major attraction for bird watching activity around Potter Marsh. Shorebirds, grebes and gulls also nest in the marsh. Alaska DFG (1976) lists the Potter Point State Game Refuge as a very important wildlife habitat in the Cook Inlet area.

Muskrat (Ondatra zibethicus) and mink (Mustela vison) are relatively common in Potter Marsh. Snowshoe hare (Lepus americanus), red squirrel (Tamiasciurus hudsonicus), least weasel (Mustela rixosa), red-backed vole (Clethrionomys rutilus), and shrews (Sorex spp.) live in the deciduous forest community. Beaver (Castor canadensis) are present in small numbers in lower Rabbit Creek.

Biological Setting of Tidal Wetlands

Extensive mudflats and marsh habitat are found at the base of the bluff between Campbell Point and Potter Creek. This area comprises the bulk of Potter Point State Game Refuge. High marsh habitats are affected by tides only during the lunar spring tide periods; tide pools are frozen over during the winter months. Low marsh habitats (tidal flats) are populated by algae in the summer months, and are subject to ice floe scouring in the spring.

The tidal flats are either barren silt or occupied by algae. Coastal marsh plant communities have been surveyed by U. S. COE (1978), Batten et al. (1978), Macdonald (1980), and Alaska DFG (1981a). The high marsh is comprised of a seaward Puccinellia/Triglochin community (alkali grass, seaside arrow grass) and a landward Carex community (sedge). A black spruce forest is also present at the base of the bluff west of De Armoun Road.

Threespine stickleback (Gasterosteus aculeatus) is the most common fish found in tide pools in the coastal marsh (Wolf et al., in press). Campbell Creek and Rabbit Creek have carved channels through the marsh, and Potter Creek empties into a narrow stretch of marsh at the southern terminus of the Potter Point State Game Refuge. Potter Creek serves as spawning habitat for a few Dolly Varden (Salvelinus

malma) and a small run of pink salmon (Oncorhynchus gorbuscha). Fisheries of Rabbit Creek are summarized in the section on Potter Marsh.

The extensive mudflats and marsh habitat provide prime habitat for migrating or nesting waterfowl and shorebirds. At least 130 different species of birds have been sighted in the refuge (Alaska DFG 1981b). Bald eagles frequently forage in the area, especially in the spring. Lesser Canada goose (Branta canadensis parvipes) and numerous species of ducks and shorebirds nest on the coastal marsh habitat. Alaska DFG (1981b) reports an average of 80 breeding ducks per square mile, which is a very high density, demonstrating the great value of this area to wildlife. Alaska DFG (1976) lists the Potter Point State Game Refuge as a very important wildlife habitat in the Cook Inlet area.

Mammal use of the coastal marsh is generally similar to that reviewed in the section on Potter Marsh. Small mammal populations are probably highest in the high marsh and forest habitats at the toe of the bluff.

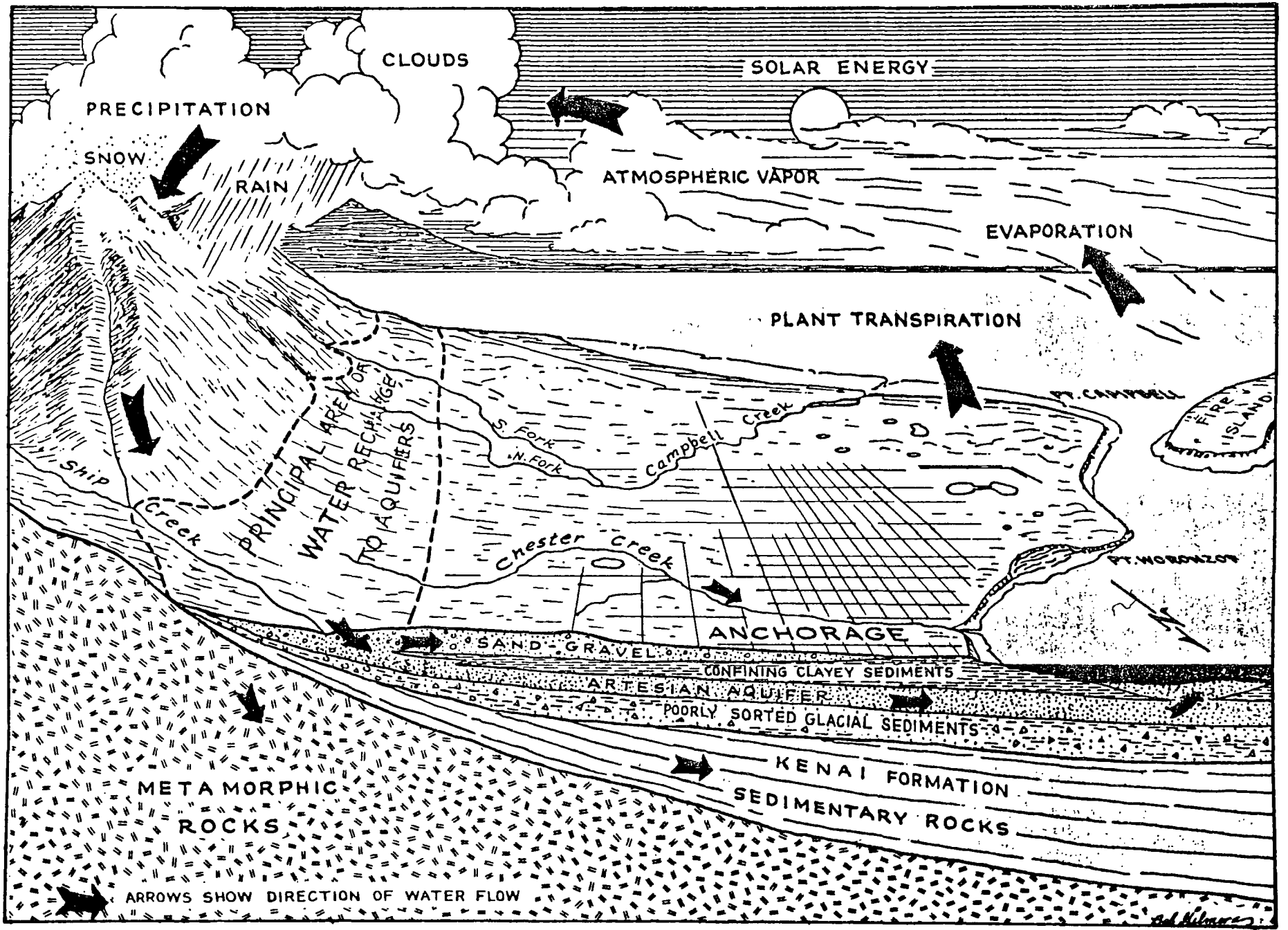
Hydrologic Setting

Hydrologic Cycle

Precipitation, in the form of rain and snow, falls onto the west slopes of the Chugach Mountains. This water flows toward the Cook Inlet either as groundwater (aquifer flow) or surface runoff, diminished by evaporation and evapotranspiration (Figure 4-5). Average annual precipitation in the Anchorage Bowl increases from 15 inches at the lowland areas near the coast to about 30 inches at an elevation of 2,000 feet. Up to 160 inches of snow accumulates on the highest mountain slopes. Surface water is plentiful with an average combined daily flow of 163 MGD from Chester Creek, Ship Creek, Campbell Creek and Rabbit Creek (U. S. Geological Survey 1978; MOA 1979). Both surface runoff and groundwater flow characteristics dictate the hydrology of streams, lakes and wetlands in the Anchorage Bowl.

Surface Runoff and Groundwater

Depending upon soil permeability and the amount of water contained in the upper soil layers, water flows either as surface runoff or groundwater. Water percolates through permeable soils to become groundwater. Impermeable and saturated soils promote surface runoff.



SOURCE: USGS, 1972

FIGURE 4-5. THE HYDROLOGIC CYCLE RELATED TO ANCHORAGE

Two major aquifer systems have been identified in the Anchorage drainage. First, an upper level aquifer, known as the unconfined aquifer, lies between 10 and 50 feet below ground level, and is composed of peat, glacial sand and gravel. In wetland areas, the aquifer is composed of peat, clay and silt, and tends to be less permeable. Twenty to thirty feet below this groundwater lies the artesian aquifer composed of thin layers of sand and gravel. Confining clayey sediments separate the two aquifer systems. Artesian groundwater, 50-300 feet below the surface, is the source of all municipal groundwater and most of the domestic supplies, about 14 million gallons of water per day (U. S. COE 1979).

Surface water flowing in streams and rivers is also important as a municipal water source and as a recreation resource. Four major drainage basins in the study area convey water toward their outlets at the Turnagain and Knik Arms: 1) Ship Creek, 2) Campbell Creek, 3) Chester Creek, and 4) Rabbit Creek watersheds. Surface water quality tends be good (Fugro 1980). Throughout the study area, most of the surface water is calcium bicarbonate type and some measured chemical and physical parameters are typical of unpolluted water. However, water analysis of the study area streams by the MOA (1979) revealed that Campbell Creek, Chester Creek, and Ship Creek have periodically exceeded fecal coliform limits (20 FC/100 ml). For instance, coliform levels of 138 FC/100 ml were measured in Campbell Creek, and Chester Creek levels were several times higher. Ship Creek and Rabbit Creek have also exceeded coliform limits. Heavy metal limit violations have also occurred in some of these streams. The study indicates that the metal sources may be commercial and industrial runoff, roadway runoff, peat bog drainage, and possibly groundwater inflow.

Most lakes in the area are small (usually less than 1 square mile) and shallow (less than 40 feet deep). In general, the lakes, with the exception of Campbell Lake, have little inflow and outflow, and are adjacent to bogs.

Surface/Groundwater/Wetland Complex

Recent studies illuminate the interrelationships between surface waters (lakes, streams) and wetlands with the groundwater systems in the Anchorage Bowl. Man-made alterations of groundwater, surface runoff and wetland hydrology have occurred. Evidence suggests hydrologic interdependency between these water systems, but quantitative data are generally not available.

One illustration of this interrelationship is the fluctuating water level of Sand Lake (U. S. COE 1979). Development within Sand Lake's drainage basin has possibly reduced groundwater recharge to the lake by speeding the removal of excess surface water with drainage channels and sewer lines, and by prohibiting the vertical flow of surface water to groundwater by covering permeable soils with impermeable cement and asphalt. Permeable gravel fill material used in storm drain construction may also encourage horizontal flow along the drain pipe's path. Thus, part of the water usually flowing into the groundwater and recharging the lake is transported out of the drainage basin. The Sand Lake system demonstrates the probable dependence of lake water level on groundwater hydrology in most of the Anchorage Bowl area.

Similarly, bogs within the Bowl possibly have many hydrologic influences on surface runoff. Campbell/Klatt Bog and Connors Lake Bog have been investigated and reports imply these relationships. Although Campbell/Klatt Bog is minimally fed by surface runoff, it has been suggested that it may also be fed by upwelling groundwater (Fugro 1980).

Connors Lake Bog and Campbell/Klatt Bog also may influence runoff chemical composition. Organic processes, usually high within peat bogs, may add dissolved nutrients such as nitrates, nitrites, and phosphorus as well as suspended organic matter to surface runoff. Heavy metals (iron, manganese, and aluminum) are also believed to be introduced to runoff by peat bogs and degrade stream receiving waters (MOA 1979). Comparison of Connors Lake Bog drainage water quality to its receiving water, Campbell Creek, indicates that such a degradation may occur (Fugro 1980).

Bogs also have great water storage capacity and may reduce flood hazards by attenuating peak surface flows. The peat soils, vegetation, and ponded areas have significant storage capacity. As a result, the bogs can release snow melt or accumulated rainfall over days, weeks or months following the initial event.

More complete evidence suggests relationships between streams and aquifers. Research by Weeks (1970) showed a sizeable interchange between the Anchorage artesian aquifer and Ship Creek. Approximately 25 cfs seeps into the ground water from Ship Creek. About half of this volume recharges the aquifer, while about 11 cfs returns to Ship Creek downstream. The U. S. Geological Survey (1978) also conducted seepage studies in North Fork Campbell Creek and determined groundwater recharge to the stream was approximately 1.5 MGD between November 17, 1970 and May 26, 1971. But because of measurement inaccuracies, the U. S. Geological Survey data may be substantially in error.

It must be pointed out that the hydrologic links between surface runoff/groundwater/wetland complexes has been only partially studied; some data on surface runoff relationships exist, but groundwater flow data are negligible. Further investigation is needed to properly assess the impact of human induced alterations on Anchorage Bowl hydrology.

Human Use Setting

In addition to providing wildlife and fish habitat, wetlands provide open space and recreational opportunities for the citizens of Anchorage. For many citizens, particularly long-term residents, the open space and natural areas and the incidental observations of moose, nesting waterfowl, and migrating salmon within the Municipality are a valuable aesthetic resource, whose loss would detract from the perceived quality of life.

The wetlands are currently used by individuals with a great range of interests. Birdwatching and wildlife observation is locally important to naturalists and residents. Waterfowl hunting is a major recreational activity occurring in some of the larger wetlands. Primary species hunted include dabbling ducks, especially mallards and pintails. Sport fishing is also a popular pursuit in streams through greenbelt areas. Potter Marsh, part of a 2,300-acre state game refuge, is an area with a great wealth of wildlife. The refuge is an important nesting and feeding place for numerous ducks, geese, swans, and shorebirds which migrate through Anchorage during spring and fall. It is enjoyed throughout the year by Anchorage residents and visitors.

There are many opportunities for summer boating in the Anchorage area including a wide array of small boats and rubber rafts on the many lakes and creeks in Anchorage, most of which are in wetland areas. Small boats and rubber rafts are widely available. Throughout the wetlands there are a number of trails used for hiking, horseback riding and biking. Certain lakes are also used extensively by residents for floatplane operations.

Winter recreation is of particular importance in the wetland areas. When snow conditions permit, snowmachines and cross-country skiers are active over most of the wetland area. Campbell Creek and Chester Creek are frozen in winter and serve as trails for snowmobiles and skiers. Four-wheel-drive vehicles are used during winter months in some of the larger wetland areas, e.g., Connors Lake Bog and Campbell/Klatt Bog.

Wetland Impacts

Wetland impacts are likely to occur when interceptors cross or are laid adjacent to wetlands, streams, lakes or ponds. Impacts of the expansion of sewerage facilities on wetlands in the Anchorage Bowl can be classified as direct and indirect impacts. Direct impacts result from emplacement of facilities in or adjacent to wetland areas, and may be of short or long duration. An example of an indirect impact is the inducement of urban growth which may result from an expansion of wastewater treatment facilities, thereby increasing development of wetlands.

Pipe Emplacement Impacts

Emplacement of sewer interceptors generally involves movement of heavy equipment at the site, excavation of a trench, potential inclusion of a dewatering operation, and backfilling of the trench with a stabilizing material. Gravel is typically used in Alaska as a backfill in wetland areas because peat does not provide a suitable fill material for holding the pipe in place.

Table 4-4 lists the interceptor pipes proposed in the facilities plan and mapped in Figure 3-6, and identifies those pipes likely to directly impact wetlands, streams, coastal marshes, other biological resources or recreation resources.

Wetland Crossings. A number of events occur which impact wetlands when interceptor lines cross wetlands. The most obvious event is destruction of the vegetation in the right-of-way. Heavy equipment crushes or removes vegetation and compacts peat deposits. Areas of bog wetlands stripped of vegetation by heavy equipment or by excavation generally do not revert to the original habitat type, but instead are overgrown by ruderal vegetation or are kept barren by foot or off-road vehicle traffic. Ruderal vegetation is composed primarily of a bluejoint grass/alder community (*Calamagrostis canadensis*/*Alnus* spp.). Long-term alteration of habitat is apparent in aerial photographs taken as long as 16 years after emplacement of pipe. For example, the alignments of a sewer line emplaced in 1965 between West 80th Avenue and Strawberry Road on the proposed Northwood Drive alignment (Figure 4-6), and a sewer line emplaced in 1968 through Baxter Bog south of Northern Lights Boulevard (Figure 4-7) are still obvious in 1981 photos.

Table 4-4. Potential Impacts on Proposed Sewer Lines on Biological and Recreational Resources

Sewer line project**	Wetland Crossing	Adjacent to Nontidal Wetland	Stream *** Crossing	Adjacent to Stream	Tidal marsh crossing	Adjacent to lake etc.	Forest Crossing	Adjacent to forest	Bike trail Crossing	
T24										
NS		x								
NL18	x	x		x				x		One section in undisturbed bog
NNL			1			x				
SNL	x					x				
MD14			2	x						
U8	x									Crosses fill area in a wetland
U14	*	x	2							
MFW										
FAE										
FAW				x		x			x	
DB15	*	x	1	x					x	*Greenbelt crossing
CCE	*		1	x					x	
CC24	*			x			x		x	Alignment at Seward?
CC30	*		1	x		x			x	New crossing of Westchester Lagoon
PA						x				
SC	*		1	x						Near fish hatchery
ARRN					x					
CBDN										
CBDM										
CBDS										
AC										
BLN				x						
FC18	x									
FC24E	x									In undisturbed bog
FC24W			3+	x					x	In Fish Creek
FC30			2+	x						In Fish Creek
FC36	*		3	x	x					In Fish Creek
FCF30		x	2	x	x					In Fish Creek
HC			1+	x			x			In Hood Creek
WP	*		1							
ARRS				x						
IARE										
IARW										
D12		x								
RWL	x	x								In undisturbed bog
R78	*		1							New outlet from bog
LCCI	x									West edge of Connors Lake Bog
CCI	*		2	x	x	x	x		x	Crosses Campbell Lake
SLN						x	x	x		
SLS	x					x	x			Crosses Sand Lake Bog undisturbed
JL	x					x	x			In undisturbed bog
JLN		x	1							
JLE		x	1			x				
JLS	*		2+	x		x				In drainage channel from Sand Lake
CKBNE	*x		1	x			x		x	In undisturbed bog basin
CKBC	x									In undisturbed bog
CKB	x						x			In undisturbed bog
KR	x		1		x	x	x			In undisturbed bog
SEI	x		1							Furrow Creek
HE	x			x				x		
OSHN										
OSHS										
TL										
RCF								x		
RCI			2			x	x			

FOOTNOTES:

* Greenbelt crossing.

** For designations, see Figure 3-6.

*** Number of times stream is crossed. In some cases, the facilities plan does not clearly indicate the number of times, in which case the minimum number is noted.

Figure 4-6. 1981 Photo of Connors Lake Bog

North is toward the top of the photo. Connors Lake is in the upper left corner, Blueberry Lake is at right center, and Strawberry Lake is in the lower right corner. A sewer line was constructed east of Connors Lake in a northwest-southeast alignment to Raspberry Road, in a northeast-southwest alignment from Raspberry Road to West 72nd Avenue, and in a north-south alignment south of West 72nd Avenue.

Figure 4-7. Comparative Photographs of Baxter Bog

1967 photo of Baxter Bog prior to sewer construction. North is toward the right-hand margin of the page.

1981 photo of Baxter Bog. A sewer has been constructed in the north-south direction, east of the pond.

A second major biological impact is less obvious and is discussed in more detail in the hydrology impact section. The hydrological characteristics of a wetland area are extremely important to the nature of the vegetation and therefore the type of wildlife habitat that occurs (Moore and Bellamy 1974). Alteration of the hydrological regime alters the wetland biota.

To a certain extent, wetland areas already intersected by interceptors have already been impacted, and replacement of existing pipes or emplacement of additional pipe in existing right-of-way will re-initiate the growth of ruderal vegetation on the right-of-way. Examples of an existing sewer facility right-of-way can be seen in Connors Lake Bog (Figure 4-6) as the 84-inch West Interceptor passes northwesterly from Raspberry Road to International Airport Road at Jewel Lake Road, and in Baxter Bog (Figure 4-7). Replacement or emplacement of additional pipe in the existing right-of-way is unlikely to have a significant biological impact since the damage to the wetland, if any, has already occurred.

Wetland areas not yet disturbed by utility rights-of-way will be significantly impacted. Existing bog habitat on the right-of-way will be replaced by bare areas or ruderal vegetation. Impacts on hydrology may occur (see Hydrology section), which alter the physical and habitat characteristics of the site. A number of wetlands not yet impacted by sewer interceptors will be crossed by the proposed facilities. Table 4-5 identifies the interceptors that represent construction in wetland areas which have not yet been directly impacted by pipe emplacement. Six sections of pipe listed in Table 4-5 cross wetlands designated for eventual development in the Municipality Wetlands Management Plan. Of these six, line FC24E crosses Heather Meadows wetland between B Street and Old Seward Highway. This wetland has been identified as a nesting area for Canada geese and other waterfowl, and was in use in 1982 as a nesting area in spite of development around and in part of the bog.

Two sections of pipe (CKB, KR) listed in Table 4-5 cross an area of Campbell-Klatt Bog which has been designated for conservation in the Municipality Wetlands Management Plan. Although the objective of the conservation designation is to permit development while conserving natural resource values of the area, the practicality of meeting this objective in Campbell-Klatt Bog is questionable. Along with other resource values (e.g., hydrologic values, value as wetland habitat), Campbell-Klatt Bog is particularly noteworthy as a nesting area for Canada geese and is the largest open bog area in the Anchorage Bowl. Because of its large size, moose utilize the area, and certain species of birds, e.g., sandhill cranes, use the bog for a foraging or resting area during the migration periods.

Table 4-5. Sections of Proposed Sewerage Interceptor Crossing Wetlands Undisturbed by Pipe Emplacement

Pipe	Impacted Area	Wetland	MOA Designation*
NL18	Northeast of Northern Lights and Muldoon intersection	Muldoon Park	Development
CC30	Westchester Lake (relocated crossing of Chester Creek)	Westchester Creek	Preservation
FC24E	B Street to Old Seward Highway	Heather Meadows complex	Development
FC24W	Extension of Tudor Road west	Fish Creek	Preservation
RWL	Entire section	Connors Lake Bog	Development
SLS	Extension of West 80th Avenue west	Sand/Sundi/Jewel Lakes	Preservation
JL	Emerald Street to Gloralee Street	Sand/Sundi/Jewel Lakes	Preservation
CKBNE	Campbell Creek greenbelt south bank	Greenbelt Marsh	Preservation
	South of West 89th Avenue	Campbell-Klatt Bog	Development
CKBC	Entire section	Campbell-Klatt Bog	Development
CKB	Entire Section	Campbell-Klatt Bog	Conservation
KR	Entire Section	Campbell-Klatt Bog	Conservation
HE	Entire Section	Furrow Creek	Conservation
SEI	Dimond Boulevard to East 100th Avenue	Campbell-Klatt Bog	Development

* Municipality of Anchorage 1982. Designation refers to immediate area of impact.

The line designated CKB in Figure 3-6 is routed through an area rich in potholes and used by Canada geese and other waterfowl as a nesting area. The USFWS Office of Ecological Services conducted field work in Campbell-Klatt Bog during the spring and summer of 1982 (Nickles, pers. comm.). The proposed routing of CKB is near a USFWS transect area which contained two (possibly four) nesting pairs of Canada geese, two mallard nests, one widgeon nest, and numerous pairs of yellowlegs, snipe, greenwing teal, northern phalarope, and gulls. A cow and calf moose were seen in early summer along this route, and two bulls were spotted later in the summer. Based on these and other observations, it is highly probable that CKB is routed through the major waterfowl nesting and wildlife area in Campbell-Klatt Bog. Even limited development in the southern half of Campbell-Klatt Bog is likely to significantly alter its value as a large wetland area offering habitat for species such as sandhill crane, which require minimal human intrusion.

Section HE also crosses a wetland (Furrow Creek) designated for conservation. Major aspects of this wetland crossing are likely to be related to hydrologic value of this wetland along Furrow Creek.

Five sections of pipe listed in Table 4-5 cross wetlands designated for preservation in the Municipality Wetlands Management Plan. Three of these (CC 30, FC24W, part of CKBNE) represent new construction in greenbelt areas (Chester Creek, Fish Creek, Campbell Creek, respectively). The Chester Creek interceptor currently crosses under Westchester Lake. Increasing the capacity of this line (CC30) may require relocation of the crossing of Chester Creek. Fish Creek from its origin near Spenard Road and Chugach Way to its mouth is paralleled by an interceptor sewer (FC24W).

New construction in a greenbelt area, e.g., the east-west leg of CKBNE, represents a unique case of construction in a wetland area. Unlike inland bogs, wetlands in the greenbelt areas depend on the hydrological regime of the creeks or on the tides. Riparian vegetation along the streams typically grows more rapidly than bog vegetation, therefore, ruderal vegetation or barren ground is not likely to persist in greenbelt areas. Most of the existing sewer lines in greenbelt areas are overgrown by birch trees, alder, sedges, and grasses.

Two interceptors cross an inland bog in an area designated for preservation by the Municipality wetlands management plan. Lines SLS and JL cross the Sand/Sundi/Jewel Lakes Bog. This lake/wetland complex is tributary to Campbell Creek by way of an existing natural channel. Flow characteristics of the outlet channel are apparently determined by precipitation patterns and water levels in Sand Lake (Quadra Engineering,

Inc. 1981). The bog is primarily open low shrub or black spruce woodland habitat. Some waterfowl nesting may occur along the lake shores. Jewel Lake is a popular fishing and recreation area.

Construction of interceptor sewers may have a significant impact on Sand Lake and Sand/Sundi/Jewel Lakes Bog. Sand Lake historically displayed a pattern of fluctuating water level corresponding to local precipitation patterns. Two construction projects, including a 1966 sewer line east of the lake at the margin of the wetland, may have caused a subsequent long-term decline in water level which did not correspond to precipitation patterns (Quadra Engineering, Inc. 1981). If construction of the sewer line in 1966 caused a drop in water level, construction of two additional interceptors across the bog may accelerate dewatering of the lake/bog complex. The mechanism of this action is discussed in the Hydrology section.

Pipes Adjacent to Nontidal Wetlands. Emplacement impacts on wetlands may occur when pipes are laid adjacent to wetland areas. If the backfill is permeable material, the sewer line may intercept groundwater flow to or from the wetland and conduct groundwater along the sewer line. This may have a major, long-term impact on the wetland as described in the Hydrology section.

Table 4-6 lists those sections of proposed interceptors which would be emplaced adjacent to wetland areas. Of the nine sections identified, seven are adjacent to wetland areas which the Municipality has designated for eventual development (MOA 1982). Construction of a sewer interceptor (RWL) through Connors Lake Bog east of Minnesota Avenue could expedite development of the area, which would lead to a loss of waterfowl nesting habitat around Blueberry Lake. The remaining two sections (U14 and DB15) are adjacent to the Chester Creek greenbelt in the general vicinity of Lake Otis Parkway. Their potential impact is likely to be from sediment, which could enter the streams during construction, and from interception of groundwater in the greenbelt area. If groundwater is intercepted and transported by the backfill material, it would be transported to the greenbelt area where U14 and DB15 enter the greenbelt.

Crossing or Adjacent to Streams. Significant short-term impacts on stream flow, water quality, and fish migration can be expected during the period of time an interceptor is being laid across or adjacent to a stream, i.e., within the floodplain. Long-term impacts to stream biota and water quality may result as pipes age and deteriorate or if sections of pipe are improperly connected or damaged during seismic or freeze/thaw events. Additional long-term damage to the stream biota and water quality may occur if the interceptor surcharges during spring thaw and raw sewage is spilled out

Table 4-6. Sections of Proposed Sewer Interceptor Adjacent to Nontidal Wetland Areas

Pipe	Impacted Area	Wetland*	MOA Designation*
NS	Between Newell Street and Norman Street	North Russian Jack Springs	Development
NL18	Northern Lights Boulevard west of Patterson	Baxter Bog	Development
U14	Between Mallard Lane and Northern Lights Boulevard	Chester Creek forks	Preservation
DB15	Along Sitka Street	Chester Creek	Preservation
FCF30	Wisconsin Street south of West 31st Avenue	Turnagain Bog	Development
D12	North of Dowling between Old and New Seward	Seward Highway	Development
RWL	Entire section	Connors Lake Bog	Development
JLN	Along Jewel Lake Road and West 84th Avenue	Sand-Sundi-Jewel Lake Bog	Development
JLE	Along Birch Lake	Connors Lake Bog	Development

FOOTNOTE:

*Municipality of Anchorage 1982. Designation refers to immediate area of impact.

of manholes into the stream floodplain. This latter event now occurs on the Campbell Creek interceptor. Construction impacts on riparian habitat in creek floodplains appear inconspicuous within a few years, particularly if the right-of-way surface elevation is restored to its original contour. As an example, the right-of-way for the existing Chester Creek interceptor is now overgrown by a deciduous tree community (paper birch, alder, and willow). The path of the right-of-way is revealed only by the appearance of manhole structures and the appearance of shallow trenches where the fill has settled or slight mounds where the fill has not settled. The changes in contour are probably noticed only by those individuals looking for them and aware of their approximate location. In lower Fish Creek the sewer line right-of-way is overgrown by a sedge and grass community found in the area, but is much more conspicuous because of the dike-like effect of the backfill material.

Trenching and excavation activities during stream crossings will result in the temporary destruction or displacement of aquatic invertebrates in the project area, increase in turbidity and siltation downstream from the project area, and obstruction of fish passage.

Following completion of construction, turbidity will decline precipitously. Silt that settled on the bottom downstream of the project area will remain until increased flow at the next "breakup" or rainstorm washes it away. Aquatic invertebrates will re-establish themselves in disturbed areas if clean gravel is available.

Some beneficial impacts may be realized in the long term. Most of the sections of pipe identified in Table 4-7 are located in existing right-of-way and will expand the capability of the existing sewer line. The existing lines carry near capacity flows or already experience flow in excess of capacity. As a result of capacity expansion, the existing lines will be less likely to surcharge and overflow raw sewage into the stream or floodplain. The Campbell Creek interceptor also has deteriorated and is in need of rehabilitation. Elimination of raw sewage discharge will improve long-term water quality for aquatic biota and human recreation and water-related activity.

As noted in Table 4-7, the project facilities may impact Ship Creek, Chester Creek, Fish Creek, Hood Creek, Campbell Creek, Furrow Creek, Rabbit Creek, and Little Rabbit Creek. All project areas occur below the U. S. COE designated headwaters point except those on Fish Creek, Hood Creek, Furrow Creek, and possibly North Fork Chester Creek and a small tributary to South Fork Chester Creek (Table 4-7). Stream crossings by utility lines below headwater points are usually classified under the nationwide 404 permit according to Section 323.4-3(a)(1), (42 FR 37146 July 19, 1977), provided the following conditions are satisfied:

Table 4-7. Section of Proposed Sewer Interceptors Which Cross Streams or are in the Stream Floodplain

Pipe	Crossing	Adjacent	Approximate Location	Stream	Fishery Value	New Right-of-Way	Below Headwaters
NL18		x	South of Ptarmigan Street	South Fork Chester Creek	Moderate: remanant of former coho and pink salmon runs; Dolly Varden		Yes
NNL	x		Baxter Road near Northern Lights	South Fork Chester Creek	Moderate: as above		Yes
MD 14	x		South of College Gate Elementary School	Unnamed ditch	Low: tributary (drainage ditch) to South Fork Chester Creek		?
MD14	x		Wesleyan Drive near Pawn Place	South Fork Chester Creek	Moderate: adequate flow and gravels		Yes
U14	x		North of Gosling Circle	South Fork Chester Creek	Moderate: as above		Yes
U14	x		North of Gosling Circle	Middle Fork Chester Creek	Moderate: adequate flow and gravels; instream litter and debris common		Yes
FAW		x	South of 15th Avenue	Chester Creek	Moderate: adequate flow; some channelization		Yes
DB15	x		South of Sitka Street	Chester Creek	Moderate: adequate flow and gravels		Yes
DB15		x	Along Sitka Street	North Fork Chester Creek	None: silted drainage ditch with little flow, drains landfill area		?
CCE	x		Lake Otis Parkway	South Fork Chester Creek	Moderate: adequate flow and gravels		Yes
CCE		x	Along most of length	Middle Fork Chester Creek	Moderate: adequate flow and gravels; instream litter and debris common		Yes
CC24		x	Sitka Street to Eagle Street; C Street to West 18th Avenue	Chester Creek	Moderate: adequate flow; some channelization		Yes
CC30	x		Spenard Road	Chester Creek	Moderate: as above	Yes	Yes
CC30		x	Spenard Road to Knik Arm	Chester Creek	Moderate: as above		Yes
SC	x		Downstream of fish hatchery at Elmendorf Access Road	Ship Creek	High: salmon migration and spawning; Dolly Varden; rainbow trout		Yes
SC		x	Along most of length	Ship Creek	High: as above		Yes
BNL		x	West terminus at Fish Creek	Fish Creek	Low: blackfish; numerous impediments to fish migration		No
FC24W	x		Chugach Street near Wilson Street	Fish Creek			No
FC24W	x		Minnesota between West 39th Street and West 41st Avenue	Fish Creek	Low: as above		No
FC24W	x		Alaska Railroad near Roosevelt Drive	Fish Creek	Low: as above		No
FC24W	x		West of Tudor Road	Fish Creek	Low: as above		No

Table 4-7. Cont'd.

Pipe	Crossing	Adjacent	Approximate Location	Stream	Fishery Value	New Right-of-Way	Below Headwaters
FC24W	x		South of Spenard Road and Turnagain Street	Fish Creek	Low: as above	Yes	No
FC24W		x	Entire length	Fish Creek	Low: as above	Partially	No
FC30	x		South of Forest Road	Fish Creek	Low: as above		No
FC30	x		North of Spenard Road near West 42nd Place	Fish Creek	Low: as above		No
FC30		x	Entire length	Fish Creek	Low: as above		No
FC36			Northern Lights Boulevard near Forest Park Drive	Fish Creek	Low: as above		No
FC36			Forest Park Drive near Northern Lights Boulevard	Fish Creek	Low: as above		No
FC36			Alaska Railroad and Chester Creek	Chester Creek	Moderate:		Yes
FC36		x	Entire length	Fish Creek	Low: as above		No
FCF30	x		Alaska Railroad near Fish Creek	Fish Creek	Low: as above		No
FCF30	x		Alaska Railroad and Chester Creek	Chester Creek	Moderate:		Yes
FCF30		x	North of Northern Lights Boulevard	Fish Creek	Low: as above		No
HC	x		Telequana Drive and Katmai Circle	Hood Creek	None: inadequate flow		No
HC		x	Entire length to Katmai Circle	Hood Creek	None: inadequate flow		No
WP	x		Near Wickersham Park	Campbell Creek	High: salmon migration and spawning; Dolly Varden; rainbow trout		Yes
ARRS		x	Alaska Railroad north of Tudor Road	Fish Creek	Low: as above		No
R78	x		Alaska Railroad near 73rd Avenue	Campbell Creek	High: salmon migration and spawning; Dolly Varden; rainbow trout		Yes
CCI	x		C Street near Campbell Creek	Campbell Creek	High: as above		Yes
CCI	x		Campbell Lake outlet	Campbell Creek	High: as above		Yes
CCI		x	Entire length	Campbell Creek	High: as above		Yes
JLN	x		Jewel Lake Road near West 88th Avenue	Unnamed stream	None: drainage from Sand Lake		No
JLE	x		West 88th Avenue near Jewel Lake Road	Unnamed stream	None: drainage from Sand Lake		No
JLS	x		Blackberry Street near West Dimond Boulevard	Unnamed stream	None: drainage from Sand Lake		No

Table 4-7. Cont'd.

Pipe	Crossing	Adjacent	Approximate Location	Stream	Fishery Value	New Right-of-Way	Below Headwaters
JLS	x		West Dimond Boulevard near Blackberry Street	Unnamed stream	None: drainage from Sand Lake		No
JLS		x	Entire length	Unnamed stream	None: drainage from Sand Lake		No
CKBNE	x		Campbell Creek at West Dimond Boulevard	Campbell Creek	High: Salmon migration and spawning; Dolly Varden; rainbow trout	Yes	Yes
CKBNE		x	Greenbelt Drive to Crystal Drive	Campbell Creek	High: as above	Yes	Yes
KR	x		Klatt Road and Victor Street extended	Unnamed stream	None: drainage from Campbell-Klatt Bog	Yes	No
HE		x	Huffman Road near New Seward Highway	Furrow Creek	None: inadequate flow and significant litter and debris above Old Seward Highway	Yes	No
SEI	x		Frontage road south of Huffman Road	Furrow Creek	None: inadequate flow and significant litter and debris above Old Seward Highway	Yes	No
SEI		x	Huffman Road	Furrow Creek	None: as above	Yes	No
RCI	x		Rabbit Creek west of Ptarmigan Terrace	Rabbit Creek	Moderate: small runs of Coho and pink salmon; Dolly Varden; whitefish	Yes	Yes
RCI	x		Little Rabbit Creek near Old Seward Highway	Little Rabbit Creek	Low: few salmon; Dolly Varden	Yes	Yes

- o No change in preconstruction bottom contour will occur.

- o Activity will not be located in proximity to a public water supply intake.

- o Activity will not destroy threatened or endangered species.

- o Backfill material will be free from toxic pollutants in toxic amounts.

- o Activity will be maintained to prevent erosion and other nonpoint sources of pollution.

- o Activity will not occur in a component of a wild and scenic river system.

- o Best management practices listed in Section 330.6 of the regulations are followed to the maximum extent possible. These include:

  - Avoiding or minimizing discharge into waters of the United States and wetlands;

  - Avoiding spawning areas during spawning season;

  - Avoiding the impediment of the movement of indigenous aquatic species or high water;

  - Avoiding adverse impacts caused by changes in water flow rate;

  - Placing heavy equipment on mats in wetlands;

  - Avoiding discharge into migratory waterfowl breeding areas;

  - Removing temporary fills in their entirety.

If any of these conditions are not met by the project facilities, an individual 404 permit will be required for that part of the facilities plan.

Ship Creek. Ship Creek has high fishery values as one of the two major streams for salmon rearing in the Anchorage area. Migration of king, coho, pink, and sockeye salmon occurs June through September; spawning occurs July through November. Fish passage structures permit migrating salmon to reach spawning grounds upstream of the dam at Chugach Electric's power generation facility. The Alaska DFG maintains a fish hatchery on Ship Creek near the Elmendorf bypass.

The Mountain View area is served by an interceptor (SC in Figure 3-6) paralleling Ship Creek on the south bank, and eventually crossing the creek just downstream of the fish hatchery. Most of the route is through industrial development; however, the crossing of Ship Creek just below the fish hatchery is likely to adversely impact salmon during the construction period. Improper timing of construction could impede the movement of adults bound for spawning gravels upstream of the construction site, or the deposition of fine sediments in spawning redds downstream of the construction site. An impediment to salmon migration or excessive sediment deposition could reduce the number of adult salmon returning to spawn in subsequent years. The extent of the impact depends on the timing of construction and the mitigation measures incorporated into the construction program.

Chester Creek. Chester Creek and South Fork Chester Creek have moderate fishery value. Although much of the stream is channelized, a few natural channel areas retain spawning gravels and good fish habitat. Projects (as described in Table 4-7) likely to adversely impact fish habitat during the construction period include: NL18, U14 where they cross South Fork Chester Creek, DB15 where it crosses South Fork Chester Creek, and CC24 between Maplewood Street and Latouche Street. The Middle Fork Chester Creek (draining Russian Jack Springs area) has ample flow and gravel substrate to support fish, but heavy algal growth suggests poor water quality. Fish were spotted in July 1982 near 20th Avenue and Sunrise ball diamond. The North Fork of Chester Creek (draining along Sitka Street) is now routed through a drainage ditch, and is poor fish habitat.

Fish Creek. Fish Creek has low fishery value, particularly upstream of West 35th Avenue. Fish migration has been substantially impacted by the placement of narrow culverts on the Alaska Railroad crossing near the mouth and on almost all road crossings upstream of that point. Projects (as described in Table 4-7) likely to adversely impact fish habitat during the construction period include: BNL and FC36 downstream from the corner of Northern Lights Boulevard and Forest Park Drive. The major impact of all projects on Fish Creek (BNL, FC24W, FC30, FC36, FCF30, ARRS) probably will be an increase in turbidity which may be noticed in lower Fish Creek.

Hood Creek. Hood Creek has low flow and little or no fishery value upstream of the area impacted by the facilities plan (sewer line HC in Figure 3-6). One homeowner has developed a pond on Hood Creek as part of the landscaping.

Campbell Creek. Campbell Creek has high fishery value as one of the two major streams for salmon rearing in the Anchorage area. Pink salmon spawning occurs from Campbell Lake upstream to the confluence of North and South Fork of

Campbell Creek. Migration of king, coho, pink and sockeye salmon occurs June through September; spawning occurs July through November. The entire length of Campbell Creek provides rearing habitat for king and coho salmon throughout the year. Dolly Varden is a resident species of Campbell Creek.

All projects on Campbell Creek or in the greenbelt (R78, CCI, CKBNE) are likely to adversely impact salmon during the construction period. Improper timing of construction could impede the movement of adults bound for spawning gravels upstream of the construction site, or cause the deposition of fine sediments in spawning redds downstream of the construction site. An impediment to salmon migration or excessive sediment deposition could reduce the number of adult salmon returning to spawn in subsequent years. The extent of the impact depends on the timing of construction and the mitigation measures incorporated into the construction program.

Furrow Creek. Furrow Creek has low flow and no fishery value above Old Seward Highway and impacts on fishery resources are not significant.

Rabbit Creek. Rabbit Creek has moderate fishery value, supporting small runs of coho and pink salmon and resident populations of Dolly Varden and whitefish. Tidal gates under the Alaska Railroad embankment are a major obstacle to fish migration. The Rabbit Creek interceptor is likely to adversely impact salmon during the construction period. The project area is close to Potter Marsh, and impacts from turbidity may be noticed in Potter Marsh. This issue is addressed in the Impacts on Potter Marsh section.

Little Rabbit Creek. Little Rabbit Creek has low fishery value. Although impacts on fishery resources in Little Rabbit Creek are not significant, the project area is close to Potter Marsh, and impacts from turbidity may be noticed in Potter Marsh. This issue is addressed in the Impacts on Potter Marsh section.

Mitigation of Pipe Emplacement Impacts

A number of potential impacts associated with emplacement of pipes across or adjacent to wetlands, streams, lakes or ponds have been identified in the previous section. Most of these impacts may be mitigated by appropriate actions or techniques. These impacts and appropriate mitigation measures are summarized below.

Loss or Alteration of Habitat in Wetland Areas by New Sewer Right-of-Way in Wetlands Designated for Preservation by the MOA. This impact can best be mitigated by not routing

new sewer lines through wetlands designated for preservation by the MOA. This measure in particular would be of great value at Sand/Sundi/Jewel Lake Bog.

If a new right-of-way must be established in a wetland slated for preservation, steps should be taken to minimize the persistence of barren soil on the right-of-way. Few guidelines are available for restoring the displaced bog species (Alaska Agricultural Extension Service 1972; Johnson and Van Cleve 1976). Efforts should be concentrated on seeding the right-of-way as soon as possible with bluejoint grass and fertilizing the stripped area with the appropriate nutrients.

Loss of Waterfowl and Shorebird Nesting Habitat. Loss of nesting habitat for bird species is an unavoidable adverse impact resulting from direct and indirect impacts of the facilities plan. This loss is particularly severe if lines CKB and KR in southern Campbell-Klatt Bog encourage development in this wetland area. The loss may be partially reduced by blasting new potholes in wetland areas designated for preservation by the MOA. This effort may encourage nesting activity by certain ducks and geese.

Alteration of Groundwater Movement Into or Out of Wetlands. This impact can be partially mitigated by the use of impervious backfill material at strategic locations along the right-of-way. For example, impervious material should be used as backfill material at the boundaries of wetlands and at regular intervals (e.g., 100 m intervals) along rights-of-way through greenbelt areas. These measures would reduce the amount of groundwater moving through the more porous gravel typically used as backfill material.

Increased Sediment Load In Streams and Impediment to Fish Migration. See mitigation for short-term construction impacts, Chapter 10.

Hydrologic Impacts

The most obvious feature of wetlands is their wetness, and any activity which permanently alters the hydrology of a wetland area is likely to lead to permanent changes in the biota of the wetland. This is particularly true of bog habitats that are not directly fed by stream flow. The obvious and immediate impact of pipe emplacement in wetlands is the destruction of vegetation in the right-of-way and the long-term alteration of habitat (see Pipe Emplacement Impacts). Much more subtle, but perhaps more significant, is the delayed impact on hydrologic features of the wetland.

Most peat bogs, such as those comprising the majority of wetlands in the study area, are natural water-retaining basins (Moore and Bellamy 1974). In some ways, their character

is analogous to a teacup filled with water and cotton. If a buried pipe were placed through a wetland and if backfill material were used which did not impede water movement, the action would be approximately analogous to chipping the rim of the cup, allowing some of the water to drain away. To continue the analogy, water level in the cup (bog) will probably sink below the level of the damaged area because the cotton (peat) will act as a wick bringing moisture to the outlet area. This dewatering process will adversely change the biological and hydrologic values of wetlands.

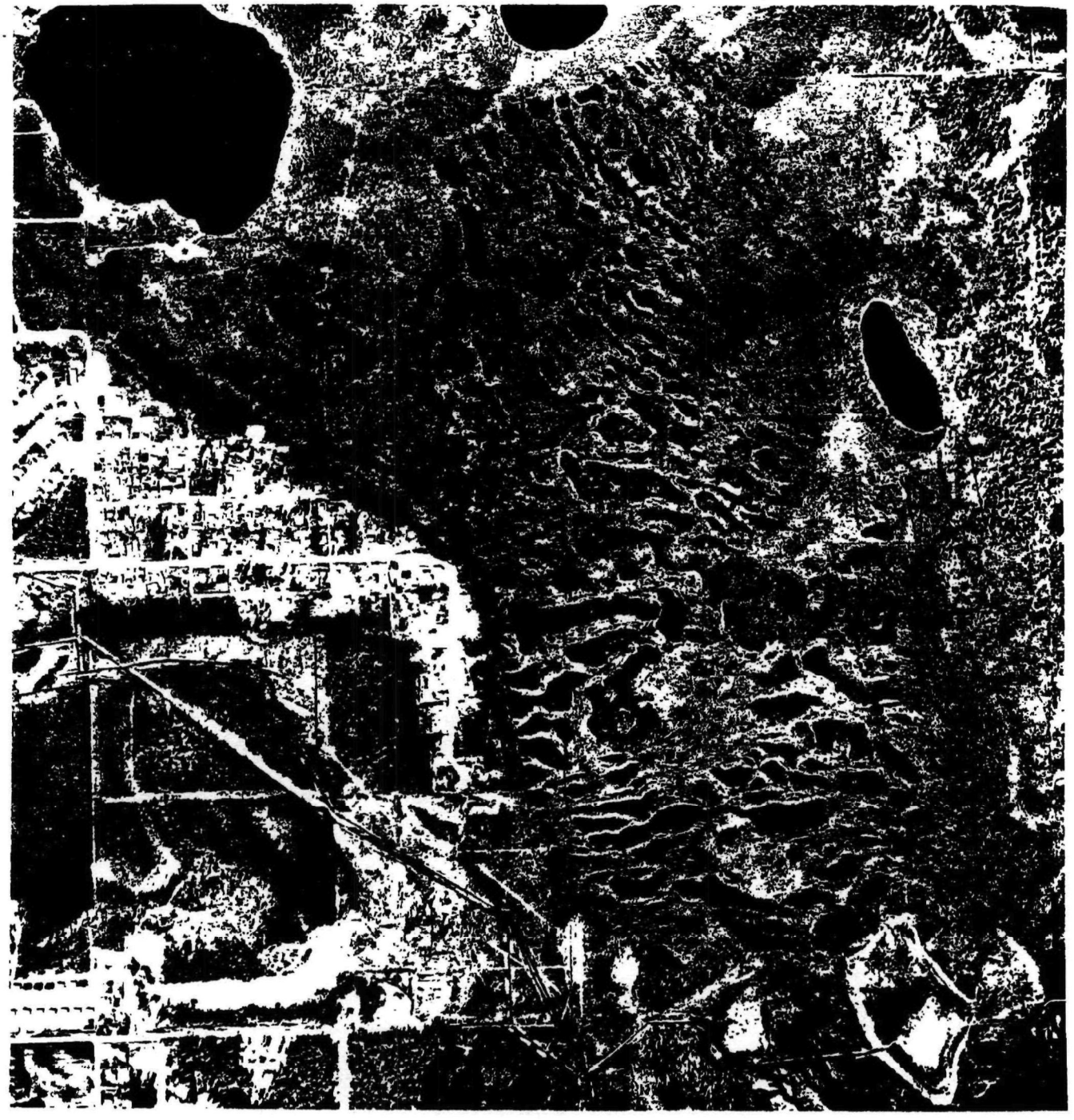
Two lines of evidence support the contention that the dewatering process has occurred in the past in the Anchorage Bowl. The first is the observation that water level in Sand Lake declined following construction of a sewer line at the margin of the Sand/Sundi/Jewel Lakes Bog, and water levels no longer display the historical pattern of fluctuating with local precipitation patterns (Quadra Engineering, Inc. 1981).

The second line of evidence is based on a series of aerial photographs of Connors Lake Bog, beginning with a 1964 photograph (Figure 4-8) and including 1970 (Figure 4-9), 1975 (Figure 4-10), 1978 (Figure 4-11), 1980 (Figure 4-12), and 1981 (Figure 4-6). Interceptor sewers were installed in 1965 on the western boundary of the bog, between 1970 and 1972 angling through the bog (West Bypass Interceptor A), and in 1979 along the Raspberry Road alignment (78-inch West Bypass Interceptor. The series of photographs, when correlated with the precipitation patterns shown in Table 4-8, indicates a gradual dewatering of Connors Lake Bog.

The June 1, 1964 photograph can be used as a reference point because it precedes construction of interceptor lines through Connors Lake Bog, follows a period of slightly below normal winter precipitation and heavy spring precipitation (Table 4-8), and also follows any tectonic changes in elevation associated with the 1964 earthquake.

The July 7, 1970 photograph is taken following a 15-month period of below normal precipitation. As might be expected, water levels in Connors Lake and Blueberry Lake are lower, and the hollows in the bog show little sign of flooding. On the other hand, the June 27, 1975 photograph is taken at the end of a wet winter and spring. Although the hollows in the bog are flooded and water level in Blueberry Lake is similar to 1964, the water level in Connors Lake has dropped further. The general dewatering trend is most obvious in the September 10, 1980 photograph, which follows a period of wet to very wet weather since the winter of 1978-1979. Water levels in Connors Lake and Blueberry Lake remain low relative to 1964, and the hollows in the bog show little sign of flooding. Low water levels in the lakes and the absence of open water in the hollows was still obvious as of June 30, 1982.

Figure 4-8. 1964 Photo of Connors Lake Bog

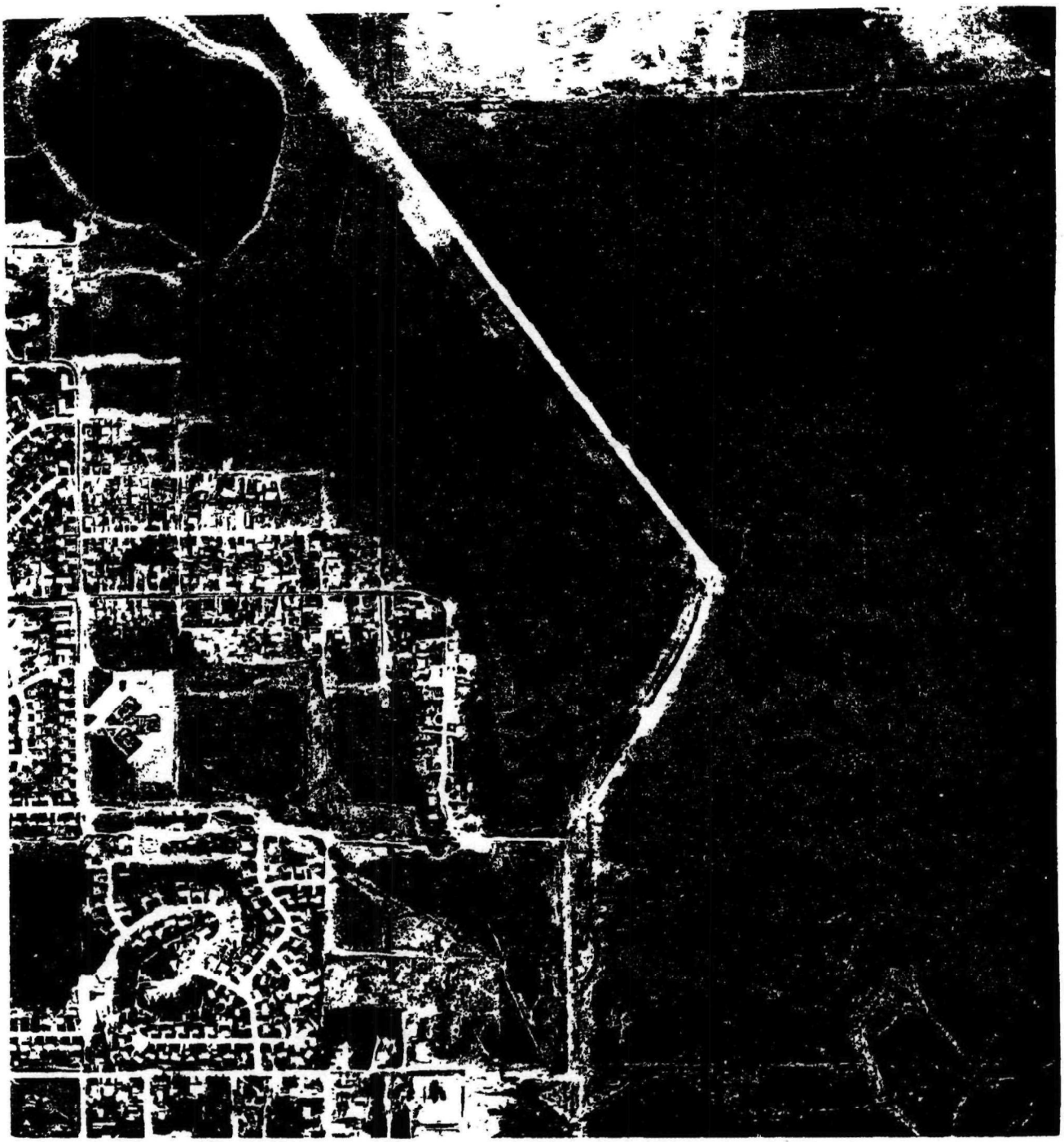


Connors Lake Bog prior to installation of the sewer as outline in Figure 4-6. North is towards the top of the photo. Connors Lake is in the upper left corner, Blueberry Lake is at right center, and Strawberry Lake is in the lower right corner. Note the drainage ditch system in the lower half of the photo.

Figure 4-9. 1970 Photo of Connors Lake Bog

Connors Lake Bog during installation of the sewer as outlined in Figure 4-6. Note the access road for construction equipment and small pond at upper center.

Figure 4-10. 1975 Photo of Connors Lake Bog



Connors Lake Bog following construction of sewer as outlined in Figure 4-6. Water level in Connors Lake remains low, although water level in Blueberry Lake has returned to that noted in 1964 photo (Figure 4-8). Small pond at upper center has been filled by the Municipality solid waste landfill.

Figure 4-11. 1978 Photo of Connors Lake Bog

Note significant reduction in water levels in Connors Lake, Blueberry Lake, and Strawberry Lake. Stockpiling of sewer pipe for the 78" West Interceptor along Raspberry Road is evident.

Figure 4-12. 1980 Photomosaic of Connors Lake Bog

Note stockpiling of sewer pipe for 78" West Interceptor. Construction of Raspberry Road and Minnesota Drive is underway.

Table 4-8. Precipitation (in inches) Summary for Periods Preceding Aerial Photography of Connors Lake Bog

Date of Photo	Previous Winter Precipitation[1]	Mean Winter Precipitation[2]	Total For Preceding 3 mos.	Mean Total For Preceding 3 mos.[2]	Preceding Month Total	Mean Total Preceding Month[2]	Summary
June 1, 1964	5.19	6.00	2.93	1.80	0.97	0.57	Dry Winter; Wet Spring
July 7, 1970	4.40	6.00	1.55	2.28	0.85	1.14	Dry
June 27, 1975	7.38	6.00	2.65	1.80	0.40	0.57	Wet
September 17, 1978	5.17	6.00	5.41	5.27	0.54	2.20	Dry Winter; Normal Spring
September 10, 1980	9.22	6.00	8.06	5.27	3.06	2.20	Very Wet
September 22, 1981	6.26	6.00	10.18	5.27	4.96	2.20	Normal Winter; Very Wet Summer

FOOTNOTES:

[1]October - March, inclusive
[2]1943-1980 (NOAA 1980)

Source: NOAA 1981, 1982

In all the photographs following 1964, water levels in Strawberry Lake have dropped, probably because of the construction of a drainage ditch system into and out of Strawberry Lake. In general, the sequence of photographs reveals that water levels have dropped in Connors Lake and Blueberry Lake and hollows no longer contain open water, even in very wet years such as 1980.

Additional hydrologic impacts may result because of a loss of wetlands to development. Wetlands, particularly those in floodplains, tend to display a water-retention ability which reduces peak flood flows and maintains stream flow and groundwater movement during low flow periods. It is not clear how important wetlands are in moderating stream flows or groundwater movement in the Anchorage area. The impacts of growth-induced development of wetlands on loss of hydrologic function cannot be assessed with the available information. Most of the wetlands designated for preservation by the MOA occur in greenbelt areas along major streams. Therefore, the impacts on wetland hydrology are most likely to be associated with effects on groundwater, because wetlands in the floodplain are not as likely to be developed.

Additional indirect hydrologic impacts may result from the use of permeable material as backfill. Pipe corridors not only may act as corridors for water movement into or out of wetlands, but also may divert groundwater away from wetland areas when the pipe corridor is adjacent to a wetland and perpendicular to the path of groundwater movement. These impacts may be of diminished importance when the wetlands appear in a floodplain, but may be very important to isolated bogs.

Mitigation of Hydrologic Impacts

Two major hydrologic impacts on wetlands and streams have been identified in the previous section. These impacts and appropriate mitigations are summarized below.

Alteration of Groundwater Movement Into or Out of Wetlands. This impact and appropriate mitigation measures are discussed following the section on pipe emplacement impacts.

Alteration of Stream Flow. No feasible mitigation measures can be proposed until site-specific details are available on the hydrologic function of the specific wetland and the impact of the proposed project.

Secondary Biological Impacts

Secondary (indirect) biological impacts of the sewerage facilities expansion relate primarily to induced growth in the urban area. Urbanization of the Anchorage Bowl has already

altered some wildlife values of the area. For example, the moose population in the area (see Biological Setting) has dropped to one-third the population of 30 years ago, primarily because of a loss of winter habitat in the Bowl (Harkness pers. comm.). Additional urbanization will place additional constraints on winter foraging by moose in the Anchorage area. As another example, restrictions on sportfishing in Campbell Creek and Rabbit Creek have been promulgated in order to maintain a salmon fishery, forcing sportfishermen to travel elsewhere for salmon fishing. The increased population growth in Anchorage over the past 20 years has increased pressure on resources such as salmon, waterfowl, and wilderness habitats in areas within reasonable driving distance of the Anchorage area.

The facilities plan will remove a major constraint on population growth in the Anchorage Bowl, particularly in the area south of Tudor Road. If population saturation is reached in 20 years and if all wetlands designated as developable by the wetlands management plan are developed, then a loss of about 55 percent of the remaining nontidal wetland habitat in the Anchorage Bowl would result. The major consequences of this overall loss are likely to be: 1) alterations in the hydrologic regimes of streams, 2) changes in groundwater movement, and 3) a major loss of bird nesting habitat including a well-established Canada goose nesting area at Heather Meadows (C Street and Tudor Road) and in southern Campbell-Klatt Bog.

Mitigation of Secondary (Growth-Related) Biological Impacts

If appropriate mitigation measures mentioned elsewhere in this chapter are adopted, losses of hydrologic and biological values may be reduced to a limited extent. Short of restricting population growth, it does not seem practical to offer mitigation measures for cumulative impacts. If growth is to occur in the Anchorage Bowl, it may be preferable to confine the losses to the already urbanized area, and not attempt to expand growth to outlying, more pristine areas.

Human Use Impacts

The use of wetlands as open space and recreational areas may be altered if sewer interceptors cross wetland areas or if the improved sewer system encourages population growth in the Anchorage Bowl. Adverse impacts include: loss of wetlands because of development pressure; decrease in wildlife abundance (especially nesting waterfowl) because of increased recreational activities on remaining wetlands; and loss of wildlife and fish habitat because of alterations in a hydrologic regime and, subsequently, habitat. To many residents accustomed to urban living, these impacts may be acceptable, but to

many citizens, particularly long-term residents, the open space and wildlife within the Anchorage Bowl area are a valuable aesthetic resource.

Beneficial impacts can be realized when sewer interceptors cross wetlands. Although emplacement of a sewer pipe in a wetland removes the existing shrub vegetation on the right-of-way, the right-of-way can serve as a new recreational trail, particularly during the winter when cross-country skiing and snow vehicle use are popular.

Potentially impacted areas may be identified by Table 4-5 (sewerage interceptors crossing wetlands) and by examining the wetland areas scheduled for development by the Anchorage 1982 Wetlands Management Plan.

Impacts on Potter Marsh

Sewerage has been proposed by the Hillside Wastewater Management Plan for about 3,600 acres (18 percent) of the Hillside area. Two major areas proposed for sewerage are lower elevation areas between Abbott Road and De Armoun Road and the area south of Rabbit Creek Road. These areas would be served by the southeast interceptor and a proposed trunk sewer running east of the Old Seward Highway east of Potter Marsh. The proposed trunk line near Potter Marsh would be connected to the southeast interceptor by a proposed pumping station and force main along the New Seward Highway. The proposed pumping station would be located near the small airstrip on the north edge of Potter Marsh.

Short-Term Construction Impacts on Potter Marsh. The trunk line east of Potter Marsh will cross Little Rabbit Creek and Rabbit Creek. Most of the construction impacts on Potter Marsh will be communicated to the marsh by these two streams. Trenching and excavation activities for stream crossings will result in temporary increases in siltation in the marsh. Some of the extra sediment burden may be transported out of the marsh at the next "breakup" or heavy storm runoff, but a portion may remain permanently in the marsh.

Long-Term and Secondary Impacts on Potter Marsh. Home construction in some areas of the Rabbit Creek watershed is partially impeded by problems with on-site disposal systems. Sewering the problem areas, as proposed by the Hillside Wastewater Management Plan and the 201 facilities plan, will eliminate this constraint, but may have adverse impacts on Potter Marsh. The construction of additional housing units may increase the sediment load transported by Rabbit Creek and Little Rabbit Creek into Potter Marsh. Additional housing units will increase demands on groundwater supplies, potentially altering the hydrologic regime tributary to Potter Marsh.

The sewering may provide benefits to Potter Marsh by preventing on-site system construction and thereby precluding water quality impacts due to system failure. Other portions of the watershed that will not be sewered may develop with on-site systems for sewage disposal. These areas will increase the threat of water quality standards violations in Rabbit Creek and in Potter Marsh. These issues are also discussed in Chapter 5.

Mitigation of Sedimentation Impacts on Potter Marsh

Short-term construction impacts on Potter Marsh relate primarily to temporary increases in siltation. One possible mitigation measure is to reroute the collection system to run along the seaward side of the Alaska Railroad embankment, as shown in Figure 3-9 (Alternative 3 of the facilities plan). Alternatively, the interceptor could be jacked under the streambeds, thereby minimizing the disturbance of the streambed. Mitigation for growth-induced impacts is discussed in Chapter 5.

Pipe Emplacement Impacts on Tidal Wetlands

The facilities plan proposes construction in tidal wetlands along the Alaska Railroad embankment from the downtown area to the lower Fish Creek wetland area. Construction along the railroad embankment between the downtown area and the mouth of Fish Creek is unlikely to result in significant adverse impacts on the environment. This area is characterized by thick silt deposits and tidal action. Construction will likely have to occur during neap tides. Crossing the mouth of Hood Creek and Chester Creek may cause increased turbidity in these areas, but it is unlikely that the turbidity resulting from construction will exceed or be distinguished from the usual turbidity of Knik Arm water.

Construction in lower Fish Creek upstream to the Alaska Railroad crossing may temporarily denude the pipeline right-of-way. The existing right-of-way is slightly elevated relative to the surrounding wetland, causing minor impounding of water upslope of the right-of-way and providing space for a slightly different tidal wetland vegetation type.

Chapter 5

Hillside Issues

- Issue Summary
- Legal, Regulatory and Policy Constraints
- Human Use Setting
- Impacts of Sewerage Decisions on Hillside

Chapter 5

HILLSIDE ISSUES

The Hillside Wastewater Management Plan comprises one element of the Section 201 facilities plan for Anchorage. The plan encompasses the Hillside area south of Abbott Road, East of New Seward Highway and west and north of Chugach State Park. The purpose of the plan is "...to identify on-site and alternative wastewater disposal techniques, the boundaries of the areas where on-site disposal [is] not possible and those areas in which some method of on-site alternative system should be feasible, and to identify appropriate and supporting land use recommendations" (MOA 1982).

The issues and potential environmental impacts of the Hillside Wastewater Management Plan are distinct in many ways from those related to the remainder of the Anchorage Bowl. This chapter addresses these issues and evaluates the impacts of the plan.

Issue Summary

The Hillside area has been sparsely settled by residents who wish to live in a less crowded area than exists elsewhere in the Anchorage Bowl, and who wish to retain some flavor of rural Alaska in their residential setting. One- to five-acre zoning is common, although some areas are platted with lots as small as one-quarter acre. With the exception of a few areas close to New Seward Highway the Hillside does not have public water or sewers. Instead, the area relies on individual domestic wells for water supply and individual on-site sewage disposal systems such as septic tanks with drain fields.

In 1979 a study was completed for the MOA that proposed sewer line extensions into the Hillside area (URS-Bomhoff 1979). Residents and groups objected, fearing that sewering would enable dense development of the Hillside. They were also concerned that the expense of public sewers would necessitate a more dense development pattern to reduce to a reasonable amount the per lot costs for bringing sewers to the Hillside.

Strong opposition to sewers continues today. The opposition to sewers is apparently a direct reflection of the desire to retain the rural character of the Hillside by allowing the limited water supply and marginal suitability for on-site sewerage

disposal on the Hillside to provide a practical limit to development densities. The U. S. Geological Survey, in Hydrology for Land Use Planning: The Hillside Area, Anchorage, Alaska (U. S. Geological Survey 1975), seriously questioned the ability of the Hillside to support added development while protecting surface water quality, groundwater quality, and individual water supply wells. The U. S. Geological Survey concluded that:

> "Dense development may result in the local depletion of aquifers or increased surface drainage problems, or lead to ground and surface water pollution unless community water and sewage facilities are substituted for individual systems in the susceptible areas...
>
> "In numerous locations, steep slopes, swamps and shallow ground water, and low permeability of surficial earth materials could make the use of septic tank systems hazardous to public health, and also cause critical drainage conditions. Septic tank effluent must percolate into and be cleansed by surficial sediments; otherwise, streams, lakes, aquifers, and even the land surface can become contaminated. At this time, the total load of pollutants that the sediments can absorb is not determinable, but onsite waste disposal has the potential to cause pollution in much of the Hillside area... Particularly where the land is not conducive to cleansing liquid-waste discharge within critical distances, the density of development will determine the degree of change in water quality locally and downslope from development...
>
> "Ground water in the Hillside area probably has not been polluted by the current density of domestic sewage systems. However, the probability of future aquifer pollution because of a much greater density of onsite waste-disposal systems is relatively high in the upper Hillside area..." (U. S. Geological Survey 1975).

Another influence is the limited supply of developable land in the Anchorage Bowl. The confined geography of the Bowl is likely to begin limiting growth several decades in the future, and the Hillside will come under greater pressure to develop in a more dense manner.

In response to these apparently conflicting concerns, the MOA began preparation of the Hillside Wastewater Management Plan in 1981. The objectives in preparing the plan were to better define physical constraints to on-site sewage disposal, delineate areas that would be served by public sewers and areas that would be served by on-site sewage systems, and to provide for proper and safe management of on-site systems to protect public health.

As described in Chapter 3, the plan delineates areas for public sewerage and for on-site systems, and recommends land use, construction, inspection, and maintenance practices to help ensure successful operation of on-site sewerage systems and protect public health.

Legal, Regulatory and Policy Constraints

The Hillside Wastewater Management Plan, adopted May 18, 1982, is now a legal constraint on sewerage in the Hillside area. The plan is described in Chapter 3, and certain specific features are discussed later in this chapter. Other laws, regulations and policies constrain on-site waste disposal, drilling of private domestic wells, land division (platting) of unsewered areas, and other activities relevant to the issues surrounding sewerage options in the Hillside area.

Platting Guidelines

Municipal ordinances govern the minimum sizes of lots allowed where development will utilize on-site sewage systems in combination with individual wells or community water supplies. Maximum density for on-site system lots using individual wells is one residence per acre, while for lots using community water supplies the limit is two residences per acre. Specific lot square footage requirements vary by soil type, and larger parcels may be required where high groundwater or bedrock outcroppings occur.

Each lot must be sized to provide one-half of its area at a slope of less than 25 percent (14 degrees) available to provide for three on-site disposal systems (one original system and two replacements).

On-Site Sewage System Inspections

Prior to obtaining a building permit, an applicant must provide evidence of suitability of the soils, location (at least 100 feet from any stream, body of water or well), and provide an acceptable system design. Minimum design standards are prescribed and enforced by the MOA DHEP. Construction inspections are performed by the Department to ensure conformance with the requirements.

A second form of inspection occurs whenever a structure is sold with financing through a commercial lending institution. These lenders, as a protection of their investment in loans on property, routinely require a reinspection of all on-site sewerage systems and recertification of individual wells.

Under this program septic systems two to four years old are pumped, and systems over four years old are pumped and an adequacy test performed on the leaching area. If the system proves inadequate, it must be upgraded or funds for upgrading must be placed in escrow before the lender will disburse loan funds.

On-Site Water Well Inspection

The MOA enforces standards for water wells and requires permits for drilling all wells. Municipal ordinances require a sanitary seal and also set minimum casing depths of 40 feet to prevent shallow infiltration into the well. Where bedrock restricts this depth the casing must be seated in the bedrock. A well log must be provided so that a permanent record is kept of conditions encountered during drilling, and wells must be tested and disinfected prior to use.

When property changes hands and is financed by a commercial lender, laboratory water quality testing is required.

Human Use Setting

The Hillside area is one of the more desirable residential areas in the Anchorage Bowl. In spite of difficult access problems in upper parts of the Hillside during winter snow and ice conditions, the area is attracting increasing large lot development activity. Future development is an issue to those residents already living in the area, as well as the rest of the Anchorage Bowl residents who have an interest in the future of their community.

The estimated population of the Hillside area was about 5,000 in 1973, and projections at that time suggested the possibility of 15,000 people by 1985 (U. S. Geological Survey 1975). Data in the Hillside Wastewater Management Plan suggest a 1980 population of about 11,200 persons with projections for saturated development of 42,300 to 66,118, or from four to six times 1980 levels. It is projected that the Hillside may increase its relative importance in providing Anchorage Bowl housing from the present level of 7.2 percent of all dwelling units to 14.8 percent (MOA 1982). These figures indicate that the MOA envisions growth in the Hillside to levels much higher than the U. S. Geological Survey assumed in conducting their 1975 study.

The western edge of the Hillside area has developed with public sewers and water supplies. The balance of existing development draws water from domestic wells and disposes of wastes via on-site disposal systems. The Hillside plan proposes that development continue in much of the area based on on-site sewage disposal and individual wells, with public sewers provided in certain areas (see Figures 3-4 and 3-5).

Hydrologic Setting

The interrelationship of surface water, groundwater, domestic wells and on-site sewerage systems is central to many of the Hillside issues. This section describes the surface water, groundwater and domestic water supply resources of the Hillside area. In addition, Figure 4-5 provides a conceptual view of the hydrologic cycle relative to Anchorage and helps place some of the water resources relationships in perspective.

Surface Water

Five streams and numerous tributaries traverse the Hillside area. The Little Campbell, Furrow, Rabbit, Little Rabbit, and Potter Creeks rise in the Chugach mountains or in the eastern Hillside and flow generally west. The south fork of Campbell Creek also skirts the north and easterly boundaries of the Hillside, but is not considered within the area covered by this chapter.

Furrow Creek has relatively low flow much of the year, and is not discussed further. Little Campbell Creek flows at less than 2 cfs for most of the year, and almost stops during severe winter icing. Rabbit Creek flows year around with an annual average flow of 17 cfs. Little Rabbit Creek averages about 6.2 cfs annually, with low flow of about 1 cfs (U. S. Geological Survey 1975). Average annual Potter Creek flows are estimated at less than 3 cfs.

Water quality of these streams is generally good, although some evidence of urban pollution is revealed in the limited testing that has been conducted. Little Campbell Creek evidences occasional elevated coliform counts, minor amounts of lead and nitrate that may be elevated above natural levels. Little Rabbit Creek also has shown some high coliform levels. These pollutants are typical of urbanized watersheds.

Groundwater

From Figure 4-5 it can be seen that the Hillside area serves as a recharge area for part of the Anchorage Bowl, and is therefore important to the Municipality's water sypply. Groundwater is generally found in the Hillside area in sand and gravel lenses betweeen less permeable till layers, below confining hardpan layers, and to a limited extent in bedrock fractures. The water-bearing deposits generally deepen and thicken with lower elevation, and movement of groundwater occurs towards lower elevations.

Water budget estimates developed for the Hillside indicate groundwater inflow to the area at the average rate of about 11 cfs and outflow of about 8-13 cfs (U. S. Geological Survey 1975, 1982). Recharge, evapotranspiration, interchange between creek flows and groundwater, precipitation, and data inaccuracies affect these estimates. It is not known what proportion of the estimated 8 to 13 cfs outflow discharges to Turnagain Arm and how much recharges the confined aquifer under the Anchorage metropolitan area. The U. S. Geological Survey estimates that an annual average of about 116 cfs enters the confined aquifers between the Little Rabbit Creek basin and the Ship Creek basin.

Groundwater quality is generally excellent for all beneficial uses, including domestic water supply. In some locations well water is treated to remove iron or reduce hardness.

Domestic Water Supply

Individual wells supply groundwater for domestic supply in most of the Hillside area. Each residence has its own well and pump, often a small hydropneumatic tank to maintain even water pressure and, where wells yield at low rates, storage tanks to provide for peak demand times. No treatment is usually required, unless iron is present, or it is desired to reduce hardness.

Well testing is conducted regularly by the Municipality for bacterial contamination. In 1981, the Municipality DHEP tested over 1,200 wells at residences as part of resale inspections and new well certification. The standard requires that no coliform be present in the sample. A test failure rate of less than 1 per 1,000 wells tested is reported (Rasmussen pers. comm. 1982). The U. S. Geological Survey has occasionally tested wells for chemical quality. Their 1975 Hillside report cited 12 wells tested, with constituents within EPA water supply limitations. Two wells reported nitrate levels of 7.8 and 9.0 mg/l, respectively, close to the EPA standard of 10 mg/l. This standard is intended to protect public health, specifically to prevent methemoglobinemia, a potentially fatal form of oxygen starvation in infants.

In March and May of 1982, U. S. Geological Survey sampled nine additional wells for chemical constituents. A nitrate level of 6.5 was found in one shallow hand-dug well located south of Rabbit Creek near Buffalo Street. The property has not changed hands in many years, and the MOA retesting program has therefore not required upgrading. The nitrate contamination may be from shallow septic tank seepage in the general area. No tests for bacterial contamination were made (Brabetts pers. comm.).

Impacts of Sewerage Decisions on Hillside Area

The sewerage decisions relating to the Hillside area will impact the resources and future residents of the area in various ways. The impacts relate to whether or not public sewerage will be provided, whether individual or cluster type on-site disposal will be allowed on individual lots in the remaining area, and whether these systems will function effectively over the long term (at least for the EPA recommended 20-year planning period). The areas to be sewered are evaluated first, followed by the on-site system areas, incorporating the proposed cluster system area.

Impacts of Sewering Portions of Hillside Area

Providing public sewers to the lower Hillside area between Abbott Road and DeArmoun Road in accordance with the adopted Hillside plan will allow development to occur at higher density than could occur with on-site sewerage systems. Densities of 3 dwelling units per acre and greater were proposed in the plan and discussed between the Planning Department and Hillside Advisory Committee during plan formulation. The densities in these areas were often at issue, and objections were apparently resolved by defining buffer areas and standards to effect an acceptable transition between low density (on-site sewerage) and higher density (public sewerage) areas. Transition Area Standards were adopted as part of the Hillside plan. Establishment of densities in the entire Hillside area now awaits adoption of the Comprehensive Development Plan. The decision to provide sewerage to this area has thereby removed a constraint to growth.

If the sewers to be provided in this area have extra capacity such as can occur through conservative design (that is, provision for high infiltration flows, high peaking factors, or other factors), future extension of sewerage service to adjacent portions of the Hillside may be possible. The MOA Planning Department indicated in Assembly hearings on the Hillside plan that a 25 percent oversizing was being incorporated into design of interceptors serving the Hillside area; Water and Sewer Utilities representatives later questioned these statements. The facilities plan does not indicate a 25 percent allowance in flow computations. (See interceptor sizing discussions in Chapter 3).

If the area of public sewerage is expanded in the future, premised on extra downstream sewer capacity, the timing of such an expansion would be an important factor in determining the effects of oversizing. If oversizing occurs, but no new sewer extensions are authorized until rural density development patterns are assured, then few development impacts would occur. There could be some pressure to subdivide single lots into two or three parcels in some cases. If authorization to extend the sewerage area

were to occur early in the development process, however, the availability of sewers may induce some landowners to seek the greater profits from development of their lands that can occur at higher residential densities. Depending on the attitude of approval agencies, the excess capacity could affect land use density under these circumstances.

Higher densities than currently allowed would decrease the rural character of the affected portion of the Hillside, lending a more urban character to the area. This would be contrary to the desires of many current residents of the area, and would be contrary to the implied objective of the Hillside plan to maintain low density development through exclusion of sewers. Greater densities would accommodate a greater population in the Anchorage Bowl and provide a greater total population holding capacity.

Provision of extra capacity in downstream interceptor sewers may provide a benefit in future years if on-site system failures increase in frequency or water supply contamination occurs, and residents press for public sewers. This is discussed in greater depth later in this chapter.

Sewering the lower Hillside area south of Little Rabbit Creek, as shown in the Hillside plan will enable development at significantly higher densities than would otherwise occur supported by on-site sewerage systems. The Golden View Drive area and much of the Potter Creek watershed were judged generally unsuitable for on-site treatment systems (Figure 3-5), and portions of these areas may not be developable without sewers, even with innovative (special technology) on-site systems. Thus, sewering of this area can be considered growth-inducing. Chapter 7 provides additional information on the secondary impacts of growth.

If surplus capacity is provided in the Potter Creek-Rabbit Creek collection system, pump station and force main, further extension of the sewerage facilities could occur, with impacts similar to those discussed above for the northern portion of the Hillside area.

An additional issue relative to development of the south Hillside area centers on water supply to Potter Marsh. It has been suggested that a new water supply for the south Hillside would be developed from surface water in the area, and that inflow to Potter Marsh would be reduced. Potter Marsh is fed by Rabbit and Little Rabbit Creeks. The worst case impact that could occur would be for the entire water supply to be developed in Rabbit and Little Rabbit Creeks. (Potter Creek does not flow to Potter Marsh, and may have insufficient flow to provide a dependable water supply.

Total natural inflow to Potter Marsh from Rabbit and Little Rabbit Creek is estimated at about 23 cfs (U. S. Geological Survey 1975). The quantity of sewage to be exported from the area in the proposed pump station and force main is about 1.1 mgd or 1.7 cfs. In addition to this export, some of the developed water supply will become surface runoff due to car washing, lawn watering and other activities, and some will be lost through evaporation. An estimated water supply averaging 2 mgd or 3.1 cfs would be required, based on 145 gallons per capita per day, the estimated consumption rate in the Anchorage Bowl. Thus the maximum impact of developing a water supply for the sewered area of the South Hillside area from Little Rabbit and Rabbit Creeks would be to reduce Potter Marsh inflow from about 23 cfs to as low as 20 cfs on an annual basis.

At some times of the year combined inflow from Rabbit and Little Rabbit Creeks is less than 6 cfs. At such times water diversions could reduce inflow to Potter Marsh by more than 50 percent. The wildlife values of Potter Marsh could be adversely affected by such a change in hydrologic regime. Fishery resources of the creeks could also be adversely affected.

The presence of sewers in and adjacent to Potter Marsh presents a threat of spills and seepage of untreated sewage to the Marsh. If the pump station or force main near Rabbit Creek were to fail, sewers would overflow at manholes once their limited storage capacity is filled.

Seismic activity and frost heaving can separate pipe joints, move manholes and allow infiltration as well as exfiltration, depending on groundwater depth as compared to pipe depth. Seismic activity in particular can cause catastrophic damage, and could disable the sewerage system for an extended period.

The potential impact of contamination of Potter Marsh can be partly mitigated by providing standby pumping and storage capacity at the Rabbit Creek Pump station. Conservative design and construction practices can help reduce the susceptibility of sewers to frost heaving and seismic activity, lessening infiltration and exfiltration.

Impacts of Designating On-Site Sewerage for Portions of Hillside Area

By adopting the "Recommended Maximum Perimeter of Public Sewerage" the Municipality has excluded sewers from a major portion of the Hillside area. In order to develop within this unsewered area each landowner must demonstrate that adequate land is available to support three drain fields and that other conditions are met. If a property is located on areas designated as generally

unsuitable for on-site treatment systems, approval is more difficult, but is still possible. Innovative (special technology) on-site systems are required unless it can be shown that the traditional system is acceptable.

The Hillside plan will keep maximum densities at or below one dwelling unit per acre unless a community water supply is provided, in which case maximum densities of 2 dwelling units per acre would be allowed. In addition, where areas judged generally unsuitable for on-site systems are designated, development may, in some cases, be precluded. However, the plan does provide that "...innovative systems as well as the conventional deep trench system may be used in those areas identified as generally unsuitable where it can be demonstrated that particular site conditions allow for such on-site wastewater treatment". The extent to which development would be precluded will depend on the criteria applied by the Municipality in reviewing specific lots and development proposals.

Table 5-1 provides a generalized indication of the areas designated as suitable and unsuitable for on-site systems in the Hillside area. It can be seen that approximately 5,840 acres in the Hillside area, comprising 30 percent of the study area, are judged unsuitable for on-site treatment. Of these unsuitable acres only 1,560 or 27 percent are proposed to be served by sewers. The recommended plan for wastewater treatment and disposal on the Hillside does not appear to solve the problem of waste disposal on lands judged unsuitable for on-site treatment systems.

The potential for development of these generally unsuitable areas may lead to higher failure rate and cumulative impacts on the area's water resources. Enterprising landowners are likely to exert strong efforts to demonstrate suitability of some type of innovative system on their property. The economic and social rewards of owning a home in the exclusive Hillside area will provide a strong impetus for continued development, including the generally unsuitable areas. This reasoning suggests that the Hillside will experience significant infill largely independent of suitability designations.

As noted earlier in this chapter, the U. S. Geological Survey raised significant questions in 1975 as to the local depletion of aquifers, increased surface drainage problems, groundwater pollution and surface water pollution as a result of continued development supported by individual wells and on-site sewage disposal. The following sections discuss these issues and explore potential impacts and mitigations.

Table 5-1. Tabulation of Areas to be Served by Public Sewers and by On-Site Sewerage Systems in the Hillside Area

	Area In Acres	% of Subarea	% of Study Area
Total Study Area	19,550	100%	100%
Generally suitable for on-site treatment	10,850	55	55
Generally unsuitable for on-site treatment	5,840	30	30
Not evaluated	2,860	15	15
Areas to be Served by Public Sewers	4,120	100	21
Generally suitable for on-site treatment	2,250	55	11
Generally unsuitable for on-site treatment	1,560	38	8
Not evaluated	310	7	2
Area to be Excluded from Public Sewerage	15,430	100	79
Generally suitable for on-site treatment	8,600	56	44
Generally unsuitable for on-site treatment	4,280	28	22
Not evaluated	2,550	16	13

	Area in Acres	% of Evaluated Area	Area to be Sewered, Acres	%	Area not to be Sewered, Acres	%
Total Evaluated Area*	16,690	100%	3,810	100%	12,880	100%
Generally suitable for on-site treatment	10,850	65%	2,250	59%	8,600	67%
Generally unsuitable for on-site treatment	5,840	35%	1,560	41%	4,280	33%

* 19,550 acres less 2,860 acres in public ownership or otherwise excluded from suitability analyses.

SOURCE: Jones & Stokes Associates, calculated from maps in Hillside Wastewater Management Plan, MOA 1982.

Water Availability Impacts. The Hillside plan does not address the water supply issue. EIS analyses assume that individual wells will continue to be the source of domestic water for the Hillside. As U. S. Geological Survey points out, water availability is very limited in localized portions of the Hillside, even though sufficient water resources exist on an areawide basis to support full development. Some development may be precluded by an inability to develop a well. It is also possible that numerous wells tapping the same limited aquifer could exceed the recharge of the aquifer, leaving upslope or shallower wells without water.

This impact can be mitigated by providing a public water supply system to the area, or by limiting development by water availability based on evaluation of local groundwater supplies.

Surface Drainage Problems. The Hillside area has certain unique surface drainage problems that may subject development to risk of damage, and which complicate the use of on-site disposal systems. With the exception of the major streams, much of the area lacks defined natural drainage channels; wetland areas are present on the Hillside, along with areas with shallow groundwater; flood hazard areas adjoin the major creeks; and water icing and spring thaws complicate transportation and affect local drainage.

Conflicts between these natural conditions and urban development are likely to increase as residential infill occurs in the Hillside. For example, development may increase total runoff and may inadvertently channel it towards existing downstream residences. The Hillside plan includes a requirement that surface water disposal plans be prepared covering "...erosion and sediment controls, water quality controls, surface water conveyance and disposal, and on-site system operation". This requirement will help mitigate some of the risks to development related to the drainage problems of the Hillside. It may be difficult for an individual property owner to evaluate the total area tributary to his property, and to plan for flow leaving his property if he has to provide a plan for it to reach a distant watercourse. Areawide drainage planning, similar to that being conducted elsewhere in the Anchorage Bowl, combined with the requirement for individual drainage plans, would provide a more unified approach.

Drainage planning should also recognize flood risks. Floodplains that are presently delineated should be maintained free of development, and it may be desirable to develop floodplain mapping for presently unmapped areas.

Wetland areas are protected under Section 404 of the Clean Water act, locally administered by the Corps of Engineers. Chapter 4 discusses wetland issues and impacts in detail. It

should be noted that the "waterlogged" areas defined by U. S. Geological Survey in 1975 differ in location and area from the wetland areas shown in the Municipality's Wetlands Management Plan.

Additional discussion of drainage concerns related to development can be found in the 1975 U. S. Geological Survey report.

Groundwater Quality and Public Health Impacts. The 1975 U. S. Geological Survey Hillside study provided strong indications that increased development of the Hillside area with on-site sewerage systems will significantly increase the risk of groundwater pollution. The concerns and cautions of that report remain valid. Further, the higher level of growth projected in the Hillside plan as compared to in the U. S. Geological Survey report intensifies these concerns.

It is estimated that the Hillside area population has more than doubled from about 5,000 in 1975 to about 11,200 in 1980. The Hillside Wastewater Management Plan projects a four- to six-fold population increase to a level between 42,300 and 66,118 at full build-out. About 23,000 of these people would be served by some 9,000 on-site sewerage systems (MOA 1982). In contrast, the U. S. Geological Survey report expressed concerns based on a projected Hillside population of only 15,000 by 1985. While the areas covered by the two studies differ somewhat, these population projections both appear to cover the Hillside area in total. In any event, the population that is likely to be present in the Hillside area in the year 2005 (EPA's Section 201 planning period), while not estimated in the Hillside Wastewater Management Plan, is likely to be significantly larger than that which triggered much of the U. S. Geological Survey concern.

The potential for localized groundwater pollution in the Hillside is relatively high, based on work by both U. S. Geological Survey (1975) and Arctic Environmental Engineers (1981). This high potential exists because most chemicals, detergents, and pathogens are not removed in the septic tank, but rather by contact with unsaturated soil particles in the drain fields. If this contact is inadequate, pollutants may remain untreated. In addition, certain pollutants such as nitrates are not readily removed, and may contaminate the underlying groundwater. In the Hillside area, bedrock outcrops, shallow bedrock, shallow groundwater, steep slopes, roadway excavations, building site excavations and freezing conditions increase the risks of inadequate treatment.

System failures are the vehicle by which much contamination can occur. If a tank fills with solids, if a drain field refuses to accept the volume of waste discharged to it or if a system freezes, remedial work will be required. Most homeowners will

probably be conscientious and will rapidly pursue upgrading before a lengthy discharge of pollutants occurs. As the number of on-site systems on the Hillside increases from 1,500 to nearly 9,000, the number of failures from all causes is likely to increase, even considering tighter design standards and pumping requirements. As existing systems age, failures will increase. Septic systems do not last forever; new drain fields will need to be provided as existing fields absorb pollutants and suspended solids, and eventually fail to meet adequacy testing on resale or simply fail to accept discharged wastes.

While the Hillside plan requires pumping of tanks every two years, total adequacy tests are required only on resale, and failures can occur and go undetected by the Municipality for extended periods. Failures involving pollution of groundwater may go undetected for many years if no surface evidence exists.

The following discussion, quoted from the U.S. Geological Survey (1975) report, points up some of these aspects of the pollution threat. Note that the U. S. Geological Survey cites "as many as 3,000 systems", contrasted to MOA's estimate of 3,500 on-site systems existing in 1980 with 5,459 new systems projected by build-out, resulting in a projected total of nearly 9,000 on-site systems.

> "As septic system density in the study area increases, effluent will increase the rate of recharge to the areal groundwater body. A future population of 10,000 people in the study area may require as many as 3,000 systems, or one system per 3 acres. The total daily discharge of these systems probably would increase from the current estimated 0.4 million gallons to about 1.2 million gallons. This increase represents an average distribution of about 130 gallons of septic wastes per day on each acre of the study area. If the water supply continues to be obtained from local wells, the supply will be in part recycled by the residents. Analysis of the water budget indicates that groundwater recharge from precipitation is between 300 and 700 gallons per acre. If it is assumed that all effluent percolates to the groundwater body, a density of one system per 3 acres will increase local recharge by 19 to 43 percent. If development density reaches one system per acre, local recharge will be increased 56 to 130 percent and total septic system discharge may be as much as 3.6 Mgal/d in the study area. Present land use trends indicate that these systems will not be evenly distributed. Consequently, pollution problems may result where high septic tank density coincides with areas where the susceptibility of the physical environment to pollution is high" (U. S. Geological Survey 1975).

In effect, the Hillside plan would allow development densities of one unit per acre. If an aquifer in a local area received all of its recharge from local precipitation prior to development, septic tank recharge of the aquifer could become the predominant source of water serving individual wells in that area. Threats to public health from high nitrate levels and waterborne diseases would be magnified in such cases. If seasonal high groundwater occurs in these areas, treatment of septic tank effluent in drain fields could be inadequate, and direct contamination of the water supply would occur.

> "There is a high probability of ground water contamination where either the water table or bedrock lies between 15 and 25 feet below the surface. If septic tank systems are installed where either the water table or bedrock surface is less than 15 feet below the surface, ground water contamination is a strong possibility.
>
> "Where a seepage pit is constructed in saturated material, the effluent may overflow the pit and eventually rise to the surface. This occurs where the capacity of the material to transmit water is too small to allow the dispersion of septic tank discharge. Contaminants in the effluent also mix with and pollute the shallow ground water surrounding the seepage pit.
>
> "Contaminated effluent probably will find its way into bedrock fractures if seepage pits are constructed in sediments that are only 15 feet thick or less. Where fractures in the bedrock contain ground water, pollution may spread rapidly and wells tapping fractures more than 1 mile away may pump contaminated water in a relatively short time after the effluent reaches bedrock". (U. S. Geological Survey 1975).

The Hillside Wastewater Management Plan does not prohibit on-site systems in shallow bedrock areas, nor does it require seasonal groundwater monitoring to detect seasonal fluctuations that would affect the degree of treatment.

The large number of on-site systems will increase the risk of accumulations of conservative pollutants such as nitrates that are not readily treated in travel through the soil. The contamination of the three wells with nitrate approaching EPA standards cited earlier in this chapter may be an example. Cumulative impacts of substantial groundwater recharge from nearly 9,000 on-site systems may be significant. Nitrate levels could exceed the EPA drinking water standards in localized areas, and could affect the artesian aquifer under the lower hillside and within the Anchorage Bowl.

In areas where cluster systems are used the effects of potential failures may be more severe. Whenever more than one dwelling unit drains to a system, repair difficulties and determination of financial responsibility tend to be greater

problems. Homes served by a cluster system may be more reluctant to curtail water use during failures than would be the case with an individual system failure in a person's own yard. The quantity of discharge from a failed cluster system will likely be greater than for a failed individual system, causing potentially greater impacts on surface and groundwater quality and on public health risks.

Mitigation Measures. Mitigating the potential groundwater impacts on public health and water quality that result from the decision to preclude public sewers and allow a substantial increase in on-site systems in the Hillside presents many challenges. Developing an adequate plan to drink from a limited groundwater supply and discharge wastes back to that supply entails risks. Implementing such a plan under the adverse soils, geologic and climatic conditions of the Anchorage Hillside area magnifies those risks. Attempting to mitigate the risks in a social environment where there is a strong desire to minimize governmental involvement further complicates the problem.

The Hillside Wastewater Management Plan incorporates certain mitigation measures that are discussed earlier in this chapter. They include training and certification of persons involved in the design, construction, maintenance and administration of on-site systems; review of drain field location and soil conditions; requiring more rigorous design and a pilot program of innovative systems for areas generally unsuitable for on-site systems; pumping and insulation of septic tanks to reduce failures; and requiring three drain fields for each building site.

These mitigations do not reduce the impacts to the lowest possible level, however. The impacts described in this chapter are likely to occur if the Hillside Wastewater Management Plan is implemented as adopted. Additional mitigations could be employed to further reduce risks to public health and water resources. They include:

- Groundwater monitoring, including coliform and nitrate as well as other substances of concern to public health. Monitoring could be designed to regularly sample shallow and deep groundwater on the Hillside and in downslope areas to determine whether on-site system loading is threatening water supplies on the Hillside and in the Anchorage Bowl.

- Periodic certification of domestic wells. Data developed for the Hillside plan showed that the average resident lives in his home for a period of 5.6 years, indicating most wells are now tested on an infrequent basis. An annual or biennial testing of wells would protect those who have not financed their home and those who have lived in the area more than 1-2 years. Periodic certification would provide greater protection for visitors to homes in the Hillside, who may be more sensitive to contaminants in the water than residents who consume it daily and who may have developed higher tolerance.

- Operate a public septic tank maintenance district for the entire Hillside on-site disposal area. The district could be administered by the Municipality or a specially-organized entity that would perform groundwater and surface water monitoring. The agency could assume responsibility for all system operation, maintenance and liability. Revenues could be derived from assessments against properties or as service fees from residents. Other variations of this approach are possible (EPA 1981).

- Provide public sewerage capacity as a mitigating option. As development of the Hillside area proceeds and densities increase, there are likely to be increased failures, and some serious public health threats may be detected. Future populations are likely to request public sewer service in some cases. If the capacity is provided in downstream interceptors to serve the Hillside, this
- option would be possible. If capacity is not provided, the practical and economic burdens of providing sewerage could be far greater. In either case, financing of extensions into the upper Hillside area would likely be difficult.

- Provide a public water supply to the Hillside area. Potential health threats due to contamination of individual wells could be eliminated by providing a public water supply to the entire Hillside area. The supply would be assumed to be drawn from areas free from substantial recharge by Hillside wastewater systems. The proposed Eklutna project would be a potential source. Provision of a water distribution system would be expensive due to relatively low density and great variation in elevation, requiring numerous separate pressure zones. Financing might be difficult. It should also be noted that a doubling of density of the Hillside could be allowed with a public water supply system.

- Improvement of site inspection criteria. Tightening of approvals for on-site systems may help prevent failures. In addition to the methods set forth by MOA, seasonal groundwater levels could be monitored to detect "worst case" conditions on each site, and prevent construction of on-site systems that may discharge inadequately treated wastes during one or several months of seasonal high groundwater each year. Also, areas generally unsuitable for on-site systems could be precluded from development unless it is positively demonstrated by pilot testing of innovative systems and site data that on-site sewerage is appropriate for that site.

Surface Water Quality Impacts. Wherever septic tank effluent is allowed to surface, or where shallow groundwater recharges a surface water body, the potential for surface water pollution exists. There are many ways in which septic tank effluent can surface. Shallow seasonal groundwater may interfere with infiltration and cause the effluent to pond to the surface; drain fields can be plugged by improper tank maintenance; relatively impermeable soils may refuse to accept the volume of discharge, causing ponding; steep slopes (greater than 20 percent), roadway excavations, or building site excavations can intercept lateral flow of effluent; and deep frost can freeze shallow pipes.

The growing number of roadway excavations and building site excavations poses a high risk of intercepting percolating effluent. At a density of one unit per acre excavations frequently will be in close proximity to on-site sewerage systems. The potential for public health impacts would be magnified substantially by incompletely treated effluent flowing in local drainage courses and roadside ditches.

Mitigation Measures. A number of mitigation measures can be employed to reduce impacts on surface water quality. They are:

- Surface water monitoring of quality of local streams to detect effluent discharge to surface waters. The program could be structured to detect pollutants and trace sources.

- Prohibition of drain fields upslope of existing and proposed roadway excavations. The MOA could prohibit the location of on-site treatment system drain fields within 100 feet upslope of existing and proposed roadway excavations. This would reduce the threat of surfacing effluent reaching roadside ditches and watercourses.

- Prohibition of building site excavations downslope of drain fields. A similar mitigation would be the prohibition of excavation for home construction or other related purposes within 100 feet downslope of an existing or permitted drain field. This would also reduce the threat of inadequately treated effluent reaching locations where public contact can occur.

Economic Impacts. The Hillside Wastewater Management Plan presents limited cost data that suggest sewering the Hillside on a large-lot basis would cost $38,180 per unit, while on-site systems would cost $4,390 per unit. However, no 20-year present worth analysis is developed to compare true life-cycle costs of both systems through the planning period.

Chapter 6
Cultural Resource Impacts

- Archeological Resources
- Historic Places

Chapter 6

CULTURAL RESOURCE IMPACTS

Archeological Resources

The Anchorage Bowl area is not noted for extensive use by prehistoric populations. A known archeological site occurs at Point Woronzof one-half mile south of the WWTP (49-TYO-030). The Tanaina were known to have fish camps at the mouth of Ship Creek during early historic times. A more detailed description of archeological resources is found in

Impacts to known or newly-discovered archeological sites can be minimized through avoidance where possible. The facilities plan does not threaten the site in the Point Woronzof area. A preconstruction survey of the expansion area at the WWTP should be conducted as a precautionary measure. Since watercourses are often places of high habitation probability, a brief reconnaissance at all stream crossings is recommended. During all construction activity, a localized work halt should occur and the State Historic Preservation Officer should be immediately notified if an archeological site is uncovered.

Historic Places

Although Anchorage is a comparatively young city, having been established in 1915, it has a number of places of historic value, including seven sites listed in the National Register of Historic Places:

- the Oscar Anderson House on 4th Avenue
- the Old Federal Building and U.S. Courthouse at 601 W. 4th Avenue
- the Campus Center on Wesley Drive
- the Eklutna Power Plant northeast of Anchorage
- the Old St. Nicholas Russian Orthodox Church on Eklutna Village Road
- the old Anchorage City Hall at 524 W. 4th Avenue
- the Pioneer School House at 3rd Avenue and Eagle St.

None of these sites is affected by the facilities plan.

Chapter 7

Secondary Impacts

- Growth Inducement
- Consequences of Growth
- Perceived Quality of Life

Chapter 7

SECONDARY IMPACTS

The impacts of urban growth are often considered to be secondary or consequential effects of the action that induces or allows growth to occur. This chapter discusses growth inducement related to the sewerage expansion and presents the secondary impacts that would occur at the projected population growth rate, assuming adequate sewer facilities are available and lack of facilities does not become a constraint.

Growth Inducement

The normal growth inducement roles of utility facilities can be summarized as follows. A capacity expansion of sewerage facilities usually increases the holding capacity but does not stimulate growth in areas where the existing holding capacity has not been reached. Holding capacity can be defined as the total amount of possible development in terms of population or area. However, if the holding capacity has been reached, and new hookups are prohibited because of lack of sewerage capacity, then expansion of the facilities may well stimulate development. Depending on specific circumstances, decisions not to expand or to limit the expansion of sewerage facilities may restrict growth by delaying, limiting or preventing it. Extension of facilities to a previously unserviced area may stimulate or accelerate development.

The growth inducement potential of a proposed project can be defined primarily by its influence on the holding capacity and growth rate of an area. The analysis of growth-related impacts involves identifying the role of the proposed project in influencing economic and/or population growth in an area and the identification and analysis of the environmental impacts attributable to any growth produced or accommodated by the project.

Lack of sewerage facilities is not now constraining the rate of growth in the Anchorage area. There is no moratorium on new sewer connections. The Point Woronzof treatment plant currently exceeds its capacity at times, and some inadequate interceptor sewer and pump station facilities occasionally allow spills of raw sewage to Campbell Creek and Chester Creek. If no expansion of sewer

facilities occurs, this situation is expected to worsen with growth, probably to the extent that a moratorium on new sewerage service could eventually be imposed. No estimate of the amount of such new growth that would trigger a moratorium is attempted in this EIS.

Although not a constraint on the areawide growth rate, lack of existing sewerage service is probably a constraint on the location of new growth. For example, areas south of Little Rabbit Creek in the Hillside area cannot develop until the southeast interceptor is extended and the Rabbit Creek interceptor's pump station and force main are constructed as recommended in the facilities plan. Also, some Hillside area lots may not be developable under provisions of the Hillside Wastewater Management Plan.

The amount of growth that the facilities plan expansion would induce or support can be considered as the sewer-dependent portion of projected new population that could not live in the Anchorage Bowl without those sewers. This can be estimated as a population equivalent to the year 2005 sewered population (projected in the facilities plan as 287,400 persons) less the 1985 sewered population, (estimated to be 167,100 persons), and also less any growth beyond the 167,100 persons that would otherwise be allowed in the absence of sewerage expansion. For ease of analysis this EIS considers the facilities expansion to support growth from the 1985 level to the 2005 level, or 120,300 persons. The Hillside Wastewater Management Plan is assumed to provide for growth in the unsewered areas of the Hillside from about 9,100 (1980 estimate) to 23,300, or an increase of 14,200 persons (MOA 1982). Thus, total growth related to these plans is about 134,500 persons.

The facilities plan is assumed to be a direct inducer of growth in the south Hillside areas from Little Rabbit Creek to Potter Creek, where development will depend on the sewerage extensions included in the facilities plan.

The most visible sign of population growth is the development of land. Unless there is a high vacancy rate or unused capacity in existing structures, residential, commercial and industrial developments will occur to fulfill the needs of the growing population.

A major factor in the development of residential areas is the amount of undeveloped land and unrestricted zoned land. Eighty-six percent of the remaining undeveloped land is in central and southern portions of the Anchorage Bowl. Of the total undeveloped land in the Anchorage Bowl, the Hillside area accounts for 61 percent (Arctic Environmental Engineers and MOA Planning Department 1982). The northern portion of the Anchorage Bowl contains scattered undeveloped land parcels that can support additional infill. Residential land uses and undeveloped land acreages for various areas of the Anchorage Bowl are shown in Table 7-1.

Table 7-1. Residential Land Use Comparisons by Anchorage Bowl Areas for Current (1980) and Future (Saturation) Conditions

Area	Current						Future		
	Dwelling Units (DU's)	% share of total DU's	Developed Land (acreage)	Density (DU's/Developed ac.)	Undeveloped Land (acreage)	% Share of Total	Dwelling Units (DU's)	% Share of Midpoint Total	Density (DU's/total ac.)
Downtown	2,308	3.86	169	13.7	17	(0.01)	2,595 - 2,718	(1.95)	14.0 - 14.6
Northwest	18,043	30.20	2,196	8.2	622	(3.2)	25,315 - 29,267	(19.97)	8.8 - 10.2
Northeast	21,000	35.10	3,789	5.5	2,015	(10.4)	33,425 - 41,414	(27.48)	5.8 - 7.1
Central	9,820	16.44	2,200	4.5	3,150	(16.1)	28,539 - 39,240	(24.89)	5.3 - 7.3
Southwest	4,254	7.20	1,210	3.5	1,703	(8.8)	12,781 - 19,551	(11.87)	4.4 - 6.7
Southeast (Hillside)	4,305	7.20	3,940	1.1	11,945	(61.4)	17,807- 25,430*	(14.83)	1.1 - 1.6
Anchorage Bowl	59,730	100.00	13,513	4.4	19,452	(100.0)	120,462 - 157,620	(100.0)	3.6 - 4.8

*Based upon recommendations of Hillside Wastewater Management Plan.

The draft Comprehensive Development Plan (MOA 1982) encourages multifamily residential units in the more central areas of the Anchorage Bowl, particularly in Muldoon, Fairview, Mountain View and Spenard. This development would be a mixture of infilling undeveloped parcels and redevelopment of deteriorating structures. Upgrading the existing sewerage facilities in these areas would facilitate higher density residential growth.

Medium density single-family residential development is encouraged by the plan for the southern portion of the Anchorage Bowl, in western Sand Lake near Kincaid Park, Abbott-O'Malley, Lake Otis, and sections of Campbell-Klatt. New and upgraded sewer facilities would permit expanded residential growth and higher density levels.

The plan proposes to retain the majority of the Hillside area in rural low-density residential development. The establishment of sewerage facilities in those areas of the Hillside that have been identified as environmentally unsuitable for any type of on-site disposal system, and that are geographically feasible for sewerage, such as large undeveloped tracts, would open up the area for residential development at various densities, together with supporting uses.

Major commercial development would continue to be located in the downtown and midtown areas with supporting community commercial nodes in east, south and west Anchorage. Industrial development would continue to grow in the Port/Ship Creek, International Airport and Merrill Field areas. New industrial development could also occur along the Alaska Railroad in central and southern Anchorage. New and upgraded sewerage facilities would facilitate expansion of commercial and industrial uses in these areas.

Consequences of Growth

The effects of growth, both beneficial and adverse, may be observed in environmental and socioeconomic areas, and may have regional and local consequences. Growth usually affects the following:

Services and utilities
- sewerage
- water supply
- solid waste disposal
- energy
- transportation
- education
- police and fire protection

- parks and recreation
- social services

Resources
- air quality
- water quality
- hydrology, erosion, seismicity
- open space
- wetlands
- biological resources
- aesthetics
- noise

Socioeconomic values
- development-related economic activity
- community cultural resources
- social structure
- fiscal strength
- perceived quality of life

The above list is illustrative rather than exhaustive. Several of the above topic areas were selected for analysis in this EIS based on results of the EIS scoping process and EIS impact evaluations. These include water supply, solid waste disposal, energy, transportation, education, police and fire protection, recreation, air quality, hydrology, erosion and sedimentation, and perceived quality of life. Impacts on wetlands and biological resources are addressed in detail in Chapter 4, including growth-related impacts. Chapter 5 similarly addresses growth-related issues pertaining to the Hillside area.

The impacts discussed in the remainder of this chapter are independent of alternative, except for no action. If no sewerage expansion is undertaken, growth-related secondary impacts will occur only to the point where the lack of sewerage facilities constrains growth. Among the other alternatives evaluated in the facilities plan, no differences in the resulting growth can be identified. Each would allow unconstrained growth up to the capacity of planned facilities.

Water Supply

A detailed study of the existing water supply situation and the critical need for additional water supplies for Anchorage was published by the U. S. COE (1979). Currently, the MOA water supply is provided by Ship Creek and groundwater sources within the Anchorage Bowl. The following summary of the existing system and projected need is derived from the above study.

Water consumption in the Anchorage Bowl in 1977 averaged 26.2 MGD, of which 14.5 MGD came from groundwater and 11.7 MGD from Ship Creek. Production capacity in 1977 was calculated to be 29.7 MGD. Future water demand was forecast by presuming a per capita use of 157 gallons per day. Part of this demand occurs from residents allowing their water to run during cold spells to prevent water lines from freezing. Assuming a water service area population of 305,000 by the year 2005, the calculated water demand would be 47.9 MGD.

It is immediately obvious that water problems will develop in the short term if additional sources are not provided. In the summers of 1976 and 1977, during an extended dry period, both the Anchorage Water Utility and Central Alaska Utilities publicly requested that their customers curtail water use because demand exceeded production and a drop in water pressure was experienced in various areas. In 1980, the MOA retained a consultant to investigate the feasibility of obtaining a 70 MGD water supply from Eklutna Lake by pumping water from the tailrace below the Eklutna powerhouse. If this project is undertaken, the water supply will be adequate for the growth predicted by the 201 facilities plan.

In the meantime the MOA is investigating the drilling of additional wells to use groundwater supplies until the Eklutna project is constructed. A short-term threat of water shortages in early summer and in winter will still exist due to limited supplies.

A relationship between water supply and sewerage exists, in that a portion of the water supply becomes wastewater. If the water supply available to Anchorage is not increased, water conservation and/or rationing could be imposed. This would tend to keep sewage flows lower than projected by the facilities plan. Lack of adequate water supplies could delay the need for part of the proposed expansion of sewerage facilities.

Lack of adequate water supplies can also constrain growth, particularly if a "wet" industry such as a cannery is prevented from locating in the area due to water supply constraints. Reduced growth would also reduce the need for sewerage facilities.

Solid Waste Disposal

The MOA is running short on capacity at the existing Merrill Field landfill, and is expected to require a new landfill no later than mid-1986. This projection was developed in early 1981 based on annual solid waste loads of 160,000-170,000 tons. Actual landfill volume in 1981 was 200,000 tons, up from a total of 160,000 tons in 1980. If the volume

of waste continues at 200,000 tons per year, the landfill would be full in mid-1985. If the tonnage increases with accelerated development of urban growth, the landfill could be full even sooner. Historically, solid waste volume has increased on the order of 10-15 percent annually (Niftler pers. comm.).

The MOA Planning Department undertook site-specific landfill location studies in 1980 as an update to the 1975 Solid Waste Management Plan. This planning effort, which never culminated in a formally adopted report, noted that the availability of sites for landfills was severely limited and that environmental problems and/or community opposition was likely to exist at those few remaining sites. The MOA Planning Department study efforts were terminated and plans laid to develop a new solid waste management plan. Information obtained from the Solid Waste Division (Niftler pers. comm.) reveals that the Solid Waste Management Plan will be updated in 1983. Only three candidate landfill sites remain in the Anchorage Bowl, and all are surrounded by residential areas. Processing now costs $20-25 per ton at the Merrill Field landfill and processing costs would double if a disposal site were to be located outside the Bowl area. The new study will also consider the feasibility of resource recovery (i.e., recycling). Current processing does not include resource recovery practices, although shredding does occur.

Energy Resources

A fairly direct relationship exists between land use patterns, transportation, and energy consumption. In a more centralized, higher density land use area, the number of vehicles required, miles traveled and the overall number of trips taken decreases. This transportation decrease results in less energy consumed. Higher density multifamily residential areas generally consume less energy per capita than single-family residential areas. This is because of the space heat savings associated with common-wall multifamily dwelling units and the more efficient use of public utilities.

The population increase associated with the new sewer facilities will increase the amount of energy consumed in the MOA substantially. Energy consumption need not increase directly with population since some energy may be conserved through higher density land use patterns, public transportation usage, and building code conservation measures.

Natural gas is supplied to the MOA by Alaska Gas and Service Company (AG&S). AG&S serves the entire Bowl from Eklutna River to Potter Creek. About 50 percent of the load is consumed by power plants, which are fully interruptible. Occasional peak load problems force the use of alternate fuels by the power plants. Gas supply is primarily a contract problem. Union Marathon Oil Company is the primary supplier, with additional quantities produced by a small AG&S-owned well or purchased from the state. Gas is readily available in the area, but renegotiation of the contract with suppliers usually results in a rate increase. The MOA has one of the lowest gas billing rates in the nation, and it is presumed that production and supplies will keep pace with population growth (Sinclair 1982 pers. comm.).

Electric power is provided to the International Airport area and the downtown core area (north of 36th Avenue, west of Boniface Parkway and east of Minnesota Bypass) by Municipal Light and Power (MLP). Chugach Electric supplies electricity to the remainder of the Anchorage Bowl. Generation capacity for MLP is currently 120 megawatts, compared to a 330-megawatt capacity of Chugach Electric (Day pers. comm.). MLP is expanding substation capacity in the Airport area from 7.5 megawatts to 25 megawatts. This expansion program and site-specific expansion in the downtown area remains within the framework of existing generation capacity, but it is uncertain as to how much growth can be assimilated by MLP (Day pers. comm.). Day (pers. comm.) reports the average annual residential use of electricity is around 750 kwh per month (i.e., 9,000 kwh per year).

Chugach Electric has the largest service area in the State of Alaska with over 54,000 retail customers, including over 1,000 retail customers in the Kenai area. Wholesale customers such as Seward are also supplied. Markley (pers. comm.) reports an average annual retail customer use of electricity around 15,000 kwh per year, including residential and nonresidential customers. Although Chugach Electric has some reserve generating capacity, substantial growth in the Anchorage Bowl would require new generating facilities. Planning is underway to expand facilities to accommodate population growth (Markley pers. comm.).

Traffic and Transportation. The Anchorage Metropolitan Area Transportation Study Long-Range Element Transportation Plan proposes measures to help alleviate traffic problems and accommodate the MOA transportation needs through 1995. The plan proposes that by 2000, 10 percent of all person trips will be made by public transportation, representing approximately a ten-fold increase in transit usage. The plan recommends a major expansion of the number of buses

and fixed route services, and the development of express route services from outlying residential areas to close in employment areas.

Roadway improvements and new roadways will be phased in response to incremental increases in traffic volume, perceived need and funding availability. Much of the projected increased traffic volume should be funneled within the three major corridors, the Glenn Highway, the Seward Highway and the Minnesota Bypass. The plan also proposes developing an alternative transportation modes program for pedestrians, bicyclists, and carpoolers.

The increased population and automobile use will place additional demands on the existing roadway network and public transportation services. Roadways and services will need to be established in the new sewered residential and commercial areas. Certain secondary impacts are also generated by increased transportation use. These include increased energy consumption and higher levels of air pollution, particularly carbon monoxide.

Education

Demand for educational services is an important aspect of growth. Unless exceptional conditions are present (e.g., migration of predominantly retirees or young married couples with children), school enrollment is a reasonable barometer of population trends. In the MOA, the school population is approximately 20 percent of the total population (Schaedel pers. comm.). Based on school enrollments, population growth is now occurring in every part of the school system. Available space in the north area is rapidly disappearing and school overcrowding currently exists in the Eagle River area (experiencing the fastest growth) and south Anchorage. The Anchorage School District anticipates continued expansion and building programs over the next decade (Schaedel pers. comm.).

Police Protection

The police department in the MOA currently employs 265 sworn officers to handle law enforcement (Ricketts pers. comm.). Because the number of law enforcement officers is largely population-dependent, police protection services will need to expand essentially at the same rate as the population increases. The number of law enforcement officers necessary to adequately serve a given population can be calculated using the national average of 1.5 officers per

1,000 permanent residents. This standard varies according to population density and per capita income. Based on this ratio, the MOA would have to add 54 additional sworn officers to achieve the national standard and would add approximately 200 additional law enforcement officers by the year 2000 to meet the projected population increase. Depending on the character, income level and ethnic diversity of the new population and the density of new developments, crime may intensify in some urban areas, requiring additional law enforcement effort. Additional jail, courtroom and other facilities would also be needed to serve a growing population.

Fire Protection

The fire department of the MOA has a full-time staff of 275 fire fighters to handle required services (Crossman pers. comm.). This present staffing level is considered inadequate by the fire department at present, and a staff increase of 11 percent is needed to cover population growth in new areas. In addition to existing full-time staff, the MOA provides equipment for three volunteer organizations (Girdwood, Chugiak, and Southport/Eagle River Valley). The MOA has a solid, well-enforced fire code for taller buildings, which alleviates a major concern over fire protection in urban areas.

Fire protection services are also population-related, and the number of fire fighters and facilities will need to expand as population increases. According to national averages, about 1.2 fire fighters are necessary to adequately serve every 1,000 permanent residents. Based on this ratio, a total of 130 additional fire fighters would be needed by the year 2000.

Recreation

The Anchorage Bowl has numerous and varied recreational resources. Population growth will put increasing pressure on these resources. Some existing resources may become more heavily used and seem overcrowded, particularly local and neighborhood park facilities and bike trails in greenbelt areas. Although growth may be accompanied by the provision of additional urban recreational facilities, the expansion is not possible in the case of finite resources such as beaches and greenbelt areas. Chugach State Park and other open land areas in south-central Alaska will also get heavier use, thus reducing the solitude and aesthetic values of these areas.

Air Quality

Existing Conditions. Urban development and meteorological conditions in the Anchorage area have combined to produce occasional air quality problems. The 8-hour federal ambient air quality standard for carbon monoxide (9 ppm) has been exceeded several times a year at various locations in the urbanized Anchorage area. Peak 8-hour carbon monoxide levels generally exceed 15 ppm at one or more monitoring stations each year. The highest 8-hour carbon monoxide level yet monitored was 27.4 ppm in 1980 at the Spenard/Benson monitoring station.

Most of the urbanized area of the Anchorage Bowl has been formally designated as a carbon monoxide "nonattainment area" due to these violations of federal air quality standards. The MOA is designated as being in attainment of other federal air quality standards (ozone, nitrogen dioxide, sulfur dioxide and suspended particulate matter).

The federal Clean Air Act requires the development and implementation of plans to achieve and maintain federal air quality standards by certain deadlines. The plan for the Anchorage area focuses on attaining the federal carbon monoxide standard by 1987. Programs incorporated into the Anchorage Air Quality Plan include:

- o Roadway extension and widening projects;
- o Intersection improvement projects;
- o Ridesharing programs;
- o Public transit system improvements;
- o Mandatory vehicle inspection and maintenance for fleet and government vehicles;
- o Voluntary vehicle inspection and maintenance for private vehicles.

In June 1982, the Anchorage Assembly formally adopted the traffic improvements, ridesharing and transit improvement elements of the air quality plan. The vehicle inspection and maintenance elements of the air quality plan were approved "in concept," but adoption of a specific program was deferred until results from a research study in Fairbanks became available.

Consistency Evaluation. The Clean Air Act requires that federal funding programs, such as the Clean Water Grant program, not be used to support projects which are inconsistent with local air quality plans. Consistency between wastewater and air quality management plans is determined primarily by comparing the growth forecasts used in developing the two plans.

The air quality plan assumes that the population of the MOA will increase to 334,200 by 1995, with 263,700 people in the Anchorage Bowl. The facility plan assumes a study area population of 247,200 by 1995. The facility plan study area is essentially the same as the Anchorage Bowl. The facility plan can be considered consistent with the growth assumptions of the air quality plan since the facility plan does not accommodate growth levels beyond those anticipated in the air quality plan.

The proposed expansion of sludge incineration capacity at the Point Woronzof WWTP must also be considered in assessing the consistency of the facility plan with the air quality plan. As discussed in Chapter 9, the increased sludge incineration at the treatment plant is expected to produce little change in carbon monoxide emissions. It should also be noted that the treatment plant site is outside the formal carbon monoxide nonattainment area boundary. Thus, the facility plan is consistent with the air quality plan in terms of both direct facility emissions and indirect, growth-related emissions.

Hydrology, Erosion, Seismicity

Urban construction has wide-ranging effects on surface and groundwater hydrology (Figure 7-1). Most of these impacts are caused by the reduction of naturally permeable soil surfaces with impermeable concrete, asphalt, and buildings. Percolation of rainwater and snowmelt to the groundwater is substantially reduced, and runoff to stream channels is greatly hastened. Larger flow volumes result, and stream channels may become inadequate to contain the man-altered runoff regime. Greater flows and higher velocities can, in turn, increase erosion.

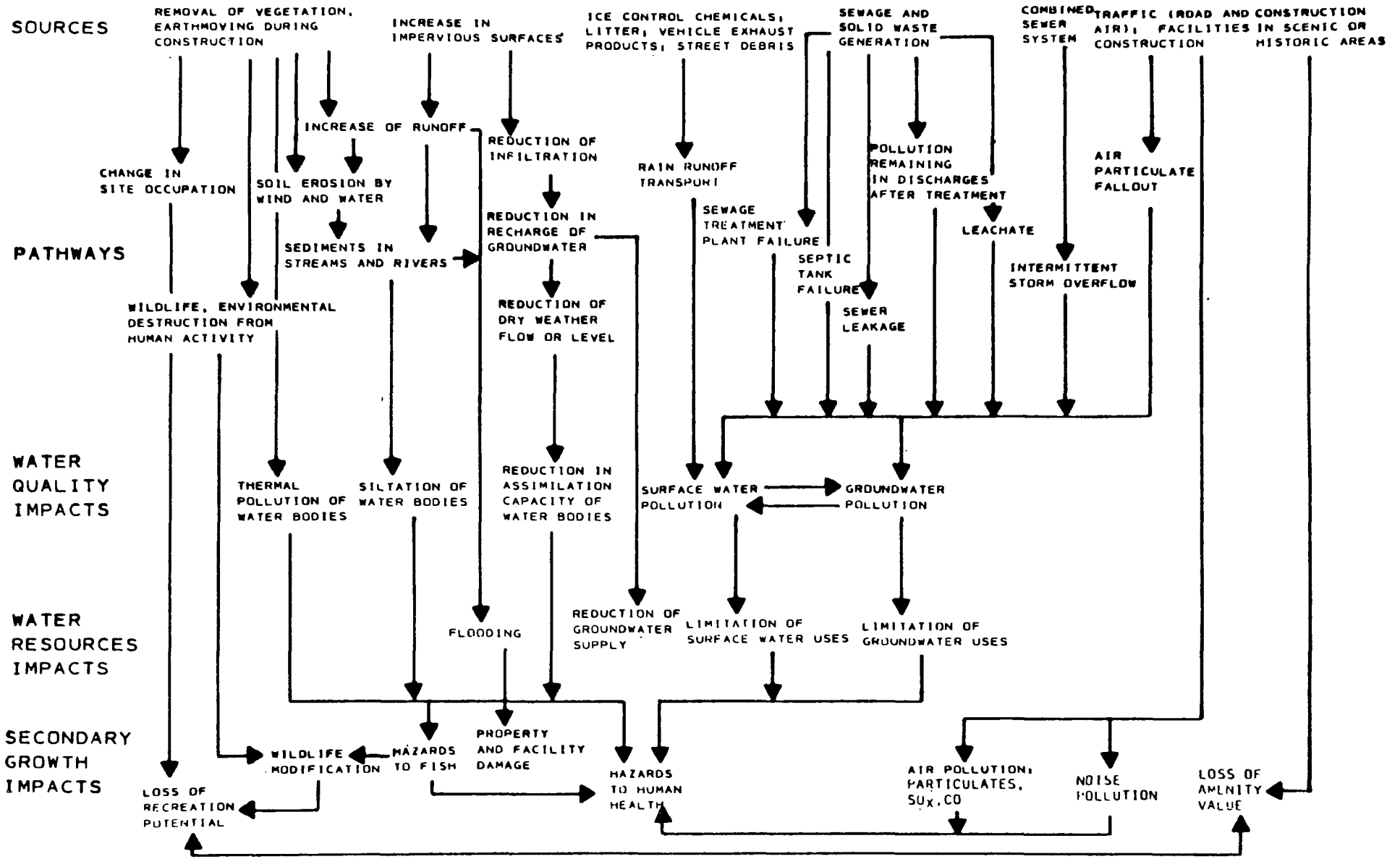


Figure 7-1. Residential Land Use Impacts of Urban Runoff.

SOURCE: Municipality of Anchorage, 208 Areawide Water Quality Management Plan, January 1979.

Groundwater recharge, which is most important along the Chugach mountain front (Figure 4-5), may be reduced by increased development. In turn, the portion of stream flow that is attributable to upwelling groundwater would be reduced (see Chapter 4). Spring breakup flows may be especially affected by urban expansion.

Erosion increases with urban expansion and development, degrading water quality, destroying spawning habitat, and filling lakes and wetlands with silt. Population growth in the Anchorage basin will increase erosion and amplify its consequences.

Knowledge of Anchorage Bowl soils and topography is fundamental to sound land use planning and erosion control and, as a result, has been rigorously studied and extensively mapped. The study area consists of a complex mosaic of 23 soil types or series, described in detail in the U. S. COE's Metropolitan Anchorage Urban Study, Volume 7 (1979).

Surficial deposits in the study area mostly originate from glacial scour, and ocean and river sediment deposits. Fragmented rock and gravels characteristic of scour are found on the lower elevations of the Chugach Mountains and the northern section of the Anchorage Bowl. River deposition alluvium covers much of the central Anchorage area, and ancient Cook Inlet marine deposits form what is referred to as Bootlegger Cove clay. Because of the relative geologic youth of the deposits and cool climate, soils are thin and poorly developed.

Topography in the study area generally has low relief; its highest points gently slope from 500-600 feet on its eastern boundary to an alluvial plain upon which most of Anchorage is built. Over 90 percent of the study area has slopes of less than 12 percent, but the western extremities (Point Woronzof and Point Campbell) have hummocky terrain. Soils on these points tend to be silty loam interspersed with gravelly soils. Precipitous cliffs border the Cook Inlet.

Some slopes are also steep in the southeastern portion of the study area. For instance, the Hillside area contains moderate to steep slopes (5-45 percent). Elevations range from 1,600 feet at the eastern border to about 400 feet near Abbott Road. Homestead loam soil (silt, sand, and clay) are abundant in this area, generally overlying alluvium in lower elevations with fragmented rock and sand in the upper hillside.

Much vegetative cover is usually removed during development of homes, roads, and utilities. Clearing the soil surface allows rain splash, sheet erosion and ice accumulations to

wash away topsoil. The sand, silt and clay soils which are widespread in the Bowl are particularly susceptible to erosion; especially subject are those soils exposed on moderate to steep slope relief such as in the Hillside area. Road cuts and fills are of special concern.

Erosion can also increase the likelihood of flooding. The capacity of stream channels may be reduced in response to erosion and subsequent sediment deposition, resulting in bank overflow even during normal runoff events.

Increased urban development may also expose more people and structures to potentially disastrous effects of seismic activity. South-central Alaska has a long history of seismic activity. Between 1899 and 1965 the vicinity of Anchorage has experienced nine events that equaled or exceeded 8.0 on the Richter Scale, and more than 60 that equaled or exceeded 7.0. This intense seismic activity emanates from the circum Pacific Belt extending from the Aleutian Chain to the southernmost Alaska/Canada border. About 7 percent of annual global seismic energy is released along this belt.

The Good Friday earthquake of March 27, 1964 (8.4 on the Richter Scale) demonstrates the devastating effect of seismic activity on urban areas. Much of the damage was attributed to Bootlegger Cove clay which underlies much of the study area. Water-saturated sand pockets within the Bootlegger formation may have liquefied during the quake allowing considerable land subsidence and greatly aggravating structural damage.

Statistical analysis of the frequency of past seismic events indicates that earthquakes are likely to recur in Alaska. It is predicted that quakes with the magnitude of the Good Friday event will occur once every 10 years in the circum Pacific Belt. Four large quakes have jolted Anchorage from the 1964 epicenter in recent years, and the chance of a "damaging" earthquake (7.0 centered near Anchorage or 8.0 in the general region) in any given year is estimated at 1 in 50 or 2 percent. If the statistics of past events prove to be an accurate indication of future events, there is a distinct likelihood of another strong quake in southern Alaska within the next 35 years.

Growth from the 1964 population of about 100,000 persons to the 2005 projection of about 305,000 will expose triple the number of persons to seismic activity. Logistical problems such as evacuation and care for the homeless would be multiplied by the larger population.

Mitigation Measures. Sound land use planning and erosion control measures can reduce many undesirable effects of urban expansion and development. Erosion can be controlled during construction phases by leaving as much vegetation in place as possible. Areas which are denuded of vegetation can be covered or reseeded (Figure 7-2).

Measures to control increases in runoff and decreases in infiltration can be implemented. Stream impoundment, meandering surface drainage, retention of natural stream channels and retardation basins may be of substantial benefit (Figure 7-3).

Seismic impacts may be reduced by adopting and enforcing building codes and permits specifically designed for construction on areas such as south-central Anchorage, which are moderately susceptible to land failure. Mapping of areas susceptible to ground failure has been completed for the Anchorage Bowl area. Land use and structural controls in such areas can be maintained at a stricter level to minimize exposure to and damage from seismic events.

Perceived Quality of Life

Quality of life in the Anchorage Bowl will change as the population grows and land develops. Open space will decrease, the competition for available areas of leisure pursuits will increase, and a more crowded feeling will pervade the area. Highways leading toward the Kenai Peninsula and Denali National Park will become more congested on weekends, houses will be closer together in the Hillside area, and the feeling of being a pioneer living on the fringes of a wilderness will decrease.

Development will bring economic activity, including construction and accompanying employment. This construction will stimulate the local economy.

A larger population can support a greater diversity of cultural resources, such as plays, ballet, symphonies, art exhibits, popular entertainment, museums, and libraries.

The aesthetic impacts associated with population growth include the elimination of open space and vegetation, the obstruction of vistas and scenic points and development near streambanks and shorelines. Increased crime, noise, odors and air pollution associated with growth also degrade the aesthetic value.

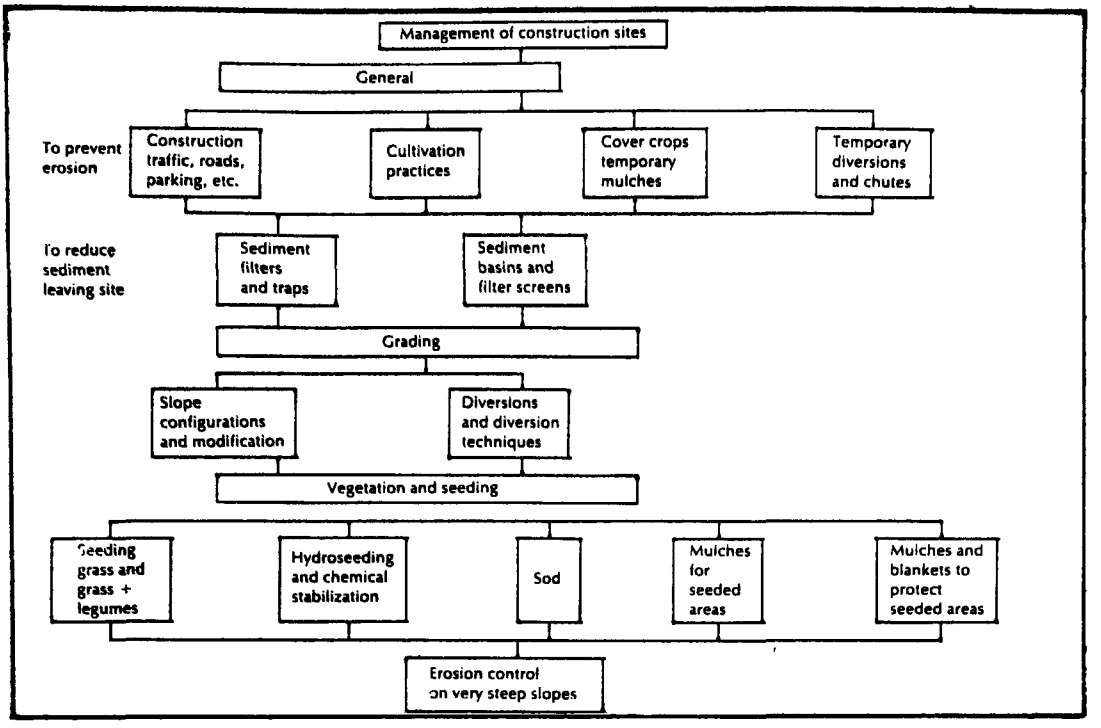
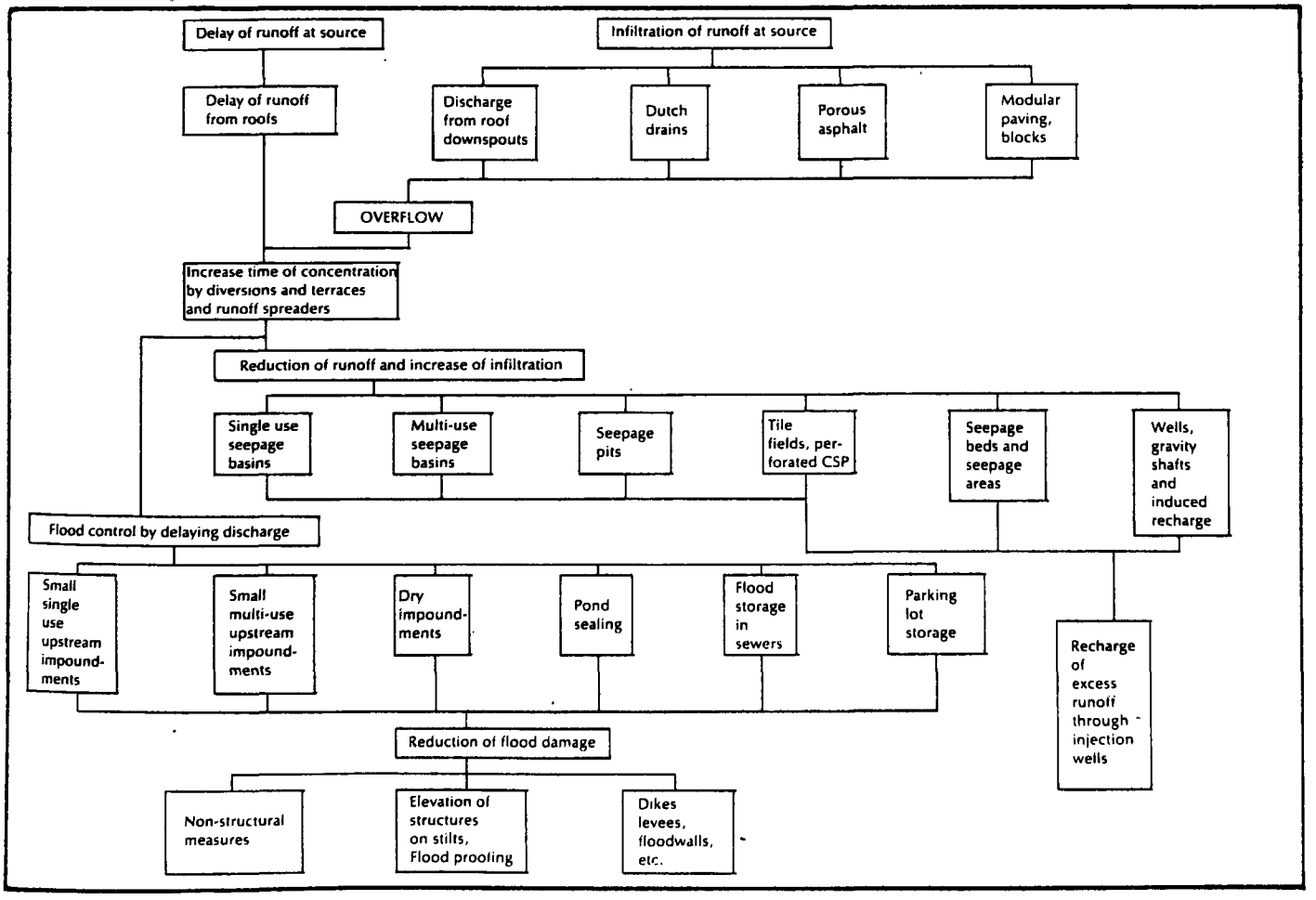


FIGURE 7-2. MEASURES TO CONTROL EROSION AND SEDIMENTATION



SOURCE: Water resources protection technology. The urban land Institute, 1981

FIGURE 7-3. MEASURES TO CONTROL INCREASES IN RUNOFF AND DECREASES IN INFILTRATION

Although growth-related aesthetic impacts cannot be eliminated, zoning restrictions and other land development regulations can help ensure that the effects are minimized. The Comprehensive Development Plan, the Coastal Zone Management Plan, and the Wetland Management Plan contain policies designed to minimize development impacts on aesthetics.

Noise can produce physiological effects on both man and wildlife; it interferes with speech, sleep and walking, reduces the aesthetic value of wilderness, rural areas, and open space areas, and recreation activity and annoys the general community.

A direct relationship exists between urbanization and noise, thus noise levels will rise with increased development. Although noise levels increase with development, measures can be taken to reduce the noise impacts of growth. Noise attenuation can be achieved through building and site design, barriers, landscaping, and restrictions on the hours of operation of noise sources. Noises associated with the increase in transportation levels can be reduced by limitations on traffic volumes and routes. Noise levels can also be reduced through zoning.

Chapter 8

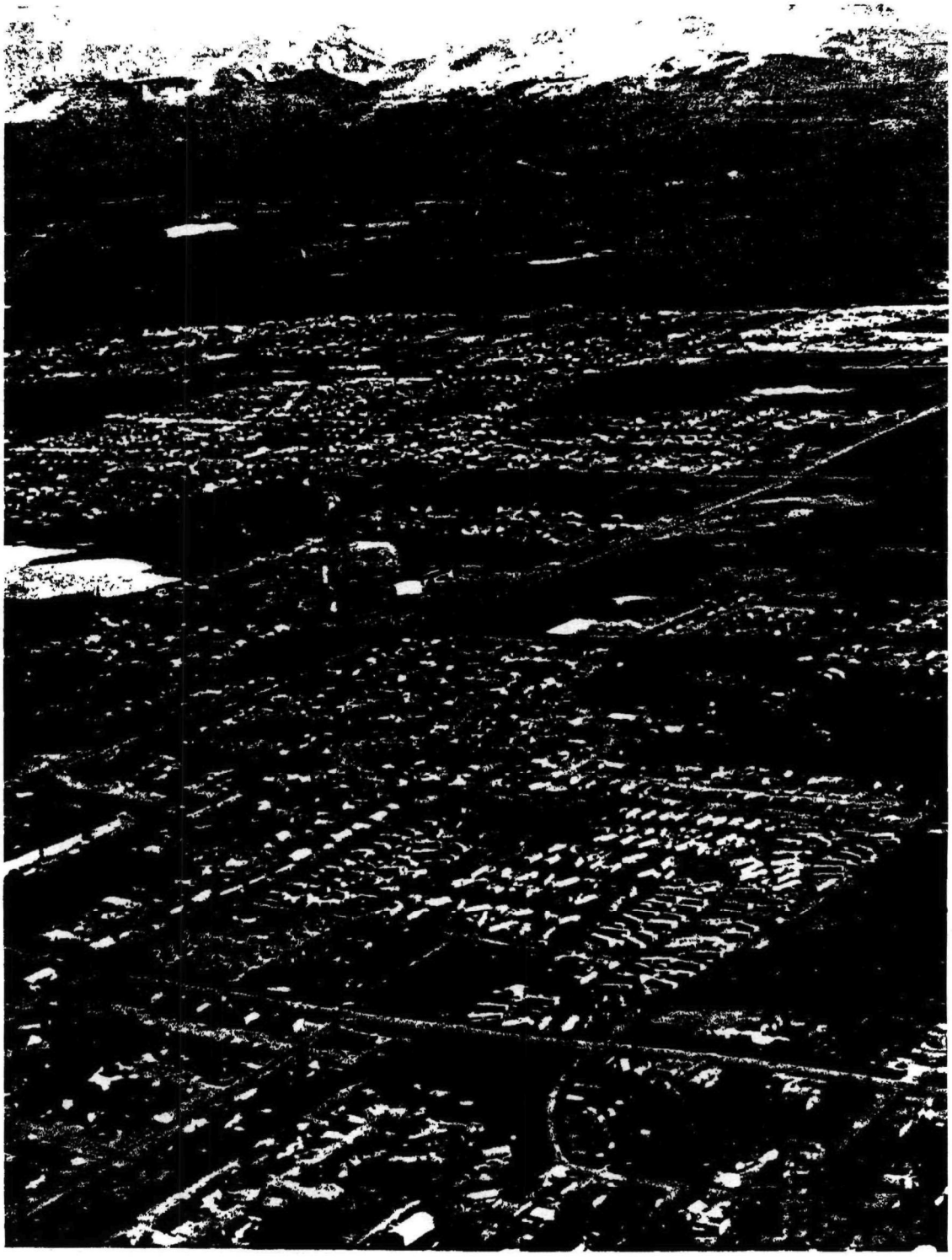
Effluent Treatment and Disposal Impacts

- Introduction
- Physical Oceanography
- Chemical Oceanography and Bacteriology—Cook Inlet
- Conclusions
- Wastewater Treatment Impacts

Chapter 9

Sludge Processing Disposal Impacts

- Air Quality
- Knik Arm Impacts
- Landfill Capacity Impacts



Chapter 9

SLUDGE PROCESSING AND DISPOSAL IMPACTS

Impacts from solids processes at Point Woronzof WWTP and disposal of residues from those processes are covered in this chapter. The recommended plan for sludge treatment and disposal involves dewatering, incineration and discharge of ash to the Knik Arm of Cook Inlet via the outfall, landfilling the ash, or discharging the ash to a lagoon or gravel pit near the plant as a slurry blended with wastewater.

The impacts of potential concern that are addressed in this chapter are air quality effects from expanded incineration operations; energy consumption of incineration; accumulation of toxic substances in Cook Inlet; use of landfill capacity; and groundwater and land use impacts of lagoon or gravel pit discharge, including leachates from the ash. The evaluation of the impacts is hampered somewhat by the solid waste situation in Anchorage, namely that the existing Merrill Field landfill is expected to be full about the time the projects being evaluated by this EIS come on line. A further disadvantage is a lack of information on the composition of the sludge ash. Further information is required before full evaluation of sludge disposal can occur.

Air Quality

Direct air quality impacts of the proposed project are primarily related to sludge incineration. The major air pollutants associated with multiple hearth sludge incinerators are particulate matter and nitrogen oxides. Carbon monoxide emissions from sludge incineration are generally considered to be negligible (EPA 1974). Particulate emissions can be substantial unless appropriate emission control devices (usually a wet scrubber) are used.

Projected average daily emissions from the existing and proposed sludge incinerators are summarized in Table 9-1. Based on the available data, the proposed project would not be considered a major stationary source subject to special air quality review under EPA's "prevention of significant deterioration" regulations.

Table 9-1. Average Daily Sludge Incinerator Emissions

POLLUTANT	Average Daily Emissions (Pounds) 1985	1990	1995	2000	2005	CAPACITY
Particulate Matter	32.25	41.85	48.45	55.05	61.61	115.20
Nitrogen Oxides	58.75	69.75	80.75	91.75	102.68	192.00
Volatile Organics	11.75	13.95	16.15	18.35	20.58	38.40
Sulfur Dioxide	9.40	11.11	12.92	14.68	16.43	30.72
Carbon Monoxide	ND	ND	ND	ND	ND	ND
Hydrogen Chloride	3.53	4.19	4.85	5.51	6.16	11.52

Notes: ND = no data; data source indicates "negligible" emissions.

Emission estimates by calendar year based on facility plan projections of dry sludge generation and emission factors from EPA (1974), assuming use of wet scrubbers for emission control

Energy Consumption

Operation of the incinerators will require energy to start up and maintain heat. It is unclear from the facilities plan whether the incineration process is self-sustaining. During the winter, waste heat from the incineration process is used to meet heating requirements for the plant buildings. The net heat input and savings from heat recovery systems is not known.

Knik Arm Impacts

Discharge of sludge ash through the outfall pipe following incineration will increase the suspended solids concentration in plant effluent. The ash alone would increase total suspended solids by about 13 mg/l. Considering that the plant currently has difficulty meeting discharge requirements of 100 mg/l (monthly average), the addition of ash will make it increasingly difficult to avoid NPDES permit violations.

As a mitigation measure, the plant could be designed to achieve a consistent effluent quality of 85 mg/l suspended solids in the clarifier overflow, allowing for an additional 13 mg/l from incinerator ash. This would increase the cost of the treatment system, however, possibly requiring additional clarifiers or new steps in the treatment process. No feasibility analysis or cost estimates have been prepared for this option.

The mean suspended solids concentration in the Knik Arm during the critical summer period is estimated at 1,280 mg/l (Arctic Environmental Engineers, et al. 1979). Wastewater meeting the NPDES permit requirements contains one-tenth the suspended solids of the receiving water. The discharge of ash is expected to have no effect on suspended solids concentrations in the receiving waters.

There is a slight chance that discharge of ash in suspension with treated effluent could introduce toxic materials, such as heavy metals, to the Knik Arm of Cook Inlet. While some of the ash could settle into the mud along the proposed diffuser, most would probably remain in suspension and would be widely distributed in the Inlet. Assuming a fine ash, the ultimate fate of the ash would probably be a minuscule proportion of muds deposited on the Inlet floor over many hundreds of square miles. No measurable effect on turbidity would occur.

Without an analysis of constituents of the ash, evaluation of solubility of end products, particle size and volume of discharge, no further analysis is possible. With the exception of discharge volumes, this information is not currently available.

Federal law prohibits the discharge of sludge to fresh or marine waters. A determination would have to be made as to whether the ash from incineration of sludge would be considered as sludge under the law. If it is, this alternative would be prohibited.

Landfill Capacity Impacts

The incineration of sludge is expected to produce 1.8 tons of ash per day (3.9 cubic yards) in 1985, and 3.1 tons per day (6.6 cubic yards) by 2005. The disposal of ash to a landfill will use landfill volume that would otherwise be available for municipal refuse and other solid waste.

As discussed in Chapter 7, the Merrill Field landfill is expected to be full by about 1985 when the expanded sewerage facilities come on line. No new site has been selected for a landfill, although gravel pits in the Campbell Point area are mentioned as potential sites. Site-specific impacts on capacity cannot be estimated. However, current solid waste volumes to the Merrill Field landfill are about 200,000 tons per year. At a rate of 1.8 tons per day, the incinerator would produce about 660 tons per year, representing 0.33 percent of total landfill volume. This proportion would likely remain constant as both solid waste and sludge volumes increase in proportion to population.

Another way of analyzing this impact is to assume a landfill life based on its available volume, and compute how much longer the landfill's life can be prolonged if it does not receive sludge ash. If a new site is chosen that has a 20-year life, a new landfill would last 24 days longer without the ash.

Landfill Leachate Impacts

If toxic substances are present in landfilled sludge ash, percolating rainwater could leach these substances into the groundwater, adversely affecting water quality and beneficial uses of the water resource. The potential for such impacts occurring is unlikely, but a definitive answer depends on constituents in the ash, location of the landfill, landfill construction, the presence or absence of groundwater, direction of groundwater flow, well locations and eventual fate of the groundwater. Without an identified landfill site, no further analysis is possible.

Groundwater Impacts of Ash Lagoons

There is a remote risk that discharging sludge ash to lagoons or gravel pits near Point Woronzof (within 0.25 mile of the WWTP) could lead to local pollution of groundwater, depending on constituents in the ash. Evaluations of land disposal of wastewater at nearby Point Campbell (USCOE 1979) indicated that groundwater flow was toward Cook Inlet in this general area. A more detailed review of both shallow and deep aquifers in this area is necessary to ascertain movement direction and potential interchange between aquifers. The U. S. Geological Survey (1972) points up a potential for saltwater intrusion in Anchorage if groundwater overdraft occurs. The Municipality is currently considering increasing pumping from groundwater to augment current supplies. The relationship between this pumping, which could effect the direction of groundwater flow, and percolation of water from an ash-effluent slurry requires further evaluation before impacts can be accurately predicted. The potential for adverse impacts does exist.

Lagoons or gravel pits for ash disposal would require 10 to 15 acres of land. In addition, ash would be periodically moved to another location or landfill. Total land requirements for a 20-year lagoon system for ash disposal are unclear. However, at least 10 to 15 acres of land would be lost to other uses. No location for the lagoons or gravel pits is given, so no identification of uses affected is possible.

Chapter 10

Short-term Construction Impacts

- Impacts Common to Most Construction Activities
- Special Case Impacts

Chapter 10

SHORT-TERM CONSTRUCTION IMPACTS

Impacts Common to Most Activities

Construction of wastewater facilities typically results in an assortment of short-term nuisance impacts. This type of impact typically lasts for the duration of the activity in a particular local area. These impacts include noise, dust, stream turbidity, access problems, traffic congestion, potential safety hazards and visual "eye sores". These impacts are usually judged insignificant unless someone is injured or a stream is severely damaged. In most cases, these impacts are readily mitigated to tolerable levels. When construction is completed, the impact is relieved. Common short-term impacts and their mitigation measures are presented in Table 10-1. The short-term impact of greatest concern is likely to be water quality degradation. This issue is discussed in more detail in Chapter 4, Wetland Impacts.

Special Case Impacts

A few short-term impacts are unique to only a few of the proposed activities in the facilities plan. These are discussed below.

Alaska Railroad

A number of existing and proposed sewer lines parallel or cross the Alaska Railroad right-of-way. Of particular concern are sewer construction activities along the Alaska Railroad right-of-way along Knik Arm between West Third Avenue and Fish Creek, the crossing of CC30 at Chester Creek, the crossing of FC36 along lower Fish Creek, the crossing of FC30 on the West 30th Avenue alignment, and the crossing of FC24W near the Tudor Road alignment. These sewer lines either cross the Alaska Railroad right-of-way or parallel the right-of-way in an area where the Alaska Railroad travels on an embankment. Special construction techniques may be necessary to prevent interference with rail operations and maintain stability of the Alaska Railroad embankment, especially along Knik Arm. When crossings are involved, a pit typically is dug alongside the tracks and a steel or concrete casing is forced beneath the tracks by hydraulic jacking and tunneling. The sewer pipe would then be placed within the casing pipe.

Table 10-1. Potential Short-Term Impacts Typically Associated With Construction Activities. Many are Relatively Minor in Effect and Magnitude and can be Effectively Mitigated as Outlined

Short-Term Impact	Recommended Mitigation Measures
Water quality degradation	Construction activities in streams and floodplains limited to periods of least sensitive fish use. Care taken to not discharge petroleum or other pollutants into streams. Slope stabilization and streambed protection should be provided to reduce erosion potential.
Increased soil erosion and dust	Soil should be watered during construction. After construction, exposed soil areas should be reseeded with native species as soon as possible.
Disruption of traffic, increased road congestion, dust and noise from construction vehicles.	Barricades and flagmen should be posted as necessary to guide traffic through construction zones and impacted street intersections. Residents in area should be notified as to location, nature, and duration of construction. Construction traffic should avoid school and hospital areas at all times to the extent possible. Construction vehicle traffic should be minimized on congested roads during peak traffic volumes.
Safety hazards	Open trenches along back lots should be covered at the end of each work day. All open ends of emplaced pipe should be sealed at the end of each working day to prevent access by small children.
Vehicle emissions and noise from construction vehicles.	All vehicles and equipment should be fitted with appropriate and properly maintained pollution control devices and muffler.
Visual impact of construction	Equipment should be stored in a designated area. Employees' vehicles should be parked at designated locations. Trees slated for removal from private property should be offered to landowner, if practical, for use as firewood.
Disruption of business activity	All businesses along construction rights-of-way should be notified in advance of proposed construction schedule. Meetings should be held with owner/operators to determine periods of minimal disruption to business activity.
Spoil storage and disposal	Whenever possible, disposal of spoil material should be coordinated with other ongoing projects needing fill material.

The southeast interceptor parallels the Alaska Railroad between East 78th Avenue and Huffman Road, but in an area where the Alaska Railroad right-of-way is generally at ground level. Construction of this interceptor should not interfere with Alaska Railroad operations or stability of the track.

An additional area of potential concern is the construction along the Alaska Railroad right-of-way between Tudor Road and International Airport Road. The Minnesota Bypass crosses the Alaska Railroad on an overpass structure in this area. The construction activity will either take place through the existing overpass bridging area, in which case construction may impede rail movement, or will require tunneling beneath the northern approach to the overpass bridge. The latter course can be mitigated by an engineering approach which will not disrupt vehicle traffic on Minnesota Bypass.

Hospitals. Restricting access to hospitals can have a severe impact during an emergency. The construction of interceptor DB15 along Debarr Road and DBWL across Airport Heights Road at Penland Parkway may impede access to Alaska Hospital and Medical Center. Construction of these two lines may need to be phased such that emergency vehicles will retain access to the hospital. Additional provisions should be made such that access from the north along Airport Heights Road is not completely denied at any time.

Chapter 11

Impacts of Alternatives

- Land Application of Effluent
- Primary Clarification with No Chlorination of Effluent
- Secondary Treatment of Effluent
- Sludge Disposal
- West Interceptor Bypass
- Rabbit-Potter Creek Areas
- No Action Alternative

Chapter 11

IMPACTS OF ALTERNATIVES

The recommended facilities plan and the alternatives considered in recommending the plan are outlined in Chapter 3. The following is a brief summary of the probable environmental impacts of alternatives mentioned in the facilities plan but not recommended by the MOA. In addition, a brief discussion of the consequences of the no-action alternative is presented.

Land Application of Effluent

The facilities plan refers to an earlier consideration of applying wastewater effluent to land in the Point Campbell Military Reservation. This area was considered because it is near the Point Woronzof WWTP and is underlain by sand and gravel deposits which are often suited for land disposal of wastewater. Furthermore, groundwater flow in the area is stated to be generally toward Cook Inlet, away from the urbanized areas of the Anchorage Bowl (U. S. COE 1979).

Certain environmental impacts could accrue from this technique. Land application would reduce or eliminate the discharge from the outfall into Cook Inlet. While wastewater percolates through soil, heavy metals, organic compounds, bacteria and viruses can be filtered, biologically degraded or bound to soil particles and probably not reach Cook Inlet in significant amounts. The Point Campbell Military Reservation is moose habitat, and nutrient enrichment of the soils may accelerate growth of forage species, particularly if appropriate forage management actions were undertaken.

Potential adverse environmental impacts relate to projected and existing human use of the disposal area. The MOA plans to develop a park in the Point Campbell area following transfer of the property from military to MOA jurisdiction. Existing public recreational use includes an offroad vehicle facility off Kincaid Road and cross-country skiing during the winter.

Groundwater impacts could also result from land disposal of effluent in the Point Campbell area. As noted in the prior chapter, prior study (ASCOE 1979) indicated flow of groundwater was generally toward Cook Inlet. A more detailed review is needed of shallow and deep aquifers in this area to confirm movement direction and assess possible

interchange between aquifers. Such an analysis should include consideration of the effects of increased MOA groundwater pumping on the direction of flow.

Land area would be occupied by the disposal operation, with other uses precluded. Accumulation of conservative substances could permanently affect use of the land. Another special problem with this alternative is feasibility of application and percolation during the winter months.

Wastewater Renovation and Reuse

The environmental impacts of this technique cannot be addressed because the facilities plan does not identify any potential uses of reclaimed wastewater.

Alternative PA: Primary Clarification With No Chlorination of Effluent

Chlorination of effluent is a generally accepted technique for killing viruses and bacteria which may cause human disease. Chlorination of wastewater, on the other hand, is known to result in the formation of potentially toxic halogenated organic compounds (e.g., chloramines) and free chlorine which are toxic to salmonids and other aquatic species (Brungs 1973; Tsai 1973; Buckley 1977). Partially in response to these toxicants, ADEC has recommended an extension of the outfall (to carry effluent further out from shore) and elimination of the chlorination process as measures to minimize the potential for adverse impacts on migrating salmon. Actual benefits to the salmon resource are unknown, primarily because the impact of the chlorinated effluent on the Knik Arm is unknown. Elimination of chlorination will result in elevated levels of bacteria and viruses in the discharge mixing zone, beyond the mixing zone, and in near-shore areas. This impact is expected to be minimized if the outfall is extended further into Knik Arm, and an adequate diffuser is constructed.

Preliminary studies of the outfall and diffuser by Ott Water Engineers indicate that current water quality standards would be violated if chlorination is discontinued. As explained in discussions of the outfall and diffuser in the Recommended Plan section of Chapter 3, two different coliform standards were evaluated by Ott for their effect on required diffuser length. Alternative 1, with a 6,100-foot diffuser to meet a coliform standard of 200 FC/100 ml, would delete certain designated beneficial uses for the waters of Cook Inlet, specifically, water supply for seafood processing, water contact recreation, and harvesting for consumption of raw mollusks or other raw aquatic life.

This change in standards would probably not affect any existing uses, nor would it preclude any likely future uses. High turbidity of the Knik Arm waters would prevent the water from being used for seafood processing. The population of raw mollusks is virtually nonexistent in the study area (Chapter 8), and no such use is ever likely to develop. Water contact recreation does occur to a small degree on Cook Inlet, however. Public use of the shoreline area occurs, and high coliform counts have historically been of concern. Swimming, diving and other similar types of contact recreation are virtually nonexistent, although at least one water skier has been observed.

Alternative 2, with a minimal (about 100-foot) diffuser would require deletion of all beneficial uses except growth and propagation of fish, shellfish, aquatic life, and wildlife, including seabirds, waterfowl and furbearers. This would result in no coliform standard being applicable, pursuant to State water quality standards. In addition to the uses foregone as described for Alternative 1 above, water supply for aquaculture, water supply for industry and secondary water recreation would no longer be protected (designated) uses.

High natural turbidity levels in Knik Arm would be serious problems for aquaculture or an industrial water supply. Such uses are not currently established, nor do they appear likely to develop in the future. Secondary water recreation, including use of the shoreline and boating, could result in public health threats from coliform levels above state standards. The significance of this threat is not presently quantified.

Secondary Treatment of Effluent

Two alternative alterations of Point Woronzof WWTP are suggested in the facilities plan that would result in the discharge of secondary treated effluent. No significant adverse environmental impacts are anticipated with the discharge of secondary effluent. However, it has not been demonstrated that the discharge of less than secondary treated effluent would harm Cook Inlet fishery resources or human health (Murphy et al. 1972), although secondary treatment would reduce suspended solids and BOD.

Secondary treatment would require a greater capital investment, greater energy consumption, more land at the plant, and would generate larger volumes of sludge.

Sludge Disposal

The facilities plan recommends that incineration of sludge continue and suggests three alternative methods of ash disposal. The plan does not designate any one of the three ash disposal alternatives as part of the Recommended Plan. Since these disposal options remain alternatives, the impacts of the ash disposal methods are discussed in Chapter 9, Sludge Disposal Impacts.

An alternative to incineration, namely digestion of the sludge and subsequent disposal in a landfill, is not preferred by MOA. A major environmental impact would be the accelerated reduction in available landfill capacity. The existing landfill will be full in the next 3-4 years, and no alternate site has been selected. This impact is discussed in more detail in Chapter 7.

Another alternative discussed in the facilities plan is co-incineration of sludge and refuse. This alternative has the environmental advantage of reducing the amount of solid waste destined for a landfill and generating energy as a byproduct. Adverse impacts on air quality may occur if steps are not taken to minimize the release of carbon monoxide and particulates.

West Interceptor Bypass

The impacts of the recommended alternative, a pump station south of Campbell Creek and west of the Alaska Railroad, and a force main from the pump station along C Street and Raspberry Road to the existing West Interceptor Bypass, are discussed in Chapter 4.

Two alternatives to the Recommended Plan, a gravity flow interceptor with open ditch construction, and a combination of open ditch and tunneling construction, have impacts on the biological environment that are similar to the impacts of the recommended alternative. All three cross Campbell Creek and may temporarily impede movement of salmonids or increase turbidity and sedimentation in the creek.

The potential physical impacts of the gravity flow alternatives are quite different than for the recommended force main. Gravity flow alternatives require significantly deeper excavations than the preferred alternative. In order for the interceptor to be constructed to flow by gravity it must be placed on a relatively flat grade connecting the existing interceptor sewers at the Alaska Railroad/Campbell Creek location to the existing section of the west bypass interceptor on Raspberry Road near Minnesota Bypass. The ground rises

between these two points, and a 50-foot excavation would be required along much of the alignment in C Street and the easterly portion in Raspberry Road. Shallow groundwater is prevalent in this area, with sand and gravel deposits predominating. Dewatering would be required in order to allow construction of either the open trench alternative or the tunnel alternative. In estimating construction costs, Ott Water Engineers developed estimates of the extent of dewatering that would be needed based on available soil borings taken along the alignment. Ott estimated that a series of about 36 temporary wells slightly deeper than the excavation would be required for each 0.25 mile of trench along the alignment. The wells would be spaced about 70 feet apart, and each would have to pump about 480 gallons per minute to successfully dewater the excavation. Continuous dewatering would be required for about 6 weeks for each section of trench or tunnel. It was recognized that the wells would have to discharge the pumped water, but no acceptable discharge was readily located. This problem was not resolved by the facilities planners, and became a further reason for recommending the alternative of a pump station with a much shallower force main.

One of the highest yielding water wells in the Anchorage Bowl, operated by Central Alaska Utilities, Inc., (CAU) for domestic water supply, is located several hundred feet east of C Street and a similar distance north of the interceptor's route from Campbell Creek to C Street. Dewatering required for each nearby leg of the interceptor construction was estimated by Ott Water Engineers to lower the water level in the well by about 10-15 feet, or about 25 feet if both legs are dewatered at once, temporarily lowering the well yield by as much as 50 percent and increasing pumping costs. This impact would last about 6 weeks to 3 months, depending on the rate of construction. The impact would occur during the summer construction season, possibly coinciding with the early summer period when water supply is at a critically low level.

While force main construction would not require dewatering, it would leave a pressurized sewer near the surface of the shallow groundwater table. Leakage from the force main due to frost heaving or seismic action could pollute the groundwater. A public health threat could exist through use of the CAU well if leakage were to occur.

The dewatering could decrease the Anchorage water supply for several months. Considering that the Anchorage water supply is currently barely adequate to meet demands at critical periods, loss of well production could cause a water shortage in Anchorage.

Several commercial buildings and residences are located near the interceptor alignment and could be affected by construction activities, especially dewatering. When certain types of soils are dewatered, the soil particles are allowed

to compress more tightly together, allowing the land surface to settle or subside slightly. Construction dewatering for utilities and roadways has caused subsidence in many different areas of the country, and the soils in the area of the west bypass may be susceptible to subsidence if dewatering occurs.

The Alaska Bank maintains a large building with computer facilities on Raspberry Road along the interceptor alignment. If subsidence did occur, structural damage from differential settlement would be likely. Any subsidence or vibration from construction equipment could also interfere with the operation of the computer system. Several weeks to several months of construction activities in this area could substantially interfere with the operation of the bank computer system and could leave the building unsuitable for that use.

Subsidence of soils in residential areas along the interceptor alignments can lead to cracks in walls, possible differential settlement of paving, and leakage of water and sewer pipes.

Campbell Creek lies upslope from the project area and may be a major source of recharge to local groundwater. The dewatering could induce greater recharge from Campbell Creek, reducing flow in the creek and adversely affecting salmon runs in the creek.

In the event of seismic activity the interceptor could separate at joints, allowing both infiltration and exfiltration. Infiltration would increase the flow to the plant, decreasing treatment capacity available for sewage. Exfiltration can contaminate groundwater resources, including the CAU well.

Rabbit Creek/Potter Creek Area

The facilities plan describes a number of alternatives for providing sewerage service to those portions of the lower Hillside area requiring connection to the public system. Five alternatives (A-E) dealt with the treatment of the collected wastewater, and four alternative (1-4) were proposed for the collection system.

Rabbit Creek/Potter Creek Area Wastewater Treatment Alternatives

Alternatives A through C generally provide for a small WWTP at the north edge of Potter Marsh that would discharge secondary treated effluent into Rabbit Creek. This method of disposal is likely to have adverse environmental impacts on Potter Marsh and the fishery resources in Rabbit Creek. Of major concern are the adverse impacts of an accidental discharge of raw or inadequately treated sewage, elevated water temperatures during winter, chlorine, and turbidity.

Recent studies by Sanville (1981) and Schwartz (1982) have challenged the assumption that wetlands can act as a nutrient sink or as a biotic nutrient filter. The Alaska DFG (1981a, 1981b) has expressed strong objections to the discharge of sewage into Rabbit Creek:

> "Water quality and quantity in Potter Marsh must be maintained at established levels to ensure the continued health and productivity of the fish and wildlife which inhabit the area. Disposal of sewage or industrial wastes, whether treated or untreated, and the channeling of surface runoff into Potter Marsh or any other portion of the Refuge will be opposed by the Department".

Alternative E in the facilities plan provides for a small WWTP discharging secondary treated effluent into Potter Creek. Although Potter Creek does not drain into Potter Marsh, it empties into Turnagain Arm just below the Potter Point State Game Refuge. Alaska DFG may object to the discharge of secondary effluent into Potter Creek. Potter Creek has minimal numbers of Dolly Varden trout and a small run of pink salmon (Alaska DFG 1981a). A small marsh has developed in Potter Creek just upstream of the Seward Highway, probably because of the restricted flow provided by the corrugated steel culvert under the highway. The small marsh may be adversely impacted by the proposed wastewater discharge, particularly during the winter months when most water movement in Potter Creek occurs under ice.

Alternative D is the Recommended Plan and is discussed in Chapter 4. This alternative delivers the wastewater to the southeast interceptor via a pump station and force main for eventual treatment at Point Woronzof WWTP.

Rabbit Creek/Potter Creek Area Wastewater Collection Alternatives

Four alternative routings were proposed for the sewage collection system in the Rabbit Creek and Potter Creek areas (Figure 3-9). Three of the alternative routings (Alternatives 1-3) deliver sewage to either a small WWTP or a pumping station at the north end of Potter Marsh, and are compatible with Alternatives A-D described above. Alternative 4 is compatible only with a small WWTP at Potter Creek (Alternative E above). Alternative 1 proposes a gravity interceptor flowing north located east of the Old Seward Highway. This route is the recommended alternative in the Facilities Plan, and the impacts are discussed in Chapter 4.

Alternative 2 (Figure 3-9) proposes gravity flow to the south along Old Seward Highway, with a pumping station located at the south end of Potter Marsh and a force main carrying wastewater north along the Old Seward Highway to the Rabbit Creek facility. The environmental impacts of crossing Rabbit Creek and Little Rabbit Creek are essentially similar to those of Alternative 1. The two major differences are that the sewer right-of-way will be closer to Potter Marsh in Alternative 2, and a pumping station will be built at the south end of Potter Marsh near the weigh station. Alternative 2 locates construction activity more closely to Potter Marsh.

Alternative 3 proposes gravity flow to the south along Old Seward Highway, as in Alternative 2, with gravity flow turning to the north toward the Rabbit Creek area in an interceptor placed west of the Alaska Railroad embankment. Alternative 3 minimizes the amount of construction activity along Old Seward Highway and eliminates the potential impacts associated with a separate crossing of Little Rabbit Creek. Alternative 3 would have only one stream crossing, on Rabbit Creek below the tidegates. The interceptor would be located in tidal mudflat habitat along most of the Alaska Railroad right-of-way in an existing pipeline corridor. Tidal marsh habitat would not be encountered until about the point that the interceptor would cross Rabbit Creek. Placement of pipe in the existing railroad-highway corridor is a preferred alternative according to ADFG (1981b) as noted in the Potter Point State Game Refuge Management Plan. The Alaska Railroad would be crossed in two locations, one just north of Potter Creek and the other just north of Rabbit Creek.

In some respects, the potential environmental impacts of Alternative 3 are less adverse than those of the other three routes, including the Recommended Plan. Some of these are noted in the preceding paragraph, e.g., only one stream crossing as compared to two. The interceptors are potentially subject to failure, or leakage, such as can occur following frost heaving and seismic events, and it may be preferable to have raw sewage spilled along Turnagain Arm rather than upslope of Potter Marsh. Alternative 3 reduces by half the length of the interceptor on the upstream side of Potter Marsh and therefore reduces the risk of sewage spills or exfiltration affecting Potter Marsh. MacDonald (1980) has noted that the existing sewer berm along the Turnagain Arm between Campbell Creek and Furrow Creek is occupied by a unique, but trampled coastal marsh plant association. The existing situation is somewhat different from the proposed interceptor in that the existing berm travels through an established coastal marsh area and is frequently used as a convenient footpath, whereas the proposed berm would be located in a muddy silt area and the railroad embankment is a more convenient "trail".

Alternative 4 proposes a gravity flow interceptor traveling south along Old Seward Highway to a small treatment plant at Potter Creek. This alternative represents the least amount of pipe emplacement around Potter Marsh, and does not cross Rabbit Creek or Little Rabbit Creek. It may cross Potter Creek, depending on the final location of the small WWTP. The route and the route-specific impacts are very similar to the corresponding portion of Alternatives 2 and 3.

No-Action Alternative

The long-term environmental consequences of no action appear more adverse than the long-term consequences of any of the alternatives or the Recommended Plan. The status quo would increasingly violate federal and state water quality laws and could result in a state-imposed moratorium on new sewer hookups in the Anchorage Bowl. Failure to expand or renovate the existing sewer system would increase the incidence of pollution of local streams and of local groundwater supplies. This situation would place severe constraints on local growth and the local economy, and sharply increase the hazard to public health.

Chapter 12

Issues Unresolved by Alternatives

Chapter 12

ISSUES UNRESOLVED BY ALTERNATIVES

A number of issues have been raised during scoping and preparation of this EIS that are related to the Recommended Plan or alternatives, but that are not resolved by them. This may occur because the issues are only peripherally affected by the alternatives, because other factors determine the outcome of the issues, or because the alternatives are not directed toward resolution of the issues. Each relevant issue that is unresolved by the alternatives is identified below.

- Substantial wetland areas may be developed as a result of sewerage expansion. While the EIS evaluates wetlands and potential losses in depth and discusses the relationship between sewerage expansion and this issue, final resolution of wetland issues remains a responsibility of the Municipality, the ADEC Office of Coastal Zone Management, and the U. S. COE. The U. S. COE permit authority under Section 404, the State Coastal Zone Management Plan and the MOA Wetland Management Plan will determine the fate of Anchorage's wetlands.

- Sewerage options proposed for the Hillside area may not provide a long-term (20-year) solution to wastewater treatment and disposal needs. More than one-quarter of the area is judged generally unsuitable for outside treatment systems. The potential for one unit per acre development throughout the portion of the Hillside that is excluded from the public sewerage area will lead to increased system failures and public health risks as density increases, systems age and groundwater recharge from on-site system effluent increases. Should the Hillside Wastewater Management Plan prove unable to provide for adequate sewerage while protecting potable water supplies and minimizing public health risks, additional action will be required. The selection of such actions would be the responsibility of the MOA. These actions are undefined in MOA 201 planning, although possible mitigations are addressed in the EIS.

- Anchorage is occasionally short of water during critical periods. This problem will intensify as the Municipality gains population. Without an increase in water supplies, Anchorage's growth may be adversely affected,

and there may not be a sufficiently large increase in sewage flows to justify the level of sewerage system expansion envisioned in the facilities plan. This problem may be resolved by planning efforts beyond the scope of the Section 201 facilities planning, if the Ekluta water importation project is implemented.

- Anchorage will fill its existing solid waste landfill by about 1985, and no new site is identified. Disposal of sludge ash and other treatment byproducts may require a landfill site; a new site is mandatory for disposal of municipal trash. Planning for a new site is beyond the scope of 201 planning.

- Location of development within the Anchorage Bowl. The MOA Comprehensive Development Plan, currently under review, will establish land use densities and the location of future urbanization.

- Issues outside of the EIS study area, including industrial development on Fire Island, sewerage in Eagle River or Girdwood, or urban development across the Knik Arm are not addressed or resolved in the EIS. Those areas are not tributary to the Point Woronzof WWTP nor are they located in the Anchorage Bowl.

Chapter 13
Coordination

- Scoping Meetings
- Public Workshops and Meetings
- Comments Received through Preliminary Draft EIS

Chapter 13

COORDINATION

This chapter describes the public and agency contacts that have occurred through workshops, meetings and reviews of the preliminary Draft EIS. Detailed notes and minutes are available for workshops and selected meetings from EPA Region 10.

Scoping Meetings

Pursuant to formal notice in the Federal Register, an EIS scoping meeting was held in Anchorage on July 9, 1981, followed by additional meetings on July 10. A list of tentative issues was presented, discussed and expanded to include additional concerns, and priorities were assigned. A copy of the resulting issues and priorities that led to the detailed EIS scope of study is reproduced as Figure 13-1.

Public Workshops and Meetings

Several public workshops and meetings were held in Anchorage to discuss progress on EIS work and to refine its scope. They are listed below.

Interagency Workshop - September 9, 1981

An interagency workshop was held at the Hill Building in Anchorage on September 9, 1981 at the request of the MOA Planning Department to discuss wetlands biology work for the EIS. Representatives of EPA, USFWS, various MOA departments, the MOA Policy Advisory Committee and the EIS team attended. The EIS work scope was explained and the MOA's needs for special study work on certain wetlands were described. The possibility of coordinating EIS work with MOA's special study work was discussed.

Facilities Plan Public Meeting - October 15, 1981

A 201 Facilities Plan public meeting was held on October 15, 1981 at West High School. The meeting was attended by about 40 people. Comments were received on the EIS scope following a presentation of EIS issue areas (Figure 13-1). Concerns about impacts of south Hillside area urbanization on Potter Marsh were emphasized by attendees.

Figure 13-1. Issues Identified for EIS Coverage and Priorities at July 9 and 10, 1982 Scoping Meetings

Tentative EIS Topic Areas

- Construction impacts
- Growth-related issues
  - Hillside issues
  - Wetland issues
  - Socio-economics
  - Air quality
  - Physical factors
- Effluent treatment and disposal impacts

Issues Presented and Discussed at EIS Scoping Meetings

Importance Ranking	Issue
	Construction impacts
High	Wetlands
Low	Transportation
Low	Disturbances
?	Other
	Hillside issues (growth related)
High	Surface water quality
High	Groundwater quality
High	Domestic water supply
High	Development densities
	Wetland issues (growth related)
Controversial	Biological values
Moderate	Hydrological values
High	Development issues
	Other growth-related issues
High	Socio-economic impacts
Moderate	Air quality
Low	Hydrology
Low	Seismicity
Low	Wind, water erosion
	Effluent treatment and disposal impacts
Moderate	Knik Arm discharge
Low	O&M costs
Moderate	Energy use
Low	Odor potential
?	Other
	Additional issues
High	Community-wide development issues
Moderate	Air quality - sludge incineration
High	Sludge disposal to Knik Arm or land disposal

EIS Wetlands Workshop - October 16, 1982

An EIS workshop emphasizing wetlands work was held in the new Federal Building in Anchorage on October 16, 1982. A major purpose was to identify a detailed scope of expanded biological studies to satisfy both EIS needs and MOA special study needs. Federal, state and local agency representatives attending the workshop received handouts outlining a tentative study scope and modifications were suggested by participants. (The expanded biological studies were not funded for this EIS.)

Facilities Plan Public Meeting - January 20, 1982

A 201 Facilities Plan public meeting was held on January 20, 1982 at West High School, attended by about 25 people. Wastewater project alternatives were presented and EIS issues discussed. Primary public attention was focused on Hillside and Potter Marsh impacts that might occur from sewering of the south Hillside.

EIS Wetlands and Hillside Workshop - April 14, 1982

A two-session EIS workshop was held in Anchorage on April 14, 1982 to discuss wetlands and Hillside area issues. The first session, attended by about 15 people, was held in the Hill Building. The second session, attended by about 10 people, was held at Wendler Junior High School. Issues discussed at the workshops included the outfall, Hillside issues and specific wetland impacts.

Comments Received Through Distribution of the Preliminary Draft EIS

The Preliminary Draft EIS was circulated for comments on August 30, 1982 to certain public agencies and groups that were active participants in EIS scoping. Comments were received at a meeting in the MOA Telephone Utility offices on September 15, 1982. Those comments have been considered in completing this Draft EIS.

Chapter 14
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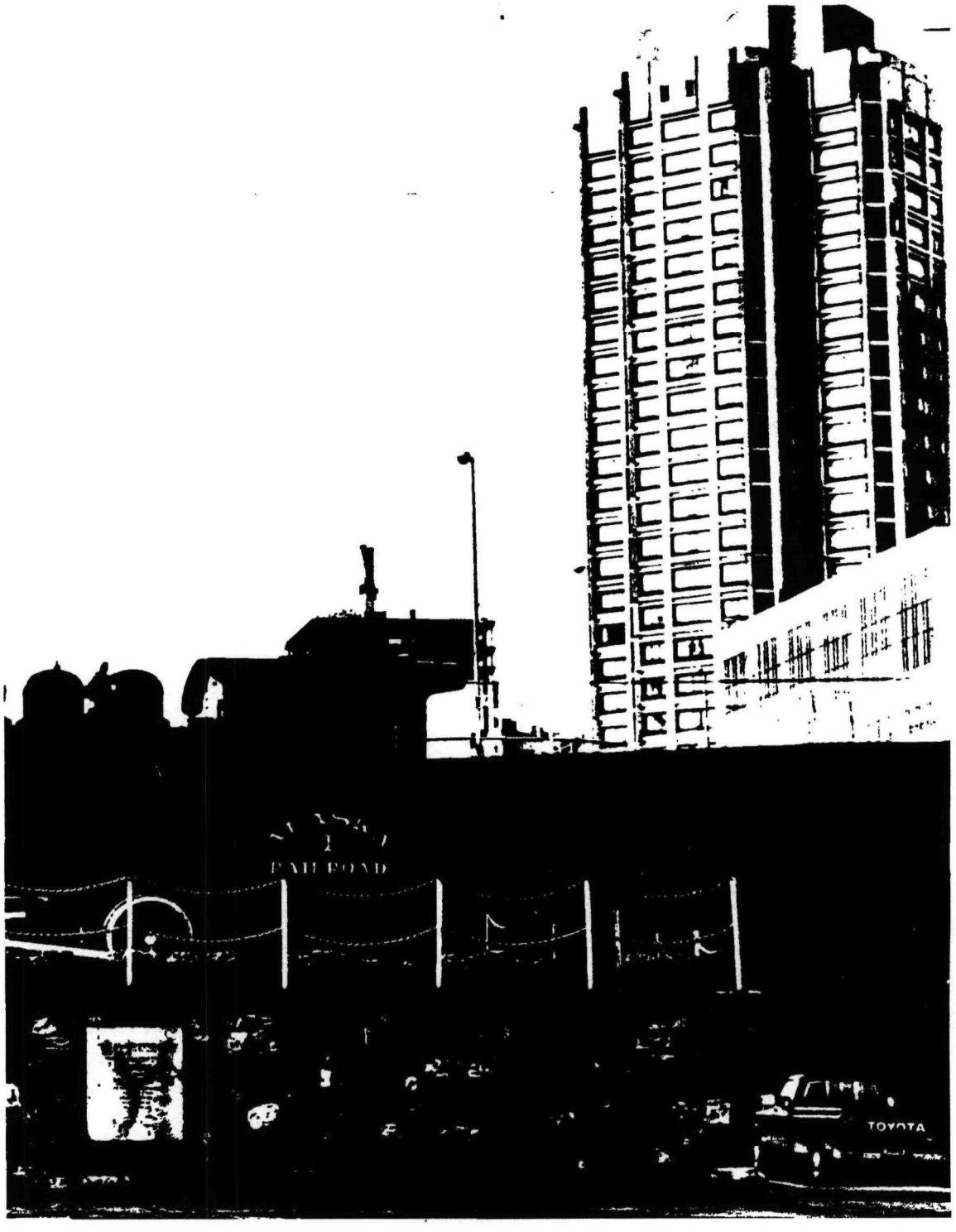

Chapter 14

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APPENDICES

U.S. ENVIRONMENTAL PROTECTION AGENCY
REGION X
1200 SIXTH AVENUE
SEATTLE, WASHINGTON 98101

APPENDIX A

REPLY TO ATTN OF: M/S 429

SEP 27 1982

Keith Kelton
Alaska Dept. of Env. Cons.
Pouch O
Juneau, AK 99801

Dear Mr. Kelton:

In reviewing our consultant's preliminary Draft Environmental Impact Statement, my staff has become aware of certain problems within the Municipality of Anchorage's "Wastewater Facilities Plan for Anchorage, Alaska." In the interest of avoiding lengthy delays in completing the EIS and in initiating other activities that will follow the release of the EIS, EPA intends that the draft EIS will identify these concerns and indicate that additional information will be included in the final EIS.

Our concerns include: (1) flow projections used in sizing the treatment works and the interceptor sewer; (2) reduced EPA eligibility for reserve capacity; and (3) cost information that does not accurately reflect EPA eligibilities and does not provide projections of annual cost to the typical residential household.

More specifically, our concern related to flow projections and facility sizing is based in part upon: (1) The attainment of saturation populations ; (2) The inclusion of an I/I allowance of 4000 qpdim which is the allowable I/I component for existing rather than for new sewers; and (3) The application of peaking factors to the I/I allowance.

Our concern on eligibility is based on the fact that the facility plan does not reflect the recent amendments to the Clean Water Act which limit or prohibit EPA grant participation in reserve capacity and in capacity for serving industrial flows.

The facility plan does not include estimates of the annual costs that a typical residential household can expect to pay. These costs must be compared to the national standard and reported in the facility plan and the EIS. We recognize that a precise estimate of such costs is impossible because of the difficulty in predicting the availability of EPA grant funding. We would expect, however, that the state priority list which is based on assumed National levels of funding of $2.4 billion per year would provide a reasonable approach for estimating the amount and timing for future EPA funding of the Anchorage project. We also believe that this projected level of EPA funding could be used in developing the most likely scenario for project financing.

It is also suggested that the facility plan incorporate an evaluation of the financial capability of the MOA in proceeding with the project. Although inclusion of this evaluation is not required to conclude the facility planning or the EIS, it is a requirement for obtaining Step 3 grant funding and if accomplished at this time, could be considered as within the scope of the Step 1 grant.

These items are being brought to your attention in the interest of reducing delays in completing the facility plan and the EIS. In accordance with the provisions of the EPA/ADEC delegation agreement, this agency defers followup activities to ADEC. We must, however, clarify these points for our final EIS, and therefore look forward to yoiur assistance in their resolution..

Sincerely,

John A. Spencer,
Regional Administrator

cc: Ken Lauzen (MOA)
Ron Kreizenbeck (AOO)
John Jones & Stokes

Appendix B

OCEANOGRAPHIC DESCRIPTION OF KNIK ARM, COOK INLET, ALASKA IN REFERENCE TO THE PROPOSED EXTENSION OF THE POINT WORONZOF OUTFALL

By:

Kinnetic Laboratories, Inc.
519 W. Eighth Avenue, Suite 205
Anchorage, Alaska 95501

August 13, 1982

LIST OF TABLES

Table		Page
1	Net Mean Currents at Point Woronzof and Tidal Excursions	B-13
2	Salinity Values as a Function of Depth for Knik Arm	B-14
3	Cook Inlet Salinity Values for 1979	B-20
4	Cook Inlet Temperature Values for 1979	B-21
5	Volumes of Cook Inlet Cross-Sections	B-22
6	Flushing Rates for Various Sections of Cook Inlet	B-23
7	Age and Size Distribution of Macoma balthica Collected in the Point Woronzof Area	B-31
8	Water Quality Data at Proposed Outfall Site Collected August 1979	B-33
9	Selected Heavy Metal and Chlorinated Hydrocarbon Analysis of Sediment Samples From the Beaches East of Point Woronzof	B-36

LIST OF FIGURES

Figure		Page
1	Generalized Bathymetry of Cook Inlet, Alaska	B-6
2	Bathymetry of Knik Arm	B-7
3	Tidal Chart for the M_2 Tide of Cook Inlet, Alaska	B-8
4	Current Speed Measured 500 Meters Off Point Woronzof	B-10
5	Point Woronzof Current Directions, August 16, 1979	B-11
6	Hansen and Rattray Classification Diagram	B-16
7	Salinity/Temperature Sampling Station Occupied by the U. S. S. Great Land During 1981	B-18
8	Estuarine Waste Assimilation Diagram	B-25
9	Water Quality, Intertidal and Subtidal Sampling Stations in Knik Arm, Kinnetic Laboratories, Inc. (1979)	B-27

Oceanographic Conditions of Knik Arm

Introduction

The analysis of estuarine pollution is concerned with the determination of the temporal and spatial distribution of contaminants introduced into the system and with their impacts on water quality and biological systems. This analysis is important in predicting both the degree of treatment required by a discharger and the maximum quantities of municipal and industrial wastes that can be assimilated by the natural circulatory system of the estuary. Contaminants normally enter the estuary via river flow and/or through outfall structures. Outfalls provide varying amounts of initial dilution through jet entrainment.

In addition to the effects of longitudinal and vertical salinity gradient on waste dispersion, tidal velocity oscillations also provide an important longitudinal dispersion mechanism in estuaries. Although the velocity attributed to freshwater discharge in an estuary is normally insignificant compared to tidal velocities, the net seaward flux due to freshwater flow provides the important flushing action in estuaries.

The following sections will discuss the physical, biological, and chemical oceanographic conditions of Knik Arm, Cook Inlet, Alaska in relation to the present (August 1982) maximum allowable discharge of 126,000 m^3 per day from the 250 m long outfall located at Point Woronzof. This overview will then be employed to estimate what effects, if any, would be observed in Knik Arm upon the extension of the Point Woronzof outfall an additional 500 m, and upon increasing the maximum allowable discharge to 219,000 m^3 per day.

Physical Oceanography

Cook Inlet is an unique estuary in that it possesses tidal ranges of 38 feet (26-foot mean height), tidal bores

in the upper reaches, current of 4-5 knots, suspended glacial silt of up to 2,000 mg/l and, in winter, pancake ice of 1 m thickness. The estuary is about 200 miles long and about 50 miles wide at the mouth (Figure 1). Generalized bathymetry (Figure 1) shows the inlet to be deep, approximately 20 fathoms (129 feet) north of the Forelands and about 90 fathoms at the mouth. A more detailed chart of the region of the outfall at Point Woronzof indicates deep water (30-170 feet) extending well past Anchorage up Knik Arm (Figure 2).

Tides

The tide at Anchorage is one of the largest in the world. It is a mixed tide whose diurnal inequality, i.e., the difference in heights of successive high waters or low water, is somewhat obscured by the large tidal range. Although the processes which generate this tide are complex, the variable boundary model of Mungall and Matthews (1970) provides some useful insight. Figure 3 shows the M_2 tide height amplitudes calculated by these authors. The dashed lines are corange lines, i.e., lines along which the range of tidal displacements (cm) is equal. The solid lines are cotidal lines, i.e., lines along which the maximum displacements occur simultaneously. The cotidal lines indicate phases of the tide and are expressed in degrees.

In Figure 3 the amplitudes are seen to double in magnitude as one moves north into the inlet, from 175 cm at the entrance to 350 cm at Anchorage. It is important to note that below the Forelands the corange lines run parallel to the axis of the inlet. A difference in amplitude of approximately 40 cm is observed across the inlet. However, north of the Forelands the corange lines tend to align with the cotidal lines. These observations indicate that the tidal regime of Cook Inlet is composed of two distinct regions

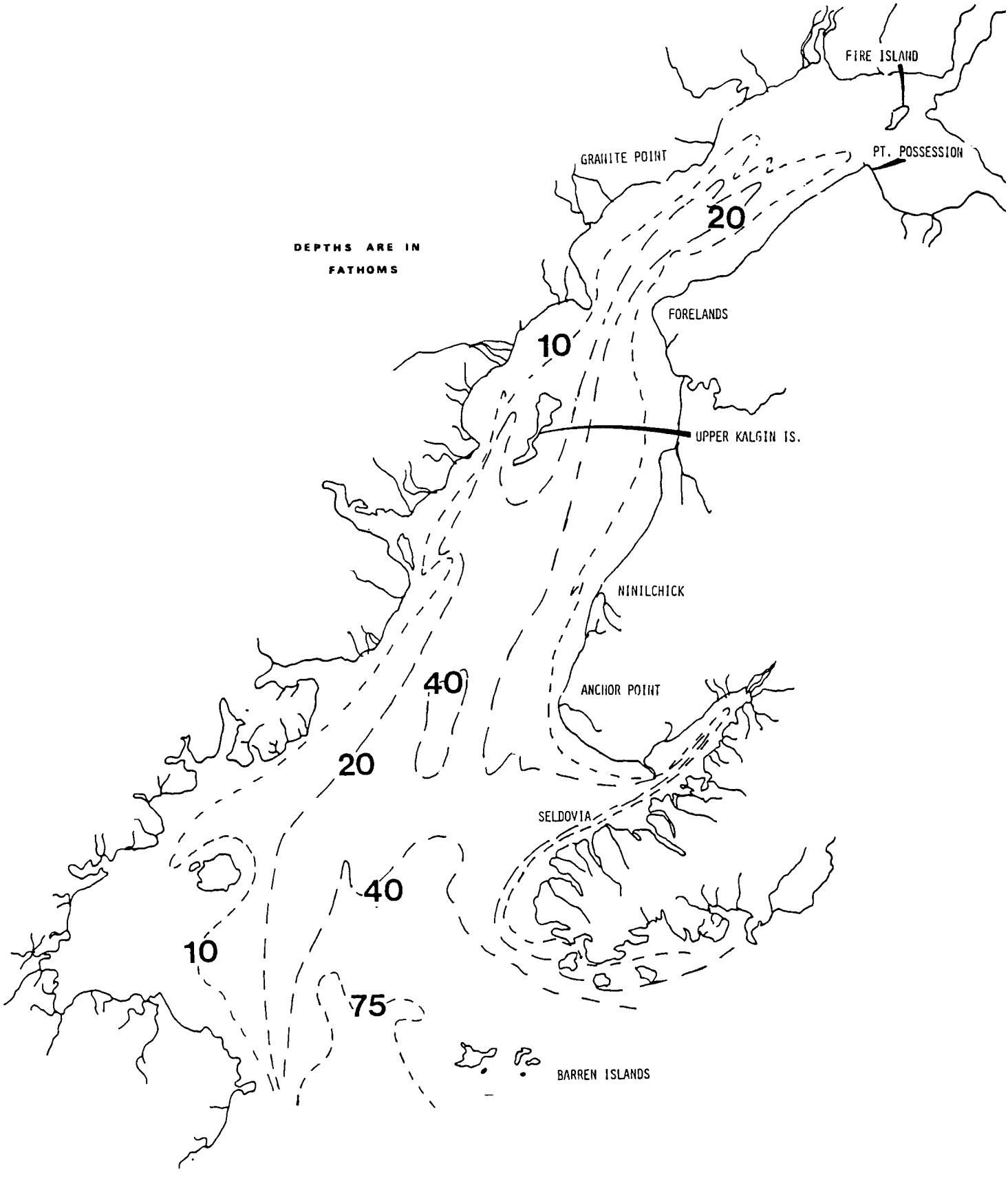

Figure B-1. Generalized Bathymetry of Cook Inlet, Alaska.

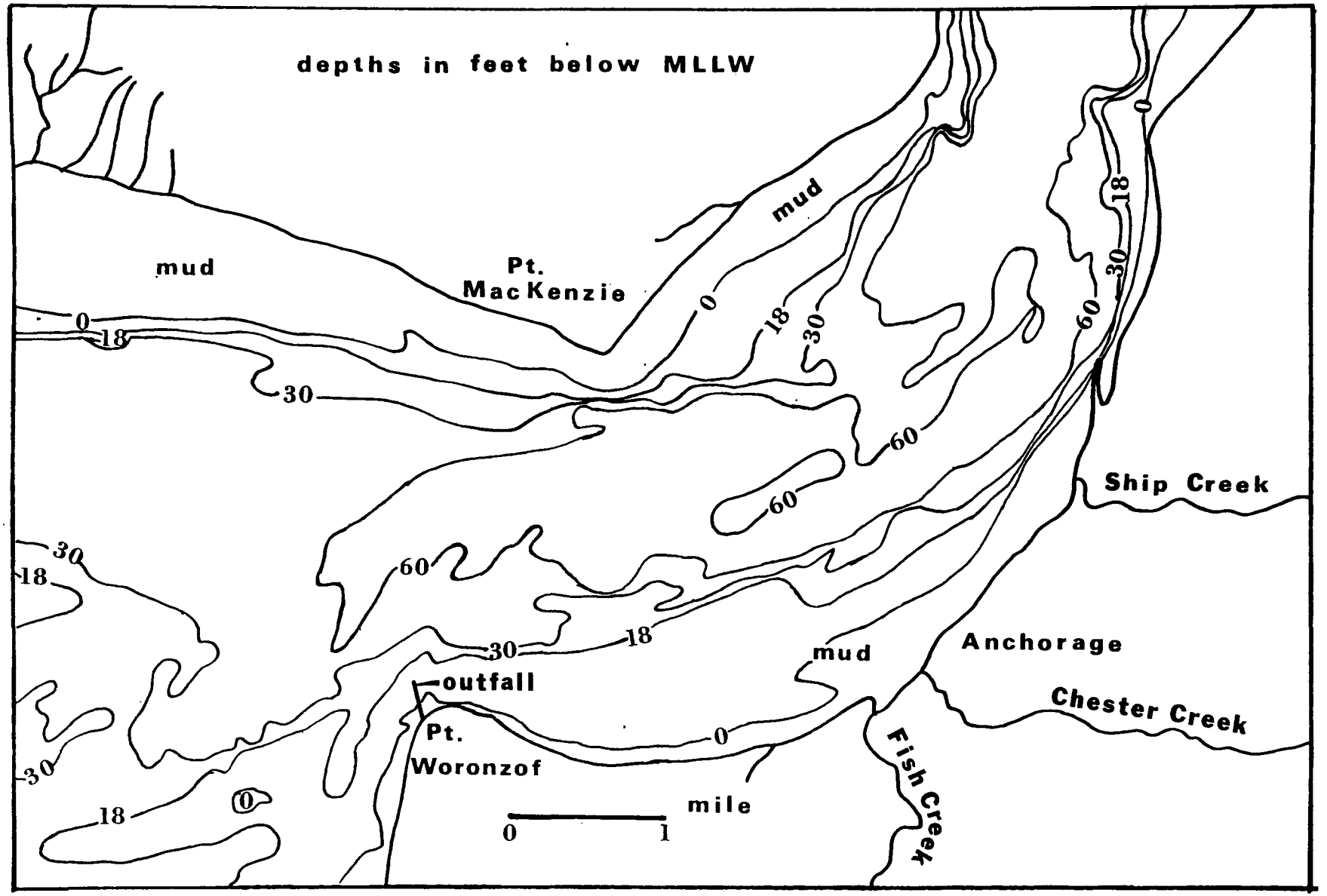

Figure B-2. Bathymetry of Knik Arm.

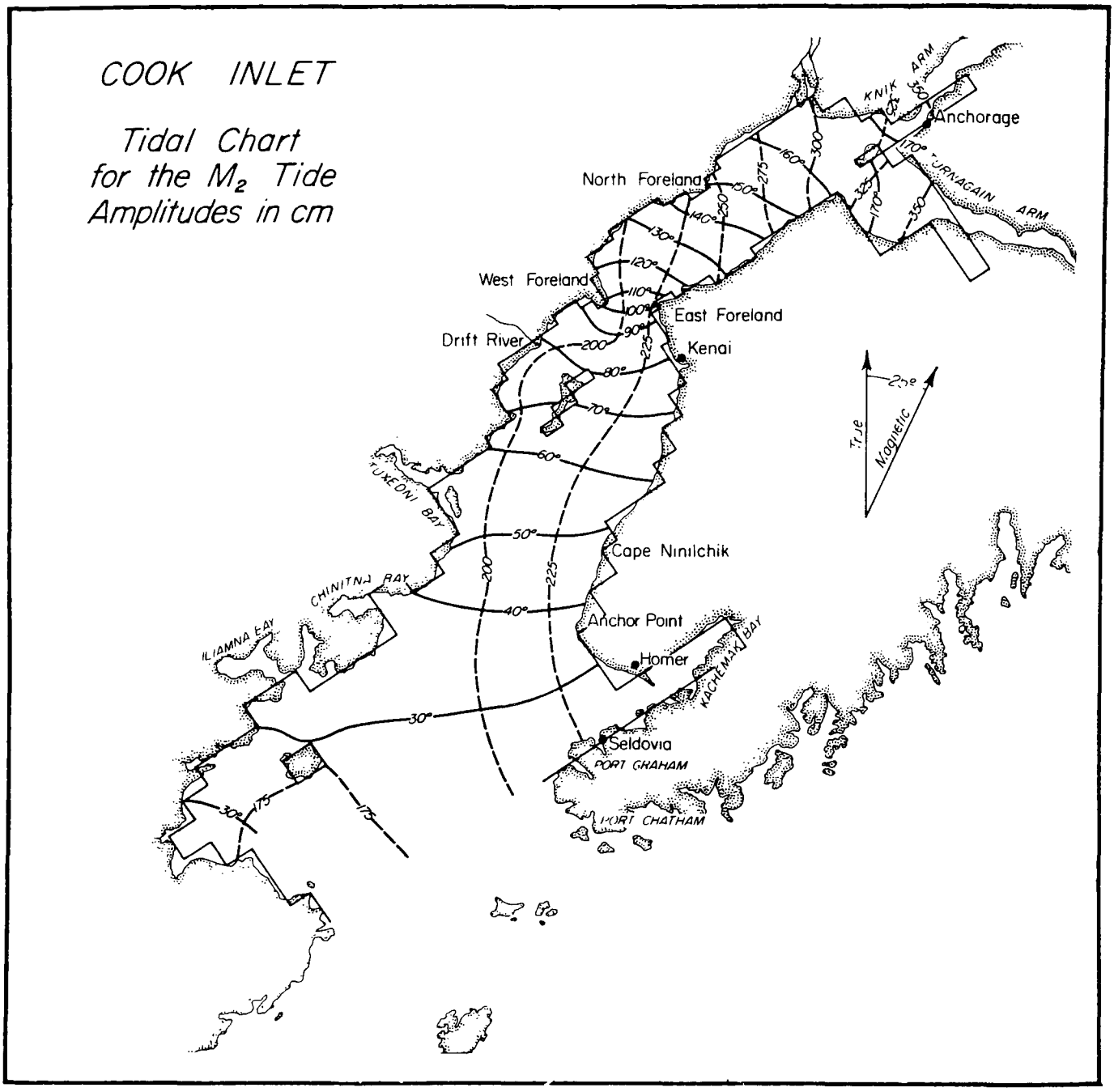

Figure B-3. Cook Inlet: Tidal Chart for the M_2 Tide. (Amplitude in cm.)

separated by the Forelands. In the south the tide shows characteristics of a progressive Kelvin wave. Because the maximum flood currents would occur at high water, the Coriolis effect would be quite great and the tidal amplitude would be greater on the east of the inlet than on the west. This phenomenon is observed. Above the Forelands, however, the tide behaves more like a conventional standing wave. The corange and cotidal lines are no longer perpendicular, indicating the frictional effects of shoaling. High and low waterssand the time of slack water are nearly simultaneous throughout this section. Thus the tidal amplitude is 90 degrees out of phase with the current velocity. Figure 4 shows this effect clearly for a current meter station off Point Woronzof (Kinnetic Laboratories, Inc. 1979). In addition, since slack water occurs at maximum tide, no Coriolis force exists at that moment and no water level variations exist across the inlet.

Tidal Currents

Although several investigators (Britch 1976; Marine Advisors 1965) have measured the currents off Point Woronzof for short periods of time, only Kinnetic Laboratories, Inc. (1979) has generated data from moored current meters. The moored data were taken at stations shown in Figure 5. Current meters (General Oceanics Model 6011, tape recording) were moored August 14-20, 1979 under a surface following buoy at three stations along the alignment bearing of the present outfall. The inshore meter was just offshore of the present outfall (304 m off the chlorination tower on the beach), the second meter was farther out at 495 m off the tower, and the third meter was out in the region of the proposed extension (705 m). The inner meters were at 6 feet below the surface; the outer meter was at 16 feet below the surface. Figure 5 shows the average velocities and directions for the flood and ebb tides at the three stations for August 15.

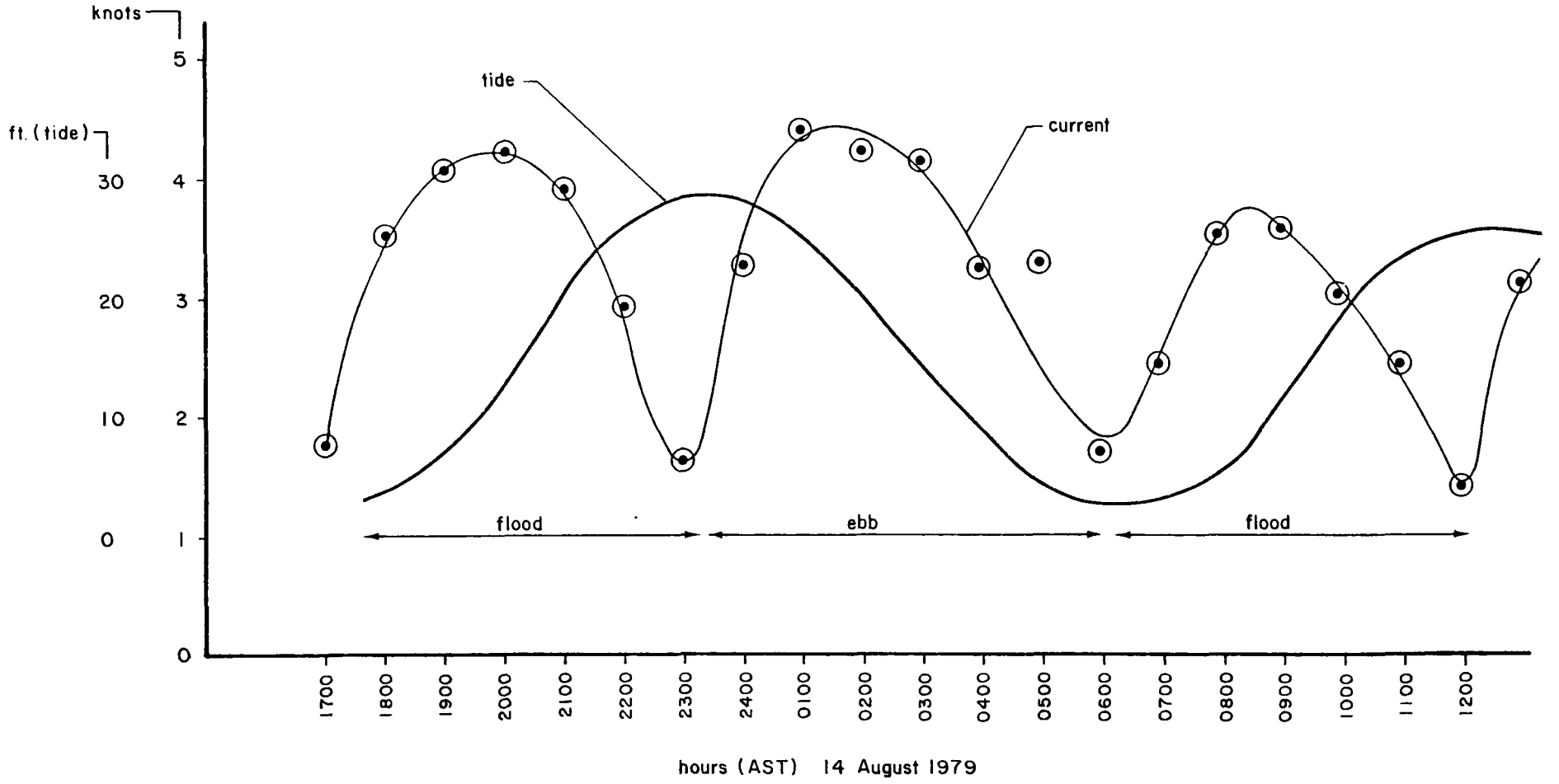

Figure B-4. Current Speed Measured 500 Meters off Point Woronzof Superimposed on Tide Heights for the Same Period.

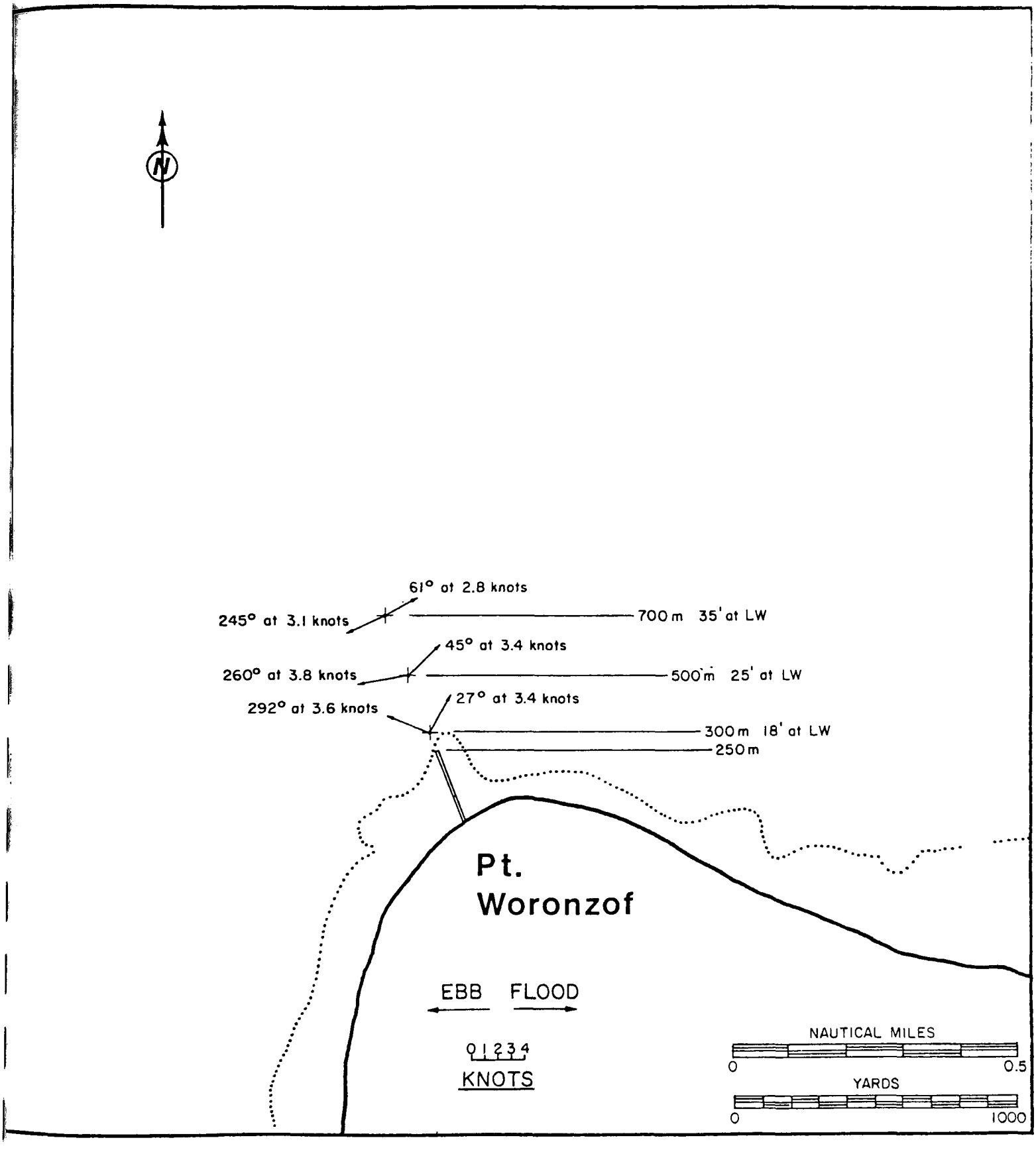

Figure B-5. Point Woronzof Current Directions, 16 August 1979. Bearings are Degrees True.

The shore effect on the two inside meters is quite noticeable in the deflection of the water away from the shore at these two stations during ebb and flood tide. Wastes from the present outfall would be immediately carried away from the shore on the flood, only to be returned to the beach as the waters fill in behind Point Woronzof. Although the existence of a gyre behind Point Woronzof has been documented by a number of studies (Marine Advisors 1965; Britch 1976; Tetra Tech 1977), the seaward boundary of the gyre has not been located accurately. Figure 5 indicates that only at 700 m does the water movement appear to be unaffected by the shore.

For diffuser design purposes the lowest 10 percentile current for these meter locations was calculated, then adjusted, assuming a linear transfer function to the mean annual tidal range (26 feet yearly mean as opposed to 23 feet mean during the measurement period). The mean of the lowest 10 percentile currents was 50-67 cm per second (1.0-1.3 kts); the maximum of the 10 percentile range was 83-96 cm per second (1.7-1.9 kts). Table 1 lists the average current velocities and tidal excursions for each meter location over the study period.

In an estuarine system the salt balance and the dynamic balance are parts of the same interlocking system. Hansen and Rattray (1966) have developed a method of estuarine classification based upon the ratios $\delta S/\overline{S}_o$ (a stratification parameter) and u_s/u_t (a circulation parameter). δS is the difference between surface and bottom salinity, $\overline{S}_o$ is the mean cross-sectional salinity, u_s is the mean surface current, and u_t is the mean cross-sectional current velocity. From Table 1 u_s is found to be 15.5 cm per second and u_t to be 12.9 cm per second. Thus the ratio u_s/u_t equals 1.2.

Table 2 lists salinity values as a function of depth for a station off Point Woronzof (61 degrees 13.3'N, 149 degrees 59.2'W) which was occupied in May 1968 by the R/V Acona of the University of Alaska. These data were abstracted from

Table 1. Net Mean Currents at Point Woronzof and Tidal Excursions

Meter Location (meters off Pt. Woronzof)	FLOOD			EBB			NET (on ebb)	
	# Time Intervals†	Velocity§	Excursion	# Time Intervals†	Velocity§	Excursion	Velocity§	Excursion
300 (surface)	23.3	153.1	32.1 km	26.9	154.2	37.3 km	11.7	5.2 km
500 (surface)	23.1	150.0	31.2 km	27.0	164.5	39.9 km	19.4	8.7 km
700 (bottom)	24.1	128.1	27.8 km	26.4	131.4	31.3 km	7.8	3.5 km

† Number of 15 minute measurement intervals
§ cm/sec

Table 2. Salinity Values as a Function of Depth for Knik Arm Station CI 93 (61° 13.3'N, 149° 59.2'W) Occupied May 28, 1968 by the R/V Acona (Kinney et al. 1970)

Depth (meters)†	Salinity (ppt)
0	17.55
5	17.67
10	-
20	17.62
30	17.63
	$\langle \bar{S}_o \rangle$ = 17.61

† Miscellaneous information: time on station 1,812 hours. Time of high water 1,930 hours (27 feet). Station depth, 50 meters.

Kinney et al. (1970). The surface and bottom salinities were 17.55 ppt and 17.63 ppt, respectively, and the mean water column salinity, $\overline{S}_o$, 17.62 ppt. Thus $\delta S/\overline{S}_o$ equals 0.004. Plotting the calculated values for the stratification and circulation parameters on Figure 6 indicates that Knik Arm falls in the classification group 1a, i.e., "the archetypical well-mixed estuary in which the salinity stratification is slight" and "the net flow is seaward at all depths and upstream salt transfer is effected by diffusion."

Flushing Rates of Knik Arm and Cook Inlet

As mentioned previously, the net seaward flux due to freshwater flow provides the important flushing action in estuaries. The average length of time required to remove 1 day's contribution of water is defined as the ratio of the quantity of river water accumulated in the estuary to the quantity introduced daily by the river, and is termed the flushing time, equation 1 (Ketchum and Keen 1953).

$$T = Q/R \qquad (1)$$

where Q is the total amount of river water accumulated in the whole or section of the estuary, and R is the river discharge.

There are a number of methods for calculating flushing times. The Tidal Prism Method assumes the water entering on the flood tide is fully mixed with that inside, and the volume of seawater and river water introduced equals the volume of the tidal prism (the volume between high and low waters). On the ebb the same volume is removed and the freshwater content of it must equal the increment of the river discharge. If V is the low tide volume and P the tidal prism, then the flushing time in tidal cycles is:

$$T = \frac{V + P}{P} \qquad (2)$$

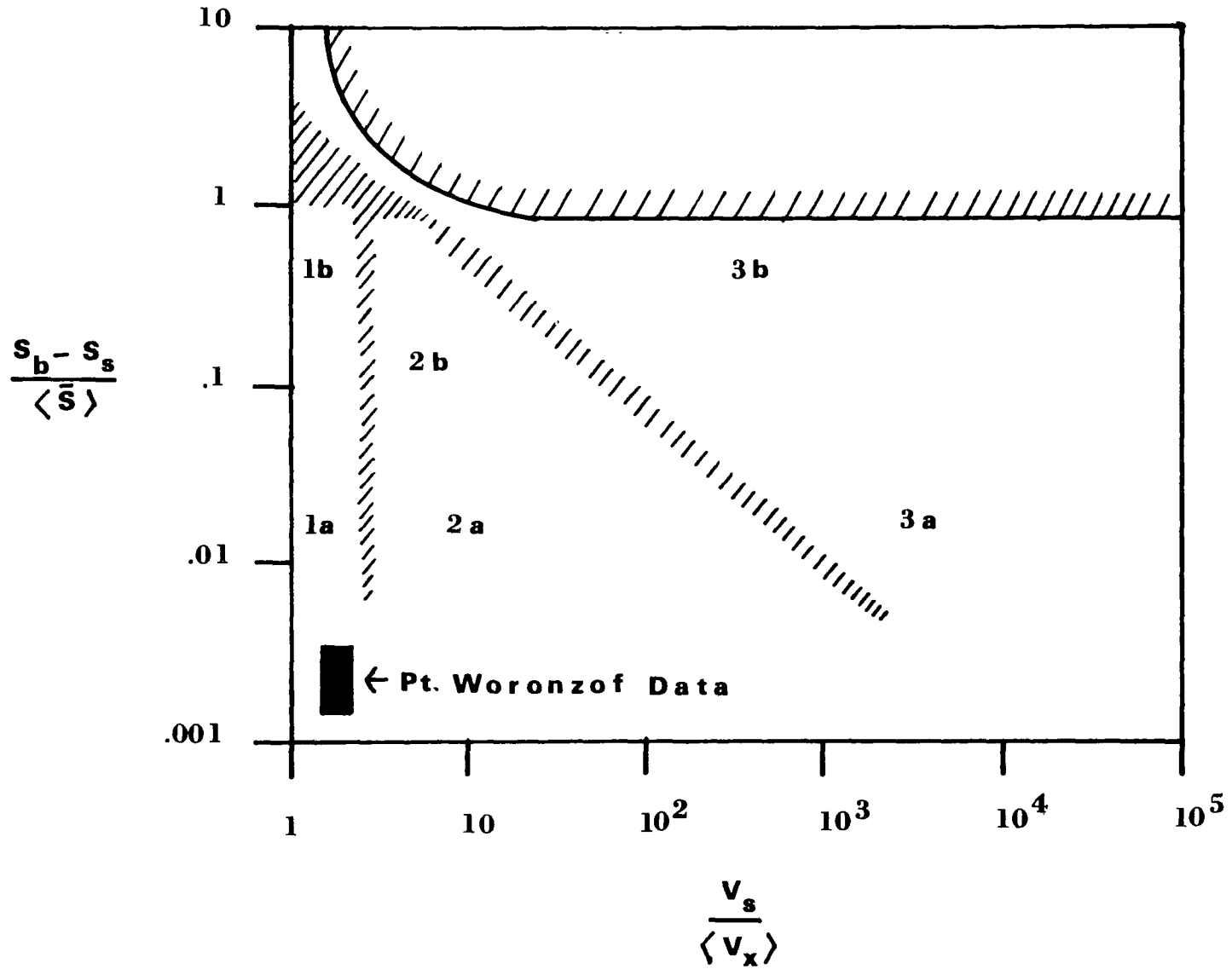

Figure B-6. Hanson and Rattray Classification Diagram.

Low water volume for Knik Arm has been determined by Kinnetic Laboratories, Inc., from NOAA chart 16664 to be 7.2×10^8 m^3. The tidal prism was measured to be 2.75×10^9 m^3. This yields a flushing time of 1.26 tidal cycles or 15.6 hours. Flushing times calculated by this method have been found to give considerably lower estimates than those of other methods. This is due to the erroneous assumption of complete mixing of the estuarine waters, i.e., the fresher water near the head of the estuary cannot reach the mouth during the ebb. Also, some of the water which does escape during the ebb returns on the following flood tide.

Another method of calculation is called the Fraction of Fresh Water Method. The mean fractional freshwater concentration in any segment of estuary is:

$$f = \frac{S_s - \bar{S}_o}{S_s} \qquad (3)$$

where S_s is the salinity of the oceanic waters and $\bar{S}_o$ is the mean salinity of a given segment of estuary. The total volume Q is found by multiplying the fractional freshwater concentration "f" by the volume of the estuary segment. This basic technique has been used by both Gatto (1976) and Kinnetic Laboratories, Inc. (1979), to determine the flushing rate of Knik Arm. Since this method depends on river runoff, Gatto's low flushing time of 13.1 hours occurred in July and has a high value of 205.3 hours in March. Kinnetic Laboratories, Inc. (1979) estimates for summer and winter flushing rates were 5 days and 31 days, respectively.

Because a consistent set of salinity data was not available for Cook Inlet during winter, Kinnetic Laboratories, Inc. arranged with Totem Ocean Trailer Express, Inc. for water samples to be taken monthly by the U. S. S. Great Land at 10 sites in Cook Inlet between Fire Island and the Barren Islands (Figure 7) on its outward trip from Port of Anchorage to Tacoma, Washington. The water samples were taken through the seawater intake at

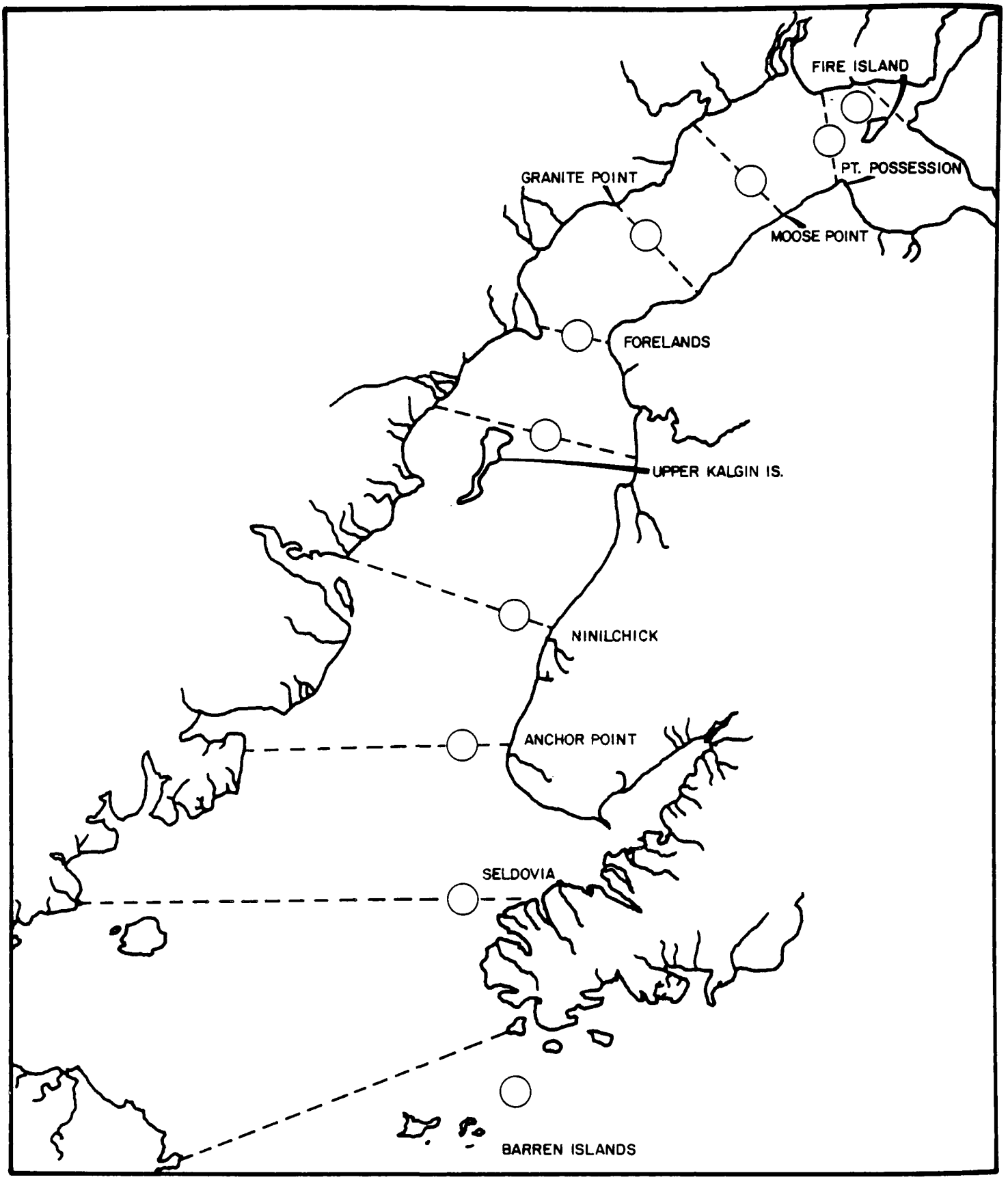

Figure B-7. Salinity/Temperature Sampling Stations Occupied by the S.S. GREAT LAND During 1981.

a depth of approximately 15 feet below the water line. Temperatures were immediately taken by the engineering staff, the sampling time and station recorded, and the sample saved for salinity determination. Samples were collected for a 8-month period beginning February 1981 and ending September 1981. These data are presented in Tables 3 and 4. Also included in these tables are river discharge data for the Susitna and Knik Rivers for the same time periods (USGS 1982). Although the Susitna River is not located in Knik Arm, there can be little doubt that its waters enter the Arm during the flood tide and are thus available for mixing. Flushing times of Knik Arm will be more optimistic when calculated by these discharge data than those calculated using only Knik and Matanuska Rivers runoff data. Table 5 lists the cross-sectional areas delineated in Figure 7 for the salinity sampling sites. Table 5 also presents the low water volumes for Cook Inlet sections bounded by these transects. These data are needed to employ equation 3 in the calculation of flushing times. The flushing times so determined are listed in Table 6.

Waste Assimilation Ability in Knik Arm

Officer and Ryther (1977) have developed a simplified model to obtain order of magnitude classifications of discharge situations in terms of biological oxygen demand and potential eutrophication effects in the marine environment. In the former case, the initial oxygen demand is averaged over the volume of the receiving waters and corrected for both first order waste decay and flushing time of the water system. This results in the calculation of the waste biochemical oxygen demand (WBOD). A similar approach to the potential utilization of the oxygen in the waste nutrients by phytoplankton during respiration or decay results in the calculation of the phytoplankton dissolved oxygen deficit (PDOD).

Table 3. Cook Inlet Salinity Values for 1979

STATION	Feb(1-2) [11,350]§	Mar(8-9) [7,100]§	Apr(5-6) [8,425]§	May(10-11) [103,900]§	Jun(22-23) [141,250]§	Jul(27-28) [188,500]§	Aug(24-25) [143,400]§	Sep(26-27) [45,570]§
Fire Island	17.00	22.35	24.26	20.37	13.12	7.04	5.33	9.56
Pt. Possession	19.47	25.36	24.44	20.88	13.33	7.53	5.72	11.84
Moose Point	19.97	22.05	24.46	23.36	13.78	9.40	7.58	14.30
Granite Point	21.78	26.68	25.18	26.95	16.82	13.98	10.34	17.47
Forelands	24.59	25.65	26.33	28.24	20.61	20.67	16.19	21.58
Upper Kalgin Is.	25.41	28.90	28.31	29.10	23.94	18.45	19.20	23.13
Ninilchik	29.21	28.96	30.03	30.33	27.55	24.12	23.38	27.83
Anchor Point	29.70	31.40	32.16	31.74	30.84	27.26	26.86	29.80
Seldovia	30.03	31.46	31.78	31.97	31.44	28.04	29.12	30.99
Barren Islands	30.03	31.66	31.78	31.97	32.20	30.76	28.67	30.09

[ ]§ indicates the average discharge of the Knik and Susitna Rivers for the stated sampling days(cfs). Data obtained from Water Resources Data for Alaska: Water Year 1981. U.S. Geological Survey (1982).

Table 4. Cook Inlet Temperature Values (°C) for 1979

STATION	Feb(1-2) [11,350]§	Mar(8-9) [7,100]§	Apr(5-6) [8,425]§	May(10-11) [103,900]§	Jun(22-23) [141,250]§	Jul(27-28) [188,500]§	Aug(24-25) [143,400]§	Sep(26-27) [45,570]§
Fire Island	4.0	4.0	4.0	7.5	17.0	17.0	15.0	10.5
Pt. Possession	3.0	2.5	4.5	6.2	17.0	17.0	14.0	11.0
Moose Point	2.8	2.0	4.0	5.5	16.5	16.5	14.2	11.5
Granite Point	1.1	4.1	3.5	5.5	15.7	17.2	14.6	11.5
Forelands	3.0	4.0	3.5	5.5	15.0	16.2	15.0	12.0
Upper Kalgin Is.	0.5	4.0	3.0	6.0	13.5	15.0	15.5	11.5
Ninilchik	4.4	5.5	3.0	6.5	12.6	9.5	17.0	12.0
Anchor Point	6.1	5.6	3.0	8.6	12.6	16.0	15.0	11.5
Seldovia	6.6	5.0	8.0	8.9	15.4	18.0	14.0	11.5
Barren Islands	5.6	5.5	7.5	9.0	16.2	14.0	13.5	13.0

[ ]§ indicates the average discharge (cfs) of the Knik and Susitna Rivers for the time periods listed.

Data obtained from Water Resources Data for Alaska: Water Year 1981. U.S. Geological Survey (1982).

Table 5. Volumes of Cook Inlet Cross-Sections

Transect	Area † $M^2 \times 10^5$	Volume † $M^3 \times 10^7$
Off Eagle River	0.8	72.0
Fire Is. (Knik Arm)	3.1	404.2
Point Possession	14.6	1459.8
Moose Point	11.6	1726.6
Granite Point	11.4	2271.3
Forelands	9.3	2017.6
Upper Kalgin Island	47.9	8180.6
Ninilchik	61.3	9083.1
Anchor Point	144.2	26960.6
Seldovia	284.7	38425.0
Barren Islands		
Totals	588.9	90600.8

† Areas and Volumes bounded by transects were calculated from NOAA Charts 16640 and 16660. Data from Kinney et al. (1970).

Table 6. Flushing Rates for Various Sections of Cook Inlet Calculated by "Fraction of Freshwater Method" Using Data of Tables 3 and 5

Transect	Flushing Rates in Days							
	Feb(1-2)	Mar(8-9)	Apr(5-6)	May(10-11)	Jun(22-23)	Jul(27-28)	Aug(24-25)	Sep(26-27)
Off Eagle River	11.2	12.2	8.2	1.0	1.2	1.2	1.7	4.4
Fire Island	62.6	58.3	53.5	6.5	8.1	7.8	10.8	26.5
Pt. Possession	239	312	216	21.9	32.3	30.6	41.4	95.5
Moose Point	410	468	389	32.6	56.1	50.9	72.9	160
Granite Point	559	714	578	43.1	79.8	67.1	101	218
Forelands	670	815	684	50.2	94.8	84.6	120	260
Upper Kalgin Is.	760	1216	902	51.9	129	123	162	315
Ninilchik	796							
Anchor Point								
Seldovia								

Method of Calculation explained in text and in Dyer (1973).

Figure 8 is a plot, after Officer and Ryther (1977), of wasteloading (W/V or P/V against flushing time) for WDOD and PDOD values of 10 and 1 mg/l. The waste assimilation characteristics of the Houston Ship Channel, Delaware River, Boston Harbor, and coastal waters have been plotted in addition to those calculated for Knik Arm using the salinity data obtained by the U. S. S. Great Land. Both summer (S) and winter (W) conditions are plotted. The wasteloading was calculated assuming a maximum discharge of 120 mg/l of BOD (NPDES permit monthly allowable average), and flows of 126,000 m^3 per day (33.4 MGD) for the present discharge, and 218,000 m^3 per day (58 MGD) for the anticipated discharge in 2005 A.D.

Water Body	Flushing Time	Volume (10^6 m^3)
Houston Ship Channel	56 d	67
Delaware River	28 d	1,330
Boston Harbor	2 d	67
Knik Arm		
(S)	1-2 d	720
(W)	11-12 d	720

Officer and Ryther (1977) state that a wasteloading of 400 x 10^6 g per day into a coastal environment of 4,000 x 10^6 m^3 which has a flushing time of 5 days would have negligible effects on the dissolved oxygen concentration of the receiving waters. From Figure 8, it is evident that BOD loading from the Point Woronzof outfall would be even less a problem for Knik Arm. It is also evident that this water body is not endangered due to cultural eutrophication.

Departing from the more simplified classifications and models, a sophisticated analysis of Cook Inlet water quality was performed using a link node model (Tetra Tech 1977). The model represents the system as a variable grid network of "nodes" of discrete volume, characterized by surface area, depth, and side slope. The nodes are interconnected by channels, each having associated length, width, cross-sectional area,

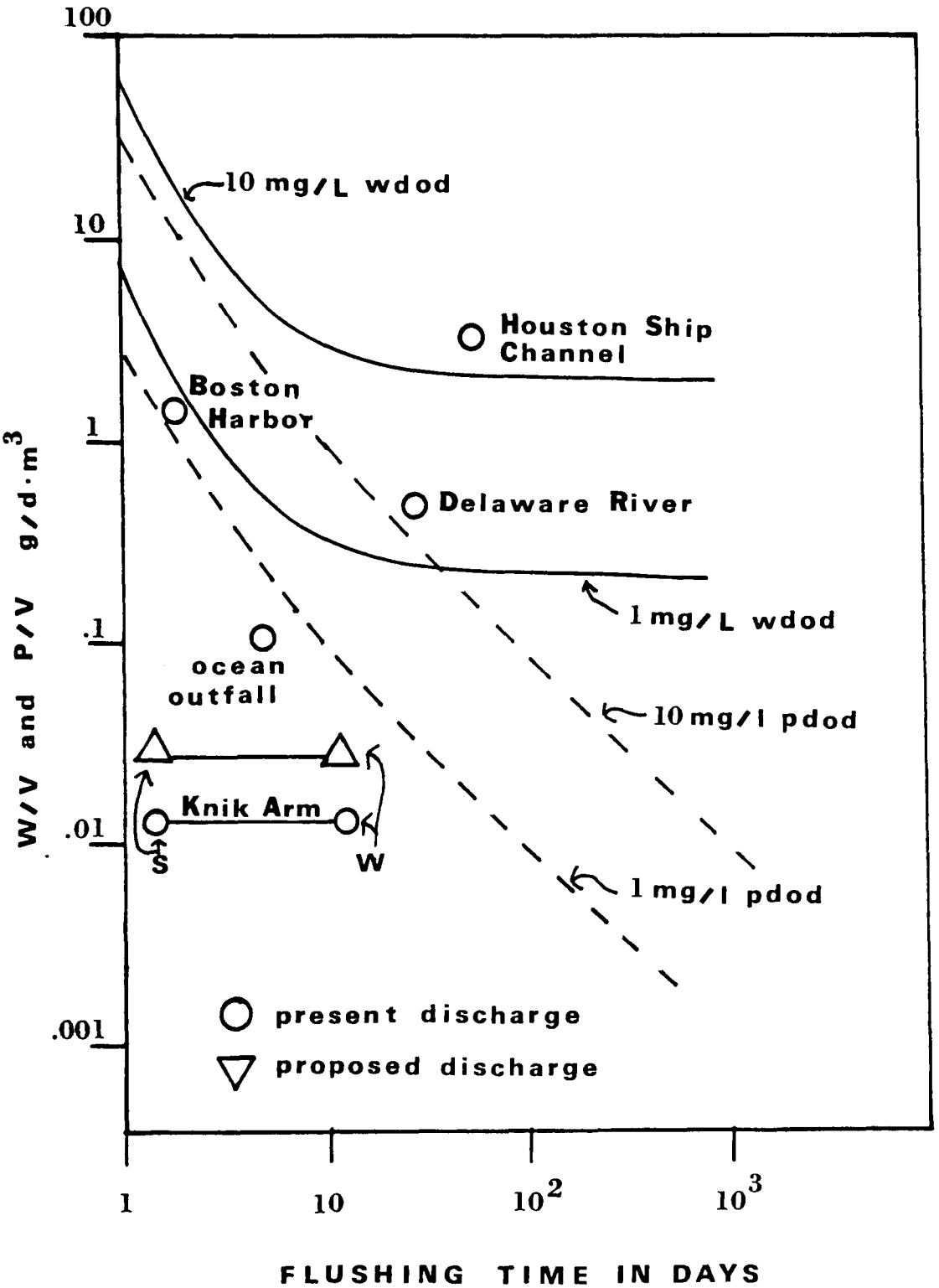

Figure B-8. Estuarine Waste Assimilation Diagram.

hydraulic radius, side slope, and friction factor. Water is restricted to flow from one node to another through these channels. Assumptions pertinent to the model are: 1) the estuarine system is well mixed vertically, 2) the law of conservation of mass holds for constituents, and 3) chemical reactions may be estimated via first order kinetics.

The chemical parameters modeled were BOD, volatile solids, ammonia, nitrate, total and fecal coliform, heavy metals and chlorinated hydrocarbons. The model was run for outfall flows of 20, 60, 100, and 250 MGD. The results indicate that even a 100 MGD discharge from primary treatment would add very little of each constituent to the estuary. It was found that a flow of 250 MGD primary treatment was required before a water quality standard was violated. In that case, the limit of 70 total coliform colonies per 100 ml was exceeded. A flow of 250 MGD corresponds to a population of 1.7 million persons. The Municipality of Anchorage estimated the sewer hookup population in 1979 to be 165,000. Tetra Tech modeling substantiates the conclusions of the Officer and Ryther (1977) models, i.e., that wasteloading to Knik Arm by the Point Woronzof outfall is easily assimilated by that water body.

Biological Oceanography of Knik Arm, Cook Inlet

During August 1979, Kinnetic Laboratories, Inc. occupied five principal intertidal transects in the vicinity of Point Woronzof. These were located at Point Woronzof (Transect 1), on the mudflats on each side of Point Woronzof (Transects 2 and 5), Cairn Point (Transect 3), and Race Point on Fire Island (Transect 4) (Figure 9). Each transect consisted of 4 or 5 stations each separated by a 2 m (vertical) interval. A total of 8 random cores (15 cm x 18 cm) were taken at each station.

In addition, two partial transects consisting of 1 or 2 stations of 7 replicates each were taken on the mudflats

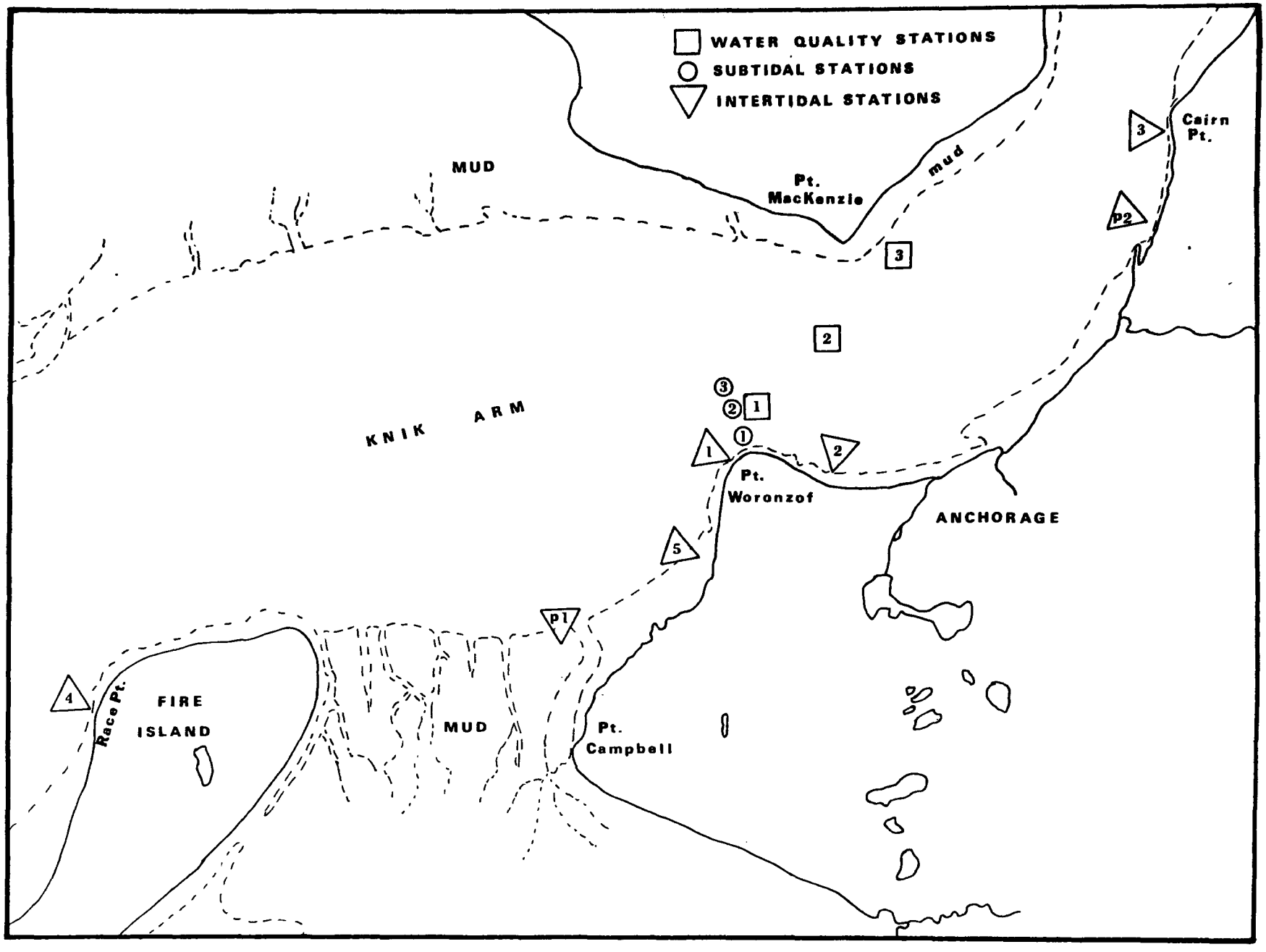

Figure B-9. Water Quality, Intertidal and Subtidal Sampling Stations in Knik Arm. Kinnetic Laboratories Inc. (1979).

adjacent to the north end of the Anchorage docks and on the tidal flats between Fire Island and Point Woronzof (P1 and P2 in Figure 9).

Three subtidal benthic stations (Figure 9) were occupied in the vicinity of the Point Woronzof outfall by divers to ensure that benthic fauna were not missed because of sampling device errors. One of the stations was located within the present outfall's Zone of Initial Dilution (247 m off the chlorination tower), another outside the zone along the outfall alignment (595 m off the tower), and a third in the general area proposed for the extension (700 m off the tower).

Appendix B1 contains detailed physical descriptions of the intertidal and subtidal transects and stations. Appendix B2 lists the density and standing stock biomass of the intertidal transects and stations occupied.

The results of the Kinnetic Laboratories, Inc. biological survey of the Point Woronzof vicinity can be summarized as follows. Both qualitative and quantitative results indicate a benthic marine fauna and flora of very low standing stock and diversity. No benthic organisms were found in the subtidal collections. Only three taxa of marine macrophyte algae were found in the intertidal collections, and only 4 or 5 species of macrofaunal invertebrates which can be considered truly marine (Macoma balthica, Eteona longa, Orchestia ochotensis, Anisogammarus confervicolus, and a crangonid shrimp). Of these taxa the crangonid consisted of only one fragmentary collection and may not represent a resident intertidal population. The amphipod O. ochotensis was found only in the supralittoral zone of Fire Island, while the other amphipod, A. confervicolus, is an epibenthic species which seems to come and go over the mudflats with the movement of the tides. This leaves only the bivalve M. balthica and the polychaete E. longa as invertebrate species which can be considered as resident marine intertidal populations in the study area.

The populations of these two resident species are generally so low and so patchy in distribution as to present difficulties for any long-term monitoring design which would have statistical validity. This is especially true in that nothing is known about seasonal and annual fluctuations of these populations in the area.

The observed low diversity and standing stock is much lower than would be expected in the North Pacific region. This is thought to be the result of physical environmental stresses. The main elements contributing to this stress are the heavy suspended loads of glacial silt, low and fluctuating salinity values, intertidal temperature fluctuation, and mechanical disturbance of the substrate by strong tidal currents and winter ice. On the rocky exposed beaches and in the subtidal samples, this mechanical disturbance was judged to be quite severe from the rounded and abraided appearance of the cobbles.

Over the midtidal to upper intertidal range of the mudflat beaches an algal mat (Vaucheria) appears to lend stability to the substrate, permitting limited colonization by benthic macrofaunal species, principally Macoma balthica and Eteona longa. Populations of oligochaete worms and nematodes are also found on all of the mudflat beaches. These taxa are encountered primarily in the upper intertidal where freshwater drainage and seepage may promote their existence. Both M. balthica and E. longa are considered pioneer species and are known to tolerate broad salinity/temperature fluctuations. They are probably the only marine benthic species which are able to colonize these beaches with any degree of success.

In comparing the mudflat beaches of the Point Woronzof area, there are some indications that Transect 2, located southeast of the sewer outfall, may support a faunal diversity and standing stock which is richer than that of Transect 5, on the opposite side, or of Transect 3 located above the

Anchorage docks. Even though the standing stock of Transect 2 is quite low (~3.9 g/m^2), it appears to be an order of magnitude greater than that observed at all other stations (0.1 g/m^2). Most of the biomass obtained from the beaches is generated by Macoma balthica. From growth ring analysis of this species, it appears that the Bootlegger Cove beach (Transect 2) supports a higher proportion of mature clams than do the other beaches (Table 7).

In addition to increased standing stock, the Transect 2 beach also supports at least one species not encountered at the other transects, the large protozoan of the family Gromidae. This occurrence in conjunction with the greater biomass and apparent maturity of M. balthica, could indicate organic enrichment of this locale. The genus Macoma, classed as a selective detritus feeder, is known to feed on bacteria in the surface sediments and near bottom waters. This enrichment could be brought about by the transport of wastes from the outfall to the shore by the gyre which develops to the east of Point Woronzof on the flood tide. Caution must be exercised in this comparison of faunal characteristics since, with the exception of the Gromidae, there is no apparent difference in species composition over the three mudflat beaches sampled. Also, while the beaches were selected according to similar physical characteristics, they were by no means identical. The observed faunal differences could easly be the result of physical factors rather than organic enrichment.

Growth/size analysis of M. balthica recovered from the quantitative samples indicates that its growth in this area is relatively slow. The oldest size class recorded (7+ years from Transect 2) had attained a length of only 16.7 mm (Table 7).

The Kinnetic Laboratories, Inc. survey did not include plankton species. However, a study performed by Tetra Tech (1977) listed the results of two plankton tows in the

Table 7. Age and Size Distributions of *Macoma balthica* Recovered From Quantitative Samples in the Anchorage Vicinity

Transect	Age	Shell Length (mm)	Sample Size (no. individuals)
2	0+	1.0-1.7	11
2	1+	4.1-6.8	4
5	1+	5.8	1
2	2+	6.5-8.7	5
2	3+	8.1-8.8	2
5	4+	11.8	1
2	5+	12.4	1
2	6+	14.1-15.4	5
2	7+	16.6-16.7	2

Point Woronzof area. The dominant components in the two plankton samples were land plant debris and silt. The diatom Coscinodiscus was the numerically dominant planktonic organism followed by the diatom Ditylum. The presence of these organisms in such highly turbid waters indicates that water turbulence plays an important role in bringing them to the surface where they may receive light. The plankton samples of Tetra Tech (1977) contained very few zooplankton, and those were mostly copepods.

Chemical Oceanography and Bacteriology of Knik Arm, Cook Inlet

Alkalinity and pH.

Little data are presently available concerning pH variations in Knik Arm. Murphy et al. (1972) reported the pH ranged from approximately 7.7 in May to slightly greater than 8.3 in August of the same year. He stated that the observed variation could be attributed to normal chemical equilibrium processes. Kinnetic Laboratories, Inc. (1979) measured the pH of waters at the outer current meter station (700 m off the chlorination tower) as between 7.9 and 8.0 in mid-August. No significant variation was found either in the water column or during the tidal cycle, Table 8. Alkalinities measured for the same samples ranged from 1.3-1.4 meq per liter and appeared to be homogenous throughout the water column at all stages of tide.

Dissolved Oxygen.

The dissolved oxygen content of the water column at the proposed outfall site was determined as between 8.20 and 8.55 ppm for slack high tide and between 8.28 and 8.49 ppm for slack low water (Table 8), Kinnetic Laboratories, Inc. (1979). During that study the waters off Point Woronzof could be characterized as having an average salinity of 6.8 ppt and an average temperature of 13.6°C. The oxygen saturation

Table 8. Outfall Station No. 3 Water Quality Data Obtained at the Proposed Outfall Site During August 1979†

High Slack Water:

Depth	Time*	DO(mg/l)	pH	ALK(meq/l)	Suspended Solids(mg/l)	Dissolved Phosphorous (mg P/l)	Dissolved Silica (mg/l)	NO_3^- (mg N/l)	NO_2^- (mg N/l)
Surface	1455	8.20	7.9	1.34	660	0.112	1.60	0.24	< 0.01
Middle	1445	8.20	7.9	1.34	1020	0.155	1.61	0.26	< 0.01
Bottom	1430	8.55	7.9	1.40	1040	0.096	1.61	0.19	< 0.01

Low Slack Water:

Depth	Time*	DO(mg/l)	pH	ALK(meq/l)	Suspended Solids(mg/l)	Dissolved Phosphorous (mg P/l)	Dissolved Silica (mg/l)	NO_3^- (mg N/l)	NO_2^- (mg N/l)
Surface	2030	8.75	8.0	1.30	1490	0.079	1.46	0.25	< 0.01
Middle	2015	8.62	7.9	1.30	1320	0.068	1.44	0.18	< 0.01
Bottom	2000	8.58	8.0	1.30	1330	0.093	1.45	0.35	< 0.01

*Note: Not instantaneous profiles.

†Data from Kinnetic Laboratories, Inc. (1979)

value for these conditions is 10.23 (Harvey 1960). Thus, near saturation conditions existed in Knik Arm in August 1979. The data of Kinney et al. (1970) also indicate near saturation to have existed in Knik Arm in May 1968. Murphy et al. (1972) reported the dissolved oxygen of Knik Arm to be 9.1 ppm in March 1970. The salinity and temperature values recorded at that time were 20 ppt and -1.1°C, respectively. Oxygen saturation for these conditions is 13.2 ppm. Waste BOD should not be a problem during the winter months.

Suspended Solids/Nutrients

The suspended solids content of Point Woronzof waters is quite high (Table 8). The suspended sediment is derived from glaciers at the headwaters of the Matanuska and Knik Rivers. The materials range in size from colloidal to rather large particles. The few samples collected in this study do not indicate any relationship between suspended load and tidal cycle, although one may exist. Kinney et al. (1970) found that high suspended solids values tended to occur in the well mixed region of strong tidal currents on the east side of Cook Inlet.

Soluble phosphorus concentrations were found to be between 0.155 and 0.068 mg P per liter. These values are in accord with the 0.20-0.01 mg P per liter range reported by Tetra Tech (1977) for the same time of year, but less than the 0.025 mg P per liter value Kinney et al. (1970) found typified upper Cook Inlet waters. However, during the Kinney cruise the salinity measured 17 ppt. This value is much higher than the 8 ppt recorded during the 1979 study, and indicates the presence of a substantial quantity of seawater off Point Woronzof during May 1968. Oceanic water has an average dissolved phosphorus concentration of 0.07 mg P per liter as compared to the 0.59-1.1 mg P per liter measured in the Matanuska River during the late summer (USGS 1977). Thus the discrepancy between the above values can be attributed to the greater freshwater input in the latter case.

Dissolved silica concentrations were found to vary between 1.44 and 1.61 mg per liter (Table 8). Silica concentration has been found to be directly related to sediment load in Cook Inlet (Kinney et al. 1970).

Nitrate values have been found to range from 0.35-0.19 mg N per liter. Nitrite concentrations, however, are usually less than 0.01 mg N per liter (Table 8).

Primary Pollutants

Appendix B3 contains the results of the Primary Pollutant Analysis performed by Kinnetic Laboratories, Inc. (1979) for Anchorage "wet and dry weather" effluents. Of the organic members of the list, only toluene (36 µg per liter) and tetrachloroethylene (22 µg per liter) were detected above 10 µg per liter. Dietyl phthalate was found at 10 µg per liter concentration level. For the metallic elements, all metals were below their detection limits with the exception of copper (65 µg per liter) and lead (29 µg per liter).

Analysis of the "dry weather" effluent showed similarities to the above with only methylene chloride (26 µg per liter), tetrachloroethylene (44 µg per liter) and trichloroethylene (14 µg per liter) being detected above 10 µg per liter. Metal concentrations reported for the "dry weather" effluent to be above their detection limits were chromium (46 µg per liter), copper (68 µg per liter), lead (14 µg per liter), nickel (15 µg per liter), and zinc (105 µg per liter).

Bioaccumulation of toxic materials was not investigated by Kinnetic Laboratories, Inc. (1979) because of the extreme difficulty in collecting for analysis enough specimens on the beach east of Point Woronzof. Sediment samples from beaches studied did not show significant concentration of toxicants (Table 9).

Table 9. Selected Heavy Metals and Chlorinated Hydrocarbon Analysis of Sediment Samples From Beaches East of Point Woronzof

Constituent †	Transect 2	Earthquake Park	Chester Creek
Antimony (Sb)	0.2*	2.0*	2.0*
Arsenic (As)	0.2	0.1	0.4
Beryllium (Be)	1.0*	1.0*	1.0*
Cadmium (Cd)	1.9	1.6	2.3
Chromium (Cr)	122	72	151
Copper (Cu)	24	21	54
Lead (Pb)	3.4	2.0	4.7
Mercury (Hg)	1.7	2.1	1.3
Nickel (Ni)	70	47	90
Selenium (Se)	2.0*	2.0*	2.0*
Silver (Ag)	0.35	0.26	0.45
Thallium (Tl)	1.0*	1.0*	1.0*
Zinc (Zn)	64	49	108
Chlorinated Hydrocarbons & Polychlorinated biphenols	0.001*	0.001*	0.001*

* Less than the number stated

† Data from Kinnetic Laboratories, Inc. (1979).

Coliform Bacteria

Coliform sampling was accomplished at the three sites at high tide (Transect 2, Earthquake Park, and Chester Creek) by Kinnetic Laboratories, Inc. (1979). Fecal coliforms averaged from 71-324 colonies per 100 ml in surface waters, and from 31-2,310 colonies per 100 ml in surface muds. Total coliforms were normally too numerous to count in these samples. The bacterial studies clearly indicate the transport of municipal effluent to shore between Chester Creek and Point Woronzof by the gyre present during the flood tide.

Conclusions

The discussions of the physical processes which occur in upper Cook Inlet should convince the reader that Knik Arm is one of the most dynamic water bodies in the world. The physical environment is so harsh, in fact, as to hinder the establishment of a benthic biological community.

The only observable evidence that municipal wastes are injected into Knik Arm via an outfall at Point Woronzof is the accumulation of coliform bacteria on the beaches to the east of the discharge. The bacteria are brought ashore on the flood tide by the previously described Point Woronzof gyre. As discussed in the section on tidal currents, the lengthening of the outfall by an additional 1,500 feet will ensure that wastes are injected outside of the gyre system and thus, not returned to shore.

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Appendix B1

Physical Description of Intertidal Transects and Stations

Transect 1: Point Woronzof

Date Sampled: 15 August, 1979 Time Begun: 0740
Time of Low Tide: 0612 Low Tide Height: +1.2 ft.

General site location and description: Exposed rocky beach approximately 60 meters west of chlorination tower on Pt. Woronzof, fairly steep gradient, no apparent flora or fauna.

Station	Height Above MLW (m)	Substrate Description
1	0.8	sand/cobbles
2	2.0	sand/cobbles
3	4.0	sand/gravel/cobbles
4	6.0	sand/cobbles
5	8.0	sand/cobbles

Transect 2: Bootlegger Cove

Date Sampled: 17 August, 1979 Time Begun: 1100
Time of Low Tide: 0949 Low Tide Height: +2.2 ft.

General site location and description: Low-profile mudflat covered, over much of the tidal range, by filamentous algal mat (*Vaucheria* sp.) approximately 1 mile southeast of Point Woronzof.

Station	Height Above MLW (m)	Substrate Description
1	1.1	exposed blue clay
2	2.0	lower edge of algal mat; thin silt over blue clay
3	4.0	inside algal mat; thick silt over blue clay
4	6.0	inside algal mat; thick silt over blue clay
5	8.0	above algal mat; loose, coarse-grained sand

Physical Description of Intertidal Transects and Stations (cont.)

Transect 3: Cairn Point

Date Sampled: 16 August, 1979 Time Begun: 1005
Time of Low Tide: 0949 Low Tide Height: +2.2 ft.

General site location and description: Exposed rocky beach approximately 75 meters south of navigation/survey quadripod on Cairn Point, fairly steep gradient, no apparent fauna or flora.

Station	Height Above MLW (m)	Substrate Description
1	2.0	coarse sand/angular gravel/rounded cobble
2	4.0	"
3	6.0	"
4	8.0	"

Transect 4: Fire Island

Date Sampled: 16 August, 1979 Time Begun: 1530
Time of Low tide: 2052 Low Tide Height: +7.9 ft.

General site location and description: Exposed rocky beach on Race Point, Fire Island; fairly steep gradient, no apparent fauna, very sparse macroalgae (*Fucus gardneri*, *Enteromorpha linza*).

Station	Height Above MLW (m)	Substrate Description
1	2.0	sand/cobble/boulder
2	4.0	sand/cobble/boulder
3	6.0	sand/cobble
4	8.0	sand/cobble

Physical Description of Intertidal Transects and Stations (cont.)

Transect 5: Woronzof-Campbell Cove

Date Sampled: 18 August, 1979 Time Begun: 1100
Time of Low Tide: 1102 Low Tide Height: +0.9 ft.

General site location and description: Low profile mud flat about 1 mile south of Point Woronzof; covered over mid-tide range by algal mat (Vaucheria) and over upper tidal range by grasses (primarily Puccinellia c.f P. phryganodes, with pockets of Carex c.f C. ramenskii and fringe of Triglochin maritima at HHW line). Ducks (unidentified), and geese (lesser Canada or white-fronted) seen on grass flats.

Station	Height Above MLW (m)	Substrate Description
1	0.3	pitted blue clay
2	2.0	pitted blue clay
3	4.0	lower edge of algal zone; thin silt over blue clay
4	6.0	upper algal zone; thick silt over blue clay
5	8.0	matted grass (Puccinellia) over thick silt
6	9.0	Triglochin fringe at HHW; 3 samples taken

Partial Transect: Municipal Flat

General site location and description: Low profile mud flat approximately 100 meters north of north end of municipal dock; coverd over much of tidal range by algal mat (Vaucheria). Two stations of 8 samples each were completed, 16 August, 1979.

Station	Height Above MLW (m)	Substrate Description
1	2-4	lower 1/3 of algal zone; thick silt over blue clay
2	4-6	upper 1/3 of algal zone; thick silt over blue clay

Physical Description of Intertidal Transects and Stations (cont.)

Sample Station: Turnagain Arm

General site location and description: Low profile sand flat between Fire Island and Point Campbell at mouth of Turnagain Arm, exposed only during low water. One station of 7 samples was completed, 18 August, 1979.

Station	Height Above MLW (m)	Substrate Description
1	2.0	coarse sand with some organic debris, apparently terrestrial

Appendix B2

Density and Standing Stock Biomass on Stations and Transects Sampled During August, 1979.

Transect 1

Station	Sieve Size	Taxa	Mean Density (indiv/m^2)	Mean Standing Stock (g/m^2 wet wt.)
1	1.0 mm	M. balthica	2	1.0

No other flauna or flora apparent in Transect 1 samples. Only 1 M. balthica individual was recovered.

Transect 2

1	1.0 mm	M. balthica	18	0.605
2	1.0 mm	Vaucheria sp.	-	2.693
		M. balthica	24	0.669
		E. longa	6	0.010
		Gammaridae	4	0.004
2	0.5 mm	M. balthica	26	0.008
		Gammaridae	2	0.002
3	1.0 mm	Vaucheria sp	-	31.316
		M. balthica	16	2.579
		E. longa	20	0.050
		A. confervicolus	4	0.024
		Oligochaetes	26	0.006
3	0.5 mm	E. longa	56	1.242
4	1.0 mm	Vaucheria sp	-	68.802
		M. balthica	30	8.076
		E. longa	16	0.151
		Gammaridae	16	0.038
		Oligochaetes	44	0.010
		Nematodes	2	0.001
		Crangonidae	2	fragment only

Also found 1 unidentifed algae fragment. Possible Porphyra sp.

4	0.5 mm	M. Balthica	108	0.036
		E. longa	10	0.121
		Oligochaetes	>200	0.036
		Nematodes	>300	0.006
		Gammaridae	4	0.002
		Platyhelminth	6	0.002
		Gromidae	~200	0.025
5	No fauna or flora in either sieve size			

Density and Standing Stock Biomass on Stations and Transects sampled During August, 1979. (cont.)

Transect 2 (cont.)

Station	Sieve Size	Taxa	Mean Density ($indiv/m^2$)	Mean Standing Stock (g/m^2 wet wt.)
Transect means (Station 5 excluded)				
	1.0 mm	M. balthica	22	2.982
		E. Longa	11	0.053
		Gammaridae	7	0.017
		Oligochaetes	18	0.004
	1.0 mm	Faunal $\bar{x}$	58	3.531
		Vaucheria sp	-	25.703
	0.5 mm	M. balthica	34	0.011
		E. longa	17	0.341
		Gammaridae	2	0.001
		Oligochaetes	50	0.009
		Nematodes	75	0.002
		Platyhelminth	2	0.001
		Gromidae	50	0.006
	0.5 mm	Faunal $\bar{x}$	230	0.371
	combined	Faunal $\bar{x}$	288	3.902

Transect 3

No fauna or flora apparent in quantitative samples from Transect 3.

Transect 4

No fauna or flora apparent in quantitative samples from Transect 4. Qualitative samples from the vicinity yielded the algae Fucus gardneri and Enteromorpha c.f. E. linza, and the littoral amphipod Orchestia c.f. O. ochotensis.

Transect 5

1	1.0 mm	M. balthica	6	0.084
2	0.5 mm	M. Balthica	6	0.006
3	1.0 mm	M. balthica	2	0.270

Density and Standing Stock Biomass on Stations and Transects Sampled During August, 1979. (cont.)

Transect 5 (cont.)

Station	Sieve Size	Taxa	Mean Density ($indiv/m^2$)	Mean Standing Stock (g/m^2 wet wt.)
4	1.0 mm	Vaucheria sp	-	130.500
		Oligochaetes	72	0.008
		Dolichopodidae	4	0.010
	0.5 mm	M. balthica	2	0.002
		Oligochaetes	173	0.018
		Nematodes	28	0.002
		Anurida maritima	2	0.002
5	1.0 mm	Puccinellia	-	550.000
		Oligochaetes	117	0.010
		Chironomidae	2	0.002
		Nematodes	2	0.002
5	0.5 mm	Oligochaetes	52	0.014
		Nematodes	>400	0.012
		Aphidae	135	0.046
		Pupae	6	0.004
		Unident. beetle	2	0.002
		Unident. spider	2	0.002
6	1.0 mm	Puccinellia	-	170.000
		Oligochaetes	10	0.002
		Nematodes	>250	0.002
		Chironomidae	4	0.002
		Dolichopodidae	4	0.002
		Aphidae	84	0.028
		Pupae	2	0.002
6	0.5 mm	Oligochaetes	52	0.024
		Chironomidae	2	0.002
		Dolichopodidae	8	0.012
		Aphidae	90	0.012
		Ephydidae	2	0.002
		Staphylinoidae	4	0.002
		Unident. spider	2	0.002
Transect means (Stations 5 and 6 excluded)				
	1.0 mm	M. balthica	2	0.082
		Oligochaetes	18	0.002
		Dolichopodidae	1	0.003
	1.0 mm	Faunal $\bar{x}$	23	0.087
		Vaucheria sp.	-	32.625
	0.5 mm	M. balthica	2	0.002
		Oligochaetes	43	0.005
		Nematodes	7	0.001
		A. maritima	1	0.001
	0.5 mm	Faunal $\bar{x}$	53	0.008
	Combined	Faunal $\bar{x}$	76	0.095

Density and Standing Stock Biomass on Stations and Transects Sampled During August, 1979. (cont.)

M-Flat

Station	Sieve Size	Taxa	Mean Density ($indiv/m^2$)	Mean Standing Stock (g/m^2 wet wt.)
1	1.0 mm	M. balthica	8	0.008
		Vaucheria sp.	-	10.874
1	0.5 mm	M. balthica	257	0.068
		Chermidae	2	0.002
2	1.0 mm	Vaucheria sp.	-	141.203
		M. balthica	94	0.076
		Oligochaetes	6	0.002
		A. confervicolus	2	0.002
2	0.5 mm	M. balthica	22	0.016
Transect Means				
	1.0 mm	M. balthica	51	0.042
		Oligochaetes	3	0.001
		A. confervicolus	1	0.001
	1.0 mm	Faunal $\bar{x}$	55	0.044
		Vaucheria sp.	-	76.039
	0.5 mm	M. balthica	140	0.042
		Chermidae	1	0.001
	0.5 mm	Faunal $\bar{x}$	141	0.043
	Combined	Faunal $\bar{x}$	196	0.087

T-Flat

1	1.0 mm	Oligochaetes	8	0.005
		Gammarus sp.	2	0.020

Also found 1 hydroid fragment, long dead.

Appendix B3

Chemical Analysis of Effluent

Effluent Concentrations (ug/l)

Parameter	Dry Weather	Wet Weather
ACID COMPOUNDS		
2,4,6-trichlorophenol	N/D	N/D
p-chloro-m-cresol	N/D	N/D
2-chlorophenol	N/D	N/D
2,4-dichlorophenol	N/D	N/D
2,4-dimethylphenol	N/D	N/D
2-nitrophenol	N/D	N/D
4-nitrophenol	N/D	N/D
2,4-dinitrophenol	N/D	N/D
4,6-dinitro-o-cresol	N/D	N/D
pentachlorophenol	N/D	N/D
phenol	*	*
BASE/NEUTRAL COMPOUNDS		
acenaphthene	N/D	N/D
benzidine	N/D	N/D
1,2,3-trichlorobenzene	N/D	N/D
hexachlorobenzene	N/D	N/D
hexachloroethane	N/D	N/D
bis(2-chloroethyl)ether	N/D	N/D

(continued)

BASE/NEUTRAL COMPOUNDS (Cont'd)

2-chloronaphthalene	N/D	N/D
1,2-dichlorobenzene	*	N/D
1,3-dichlorobenzene	N/D	*
1,4-dichlorobenzene	*	*
3,3'-dichlorobenzidine	N/D	N/D
2,4-dinitrotoluene	N/D	N/D
2,6-dinitrotoluene	N/D	N/D
1,2-diphenylhydrazine (as azobenzene)	N/D	N/D
fluoranthene	N/D	N/D
4-chlorophenyl phenyl ether	N/D	N/D
4-bromophenyl phenyl ether	N/D	N/D
bis(2-chloroisopropyl) ether	N/D	N/D
bis(2-chloroethoxy) methane	N/D	N/D
hexachlorobutadiene	N/D	N/D
hexachlorocyclopentadiene	N/D	N/D
isophorone	N/D	N/D
naphthalene	*	*
nitrobenzene	N/D	N/D
N-nitrosodimethylamine	N/D	N/D
N-nitrosodiphenylamine	N/D	N/D
N-nitrosodi-n-propylamine	N/D	N/D
bis(2-ethylhexyl) phthalate	*	*
butyl benzyl phthalate	*	N/D

BASE/NEUTRAL COMPOUNDS (Cont'd)		
di-n-butyl phthalate	*	*
di-n-octyl phthalate	N/D	N/D
diethyl phthalate	10	*
benzo(a)anthracene	N/D	N/D
benzo(a)pyrene	N/D	N/D
3,4-benzofluoranthene	N/D	N/D
benzo(k)fluoranthene	N/D	N/D
chrysene	N/D	N/D
acenaphthylene	N/D	N/D
anthracene	N/D	N/D
benzo(ghi)perylene	N/D	N/D
fluorene	N/D	N/D
phenanthrene	N/D	N/D
dibenzo(a,h)anthracene	N/D	N/D
idenol(1,2,3-cd)pyrene	N/D	N/D
pyrene	N/D	N/D
2,3,7,8-tetrachlorodibenzo-p-dioxin	N/D	N/D
VOLATILES		
acrolein	N/D	N/D
acrylonitrile	N/D	N/D
benzene	*	*
carbon tetrachloride	N/D	N/D
chlorobenzene	N/D	N/D
1,2-dichloroethane	N/D	*

VOLATILES (Cont'd)

1,1,1-trichloroethane	*	*
1,1-dichloroethane	N/D	N/D
1,1,2-trichloroethane	N/D	N/D
1,1,2,2-tetrachloroethane	N/D	N/D
chloroethane	N/D	N/D
bis(chloromethyl) ether	N/D	N/D
2-chloroethylvinyl ether	N/D	N/D
chloroform	*	*
1,1-dichloroethylene	N/D	N/D
1,2-trans-dichloroethylene	*	*
1,2-dichloropropane	N/D	N/D
1,3-dichloropropylene	N/D	N/D
ethylbenzene	N/D	*
methylene chloride	26	*
methyl chloride	N/D	N/D
methyl bromide	N/D	N/D
bromoform	N/D	N/D
dichlorobromomethane	N/D	N/D
trichlorofluoromethane	N/D	*
dichlorodifluoromethane	N/D	N/D
chlorodibromomethane	N/D	N/D
tetrachloroethylene	44	36
toluene	*	22
trichloroethylene	14	*
vinyl chloride	N/D	N/D

(continued)

PESTICIDES		
aldrin	N/D	N/D
dieldrin	N/D	N/D
chlordane	N/D	N/D
4,4'-DDT	N/D	N/D
4,4'-DDE	N/D	N/D
4,4'-DDD	N/D	N/D
(Alpha) endosulfan	N/D	N/D
(Beta) endosulfan	N/D	N/D
endosulfan sulfate	N/D	N/D
endrin	N/D	N/D
endrin aldehyde	N/D	N/D
heptachlor	N/D	N/D
heptachlor epoxide	N/D	N/D
(Alpha) BHC	N/D	N/D
(Beta) BHC	N/D	N/D
(Gamma) BHC	N/D	N/D
(Delta) BHC	N/D	N/D
PCB-1242	N/D	N/D
PCB-1254	N/D	N/D
PCB-1221	N/D	N/D
PCB-1232	N/D	N/D
PCB-1248	N/D	N/D
PCB-1260	N/D	N/D

PESTICIDES (Cont'd)

PCB-1016	N/D	N/D
toxaphene	N/D	N/D
Mivex	N/D	N/D
Guthion	N/D	N/D
Methoxychlor	N/D	N/D
Parathion	N/D	N/D
Demeton	N/D	N/D
Malathion	N/D	N/D

METALS

	Sample 1	Sample 2	Sample 1	Sample 2
Antimony	<100	<100	<100	<100
Arsenic	<5	<5	<10	<10
Beryllium	<5	<5	<5	<5
Cadmium	<2	<2	<2	<2
Chromium	54	39	<5	<5
Copper	70	65	70	60
Lead	16	12	30	28
Mercury	<0.1	<0.1	0.1	<0.1
Nickel	16	15	10	10
Selenium	<10	<10	<10	<10
Silver	<5	<5	<3	<3
Thallium	<50	<50	<50	<50
Zinc	123	88	<3	<3

(continued)

OTHER		
pH, Units	7.1	-
BOD	114	-
Suspended Solids	66	-
Volatile Suspended Solids	51	-
Total Dissolved Solids	401	-
Ammonia Nitrogen	11.1	-
Total Kjadehl Nitrogen	4.4	-
Total Nitrogen	15.5	-
Nitrate Nitrogen	0.1	-
Nitrite Nitrogen	0.01	-
Total Phosphate (as P)	5.3	-
Cyanide		-
Asbestos, million fibers per liter	12.0[a]	38.5[a]

[a] chrysotile; amphibole was below detection limit

* = Less than 10 ug/l

(Pesticides less than 5 ug/l)

N/D = Not Detected

0.5 ug/l