WATER SYSTEM
SCHEMATIC DESIGN

PROPOSED VISITOR FACILITIES AND HEADQUARTERS

WRANGELL-ST. ELIAS NATIONAL PARK AND PRESERVE

ALASKA

Denver Service Center
National Park Service

Design Objective and Goal

It is the objective of this document to provide a schematic design for providing high quality treated water utilizing the existing production water well at the proposed Wrangell-St. Elias National Park and Preserve Visitor Center site. This high quality treated water will be provided for the needs of the public and the NPS staff at the new visitor center site. High quality treated water will be provided by the process control of a capable plant through an effective program integrating administration, maintenance, and design. See Appendix A for Project Location.

Recommended Actions and Conclusions

Recommended Treatment Option

The recommended treatment option is to provide high quality water through a process which splits the water into two components.

The first component is potable water produced by a central Reverse Osmosis (RO) process. This water will provide drinking, wash and shower water. An inhibitor will be added to enhance the RO process. The potable water will be disinfected. The size of the RO unit will be 600 gallons per day (gpd).

The second component will be toilet flush water. This water will be provided by utilizing the rejected water from the RO process for flushing. The rejected RO water will still have the inhibitor which will leave the iron, manganese, and hardness in a stabilized suspension. The toilet flush water will not be disinfected. The antiscalant feed will be capable of treating up to 4000 gpd.

Water storage will play an integral part of the scenario by providing a storage buffer for fire flows and extreme peak demands. See Appendix B for the recommended treatment design scheme.

Water System Standards

High quality water standards shall meet or exceed the following standards:

- Drinking Water, 18 AAC 80, State of Alaska, Department of Environmental Conservation.
- Public Health Guideline NPS - 83, National Park Service.
- Public Law 104-182, Title XIV of the Public Health Service Act (commonly known as the “Safe Drinking Water Act"), 42 USC. As amended 1996.
- Recommended Standards for Water Works, The Great Lakes-Upper Mississippi River Board of Public Health and Environmental Managers, 1992.

Water System Classification

According to the Alaska Department of Environmental Conservation (ADEC) Title 18 Environmental Conservation, Chapter 80. Drinking Water. 18 AAC 80, the water system classification for the project shall be considered to be a “Class B public water system”. If staff on site increases to 25 or more, then the water system classification for the project shall be considered to be a “Class A public water system”.

The National Park Service water system classifications are similar to the State of Alaska's. According to NPS Public Health Management Guideline (NPS -83), the system shall be considered to be a Public Non-Transient Non-Community Water System (PNT). If staff on site increases to 25 or more, then the water system classification shall be considered to be a Public Non-Community Transient Water System (PNC).

Pilot Plant

It is this study's recommendation to formulate and implement a pilot plant study at the site in the summer of 1998 to determine the final design of the water treatment system. The study will focus on optimizing inhibitor selection. Cost for this study will be approximately $15,000 (including water testing).

Water Testing

Water testing should be accomplished concurrently with the pilot plant study to be implemented in the summer of 1998. The existing production water well has only been tested for private water systems standards (only half of the primary inorganic MCL's have been tested). Test existing production water well for all primary and secondary inorganic, organic, chemical and radioactive contaminates, as per state, agency and federal requirements. Additional testing will be required to provide design parameters for the water treatment system. See Appendix C for water testing contaminates and parameters.

Program Refinement

Continue to refine a cost effective program integrating administration, maintenance, and design into design development. It is anticipated that final costs for the water system will be within current estimates of $324,850. Through a constant refinement process this document will eventually become the Administration and Maintenance Manual for the water system.

Site Conditions

The site is located on the Richardson Highway (Alaska 4) eight miles south of Glennallen. It is located in the Copper River Basin area of eastern south-central Alaska. See Appendix D for the USFS ecoregion description of the area.

The proposed visitor center and headquarters would be located on a site in the Copper River Basin between Glennallen and Copper Center. The mostly gently sloping 230-acre site lies on a broad shelving bluff above the Copper River, sandwiched between the river and the Richardson Highway. The site is also split northwest to southeast by the steep bluff, and at the site's northern end the imposingly steep and unstable bluff is cut nearly vertically 200' down to the river. A dense spruce forest covers the northern and eastern portion of the site, while the central portion along the bluff contains a mixed spruce/aspen forest with lush ground. Here, the bluff drops to an aspen forested bench and the river is largely out of view. The site is underlain by gravel and discontinuous permafrost. It is likely that the areas covered with black spruce are underlain with permafrost. The southern portion of the site includes a played-out and abandoned gravel quarry. A segment of the historic Valdez Trail, that roughly parallels the Richardson Highway, transverses the site.

An overhead power line follows the Richardson Highway on the visitor center side of the road. It will supply the new development with electricity and telephone. Fuel oil is the only economical local source of heat. A fuel oil storage facility will be needed on the site, and the tank would presumably need to be above ground. Sewage disposal will be handled on-site, presumably in wastewater disposal fields.

Design Conditions

Introduction

The site will be composed of a visitor center and headquarters on the NPS site on the Richardson Highway approximately 8 miles southeast of Glennallen. The facility would serve as the primary visitor contact point for the entire park and preserve; currently 50,000 visitors annually, with 10-20% increases per year. The headquarters would provide offices and work space for approximately 24 permanent and seasonal employees.

The proposed visitor center would be approximately 8,000 square feet in a multi-building "village" layout, providing orientation to the park and preserve, parking, trails, picnic area, ethnobotany garden, interpretive and commercial space.

The park and preserve headquarters facility would also have several buildings (staff offices, seasonal offices, and garage) totaling approximately 11,000 square feet. The headquarters would occupy a convenient and complementary position on the site immediately east of the visitor center. Appendix E for the project layout.

Water Demand

Water is demand is a primary design constraint related to the water system. Demand varies radically between the peak summer months and the winter season. Basically, the winter season has close to no visitation at all due to the cold dark winter. Summer peak demand is approximately 4,700 gallons per day while the low winter demand is approximately 40 gallons per day. See Appendix F for proposed water usage figures.

Water Conservation

Water Quality Characteristics

Physical. Temperature affects the absolute viscosity of the water inversely, i.e., as water temperature decreases there is an increase in viscosity. Viscosity in turn affects the settling velocity of particles as well as energy requirements for mixing. The temperature of the water has not been confirmed. The only temperature taken of the water has been 46°F and it is suspect due to drilling mud contamination.

Chemical. Low temperatures reduce the rate of chemical reactions as well as solubility. This affects both the fate of chemicals in natural waters as well as treatment performance. Excessive iron, manganese, sodium, total dissolved solids, and hardness are the principle areas of concern..

> **Iron (5.2ppm well, 0.3 ppm SMCL).** A very common element often present in groundwater in amounts ranging from 0.01 to 10.0 ppm (mg/L). Iron may be found in three forms: 1. In soluble form such as in ferrous bicarbonate; 2. Bound with a soluble organic compound; and 3. As suspended ferric iron particles. Iron above 0.3 mg/L is objectionable in water because of staining of laundry and plumbing fixtures caused by the oxidation and precipitation of ferric hydroxide and/or ferric oxide (ferric iron) into small solid iron particles. Iron can also give a metallic or distorted flavor to beverages.
>
> **Manganese (0.08 ppm well, 0.05 SMCL).** Naturally occurring metamorphic and sedimentary rocks, industrial contaminant. Taste is affected. Staining, scaling, and discoloration of water.
>
> **Sodium (438 ppm well, 250 ppm SMCL).** A metallic element found abundantly in compounds in nature, but never existing alone. Sodium compounds are highly soluble and do not form curds when used with soaps or detergents. Many sodium compounds are used in the water treatment industry. Most notable is the use of sodium chloride as a regenerant in the cation exchange water softening process.
>
> **Total Dissolved Solids (1790 ppm well, 500 ppm SMCL).** The total weight of the solids that are dissolved in the water, give in ppm per unit volume of water. TDS is determined by filtering a given volume of water (usually through a 0.45 micron filter), evaporating it at a defined temperature (usually 103-105 degrees Celsius), and then weighing the residue. Note: A test measuring the electrical

conductivity of the water provides only an estimate of the TDS present, as conductivity is not precisely proportional to the weight of an ion and nonconductive substances cannot be measured by electrical tests.

Hardness (601 ppm well, >180 = Very Hard). The existing water is very hard. A common quality of water which contains dissolved compounds of calcium and magnesium and, sometimes, other divalent and trivalent metallic elements. The term hardness was originally applied to waters that were hard to wash in, referring to the soap wasting properties of hard water. Hardness prevents soap from lathering by causing the development of an insoluble curdy precipitate in the water; hardness typically causes the buildup of hardness scale (such as seen in cooking pans). Dissolved calcium and magnesium salts are primarily responsible for most scaling in pipes and water heaters and cause numerous problems in laundry, kitchen, and bath. Hardness is usually expressed in grains per gallon (or ppm) as calcium carbonate equivalent.

The degree of hardness standard as established by the American Society of Agricultural Engineers (S-339) and the Water Quality Association (WQA) is:

Term grains/gallon mg/Liter(ppm) Soft = less than 1.0 less than 17.1 Slightly Hard = 1.0 to 3.5 17.1 to 60 Moderately Hard = 3.5 to 7.0 60 to 120 Hard = 7.0 to 10.5 120 to 180 Very Hard = 10.5 and above 180 and above

The table below shows the amount of hardness removal potentially required.

Hardness Removal	Grains	Pounds
Yearly Hardness Removal	17,870,871.18	2,552.98
Peak Summer Daily Hardness Removal	240,251.31	34.32
Average Daily Hardness Removal	48,961.29	6.99
Peak Winter Daily Hardness Removal	20,792.51	2.97

Biological. Since the water are dealing with is ground water the probability of biological activity is very low. However when the water is brought up to the surface and placed into contact with the air there is a potential for iron bacteria to be incubated, resulting in biofouling of the water system.

Process Design Constraints

Corrosion Potential

General

Corrosion potential is a very serious water issue. High costs due to the replacement and repair of prematurely deteriorated pipes, elevated concentrations of metal compounds in drinking water increased pumping costs, microbial agents associated with corrosion can also pose health and aesthetic concerns are some of the issues to be solved about corrosion. The existing groundwater has a high potential for corrosion within the water system.

Dissolved corrosive gases . There is a possibility that dissolved CO2 exist in the well water. Heating will release gases resulting in corrosion.

Solubility. Maintain pH of water within normal margins.

Biological agents . Sulfur- and iron-oxidizing bacteria, in particular, are responsible for water system corrosion. Biological corrosion can be avoided by avoiding the production of a metabolic byproduct corrosive to metals (i.e., H2S); and reducing the potential creation of biofilms that favor corrosion.

Electrochemical cells. Avoid dissimmular electrical potentials within the water system between piping and equipment.

Erosion. Keep flow velocities below 3.6 fps.

Scaling

Due to the hardness of the water scaling is certain unless sequestering or ion exchange is performed.

Staining

Iron is responsible for red water staining. Manganese is responsible for black water staining. Levels of iron and Manganese are high enough for staining. Sequestration or green sand filter will be needed to reduce the potential for staining.

Treatment Processes

Mixing

Mixing is an important function in water treatment. Mixing is strongly dependent on temperature because of changes in the viscosity of the liquid. To maintain the same velocity gradient in the tank as the liquid temperature decreases, the 20C power equipment has to be adjusted by a multiplier. Mixing requirements are usually selected according to the product of the root mean square velocity gradient and mixing time (Gt). It is influenced by the time required for desired reactions to occur and is often arbitrarily based on the successful performance of similar units. One alternative to extended flocculation time is the use of higher chemical doses. Another is to adjust pH to the optimum for the temperature of the water being treated. Optimum pH varies inversely with water temperature. It is advisable to evaluate each alternative, since one may be more economical than another.

Iron and Manganese Removal

Removal of iron and manganese can be provided through oxidation using either pyrolox filtration media or manganese greensand. Sizing the units will be based on demand and oxidation loading. Channelization may occur due to improper sizing of the filters.

Pyrolox Filtration Media. A granular filtration media to remove iron, hydrogen sulfide, manganese. It can also be used to remove taste and odor, as well as chlorine reduction and turbidity reduction. Pyrolox acts as a catalyst in oxidation reactions, but remains relatively unchanged as the oxidation takes place. The addition of oxidizers ahead of the media will greatly enhance its performance, but is not a requirement. If the pH is below 7.5 a micronizer or chlorine feed is recommended.

Manganese Greensand. Formulated from a glauconite greensand which is capable of removing iron, manganese, and hydrogen sulfide through oxidation. Soluble iron and manganese are oxidized and precipitated by contact with the higher oxides of manganese on the greensand granules. When the oxidizing capacity power is exhausted, the green sand has to be regenerated with potassium permanganate. Two to four ounces of potassium permanganate solution per cubic foot greensand is considered sufficient for a normal regeneration. One gallon of solution is required for each cubic foot of greensand filter media. Maximum iron limit is 5.0 ppm.

Performance Characteristics of Oxidizing Filters

	Pyrolox	Greensand
Bed Depth (inches)	20	30

Service Flow Rate (gpm/ft3)	6	5
Backwash Time (min.	20	10
Backwash (gpm/ft2)	20	30

Water Softening

Water softening can be required to reduce the hardness of the well water prior to flush water distribution. An acid-based cation exchanger is recommended. Low water temperatures influence the rate of flow through the exchange media because of higher viscosities. The ion exchange rate itself is rapid enough to not limit softening at low temperatures. Sodium concentrations will increase after the ion exchange process. Sodium at 438 ppm is already above the SMCL of 250 ppm. The pilot plant study this summer will determine the exact efficiency of the water softening process.

Acid-based Cation Exchange. Strongly acidic cation resins derive their functionality from the sulfonic acid groups. These strong acid exchangers operate at any pH, split all salts, and require substantial amounts of regenerant. This is the resin of choice for almost all softening applications and as the first unit in a two bed demineralizer or as the cation component of a mixed bed. These cation exchangers are useful on all waters, provide complete cation removal, allow variable capacity, good physical stabilities, good oxidation stabilities, and low initial cost.

Sequestration (Inhibitors)

A chemical reaction in which certain ions are bound into a stable water-soluble compound so that they (ions) are prevented from certain normal but undesirable actions. For example, the sequestration of iron to prevent it from oxidizing, precipitating, and staining. An antiscalant is used in the RO process to keep the membranes from fouling.

Orthophosphates, polyphosphates, and polymers are common sequestering agents. These agents are a unique group of products designed to control color, corrosion and scale formation in waters of all kinds. For a small investment they return large dividends in the form of lower capital and operating costs, higher quality, improved plant performance, increased safety, and reduced health risks.

Orthophosphates. The orthophosphates can act as anodic corrosion inhibitors in the presence of oxygen. For example, dissolved oxygen attacking a metal such as iron, forms alpha Fe_2O_3 . The ferrite film gradually spreads, corrosive attack occurring at the breaks in the oxide film. These gaps are then plugged by the formation of insoluble iron phosphates resulting from the reaction of sodium orthophosphate with the anodic corrosion product. This type of corrosion control is called passivation. Passivation results initially from chemical precipitation which provides a barrier between the metal and the corroding liquid. In the case of orthophosphates a thin film which is very insoluble and resistant to dissolution is put down. It is a form of conversion coating. Such coatings result when films capable of preventing the migration of ions from the solid state to the solution state are formed. These thin films retard the flow of electrons through the galvanic cell which is driving the reaction, reducing its effects and controlling corrosion

Polyphosphates. Divalent cations such as calcium (Ca^{+2}) at levels of at least 10ppm are needed along with the polyphosphates for them to be effective. Positively charged colloidal complexes are formed which migrate to the cathode forming an amorphous polymeric film. This film is self limiting. Analysis of the film shows ferric pyrophosphate and iron/calcium metaphosphate to be the primary constituents. The pH is best maintained at the level of 6.5 to 7.0 since as the pH drops, the rate of reversion of the polyphosphate to the orthophosphate increases. In these applications, the polyphosphate is acting both as a reservoir of potential orthophosphate and as a cathodic corrosion inhibitor. More soluble and less likely to be precipitated in its polymeric form, polyphosphates can be retained longer in the system than orthophosphates. Much of the polyphosphate will eventually revert to the orthophosphate condition, at which time it may react with elements such as calcium, lead and iron, to be precipitated and to form protective conversion coatings. Sequestering offers two major benefits when it is used in water treatment. First, it reduces scale formation by preventing the precipitation of calcium salts and second, it prevents discoloration of the water by inhibiting the precipitation of iron and manganese hydroxides. Polyphosphates reduce scale formation by interfering with the formation of calcium carbonate crystals, thereby reducing the rate of film formation. There is a “threshold effect” in using polyphosphates in this way. Once the threshold is reached polyphosphates can prevent scaling at calcium carbonate concentrations far above the saturation concentration. In addition to preventing scale formation polyphosphates can be used to remove scale. Polyphosphates form colloidal dispersions with metals such as iron, manganese and calcium. Stable negatively charged particles are formed in which the metal is coated with polyphosphate ions. This prevents the particles from coalescing and maintains them in solution. The actual mechanism is not precisely defined at present and it probably varies with each cation. The result is the prevention of scale and of red and black water. It should be noted that if the polyphosphate reverts to the orthophosphate condition, aggregation and precipitation may occur.

Ortho/Polyphosphate Blends. The properties of the orthophosphates and the polyphosphates are enhanced when blends of the two are used. Because orthophosphates are very reactive in solution and form insoluble salts with calcium, iron and lead, it may be difficult in some circumstances to keep a sufficient concentration of orthophosphate in the treated water to maintain its effectiveness. To compensate for this, the dose of orthophosphate must be increased, which can lead to additional expense and to areas of excessive deposition in the system, while other areas are still under treated. Polyphosphates on the other hand are unlikely to be precipitated unless they undergo reversion. Since orthophosphates are anodic corrosion inhibitors and polyphosphates are cathodic inhibitors, and since polyphosphates in solution slowly revert to the orthophosphate condition, by formulating blends of these two phosphate forms we can achieve both anodic and cathodic corrosion inhibition, ensure the orthophosphate ion availability over a longer period of time and control calcium, iron and lead deposition, all at the same time. In this way, blended phosphate products can offer better protection than either ortho or polyphosphate can alone. As an added benefit, blends are effective in reducing copper corrosion, which neither type does very well by itself..

Membrane Processes

Reverse osmosis is a water treatment process that removes undesirable materials from water by using pressure to force the water molecules through a semipermeable membrane. This process is called "reverse" osmosis because the pressure forces the water to flow in the reverse direction (from the concentrated solution to the dilute solution) to the flow direction (from the dilute to the concentrated) in the process of natural osmosis. RO removes ionized salts, colloids, and organic molecules down to a molecular weight of 100.

The recommended treatment for potable water on the site will be reverse osmosis. After the iron and hardness removal processes the water will be very salty and unpalatable. The RO process will remove the majority of the remaining contaminant and provide quality drinking water for the public and staff.

Heat (improved membrane efficiency) and an antiscalant (reduced membrane fouling) addition prior to and gasification (increased pH) after the treatment will be required. The pilot plant study this summer will determine the exact efficiency of the RO process.

Waste Water Disposal

Waste water disposal is a critical element of the treatment process.

If pretreatment with a green sand filter and an ion exchanger is used, approximately 2,200 pounds of hardness will be removed a year. In order to remove this amount of hardness a good proportion of the produced water will have to be used to backwash and regenerate the oxidation and ion exchange filters. RO will produce a sizable amount of waste water through its process also. If sequestration is used no waste will be generated except for infrequent backwashing.

Process Waste Water Percentages	Yearly Waste (%)
Iron and Manganese Removal plus Water Softening	45
RO Process	85
Sequestration	<5

Disinfection

Disinfection is required in the treatment of water to inactivate, destroy, and/or remove pathogenic (disease-producing) bacteria, viruses, cysts, and other microorganisms (but not completely eliminating all microorganisms) for the purpose of making the water microbiologically safe for human consumption. On this project disinfection will involve the use of the disinfecting chemical, chlorine.

The treatment will use either calcium hypochlorite or sodium hypochlorite dispensed into the water system. Chlorine contact time and minimum residuals dictate the dispense location to be placed before a small separate storage tank sized to contact time and residual.

Plant Design Guidelines

Topic	Guidelines
Building	• Prepare for possible expansion. • Provide equipment lifting support in roof. • Provide heated space. • Placement of underground storage tanks • Install heavy duty vapor barrier • Optimize energy efficiencies.
Confined Spaces	• Keep confined spaces to a minimum. • Place all items that need to be serviced above grade.
Seasonal Usage	• Split system to account for wide variation of water demands. • Allow for seasonal shutdown and drain back.
Blending	• Promote blending which will reduce the amount of wastewater generated by the treatment processes, thereby reducing the cost of water production.
Ventilation	• Provide adequate ventilation for high humidity and low temperatures.
Lighting	• Provide extra exterior and interior lighting for winter use. • Place lights at strategic locations on small circuits.
Controls	• Provide Programmable Logic Control (PLC) devices with integral alarm and condition outputs. • Install automatic systems which operate via demand on the system. • Provide adequate climate control for sensitive equipment controls.
Alarms	• Install alarms integral to the controls. • Setup both proactive and reactive alarm devices.
Standby Equipment	• Provide for redundancy with duplex systems • Allow increased reliability • Provide for maintenance without shutdown
Drainage	• Provide for gravity drainage in water system where ever possible
Auxiliary power	• Provide emergency electric generator to support minimum operation.
Replacement Parts	• Provide a storage container and inventory list for replacement parts • Resupply uncertain due to remote location
Space/Process Trade-offs.	• Look into space efficient but energy-intensive equipment to reduce space needs
Operation	• On-line monitoring of processes

Plant Administration and Maintenance Guidelines

Topic	Guidelines
Personnel	• Promote personnel training and development
Operations	• Establish communication procedures, emergency planning, and safety program • Compare operations with similar agencies and trade industry standards • Establish performance measures of both personnel and equipment.
Equipment	• Recycle and reuse of materials • Promote energy efficiency and conservation techniques • Establish preventative maintenance program

Alternatives

No Action Alternative

The no action alternative is not feasible due to the excessive amount of iron, manganese, and hardness of the water. The heating systems and water lines would have to be replaced within five years. Anything coming into contact with the water would be stained permanently by the water. Since the water testing is incomplete it is not known if the are primary contaminants above the State and Federal health limits. If any primary MCL's are above State and Federal standards treatment would be necessary. Also, disinfection of the water is a NPS requirement. Some treatment action must be provided to the water within the water system.

Proposed Alternative

The recommended treatment option is to provide high quality water through a process which splits the water into two components.

The first component is potable water produced by a central Reverse Osmosis (RO) process. This water will provide drinking, wash and shower water. An inhibitor will be added to enhance the RO process. The potable water will be disinfected. The size of the RO unit will be 600 gallons per day (gpd).

The second component will be toilet flush water. This water will be provided by utilizing the rejected water from the RO process for flushing. The rejected RO water will still have the inhibitor which will leave the iron, manganese, and hardness in a stabilized suspension. The toilet flush water will not be disinfected. The antiscalant feed will be capable of treating up to 4000 gpd.

Water storage will play an integral part of the scenario by providing a storage buffer for fire flows and extreme peak demands. See Appendix B for the recommended treatment design scheme.

Alternatives Considered but Rejected

Trucking in Water

Trucking water is a common practice of providing water to residents of the Copper River valley. Trucking water in the winter months is very difficult due to the extremely low temperatures (-50° F). A special arctic water truck would have to be purchased and a dedicated driver would be required. Due to the volume of water needed a water truck would be difficult to provide the full amount of water necessary for the project. The existing water well can provide the amount of water needed for the project.

Package Water Treatment Plant

A package water treatment plant composed of two or more integral unit processes for the removal of one or more contaminants was considered. Package plants are factory assembled and generally skid mounted for simple installation. Water production using the package plant and existing well water are not very efficient because the package plant would need pretreatment For the well water quality Sludge disposal would be a problem.

Pretreatment Only

Pretreatment only was considered as an option. However, the water will be extremely salty (estimated sodium content of at least 900 ppm). This water will be acceptable for flushing but will not be palatable for human consumption. Health warning signs for salt intolerant individuals would have to be installed at all drinking water locations.

Reverse Osmosis Only

Reverse osmosis for the entire system was analyzed. The water quality will be extremely good after treatment. The drawback is the twice as much water would be wasted as would be produced. Most of the water to be produced will be for flushing so the need for high quality water all the needs of the park are not necessary.

Pretreatment with Green Sand Filter/Ion Exchange

Pretreatment with Green Sand Filter and Ion Exchange was originally considered to be a good option. However the amount of wastewater to be generated from backwashing both the green sand filter and the ion exchange (over 125,000 gallons per years or 1/3 of total water pumped from well) does not make sense when the majority of water (85%) is being used for flush water.

Cost Estimates

One-time Capital Construction Costs	No Action	Preferred
Well Pump	$5,000	$5,000
Cartridge Filter	$200	$200
Building (600 sf)	$80,000	$80,000
RO System	$0	$6,000
Potable Storage (10,000 gal)	$40,000	$40,000
Flush Storage (5,000 gal)	$25,000	$25,000
Disinfection	$2,000	$2,000
Pneumatic System	$2,000	$2,000
Cost of Water Treatment System	$154,200	$160,200
Cost of Water Distribution System	$150,000	$150,000
and Plumbing		
Annual Operation Costs		
Supervision	$500	$500
Training	$500	$1,000
Preventative Maintenance	$1,300	$650
Inspection	$4,563	$4,563
Emergency Maintenance	$4,563	$500
Filters/Chemicals	$500	$2,000
Tools	$750	$500
Testing	$3,000	$3,000
Annual Cost of Operations	$15,676	$12,713
Annualized Replacement Costs		
Equipment	$30,840	$6,046
Piping	$30,000	$4,950
Annual Cost of Replacement	$60,840	$10,996
Total Annual Maintenance Costs	$76,516	$23,709
Preferred Alternative Cost Above No Action	**$29,000**	
Extra Cost of No Action per Year	**$52,807**	
Preferred Alternative Payback	**0.54 Years**	

Compliance, Consultation, and Coordination with Laws, Policies and Regulations

Local

At this time there are no known laws, policies or regulations related to drinking water at the local level.

State of Alaska

The State of Alaska has the following laws, policies or regulations in place for water distribution systems:

Title 18 Chapter 80 - 18 AAC 80.005 - Alaska Drinking Water Standards.

> (a) A public water system must meet, and its owner or operator shall comply with the requirements of this chapter.
>
> (b) Subject to 18 AAC 80.920 and 18 AAC 80.930 , the owner or operator of a public water system may not cause or allow the use of water available for human consumption from that system if the water contains, or has a significant potential for containing
>
> (1) a contaminant in noncompliance with a primary maximum contaminant concentration level (MCL) set by 18 AAC 80.070 ; or
>
> (2) any other contaminant in sufficient amount, as determined by the department, to make the water a hazard to human health.
>
> (c) The department will classify each public water system based on information submitted by the owner or operator of the system or information compiled by the department or its authorized agent and based on the definitions of a Class A, B, and C public water system in 18 AAC 80.990.

Agency - National Park Service

The National Park Service has the following laws, policies or regulations in place for water distribution systems:

> Public Health Guideline, NPS - 83. 1993
>
> WATER SUPPLY SYSTEMS
>
> Superintendents who have NPS water supply systems within their jurisdictions must develop and maintain a water supply monitoring and management program for each system to assure compliance with the provisions of the Safe Drinking Water Act (40 CFR, Parts 141-144). Assistance can be provided by the Public Health Service (PHS) Consultants serving in each Region.
>
> In some cases, NPS requirements are more stringent than the minimum required by the Act and they apply to water systems such as non-public systems that are not covered by the Act. If there are any conflicts with the requirements of the Act, regulatory agencies or NPS-83 Chapter 1, Park Areas are expected to comply with the most stringent requirement.

A. GENERAL:

1. Superintendents must assure that water supply systems are properly operated and maintained, deficiencies promptly corrected and that the designated operators, including backup operators, are adequately trained. Operators of systems must meet the requirements specified by the Primacy Agency. Parks operating public water supply systems must have at least one certified operator responsible for the operation of the systems in that particular park.

2. Superintendents must assure that operators receive required training. A list of operators needing training must be submitted annually to the Regional Director with a copy to the PHS Consultant.

3. Superintendents must designate, in writing, personnel to assure proper record keeping and review of records including submittal of all required reports to the PHS Consultant, and Primacy Agency on a timely basis.

National Park Service Strategic Plan 1997

Visitors safely enjoy and are satisfied with the availability, accessibility, diversity, and quality of park facilities, services, and appropriate recreational opportunities.

NPS Management Policies - Facility Planning and Design:

Designs for park facilities, regardless of their origin (NPS, contractor, concessioner, or other), will be harmonious with and integrated into the park environment and will be subject to the same high standards of design and functionality and to the same review and approval processes, including inspection while construction is underway.

Water Quantity and Quality. The National Park Service will seek to perpetuate surface and ground waters as integral components of park aquatic and terrestrial ecosystems. Park waters, either surface waters or groundwaters, will be withdrawn for consumptive use only where such withdrawal is absolutely necessary for the use and management of the park and when studies show that it will not significantly alter natural processes and ecosystems. All water withdrawn from a park for domestic use will be returned to the park watershed system once it has been treated to a degree that assures there will be no impairment of park resources. Interbasin transfer will be avoided.

The National Park Service will seek to restore, maintain, or enhance the quality of all surface and ground waters within the parks consistent with the Clean Water Act (33 USC 1251 et seq.) and other applicable federal, state, and local laws and regulations.

Water Supply and Wastewater Treatment Systems. Water systems will be designed to conserve water. Before new water systems or extensions of existing systems are constructed, it will be determined that reasonable economies in the use of existing water systems will not cover expected needs. Where feasible, groundwater sources will be developed in lieu of or to replace surface water diversions in parks. Water systems are subject to state and federal health standards.

Federal

Environmental Protection Agency

The Environmental Protection Agency has the following laws, policies or regulations in place for water distribution systems:

Title XIV of the Public Health Service Act (commonly known as the “Safe Drinking Water Act"), 42 USC, Public Law 104-182. As amended 1996.

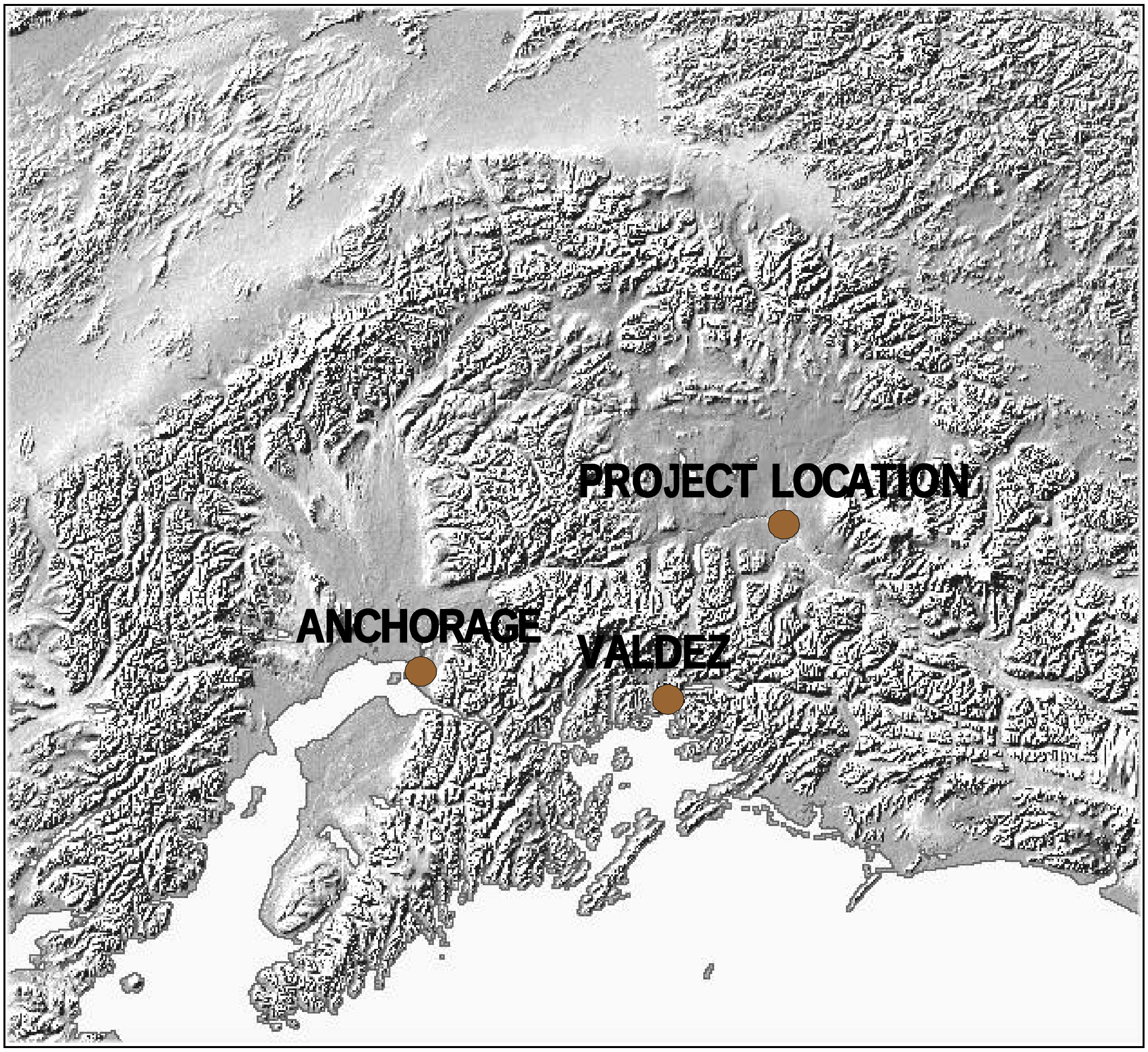
Department of Labor - Occupational Safety and Health Administration

The Department of Labor - Occupational Safety and Health Administration has the following laws, policies or regulations in place for water distribution systems:

OSHA Regulations (Standards - 29 CFR) PART 1910 Occupational Safety and Health Standards

Appendix

Appendix A - Project Location



Appendix B - Recommended Treatment Design Scheme

Available Upon Request

Appendix C - Water Quality

Article	Units	Well	ADEC MCL	ADEC SMCL	NPS MCL	EPA MCL	EPA MCLG	EPA SMCL	Grains /Gal
Antimony *	Mg/l	???	0.006		0.006	0.006	0.006		
Aluminum	Mg/l	.0500U		0.2				0.05-0.2	
Arsenic	Mg/l	.050U	0.05		0.05	0.05			
Asbestos *	MFL	???	7		7				
Barium	Mg/l	1.55	2		2	2	2		
Beryllium *	Mg/l	???	0.004		0.004	0.004	0.004		
Cadmium *	Mg/l	0.010U	0.005		0.005	0.005	0.005		
Calcium	Mg/l	124	NLDWS						
Chromium	Mg/l	.0050 U	0.1		0.1	0.1	0.1		
Copper	Mg/l	.0050U		1	1.3 (90%)	1.3TT	1.3		
Cyanide *	Mg/l	???	0.2		0.2	0.2	0.2		
Fluoride *	Mg/l	???	4		4	4	4		
Iron	Mg/l	5.21		0.3				0.3	0.304
Lead *	Mg/l	.050U?	NLDWS		0.015 (90%)	0.015TT	0		
Magnesium	Mg/l	92.6	NLDWS						
Manganese	Mg/l	0.0827	0.05					0.05	0.004
Mercury *	Mg/l	???	0.002		0.002	0.002	0.002		
Nickel *	Mg/l	???	0.1		0.1	0.1	0.1		
Phosphorus	Mg/l	0.212	NLDWS						
Potassium	Mg/l	6.86	NLDWS						
Selenium *	Mg/l	???	0.05		0.05	0.05	0.05		
Silicon	Mg/l	27	NLDWS						
Silver	Mg/l	.0050U		0.1				0.1	
Sodium	Mg/l	438		250	<200				
Thallium *	Mg/l	???	0.002		0.002	0.002	0.0005		
Zinc	Mg/l	0.0185		5				5	
Chloride	Mg/l	223		250				250	
Nitrate-N	Mg/l	0.100U	1		1	1	1		
Nitrite-N	Mg/l	0.100U	10		10	10	10		
Sulfate	Mg/l	4.78		250				250	
Hardness as CaCO	Mg/l	691	NLDWS						40.40
Sum of constituents above	Mg/l	1614.31							
TDS	Mg/l	1790		500				500	
Alkalinity	Mg/l	1420	NLDWS						
Conductivity	MMho s/cm	2700	NLDWS						
pH	pH Units	6.73		6.5-8.5				6.5-8.5	
Color **	color units	???		15				15	
Turbidity**	NTU	???							

Silt Density Index (SDI) **		???							
DOC**		???							
CO2**		???							
Foaming Agents	Mg/l	???		0.5				0.5	
Precipitation potential	Mg/l	152							4-10
Langlier Index		0.65							>0
Ryznar Index		7.03							<6
Odor **	Ton	???						3	
HCO3 Alkalinity	Mg/l	1420	NLDWS						
CO3 Alkalinity	Mg/l	1.00U	NLDWS						
OH Alkalinity	Mg/l	1.00U	NLDWS						
Compensated Hardness	Mg/l								50.82

* Still need to test for MCL
** Still need to test for SMCL and design parameters

Appendix D - Ecoregion Description

M135 Alaska Range Humid Tayga-Tundra-Meadow Province
Alaska Range, Wrangell Mountains, 61,000 mi2 (158,000 km2)

Land-surface form--The Alaska Range is a continuation of the Pacific Coast Mountains extending in an arc across the northern Pacific. The towering, glaciated peaks of the Wrangell Mountains and of the Alaska Range--which includes Mt. McKinley at 20,320 ft (6,194 m)--typify the ruggedness of the area. The only major waterways are the Susitna and upper Copper Rivers.

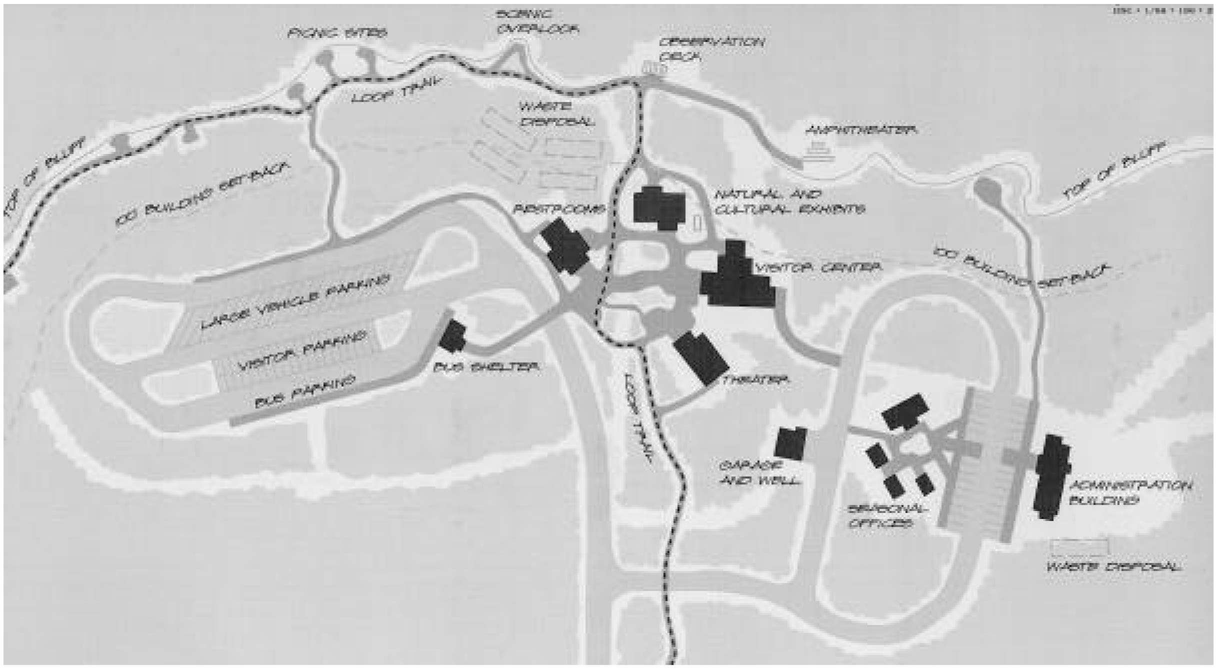
Climate.--The Alaska Range and the Wrangell Mountains have a transitional climate of severe winters and hot, dry summers. Temperatures range from 90F to -70F (32C to -57C). Precipitation averages only 16 in (410 mm) annually.

Vegetation.--Vertical vegetational zonation characterizes the Alaska Range and Wrangell Mountains, beginning with dense bottom-land stands of white spruce and cottonwood on the floodplains and low terraces of the Copper and Susitna Rivers. Above the terraces, poorly drained areas up to 1,000 ft (300 m) support stands of black spruce. Upland spruce-hardwood forests of white spruce, birch, aspen, and poplar, with an undergrowth of moss, fern, grass, and berry, extend to timberline at about 2,500-3,500 ft (800-1,100 m). Tundra systems of low shrubs and herbaceous plants form discontinuous mats among the rocks and rubble above timberline. White mountain-avens may cover entire ridges in the Alaska Range, associated with moss campion, black oxytrope, arctic sandwort, lichens, grasses, and sedges. These tundra systems stop short of the permanent ice caps on the highest peaks.

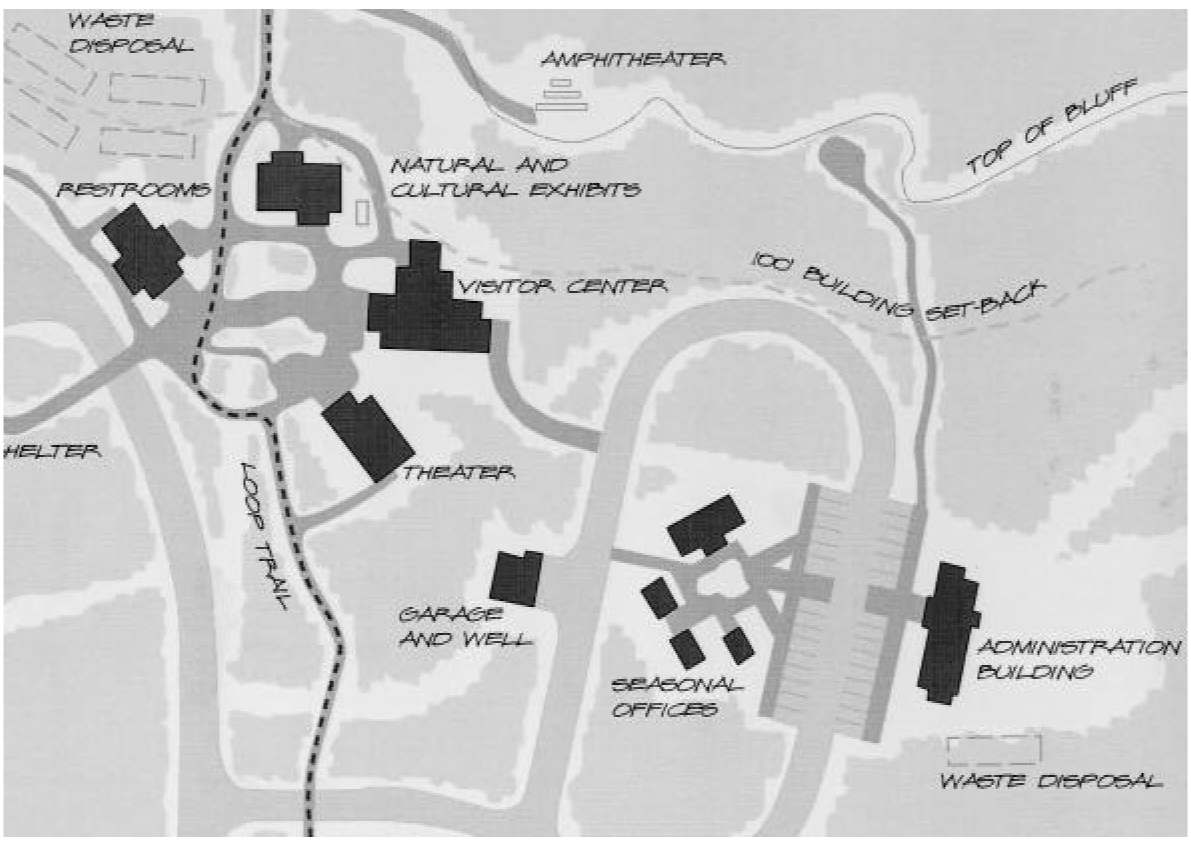
Soils.--Bottom-land and terrace soils of the Copper and Susitna Rivers are stratified, well-drained Entisols without pedogenic horizons. Upland hardwood forest soils are mostly shallow, well-drained Inceptisols. Permafrost is continuous on northfacing slopes, discontinuous on southfacing ones. Soils that support the moister tundra areas range from wet Inceptisols to Histosols. Alpine Inceptisols are generally shallow and poorly developed, with discontinuous or continuous permafrost.

Fauna.--The Alaska Range supports large big-game populations of moose, Dall sheep, black and brown bear, wolf, caribou, and wolverine. Smaller mammals include beaver, red fox, lynx, otter, marten, squirrels, and weasel. Golden eagles, ptarmigan, ravens, and sharp-shinned hawks inhabit the uplands.

Appendix E - Project Layout



Overall Project Layout



Developed Area Layout

Appendix F - Proposed Water Usage Figures

	VISITORS	STAFF DAYS	SEWAGE GAL	SEWER USE / PERSON	POTABLE GAL	POTABLE USE / PERSON	TOTAL WATER DEMAND
SITE TOTALS	**134,523**	**11,560**	**283,618**	**1.94**	**31,105**	**0.21**	**314,724**
TOTAL SUMMER (3 months)	**121,545**	**4,005**	**203,429**	**1.62**	**23,948**	**0.19**	**227,378**
PEAK SUMMER DAY			**3,720**		**546**		**4,266**
TOTAL SHOULDER (2 Months)	**10,139**	**1,417**	**26,543**	**2.30**	**2,994**	**0.26**	**29,537**
PEAK SHOULDER DAY			**1,144**		**211**		**1,355**
TOTAL WINTER (7 Months)	**2,839**	**6,138**	**53,646**	**5.98**	**4,163**	**0.46**	**57,809**
PEAK WINTER DAY			**376**		**77**		**453**

COMFORT STATION	VISITORS	STAFF	SEWAGE GAL	SEWER USE / PERSON	POTABLE GAL	POTABLE USE / PERSON	TOTAL WATER DEMAND
PEAK CS SUMMER	2,000	-	3,200	1.60	375	0.188	3,575
SUMMER AVE	1,332	-	2,131	1.60	250	0.188	2,381
SUMMER DAYS	91	91	91	91	91	91	91
TOTAL SUMMER	121,545	-	194,472	1.60	22,790	0.188	217,262
			-		-		
PEAK CS SHOULDER	500	-	800	1.60	94	0.188	894
SHOULDER AVE.	167	-	267	1.60	31	0.188	298
SHOULDER DAYS	61	61	61	61	61	61	61
TOTAL SHOULDER	10,139	-	15,208	1.50	1,901	0.188	18,123
PEAK CS WINTER	-	-	-	-	-	-	-
WINTER AVE.	-	-	-	-	-	-	-
WINTER DAYS	213	213	213	213	213	213	213
TOTAL WINTER	-	-	-	-	-	-	-
TOTAL	131,684	-	209,680		24,691		235,385

VISITOR CENTER	VISITORS	STAFF	SEWAGE GAL	SEWER USE / PERSON	POTABLE GAL	POTABLE USE / PERSON	TOTAL WATER DEMAND
PEAK VC SUMMER	-	5	40	8.00	5	0.938	45
SUMMER AVE	-	4	32	8.00	4	0.938	36
SUMMER DAYS	91	91	91	1.00	91		91
TOTAL SUMMER	-	365	2,920	8	341	0.935	3,262

PEAK VC SHOULDER	-	5	40	8.00	5	0.938	45
SHOULDER AVE.	-	2	16	8.00	2	0.938	18
SHOULDER DAYS	61	61	61	61	61	61	61
TOTAL SHOULDER	-	122	973	8.00	114	0.938	1,087
PEAK VC WINTER	40	5	104	2.31	12	0.271	116
WINTER AVE.	13	2	37	2.43	4	0.285	42
WINTER DAYS	213	213	213	0.50	213	213	213
TOTAL WINTER	2,839	426	7,949	2.43	932	0.285	8,880
TOTAL	2,839	913	11,842		1,387		13,230

ADMINISTRATION CENTER	VISITORS	STAFF	SEWAGE GAL	SEWER USE / PERSON	POTABLE GAL	POTABLE USE / PERSON	TOTAL WATER DEMAND
PEAK ADMIN SUMMER	-	48	384	8.00	155	3.229	539
SUMMER AVE	-	32	256	8.00	140	4.378	396
SUMMER DAYS	91	91	91	91	91	91	91
TOTAL SUMMER	-	2,917	23,337	8.00	1,440	0.494	36,109
PEAK ADMIN SHOULDER	-	32	256	8.00	107	3.346	363
SHOULDER AVE.	-	21	170	8.00	97	4.554	267
SHOULDER DAYS	61	61	61	61	61	61	61
TOTAL SHOULDER	-	1,295	10,361	8.00	750	0.579	16,260
PEAK ADMIN WINTER	-	32	256	8.00	63	1.970	319
WINTER AVE.	-	21	170	8.00	53	2.487	223
WINTER DAYS	213	213	213	213	213	213	213
TOTAL WINTER	-	4,533	36,265	8.00	2,127	0.469	47,541
TOTAL	-	8,745	69,963		4,317		99,910

GARAGE	VISITORS	STAFF	SEWAGE GAL	SEWER USE / PERSON	POTABLE GAL	POTABLE USE / PERSON	TOTAL WATER DEMAND
PEAK GARAGE SUMMER	-	12	96	8.00	11	0.938	107
SUMMER AVE	-	8	63	8.00	7	0.938	71
SUMMER DAYS	91	91	91	91	91		91
TOTAL SUMMER	-	723	5,782	8.00	678	0.938	6,459

PEAK GARAGE SHOULDER	-	6	48	8.00	6	0.938	54
SHOULDER AVE.	-	4	32	8.00	4	0.938	36
SHOULDER DAYS	61	61	61	61	61	61	61
TOTAL SHOULDER	-	243	1,947		228	0.938	2,175
PEAK GARAGE WINTER	-	2	16	8.00	2	0.938	18
WINTER AVE.	-	1	8	8.00	1	0.938	9
WINTER DAYS	213	213	213		213	212.917	213
TOTAL WINTER	-	213	1,703		200	-	1,903
TOTAL	-	1,179	9,432		1,105		10,537

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Preparer

Denver Service Center

Russell Belknap, P.E., Civil Engineer

Consultants

Wrangell-St. Elias National Park and Preserve

Jonathan Jarvis, Superintendent
Will Tipton, Chief, Maintenance

Alaska System Support Office

Lucy Gonyea, Chief of Design
Bill Heubner, Civil Engineer
Brad Richey, Architect

Columbia System Support Office

Phil Pollard, PHSO

Denver Service Center

Michael Donnelly, Project Manager
Pat Fleming, Civil Engineer, Quality Leader
Walt Graham, Civil Engineer, Technical Expert
Felton Brunson, Civil Engineer
Dan Overzet, Civil Engineer
Craig Paterson, Civil Engineer
Jodie Petersen, Landscape Architect,
John Reber, Natural Resource Specialist
Suzanne Stutzman, Landscape Architect, Quality Leader

R&M Consultants

Charles Riddle, C.P.G., Project Manager
Vic Gretzinger, P.E., Civil Engineer

Other Consultants

Brian Watson, Culligan Industrial, Anchorage, AK
Troy Stockdale, Applied Membrane, San Marcos, CA
Pat Sullivan, Senior Chemist, FMC Corp., Princeton, NJ
Frank Falkiewicz, FMC Corp., Princeton, NJ
Ray Smith, Manager, Technical Services, Rhone-Poulenc, Cranbury, NJ
Dan Moran, Water Treatment Plant Operator, Death Valley National Park, CA
Tom Fredrickson, Regional Manager, American Fluid Technologies, Minneapolis, MN

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NPS February 1998

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