**Alaska Department of Environmental Conservation**
**Division of Air and Water Quality**
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**Anchorage, Alaska 99501**

# Total Maximum Daily Load (TMDL) for Sediment and Turbidity in the Waters of Granite Creek in Sitka, Alaska

**September 2002**

*Prepared by Redburn Environmental & Regulatory Services through a grant to the City and Borough of Sitka provided by the Alaska Department of Environmental Conservation*

Total Maximum Daily Load (TMDL) for

# Sediment and Turbidity

in the waters of Granite Creek in Sitka, Alaska


**TMDL AT A GLANCE:**

| | |
|---|---|
| *Water Quality-Limited?* | *Yes* |
| *Hydrologic Unit:* | *10203-005 (Lat 57º 06'N; Long.135º 23'W* |
| *Standards of Concern:* | *Suspended sediment and Turbidity* |
| *Designated Uses Affected:* | *Growth and Propagation of Fish, Shellfish, other Aquatic Life and Wildlife; Recreation* |
| *Environmental Indicators:* | *Turbidity and Total Suspended Solids (TSS)* |
| *Major Sources:* | *Gravel mining, material stockpiling, roads, recreation and industrial stormwater runoff* |
| *Loading Capacity:* | *122.0 tons TSS/year; 2.5 to 24.8 tons TSS/month* |
| *Existing Source Load Allocation:* | *99.75 tons to 106.18 tons TSS/year* |
| *Future Source Load Allocation and/or Wasteload Allocation* | *15.82 tons TSS/yr (Option 2) reserved for LA and/or WLA; up to 22.25 tons TSS/yr (Option 1)* |
| *Wasteload Allocation:* | *No individual NPDES permitted point source discharges; set to zero* |
| *Margin of Safety:* | *Implicit; included through conservative assumptions* |
| *Recent Waterbody Assessments:* | *October 1996; April 1997; December 2000; October 2001; and November 2001* |
| *Proposed Future Actions:* | *Improve collection and treatment of industrial stormwater runoff; strengthen lease agreements and conduct annual audits; reroute some drainage away from Granite Creek; establish functional vegetated buffers; implement a long-term water quality monitoring program; complete required stormwater control plans; and explore opportunities for fisheries enhancement* |

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* These elements are required by Federal statute and EPA's implementing regulations

## OVERVIEW

Section 303(d)(1)(C) of the federal Clean Water Act and the U.S. Environmental Protection Agency's (EPA) implementing regulations (40 CFR Part 130) require the establishment of a Total Maximum Daily Load (TMDL) for achieving water quality standards when a waterbody is water quality-limited (i.e. impaired). A TMDL identifies the pollutant reductions and controls needed to meet state water quality standards. The focus of the TMDL is reducing pollutants entering a waterbody to a level - or a prescribed "load" - that fully supports the designated uses of the waterbody. In the case of Granite Creek, the parameters of concern are sediment and turbidity from nonpoint sources. The means to evaluate success and address nonpoint source water quality issues after the TMDL is completed include a combination of best management practices and monitoring.

Every two years since the mid-1980's, the Alaska Department of Environmental Conservation (ADEC) has submitted a list of waters to the EPA that persistently exceed water quality standards and/or exhibit impairment of uses. Beginning with the 1996 Section 303(d) list, the Alaska Department of Environmental Conservation (ADEC) identified Granite Creek as a Tier I "impaired", or water quality-limited water, due to excess turbidity and sediment introduced from industrial gravel mining. Sources of impact are listed exclusively as nonpoint sources. Granite Creek is among 58 impaired waterbodies statewide on Alaska's current federally approved Section 303(d) list.

*Figure 1* summarizes Alaska's Section 303(d) process for addressing Tier I, II, III and IV waterbodies. ADEC's web site at *www.state.ak.us/dec/* has details.

Alaska's final 1998 Section 303(d) list was published in June 1999 (ADEC, 1999). It classified Granite Creek as Tier I -- those waters which require further assessments to verify the extent of pollution and whether existing controls in-place are adequate to meet water quality standards by the next listing cycle in 2002. Granite Creek is currently protected for all uses (water supply, water recreation, and growth and propagation of fish and wildlife) under the water quality standards and the most stringent standards apply to the creek.

The following description is found in ADEC's 1998 Section 303(d) list:
(the narrative covers information available through December 1998)

*"This waterbody was placed on the 1996 Section 303(d) list for turbidity and sediment. A citizen provided an assessment form that describes how industrial gravel extraction activity has caused water quality problems. An ADEC site inspection of the gravel operation indicated that suspended sediment and associated higher levels of turbidity were occurring at the gravel pit holding ponds. Other ADEC information indicates that turbidity and sedimentation problems have occurred on Granite Creek over the past several years. ADEC has been working with the City of Sitka and inspections and recommendations were made, but follow-up/verification is needed."*

New information gathered since 1998 warrants updating this narrative. Five water quality assessments have been completed at Granite Creek since the 1994 assessment: October 1996;

April 1997, December 2000, and October and November 2001. The objective of the December 2000 investigation was to evaluate progress on recommendations in the 1996/1997 assessments, assign responsible parties to tasks and schedule completion dates. Subsequent water quality monitoring in Granite Creek during October and November 2001 provided further information for preparation of this TMDL. All on-site assessments were team efforts that included municipal, ADEC and Fish and Game staff. The results of the waterbody assessments are summarized in this TMDL or are included in the *Appendix.*

These field investigations confirmed the extent of impairment to water quality and/or designated uses, and confirmed pollutant sources and parameters of concern.

Subsequent to the completion of the 1998 Section 303(d) list, a comprehensive analysis of water quality issues and conditions was also completed for Granite Creek. The *Granite Creek Environmental Analysis: A review of lease site operations and recommended best management practices for water quality protection* (Redburn Environmental & Regulatory Services, 2001) - completed for the City and Borough of Sitka in February 2001. The EA reviewed lease agreements governing gravel mining operations, identified issues needing solutions, and recommended best management practices necessary for protecting water quality from industrial sources in the watershed. This analysis led to the CBS' request to ADEC for grant funds to develop this TMDL.

The availability of new information since 1998 currently qualifies Granite Creek as a Tier II waterbody - even prior to approval of this TMDL- under the following ADEC criteria found on its website:

> "Tier II: Water quality limited waterbodies which meet requirements of Section 303(d), and have undergone comprehensive water quality assessments to determine the most effective methods for water quality restoration through the application of waterbody recovery plans."
>
> "A waterbody recovery plan describes the process and steps to be taken to restore a water quality-limited waterbody to a condition that meets the water quality standards for pollutant parameters indicated. A waterbody recovery plan may include a Total Maximum Daily Load (TMDL), described in accordance with Section 303(d)(4)(A) of the Clean Water Act to include effluent limitations based on TMDL wasteload allocations from point sources and/or load allocations from nonpoint sources. "

The companion document to this TMDL - the *Granite Creek Watershed Recovery Strategy* - constitutes a "Waterbody Recovery Plan" under the ADEC/EPA definition above. It is expected that TMDL approval *and* implementation of controls listed in both the Waterbody Recovery Strategy and the TMDL will result in meeting water quality standards. *Consistent with current regulations and guidance, these actions (TMDL approval and implementation of the Waterbody Recovery Plan) support the delisting of Granite Creek from the 2002 Section 303(d) list and reclassifying the creek from Tier I to Tier III status subject to tracking and monitoring (see Figure 1 for process).*

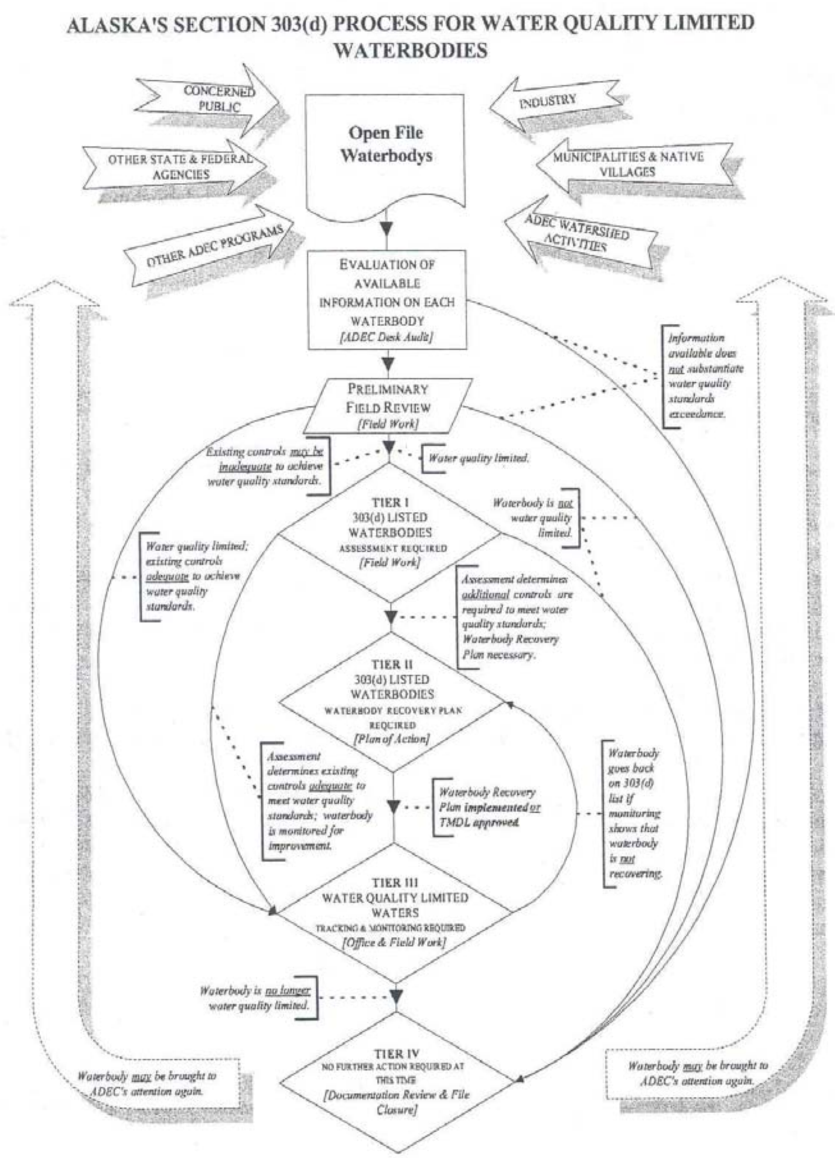



**Figure 1:** Alaska's Section 303(d) Process for Water Quality Limited Waterbodies

## GENERAL BACKGROUND AND WATERSHED DESCRIPTION

### *Physical Setting and Land Use History*

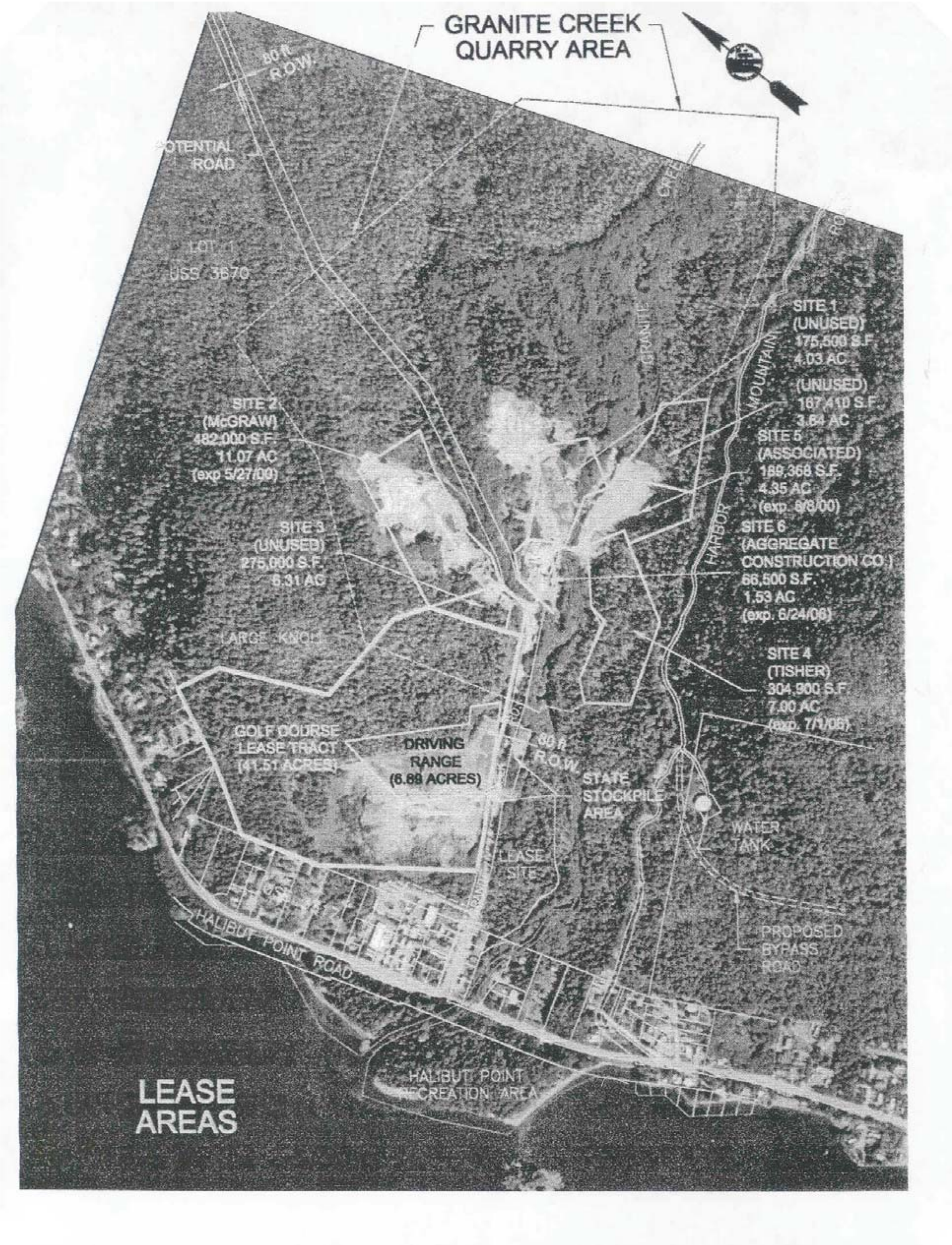
The municipality of Sitka, within the City and Borough of Sitka, is located on the west coast of Baranof Island fronting Sitka Sound. Baranof Island is an outer coast island in the northwest area of southeast Alaska's Alexander Archipelago bordering the Gulf of Alaska. According to the 2000 Census data, the population of the City and Borough of Sitka is 8,835.

Granite Creek is located four miles northwest of downtown Sitka, accessed from the Halibut Point Road *(Figure 2)*. The Granite Creek watershed is relatively small, encompassing roughly 2.2 square miles or 1460 acres, 8 % of which is occupied by industrial gravel lease sites, roads, recreation areas, and residential/light commercial areas. The remainder is characterized as muskeg, spruce-hemlock forested wetlands. The lease sites are accessed by the Granite Creek Road. Based on this land use distribution, the Granite Creek watershed was divided into the following land use categories (and acreage): industrial gravel operations (50 acres), overburden waste disposal sites (14 acres), roads (3 acres), recreational sites (39 acres), and residential/light commercial (11 acres). The Alaska Department of Natural Resources manages the popular Halibut Point Recreation Area at the mouth of Granite Creek.

Granite Creek has two major tributaries - the North Fork and South Fork - that converge into the mainstem that runs through the State DNR Halibut Point Recreation Area prior to discharge to Sitka Sound. The U.S. Forest Service stream classification for Granite Creek is MM2- a moderate gradient (2-6%), moderate width, narrow flood plain, forested stream in mid- or lower valley position. The creek is shallow and wadable and does not freeze completely in winter. Coarse gravel to small boulders characterizes the stream substrate. Stream velocity can be high during the fall. Peak flow rates are estimated at 250 to 300 cubic ft/sec (cfs), with estimated monthly mean flows ranging from 6 to 53 cfs. The hydrology of Granite Creek is driven by precipitation and surface water runoff and the creek responds quickly to rain events. The creek is not glacially fed. Groundwater seepage from the North rock pit face in collected in ditches at the base of the pit, and routed to and treated in a series of settling ponds constructed by the CBS in July 2001 before discharge into the North tributary of Granite Creek. The high retention times in the ponds effectively remove sediments and reduce turbidity levels.

The Granite Creek watershed has historically experienced considerable land clearing and disturbance in support of lessee gravel mining, blasting, realignment of the tributaries, stream vegetative buffer encroachment, roads and asphalt plant operations. The City and Borough of Sitka leases and oversees several industrial and recreational lease operations in the watershed *(Figure 2)*. An existing overburden waste disposal site on the north side of Granite Creek Road receives stumps and organic overburden. A driving range is located adjacent to the overburden site. Future uses of the watershed include a proposed forty-two acre golf course and a new benchland overburden landfill site. Stormwater runoff from the existing overburden disposal site

**Figure 2:** Aerial view of Granite Creek and the gravel mining lease sites



and residential areas is channeled to a ditch at the base of the fill and drains into the mouth of Granite Creek below the Halibut Point Road bridge. Leachate from the fill site tends to be high in iron and floc and staining is evident in both the ditch water and mouth of Granite Creek.

The results of sediment and turbidity monitoring from several seasons and locations within the watershed suggest time-specific, periodic sediment and turbidity impairment that is normally tied to high rainfall events, blasting or settling pond maintenance. Chronic sedimentation of the creek is not typical. The principal sources of sediment are stormwater runoff from the gravel lease operations, material stockpiles and road maintenance. Wood waste leachate and sediments from the overburden waste disposal site and newly constructed golf course bypasses the majority of the length of Granite Creek and discharges to the immediate mouth of the creek. Residential development at the mouth of the creek contributes little sedimentation. Background water quality draining into the lease sites is very high, with average turbidity readings of less than 2 nephelometric turbidity units (NTUs). Muskegs and other forested vegetation, where left undisturbed, are effective at filtering sediment from runoff before it reaches the creek.

Controlling sediment and turbidity introduced from gravel operations is the principle focus of this TMDL. The gravel operations are located in an active floodplain, and both the alluvium and overburden have a high quantity of silt-sized volcanic ash particles that easily erode and are difficult to contain and treat. Pit run material often has a high percentage of fines that can lead to siltation. Roads also have a high percentage of fine material. The CBS completed the installation of a series of new settling ponds, diversion ditches and pit floor grading in July 2001 to improve the collection and treatment of sediment-laden stormwater. These improvements are reflected in the water quality data from the creek collected in fall 2001.

The area's history as a gravel source dates back to 1955. The State of Alaska Department of Highways was a prime user during the 1960s. The State of Alaska, Department of Natural Resources, conveyed the lands to the City and Borough of Sitka and since 1982, the CBS has leased several sites (*see Figure 2*) to a variety of operators. Upon completion of gravel extraction, the municipality's objective is to have the site reclaimed to allow other commercial or industrial uses. The CBS lease agreements stipulate reclamation of sites.

The impact of gravel operations on water quality and fisheries values was identified early by the municipality. Granite Creek and its North and South Fork tributaries are classified as anadromous (ADF&G catalog number 113-41-10170), supporting coho and pink salmon and Dolly Varden trout. Woodward-Clyde Consultants was contracted in 1982 to complete a Granite Creek Operation and Reclamation Plan as an element of an overall Sitka Gravel Resource and Management Study (Woodward-Clyde Consultants, 1982). The report examined operational methods for Granite Creek material sites that were compatible with federal and state environmental regulations, the development objectives of the City and Borough of Sitka, and the current operations at the site. Recommendations were provided to meet environmental standards and to assess reclamation success. Reclamation standards were included in the report.
The proposed *Sea Mountain Golf Course* will comprise approximately forty-two acres of city land on the north side of the Granite Creek Road, about 1000 feet up from the Halibut Point Road. Roughly thirty-one acres will be developed into golf course fairways, greens and tees,

roads, maintenance facilities or supporting service extensions. Less than thirty acres will involve soil disturbance. Some site clearing and filling is already completed.

This proposed *Benchland Overburden Landfill* site lies adjacent to Granite Creek's South Fork and would provide a new overburden waste disposal site for locally generated vegetation and soil debris. The adjacent Benchland road project would generate roughly 55,000 cyds of waste material that would go to the landfill. The landfill would affect approximately 5.5 acres of forested wetlands and receive an estimated volume of 225,000 cyds. *Figure 3* shows the project boundaries and features. Containment berms will be placed at the toe of the overburden fill and a 150 ft forested buffer separates the landfill from Granite Creek. The CBS received federal and state approvals for the project in April 2001 and went out to bid on the project in January 2002. Finished fill surfaces will be revegetated and natural drainage through the area addressed with culverting and silt fencing. Upgradient surface runoff will be intercepted by ditches and routed around the disposal area to minimize contact with organics and to reduce leachate generation. Two new settling ponds (and one reconfigured pond for fish habitat) were installed off-site along the North Fork of Granite Creek as partial mitigation for the project.

*Climate*

Sitka has a maritime climate with frequent and heavy precipitation. Low-lying fog, overcast skies, rain and drizzle dominate weather conditions. Periods of extremely heavy rainfall (in excess of 2.5 inches per day) can occur in September and October. Average annual precipitation at Sitka is about 86 inches, as measured at the airport, some of which falls as snow. Granite Creek receives about 120 inches of precipitation annually, given the mountainous heterogeneity of the area.
Normal summer air temperatures range from 50 degrees Fahrenheit (F) to 60 degrees F while normal winter air temperatures range from 31 degrees to 39 degrees F (National Weather Service, 1999). Prevailing summer winds are from the south and southeast and from the southeast in fall. Monthly average wind speeds range from 3 to 6 mph.

Tides have only a minor effect on the mouth of Granite Creek and are semi-diurnal, with a range of 14.4 feet (MHHW) to -4.0 feet (ELW).

*Recent Environmental Assessments (2000 and 2001)*

In response to environmental concerns over Granite Creek, the City and Borough of Sitka, Public Works Department, contracted the completion of a *Granite Creek Environmental Analysis* in February 2001. The Scope of Work was divided into four tasks. *Task 1* reviewed and summarized existing literature on Granite Creek, such as Alaska Department of Environmental Conservation (ADEC) impaired waterbody designation, any NOV's or ADF&G Title 16 anadromous fish permit notices, and previous erosion control plans. *Task 2* identified major

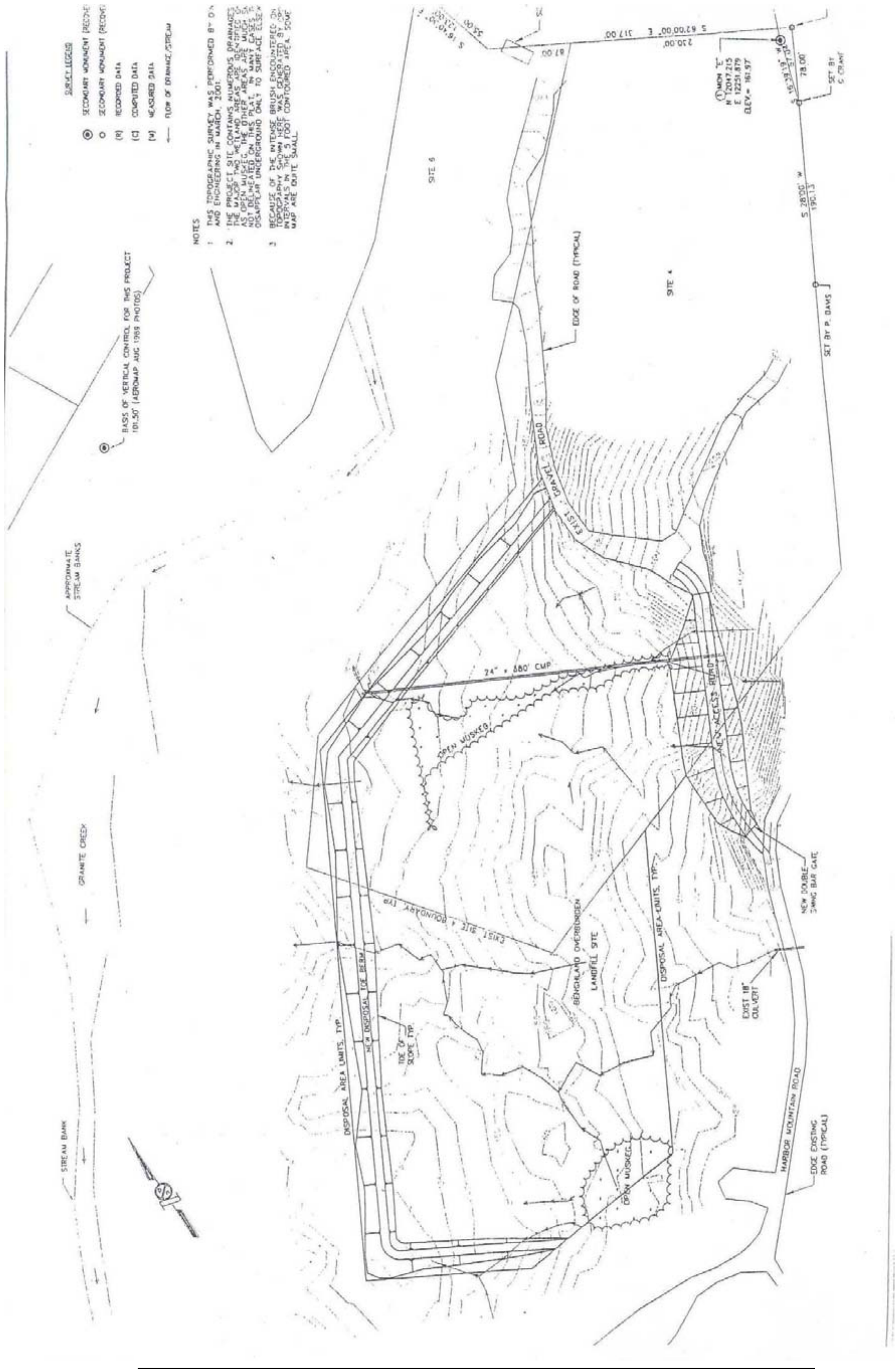



Figure 3. Benchland Overburden Landfill Site Project layout

issues that needed solving to de-list Granite Creek as an impaired waterbody on the State of Alaska's Section 303(d) list. *Task 3* reviewed existing tenant lease operations in relation to previous erosion control/stormwater pollution control plans or agreements with ADEC and EPA. *Task 4* recommended Best Management Practices (BMPs) the City and Borough of Sitka would suggest to the Army Corps of Engineers, Fish and Game and ADEC for the new benchland landfill at Granite Creek. A series of recommendations were provided for gravel lease operations and the new benchland overburden site to promote protection of water quality and fish habitat.

The project objectives were: 1) identify major water quality issues with tenant lease operations and propose solutions to the problems that will result in meeting water quality standards and the eventual delisting Granite Creek as an impaired waterbody; and 2) provide information useful to the CBS for development of a future Master Plan for the Granite Creek area. The *Granite Creek Environmental Analysis* served as a necessary first step towards developing a Granite Creek Watershed Recovery Strategy and this TMDL. The Strategy and TMDL address all activities within the watershed, including gravel mining operations, the ongoing construction and eventual completion of the proposed golf course, the existing overburden landfill site, and the new benchland landfill site scheduled for opening in late 2002.

The environmental analysis relied on existing published information obtained from the files of resource agencies and the CBS. These included memoranda, the 1982 Granite Creek Operation and Reclamation Plan, field inspection and monitoring reports and enforcement actions. Interviews with CBS, ADEC and ADF&G staff were also conducted. Additionally, a field inspection with CBS and Fish and Game staff was conducted on December 19-20, 2000 to evaluate conditions and recommend BMPs at the proposed new overburden landfill site, and to inspect gravel mining operations and water quality in the upper Granite Creek basin.

Lastly, Redburn Environmental & Regulatory Services collected water quality data in October 2001 and November 2001 as part of the TMDL analysis for Granite Creek. Simultaneous turbidity, total suspended solids (TSS) and settleable solids measurements were taken at several permanently established stations in the watershed *(Figures 4 and 5)* to supplement previous turbidity data collected by ADEC. Stream velocity and flow rates (cfs) were measured in October 15 and 17 and November 20, 2001 with the assistance of Forest Service hydrologists. Collecting simultaneous TSS and turbidity data allowed for developing a TSS-to-turbidity concentration ratio that was used to convert historical turbidity data to TSS for purposes of calculating load capacity and load allocations (tons). Also, correlating flow rate with TSS concentration is necessary for calculating tons of sediment per month transported by Granite Creek. All water quality monitoring since October 2001 has been guided by an ADEC-approved Quality Assurance Project Plan (QAPP).

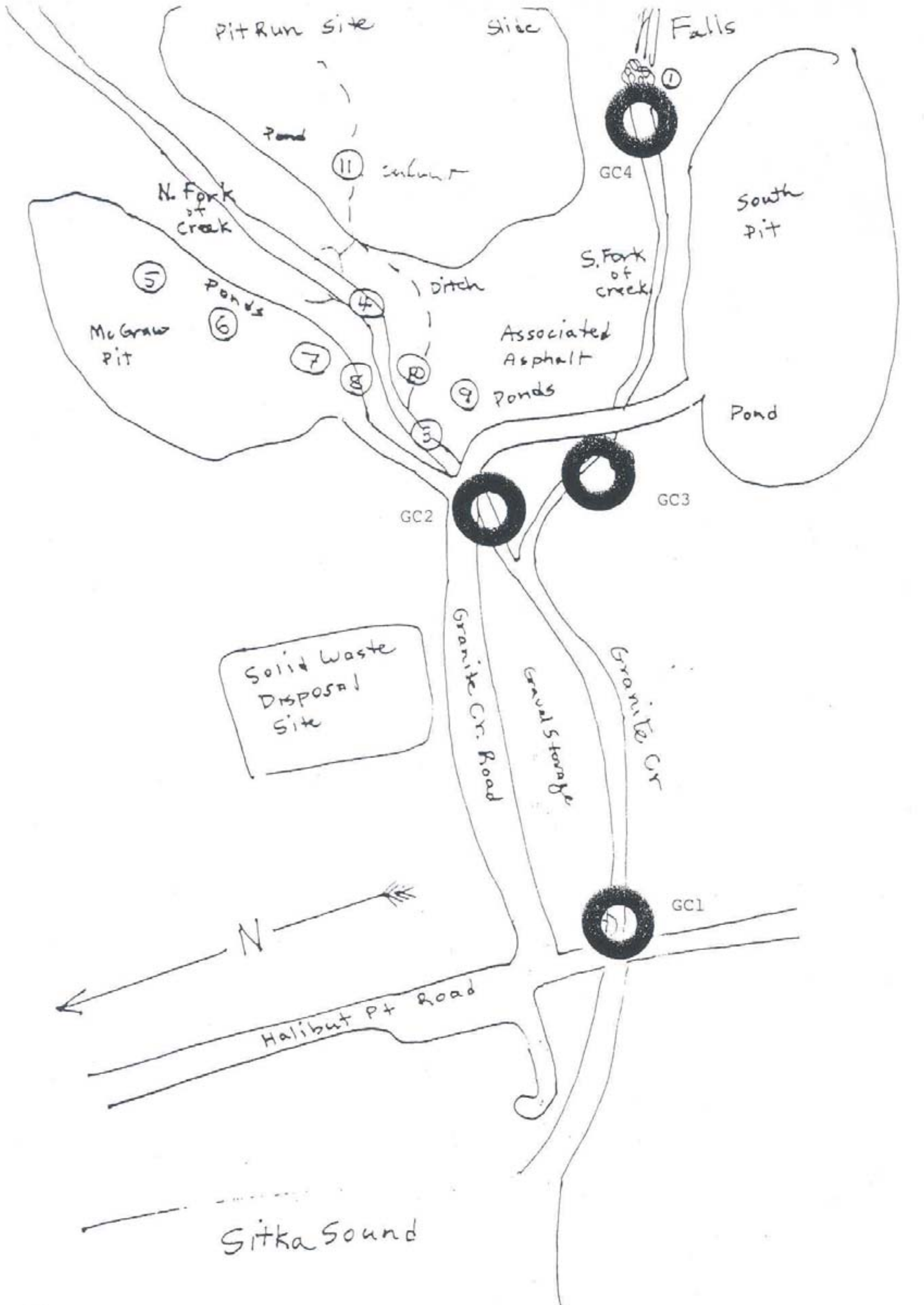



Figure 4: Water quality monitoring stations at Granite Creek, Sitka, Alaska with historic ADEC turbidity sampling sites in circle

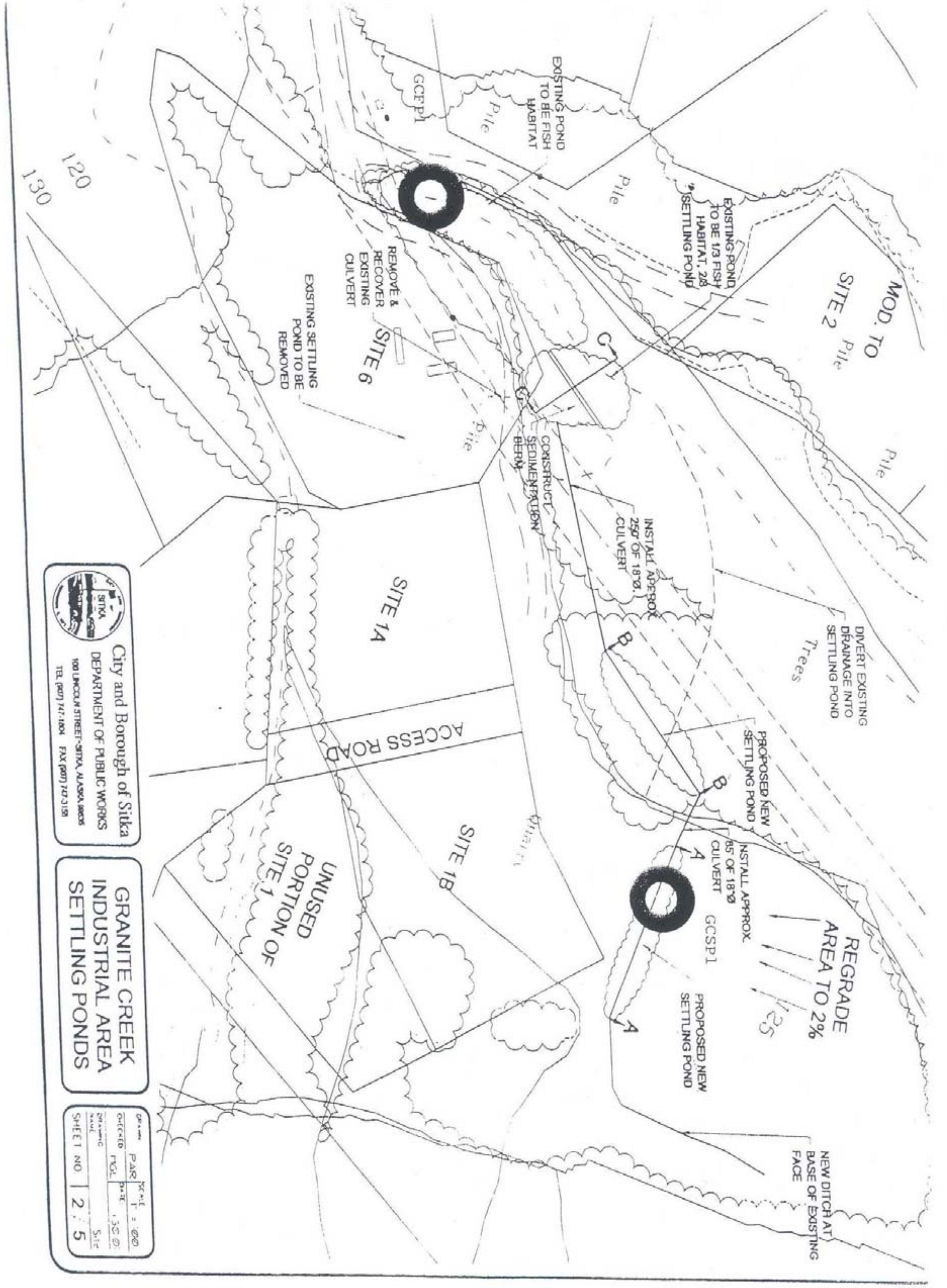



Figure 5: Upper Granite Creek settling pond and fish pond monitoring stations, Sitka, Alaska

## Applicable Water Quality Standards

TMDLs are developed to meet applicable water quality standards found in 18 AAC 70. These may include numeric water quality criteria and narrative criteria for the support of designated uses. The numeric targets (e.g. allowable suspended sediment or turbidity levels) identify the specific endpoints for the TMDL that result in attainment of Alaska water quality standards. The numeric target may be equivalent to a numeric water quality criterion (e.g. 5 NTUs above natural conditions for turbidity) where one exists, or it may represent a quantitative interpretation of a narrative standard. This section reviews the applicable numeric target levels for the calculation of the TMDL for Granite Creek.

### *Designated Uses*

Designated, or protected, uses for Alaska's fresh waters are established in Alaska Water Quality Standards regulations in 18 AAC 70. These designated uses include 1) water supply, 2) water recreation, and 3) growth and propagation of fish, shellfish, other aquatic life and wildlife. The designated uses of Granite Creek most at risk from sedimentation from gravel mining operations and other sources are growth and propagation of fish and wildlife and water recreation at the Halibut Point Recreation Area. The most stringent of the standards apply to water supply.

### *Parameters of Concern*

The Alaska 1998 Section 303(d) list of impaired waterbodies identified Granite Creek as water quality-limited due to periodic exceedances of sediment and turbidity criteria caused by gravel mining operations. This TMDL addresses load reductions and allocations (in tons of sediment) and also establishes monitoring endpoints for turbidity and sediments to evaluate the effectiveness of control actions.

### Applicable Water Quality Criteria and Numeric Targets

Applicable water quality criteria for the TMDL are sediment and turbidity. Granite Creek is protected for all designated uses. The most stringent use is drinking water.

For purposes of this TMDL, applicable water quality criteria for turbidity and sediment (18 AAC 70.020) for drinking water are:

> *"May not exceed 5 nephelometric units (NTUs) above natural conditions when the natural turbidity is 50 NTU and less, ..."*

and

> *"... no sediment loads (suspended or deposited) that can cause adverse effects on aquatic*

*animal or plant life, their reproduction or habitat may be present."*

and

*"No measurable increase in concentrations of settleable solids above natural conditions, as measured by the Imhoff cone method (See Note 13)."*

Water quality monitoring has targeted these three criteria as a basis for evaluating compliance with water quality standards.

Natural background water clarity in Granite Creek (i.e. the natural condition upstream of human influences) is very high. The established upstream background reference station GC4 on the South Fork *(see Figure 4)* is located above all gravel mining operations or other activities. This station reflects natural conditions - and baseline turbidity and sediment values - for Granite Creek. The mean turbidity concentration calculated from multiple measurements made from October 1996 through November 2001 is 1.64 NTUs. Therefore, the water quality target for turbidity (ADEC, 18 AAC 70.020(b)) in Granite Creek is 1.64 NTU + 5.00 NTU = 6.64 NTU, a numeric expression of the following standard:

*May not exceed 5 NTU above natural conditions when the natural turbidity is 50 NTU and less, ...."*

Since the water quality issues associated with turbidity are typically linked to sediment loading from watershed sources, the sediment criteria are also relevant indicators for this TMDL. Historical water quality data collected in the watershed are almost exclusively for turbidity. Because of the dearth of available data to characterize sediment characteristics, coupled with the fact that Alaska water quality standards include a narrative criterion for total suspended solids (TSS) but not a numeric criterion, the numeric turbidity criterion listed above was selected as an appropriate measurement indicator for the TMDL. Turbidity measurements must be converted to a gravimetric (weight) indicator for purposes of sediment load calculations as discussed below.

Turbidity and TSS are related in that they are both measures of particle concentrations in the water column. Reductions in turbidity will result in reductions in TSS. Turbidity is an optical measure of water related to light transmission and is a measure of the total amount of light-scattering particles in the sample. TSS, also called total nonfilterable residue (TNFR), refers to solids that are not in true solution and can be removed by filtration. Such suspended solids usually contribute directly to turbidity. TSS includes both organic particles and inorganic, mineral particles. Occasional high suspended solids have been documented in Granite Creek and were responsible, along with elevated turbidity, for the initial impaired waterbody listing in 1994. Discussions with ADEC and USGS staff suggest a low contribution of organic material to the suspended solids concentration. An important logistical consideration was that Juneau analytical laboratories and the CBS Wastewater Treatment Plant staff are both certified to conduct TSS analyses, but not Suspended Sediment Concentration (SSC) analysis, allowing for a quick turnaround on analysis at lower cost. Water quality monitoring therefore targeted TSS concentrations, not SSC. These two measures are considered equivalent in Granite Creek pending collection of concurrent TSS and SSC data that provide evidence to the contrary. Such data sets are currently not available.

The best available information must be used in developing the TMDL. This acknowledges that, in many cases, time does not allow collection of considerable new information in preparing a TMDL. Extrapolation is often necessary to glean the most information from historical water quality data. A fairly good turbidity database exists for Granite Creek back to 1996. Given the requirement to develop a load allocation (tons/year) for nonpoint sources affecting the watershed, available turbidity information (an optical measure) must be converted to Total Suspended Solids (mg/liter) using accepted plotting of data sets and regression analysis. Total suspended solids and turbidity data were collected simultaneously from multiple stations in October 2001 and November 2001 and allowed for regression analysis and an equation depicting the TSS-turbidity relationship.

## Critical Conditions

Several Granite Creek uses are potentially affected by the accumulation and transport of fine sediment and turbidity. This anadromous stream supports coho and pink salmon and Dolly Varden. Recent years' adult coho spawning population in the creek is estimated at 40 individuals (Phil Mooney, ADF&G, personal communication). Surveys in the late 1970's documented over 1000 pink salmon spawning in the lower reaches of Granite Creek (Hughes, Fish and Wildlife Service). Dolly Varden are also present and spawn in November-early December. Coho fry rear in the North and South tributaries and have been documented in settling ponds that were installed to treat stormwater. Coho are highly migratory and are dependent on good habitat conditions. Lack of physical obstructions, adequate water depth and flow for oxygenation of eggs and alevins, high water quality and sufficient riparian cover are critical elements optimizing survival. Small streams and tributaries - such as Granite Creek and its two feeder tributaries - are particularly important to coho salmon.

Three critical periods exist for coho salmon: spawning; egg incubation and fry emergence; and smolt migration to marine waters. First, adult coho typically enter Granite Creek to spawn from July 15 to early November, often during periods of high runoff. These periods can coincide with heavy rains and high levels of turbidity and sediment. Second, eggs develop during the winter (January through early April) to the alevin stage, and emerge as fry in April through late May. The overwintering January to April period is perhaps the most critical in the coho's life history as these stages are the most vulnerable to sedimentation impacts. Porous, silt-free gravel substrates are required to allow exchange of cool water and dissolved oxygen and waste products. Such conditions optimize egg-to-fry survival in salmon. While no quantitative interstitial sediment samples have been collected to evaluate fine sediments, Granite Creek spawning gravels are expected to the generally sediment-free. Adequate flushing during high stream velocities in fall, and reduced gravel lease operations during winter, help ensure higher water quality during winter.

Juvenile coho rear in Granite Creek for one to two rearing years, after which they migrate to Sitka Sound as smolt during the third critical period - April through June. Granite Creek does not typically experience inadequate water flow in the lower reaches during this period or obstructions due to low water as do several southeastern streams (e.g. Duck Creek in Juneau). No evidence exists to suggest that smolting coho are trapped by low water or otherwise impeded by water quality - or water quantity - conditions in their migration to Sitka Sound. Adequate flows exist year round to transport sediments and oxygenate waters.

Understanding these critical "fisheries windows" and seasonal flow conditions is important to managing industrial operations in the watershed. As an example, these windows are used to schedule settling pond maintenance for June 1 - July 15, the period of least environmental sensitivity to sediment introduction.

Recreational use of Granite Creek is high in its lower reaches. The State of Alaska's Halibut Point Recreation Area is located at the mouth of Granite Creek. The area receives extensive use by recreationalists from April through early September, plus use by winter divers. Observing spawning salmon, birding, snorkeling and scuba diving, picnicking, and kayaking are prime uses. Low turbidity and sediment levels are necessary to ensure these amenities are protected and maintained as required under State water quality standards.

In summary, the critical fisheries periods that are most susceptible to sediment and turbidity impairment are *mid-July to November* and *January to early June*.

## Water Quality Analysis

The *Granite Creek Watershed Recovery Strategy* provides the overarching direction for the restoration and maintenance of water quality in the watershed. Generally, such strategies may include, as appropriate, a TMDL to restore a waterbody to conditions that meet water quality standards. EPA and ADEC have determined that the TMDL is an appropriate tool in the context of an overall Watershed Recovery Strategy and provided grant funds to the City and Borough of Sitka to complete both elements. Historical water quality data collected in the watershed and analyzed for the TMDL are summarized below.

### Water Quality Data

The data available for assessing the condition of Granite Creek are described in this section. In July 2001, several major improvements in the collection and treatment of stormwater runoff were completed. Three new settling ponds, multiple diversion ditches and road maintenance practices have reduced sedimentation into Granite Creek. Therefore, historical data (collected prior to 2001) does not necessarily reflect current conditions, with the exception of background condition. Water quality information collected in October 2001 and November 2001 appear most relevant to the TMDL analysis. Data from October 1996 and December 2000 are used principally to supplement recent data, confirm background conditions, and to fill in seasonal holes in the database.

The data available for developing sediment load calculations for Granite Creek are best characterized as periodic, and do not cover all months of the year. Because turbidity represents the vast majority of available water quality data, these data were converted to TSS concentrations for periods where TSS data do not exist. The relationship between turbidity and TSS is based on two approaches. First, simultaneous measurements of TSS and turbidity concentrations were made at over ten stations in October and November 2001. The ratio of turbidity/TSS was calculated, regression analysis run on the data sets, and a regression equation generated. This direct linear relationship was applied to convert turbidity data to TSS (mg/liter). An equation specific to Granite Creek was generated. Second, the relationship presented in Lloyd et al (1987) for interior Alaskan streams was applied to turbidity data and the results compared to the direct regression analysis results. Both equations are discussed in the later section on Analytical Approach.

Water quality data are not adequate for several seasons (spring and summer) but are representative of fall and early winter periods. EPA TMDL guidance provides that TMDLs be developed using the best available information, especially when nonpoint sources are the primary concern. This is the case for Granite Creek. Available data were reviewed and are summarized below.

*1996-2000 ADEC Water Quality Monitoring in Granite Creek*

The ADEC Southeast Watershed Unit conducted two inspections of Granite Creek gravel operations in October 1996 and April 1997. CBS and ADF&G staff participated with ADEC. Water quality inspection and monitoring reports were completed for each visit and drafts shared with CBS and ADF&G staff for concurrence (*see Appendix*).

Key recommendations for the October 1996 and April 1997 inspections were K

X the need to jointly agree on a plan to resolve water quality problems
X keep the South Fork from entering the pit run area
X securing necessary Title 16 permits for in-stream work
X reroute ditch water away from the pit run area into settling ponds
X better maintenance of silt fabric/hay bales
X construct several new ponds in a series to collect and treat runoff
X reestablish 50 ft vegetative buffers along both forks
X conduct municipal compliance audits of lessee operations
X cessation of operations during heavy rains
X CBS to conduct periodic turbidity monitoring at the Halibut Point Road bridge, and
X need for proactive and improved CBS enforcement of lease terms.

Restricting traffic to defined areas to reduce siltation from erodible soils and grading the pit floor so that drainage flowed away from the creek were also recommended.

Replicate turbidity concentrations were measured at twelve sampling stations throughout the watershed *(see Figure 4)* to test the effectiveness of settling pond treatment, establish natural background levels and compare values against the allowable water quality standard of 5 NTUs above natural background. The turbidity data collected at these sites did not have any corresponding flow, TSS or SSC measurements.

*Turbidity Results (October 25, 1996)*

| **Location** | **Turbidity 1** (NTU) | **Turbidity 2** (NTU) | **Station #** |
|---|---|---|---|
| S. Fork at falls | 0.80 | 0.71 | 1 |
| S. Fork below dbl culvert & pit | 0.98 | 1.00 | 2 |
| N. Fork just above culvert | 24.4 | 23.8 | 3 |
| N. Fork above gravel pit inputs | 0.79 | 0.64 | 4 |
| 1st pond at McGraw gravel pit | 43.9 | 42.7 | 5 |
| Just below 1st pond at McGraw | 47.7 | 46.9 | 6 |
| 3rd pond at McGraw gravel pit | 53.6 | 46.6 | 7 |
| Outlet of 4th pond at McGraw | 21.0 | 20.1 | 8 |
| Last pond in series Associated pit | 17.9 | 16.7 | 9 |
| Ditch from pit run around ponds | 274 | 272[1] | 10 |
| Temp. stream across pit run area | 365 | 369 | 11 |
| Main stream at highway bridge | 5.81 | 6.27 | 12 |

The CBS contractor for this project visited the Granite Creek site with ADEC, ADF&G and CBS staff on December 19 and 20, 2000. In addition to team discussion of drainage, settling pond construction and buffer issues, replicate turbidity samples were collected at several stations in the Granite Creek drainage on December 19 and 20, 2000. Results are as follows:

*Turbidity Results (December 19-20, 2000)*

December 19, 2000

- Halibut Pt Road bridge: 1.66 NTU, 1.70 NTU
- South Fork below falls: very clear and estimated at 1.50 to 2.00 NTU

December 20, 2000

- Halibut Pt. Road bridge: 11.7 and 11.5 NTU
- Main road crossing/bridge in lease area: 45.7 and 48.0 NTU
- North Fork immediately about culvert: 46.3 and 46.7 NTU
- Pit ditch water at culvert under access road: 482 to 833 NTU[2]
- Lower settling pond: 1.44 NTU (ditch water was circumventing both ponds)

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[1]This ditch was rerouted directly to a settling pond in July 2001.

[2]This ditch no longer exists. Runoff has been rerouted to the newly installed series of settling ponds for treatment prior to discharge to the North Fork of Granite Creek.

The differences in turbidity levels between December 19 and 20 were due to soil thawing on the 20th, coupled with increased truck traffic and pit run operations. On December 19, the soil was frozen and gravel operations were not occurring.

***October - November 2001 Water Quality Monitoring in Granite Creek***

In July 2001, a number of structural improvements in the collection and treatment of stormwater runoff from gravel leases were completed by CBS Public Works. Three new settling ponds, multiple diversion ditches and road maintenance practices have reduced sedimentation of Granite Creek. Therefore, historical data (prior to July 2001) does not necessarily reflect current conditions, with the exception of background conditions. A Quality Assurance Project Plan (QAPP) was completed and approved by ADEC in October 2001 prior to monitoring. The QAPP will guide all future water quality monitoring.

To supplement the water quality database for this TMDL, additional water quality monitoring data were collected in Granite Creek on October 15-17, 2001 and November 20, 2001. Permanent monitoring stations were established for future monitoring of the effectiveness of sediment controls (s*ee Figures 4 and 5)*. Water quality results are summarized in *Tables 1 and 2*.

**Table 1.** Water quality and stream flow measurements for Granite Creek, October 2001 [3]

| Station | Date | TSS (mg/l) | Turbidity (NTU) | Flow rate (cfs) | Settleable solids (ml/liter) |
|---|---|---|---|---|---|
| GC4(control) | 10/15/01 | <1.3, <1.3 | 1.32, 1.74 | 12.869 cfs @ GC1 | ND; <0.1 |
| GC3 | " | <1.3, <1.3 | 2.92, 1.73 | | ND; <0.1 |
| GC2 | " | <1.3, <1.3 | 4.88, 5.09 | | _____- |
| GC1 | " | <1.3, <1.3 | 2.56, 2.64 | | ND; <0.1 |
| IR1 | " | <1.3, <1.3 | 1.85, 1.86 | | ND; <0.1 |
| GCSP1(settling pond) | 10/16/01 | 3.2 | 7.98, 6.95 | estimated @ 22.95 cfs @ GC1 | ND; <0.1 |
| GCFP1 | " | 10.7 | 9.44, 12.32 | | ND; <0.1 |
| North Fork | " | ___ | 0.88, 1.08 | | ___ |
| GC1 | " | 1.5 | 4.08, 3.95 | | ___ |
| GC1 | 10/17/01 | ___ | 22.85, 24.82 | 183.74 cfs[4] | ___ |
| GC2 | " | 20.4 | 18.34, 21.1 | | 0.15 |
| GC4 | " | ___ | 13.58 | | ___ |
| IR1 | " | 5.6 | 2.58, 2.19 | | ___ |
| North Fork | " | ___ | 6.34 | | ___ |
| GCFP1 (pond) | " | ___ | 105, 110 | | ___ |

[3] Station numbers are referenced to Figures 4 and 5.

[4] Estimated from velocity measurement of 4 ft/second times cross-sectional wetted area of creek. Heavy rain during day, with > 2 inches reported.

**Table 2.** Turbidity, TSS, settleable solids and flow results from Granite Creek, November 20, 2001

| Station | Date | TSS (mg/l) | Turbidity (NTU) | Flow rate (cfs) | Settleable solids (ml/l) |
|---|---|---|---|---|---|
| GC1 | 11/20/01 | ND | 1.53, 1.38 | 12.15 cfs | ND[5] |
| GCOBDITCH | " | ___ | 15.75, 12.92 | | ___ |
| GCOBD2 | " | 2.0 | 12.16, 12.36 | | ___ |
| GC4 | " | ___ | 1.58, 0.85, 1.40 | | ND |
| GC3 | " | ND | 1.75, 2.91 | | ND |
| GCSP3 | " | | 7.62, 9.37 | | ___ |
| GCSP4 | " | ND | 3.20, 3.19, 4.03 | | ___ |
| North Fork (control #2) | " | ___ | 1.32, 2.72 | | ___ |
| GCSP1 | " | 3.0 | 12.17, 13.02 | | ___ |
| GC2 | " | 0.5 | 2.99, 3.32 | | ND; <0.1 |
| IR1 | " | ND | 0.68, 0.90 | | ___ |

***Forest Service and Contractor Stream Flow Measurements at Granite Creek***

On October 15, 2001, the Forest Service Sitka District Office hydrologist (Steve Paustian) and the CBS contractor for the TMDL (Redburn Environmental & Regulatory Services) completed a cross-sectional flow transect using a Price AA meter and top-setting rod at the GC1 reference station below the Halibut Point Bridge crossing of Granite Creek. A permanent stream elevation reference mark (RM) was established on the underside of the bridge for future measurement of stream elevation. A flow of 12.869 cfs was measured for October 15 @1300 hours (clear day, no rain), coinciding with a stream elevation of 84 1/8" as measured relative to the RM. Flow velocity was also estimated at 4 ft/sec on October 17 (a day of heavy rain), and when multiplied by the wetted cross-sectional area of the stream at the transect site, provided an estimated flow rate of 184 cfs. This flow rate was roughly 14 times higher than the flow rate just two days previous. These two events help to bracket the range of flow conditions for Granite Creek during fall periods. This information, when compared with simultaneous flow measurements at

[5] ND = nondetectable. Less than 0.1 ml/l using the Imhoff cone.

the USGS Indian River gaging station, provides the basis for developing the flow ratio between Granite Creek and Indian River and was used to estimate average monthly flows for Granite Creek.

### *USGS Flow Gage/Flow Rate Information for Indian River*

Daily and monthly stream flow rates (cfs) have been recorded by the USGS at two stations on Indian River in Sitka over several years *(Appendix)*. The lower station has been maintained continuously since October 1998. A stage-discharge curve has been developed and stream elevations are recorded in 15-minute increments for later extrapolation to flow (cfs) for that particular time increment.

Indian River flow data are essential and critical to extrapolating to Granite Creek flow data since Granite Creek does not currently have a stream gaging station. The ratio of Granite Creek flow/Indian River flow was measured on three different occasions during October 2001 and November 2001, as were TSS and turbidity concentrations in these drainages. Average monthly flow of Granite Creek is estimated at 22.8% of Indian River's average monthly flow, based on the three simultaneous flow measurements.

Granite Creek flow responds quickly (within 4 hours) to heavy rain events. This short lag time indicates that flow rate is influenced principally by precipitation and overland runoff, with a smaller but unquantifiable groundwater contribution. Granite Creek flow is estimated to peak approximately 4 hours before Indian River. The Granite Creek watershed is roughly 17 % of the size of the Indian River watershed. Peak monthly discharges and precipitation in both the Indian River and Granite Creek watersheds occur during September and October. This represents the period of maximum runoff and increased nonpoint source sediment loading from industrial gravel operations. Salmon egg incubation in Granite Creek occurs during winter low flow periods (January through April). It is are critical to maintain adequate water flows for oxygenating eggs in spawning gravels and to limit sediment inputs during such periods of reduce sediment transport.

### *Other Historical Water Quality and Habitat Surveys*

Water quality and fisheries concerns were identified for Granite Creek as early as the 1970s. North and South Forks (tributaries) are anadromous (ADF&G catalog number 113-41-10170), principally supporting coho and pink salmon and Dolly Varden trout. Woodward-Clyde Consultants was contracted in 1982 to complete a Granite Creek Operation and Reclamation Plan as an element of an overall Sitka Gravel Resource and Management Study (1982). The report examined operational methods for Granite Creek material sites that were compatible with federal and state water environmental regulations, the development objectives of the City and Borough of Sitka, and the current operations at the site. Recommendations were provided to meet environmental standards.

## Pollutant Sources

Potential pollutant sources in the Granite Creek watershed must be assessed to evaluate the type, magnitude, timing and location of sediment loading to Granite Creek. Source assessment includes identifying the types of sources, the relative location and magnitude of loads from each source, and the transport mechanisms and runoff coefficients. This evaluation uses several approaches, including existing water quality monitoring information, aerial photographs, extrapolation from similar watersheds, and regression analysis. The methods for determining existing and allowable sediment loads to Granite Creek were based on the best available monitoring data, methods used in previously approved sediment TMDLs (e.g. Duck Creek and Lemon Creek), and published values for similar land uses.

### Point Sources

No individual NPDES-permitted point sources discharge to the Granite Creek watershed. Therefore, individual discharge permits and effluent limitations are not relevant tools to limit sediment and turbidity in Granite Creek. Granite Creek is listed as impaired exclusively from nonpoint source operations affecting water quality (ADEC, 1999).

### Nonpoint and Natural Sources

The 1998 Alaska Section 303(d) list identifies Granite Creek as impaired from nonpoint sources. Gravel mining is listed as the source. Industrial gravel operations include activities such as stripping overburden, excavation, material stockpiling, blasting and crushing rock, and road transportation and maintenance. In addition, less significant sediment sources were also addressed. Winter road maintenance, recreational areas, residential/light commercial and overburden disposal sites were each evaluated. An estimate of existing in-stream sediment loads from these activities was developed for comparison with the allowable in-stream loading capacity for Granite Creek. Bank erosion and bedload transport are considered relatively insignificant sources of sediment compared to stormwater runoff from roads, pit areas, gravel operations, and sheet flow from non-vegetated surfaces. In any case, no data exists on which to estimate bank erosion and bedload transport.

The information available does not allow for the development of an exact estimate of sediment transported into Granite Creek, but does provide sufficient information to address total loading, the relative contributions of main sources of sediment, and reductions needed to attain water quality standards.

To supplement in-stream existing load calculations based on available TSS and turbidity data, an analysis of watershed, or land use-based, loadings was conducted to address the relative contributions of sediment from gravel operations, roads, recreational areas, overburden sites, and residential/light commercial developments (*Table 4)*. Published runoff coefficients and typical TSS concentrations for each land use type were used to calculate expected sediment transport.

*Analysis of In-stream Data (TSS)*

Granite Creek TSS monitoring data are summarized in *Table 1 and 2*. Suspended sediment concentrations in Granite Creek vary as a function of rainfall, flow, proximity to stream, type of land use, runoff coefficient and TSS concentrations in typical runoff.

A key variable guiding estimates of monthly in-stream sediment loads in Granite Creek is the TSS-flow relationship. While insufficient data exist to support a statistically significant regression equation, data are sufficient to bracket high and low ranges. Direct TSS-flow data sets exist for flows less than 23 cfs and for flows of 186 cfs. Turbidity data exists for flows between this range, but no direct TSS measurements. However, the TSS concentration for intermediate flows can be reasonably estimated based on a combination of historical turbidity data, rough estimates of flow, the statistically-supportable conversion of turbidity- to-TSS, and best professional judgement based on several years of monitoring operations in the watershed. This approach is consistent with EPA's guidance that allows for the use of best available information in developing TMDLs.

Based on the above information, the following relationship of flow-to-TSS was used to estimate monthly existing in-stream sediment loads in Granite Creek. [6]

< 15 cfs = 1.0 mg/liter average monthly TSS concentration
15-35 cfs = 5.0 mg/liter average monthly TSS concentration
35-50 cfs = 8.0 mg/liter average monthly TSS concentration
>50 cfs = 10.0 mg/liter TSS average monthly TSS concentration

For purposes of calculating sediment loads, the only deviation from the values above was for April and May, where an average value of 7 mg/liter TSS was used rather than 5 mg/l because of the slightly increased sediment load (from winter sanding) expected to be released from melting snow adjacent to the stream.

As stated earlier, Granite Creek does not currently have a continuous flow meter or staff gage to provide instantaneous, daily or monthly stream flow data. Monthly average flows for Granite Creek were estimated using the following method.

Flow (cfs) measurements at Granite Creek were made on three intervals to capture a range of high and low flow events: October 15, October 17 and November 20, 2001. Measured flows ranged from 12.8 cfs to 186 cfs. For each date and time, measured flow was compared to the corresponding flow for that date and time for Indian River in the Sitka area. The USGS maintains flow records at 15-minute intervals at Indian River *(see Appendix*) and these tables were used to develop a ratio of Granite Creek flow/Indian River flow for a given time.

[6] Conservative estimates used. See discussion under Margin of Safety section.

The three simultaneous flow measurements taken at both creeks showed a ratio of Granite Creek flow/Indian River flow of 16.28%, 24.67%, and 28.0%, with a mean of 22.8%. Using this ratio, mean monthly flows for Indian River covering the period of record (October 1998 to September 2000) were multiplied by 0.228 to calculate the corresponding average monthly flow for Granite Creek. Those values are recorded in *Table 3, column 2.*

The TSS-flow relationship on page 23 provides the basis for estimating tons of sediment per month in Granite Creek.

Average monthly in-stream TSS loads (tons) are calculated by multiplying the estimated average monthly Q (flow) in cfs by the average monthly TSS concentration (mg/l) for that flow category (taken from page 19). This number is multiplied by 0.0027 to convert the result to tons/day. The resulting number is *tons/day* of TSS. Tons/day is multiplied by the number of days in the respective month to yield *tons TSS/month*. These values are shown in the last column of *Table 3.*

Using January as an example, the existing in-stream TSS load for that month is calculated as:

*20.98cfs * 5.0 mg/liter TSS * 0.0027 * 31 days in the month = 8.78 tons TSS*

Each month was calculated in this way. All months were summed to provide an annual yield of 140.85 tons of TSS in Granite Creek generated from all land use sources.

Absent continuous water quality monitoring data, this approach relies on best available information and reasonable assumptions on estimating average monthly TSS concentrations.

**Table 3.** Monthly existing (in-stream) suspended sediment loads in Granite Creek

| Month | Average Monthly Flow (cfs) [7] | Existing In-Stream Suspended Sediment (TSS) Load (tons)[8] |
|---|---|---|
| January ⎧ | 20.98 | 8.78 |
| February ⎧ | 6.06 | 0.46 |
| March ⎧ | 9.37 | 0.78 |
| April ⎧ ⎨ ⎩ | 18.40 | 10.43 |
| May ⎨ ⎩ | 24.17 | 14.16 |
| June | 23.94 | 9.70 |
| July ⎪ | 14.84 | 1.24 |
| August ⎪ | 12.11 | 1.01 |
| September ⎪ | 38.30 | 24.82 |
| October ⎪ | 53.58 | 44.85 |
| November ⎪ | 13.70 | 1.11 |
| December | 35.11 | 23.51 |
| **Annual Total** | | **140.85 tons** |

⎧ Critical period for coho salmon egg and alevin development in Granite Creek
⎨ Critical period for coho fry emergence
⎩ Coho smolting period
⎪ Corresponds to critical period for adult coho spawning migration into Granite Creek

*Watershed-Based Loading Estimates for Sediment (TSS)*

Granite Creek is affected by a variety of nonpoint sources, principally gravel mining operations.

[7]Based on a measured Granite Creek/Indian River flow ratio of 22.8%. Average monthly flow is calculated as 22.8% x average monthly flow for Indian River for the respective month. USGS monthly mean flow data on Indian River used for this purpose covered the period October 1998 through September 2000 (Water Year 1999 and WY2000).

[8] Tons of TSS/month = 0.0027 * monthly average Q (cfs) * average TSS (mg/l) from page 64 * # days in the month. Monthly loads are based on analysis of in-stream water quality data correlated to flow data.

The existing in-stream loads shown in *Table 3* integrate *all* source contributions and do not distinguish loads between specific sources. After calculating the existing in-stream load in Granite Creek, the next step is to determine the relative contribution of *each* source to the total load.

Estimating the tons of sediment delivered to Granite Creek from *each* of these sources requires making assumptions about source-specific runoff coefficients, typical TSS concentrations in runoff by source, and the acreage represented by each source. Absent site-specific runoff information, published values (see citations in footnote 9 below) were used in the water quality analysis. Land use types, area in acres, runoff coefficients, and typical TSS concentrations in runoff are summarized in *Table 4*. An annual precipitation of 120 inches (10 feet) was used for Granite Creek to calculate acre-ft/year in runoff. Historical precipitation records for the Sitka airport are found in the *Appendix.*

Watershed land uses were grouped into the following categories: 1) industrial gravel operations; 2) overburden waste disposal sites; 3) roads; 4) residential/light commercial; and 5) recreational areas. Acreage for each land use was obtained from CBS lease maps for the area *(see Figure 2)*. Published land use-specific runoff coefficients and estimates of [sediment] in runoff, measured as TSS concentration in mg/l, were used in the calculations (*Table 4)*.

**Table 4.** Land uses contributing sediment in the Granite Creek watershed and typical sediment (TSS) concentrations in runoff.

| Land Use Type | Area (acres) | Runoff Coefficient | TSS Concentration (mg/l)[9] |
|---|---|---|---|
| Industrial gravel operations, settling ponds & stockpiles | 50 | 0.45 | 300 |
| Overburden waste disposal sites | 14 | 0.20 | 200 |
| Roads and grading (Granite Creek road, Benchland and Golf Course roads) | 3 | 0.50 | 300 |
| Residential-light commercial | 11 | 0.27 | 212 |
| Recreational areas (Driving Range, Halibut Pt. Rec Area), and proposed Golf Course) | 39 | 0.23 | 200 |

[9] Values estimated from Bennerman (1994), Lorentz (1998), and Horner (1992)

The estimated sediment loading (tons/year) to Granite Creek *for each source* category is estimated by multiplying the *source acreage x [TSS] mg/l x runoff coefficient for source x annual precipitation (ft/year) x 43,560 cubic ft/acre-ft x 28.31 liters/cubic ft x kg/10 mg x 2.2 lb/kg x tons/2000 lbs*

(Note: The last 5 factors in the equation are conversion factors to allow calculation in tons/year)

Using the industrial land use category as an example, this equation yields:

*50 acres * 300 mg/liter * 0.45 * 10 ft/yr precipitation * 43,560 ft³/acre-ft * 28.31 liters/ft³ *6 kg/10 mg * 2.2 lb/kg * tons/2000 lb = 91.80 tons TSS/year into Granite Creek from industrial gravel operations*

All five source categories were calculated in this way and total monthly and annual source loads are shown in Table 6. Winter road sanding sediment contributions are also included as a category and are described below.

The percentage of the total existing in-stream load contributed by each source is:

Industrial: 65.17%
Overburden waste disposal sites: 5.41%
Road runoff and grading: 4.45%
Residential/light commercial: 6.08 %
Recreational areas: 17.32%
Winter road sanding and maintenance: 1.55%

The monthly suspended sediment loads for each source were calculated by multiplying the percentage above times the existing monthly in-stream load in *Table 3*.

*Winter Road Maintenance Load Estimate (TSS)*

Application of sand and gravel to Granite Creek Road (the access road to gravel leases and other operations in the watershed) generally occurs from November through February. There exists a variable width vegetated setback between the road and Granite Creek along its length, acting to moderate sedimentation to the creek. City and Borough staff perform winter road maintenance. One pass (application) is made on the road up to 30 times per winter. The composite is roughly 75% sand and 25% gravel. Sand is more transportable and is the fraction of most interest in calculating sediment runoff and loads to creeks.

The annual load (tons) of sand and gravel applied to the road - and the % transported to Granite Creek - was estimated using the following values (Brian Bergman, CBS, personal communication):

(30 applications/yr) x ( 0.25 cyds/application) x (1.3 tons/cyd) x (75% sand content) x (30 % delivery rate to creek)

Plugging in the numerical values results in an annual estimate of 2.19 tons of TSS/year transported to Granite Creek (1.55 % of total sediment load). This annual amount is allocated among the months of November through June.

**Analytical Approach**

Developing a TMDL for Granite Creek requires technical analysis of data, extrapolation from other similar watersheds, a site-specific understanding of watershed processes and the seasonality of industrial operations, and interpretation of watershed loadings. The following principles were applied to developing the Granite Creek TMDL:

1. The TMDL must be based on reasonable and acceptable assumptions and accepted scientific analysis. Assumptions have been made based on best available water quality and flow data and in full consultation with CBS staff, USGS and Forest Service hydrologists, and ADEC and ADF&G water quality and fisheries specialists.

2. The TMDL must use the best available information. Granite Creek lacks water quality data for some months of the year, particularly during winter and summer months. All available TSS and turbidity data for the Granite Creek watershed were reviewed and used in the analysis as appropriate. Water quality and flow data from the nearby Indian River watershed were also reviewed and included in the analysis for comparative purposes and for estimation of flow conditions.

3. Available data and the diffuse, nonpoint nature of the pollutant sources did not support, or require, the use of complex watershed or water quality models.

4. Methods used should be clear and simple to allow understanding by the target audience and general public. Methods and calculations are described in detail, along with numerous tables and figures. Major assumptions are clearly stated.

The analytical approach used to estimate allowable loading capacity, existing in-stream sediment loads, and load allocations and reductions among sediment sources relies on the above principles.

**Loading Capacity**

An important element of the TMDL is identifying the relationship between the *allowable or desired* condition of Granite Creek (expressed as the water quality standard) and the *actual, or existing*, condition for sediment and turbidity loading. This relationship determines the degree to which Granite Creek exceeds its assimilative capacity for sediment.

The allowable sediment load, or loading capacity, defines the upper limit for sediment loads while still meeting water quality standards and supporting fisheries, recreation and other protected uses of the creek.

Alaska water quality standards limit allowable turbidity to 5 NTUs above natural conditions to protect the drinking water use - the “default” designated use for Granite Creek. The turbidity criterion for the aquatic life use may not exceed 25 NTUs above natural conditions.

A sufficient turbidity database exists for the upper reaches of Granite Creek (unaffected segments of the North and South tributaries) to establish natural background conditions for turbidity. Historical data from 1996 to the present were analyzed. A mean natural turbidity value of 1.64 NTU was calculated from using all available data.

Therefore, the following assumptions were made:
1. Granite Creek has a natural background turbidity of *1.64 NTU*.
2. A turbidity of 1.64 NTU + 5 NTU = *6.64 NTU* as the target turbidity water quality standard

Another important conversion is necessary to allow for a quantitative calculation of sediment loading capacity for Granite Creek. The majority of water quality data collected from Granite Creek is turbidity. Turbidity is an optical property and is a measure of the amount of light-scattering particles in the water. Loading capacities are most often expressed as a mass per unit time. Not being a measure of the weight of particles in water, turbidity cannot be used directly to calculate pollutant loads (in tons of sediment) or load allocations. Conversion of turbidity values to TSS values is necessary to estimate sediment loads gravimetrically (by weight, in tons). Total suspended solids (TSS) is the selected parameter used here to represent sediment (and turbidity) loads to Granite Creek.

Defining the mathematical relationship between TSS and turbidity through simultaneous measurements was a central focus of water quality monitoring in October and November 2001. Over 16 TSS grab samples were collected from various stations in the watershed and analyzed for the development of a regression equation. Turbidity was measured simultaneously on-site at each station using a Hach 2100P portable turbidimeter.

Regression analysis was completed on the data sets to establish the TSS-turbidity relationship. Sixteen data sets were plotted. The following equation describes the relationship between TSS and turbidity:

$$\text{TSS (mg/l)} = [1.075 \text{ (turbidity in NTUs]} - 1.681$$

The correlation coefficient for the data is a highly significant 0.9676. A linear relationship exists.

Using this conversion formula, the *allowable target level for TSS is calculated as 5.46 mg/liter, of which an average of 1.0 mg/liter is natural background*. This target level was used to calculate the TSS loading capacity on a monthly basis for Granite Creek as follows:

*average monthly flow (cfs) * 5.46 mg/liter TSS * 0.0027 * # days in the respective month*

Monthly sediment (TSS) loading capacity for Granite Creek, which includes the natural sediment load, is summarized in *Table 5*. Load capacity varies as a function of monthly flow. The monthly load capacities set the "ceiling" for allowable sediment inputs to the creek from all sediment sources in the watershed. ***The annual load capacity for Granite Creek is 122.00 tons of TSS.*** Monthly allowable loads vary from 2.50 tons to 24.80 tons. The natural background sediment load in Granite Creek is 22.63 tons of TSS. Natural background loads are included as part of the calculated loading capacity of Granite Creek. These values are fixed and all load reductions/allocations are designed to meet these values.

The 5.46 mg/liter target for TSS (= 6.64 NTU turbidity) applies throughout the year, as natural background turbidity varies little throughout the year. In order to recognize seasonal flow regimes, the seasonality of some operations in the watershed, and critical periods for salmon and recreational resources in Granite Creek, monthly sediment loading capacities were calculated.

A second conversion approach was examined to see how it compared with the primary method. Lloyd, Koenings, and LaPerrierre (1987) examined the relationship of turbidity to sediment in fresh waters in parts of Alaska. They developed the following equation to convert turbidity to SSC: [10]

Turbidity (NTU) = 1.103* [SSC (mg/l)]0.968

This equation, while developed from data gathered from streams in Interior Alaska, also fit quite well to the Granite Creek data, suggesting the TSS-turbidity relationship used here is sound.

[10] [SSC] and [TSS] are considered be equal in the Granite Creek watershed, as discussed in the narrative. Mineral soils predominate and have a very low concentration of organics.

**Table 5.** Monthly Suspended Sediment (TSS) Loading Capacity for Granite Creek

| Month | Average Flow (cfs) | Natural Background Load (tons) / (tons/day) | Loading Capacity for TSS (tons)[11] |
|---|---|---|---|
| January⎧[12] | 20.98 | 1.86/(0.06) | 9.59 |
| February⎧ | 6.06 | 0.56/(0.02) | 2.50 |
| March⎧ | 9.37 | 0.93/(0.03) | 4.28 |
| April⎧⎨⎩ | 18.40 | 1.50/(0.05) | 8.14 |
| May⎨⎩ | 24.17 | 2.17/(0.07) | 11.05 |
| June | 23.94 | 1.80/(0.06) | 10.59 |
| July ⎪ | 14.84 | 1.24/(0.04) | 6.78 |
| August⎪ | 12.11 | 0.93/(0.03) | 5.53 |
| September⎪ | 38.30 | 3.00/(0.10) | 16.94 |
| October⎪ | 53.58 | 4.34/(0.14) | 24.49 |
| November⎪ | 13.70 | 1.20/(0.04) | 6.06 |
| December | 35.11 | 3.10/(0.10) | 16.05 |
| **Annual Total** | | **22.63** | **122.00**[13] |

## Source Load Estimates

A variety of sediment sources exist within the Granite Creek watershed. These include industrial gravel operations, road runoff and maintenance, winter road sanding, residential/light

[11] Monthly load capacity based on analysis of in-stream data. Includes natural background sediment load. Calculated as: (Monthly Q (cfs)) * (5.46 mg/liter TSS) * (0.0027) * (# days in month).

[12] See Table 3 for explanation of critical fisheries periods.

[13] Load capacity (tons) includes sum of existing loads, future loads (LA/WLAs) and any explicit MOS.

commercial runoff, roads, natural sources, sediment retention ponds, recreational areas (Golf Course and driving range) and the municipal overburden sites. Table 6 summarizes annual and monthly source load estimates (in tons) by source type, based on the runoff coefficients, acreage and average TSS values shown in *Table 4*, and using the percentages and calculation methods described earlier in the section Watershed-Based Loading Estimates.

**Load Allocations (LAs) and Target Load Reductions**

Load reductions are the reductions in sediment source loads needed so that the total sediment load to Granite Creek from all sources is less than or equal to the allowable load capacity of the creek (*Table 7*). Load reductions represent the difference between the existing in-stream load and the load capacity for the particular month. For seven months of the year, no load reductions are necessary since the estimated load to the creek is less than the allowable load capacity. Percent reduction is calculated as:

$$\frac{\text{Existing in-stream load(tons) - load capacity (tons)}}{\text{Existing in-stream load (tons)}} \times 100$$

Using May as an example, $\frac{\text{14.16 tons - 11.05 tons}}{\text{14.16 tons}} \times 100$ = 22 percent reduction or 3.11 tons

The load allocation for May is therefore 14.16 tons - 3.11 tons = 11.05 tons

EPA regulations (40 CFR§ 130.2(g)) require that a TMDL include load allocations (LAs), which identify the portion of the sediment loading capacity allocated to existing and future nonpoint sources and to natural background. Load allocations may range from reasonably accurate estimates to gross allotments. Separate load allocations are given to natural background and to future sources (Tables 8 and 9). The total load allocations for existing sources and future sources must be equal to or less than the total load capacity of Granite Creek. An implicit margin of safety (MOS) was used because of the already conservative TSS concentrations (monthly averages) that were used in the calculations. Therefore, a MOS of zero (0) tons was allocated.

Load allocations are the basis for permitting actions and developing and evaluating best management practices. Implementation of best management practices and evaluation of their effectiveness against the target levels for TSS and turbidity have been - and will remain - the focus of control actions in the watershed.

Tables 7 through 9 summarize source load estimates, target load reductions, and the source-specific load allocations for Granite Creek. It is important to note that these initial load allocations will likely need to be updated as further monitoring data becomes available for all months of the year. This iterative approach is typical for TMDLs based on less than optimal data.

**Table 6 .** Estimated Existing Monthly Suspended Sediment Load (tons) to Granite Creek, by Source

| Month | Industrial Gravel Operations[14] | Overburden Waste Disposal Sites | Road Runoff and Grading | Residential-Light Commercial | Recrea-tional Areas | Winter Road Sand/ Mainten.[15] |
|---|---|---|---|---|---|---|
| January | 5.72 | 0.47 | 0.39 | 0.53 | 1.52 | 0.25 |
| February | 0.36 | 0.03 | 0.02 | 0.03 | 0.10 | 0.21 |
| March | 0.61 | 0.05 | 0.04 | 0.06 | 0.16 | 0.11 |
| April | 6.80 | 0.56 | 0.46 | 0.63 | 1.81 | 0.16 |
| May | 9.23 | 0.76 | 0.63 | 0.86 | 2.45 | 0.23 |
| June | 6.32 | 0.52 | 0.43 | 0.60 | 1.68 | 0.15 |
| July | 0.81 | 0.07 | 0.06 | 0.08 | 0.22 | 0 |
| August | 0.66 | 0.05 | 0.04 | 0.06 | 0.20 | 0 |
| September | 16.38 | 1.34 | 1.10 | 1.51 | 4.49 | 0 |
| October | 29.01 | 2.40 | 1.98 | 2.71 | 7.71 | 0 |
| November | 0.78 | 0.06 | 0.05 | 0.07 | 0.21 | 0.22 |
| December | 15.32 | 1.27 | 1.05 | 1.43 | 4.07 | 0.36 |
| **Total Annual (140.85 tons)** | **91.80** | **7.62** | **6.27** | **8.57** | **24.40** | **2.19** |

[14] Includes existing gravel lease operations, material stockpiles, and settling ponds.

[15] Available for delivery to Granite Creek from direct deposit to the stream banks and from snow melt during March, April and May. Estimated from CBS figures (Bergman) using 30 applications x 0.25 cyd/applic x 1.3 tons/cyd x 75% sand content x 30% delivery ratio to creek

**Table 7.** Monthly Suspended Sediment (TSS) Load Reductions and Load Allocations for Granite Creek

| **Month** | **Existing In-Stream Sediment (TSS) Load (tons)** | **Load Capacity for TSS (tons)**[16] | **Required Reduction in Existing Load (%) / (tons)** | **Load Allocation (tons) - (Option 1- Table 8 )** | **Load Allocation (tons) (Option 2 - Table 9)** |
|---|---|---|---|---|---|
| January | 8.78 | 9.59 | (0%) / 0 | 8.78 | 8.78 |
| February | 0.46 | 2.50 | (0%) / 0 | 0.46 | **1.50** |
| March | 0.78 | 4.28 | (0%) / 0 | 0.78 | 0.78 |
| April | 10.43 | 8.14 | (22%) / 2.29 | 8.14 | 8.14 |
| May | 14.16 | 11.05 | (22%) / 3.11 | 11.05 | 11.05 |
| June | 9.70 | 10.59 | (0%) / 0 | 9.70 | 9.70 |
| July | 1.24 | 6.78 | (0%) / 0 | 1.24 | **2.75** |
| August | 1.01 | 5.53 | (0%) / 0 | 1.01 | **3.00** |
| September | 24.82 | 16.94 | (32%) / 7.88 | 16.94 | 16.94 |
| October | 44.85 | 24.49 | (45%) / 20.02 | 24.49 | 24.49 |
| November | 1.11 | 6.06 | (0%) / 0 | 1.11 | **3.00** |
| December | 23.51 | 16.05 | (31%) / 7.46 | 16.05 | 16.05 |
| **Total Annual** | **140.85** | **122.00** | **41.10** | **99.75** [17] | **106.18**[18] |

The goal in assigning load reductions to specific sources is to fairly distribute the burden among

[16] Loading capacity includes natural background sediment load.

[17] Represents load allocation for *existing* sources. 122.00 - 99.75 = up to 22.25 tons TSS are reserved for allocation among *future* nonpoint and point sources (Table 8).

[18]Under an alternative (Table 9), 6.43 tons of TSS will be taken from the future allocation, bringing the existing source load allocation to 106.18 tons TSS/year (99.75 tons + 6.43 tons) and reducing future LA/WLAs to 15.82 tons TSS/yr. This extra allocation is made available from 4 of the 7 months where there is an “excess” load capacity (load capacity exceeds existing estimated in-stream loads). These four months are shown in **bold** in the last column.

all affected sources. The target load reductions and allocations in Tables 8 and 9 were carefully scrutinized by the municipality so that all sources shared in the reductions proportionate to their sediment contributions and their ability to affect necessary controls.
Two optional approaches provide the necessary sediment reductions. Option 1 (*Table 8*) is contingent on securing new funds to reroute the ditchwater/drainage from the golf course and existing overburden waste site directly into Sitka Sound. This action alone would go a long ways to meeting the required sediment load reductions in the watershed and would considerably reduce the burden on the remaining sources. Both options are provided in the public review draft to solicit comment.

In summary, an overall annual reduction of TSS of approximately 29 percent for existing sources is required to bring the sediment loads to within Granite Creek's annual loading capacity. In order to achieve these reductions, a variety of control actions will be employed. These are expected to collectively achieve the necessary reductions. The monthly load reductions should be achievable by following the best management practices discussed in the Implementation Section. As mentioned earlier, considerable structural improvements (e.g. construction of a series of settling ponds and ditching by the municipality) have been recently completed towards this objective. Additional ponds will soon be constructed. Rerouting ditchwater away from the creek would be a very effective control. Control of sediment transported by runoff from roads is expected to be more difficult to successfully implement due to the highly erodible nature of the soils. Nonetheless, roads do not contribute a significant amount of sediment to Granite Creek.

*Settleable Solids and Gravel Embeddedness*

No evidence exists to indicate that streambed gravels are impacted by the heavier, settleable fraction of sediments. The nature of operations and runoff from gravel lease operations, confirmed through water quality monitoring, support a focus on turbidity and total suspended solids. This TMDL was prepared for these two parameters consistent with the 303(d) listing.

While settleable solids are not an indicator parameter under this TMDL, the load "target" is to eliminate the non-natural load of heavy sediments. Settleable solids concentrations measured at a number of stations in October and November 2001 were all non-detectable (i.e. < 0.2 ml/l). The only exception was a single sample taken on October 17, 2001, during a heavy rain event. A concentration of 0.15 ml/l was detected, but is thought to be likely due to resuspended bedload sediments from the high velocity flow.

Settleable solids will be further reduced, along with TSS and turbidity, by the newly constructed series of four settling ponds in the upper drainage. All surface flow from the North tributary side of the leases is now diverted to these ponds for retention and treatment prior to discharge into the North Fork of Granite Creek. The increased retention time has reduced the heavier, settleable fraction of sediment to non-detectable levels.

**Wasteload Allocation (WLAs)**

Existing target load reductions in sediment for Granite Creek are associated with nonpoint sources. Because no individually permitted point sources contribute to the sediment impairment of Granite Creek (for which effluent limitations could be a control), the wasteload allocation for existing sources was set to zero. A sediment load allocation (tons/year) for future growth is provided in Tables 8 and 9. This allocation is reserved for future nonpoint sources (LA) or point sources (WLA), or a combination of both, as determined by the future development plan for the watershed.

**Margin of Safety (MOS)**

EPA regulations require the incorporation of a margin of safety (MOS) in the TMDL analysis. The MOS accounts for any uncertainty or lack of knowledge concerning the relationship between pollutant load allocations and water quality. EPA guidance specifically allows the option of including the MOS in the TMDL analysis either implicitly through conservative assumptions or explicitly as a stand-alone portion of the total load allocation. An implicit MOS must be supported by a discussion of the conservative assumptions used and how they adequately account for uncertainties.

A MOS for Granite Creek is included implicitly in the TMDL source load calculations through a series of conservative assumptions. The assumptions that support this approach were:

1. *The contributions of sediment to Granite Creek typically are episodic and variable*, rather than continuous, and are typically tied to heavy rainfall, seasonality of operations, and settling pond maintenance schedules. Estimating monthly in-stream sediment loads based on assumptions of a continuous, average monthly TSS concentration is conservative. Once additional longer-term water quality data are available for all months (using an average TSS value of multiple samples taken over each month), improved estimates of monthly TSS concentrations can be made.

2. *Recently installed settling ponds and ditching have reduced sediment loads.* Water quality data used in the TMDL analysis include that collected both before and after these structural improvements. Using all this information tends to bias the analysis towards being conservative, with higher turbidity values measured prior to pond installation.

3. *The use of TSS rather than SSC to represent sediment loads.* Total suspended solids were selected to represent sediment for this TMDL. The justification for this was described earlier. Since TSS includes any organic as well as inorganic sediment particles, its concentration will be either equal or greater than the suspended sediment concentration (SSC), which only measures inorganic sediments. Loads estimated using TSS are therefore inherently higher than or equal to loads estimated using SSC concentrations. This errors on the conservative side for estimating sediment loads.

4. *The use of an estimated 10 mg/l TSS average monthly concentration for the high flow category (>50 cfs).* The maximum measured [TSS] in October was 20.4 mg/l @ a flow of 186 cfs. No sediment (TSS) data exist for flows between 50 cfs and 186 cfs, and average monthly TSS concentrations for this flow category had to be estimated using historical turbidity data and best professional judgement (BPJ). Given that chronic sedimentation of Granite Creek is not typical of operations, using a average monthly level of 10 mg/l to represent flows >50cfs is somewhat conservative and serves as a "built in" margin of safety until more TSS data are collected for this flow range over several months. The TSS-flow relationship may be modified based on this information.

Taken collectively, these approaches tend to overestimate actual sediment loadings and provide the required "built in" margin of safety pending acquisition of more complete long-term monitoring data. An implicit margin of safety is therefore justified.

**Table 8.** Annual Sediment Source Load Allocations (tons/yr), Granite Creek (Option 1) [19]

| Source | Source Sediment Load (tons/yr) | Contingent Target Load Reduction (%) | Contingent Load Allocation (tons/yr) | Load Capacity (tons/yr) |
|---|---|---|---|---|
| Industrial Gravel Operations | 77.04 | 18 | 63.25 | |
| Overburden waste Disposal Sites ¬ | 6.40 | 90 | 0.64 | |
| Road Runoff and Grading | 5.26 | 30 | 3.63 | |
| Residential-Light Commercial | 7.19 | 35 | 4.68 | |
| Recreational Areas ¬ | 20.48 | 85 | 3.07 | |
| Winter Road Maintenance | 1.85 | 0 | 1.85 | |
| Natural | 22.63 | 0 | 22.63 | |
| Total Existing Source | | | 99.75 | |
| Margin of Safety | | | 0 [20] | |
| Future Growth[21] | | | 22.25 | |
| **TOTALS** | **140.85** | | **122.00** | **122.00** |

[19] Target load reduction %s for sources indicated with a ¬ above are contingent on rerouting the existing ditchwater channel away from Granite Creek and directly into Sitka Sound. This diversion would significantly reduce sediment inputs from the existing overburden waste site, and the golf course/driving range. ADEC municipal matching grant funds (1:1 ratio) and other sources will be sought by the CBS for this project. Total costs are estimated at $75K- $100K.

¬ Drainage from these areas enters the mouth segment of Granite Creek; the majority of the creek's reach is unaffected by these inputs.

[20] MOS is implicit and included in conservative assumptions.

[21] Future growth allocations may include nonpoint sources (LA), point sources (WLA) or both.

**Table 9.** Annual Sediment Source Load Allocations (tons/yr), Granite Creek (Option 2)

| Source | Source Sediment Load (tons/yr) | Target Load Reduction (%) | Load Allocation (tons/yr) | Load Capacity (tons/yr) |
|---|---|---|---|---|
| Industrial Gravel Operations | 77.04 | 25 | 57.78 | |
| Overburden waste Disposal Site | 6.40 | 30 | 4.48 | |
| Road Runoff and Grading | 5.26 | 40 | 3.16 | |
| Residential-Light Commercial | 7.19[22] | 25 | 5.39 | |
| Recreational Areas | 20.48[23] | 45 | 11.26 | |
| Winter Road Maintenance | 1.85 | 20 | 1.48 | |
| Natural | 22.63 | 0 | 22.63 | |
| Total Existing Sources | | | 106.18 | 122.00 |
| Margin of Safety | | | 0[24] | |
| Future Growth[25] | | | 15.82 | |
| **TOTALS** | **140.85** | | **122.00** | **122.00** |

[22] Enters exclusively at mouth of Granite Creek; mainstem largely unaffected.

[23] Estimated 85% of load from this source enters at mouth of Granite Creek through a small ditchwater channel.

[24] MOS is implicit. See justification in narrative.

[25] Future growth allocations may include nonpoint sources (LA) and/or point sources (WLA).

## Seasonal Variation

Suspended sediment delivery to Granite Creek and its tributaries occurs to some degree throughout the year but is principally driven by heavy rain events. The shallow, mineral soils contain a high percentage of volcanic ash and erode easily during such events. Turbidity monitoring data confirm this relationship. To account for seasonal differences in sediment loading throughout the year, the TMDL provides monthly, combined-source, load allocations and load reductions and also includes annual load allocations and reductions by source category (see Tables 7 and 8). This approach is important in order to match loads against critical periods associated with the salmon stocks and recreational uses at the mouth of the creek. Critical periods for coho salmon are identified in *Table 3*. A particularly sensitive period is the low-flow period from January through March when coho and pink salmon eggs and alevin are incubating in spawning gravels. It is worth noting that during this period, sediment loading to Granite Creek is very low and well within the allowable loading capacity of the stream during this period. The period of highest potential fisheries conflicts exists during the September through December period - the high rain months in the Sitka area - and which corresponds to the adult salmon spawning migration period. Monthly load allocations and percent reductions are most important during these months and are addressed specifically through a variety of structural and operational BMPs identified in the Implementation Strategy and Action Plan.

## Quantifiable Endpoints and Indicators

Water quality *indicators* are Total Suspended Solids, turbidity and settleable solids. *Endpoints* are no increase in turbidity above 6.64 NTU, which is equivalent to no increase in TSS above 5.64 mg/liter. Settleable solids are limited to less than 0.2 ml/l in receiving waters, corresponding to the Method Detection Limit for the Imhoff Cone.

## Future Growth

The load allocations for existing sources and natural background are less than the total sediment load capacity of Granite Creek. *Tables 8 and 9* itemize existing and future source allocations under two scenarios. An allocation of up to 22.25 tons/yr (depending on the scenario) of suspended sediment is reserved for future sources operating in the watershed.

# MONITORING PLAN

Sediment-related impacts on designated uses are often difficult to characterize. Given the uncertainties of estimating source loadings, and the fact that nonpoint sources are involved, a reasonable expectation is that a water quality monitoring plan will accompany the TMDL. Such a plan should be geared towards confirming the effectiveness of structural and operational BMPs in meeting water quality standards, verify source estimates, validate TMDL elements, and confirm that structural BMPS are put in place and maintained.

The Monitoring Plan for Granite Creek was formalized in October 2001. The *Quality Assurance Project Plan for the Granite Creek Watershed Recovery Project and Total Maximum Daily Load (TMDL) Determinations* was approved by ADEC in October 2001. The QAPP guided water quality data collection in fall 2001 and will guide future data collection. The QAPP sets the objectives and schedule for future monitoring in the watershed. *Figures 4 and 5* show permanent monitoring stations established along the mainstem, North and South tributaries, and at the series of sediment retention ponds constructed in summer 2001. The location of stations is intended to assess individual source contributions as well as to document the integrated effects of all sources. Control stations are also included. Future, long-term monitoring will provide information that will:

- determine compliance with numeric in-stream TSS and turbidity targets
- verify the TSS-to-turbidity and TSS-to-flow relationships used in the TMDL
- access allowable sediment loads to Granite Creek
- assess effectiveness of operator BMPs in protecting water quality
- assess the degree of BMP implementation in the watershed
- detect and report significant changes in water quality and track water quality trends in the future
- restore/rehabilitate the watershed consistent with CBS lease requirements
- ensure collected data are of high quality and are used by the CBS and other agencies in managing lease operations in the watershed

The water quality monitoring parameters to be measured in the Granite Creek watershed are included in *Table 10*. Data Quality Objectives (DQOs) are included in the *Appendix*.

Sections B1.a and B1.b of the QAPP provide further details on monitoring site selection criteria and sampling parameters and collection frequency.

Stations for water quality monitoring are representative of the varied hydrologic, biological and physical/chemical conditions in the watershed as well as addressing several source activities. Accessibility to sampling sites was a major consideration. Representative stations are established on the main stem of Granite Creek (at the Halibut Point Road bridge site), a reference station prior to entering the gravel operation area, and both the north and south forks/tributaries to Granite Creek before they converge into the mainstem. Also, periodic sampling at selected settling ponds and drainage channels within the watershed are recommended using these criteria (*Figure 5*). Surface water quality will exclusively address sediments (settleable solids and total suspended solids), turbidity and flow. Confirming the mathematical relationship of turbidity -to-TSS for Granite Creek through further monitoring will allow for the use of turbidity alone as a cost-effective, surrogate means to evaluate compliance with sediment allocations.

**Table 10:** Water Quality Monitoring Checklist for the Granite Creek Watershed

| WQ PARAMETER | GRANITE CREEK MAINSTEM | NORTH AND SOUTH FORKS | SETTLING PONDS AND CHANNELS |
|---|---|---|---|
| *Primary measurements* | | | |
| -sediments (settleable solids) | X | X | X |
| -total suspended solids (TSS) | X | X | X |
| -turbidity (water clarity) | X | X | X |
| -flow velocity and discharge rate[26] | X | | |
| Additional measurements | | | |
| -petroleum hydrocarbons (oily visible sheen) | X | X | X |
| -suspended sediment concentration (SSC) [27] | X | X | X |
| -smolt counts(fry surveys)[28] | X | X | X |

USGS and Forest Service hydrologists have assisted the water quality contractor in documenting Granite Creek flow rates, establishing permanent benchmarks at the Halibut Point Road bridge for determining long term stream discharge rates, and providing stream discharge data for Indian River for comparison with Granite Creek. As mentioned above, the USGS may provide information on the relationship of SCC-to-TSS at Indian River.

A future recommended monitoring task found in the Implementation Plan is to develop a *stage-discharge curve* for Granite Creek. This curve would allow for estimating flow based on stream elevation readings, allowing for quick and accurate flow estimates. Direct long- term stream elevation data from Granite Creek will be obtained from the permanent reference mark made at

[26] A Price Type AA current meter or equivalent will be used to measure stream velocity.

[27] outside this project duplicate sampling for SSC and TSS may be conducted by the USGS to evaluate whether any major differences exist between parameters. For purposes of this TMDL, both measures are considered equivalent and October 2001 TSS data, plus converted historical turbidity data, were used exclusively for load allocation and load capacity calculations.

[28] Department of Fish and Game, Habitat Division, periodically conducts salmon and resident species population assessments in the upper watershed.

the Halibut Point Road bridge site in October 2001. This will allow for the eventual calculation of a stage discharge curve, where flow (cfs) can then be estimated directly from stream elevation. Stream elevation readings should be taken several times during all months of the year in concert with TSS and turbidity measurements. The result would lead to a more prescriptive TSS-flow relationship.

Given the tight schedule for development of the TMDL, water quality monitoring was envisioned to occur in two phases. During Phase 1, extending from October 1 through November 25, 2001, permanent stations were established on Granite Creek, staked for future reference, and monitored. These stations are selected to represent background conditions, integrate the downstream effects of all operations, and establish the relative contributions of sediment from each of the North Fork and South Forks of Granite Creek before they converge and enter the mainstem.

*Longer-term monitoring* will need to occur after the TMDL is approved to evaluate the effectiveness of sediment controls as well as to further refine the relationship of water quality to flow rate in Granite Creek.

Phase 2 monitoring will include periodic assessment of settling pond sediment and turbidity removal efficiency at two (2) upper creek stations and routine turbidity monitoring by CBS staff at the four permanent water quality stations (*Figure 4*) to evaluate compliance with water quality standards. Operator self-monitoring (checks for cloudy water) is encouraged to quickly detect and address short-term water quality problems. Same-day collection of simultaneous TSS and turbidity data will continue to occur at the Granite Creek bridge station. As mentioned above, simultaneous with the water quality data collection, Granite Creek flows/elevations will need further measurement at the Halibut Point Road/Granite Creek crossing to better establish a TSS-flow relationship. Local CBS environmental staff will be available to read the height/elevations over an extended period and report that information to the USGS for use in refining the stage discharge curve for Granite Creek.

Both CBS contractors and CBS staff will also report narrative or anecdotal environmental observations in addition to conducting discrete grab sampling and will use photographs to document conditions. For example, photographic time series will be used to evaluate drainage modifications within the gravel lease sites and the success of using various operational and structural BMPs to reduce sediment and turbidity levels in Granite Creek.

Principal users of the data will be the CBS Public Works Department, the responsible party for lease operations in the upper Granite Creek basin. Data collected will also be provided to the ADEC using the format required in the current grant agreement. ADEC will enter data into the STORET database. The approved TMDL will be included on the ADEC website. The posting will provide Sitka residents and resource agencies a picture of what will be done to improve water quality conditions.

## OPERATIONAL AND MANAGEMENT ISSUES AND CONTROLS

The February 2001 *Granite Creek Environmental Analysis: A review of lease site operations and recommended best management practices for water quality protection* explored a comprehensive series of operational and management issues and recommended sediment controls for the watershed. The analysis focused on gravel lease operations, as these are the primary source of sediment to Granite Creek. The reader is referred to the full EA for further details.

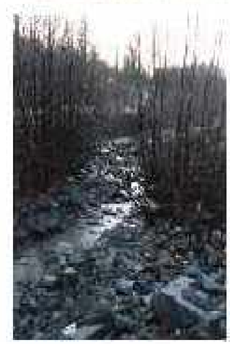
These controls -where implemented - are reasonably expected to result in reducing turbidity, suspended sediment and settleable solids input to Granite Creek and its tributaries to levels that consistently meet water quality standards during all periods of the year.

Major water quality and fisheries habitat issues for Granite Creek are listed below in italics, followed by recommended BMPs and other controls to bring operations back into compliance with water quality standards. The recommendations include both immediate and long-term BMPs. Those BMPs that should be followed in the near-term are noted with an asterisk (*). The Implementation Plan section of the TMDL includes both a near-term and long-term Action Plan and includes many of the tasks listed below.

***1. Operational Issues and BMPs***

*Issue 1: Required Stormwater Pollution Prevention (SWPP) Plans and Notice of Intent (NOI) to be covered under the general NPDES permit for the multi-sector category (Sector J)*

(*) 1. Individual gravel mining operators need to complete the required SWPP Plan - and the Notice of Intent (NOI) to be covered under the general permit - for the multi-sector category and submit it to EPA and ADEC. ADEC must review and approve it. Models of previously approved Plans should be provided to lessees who still need to file plans or update existing ones. Operators need to file a NOI with EPA to be covered under the General Permit prior to the spring 2001 operating season.



*Issue 2: Amendments to municipal lease agreements*

(*) 1. Strengthen the relationship between the CBS and lease operators through including the conditions of the SWPP as enforceable conditions of the municipal lease. (See additional amendments to existing language recommended in the earlier section).

(*) 2. Amend the leases "as a package" in concert with the operators before going before the Assembly for approval. This avoids multiple Assembly presentations and approval and is more time efficient.

*Issue 3: Buffers around Granite Creek and its North and South tributaries*

(*) 1. Establish and maintain functional buffers around the tributaries and main stem. Permanently stake and physically rope off buffers adjacent to critical stream areas so that alders and other vegetation can become established without encroachment from vehicles or operations.

2. Recognizing the goal of achieving a 50 ft buffer measured from OHW along each bank, establish a minimum 25 foot buffer along each side of watercourses consistent with Habitat Policy 10.1 in the Sitka CZM Plan. Use an ADEC, CBS and ADF&G team to delineate site-specific variations.

3. Prohibit vehicles from encroaching on the established buffers.

(*) 4. Prohibit fuel, oil or hazardous material storage within 50 ft of Granite Creek or its tributaries.

5. No overburden should be placed in Granite Creek or its tributaries.

*Issue 4: Drainage and erosion control*

(*) 1. Direct side drainage/ditch water from entering the pit run area and route it to settling ponds prior to discharge to Granite Creek and its tributaries.

2. Complete a surface water drainage plan for the entire Granite Creek lease area.

(*) 3. Construct berms, as needed, to intercept and divert surface runoff to the ponds.

4. Grade the pit floor area so that surface water and groundwater runoff flows towards collection ditches and settling ponds and not directly into the North or South Forks of Granite Creek.

5. The current restriction on blasting and earthmoving during heavy rains should be enforced by the CBS.

*Issue 5: Settling pond construction and maintenance*

(*) 1. Construct properly designed and engineered settling ponds to meet water quality standards for settleable solids and turbidity control. [29]

[29] In July 2001, CBS completed the installation of three new settling ponds, modifications to an existing pond, placement of berms, and diversion of existing ditch drainage into the existing upper pond near the N. Fork. These water quality and fisheries enhancements were addressed in a Title 16 permit application. Use of bioswales or sodding to treat surface runoff and protect tributaries, silt fences and hay bales to better control turbidity, locating future ponds on S. Fork area, and establishing a settling pond maintenance schedule are additional recommendations.

(*) 2. Upgrade existing settling ponds to provide adequate depth, area and retention time to treat wastewater before discharge to Granite Creek.

3. Augment settleable solids controls with experimental techniques to reduce turbidity and suspended solids loadings. Use of gel logs, coagulants, hay bales, silt fences and screens are recommended.

4. For settling ponds used for gravel washing (vs. treating surface runoff and ditch water), provide for a detention time greater than 2 hours and up to 6 hours.

5. Retain old settling ponds in series as operators work up valley over time. Only decommission old ponds if no future use is anticipated.

6. Maintain/muck out settling ponds on a scheduled basis, taking care to work during acceptable fisheries windows, typically June 1 through July 15.

(*) 7. Examine the need for settling pond construction and ditches on the Tisher Lease (Site 4) to accommodate surface runoff and possible gravel washing. Runoff into this lease site from the area of the proposed overburden landfill and the from the road upgrades may require new collection ditches and treatment ponds. [30]

*Issue 6: Research and apply improved turbidity controls*

(*) 1. Encourage use of experimental turbidity controls and conventional methods. Hay bales and silt fences should be maintained to be functional after high flow events.

2. Gel logs, chitosin, coagulants and other turbidity treatments used in placer mining industry should be evaluated for possible application to Granite Creek.

3. Increase detention time of water in settling ponds to improve fines removal.

*Issue 7: Stabilize stream channels*

1. Contain the active channel and minimize future realignment of the creek or tributaries through berming and care

[30] The degree of gravel washing, if any, in the upper Granite Creek basin needs to be documented. Settling ponds for gravel washing need to be larger and deeper than those used for treating surface water runoff. Retention times of 6 hours are usually recommended for wash ponds in order to meet the settleable solids limit of 0.2 ml/liter in Alaska water quality standards.

in blasting. [31]

*Issue 8: Creek crossings and obstructions*

(*) 1. Bridges are favored over culverts for providing fish passage, minimizing soil disturbance and water quality impacts, and in reduced maintenance. Consider a bridge at the upgraded crossing to the Tisher lease.

(*) 2. Remove boulders and any obstructions to fish passage near the main road crossing as stipulated by the CBS in the 1995 lease extension issued to Associated Sand and Gravel. Coordinate timing of removal with ADF&G staff.

*Issue 9: Monitoring*

1. Operators should voluntarily "self-monitor" water quality downstream of their operations and take corrective actions on a real-time basis. Citizen complaints and agency actions should not be the principle trigger forcing corrective actions.

(*) 2. City and Borough of Sitka staff should periodically monitor turbidity at the Harbor Pt. Road bridge and develop a long-term database. This is most important during rain events.

*Issue 10: Fuel and oil/hazardous waste storage*

(*) 1. Fuel and oil storage should be prohibited within 50 ft of Granite Creek and its tributaries. Fuel stored within this zone should be moved to other locations. Storage areas should be lined and secondary containment provided to accommodate the full volume of the stored fuel and oil in the event of a spill.

*Issue 11: Solid waste storage and disposal*

(*) 1. Abandoned tanks, scrap metals, and drums and any vehicles should be removed from all lease sites and disposed of at the approved landfill.

*Issue 12: Traffic patterns and vehicle storage affecting water quality*

(*) 1. Keep truck and equipment traffic out of ditches carrying runoff water. Install culverts (or bridge over) where ditch water channels intersect road crossings. Keep road sediment and silt from entering the channels.

2. Restrict traffic to defined areas to reduce siltation from erodible soils.

[31] The South Fork channel of Granite Cr. was inspected during the December 2000 field visit. Consensus was to leave the channel and rip-rapped bank alone, retain the adjacent overflow basin for containing water overtopping the banks, and allow the areas to revegetate with alder.

(*) 3. Remove parked or stored vehicles away from buffer areas immediately adjacent to the creek and tributaries.

*Issue 13: Revegetation of erodible soils*

(*) 1. Natural revegetation by alders should be allowed to progress without encroachment. Reuse overburden where possible and a variety of revegetation techniques to stabilize encroached stream buffers.

2. Create bioswales to treat surface runoff water adjacent to watercourses that have diminished buffers.

*Issue 14: Fisheries habitat improvements*

1. Examine opportunities for fisheries enhancement projects as mitigation for other CBS projects in the borough (e.g. similar to the benchland overburden permit approach).

*Issue 15: Inspection and maintenance schedules*

1. Operators should conduct annual inspection and maintenance of settling ponds.

2. Operators should log the results of maintenance and inspections and maintain copies on site for inspection by CBS staff or their agents.

***Management Issues and BMPs***

*Issue 1: Master Planning and Watershed Recovery Strategy (TMDL) Development*

1. Develop a Master Development Plan for the Granite Creek Watershed. Future gravel lease expansion should be addressed along with reclamation planning and operational provisions for environmental protection. More permanent solutions to water quality problems can be provided if this information is available, including optimal pond location and sizing, ditch water collection, and transportation routes.

(*) 2. Support development of a Granite Creek Watershed Recovery Strategy that addresses all operations in the watershed and would fulfill TMDL requirements under the Clean Water Act. A comprehensive site drainage and stormwater pollution control strategy for the watershed would be one product, building on the recommendations of this report.

*Issue 2: Management of water quality aspects of lease operations by the CBS and operators should be proactive and not triggered primarily by citizen complaints of water quality violations.*

1. CBS should conduct annual audits and site inspections of lessee compliance with lease terms.

(*) 2. The City and Borough of Sitka should consider hosting annual winter workshops with gravel lease operators and resource agencies to outline expectations, allow each operator to discuss operations and possible problems, offer training on issues, and provide resource information (e.g. example stormwater pollution prevention plans) and EPA requirements in advance of the upcoming operating season.

3. Strengthen the relationship (and accountability) between the lessees and the CBS through:

- consider offering financial incentives (royalty or lease fee reduction) for operators that follow model pollution prevention practices
- use operator "peer pressure" to get all operators up to a similar environmental standard
- consider contracting with McGraw Construction to maintain/muck out all lease settling ponds on behalf of the CBS

4. Subcontractors to lessees should be required to attend any training sessions sponsored by CBS or resource agencies.

## THE IMPLEMENTATION PLAN - PROPOSED FUTURE ACTIONS

The Implementation Strategy (Action Plan) is guided by the Operational and Management Issues identified in the preceding section. The Action Plan includes both source-specific and general tasks. Both near-term and longer-term Action Plans are included. Tasks, responsible party(s) and a schedule for completion are addressed. All major land uses in the watershed are addressed, with most attention focused on gravel mining operations as they are the major source of sediment to Granite Creek. Certainly, new funds will be needed to carry out many of the tasks. The phasing of the tasks over time recognizes this reality.

The City and Borough of Sitka - as the major landowner in the watershed - plays the most important role in carrying out the Action Plan.

Critical to the success of the Strategy is the close cooperation of industrial lease operators with CBS and resource agency staff. The established watershed team assembled to address water quality and habitat issues should continue to serve in an advisory capacity to the CBS through the implementation phase. A close partnership will help promote consensus on innovative solutions and open up grant funding opportunities.

Recent EPA Region 10 guidance "New Policies for Establishing and Implementing Total Maximum Daily Loads (TMDLs)" establishes a framework for achieving load allocations for waters impaired solely or primarily by nonpoint sources. That guidance was reviewed thoroughly.

The following are actions that will, individually and collectively, help meet the recreational, fisheries and water quality goals for the Granite Creek watershed. Some are voluntary actions that require initiative. Many are being successfully used in other watershed protection efforts in

Alaska.

### *THE ACTION PLAN FOR 2002 THROUGH JUNE 2003*

Twenty-three (23) tasks are recommended for immediate or near-term implementation. Tasks are not listed in any particular order of priority. Each task addresses one or several of the operational or management issues listed above. Responsible parties are shown with completion dates. Tasks are organized to address specific sources/ land use categories within the watershed. Management and Oversight, Monitoring and Funding are also addressed as generic categories, as they transcend and apply to all land uses.

New funding is needed to carry out several of the tasks and is recognized as a discrete category under the Action Plan.

### *THE ACTION PLAN FOR 2003 AND BEYOND*

The near-term strategy for reducing sediment and leachate inputs to Granite Creek, once completed, will address several immediate regulatory issues facing the municipality. Among these are compliance with water quality standards and TMDL load allocations and the CBS' desire for Granite Creek to be "delisted" from the ADEC impaired waterbody list. Short-term efforts need to be augmented with longer-term tasks that take a proactive, "big picture" view of how to maintain watershed health and meet the community's vision for what the watershed should look like in the future. Six long-term tasks are identified.

| GRANITE CREEK WATERSHED RECOVERY STRATEGY | RESPONSIBLE PARTY(S) | COMPLETION DATE |
|---|---|---|
| *THE ACTION PLAN FOR 2002 TO JUNE 2003* | | |
| **GRAVEL LEASE OPERATIONS** | | |
| 1) Complete and implement stormwater pollution prevention plans | Operators, CBS | 6/30/2002 |
| 2) Install engineered settling ponds for treatment of runoff | CBS, Operators | 7/15/2001 |
| 3) Clean out and maintain settling ponds annually | Operators, CBS | 6/1/2002 |
| 4) Host operator workshop on stormwater controls | CBS and Contractor | 11/19/2001 |
| 5) Amend CBS material lease agreements to add water quality terms | CBS | 6/30/2002 |
| 6) Grade pit floor and divert drainage to central collection areas | CBS, Operators | 7/15/01, 6/2002 |
| 7) Stabilize the South Fork creek channel | Operators | 6/30/02, ongoing |
| 8) Establish stable, vegetated buffers along North and South Forks | CBS, Operators | 6/30/2003 |
| 9) Drain material stockpile runoff to collection/treatment points | Operators | 6/30/2002 |
| **ROAD RUNOFF AND MAINTENANCE** | | |
| 1) Reduce sediment runoff to creek from road maintenance | CBS | 6/30/02, ongoing |
| 2) Minimize snow dumping and snow side casting into the creek | CBS, Operators | Ongoing |
| **GOLF COURSE/OVERBURDEN WASTE DISPOSAL SITES** | | |
| 1) Reroute ditch water/leachate away from Granite Creek and directly to Sitka Sound | CBS | 6/30/2003 |
| **NEW BENCHLAND WASTE DISPOSAL SITE** | | |
| 1) Complete and implement Stormwater Pollution Prevention Plan | CBS | 4/15/2002 |
| **MANAGEMENT AND OVERSIGHT** | | |
| 1) Dedicate staff to oversee CBS lease operations | CBS | 5/1/2002 |
| 2) Conduct annual audits of lessee operations/host workshops | CBS | 6/30/02; annual |
| 3) Provide financial and other incentives to operators for model pollution control efforts | CBS | Ongoing |
| 4) Complete a Granite Creek Watershed Recovery Strategy and TMDL | CBS/contractor | 5/15/2002 |
| 5) Maintain existing watershed team to advise CBS on controls | CBS | 4/15/02; annual |
| 6) Verify fuel and vehicle storage compliance with lease terms | CBS | 5/1/02; ongoing |
| **MONITORING** | | |
| 1) Implement regular and long-term water quality monitoring per the ADEC-approved monitoring plan (QAPP) | CBS/contractor | begin 10/15/01, ongoing |
| 2) Develop a stage-discharge curve for Granite Creek | USGS/Forest Service | 4/30/2003 |
| 3) Encourage operator self-monitoring of operations | Lease operators | Ongoing |
| **FUNDING** | | |
| 1) Apply for grants to carry out the Watershed Recovery Strategy | CBS | 2/15/02; ongoing |
| ***THE ACTION PLAN FOR 2003 AND BEYOND*** | | |
| 1) Complete a site drainage plan for industrial leases | CBS and/or contractor | 6/2004 |
| 2) Research and apply innovative turbidity controls | Operators, CBS | Ongoing |
| 3) Conduct fisheries enhancement projects | CBS, ADF&G | 7/15/01, ongoing |
| 4) Use a “Planning Review Station” approach for CBS reviews | CBS Departments | 6/30/2003 |
| 5) Develop a Master Development Plan for Granite Creek | CBS | 6/2003 |
| 6) Complete a revegetation guidebook for streamside buffers | CBS, operators | 6/2003 |

## REASONABLE ASSURANCE

Granite Creek is a waterbody listed by ADEC and EPA as impaired solely by nonpoint sources. For such waters, reasonable assurances that load reductions will be achieved are strongly encouraged - but not required - by EPA in order for the TMDL to be approved. However, through the current and future implementation of the variety of best management practices and control actions listed in the Action Plan (see page 93), load reductions and compliance with water quality standards are reasonably assured. Indeed, many new controls have been implemented since July 2001 (e.g. installation of three new settling ponds) as part of the overall Watershed Restoration Strategy to reduce sediment loading. The Implementation Plan includes a mix of both regulatory and non-regulatory controls as well as incentive-based tasks.

Ample local and state authorities exist to affect the controls. Important among these are material site lease agreements, enforceable policies of the CZM plan, local zoning and conditional land use permits, and stormwater pollution prevention plans. The Granite Creek Watershed Recovery Strategy (Part I) includes a detailed discussion of local, state and federal controls over activities in the watershed.

The established Granite Creek watershed recovery team, consisting of representatives from CBS, ADF&G, ADEC, Forest Service, USGS, gravel operators and the scientific coordinator for the watershed recovery project, have an ongoing responsibility for advising the CBS in the TMDL implementation and oversight of activities in the watershed.

## PUBLIC PARTICIPATION

EPA regulations [40 CFR §130.7(c)(1)(ii)] require public review consistent with the ADEC continuing planning process and public participation requirements. EPA TMDL guidance calls for a description of the public participation process, including a summary of significant comments and the responses to those comments (i.e. a responsiveness summary).

The process followed complies with the State's requirements for public participation. A public notice for the meeting on the draft Granite Creek Watershed Recovery Strategy and TMDL was published in the Sitka Daily Sentinel on March 28, April 3, 5, and 8th and included the meeting time and place, a description of issues to be discussed, the availability of the draft Strategy/TMDL starting on March 29 at municipal offices, and the schedule for public comments. Additionally, the local tribal organization - Sitka Tribe of Alaska - and all lease operators in the Granite Creek watershed received individual mailings announcing the public meeting. The 30-day public comment period ran from March 29 through April 29, 2002.
The Department of Environmental Conservation also published both the notice and the draft TMDL on their website:

www.state.ak.us/dec/dawq/tmdl/documents/publicnoticegranitecreek.htm.
The final Granite Creek TMDL will also be available electronically on this website.

The public meeting was held in Sitka on April 10, 2002 at the Swan Lake Senior Center to present the draft Strategy and TMDL and to receive and respond to comments. A copy of the public notice, meeting agenda, and meeting summary are included in the *Appendix* along with the major comments received and a response to those comments (i.e. the Responsiveness Summary). Public comments made at the meeting focused on the Implementation Plan tasks in the Strategy and TMDL. No additional written comments were received during the public review period.

## OTHER COMMENTS OR CONSIDERATIONS

It is important to note that since the original §303(d) listing of Granite Creek, a number of improvements have occurred addressing gravel mining operations. Some water quality data collected from Granite Creek used in this TMDL *preceded* the installation of these controls. Recent water quality information demonstrates considerable reduction in sediment loads and the absence of chronic sedimentation of the stream and its tributaries. Existing in-stream sediment load estimates are therefore conservative and represent an “upper end” of expected suspended sediment loads. Additionally, high sediment occurrences in Granite Creek tend to be episodic-event driven. Continuous, chronically high inputs of sediment are not the norm. It was for these reasons that a Margin of Safety was deemed implicit to the load allocations and does not require a separate, explicit, allocation. The Implementation Plan provides concrete reasonable assurance that actions have been, and will continue to be taken, towards achievement of load allocations.

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