January 6, 2022

Mr. Ed Martin III
President
Kenai Peninsula Aggregate and Contractors Association
via email: Kpac Association [kpacassociation@yahoo.com]

Re: Comments on KPB proposed material site ordinance amendments

Dear Mr. Martin:

You have requested that I review the recently proposed Kenai Peninsula Borough material site ordinance amendments introduced December 7, 2021, by the Mayor along with your suggested revisions to the amendments and provide comments. You and I have also discussed the process leading up to these proposed amendments. My comments are provided pro bono as a courtesy to your organization, as well as to the Kenai Peninsula Borough and all residents and businesses interested in this topic.

I do not have any current clients or projects in the Borough that I would consider a conflict of interest, however I do have more than 39 years of experience performing hydrogeologic work in Alaska with some of it on the Kenai Peninsula, as well as relevant experience being involved in the regulation and management of complex resource development issues from both government and private sector perspectives.

My comments are grouped into two areas: 1) the process of developing these amendments; and 2) technical considerations regarding gravel pits and groundwater resources.

Process

The draft ordinance amendments state that:

> the assembly established a material site work group by adoption of resolution 2018-004 (Substitute) to engage in a collaborative discussion involving the public and industry to make recommendations regarding the material site code;

From our discussion, it is obvious that the material site work group did not operate on a level playing field, but rather produced its findings through majority vote. In my opinion, this is a fatal flaw of the process that resulted in the current proposals.

As background, I have been involved in two work groups regarding very complex and controversial topics that were highly successful as a result of operating on a level playing field. By this I mean that all decisions, large and small, were made by consensus, not majority rule.

In the 1980s, there was considerable concern over potential and actual groundwater and water well contamination issues on the Kenai Peninsula related to the oil and gas industry. The result was that I, as an employee of the Alaska Division of Geological and Geophysical Surveys, cochaired the Kenai Peninsula Groundwater Task Force. This task force obtained considerable funding from the oil and gas industry that was operating on the peninsula at the time to conducted groundwater studies to better understand groundwater resources and disposal sites such as the Sterling Special Waste Management Site. The condition placed on the task force by industry representatives in order to participate and provide funding was that of a "level playing field". While sometimes it took quite a bit of time to achieve consensus, the results were durable and not very controversial.

More recently, the Alaska Department of Environmental Conservation initiated a statewide effort to regulate the drilling of single-family domestic wells. A Stakeholders Working Group (SWG) was convened to explore the issues, and again, all work was conducted by consensus. The group was hugely successful in developing a set of Best Management Practices for drilling private single-family wells, in developing another document for properly decommissioning wells and in creating a new website with numerous resources for well owners: https://dec.alaska.gov/eh/dw/dwp/private-wells/.

I bring these examples to your attention because, in reviewing the proposed amendments and your comments, it is apparent that these proposed amendments are complex and controversial, often interrelate to one another, and would benefit greatly from more work by a working group operating collaboratively by consensus prior to being considered for adoption.

It is worth noting that in our society ever-tightening environmental regulations are typically a one-way street. The long-term harm from over-regulating resource extraction is increasing costs and increasing scarcity of the resource on the open market. Sand and gravel resources are fundamentally important to the orderly economic development of the Kenai Peninsula Borough, are not highly transportable from other locations, and are dependent on time-limited extraction activities at most sites as a result of resource depletion. In south-central Alaska, there are many examples of reclaimed former gravel pits (some with ponds) that are important assets for long-term community development and wildlife.

A working group operating by consensus should be afforded whatever time it takes to achieve results. They should self-organize, with Chairs or Co-Chairs selected on the basis of impartial administration of the group. A potentially long timeframe should be considered for this important work because the KPB currently has a functional ordinance governing gravel resource extraction to serve in the interim. While many would likely consider the existing ordinances imperfect, it seems that it is far more important to get revisions right, rather than to get them fast.

In a nutshell, the existing proposed amendments should be scrapped and the whole process should start over with a level playing field amongst all stakeholders who agree to work in a collaborative and productive atmosphere towards improvements to the existing ordinances.

Technical considerations

There are many legitimate issues associated with gravel pits such as noise, dust, traffic, visual impacts, etc. which I will not address. One of the key concerns that commonly arises with gravel pits is impacts to groundwater or surface water resources. This is important, because while land

and gravel resources are typically privately owned, water resources in Alaska are reserved to the people for common use and responsibility for their management is delegated to agencies. Also, water has the uncanny habit of moving from place to place. So what happens to water at a gravel pit does not stay at the gravel pit.

The existing ordinance allows excavation into the water table under certain conditions. Proposed revisions by Kpac suggest loosening those restrictions and allowing more general mining of sand and gravel to a depth of up to 15 feet below the water table.

There is not a clear-cut answer to how mining of aggregate resources below the water table should be regulated. As described above, this should be subjected to deliberation by a stakeholder working group operating under consensus rules. Below, however are some considerations.

First, mining resources below the water table is not inherently "bad" or "not permittable" by agencies. The recently completed and approved Environmental Impact Statement for the proposed Donlin gold mine in southwest Alaska, for example, proposes digging an open pit about two miles long, one mile wide and more than 1/4 mile deep that would fill almost to the brim after mining to form a pit lake. With mining below the water table, however, precautions are warranted to protect nearby users of groundwater and potentially-affected surface water resources, wetlands and wildlife.

Throughout south-central Alaska, and notably in the Anchor Point area, numerous old gravel pits are now flooded to form small lakes or ponds. Some of these features provide wildlife habitat and potential visual and recreational enhancement for neighboring homes and businesses.

During gravel pit operations, one of the largest concerns about groundwater contamination comes from accidental fuel spills. All gravel pits should have rigorous and robust measures in place to prevent such spills and some degree of capacity to clean up spills if they occur.

The current ordinance calls for a two-foot vertical separation between the bottom of a pit and the seasonal high water table under most conditions. The rationale for this separation is not clear. In the event of a sizeable fuel spill, such a buffer would not be very useful in preventing fuel from reaching the water table. In a gravel pit, fuel would tend to infiltrate vertically downward from the spill point and "pancake" out on the surface of the water table two feet or more below the ground. The pore-space storage that would capture spilled fuel before reaching the water table could be as low as about 10 gallons. Once a spill encountered the water table, dissolved fuel components would begin to migrate in a downgradient direction along with the groundwater. To be most effective, cleanup should be rapid and may entail excavating a large quantity of contaminated sand and gravel. In contrast, if a fuel spill reached a gravel pit pond, the resulting sheen and/or floating product would likely be immediately obvious. Sorbents and/or booms stored on-site could be rapidly deployed to contain and mop up the bulk of the contamination.

Some perspective on regulatory requirements for two- or four-foot separation to the water table may be useful. It is a common regulatory requirement that the distance between the bottom of a septic system leachfield and the top of the seasonal high water table must be at least four feet.

The reason for this requirement is that wastewater percolating downward from leachfields needs to receive aerobic (i.e. oxygenated) subsurface treatment in the unsaturated zone between the bottom of the leachfield and the low-oxygen saturated sediments below the water table in order to treat and removed certain compounds and microrganisms from the wastewater. Such logic does not apply to gravel pits where no wastewater treatment occurs.

Part of Kpac's proposed revision to ordinances is that, in order to make wider and taller surrounding berms (10 ft high rather than 6 feet high) and simultaneously preserve the economic viability of extracting aggregate resources, excavation below the water table should be considered along with appropriate protective measures.

A consequence of extracting sand and gravel below the water table is that the total footprint of gravel pits in any given area may be reduced. This could occur because if there is a fixed market demand for aggregate the aggregate has to come from somewhere. If pits were able to extract an additional 17 vertical feet (two feet above and 15 feet below the water table) of aggregate resources from part of their operation, then it follows that fewer net acres of land surface would need to be disturbed to meet the market demand.

One useful protective measure for water table excavation would be the prohibited distance to surrounding water wells or even potential water well locations on nearby undeveloped property. A gravel pit should not "shadow" a potential well location on a nearby property such that the property is undevelopable using a well and a septic system. A large public water-supply well, for example, must be sited more than 200 feet from certain potential sources of contamination, and that distance should be considered as suitably applicable for private well distances from gravel pit ponds, as well.

Another potential contaminant source from excavating below the water table is fine silt or clay that could become entrained in groundwater and travel some distance towards a well. Again, a protective distance to surrounding wells, especially if groundwater flow directions can be determined, would likely be the most practical way of reducing risk from entrained silt or clay in groundwater.

The concept of requiring the bottom of an excavation to be 15 feet above nearby private well intake openings is only marginally protective. This is because, if a contaminant plume should develop in groundwater, lateral and vertical dispersion (i.e. spreading) of the plume could readily exceed this amount. Also, the construction details of nearby wells are not always known.

Should you have any questions, please call me at 907-345-0165 or 907-727-6310 (cell).

Sincerely,
***J. A. Munter Consulting*, Inc.**

James A. Munter, CPG
Certified Ground Water Professional No. 119481
Alaska Licensed Professional Geologist No. 568

Turner, Michele

Subject: FW: <EXTERNAL-SENDER>Fw: DEC Drinking Water regulations related to gravel extraction
Attachments: image001.png

From: Kpac Association <kpacassociation@yahoo.com>
Sent: Thursday, January 20, 2022 2:08 PM
To: G_Notify_AssemblyClerk <G_Notify_AssemblyClerk@kpb.us>
Subject: <EXTERNAL-SENDER>Fw: DEC Drinking Water regulations related to gravel extraction

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Hi Johni,
Please forward to the assembly.
Ed Martin III
President
KPACA
252-2554

----- Forwarded Message -----
From: Palmer, Charley (DEC) <charley.palmer@alaska.gov>
To: kpacassociation@yahoo.com <kpacassociation@yahoo.com>
Cc: Rypkema, James (DEC) <james.rypkema@alaska.gov>; Miller, Christopher C (DEC) <chris.miller@alaska.gov>
Sent: Monday, January 10, 2022, 10:06:57 AM GMT-9
Subject: DEC Drinking Water regulations related to gravel extraction

Hi Ed Martin,

As mentioned before, we have little authority with respect to land use activities near a public water system in our current regulations, 18 AAC 80. For that reason, we did work with the Division of Water to update a Best Management Practices document found at https://dec.alaska.gov/water/wastewater/stormwater/gravel/, to include consideration of nearby public water systems. I've cc'd Jim Rypkema in case he has anything to add regarding the BMP document. I've also cc'd my supervisor, Chris Miller, just so he's aware of our communication.

As requested, below are relevant regulations that could apply:

18 AAC 80.015. Well protection, source water protection, and well decommissioning.

(a) A person may not

(1) cause pollution or contamination to enter a public water system; or

(2) create or maintain a condition that has a significant potential to cause or allow the pollution or contamination of a public water system.

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(d) A person who owns or is responsible for a well, hole, or excavation into a water supply source or potential water supply source for a public water system shall use appropriate methods as follows to protect the water supply source as required under (a) of this section:

(1) if the well, hole, or excavation is either active or temporarily inactive, the person shall maintain the well, hole, or excavation using appropriate methods, including methods set out in (b) of this section;

(2) if the well, hole, or excavation is permanently inactive or abandoned, the person shall protect, seal, or fill the well, hole, or excavation using appropriate methods approved by the department as set out in (e) of this section;

(3) in this subsection "wells, holes, or excavations" include

(A) a well that may or may not be used for potable water;

(B) a hole drilled, augured, or jetted for the purpose of subsurface exploration or sampling;

(C) a cathodic protection well; or

(D) another form of excavation that might contaminate a public water supply source.

18 AAC 80.020. Minimum separation distances.

(a) A person may not construct, install, maintain, or operate a public water system unless the minimum separation distances in Table A, in this subsection, are maintained between a potential source of contamination and a drinking water source for the public water system.

TABLE A. Minimum Separation Distances[a] Between Drinking Water Sources and Potential Sources of Contamination (Measured horizontally in feet)	
	Type of Drinking Water System
Potential Sources of Contamination	**Community Water Systems, Non-transient Non-Community Water Systems, and Transient Non-Community Water Systems**
Wastewater treatment works,[b] wastewater disposal system,[b] pit privy,[b] sewer manhole, lift station, cleanout	200
Community sewer line, holding tank,[b] other potential sources of contamination[c]	200
Private sewer line, petroleum lines and storage tanks,[d] drinking water treatment waste[e]	100

Notes to Table A:

[a] These minimum distances will be expanded, or additional monitoring will be required under 18 AAC 80.020(b) and (e)(2).

[b] Distance to a drinking water source is measured from the nearest edge of the drinking water source to the nearest edge of the potential source of contamination.

[c] Other potential sources of contamination include [but are not limited to] sanitary landfills, domestic animal and agricultural waste, and industrial discharge lines.

[d] The minimum separation distances for petroleum storage tanks do not apply to tanks that contain propane, or to above-ground storage tanks or drums that, in the aggregate, have a storage capacity of less than 500 gallons of petroleum products, and that store only petroleum products necessary for the operation and maintenance of pumps, power generation systems, or heating systems associated with a potable water source.

[e] Drinking water treatment wastes include the backwash water from filters and water softeners, and the reject water from reverse osmosis units.

(b) The department will require a greater separation distance than that required by Table A in (a) of this section if the department determines that additional distance is necessary to protect surface water, groundwater, or a drinking water source. The department will make this decision after considering soil classifications, groundwater conditions, surface topography, geology, past experience, or other factors relevant to protection of surface water, groundwater, or drinking water.

Regards,

Charley Palmer

Hydrologist 3

FAA Certified sUAS (drone) Pilot

DEC-EH | Drinking Water Program

Drinking Water Source Protection

PHONE 907-269-0292

charley.palmer@alaska.gov

555 CORDOVA STREET

ANCHORAGE, AK 99501

Turner, Michele

Subject: FW: <EXTERNAL-SENDER>Fw: Gravel pits with waterbodies

From: Kpac Association <kpacassociation@yahoo.com>
Sent: Thursday, January 20, 2022 2:11 PM
To: G_Notify_AssemblyClerk <G_Notify_AssemblyClerk@kpb.us>
Subject: <EXTERNAL-SENDER>Fw: Gravel pits with waterbodies

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Hi Johni,
Please forward to the assembly as comment on 2021-41
Ed Martin III
President
KPACA
252-2554

----- Forwarded Message -----
From: Peterson, Ryan E (DEC) <ryan.peterson@alaska.gov>
To: Kpac Association <kpacassociation@yahoo.com>
Cc: Wilfong, David L (DEC) <david.wilfong@alaska.gov>; Bear, Tonya (DEC) <tonya.bear@alaska.gov>
Sent: Friday, January 7, 2022, 01:34:23 PM GMT-9
Subject: RE: Gravel pits with waterbodies

Good Afternoon Ed,

Thank you so much for the inquiry. In regards to your question of what applicable regulations of the wastewater disposal regulations 18 AAC 72 could apply during the development of a materials site resulting in the creation of surface water and/or steep slopes, the sections that come to mind are:

18 AAC 72.020(b) which goes over separation distances from a wastewater disposal system to surface water sources; and
18 AAC 72.035(9) which goes over separation distances from a conventional onsite system to a ground surface slope greater than 25 percent with a drop in the surface height greater than 10 feet.

These will cover most private residential systems. If the nearby property or development is a commercial facility, additional restrictions based on site specific considerations may apply.

Please let me know or the Soldotna wastewater review engineer Dave Wilfong, 262-3405, david.wilfong@alaska.gov , know if you have any additional questions. Thank you!

Ryan Peterson
Dept of Environmental Conservation / Division of Water
Engineering Support and Plan Review Section
43335 Kalifornsky Beach Road, STE 11 Soldotna AK 99669
ryan.peterson@alaska.gov
Phone: 907-262-3402 Fax: 907-262-2294
septic.alaska.gov

-----Original Message-----
From: Kpac Association <kpacassociation@yahoo.com>

Sent: Friday, January 7, 2022 7:24 AM
To: Peterson, Ryan E (DEC) <ryan.peterson@alaska.gov>
Subject: Gravel pits with waterbodies

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Hi Ryan. Per our conversation yesterday, could you write me back something referring to the DEC waste water divisions regulations regarding waterbodies and slopes that could occur in the development of a material site? Thanks, Ed.

Sent from my iPhone

O2021-41

Turner, Michele

Subject: FW: <EXTERNAL-SENDER>Fw: [External Email]Info on gravel pit habitat
Attachments: Gravel Pit Ponds as Habitat Enhancement for Juvenile Coho Salmon pnw_gtr212.pdf; Guidelines for Gravel-Pit Wetland Creation 0653-Prange.pdf; Nancy St Article.pdf; Nancy St As-Built-lowres (002).pdf

From: Kpac Association <kpacassociation@yahoo.com>
Sent: Thursday, January 20, 2022 2:03 PM
To: G_Notify_AssemblyClerk <G_Notify_AssemblyClerk@kpb.us>
Subject: <EXTERNAL-SENDER>Fw: [External Email]Info on gravel pit habitat

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Hi Johni,
Could you send this to the assembly for comment on 2021-41? It is from the forest service about some amazing uses they have done with old gravel pits that have been excavated into the water table. Reclamation benefits and options.
Ed Martin III
President
KPACA
252-2554

----- Forwarded Message -----
From: Cross, Adam -FS <adam.cross@usda.gov>
To: Kpac Association <kpacassociation@yahoo.com>
Sent: Thursday, January 13, 2022, 02:40:43 PM GMT-9
Subject: RE: [External Email]Info on gravel pit habitat

Good Afternoon Ed,
I wanted to share some of the literature my co-workers located. Some of it is a bit older but still relevant. Unfortunately, the FS has not published much if anything about the work of transitioning gravel ponds into salmon habitat or even recreational areas in Portage Valley. The area is a great "show me" example for folks who may be interested.

I hope the attached will be helpful.

Best Regards,
Adam

Adam Cross
KPZ Aquatics Program Manager
Forest Service
Chugach National Forest, Kenai Peninsula Zone
p: 907-288-7715
f: 907-288-5111
adam.cross@usda.gov
33599 Ranger Station Spur
Seward, AK 99664
www.fs.fed.us

Caring for the land and serving people

-----Original Message-----

From: Kpac Association <kpacassociation@yahoo.com>
Sent: Thursday, January 6, 2022 10:52 AM
To: Cross, Adam -FS <adam.cross@usda.gov>
Subject: [External Email]Info on gravel pit habitat

[External Email]
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Great conversation with you today! Any info you have on any pits converted to habitat would be appreciated. A simple letter explaining your success in that area would be excellent to start a discussion in the presentation I'm producing for the KPB. Thank you so much! Ed Martin. 252-2554.

Sent from my iPhone

United States
Department of
Agriculture

Forest Service

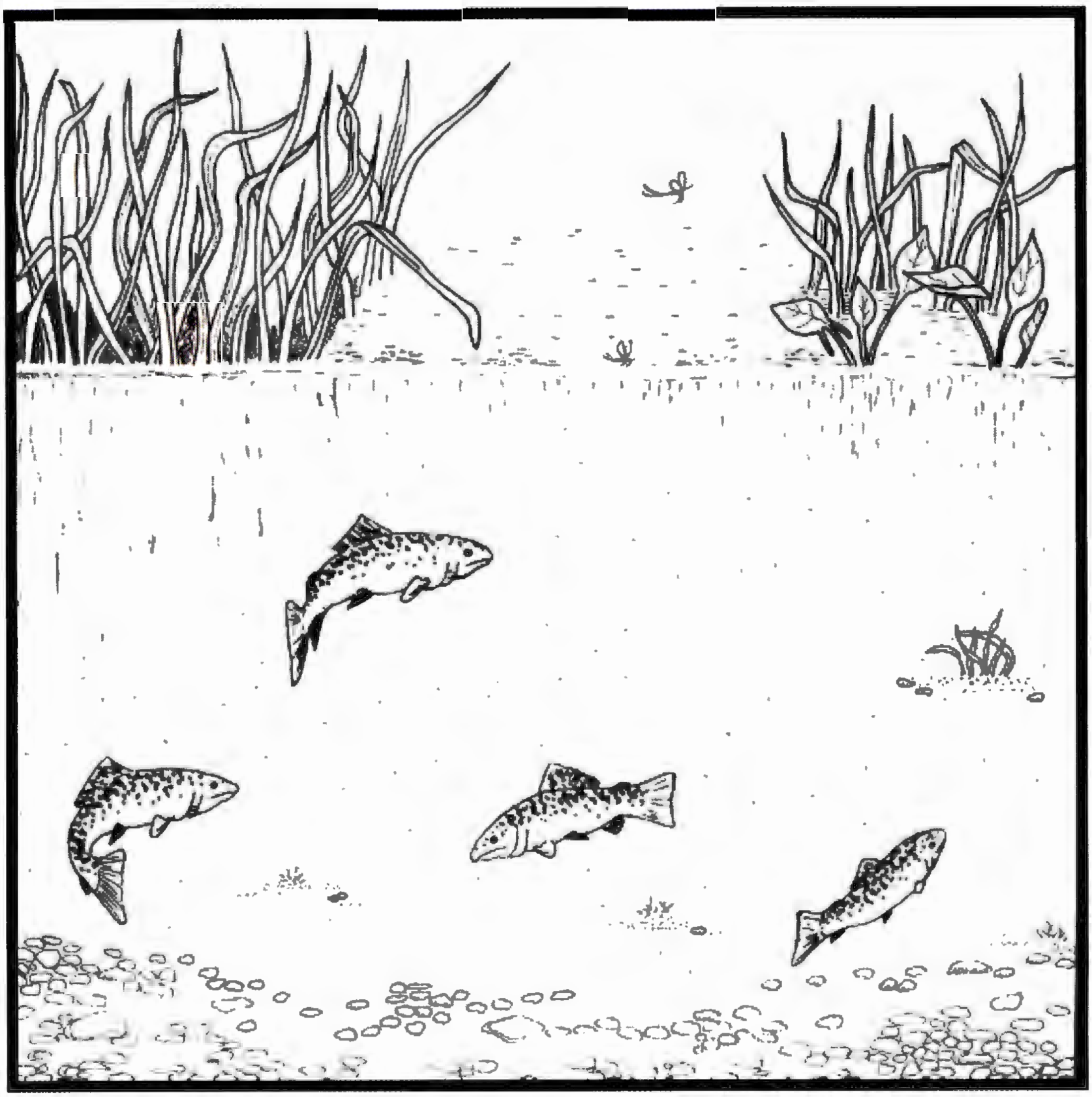
Pacific Northwest
Research Station

General Technical
Report

PNW-GTR-212

Gravel Pit Ponds as Habitat Enhancement for Juvenile Coho Salmon

Mason D. Bryant



Author

MASON D. BRYANT is a research fishery biologist, Forestry Science Laboratory, P.O. Box 20909, Juneau, Alaska 99802.

Abstract

Bryant, Mason D. 1988. Gravel pit ponds as habitat enhancement for juvenile coho salmon. General Technical Report PNW-GTR-212. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 10 p.

Gravel pits built during road construction in the early 1970's near Yakutat, Alaska, filled with water and were connected to nearby rivers to allow juvenile salmonids to enter. Seasonal changes in population size, length and weight, and length frequencies of the coho salmon population were evaluated over a 2-year period. Numbers of coho salmon fluctuated, but two of the ponds supported high populations, more than 2,000 fish, throughout the study. These ponds appeared to support coho salmon throughout the winter. The range of physical measurements of the ponds did not seem to account for differences in numbers of salmon, but low concentrations of dissolved oxygen were detected in all ponds near the bottom. Aquatic vegetation, water exchange rate, and access may have affected the number of coho salmon in the less-productive ponds.

Keywords: Fish habitat, salmonids, stream habitat management, southeast Alaska, Alaska (southeast).

Contents

Introduction

Road construction and forest development are commonly associated with detrimental effects on salmonid habitat; with proper planning, however, such effects can be avoided. In this paper, I discuss a method to improve salmonid production in conjunction with road construction.

Juvenile coho salmon *(Oncorhynchus kitsuch)* are aggressive, invasive, and mobile (Allee 1974, Chapman 1962, Skeesick 1970). Sheridan 1 suggested that the gravel pits, created during road construction on the glacial outwash of the Yakutat forelands (Alaska Department of Fish and Game 1984), would be exploited by juvenile coho salmon if the ponds were connected to river systems containing coho salmon. Several gravel pits that had filled with water were connected by artificial channels to nearby rivers during the 1970's. Coho salmon fry were observed in the ponds, but no systematic effort was undertaken to estimate the number of fish in the ponds or to evaluate their effectiveness as rearing habitat.

The purpose of this study was to determine if these ponds were suitable rearing habitat for juvenile coho salmon. Numbers of juvenile coho in four ponds were estimated over several seasons. Size and ages were determined. Selected chemical and physical measurements were taken on the ponds to identify factors that could account for differences in salmon populations.

Although ponds are not generally associated with coho salmon habitat, beaver ponds and riverine ponds have been identified as productive coho habitat in Alaska and in Washington in recent years[2] (Bryant 1984, Peterson 1982). Russell and Schramek (1984) found about 2,500 coho salmon fry and 500 fingerlings in a gravel pit associated with a beaver pond during the summer of 1977. They did not follow the populations through the winter, however. Both Peterson (1982) and Russell and Schramek (1984) reported seasonal migrations to and from the ponds. Although most of these studies were on natural ponds, their results indicate that ponds created by gravel borrow pits can support juvenile coho salmon; such ponds may be an inexpensive method to increase coho salmon production.

Methods

Four ponds-Nine-Mile, Green, Twenty- Two-Mile, and Beanbelly-were sampled monthly from July through October 1983 and during spring or early summer and autumn in 1984 and 1985. Minnow traps (mesh size = 6.3 mm) were baited with salmon eggs and distributed along the edge of the ponds, usually within a few meters of the bank, 1 to 2 m deep. A few were placed in the middle of the ponds. Between 26 and 30 traps were sufficient to sample each of the ponds. In 1984, Twenty- Two-Mile Pond was not sampled because of low coho salmon populations. Green Pond was not sampled in 1985 for the same reason. Traps were allowed to fish for 1 hour, long enough to capture a sufficient sample. Longer periods occasionally resulted in high mortalities. Mortalities incurred during handling were identified and removed from the experiment.

All fish were identified and measured (total length). Scales and weights were taken from a subsample of the salmonid population. Salmonids were marked by punching a hole in the caudal fin. In the fall of 1984, salmonids were marked by freeze branding (Bryant and Walkotten 1980).

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[1] Sheridan, W.L 1970. Coho salmon habitat improvement-on glacial outwash plains. U.S. Department of Agriculture, Forest Service, Region 10. Unpublished.

[2] Sanders, G.H. Movement and territoriality in juvenile coho salmon *(Oncorhynchus kisutch)* in a southeast Alaska pond. Alaska Department of Fish and Game, Juneau, AK. Unpublished report.

Population size was estimated either with the Schnabel multiple mark and recapture method or the Bailey modification of the Peterson estimate (Ricker 1975). The Schnabel method was used in all the 1983 samples. The method varied in later samples because of limited sampling time. The multiple mark and recapture experiments were conducted over a period of 5 days or less. Emigration and immigration were negligible during the summer. During of the summer sampling periods, water levels were low and streams into and out of the ponds were either not running or had small flows. Increased rainfall in the autumn resulted in higher flows, but mark and recapture samples were done over a period of 2 or 3 days to minimize the effect of fish moving into or out of the ponds.

All four ponds were surveyed to determine surface area. Depth profiles were not made, but maximum depths were determined during secchi disk and oxygen measure ments. Temperature and oxygen were measured with a YSI[3] oxygen meter in 1983 and 1984. Oxygen measurements in June 1985 were made with the Alsterburg modification of the Winkler method (U.S. Environmental Protection Agency 1974).

Results

The number of coho salmon in Nine-Mile and Beanbelly Ponds increased from July to October in 1983. Each pond supported more than 3,500 coho salmon in the fall of 1983 (fig. 1). Green and Twenty-Two-Mile Ponds were not sampled after October 1983 because few fish were captured. The number of coho salmon in Green Pond declined from an estimated 2,700 in August to a point where no estimate was possible in October (fig. 1). The number of coho salmon in Twenty-Two-Mile Pond was consistently low.

[3] Use of trade names is for the information and convenience of the reader. Such use does not imply endorsement by the U.S. Department of Agriculture of any product or service to the exclusion of others that may be suitable.

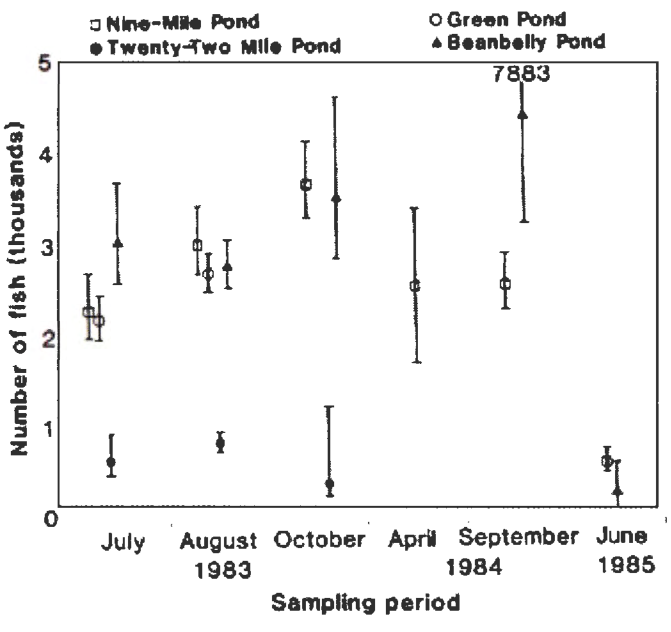


Figure 1—Population estimates of coho salmon captured in Nine-Mile, Green, Twenty- Two-Mile, and Beanbelly Ponds from 1983 to 1985.

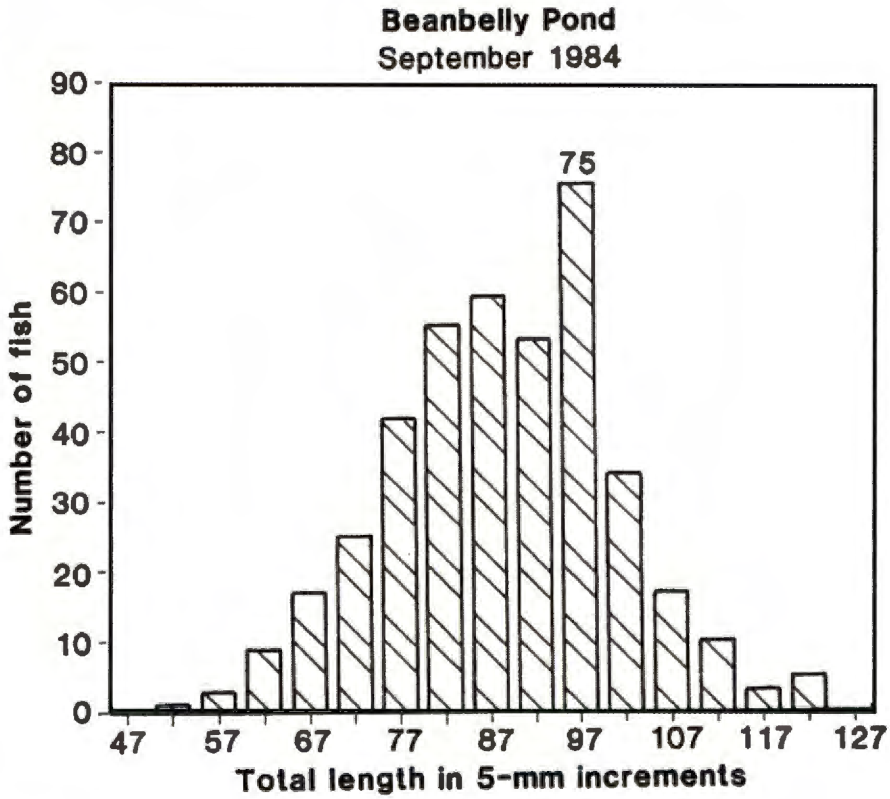
Population estimates in Nine-Mile and Beanbelly Ponds were made October 1983, April 1984, September 1984, and June 1985 to assess overwinter use of the ponds. Beanbelly Pond was not sampled in April. 1984 because snow on the road made it inaccessible. In Nine-Mile Pond, the number of juvenile coho salmon decreased from 3,666 to 2,547 between October 1983 and April 1984. Fin punches applied in October were observed in the April sample; therefore, coho salmon overwintered in the pond, but emigration and immigration likely occurred between the sample periods. Because of heavy snow, the ponds were not sampled until the 1st week in June 1985. The low populations in both ponds in June may be attributed to smolt migration. Comparison of length frequencies in September 1984 and June 1985 in Beanbelly Pond corroborate this migration (fig. 2). In September 1984, the median length of coho salmon in Beanbelly Pond was 88 mm (total length), and more than 10 percent of the total catch was longer than 100 mm; in June 1985, the median length was 82 mm, and less than 2 percent of the total catch was longer than 100 mm.

A few coho salmon marked with freeze brands in September 1984 were recovered from both ponds in June 1985, but they numbered less than 1 percent of the total catch; therefore, overwinter survival cannot be estimated. Recovery of marked fish in June 1985 and the persistence in the ponds of coho salmon that were at least 1 year old in the spring and early summer of 1984 and 1985 indicate that the ponds are used over the winter.

Recruitment to the ponds appears to be the result of upstream migration of juvenile coho, except in Beanbelly Pond which is fed by a stream with spawnable habitat. Recruitment of fry into the ponds appears to begin in June. During May 1984, fewer than 5 percent of the coho salmon caught in Nine-Mile Pond were smaller than 62 mm (total length); by September, more than 16 percent were smaller than 62 mm (fig. 3). Between July and September, the percentage of smaller coho salmon increased slightly in Nine-Mile Pond, indicating that fry moved into the pond. In Beanbelly Pond, the percentage of smaller coho salmon decreased slightly from July to September in 1983, suggesting that smaller fish did not move into the pond and that the difference in size was the result of growth.

Significant differences occurred among the length-weight regressions computed for the coho salmon captured in the four ponds in July and August 1983 (table 1). Throughout the analysis, Nine-Mile Pond shows a consistently higher slope than the other ponds, indicating more robust fish and better growth. In September 1983, large differences appear in the slope of the regression for Twenty- Two-Mile Pond (2.2) compared to those of Nine-Mile and Beanbelly Ponds (2.8 and 2.7). The lack of significance in September 1983 may result from the smaller sample size in Twenty-Two-Mile Pond compared to that in the other two ponds.

Although depths of each pond varied, each had a relatively uniform profile tapering from a deep end to a shallow end with steep sides. The least productive pond, Twenty-Two-Mile, was also the shallowest. Green Pond and Nine-Mile Pond were similar in depth and shape (table 2); both are connected to the Situk River. Beanbelly, the largest and deepest of the four ponds, has an irregular shape and is more like a natural pond. It is fed by a perennial stream.



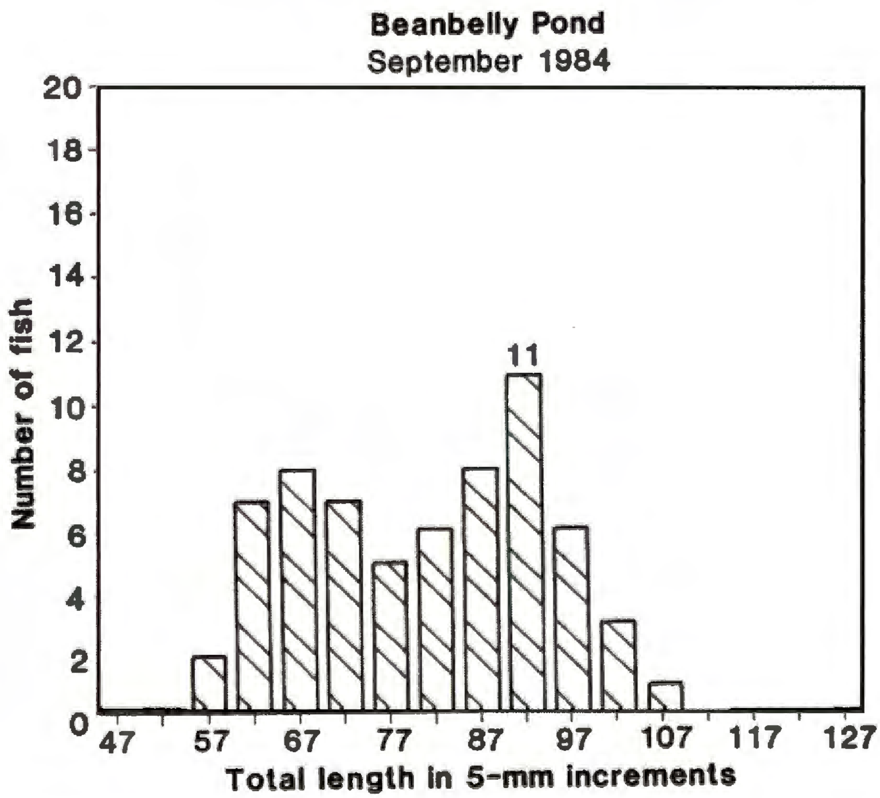


Figure 2—Length frequency distribution of coho salmon captured in Beanbelly Pond in September 1984 and June 1985.

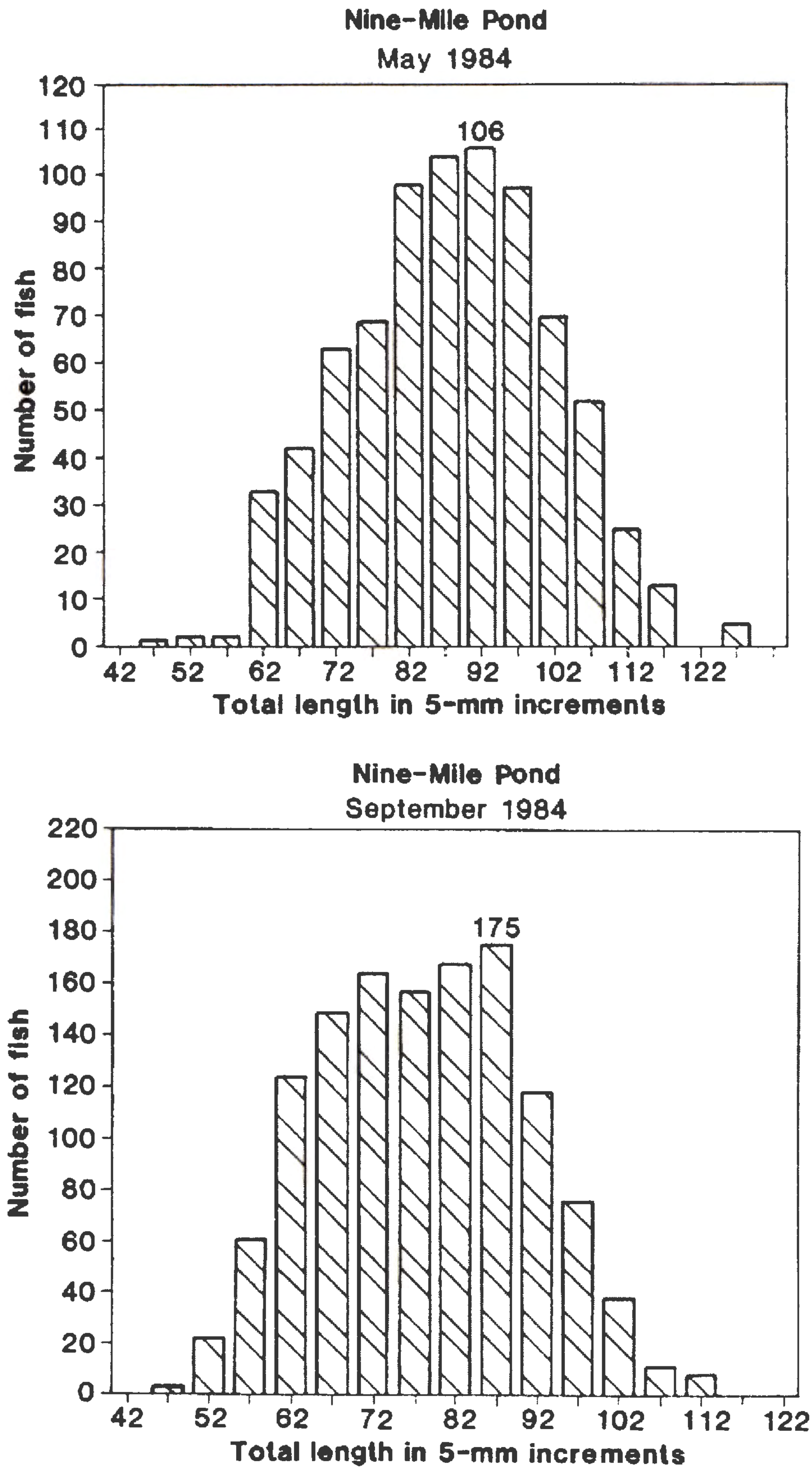


Figure 3—Length frequency distribution of coho salmon captured in Nine-Mile Pond in May and September 1984.

Table 1-Differences among ponds in length-weight regressions

Date and pond	Intercept a	Slope b	Significance Level	Significance Slope
July 1983:				
Nine-Mile	-5.3683	3.157		
Green	-4.0452	2.482	≤ .05	≥ .05
Twenty-Two-Mile	-4.1865	2.5663		
Beanbelly	-3.9622	2.4281		
August 1983:				
Nine-Mile	-5.1244	3.0233		
Green	-4.153	2.5325	≤ .05	≥ .05
Twenty-Two-mile	-4.844	2.867		
Beanbelly	-5.1789	3.0326		
Sept. 1983				
Nine-Mile	-4.783	2.8378		
Green	—			
Twenty-Two-Mile	-3.6585	2.2101	≤ .05	≥ .20 (NS)
Beanbelly	-4.5538	2.7266		
April 1984				
Nine-Mile	-5.1337	2.9813		
Green	-4.6439	2.7453	≤ .05	≥ .05
Twenty-Two-Mile	—			
Beanbelly	—			

— = no data: NS = not significant

Table 2—Yakutat gravel pit ponds morphology

	Area	Volume[a]	Maximum depth	Average depth[b]
	Square meters	Cubic meters	--------Meters--------	
Green	7,644	9,500	2.5	1.25
Nine-Mile	10,010	12,513	2.5	1.25
Twenty-Two-Mile	27,972	27,513	2.0	1.0
Beanbelly	34,954	61,170	3.5	1.75

a Volume = area times average depth.

b Average depth = maximum depth divided by 2

Temperature and oxygen were slightly stratified in all ponds during the summer and winter. The ponds were isothermal in the spring and fall (fig. 4). Oxygen supply depends partly on the water-exchange rate in each of the ponds during periodic thaws throughout the winter. Oxygen levels near the bottom of the ponds were lowest during December but were above 5 p/m at the surface in all four ponds. The dissolved oxygen supply may have become critically low later in the winter after a thick layer of ice formed.

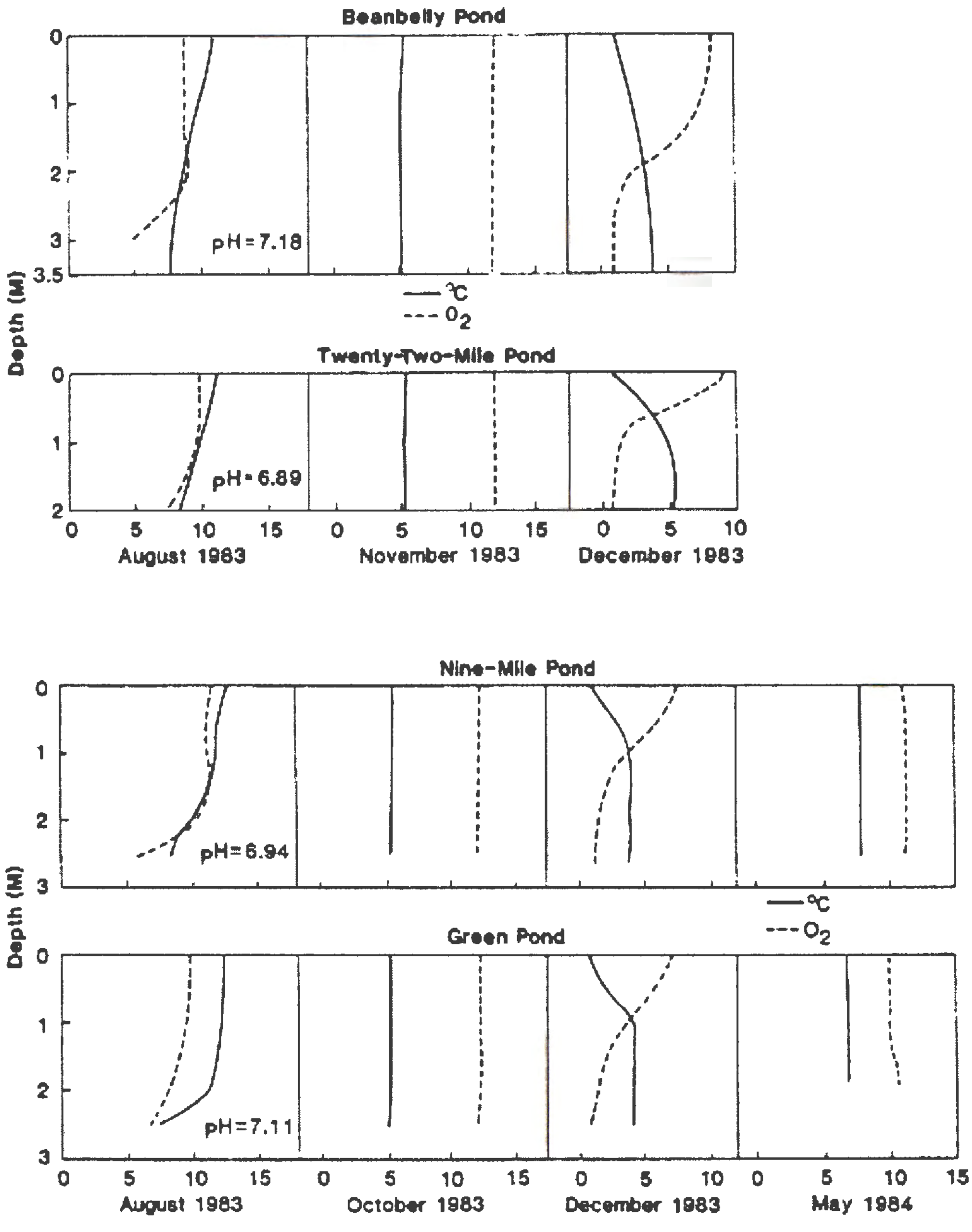


Figure 4—Seasonal temperature and oxygen profiles for Green, Nine-Mile, Twenty- Two-Mile, and Beanbelly Ponds.

Discussion

All four ponds were used to a greater or lesser extent by juvenile coho salmon during the study. Even over the short period of this study, populations fluctuated from year to year. In Green Pond, the salmonid population virtually disappeared after the fall of 1983. The population at Twenty-Two-Mile Pond was consistently low. Beanbelly and Nine-Mile Ponds consistently supported the highest populations of coho salmon.

None of the morphological or chemical features measured during the study appear to account for the differences and changes in the coho salmon population in the ponds. A more likely explanation may be the connection between the ponds and the river. Both Nine-Mile Pond and Beanbelly Pond had well-defined channels between the ponds and the river. The outlet to Twenty-Two-Mile Pond was poorly defined. Neither Twenty- Two-Mile Pond nor Green Pond had a defined inlet channel. Although ground water is an important source of water for the ponds, flow of surface water into and out of the ponds may be an important factor determining the water quality of the ponds as habitat for juvenile coho salmon.

Because all juvenile coho salmon immigrated into the ponds, the channel between the river and the ponds is critical to their use by coho salmon. All ponds were apparently accessible at high-flow periods (spring and fall) to juvenile coho salmon in the adjacent rivers, but the less well-defined channels connecting Twenty-Two-Mile Pond and Green Pond may have contributed to the low populations in these ponds. A poorly defined channel has lower velocity and is less likely to be found by the fish. Once found, it may not offer a clear path to the pond.

The coho salmon in the less productive ponds appeared to be less robust than those in the other two ponds. Where significant differences among length-weight regressions occurred, the lower values were associated with the ponds that had fewer coho salmon; therefore, factors other than access may be affecting productivity in the ponds. Among possible factors that were observed but not evaluated in this study are food and competition. Food may be a limiting factor and the differences in length-weight ratios may reflect fewer aquatic organisms available for food in these ponds. Large populations of threespine sticklebacks *(Gasterosteus aculeatus)* were observed in all the ponds. Beanbelly, Nine-Mile, and Twenty-Two-Mile Ponds had a dense cover of aquatic plants, and the bottom of Green Pond was covered with a dense mat of algae. The dense cover of aquatic vegetation would contribute to a large stickleback population by providing excellent habitat for reproduction and cover for newly hatched sticklebacks. The effect of competition for space and food between sticklebacks and coho salmon was not studied. Aquatic plants and algal growth would also contribute to low concentrations of benthic dissolved oxygen during fall and winter as the vegetation died and began to decompose. In addition, sticklebacks may be able to tolerate lower dissolved oxygen concentration than coho salmon.

Timber along the bank was apparently not a factor in any of the ponds. Twenty- Two-Mile Pond was the only one with large trees along the bank. These trees did not appear to influence the pond. Willow *(Salix* sp.) and alder *(Alnus* sp.) were the dominant vegetation along the banks of the other ponds. Based on observations of numbers of coho salmon captured near vegetation in the water, coho salmon do not appear to prefer brush habitat associated with these ponds. Nevertheless, shrubs along the bank may provide cover and a source of terrestrial insects to coho salmon.

Although the results of this study show differences among the ponds, specific factors controlling numbers of coho salmon in the ponds were not identified. The range of morphological and chemical differences measured in the ponds did not appear to affect numbers of coho salmon. The ponds apparently provide habitat for juvenile coho salmon although low dissolved oxygen sometimes may increase mortality. Coho salmon apparently remain in the ponds through winter.

The design of artificial ponds for juvenile coho salmon habitat should include several important morphological features. Adequate water quality is necessary throughout the year, particularly during the winter. A perennial flow of surface water into the pond may satisfy this requirement. The second requirement is access. An effective method for providing both these features is to construct an upstream inlet from the stream to the pond and a downstream outlet from the pond to the stream. Other favorable features include an average depth greater than 2 meters and bank vegetation for shade and cover.

Additional study on the effects of competitive interaction between salmonids and other species such as sticklebacks, the role of aquatic vegetation as cover and its effect on water quality, and the effects of pond morphology and water exchange rates could improve the design of artificial ponds. As projects are effectively evaluated, design criteria will be improved to increase the effectiveness of similar ponds. Ponds have not been extensively used as an enhancement tool for increasing coho salmon production, but they offer a promising and often low-cost enhancement method.

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Bryant, Mason D. 1988. Gravel pit ponds as habitat enhancement for juvenile coho salmon. General Technical Report PNW-GTR-212. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 10 p.

Gravel pits built during road construction in the early 1970's near Yakutat, Alaska, filled with water and were connected to nearby rivers to allow juvenile salmonids to enter. Seasonal changes in population size, length and weight, and length frequencies of the coho salmon population were evaluated over a 2-year period. Numbers of coho salmon fluctuated, but two of the ponds supported high populations, more than 2,000 fish, throughout the study. These ponds appeared to support coho salmon throughout the winter. The range of physical measurements of the ponds did not seem to account for differences in numbers of salmon, but low concentrations of dissolved oxygen were detected in all ponds near the bottom. Aquatic vegetation, water exchange rate, and access may have affected the number of coho salmon in the less-productive ponds.

Keywords: Fish habitat, salmonids, stream habitat management, southeast Alaska, Alaska (southeast).

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Recycled Soils Enhance Wetland Habitat in Juneau, Alaska

by Michele Elfers

IN disturbed ecosystems needing reclamation, excess materials from development projects offer new opportunities for wildlife habitat enhancement. The Nancy Street Wetland Enhancement Project pioneered a creative strategy to partner the development needs of a fill disposal site with desirable conservation goals. The project utilized clean native soils generated by a high school construction project in the Mendenhall Valley of Juneau, Alaska, to reclaim a 1950s era gravel pit into a functional wetland. Clean fill material was deposited and shaped to create mixed wetland topography, including a stream channel, deep and shallow water areas, and small islands. Plantings of emergent wetland, riparian, and upland vegetation improved habitat for fish and wildlife and water quality in what is part of a state designated impaired waterbody.

Located along Duck Creek in the Mendenhall Valley, the enhancement of the Nancy Street gravel pit was identified as a priority project in the Duck Creek Watershed Management Plan (National Marine Fisheries Service, 1999). Intense residential development over the past forty years in the Mendenhall Valley has impacted Duck Creek significantly. The increase of nonpoint source pollution, channelization, and above-grade stream crossings has degraded water quality and habitat. In 2002, the Alaska Biological Monitoring and Water Quality Assessment Program Report rated Duck Creek the lowest for habitat variables of all streams studied in Southeast Alaska (Alaska Department of Environmental Conservation, 2003). Poor habitat quality has reduced anadromous fish populations such as coho and chum salmon, and has impacted habitat for the large number of mallards and other waterfowl that use these wetlands as refuge from nearby popular hunting zones.

In the 1950s and 1960s, gravel extraction created three adjacent, open water pits on the East Fork of Duck Creek. The most downstream pit is located at Nancy Street. Groundwater flowing into the pit carries dissolved iron from soil strata, which reacts with atmospheric oxygen upon reaching the surface. The resulting formation of iron oxide precipitate (iron "floc") decreases the concentration of dissolved oxygen in the water column, impacting aquatic invertebrates and fish. While not inherently toxic, iron floc also settles into the substrate, clogging gravel beds that might otherwise provide good spawning habitat for fish.

The gravel pit at Nancy Street is located less than one mile from the high school construction site, and the enhancement project opportunity required a substantial amount of fill that had previously not been available.

The Engineering Department at the

Emergent wetlands are created along the perimeter of a deep water pool for juvenile coho salmon habitat.

City and Borough of Juneau (CBJ) initiated the wetland enhancement project in 2005 when designs for a new high school indicated a large amount of excess soil would be generated during construction. Transport of the fill for disposal would have required a three mile drive to a privately owned waste site. The gravel pit at Nancy Street is located less than one mile

Using the Nancy Street pit as a fill disposal site, the CBJ Engineering Department charged the high school construction contractor a lower rate for fill disposal and used the revenue to recover a portion of the land purchase cost.

from the high school construction site, and the enhancement project opportunity required a substantial amount of fill that had previously not been available. CBJ

The construction of a new high school contributed 64,000 cubic yards of clean fill to the wetland enhancement of the former gravel pit.

began coordinating with the U.S. Fish and Wildlife Service (USFWS) and the Natural Resources Conservation Service (NRCS) to use the clean native soil for wetland enhancement at the Nancy Street pit.

Consolidation of land ownership was the first step toward reclaiming the pit. CBJ owned most of the seven acre site, but a large parcel encompassing both open water wetland and upland areas was privately owned. The parcel was purchased for $137,000. Using the Nancy Street pit as a fill disposal site, the CBJ Engineering Department charged the high school construction contractor a lower rate for fill disposal and used the revenue to recover a portion of the land purchase cost. The cost to the CBJ of filling the Nancy Street site, including the land purchase, was $319,000. The cost of the typical market alternative was $572,000. By undertaking the wetland enhancement project partially funded by USFWS and NRCS cost share programs, the CBJ saved $253,000 on the cost of the high school construction.

Site Planning:

To design and execute the fill disposal

Americorps workers, with a local youth agency, SAGA, transplanted over 5,000 native plants from nearby wetlands into the former gravel pit.

and wetland enhancement project, the CBJ contracted the engineering firms Toner-Nordling Associates for the initial fill design and R&M Engineering, Inc. for the design development of the filling process. Glacier State Contractors, Inc. executed the design. To maintain flow through Duck Creek, a stream channel at a minimum of four feet deep was designed to meander through the wetland. From the perimeter of the wetland, shallow platforms, or marsh "fingers", were filled to allow for the planting of emergent marsh vegetation for fish and wildlife foraging and protective habitat. During construction, the fingers provided functional benefit by allowing access for dump trucks to the center of the wetland for filling. At each end of the wetland, two deep water areas were left in place to provide overwintering habitat for juvenile coho. After nine months of filling in 2005, 64,000 cubic yards were placed to create the wetland, resulting in increased savings for the CBJ.

An earthen dam was constructed to control water levels at the project site and in the two upstream pits. This occurred after the filling and revegetation phase to create more stable and drier conditions during construction and planting. A meandering outlet stream was excavated to allow fish passage through the earthen dam. Both the dam and the outlet stream were constructed using an impermeable liner to prevent water loss. Layers of became an important component in gaining public approval and support of the project. Adjacent landowners initially viewed the enhancement project as disruptive, but through the process of filling, planting and trail construction, many neighbors and community members have expressed that the enhancement is an improvement to the neighborhood. It offers recreational opportunities for a neighborhood composed of streets and private property, and provides access to a successional landscape with a fantastic view of the Mendenhall Glacier.

To encourage neighborhood use of the site, CBJ and Trail Mix Inc, constructed a six foot wide gravel trail, and a deck was sited at the south end to capture a remarkable view across the wetland of the Mendenhall Glacier. The decking on the observation deck and boardwalk, railings, and benches were built with recycled plastic lumber. An island at the north end is accessed by a bridge and boardwalk and offers a bench and viewing point south. The 70' bridge is a steel gangway recycled from a CBJ Docks and Harbors improvement project.

Throughout the construction process, volunteers donated time, materials and money to the project. Neighbors began appearing during the summer construction to comment on how excited they were about the project. The CBJ Ports and Harbors Department donated the bridge and benches and the U.S. Coast Guard Engineering Division volunteered to construct the observation deck.

As a result of the success of this project, a similar process is planned for the Allison Pond upstream of the Nancy Street Wetland. The process will be improved based on the lessons learned and applied to the Allison Pond site needs. The strategy and process developed by the Engineering Department at the CBJ has saved the taxpayer's money by pioneering this alternative option to fill disposal. The support of resource agencies, local organizations, and citizen volunteers has enhanced habitat for fish and wildlife and reclaimed a valuable community resource. **L&W**

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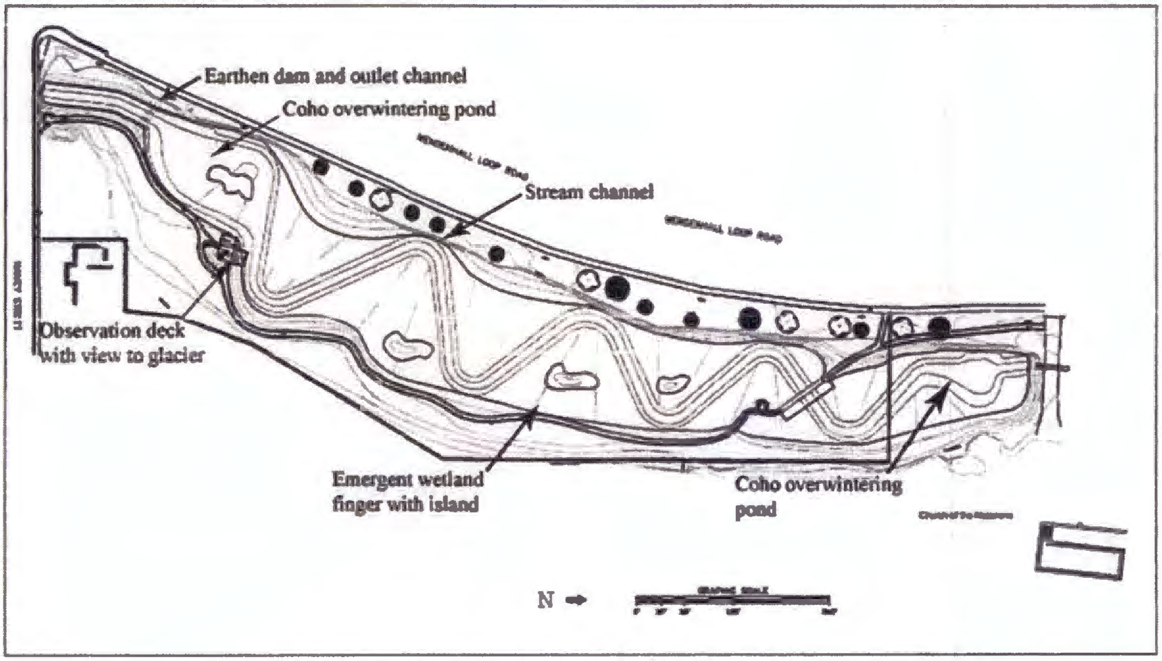
cobbles and gravel for spawning were placed on top of the stream channel liner to create riffles and shallow pools.

The site design and implementation plans of the filling process determined both habitat improvement and operational efficiency. By filling and completing each "finger" and section of the wetland individually, greater variety and attention to each landform was introduced. Initially the option of filling the entire site and then returning to dredge the stream channel had been considered, but would have resulted in less diversity of habitat and less attention to the design details. The chosen approach facilitated meeting the design elevations to within 3 inches to provide necessary habitat for emergent wetland plants—a difficult task on a large project where over 60,000 cubic yards of fill are being placed.

Revegetation planning began in early 2006 by researching and evaluating three locally constructed wetlands and interviewing local naturalists experienced in reclamation and revegetation projects. There was no previously documented information on constructed wetlands in Southeast Alaska, so this project is being carefully monitored to provide baseline information that can be used for development of future wetland enhancement projects. For the purpose of planting design, plants were divided into concentric zones based on the depth of water in which they grow. Although the Nancy Street Wetland is primarily ground water fed, precipitation and surface runoff influence the water level and will therefore affect the survival and composition of the site's wetland plant community.



During the planting season of 2006, volunteers from the community and Americorps workers funded by USFWS planted over 5,000 emergent plugs and cuttings, and 150 lbs of grass and forbs seeds. As there are no native plant nurseries in Juneau or Southeast Alaska, the workers transplanted plugs and cuttings from local wetlands to maintain native gene stock and minimize the possibility of importing invasive plants. Seeds were purchased or donated from sources in Alaska and British Columbia. All plantir work was done by hand using shovel bulb planters, and pulaskis.

There was no previously documented information on constructed wetlands in Southeast Alaska, so this project is being carefully monitored to provide baseline information that can be used for development of future wetland enhancement projects.

Lessons Learned:

To improve the revegetation proce for future projects, better planning fc irrigation should be i place prior to trans planting. As mer tioned earlier, the dar was constructed aft the completion of th planting of th emergent vegetatior Revegetation occurre between the months c April and Augu: when Juneau receive thirty inches of rai However, a two-wee period of unusuall warm, sunny weathe desiccated the hig marsh area. Waterin was necessary, but di ficult to accomplis on such a large sit Crews used bucke and a garden qualit gasoline-powered water pump to irriga the wetland. Some plant mortalit occurred, and it is likely that a prolonge period of hot, dry weather would hav significantly impacted plant survival. T prevent this from happening on futur projects, fill and topsoil with a highe organic content than what was used i this project would help retain moistur Other strategies include controlling wat levels to keep soil saturated while plan ing, or the delaying of planting until Jul when precipitation is more reliable an frequent in Juneau.

There is some concern that the wat level is higher than the designed leve However, the rainfall was higher tha average in 2006, so it is difficult to tell the water levels in the wetland will dro For this reason, designing a dam wit adjustability to account for the discrepanc in water level would improve the functio and success of the project.

Recreational Use of the Site:

The design and development of community trail through the wetlan

Guidelines for Gravel-Pit Wetland Creation

by

Bonnie Baldwin Prange

Abstract. The frequent colonization of the margins of abandoned and unreclaimed wet sand and gravel pits by typical marsh vegetation indicates the feasibility of a created wetlands component in gravel/sand reclamation planning. Using the natural pit wetlands as models and examining the pertinent literature, guidelines were developed for: (1) selecting promising sites, (2) planning with a regional perspective, and (3) construction and monitoring. Key concepts are: hydrological stability and adjacent land uses that will not have an adverse impact; consideration given to how a pit wetland will interact with adjacent ecosystems on a regional level; grading of pit perimeters to produce irregular contours and no more than a 0.6 m change of elevation within the proposed wetland; a combination of limited deliberate planting along with natural colonization whenever the reclamation permit can be adjusted to allow the 3 to 4 years commonly necessary for such colonization; the establishment of self-perpetuating marsh vegetation confirmed over a 3-year period of observation as a minimum requirement for determining permit compliance. Longer term monitoring of pits reclaimed under these guidelines could provide information that would increase and refine post-mining land-use options for wet sites. Research projects could focus on learning more about development of wetland functions within created systems, eventually providing standards for evaluation on a functional level.

Introduction

Wetland creation is still in its infancy as an applied science and is not yet capable of producing predictable results. It is, consequently, a subject of considerable controversy. To some it appears to be a relatively simple, repeatable process; to others a minefield of assumptions regarding ecosystem structure and function. The experimental nature of wetland-creation has made it less attractive for mine reclamation proposals, resulting in very little effort made to purposefully create gravel-pit wetlands, even where conditions are very favorable. The vast majority of wetlands and waterbodies on mined lands nationwide exist not because they were planned for, but by accident as a result of the mining of gravel for highway and other construction projects (Brooks, 1990). As examples of natural regeneration, these sites can provide valuable information regarding the species composition, life-support functions, and long-term persistence that might be expected in future "successful" wetland creations.

Without substantial scientific evidence, which we do not have, there is no reason to assume that these volunteer wetlands function on the same level or provide the benefits of the long-established ecosystems which have been filled-in and lost to agriculture and development. It seems likely, however, that even disturbed and degraded wetland sites may have unknown value. Increasingly, studies indicate that these sites may be very significant for rare species, migratory birds, and regional hydrological functions (Josselyn and others, 1990). "Sites presumed to have little value may provide vital

Proceedings America Society of Mining and Reclamation, 1993 pp 653-664

refuge for species during storm events or support rare and endangered species due to lower interspecific competition within these marginal habitats" (Josselyn and others, 1990).

Scientists have now begun to study wetland creation and restoration in an effort to manage and accelerate processes which may take generations to occur naturally. From these experimental studies will come information which may ultimately allow true replacement of lost or damaged ecosystems. More research is needed, and sand/gravel pits are in many instances ideal as test sites. Excavations that expose the water table commonly create the hydrological features necessary for a wetland, and they eliminate the need for diking and high-maintenance pumping and drainage systems.

The gradual colonization of numerous abandoned wet pits by wetland species indicates both their suitability for subsequent use as a planned wetland and the potential to add to the wetland resource base. Innovative reclamation could supply valuable habitat, contribute to regional hydrological resources, and provide research opportunities to improve our understanding of artificial wetlands. Sand/gravel-pit wetlands offer benefits to society with which mining companies could be pleased to be associated and identified.

Minimum Site Requirements

Hydrology

Hydrology is the key to long-term functioning of wetland ecosystems (Kusler and Kentula, 1990). Since establishment of hydrophytic vegetation will depend on both the predictability and controlled fluctuation of water levels, wetland creation should be restricted to those sites for which seasonal water-level elevations have been determined and where some manipulation is possible. Freshwater gravel-pit wetlands not in river or stream beds will be dependent on ground water and variable surface water flows. Ground water and surface runoff do not always provide dependable water sources, but in most situations they will satisfy the requirements of a wetland project (Van Egmond and Green, 1992).

Assessing the reclamation potential of sand or gravel excavations as wetlands should involve monitoring test pits for annual water-level fluctuations. The amount of fluctuation depends on the nature of the aquifer and on how much water mining operations and nearby users consume. Ranges of 2 meters per year are not uncommon in porous sand and gravel aquifers with local recharge zones (Michalski and others, 1987). Some gravel-pit sites may not be suitable for wetland development due to extreme variations of the water table. Suitability can not be determined until the expected range of the water-table elevation has been established with statistically sound data. Since a successful wetland design incorporates many site-specific variables, it is not possible to generalize acceptable range maximums or periodicity. A decision must be based on project goals and the requirements and tolerances of the wetland-plant communities that project designers want to establish (T. S. Miller, King County Services, oral commun., 1992). The widely varying flooding tolerances among wetland species can be used to advantage in increasing wetland creation options for a particular site. A flexible plan that can accommodate unexpected changes in plant community composition will have a greater chance of success, especially where ground water flows are seasonally unstable.

Potential Land-Use Conflicts

Social considerations may be just as important determinants of site suitability as physical ones. "Adjacent land use . . . could detrimentally impact functioning of wetlands or the wetlands may have detrimental impacts on current or planned uses of neighboring lands" (Hammer, 1992). Intensive agriculture or heavy industry adjacent to the site might produce sediment or chemical-loaded runoff that would prevent wetland establishment.

Wetlands themselves can be unwelcome neighbors. Although some new housing developments and office complexes are planned around preserved sections of wetlands, residents of established communities may well object when wetland alternatives are proposed. Neighborhood opposition often focuses on the prospect of public use, with fears of noise, traffic, and vandalism paramount. Several mining companies have shelved plans to donate lands to the public when faced with organized community opposition (Morris, 1982).

Planning Pit-to-Wetland Conversions

Pre-planning for Realistic Goals

Wetland conversion plans should be "integrated with mining operations and reclamation at the beginning of any project" (Brooks, 1990). This ideal should not preclude adding wetlands to an existing reclamation plan. Wetland creation could be added to a previously permitted proposal for a post-mining open-water pond, for instance, assuming the hydrologic conditions to support the pond had already been established. Reclamation designed around an aquatic ecosystem goal provides direction in the early planning stages, but the decision to attempt creation of specific wetland functions might best be left until mining is nearly complete. At that point the altered hydrology of the site could be re-evaluated, and objectives could be based on several seasons of hydrological data-gathering plus assessment of regional land-use trends over the same time-span. When objectives have been established, they should be clearly described and recorded, along with any subsequent amendments, because on-site modifications during construction and planting are commonly necessary (Hammer, 1992).

Michalski and others (1987) recommend detailed studies to determine surficial characteristics of the site before, during, and after extraction. If pumping of ground water is part of the extraction process, the output could be monitored to estimate in-flow rates and the potential area of ground-water influence after mining (Michalski and others, 1987). Pre-mining planning could include provisions for hydrological monitoring and record-keeping at various stages over the life of the mine. This provides the database from which to determine the most feasible final configuration. The information would be useful for establishing other reclamation endpoints if it did not ultimately support the proposed wetland goal.

Regional Reference Wetlands as Guidelines

The most fundamental goal, regardless of the specific chosen objectives, is to develop self-maintaining systems that mimic natural ones in as many ways as possible. The study of local natural wetlands is important because artificial wetlands must closely imitate natural systems adapted to the region if a creation project is to succeed without continual operating and maintenance costs (Hammer, 1992). This means that design parameters must be appropriate to local hydrology, climate, and soil conditions. Measurements of elements of wetland structure at a natural site within the region or watershed that shares these conditions will provide insights into what is obtainable and how to evaluate progress at the constructed site (Hammer, 1992). In the context of comparisons of natural to artificial, the objectives for a created wetland must encompass "only a very early successional stage if the evaluation period is short (less than 10 years for a marsh)" (Hammer, 1992).

Landscape Considerations

Even if the physical parameters of a site are favorable for reclamation as wetland, the result will be counterproductive if it conflicts with regional land-use priorities or overall ecological balance. "Land managers need to establish their mitigation policies in the context of what changes are occurring in wetland types throughout a given physiographic region, not just on a particular mine site" (Brooks, 1990). Assessing these trends to determine regional need for specific wetland types requires coordination among federal and state agencies. Cooperating agencies must then see that this information is transferred to those who will be planning wetland construction, including the mining industry (Brooks and others, 1988).

Constructing a Gravel-pit Wetland

Site-specific Considerations and Grading Plans

Since each site presents a particular combination of hydrology, topography, and substrate, only generalized instructions can be provided. There are no exact guidelines yet accepted in the very young science of wetland creation. Given favorable site hydrology, however, it is possible to proceed with assurance that the creation of gentle slopes at pit perimeters plus restoration of topsoil, or even moderately amended subsoil, will result in establishment of wetland vegetation. Many abandoned wet pits have, over time, acquired typical wetland vegetational characteristics with far less encouragement.

Although many mine reclamation plans are submitted in the initial permitting process, it may not be practical to plan the specifics of a post-mining pit wetland until the extraction is nearly complete. At that point it should be possible to draw up a detailed site grading plan which will take the site variables into account. The final hydrological parameters, in particular, may not be fully anticipated or understood until the alterations that mining imposes have actually been realized. The site grading plan is an essential element in engineering the site for wetlands because it will determine basin morphometry, which in turn determines vegetational composition (Garbisch, 1986). Because many wetland plants are sensitive to water depths within a low range of tolerance, the most useful plan would have contours of 1 foot or less at a scale of 1 inch equals 20 to 50 feet (Miller, 1987).

The precision grading required to bring the site to the final grade within the established tolerances may not be possible if water cannot be excluded from the pit (Garbisch, 1986). In these instances, "the site grading plan should reflect this . . . and specify the scattered mounding of fill materials in order to diversify the wetland habitat" (Garbisch, 1986).

Shorelines and Slopes

A common recommendation for sand-or-gravel-mine wetland construction is to increase the area of the pit basin by creating an irregular shoreline. Bays, inlets, coves, peninsulas, and islands increase topographic heterogeneity and habitat diversity and provide more "edge" by increasing percentage of shoreline per unit area (Crawford and Rossiter, 1982). Pit floors should also have an irregular topography with mounds and depressions (Norman and Lingley, 1992; Van Egmond and Green, 1992; Michalski and others, 1987). Dumping overburden in irregularly spaced piles will create rough bottom contours and perimeter landforms (Van Egmond and Green, 1992).

Construction of some of these landforms can take place during mining to simplify post-mining reclamation. Overburden and waste materials (including boulders and tree debris) can be graded into landforms above and below the water line (Michalski and others, 1987). Islands for protection of waterfowl and general ecosystem diversity can be developed in undrained pits during operations (Michalski and others, 1987). They should be separated from the shore by a permanent water depth of 1-to-2 m and a width of 4-or-5 m, with tops at least 1 m above the estimated highwater mark (Van Egmond and Green, 1992).

Slopes for a true marsh community need to be almost flat – no more than a 0.6-m change of elevation between the deep and shallow marsh (Miller, 1987). Shallow slopes maximize flooding and minimize erosion (Kruczynski, 1990). Brooks (1990) and Crawford and Rossiter (1982) recommend gentle slopes at 10H:1V or 20H:1V; Kruczynski (1990) suggests that a range of 5H:1V to 15H:1V is acceptable. Since it is unlikely that efficient mining will be possible at these angles, the cut-and-fill method can be used to create recommended slopes (Norman and Lingley, 1992).

Unless slopes have been left ungraded and unstabilized, gravel-pit waterbodies typically have two distinct habitats: the shoreline wetland and open water. Grading plans will determine how much area will be allotted for each. Fifty percent open water to 50% marsh or swamp is often cited as optimal for fish and wildlife habitat (Van Egmond and Green, 1992; Crawford and Rossiter, 1982). Norman and Lingley (1992) suggest 25% of the waterbody in shallow water less than 0.6 m deep, 25% in shallow water 0.6-2 m deep, and 50% in water greater than 3 m as a general guideline for use by fish and waterfowl. If wetland communities are the objective, however, "the higher percentage of shallow areas the better" (Norman and Lingley, 1992).

Water Level Adjustment

Gravel and sand pit-wetland creations are primarily ground water-fed and therefore may not require elaborate water-control mechanisms. According to Van Egmond and Green (1992), "natural cycles of drought and wet spells will sometimes provide adequate changes in water levels." An outlet with a controllable weir will increase management options, however, and will enable periodic partial drainage which helps reestablish wetland vegetation. Van Egmond and Green (1992) recommend that a water-level drawdown should occur every 3 to 10 years. Boule (1988) emphasizes the importance of simple systems which are more likely to be self-regulating and self-maintaining. He advocates relatively inexpensive weirs or other similar devices which are unlikely to fail and disrupt the entire system. Outlets should be identified on-site and recorded in plans so that they can be periodically inspected and protected from erosion (Norman and Lingley 1992).

Branch (1985) reported successful vegetation establishment on a 5-ha portion of an abandoned sand and gravel mine in Maryland using a device with a removable weir plate which controlled the top 0.3 m of water in the basin. Removal of the weir plate exposed perimeter areas for planting; once this was complete, the plate was reinstalled to restore the project design water levels. Garbisch (1986) suggests that incorporation of an adjustable weir in the project design may compensate for less-than-precise grading.

Although periodic "drawdowns" are important for waterbodies that function as waterfowl habitat, many pit ponds lack surface drainage and "cannot be drawn down using standard dikes and weirs" (Michalski and others, 1987). For landlocked ponds receiving supplemental water from surface runoff, a partial drawdown can be engineered by periodically diverting this surface flow (Michalski and others, 1987). Unless there are concerns about contaminants in the surface water, it can be directed toward the pit-pond impoundments (Van Egmond and Green, 1992). The drainage channels "should have a natural sinuosity and gradient", should be stabilized with riprap or vegetation, and should be directed through upland "vegetated areas to slow runoffs and aid in water filtration" (Norman and Lingley, 1992).

Sealing and Lining

Since "most natural wetlands are perched above an impervious layer that reduces or prevents water loss", Hammer (1992) believes that there are few situations in which a basin can sustain a wetlands ecosystem without an impermeable lining. Brooks (1990), on the other hand, states that "basins constructed below the water table rarely need to be sealed." Wet pits have an advantage as wetland creation sites not only because they are filled primarily by ground water flow, but also because natural sealing is common. The material left behind after gravel mining usually has a fairly high percentage of clay or silt, especially if aggregate was washed on site (Bradshaw and Chadwick, 1980). These "fines" will contribute to the blocking of water movement, and over time additional fine sediments will be eroded or carried into the pit lake with surface runoff (Evoy and Holland, 1989). The extent of this natural sealing will vary from site to site depending on the shape of the pit, bank materials, perimeter vegetation and water turbidity (Durbec and others, 1987). It seems likely, however, that even a partial lining of sediments within the pit would be beneficial from a wetland creation perspective.

Soils

An appropriate substrate for plant establishment can be created by placing topsoil on banks, islands, and submerged areas that have the recommended shallow grade. Norman and Lingley (1992) recommend a 15-to-20 cm layer of topsoil over a thicker layer of subsoil; Hammer (1992) suggests a 40-to-60 cm total soil layer (topsoil and subsoil) will be needed to provide adequate substrate for root growth. This soil layer should be placed on islands and down to 1.5 m below the expected highwater mark for the wetland perimeter (Van Egmond and Green, 1992). If grading-plan configurations are to remain accurate, the pre-final grades will have to be made lower than the final design elevations to allow room for the topsoil (Miller, 1987).

Stripping and stockpiling of topsoil before mining will reduce reclamation costs later on. To maximize efficient use of on-site materials, clean process-waste fines can be used to augment salvaged topsoil (Hart and Keammerer, 1992). Structural damage can be minimized if soil stripping and replacement is limited to dry periods and if proper machinery (e.g., wide-track crawler bulldozers) is used in re-application (Norman and Lingley, 1992). Any sort of unnecessary equipment movement over the soil should be avoided.

There are varied estimations of appropriate topsoil storage periods. Brooks (1990) specifies a maximum of 3 months. Garbisch (1986) says stockpile duration must be less than 4 weeks. Segmental reclamation is the only procedure that will be compatible with these storage times, because it allows transfer of topsoil directly from an active mining segment to another segment which is in the process of being reclaimed. This reclamation approach is ideal for larger sites and long-term operations, but it is not always an option where deposit heterogeneity and market fluctuations prevent continual movement of the operation from one segment to the next (Norman and Lingley, 1992). Where longer storage periods are necessary, Michalski and others (1987) suggest seeding of the piles as a way to reduce loss of quality.

For mined sites that have no salvaged topsoil available, the partially weathered subsoil may be an acceptable substitute (Michalski and others, 1987). Garbisch (1986) goes so far as to say that most clean (uncontaminated) inorganic borrow and dredged fill materials will be satisfactory substrates for wetland establishment. Hammer (1992) agrees that "most common substrates are suitable for wetland establishment" and that "wetland plants thrive in a broad range of soil types", but adds that topsoil replacement may eliminate the need for soil amendments.

If subsoil or overburden material is the only planting medium available, then a controlled time-release fertilizer that performs in saturated soils should be put into the substrate together with the transplant (Garbisch, 1986). If the planting is occurring underwater, Garbisch (1986) suggests placing the fertilizer in burlap sacks underneath the transplant. Fertilizers should never be broadcast or spread on the soil surface of wetlands (Shapiro and Associates, 1991). The cost and additional labor necessary to apply these fertilizers would seem to argue for on-site salvaging or site-to-site transfer of topsoil whenever possible.

Straw or hay mulch is another option to consider for any reclaimed site where the substrate lacks organic matter (Brooks, 1990) and could be an inexpensive adjunct or alternative to commercial fertilizer for wetland applications. Street (1982) recommends 1 kg straw mulch per square meter.

Wetland Vegetation

For wetland creations, there are only two basic reasons for choosing managed revegetation over natural colonization: timing and species composition (Josselyn and others, 1990). Composition, especially, is a factor in many mitigation proposals. Revegetation by artificial means may be required, for example, if a specific wetland plant community is necessary to replace habitat for wildlife species that are loosing habitat elsewhere. In these situations it may be advisable to salvage plants from wetland sites that are being destroyed and transfer them to a new site where their genetic diversity is likely to be preserved.

Managed revegetation programs are also generally more successful in controlling exotic species which commonly invade disturbed areas and become established first (Josselyn and others, 1990). These exotics usually have a competitive edge over native marsh species and may form extensive monotypic or low diversity stands that decrease the wildlife habitat or nutrient processing functions of the wetlands they take over. Reed canarygrass (*Phalaris arundinacea*) and purple loosestrife (*Lythrum salicaria*) are notorious local examples in freshwater wetlands.

There are also a few ubiquitous native wetland plants which may be considered undesirable due to their aggressive, weedy characteristics. Many wetland ecologists would advise control of dominants such as common cattail (*Typha latifolia*), willow (*Salix* spp.), and cottonwood (*Populus* spp.) because of their tendency to reduce system diversity and crowd out plants more valuable to wildlife (Hammer, 1992; Odum, 1988; Erwin and Best, 1985). These pioneer colonizers are adapted to invade disturbed sites, and "creation projects often behave like disturbed wetlands" (Odum, 1988). Nonetheless, dominant natives such as cattail, willows and cottonwoods remain popular components of revegetation projects and are found on many lists of suggested species for wetland plantings. As naturally occurring features on most disturbed freshwater wetland sites, they would seem to be far preferable to weedy exotics and perhaps not worth great effort and expense to control unless their establishment would conflict with project goals.

If a natural seed source is nearby, or if the substrate contains a seedbank from another location, periodic manipulation of water levels in the constructed wetland basin can be sufficient to start germination and retard growth of terrestrial species. Miller (1987) suggests that a seed source can be obtained from mud removed from shorelines of existing ponds and marshes and spread in the shallows (water depth less than 10 cm) of the created site. Brooks (1990) mentions the possible transfer of seed-bearing hydric soils from wetlands scheduled to be altered or filled-in for development. The removal of plants or soil can be justified only when the destruction of the natural wetland is a legally sanctioned certainty and all relevant government regulations have been followed. If these conditions are met, salvaging of plants and hydric soils from nearby development sites or during segmental reclamation should be encouraged as a means of preserving what would otherwise be lost.

A post-reclamation study comparing treatments in a central Florida marshland reclaimed from a phosphate mine provides support for the use of relocated hydric soils. The study determined that topsoiling with a 2-to-10cm-thick layer of "mulch" containing seed and root material obtained from a wetland borrow site showed "distinct advantages over natural revegetation of overburden" (Erwin and Best, 1985). After two full growing seasons, the mulched areas had higher species diversity and more complete vegetative cover than the untreated overburden areas. More importantly, this topsoiling method "appears to encourage the accelerated establishment of late successional plants in sufficient quantities to compete with aggressive weedy species" (Erwin and Best, 1985).

Natural hydric soil seedbanks thus obtained should not be stockpiled for longer than 1 month to avoid desiccation and possible re-oxidation of metals (Brooks, 1990). Hammer (1992) advises that any wetlands soil reserved for later use should be stored underwater to prevent release of bound metals.

If a legally and ecologically acceptable donor site is available, Hammer (1992) recommends an alternative to digging out and spreading a layer of wetland soils. This method involves collecting cores of wetland soil (10-12 cm diameter and 15-25 cm long) and inserting them in the substrate at the reclamation site. The cores contain seeds as well as roots, tubers and rhizomes and can rapidly develop into a complex wetland community. They are also a reservoir of propagules that may produce additional plant growth for several years after they are installed at the new site. Disadvantages center around labor costs involved in collecting, transporting, and installing the cumbersome and somewhat fragile cores.

If species composition for a particular mitigation purpose is not a concern, and if establishment within a limited time frame and budget is the priority, then a combination of natural colonization and deliberate planting may be the most effective way to establish vegetation on gravel-pit wetlands. Natural regeneration, while not "manageable" enough for situations where precise control over outcome is important (Garbisch, 1986), may provide the best long-term results because the plants will grow where they are best adapted (Clewell and Lea, 1990). The availability of natural seed sources adjacent to the project site or the possibility of seed transport into the site via flood waters needs to be evaluated if natural revegetation is part of the reclamation plan (Clewell and Lea, 1990). The amount of hand planting undertaken should depend on the proximity or reliability of a seed source, labor and materials costs, and time allotted to complete the project.

For those pit wetlands that can or must be hand planted, the best guide for species selection will be found in the vegetative composition of similar nearby wetlands (Hammer, 1992). Local native-plant nurseries, a few of which specialize in wetland vegetation, are sources of advice on what species combinations will produce the most natural plant communities. The objectives of the reclamation plan, which might include wildlife habitat, aesthetic enhancement, and/or stormwater detention and purification, will also help determine appropriate plant species (McMullen, 1988). The limiting factors, however, will be the physical conditions at the site and the environmental tolerances of available nursery stock.

The type of plant stock chosen will influence timing of planting and vice versa. Spring is usually the best time to plant, with fall the next best choice (McMullen, 1988). Propagules planted in late spring may be less susceptible to wildlife damage due to the shorter time to be expected between planting and germination. These timing recommendations generally apply to the seeds, rhizomes, corms, and tubers of herbaceous species, as well as to the whole plants. Woody vegetation such as trees and shrubs should be planted in the dormant state which generally extends from November through March in the Pacific Northwest (Norman and Lingley, 1992).

A biologist familiar with local wetlands should review the proposed planting design. "The number of each plant species to be used will be based on the type of community, the plant's position in the community, and the required spacing between plants" (Miller, 1987). Miller (1987) generally recommends that trees planted on 4.6-to-7.6-m centers, shrubs on 0.9-to-2.4-m centers and groundcovers on 1.0-m centers would be appropriate for the emergent shorelines of created freshwater wetlands. Marshes created in standing water deeper than 10 cm are most easily established using sprigs (culms), tubers, or rhizomes (Miller, 1987). These propagules are pushed into the mud/mulch substrate on 0.3-to-1.5-meter centers (Brooks, 1990). Plantings should be irregularly spaced in clumps to mimic natural spacing as closely as possible.

The cost of managed revegetation with nursery stock and labor intensive hand planting can be substantial (Brooks and others, 1988). Miller (1987) estimates that approximately 27,000 transplants per hectare will be necessary to establish a created marsh wetland. Costs can be greatly reduced if time expectations and reclamation objectives allow at least partial natural colonization. If the hydrological aspects of a site are favorable to begin with, precise grading and substrate preparation should be enough to assure emergence of at least a few native and/or naturalized wetland species. On sites being created as a diversity-enhancing feature of a mine reclamation plan and not as mitigations for specific wetland losses, this may be all that is needed.

Buffer areas consisting of native upland vegetation and at least 30 meters wide will increase habitat diversity and protect the shoreline and should be planted/seeded on the higher ground surrounding the pit impoundment and created perimeter wetland (Norman and Lingley, 1992). According to Munro (1991), vegetated areas should be provided as buffers between wetlands and adjacent developed land or as transition zones between wetlands and adjacent natural areas even if not required by regulations.

Post-construction Monitoring

Evaluating Success

The construction process, if carefully planned and well executed, should produce a site on which the altered hydrologic conditions favor wetland development. The introduction of wetland plant species, whether by natural colonization or managed revegetation, is only the first step in that development. Wetland functions for which the project was designed might not develop for decades, if at all. According to Hammer (1992), it is "grossly unrealistic to expect to create even the simplest type of natural wetlands systems" within 2 or 3 years after construction. This makes it very difficult for regulators to determine whether a wetland reclamation has been "successful", particularly if the site is part of a mitigation effort to replace the functions of natural wetlands sacrificed to development.

The time limits for completion of revegetation that are specified by many surface-mine regulatory programs are inadequate for the evaluation of created wetlands. Washington State allows 2 years or "such later date as may be authorized by the department" (Chapter 332-18-050 WAC). The literature on wetland creation and restoration indicates that 2 years is not sufficient time for stabilization of new emergent marsh ecosystems. Boule (1988) suggests that establishment and natural perpetuation of plants in marsh and shrub-swamp systems would require 3 to 5 years. Brooks (1990) states that "there is some scientific evidence for the stabilization of emergent marsh systems after three years." Josselyn and others (1990) report their observations that many San Francisco Bay area wetland restoration projects which had been considered revegetation failures became fully vegetated when allowed a 3-to-4-year period of natural regeneration.

Past experience with restored or created wetlands also indicates that revegetation over 1 or 2 years is "no guarantee that the area will continue to function over time" (Kusler and Kentula, 1990). Active monitoring, with periodic review by qualified personnel, would provide some perspective on the direction that site development is following and would allow for timely mid-course corrections if necessary. Reports, submitted within 90 days following sampling, should document any vegetation changes including percent survival and cover of planted and/or volunteer species (Erwin, 1990). Monitoring reports should also document issues related to water levels, water quality, and sedimentation and discuss recommendations for improving the degree of success observed (Erwin, 1990).

Short-term vs. Long-term Monitoring

The evidence regarding the establishment of marsh vegetation seems to indicate a minimum 3-year monitoring program for wetland creation projects. Brooks (1990) suggests that expenses for a 3-year monitoring period be included in the cost projections for any mine reclamation plan with a wetlands component. This allows for assessing of varying conditions over three growing seasons and should not result in unbearable economic burdens on the permittee (Brooks, 1990). Boule (1988) feels that annual monitoring of wetland creations over a 3-year period is the minimum acceptable term; 5 years would be more appropriate for some complex projects. Erwin (1990) agrees that post-construction monitoring should be conducted over a 5-year period, with a minimum of 3 years, and with annual inspections at the end of each wet season.

The short-term monitoring proposed here will not be sufficient for scientific research and data collection, and it will not help redirect evaluations toward establishment of wetland functions rather than appearance. Success in a 3-year time-frame may have to be measured in terms of survival and growth of plant species characteristic of a wetland community with no consideration of functional attributes.

Long-term research projects that will enhance our ability to predict the outcomes of mitigation policy should be encouraged and carried out whenever possible. These projects can focus on learning more about development of wetland functions within created systems and may eventually provide standards for evaluating function. Until such standards exist, personnel responsible for judging compliance with permit requirements will have to rely on the tools at hand. For wetlands created outside a mitigation context the establishment of self-perpetuating marsh vegetation, confirmed over a 3-year period of observation, seems a realistic and appropriately flexible reclamation objective.

Correcting Problems

In addition to verifying compliance with reclamation plan requirements, monitoring programs can also identify problems which might eventually lead to failure. Miller (1987) and Garbisch (1986) list several reasons for poor results at some wetland creation projects: improper final grade, invasion or deliberate planting of nonnative plant species, poor planting techniques, inadequate water levels, vandalism, and wildlife predation. Mid-course corrections can often mitigate these problems before the project becomes a lost cause, but corrective measures are best determined by professionals qualified in fields such as wetland science or restoration ecology.

Some created wetlands need long-term management to survive and function as they were intended. This "may include water level manipulation, control of exotics, controlled burns, predator control, and periodic sediment removal" (Kusler and Kentula, 1990). Management of this type beyond a 3-to-5-year program coordinated with annual monitoring is probably not feasible for most reclaimed pit sites. Once the mine operator is released from further obligations under the reclamation permit, the site will have to be self-sustaining. This means that problems that are not correctable within the proposed 3-year monitoring period will continue to have a detrimental influence, perhaps a regional one.

This further emphasizes the importance of site-specific project designs developed from data gathered both before and during the mining operation. Although each site is an experiment within which complete control is never possible, development of a practical, self-sustaining design that uses knowledge of site characteristics is the best defense against the unexpected. Larson (1988) suggests that minimum data requirements for freshwater wetland creation projects include a baseline of information on land-use history, macrotopography, general surficial geology, streamflow, lake hydraulics, and ground water levels and quality. Hart and Keammerer (1992) stress the importance of accurate historical project records documenting the techniques used, including a detailed photographic record. "This information is of paramount importance relative to understanding successes or failures" (Hart and Keammerer, 1992).

Conclusions

The sand and gravel industry, increasingly under public scrutiny as its operations are encroached upon by suburban development, must now focus on the long-term regional implications of post-mining land-use decisions. It has been proven that worked-out pits lend themselves to a wide range of subsequent uses, but the majority of these uses have come about by accident rather than intent through planning. The natural regeneration that has occurred at many abandoned wet-pit sites indicates tremendous potential for increasing the nation's freshwater aquatic ecosystem resources, but this potential is not being fully used. Wetlands, in particular, have been neglected or overlooked in sand-and-gravel-mine reclamation planning.

Opportunities to balance use of an essential non-renewable resource with development of new resources may in time prove more valuable than the materials which have been extracted. Wetlands are in short supply and increasingly threatened. While creations are not a substitute for mature natural systems, they have the potential to initiate functional wetlands for future generations. For the immediate future, they can add to regional ecosystem diversity and provide habitat for many species of plants and animals. The hydrology of worked-out sand and gravel pits is typically ideal for wetland creation projects. What is needed is industry commitment, cooperation among government agencies, and support from an informed public.

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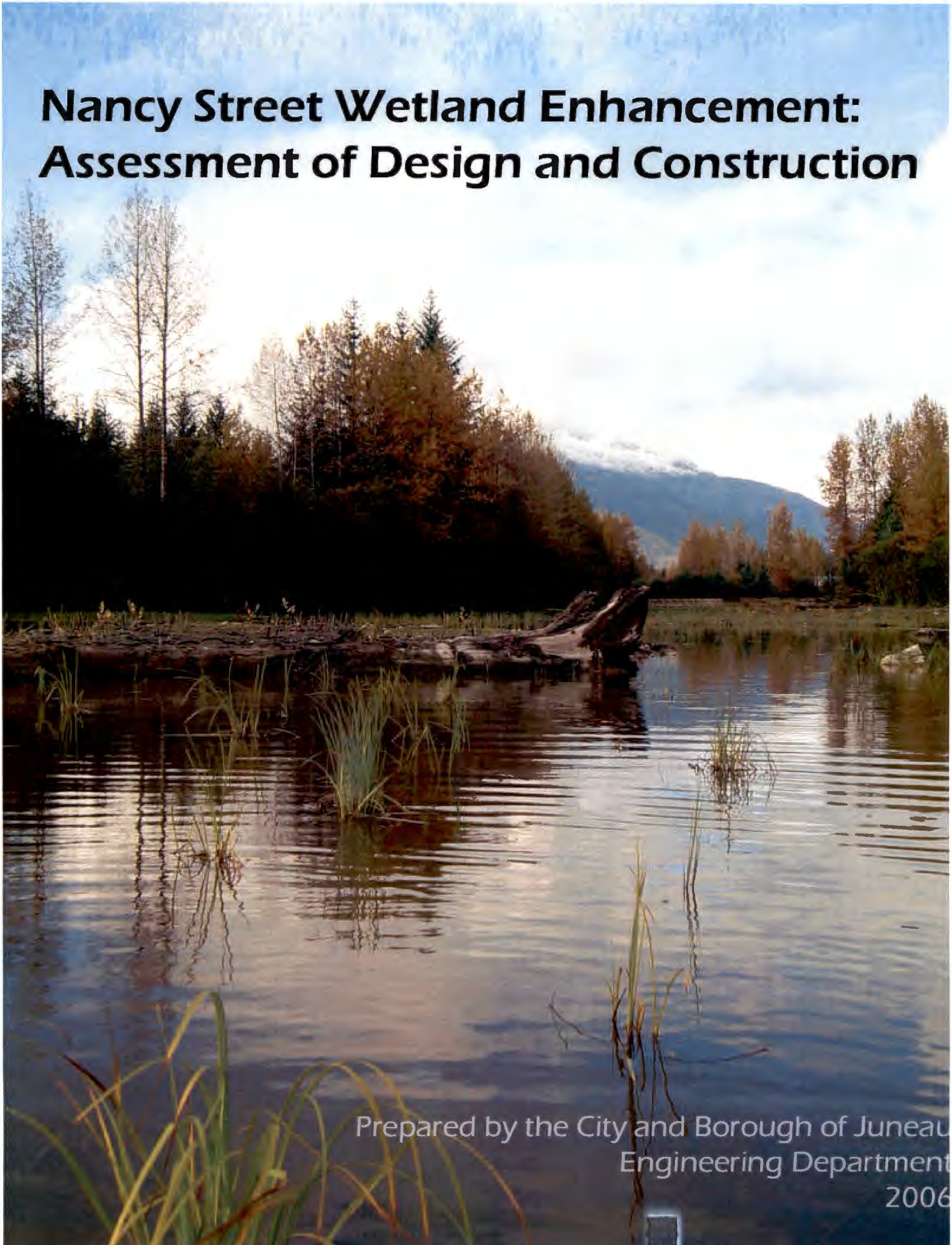

Prepared by the City and Borough of Juneau
Engineering Department
2006

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I. Introduction and Site Description

The Nancy Street Reclamation Project pioneers a creative strategy to partner development needs of a fill disposal site with conservation needs of wetland habitat and water quality enhancement. Six acres of wetlands along an impaired anadromous salmon stream became the site of fill disposal for a high school construction project in the Mendenhall Valley in Juneau, Alaska. The filling was designed to provide a platform for wetland emergent plantings and a meandering stream with riffles and deep water pools for juvenile salmon. For the City and Borough of Juneau (CBJ), the purchase of this parcel from a private landowner meant $137,000 dollars to provide a disposal site only one mile from the construction site. Otherwise, the transport of the fill would require a three mile drive to Lemon Creek. The CBJ Engineering Department charged the contractor a lower rate for fill disposal and used this revenue to partially recover the cost of the land purchase (Appendix 3).

From the conservation perspective, this strategy met goals of a ten year old community watershed plan and the Juneau Wetland Management Plan to improve the habitat and water quality of the Nancy Street Wetland. In the 1950s and 1960s, the land was dredged to extract gravel deposits. The pit filled with groundwater that was high in iron and low in dissolved oxygen. The water from this system enters the Duck Creek system and ultimately flows into the valuable Mendenhall Wetlands. By filling to create an emergent wetland, the plants act as water filters and improve salmon and bird habitat.

The integration of a community participation component to the project raised support and enthusiasm for the creation of the wetland. Local volunteers planted willow and cottonwood in the wetland and various community groups donated time and money to the revegetation and the construction of a trail. Since the construction of the trail, nearby property owners have expressed approval and gratitude for the wetland reclamation.

This document summarizes the planning, design, and construction of the Nancy Street Wetland Reclamation Project. The site description presents the history and ecological problems found in the former gravel pit. Then the design and process of filling, revegetation and trail creation is discussed. Finally, a plan for monitoring and maintenance is proposed in order to measure the functionality and the success of the design and construction. Future plans to fill the Allison Pond as a wetland depend on the economic and ecological success of the reclamation as well as the public perception of the project. This document provides a guide to measure this success.

Site Description

The Nancy Street Wetland is located in the East Mendenhall Valley along Duck Creek, ten miles south of downtown Juneau. As part of a glacial valley, the land has been in flux for centuries, the most prominent example of this being glacial rebound. Only in the past century have people been continuously inhabiting this land. Juneau, as a gold rush town, formed in the late 19th century around two mines located near the downtown area. Prior to the arrival of the gold miners in Juneau, the Tlingit people had established a summer village a few miles north of the Mendenhall Valley. It is believed that the Tlingit only visited the valley occasionally. In 1885, the first record of land use in the valley identifies Daniel Foster as a homesteader. He raised animals and farmed the land at the mouth of the valley (Koski and Lorenz, 1999).

In the next 40 years, development of the valley occurred rapidly. A road was built to access a hydroelectric plant constructed near the glacier. Fox and mink farms, common in this part of Alaska in the 1920s, occupied much of the flat valley land. Salmon harvested from Duck Creek fed the animals. In the mid-1900s the Juneau airport was constructed on the land where Duck Creek flowed into the ocean. The creek was diverted to empty into the Mendenhall River. Along the creek bed, gravel pits were dug and homes, schools, and commercial areas were developed (Koski and Lorenz, 1999).

In the 1950s and 1960s the current Nancy Street wetland including land to the north and south of the site were dug for gravel extraction to support the rapid development of the city. After the mining was completed, the holes were left to fill with water. The pond then supported a stump dump and the neighborhood dumping of yard waste and many other household items. A private owner of the Nancy Street site sold the land to the City and Borough of Juneau to be used as a fill disposal site and reclaimed wetland. The northern portion of the site is still owned by the Church of the Nazarene

Photo from Koski and Lorenz, 1999.
Duck Creek, early 1900s

who has agreed to allow city access to the wetland for the reclamation project. From this early industrial history of the landscape, the only visible remnants are piles of gravel mining waste along the southern end of the Nancy Street Pond.

Currently, the Nancy Street Wetland is surrounded by dense suburban development with supporting infrastructure such as roads, schools, churches, and a commercial center. According to a study done by the Department of Parks and Recreation

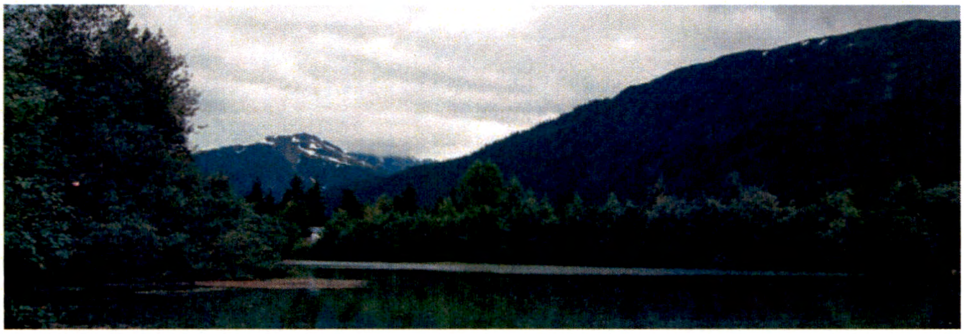


Photo taken by Michele Elfers.
Nancy Street Pond 2005, prior to reclamation, Thunder Mountain is seen on the right

in Juneau, 11,000 people live in the East Mendenhall Valley with a higher than average density of 5 to 18 residential units per acre (1996). Immediately surrounding the Nancy Street Wetland is a church to the north, single family home developments to the east and south, and the collector road through the valley to the west that separates the wetland from a mobile home community. The dense development limits access to off street recreation for residents. It is difficult to move through this part of the valley without crossing streets or private property.

The Nancy Street Wetland site is seven acres of wetlands and uplands located on the East Fork of Duck Creek in the Mendenhall Valley in Juneau, Alaska. The East Fork drains 266 acres of land into the mainstem of Duck Creek. The entire Duck Creek Watershed drains 1.7 square miles of land into the Mendenhall River just upstream of the largest tidal wetland in Southeast Alaska. As part of this larger system, the water quality and habitat resources of this stream are vitally important to the ecosystem of Southeast Alaska. The Duck Creek Watershed has been recognized for its valuable habitat for salmon and its poor water quality. It is classified by the state as anadromous fish waters (Alaska Department of Fish and Game Catalog No. 111-50- 10500-2002) for its run of coho salmon. It is also designated an impaired water body by the Alaska 303(d) list of Impaired Waters, Alaska Department of Environmental Conservation. These two factors have motivated the city of Juneau and federal agencies to focus on the improvement of the stream system.

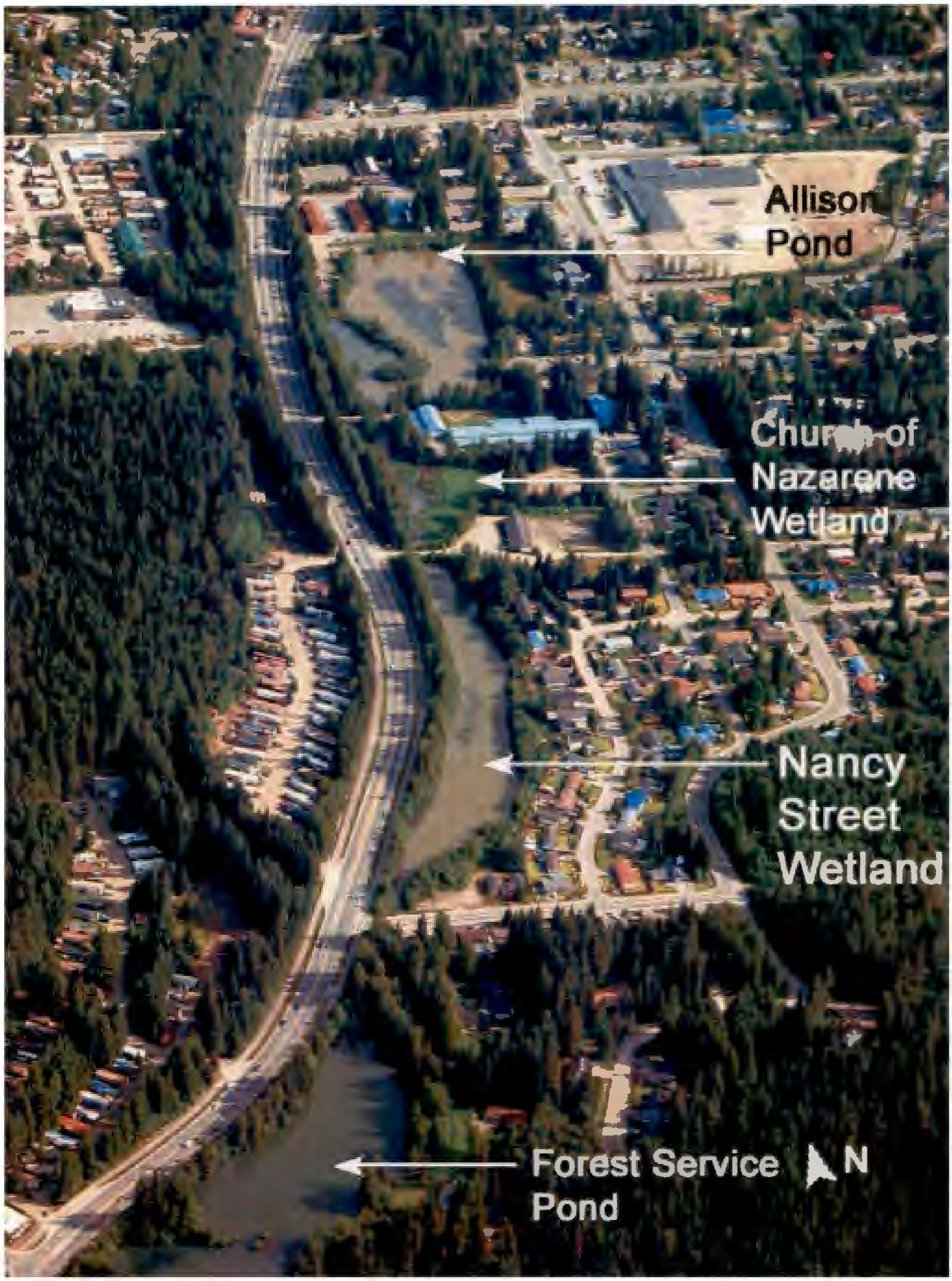


Photo from Koski and Lorenz, 1999.

The East Fork of Duck Creek flows through a chain of ponds and wetlands that were once gravel mines. Currently dense development crowds the ponds and wetlands into a narrow corridor along the main commuter road through the Mendenhall Valley.

Throughout its 250 year history as a watershed, the topography, stream flow and vegetation have massively changed due to glacial rebound, glacial succession and human influence. In its current state, the densely populated residential areas surrounding the wetland contribute to problems of turbidity, heavy metals, iron floc, fecal coliform and low dissolved oxygen rates within the watershed (Koski and Lorenz, 1999). However, many of the current water quality problems result from the geologic and cultural history within the Mendenhall Valley.

The known geologic history began during the Pleistocene Era 18,000 years ago. Metamorphosed igneous and sedimentary rock composed the Mesozoic bedrock under what is now the Mendenhall Valley. Glaciers advanced and covered the land with 4000-5000 feet of ice. When the glacier retreated, it carved out the depression that is now called the Mendenhall Valley. The glacial moraine deposited marine sediments, sand, gravel and organic materials in the valley. The most recent glacial advance in this valley began 700 years ago during the Wisconsin Age. The glacier advanced until 1750, and covered at least half of the current Duck Creek watershed. As the glacier retreated, Duck Creek gushed from the face and created an outwash plain as it flowed to the ocean. Several terminal moraines were deposited throughout the current watershed. As the glacier continued to melt, however, it formed a basin and a lake. The melt water from the glacier filled what is now Mendenhall Lake and spilled out into the Mendenhall River, cutting off the flow to Duck Creek. Today, groundwater is the primary source of the Duck Creek stream flow.

Since the retreat of the glacier, isostatic rebound has significantly impacted the landscape. In 1965, Hicks and Shofnos reported the rates of .05 feet/year uplift of land between 1936 and 1962. They believed the deglaciation of the land caused this uplift. The water table lowered relative to the surface of the land as a result of this process. Currently, low stream flow levels pose problems for fish habitat in Duck Creek. There is speculation that the isostatic rebound may contribute to this problem (Host and Neal, 2004).

In addition to isostatic rebound, the highly permeable soils in this area contribute to low flow. The soils characteristics of this flat landscape are common to alluvial plains and stream valleys: well to excessively well draining. The USDA, Soil Conservation Service, surveyed the soils in 1974 in the Juneau area and found along Duck Creek primarily soils in the He and Be series.

The He series of soils are composed of silty and sandy sediments that are generally waterlaid. For this reason, the soil is stratified. The stratification is generally 40 inches to 6 feet deep and is composed of silt, very fine sand, fine sand, deposits of organic matter, and coarse sand and pebbles. The depth to water table is usually greater than 4 feet, but can be less at times. HeA is the specific soil type in this series found along Duck Creek; this signifies slopes of 0 to 3 percent and a texture of Fine Sandy Loam.

The second series found in the Duck Creek watershed, the Be series, is also common on alluvial plains and terraces as well as hilly moraine landscapes. The gravelly sandy soils indicate an excessively well drained substrate. The first layer of the soil is very gravelly sand. The material 10 inches below the surface is 50 to 75 percent gravel and cobblestone by volume. Some large stones and boulders will be present. The water table, like the He series, is greater than 4 feet, but in some areas may be close to the surface. Flooding is rare in these soils; however, close to streams flooding may occur (Schoephorster and Furbush, 1974). Field testing close to the Nancy Street Wetland revealed a layer of approximately twenty inches of fine silt underlain by five feet of sand (Beilharz, 1998). This type of soil is highly permeable and contributes to the loss of stream flow to groundwater. In some reaches of Duck Creek, the stream goes dry or becomes puddles of standing water. Low flow destroys aquatic habitat and prevents aquatic life from moving through the stream.

The geologic conditions that create low flow in Duck Creek are compounded by the suburban land use within the watershed. The upper reaches of the stream flow through residential neighborhoods of primarily single family houses, while the lower sections abut commercial centers and the Juneau airport. According to studies done in the 1980s and 1990s, residential land use covers 540 acres of the watershed, commercial/industrial uses cover 282 acres, transportation 83 acres, and recreation/wetland cover 175 acres (TMDL, 2000). In 1969, the watershed was mapped to be 3.42 square miles. In 1988, it was estimated at 1.7 square miles. Riparian buffers and wetland areas have decreased as a result of the development (Koski and Lorenz, 1999). There is speculation that the moving of stream segments as a result of development may have moved the stream onto more permeable substrates. Stream flow is lost to groundwater when this occurs.

The water quality problems of turbidity, heavy metals, fecal coliform and low dissolved oxygen rates within the watershed in Duck Creek are largely caused by the suburbanization of the valley. Approximately 36 percent of the land cover is impervious surface and in 1997, there were a total of 39 road crossings over the creek. Stormwater runoff from the impervious surface carries sediment, metals, oils and fluids from vehicles, and de-icing agents into the creek (Koski and Lorenz, 1999).

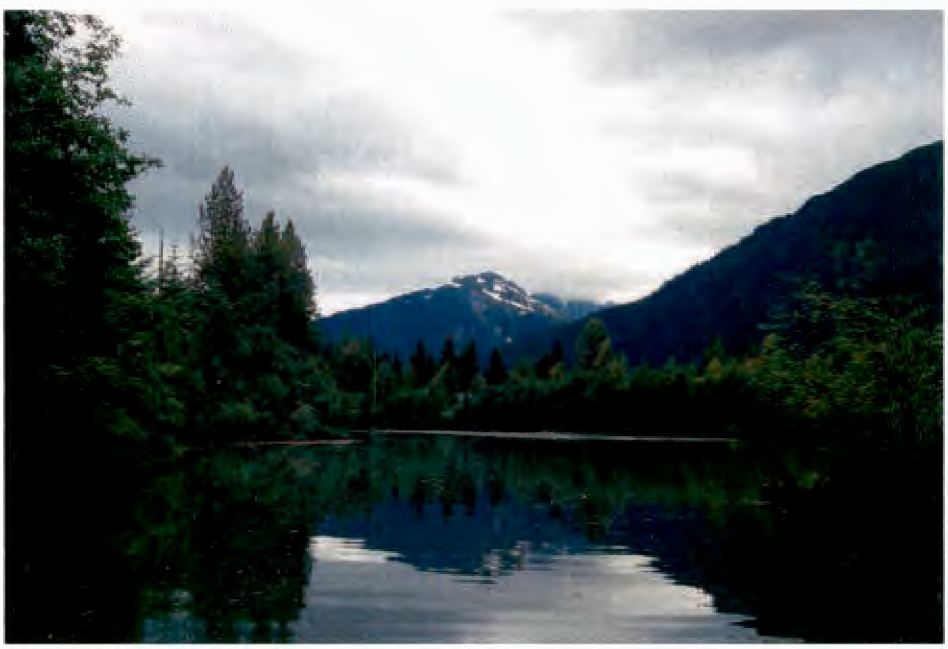
Within the Nancy Street Wetland, one of the most detrimental results of the gravel extraction is the increase in groundwater that is high in iron content seeping into the Nancy Street Pond and the other ponds along Duck Creek. Iron is commonly found in glacial outwash plains. While underground, it remains in a soluble form of Fe(II) because of the lack of oxygen in groundwater. When groundwater carries the iron to the surface, iron oxidizing bacteria are believed to oxidize the iron and create Fe(III). This oxidized form of iron is insoluble and settles on the ground surface as orange sediment known as iron floc (Megonigal, 2001). The process of conversion of Fe(II) to Fe(III) is detrimental to the Nancy Street Wetland because it robs the water of dissolved oxygen. Fish, macro invertebrates, and other animals require high levels of dissolved oxygen for survival. Additionally, the iron floc is small sediment that clogs interstitial spaces between gravel on the floor of the stream and prevents salmon eggs from accessing the oxygen and water flow they need to develop.

Wetland vegetation promotes the conversion of Fe(II) to Fe(III) and retains the iron floc in the roots of the plants. The roots of wetland plants leak oxygen into the soil. This zone surrounding the roots that contains oxygen is called the rhizosphere. Within the rhizosphere, Fe(II) is converted to Fe(III) by oxidizing bacteria. The Fe(III) precipitates to form a solid that sticks to the plant roots, called iron plaque (Megonigal, 2001). This characteristic of wetland plants creates the iron sink in the Church of Nazarene wetland. However, there may be some problems with this strategy in the long term. Wetland plants have been found to have high root turnover rates. Root turnover is the dying off of root hairs as part of a regular cycle of plant nutrient cycling and growth. Wetland plants are estimated to have 55% of their fine roots turnover annually (Gill and Jackson, 2000). If these roots are dislodged and carried downstream, the iron plaque may also be carried downstream, thereby negating the effects of the iron sink. Additionally, iron is known to diminish the uptake by plants of other metals or organic compounds. The iron plaque covers the root hairs, reduces oxygen in the rhizosphere, and minimizes the ability of microbes to interact with chemicals excreted by root hairs. This prevents the roots from uptaking other metals or organic compounds and reduces the phytoremediative effect of wetlands. The presence of iron could negate any other degradation of pollutants (Lanza lecture, 2005).

Historically, the Duck Creek Watershed was a rich habitat for coho, chum, and pink salmon. In its current state it provides limited habitat for coho spawning and overwintering as well as some habitat for birds and waterfowl (Koski and Lorenz, 1999). The Alaska Biological Monitoring and Water Quality Assessment Program Report rated Duck Creek the lowest of all streams studied in Southeast Alaska for habitat variables in 2003. The study measured dissolved oxygen, Ph, conductivity, temperature, taxa richness and stream structure characteristics. The mean habitat assessment value for urban streams was 157 and Duck Creek scored 96. Poor quality habitat resulting from an urban watershed with high erosion and low canopy cover combined with the geologic history have degraded habitat for the fish that once used the stream system.

Iron seepage in the Nancy Street Pond

The iron itself does not seem to harm fish and wildlife. However, the conversion process of Fe(II) to Fe(III) removes dissolved oxygen from the water. The photo is taken at Nancy Street Pond in July 2005.



Photos taken by Michele Elfers.

II. Design and Layout of Earthwork

The impetus for this partnership formed around the need for a waste disposal site for material extracted from the Mendenhall Valley high school contruction project at Dimond Park. The initial design completed by Toner-Nordling Associates estimated the placement of 52,000 cubic yards of silty fill in the Nancy Street Pond. The proximity of the Nancy Street disposal site to Dimond Park ensured that this would be a cost effective fill site.

In 2004, Toner-Nordling worked with CBJ and the U.S. Fish & Wildlife Service to design the fill placement to achieve hydrologic, habitat and operational needs (See Figure 1 and 2). As part of a long-term plan to convert the upstream Allison Pond to a wetland through a similar filling process, this pond and the Church of the Nazarene water levels were designed to be controlled by an earthen dam at the southern end of the Nancy Street Wetland. The design of the Nancy Street fill and dam elevations were critical to the success of these three waterbodies. Additionally, the fill design determined habitat diversity. Low marsh and high marsh areas supported wetland emergent plants, deep water holes and the stream channel allowed for water flow and fish habitat, and the edge of the marsh maintained upland habitat. The need for efficient hauling of material required a haul road along the edge of the wetland and protruding fingers that would allow trucks access to the middle of the wetland to dump material. These access fingers became the low and high marsh habitat zones. The filling elevations below water surface elevation will be discussed in Chapter IV, Design and Layout of Vegetation.

In 2005, the design was revised by CBJ Engineering staff to enhance habitat and maximize fill placement (See Figure 3-7). As a former mining site, the extraction of gravel resulted in steep slopes at the edges of the pit. By modifying the design to increase the fill at the edges of the wetland, the slopes would be reduced to improve habitat and safety, as well as provide economic benefit through the disposal of fill. The modification reduced slopes on average from 30 to 60 percent to 7 to 15 percent throughout most of the wetland. Steep slopes were maintained where the stream channel curves at the edge of the pond to allow for overhanging vegetation that provides thermal protection for the water. The revegetation section discusses the variety of plant communities that are able to grow on the moderate slopes. The increase in fill along the slopes provided incentive for the expansion of the coho overwintering ponds by reducing the amount of fill added to these areas. The larger deep water areas benefit the juvenile coho salmon as well as providing more open water habitat for macro invertebrates.

To maintain the necessary water levels and provide a diversity of habitat, the U.S. Fish & Wildlife Service worked with R&M Engineering to design an earthen dam and outlet channel. The design of the dam called for an impermeable liner to wrap around the upstream side of the dam and fold back. The outlet stream design also included this liner to prevent water loss in the stream channel. The channel included a meander and two riffle sections for aeration. A combination of cobbles and gravel for spawning formed the streambed.

As an urban wetland, the heavy consruction at the site required public meetings and compromises with adjacent property owners. The Church of Nazarene owns the northern portion of the wetland as well as the driveway needed to access the haul road (See Figure 1). To gain access to the wetland for filling, CBJ paved the Church's driveway and constructed the extension of their parking lot after construction along the northeast edge of the wetland. The property owners along the east edge of the wetland requested that the tree buffer be preserved along the Mendenhall Loop Road. For this reason, the haul road was built on the east edge of the wetland.

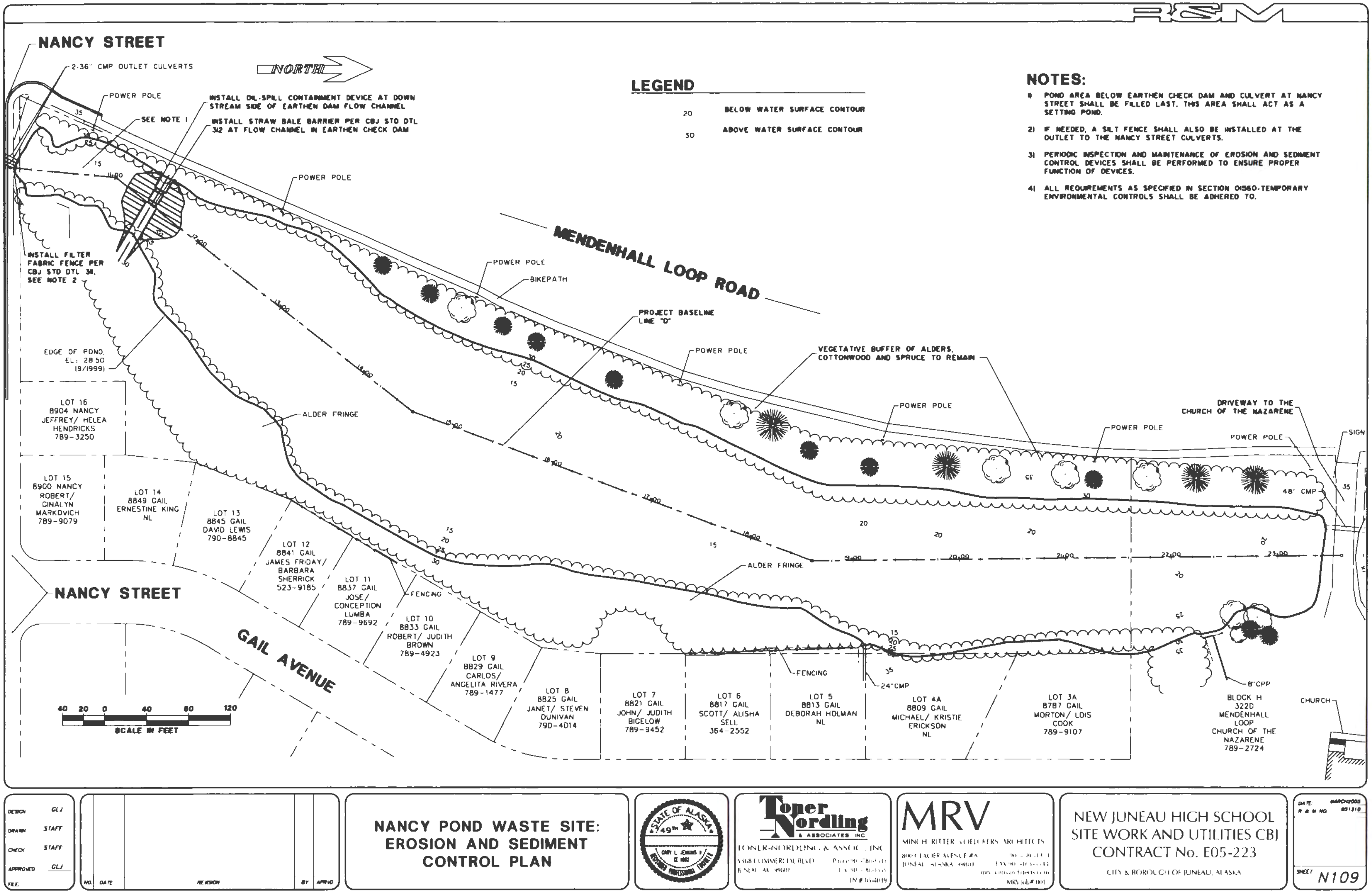


Figure 1. Existing Conditions for the Nancy Street Wetland

R&M Engineering and Toner Nordling Associates produced the existing plan for the Nancy Street Wetland Enhancement Project. The water surface elevation is approximately 28'. The plan shows a few holes that are 16' below the water's surface. Steep banks surround the pond and prevent wetland vegetation from growing.

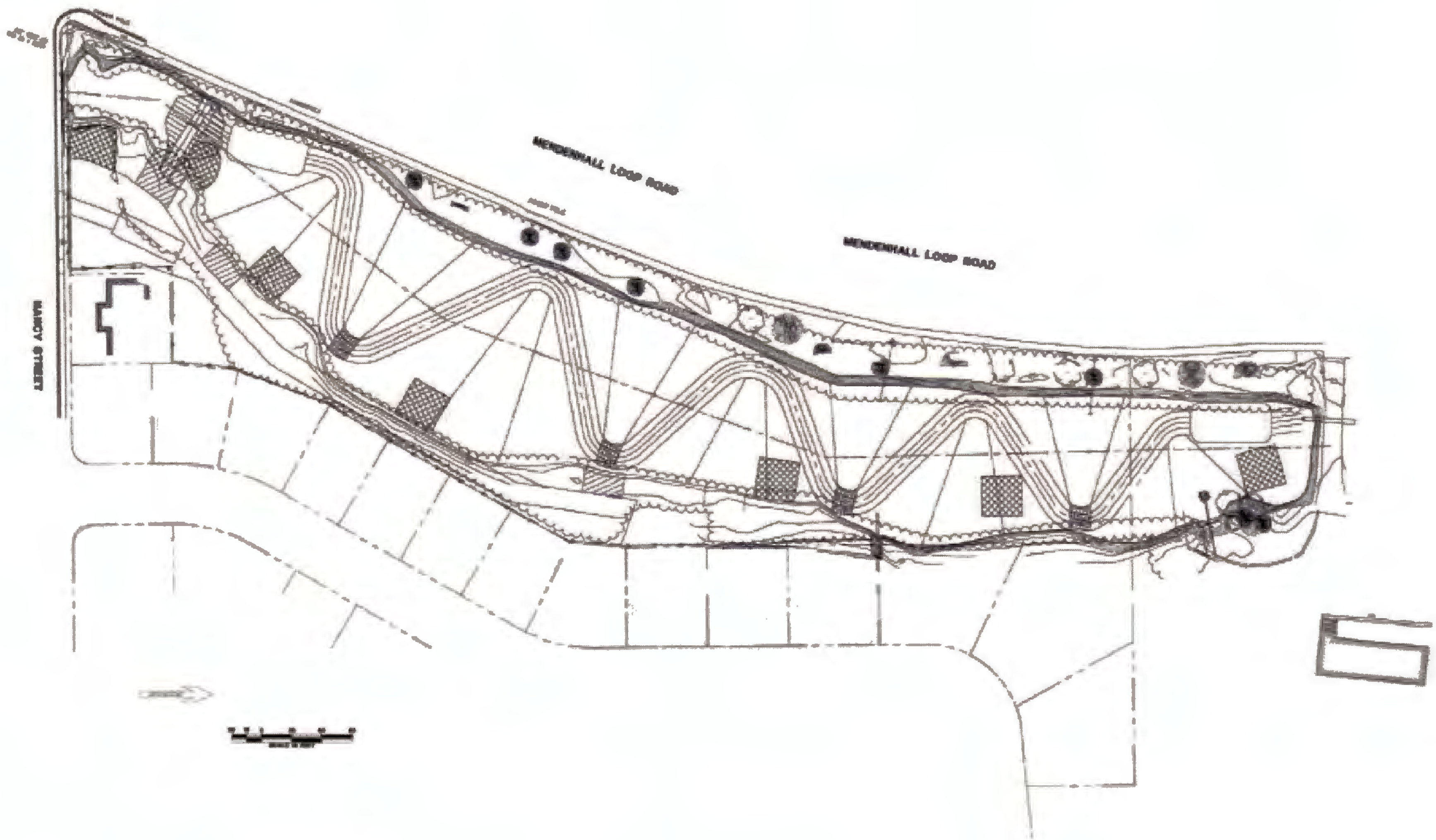


Figure 2. Initial Design for the Nancy Street Wetland Enhancement Project

R&M Engineering and Toner Nordling Associates worked with the U.S .Fish & Wildlife Service, the Natural Resource Conservation Service, and The Nature Conservancy to design the wetland enhancement. A meandering stream channel 4' deep flows from the North to the South through shallow marsh.

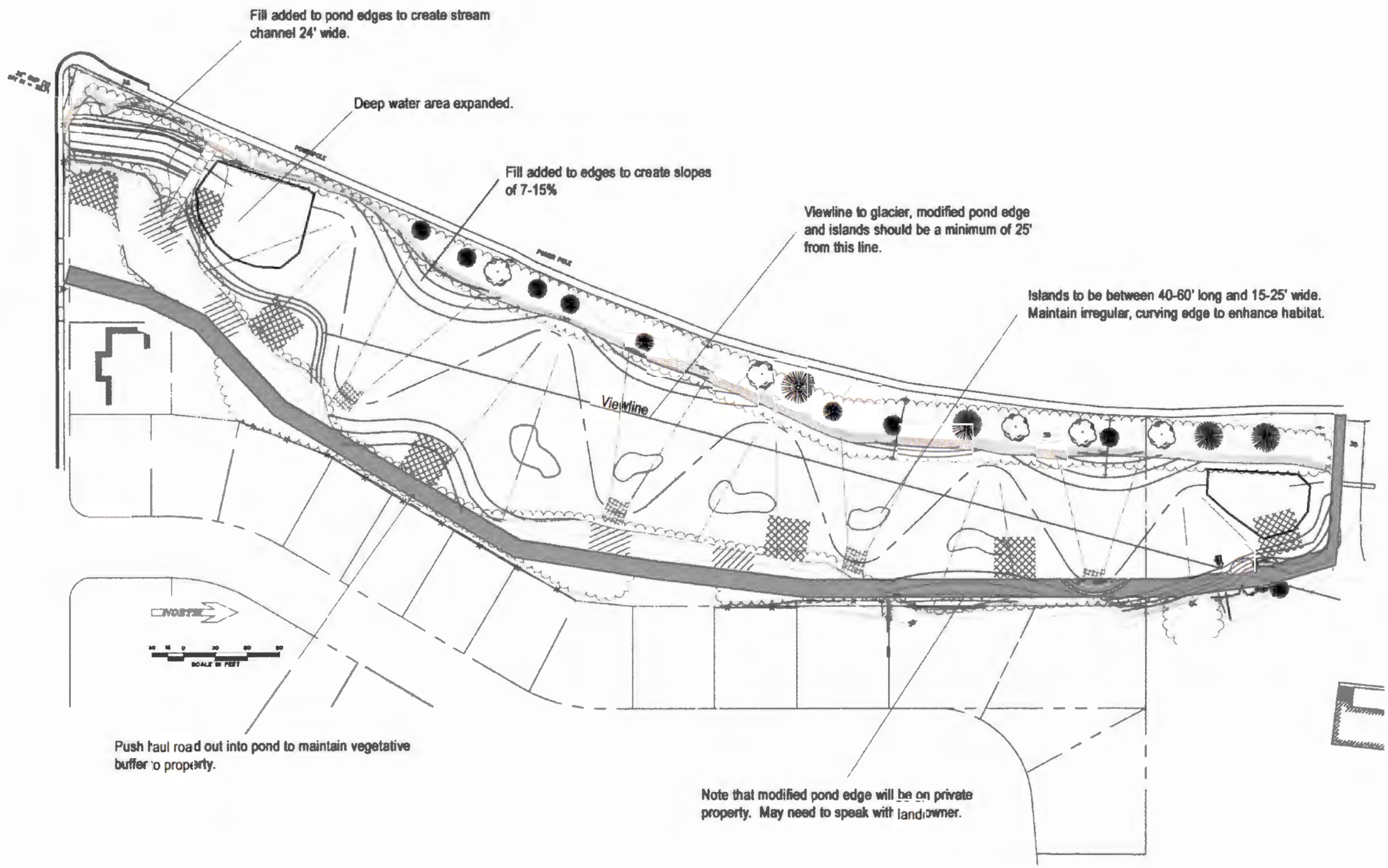


Figure 3. Modifications to the Nancy Street Wetland Design

In the summer of 2005, changes to the grading plan were proposed by CBJ to improve habitat by reducing the grade of the edges of the wetland. In anticipation of developing a trail plan, the islands were moved to allow for a view of the glacier.

Figure 4. Cross Section of the Coho Salmon Overwintering Pond
Fill is added to modify the steep wetland edge and cut is removed to allow the truck hauling road for the construction phase.

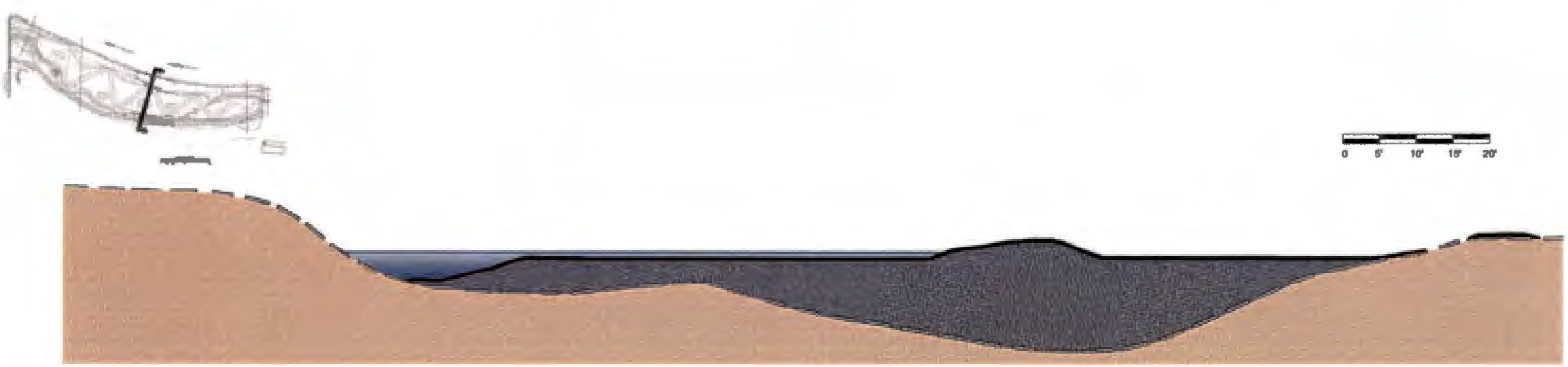


Figure 5. Cross Section of the Stream Channel, Marsh, and Island
Fill is added to create wetland emergent plant zones. The upland island will create protected bird nesting habitat.

Figure 6. Cross Section of the High marsh, Low Marsh, and Stream Channel

Figure 7. Cross Section of the Outlet Stream Channel
Fill and gravel is added to create a stream channel with salmon spawning habitat.

III. Earthmoving Process and Commentary

Based upon discussions among Glacier State, R&M Engineering, CBJ, and the U.S. Fish & Wildlife Service, the process of filling was undertaken by shaping the fingers around the stream channel without filling in the stream channel or coho overwintering ponds. The alternative, to fill the entire pond and then dig out the stream channel and deep ponds would result in much less habitat diversity and variety in landform.

Glacier State began hauling and placing fill in September, 2005 and placed 64,000 cubic yards of fill by May. Ten cubic yard capacity dump trucks were used requiring approximately 6400 trips. One excavator operator worked filling and spreading the material. The material excavated from the highschool site varied from silty, to rocky mineral soil, to sandy depending on the area of excavation. At the Nancy Street pond, the excavator operator completed the filling by section, working and finishing one finger at a time. For this reason, the type of fill varies by section. After the completion of each finger, a 6-8" lift of topsoil was added for re-vegetation purposes. The unscreened topsoil came from Stabler's Quarry and was delivered at no cost to the project as part of an EPA mitigation penalty to a local company. The topsoil quality was low in organic content and high in cobble rock and woody debris content.

At the time of filling, the dam was not constructed. The fingers were filled to approximtaely 1-4 inches above the summer water level. The heavy rainful received during the summer helped to compact the fingers. Usually within two weeks of shaping a finger, it would compact and solidify enough to walk easily on it. In many areas, the rocky silty fill would compact with the rains, dry out and harden to a cement like substance.

The dam and outlet channel construction began in early July, 2006 and required approximately 1-2 weeks of work. Fill was placed through the entire area where the stream channel would be located except for a narrow channel along the west edge of the wetland. This channel maintained water flow from the wetland to the culverts. After filling the area, the stream channel was excavated according to survey markers placed by Toner-Nordling Associates. The liner was secured in place under the streambed and the cobbles placed on top of it. The dam was shaped with fill, but the liner was never folded across the upstream face of the dam. It was determined by the Glacier State Contracting, R&M Engineering, CBJ, and the U.S. Fish & Wildlife Service that the fill was stable enough to maintain its integrity. The water flow in the wetland is minimal and so erosion is not a concern.

After completion of the initial dam and outlet structures, the area was given two weeks to rest. After this period, it was observed that the liner in the stream channel was surfacing due to upwelling of air and water from the substrate. Also, the established dam elevation was determined to be high relative to the elevations of the fingers. This resulted in high water levels in the wetland emergent area which could affect plant growth.

Glacier State Contracting went back into the wetland, lowered the dam level by removing fill from under the liner, re-layed the liner, added more cobbles and gravel to settle it, and reworked the stream channel meandering form. After this second effort, the liner is less visible and the effect is much more aesthetically pleasing. Due to high precipitation levels, it is unknown if the lowering of the dam will result in lowered water surface elevation.

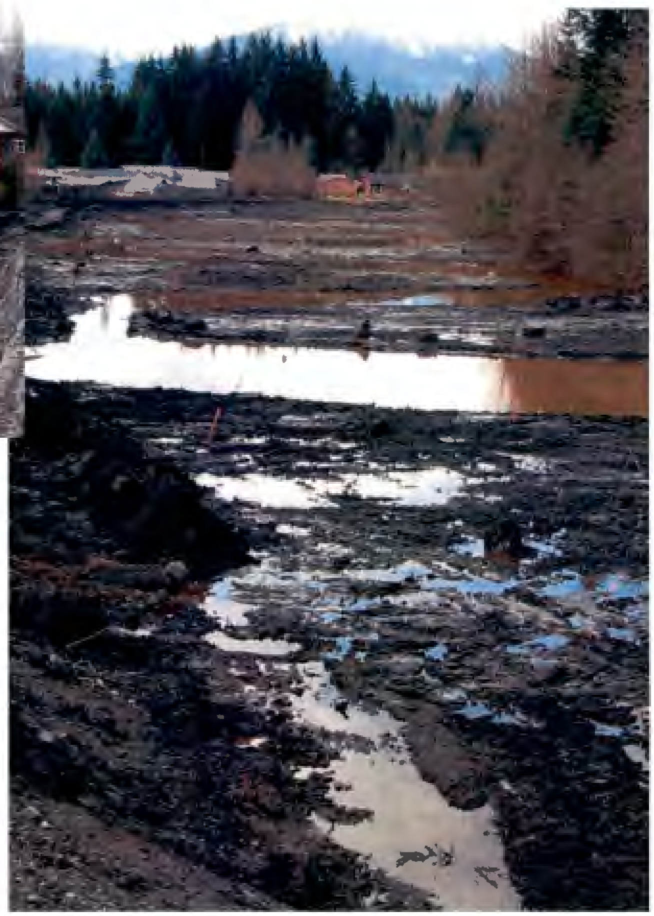
Early stages of filling in November, 2005. Logs are used to support machinery as the fill the fingers.

Photo taken by Neil Stichert.

Early stages of filling in November, 2005. Photo looks south at the filling of the fingers.
Photo taken by Alan Steffert.

Photos taken in April, 2006 by Michele Elfers.

Hay bales and silt fence used to control sediment at downstream end of wetland.



In May, 2006 the channel sinuosity begins to take shape.

Photos taken by Michele Elfers.

Digging of outlet stream channel, laying of impermeable fabric and initial stream shaping in July 2006.

Glacier State returned to the outlet channel and dam 2 weeks after initial construction and added more cobble, lowered the dam elevation, and reshaped the channel.

Photos taken by Michele Elfers.

IV. Design and Layout of Vegetation

To plan for the process of revegetation, native plant communities that will thrive in the conditions at the Nancy Street Wetland must be understood. There is little to no documentation or literature on the revegetation of wetland reclamation projects in Southeast Alaska. Interviews and qualitative evaluations of three constructed wetlands during the summer of 2005 form the foundation for the planning of the revegetation process. The Church of the Nazarene Wetland, the Floyd Dryden Middle School Wetland, and Kingfisher Pond are studied to understand the successes and failures of native species and transplants within constructed wetlands. The results are applied to the planning for the revegetation of the Nancy Street Wetland.

1. Church of the Nazarene (CoN) Wetland, Mendenhall Valley

The Church of the Nazarene Wetland is located immediately upstream of the Nancy Street Wetland. The two wetlands are separated by a culvert. Similar to the Nancy Street Wetland, most of the water comes from groundwater seepages which carry iron into the surface water. The soils, geologic and human use are the same for both wetlands. The Church of the Nazarene wetland was part of the gravel pit and then filled in 1997 as part of a wetland reclamation project headed by K Koski of the Duck Creek Advisory Group. The reclamation utilized 20,000 cubic yards of fill composed mostly

Church of the Nazarene Wetland

Photo taken by Michele Elfers.

of sand and gravel from a stormwater improvement project in the floodplain of Duck Creek. Approximately 1000 cubic yards of peat were placed on top of the fill in a 6-10 inch lift. To accomplish the filling and planting, the water level in the pond was lowered using pumps. The fill was then added to allow for a stream channel 2-4 feet below the water surface elevation that covered 20 percent of the wetland. The remainder of the wetland was graded to allow for three different levels: 50 percent of the wetland is high marsh at 0-3 inches below water surface elevation, 15 percent of the wetland is mid-level marsh at 0-6 inches below water surface elevation, and 15 percent of the wetland is low marsh at 6-18 inches below water surface elevation. Plants were chosen for revegetation based on the established elevations.

Low Marsh 6-18" water depth

Nuphar luteum,
Yellow Pond Lily
Potamogeton gramineus,
Grass-Leaved Pondweed
Sparganium emersum,
Narrow-Leaved Burrweed

Mid-Level Marsh 0-6" water depth

Carex aquatilis,
Water sedge
Equisetum fluviatile,
Swamp Horsetail
Caltha palustris,
Yellow Marsh Marigold
Menyanthes trifoliata,
Buckbean
Beckmania syzigachne,
American Slough Grass

High Marsh 0-3" water depth

Carex aquatilis,
Water Sedge
Equisetum fluviatile,
Swamp Horsetail
Caltha palustris,
Yellow Marsh Marigold
Menyanthes trifoliata,
Buckbean
Beckmania syzigachne,
American Slough Grass
Carex sitchensis,
Sitka sedge
Calamagrostis canadensis,
Bluejoint Reed Grass

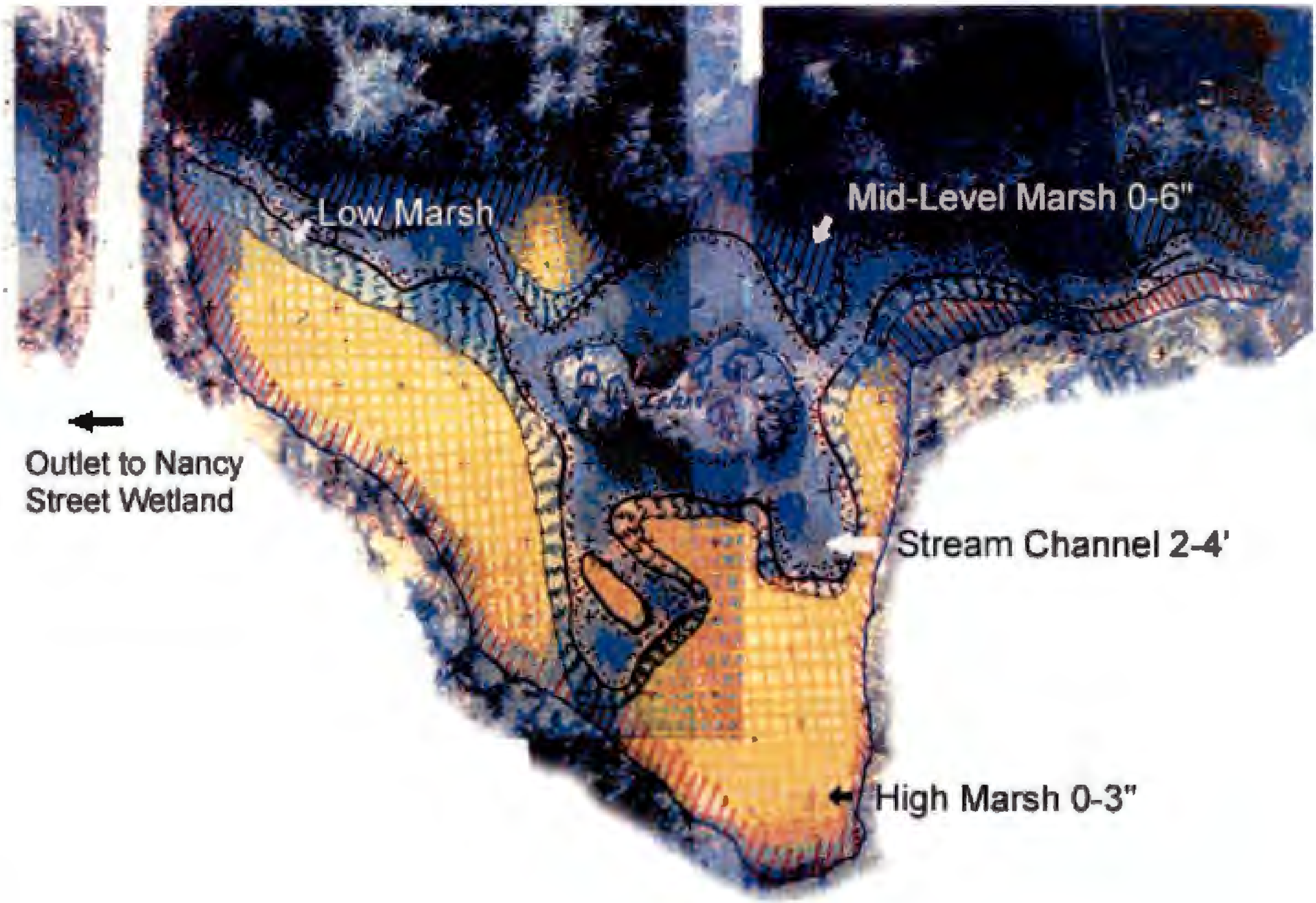


Figure 8. Church of the Nazarene Plan
Plan by K Koski.

The Wetland Enhancement Project for the Church of Nazarene Pond shows a grading plan that was developed to accomodate different plant communities. A meandering stream channel provides water to the marsh areas.

Table 1. Church of the Nazarene Plant Evaluation

site	water depth (cm)	% cover	live stems	description of quadrant	plant species
1a	7.5	90	57	saturated mud	horsetail, sitka sedge
1b	4	60	104	saturated mud	horsetail, sitka sedge
1c	3	95	14	saturated mud	horsetail, sitka sedge, blue joint grass
1d	14.5	35	17	standing water, iron oxide	horsetail, yellow marsh marigold
2a	5	75	50	saturated mud	horsetail, sitka sedge
2b	10.5	75	50	standing water	horsetail, sitka sedge
2c	6.5	35	37	saturated mud	horsetail, sitka sedge, western black willow, moss
2d	37.5	90	116	standing water, iron oxide	horsetail
3a	15	50	69	standing water	horsetail, sitka sedge, blue joint grass, bullrush
3b	35.5	95	89	standing water	horsetail, sitka sedge
3c	47.5	30	48	standing water	horsetail
3d	15.5	80	78	standing water	horsetail, sitka sedge
3e	12	20	9	standing water	sitka sedge
4a	13.5	40	90	standing water	carex, merten's sedge
4b	21.5	80	76	standing water	horsetail, sitka sedge
4c	22	40	32	standing water	horsetail

Table from "Inventory of Created Wetland and Baseline Data for Future Wetland Creation Sites". Hoferkamp, Lisa. Prepared for United States Fish and Wildlife Service, 2004-2005.

A combination of seeding, transplanting and planting of container grown stock were used for revegetation. During the transplanting, the plants that were dug from nearby wetlands were based more on availability and less on the planned species list. The plants were planted in rows four feet apart and with a spacing of two feet. Additionally, a local nursery planted upland species from container stock on a bank of the wetland (notes and plans from K Koski, 2005). Salix and Alder species were planted but did not survive. The wetland vegetation was counted and evaluated in 2004 by Lisa Hoferkamp, an assistant professor and a student at the University of Alaska, Southeast as part of a study of the water quality in the constructed wetland. Sixteen quadrants of .5 square meters were delineated within the saturated zone. Estimates of vegetative cover and an analysis of dominant species cover were performed.

The report estimates overall vegetative coverage of the wetland at 30-95 percent in 2004. This is in increase from an estimated 1 percent coverage in 1997 when it was first planted. The current plant community in the Church of Nazarene Wetland is dominated by Horsetail and Sitka Sedge with a few other species growing. According to the report by Lisa Hoferkamp, it is functioning as an iron sink and so the lack of diversity may not be a problem for this objective.

From the perspective that Nancy Street Wetland is part of ongoing experimentation and research into constructed wetlands in Southeast Alaska, expanding the diversity of the plant community may be beneficial to learn which types of plants colonize rapidly and if there are species that retain iron more efficiently. Species of Horsetail have long, thin root systems that may not be the most effective option for the trapping and retention of iron. Sedges, with dense fibrous root systems may be a better choice. Also, increasing the diversity of the plant community will allow for increased forage and habitat options for various species of birds and macro invertebrates.

2. Floyd Dryden Middle School Wetland, Mendenhall Valley


Photo taken by Michele Elfers.
View of the Floyd Dryden Wetland in July 2005

The Floyd Dryden Wetland is located north of the Nancy Street Wetland in the Mendenhall Valley. It occupies the post-glacial landscape but it does not have the same gravel extraction history. The constructed wetland is on school grounds and has been a wet area since the creation of the school. Surrounded by playfields and a building, it has become a detention

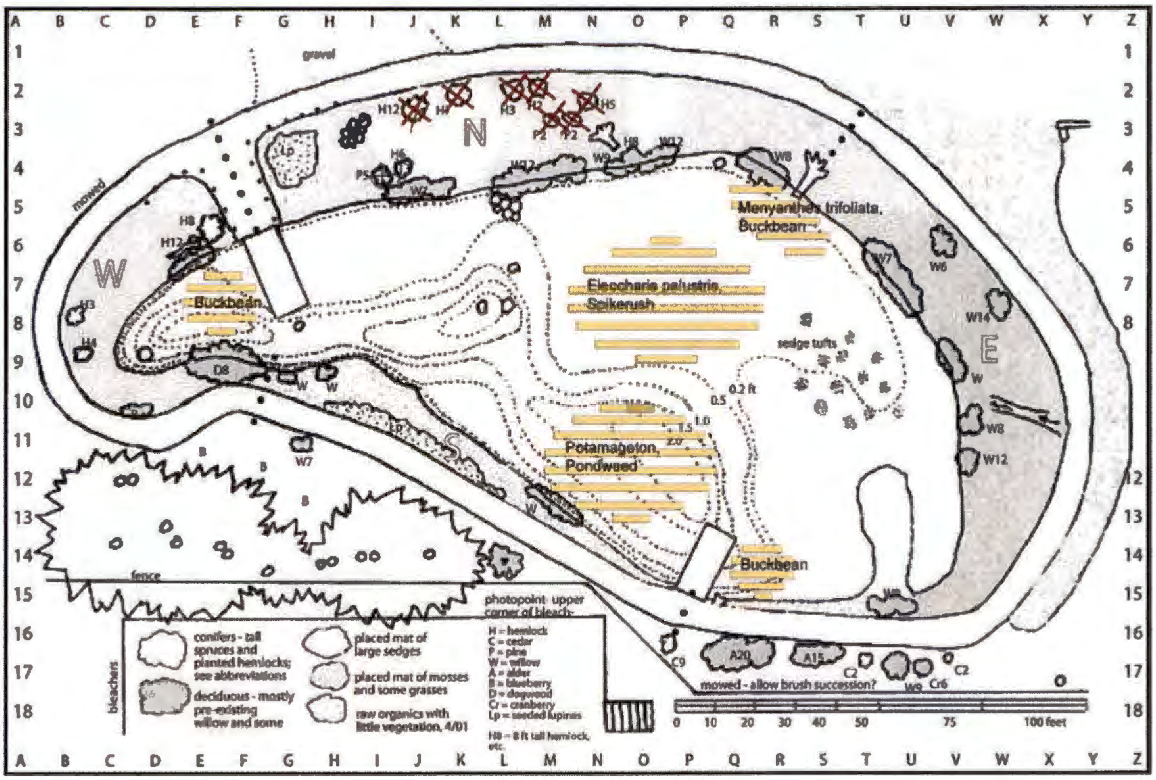


Figure 9. Floyd Dryden Pond

Original plan from Richard Carstensen of Discovery Southeast.

Observation of major species colonization in July 2005 shows that the Hemlocks and Pines did not survive, the Sedge, Spikerush, Buckbean, and Pondweed did very well.

area for stormwater. Between 1999 and 2001 the current wetland was graded and planted. The deepest area is roughly 450 square feet at a depth of 2 feet below water surface elevation and the grade rises to approximately 2.5 inches below water surface elevation within a large area of the wetland.

Richard Carstensen of Discovery Southeast, a nature education organization in Juneau, developed a vegetation plan for the wetland. Hemlock, Cedar, Pine, Willow, Alder, Blueberry, Dogwood, Cranberry, mats of Sedges, mats of Moss and Grasses, and Lupine seeds were used for the revegetation. Observation in August of 2005 showed that within the saturated zone the plants that are thriving are species of Carex (Sedge), Equistetum (Horsetail), Eleocharis palustris (Spikerush), Menyanthes trifoliata (Buckbean), and species of Juncus (Rush). Moving out of the saturated zone into the uplands, Willows, Alders, and Dogwood are thriving. The Hemlocks and Pines are either dying or are very small plants and there are very few Lupine plants. There is little open water in the wetland and a species of Potomageton densely covers a significant amount of surface area in the deeper water areas.

The failure of the Hemlock and Pine trees may be due to the lack of adequate soil conditions. Hemlock requires a soil with a high organic content that is rare in the recently deglaciated Mendenhall Valley. Native Pine trees only grow in peat bogs in this part of Southeast Alaska. Sedges, Spikerush and Buckbean have thrived in this wetland at water depths of 2-6 inches for the Spikerush and Sedges and 2.5 inches for the Buckbean. These species are potential candidates for the Nancy Street Wetland.

It is important to note in this wetland that the deepest water is 2 feet and that there is little open water without vegetation. Potamageton as well as other aquatic species such as Nuphar polysepalum are able to grow in 2 feet of water. In order to diversify habitat at Nancy Street and encourage the macro invertebrate population, open water is desired and the deep water levels must be greater than 2 feet deep. A study by Nelson, Roline, et al. shows that in constructed wetlands for wastewater treatment, the most productive habitat for invertebrates is open water with oxygen producing submerged plants. The least productive habitat is open water that has a continuous cover of duckweed and low dissolved oxygen levels (2000).

3. Kingfisher Pond at the Juneau Police Department, Lemon Creek

Photo taken by Michele Elfers.
View of Kingfisher Pond in July 2005

Kingfisher Pond at the Juneau Police Department is located at the mouth of a glacial valley, Lemon Creek. The primary source of water is groundwater supplemented by runoff as well as a small amount of brackish tidal water that enters through a faulty control structure at the outlet of the pond. As a reclaimed gravel pit, iron seepage is a problem in this wetland as well as pre-reclamation dumping of oil and other contaminants.

Between 2002 and 2003, the pond was filled and shaped to create a wetland and then planted with seeds, vegetative mats, and limited container stock plants. A section of the saturated zone was delineated to study the success of the seeding and the colonization of plants. The evaluation of the twelve study plots is recorded in Table 2. The evaluation is taken from observation in July 2005 of the plants growing compared to a seeding plan done at the time of revegetation. In the uplands area, Alder dominates, in some areas it is growing in dense thickets. There is also some Lupine, Dogwood, and

Highbush Cranberry in the upland areas. Both Tufted Hairgrass and Merten's Sedge have spread from saturated lowlands into well-draining upland areas. In the saturated areas to standing water, Small Leaf Bulrush, and Mare's Tail have colonized.

Table 2.
Kingfisher Pond Plant Evaluation

Plot	Conditions	Seeded in 2000	Growing in 2005	Plot	Conditions	Seeded in 2000	Growing in 2005
1	Saturated	Merten's Rush	Merten's Rush	7	Moist ground, upslope	Hardtack Steeplebush	Merten's Sedge
			Merten's Sedge			Goat's Beard	Tufted Hairgrass
			Tufted Hairgrass				Lupine Alder
2	Saturated	Merten's Rush	Merten's Rush	8	Moist ground, upslope	Hardtack Steeplebush	Merten's Sedge
		Small Leaf Bulrush	Merten's Sedge				Tufted Hairgrass
			Tufted Hairgrass				Lupine Alder
3	Saturated	Control, no seeding	Merten's Rush	9	Moist ground, upslope	Control, no seeding	Merten's Sedge
			Merten's Sedge				Tufted Hairgrass
			Tufted Hairgrass				Lupine Alder
4	Saturated, beginning of upslope	Sawbeak Sedge	Merten's Sedge	10	Well-drained, upland	Tufted Hairgrass	Tufted Hairgrass
			Tufted Hairgrass				
5	Saturated, beginning of upslope	Control, no seeding	Merten's Sedge	11	Well-drained, upland	Tufted Hairgrass	Tufted Hairgrass
			Tufted Hairgrass			Meadow Barley	Meadow Barley
			Sawbeak Sedge				
6	Saturated, beginning of upslope	Merten's Sedge	Merten's Sedge	12	Well-drained, upland	Control, no seeding	Lupine
		Sawbeak Sedge					Alder

Data from observation in July 2005 and a Seeding Plan provided by the U.S. Fish & Wildlife Service.

A few species did not survive and many showed only one or two plants. Spiraea douglasii, or Hardtack Steeplebush was seeded but not growing on the site. This plant grows in southern Southeast Alaska, but it is not native to the northern part of the region. It will grow only in certain microclimates in this area and is therefore not hardy enough for a reclamation project. Meadow Barley, although native in this area, did not colonize successfully. The seeds may not have been viable, or the ground may have been too wet for the plants. This plant will not be recommended for revegetation of Nancy Street Wetland as literature suggests it is most successful in maritime areas (Pojar and Mackinnon, 1994). Sawbeak Sedge was only found in one area and may not be hardy enough to start from seed in a reclamation project.

By documenting the evaluation of these three constructed wetlands, interviews with local naturalists experienced in reclamation and revegetation projects, and literature pertinent to Southeast Alaskan plant communities, a table was created to document the successes, failures and potential for freshwater wetland species in reclamation wetlands. (See Appendix 1).

At the Nancy Street Wetland, plants have been selected based on the assessment and evaluation of their success in constructed wetlands in the region, experience of local naturalists, their ability to be transplanted or seeded, and their potential for the phytoremediation of iron. For the purpose of a planting design the plants were divided into zones based on the depth of water in which they grow. (See Table 3). The Nancy Street Wetland is designed with a water surface elevation of 28 feet. Although the Nancy Street Wetland is primarily ground water fed, runoff has been observed to affect water levels significantly in different seasons. However, the water level will fluctuate throughout the season with the rise and fall of precipitation rates. Rainfall increases between July and November and decreases between January and April. For this reason, the communities and water depths are general and meant as guidelines only. The zones are delineated on the wetland planting plan in Figures 10 and 11.

The deep water zone consists of the stream channel that flows from the inlet culvert to the outlet culvert as well as two deep pools at either end. This zone covers 55,000 square feet and is 28 percent of the total area to be revegetated. However, less than 5 percent of this area will be planted. Water will be 4 feet deep through most of this area with greater depths in each deep pool. This zone will be planted with Potamageton natans (Floating Pondweed), Sparganium angustifolium (Narrow Leaved Burreed) , and Nuphar polysepalum (Yellow Pond Lily). The first two species were observed growing in the Nancy Street Pond prior to filling. Both are present upstream in the Church of the Nazarene

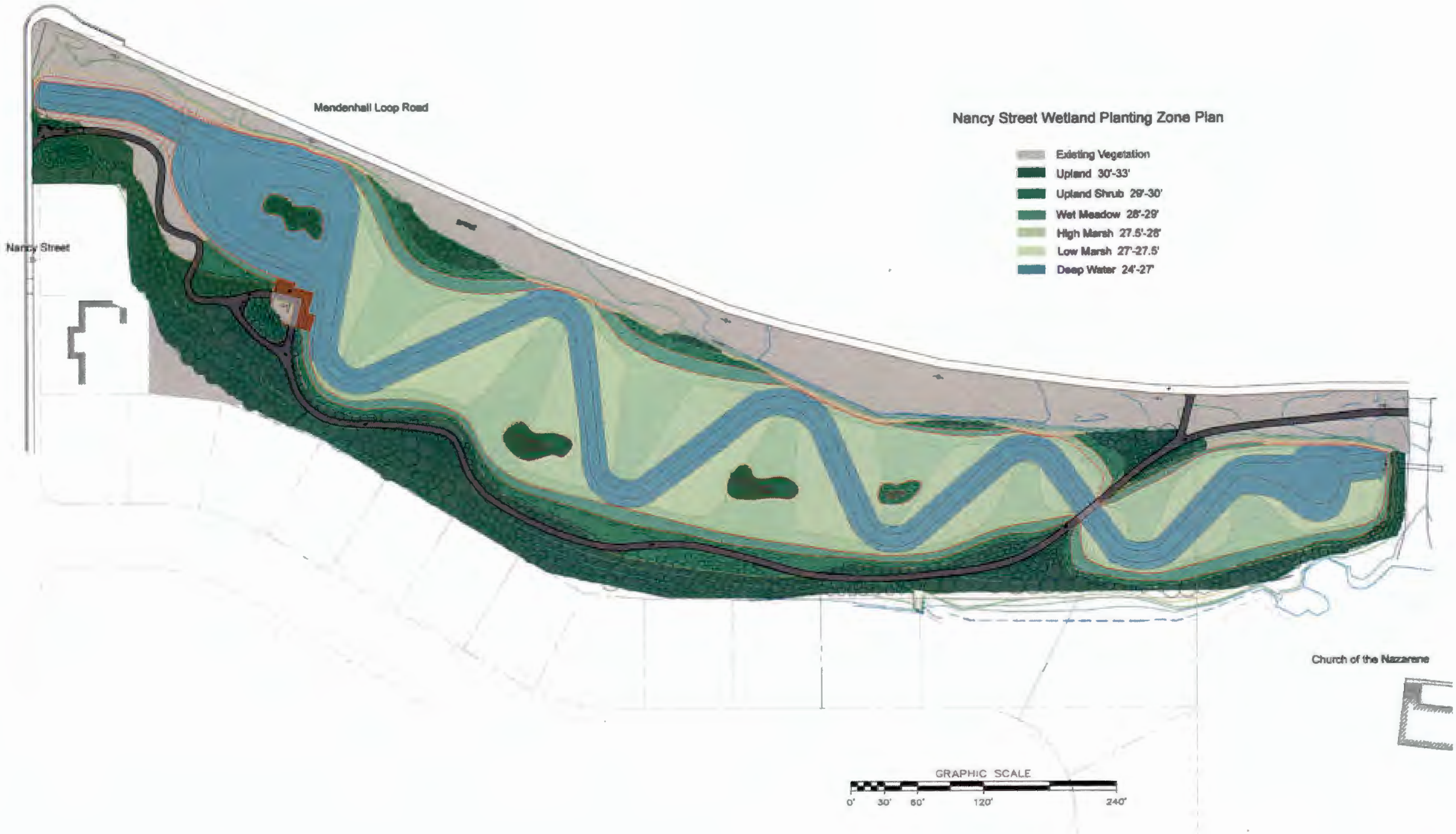


Figure 10. Planting Communities

The revegetation plan for the Nancy Street Wetland incorporates different plant communities based on elevation above the water surface. This revegetation plan was developed prior to the completion of the trail design.

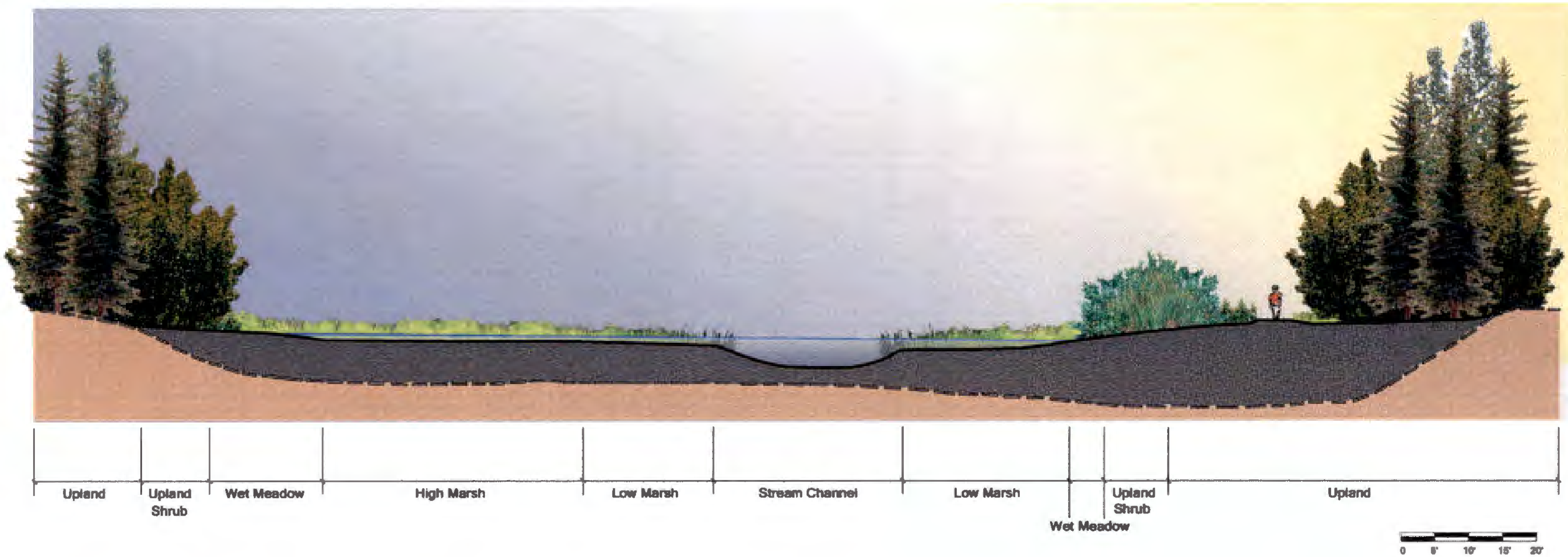


Figure 11. Typical Planting Zone Elevation

The revegetation plan for the Nancy Street Wetland is based on the elevation of the land above or below the water surface.

Pond. Sparganium is known to be a local food for muskrat. Nuphar polysepalum is found in a nearby pond downstream of the Nancy Street Wetland.

The low marsh zone covers 30,000 square feet and comprises 15 percent of the total area to be revegetated. The land between the stream channel and the high marsh 'fingers' is designed to the elevation of 27 feet to 27.5 feet. The plants in this zone include Carex sitchensis (Sitka Sedge), Eleocharis palustris (Spikerush), Juncus mertensianus (Merten's Rush), and Scirpus microcarpus (Small Leaf Bulrush). All of these plants have been successful at colonizing constructed wetlands in Juneau and can be transplanted or started by seed. Carex sitchensis is one of the two dominant plants in the Church of the Nazarene Wetland. The dense root system of this plant may be capable of retaining large amounts of iron.

The stream channel winds around fingers of high marsh zone areas at an elevation of 27.5 feet to 28 feet. The high marsh zone encompasses 35,000 square feet and covers 18 percent of the total area to be revegetated. Carex sitchensis and Eleocharis palustris have exhibited the ability to survive in a variety of water levels. They will transition the communities from low marsh to high marsh zones. Other plants in this zone include Carex mertensii (Merten' Sedge), Juncus effusus (Common Rush), Lysichiton americanum (Skunk Cabbage), Deschampsia cespitosa (Tufted Hairgrass), and Menyanthes trifoliata (Buckbean). All of these plants have been grown successfully in the constructed wetlands in Juneau. The Lysichiton americanum grows throughout Juneau in shaded wetland edges or stream banks. In the early spring it 'blooms' with a yellow spadex that is very attractive and provides food for animals. It has been transplanted successfully by naturalists in the region.

At the edge of the standing water zones is the transition zone of wet meadow. This zone is at an elevation of 28 feet to 29 feet and will be saturated most of the time and may flood during parts of the year. The wet meadow covers 12,000 square feet and comprises 6 percent of the total area to be revegetated. Many plants that can tolerate different water levels and periodic flooding are planted here. Carex mertensii, Deschampsia cespitosa ssp. beringensis, and Juncus effusus will all do well closer to the water's edge. Moving up through this zone, grasses and flowering plants that do well in wet meadows are planted. Calamagrostis canadensis (Bluejoint Reedgrass), Festuca rubra (Red Fescue), Viola palustris (Marsh Violet), Frittilaria camschatcensis (Chocolate Lily), Iris setosa (Wild Flag), Lupinus nootkatensis (Lupine), and Aquilegia formosa (Columbine) thrive in saturated soils and provide color during the summer season.

The wet meadow zone and the upland shrub zone will be indistinguishable in many areas as many of these plants thrive in saturated to moist soils. The upland shrub zone is delineated from 29 feet to 30 feet and covers 11,500 square feet. It comprises 6 percent of the total area to be revegetated. Many grasses and flowering plants including Deschampsia cespitosa (Tufted Hairgrass), Calamagrostis canadensis (Bluejoint Reedgrass), Festuca rubra (Red Fescue), Aquilegia Formosa (Columbine), and Lupinus nootkatensis (Lupine) will form the transition from wet meadow to upland shrub. Also in this zone will be Cornus stolonifera (Dogwood), Salix barclayii (Barclay's Willow), Salix sitchensis (Sitka Willow), Alnus viridus (Sitka Alder), Aruncus dioicus (Goat's Beard), Rubus spectabilis (Salmonberry), and Viburnum edule (Highbush Cranberry). The Salix, Alnus, Aruncus and Viburnum species were all observed on this site prior to filling.

Above 30 feet elevation is the well-drained upland zone. The uplands to be revegetated cover 52,500 square feet and 27 percent of the total area to be revegetated. The plants include many of the shrubs from the upland shrub zone: Aruncus dioicus, Cornus stolonifera, Rubus spectabilis, Viburnum edule, Alnus viridus, Salix barclayi, and Salix sitchensis. Additional trees to be planted that exist elsewhere on the site are Populus balsamifera (Cottonwood), Alnus rubra (Red Alder) and Picea sitchensis (Sitka Spruce). An understory of grasses and herbaceous perennials include Festuca rubra, Calamagrostis canadensis and Aquilegia formosa.

From this general planting zone plan in Figure 10, a detailed planting design for the uplands and upland shrub zones was created. This allows for numbers of each species needed for transplant, purchase or seeding. The design strives to create diversity in plantings to allow for habitat diversity while also considering the experience of the visitor along the trail, and the relationship of the adjacent private property owners to the wetland and the trail. For example, Detail 5 in Appendix 5 shows clusters of Rubus spectabilis, Cornus stolonifera, and Viburnum edule. These shrubs fruit from mid summer into fall and provide food into the winter for birds and small animals. Also, a combination of Picea sitchensis groupings as well as deciduous trees of Alnus and Populus balsamifera allow for varied habitat for birds. Detail 3 in Appendix 3 shows a narrow buffer between the adjacent property owners and the trail and wetland. The large cluster of Alnus and Picea is in front of homes with fencing. This choice of trees will further separate the homes from the wetland and trail.

The diverse planting communities represent the ideal revegetation plan. However, the objective of using only native plants limits the availability and spectrum of species that can be obtained and planted in the wetland. Native plant nurseries and native seed sources do not exist in Southeast Alaska. Small amounts of native seeds are available in the area from individuals who collect seed seasonally. A few native species of grasses are sold commercially in the northern part of Alaska. The best solution to the reclamation of wetlands in Juneau is to gather wetland seed in the years prior to the reclamation of the wetland and then start them in greenhouses based on the specific needs of the plants. This process works well if the reclamation of the wetland is planned at the time of the surface mining or land disturbance. However, the circumstances of the Nancy Street Enhancement Project do not allow for the gathering and starting of seed. Therefore, transplanting of plugs will be the major source of revegetation, with some hardwood cuttings and seeding.

V. Vegetation Process and Commentary

The planning and design of the revegetation process provided a guide for the actual implementation. However, the decision by the resource agencies to focus on transplanting of local plants to preserve local gene stock and minimize the purchase of plants largely determined the revegetation process. For a 6 acre revegetation, transplanting is feasible, but for a freshwater emergent wetland that is much larger, the limitations of transplanting may warrant a different strategy.

For the Nancy Street Wetland revegetation, the availability, accessibility, and diversity of source wetlands determined the process (See Tables 3,4). Source wetlands were selected in the Mendenhall Valley and Lemon Creek to minimize cost and driving time to Nancy Street. Additionally, only wetlands that were accessible for a crew with a vehicle were considered. The ownership of the wetlands ranged from CBJ land, U.S. Coast Guard land to private land. In all cases, permission for access and transplanting was granted. Another consideration in choosing source wetlands was the size of plant population present for the targeted species. The population had to be large enough to be able to remove a sizable quantity without decimating or affecting the source wetland population.

With all of these limitations, it was difficult to find appropriate wetlands to source plants. The majority of the Nancy Street wetland is freshwater marsh with emergent species, however in Juneau there is much more forested wetland habitat than emergent wetland. The revegetation of an emergent wetland much larger than Nancy Street would be very difficult using only transplants. The source wetlands used for Nancy Street should not be used again for at least two years and finding adequate populations of emergent species may be difficult. A potential source that exists for this type of wetland is along Department of Transportation (DOT) Right of Ways. There are many drainage ditches along Glacier Highway, particularly between Fred Meyer's and McDonald's in the Valley that are sedge and bulrush emergent wetlands. DOT utilizes SAGA crews for maintenance of Right of Ways to prune and remove shrubs and trees. An opportunity exists for a partnership to be formed with DOT where SAGA crews maintain and transplant simultaneously on future reclamation projects.

In addition to the transplanting of emergent wetland species, the revegetation included cuttings of willow and cottonwood, transplanting of berry shrubs and alder, and seeding. To accomplish these tasks, various sources of labor were used over a period of five months. Volunteers cut stakes in April and planted in June, paid SAGA workers transplanted emergent species and seeded in June and July, and paid Trail Mix workers transplanted trees and shrubs in August (See Table 4).

While the volunteers only worked for two days, their work in taking cuttings of willow, cottonwood and high bush cranberry was very important to the revegetation of the upland shrub and upland zones. Also, the involvement of community volunteers raised enthusiasm and support for the project. The volunteers were members of Full Circle Farms, a farm and distributor of organic produce in Juneau. The farm solicited volunteers through emails and donated $5000 to the project. The cuttings were taken on April 8 with twenty volunteers. The group divided in three and went to sites near Back Loop Road. With pruners, 1000 Barclay's Willow stakes, 200 High Bush Cranberry stakes, and 75 Black Cottonwood stakes were cut. Full Circle Farms donated the use of their cold storage facility in Lemon Creek to hold the cuttings until planting. On June 7, fifteen volunteers planted the cuttings at Nancy Street. Many of the stakes were cut in half or thirds. Steel rods with mallets or sharp pointed shovels were used to plant single stakes or bouquets of 3-5 stakes. The High Bush Cranberry stakes all died in storage, however many of the willow and cottonwoods sent out roots and shoots.

For the next phase in planting, the U.S. Fish & Wildlife Service contracted a SAGA crew for 4 weeks. In 13 days, the crew worked approximately 650 labor hours. They accomplished 70% of the revegetation process by planting 3600 plugs, shrubs and small trees and seeding portions of the wetland. The crew developed efficient methods for transplanting and solved problems effectively throughout the four weeks. Each day, two workers stayed at the wetland and used an augur to dig holes in the soil for planting. The other six crew members went to the source wetland. To extract plants they found that a sharp shovel was most effective. Often they would take small mats and then cut them into plugs using a knife or sharp shovel. They suggested using a hand held shovel to cut the mats in the future. They found that bulb planters were time consuming and difficult to use in gravel or dense mud. To remove shrubs, pulaskis were the most efficient and shovels were used for trees. Despite the efficient work of the crew, the lack of proper gear and equipment at the start of the project slowed down progress. The crew needed shoulder length waterproof gloves, hip waders, rubber boots, and five gallon buckets for transporting plants. Additionally, throughout the four weeks, the augur would break down and slow progress. Better preparation and support for the crew is needed in the future.

SAGA accomplished most of the remaining revegetation work; however the grading and shaping of the outlet channel, earthen dam, and trail were not completed in time to finish the planting. Trail Mix crews transplanted alders and berry bushes into the upland and upland shrub areas and a small amount of sedges along the boardwalk and earthen dam using similar techniques as SAGA. Additionally, CBJ staff purchased and planted Cornus stolonifera plugs along the steep northeast slope on the Church of the Nazarene property. These plants were purchased because of the significant benefit to the project and the lack of an appropriate population from which to take cuttings in Juneau. They grow rapidly in the Juneau climate, provide berries for birds, and control erosion with spreading rhizomes. CBJ also purchased and spread seed throughout the five month period of revegetation for erosion control and habitat enhancement.

To improve on the revegetation process for future projects, better planning for irrigation should be in place prior to transplanting. This summer in Juneau was very rainy with only a few periods of sunny dry weather. However, for two weeks in June, the sun came out and dried the high marsh area. During the revegetation period, the water level was approximately 1-3 inches below the high marsh elevation. The rocky and sandy topsoil combined with the silty fill dried in sunny conditions to form a cement like consistency. Watering was necessary to keep the plants alive during this period. SAGA crews used buckets and a garden quality gasoline powered water pump to irrigate the wetland. If the dry sunny weather persisted, these methods would not be able to keep the plants alive. To prevent this from happening on future projects a soil with a higher organic content would help to retain moisture better in dry conditions. Also, working with the Department of Public Works to obtain a permit for fire hydrant access would allow for an appropriate water source. Other strategies include the control of water levels to keep soil saturated while planting or the delay of planting until July when precipitation is more frequent.

Table 3: Recommended Plant Species Actual Planted Species

Low and High Marsh			**Low and High Marsh**	
Species	*Common Name*		*Species*	*Common Name*
Caltha palustris	Marsh Marigold		Caltha palustris	Marsh Marigold
Carex sitchensis	Sitka Sedge		Carex sitchensis	Sitka Sedge
Eleocharis palustris	Spike Rush		Eleocharis palustris	Spike Rush
Scirpus microcarpus	Small Leaved Bulrush		Scirpus microcarpus	Small Leaved Bulrush
Juncus mertensianus	Merten's Rush		Carex lyngbae	Lyngby's Sedge
Lysichiton americanum	Skunk Cabbage			
Menyanthes trifoliata	Buckbean			
Carex mertensii	Merten's Sedge			
Calamagrostis canadensis	Blujoint Reedgrass			
Deschampsia cespitosa	Tufted Hairgrass			
Wet Meadow			**Wet Meadow**	
Aquilegia formosa	Western Columbine		Aquilegia formosa	Western Columbine
Calamagrostis canadensis	Bluejoint Reedgrass		Calamagrostis canadensis	Bluejoint Reedgrass
Deschampsia cespitosa	Tufted Hairgrass		Deschampsia cespitosa	Tufted Hairgrass
Frittilaria camschatcensis	Chocolate Lily		Fritillaria camschatensis	Chocolate Lily
Iris setosa	Iris		Iris setosa	Iris
Aconitum delphinifolium	Monkshood		Lupinus nootkatensis	Lupine
Dodecathon pulchellum	Shooting Star		Hierchloe odoratum	Sweet Grass
Eriophorum angustifolium	Cottongrass			
Viola palustris	Marsh Violet			
Upland Shrub			**Upland Shrub**	
Alnus viridus	Sitka Alder		Alnus viridus	Sitka Alder
Aruncus dioicus	Goat's Beard		Aruncus dioicus	Goat's Beard
Cornus stolonifera	Red Twig Dogwood		Cornus stolonifera	Red Twig Dogwood
Rubus spectabilis	Salmonberry		Rubus spectabilis	Salmonberry
Salix barclayi	Barclay's Willow		Salix barclayi	Barclay's Willow
Salix sitchensis	Sitka Willow		Festuca rubra	Red Fescue
Viburnum edule	High Bush Cranberry		Rubus parviflorus	Thimbleberry
			Alnus rubra	Red Alder
Upland			**Upland**	
Alnus rubra	Red Alder		Alnus rubra	Red Alder
Alnus viridus	Sitka Alder		Alnus viridus	Sitka Alder
Cornus stolonifera	Red Twig Dogwood		Cornus stolonifera	Red Twig Dogwood
Picea sitchensis	Sitka Spruce		Picea sitchensis	Sitka Spruce
Populus balsamifera	Black Cottonwood		Populus balsamifera	Black Cottonwood
Rubus spectabilis	Salmonberry		Rubus spectabilis	Salmonberry
Salix barclayi	Barclay's Willow		Salix barclayi	Barclay's Willow
Salix sitchensis	Sitka Sedge		Rubus parviflorus	Thimbleberry
Viburnum edule	High Bush Cranberry		Festuca rubra	Red Fescue

Table 4: Record of Planting Quantity, Source and Labor

Date	Species	Type	Quantity	Source	Labor
18-Apr	Festuca rubra	seed	10 lbs	Alaska Mill and Feed	USFWS
7-Jun	Salix barclayi	cutting	1500	Wren Drive/Back Loop Road	volunteer
7-Jun	Populus balsamifera	cutting	150	Behind Community Gardens	volunteer
13-Jun	Carex lyngbae	plug	130	Coast Guard Wetland	SAGA
14-Jun	Carex sitchensis	plug	450	Duck Creek by Superbear	SAGA
14-Jun	Caltha palustris	plug	40	Duck Creek by Superbear	SAGA
15-Jun	Carex	plug	300	Coast Guard Wetland	SAGA
15-Jun	Carex sitchensis	plug	375	Church of Nazarene Wetland	SAGA
15-Jun	Carex sitchensis	plug	200	Church of Nazarene Wetland	SAGA
19-Jun	Calamagrostis/ Deschampsia	plug	164	Lemon Creek Wetland	SAGA
19-Jun	Fritillaria camschatensis	plug	34	Lemon Creek Wetland	SAGA
19-Jun	Hierchloe odoratum	plug	31	Lemon Creek Wetland	SAGA
19-Jun	Iris nootkatensis	plug	31	Lemon Creek Wetland	SAGA
20-Jun	Calamagrostis/Deschampsia	plug	276	Lemon Creek Wetland	SAGA
20-Jun	Fritillaria camschatensis	plug	83	Lemon Creek Wetland	SAGA
20-Jun	Hierchloe odoratum	plug	49	Lemon Creek Wetland	SAGA
20-Jun	Iris nootkatensis	plug	60	Lemon Creek Wetland	SAGA
21-Jun	Rubus spectabilis	transplant	200	Duck Creek by Superbear	SAGA
22-Jun	Carex sitchensis	plug	20	Duck Creek by Superbear	SAGA
22-Jun	Picea sitchensis	transplant	8	DOT ROW Loop Rd	SAGA
23-Jun	Lupinus nootkatensis	seed	unweighed	US Forest Service, Ketchikan	NRCS
26-Jun	Eleocharis palustris	plug	100	Coast Guard Wetland	SAGA
26-Jun	Scirpus microcarpus	plug	100	Lemon Creek Wetland	SAGA
27-Jun	Thimbleberry	transplant	55	DOT land on channel by GCI	SAGA
27-Jun	Rubus spectabilis	transplant	35	Duck Creek by Superbear	SAGA
29-Jun	Carex	plug	175	DOT ROW north of SE Vet	SAGA
29-Jun	Festuca rubra	seed	20 lbs	Alaska Mill and Feed	SAGA
29-Jun	Calamagrostis canadensis	seed	10 lbs	Alaska Mill and Feed	SAGA
29-Jun	Deschampsia cespitosa	seed	10 lbs	Alaska Mill and Feed	SAGA
30-Jun	Cornus sericea	plug	216	Nat's Nursery, BC	CBJ
30-Jun	Festuca rubra	seed	10 lbs	Alaska Mill and Feed	CBJ
30-Jun	Calamagrostis canadensis	seed	10 lbs	Alaska Mill and Feed	CBJ
30-Jun	Deschampsia cespitosa	seed	8 lbs	Alaska Mill and Feed	CBJ
5-Jul	Carex	plug	490	DOT ROW north of SE Vet	SAGA
6-Jul	Carex	plug	245	DOT ROW north of SE Vet	SAGA
20-Jul	Picea sitchensis	transplant	?	DOT ROW Loop Rd	CBJ
20-Jul	Festuca rubra	seed	20 lbs	Alaska Mill and Feed	CBJ
20-Jul	Calamagrostis canadensis	seed	5 lbs	Alaska Mill and Feed	CBJ

cont. Table 4: Record of Planting Quantity, Source and Labor

Date	Species	Type	Quantity	Source	Labor
20-Jul	Deschampsia cespitosa	seed	5 lbs	Alaska Mill and Feed	CBJ
24-Jul	Cornus stolonifera	transplant	17	old Fred Meyer landscape	CBJ
26-Jul	Rubus spectabilis	transplant	24	Duck Creek by Superbear	Trail Mix
7-Aug	Carex sitchensis	plug	50	Church of Nazarene Wetland	Trail Mix
8-Aug	Alnus	transplant	100	Duck Creek by Superbear	Trail Mix
9-Aug	Rubus spectabilis	transplant	60	Duck Creek by Superbear	Trail Mix
15-Aug	Festuca rubra	seed	40 lbs	Alaska Mill and Feed	CBJ
15-Aug	Deschampsia cespitosa	seed	10 lbs	Alaska Mill and Feed	CBJ
		Total Quantity	4993		

Above: Volunteer planting of willow and cottonwood cuttings in June. Right: Cuttings send out leaves in August.

Above: SAGA extracts sedges from a wetland in Lemon Creek. Right: Transport of sedges and marsh marigold in buckets.

Above: SAGA plants wet meadow grasses.
Right: Low marsh and high marsh sedges and bulrushes.

Left: Alders transplanted along stream channel.

Photos taken by Michele Elfers.

VI. Trail Design and Construction

The design and development of a community trail through the wetland has become an important component to gaining public approval and support of the project. Adjacent landowners initially viewed the reclamation project as disruptive, but through the process of filling, planting and trail construction, many neighbors and community members have expressed that the reclamation is an improvement to the neighborhood. It offers recreational opportunities for a neighborhood of streets and private property and it allows access to a successional landscape with a fantastic view of the Mendenhall Glacier (See Figure 12-14).

CBJ applied for a Recreational Trails Grant through the Department of Natural Resources, Division of Parks and Outdoor Recreation. To administer the grant funds, the CBJ Engineering Department, the CBJ Department of Parks and Recreation, and Trail Mix formed a partnership to accomplish the administration, construction and management of the trail. The Engineering Department was responsible for the design, permitting and construction oversight, the Department of Parks and Recreation provided equipment, design review, and maintenance and management of the completed trail, and Trail Mix constructed the trail and administered the grant.

The trail construction began in July 2006 and continued through August. A few details will be completed in late fall and early spring such as the installation of trash cans and interpretive signage. Silty gravel forms a compact base for the six foot wide trail. A deck is sited at the south end to capture a remarkable view across the wetland of the Mendenhall Glacier. An island at the north end is accessed by a bridge and boardwalk and offers a bench and viewing point south. Eight steel pilings and a frame of treated lumber support the observation deck. The decking on the observation deck and boardwalk, railings, and benches are recycled plastic lumber. The 70' bridge is a steel gangway removed over the summer from a CBJ Ports and Harbors project.

Many of the materials and labor were donated to allow completion of the trail with only grant funding. The bridge and benches were donated by CBJ Ports and Harbors, the rough grading and shot rock placement on the trail was donated by Glacier State Contractors, and the construction of the observation deck was done by the U.S. Coast Guard Engineers in Juneau.

Figure 12. Trail Master Plan
The trail design includes the extension north of the trail to the Church of Nazarene Wetland. This extension was not constructed. Currently, the trail connects to the Mendenhall Bike Loop Path.

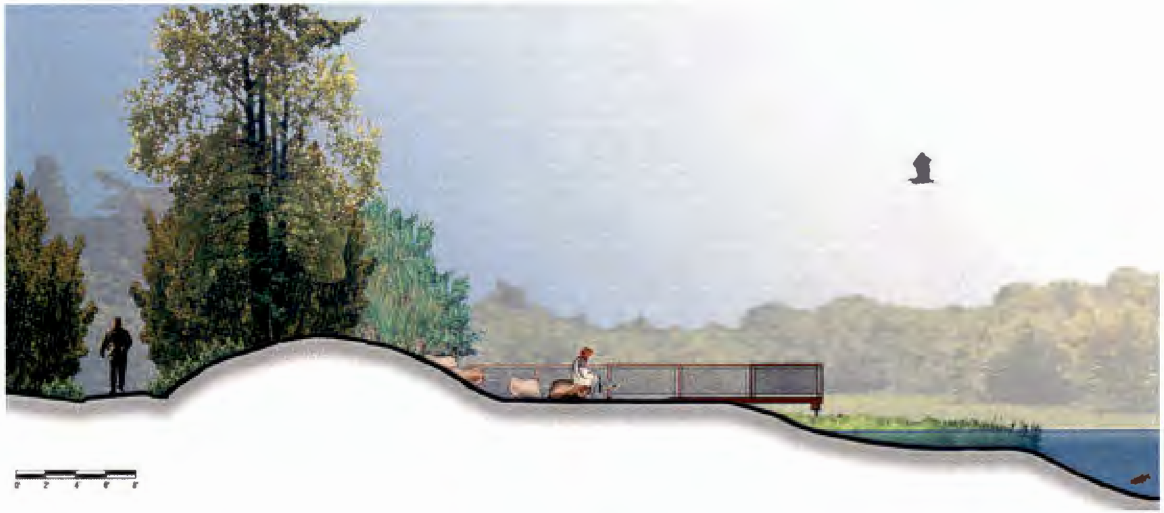


Figure 13. Cross Section of the Observation Deck

The deck is sited to allow for close viewing of open water and to capture a magnificent view of the Mendenhall Glacier as a backdrop to the wetlands.

Figure 14. Cross Section of the Bridges

The two bridges across the wetland are connected by an island. The first is a 25' wooden boardwalk across emergent wetlands, the second is a 70' steel bridge with metal grate decking across the stream channel. On the island, a gravel seating area with boulders allows for resting and wildlife viewing.

The constructed trail represents Phase I of the Duck Creek Greenway Trail that will extend through the Nancy Street Wetland and the upstream Church of Nazarene Wetland and the Allison Pond (See Figure 15). Ultimately, it will connect from the north and south to the Under Thunder trail to form a loop. The creation of a trail that links the three wetlands will raise awareness of the ecological connection for fish, birds and other wildlife among these stepping stone habitats.

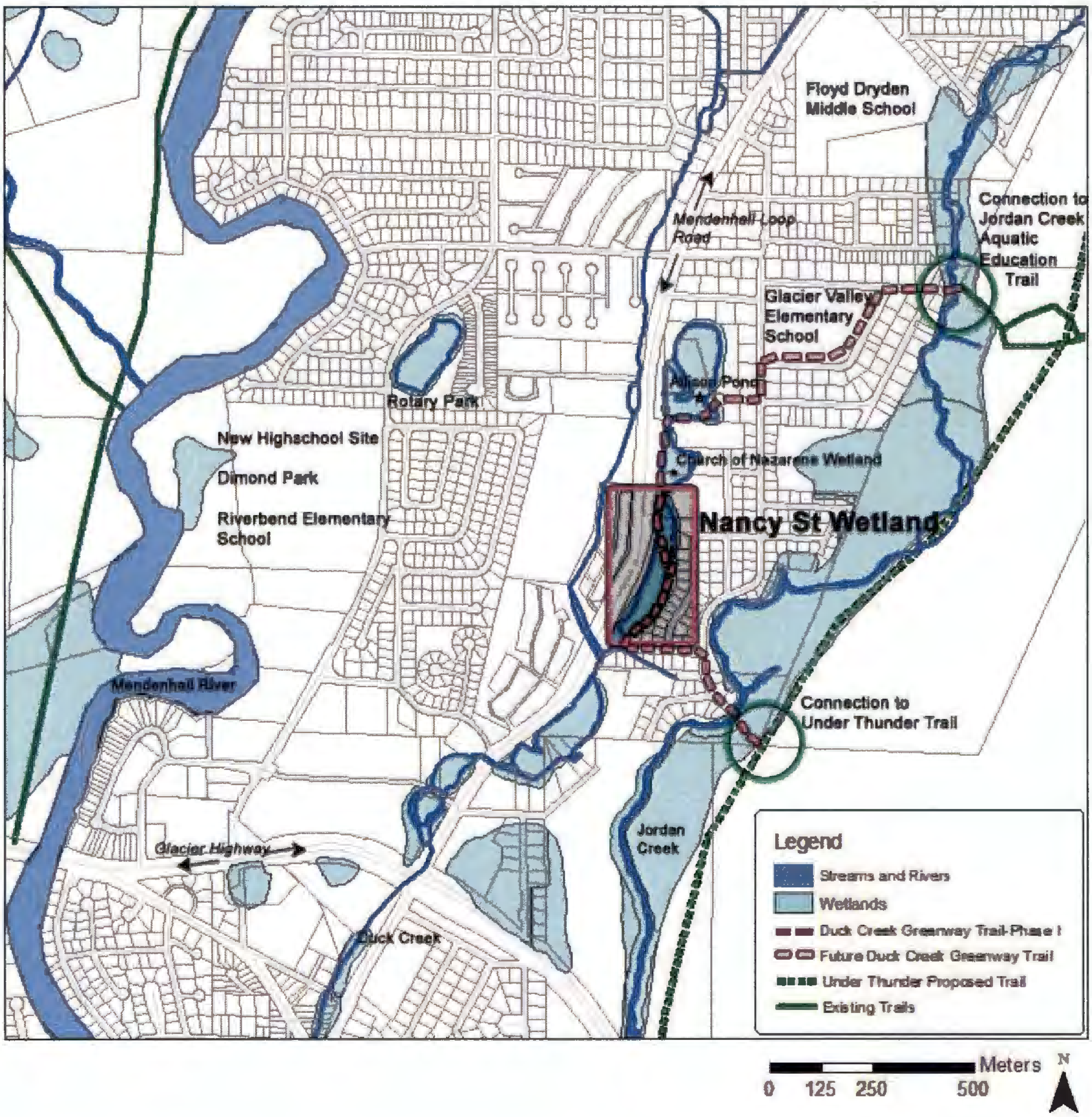


Figure 15. Duck Creek Greenway Trail Master Plan.
The trail through Nancy Street will connect the three former gravel pits to provide neighborhood connections, recreational opportunities, and to increase awareness of the ecological connections among the enhanced wetlands.

Glacier State shaped the rough trail bed and placed shot rock in May.

Trail Mix hauls gravel to build the trail across the island in August.

Trail Mix drives pilings for the observation deck and shapes the gathering area.

The finished bridge and boardwalk cross the wetland to an island with a bench for viewing.

Right: The steel gangway donated by CBJ Ports and Harbors extends from the northwest end of the trail to the east side. Trail Mix built new cedar rails for safety.

Below: The finished observation deck and gathering area.

VII. Monitoring and Maintenance

The monitoring and maintenance plan for the Nancy Street Wetland addresses issues of survival and performance of wetland vegetation, changes in wetland composition, the control of invasive species, and the general upkeep of the trail and interpretive areas. The plan for monitoring of wetland vegetation is informed by a plan for wetland monitoring in Bellevue, Washington by Herrera Environmental Consultants, a guide to "Wetland Restoration, Creation, and Enhancement" written by various federal resource agencies, and research done by Elzinga, Salzer, and Willoughby in Measuring and Monitoring Plant Populations. The plan for trail maintenance is based on observations of wetland trail requirements over time in Juneau.

Monitoring Plan

It is proposed that this work be performed in conjunction with the existing UAS water and fish monitoring plan and the data be combined into one report.

1. Establish plots in different plant community zones to measure species composition, aerial cover, and vegetative density. Measure water level above ground surface. Take measurements once per year in late July from 2007 to 2012. See Appendix XX for plot locations.

a. Plot 1 Upland - monitor a 5 meter radius around stake.

b. Plot 2 Island – monitor the entire island.

c. Plot 3 Emergent – monitor a 1 meter radius around stake.

d. Plot 4 Emergent – monitor a 1 meter radius around stake.

2. Establish 4 photopoints that capture each plot and 2 photopoints that capture emergent wetland, one from the observation deck looking north to the glacier and the second from the bench on the island looking south to the observation. See Appendix 2b and 2c for photopoints and 2006 photographs.

3. Complete table of information and draw maps recording the location, density and cover of each plot. See Appendix 2a for baseline data and sample table.

Maintenance Plan

The Nancy Street Wetland will be transferred to the CBJ Parks and Recreation Department for management. This department and Trail Mix can coordinate to maintain the trail using the excess trail grant money.

1. Prune and clear shrubs and trees obstructing passage along the trail.

2. Empty garbage cans, refill doggy bag dispenser and remove garbage from the trail.

3. Clear drainage culverts along trail.

VIII. Conclusion

The Nancy Street Wetland Enhancement Project offers an economically feasible, ecologically beneficial, and socially supported model of wetland reclamation for municipalities. Based on the data and assessment of the design and construction presented in this report, the project has been successful in the aspects of earthwork, transplanting, cost benefit and public participation. However, areas of improvement include the refining of final water levels, soil quality, and irrigation strategies during transplanting.

The design and implementation of the filling process determined largely the improvement of habitat, the efficiency of operations, and the accuracy of the as-built site to the design. By filling and completing each finger and section of the wetland individually, greater variety and attention to each landform was introduced. The other option, filling the entire site and then returning to dredge the stream channel would have resulted in less diversity of habitat and less attention to the design details. There is some concern that the water level is higher than the designed level. However, the rainfall was higher than average in 2006, so it is difficult to tell if the water levels in the wetland will drop. Designing elevations to within 3 inches to allow for necessary habitat for plants and wildlife is very difficult on a project where over 60,000 CY of fill are being placed. For this reason, designing a dam with adjustability to account for the discrepancy in water level would improve the function and success of the project.

The high rainfall this summer maintained a moist planting substrate throughout most of the summer. In late June, a sunny period of two weeks revealed the problems that would have been encountered had it been a drier summer. The soil dried and cracked around the newly transplanted plants and a hasty irrigation plan of buckets and a garden pump with hose was used to keep the plants alive. An irrigation plan should be in place prior to the revegetation phase. Tapping into city water through fire hydrants, or a private source are two potential solutions. Also, improving the quality of topsoil will improve moisture retention. The mineral topsoil had little organic content and was full of rock and cobble. Plant survival in 2007 will reveal whether higher quality topsoil is needed. At the end of the 2006 planting season, there was approximately 70% survival rate of transplanted species. Based on this estimate, the revegetation effort was very successful.

In addition to the improvement of fish and wildlife habitat, the other measure of success of the Nancy Street Wetland Enhancement is the strong base of public support. Throughout the construction process, volunteers donated time, materials and money to the project. Many neighbors began to come out during the summer construction and comment on how happy they were about the project.

As a result of the success of this project, a similar process is planned for the Allison Pond upstream of the Nancy Street Wetland. The process will be improved based on this assessment and applied to the Allison Pond site needs. The CBJ has saved the community money by pioneering this alternative option to fill disposal. The support of the U.S. Fish & Wildlife Service and the Natural Resource Conservation Service has enhanced habitat for fish and wildlife and reclaimed a valuable community resource.

Plant List for Freshwater Wetlands											
Scientific Name	**Common Name**	**Recommendation by**	**Water Level**	**Height**	**Transplant Potential**	**Seed Potential**	**Wildlife Benefits**	**Human Benefits**	**Iron phytoremediation**	**Liabilities**	**Other Issues**
Deep Water											
Caltha natans	Floating Marsh Marigold	Book	aquatic floating	1-3'				attractive flower			floats or creeps in mud, stolons root at nodes
Nuphar polysepalum	Yellow pond-lily	Patti Krosse, Ed Buyarski	3-4' average water depth, up to 6' stalk		successful, use fork or clam digger to dig up entire root, or monofilament tied to root with rock to get plant it.		food, habitat for fish, cover for ducklings, frog habitat	very attractive open water flower		Patti-very difficult to dig roots, often extensive, and hard to get roots back into the water completely	found in pond near Superbear, very shallow water, may be easy to remove
Potamogeton natans	Floating Pondweed	Observed at Nancy Street	aquatic floating from bottom 3-9'		yes		very valuable food source for mallards and other marsh birds		Existed in Nancy Street Pond so it is tolerant of iron	In CoN it forms a dense cover in open water areas, too much shade and it may limit macroinvertebrate population	present at Nancy Street Pond prior to filling, present at CoN, Floyd Dryden, becomes very dense in areas, keep deep water areas in pools if open water habitat is desired
Sparganium angustifolium	Narrow-Leaved Bur-reed	Observed at Nancy Street	aquatic floating	1-3'			nesting, cover, seeds, muskrats		Existed in Nancy Street Pond so it is tolerant of iron		present at Nancy Street Pond prior to filling
Marsh											
Caltha palustris	Yellow Marsh Marigold	Book	wet areas with slow running water	variable	divide rootball	seed direct sow in fall		attractive flower			limited survival at CoN
Carex mertensii	Merten's Sedge	Patti Krosse	upland, more dry conditions, in transition zone	4'	one of the easiest types of carex to transplant	yes		attractive colorful,large spikes	dense root system may hold more iron	Carex more difficult to dig roots	germinates easily, some found in CoN, planted in Kingfisher Pond, growing very well in low saturated soil, but also growing on wet slopes.
Carex sitchensis	Sitka Sedge	Observed at CoN Wetland	emergent	1-5'	yes	yes	excellent waterfowl habitat		dense root system may hold more iron	hard to dig up because of root system	transplanted into CoN, excellent survival rate
Carex stipata	Sawbeak Sedge	Observed at Kingfisher Pond	marsh and bog	1-3'		yes		attractive seed head	dense root system may hold more iron		planted in Kingfisher Pond (seed), found only a few plants, did not do well
Eleocharis palustris	Spike Rush	Observed at Floyd Dryden Wetland	in shallow standing water, 1-2"	6-24"				attractive head			spread very well in Floyd Dryden Pond and has an attractive head and reddish hue to the stems
Equisetum	Horsetail sp.	Patti Krosse	aquatic to semi-aquatic		yes				the roots are small and probably do not trap much iron, roots do not hold much soil	Has shown invasive tendencies in the CoN wetland	probably easy to transplant some rhizomes, excellent survival rate in CoN(dominates wetland-maybe too aggressive), also abundant in Floyd Dryden
Hordeum brachyantherum	Meadow Barley	Observed at Kingfisher Pond	moist soils	3'		yes	food for blacktail deer			Primarily a maritime species, along beaches and meadows	planted in Kingfisher Pond (seed), found only one plant

Scientific Name	Common Name	Recommendation by	Water Level	Height	Transplant Potential	Seed Potential	Wildlife Benefits	Human Benefits	Iron phytoremediation	Liabilities	Other Issues
Juncus effusus	Common Rush	Patti Krosse	some water-a little drier, gravelly disturbed land	1-4'	Difficult	yes		less attractive, smaller			germinates easily
Juncus mertensianus	Merten's Rush	Observed at Kingfisher Pond	marsh and bog	1'		yes		attractive seed head			planted in Kingfisher Pond (seed), growing in saturated soil
Lysichiton americanum	Skunk Cabbage	Observed at CoN, Ed Buyarski	wet edges of water	1-4'	thick root, need to get down deep to dig it out	yes, direct sow in fall	food for deer, bear, and gnats	attractive flower, color		Shady, forested areas	present at edges of CoN
Menyanthes trifoliata	Buckbean	Patti Krosse	aquatic to semi-aquatic	1'	easy to dig up but difficult to establish in soil	yes	fruit is food for flies, beetles, bees, and birds	attractive flower		rhizomes	planted in peat with water around it at all times, creeping rhizomes should be separated in fall or early spring. Transplanted into Floyd Dryden wetland, has spread and is doing well there
Scirpus Microcarpus	Small-Leaf Bulrush	Patti Krosse, Dave Maddix	water with a gradient	4'	very easy to dig roots and transplant successfully	yes	nesting, cover, seeds	attractive seed heads, medium height	root uptake potential		some bulrush present in CoN, believed to be this type, planted in Kingfisher Pond. It is doing very well and has spread
Wet Meadow											
Aconitum delphinifolium	Monkshood	Book	wet meadow, streambanks	3'				attractive flowers		poisonous	needs the drier upslope of wet meadow, often found at higher elevations
Aquilegia formosa	Columbine	Ed Buyarski	wet meadow, streambanks, often in rocky areas	2'	yes	yes	food for hummingbirds, cover for nesting species	attractive flower			prefers drier areas, well-drained, Ed Buyarski says seeding works very well
Calamagrostis canadensis	Bluejoint Reedgrass	Book, Dave Maddix	wet meadows and well-drained uplands	3'	yes with sprigs	limited, grassrolls or sprigging plugs	bird seed, nesting, cover for small mammals		dense fibrous root system, slightly rhizomatous		forms overhanging banks, aggressive colonizer in disturbed areas
Deschampsia cespitosa ssp. beringensis	Tufted Hairgrass	Book	moist soils	1-4'		yes, but high demand	low to moderate fishery and habitat value			Must be careful with seed, none being collected in SE AK. DNA issues with new varieties.	adaptable to many conditions, tufted growth form, seeded in Kingfisher Pond did well from low saturated locations moving up on wet slopes
Dodecathon pulchellum	Shooting Star	Patti Krosse, Ed Buyarski	moist soil but not standing water	1-1.5'	very easy	difficult, needs to be wet and cold through winter		attractive flower			challenging to start from seed

Scientific Name	Common Name	Recommendation by	Water Level	Height	Transplant Potential	Seed Potential	Wildlife Benefits	Human Benefits	Iron phytoremediation	Liabilities	Other Issues
Eriophorum angustifolium	Narrow-Leaved Cotton Grass	Book	wet, moist soil	2'				attractive seed head		rhizomes	
Festuca rubra	Red Fescue	Book	moist to well-drained	6"-40"		yes	low habitat and fishery value	reddish hue			very common in Alaska in low elevation meadows and mountain meadows, easy to seed, used for agriculture, horticulture, lawns, tolerates flooding
Fritillaria camschatcensis	Chocolate Lily	Patti Krosse	moist soil but not standing water	2.5'	Patti Krosse says it is very easy, and they take well (bulb form)			attractive flower			
Iris Setosa	Wild Flag	Book	moist soil	1-3'	easy			attractive flowers			Rhizomes can be divided and gathered in spring or in fall in mild areas
Lupinus nootkatensis	Nootka Lupine	Ed Buyarski	moist soils	2-3'	very difficult to transplant because of extensive root system	yes-gather in pods, dry out pods so they pop and capture the seeds	food for hummingbirds, cover for nesting species	attractive flowers		Needs mineral soil, likes gravel, well-drained	Fixes nitrogen,volunteered at Kingfisher Pond, seeded areas at Floyd Dryden did not take well, only a few plants
Rubus spectabilis	Salmonberry	Book	wet areas	3-9'	dig up rhizomes with many root off shoots, fairly easy		berries good for food	attractive flowers and berries, good screening		attracts bear	
Valeriana sitchensis	Sitka Valerian	Book	moist soil	1-3'				attractive flowers			
Viola palustris	Marsh Violet	Ed Buyarski	saturated soils	low	yes, easy			attractive flowers			
Tree/Shrub											
Acer glabrum	Douglas Maple		floodplain, moist, into uplands	30'	Seed, transplant, softwood cutting	yes	birds eat seeds, cover	attractive fall foliage, yellow-crimson		found mostly in Juneau on rocky coast	
Alnus rubra	Red Alder	Book	wet soils	75'	Hedge layer, transplant, seed, hardwood cutting	yes	food, cover				nitrogen fixing, good on steep slopes
Alnus viridus (Alnus sinuata)	Sitka Alder	Book	wet soils	18'	Hedge layer, transplant, seed, hardwood cutting	yes	food, cover				nitrogen fixing, longpointed teeth of two sizes
Aruncus dioicus	Goat's Beard	Observed at Kingfisher Pond	wet soils to dry uplands	3-6'	yes	yes					Planted in Kingfisher Pond (seed), no mature plants found

Scientific Name	Common Name	Recommendation by	Water Level	Height	Transplant Potential	Seed Potential	Wildlife Benefits	Human Benefits	Iron phytoremediation	Liabilities	Other issues
Cornus stolonifera	Red Osier Dogwood	Book	moist soils	3-18'	dormant cutting, live stakes,bundles, brush layer, hedge layering, rooted cuttings, transplants, seed	yes	berries provide winter food for deer	attractive white flowers, berries, and red twigs			2-4 specimens planted in Kingfisher Pond, looks like the original shoots died, but root base survived and is sending up new shoots.
Picea sitchensis	Sitka Spruce	Book	wet soils to dry uplands	200'	transplant, seed	yes	birds eat seed, habitat, winter nesting	evergreen, good screen			
Populus balsamifera	Black Cottonwood	Book	water edge	150'	dormant cuttings, live stakes, bundles, brush layer, hege layering, rooted cuttings, transplants, seed	yes	birds eat seed, habitat				
Salix barclayii	Barclay's Willow	Ellen Anderson	water edge	6-8'		yes	habitat				often has 'willow roses' at end of twigs from deformed leaves and insects
Salix sitchensis	Sitka Willow	Book	water edge	3-24'	dormant cutting, live stakes, bundles, frush layer, live siltation, hedge layering, rooted cuttings, transplants, seed	yes	habitat				
Spirea douglasii	Hardtack Steeplebush	Observed at Kingfisher Pond	wet soils							Juneau is north of its zone	Seeded in Kingfisher Pond, no plants found.
Tsuga heterophylla	Western Hemlock		wet soils	180'	transplant, seed	yes	habitat	evergreen, good screen			needs significant organic content on site to grow, does not do well in recently deglaciated areas, shade tolerant
Viburnum edule	Highbush Cranberry	Observed at Nancy Street in uplands	wet soils and streambanks to dry uplands	5-8'	cuttings possible		berries	attractive and edible berries			Ed Buyarski says its easy to take cuttings, similar to willow

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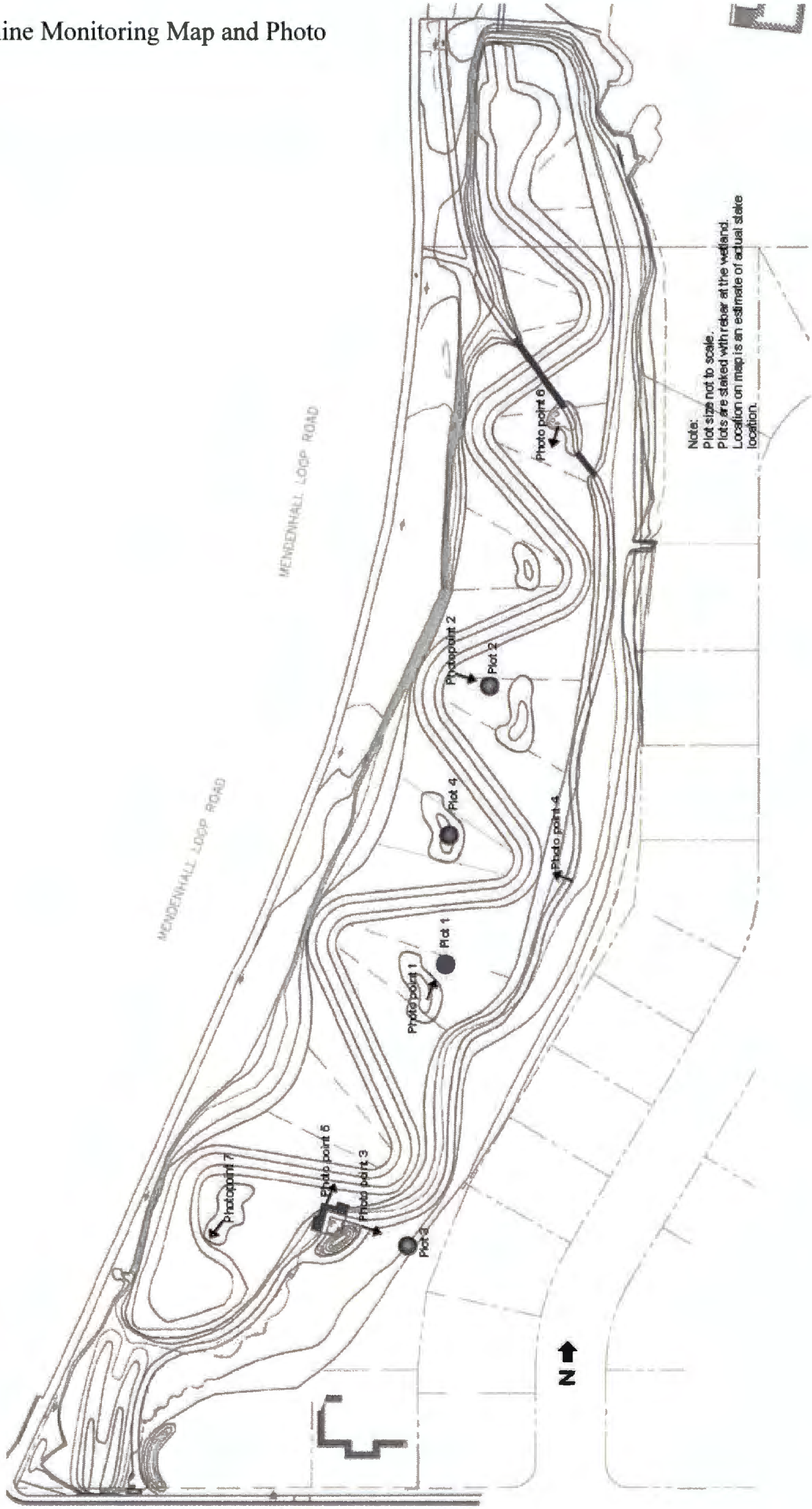
Appendix 2a. Baseline Monitoring Data
October 2006

Sample Plot	Dominant Species	Common Name	Coverage (%)	Density (number count of species)	Standing water (in)
Plot 1	Carex sitchensis	Sitka sedge		17	11.5
	Caltha palustris	Marsh marigold		1	11.5
Plot 2	Carex sitchensis	Sitka sedge		12	10
	Scirpus microcarpus	Small-Leaf Bulrush		2	10
	Equisetum	Horsetail		2	10
Plot 3	Salix barclayi	Barclay's Willow		11	0
	Alnus	Alder		3	0
	Rubus spectabilis	Salmonberry		2	0
	Athyrium filix-femina	Lady Fern		2	0
	Festuca rubra	Red Fescue			
Plot 4	Salix barclayi	Barclay's Willow		11	0
	Rubus spectabilis	Salmonberry		1	0
	Cornus stolonifera	Red-Twig Dogwood		1	0
	Deschampsia cespitosa	Tufted Hairgrass			0
	Calamagrostis canadensis	Blue-Joint Reed Grass			0
	Festuca rubra	Red fescue			0

Appendix 2b. Baseline Monitoring Map and Photo Point Locations



Appendix 2c. Photo points
October 2006


Photo point 1

Photo point 2



Photo point 3

Photo point 4

Photo point 5

Photo point 6

Photo point 7

Appendix 3A. Budget - CBJ Cost Benefit for New High School Project

Option 1: Typical Cost for Filling at Lemon Creek					
	Price	**per Unit**	**Quantity**	**Unit**	**Cost**
Filling Lemon Creek 52,000 cy					
tipping fee	$2.50	cy	52,000	cy	$130,000
trucking fee	$68	load (8 cy)	6,500	loads	$442,000
				Total Cost for Lemon Creek Filling	**$572,000**
Option 2: Nancy Street Wetland Filling					
	Price	**per Unit**	**Quantity**	**Unit**	**Cost**
Filling Nancy Street 52,000 cy					
tipping fee	$1	cy	52,000	cy	$52,000
trucking fee	$20	load (8 cy)	6,500	loads	$130,000
				Total Cost for Nancy Street Filling	**$182,000**
				Total Cost for Lemon Creek Filling	$572,000
				Total Cost for Nancy Street Filling	-$182,000
				CBJ cost of land purchase of Nancy Street Wetland	-$137,000
				Savings for CBJ after land purchase	**$253,000**

The City and Borough of Juneau saved $253,000 by purchasing, filling and enhancing the Nancy Street Wetland instead of following the following the typical process of fill disposal at Lemon Creek. The reasons for the savings include:

1. The distance from the construction site to the Nancy Street Wetland is approximately 3 miles shorter than the distance to the Lemon Creek disposal site. This reduces fuel and transportation costs.

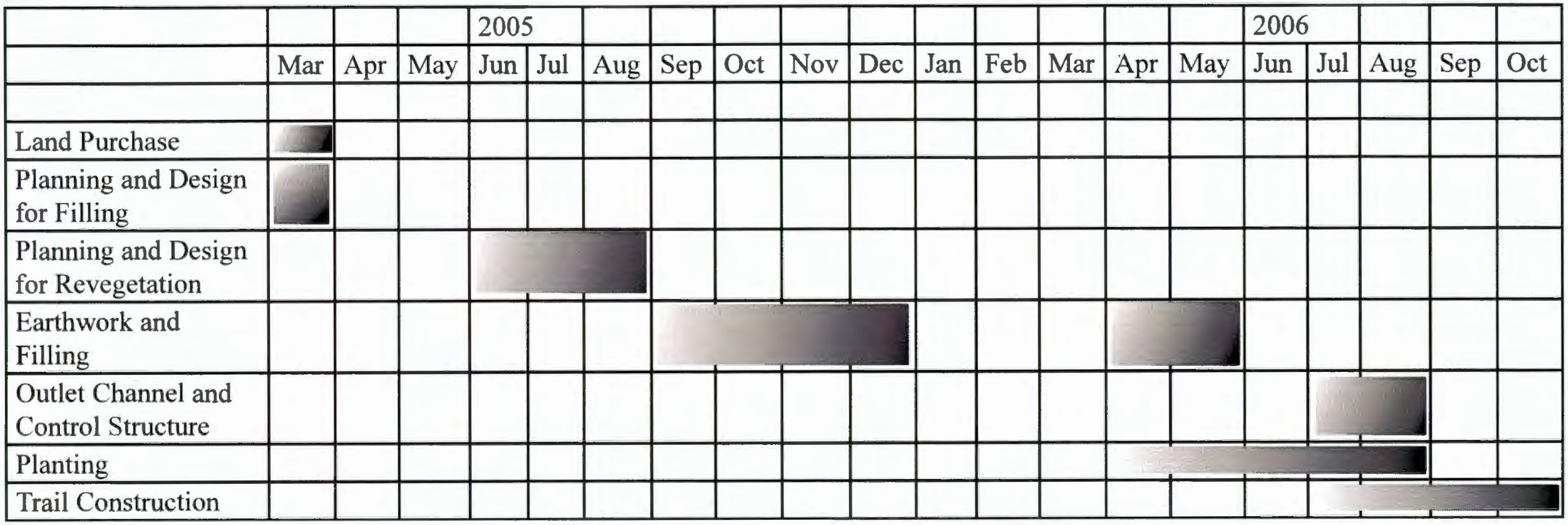
2. The CBJ owned the disposal property and could reduce the tipping fees considerably, thereby saving the project money.

3. The process of enhancing the Nancy Street Wetland was funded entirely by the U.S. Fish & Wildlife Service, the Natural Resource Conservation Service, and other grants and donations. The involvement of the resource agencies at all stages of planning, design and construction facilitated the filling and enhancement process. See Appendix 3B for contribution details.

Appendix 3B. Budget - Contributions

	Entity	Program	Task	Amount
1.	***Land Purchase***			
	CBJ	Street Sales Tax	Land Purchase	$137,000
			Total	**$137,000**
2.	***Earthwork***			
	USFWS	Partners for Fish and Wildlife Program	Intern	$9,000
			Earthwork	$31,000
	NRCS	Wildlife Habitat Improvement Program	Fill placement and rough grading	$75,000
			Total	**$115,000**
3.	***Planting, Final Grading, Outlet Channel and Control Structure***			
	USFWS	Partners for Fish and Wildlife Program	Outlet Design, Final Grading	$45,000
			SAGA-FWS Contract - Reveg	$26,800
			Intern	$10,000
	NRCS	Wildlife Habitat Improvement Program	Fish passage channel	$6,000
			Structure for water control	$3,750
			Final grading, topsoil placement, planting	$42,000
	Full Circle Farms	Donation-Cash	Plant Materials	$5,000
	Full Circle Farms	Donation-Labor	Collection and Planting	$5,600
	Full Circle Farms	Donation-In Kind	Plant Storage	$3,000
	Duran Construction Co.	Third Party EPA Mitigation Compliance	Topsoil Delivery, 5500cy	$30,000
			Total	**$177,150**
4.	***Trail Construction***			
	DNR	Recreational Trails Grant	Trail materials, construction	$46,746
	Glacier State Contractors	Private Donor	Trail grading and gravel	$14,000
	Juneau Docks and Harbors	Donation- In Kind	Bridge and Delivery	$14,900
			Total	**$75,646**
			GRAND TOTAL	**$504,796**

Timeline for Purchase, Filling and Enhancement



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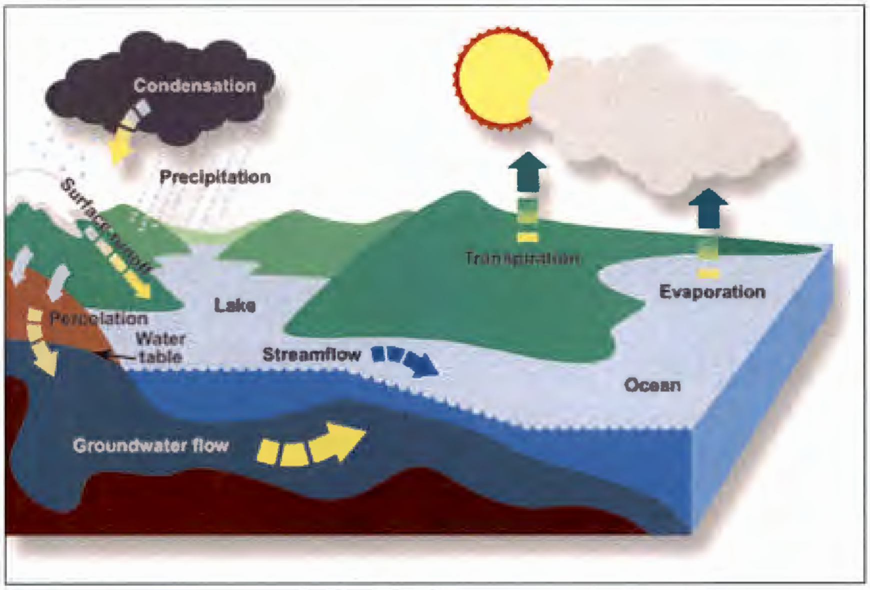
ONTARIO STONE, SAND & GRAVEL ASSOCIATION

Essential materials for building a strong Ontario

GROUNDWATER IN THE AGGREGATE INDUSTRY

Groundwater is a renewable resource that is in constant motion as part of the hydrologic cycle. Above-water pits and quarries have little or no effect on water levels or the flow of groundwater.



What is Groundwater?

Just as the name implies, groundwater is water contained in the pores and fissures of the earth. Groundwater is a renewable resource. It is in constant motion, part of the hydrologic cycle (see Hydrologic Cycle on the cover page). Rainfall and snowmelt infiltrate into the earth to recharge groundwater, which then flows as baseflow into streams and lakes. Evaporation from open water, and transpiration from plants, returns water to the atmosphere to complete the cycle.

A common misconception is that groundwater flows in underground rivers and lakes like surface water. Instead, groundwater seeps very slowly through the pore spaces and small fissures in the soil and rock. Materials such as clay have a low permeability, and hence very slow groundwater flow, while sand and gravel, or highly fractured rock, have high permeability and permit groundwater to flow faster. These more permeable layers are called aquifers.

The water table is the depth at which the soils or rock become completely saturated with groundwater. If a hole were dug, and left to stand for a while for groundwater to seep in, the water level in the hole would represent the water table. The water table elevation is not static, though, and it can fluctuate in different seasons and from year-to-year, depending on the amount of recharge. Natural depressions can intersect the water table to form lakes, ponds and wetlands.

Water Wells

Groundwater is a critical resource in Ontario - nearly one quarter of us rely on wells for our water supply. Some of these are municipal wells serving urban communities, but the vast majority are private water wells, mainly in the rural parts of the province. Two common types of wells are shallow dug wells which draw water from the water table, and bored or drilled wells which draw water from deeper aquifers.

The *Ontario Water Resources Act* and the *Environmental Protection Act* both serve to protect the quality and quantity of groundwater. They are administered by the Ontario Ministry of the Environment, which will respond to public complaints regarding interference with water wells. The Ministry has several excellent publications available to homeowners on subjects including proper water well construction and maintenance, protecting water quality in wells and managing water shortages (1-800-565-4923 or www.ene.gov.on.ca).

Fact Sheet

Groundwater at Pits and Quarries

- *Groundwater is a renewable resource.*
- *Water wells are protected under provincial legislation.*
- *Above-water pits and quarries can have a beneficial effect on groundwater and aquatic resources.*
- *Below-water pits and quarries can be operated without significant groundwater impacts if they are carefully designed and operated.*
- *Permits to Take Water ensure that aggregate wash plants do not harm water resources.*

Aggregate extraction and processing is a clean industry that does not provide groundwater contaminants.

Wells and their associated equipment require ongoing maintenance. Even with the best maintenance, though, they still tend to degrade naturally over a period of years, through mechanical wear and clogging of the well screen, pump and pipes, .

Can Pits and Quarries Affect the Flow of Groundwater?

The answer depends on the type of pit or quarry.

Above-Water Pits and Quarries

Most of Ontario's sand and gravel pits, and a few of its rock quarries, are excavated entirely above the water table. This type of operation has little or no effect on water levels or the flow of groundwater because there is no direct, physical alteration of the water table or any aquifers. Monitoring programs at above-water pits and quarries across Ontario have confirmed that groundwater is unaffected.

In some ways, above-water pits and quarries can actually be beneficial to groundwater. They create a "bowl" that captures and infiltrates all rainfall and snowmelt rather than allowing some of it to run off across the ground surface. A study on the Oak Ridges Moraine documented a number of benefits related to this extra groundwater recharge (Hunter/Raven Beck, 1996). One of the important benefits is to reduce direct run-off to surface water streams and increase cold groundwater baseflow which is critical to fish habitat.

Below-Water Pits

Below-water pits usually use large excavators or draglines to dredge sand and gravel from the *pit ponds* that form below the water table level. Generally, this type of extraction does not have major impacts because most of the groundwater remains in the pit, or drains back into the pit. This type of pit also captures surface water run-off and promotes more groundwater recharge, but these benefits are offset by the increased evaporation that will occur from the surface of a pit pond. Minor water losses also occur due to residual moisture contained in the aggregate products that are shipped from the site. Finally, the removal of solid sand and gravel particles from below the water table has the effect of temporarily lowering the water level in a pit pond (imagine removing a rock from a bucket of water).

The water surface in very large below-water pit ponds will stabilize at a uniform level, whereas the groundwater table before extraction may have been irregular or sloping. Therefore, the water table around the pit will have to "adjust" to the water level in the pit pond, possibly resulting in slightly different groundwater flow patterns. Fortunately, there is a simple solution where this may be a problem – digging several smaller pit ponds rather than one large pond (Ostrander *et al*, 1998).

When all of these factors are combined, the net effects of below-water extraction are normally minor and very localized. However, in certain circumstances they could still be significant if there are sensitive features such as wetlands or shallow wells in close proximity. As a result, a detailed and careful hydrogeological study is necessary when licencing this type of pit (Ministry of Natural Resources, 1997), and mitigation (solutions) to any negative impacts will be required. An ongoing groundwater monitoring program may be required.

Below-Water Quarries

Most quarries that extract from below the water table pump water out of the excavation so that the work of blasting and recovering the bedrock can be done on a dry floor. *Dewatering* usually does affect groundwater levels and flow patterns around the site, since it artificially lowers the water table to at least the base of the quarry. Hydrogeologists call the area around the quarry that is affected by the dewatering the *drawdown cone* or the *radius of influence*. Wells, streams, wetlands, or other sensitive features within this area must be carefully studied to predict the impacts and devise mitigation measures before the quarry can be licenced (Ministry of Natural Resources, 1997) and a groundwater monitoring program will normally be required.

There are many locations in Ontario where below-water quarries are successfully operated while sensitive water uses continue nearby – it depends very much on the specific hydrogeological setting. Recently, some innovative technologies have been introduced in Ontario to lessen the effects of quarry dewatering, such as pumping the water from the quarry back into the groundwater system around the quarry to artificially recharge the water table. This has so far proven to be quite successful (Gartner Lee Limited, 2001).

Other Water Takings

Pits and quarries have uses for water, similar to other businesses, such as supplying offices and shops with drinking water, watering lawns and gardens, etc., but these tend to be relatively minor. Most types of aggregate processing, such as crushing and screening, are dry operations and do not require water supply.

However, to minimize dust (which is a byproduct of excavation in a pit or quarry) spray water is used on internal haul roads, processing equipment, stockpiles and trucks.

One exception is aggregate washing plants, which are used at some sites, and do require relatively large quantities of water. Most plants recycle wash water through a "closed loop" series of holding ponds and settling ponds (i.e., the water is re-circulated, with no off-site discharge), so that the amount of water actually consumed in the process is usually less than about 10%. This *make-up water* normally comes from local groundwater or surface water sources. A common configuration would be to have a well that would be used occasionally during the production season to "top up" the ponds.

These water takings are regulated separately from the pit licence under the *Ontario Water Resources Act*, and controlled through Permits to Take Water. The applications and related hydrogeological studies are carefully reviewed by the Ministry of the Environment, other government agencies, and the interested public through the Environmental Bill of Rights process to ensure there will be no unacceptable impacts from these water takings, before the permit is issued.

GROUNDWATER IN THE AGGREGATE INDUSTRY

Can a Pit or Quarry Contaminate Groundwater?

It surprises some people to learn that aggregate extraction is a clean industry. Processing aggregates is a purely mechanical process of crushing, screening, blending, and sometimes washing (with water), without the need for chemicals. At most sites, fuels and lubricants for the equipment are the only potential sources of groundwater contamination, and these are closely regulated under the *Technical Standards and Safety Act*. A spills contingency plan is a standard condition of every new aggregate licence.

Bacteriological contamination of the type responsible for the Walkerton tragedy comes from human and animal wastes. Aggregate extraction and processing is not a source of this type of contamination.

As a result, water quality in and around pits and quarries is not normally an issue. This was confirmed through a study in 1989 as part of the Ontario government's MISA program, where monitoring at a selected number of pits and quarries found good water quality, with only sporadic traces of organic compounds at some sites that might indicate the use of petroleum products (SENES, 1989). In addition, there are many site specific monitoring programs in place at aggregate operations.

What About Water Temperature?

Water temperature concerns are occasionally raised in conjunction with below-water pits. A pit pond warmed through the summer months could result in a flow of warmer groundwater to nearby points of baseflow discharge and, in turn, affect cold water fisheries resources. An analysis conducted on behalf of the Credit Valley Conservation Authority in 1998 concluded that pit ponds have minimal impact on groundwater temperatures, and that these minor effects are completely dissipated within a few hundred metres from a pit (Ostrander *et al*, 1998). Field monitoring has also confirmed that groundwater returns to its normal background temperature within tens of metres of pit ponds (Harden Environmental, 1995).

As a result of the research to-date, thermal effects of pits and quarries is not considered to be a major issue in most cases. However, where there are cold water fisheries close to a pit pond, appropriate investigations and studies are required, and the setbacks and buffer zones will be adjusted accordingly.

For further information, please contact the OSSGA Environment and Resources Manager, at (905) 507-0711 or visit the OSSGA website at www.ossga.com.

Prepared by Gartner Lee Limited in consultation with OSSGA's Environment Committee.

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The "About Aggregates" series:

1. Aggregates and the Law
2. Bronze Plaque Award
3. Rehabilitation of Pits and Quarries
4. Being a Good Neighbour
5. Importance of Aggregates
6. Geology and Aggregate Extraction
7. Controlled Blasting at Quarries
8. Groundwater in the Aggregate Industry
9. Management of Abandoned Aggregate Properties (MAAP) Program

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January 17, 2022

Mr. Ed Martin III, President
Kenai Peninsula Aggregate and Contractors Association
Via email: Kpac (kpacassocoation@yahoo.c0m)

Subject: Comments on KPB proposed material site ordinance amendments

As requested, I have reviewed the ordinance proposed to amend KPB 21.25 and 21.50.055 regarding material site permits, applications, conditions and procedures and offer the following comments, observations and suggestions. These comments are provided pro bono as a courtesy to your organization as well as to the Kenai Peninsula Borough and its residents.

I have been retired, as a principal partner with the engineering firm of Wince-Corthell-Bryson in Kenai, for the past three years and therefore have no further interest in contracts or projects within the Borough. I have been a Kenai Peninsula resident since childhood when my parents homesteaded the Kasilof area in 1957 and have over 50 years of construction and engineering experience in the central, southcentral and southwestern regions of Alaska.

I have over 40 year's experience in the planning, design, and management of federally funded highway and airport projects where the National Environmental Protection Policy Act (NEPA) procedures are followed to evaluate and mitigate environmental impacts caused by construction and use of the resulting infrastructure.

All this being said I will offer my comments from a engineering prospective and as a good neighbor in the order of the documents you provided.

Whereas #1and2: Not clear to me what Climate Change has to do with this ordinance

Whereas #3: I assume "other uses" refers to material production. I.e.. Crushing, screening, asphalt and concrete supply.

Whereas #4: I agree larger setbacks are not the answer where a material barrier will address impacts off site.

Whereas #5: Protecting, maximizing, minimizing is not a very definitive word, perhaps mitigating should be considered.

Whereas #12: Dust, noise, traffic and visual aesthetics appears to me to be the crux of this ongoing debate and as a good neighbor is a reasonable topic. Its how they are reasonably addressed is the issue to me.

Whereas #17: I agree this catchall statement that additional requirements may be required casts uncertainty in the process and should be removed. The permit process should establish the conditions up front.

SECTION 1. KPB 21.25.030

21.25.030. – Definitions

Permit Area and Haul routes I think this is a valid issue that should be addressed in the permit process. While I agree all vehicles have the right to use the borough roads, most of the Borough roads are not designed and built to carry high numbers of heavy trucks on a daily basis. Alternate access and/or upgrading existing roads my be something to consider to mitigate damage to existing roads as well as other traffic concerns.

21.29.020 Material extraction and activities requiring a permit

B. Conditional land use permit (CLUP) I see no problem with including material processing in with the site plan as crushing and screening operations can be noisy and dusty and can be addressed with effective barrier plans such as earth berms. For the smaller pits processing is not usually not going on so would be a non applicable item on a checklist.

21.29.030 Application Procedure

9. Site Plan. The Site plan along with accompanying SWEPP, Traffic, and Environmental mitigation proposals should be prepared or at least reviewed and signed off on by a Alaska registered Civil Engineer. A checklist would be convenient with this process.

9f. Test Holes. Perhaps the mining plan should be limited to the depth of test holes with provisions to amend the plan later or utilize a drill rig to bore the test holes.

9h. Waterbodies and wetlands. The Borough GIS source provides good planning level information on wetlands. Definitive designations can easily be requested with a two-page application to the local Corp of Engineers office in Soldotna for little to no cost and only takes 2-4 weeks to obtain.

21.29.040. Standards for sand, gravel or material sites. This section addresses protecting or minimizing environmental conditions again perhaps mitigating would be an acceptable term. Regarding damage to adjacent properties, I believe that goes with out saying. Any damage to another person's property is protected under state law and pursuable in civil court.

21.29.050. Permit Conditions

2. Buffer Zone. A) I don't believe a 50-foot strip of trees affectively buffers adjacent property and ROW from visual, noise or dust impacts. A 10-foot minimum, neatly shaped and seeded, earth berm would affectively mitigate those three impacts and is readily available from site stripping as well as being available for reclamation activities. The buffer should not overlap ROW utility easements as those are dedicated for utility use.

I think it might be a good idea to establish some parameters to be achieves with the buffer such as visibility level which a 10-foot berm achieves. Noise levels which the borough proposes late at 75 decibels should be achievable considering FAA noise standards for airport noise is 65 decibels and easily measured with a decibel meter which I have can loan you. Airborne particulate is a difficult to measure without special equipment so maybe a visible standard could be used.

4. Water Source Separation b. I don't believe a few feet of gravel separation to the ground water protects it at all from fuel and oil spills, on the contrary. Minor spills that can be obscured by pit operations can build up over time and steadily leach into the water table not showing up for quite some time and well down gradient resulting in a long tern impact.

Dredging operations below water table can be boomed off and if a spill occurs is immediately visible and can be quickly boomed in, skimmed and absorbed.

5. Excavation in the water table. Simply dredging into the water table should have little affect on its level or down gradient wells. I agree some horizontal separations is required and would think the 200-foot separation required by ADEC would be sufficient.

If dewatering is proposed, then the following requirements address those impacts .

6. Waterbodies. I believe a 100-foot buffer with appropriate SWEPP practices will adequately protect surface water and wetlands.

11. Hours of Operation. Over my career I have only been involved with a few double shifting projects and they were on airports well away from residential areas. From what I have observed most operations run about 12 hours a day 5-7 days a week. Perhaps a special use permit could be utilized for unusual working hours.

17. Sound Level. The 75 decibel limit may be impossible to meet during initial pit development until the clearing, stripping, berming and the pit is to a depth below grade. Perhaps the permit could allow the 1.5 increase during initial development. This should be achievable during the first season of operation.

The smaller pits (1-2.5 acres) should be exempt from this requiremen, as I don't believe they can ever meet the requirement and they are normally project specific, only operating for a few weeks to a few months.

19. Ingress and Egress. Should be addressed in the permit process to assure existing Borough roads are capable of accommodating the increase in heavy truck traffic.

I have no comments on the Decision and Reclamation sections as that is housekeeping between the operators and the Borough in m my mind.

I also think that the final product of this ordinance should be a result of a consensus of the stakeholders and not simply a mater of majority vote rule. In the end a Permit Checklist should be provided that addresses all the impacts, their limits and provides a template for proposed mitigation .

One last observation is that considering how important gravel borrow sites are to the long term development and economics of the Peninsula I think the Borough and State should be encouraged to set aside some suitable land in proximity to the road system but buffered from private holding for land lease or sale. Making land available that is more neighbor friendly would solve not only this current issue but insure the continued growth of our area.

I hope my comments provide some ideas for consideration and wish you and the Borough success with the continued process to address this matter

Sincerely

Casey Madden, P.E.
Alaska Registered Civil Engineer No. 7235

Broyles, Randi

From: Blankenship, Johni
Sent: Monday, January 24, 2022 10:52 AM
To: Broyles, Randi
Subject: FW: New Public Comment to Assembly Members

Public comment

From: Kenai Peninsula Borough <webmaster@borough.kenai.ak.us>
Sent: Monday, January 24, 2022 10:48 AM
To: BoroughAssembly <Borough-Assembly@kpb.us>; Mayor's Department <MayorDepartmental@kpb.us>
Subject: New Public Comment to Assembly Members

Your Name: Joseph Ross

Your Email: smokeross@alaska.net

Subject: Gravel ordinance

Message:

No other industry in the borough is regulated to the extent that you are considering for our local gravel producers. Where are the regulations for the dirt burner? There was an immense amount of public outcry about it, but no task force was formed by KPB to address it. Homeless shelters? Same deal. Marijuana growers? Crickets. What you are attempting is spot zoning, and will cripple the gravel industry. One item you are considering in the new list of zoning is back up alarms. Will you be making rules about back up alarms for everyone, or just gravel producers? I hear back up alarms from Peak Construction every day. Sometimes even at night. How about the back up alarms on the graders out plowing snow at night?

Need to look @ 18 AAC 80 SOA Drinking Water Regs - there are some source water protection provisions 80.015.

and are valid for one year. The site development plan may be renewed on an annual basis subject to the planning director's approval.

21.29.020. Material extraction and activities requiring a permit.

A. *Counter permit.* A counter permit is required for material extraction which disturbs no more than 2.5 cumulative acres and does not enter the water table. Counter permits are approved by the planning director, and are not subject to the notice requirements or planning commission approval of KPB 21.25.060. A counter permit is valid for a period of 12 months, with a possible 12-month extension.

B. *Conditional land use permit.* A conditional land use permit (CLUP) is required for material extraction which disturbs more than 2.5 cumulative acres, or material extraction of any size that enters the water table. A CLUP is required for materials processing. A CLUP is valid for a period of five years. The provisions of KPB Chapter 21.25 are applicable to material site CLUPS and the provisions of KPB 21.25 and 21.29 are read in harmony. If there is a conflict between the provisions of KPB 21.25 and 21.29, the provisions of KPB 21.29 are controlling. (Material processing occurs on every civil construction jobsite. This is a burden to the public at large to develop their property)

- difference b/t major and minor extraction operations, w/ and those i/2 GW & those that stay above GWT

21.29.030. Application procedure.

A. In order to obtain a counter permit or CLUP, an applicant shall first complete and submit to the borough planning department a permit application, along with the fee listed in the most current Kenai Peninsula Borough Schedule of Rates, Charges and Fees. The planning director may determine that certain contiguous parcels are eligible for a single permit. The application shall include the following items:

1. Legal description of the parcel, KPB tax parcel ID number, and identification of whether the permit is for the entire parcel, or a specific location within a parcel;

2. Expected life span of the material site;

3. A buffer plan consistent with KPB 21.29.050(A)(2);

4. Reclamation plan consistent with KPB 21.29.060;

5. The depth of excavation;

6. Type of material to be extracted and type of equipment to be used;

7. Any voluntary permit conditions the applicant proposes. Failure to include a proposed voluntary permit condition in the application does not preclude the applicant from proposing or agreeing to voluntary permit conditions at a later time;

8. Surface water protection measures, if any, for adjacent properties designed by a SWPPP certified individual civil engineer (many of the operators are certified), including the use of diversion channels, interception ditches, on-site collection ditches, sediment ponds and traps, and silt fence;

DEC Reg's on "Certified Individual" may not incl Civil Engr

Don't know what this means

9. A site plan and field verification prepared by the site operator or a professional surveyor licensed and registered in the State of Alaska, including the following information: (surveyors don't offer this service, nor are qualified)

Should separate site plan from other issues calling it a "site plan" may bring other state requirements into play

a. Location of excavation, and, if the site is to be developed in phases, the life span and expected reclamation date for each phase;

b. Proposed buffers consistent with KPB 21.29.050(A)(2), or alternate buffer plan;

c. Identification of all encumbrances, including, but not limited to easements;

d. Points of ingress and egress. Driveway permits must be acquired from either the state or borough as appropriate prior to the issuance of the material site permit;

e. Anticipated haul routes;

f. Location and [DEPTH] elevation of test holes, and depth of groundwater, if encountered between May and December. At least one test hole per ten acres of excavated area is required to be dug. The test holes shall be at least four feet below the proposed depth of excavation; (can't dig that deep many times, if resource is deeper than conventional equipment can dig without stage excavation)

g. Location of wells of adjacent property owners within 300 feet of the proposed parcel boundary;

May not be enough for Public wells – Separate Private from public sources

h. Location of any water body on the parcel, including the location of any riparian wetland as determined by "Wetland Mapping and Classification of the Kenai Lowland, Alaska" maps created by the Kenai Watershed Forum; (wetland mapping by KWF under contestment and found unreliable)

[I. SURFACE WATER PROTECTION MEASURES FOR ADJACENT PROPERTIES, INCLUDING THE USE OF DIVERSION CHANNELS, INTERCEPTION DITCHES, ON-SITE COLLECTION DITCHES, SEDIMENT PONDS AND TRAPS, AND SILT FENCE; PROVIDE DESIGNS FOR SUBSTANTIAL STRUCTURES; INDICATE WHICH STRUCTURES WILL REMAIN AS PERMANENT FEATURES AT THE CONCLUSION OF OPERATIONS, IF ANY;]

[J]i. Location of any processing areas on parcel, if applicable;

[K]j. North arrow;

[L]k. The scale to which the site plan is drawn;

Separate Site Plan From other Requirements

[M]l. Preparer's name, date and seal; (A site operator may not have a seal)

[N]m. Field verification shall include staking the boundary of the parcel at sequentially visible intervals. The planning director may grant an exemption in writing to the staking requirements if the parcel boundaries are obvious or staking is unnecessary.

B. In order to aid the planning commission or planning director's decision-making process, the planning director shall provide vicinity, aerial, land use, and ownership maps for each application and may include additional information.

21.29.040. Standards for sand, gravel or material sites.

A. These material site regulations are intended to protect against (protects against is an absolute term and most of the time is unobtainable) Minimize aquifer disturbance, road damage, physical damage to adjacent properties, dust, and, noise, and visual impacts. (See explanation below) Only the conditions set forth in KPB 21.29.050 may be imposed to meet these standards:

1. Protects against Minimizes the lowering of water sources serving other properties;

2. Protects against Minimizes physical damage to [OTHER] adjacent properties;

3. [MINIMIZES] Protects against off-site movement of dust;

4. [MINIMIZES] Protects against noise disturbance to other properties;

5. [MINIMIZES] Protects against visual impacts of the material site; [AND] (visual impacts implies the taking of visual rights from one citizen and giving to another. I have done extensive research on this and found the KPB just doesn't have the authority. Keeping this language puts the KPB at risk of litigation.)

6. Provides for alternate post-mining land uses[.];

7. Protects Minimizes Receiving Waters against adverse effects to fish and wildlife habitat;

8. Minimizes Protects against traffic impacts; and

9. Provides consistency with the objectives of the Kenai Peninsula Borough Comprehensive Plan and other applicable planning documents. (Possible Zoning)

21.29.050. Permit conditions.

A. The following mandatory conditions apply to counter permits and CLUPs issued for sand, gravel or material sites:

1. *[PARCEL]Permit boundaries.* [ALL BOUNDARIES OF THE SUBJECT PARCEL] The buffers and any easements or right-of-way abutting the proposed permit area shall be staked at sequentially visible intervals where parcel boundaries are within 300 feet of the excavation perimeter. Field verification and staking will require the services of a professional land surveyor or site operator. Stakes shall be in place [AT TIME OF APPLICATION] prior to issuance of the permit. (Many site operators have GPS capability accurate to +/- 1".)

operators typically know coordinates of prop. boundary lines, etc.

[2. *BUFFER ZONE.* A BUFFER ZONE SHALL BE MAINTAINED AROUND THE EXCAVATION PERIMETER OR PARCEL BOUNDARIES. WHERE AN EASEMENT EXISTS, A BUFFER SHALL NOT OVERLAP THE EASEMENT, UNLESS OTHERWISE CONDITIONED BY THE PLANNING DIRECTOR OR PLANNING COMMISSION.

A. THE BUFFER ZONE SHALL PROVIDE AND RETAIN A BASIC BUFFER OF:

I. 50 FEET OF UNDISTURBED NATURAL VEGETATION. OR

II. A MINIMUM TEN SIX-FOOT EARTHEN BERM WITH AT LEAST A 2:1 SLOPE, OR (THIS 10FT BERM IS CONTINGENT ON THE SETTLEMENT OF THE WATER TABLE ACCESS)

III. A MINIMUM SIX-FOOT FENCE.

with a slope not steeper than 2:1

B. A 2:1 SLOPE SHALL BE MAINTAINED BETWEEN THE BUFFER ZONE AND EXCAVATION FLOOR ON ALL INACTIVE SITE WALLS. MATERIAL FROM THE AREA DESIGNATED FOR THE 2:1 SLOPE MAY BE REMOVED IF SUITABLE. STABILIZING MATERIAL IS REPLACED WITHIN 90 DAYS FROM THE TIME OF REMOVAL.

C. THE PLANNING COMMISSION OR PLANNING DIRECTOR SHALL DESIGNATE ONE OR A COMBINATION OF THE ABOVE AS IT DEEMS APPROPRIATE. THE VEGETATION AND FENCE SHALL BE OF SUFFICIENT HEIGHT AND DENSITY TO PROVIDE VISUAL AND NOISE SCREENING OF THE PROPOSED USE AS DEEMED APPROPRIATE BY THE PLANNING COMMISSION OR PLANNING DIRECTOR.

Comply w/ 18AAC 70-SOA water quality Regulations

D. BUFFERS SHALL NOT CAUSE SURFACE WATER DIVERSION WHICH NEGATIVELY IMPACTS ADJACENT PROPERTIES OR WATER BODIES. SPECIFIC FINDINGS ARE REQUIRED TO ALTER THE BUFFER REQUIREMENTS OF KPB 21.29.050(A)(2)(A) IN ORDER TO MINIMIZE NEGATIVE IMPACTS FROM SURFACE WATER DIVERSION. FOR PURPOSES OF THIS SECTION, SURFACE WATER DIVERSION IS DEFINED AS EROSION, FLOODING, DEHYDRATION OR DRAINING, OR CHANNELING. NOT ALL SURFACE WATER DIVERSION RESULTS IN A NEGATIVE IMPACT.

E. AT ITS DISCRETION. THE PLANNING COMMISSION MAY WAIVE BUFFER REQUIREMENTS WHERE THE TOPOGRAPHY OF THE PROPERTY OR THE PLACEMENT OF NATURAL BARRIERS MAKES SCREENING NOT FEASIBLE OR NOT NECESSARY. BUFFER REQUIREMENTS SHALL BE MADE IN CONSIDERATION OF AND IN ACCORDANCE WITH EXISTING USES OF ADJACENT PROPERTY AT THE TIME OF APPROVAL OF THE PERMIT. THERE IS NO REQUIREMENT TO BUFFER THE MATERIAL SITE FROM USES WHICH COMMENCE AFTER THE APPROVAL OF THE PERMIT.]

2. *Buffer Area.* Material sites shall maintain buffer areas in accord with this section.

a. A buffer area of a maximum of 100 feet shall be established between the area of excavation and the parcel boundaries. The buffer area may include one or more of the following: undisturbed natural vegetation, (Historically, choosing the *natural vegetation buffer has almost always ended with both* neighbors disappointed. The home owner doesn't realize that the forest isn't very dense and can see and hear the material operation.) a minimum six-foot fence, a minimum six-foot berm or a combination thereof. (The berms are historically the best tool. Does a great job of minimizing the dust and noise, as well as providing a visual screen. A ten-foot berm will add 280% more in size and reclaimable material stored for later use in reclamation.)

b. A 2:1 slope shall be maintained between the buffer zone and excavation floor on all inactive site walls. Material from the area designated for the 2:1 slope may be removed if suitable, stabilizing material is replaced within 90 30days from the time of removal. (30 days may not be enough time to move the amount of material)

c. Where an easement exists, a buffer shall not overlap the easement, unless otherwise conditioned by the planning commission or planning director, as applicable. (Basically, stacking buffers)

d. The buffer area may be reduced where the planning commission or planning director, as applicable, has approved an alternate buffer plan introduced by the applicant. (This is necessary to clarify that the planning commission or director cannot make an alternate plan at will) The alternate buffer plan must consist of natural undisturbed vegetation, or a minimum ten six-foot berm, or a minimum six-foot fence or a combination thereof, consisting of only one option in a single geographical location; (prevents stacking of buffers, and provides consistency in permit requirements) unless the permittee proposes another solution approved by the planning commission or planning director, as applicable, to meet this condition.

e. The buffer requirements may be waived by the planning commission or planning director, as applicable, where the topography of the property or the placement of natural barriers makes screening not feasible or unnecessary.

f. There is no requirement to buffer a material site from uses that commence after approval of the permit.

g. When a buffer area has been denuded prior to review of the application by the planning commission or planning director revegetation may be required. (Could be a lot cleared years before or an old wildfire site)

3. *Processing.* In the case of a CLUP, any equipment which conditions or processes material must be operated at least 300 feet from the parcel boundaries. At its discretion, the planning commission may waive the 300-foot processing distance requirement, or allow a lesser distance in consideration of and in accordance with existing uses of [OF ADJACENT PROPERTY AT THE TIME] the properties in the vicinity at the time of approval of the permit. (Until vicinity is better defined, we can't consider this)

4. *Water source separation.*

Drinking water source? — min 200' for Public well/source

a. All permits shall be issued with a condition which prohibits any material extraction within 100 horizontal feet of any water source existing prior to original permit issuance.

b. All counter permits shall be issued with a condition which requires that an excavation distance of 15 feet below the seasonal high-water table must be maintained under these conditions:
1. No dewatering is allowed.
2. The bottom of excavation must be 15 feet above the nearest, shallowest private wells intake, within 500 ft of operation.
3. A spill response kit. — see 18 AAC 80.1990(4)
4. Operations shall not breach an aquifer-confining layer.
A four-foot vertical separation [FROM]between extraction operations and the seasonal high-water table be maintained. (I have talked with multiple hydrologists and engineers and have come to a conclusion that this is not only possible, but preferable in regard to reclamation, spill response and potential clean up. I will have letters of opinion in favor. The ponds or lakes created will be reclaimed upon existence, provide habitat for wetlands and wildlife, potentially raise property values as lake front property, etc.)

Who provides the adjacent well information? How is it obtained? What if an adjacent property owner refuses to give that info? Well drillers will not provide a Log for someone's well w/o owner's approval - especially in a contested situation.

The above seems conflicting — Allows operator to excav. 15' into GWT but requires a 4' vert separation to GWT?

c. All CLUPS shall be issued with a condition which requires that a [TWO] four-foot vertical separation [FROM]between extraction operations and the seasonal high-water table be maintained. (Null and void if minimum water table excavation regulation is considered)

d. There shall be no dewatering either by pumping, ditching or some other form of draining unless an exemption is granted by the planning commission. The exemption for dewatering may be granted if the operator provides a statement under seal and supporting data from a duly licensed and qualified impartial civil engineer, that the dewatering will not lower any of the surrounding property's water systems and the contractor posts a bond for liability for potential accrued damages.

5. *Excavation in the water table.* Excavation in the water table greater than 15 vertical 300 horizontal feet of a water source may be permitted with the approval of the planning commission based on the following: (15 vertical feet is better measurement if minimum water table excavation regulation is considered)

Again; Need to look at 18AAC 80.015

a. Certification by a qualified independent civil engineer or professional hydrogeologist that the excavation plan will not negatively impact the quantity of an aquifer serving existing water sources.

b. The installation of a minimum of three water monitoring tubes or well casings as recommended by a qualified independent civil engineer or professional hydrogeologist adequate to determine flow direction, flow rate, and water elevation.

c. Groundwater elevation, flow direction, and flow rate for the subject parcel, measured in three-month intervals by a qualified independent civil engineer or professional hydrogeologist, for at least one year prior to application. Monitoring tubes or wells must be kept in place, and measurements taken, for the duration of any excavation in the water table.

Any testing required for down gradient well? If test W.Q. is not required, what is the purpose of a well?

d. Operations shall not breach an aquifer-confining layer.

6. *Waterbodies.*

a. An undisturbed buffer shall be left and no earth material extraction activities shall take place within [100] 200 linear feet from excavation limits and the ordinary high water level

If I owned a large Gravel extraction operation, I would want an accurate GW Flow study with background W.Q. test results to protect me from False Contamination Claims.

of surface water bodies such as a lake, river, stream, [OR OTHER WATER BODY, INCLUDING] riparian wetlands and mapped floodplains as defined in KPB 21.06. This regulation shall not apply to ponds less than one acre on private land, man-made waterbodies being constructed during the course of the materials extraction activities. In order to prevent discharge, diversion, or capture of surface water, an additional setback from lakes, rivers, anadromous streams, and riparian wetlands may be required. (Again, we can not trust the current adopted wetland mapping. It has been found incorrect. Also, we would like to manipulate and possibly enlarge waterbodies within private land. Promoting wetland expansion and environmental habitat.)

b. Counter permits and CLUPS may contain additional conditions addressing surface water diversion.

Containment Areas are Problematic bk they Collect water that will prob. have a sheen - then what?

7. *Fuel storage.* Fuel storage for containers larger than 50 gallons shall be contained in impermeable berms and basins capable of retaining 110 percent of storage capacity to minimize the potential for uncontained spills or leaks. Fuel storage containers 50 gallons or smaller shall not be placed directly on the ground, but shall be stored on a stable impermeable surface. Double wall tanks are also acceptable. (Double wall tanks are an acceptable standard for many other agencies)

8. *Roads.* Operations shall be conducted in a manner so as not to damage borough roads as required by KPB 14.40.175 and will be subject to the remedies set forth in KPB 14.40 for violation of this condition.

9. *Subdivision.* Any further subdivision or return to acreage of a parcel subject to a conditional land use or counter permit requires the permittee to amend their permit. The planning director may issue a written exemption from the amendment requirement if it is determined that the subdivision is consistent with the use of the parcel as a material site and all original permit conditions can be met.

10. *Dust-control.* Dust suppression is required on haul roads within the boundaries of the material site by application of water or calcium chloride.

11. *Hours of operation.* [ROCK CRUSHING EQUIPMENT SHALL NOT BE OPERATED BETWEEN 10:00 P.M. AND 6:00 A.M.]

a. Processing equipment shall not be operated between 10:00 7:00 p.m. and 6:00 a.m. (Construction season is short and processing operations are usually job specific. This puts a burden on development at all levels and can extend the length of days on a job that effects public safety.)

b. The planning commission may grant exceptions to increase the hours of operation and processing based on surrounding land uses, topography, screening the material site from properties in the vicinity and conditions placed on the permit by the planning commission to mitigate the noise, dust and visual impacts caused by the material site.

12. *Reclamation.*

a. Reclamation shall be consistent with the reclamation plan approved by the planning commission or planning director as appropriate in accord with KPB 21.29.060.

b. [AS A CONDITION OF ISSUING THE PERMIT, THE APPLICANT SHALL SUBMIT A RECLAMATION PLAN AND POST A BOND TO COVER THE ANTICIPATED RECLAMATION COSTS IN AN AMOUNT TO BE DETERMINED BY THE PLANNING DIRECTOR. THIS BONDING REQUIREMENT SHALL NOT APPLY TO SAND, GRAVEL OR MATERIAL SITES FOR WHICH AN EXEMPTION FROM STATE BOND REQUIREMENTS FOR SMALL OPERATIONS IS APPLICABLE PURSUANT TO AS 27.19.050.] The applicant shall operate the material site consistent with the approved reclamation plan and provide bonding pursuant to 21.29.060(B). This bonding requirement shall not apply to sand, gravel or material sites for which an exemption from state bond requirements for small operations is applicable pursuant to AS 27.19.050.

13. *Other permits.* Permittee is responsible for complying with all other federal, state and local laws applicable to the material site operation, and abiding by related permits. These laws and permits include, but are not limited to, the borough's flood plain, coastal zone, and habitat protection regulations, those state laws applicable to material sites individually, reclamation, storm water pollution and other applicable Environmental Protection Agency (EPA) regulations, clean water act and any other U.S. Army ~~Corp of Engineer permits, any EPA~~ air quality regulations, EPA and ADEC air and water quality regulations, EPA hazardous material regulations, U.S. Dept. of Labor Mine Safety and Health Administration (MSHA) regulations (including but not limited to noise and safety standards), and Federal Bureau of Alcohol, Tobacco and Firearm regulations regarding using and storing explosives. Any violation of these regulations or permits reported to

or observed by borough personnel will be forwarded to the appropriate agency for enforcement.

14. [*VOLUNTARY]Volunteered permit conditions.* Conditions may be included in the permit upon agreement of the permittee and approval of the planning commission for CLUPs or the planning director for counter permits. Such conditions must be consistent with the standards set forth in KPB 21.29.040(A). Planning commission approval of such conditions shall be contingent upon a finding that the conditions will be in the best interest of the borough and the surrounding property owners. [VOLUNTARY] Volunteered permit conditions apply to the subject parcel and operation, regardless of a change in ownership. A change in [VOLUNTARY] volunteered permit conditions may be proposed [AT] by permit [RENEWAL OR AMENDMENT] modification.

15. *Signage.* For permitted parcels on which the permittee does not intend to begin operations for at least 12 months after being granted a conditional land use permit, the permittee shall post notice of intent on parcel corners or access, whichever is more visible. Sign dimensions shall be no more than 15" by 15" and must contain the following information: the phrase "Permitted Material Site" along with the permittee's business name and a contact phone number.

16. *Appeal.* No clearing of vegetation shall occur within the 50 100-foot maximum buffer area from the permit boundary nor shall the permit be issued or operable until the deadline for the appeal, pursuant to KPB 21.20, has expired. (No need for this regulation as the natural vegetative buffer is not and should not be a best choice. If the need for additional buffing is required, the ten foot berm will suffice.)

17. *Sound level.*

    a. No sound resulting from the materials extraction activities shall create a sound level, when measured at or within the property boundary of the adjacent land, that exceeds 75 dB(A).

    b. For any sound that is of short duration between the hours of 7 a.m. and 7 p.m. the levels may be increased by:

        i. Five dB(A) for a total of 15 minutes in any one hour; or

        ii. Ten dB(A) for a total of five minutes in any hour; or

        iii. Fifteen db(A) for a total of one and one-half minutes in any one-hour period.

c. At its discretion, the planning commission or planning director, as applicable, may reduce or waive the sound level requirements on any or all property boundaries. Sound level requirements shall be made in consideration of and in accordance with existing uses of the properties in the vicinity at the time of approval of the permit.

d. Mandatory condition KPB 21.29.050(A)(17) shall expire 365 days from adoption of KPB 21.29.050(A)(17) unless extended or modified by the assembly.
(There is no science behind this. Almost every instance, it will be impossible to achieve with OSHA and MSHA standards. Also, will be further managed by the introduction of larger 10ft berms)

18. *Reverse signal alarms.* Reverse signal alarms, used at the material site on loaders, excavators, and other earthmoving equipment may shall be more technically advanced devices; such as, a multi-frequency "white noise" alarms rather than the common, single (high-pitch) tone alarms. At its discretion, the planning commission or planning director, as applicable, may waive this requirement or a portion of this requirement. The waiver of this requirement shall be made in consideration of and in accordance with existing uses of the properties in the vicinity at the time of approval of the permit. (May is the proper term and gives flexibility)

19. *Ingress and egress.* The planning commission or planning director may determine the points of ingress and egress for the material site. The permittee is not required to construct haul routes outside the parcel boundaries of the material site. Driveway authorization must be acquired, from either the state through an "Approval to Construct" or a borough road service area as appropriate, prior to issuance of a material site permit when accessing a public right-of-way. (This can only be instituted with strict standards and limitations of the planning commissions discretionary power. As written, it gives the planning commission discretion at will in an area of construction that they don't have the expertise.)

20. *Dust suppression.* Dust suppression may shall be required when natural precipitation is not adequate to suppress the dust generated by the material site traffic on haul routes within property boundaries. Based on surrounding land uses the planning commission or planning director, as applicable, may waive or reduce the requirement for dust suppression on haul routes within property boundaries. (As explained before)

21. *Surface water protection.* Use of surface water protection measures as specified in KPB 21.29.030(A)(8) must be approved by a licensed civil engineer or SWPPP certified individual.

what's the purpose of the monitoring well? is it (are they?) downgradient? monitoring? Testing?

22. *Groundwater elevation.* All material sites must maintain one monitoring tube per ten acres of excavated area four feet below the proposed excavation. (This will be unnecessary as the material site will be digging in the water table or unable to reach it and not effecting its formation.)

23. *Setback.* Material site excavation areas shall be 250-feet from the property boundaries of any local option zoning district, existing public school ground, private school ground, college campus, child care facility, multi-purpose senior center, assisted living home, and licensed health care facility. If overlapping, the buffer areas of the excavation shall be included in the 250-foot setback. At the time of application. (This gives consistency in the regulation)

21.29.055. Decision.

The planning commission or planning director, as applicable, shall approve permit applications meeting the mandatory conditions or shall disapprove permit applications that do not meet the mandatory conditions. The decision shall include written findings supporting the decision, and when applicable, there shall be written findings supporting any site-specific alterations to the mandatory condition as specifically allowed by KPB 21.29.050(A)(2)(a), (2)(c), (2)(d), (2)(e), (2)(g), (3), (4)(d), (5), (11)(b), (12), (14), (17)(c), (18), (19), and (20) and as allowed for the KPB 21.29.060 reclamation plan. (This is written that the planning commission will disapprove of applications that do not meet the mandatory conditions. It contradicts many previous languages that gives the planning commission discretion to approve applications that may need special modifications.)

21.29.060. Reclamation plan.

A. All material site permit applications require an overall reclamation plan along with a five-year reclamation plan. A site plan for reclamation shall be required including a scaled drawing with finished contours. A five-year reclamation plan must be submitted with a permit extension request. (Why the need for a five-year reclamation plan? As site operators, we cannot foresee the market in a five-year span, therefore, cannot provide an accurate plan for five years.)

B. The applicant may shall revegetate with a non-invasive plant species and reclaim all disturbed land (There are many ways to reclamation. This limits it to one method) [UPON EXHAUSTING THE MATERIAL ON-SITE, OR WITHIN A