STATE OF ALASKA
Department of Environmental Conservation
Village Safe Water Program

Request for Statement of Qualifications
VSW-HPB-2019-33

City of Hooper Bay, Alaska
Design Services

Date of Issue: April 12, 2019

Proposal Due Date & Time: May 3, 2019 & 3:00 PM AKST

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On behalf of the City of Hooper Bay, Alaska, the Department of Environmental Conservation (DEC), Village Safe Water (VSW) Program is requesting Statement of Qualifications (SOQ) for Design Services.

The Procurement Officer for this SOQ is:

Pearley M. Bingham, Procurement Officer
Department of Environmental Conservation
Village Safe Water Program
555 Cordova Street, 4th Floor
Anchorage, Alaska 99501
Telephone: 907-334-2638
Email: **DECDASPROCUREMENT@alaska.gov**

1.0 BACKGROUND

Hooper Bay is a community of approximately 1,200 people located in Western Alaska and on the Bering Sea coast. The community currently has a single-cell 5-acre facultative lagoon that was constructed in 1994. Since the completion of the City's water treatment plant, utilidor system and water and sewer service connections in 2006, demand on the lagoon has exceeded what current regulations allow. The aging lagoon is also leaking wastewater at a rate of 20,000 to 25,000 gallons per day through the base of the berm.

In 2018, a Preliminary Engineering Report (PER) was completed for a new lagoon and identified a preferred alternative located north of the existing lagoon in an upland area across the floodway. This location was chosen as it was the only viable option not within the floodway. There are three main components of this project, the lagoon, helical supported access, and the force main.

The 2-cell facultative lagoon is expected to have a 10.6-acre primary cell and an 11-acre secondary cell. Additional geotechnical work will be required in the vicinity of the secondary cell to determine the final design and elevation of the secondary cell.

The helical supported access would need to support a light pickup and trailer (H-5 loading). The length of the floodway crossing would be approximately 3000 LF.

A new force main would be extended to connect the existing system to the new lagoon. The 3,600 LF force main would be part of the helical supported access crossing.

2.0 SCOPE OF SERVICES

The Contractor shall provide the following Design Services for the City of Hooper Bay:

Provide full design services for a 2-cell facultative lagoon complete with access and force main that shall meet State and Federal regulations. This includes conducting any additional geotechnical investigation, topographic surveying, and completing all permitting and site control documentation.

Any contract resulting from this SOQ and Request for Proposals (RFP) may be amended to provide Contract Administration services during construction, including design change approvals, submittal reviews, construction observations, producing record drawings and O&M manuals and processing the documentation for a permit to operate.

The selected firm will not be eligible to compete for the construction management of this scope of work.

Project Tasks, Deliverables and Schedule:

The project task, deliverables and schedule dates will be provided at the RFP stage.

3.0 MINIMUM QUALIFICATIONS AND RELEVANT PROJECT EXPERIENCE

The proposing firm shall be in the business of providing engineering design services for water and wastewater systems in rural Alaska.

The proposing firm shall provide a written narrative in the form of a cover letter with their proposal verifying how the Project Manager meets the minimum qualifications and experience. The project manager must have project management experience overseeing large design or construction projects.

The project manager shall be a current licensed Professional Engineer (P.E.) in the State of Alaska, and have at least five years of design experience as a P.E. in the State of Alaska.

Key Personnel on the Project Team shall *collectively* have the following minimum qualifications:

- Provide **design experience on at least three large facultative lagoons** that are at least 5 acres in size in rural western Alaska;
- Provide project **experience designing foundations in arctic permafrost conditions** on at least three successful large projects exceeding $10 Million;
- Provide a minimum of **three projects involving large earthwork** experience in western Alaska describing seasonal, logistical and equipment challenges managed and overcome;
- Provide **quantity and cost estimating** experience on at least three large civil projects built in rural Alaska describing cost saving measures employed.

This cover letter shall identify and describe the Project Manager and project team, including sub consultants, and summarize the Project Manager's and team's qualifications and relevant project experience. An individual authorized to bind the offeror must sign the letter. The firm must hold a valid Alaska business license.

Proposals that do not meet the minimum qualifications and provide the cover letter requirements shall be deemed non-responsive and disqualified from consideration.

Please include projects that are related to the scope of services in Section 2.0 with your submission. The offeror's proposal will expand on the relevant qualifications and experience of the firm's team by the category scoring breakdown below.

4.0 FORMAT, CONTENT AND EVALUATION SCORING OF SOQ

The SOQ shall follow the format and content requirements described below. The SOQ shall be typed on standard 8.5" X 11" paper, the font shall be no smaller than 12 point and margins shall be at least 1" all the way around the page. The evaluation scores will be on a 100 point scale as defined in this section. All SOQ's will be evaluated and scored using the following criteria and total points basis.

Proposals that do not meet the format and content requirements shall be deemed non-responsive and disqualified from consideration.

Cover Letter = 5 points

Interested firms shall provide a cover letter that identifies and describes the Project Manager and project team, including sub consultants, and summarizes the Project Manager's and team's qualifications and relevant project experience. An individual authorized to bind the offeror must sign the letter.

Limit two pages.

Project Manager and Team Experience = 80 points

Project Manager (40 points)

Describe the qualifications and experience of the proposed Project Manager to complete the scope of services in Section 2.0, showing that he or she meets the minimum qualifications and relevant project experience in Section 3.0.

Relevant Project Manager experience must be identified as follows:

a) Project title;
b) Project description;
c) Project start and end dates;
d) Client name, telephone number and email address.

Limit three pages.

Team Experience (40 points)

Describe example projects which best illustrate the proposed team's qualification to complete this contract scope. Identify key personnel participation in example projects with the following:

a) Personnel by discipline;
b) Project title;
c) Project description;
d) Project start and end dates;
e) Client name, telephone number and email address.

Limit eight pages.

References = 10 points

Provide at least three references for the firm and at least three references for the proposed Project Manager. Information shall include the name, phone numbers, email address and project(s) name for work similar to the project described herein. In addition to these references, VSW reserves the right to check any other available references for evaluating and scoring.

MBE/WBE Preference = 5 points

To receive the points, the qualified Minority Business Enterprise (MBE) or Women's Business Enterprise (WBE) offeror or subcontractor will provide evidence of certification and the work that they will perform. Please refer to Section 6.0 for additional information on the MBE/WBE preference.

Limit one page.

The SOQ evaluation phase will establish the three highest ranking offerors based on the evaluation criteria and points identified in this section. The three highest ranking offerors will be short-listed and receive a RFP. Only the three short-listed offerors will receive the RFP.

5.0 SOQ QUESTIONS

Questions regarding this SOQ shall be addressed in writing (email preferred) to the Procurement Officer.

The deadline for submission of questions is April 22, 2019 at 3:00 PM Alaska Time. This will allow time for an amendment to be issued if one is required. It will also help prevent the opening of a defective proposal.

6.0 MBE/WBE PREFERENCE

To receive the points, the qualified Minority Business Enterprise (MBE) or Women's Business Enterprise (WBE) Contractor or subcontractor must provide evidence of certification and the work that they shall perform.

Minority Business Enterprise (MBE) and Women's Business Enterprise (WBE)

This procurement is funded in part or fully through federal grants or cooperative agreements. It is a national policy to award a fair share of contracts to Minority Firms and Women's Business Enterprises through affirmative action. The negotiated Federal "Fair Share" percentage for **fiscal years 2018 through 2019** is 3.67% MBE and 1.54% WBE. This solicitation incorporates a five point preference for all qualified minority firms and women's business enterprises.

In order to be deemed a bona fide Minority Business Enterprise (MBE) or Women's Business Enterprise (WBE) a firm must be an independent business concern which is a least fifty-one percent (51%) owned and controlled by minority group members or women.

It is the responsibility of the offeror to include in their proposal their qualifications and/or of the qualifications of their subcontractors for this preference. It is also the responsibility of the offeror claiming eligibility for this preference to pledge in their proposal that the eligible subcontractor will be **guaranteed** at least 5.21% of the proposed work.

Following is an example of how the preference points will be calculated for qualifying businesses:

MBE/WBE Offeror's Preference

[STEP 1]
Determine the number of points available to MBE/WBE eligible offerors under this preference.

Total number of points available in this example situation = 100 Points

100 x	5%	=	5
Total Points	MBE/WBE Offeror's Percentage Preference		Number of Points Available to Eligible Offerors Under MBE/WBE Preference

[STEP 2]
Add the preference points to the qualified MBE/WBE SOQ's. In a hypothetical situation, there are three (3) offerors. After being evaluated, each received the following points:

Offeror #1 95 points
Offeror #2 90 points
Offeror #3 92 points

Before preference points are calculated, offeror #1 is the apparent winner. However, in this hypothetical situation, offeror #2 and offeror #3 are eligible for the MBE/WBE preference. After adding five points to their scores, offeror #3 is the new apparent winner, with 97 points.

7.0 ASSISTANCE TO OFFERORS WITH A DISABILITY

Offerors with a disability may receive accommodation regarding the means of communicating this SOQ or participating in the procurement process. For more information, contact the Procurement Officer no later than five calendar days prior to the deadline for receipt of SOQ's.

8.0 SUBMITTAL INFORMATION AND SCHEDULE

Offerors shall submit an original signature paper version of the completed SOQ with three paper copies and one electronic version on CD/ or DVD.

SOQ's shall be received on May 3, 2019 by no later than 3:00 PM Alaska time. Faxed, oral or emailed SOQ's are not acceptable. SOQ's submitted after the deadline established for submitting SOQ's shall be deemed non-responsive and disqualified from consideration.

SOQ's shall be submitted to the address below:
Department of Environmental Conservation
Village Safe Water Program
Attn: Pearley M. Bingham, Procurement Officer
SOQ # VSW-HPB-2019-33
555 Cordova Street, 4th floor
Anchorage, Alaska 99501

SOQ/RFP Schedule:

Below is the schedule for this solicitation. If any of the dates are changed, the other dates will change accordingly:

Issue Request for SOQ's	April 12, 2019
SOQ question submission deadline	April 22, 2019, 3:00 PM AKST
SOQ submission deadline	May 3, 2019 3:00 PM AKST
Short-list three offerors approximately	Week of May 6, 2019
Issue RFP approximately	Week of May 13, 2019

9.0 PROTEST PROCEDURE Similar to AS 36.30.550 provides that an interested party may protest the content of the solicitation.

An interested party is defined in 2 AAC 12.990(a) (7) as "an actual or prospective bidder or offeror whose economic interest might be affected substantially and directly by the issuance of a contract solicitation, the award of a contract, or the failure to award a contract."

An interested party must first attempt to informally resolve the dispute with the procurement officer. If that attempt is unsuccessful, the interested party may submit a written protest. Written protest must include the following information:

- The name, address, and telephone number of the protester;
- The signature of the protester or the protester's representative;
- Identification of the contracting agency and the solicitation or contract at issue;
- A detailed statement of the legal and factual grounds of the protest including copies of relevant documents; and the form of relief requested.

All protests will be submitted to and responded to by the Procurement Officer IV as the protest decision authority. The appeal of a protest decision will be submitted to and responded to by the Procurement Officer IV and VSW Program Manager as the appeal decision authority. The appeal decision authority is the final decision and cannot be protested further. If protesting a solicitation document including the content of a specification, the protest must be filed with the Procurement Officer no later than **four** business days before quotations, bids, or proposals are due. Within **one** business day of receiving the protest, the Procurement Officer shall provide notice of the protest to all firms or persons that received the solicitation.

If protesting a decision to cancel a solicitation or the award of a purchase or contract, the protest shall be filed with the Procurement Officer within 10 calendar days of the date of the written Notice of

Cancellation or Notice of Award. The deadline date cannot end on a weekend or state holiday. Within **one** business day of receiving the protest, the Procurement Officer shall provide notice of the protest to all firms or persons that received the solicitation and will acknowledge receipt of the protest. After protest receipt, the Procurement Officer shall take one of the following actions within 15 calendar days:

a) Issue a written decision denying the protest including the specific reasons for the denial;
b) Issue a written decision sustaining the protest in whole or in part and implementing an appropriate remedy.

If the protester is not satisfied with the protest decision, they may appeal the protest decision to the VSW Program Manager. The written appeal must be filed within 10 calendar days of the date of the protest decision. The deadline date cannot end on a weekend or state holiday. The appeal shall not raise any new issues that were not included in the written protest. An informal hearing on the protest appeal may be conducted by the VSW Program Manager to attempt to resolve the dispute. A written appeal decision on the appeal will be issued as follows:

a) Issue a written decision denying the appeal; citing the specific reasons for the denial;
b) Issue a written decision sustaining the appeal in whole or in part and implementing an appropriate remedy.

10.0 FEDERAL DEBARMENT CERTIFICATION AND BYRD ANTI-LOBBYING AMENDMENT

Expenditures from a contract resulting from this solicitation may involve federal funds. The U.S. Department of Labor requires all state agencies that are expending federal funds to have a certification filed in the proposal (by the offeror) that they have not been debarred or suspended from doing business with the federal government. Certification regarding debarment, suspension, ineligibility and voluntary exclusion lower tier covered transactions must be completed and submitted by the contractor to the Procurement Officer prior to being "short listed" and advancing to the RFP process (Appendix B: Federal Debarment Certification Form).

The Contractor agrees to comply with all requirements of the Byrd Anti-Lobbying Amendment (31 U.S.C 1352). A certification must be completed and submitted to the Procurement Officer prior to being "short listed" and advancing to the RFP process (Appendix C: Certification and Disclosure Regarding Payments to Influence Certain Federal Transactions).

APPENDICES:

Appendix A: General Provisions (10 pages).
Appendix B: Federal Debarment Certification Form (two pages).
Appendix C: Certification and Disclosure Regarding Payments to Influence Certain Federal Transactions (three pages).

ATTACHMENTS

Attachment One: Wastewater Lagoon Preliminary Engineering Report (117 pages).

APPENDIX A

GENERAL PROVISIONS

Article A1. Payments to Contractor

A1.1: No payment will be made for services performed or materials furnished prior to the contract being signed by both the community and the contractor, or for services or materials not included within Appendix B. At least five percent of the total amount of the contract, including amendments, will be retained until all work stated in the contract including amendments is satisfactorily completed and approved by the Alaska Department of Environmental Conservation, Village Safe Water (VSW) Program.

A1.2: In all cases, the contractor shall be liable for cost overruns (*i.e.*, where the total cost for materials and labor to complete the work as detailed in Appendix B exceeds the total compensation amount stated in Appendix C or as provided for in a written amendment to this contract). It is the contractor's responsibility to budget appropriately to allow for completion of all work within the total agreed upon compensation amount. If, due to unforeseen and unavoidable circumstances, the contractor determines that costs for labor or materials shall exceed the total compensation amount, VSW may work with the contractor to amend the contract as needed.

> **A1.2.1**: Payment shall be on either a fixed fee basis or a time and materials basis, as described in Appendix C.
>
> **A1.2.2**: For payment on a fixed fee basis: Payment shall be made in accordance with the payment schedule as outlined in Appendix C. Payment will be made only after services or materials are received by the community and approved by VSW.
>
> **A1.2.3**: For payment on a time and materials basis: The contractor shall prepare written invoices for all labor and materials furnished in furtherance of this contract. All invoices must be submitted to and approved by VSW. Payment shall be made in accordance with Appendix C and only after services or materials detailed on an invoice are received by the community and approved by VSW. In no case shall the sum of payments exceed the total compensation amount identified under Appendix C unless a written amendment to this contract has been agreed upon and signed by both the community and the contractor. In the event that items on an invoice are disputed, payment on the disputed items only will be withheld until the dispute is resolved.

A1.3: Only items identified on the contractor's fee estimate are eligible to be marked up once by the percentage specified. Billings submitted by the contractor that include items that have been marked up more than once will be adjusted for the correct single mark up. This contract does not allow an item to be marked up once by the subcontractor, and then again by the primary contractor, thus, no "double mark ups" are allowed.

A1.4: All services are subject to inspection and approval by VSW. If a service is found to be unacceptable (unacceptable is defined as not completed per the work order scope of services and not in accordance with Article 16. Professional Standards), the contractor shall be required to make necessary modifications to correct the deficiencies at no additional cost to the community or VSW.

The contractor shall not unreasonably withhold such corrections. Substantial failure of the contractor to perform required corrections may cause VSW to terminate the work order. If the community or VSW suffers damages associated with the unacceptable service, the community or VSW may seek compensation for these damages.

A1.5: This contract does not allow an item to be marked up once by the subcontractor, and then again by the primary contractor, thus, no "double mark ups" are allowed. Pursuant to requirements of the Federal Government's OMB Circular A-87 regarding allowable costs, all direct costs related to travel by the contractor and its subcontractors are subject to the State of Alaska per diem rates as described in AAM 60 (Travel) unless otherwise stated in the contract.

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Article A2. Indemnification

The contractor shall indemnify, hold harmless, and defend the community from and against any claim of, or liability for error, omission or negligent act of the contractor under this agreement. The contractor shall not be required to indemnify the community for a claim of, or liability for, the independent negligence of the community. If there is a claim of, or liability for, the joint negligent error or omission of the contractor and the independent negligence of the community, the indemnification and hold harmless obligation shall be apportioned on a comparative fault basis. "contractor" and "community", as used within this and the following insurance articles of this contract, include the employees, agents and other contractors who are directly responsible, respectively, to each. The term "independent negligence" is negligence other than in the community's selection, administration, monitoring, or controlling of the contractor and in approving or accepting the contractor's work.

Article A3. Insurance

Without limiting contractor's indemnification, it is agreed that contractor shall purchase at its own expense and maintain in force at all times during the performance of services under this contract the following policies of insurance. Where specific limits are shown, it is understood that they shall be the minimum acceptable limits. If the contractor's policy contains higher limits, VSW shall be entitled to coverage to the extent of such higher limits. Certificates of Insurance must be furnished to VSW prior to beginning work and must provide for a 30 day prior notice of cancellation, non-renewal or material change of conditions. Failure to furnish satisfactory evidence of insurance or lapse of the policy is a material breach of this contract and shall be grounds for termination of the contractor's services. All insurance policies shall comply with and be issued by insurers licensed to transact the business of insurance under AS.21.

A3.1 Workers' Compensation Insurance: The contractor shall provide and maintain, for all employees engaged in work under this contract, coverage as required by AS.23.30.045, and where applicable, any other statutory obligations including but not limited to Federal U.S.L. & H. and Jones Act requirements. **The policy must waive subrogation against the State of Alaska.** The coverage shall include:

- Employer's Liability Protection at $500,000 each accident/each employee and $500,000 policy limit

A3.2 Commercial General Liability Insurance: The contractor shall provide and maintain coverage for all business premises and operations used by the contractor in the performance of

services under this contract with minimum combined single limit coverage per the following schedule:

- $1,000,000 each occurrence
- $1,000,000 personal injury
- $1,000,000 general aggregate
- $1,000,000 products completed operations aggregate

The State of Alaska shall be named as an additional insured.

A3.3 Commercial Automobile Liability Insurance: The contractor shall provide and maintain coverage for all vehicles used by the contractor in the performance of services under this contract with minimum coverage limits of $1,000,000 combined single limit per occurrence.

A3.4 Professional Liability Insurance: The contractor shall provide and maintain coverage covering all errors, omissions or negligent acts in the performance of professional services under this contract. Limits required per the following schedule:

Contract Amount	Minimum Required Limits
Under $100,000	$300,000 per claim/annual aggregate
$100,000-$499,999	$500,000 per claim/annual aggregate
$500,000-$999,999	$1,000,000 per claim/annual aggregate
$1,000,000 or over	Refer to Risk Management

Article A4. Inspection and Reports

A4.1: VSW shall have the right to inspect, in such a manner and at all reasonable times deemed appropriate, all activities of the contractor arising in the course of contractor's performance of services under this contract.

A4.2: The contractor shall report progress in writing on a monthly basis, or other mutually agreeable basis, in such a manner as VSW's designated representative may reasonably require.

Article A5. Contract Compliance and Cure Notice

VSW reserves the right, without limitation, to monitor, audit, assess, or conduct oversight of the contractor's performance of and compliance with the terms and conditions of this contract. Contract compliance and performance audits shall be conducted in accordance with VSW practices.

In the event the contractor is not in compliance with the contract terms and conditions, either in part or in whole, VSW will provide written notice to the contractor to cure all instances of non-compliance or deficiencies. The contractor shall respond in writing or via email to the VSW that it has received the written notice of non-compliance or deficiency within 24 hours of the date of the notification by VSW. The contractor shall cure, or to the VSW's satisfaction make substantial progress towards remedy of, all instances of non-compliance or deficiencies within 30 calendar days from the date of written notification of non-compliance or deficiencies by VSW.

If the contractor fails to cure or make substantial progress towards remedy of, the instances of non-

compliance or deficiencies within the time frame above, VSW may determine the contractor to be in breach and will pursue remedial action as described in Article A7 (Remedial Action).

Article A6. Disputes

A6.1: Except as otherwise provided in this contract, any dispute concerning a question of fact arising under this contract which is not disposed of by agreement shall be decided by the Commissioner of the Alaska Department of Environmental Conservation, hereafter called the Commissioner, provided the resolution of such dispute be limited to the specified funds appropriated for the services to be performed under this contract. The Commissioner shall furnish a written decision to both the community and the contractor. The decision of the Commissioner or the Commissioner's duly authorized representative shall be final, unless within 30 days from the date of the decision, the contractor or VSW delivers a written appeal of the decision to the Commissioner. Upon receipt of an appeal, the parties involved may agree to have the dispute settled byarbitration.

A6.2: If the contractor has a claim arising in connection with the contract that it cannot resolve with VSW by mutual agreement, it shall pursue the claim, if at all, in accordance with the provisions of AS 36.30.620 – AS 36.30.632. To the extent not otherwise governed by the preceding, the claim shall be brought only in the Superior Court of the State of Alaska and not elsewhere.

Article A7. Remedial Action

In addition to any remedies available to VSW under law or equity, VSW at its sole discretion may require one or more of the following remedial actions if the contractor fails to cure findings of breach, or as otherwise provided for herein:

1. VSW may take reasonable steps to provide for such cure and may offset the costs of such cure against the contract pricing in effect at the time of occurrence of abreach;

2. Reduce and/or offset payment to reflect the reduced value of servicesreceived;

3. Require the contractor to subcontract all or part of the service at the contractor's solecost;

4. Withhold payment or require payment of actual damages caused by a breach;or

5. Terminate the contract pursuant to Article A8 (Termination).

Withholding of payment by VSW for the failure of the contractor to perform shall not relieve the contractor from its obligations under the contract and shall not be a basis for termination by the contractor under Article A8 (Termination).

Article A8. Termination

A8.1: Termination for Convenience: VSW may also at any time for good cause, terminate this contractual agreement or suspend performance under the contract. This shall include, but is not limited to, such reasons as VSW being unable to obtain adequate funding for the project or the community no longer requiring the facilities. The contractor will be given written notice of termination at least 30 days prior to the date of termination.

A8.2: Termination for Cause: The occurrence of any of the following events shall be an event of

default under the contract and cause for termination: 1) A material breach of any term or condition of the contract; 2) Any representation or warranty by Contractor in its quote, bid or proposal that proves to be untrue or materially misleading; 3) Any default or non-compliance as otherwise specified in the contract.

VSW may terminate the contract if VSW provides the Contractor written notice of default and the Contractor has failed to cure the default within 30 calendar days. If VSW terminates the contract for default, VSW reserves the right to take any action it may deem necessary including, without limitation:

1. Exercise any remedy provided by law or equity.

2. Withhold payment until the default is remedied.

3. Offset of damages against payment due.

A8.3: In the event of termination or suspension of performance by VSW under this contract, VSW will compensate the contractor as follows:

a) Contracts with payment on a time and materials basis: Contractor will be compensated for authorized and approved services and expenditures performed in good faith until the date of receipt of final written notice of termination or suspension.

b) Contracts with payment on a fixed-fee basis: VSW shall choose to either 1) compensate the contractor using the method as described above for time and materials based contracts (but only if supported by sufficient documentation); or 2) pay the contractor a percentage of the total compensation under this contract equal to the percentage of work completed as of the date of receipt of written notice of termination or suspension and that can be substantiated in whole or part by the contractor to VSW's satisfaction.

A8.4: VSW may deduct from the compensation as detailed above the amount of any damages incurred by VSW as a result of the contractor failing to perform in substantial conformance with this contract or any delay caused by such breach.

A8.5: If VSW is terminating or suspending the contract for reasons unrelated to contractor's actions (*e.g.*, loss of funding for the project), VSW shall pay the contractor for reasonable costs directly related to the termination or suspension of the contract. No fee or other compensation for the uncompleted portion of the services will be paid with the exception that VSW may pay costs already incurred by the contractor, which the contractor can establish, and which would have been compensated for over the life of the contract, but because of termination or suspension would otherwise have to be absorbed by the contractor without further compensation.

A8.6: In the event of termination or suspension under this contract, regardless of the reason or party initiating the termination or suspension, the contractor shall deliver to VSW all work products, reports, estimates, schedules, and other documents and data produced or prepared pursuant to this contract.

Article A9. No Assignment or Delegation

A9.1: The contractor may not assign or delegate this contract, in whole or in part, nor any right to any of the money to be paid under it, except with the written consent of VSW.

A9.2: The contractor may not sublet any part of the work done or material furnished under this contract except with the written consent of VSW unless set forth in the contractor's response to the request for proposals.

Article A10. Changes

A10.1: This contract, including the appendices, may be changed only by written amendment signed by both the community and the contractor. No oral agreements will be considered binding under this contract. All written amendments shall become part of this contract and equal in force to other provisions contained herein.

A10.2: It is expressly understood and agreed that no claim for additional work or materials, done or furnished by the contractor and not specifically herein provided for, will be accepted by VSW unless such work is first ordered in writing by VSW. In no event shall VSW be liable for any materials furnished or used, or for any work or labor done, unless the materials, work, or labor are required by the contract or on written order furnished by VSW. Any such work or materials which may be done or furnished by the contractor without written order first being given shall be at the contractor's own risk, cost, and expense, and the contractor hereby covenants and agrees to make no claim for compensation for work or materials done or furnished outside the scope of services outlined in the contract or without other written order.

A10.3: If at any time, VSW either verbally or in writing requests services or directs contractor to act in a manner that contractor considers outside the scope of services, contractor shall, within 30 days and prior to pursuing such instructions, notify VSW in writing. VSW shall then evaluate, and if appropriate, negotiate an amendment to this contract. Unless so notified by the contractor, VSW shall assume such instructions have not changed any provisions of this contract, including the appendices, and the contractor shall be required to complete work or furnish materials as directed by VSW. No additional payments shall be made to contractor without such notice andamendment.

Article A11. Independent Contractor

The contractor and any agents and employees of the contractor act in an independent capacity and are not officers or employees or agents of VSW in the performance of this contract.

Article A12. Availability of Appropriation

This contract and amendments hereto are subject to approval by VSW and are contingent upon the availability of funds administered by VSW. VSW reserves the right to terminate the contract in part or in whole if, in VSW's sole judgement, funding entities fail, neglect, or refuse to appropriate sufficient funds as may be required for VSW to continue contract payments, or if cuts or holdbacks in spending are mandated, or if funds are not budgeted or otherwise available.

Article A13. Alaska Business License

It is understood and agreed upon that an Alaska Business License (ABL) is required under Alaska statutes and that the contractor will be in the possession of a current ABL during the performance period of this contract.

Article A14. Payment of Taxes

As a condition of performance of this contract, the contractor shall pay all federal, State, and local taxes incurred by the contractor and shall require any party with which the contractor subcontracts to

pay federal, State and local taxes in the performance of this contract. Satisfactory performance of this paragraph is a condition precedent to payment by VSW under this contract.

Article A15. Ownership of Documents

All work products and deliverables, designs, plans, drawings, field notes, surveys, calculations, specifications, cost estimates, summaries, electronic files, reproducible documents, project records and any other work product necessary for or associated with the performance of this contract remain the property of VSW and may be used by VSW for any purpose without additional compensation to the contractor. The contractor shall have no claim for further employment or additional compensation as a result of exercise of these full rights of ownership of all documents and materials produced under this contract.

Any discovery or invention of copyrightable materials developed in the course of or resulting from work carried on under this contract shall be the property of VSW. The contractor agrees not to assert any rights and not to establish any claim under the design patent or copyright laws. If the source of funding for this contract is federal, any applicable federal patent and copyright rules also apply, take precedence and supersede this provision. Rights of use for public purposes of work products and/or intellectual property and/or intangible property under federally assisted projects shall be governed by the provisions of applicable federal OMB Circulars including A-110 and A-102.

The contractor, for a period of six years after the final payment under this contract, agrees to furnish and provide access to all retained materials at the request of VSW. Unless otherwise directed by VSW, the contractor may retain copies of all materials.

Article A16. Professional Standards

The contractor shall furnish services with the care and skill ordinarily used by members of the contractor's profession practicing under similar circumstances. The contractor shall be responsible for the technical accuracy of its services and documents resulting therefrom, and VSW will not be responsible for discovering deficiencies therein. The contractor must correct, without additional compensation, the deficiencies resulting from the contractor's failure to perform such services in accordance with the care and skill practiced under these professional standards. Any dispute concerning said deficiencies shall be decided by a panel of three qualified and experienced professionals practicing under similar circumstances selected by VSW and the contractor. If in dispute during performance under this contract, the applicable professional standard shall be established by a panel of three qualified, impartial professionals objectively selected by VSW and the contractor and within the same occupational field.

Article A17. Legal Expenses

In the event legal action is brought by VSW against the contractor to enforce any of the obligations, terms or conditions of this contract, or arising out of any dispute under this contract, the losing party shall pay the prevailing party such reasonable amounts for fees, costs and expenses as may be set by the presiding court.

Article A18. Survival

All express representations, indemnifications or limitations of liability made or given in this contract will survive the completion of all services of the contractor under this contract or the termination of the contract.

Article A19. Severability
Any provision or any part of this contract or any written amendment hereto that is held to be void or unenforceable under law or regulation shall be deemed stricken, and all remaining provisions shall continue to be valid and binding.

Article A20. Conflicting Provisions
Unless specifically required or approved by VSW and authorized through a written amendment signed by both the community and the contractor, the general provisions of this contract supersede any provisions in other appendices. In the event of a conflict of provisions, the following order of precedence will apply in resolving which provisions control:

1. General Provisions (Appendix A)
2. Scope of work/services (Appendix B)
3. Compensation and Fee Estimate/and Fee Schedule (Appendix C)
4. Solicitation document including all attachments and amendments (Appendix D)
5. Contractor's Proposal including cost and all attachments (Appendix E)

The solicitation documents, contractor's proposal and all appendices listed herein are part of this contract by reference.

Article A21. Governing Law
The contract is governed by the laws of the State of Alaska. All actions concerning this contract shall be brought in the Superior Court of the State of Alaska.

Article A22. Covenant against Contingent Fees
The contractor warrants that no person or agency has been employed or retained to solicit or secure this contract upon an agreement or understanding for a commission, percentage, contingent fee, or brokerage except employees or agencies maintained by the contractor for the purpose of securing business. For the breach or violation of this warranty, VSW may terminate this contract without liability or in its discretion deduct from the contract price or consideration the full amount of the commission, percentage, contingent fee, or brokerage.

Article A23. Key Personnel Changes
The practice of "bait and switch" of the contractor's Project Manager, other key personnel or subcontractors of lesser qualifications and experience is strictly prohibited. Also, the "bait and switch" practice of the contractor completing services instead of the key subcontractor who was originally proposed by the contractor to perform the work is strictly prohibited. If there are any changes to key project team members, personnel replacements shall meet the qualifications and experience of the persons they are replacing. The same applies to any reassignment of key subcontractor services. Requests for any changes shall be made in advance and in writing to VSW for approval. Depending on the seriousness of the violations, VSW may terminate the contract for cause.

Article A24. Clean Air Act and Water Pollution Control Act
The contractor agrees to comply with all requirements of the Clean Air Act (42 U.S.C. 7401-7671q) including section 114 and section 308 of the Water Pollution Control Act (33 U.S.C. 1251-1388).

Article A25. Copeland Anti-Kick Back Act
The contractor agrees to comply with all requirements of the Copeland Anti-Kick Back Act (18 U.S.C.

874 and 40 U.S.C 3145) as supplemented in Department of Labor regulations (29 CFR, Part 3).

Article A26. Solid Waste Disposal Act
The contractor agrees to comply with all requirements of section 6002 of the Solid Waste Disposal Act, as amended by the Resource Conservation and Recovery Act.

Article A27. Clean Water Act
The contractor agrees to comply with all requirements of section 215 (Requirements for American Materials) of the Clean Water Act (33 U.S.C. 1251 et seq.) and implementing EPA regulations. The contractor agrees that preference must be given to domestic construction materials by the contractor, subcontractors, materialmen and suppliers.

Article A28. Contract Work Hours and Safety Standards Act
The contractor agrees to comply with all requirements of the Contract Work Hours and Safety Standards Act (40 U.S.C 3701-3708), as supplemented by the Department of Labor regulations (29 CFR part 5).

Article A29. Equal Employment Opportunity
The contractor agrees to comply with all requirements of Executive Order 11246 (3 CFR, 1966 Comp., p. 339), entitled, "Equal Employment Opportunity," as amended by Executive Order 11375 (3 CFR, 1968 Comp., p. 321), and as supplemented by the Department of Labor regulations 41 CFR chapter 60.

Article A30. Americans with Disabilities Act (ADA) of 1990
The contractor agrees to comply with all requirements of the Americans with Disabilities Act of 1990 (42 U.S.C 12101 et seq.).

Article A31. Civil Rights Act of 1964
The contractor agrees to comply with all requirements of Title VI of the Civil Rights Act of 1964 (42 U.S.C. 2000d et seq.) as outlined in 7 CFR 1901 subpart E.

Article A32. Rehabilitation Act of 1973
The contractor agrees to comply with all requirements of section 504 of the Rehabilitation Act of 1973, as amended (29 U.S.C. 794).

Article A33. Age Discrimination Act of 1975
The contractor agrees to comply with all requirements of the Age Discrimination Act of 1975 (42 U.S.C. 6101 et seq.).

Article A34. Drug Free Workplace Act of 1988
The contractor agrees to comply with all requirements of the regulations implementing Sections 5151-5160 of the Drug Free Workplace Act of 1988 (Pub. L. 100-690, Title V, Subtitle D; 41 U.S.C, 701 et seq.), 7 CFR Part 3017, Subpart F, Section 3017.600, Purpose. The regulations were published as Part II of the January 31, 1989 Federal Register (pages 4947-4952).

Article A35. Byrd Anti-Lobbying Amendment

The contractor agrees to comply with all requirements of the Byrd Anti-Lobbying Amendment (31 U.S.C 1352). A certification **must be completed and submitted prior to award**.

Article A36. Federal Debarment, Suspension, Ineligibility and Voluntary Exclusion

Expenditures from this contract may involve federal funds. The U.S. Department of Labor requires all state agencies that are expending federal funds to have a certification filed in the proposal or bid (by the offeror or bidder) that they have not been debarred or suspended from doing business with the federal government. Certification regarding Debarment, Suspension, Ineligibility and Voluntary Exclusion Lower Tier Covered Transactions **must be completed and submitted prior to award**. This certification is required by the regulations implementing Executive Order 12549, Debarment and Suspension, 29 CFR Part 98, Section 98.510, Participant's responsibilities. The regulations were published as Part VII of the May 26, 1988 Federal Register (pages 19160-19211).

Article A37. Local, State and Federal Requirements

The contractor shall comply with all applicable local, state and federal statutes, regulations, ordinances and codes, whether or not specifically mentioned herein.

Article A38. Records Retention and Access

Representatives of VSW or any of their authorized representatives and the federal awarding agency or any of their authorized representatives have the right of access to any pertinent books, documents, papers, or other records of the contractor and its subcontractors, which are pertinent to the funding of this contract, in order to make audits, examinations, excerpts, and transcripts. Retention of all records is required for six years after final payments by VSW and all other pending matters are closed. The right of access shall last as long as the records are retained.

Article A39. Consumer Price Index

Contractors must request price adjustments, in writing, **30 days prior to the renewal or adjustment date**. If a contractor fails to request a CPI price adjustment 30 days prior to the adjustment date, the adjustment will be effective 30 days after the State receives their written request.

Price adjustments will be made in accordance with the percentage change in the U.S. Department of Labor Consumer Price Index (CPI-U) for All Urban Consumers, All Items, Anchorage Area.

The price adjustment rate will be determined by comparing the percentage difference between the CPI in effect for the base year six month average (January through June OR July through December 200_); and each (January through June OR July through December 200_ six month average) thereafter. The percentage difference between those two CPI issues will be the price adjustment rate. No retroactive contract price adjustments will be allowed. Contractors must submit price adjustment request directly to DEC DAS Procurement email address:DECDASPROCUREMENT@alaska.gov.

Federal Debarment Certification Form

Certification Regarding Debarment, Suspension, Ineligibility and Voluntary Exclusion Lower Tier Covered Transactions

This certification is required by the regulations implementing Executive Order 12549, Debarment and Suspension, 29 CFR Part 98, Section 98.510, Participant's responsibilities. The regulations were published as Part VII of the May 26, 1988 Federal Register (pages 19160-19211).

(BEFORE COMPLETING CERTIFICATION, READ THE INSTRUCTIONS ON THE FOLLOWING PAGE WHICH ARE AN INTEGRAL PART OF THE CERTIFICATION)

(1) The prospective recipient of Federal assistance funds certifies, by submission of this bid, that neither it nor its principals are presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from participation in this transaction by any Federal department or agency.

(2) Where the prospective recipient of Federal assistance funds is unable to certify to any of the Statements in this certification, such prospective participant shall attach an explanation to this Proposal.

_____

Name and Title of Authorized Representative

_____

Signature Date

Federal Debarment Certification Form Instructions

Instructions for Certification

1. By signing and submitting this Proposal, the prospective recipient of Federal assistance funds is providing the certification as set out below.

2. The certification in this class is a material representation of fact upon which reliance was placed when this transaction was entered into. If it is later determined that the prospective recipient of Federal assistance funds knowingly rendered an erroneous certification, in addition to other remedies available to the Federal Government, the Department of Labor (DOL) may pursue available remedies, including suspension and/or debarment.

3. The prospective recipient of Federal assistance funds shall provide immediate written notice to the person to whom this Proposal is submitted if at any time the prospective recipient of Federal assistance funds learns that its certification was erroneous when submitted or has become erroneous by reason of changed circumstances.

4. The terms "covered transaction," "debarred," "suspended," "ineligible," "lower tier covered transaction," "participant," "person," "primary covered transaction," "principal," "Proposal," and "voluntarily excluded," as used in this clause, have the meanings set out in the Definitions and Coverage sections of rules implementing Executive Order 12549. You may contact the person to which this Proposal is submitted for assistance in obtaining a copy of those regulations.

5. The prospective recipient of Federal assistance funds agrees by submitting this Proposal that, should the proposed covered transaction be entered into, it shall not knowingly enter into any lower tier covered transaction with a person who is debarred, suspended, declared ineligible, or voluntarily excluded from participation in this covered transaction, unless authorized by the DOL.

6. The prospective recipient of Federal assistance funds further agrees by submitting this Proposal that it will include the clause titled "Certification Regarding Debarment, Suspension, Ineligibility and Voluntary Exclusion - Lower Tier Covered Transactions," without modification, in all lower tier covered transactions and in all solicitations for lower tier covered transactions.

7. A participant in a covered transaction may rely upon a certification of a prospective participant in a lower tier covered transaction that it is not debarred, suspended, ineligible, or voluntarily excluded from the covered transaction, unless it knows that the certification is erroneous. A participant may decide the method and frequency by which it determines the eligibility of its principals. Each participant may but is not required to check the List of Parties Excluded from Procurement or Non-procurement Programs.

8. Nothing contained in the foregoing shall be construed to require establishment of a system of records in order to render in good faith the certification required by this clause. The knowledge and information of a participant is not required to exceed that which is normally possessed by a prudent person in the ordinary course of business dealings.

9. Except for transactions authorized under paragraph 5 of these instructions, if a participant in a covered transaction knowingly enters into a lower tier covered transaction with a person who is suspended, debarred, ineligible, or voluntarily excluded from participation in this transaction, in addition to other remedies available to the Federal Government, the DOL may pursue available remedies, including suspension and/or debarment.

FAR 52.203-11
CERTIFICATION AND DISCLOSURE REGARDING PAYMENTS TO INFLUENCE CERTAIN FEDERAL TRANSACTIONS (SEPT 2007) (a) *Definitions.* As used in this provision—"Lobbying contact" has the meaning provided at 2

U.S.C. 1602(8). The terms "agency," "influencing or attempting to influence," "officer or employee of an agency," "person," "reasonable compensation," and "regularly employed" are defined in the FAR clause of this solicitation entitled "Limitation on Payments to Influence Certain Federal Transactions" (52.203-12).

(b) *Prohibition*. The prohibition and exceptions contained in the FAR clause of this solicitation entitled "Limitation on Payments to Influence Certain Federal Transactions" (52.203-12) are hereby incorporated by reference in this provision.

(c) *Certification*. The offeror, by signing its offer, hereby certifies to the best of its knowledge and belief that no Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress on its behalf in connection with the awarding of this contract.

(d) *Disclosure*. If any registrants under the Lobbying Disclosure Act of 1995 have made a lobbying contact on behalf of the offeror with respect to this contract, the offeror shall complete and submit, with its offer, OMB Standard Form LLL, Disclosure of Lobbying Activities, to provide the name of the registrants. The offeror need not report regularly employed officers or employees of the offeror to whom payments of reasonable compensation were made.

(e) *Penalty*. Submission of this certification and disclosure is a prerequisite for making or entering into this contract imposed by 31 U.S.C. 1352. Any person who makes an expenditure prohibited under this provision or who fails to file or amend the disclosure required to be filed or amended by this provision, shall be subject to a civil penalty of not less than $10,000, and not more than $100,000, for each such failure.

CONSENT TO USE OF ELECTRONIC SIGNATURES

☐ BY CHECKING HERE, I AGREE TO THE USE OF ELECTRONIC SIGNATURES AS VALID, LEGALLY BINDING SUBSTITUTES FOR ORIGINAL, HANDWRITTEN SIGNATURES ON THIS DOCUMENT.

Company _____

Name (signature) _____

Name (printed) _____

Title _____ **Date of execution** _____

DISCLOSURE OF LOBBYING ACTIVITIES

Approved by OMB
0348-0046

Complete this form to disclose lobbying activities pursuant to 31 U.S.C. 1352
(See reverse for public burden disclosure.)

1. Type of Federal Action:	2. Status of Federal Action:	3. Report Type:
☐ a. contract b. grant c. cooperative agreement d. loan e. loan guarantee f. loan insurance	☐ a. bid/offer/application b. initial award c. post-award	☐ a. initial filing b. material change **For Material Change Only:** year _____ quarter _____ date of last report _____

4. Name and Address of Reporting Entity:	5. If Reporting Entity in No. 4 is a Subawardee, Enter Name and Address of Prime:
☐ **Prime** ☐ **Subawardee** Tier _____, *if known*: **Congressional District**, *if known*: 4c	 **Congressional District**, *if known*:
6. Federal Department/Agency:	**7. Federal Program Name/Description:** CFDA Number, *if applicable*: _____
8. Federal Action Number, *if known*:	**9. Award Amount,** *if known*: $
10. a. Name and Address of Lobbying Registrant (*if individual, last name, first name, MI*):	**b. Individuals Performing Services** (*including address if different from No. 10a*) (*last name, first name, MI*):
11. Information requested through this form is authorized by title 31 U.S.C. section 1352. This disclosure of lobbying activities is a material representation of fact upon which reliance was placed by the tier above when this transaction was made or entered into. This disclosure is required pursuant to 31 U.S.C. 1352. This information will be available for public inspection. Any person who fails to file the required disclosure shall be subject to a civil penalty of not less than $10,000 and not more than $100,000 for each such failure.	Signature: _____ Print Name: _____ Title: _____ Telephone No.: _____ Date: _____
Federal Use Only:	Authorized for Local Reproduction Standard Form LLL (Rev. 7-97)

PRINT

INSTRUCTIONS FOR COMPLETION OF SF-LLL, DISCLOSURE OF LOBBYING ACTIVITIES

This disclosure form shall be completed by the reporting entity, whether subawardee or prime Federal recipient, at the initiation or receipt of a covered Federal action, or a material change to a previous filing, pursuant to title 31 U.S.C. section 1352. The filing of a form is required for each payment or agreement to make payment to any lobbying entity for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employeeof a Member of Congress in connection with a covered Federal action. Complete all items that apply for both the initial filing and material change report. Refer to the implementing guidance published by the Office of Management and Budget for additional information.

1. Identify the type of covered Federal action for which lobbying activity is and/or has been secured to influence the outcome of a covered Federal action.

2. Identify the status of the covered Federal action.

3. Identify the appropriate classification of this report. If this is a followup report caused by a material change to the information previously reported, enter the year and quarter in which the change occurred. Enter the date of the last previously submitted report by this reporting entity for this covered Federal action.

4. Enter the full name, address, city, State and zip code of the reporting entity. Include Congressional District, if known. Check the appropriate classification of the reporting entity that designates if it is, or expects to be, a prime or subaward recipient. Identify the tier of the subawardee, e.g., the first subawardee of the prime is the 1st tier. Subawards include but are not limited to subcontracts, subgrants and contract awards under grants.

5. If the organization filing the report in item 4 checks "Subawardee," then enter the full name, address, city, State and zip code of the prime Federal recipient. Include Congressional District, if known.

6. Enter the name of the Federal agency making the award or loan commitment. Include at least one organizationallevel below agency name, if known. For example, Department of Transportation, United States Coast Guard.

7. Enter the Federal program name or description for the covered Federal action (item 1). If known, enter the full Catalog of Federal Domestic Assistance (CFDA) number for grants, cooperative agreements, loans, and loan commitments.

8. Enter the most appropriate Federal identifying number available for the Federal action identified in item 1 (e.g., Request for Proposal (RFP) number; Invitation for Bid (IFB) number; grant announcement number; the contract, grant, or loan award number; the application/proposal control number assigned by the Federal agency). Include prefixes, e.g., "RFP-DE-90-001."

9. For a covered Federal action where there has been an award or loan commitment by the Federal agency, enter the Federal amount of the award/loan commitment for the prime entity identified in item 4 or 5.

10. (a) Enter the full name, address, city, State and zip code of the lobbying registrant under the Lobbying Disclosure Act of 1995 engaged by the reporting entity identified in item 4 to influence the covered Federal action.

    (b) Enter the full names of the individual(s) performing services, and include full address if different from 10 (a). Enter Last Name, First Name, and Middle Initial (MI).

11. The certifying official shall sign and date the form, print his/her name, title, and telephone number.

Attachment One

CITY OF HOOPER BAY, ALASKA

WASTEWATER LAGOON

Preliminary Engineering Report

PER, prepared in USDA format

Prepared by:

CE2 Engineers, Inc.

Date Issued:

May 2018

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List of Appendices

1) PROJECT PLANNING

A) LOCATION

A map of the area of interest for potential sewage treatment lagoons is shown in Figure 1-Hooper Bay Lagoon Survey Area Map, provided in the Figures tab located at the end of this document. The boundary of the aerial survey in the figure denotes the limits of the possible lagoon locations.

B) ENVIRONMENTAL RESOURCES PRESENT

Hooper Bay is an archeologically rich community; previous federally-funded projects in the community have required archeological surveys and monitoring. A National Historic Preservation Act Section 106 review and consultation with the Alaska State Historic Preservation Office is required of this project, as federal funding is assumed.

The project is proposed to be constructed in an uplands area, which is not as detrimental as building one of the other three alternatives in the lower wetlands areas. Since the U.S. Army Corps of Engineers (USACE) no longer performs jurisdictional determination reviews for projects greater than five (5) acres in size, a USACE permit application under Section 404 of the Clean Water Act should be submitted as the proposed project could potentially be identified as a jurisdictional wetlands area.

Consultation with the U.S. Fish & Wildlife Service—under Section 7 of Endangered Species Act—is advised due to the possibility of the project being in or near critical habitat for the threatened Spectacled Eider.

A search of the State of Alaska Contaminated Sites Database reviews four contaminated sites in the area, none of which are close to the project area, and two of which are closed. It is not anticipated that a contaminated site will impact the project in any manner.

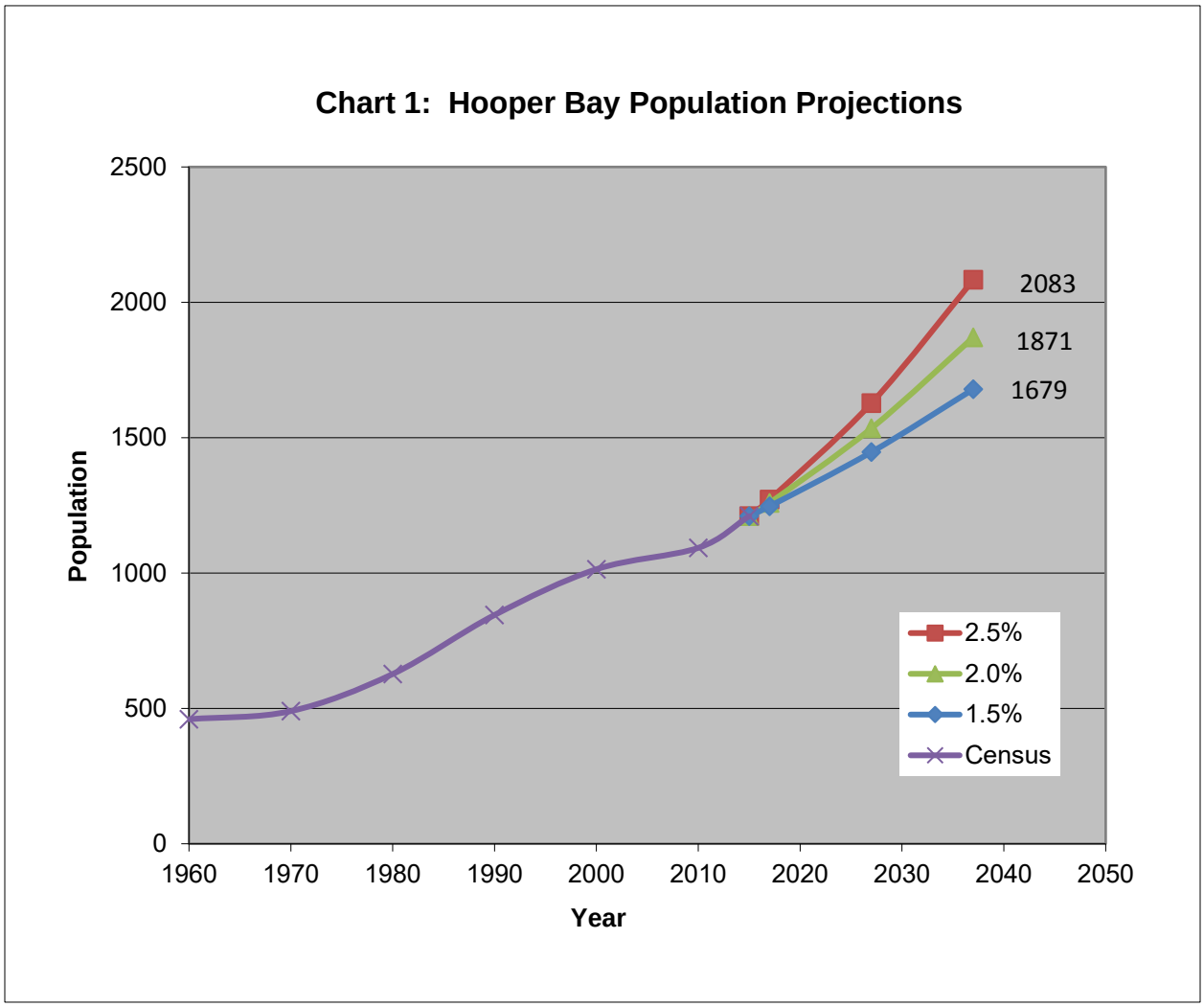
C) POPULATION TRENDS

The City of Hooper Bay has experienced sustained growth since 1960, according to data gathered every ten years by the United States Census. The table below shows this population data, as well as the calculated equivalent annual growth in percent between Census years.

Year	Population	Annual Percent Change
1960	460	-
1970	490	0.60%
1980	627	2.50%
1990	845	3.00%
2000	1014	1.80%
2010	1093	0.80%
2015	1210*	2.10%

*State of Alaska DCCED Certified population

The chart below shows this Census data, and a 20-year projection of population (from 2017), or—looking from the 2015 State of Alaska DCCED population figure—a 22-year projection.



Based upon past Census trends, the 2.0% annual growth figure would provide a reasonable 20-year population estimate for conservatively sizing the proposed wastewater treatment system for the design year 2037.

D) COMMUNITY ENGAGEMENT

It is vitally important that the residents of the City of Hooper Bay understand what their community water system needs in improvements to the wastewater treatment component of their water and sewer system, why these improvements are needed now, and how this will be accomplished. The improvements will determine what will be done to remedy the inadequate wastewater treatment issue as well as have some effect on monthly water and sewer rates, that is, the costs to them and their families.

Communication of the aspects of the situation and proposed improvements, as well as financing of the improvements will take place in several ways.

- Community meetings can be held periodically to educate the public on the existing system, as well as the proposed improvements to the water system;
- Flyers and information sheets can be distributed to homeowners to keep them informed of the ongoing studies and proposed actions for improvements.
- After public input and discussion, the Hooper Bay City Council will vote on an action plan and commitment to implement the improvements.

2) EXISTING FACILITIES

A) LOCATION MAP

The present lagoon site is shown in Figure 2-Existing Facultative Lagoon Location Map (presented in the Figures tab at the end of this document).

B) HISTORY

The present wastewater lagoon was constructed in 1994 to serve both as a wastewater lagoon for the school and eventually the whole community once piped water and sewer was brought to the community. The lagoon was constructed in conjunction with the landfill, so they are two conjoined semicircles of five (5) acres each.

The lagoon was mainly serving the school until 2006, when the new school located at Tomaganuk Subdivision was opened, after a fire destroyed the existing school at Old Town, near the AVEC power plant. Froom 2007 to present, over 200 housing units have been placed in service for water and sewer, using the same one-celled 5-acre wastewater lagoon constructed in 1994.

C) CONDITION OF EXISTING FACILITIES

The lagoon has been heavily used beyond its design limits with the new school and the addition of 200 housing units. The existing lagoon contains 5.3 acres for primary treatment, but the required acreage for a lagoon serving this population is now 10.6 acres. Besides not having a large enough and configured wastewater lagoon that meets the current Alaska Department of Environmental Conservation (ADEC) guidelines[1], the lagoon has encountered settlement in areas, as shown in the photo below. Note the dip in the fence line, showing where the settlement has occurred. The water seepage is due to the wastewater in the lagoon

[1] *Guidelines for the Design and Construction of Wastewater Lagoons,* Alaska Department of Environmental Conservation, Division of Water, Engineering Support and Plan Review Section, March 2010. See Appendix A.

seeping through the sand at the base of the berm. The lagoon has never overflowed, as higher wastewater levels in the lagoon exert more hydrostatic head on the berm, resulting in more flow through the sand layers in the berm. This was verified in 2011 in a flow test[2] to determine the lagoon response to high force main flow rates.

D) FINANCIAL STATUS OF ANY EXISTING FACILITIES

	Jan - Dec 17
Ordinary Income/Expense	
Income	
City Revenue Sharing	94,000.00
Commercial Piped	188,241.76
Residential Piped	158,100.00
Utility Revenue	41,934.60
Washeteria Earnings	147,296.78
Total Income	629,573.14
Expense	
Airfare	914.00
Bank Charges	599.25
Building Maintenance & Repair	1,121.43
Consession Sales	7,949.21
Electric MS#11028414-WTP	55,576.76
Electric MS#7986868-SF	62,332.56
Electric MS#9558344-WP	29,710.71
Electric MS#9558444 -WTP Temp	9,479.35
Equipment Repairs & Maintenance	7,909.62
Hazmat/Chemicals	31,650.21
Heat Recovery Costs AVEC	23,650.00
Heating Fuel	94,000.00
Honda/Snowmachine Expenses	1,128.80
Interest Expense	133.34
Janitorial Supplies	8,835.42
Liability Insurance	3,035.00
Office Supplies	433.34
Other Expenses	704.46
Per Diem	333.45
Postage and Freight	27,999.78
Professional Fees	18,996.60
Salaries	230,459.76
Telephone and Internet	1,518.15
Water Testing Fees	1,240.00
Worker's Compensation Insurance	8,152.82
Total Expense	627,864.02

[2] *Conceptual Design Memorandum, City of Hooper Bay Wastewater Treatment Improvements*, CE2 Engineers, Inc., April 2011

E) WATER/ENERGY/WASTE AUDITS

An energy audit was performed in December 2017 by the Alaska Native Tribal Health Consortium (ANTHC). This audit covered the well control house in Old Town and related well field, Water Treatment Plant (WTP), and Satellite Facility.

3) NEED FOR PROJECT

A) HEALTH, SANITATION, AND SECURITY

The existing 5-acre facultative lagoon was constructed in 1994. Since that time, this lagoon has been the main wastewater treatment facility in Hooper Bay. Beginning in 2006, following the completion of the City well field water source, WTP, utilidor system, and ongoing housing water and sewer connection projects, demand on this lagoon is more that current regulations allow. Presently, there is only a 5.3-acre primary cell, with no secondary storage cell.

To meet the increased wastewater treatment demand, as well as to protect the environment from pollution of nearby land from fecal coliform and other noxious wastes and pathogenic organisms, the existing facultative lagoon will have to be improved and/or replaced with an updated or new wastewater treatment system.

The ongoing piped water and sewer upgrade project in Hooper Bay has significantly increased the level of public health in the community, with approximately 200 residences (including the School Complex) receiving the benefits of clean water and sanitary sewage collection. Having the residences converted to piped water and sewer has greatly decreased the amount of honeybucket waste taken to the landfill, which was constructed adjacent to the existing lagoon.

A new or updated wastewater treatment project will increase the security of the wastewater treatment system because it will be designed to be a system that will protect the public, and especially children, from entering the wastewater treatment system infrastructure, particularly the facultative lagoon.

B) AGING INFRASTRUCTURE

The existing facultative lagoon is 23 years old. It needs some upgrading of the berms, as wastewater is steadily leaking through the base of the berm at a rate of 20,000 to 25,000 gallons a day to the tundra. In effect, the berm is serving as a sand filter for the lagoon. Erosion of the berm has not been observed, but control of released effluent from this lagoon is lacking, either in the levels of BOD_5, TSS, or fecal coliform, due to the lack of ability to disinfect the discharged wastewater. If the lagoon is to be used as part of the upgraded wastewater treatment system, then the leaking berm issue will have to be addressed.

C) REASONABLE GROWTH

The population of Hooper Bay is estimated at the time of writing this PER in 2017 at 1200 persons. Based upon population predictions in a 20-year design horizon, the design population in 2037 will be 1871 persons (see Section 1.C). Estimated daily wastewater generation in 2037 will be 75,000 gallons, based on 1871 persons generating 40 gallons per person per day of wastewater. This lower per capita generation quantity of wastewater is due to the use of vacuum sewer toilets, rather than the use of traditional 3.5 gallons per flush toilets.

4) ALTERNATIVES CONSIDERED

A) DESCRIPTION

- **Alternative 1: Do Nothing (Continue with Status Quo)**
  This alternative continues the present use of the single cell wastewater lagoon and its operational and regulatory implications.

- **Alternative 2: Utilize Existing Lagoon Primary Cell, Add Secondary Cell, Seasonal Discharge**
  This alternative would utilize the existing primary cell in the lagoon. A new secondary lagoon cell would be constructed. Seasonally, effluent from the secondary cell would be disinfected/neutralized, then discharged to land or water. The secondary cell would hold eight (8) months of wastewater for winter storage and would be pumped to land during the summer.

- **Alternative 3: Existing Lagoon Primary Cell, Followed Fixed Film Media Trickling Filters, Seasonal Discharge**
  This alternative would retain the existing lagoon cell for primary treatment and install a series of treatment tanks utilizing fixed film media filters (Quanics™ or equal), followed by disinfection/neutralization, and seasonal discharge to a secondary cell.

- **Alternative 4: Draw from Existing Lagoon Primary Cell with Aeration Modules situated Remotely, Added Secondary Cell, Seasonal Discharge**
  This alternative would retain the existing lagoon cell for primary treatment, and add a remote aeration step, using Bio-Shells or equivalent, followed by disinfection/neutralization, and discharge to land.

- **Alternative 5: Construct New Lagoon Primary Cell and Secondary Cell in the Uplands North Across the Floodway; connect to Hooper Bay City with Helical-Supported Access**
  This alternative would create a new facultative lagoon to the north of the existing lagoon, across the floodway, and into the higher ground to the north. The connecting helical-supported access would carry an extension of the existing force main to the intake location of the new primary cell.

B) DESIGN CRITERIA

The Design Criteria for Alternative 1: Do Nothing (Continue with Status Quo) does not meet the current ADEC Draft Guidelines for even a standard 2-cell lagoon because the primary cell is 5.3 acres and needs to be 10.6 acres. The secondary cell does not exist but needs to have a 17.96 million gallon holding capacity for 240 days of seasonal storage (hydraulic retention time), or 11.0 acres. The design criteria for a standard 2-cell facultative lagoon meeting ADEC guidelines are shown below. This would be the standard for **Alternative 5: Construct New Lagoon Primary Cell and Secondary Cell in the Uplands North Across the Floodway, connect to Hooper Bay City with a Helical-Supported Access**

Hooper Bay Lagoon Design Criteria - Standard 2-Cell Lagoon			
Assumptions: Design based upon Alaska Department of Environmental Conservation Draft Lagoon Guidelines			
Parameter	**Qty**	**Unit**	**Notes**
2037 Design Population	1871	People	Assumed growth rate of 2.0% per year
Design Wastewater Flow Rate (piped sewer plus pumped Honeybucket Waste)	40	Gal/Cap-Day	40 GPCD larger than original 35 GPCD in initial design of system to be conservative
BOD	0.17	lbs/Cap-Day	ADEC Draft Lagoon Construction Guidelines
Primary Cell BOD Loading (Maximum)	30	lbs/acre	
Overall BOD Loading (Maximum)	20	lbs/acre	
Primary Cell Hydraulic Retention Time (HRT)	60	Days	
Secondary Cell HRT	240	Days	
Primary Cell Maximum Depth	10	Feet	
Primary Cell Design Depth	5	Feet	Actual depth 7 feet less bottom 2 feet excluded from calculation for sludge
Secondary Cell Maximum Depth	5	Feet	ADEC Draft Lagoon Construction Guidelines
Secondary Cell Design Depth	5	Feet	Actual depth 7 feet less bottom 2 feet excluded from calculation for sludge
2037 Design Conditions			
Average Daily Flow	74,840	Gallons	Housing Piped Sewer + Honeybucket Waste + School + Washeteria
BOD/day production	318.1	lbs	
Minimum Overall Size (based on BOD Loading)	15.9	Acres	Assumes 20 lb BOD/acre loading, per ADEC guidelines
Minimum Primary Cell Size (based on BOD Loading)	10.6	Acres	Assumes 30 lb BOD/acre loading, per ADEC guidelines
Minimum Secondary Cell Size (based on BOD Loading)	5.3	Acres	15.9 acres overall less 10.6 acres for primary cell
Required Primary Cell Volume (based on HRT)	4,490,400	Gallons	Assumes 60 days of wastewater flow.
Minimum Primary Cell Area (based on HRT)	2.8	Acres	Based upon 10-ft deep primary cell with 3:1 slopes.
Required Secondary Cell Volume (based on HRT)	17,961,600	Gallons	Secondary cell volume based on 240 days of storage
Minimum Secondary Cell Area (based on HRT)	11.0	Acres	Based upon 5-ft deep secondary cell with 3:1 slopes.
Minimum Primary Cell Size	**10.6**	**Acres**	BOD Loading Controls
Minimum Secondary Cell Size	**17,961,600**	**Gallons**	Hydraulic Retention Time Controls
Minimum Secondary Cell Size	**11.0**	**Acres**	Hydraulic Retention Time Controls

The design criteria for **Alternative 2: Existing Lagoon Treatment Cell, Added Secondary Cell, Seasonal Discharge** are the same as Alternatives 1 and 5 above. However, the existing primary cell is 5.3 acres, and the proper size of the primary cell, according to ADEC's "Guidelines for the Design and Construction of Wastewater Lagoons," (presented in Appendix A), is 10.6 acres. This gives the overall size, based on 20 lb BOD_5/acre at 15.9 acres. Based on hydraulic retention, the secondary cell would have to be sized

to 11.0 acres. This would bring the total acreage of the lagoon (existing insufficiently sized 5.3-acre cell plus 11.0 acres for the proposed secondary cell) to 16.3 acres. This puts Alternative 2 at 5.3 acres undersized for ADEC standards for 2-cell lagoons.

Below are the design criteria for **Alternative 3-Existing Lagoon Primary Cell, Followed Fixed Film Media Trickling Filters, Discharge into Seasonal Holding Cell** The primary cell upstream from the process is designed to lower the BOD_5 to half of the Year 2037 design raw wastewater flow into the primary cell of the existing lagoon, thus allowing the existing lagoon cell to accommodate the design wastewater flow. A secondary cell will be required to be constructed. The controlling factor will be the 240-day seasonal storage requirement (hydraulic retention time), so this new secondary cell would require an area of 11.0 acres.

Hooper Bay Lagoon Design Criteria: 2-cell Lagoon with Pretreatment Cell Upstream of Lagoon			
Assumptions: Pretreatment cell min volume 516,000 gal, followed by primary and secondary cells			
Parameter	**Qty**	**Unit**	**Notes**
2037 Design Population	1871	People	Assumed growth rate of 2.0% per year
Design Wastewater Flow Rate	40	Gal/Cap-Day	40 GPCD (more conservative than original system design of 35 GPCD)
BOD	0.17	lbs/Cap-Day	ADEC Draft Lagoon Construction Guidelines
Primary Cell BOD Loading (Maximum)	30	lbs/acre	
Overall BOD Loading (Maximum)	20	lbs/acre	
Pretreatment Cell Min Hydraulic Retention Time (HRT)	5	Days	Equates to 374,200 gallons
Primary Cell Hydraulic Retention Time (HRT)	60	Days	ADEC Draft Lagoon Construction Guidelines
Secondary Cell HRT	240	Days	
Pretreatment Cell Maximum Depth	10	Feet	
Pretreatment Cell Design Depth	10	Feet	
Primary Cell Maximum Depth	10	Feet	ADEC Draft Lagoon Construction Guidelines
Primary Cell Design Depth	5	Feet	Actual depth 7 feet less bottom 2 feet excluded from calculation
Secondary Cell Maximum Depth	5	Feet	ADEC Draft Lagoon Construction Guidelines
Secondary Cell Design Depth	5	Feet	Actual depth 7 feet less bottom 2 feet excluded from calculation
2037 Design Conditions			
Average Daily Flow	74,840	Gallons	Piped Housing + Honeybucket Waste + School + Washeteria
BOD/day production	318.1	lbs	
BOD Loading (based on 50% BOD removal in septic tank)	159.0		
Minimum Overall Size (based on BOD Loading)	8.0	Acres	
Minimum Pretreatment Cell Volume (based on HRT)	374,200	Gallons	5 days at design flow of 75,000 gpd
Minimum Pretreatment Cell Volume, based upon 20-yr sludge retention	3,208,900	Gallons	Will include 127,800 cf of unsettled sludge in 20 years (conservative). 24.8% sludge by
Minimum Primary Cell Size (based on BOD Loading)	5.3	Acres	
Minimum Secondary Cell Size (based on BOD Loading)	2.7	Acres	
Required Primary Cell Volume (based on HRT)	4,490,400	Gallons	
Minimum Primary Cell Area (based on HRT)	2.8	Acres	
Required Secondary Cell Volume (based on HRT)	17,961,600	Gallons	
Minimum Secondary Cell Area (based on HRT)	11.0	Acres	
Minimum Primary Cell Size	**5.3**	**Acres**	BOD Loading Controls
Minimum Secondary Cell Size	**17,961,600**	**Gallons**	Hydraulic Retention Time Controls
Minimum Secondary Cell Area (based on HRT)	**11.0**	**Acres**	

Below are the design criteria for **Alternative 4: Draw from Existing Lagoon Primary Cell with Aeration Modules situated Remotely, Added Secondary Cell, Seasonal Discharge.** This alternative would retain the existing lagoon cell for primary treatment and install a series of treatment tanks in insulated modules, utilizing fixed film media filters (Quanics™ or equal), followed by disinfection/neutralization, discharge.

Hooper Bay Lagoon Design Criteria - Existing Lagoon Cell w/ Fixed Film Media Trickling Filters			
Existing lagoon cell to provide primary treatment (50% BOD removal).			
Parameter	**Qty**	**Unit**	**Notes**
2037 Design Population	1871	People	Assumed Growth Rate of 2.0% per year
Design Wastewater Flow Rate	40	Gal/Cap-Day	40 GPCD (Higher than original 35 GPCD in initial design of system to be conservative)
BOD	0.17	lbs/Cap-Day	ADEC Draft Lagoon Construction Guidelines
Primary Treatment Cell Volume	5,488,644	Gallons	Ref: CE2 Conceptual Design Memorandum, April 2011.
Primary Effluent BOD Target	100-300	mg/L	Quanics Advanced Treatment System Technical Manual
Secondary Effluent BOD Target	15	mg/L	
Secondary Effluent TSS Target	15	mg/L	
Quanics AeroCell Maximum Loading Rate	8	gpd/ft^3	Quanics Advanced Treatment System Technical Manual - Table 6
2037 Design Conditions			
Average Daily Flow	74,840	Gallons	Housing Piped Sewer + Honeybucket Waste + School + Washeteria
Average Daily Flow	0.075	MGD	
BOD/day production	318.1	lbs	
Raw Wastewater BOD Strength	509.6	mg/L	
Primary Effluent BOD Strength	254.8	mg/L	Assume 50% BOD removal in primary treatment cell
Design AeroCell Loading Rate	6.5	gpd/ft^3	
Minimum AeroCell Treatment Volume	11,514	gpd/ft^3	
Minimum AeroCell ATS-16 Treatment Cells	29	Each	400 ft^3 per Cell
Design AeroCell ATS-16 Treatment Cells	32	Each	

Below are the design criteria for Alternative 5: Existing Lagoon Primary Cell with Added Aeration, disinfection, and discharge to land. This alternative would retain the existing lagoon cell for primary treatment, add aeration with "Bio-domes" or equivalent, and effluent from the primary aerated cell would be disinfected/neutralized, then discharged to land.

Hooper Bay Lagoon Design Criteria - 2-Cell Lagoon w/ Bio-Dome Aeration			
Assumptions: ADEC approval of primary cell sizing in consideration of Bio-Dome aeration.			
Parameter	**Qty**	**Unit**	**Notes**
2037 Design Population	1871	People	Assumed Growth Rate of 2.0% per year
Design Wastewater Flow Rate	40	Gal/Cap-Day	40 GPCD (Higher than original 35 GPCD in initial design of system to be conservative)
BOD	0.17	lbs/Cap-Day	ADEC Draft Lagoon Construction Guidelines
Primary Cell BOD Loading (Maximum)	60	lbs/acre	Increased loading due to enhanced BOD removal by Bio-Dome aeration system.
Overall BOD Loading (Maximum)	20	lbs/acre	ADEC Draft Lagoon Construction Guidelines
Primary Cell Hydraulic Retention Time (HRT)	60	Days	
Secondary Cell HRT	240	Days	
Primary Cell Maximum Depth	10	Feet	
Primary Cell Design Depth	5	Feet	Actual depth 7 feet less bottom 2 feet excluded from calculation
Secondary Cell Maximum Depth	5	Feet	ADEC Draft Lagoon Construction Guidelines
Secondary Cell Design Depth	5	Feet	Actual depth 7 feet less bottom 2 feet excluded from calculation
2037 Design Conditions			
Average Daily Flow	74,840	Gallons	Housing Piped Sewer + Honeybucket Waste + School + Washeteria
BOD/day production	318.1	lbs	
Minimum Overall Size (based on BOD Loading)	15.9	Acres	
Minimum Primary Cell Size (based on BOD Loading)	5.3	Acres	
Required Primary Cell Volume (based on HRT)	4,490,400	Gallons	
Minimum Primary Cell Area (based on HRT)	2.8	Acres	
Minimum Primary Cell Size	**5.3**	**Acres**	BOD Loading Controls

C) MAP

A location and vicinity map of Hooper Bay is shown in Figure 3-Hooper Bay Location and Vicinity Map (provided in the Figures tab at the end of this document).

D) ENVIRONMENTAL IMPACTS

The proposed action involves the construction of a two-celled sewage lagoon with two alternatives as to the location of the lagoon: Alternative 2 is in the wetland and floodway area, and Alternative 5 is in the upland tundra area. The secondary cell will annually discharge treated effluent, depending on the alternative, to the wetland and floodway area or the tundra area directly adjacent to the lagoon, in accordance with the effluent quality standards set by ADEC.

The environmental impacts of Alternative 2 are more detrimental, fill for the lagoon berms will be place in a wetland area and in the floodway, serving to decrease the wetland area and impacting the flow of water in the floodway.

The environmental impacts of Alternative 5, building the lagoon on more upland tundra, are not as detrimental as building in the wetland and floodway area. This alternative does not involve placing fill in wetlands, will not decrease the wetland area, and will not impact the flow of water in the floodway.

The environmental impacts of either location are less than the No-Action alternative, with the difference being that the No-Action alternative does not provide the community with a functioning, environmentally safe wastewater treatment facility.

Only short-term, minor adverse impacts to aesthetics, air, and noise would occur during construction. No long-term impacts would occur to climate, air, endangered species, socioeconomics, environmental justice, or cultural resources. Beneficial impacts would occur to human health and safety, and water quality. The proposed project would not result in any moderate or significant, short-term, long-term or cumulative adverse effects to the environment.

E) LAND REQUIREMENTS

i. Alternative 1: Do Nothing (Continue with Status Quo)

There are no additional land requirements with this alternative, other than the approximate 6-acre footprint of the existing lagoon. An illustration of this alternative is shown in Figure 2-Existing Facultative Lagoon Location Map (presented in the Figures tab at the end of this document).

ii. Alternative 2: Utilize Existing Lagoon Primary Cell, Add Secondary Cell, Seasonal Discharge

In addition to the approximate 6-acre footprint of the existing lagoon cell, an additional 13-acre footprint will be required in the additional secondary storage cell, located adjacent to the existing primary cell, and wholly within the floodway. The new system will require a total of 19 acres in its footprint. An illustration of this alternative is shown in Figure 4-Alternative 2 Conceptual Facultative Lagoon layout (Figures tab).

iii. Alternative 3: Existing Lagoon Primary Cell, Followed Fixed Film Media Trickling Filters, Seasonal Discharge

In addition to the approximate 6-acre footprint of the existing lagoon cell, an additional 13-acre footprint will be required in the secondary storage cell, located adjacent to the existing primary cell, and wholly within the floodway. An additional two (2) acres will also be needed for the trickling filters and water tank, as part of the treatment system. The new system will require a total of 21 acres in its footprint.

iv. Alternative 4: Draw from Existing Lagoon Primary Cell with Aeration Modules situated Remotely, Added Secondary Cell, Seasonal Discharge

In addition to the approximate 6-acre footprint of the existing lagoon cell, an additional 13-acre footprint will be required in the secondary storage cell, located adjacent to the existing primary cell, and wholly within the floodway. An additional two (2) acres will also be needed for the water tanks housing the aeration modules, as part of the treatment system. The new system will require a total of 21 acres in its footprint.

v. Alternative 5: Construct New Lagoon Primary Cell and Secondary Cell in the Uplands North across the Floodway, connect to Hooper Bay City with a Fill Causeway or Helical-Supported Access

This completely new facultative lagoon will require a 10.5-acre primary cell and an 11-acre secondary cell. Approximately four (4) additional acres will be required for the footprint of the outer berm, one (1) acre for the access road from the north side of the floodway to the lagoon, and two (2) acres for the helical-supported access. The total land requirement will be approximately 28.5 acres. An illustration of this alternative is shown in Figure 5-Alternative 5 Conceptual 2-Cell Facultative Lagoon (see Figures tab at the end of this document). Figure 6–Typical Helical-Supported Access shows a typical helical pier foundation system for a helical-supported access, capable of supporting a side-by-side all-terrain vehicle (see Figures tab).

F) POTENTIAL CONSTRUCTION PROBLEMS

i. Alternative 1: Do Nothing (Continue with Status Quo)

This alternative is the trivial case, as no new construction will be performed. However, erosion of the base of the existing 5.3-acre lagoon from wave action, as well as differential settlement of the lagoon berm will have to be dealt with as maintenance issues.

ii. Alternative 2: Utilize Existing Lagoon Primary Cell, Add Secondary Cell, Seasonal Discharge

This alternative will have to address the existing lagoon deficiencies mentioned in (ii) above, as well as the problem of seepage of sewage through the base of the lagoon berm. The existing primary cell will have to be drained and repaired to be used, which will be problematic, due to sludge presence, and having to lay geotextile and membranes on the inside of the berms. In addition, the secondary cell will have to be placed in the floodway, which has significant construction problems:

- Soils in the floodway have saturated silts and varying depths of organics varying from shallow depths to six or seven-foot thick layers. These will cause differential settlements on the berm, which can threaten the integrity of the sewage containment in the proposed secondary cell.

- The proposed secondary cell will have to be armored with rock imported from Nome or other distant locations to protect against erosion from storm surges and related ice. Sand for the berms will have to be hauled three (3) miles from the beach source to build the berms.
- Materials will have to be stockpiled nearby before construction. The construction of the berm will have to be carefully performed and rapidly. There is always the chance of flooding, which can damage or wipe out the berm before it is completed.

The geotechnical report from Golder Associates Inc. entitled, *WASTEWATER LAGOON GEOTECHNICAL FINDINGS AND RECOMMENDATIONS, HOOPER BAY, ALASKA,* dated April 26, 2018 is presented in Appendix B.

iii. Alternative 3: Existing Lagoon Primary Cell, Followed Fixed Film Media Trickling Filters, Seasonal Discharge

This alternative will have to address the existing lagoon deficiencies mentioned in (ii) above, as well as the problem of seepage of sewage through the base of the lagoon berm. The existing primary cell will have to be drained and repaired to be used, which will be problematic, due to sludge presence, and having to lay geotextile and membranes on the inside of the berms. In addition, the secondary cell will have to be placed in the floodway, which has significant construction problems:

- Soils in the floodway have saturated silts and varying depths of organics varying from shallow depths to six or seven-foot thick layers. These will cause differential settlements on the berm, which can threaten the integrity of the sewage containment in the proposed secondary cell.
- The proposed secondary cell will have to be armored with rock imported from Nome or other distant locations to protect against erosion from storm surges and related ice. Sand for the berms will have to be hauled three (3) miles from the beach source to build the berms.
- Materials will have to be stockpiled nearby before construction. The construction of the berm will have to be carefully performed and rapidly. There is always the chance of flooding, which can damage or wipe out the berm before it is completed.

iv. Alternative 4: Draw from Existing Lagoon Primary Cell with Aeration Modules situated Remotely, Added Secondary Cell, Seasonal Discharge

This alternative will have to address the existing lagoon deficiencies mentioned in (ii) above, as well as the problem of seepage of sewage through the base of the lagoon berm. The existing primary cell will have to be drained and repaired to be used, which will be problematic, due to sludge presence, and having to lay geotextile and membranes on the inside of the berms. In addition, the secondary cell will have to be placed in the floodway, which has significant construction problems:

- Soils in the floodway have saturated silts and varying depths of organics varying from shallow depths to six- or seven-foot thick layers. These will cause differential settlements on the berm, which can threaten the integrity of the sewage containment in the proposed secondary cell.
- The proposed secondary cell will have to be armored with rock imported from Nome or other distant locations to protect against erosion from storm surges and related ice. Sand for the berms will have to be hauled 3 miles from the beach source to build the berms.

- Materials will have to be stockpiled nearby before construction. The construction of the berm will have to be carefully performed and rapidly. There is always the chance of flooding, which can damage or wipe out the berm before it is completed.

v. Alternative 5: Construct New Lagoon Primary Cell and Secondary Cell in the Uplands North Across the Floodway, connect to Hooper Bay City with a Helical-Supported Access

This alternative, though out of the flood hazards presented in Alternatives 1 through 4, has construction issues that must be addressed:

- Additional geotechnical drilling will have to be performed around the secondary cell site, and to the north and west to determine if there is a hydraulic connection that will affect the design and elevation of the secondary cell.
- Construction equipment will have to be brought up on the fall barge and moved across the floodway during winter to avoid sinking into the soft ground of the floodway.
- Excavation and stockpiling of materials for the primary and secondary lagoon cells will have to be done in winter. Windrows of the sand/silt materials will have to be drained for a season to thaw out the imbedded ice crystals and consolidate the excavated material. Plastic sheeting will have to be placed over the material to prevent winds from blowing the material away.
- Access to the site will have to be developed through a helical-supported access above the flood level. This will require winter construction to install the piers with an excavator in frozen surface material to prevent sinking into the soft silts and organics of the floodway.

G) SUSTAINABILITY CONSIDERATIONS

There are not a lot of measures that increase the efficiency of the lagoon. There will be additional maintenance that will be required for the new facultative lagoon – mainly annual discharges to land to drain down the secondary treatment cell. This will require about three weeks of pumping once a year, using a diesel-powered pump. In addition, there will be an additional 1300 kilowatt-hours of electricity needed to pump the sewage in the force main extension to the new lagoon location.

i. Water and Energy Efficiency

There is a minimum velocity required to have the sewage flow in the force main, to prevent sedimentation at the bottom of the force main pipe. Making the extension to the force main a larger pipe will lower the energy used to pump the sewage but will lower the velocity of the pumped liquid.

A better method of saving pump energy would be to examine the resized pump impeller, and to select the most efficient motor available today. A 5% increase in efficiency would mean an approximate saving of $200/year in electricity costs by a motor change. This is estimated to be a 6- to 8-year payback.

Another method of increasing energy efficiency is to modify pumping speed of the glycol heat trace for the force main, which will lower the kilowatt-hour energy load. A 5% drop in electrical energy demand on this heat trace pump will save $120/year. It is estimated that it will have a 6-year payback.

ii. Green Infrastructure

Not applicable.

iii. Other

Not applicable.

H) COST ESTIMATE

A capital cost estimate for Alternative 5 is shown below. The other four alternatives were not feasible as discussed below in Section 5 (B) Non-Monetary Factors; so no cost estimates were developed for them.

CAPITAL COST ESTIMATE ALTERNATIVE 5: 2-CELL LAGOON	
LAGOON COMPONENT	**COST EST**
Helical-Supported Access	$2,474,000
Road to Primary Cell	$275,000
Force Main Extension	$935,000
Lagoon Construction:	
Equipment	$770,000
Fuel	$154,000
Freight/Transportation	$330,000
Labor	$1,375,000
Construction Mgmt	$550,000
Materials	$1,287,271
Misc Pump and Equipment	$110,000
Subtotal Lagoon Option	$ 8,260,271
Engineering 10%	$ 826,027
EMT 8%	$ 660,822
Estimated Total For Lagoon Alternative 5	**$ 9,747,120**
Less Funding Already Secured	**$ (3,132,227)**
Net Additional Funding Required	**$ 6,614,893**

5) SELECTION OF AN ALTERNATIVE

A) LIFE CYCLE COST ANALYSIS

i. Alternative 1: Do Nothing (Continue with Status Quo)

The life cycle cost analysis for this alternative was not computed because it was rejected in section (B)(ii) – Non-Monetary Factors on page 20.

ii. Alternative 2: Utilize Existing Lagoon Primary Cell, Add Secondary Cell, Seasonal Discharge

The life cycle cost analysis for this alternative was not computed because it was rejected in section (B)(ii) – Non-Monetary Factors on page 21.

iii. Alternative 3: Existing Lagoon Primary Cell, Followed Fixed Film Media Trickling Filters, Seasonal Discharge

The life cycle cost analysis for this alternative was not computed because it was rejected in section (B)(iii) – Non-Monetary Factors on page 22.

iv. Alternative 4: Draw from Existing Lagoon Primary Cell with Aeration Modules situated Remotely, Added Secondary Cell, Seasonal Discharge

The life cycle cost analysis for this alternative was not computed because it was rejected in section (B)(iv) – Non-Monetary Factors on page 22.

v. Alternative 5: Construct New Lagoon Primary Cell and Secondary Cell in the Uplands North Across the Floodway, connect to Hooper Bay City with a Helical-Supported Access

Life Cycle Cost Estimate - Alternate 5: New Lagoon Primary and Secondary Cell in Uplands							
Operation and Maintenance Cost OC						Initial Cost Design Procure Install	Total LCC Life Cycle Cost
Time Period n^{th} year	Discounting Factor = $1/(1+4.125/100)^n$	Inflation Factor $(1+.5/100)^{n-1}$	Future OC at n^{th} year	PV of any year	Total PV Incurred		
A	B	C	D	E=DxBxC	F = E+last year's F	G	H = G+F
1	-	-	$ -	$ -	$ -	$ 9,747,120	$ 9,747,120
2	0.94	1.005	$ 12,600	$ 11,890	$ 11,890	$ 9,747,120	$ 9,759,010
3	0.91	1.010	$ 12,600	$ 11,579	$ 23,469	$ 9,747,120	$ 9,770,589
4	0.88	1.015	$ 12,600	$ 11,276	$ 34,745	$ 9,747,120	$ 9,781,865
5	0.85	1.020	$ 12,600	$ 10,981	$ 45,725	$ 9,747,120	$ 9,792,845
6	0.83	1.025	$ 12,600	$ 10,694	$ 56,419	$ 9,747,120	$ 9,803,539
7	0.80	1.030	$ 12,600	$ 10,414	$ 66,833	$ 9,747,120	$ 9,813,953
8	0.78	1.036	$ 12,600	$ 10,141	$ 76,974	$ 9,747,120	$ 9,824,094
9	0.75	1.041	$ 12,600	$ 9,876	$ 86,850	$ 9,747,120	$ 9,833,970
10	0.73	1.046	$ 12,600	$ 9,618	$ 96,468	$ 9,747,120	$ 9,843,588
11	0.71	1.051	$ 12,600	$ 9,366	$ 105,834	$ 9,747,120	$ 9,852,954
12	0.69	1.056	$ 12,600	$ 9,121	$ 114,955	$ 9,747,120	$ 9,862,075
13	0.66	1.062	$ 12,600	$ 8,882	$ 123,837	$ 9,747,120	$ 9,870,957
14	0.64	1.067	$ 12,600	$ 8,650	$ 132,487	$ 9,747,120	$ 9,879,607
15	0.62	1.072	$ 12,600	$ 8,424	$ 140,911	$ 9,747,120	$ 9,888,031
16	0.60	1.078	$ 12,600	$ 8,203	$ 149,114	$ 9,747,120	$ 9,896,234
17	0.59	1.083	$ 12,600	$ 7,989	$ 157,103	$ 9,747,120	$ 9,904,223
18	0.57	1.088	$ 12,600	$ 7,780	$ 164,882	$ 9,747,120	$ 9,912,002
19	0.55	1.094	$ 12,600	$ 7,576	$ 172,458	$ 9,747,120	$ 9,919,578
20	0.53	1.099	$ 12,600	$ 7,378	$ 179,836	$ 9,747,120	$ 9,926,956

B) NON-MONETARY FACTORS

i. Alternative 1: Do Nothing (Continue with Status Quo)

This alternative has major problems:

- The existing lagoon does not meet ADEC standards for the size of the primary cell. Presently this cell is undersized in area, being 5.3 acres and requiring 10.6 acres, based on BOD_5 loading. This means that there is not enough surface area in the primary cell for adequate oxygen transfer from the air to the water to keep the digestion process aerobic.
- The existing lagoon is seeping wastewater through the base of the sand berm, rather than containing the wastewater in the cell. This situation can pass excess total suspended solids and fecal coliform more than the maximum allowed by ADEC standards.

- Areas of the lagoon are suffering from differential settlement, indicating deterioration of the berms.
- There is no secondary treatment cell, which is a requirement of current ADEC standards.

Because of these inherent problems, the present system cannot adequately treat and seasonally store the wastewater, so this alternative is rejected. There was no life cycle cost analysis performed on this alternative, as the non-monetary factors ruled it out.

ii. Alternative 2: Utilize Existing Lagoon Primary Cell, Add Secondary Cell, Seasonal Discharge

This alternative has major problems:

- The existing lagoon does not meet ADEC standards for the size of the primary cell. Presently this cell is undersized in acreage, being 5.3 acres and requiring 10.6 acres, based on BOD_5 loading. This means that there is not enough surface area in the primary cell for adequate oxygen transfer from the air to the water to keep the digestion process aerobic.
- The existing lagoon is seeping wastewater through the base of the sand berm, rather than containing the wastewater in the cell. This situation can pass excess total suspended solids and fecal coliform exceeding the maximum allowed by ADEC standards.
- Areas of the lagoon are suffering from differential settlement, indicating deterioration of the berms.
- The existing primary cell would have to be repaired and enlarged to provide adequate treatment area, or 150,000 gallons capacity in septic tanks to provide 50% BOD_5 reduction. The problem with the septic tank option is that there is no means of removing the sludge and disposing it.
- The proposed 11-acre secondary (seasonal storage) cell would have to be constructed in a floodway, which can run with ice-laden storm surge water in the fall or early winter, or storms in summer. This would require a large quantity of armor rock on the berms. From the Golder and Associates geotechnical report, the location of the proposed 11-acre secondary cell is in saturated silty soil with varying depths of organics, with depths up to six or more feet deep. These organics will cause differential settlement of the overlying sand berms in the order of two feet over a process of years. It is not feasible to dig out the organics and replace it with sand, as the water table is close to the surface. Though this site is low in seismic potential, an earthquake can cause significant damage to the structure, causing a sewage spill.
- ADEC *Guidelines for the Design and Construction of Wastewater Lagoons*, in the March 2010 Final Draft in Section 2.2 Topography (1) states that, “The lagoon’s location shall be out of the floodplain and above the 20-year flood level.” This proposed site for the secondary cell is right in the flood plain.

Because of these inherent problems, there is no way that this present system can adequate treat and seasonally store the wastewater, and that the proposed site for the secondary cell is in a floodway and poor ground for this earthen structure, so this alternative was rejected. There was no life cycle cost analysis performed on this alternative, as the non-monetary factors ruled it out.

iii. Alternative 3: Existing Lagoon Primary Cell, Followed Fixed Film Media Trickling Filters, Seasonal Discharge

There are some basic issues with this alternative. Originally, it was envisioned in the early stages of this PER that a mechanical sewage treatment plant, mainly using pumps, would save considerable funds over building a large facultative lagoon. The funding agencies, however, were concerned about long term O&M issues, both with maintainability and affordability with respect to energy costs (heat and electricity). They wanted to see alternatives in facultative lagoons and get away from sewage treatment systems that depended more on numbers of pumps or blowers. Alternatives 3 and 4 depended more upon mechanical equipment, so they were abandoned in favor of Alternatives 2 and 5 (the facultative lagoon alternatives). Alternatives 3 and 4 were kept in the PER for historical purposes.

iv. Alternative 4: Draw from Existing Lagoon Primary Cell with Aeration Modules situated Remotely, Added Secondary Cell, Seasonal Discharge

There are some basic issues with this alternative. Originally, it was envisioned in the early stages of this PER, that a mechanical sewage treatment plant, mainly using pumps, would save considerable funds over building a large facultative lagoon. The funding agencies, however, were concerned about long term O&M issues, both with maintainability and affordability with respect to energy costs (heat and electricity). They wanted to see alternatives in facultative lagoons and get away from sewage treatment systems that depended more on numbers of pumps or blowers. Alternatives 3 and 4 depended more upon mechanical equipment, so they were abandoned in favor of Alternatives 2 and 5 (the facultative lagoon alternatives). Alternatives 3 and 4 were kept in the PER for historical purposes.

v. Alternative 5: Construct New Lagoon Primary Cell and Secondary Cell in the Uplands North Across the Floodway, connect to Hooper Bay City with a Helical-Supported Access

This alternative meets all the requirements of the ADEC facultative lagoon standard for primary cell and secondary cell sizes. It is also out of the flood zone. However, it will need a helical-supported access to support the force main across the floodway, and light motorized vehicles to access and service the lagoon.

6) PROPOSED PROJECT (RECOMMENDED ALTERNATIVE)

The proposed project will be **Alternative 5: Construct New Lagoon Primary Cell and Secondary Cell in the Uplands North Across the Floodway, connect to Hooper Bay City with a Helical-Supported Access**

This project keeps the lagoon out of the floodway and onto the uplands north of the community. This design will adequately treat wastewater from the community according to lagoon design standards of ADEC. The location will prevent odors from reaching town, and will keep the lagoon away from children, unlike the present single-celled lagoon near the solid waste site.

A) PRELIMINARY PROJECT DESIGN

A conceptual plan view drawing of the facility and the helical-supported access is shown in Figure 5-Alternative 5 Conceptual 2-Cell Facultative Lagoon (Figures tab). Because of the need to cross the 2200-foot-wide floodway, a helical-supported access capable of holding a light pickup and trailer (H-5 loading) for maintenance access to the facility will have to be constructed. A structure supported by helical piers would provide access, and yet would provide minimal obstruction to flood waters and floating ice cakes. Hooper Bay does not have very many choices for satisfactory lagoon location.

B) PROJECT SCHEDULE

Because of the terrain, size of excavation, and the limited access to the uplands site across the floodway, this will be a multi-year project.

- *Year 1:* Notice to proceed. Perform additional geotechnical boring on secondary cell site to rule out hydraulic connections, load tests for helical-supported access across floodway. Design and permit. Perform lease vs buy analysis for construction equipment procurement. Have construction equipment on last barge, stage for winter crossing across floodway.
- *Year 2:* Winter excavation of proposed primary and secondary cells. Stockpile excavated material for thawing and draining moisture in summer. Construct helical-supported access across floodway for light traffic. Construction equipment to remain on site.
- *Year 3:* After allowing the soils to drain for the entire summer of Year 2, construction can resume in the Spring of Year 3. Form berms and control structure for lagoon. Build fill road to lagoon from helical-supported access. Commission lagoon.
- *Year 4:* Close out existing lagoon. Demobe any leased equipment.

C) PERMIT REQUIREMENTS

- A Section 404 Clean Water Act permit application should be submitted to the USACE as the proposed project could potentially be identified as a jurisdictional wetlands area.
- Archaeological clearance and conditions from SHPO.
- Agreement with Sea Lion Corporation on land use for lagoon site and access.
- An ADEC Approval to Construct will be necessary.

- A State of Alaska General Construction Permit will be required, along with a Storm Water Pollution Prevention Plan (SWPPP).

D) SUSTAINABILITY CONSIDERATIONS

There are not a lot of measures that increase the efficiency of the lagoon. There will be additional maintenance that will be required for the new facultative lagoon–mainly annual discharges to land to drain down the secondary treatment cell. This will require about three weeks of pumping once a year, using a diesel-powered pump. In addition, there will be approximately 1300 kilowatt-hours of electricity consumption to pump the sewage in the force main extension to the new lagoon location.

i. Water and Energy Efficiency

There is a minimum velocity required to have the sewage flow in the force main, to prevent sedimentation at the bottom of the force main pipe. Making the extension to the force main a larger pipe will lower the energy used to pump the sewage but will lower the velocity of the pumped liquid.

A better method of saving pump energy would be to examine the resized pump impeller, and to select the most efficient motor available today. A 5% increase in efficiency would mean an approximate saving of $200/year in electricity costs by a motor change. This is estimated to be a 6 to 8-year payback.

Another method of increasing energy efficiency is to modify pumping speed of the glycol heat trace for the force main, which will lower the kilowatt-hour energy load. A 5% drop in electrical energy demand on this heat trace pump will save $120/year. It is estimated that it will have a 6-year payback.

ii. Green Infrastructure

Not applicable.

iii. Other

Not applicable.

E) TOTAL PROJECT COST ESTIMATE (ENGINEER'S OPINION OF PROBABLE COST)

CAPITAL COST ESTIMATE ALTERNATIVE 5: 2-CELL LAGOON	
LAGOON COMPONENT	**COST EST**
Helical-Supported Access	$2,474,000
Road to Primary Cell	$275,000
Force Main Extension	$935,000
Lagoon Construction:	
Equipment	$770,000
Fuel	$154,000
Freight/Transportation	$330,000
Labor	$1,375,000
Construction Mgmt	$550,000
Materials	$1,287,271
Misc Pump and Equipment	$110,000
Subtotal Lagoon Option	$ 8,260,271
Engineering 10%	$ 826,027
EMT 8%	$ 660,822
Estimated Total For Lagoon Alternative 5	**$ 9,747,120**
Less Funding Already Secured	**$ (3,132,227)**
Net Additional Funding Required	**$ 6,614,893**

F) ANNUAL OPERATING BUDGET

i. Income

For utility income listing, please see section (2)(D) Financial Status of Any Existing Facilities on page 5.

ii. Annual O&M Costs

This is an estimate for expensed directly related to the proposed 2-cell lagoon (Alternate 5) for

EXPENSES FOR PROPOSED TWO CELL LAGOON - ALTERNATIVE 5	
EXPENSE	**AMOUNT**
Salaries, Wages, and Benefits	$ 8,000
Maintenance supplies, spare parts	$ 1,000
Travel for training	$ 3,000
Fuel for pumps, vehicles	$ 5,000
Electricity for force main	$ 2,600
Insurance for Lagoon	$ 6,000
Laboratory expense	$ 1,500
Total Expenses	**$ 27,100**

iii. Debt Repayments

As this is a grant funded project, there are no debt repayments.

iv. Reserves

A reserve fund of $3,000 per year should be set aside for major repairs or replacement of hoses and discharge pump for the lagoon secondary cell.

7) CONCLUSIONS AND RECOMMENDATIONS

A) CONCLUSIONS

- The City of Hooper Bay is limited in viable locations for wastewater treatment due to the lack of land in the community's vicinity that is above the flood zone.
- Because of limitations by funding agencies due to concerns about maintenance issues, sustainability, and consequences of process failure, mechanical sewage treatment processes are discouraged, and facultative lagoon designs are favored for simplicity and reliability.
- The existing lagoon site would require major renovation, and the secondary cell extension would have to be constructed in the floodway, which has problem soils and does not meet the ADEC lagoon design standards.
- The best site for a facultative lagoon that meets the ADEC design standards is in the uplands north of the existing lagoon, across the floodway.
- There should be year-round access to the site by a helical pier supported access across the floodway—situated above the flood level—to allow for light traffic consisting of four wheelers or side-by-side, all-terrain vehicles.

B) RECOMMENDATIONS

- A two-cell lagoon should be constructed as shown in Figure 5 (see Figures tab at the end of this document), with the area and depths as stated in the *ADEC Guidelines for the Design and Construction of Wastewater Lagoons, March 2010.*
- Access should be provided for four-wheeler or side-by-side all-terrain vehicles with a helical supported access above the flood level of the floodway. An illustration of the helical support system is shown on Figure 6 –Typical Helical-Supported Access (located in the Figures tab).
- The existing force main with glycol heat trace should be extended across the floodway to the new lagoon site by hanging it onto the proposed helical-supported access.
- Examine the performance of the existing force main pumps at the Satellite Facility and upgrade impellers and motors for higher head conditions, and increased motor energy efficiency.
- Examine the performance of the glycol heat trace system for the force main, and modify the motor and pump, and possibly add a variable frequency drive to the pump to maximize energy efficiency.

FIGURES

List of Figures

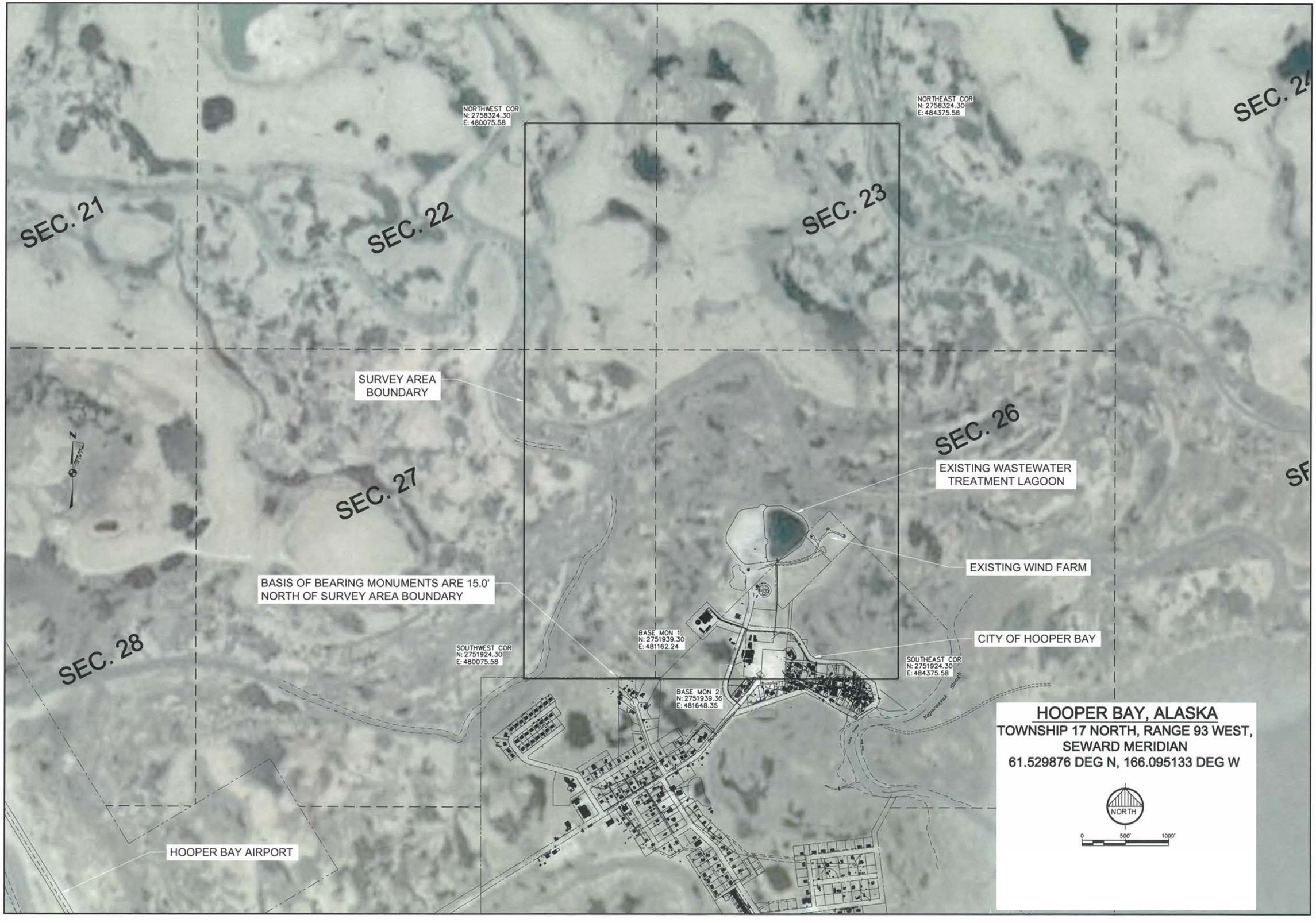


FIGURE 1

WASTEWATER TREATMENT SYSTEM IMPROVEMENTS

HOOPER BAY LAGOON SURVEY AREA MAP

HOOPER BAY, ALASKA

Scale: AS SHOWN

Date: APRIL 2018

Drawn: CM

CE2 ENGINEERS, INC.
PO BOX 229548 ANCHORAGE, AK 99523 PH: 907-348-1018 FAX: 907-348-1015

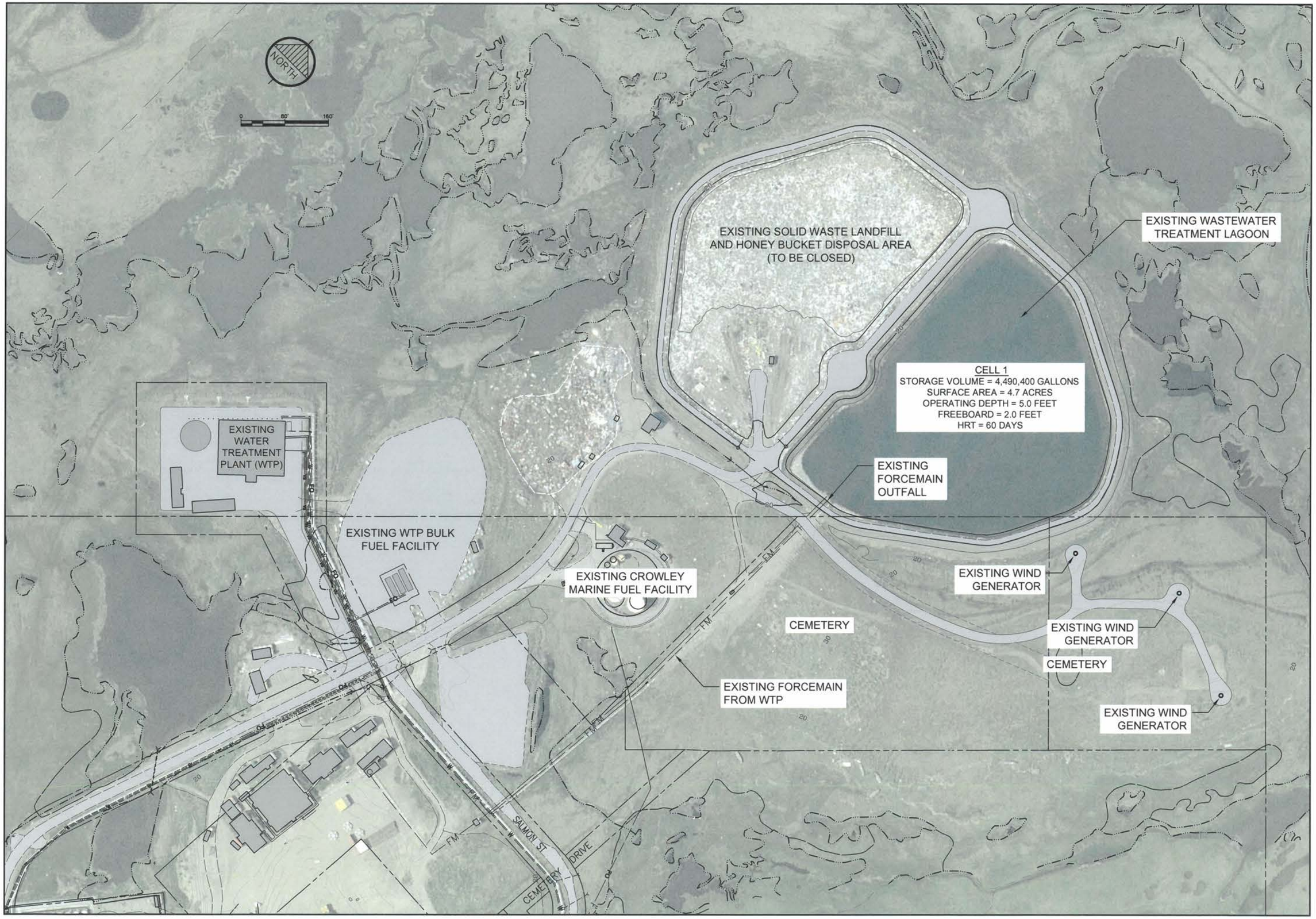


FIGURE 2

WASTEWATER TREATMENT SYSTEM IMPROVEMENTS

EXISTING FACULTATIVE LAGOON LOCATION MAP

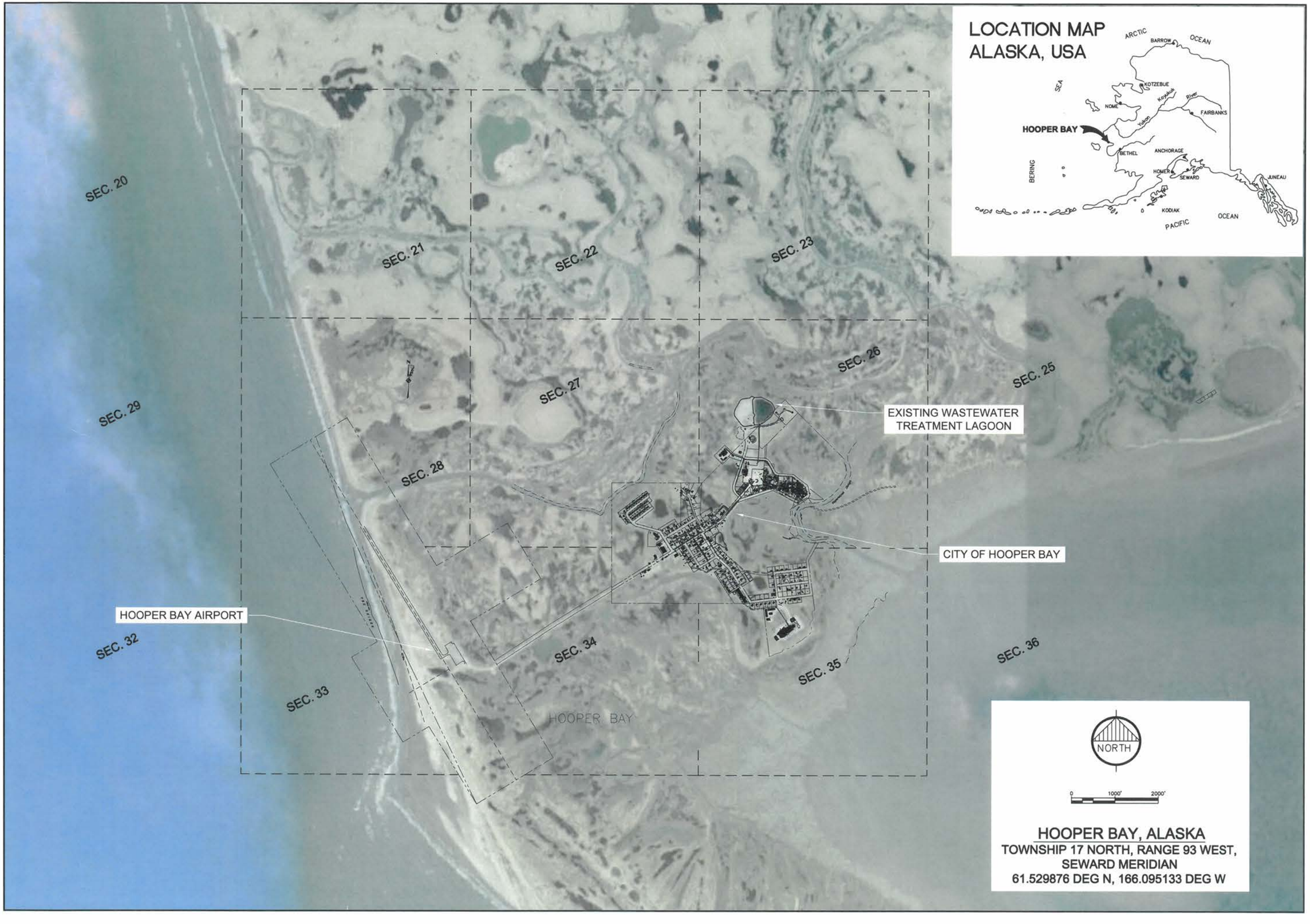
HOOPER BAY, ALASKA

Scale: AS SHOWN

Date: APRIL 2018

Drawn: CM

CE2 ENGINEERS, INC.
PO BOX 232048 ANCHORAGE, AK 99523 PH: 907-349-1013 FAX: 907-349-1015



HOOPER BAY, ALASKA
TOWNSHIP 17 NORTH, RANGE 93 WEST, SEWARD MERIDIAN
61.529876 DEG N, 166.095133 DEG W

FIGURE 3

WASTEWATER TREATMENT SYSTEM IMPROVEMENTS

HOOPER BAY LOCATION AND VICINTIY MAP

HOOPER BAY, ALASKA

Scale: AS SHOWN
Date: APRIL 2018
Drawn: CM

CE2 ENGINEERS, INC.
PO BOX 223948 ANCHORAGE, AK 99523 PH: 907-348-1010 FAX: 907-348-1015

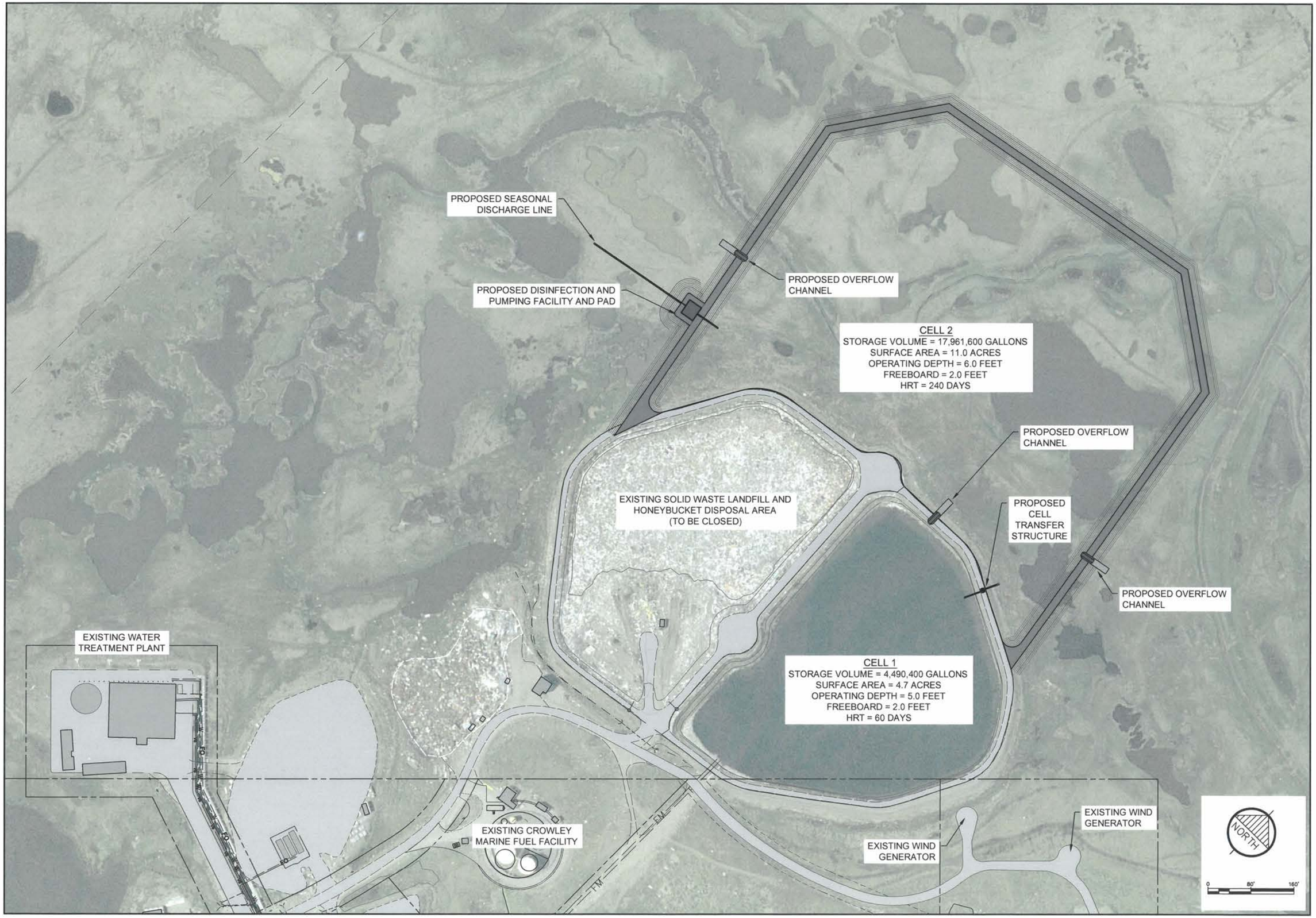


FIGURE 4

WASTEWATER TREATMENT SYSTEM IMPROVEMENTS CDM

ALTERNATIVE 2 - CONCEPTUAL FACULTATIVE LAGOON LAYOUT

HOOPER BAY, ALASKA

Scale: AS SHOWN
Date: APRIL 2018
Drawn: CM

CE2 ENGINEERS, INC.
PO BOX 223948 ANCHORAGE, AK 99523 PH: 907-349-1010 FAX: 907-349-1015

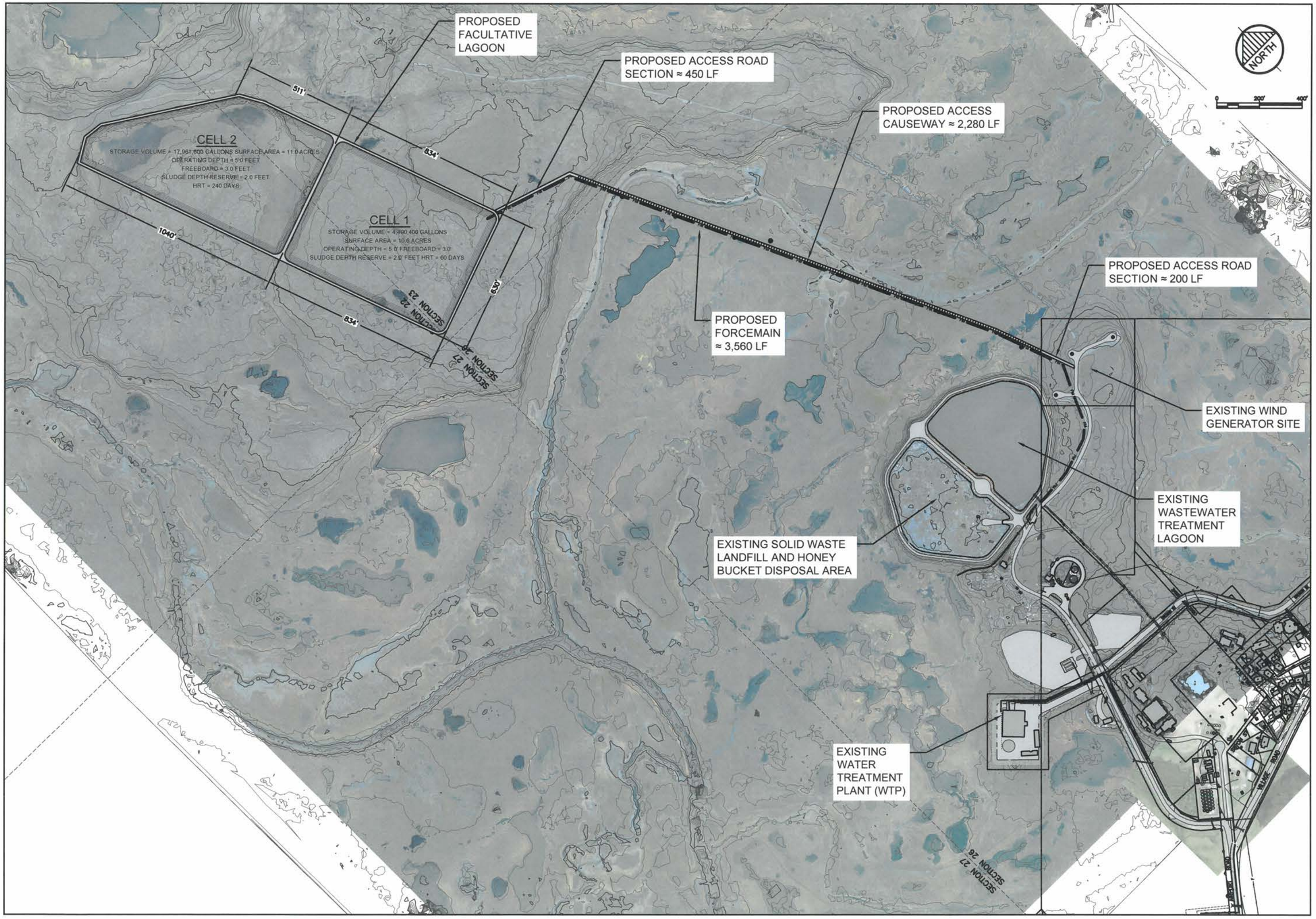


FIGURE 5

WASTEWATER TREATMENT SYSTEM IMPROVEMENTS

ALTERNATIVE 5 - CONCEPTUAL 2-CELL FACULTATIVE LAGOON

HOOPER BAY, ALASKA

Scale: AS SHOWN

Date: APRIL 2017

Drawn: CM

CE2 ENGINEERS, INC.
PO BOX 232646 ANCHORAGE, AK 99523 PH: 907-349-1970 FAX: 907-349-1915

Appendix A-Guidelines for the Design and Construction of Wastewater Lagoons
(ADEC, March 2010 Final Draft)

Guidelines

For the Design and Construction of

Wastewater Lagoons

Stuyahok Lagoon

Alaska Department of Environmental Conservation
Division of Water
Engineering Support and Plan Review Section

March 2010

Final Draft

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Acknowledgements

Department of Environmental Conservation staff gratefully acknowledge the participation, contributions and support of the following individuals and agencies:

Arctic Village Lagoon in winter

Contents

Abbreviations and Acronyms

AAC	Alaska Administrative Code
ADEC	Alaska Department of Environmental Conservation
ADNR	Alaska Department of Natural Resources
ANTHC	Alaska Native Tribal Health Consortium
ASTM	American Society of Testing and Materials
BOD	Biochemical Oxygen Demand
BOD_5	5 day Biochemical Oxygen Demand
DO	Dissolved Oxygen
EPA	Environmental Protection Agency
FAA	Federal Aviation Administration
HDPE	high density polyethylene
HRT	hydraulic retention time
Lb	pound
µg/L	micrograms per Liter
µ	Microns
Mg/l	milligrams per liter
Ml	milliliter
pH	hydrogen (ion) concentration
TSS	Total Suspended Solids
VSW	Village Safe Water

Definitions

Bedrock: The native consolidated rock underlying the Earth's surface. In this document, bedrock includes any refusal layers such as permafrost.

Impermeable layer: A layer of material beneath ground surface that can impede the downward percolation of water.

Maximum groundwater: As determined from at least two readings taken a minimum of 30 days apart.

Elevation: At least one of these readings shall be collected in September or October.

Occupied Building: A building within which one or more persons reside, work, or are served for fouhours per day: two or more days a week: and eight or more weeks a year. Without limiting the generality of the foregoing, this description includes such developments as school, hospital, food establishment, residences, etc.

Shoreline: The fringe of land at the edge of a large body of water, including an ocean, sea or lake.

Tremie tube: A concrete feeding tube used to feed concrete grout, or similar substances, underwater.

1. Introduction and Objectives

The goal of this guideline is to provide a basis for successful wastewater lagoon design, construction and operation that will protect public health. The Alaska Department of Environmental Conservation (ADEC) staff believe that clear guidelines benefit everyone by establishing baseline standards that reflect common interests of regulators, design consultants and the community.

This document is based on information collected from a literature search and evaluation of rural lagoon systems in cold climates. In addition, comments and suggestions were included from individuals and groups with rural Alaska wastewater treatment interests. Finally, this document is consistent with regulations in northern communities, and it incorporates regulatory concerns based on past wastewater successes (and failures) in rural Alaska.

These guidelines are just that—guidelines. They are not regulations. However, plans submitted to ADEC for review and approval that include wastewater lagoons will be reviewed in accordance with these guidelines. Variance from these guidelines must be justified with suitable technical support and explanations.

The report was prepared with the assistance of CH2M HILL under contract with ADEC. The ADEC project manager was Bill Rieth, P.E.

Aerial view of the Akiachak Lagoon

2. Lagoon Location

The lagoon design shall investigate the following elements and adhere to the following limits:

2.1 Separation Requirements

1. The lagoon shall be placed a minimum of 330 feet (100 meters) from all roads and railways.
2. The lagoon shall be placed a minimum of 1,000 feet from an occupied building (see definitions).
3. The lagoon shall be placed a minimum of 200 feet from existing community wells. A greater distance may be required in accordance with ADEC Wastewater Regulations 18 AAC 72.020.(d).
4. The lagoon's distance from any airport shall be coordinated with the Federal Aviation Administration (FAA).
5. The lagoon shall be placed downwind from the community, where possible.
6. The lagoon shall be placed a minimum of 500 feet from any shoreline.

2.2 Topography

1. The lagoon's location shall be out of the floodplain and above the 20 year flood level.
2. The lagoon location shall not intercept surface runoff channels, groundwater shall not surface in any cell, nor shall snowmelt be allowed to drain into the structure.
3. Stormwater runoff shall be diverted around the lagoon.
4. The embankment shall be protected from erosion.
5. The lagoon location shall not be located over a buried channel aquifer.
6. The lagoon location shall avoid hilly or steeply sloping terrain.
7. The lagoon location shall be selected to ensure maximum sunlight (the south side of hills is preferred).

2.3 Geotechnical Requirements

1. Maintain a minimum separation of 4-feet between the bottom of the lagoon and the maximum groundwater elevation.
2. Maintain a minimum separation of 10-feet between the bottom of the lagoon and bedrock (as defined earlier in this document).
3. Maintain a minimum of 6-feet between the bottom of the lagoon and the impermeable layer.

2.4 Permafrost

1. Permafrost shall be avoided wherever possible. When a location on the permafrost is proposed, the design must demonstrate that all other treatment alternatives have been evaluated and are not technically feasible.
2. If construction on permafrost is required, soil bore testing shall be required to determine the ice content of the permafrost and the existence of any massive ice, such as an ice wedge.
3. Thermal modeling shall be conducted to estimate the rate and maximum depth of thaw caused by the dike construction and wastewater impoundment. From these measurements, the lagoon designer shall calculate the stability and settlement of the lagoon. Design shall be completed by a geotechnical engineer with substantial permafrost experience.
4. The lagoon design shall include methods proposed for protection and stabilization of the permafrost during construction.

2.5 Areas of High Precipitation

1. In areas of high precipitation (both rainfall and snow accumulation of more than 20 inches of precipitation as rainfall), a mass balance shall be completed showing that the

   lagoon has adequate capacity to accommodate the annual precipitation. All other design options that were made in determining the selection that a lagoon is the technically best option for the site must be presented.

3. Design Requirements

3.1 Service Life

The design service life of the lagoon shall be a minimum of 20 years. The lagoon design shall delineate the method for projecting population growth and changes in wastewater conveyance. For example: A 2 percent growth in population over 20 years: $(1.02)^{20}=1.5$ design factor.

3.2 Retention Time

The retention time in the lagoon shall be a minimum of 240 days, up to 365 days for a single, seasonal discharge.

3.3 BOD_5 Loading

The loading system shall be designed for a maximum BOD_5 (5 day biochemical oxygen demand) Loading rate of 20 pounds (lbs)/acre/day.

3.4 Wastewater Flows

A value based upon the population expected at the end of the design life for the lagoon shall be used to size the facility. For waste strength a value of 0.17 lbs of BOD_5/person/day will be used.

3.5 BOD_5 /Total Suspended Solids Removal

The lagoon design effluent shall demonstrate an 85 percent removal of BOD_5 and total suspended solids (TSS).

3.6 Pathogen Reduction

The lagoon effluent shall meet pathogen levels stipulated in the selected discharge permit for the site (marine or fresh water).

3.7 Other Parameters

The lagoon shall meet the current ADEC water quality standards for discharge location and use.

4. Geotechnical Investigation

4.1 Bore Hole Tests

1. The number of test bores shall be sufficient to adequately characterize the soil type and variability and to delineate unsuitable soil areas in the field. A minimum of one borehole per five acres or three boreholes for the entire construction plan, whichever is larger, is required. Although boreholes shall not be drilled on an arbitrary grid, average borehole spacing of 300 feet to 450 feet is recommended. Where permafrost is suspected, sufficient boreholes shall be drilled to fully establish the permafrost characteristics.
2. Boreholes shall be drilled a minimum depth of 20 to 40 feet below the lagoon invert elevation. At least three boreholes shall penetrate the ground water table to provide information on flow direction and gradients, unless the groundwater level is deeper than 40 feet. At least 1 borehole shall be drilled to auger refusal in the bedrock or to a depth of 80 feet, whichever occurs first.
3. Soil sampling shall be performed in accordance with American Society of Testing and Materials (ASTM) D 158699 or ASTM D 158700.
4. Some boreholes may be useful as monitoring wells. All soil borings in which wells are not installed shall be properly abandoned. Boreholes drilled within the proposed lagoon area shall be grouted to prevent preferential seepage paths. Use of a tremie tube is recommended to prevent bridging of grout in the hole and formation of voids. Boreholes located well beyond the containment structure maybe backfilled with available soil. (Monitoring Wells must conform to State Standards (see attachment))

4.2 Soil Tests

1. Sieve analyses performed to determine grain size distribution shall be performed in accordance with ASTM D42263 (2002) e1.
2. Permeability shall be determined using a falling head permeability test. The test shall be performed at the same approximate density as the in-place field conditions. Test on remolded or undisturbed samples are acceptable.
3. The plasticity index shall be determined in accordance with ASTM D42588 (2001).
4. Standard proctor densities shall be determined in accordance with ASTM D69800ae1.
5. In-field percolation testing shall be conducted per EPA design manual (EPA 625/180-012). A minimal of three tests per site is required.

5. Lagoon Configuration

5.1 General

1. The shape of the lagoon shall be such that there are no narrow or elongated portions. Islands, Peninsulas, or coves will not be approved. Dikes shall be rounded at the corners to minimize accumulation of floating materials. Rectangular lagoons with a length at least three times the width are recommended to limit short circuiting.
2. A minimum of two cells operating in series is required, at least one primary cell followed by at least one secondary cell.
3. Precipitation and evaporation must be considered in the total water balance and sizing.
4. A minimum of 3 feet of free board is required for all cells.

5.2 Sizing of Cells

1. The primary cell shall operate at a maximum depth of 10 feet and a hydraulic retention time (HRT) of approximately 40 to 60 days.
2. Two cells in series are required; the secondary cell shall operate at a maximum depth of 5 feet and an HRT of 240 to 365 days. If three or more cells are used, the secondary cell shall operate at a maximum depth of 5 feet and an HRT of approximately 30 days. The subsequent storage cells shall operate at a maximum depth of 10 feet. The total HRT of the system shall be 240 to 365 days.
3. The bottom 2 feet of the lagoon shall not be used in the calculation of storage volumes to maintain space for the effluent pipe.

6. Lagoon Liners

6.1 General

1. The permeability for both soil liners and synthetic liners shall not exceed 8.5 by 10^8 inches/minute under a head of 6 feet.
2. An engineered liner will be required on the bottom and slopes of any dike structures.
3. Areas where ice rafting against the exposed lagoon lining system may occur shall be identified during the design process. In these areas, the liner shall be reinforced or a mechanism for keeping the ice off the liner shall be developed and included in the proposal.
4. A quality assurance and quality control plan must be included for review. This plan must be signed by the engineer. This plan must meet or exceed the manufactures recommendations. The execution must also be documented and the record drawing must assure this plan was implemented.

6.2 Soil Liners

1. Natural InSitu Liners:
   - InSitu soil with low hydraulic conductivity may meet the seepage control requirements for a lagoon liner.
   - Surface compaction shall be applied.
   - Natural InSitu liners shall a minimum thickness of 3 feet below the entire lagoon bottom and shall be relatively uniform and free of sand and silt.
   - A side slope shall be provided if the horizontal hydraulic conductivity of the InSitu liner does not meet the seepage control criterion or if berms are constructed with fill materials.
2. Compacted Clayey Soil:
   - Clay content of a compacted clay liner material shall be a minimum of 25 percent.
   - The liner shall have a minimum thickness of 3 feet on the bottom and 4 feet on the side slope (measured perpendicular to the slope).
   - The liner shall end at least 1 foot higher than the highest operational level.
   - Laboratory conductivity tests on the compacted clay liner shall be required.

3. Admix Liner:
    - Bentonite and sand admix liners are to be used only when mixing with native sands or silts allows a uniform admix.
    - Only high-swelling bentonite shall be used.
    - The liner shall be at least 4 inches thick after compaction.

6.3 Synthetic Liners

1. The liner type shall be carefully selected based on environmental conditions, chemical compatibility requirements, expected loads, desired design life, exposure conditions, and any other considerations.
2. All synthetic liners shall have a minimum thickness of 30 mils. High density polyethylene (HDPE) liners shall have a minimum thickness of 40 mils.
3. The liner shall be securely anchored to the dike.
4. The bottom of the liner must be adequately protected by a uniform sand bedding layer compacted to at least 90 percent of the maximum dry density or by a cushioning of geotextile fabric. The bedding surface shall be free of rocks, roots, debris, stake holes, crakes, and any rapid change in elevation.
5. The liner shall be covered with a 12 inch layer of fine grained soil on the pond side slopes to prevent liner damage.
6. Any source of potential wear in the lagoon, such as concrete foundation blocks or concrete anchors, shall be eliminated by protecting the liner with geotextile fabric or similar means. Concrete structures, such as anchor beams or pipe penetrations supports, shall be engineered to ensure liner integrity through the life of the lagoon.
7. PVC and other membrane liner materials that are susceptible to weathering when exposed shall be covered with soil on both the side slope and the bottom.
8. Liner shall be bedded on a relatively permeable layer of soil and/or geotextile to provide a venting medium for gas accumulation. Adequate base grading (a minimum one percent slope toward the edges of the lagoon) and gas vents are required for lined lagoons to ensure that no air or gas is trapped below the base of the lagoon.

7. Dike Construction

7.1 General

The dike shall be compacted to at least 95 percent of the maximum dry density to avoid settlement, slumping, and erosion, as well as to provide good support for liners, erosion protection, and vehicle traffic as follows:

- Strip the topsoil and any soft, compressible, or otherwise unsuitable materials from the dike areas, and proof roll the scarified surface to at least 95 percent of the maximum dry density.
- Hard, smooth foundation soils shall be scarified and recompacted to ensure a good bond between the fill and the foundation soil.

7.2 Dike Fill Materials

1. The dike fill material shall be free of organics, organic soil, and debris, cobbles greater than 6 inches in diameter, snow, ice, or soft compressible material.
2. The fill shall be placed in level, uniform lifts in a direction parallel to the axis.
3. The maximum loose lift thicknesses shall be 6 to 8 inches.
4. The fill shall be compacted to at least 95 percent of the maximum dry density.

7.3 Slopes

The dike slopes (interior and exterior) shall be 3 to 1 (horizontal to vertical).

7.4 Dike Crest

1. The dike crest shall be a minimum of 10 feet wide to allow vehicle access.
2. An access ramp to the top of the dike shall be provided.
3. The dike crest shall have a slight camber to promote runoff.

7.6 Erosion Control Features

1. Erosion control must be placed on interior slopes with additional protection at all piping

   Entrances and exits, where an artificial erosion protection system or riprap layer with a minimum thickness of 2 feet of 6 inch to 8 inch rocks or gabions shall be provided.

2. For large lagoons, a minimum of 24 inches of riprap protection is required on the inner side slope from the dike toe to a minimum height of 2 feet above the maximum water level to prevent wave erosion.

3. Riprap shall be generally round or cubic in shape. Slabs or elongated stone pieces having a width or thickness less than one third the lengths shall not exceed 10 percent of the total. No sand, shale, broken concrete, asphalt, or slate is allowed. Extreme care

   shall be taken to avoid incorporating fines into the riprap.

4. One layer of geotextile fabric shall be applied under the riprap to separate the fines.

5. Bentonite admix liners and synthetic liners less than 40 mils in thickness require 12 inches of soil cover under erosion protection. The cover for side slopes shall extend onto the bottom well beyond the riprap material.

6. The exterior dike slope shall be properly stabilized. Shrubs and trees shall not be planted on the dike.

7. Riprap may be required on exterior slopes where storm runoff or flooding may cause erosion of the dike.

8. When riprap is not used, the minimum erosion protection may consist of 4 inches of topsoil with an established growth of short rooted grass on the crest and inner slope down to the minimal operating depth before pre-filling or to the top edge of the riprap when applicable. The organic layer must be removed from the bottom of the lagoon.

8. Hydraulic Structures

8.1 General

1. All the influent, effluent, and interconnecting piping shall be freeze protected through means of burial depth, insulation, or heat tape.
2. Generally accepted material for underground sewage construction shall be used for piping in the lagoon. Unlined corrugated metal pipe is unacceptable.
3. Design shall address issues, such as ice damage and discharge scouring.
4. For truck-haul sewage and honey bucket dumping a suitable means shall be provided so that dumping occurs over water surface (3 foot depth of water) and not along lagoon banks.

8.2 Influent

1. The influent lines shall terminate at approximately the midpoint of the lagoon width and at approximately 10 feet from the toe of the dike slope. The influent lines shall be located as far as possible from the effluent structure for as long a length of travel to minimize short circuiting.
2. The lagoon influent effluent axis shall be perpendicular to the prevailing wind direction to minimize short circuiting caused by wind action.
3. The influent line shall be located so that the top of the pipe is no more than 6 inches higher than the finished bottom of the cell for horizontal discharge and no less than 2 feet higher than the finished bottom of the cell for vertical discharge.
4. The end of the influent line shall be maintained above the influent pipe at all times to prevent it from freezing.
5. A minimum water level of two feet shall be maintained above the influent pipe at all times to prevent it from freezing.

8.3 Control Structure

A control structure shall be designed to allow effluent to be transferred from cell to cell or to release a discharge if the effluent treatment limits are meeting. No transfer of settled solids shall be allowed. Transfers and discharges should indicate a significant treatment as the effluent passes through the successive treatment cells. Control structures must provide the engineering means to attain this goal.

8.4 Effluent

1. Effluent pipe intakes shall be located a minimum of 10 feet from the toe of the dike. Pipes with a vertical intake shall be located a minimum of 2 feet higher than the finished bottom height of the cell.
2. The effluent piping shall permit the discharge of the effluent at a minimum 6 inches of cell depth per day at the minimum working level or head.

Upper Kalskag Lagoon Inlet

9. Miscellaneous

9.1 Fence

A fence is required to prohibit unauthorized access.

9.2 Warning Sign

Warning signs shall be posted on each side of the fence to warn of a public health danger.

9.3 Gate

A vehicle access gate of sufficient width to accommodate maintenance equipment shall be provided. All access gates shall be provided with locks.

9.4 Road

An all weather access road must be built and properly maintained.

Upper Kalskag Lagoon dyke and fencing

10. Guidance on Discharge

10.1 Discharging Time and Frequency

Discharges in the spring and fall can normally be permitted. Earlier discharges may be allowed under exceptional circumstances to comply with any local conditions. If an earlier discharge is permitted, only enough volume shall be discharged to create enough storage until the fall discharge can take place. The discharge period shall not exceed three weeks unless the local conditions preclude this rate of discharge. Notification of a discharge shall be in conformance with the discharge permit.

10.2 Sampling before Discharge

1. Discrete representative samples must be taken to determine the effluent quality no later than two weeks before discharge. (This is not the Effluent Discharge Samples)
2. Samples must be taken from an aerobic secondary cell. If more than one cell is to be

   Discharged, separate samples must be taken from each.
3. All samples shall be taken from several locations in the lagoon and at least 8 feet from

   the dike and 1 foot below the surface.
4. No sample shall be taken during or immediately following excessive wind action.
5. Minimum tests conducted shall include: biochemical oxygen demand (BOD), TSS, and

   Fecal coliform. Dissolved oxygen (DO) and hydrogen (ion) concentration (pH) may be required depending on the discharge permit and must be tested on site within 24 hours before discharge.
6. Future monitoring of phosphorus and nitrogen levels may be required.
7. All sample tests shall follow the Standard Methods for Water and Wastewater Examination.

10.3 Sampling during Discharge

Sampling during discharge is compulsory according to the discharge permit requirements. Contact the local ADEC office prior to the commencement of any discharge to assure sampling meets the discharge permit requirements.

10.4 Discharge Locations

1. The location shall be determined in coordination with the Alaska Department of Natural Resources (ADNR) Habitat Division.
2. For ocean, river, or lake discharge, special attention shall be taken in the outfall structural design to protect it from ice damage, and ease of sampling.
3. For lake and river discharge, the Do shall be monitored during the discharging period.

   The lagoon discharge shall not adversely affect the receiving water DO as stipulated in the discharge permit. A minimum of 2 milligrams per liter (mg/l) DO in the wastewater is required.
4. The discharge area shall be protected and properly signed.

11. Operations and Maintenance

11.1 Prefilling

After construction, all cells shall be prefilled to a level of 2 feet minimum above the bottom to protect the liner, prevent weed growth, and confirm the integrity of the liner.

11.2 Sludge Removal

Monitoring of the sludge depth in the primary cells shall be conducted in accordance with the permit. Periodic sludge removal is required at a permitted facility.

11.3 Honey Buckets

Regular removal of debris and spills from the honey bucket dumping sites is required.

11.4 Slope Maintenance

Slopes shall be checked regularly for leaks, settlements seeps, springs, and erosion. Repairs shall be applied at least annually. Where erosion is present, placement of additional riprap or other protective material is required.

11.5 Vegetative Control

Growth of trees and shrubs on the exterior slope and interior slope above the water level shall be controlled.

11.6 Monitoring Wells

Sampling of monitoring wells shall be completed in accordance with the ADEC subsurface disposal guidance meeting both the plan review placement locations, and the requirements of the discharge permit.

11.7 Fence

The fence shall be inspected regularly, and any damage shall be repaired.

11.8 Road

Access area and road to the facility must be maintained and cleared of snow.

Akiachak Lagoon in winter

12. Lagoon Closure Procedure

12.1 Plan Approval

Lagoons which are determined to be surplus, or located in a sensitive area, must be properly closed out. As this is a change to part of a wastewater system, plan approval per the Wastewater Regulations (18 AAC 72.200. (a)) is required.

12.2 Solid Waste Regulations

If solid waste is to remain on site the requirements of the Solid Waste Regulation must be complied with see (18 AAC 60.470, 18AAC 60.490, 18 aac60.810, 18 AAC 60.820) When Bio Solids are to remain capping requirements must be protective of public health use of final capping for closure of a landfill have been established use of these standards or similar are recommended.

12.3 Bio Solids and Reuse

If Bio Solids remain at a site, development of the property must be restricted:

- Uses that do not create a health hazard maybe authorized. A development plan by the community must be established that will identify and allow a safe use.
- Uses that threaten the public or create a health hazard are restricted. (Building Homes, Parks, Day use areas, Roads, or Trails)

Worksheet for Wastewater Lagoon Design

Proposed Lagoon Location	
Worksheet Preparer	

Step 1: Rainfall Assessment

Enter the average annual precipitation (rainfall, snow, etc.) at the proposed wastewater lagoon site. →	inches

Check one box

☐ Is the average annual precipitation less than 20 inches? Then go to Step 2.

☐ Is the average annual rainfall between 20 and 30 inches? Then, go to Step 1A.

☐ Is the average annual precipitation greater than 30 inches? Then, go to Step 1B.

Step 1A

When average annual precipitation in an area is between 20 and 30 inches, experience has shown that operations problems can occur. Before proceeding any further with wastewater lagoon design, the engineering consultant should prepare a Lagoon Facility Assessment and submit it to the local ADEC office for review. This assessment should include:

- A narration of the proposed lagoon project, including the average annual precipitation in the project area.
- Any proposed design and operation enhancements (such as aeration).
- The history of lagoon use in the area.
- The rationale for selecting a lagoon as the preferred wastewater treatment option.

Step 1B

When average annual precipitation in an area is greater than 30 inches, experience has shown that **lagoon failure can occur**. Before proceeding any further with wastewater lagoon design, **the engineering consultant must meet with the local ADEC office for a project review that will include a discussion of the rationale for selecting a lagoon as the preferred wastewater treatment option.**

Worksheet for Wastewater Lagoon Design

Step 2: Design Parameters

Enter the total depth of lagoon from top of dike to lagoon bottom.	→	feet
Total depth <u>minus</u> freeboard (3 feet) and storage (2 feet)	**LD** →	feet
Enter the current population that will be served by the lagoon.	**P** →	persons
Enter the expected design life of the lagoon.	**N** →	years
Compute the Design Population: DP = $P(1.02^N)$.	**DP** →	persons

Check one box

- ☐ 25 gallons per day per person—honey bucket haul
- ☐ 45 gallons per day per person—collection by pump and haul
- ☐ 75 gallons per day per person—sewer collection system

Wastewater Generation

USE

Step 3: Hydraulic Loading Computation

<u>Hydraulic Loading in Acres</u> (DP)(240 days)(USE)/[(7.48 gal/cf)(43560 sf/acre)(LD)]	→	acres

Step 4: Organic Loading Computation

<u>Organic Loading Range in Acres</u>

OLA20: (DP)(0.17 lbs of BOD_5)/(20 lbs of BOD_5 per day per acre)	→	Acres
OLA30: (DP)(0.17 lbs of BOD_5)/(30 lbs of BOD_5 per day per acre)	→	Acres

(common use BOD loading range is 20—30 pounds per day per acre)

Worksheet for Wastewater Lagoon Design

Step 5: Lagoon Cell Sizing

All lagoons that discharge to surface waters must have at least two cells: a Primary Cell and one or more Secondary Cells. In the past, lagoon sizing in Alaska was based on the "rule of thumb" of one acre of lagoon for every 100 persons served by the lagoon. However, current organic loading guidelines require the primary cell sized for OLA30 and the total lagoon (all cells combined) sized for OLA20.

Primary Lagoon Cell Size: Write the value from Step 4, **OLA30** =	Acres
Total Treatment Lagoon Size: Compare the value from Step 4, **OLA20** with the value from Step 3 (hydraulic loading) and write the LARGER value	Acres

Step 6: Percolating Discharge Lagoons (optional)

All lagoons that discharge to ground water must have a Primary Cell, an optional Secondary Cell, and a Percolation Cell. Primary Cell size and Total Treatment Lagoon size are determined using the values from Step 5. The Percolation Cell is considered a disposal system, and it is NOT considered part of the lagoon treatment system.

The Percolation Cell must be designed based on actual site soil conditions. The surface area of functioning Percolation Cells is about 45 persons per acre. A Percolation Cell Design Report that includes percolation test data and soils information must be submitted with this Worksheet. Soil percolation rates near 1 minute per inch are acceptable. Sites underlain with shallow permafrost or seasonal shallow groundwater are not suitable for Percolation Cells.

Appendix B-Wastewater Lagoon Geotechnical Findings and Recommendations, Hooper Bay, Alaska
(Golder Associates Inc., April 26, 2018)

April 26, 2018 Project No. 1782343

Paul Weisner, PE
CE2 Engineers, Inc.
8221 Dimond Hook Dr.
Anchorage, AK 99507

WASTEWATER LAGOON GEOTECHNICAL FINDINGS AND RECOMMENDATIONS, HOOPER BAY, ALASKA

Paul:

Golder Associates Inc. (Golder) is pleased to present our geotechnical findings and recommendations for the proposed wastewater lagoon in Hooper Bay, Alaska (Figure 1). Our services were provided in general accordance with our authorized scope of services and professional services agreement with CE2 Engineers, Inc. (CE2). The geotechnical field investigations were conducted in January 2018 with CE2 logistics assistance. The field effort consisted of advancing 15 geotechnical boreholes at two planned development areas for the proposed wastewater lagoon to aid with CE2's planning and engineering analysis.

1.0 PROJECT UNDERSTANDING AND GEOTECHNICAL SCOPE OF SERVICES

The State of Alaska, Department of Environmental Conservation, Division of Water, Village Safe Water (VSW) Program is developing additional wastewater treatment capacity for the village of Hooper Bay. The proposed improvements include additional wastewater lagoon treatment storage capacity and associated infrastructure. CE2 has identified two sites for the lagoon improvements:

- Expansion of the existing lagoon northward of its current location (Expansion Site)
- Relocation of the lagoon to an upland site approximately 2,500 feet north of its current location (Upland Site)

Geotechnical investigations were conducted at both sites. In addition, geotechnical boreholes were advanced along the planned alignment between the fill pad at the existing wastewater lagoon and the Upland Site as part of an above-grade access evaluation.

CE2 established the approximate footprints for the lagoon sites and the above grade alignment corridor as part of the project planning. Preliminary geotechnical borehole locations were established as part of the pre-field planning effort with CE2's civil engineering team. CE2's surveyor located the proposed geotechnical borehole locations in the field prior to mobilizing geotechnical exploration equipment to the village.

Our geotechnical scope of services included the following key elements:

- Drill boreholes at the pre-surveyed locations and log subsurface conditions observed for each borehole as they were advanced. Recorded and retained soil samples for geotechnical laboratory testing and classification.
- Installed PVC standpipes for ground temperature measurements.
- Measured ground temperatures in the PVC standpipes at the time of drilling and in late March 2018 after drilling-induced heat dissipated.
- Geotechnical laboratory analysis for soil index properties, thaw strain testing on select permafrost soil samples, and consolidation analysis for unfrozen compressible mineral soils in areas planned for lagoon development.
- Geotechnical engineering analysis and recommendations for the lagoon development and, if needed, the above-grade access way to the Upland Site.

2.0 GEOTECHNICAL INVESTIGATION

A total of 15 boreholes were advanced on January 20 through 23, 2018 using a track-mounted Geoprobe 6620DT drill rig. CE2 provided field logistics support for the drilling operation including trackhoe, loader and drilling platform. The boreholes were advanced by GeoTek Alaska, Inc. under contract to CE2. The locations for the 15 boreholes were established by CE2 and Golder and were surveyed and marked by CE2 prior to drilling activities. The borehole locations were verified in the field using a hand-held GPS, and the borehole locations and numbers are shown in Figure 2.

Golder engineer Christopher Valentine, PE managed the field exploration program, logged each borehole as it was advanced and retained soil samples for additional classification and geotechnical analysis. Boreholes were advanced to depths ranging from 17 to 29.5 feet below ground surface at the time of the field work (bgs). Both disturbed and undisturbed soil samples were recovered and logged. Disturbed soil samples were collected by standard penetration test / split-barrel sampling methods (ASTM D1586) using a 2-inch outside diameter sampler advanced with a 140-pound drop hammer. The drop hammer blows required to advance the soil sample each 6-inch interval were recorded. The blows required to advance the sampler the final 12-inches are provided as “Blows per Foot” on the borehole logs. Disturbed soil samples were also collected by direct push soil sampling (Geoprobe Macro-Core MC5 Soil Sampling System) in select boreholes, which provided a continuous recovery throughout the sample interval. Undisturbed soil samples were collected using a thin-walled open-tube sampler (i.e. Shelby Tube) pushed using drill rig hydraulics (ASTM D1587).

Soil sampling was conducted at nominal 2.5-foot intervals from the ground surface to 10 feet bgs then at 5-foot intervals from 10 feet bgs to the boring termination depths. Recovered soil samples were visually classified in the field following the Unified Soil Classification System (USCS). After visual field logging, select portions of representative soil samples were retained in sealed polyethylene bags for further classification and laboratory analysis. All retained soil samples were transported to Golder’s US Army Corps of Engineers validated Anchorage geotechnical laboratory for further examination, classification, and testing.

Following the completion of the boreholes and sampling, sealed 1-inch PVC standpipes were installed in select boreholes for future ground temperature monitoring. Auger cuttings were used to backfill the annular space between the PVC standpipes and the borehole sidewall. Ground temperatures were measured in the PVC standpipes prior to our departure but these temperatures were not representative because of drilling induced heat

and the cold cuttings used for backfill and were not used. Golder conducted a return trip to the site in late March to measure stable ground temperatures in the PVC standpipes. CE2 provided field logistics for our ground temperature measurement efforts.

3.0 GEOTECHNICAL LABORATORY TESTING

Select soil samples were re-examined in our Anchorage laboratory to confirm the field classifications. Representative samples were selected for soil index property testing and advanced secondary laboratory testing. Soil index property testing included soil moisture content, grain size distribution and pore water salinity analysis on select soil samples. Laboratory testing followed the standards established by ASTM International (ASTM) except for pore water salinity. Pore water salinity was determined using conductivity methods. Geotechnical laboratory test results are provided on the borehole logs in Appendix A and the summary of laboratory results presented in Appendix B.

Advanced geotechnical laboratory testing included thaw strain analysis on select mineral permafrost soil samples retained from the Upland Site area to assist with our analysis of use of the in-place mineral soil for lagoon embankment engineering analysis. One-dimensional consolidation testing following ASTM D2435 was conducted on select samples of unfrozen compressible mineral soils in the proposed Expansion Site. The consolidation testing was conducted to aid in our analysis of settlement under the anticipated lagoon embankment surcharge loads.

4.0 REGIONAL GEOLOGY

4.1 Physical Setting

Hooper Bay, located on the western edge of the Yukon Delta National Wildlife Refuge, is on the southwestern tip of a peninsula bounded by Hooper Bay to the south and Kokechik Bay to the north. Hooper Bay lies approximately 20 miles south of Cape Romanzof and 25 miles south-southwest of Scammon Bay within the Yukon-Kuskokwim Coastal Lowland Physiographic area.

The area is dominated by tidally influenced marsh with numerous lakes, sloughs, and meandering streams with low gradients. Many of the drainages are distributaries or former channels of the Yukon River. Thaw lakes cover 30 to 50 percent of the landscape, many having scalloped shorelines most likely formed through the coalescence of smaller lakes[1].

4.2 Geologic Setting

In the vicinity of the project area mapped geologic formations consist of estuarine deposits (Qe) and old alluvial deposits (Qoa)[1]. Qe deposits consist of silt and sandy silt reworked and deposited by tidal currents and wave action. Conical mounds approximately 10 to 20 feet in height located on the northeast side of Hooper Bay were identified as small mud volcanoes. These appear within along the formation contact between estuarine deposits

[1] Wahrhaftig, Clyde, 1965, Physiographic divisions of Alaska: U.S. Geological Survey Professional Paper 482, 52 p., 6 sheets, scale 1:2,500,000.

and present day tidal mudflats. Qoa deposits consist mainly of silt and sand; clay and minor amounts of fine grained gravel at depth deposited by mostly fluvial and eolian processes[1].

Permafrost distribution in the vicinity of the project area is mapped as sporadic (10 to 50 percent areal extent). Where encountered, permafrost can extend to depths of 200 to 300 feet. Surficial seasonal thawing of the Qoa formation has created most of the lakes within the area.

5.0 SUBSURFACE CONDITIONS

The subsurface conditions observed in the boreholes are based on our visual classification of the recovered soil samples, disturbed auger cuttings, drilling action, and laboratory analysis results. The inferred borehole logs are presented in Appendix A. A summary of the subsurface conditions encountered in the boreholes is provided in the following table below by site. The depth of surface ice and water, if present, is noted along with the total depth and frozen soil zones (seasonal frost and permafrost). The boreholes completed with PVC standpipes for ground temperature monitoring are also noted. Please refer to the borehole logs in Appendix A for additional details.

Table 1: Summary of Subsurface Conditions by Borehole

Borehole ID	Site Location	Total Depth (feet bgs*)	Surface ice and water (feet)	Frozen Soil Zone (feet bgs*)	PVC Standpipe Depth (feet bgs*)
TH(2A)-1	Lagoon Expansion Site	24.5	5	4 - 11	24.5
TH(2A)-3	Lagoon Expansion Site	24	0.5	0 - 6.5	24
TH(2A)-5	Lagoon Expansion Site	23.5	6	All Unfrozen	Not Installed
TH(2A)-7	Lagoon Expansion Site	24.5	0.5	0 – 2 and 5 - 7	Not Installed
TH(2A)-8	Lagoon Expansion Site	25	None Encountered	0 - 2.6	25
TH(2B)-1	Above Grade Force Main Alignment	25	None Encountered	0 - 3	25
TH(2B)-3	Above Grade Force Main Alignment	24.5	None Encountered	0 - 1 and 23 - 24.5	24.5
TH(2B)-4	Above Grade Force Main Alignment	17.5	None Encountered	0 - 17.5	17.5
TH(2B)-5	Upland Site	25	None Encountered	0 - 25	25

[1] Hoare, J.M., and Condon, W.H., 1968, Geologic map of the Hooper Bay Quadrangle, Alaska: U.S. Geological Survey Miscellaneous Geologic Investigations Map 523, 4 p., 1 sheet, scale 1:250,000.

Borehole ID	Site Location	Total Depth (feet bgs*)	Surface ice and water (feet)	Frozen Soil Zone (feet bgs*)	PVC Standpipe Depth (feet bgs*)
TH(2B)-7	Upland Site	29	None Encountered	0 - 29	28.5
TH(2B)-8	Upland Site	25	None Encountered	0 – 1.5 and 14 - 25	Not Installed
TH(2B)-9	Upland Site	25	None Encountered	0 - 25	23
TH(2B)-10	Upland Site	25	None Encountered	0 - 25	25
TH(2B)-11	Upland Site	23.8	1.2	0 - 0.3	Not Installed
TH(2B)-12	Upland Site	24	None Encountered	0 - 5	Not Installed

Note: * bgs is the depth below the ground surface in feet at the time of drilling. Surface ice and/or water depth encountered above the ground surface at the time of drilling is noted in the above table and on the borehole logs as Notes.

5.1 Lagoon Expansion Site (adjacent to the existing wastewater lagoon)

The Expansion Site is characterized by numerous surface water ponds and well-established drainages. The Expansion Site also abuts the existing wastewater lagoon embankment. Snow drifting is present along the outward slope of the existing lagoon berm. The seasonal snow drifting is expected to impact the ground thermal regime along the embankment. A review of historic imagery for this area indicates the existing wastewater lagoon is at least partially located over surface terrain indicating dune deposits. These dune deposits are commonly encountered throughout the Hooper Bay area, often with permafrost.

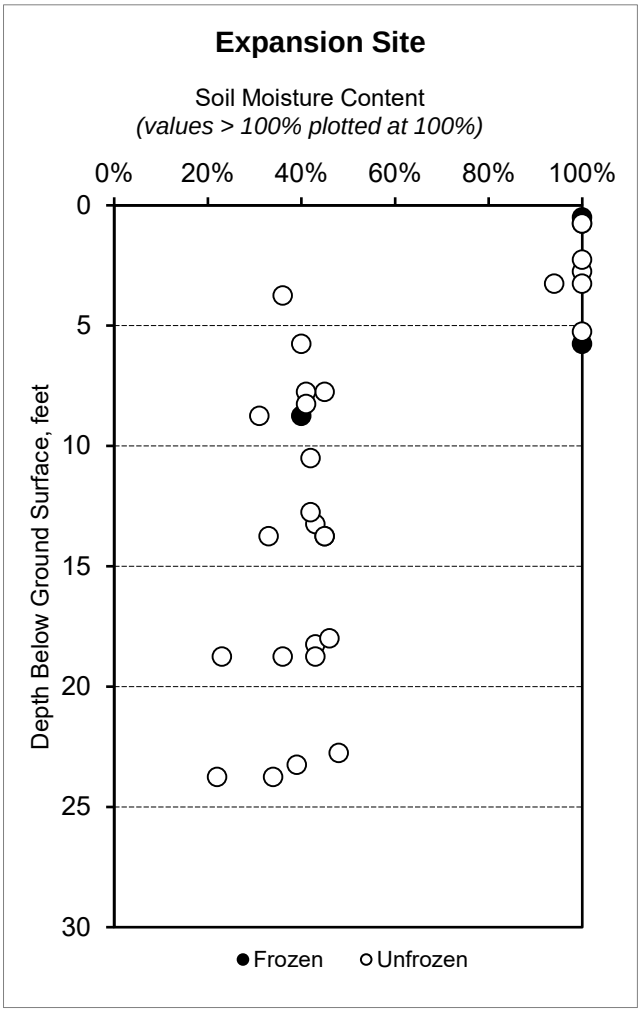
Five boreholes were advanced along the proposed Expansion Site lagoon embankment footprint and inside the planned lagoon, Figure 2. The boreholes were advanced to depths ranging from 24 to 25 feet bgs. At the time of the field explorations, boreholes TH(2A)-1 and TH(2A)- 5 encountered surface ice and water over the tundra mat. Below the ground surface the encountered soil were generally consistent. Surface peat and organic silt extended from 2 to 7 feet bgs. Below the organics, sequences of mineral silt and silt with sand were encountered. Borehole TH(2A)-7 encountered silty sand that was not encountered in the other four boreholes advanced at this site.

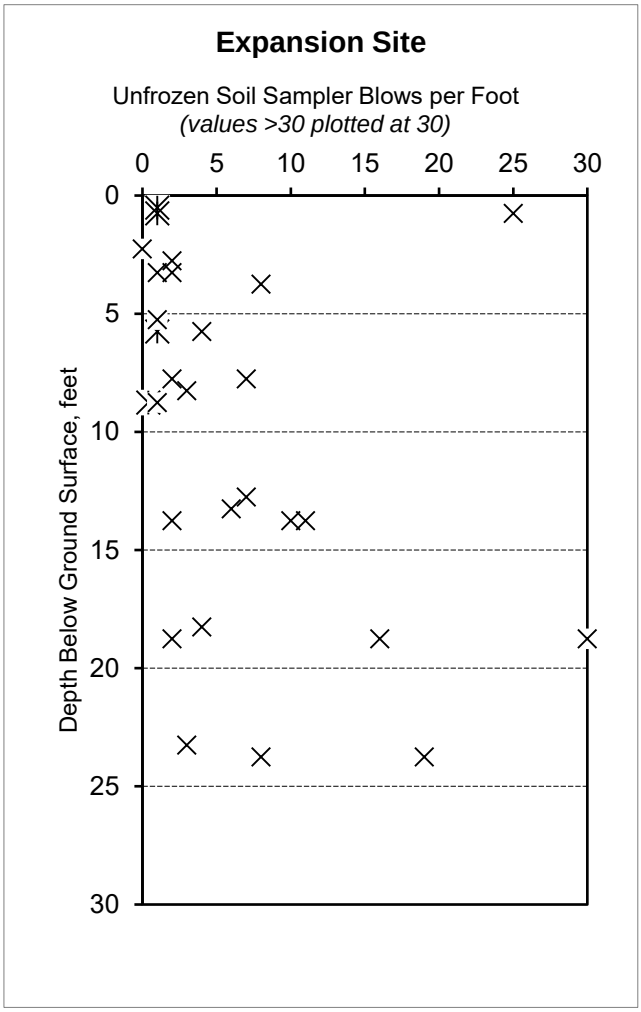
At locations without surface ice or water, seasonal frost was encountered to about 3 feet bgs in the boreholes. Except for a few isolated zones of frozen soil, the drilling action and recovered soil samples indicated unfrozen soil conditions to the borehole termination depths. Isolated permafrost conditions were inferred by drilling action and recovered soil samples between 9 to 16 feet bgs in borehole TH(2A)-1 and from 5 to 7 feet bgs in borehole TH(2A)-7. Saline conditions were observed in the sample collected from 7 to 8.5 feet bgs in borehole TH(2A)-5, with concentration of 34 parts per thousand (ppt), which is roughly seawater salinity concentrations. Salinity levels greater than 10 ppt were also observed in Boreholes TH(2A)-1 and TH(2A)-8.

The mineral silts were plastic, generally high to borderline high plasticity (MH and MH/ML), and were considered compressible materials. Consolidation testing was conducted on selected higher-plasticity mineral silt samples. In the boreholes these samples were collected from, groundwater was not observed in the borehole annular space at the time of drilling. However, based on our visual classifications and laboratory analysis, the mineral silt is considered saturated.

Within the Expansion Site, soil moisture content results as a percentage of dry weight are summarized in the following plot. As noted below, soil moistures for frozen soil (seasonal and inferred permafrost) and unfrozen soil ground thermal states are provided. In general, the surface organics have significantly elevated soil moisture contents. However, the unfrozen mineral soils indicate water contents at thawed state saturation concentrations.

Where split-barrel drive samplers were used to recover soil samples, the blows per foot required to advance the sampler were recorded and are summarized on the following plot. Blows per foot data are provided for both frozen and unfrozen soil conditions. As noted in the following plot, a general trend of increasing blows per foot was evident, but considerable scatter in the data are present. Thus, reliance on blows per foot as a sole indicator of soil density or consistency trends should be interpreted with caution.

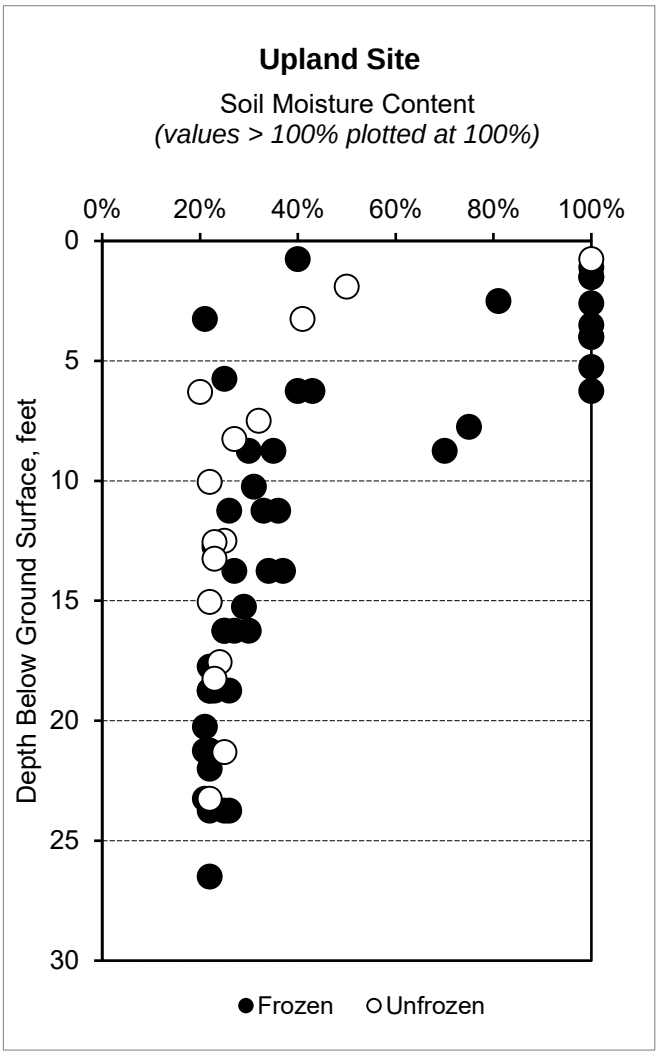




5.2 Upland Site

The Upland Site is characterized by a topographically elevated area with distinct surface water ponds and drainages. The geotechnical boreholes were in areas with ponded surface water and wind-swept areas. A total of seven boreholes were drilled at the proposed Upland Site to depths of 24 to 29 feet bgs. The soils consist of peat and organic silt from approximately 1.5 to 6 feet bgs, underlain silt with variable amounts of fine sand. Along the western portion of the investigation area sequences of silty sands were generally encountered below the organic mat. In contrast to the Expansion Site, mineral silty sands or silts with elevated fine sand content were encountered at depth in all boreholes advanced at the Upland Site.

In general, bonded permafrost was encountered throughout the Upland Site, except under the larger surface water ponds. Boreholes TH(2B)-5, TH(2B)-7, TH(2B)-9, and TH(2B)-10 encountered bonded permafrost soil conditions to depth. Boreholes TH(2B)-11 and TH(2B)-12 were in or near larger surface water ponds and encountered unfrozen soil conditions below mudline to the borehole termination depths. Groundwater was observed in these two boreholes at 10 to 11 feet bgs at the time of drilling. Borehole TH(2B)-8 is located near a defined surface water drainage. Unfrozen soil (degraded permafrost) was encountered in the borehole to about 12 feet bgs grading to poorly to well bonded permafrost to the borehole termination depth of 25 feet bgs.



Soil moisture contents for frozen and unfrozen soil samples recovered from the Upland Site are summarized on the above plot. As expected, the surface organics contained relatively high soil moisture contents. The mineral soils below the surface organics have soil moisture contents near their expected thawed state saturation concentrations. However, the frozen mineral soils indicate soil moisture contents slightly above thawed state saturation concentrations. This condition was noted in the recovered soil samples as visible ice content. Nearly all soil sampling in the Upland Site was completed with direct-push methods.

5.3 Proposed Force Main Alignment

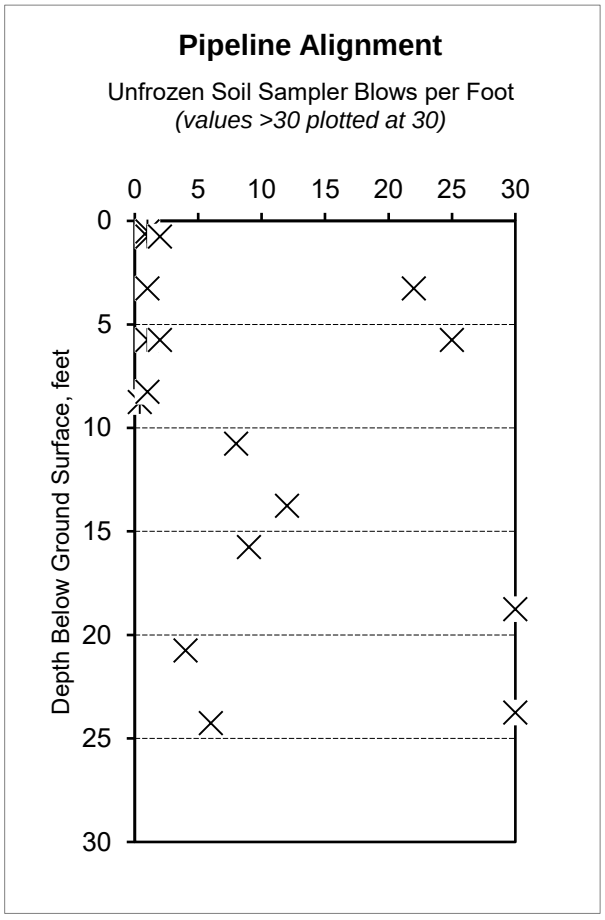
The pipeline alignment generally follows well defined surface water drainages. Three boreholes, from south to north, were drilled along the alignment: TH(2B)-1, TH(2B)-3 and TH(2B)-4. Borehole TH(2B)-1 was located near the southern terminus of the pipeline alignment. Boreholes TH(2B)-3 and TH(2B)-4 were located on the banks of a larger water drainage to aid with engineering analysis for spanning the waterway.

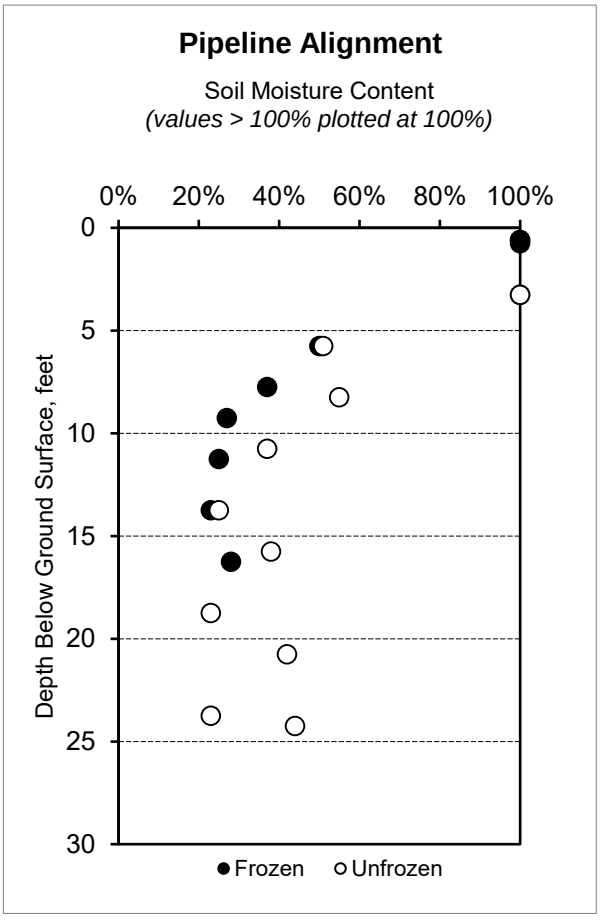
Soils in these boreholes were composed of peat and organic silt layers from ground surface to approximately 3 to 5 feet bgs. The organic soils are underlain by mineral silts with variable amounts of fine sand, elastic silt, silty sand and sand with silt.

In Boreholes TH(2B)-1 and TH(2B)-3 seasonal frost conditions were observed from ground surface to approximately 3 and 1 feet bgs, respectively. Unfrozen soils were encountered below the seasonal frost in these boreholes but drilling action and recovered soil samples indicated possible degraded permafrost from 15 to 20 feet bgs in Borehole TH(2B)-1 and near the termination depth in borehole TH(2B)-3. Bonded permafrost was encountered in Borehole TH(2B)-4. Salinity of 10 ppt and greater were observed in samples from Boreholes TH(2B)-1 and TH(2B)-3. The elevated pore water salinity is attributed to storm surge along the major drainages in this area.

While relatively few borings were advanced along the pipeline alignment the soil moisture plot indicate saturated conditions for the mineral soils and noted in the following plot. No significant variations between frozen and unfrozen state moisture concentrations were evident in the mineral soils.

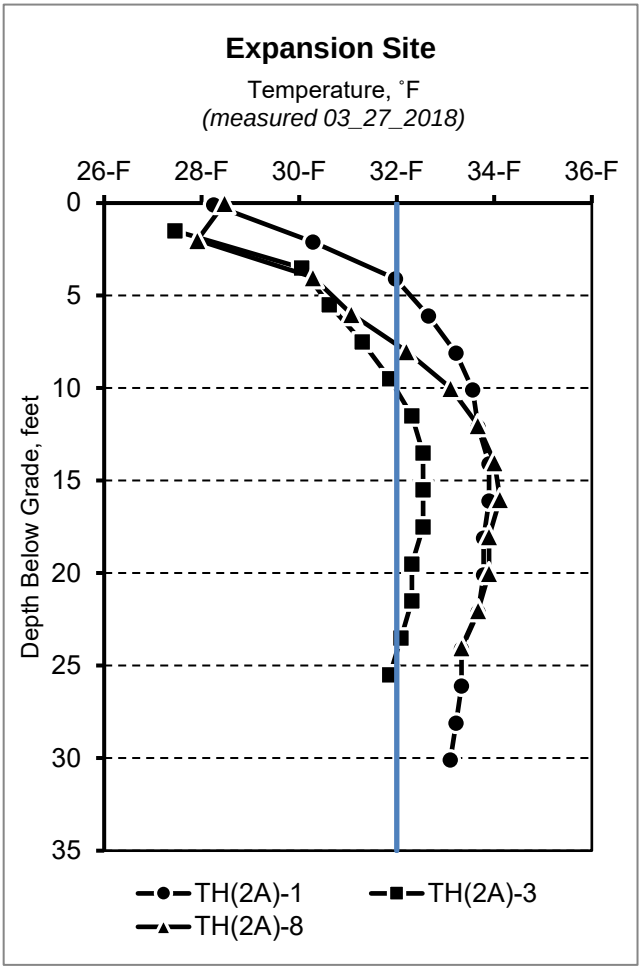
A similar plot of soil sampler blows per foot by depth is summarized in the adjacent plot. The field data indicates relatively soft/loose soil consistency/density to about 10 feet bgs increasing slightly with depth. However, some isolated data indicate larger blows per foot were required to advance the sampler in the mineral soils at depth. These larger blows per foot data points are considered outliers and do not reflect to general soil density/consistency states along the exploration depths.

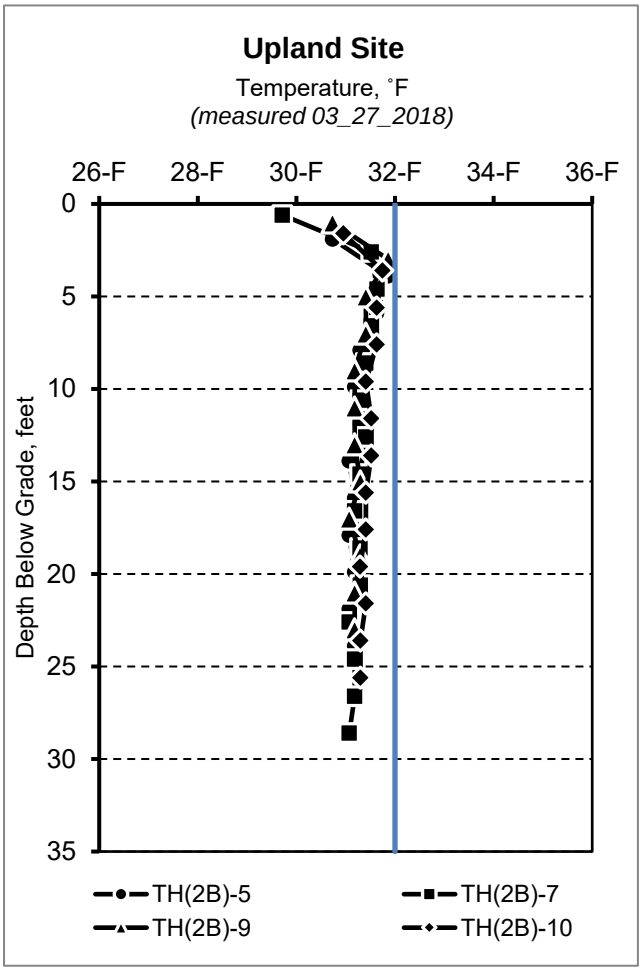


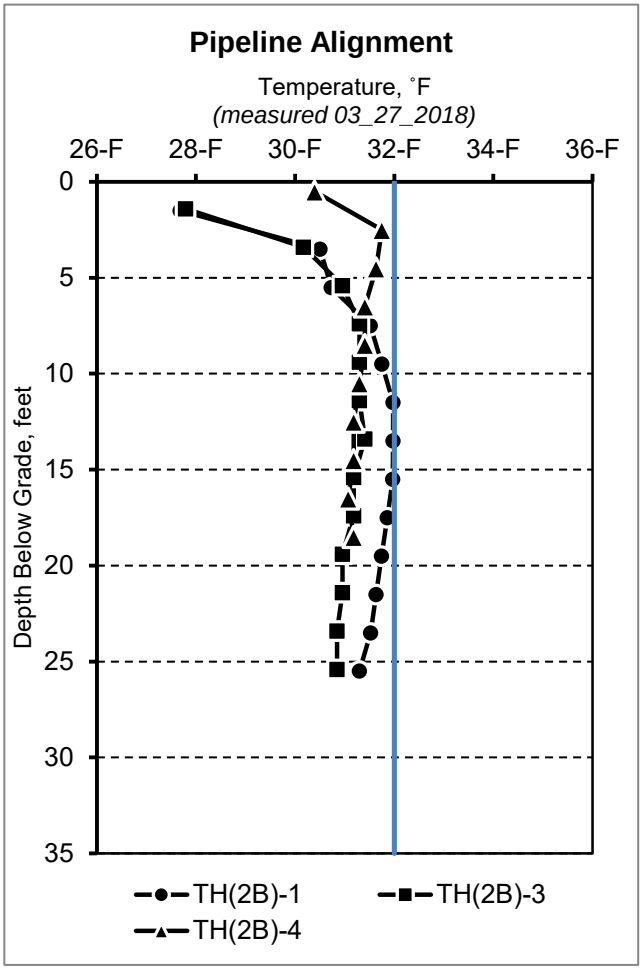


6.0 GROUND TEMPERATURES

Ground temperatures were measured in late March in the PVC standpipes installed in select boreholes. Ground temperatures were measured with Digital Temperature Cables (DTC) that was ice bath calibrated within 12 months of use at this site. Summary ground temperature profiles are provided in the following plots. The ground temperature data support the ground thermal states inferred during drilling, generally unfrozen soils at the Expansion Site with wide extents of permafrost at the Upland Site.

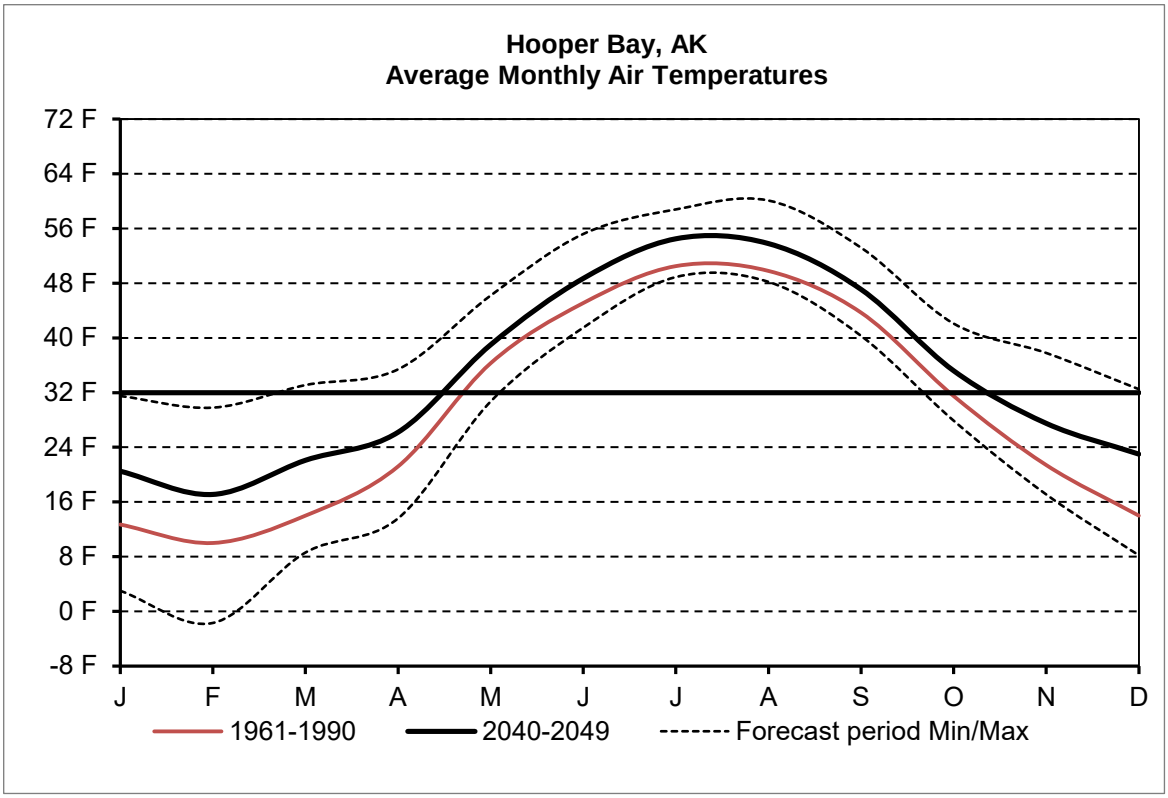






7.0 GEOTECHNICAL ENGINEERING CLIMATE INDICIES

To aid with engineering analysis, we have summarized engineering climate indices for Hooper Bay as modeled by the Scenarios Network for Alaska & Arctic Planning (SNAP) at the University of Alaska Fairbanks. The SNAP group uses five Intergovernmental Panel on Climate Change (IPCC) General Circulation Models (GCM) they consider most applicable for Alaska. SNAP includes several Representative Concentration Pathways (RCP) for their climate forecasts. For our analysis, a RCP of 6.0 (watts/m^2) was used. The model analysis results have variability. SNAP forecast data include the five GCM model average as well as the minima and maxima individual model results for the 2040-2049 forecast period.



Period		Average Air Temperature	Freeze Index	Thaw Index
1961-1990	Mean	29.2 F	2,980 F-days	2,100 F-days
2040-2049	5 Model Mean	34.6 F	1,660 F-days	2,650 F-days
2040-2049	Maximum	43.0 F	70 F-days	4,120 F-days
2040-2049	Minimum	23.9 F	4,470 F-days	1,570 F-days

Maximum: Warmest Values from all 5 GCM Models
Minimum: Coldest Values from all 5 GCM Models

ENGINEERING DESIGN INDICES	3,060 F-days	3,380 F-days

As noted above, continued climate warming is anticipated for the Hooper Bay area. Based on our evaluation of the climate model data, during the 2040-2049 period the thaw and freeze indices may roughly balance. Engineering design indices for freeze and thaw should be expected to reflect regional warming trends. Unless thermal mitigation measures are adopted, these trends should be expected to result in ground warming, deepening seasonal active layer, permafrost warming or degradation, and ground surface vegetation changes.

8.0 DISCUSSION

Two sites were identified by CE2 for the wastewater lagoon. A summary of key geotechnical findings and considerations for each site is provided below.

The Expansion Site is adjacent to the existing wastewater lagoon and will most likely key into the existing lagoon embankment. The site also appears to be in an area with the potential for storm surges and seasonal flooding during breakup. Soils in the proposed Expansion Site are predominately unfrozen, plastic mineral silts. These materials are considered compressible and will consolidate under surcharge pressures. Surcharge pressures can result from embankment fill, changes in groundwater levels and other sources. In addition, the Expansion Site also has variable thickness surface organics. Based on our field findings, the surface organics will compress under sustained loads.

We understand a key performance criterion for the wastewater lagoon is maintaining the design elevation of the embankment throughout the intended service life. The compressible organics and underlying mineral silts will experience differential consolidation over time due to surcharge pressures. Based on geotechnical laboratory test results we estimate the plastic mineral silts can experience up to 12 inches of consolidation settlement due to reasonably expected lagoon berm surcharge pressures. This consolidation settlement will be time dependent and may require many years to achieve consolidation unless mitigation measures such as wick drains are installed to accelerate the rate of consolidation.

In addition, the variable thickness surface organics will experience differential settlements under surcharge pressures. Based on the recovered samples of the organic material, volumetric changes on the order of 50 to 70 percent, possibly more, can be expected through the organic sequence thickness. While the compression of the organic layer is expected to occur over a shorter time frame relative to the underlying plastic silts, several years should be expected for primary consolidation of the organics. If the organics are removed under the embankment footprint and replaced with mineral soil, the contribution of the organic layer to the total settlement will be significantly reduced.

Assuming the surface organics are not removed, several feet of combined organics and plastic silt consolidation should be expected under reasonably expected lagoon embankment pressures. This consolidation will occur over years unless soil settlement acceleration measures are employed. Also, due to variation in organic thickness and plasticity of the mineral silts, differential settlements should be expected.

The Upland Site is characterized by lower plasticity mineral silts and in some areas significant sequences of unfrozen silty fine sands. These materials are expected to experience geotechnically-elastic settlement to a greater degree than the higher plasticity silts encountered at the Expansion Site. Thus, settlements of the mineral soils under surcharge pressures at the Upland Site are expected to occur at a faster rate relative to the Expansion Site. Based on our interpretation of the Upland Site geotechnical properties, most of the settlement due to surcharge pressures should occur concurrent with embankment fill placement and the initial few years after placement. Total settlements under surcharge pressures at the Upland Site will also experience compression of the surface organics similar to the Expansion Site.

However, the Upland Site has mixed ground thermal conditions with significant bonded permafrost zones outside the larger surface water bodies. Based on thaw strain testing results, we estimate one-dimensional thaw strains on the order of 20 to 30 percent can occur as the mineral silts and silty sands thaw. Variations in the estimated thaw strains are correlated with frozen state ice and soil moisture contents. Thaw related settlements generally

occur slowly as the thaw front extends into the bonded, frozen mineral soils. With larger embankment fill sections, the thaw front will advance differentially under the embankment footprint with greater thaw penetration along the shoulders of the fill section relative to the center of the fill section. Snow drifts, solar gain, lagoon water levels and a host of other factors will influence both the extent and rate of thaw penetration and thaw-related settlements.

Permafrost soil with excess ice may also experience creep related settlement even if the permafrost is maintained in a bonded, frozen state. The nature of the creep related settlement is impacted by several key variables including pore ice content, pore water salinity, surcharge pressures and climate impacts. However, creep related settlement is considered minor to the organic and thaw-related settlements at this site.

In general, we expect the Upland Site will not be subject to the same amount of total and differential settlements as expected at the Expansion Site. However, both sites are expected to experience relatively similar compression of the surface organic layer.

The Upland Site will require an above grade pipeline and possibly a maintenance accessway between the village and the site. The proposed alignment will traverse an area with well-defined surface drainages and water ponds. Portions of the drainageways may be subject to storm surge and ice forces during spring breakup. Ice forces on above grade structures may be significant during spring breakup.

We understand the above grade accessway may require design analysis and engineering recommendations for a standard H-5 design vehicle (pickup). Concept-level civil and structural engineering design analysis for a H-5 load state has not been developed as of this submittal. However, the soils along the proposed Pipeline Alignment have mixed organic, mineral and ground thermal states. CE2 has requested preliminary geotechnical evaluation of helical (screw) piles to support the above grade accessway to the Upland Site.

9.0 SEISMIC DESIGN CONSIDERATIONS

Based on the observed site conditions and our geologic interpretation of the proposed development area, saturated soils with variable plasticity are present. Accordingly, seismic site class “D” as defined by the 2012 International Building Code (IBC) is considered appropriate for the area. Accordingly, spectral response acceleration for short periods (S_s) of 0.143g and 0.072g for a 1-second period (S_1) are recommended for the general development area.

Site coefficient factors F_a and F_v are 1.6 and 2.4, respectively, for seismic site class “D”. Based on these values, the mapped spectral response acceleration for short period and 1-second period for seismic site class “D” are:

S_{MS} = 0.229g and S_{M1} = 0.174g

The civil engineer should determine the appropriate seismic design accelerations.

Where looser, saturated sandier soils are present, the risk of liquefaction and lateral spreading exists at this site. However, bonded, frozen soil and thawed soils with elevated fines content pose a lower risk of liquefaction. If a more detail seismic hazard evaluation is required, we should be contacted.

10.0 RECOMMENDATIONS

Based on discussion with CE2, we understand the Upland Site is preferred for the wastewater lagoon primarily due to the potential for significant differential settlements and variable rates of settlement at the Expansion Site. The desire for controlled longer-term operational and maintenance cost for the lagoon embankment is considered

a critical factor, particularly as the lagoon fills with wastewater. Accordingly, we have focused our geotechnical recommendations to the Upland Site and the required above grade Pipeline Alignment to this site.

We understand CE2 envisions dewatering and excavating mineral soils from the currently ponded area as the primary lagoon area. The excavated soil will most likely include saturated unfrozen granular material and bonded, frozen materials of similar composition. The excavation depth is being developed by CE2's civil engineering team but is expect to about 3 to 5 feet below existing grade. The excavated mineral soils will be stockpiled, allowed to thaw and moisture condition for use in geotextile encapsulated ("Burrito Wrap") embankments placed on undisturbed ground adjacent to the lagoon. The excavated organic soils will be segregated and used for a vegetative growth medium along the lagoon embankment side-slopes.

Ideally, the organic material under the lagoon embankment footprint should be removed to mineral soil and backfilled with mineral soil as part of the lagoon embankment design. If the organic layer is not removed, differential settlement of the organics will occur, and the engineering design should provide for differential compression of the surface organics.

Thaw-related settlement of the bonded, frozen soils below the embankment should be anticipated. Thaw-related settlements will occur differentially over time as the thaw front advances into the underlying in-place frozen soils. However, the greater thaw penetration is expected along perimeter of the embankment with the potential for longitudinal (tension) cracks in the fill section and possibly some slope instability along the embankment fill side-slopes.

For preliminary geotechnical analysis, we have assumed a nominal 8-foot-high lagoon embankment relative to existing grade with a nominal 5-foot excavation within the lagoon footprint. The embankment will be constructed with thawed and moisture conditioned mineral soil excavated from the lagoon footprint using geotextile encapsulated fill sections. Winter earthwork is anticipated for a least portions of the lagoon construction.

All surface water should be removed from the excavation footprint. We also recommend dewatering of the unfrozen soils planned for excavation. Dewatering can be conducted using trenches and pumps, well points and other means. We can assist the design team with construction phase dewatering options.

Portions of the Upland Site may be near existing surface water bodies outside the currently envisioned development footprint. Depending on the soil and ground thermal states, the adjacent surface water bodies may be hydraulically connected. If so, dewatering may be a complex issue. Once final siting and civil engineering elevations for the Upland Site lagoon and associated improvements are determined, we should be contacted to review the design plans and discuss the proposed site development process with the design team and owner.

The proposed wastewater lagoon can be constructed with an enclosed embankment using locally obtained mineral silts and fine-grained sands excavated from the lagoon footprint below the surface organics. The material will be saturated, particularly after the initial thaw of the excavated frozen material. Saturated mineral soils may become very soft when disturbed. Consequently, the material should be mined with a track-mounted excavators working from the undisturbed natural ground. If the ground is unfrozen, construction-phase stabilization mats should be considered during excavation. After a frozen crust has developed in the winter, the ground should support a tracked excavator. It may be necessary to rip or blast the frozen material, or layers of the material may be allowed to thaw. All frozen material should be completely thawed before use in the embankment.

To reduce seepage through the embankment, the surficial peat layer should be excavated under the embankment footprint and an unfrozen plastic silt placed directly on the underlying in-place mineral silt. Each layer of unfrozen fill should be densified to a firm state.

The material is highly frost susceptible and without geotextile encapsulation the embankment slopes expected to flatten significantly, perhaps to 5H:1V (horizontal:vertical) or flatter. To construct and maintain steeper slopes on order of 2.5 to 3H:1V, the fill should be encapsulated using geotextiles. The height of each geotextile encapsulated lift should be about 18-inches. The geotextile should fully encapsulate the fill material. The geotextile should be specified by the civil engineer along with specification and acceptance criteria if sewn seams are planned for the geotextile.

If the embankment is built during the winter, it will settle as the moisture conditioned but seasonally frozen fill thaws. If it is constructed in the summer, most of the settlement will occur during construction. Thaw related settlements in the range of 15 to 20 percent may occur if moisture conditioned but frozen fill is used, assuming the embankment fill is mineral silty soil processed by track walking. Consequently, the embankment design should include additional height to account for thaw related fill settlement. Considerably greater thaw related settlements should be expected of the embankment fill is not allowed to drain and moisture conditioned prior placement.

The encapsulated embankment should be capped with a layer of organic material, fertilized and seeded to promote a growth of vegetation. Vegetation on the surface of the dike will reduce long-term maintenance requirements.

The inside toe of the embankment must be offset horizontally from the crown of the excavation footprint. The excavation area will continue to slough and settle over time, particularly due to wave action. A nominal side slope on the order of 5 to 6H:1V can be expected along the excavation perimeter. We recommend the toe of the lagoon embankment be set back at least 6 feet from the crown of the excavation footprint, using a minimum 6H:1V slope for the excavation back-slope.

The Pipeline Alignment is expected to encountered mixed soil and ground thermal states for any above grade foundation members. Assuming an axial design load of 8,000-lbs per foundation member for an H-5 vehicle load, a 6-inch riser diameter helical (screw) piles fabricated with three helices (14, 12 and 10-inch diameter) is recommended as a design concept. Each helical pile should be embedded at least 30 feet to the uppermost helix and develop at least 3,000 foot-pounds of installation torque as averaged along the final 5 feet of embedment. Lateral capacity of the riser section will depend on the structural design loads but the shallow subsurface soils are expected to be saturated, soft or loose materials with an organic cap. Batter orientations or helical pile groups may be warranted, pending final design loads. Also, seasonal ice loads acting on the above grade riser sections will need to be considered as the engineering design advances.

Depending on importance factors, tolerances for foundation related movements, and nature of the design loads, axial and lateral load testing may be warranted on select foundation members.

As the civil and structural engineering designs are advanced for the planned development, we will need to coordinate with the design team. Revisions and/or refinements to our geotechnical discussion and recommendations presented with this submittal are anticipated. Accordingly, we should be including with design team assessments and revisions to the conceptual development plan provided as the basis for this submittal.

11.0 USE OF REPORT

This report has been prepared for the use by CE2 Engineers for the proposed wastewater lagoon expansion in Hooper Bay, Alaska. The general subsurface conditions are based on the geotechnical field and laboratory data and our interpretation of the area geotechnical, hydrogeologic and ground thermal states. If there are significant changes in the nature, design, or location of the proposed development, we should be notified so that we may review our findings and engineering concepts presented in this submittal in light of the proposed changes and provide a written modifications or verification of the changes.

There are possible variations in subsurface conditions between explorations and also with time. Therefore, inspection and testing by a qualified geotechnical engineer should be included during construction to provide corrective recommendations adapted to the conditions revealed during the work.

Unanticipated soil conditions are commonly encountered and cannot fully be determined by a limited number of explorations or soil samples. Such unexpected conditions frequently result in additional project costs in order to build the project as designed. Therefore, a contingency for unanticipated conditions should be included in the construction budget and schedule.

The work program followed the standard of care expected of professionals undertaking similar work in Alaska under similar conditions. No warranty expressed or implied is made.

It has been a pleasure to assist you with this project. Please contact us if you have any questions or require additional assistance.

Golder Associates Inc.

Tabitha A. Voeller
Staff Engineering Geologist

Christopher Valentine, PE
Senior Engineer

Richard A. Mitchells, PE
Principal

Attachments: Figure 1 – Vicinity Map
Figure 2 – Site Plan and Borehole Location Map
Appendix A – Borehole Logs
Appendix B – Summary Geotechnical Laboratory Results
Appendix C – Representative Site Photographs

Figures

Last Edited By: agarrigus Date: 2018-02-28 Time:1:36:47 PM | Printed By: AGarrigus Date: 2018-04-25 Time:12:17:07 PM
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REFERENCE(S)

1. ORTHO IMAGERY PROVIDED BY ALASKA GEOSPATIAL COUNCIL AND DISTRIBUTED BY ALASKA DEPARTMENT OF NATURAL RESOURCES (AKDNR).

CLIENT
CE2 ENGINEERS INC.

CONSULTANT
GOLDER

YYYY-MM-DD	2018-04-25
DESIGNED	-
PREPARED	APG
REVIEWED	TAV
APPROVED	RAM

PROJECT
HOOPER BAY WASTEWATER LAGOON

HOOPER BAY, ALASKA

TITLE
VICINITY MAP

PROJECT NO.	CONTROL	REV.	FIGURE
1782343		0	1

LEGEND

TH2A-1
TEST HOLE LOCATION AND NAME

REFERENCE(S)

1. BOREHOLE LOCATIONS AND BASE MAP PROVIDED BY CE2 ENGINEERS INC.
2. ORTHO IMAGERY PROVIDED BY ALASKA GEOSPATIAL COUNCIL AND DISTRIBUTED BY ALASKA DEPARTMENT OF NATURAL RESOURCES (AKDNR).

0 150 300
1" = 300' FEET

CLIENT
CE2 ENGINEERS INC.

CONSULTANT
GOLDER

YYYY-MM-DD	2018-03-14
DESIGNED	-
PREPARED	APG
REVIEWED	TAV
APPROVED	RAM

PROJECT
HOOPER BAY WASTEWATER LAGOON

HOOPER BAY, ALASKA

TITLE
SITE PLAN AND TEST HOLE LOCATION MAP

PROJECT NO.	CONTROL	REV.	FIGURE
1782343		A	2

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

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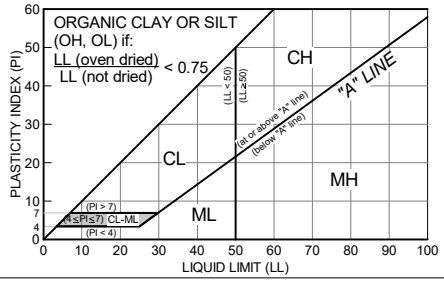
APPENDIX A

Borehole Logs

UNIFIED SOIL CLASSIFICATION (adapted from ASTM D2487)

MATERIAL TYPES	CRITERIA FOR ASSIGNING SOIL GROUP NAMES AND GROUP SYMBOLS USING LABORATORY TESTS			GROUP SYMBOL	SOIL GROUP NAMES & LEGEND	
COARSE-GRAINED SOILS >50% RETAINED ON NO. 200 SIEVE	GRAVELS >50% OF COARSE FRACTION RETAINED ON NO 4. SIEVE	CLEAN GRAVELS <5% FINES	$C_U \geq 4$ AND $1 \leq C_C \leq 3$	GW	WELL-GRADED GRAVEL	If soil contains ≥15% sand, add "with sand"
			$C_U < 4$ AND/OR [$C_C < 1$ OR $C_C > 3$]	GP	POORLY GRADED GRAVEL	
		GRAVELS WITH FINES >12% FINES	FINES CLASSIFY AS ML OR MH	GM	SILTY GRAVEL	
			FINES CLASSIFY AS CL OR CH	GC	CLAYEY GRAVEL	
	SANDS ≥50% OF COARSE FRACTION PASSES ON NO 4. SIEVE	CLEAN SANDS <5% FINES	$C_U \geq 6$ AND $1 \leq C_C \leq 3$	SW	WELL-GRADED SAND	If soil contains ≥15% gravel, add "with gravel"
			$C_U < 6$ AND/OR [$C_C < 1$ OR $C_C > 3$]	SP	POORLY GRADED SAND	
		SANDS AND FINES >12% FINES	FINES CLASSIFY AS ML OR MH	SM	SILTY SAND	
			FINES CLASSIFY AS CL OR CH	SC	CLAYEY SAND	
FINE-GRAINED SOILS >50% PASSES NO. 200 SIEVE	SILTS AND CLAYS LIQUID LIMIT <50	PLASTICITY CHART		CL	LEAN CLAY	If soil contains coarse-grained soil from 15% to 29%, add "with sand" or "with gravel" for whichever type is prominent, or for ≥30%, add "sandy" or "gravelly"
				ML	SILT	
				OL	ORGANIC CLAY OR SILT	
	SILTS AND CLAYS LIQUID LIMIT ≥50			CH	FAT CLAY	
				MH	ELASTIC SILT	
				OH	ORGANIC CLAY OR SILT	
HIGHLY ORGANIC SOILS		PRIMARILY ORGANIC MATTER, DARK IN COLOR, AND ORGANIC ODOR		PT	PEAT	



NOTES:
$C_U = \frac{D_{60}}{D_{10}}$ $\quad C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}}$

Gravels or sands with 5% to 12% fines require dual symbols (GW-GM, GW-GC, GP-GM, GP-GC, SW-SM, SW-SC, SP-SM, SP-SC) and add "with clay" or "with silt" to group name. If fines classify as CL-ML for GM or SM, use dual symbol GC-GM or SC-SM. The coefficient of uniformity, C_U, and coefficient of curvature, C_C, equations are given above where $D_{(X\%)}$ is soil particle diameter where X% is % finer. *Optional Abbeviations:* Lower case "s" after USCS group symbol denotes either "sandy" or "with sand" while "g" denotes either "gravelly" or "with gravel"

CRITERIA FOR DESCRIBING MOISTURE CONDITION (adapted from ASTM D2488)

DRY	ABSENCE OF MOISTURE, DUSTY, DRY TO THE TOUCH
MOIST	DAMP BUT NO VISIBLE WATER
WET	VISIBLE FREE WATER, USUALLY SOIL IS BELOW WATER TABLE

COMPONENT DEFINITIONS BY GRADATION

COMPONENT	SIZE RANGE
BOULDERS	GREATER THAN 12 in.
COBBLES	12 in. to 3 in.
GRAVEL	3 in. to #4 Sieve (4.76 mm)
COARSE GRAVEL	3 in. to 3/4 in.
FINE GRAVEL	3/4 in. to #4 (4.76 mm)
SAND	#4 (4.76 mm) to #200 (0.074 mm)
COARSE SAND	#4 (4.76 mm) to #10 (2.0 mm)
MEDIUM SAND	#10 (2.0 mm) to #40 (0.42 mm)
FINE SAND	#40 (0.42 mm) to #200 (0.074 mm)
SILT & CLAY (FINES)	SMALLER THAN #200 (0.074 mm)

RELATIVE DENSITY / CONSISTENCY ESTIMATE USING STANDARD PENETRATION TEST (SPT) VALUES (adapted from Terzaghi and Peck 1967 and NAVFAC DM 7.1)

COHESIONLESS SOILS [a]		COHESIVE SOILS [b]		
RELATIVE DENSITY	$(N_1)_{60}$ (blows/ft) [c]	CONSISTENCY	$(N_1)_{60}$ (blows/ft) [c]	UNCONFINED COMPRESSIVE STRENGTH (TSF) [d]
VERY LOOSE	0 - 4	VERY SOFT	0 - 2	0 - 0.25
LOOSE	4 - 10	SOFT	2 - 4	0.25 - 0.50
COMPACT (MEDIUM DENSE)	10 - 30	FIRM	4 - 8	0.50 - 1.0
		STIFF	8 - 15	1.0 - 2.0
DENSE	30 - 50	VERY STIFF	15 - 30	2.0 - 4.0
VERY DENSE	OVER 50	HARD	OVER 30	OVER 4.0

(a) Soils consisting of gravel, sand, and silt, either separately or in combination possessing no characteristics of plasticity, and exhibiting drained behavior.
(b) Soils possessing the characteristics of plasticity, and exhibiting undrained behavior.
(c) Refer to ASTM D1586 for a definition of N value. $(N_1)_{60}$ is the N value corrected for hammer energy and overburden pressure, and is detailed in ASTM D6066. N values may be affected by a number of factors including: material size, sampler size, hammer weight and type, depth, drilling method, and borehole disturbance. N values are only an approximate guide for cohesive soil and do not apply to frozen soil.
(d) Undrained shear strength, s_u= 1/2 unconfined compression strength, U_c. Note that Torvane (TV) measures s_u and pocket penetrometer (PP) measures U_c

SAMPLER ABBREVIATIONS

AR Air Rotary cuttings	**GB** Grab sample (disturbed from surface/test pit)	**SC** Soil core (continuous sampler)
AS Auger Sample, cuttings	**MC** Modified California sampler (3-in. OD split spoon, 340-lb hammer)	**SS** SPT sampler (2-in. OD, 140-lb hammer)
CS Chunk/block sample (undisturbed from surface/test pit)	**MS** Modified Shelby tube	**TO** Thin-walled, open (Shelby tube)
DO Drive Open (split spoon other than SS or MC)	**R** Refusal when driving	**TP** Thin-walled, piston
DP Direct Push (Geoprobe)	**RC** Rock core	**WS** Wash Sample

DESCRIPTIVE TERMINOLOGY FOR PERCENTAGES (ASTM D2488)

DESCRIPTIVE TERMS	RANGE OF PROPORTION
TRACE	0 - 5%
FEW	5 - 10%
LITTLE	10 - 25%
SOME	30 - 45%
MOSTLY	50 - 100%

LABORATORY TEST AND NOTES ABBREVIATIONS / SYMBOLS

Con	Consolidation	**PID**	Photoionization Detector	**TXCD**	Triaxial, Consolidated Drained
Dd	Dry Density	**PM**	Modified Proctor (D1557)	**TXCU**	Triaxial, Consolidated Undrained
K	Thermal Conductivity	**PP**	Pocket Penetrometer (Field)	**TXUU**	Triaxial, Unconsolidated Undrained
MA	Sieve and Hydrometer	**PTLD**	Point Load	**W_L**	Liquid Limit (LL)
NP	Non-plastic	**SA**	Sieve Analysis	**W_P**	Plastic Limit (PL)
OLI	Organic Loss	**SpG**	Specific Gravity	**Ω**	Soil Resistivity (Res.)
P200	Passing #200 Sieve (D1140)	**TC**	Thaw Consolidation/Strain	▼	Water Level
pH	Soil pH	**TV**	Torvane (Field)	▽	Water Level at time of drilling
PI	Plasticity Index (D4318)				

GOLDER

SOIL CLASSIFICATION / LEGEND

Figure A-1

LIBRARY-ANC(3-16-18) - NEW LOGO.GLB [ANC_SOIL_LEGEND] 3/22/18

FROZEN SOIL CLASSIFICATION (ASTM D4083)

1. DESCRIBE SOIL INDEPENDENT OF FROZEN STATE	CLASSIFY SOIL BY THE UNIFIED SOIL CLASSIFICATION SYSTEM				
2. MODIFY SOIL DESCRIPTION BY DESCRIPTION OF FROZEN SOIL	MAJOR GROUP		SUBGROUP		
	DESCRIPTION	DESIGNATION	DESCRIPTION		DESIGNATION
	Segregated ice not visible by eye	N	Poorly bonded of friable		Nf
			Well bonded	No excess ice	Nbn
				Excess ice	Nbe
	Segregated ice visible by eye (ice less than 25 mm thick)	V	Individual ice crystals or inclusions		Vx
			Ice coatings on particles		Vc
			Random or irregularly oriented ice formations		Vr
			Stratified or distinctly oriented ice formations		Vs
			Uniformly distributed ice		Vu
3. MODIFY SOIL DESCRIPTION BY DESCRIPTION OF SUBSTANTIAL ICE STRATA	Ice greater than 25 mm thick	ICE	Ice with soil inclusions		ICE+soil type
			Ice without soil inclusions		ICE

FROST DESIGN SOIL CLASSIFICATION [1]

FROST GROUP	GENERAL SOIL TYPE	% FINER THAN 0.02 mm BY WEIGHT	TYPICAL USCS SOIL CLASS
NFS (non-frost suceptable)	(a) Gravels Crushed stone Crushed rock	0 to 1.5	GW, GP
	(b) Sands	0 to 3	SW, SP
NFS [PFS[3]][2]	(a) Gravels Crushed stone Crushed rock	1.5 to 3	GW, GP
F1 [S1][2]	Gravelly soils	3 to 6	GW, GP, GW-GM, GP-GM, GW-GC, GP-GC
F1	Gravelly soils	6 to 10	GM, GC, GM-GC, GW-GM, GP-GM, GW-GC, GP-GC
F2 [PFS[3]/S2][2]	Sandy soils	3 to 6	SW, SP, SW-SM, SP-SM, SW-SC, SP-SC
F2	(a) Gravelly soils	10 to 20	GW, GP, GW-GM, GP-GM, GW-GC, GP-GC
	(b) Sands	6 to 15	SM, SW-SM, SP-SM, SC, SW-SC, SP-SC, SM-SC
F3	(a) Gravelly soils	Over 20	GM, GC, GM-GC
	(b) Sands, except very fine silty sands	Over 15	SM, SC, SM-SC
	(c) Clays, PI>12	--	CL, CH
F4	(a) Silts	--	ML, MH, ML-CL
	(b) Very fine silty sands	Over 15	SM, SC, SM-SC
	(c) Clays, PI<12	--	CL, ML-CL
	(d) Varved clays or other fine-grained banded sediments	--	CL or CH layered with ML, MH, ML-CL, SM, SC, or SM-SC

(1) From Municipality of Anchorage (MOA) Design Criteria Manual (DCM), 2007 and 2014; Federal Aviation Administration (FAA) Advisory Circular (AC) 150/5320-6E; U.S. Army Corps of Engineers (USACE) "Arctic and Subarctic Construction, Runway and Road Design," Technical Manual TM 5-852-3, 1965; and USACE "Military Soils Engineering" Field Manual FM 5-410, 1997
(2) PFS, S1, and S2 frost groups from USACE, EM 1110-3-138, "Pavement Criteria for Seasonal Frost Conditions," April 1984
(3) Possibly frost susceptible, requires lab test for void ratio to determine frost design soil classification. Gravel with void ratio > 0.25 would be NFS; Gravel with void ratio < 0.25 would be S1; Sands with void ratio > 0.30 would be NFS; Sands with void ratio < 0.30 would be S2 or F2

ICE BONDING SYMBOLS

No ice-bonded soil observed

Poorly bonded or friable

Well bonded

DEFINITIONS

Candled Ice is ice which has rotted or otherwise formed into long columnar crystals, very loosely bonded together.

Clear Ice is transparent and contains only a moderate number of air bubbles.

Cloudy Ice is translucent, but essentially sound and non-pervious

Friable denotes a condition in which material is easily broken up under light to moderate pressure.

Granular Ice is composed of coarse, more or less equidimensional, ice crystals weakly bonded together.

Ice Coatings on particles are discernible layers of ice found on or below the larger soil particles in a frozen soil mass. They are sometimes associated with hoarfrost crystals, which have grown into voids produced by the freezing action.

Ice Crystal is a very small individual ice particle visible in the face of a soil mass. Crystals may be present alone or in a combination with other ice formations.

Ice Inclusions are individual ice masses visible in the face of a soil mass. Inclusions may be present alone or in a combination with other ice formations.

Ice Lenses are lenticular ice formations in soil occurring essentially parallel to each other, generally normal to the direction of heat loss and commonly in repeated layers.

Ice Segregation is the growth of ice as distinct lenses, layers, veins and masses in soils, commonly but not always oriented normal to direction of heat loss.

Massive Ice is a large mass of ice, typically nearly pure and relatively homogeneous.

Poorly-bonded signifies that the soil particles are weakly held together by the ice and that the frozen soil consequently has poor resistance to chipping or breaking.

Porous Ice contains numerous voids, usually interconnected and usually resulting from melting at air bubbles or along crystal interfaces from presence of salt or other materials in the water, or from the freezing of saturated snow. Though porous, the mass retains its structural unity.

Thaw-Stable frozen soils do not, on thawing, show loss of strength below normal, long-time thawed values nor produce detrimental settlement.

Thaw-Unstable frozen soils show on thawing, significant loss of strength below normal, long-time thawed values and/or significant settlement, as a direct result of the melting of the excess ice in the soil.

Well-Bonded signifies that the soil particles are strongly held together by the ice and that the frozen soil possesses relatively high resistance to chipping or breaking.

GOLDER

FROZEN SOIL CLASSIFICATION / LEGEND

Figure A-2

RECORD OF BOREHOLE TH(2A)-01

SHEET 1 of 1

PROJECT: Hooper Bay Wastewater Lagoon
PROJECT NUMBER: 1782343
LOCATION: Hooper Bay, Alaska

CLIENT: CE2 Engineers, Inc.
DRILLING DATE: 1/23/2018 9:02:12 AM
EQUIPMENT: Geoprobe 6620DT

DATUM: WGS 84
APPROX. ELEVATION: n/a
APPROX. COORDS: 61.53677° N 166.09860° W

DEPTH (ft)	BORING METHOD	SOIL PROFILE DESCRIPTION	ICE BOND	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	SAMPLES NUMBER	TYPE	BLOWS per 6 in (140 lb Hammer (Automatic) 30 in. Drop)	BLOWS PER FT	REC / ATT (inch)	UNCORRECTED BLOWS / FT ■ 10 20 30 40; SALINITY (ppt) △; WATER CONTENT (PERCENT) W_P W W_L 10 20 30 40	NOTES TESTS WATER LEVELS
0	6.25-in. OD Geoprobe	0.0 - 2.0 PEAT; organic material inferred based on drilling action (PT)		PT									0 ft 1/23/2018 9:29:07 AM; WD
		2.0 - 4.0 Wet, dark gray, SILT; non plastic (ML)		ML		2.0	2	SS	2-4-4	8	18/18		
5		4.0 - 11.0 Frozen, dark gray, SILT; non plastic, well bonded with no excess ice to approximately 5% visible ice by volume as inclusions up to 0.125 inch thick (ML, Nbn-Vx)	■	ML		4.0	3	SS	2-4-6	10	18/18		
10		11.0 - 19.0 Moist to wet, olive gray, SILT with sand; fine-grained sand, non plastic, unfrozen (ML)		ML		11.0	4	SS	1-4-6	10	18/18		Gravel = 0%, Sand = 15%, Fines = 85.1%
15													
20		19.0 - 21.0 Frozen, olive gray, SILT; few fine-grained sand, non plastic, well bonded with excess ice (ML, Nbe)	■	ML		19.0	5	SS	2-6-10	16	16/18		
		21.0 - 24.5 Olive gray, SILT; few fine-grained sand, non plastic, unfrozen (ML)		ML		21.0	6	SS	3-3-5	8	18/18		
25		Borehole completed at 24.5 ft.											
30		Notes: 1) Conditions at time of drilling: -Surface ice 0-2 feet thick -Surface water 2-5 feet 2) Sealed 1-inch Schedule 40 PVC installed to 24.5 feet below ground surface. 3) Annulus between borehole and PVC backfilled with cuttings.											
35													

GOLDER

DEPTH SCALE: 1 inch to 4.4 feet
DRILLING CONTRACTOR: GeoTek Alaska Inc.
DRILLER: J. Rodgers

LOGGED: C. Valentine
CHECKED: T. Voeller
CHECK DATE: 3/16/2018

Figure A-3

1782343 HOOPER BAY .GPJ LIBRARY-ANC(3-16-18) - NEW LOGO.GLB [ANC BOREHOLE] cvalentine 4/25/18

RECORD OF BOREHOLE TH(2A)-03

SHEET 1 of 1

PROJECT: Hooper Bay Wastewater Lagoon
PROJECT NUMBER: 1782343
LOCATION: Hooper Bay, Alaska

CLIENT: CE2 Engineers, Inc.
DRILLING DATE: 1/22/2018 5:19:30 PM
EQUIPMENT: Geoprobe 6620DT

DATUM: WGS 84
APPROX. ELEVATION: n/a
APPROX. COORDS: 61.53813° N 166.09952° W

DEPTH (ft)	BORING METHOD	SOIL PROFILE DESCRIPTION	ICE BOND	USCS	GRAPHIC LOG	ELEV. DEPTH (ft)	SAMPLES NUMBER	TYPE	BLOWS per 6 in (140 lb Hammer (Automatic) 30 in. Drop)	BLOWS PER FT	REC ATT (inch)	UNCORRECTED BLOWS / FT ■ / SALINITY (ppt) △ / WATER CONTENT (PERCENT) W_P W W_L	NOTES TESTS WATER LEVELS
0	6.25-in. OD Geoprobe	0.0 - 6.5 Frozen, very dark gray, PEAT; poorly bonded and well bonded with approximately 20% visible ice by volume as inclusions and irregularly oriented formations (PT, Vx-Vr)		PT			1	SS	1-12-7	19	18/12	176	
							2	SS	1.5-1-.5	2	1/18	221	OLI = 15%
5							3	SS	1-.5-.5	1	1/18	168	
		6.5 - 9.5 Moist, very dark gray, SILT; unfrozen (ML)		ML		6.5	4	SS	0-1-1	2	16/18		
10		9.5 - 24.0 Moist to wet, dark gray, SILT; high plasticity, unfrozen, becoming wet at 24 feet (MH)		MH		9.5	5	TW			20/24	△	PI = 21
							6	SS	1-3-3	6	18/18	△	
15							7	SS	0-2-2	4	18/18		PI = 24
20							8	SS	0-.5-2.5	3	18/18		
25		Borehole completed at 24.0 ft.											
30		Notes: 1) Conditions at time of drilling: -Surface ice 0.5 feet thick 2) No groundwater observed while drilling (WD). 3) Sealed 1-inch Schedule 40 PVC installed to 24 feet below ground surface. 4) Annulus between borehole and PVC backfilled with cuttings.											
35													

GOLDER

DEPTH SCALE: 1 inch to 4.4 feet
DRILLING CONTRACTOR: GeoTek Alaska Inc.
DRILLER: J. Rodgers

LOGGED: C. Valentine
CHECKED: T. Voeller
CHECK DATE: 3/16/2018

Figure A-4

1782343 HOOPER BAY .GPJ LIBRARY-ANC(3-16-18) - NEW LOGO.GLB [ANC BOREHOLE] cvalentine 4/25/18

RECORD OF BOREHOLE TH(2A)-05

SHEET 1 of 1

PROJECT: Hooper Bay Wastewater Lagoon
PROJECT NUMBER: 1782343
LOCATION: Hooper Bay, Alaska

CLIENT: CE2 Engineers, Inc.
DRILLING DATE: 1/23/2018 2:37:19 PM
EQUIPMENT: Geoprobe 6620DT

DATUM: WGS 84
APPROX. ELEVATION: n/a
APPROX. COORDS: 61.53792° N 166.10316° W

DEPTH (ft)	BORING METHOD	SOIL PROFILE DESCRIPTION	ICE BOND	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	SAMPLES NUMBER	TYPE	BLOWS per 6 in (140 lb Hammer (Automatic) 30 in. Drop)	BLOWS PER FT	REC / ATT (inch)	UNCORRECTED BLOWS / FT ■ 10 20 30 40; SALINITY (ppt) △; WATER CONTENT (PERCENT) W_P W W_L 10 20 30 40	NOTES TESTS WATER LEVELS
0	6.25-in. OD Geoprobe	0.0 - 4.0 Wet, black, PEAT (PT)		PT									0 ft 1/23/2018; WD
							1	SS	0-0-0	0	1/18	■ 330 ○	
		4.0 - 14.0 Moist, dark gray, SILT; non plastic, becoming slightly plastic with depth (ML)				4.0							
5							2	SS	0-3-4	7	16/18	■ △ ○	Gravel = 0%, Sand = 2%, Fines = 97.9%, MA
				ML									
10							3	SS	1-3-4	7	18/18	■ ○	
		14.0 - 23.5 Moist to wet, very dark gray, SILT; high plasticity, wet at 19 feet (MH)				14.0							
15													PI = 22
							4	TW			24/24	△ ⊖	
				MH									
20							5	SS	0-0-0	0	0/18	■ ○	
		Borehole completed at 23.5 ft.											
25		Notes: 1) Conditions at time of drilling: -Surface ice 0-1.3 feet thick -Surface water 1.3-6 feet 2) Borehole backfilled with cuttings.											
30													
35													

GOLDER

DEPTH SCALE: 1 inch to 4.4 feet
DRILLING CONTRACTOR: GeoTek Alaska Inc.
DRILLER: J. Rodgers

LOGGED: C. Valentine
CHECKED: T. Voeller
CHECK DATE: 3/16/2018

Figure A-5

1782343 HOOPER BAY .GPJ LIBRARY-ANC(3-16-18) - NEW LOGO.GLB [ANC BOREHOLE] cvalentine 4/25/18

RECORD OF BOREHOLE TH(2A)-07

SHEET 1 of 1

PROJECT: Hooper Bay Wastewater Lagoon
PROJECT NUMBER: 1782343
LOCATION: Hooper Bay, Alaska

CLIENT: CE2 Engineers, Inc.
DRILLING DATE: 1/23/2018 4:12:46 PM
EQUIPMENT: Geoprobe 6620DT

DATUM: WGS 84
APPROX. ELEVATION: n/a
APPROX. COORDS: 61.53622° N 166.10301° W

DEPTH (ft)	BORING METHOD	SOIL PROFILE DESCRIPTION	ICE BOND	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	SAMPLES NUMBER	TYPE	BLOWS per 6 in (140 lb Hammer (Automatic) 30 in. Drop)	BLOWS PER FT	REC / ATT (inch)	UNCORRECTED BLOWS / FT ■ 10 20 30 40; SALINITY (ppt) △; WATER CONTENT (PERCENT) W_P W W_L 10 20 30 40	NOTES TESTS WATER LEVELS
0	6.25-in. OD Geoprobe	0.0 - 0.5 Frozen, PEAT; poorly bonded with approximately 5-20% visible ice by volume as irregularly oriented formations and inclusions (PT, Vr-Vx)		PT		0.5	1	SS	5-15-10	25	18/18	267	
		0.5 - 2.0 Frozen, brown, ORGANIC SILT; organic material as roots, poorly bonded with approximately 5-20% visible ice by volume as irregularly oriented formations and inclusions (OL, Vr-Vx)		OL		2.0	2	SS	2-1-0	1	18/18	94	OLI = 17%
5		2.0 - 5.0 Moist, brown, ORGANIC SILT; organic material as roots, unfrozen (OL)		OL		5.0	3	SS	1-0-1	1	2/18	106	
		5.0 - 7.0 Frozen, gray, lean CLAY; low plasticity, well bonded with no excess ice (CL, Nbn)		CL		7.0	4	SS	0-0-1	1	18/18		
10		7.0 - 17.0 Moist, olive gray to dark gray, SILT with sand; unfrozen (ML)		ML			5	SS	1-3-8	11	18/18		
15													
		17.0 - 24.5 Wet, gray, SILTY SAND (SM)		SM		17.0	6	SS	5-14-18	32	18/18		Gravel = 0%, Sand = 78%, Fines = 22.0%
20							7	SS	1-6-13	19	18/18	△	
25		Borehole completed at 24.5 ft.											
30		Notes: 1) Conditions at time of drilling: -Surface ice 0.5 feet thick 2) No groundwater observed while drilling (WD). 3) Borehole backfilled with cuttings.											
35													

GOLDER

DEPTH SCALE: 1 inch to 4.4 feet
DRILLING CONTRACTOR: GeoTek Alaska Inc.
DRILLER: J. Rodgers

LOGGED: C. Valentine
CHECKED: T. Voeller
CHECK DATE: 3/16/2018

Figure A-6

1782343 HOOPER BAY .GPJ LIBRARY-ANC(3-16-18) - NEW LOGO.GLB [ANC BOREHOLE] cvalentine 4/25/18

RECORD OF BOREHOLE TH(2A)-08

SHEET 1 of 1

PROJECT: Hooper Bay Wastewater Lagoon
PROJECT NUMBER: 1782343
LOCATION: Hooper Bay, Alaska

CLIENT: CE2 Engineers, Inc.
DRILLING DATE: 1/23/2018 12:46:24 PM
EQUIPMENT: Geoprobe 6620DT

DATUM: WGS 84
APPROX. ELEVATION: n/a
APPROX. COORDS: 61.53742° N 166.10162° W

DEPTH (ft)	BORING METHOD	SOIL PROFILE DESCRIPTION	ICE BOND	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	SAMPLES NUMBER	TYPE	BLOWS per 6 in (140 lb Hammer (Automatic) 30 in. Drop)	BLOWS PER FT	REC / ATT (inch)	UNCORRECTED BLOWS / FT ■ 10 20 30 40; SALINITY (ppt) △; WATER CONTENT (PERCENT) W_P W W_L 10 20 30 40	NOTES TESTS WATER LEVELS
0	6.25-in. OD Geoprobe	0.0 - 2.6 Frozen, light gray mottled orange, ORGANIC SILT; thin layer of tundra grass and roots at surface, well bonded with approximately 5% visible ice by volume as inclusions (OL, Vx)		OL			1	SS	7-10-4	14	18/18	■ 112○	
		2.6 - 13.5 Moist, gray, SILT; few fine-grained sand, non plastic, trace orange-colored mottling (ML)				2.6	2	SS	3-1-1	2	1/18	■ 171○	
5							3	SS	1-2-2	4	18/18	■ △ ○	
				ML			4	SS	.5-.5-2	3	17/18	■ ○	
10													
		13.5 - 25.0 Moist, dark gray, SILT; medium to high plasticity (ML-MH)				13.5	5	SS	0-1-1	2	16/18	■ ○	
15													
				ML-MH			6	SS	0-0-2	2	12/18	■ ⊖	PI = 10
20													
							7	TW			12/24		
25		Borehole completed at 25.0 ft.											
30		Notes: 1) No groundwater observed while drilling (WD). 2) Sealed 1-inch Schedule 40 PVC installed to 25 feet below ground surface. 3) Annulus between borehole and PVC backfilled with cuttings.											
35													

GOLDER

DEPTH SCALE: 1 inch to 4.4 feet
DRILLING CONTRACTOR: GeoTek Alaska Inc.
DRILLER: J. Rodgers

LOGGED: C. Valentine
CHECKED: T. Voeller
CHECK DATE: 3/16/2018

Figure A-7

1782343 HOOPER BAY .GPJ LIBRARY-ANC(3-16-18) - NEW LOGO.GLB [ANC BOREHOLE] cvalentine 4/25/18

RECORD OF BOREHOLE TH(2B)-01

SHEET 1 of 1

PROJECT: Hooper Bay Wastewater Lagoon
PROJECT NUMBER: 1782343
LOCATION: Hooper Bay, Alaska

CLIENT: CE2 Engineers, Inc.
DRILLING DATE: 1/20/2018 9:13:48 AM
EQUIPMENT: Geoprobe 6620DT

DATUM: WGS 84
APPROX. ELEVATION: n/a
APPROX. COORDS: 61.53701° N 166.09790° W

DEPTH (ft)	BORING METHOD	SOIL PROFILE DESCRIPTION	ICE BOND	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	SAMPLES NUMBER	TYPE	BLOWS per 6 in (140 lb Hammer (Automatic) 30 in. Drop)	BLOWS PER FT	REC / ATT (inch)	UNCORRECTED BLOWS / FT ■ 10 20 30 40; SALINITY (ppt) △; WATER CONTENT (PERCENT) W_P W W_L 10 20 30 40	NOTES TESTS WATER LEVELS
0	6.25-in. OD Geoprobe	0.0 - 1.0 Frozen, gray, PEAT; well bonded with approximately 75% visible ice by volume as uniformly distributed and inclusions (PT, Vu-Vx)		PT			1	SS	13-29-6	35	24/18	■	151
		1.0 - 3.0 Frozen, black, ORGANIC SILT; well bonded with excess ice (OL, Nbe)		OL		1.0							
		3.0 - 15.0 Moist, dark gray, SILT; unfrozen (ML)				3.0	2	SS	4-0.5-.5	1	1/18	■	209
5							3	SS	0-0-0	0	0/18	■	
				ML									
10							4	SS	1-3-5	8	16/18	■ ○	
15		15.0 - 20.0 Frozen, light gray, SILT; poorly bonded with friable ice and no excess ice (ML, Nf-Nbn)		ML		15.0	5	SS	2-3-6	9	18/18	■ ○	
20		20.0 - 25.0 Moist to wet, dark gray, SILT; medium to high plasticity (ML-MH)		ML-MH		20.0	6	SS	1-1-3	4	18/18	■ △ ○	
25		Borehole completed at 25.0 ft.					7	SS	2-2-4	6	18/18	■ ○	PI = 17
30		Notes: 1) No groundwater observed while drilling (WD). 2) Sealed 1-inch Schedule 40 PVC installed to 25 feet below ground surface. 3) Annulus between borehole and PVC backfilled with cuttings.											
35													

GOLDER

DEPTH SCALE: 1 inch to 4.4 feet
DRILLING CONTRACTOR: GeoTek Alaska Inc.
DRILLER: J. Rodgers

LOGGED: C. Valentine
CHECKED: T. Voeller
CHECK DATE: 3/16/2018

Figure A-8

1782343 HOOPER BAY .GPJ LIBRARY-ANC(3-16-18) - NEW LOGO.GLB [ANC BOREHOLE] cvalentine 4/25/18

RECORD OF BOREHOLE TH(2B)-03

SHEET 1 of 1

PROJECT: Hooper Bay Wastewater Lagoon
PROJECT NUMBER: 1782343
LOCATION: Hooper Bay, Alaska

CLIENT: CE2 Engineers, Inc.
DRILLING DATE: 1/20/2018 11:47:52 AM
EQUIPMENT: Geoprobe 6620DT

DATUM: WGS 84
APPROX. ELEVATION: n/a
APPROX. COORDS: 61.54108° N 166.10178° W

DEPTH (ft)	BORING METHOD	SOIL PROFILE DESCRIPTION	ICE BOND	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	SAMPLES NUMBER	TYPE	BLOWS per 6 in (140 lb Hammer (Automatic) 30 in. Drop)	BLOWS PER FT	REC / ATT (inch)	UNCORRECTED BLOWS / FT ■ 10 20 30 40; SALINITY (ppt) △; WATER CONTENT (PERCENT) W_P W W_L 10 20 30 40	NOTES TESTS WATER LEVELS
0	6.25-in. OD Geoprobe	0.0 - 1.0 Frozen, light brown to dark gray, Massive ICE with PEAT; well bonded with approximately 50-80% visible ice by volume as inclusions (ICE+PT, Vx)		ICE+ PT		1.0	1	SS	9-3-1	4	13/18	■ 213○	
		1.0 - 5.0 Very dark gray, ORGANIC SILT (OL)		OL			2	SS	.5-.5-0	1	0/18	■	
5		5.0 - 13.0 Moist, brown, SILT; high plasticity (MH)		MH		5.0	3	SS	0-0-2	2	13/18	■ 51○	
							4	SS	0-1-0	1	14/18	■ >>55○	PI = 26
10		13.0 - 23.0 Wet, gray, poorly graded SAND with silt; few silt (SP-SM)		SP-SM		13.0	5	SS	1-4-8	12	17/18	■ ○ △	Gravel = 0%, Sand = 91%, Fines = 9.3%
15													
20							6	SS	7-17-15	32	13/18	■ ○ △	Gravel = 0%, Sand = 91%, Fines = 9.2%, SA
		23.0 - 24.5 Frozen, gray, poorly graded SAND with silt; well bonded with excess ice (SP-SM, Nbe)		SP-SM		23.0	7	SS	24-54-54	108	18/18	>>■ ○	
25		Borehole completed at 24.5 ft.											
30		Notes: 1) No groundwater observed while drilling (WD). 2) Sealed 1-inch Schedule 40 PVC installed to 24.5 feet below ground surface. 3) Annulus between borehole and PVC backfilled with cuttings.											
35													

GOLDER

DEPTH SCALE: 1 inch to 4.4 feet
DRILLING CONTRACTOR: GeoTek Alaska Inc.
DRILLER: J. Rodgers

LOGGED: C. Valentine
CHECKED: T. Voeller
CHECK DATE: 3/16/2018

Figure A-9

1782343 HOOPER BAY .GPJ LIBRARY-ANC(3-16-18) - NEW LOGO.GLB [ANC BOREHOLE] cvalentine 4/25/18

RECORD OF BOREHOLE TH(2B)-04

SHEET 1 of 1

PROJECT: Hooper Bay Wastewater Lagoon
PROJECT NUMBER: 1782343
LOCATION: Hooper Bay, Alaska

CLIENT: CE2 Engineers, Inc.
DRILLING DATE: 1/20/2018 3:07:01 PM
EQUIPMENT: Geoprobe 6620DT

DATUM: WGS 84
APPROX. ELEVATION: n/a
APPROX. COORDS: 61.54196° N 166.10267° W

DEPTH (ft)	BORING METHOD	SOIL PROFILE DESCRIPTION	ICE BOND	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	SAMPLES NUMBER	TYPE	BLOWS per 6 in (140 lb Hammer (Automatic) 30 in. Drop)	BLOWS PER FT	REC / ATT (inch)	UNCORRECTED BLOWS / FT ■ 10 20 30 40; SALINITY (ppt) △; WATER CONTENT (PERCENT) W_P W W_L 10 20 30 40	NOTES TESTS WATER LEVELS
0	6.25-in. OD Geoprobe	0.0 - 1.5 Frozen, brown, PEAT; organic material, well bonded with approximately 50% visible ice by volume as inclusions (PT, Vx)		PT			1	SS	9-1-1	2	18/18	■ 140○	
		1.5 - 3.0 Frozen, gray, ORGANIC SILT; few to little organic material as roots, well bonded with approximately 30-50% visible ice by volume as inclusions (OL, Vx)		OL		1.5							
				ML		3.0	2	SS	5-10-12	22	18/18	■ 182○	
5		3.0 - 4.0 Frozen, olive gray, SILT; well bonded with approximately 30% visible ice by volume as inclusions (ML, Vx)		ML		4.0	3	SS	6-12-13	25	18/18	■ ○	
		4.0 - 8.5 Frozen, olive gray, SILT; well bonded with no excess ice (ML, Nbn)					4A & 4B	DP			36/36	○	
10		8.5 - 12.0 Frozen, olive gray, SILTY SAND; fine-grained sand, little silt, well bonded with no excess ice (SM, Nbn)		SM		8.5	5	DP			30/30	○	Gravel = 0%, Sand = 81%, Fines = 19.3%
		12.0 - 17.5 Frozen, olive gray, poorly graded SAND with silt; fine-grained sand, few silt, well bonded with no excess ice (SP-SM, Nbn)		SP-SM		12.0	6	DP			52/30	○ △	
15							7	DP			44/30	○	
		Borehole completed at 17.5 ft.											
20		Notes: 1) No groundwater observed while drilling (WD). 2) Sealed 1-inch Schedule 40 PVC installed to 17.5 feet below ground surface. 3) Annulus between borehole and PVC backfilled with cuttings.											
25													
30													
35													

GOLDER

DEPTH SCALE: 1 inch to 4.4 feet
DRILLING CONTRACTOR: GeoTek Alaska Inc.
DRILLER: J. Rodgers

LOGGED: C. Valentine
CHECKED: T. Voeller
CHECK DATE: 3/16/2018

Figure A-10

1782343 HOOPER BAY .GPJ LIBRARY-ANC(3-16-18) - NEW LOGO.GLB [ANC BOREHOLE] cvalentine 4/25/18

RECORD OF BOREHOLE TH(2B)-05

SHEET 1 of 1

PROJECT: Hooper Bay Wastewater Lagoon
PROJECT NUMBER: 1782343
LOCATION: Hooper Bay, Alaska

CLIENT: CE2 Engineers, Inc.
DRILLING DATE: 1/21/2018 9:04:06 AM
EQUIPMENT: Geoprobe 6620DT

DATUM: WGS 84
APPROX. ELEVATION: n/a
APPROX. COORDS: 61.54228° N 166.10500° W

DEPTH (ft)	BORING METHOD	SOIL PROFILE DESCRIPTION	ICE BOND	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	SAMPLES NUMBER	TYPE	BLOWS per 6 in (140 lb Hammer (Automatic) 30 in. Drop)	BLOWS PER FT	REC / ATT (inch)	UNCORRECTED BLOWS / FT ■ 10 20 30 40; SALINITY (ppt) △; WATER CONTENT (PERCENT) W_P W W_L 10 20 30 40	NOTES TESTS WATER LEVELS
0	2.5-in. OD Geoprobe	0.0 - 1.3 Frozen, brown, PEAT; organic material, well bonded with approximately 5-30% visible ice by volume as irregularly oriented formations (PT, Vr)		PT		1.3	1	DP			60/60	81	
		1.3 - 10.0 Frozen, brown, SILT; trace sand, well bonded with approximately 5-35% visible ice by volume as irregularly oriented formations and inclusions up to 0.125 inch thick (ML, Vr-Vx)		ML			2	DP			48/30	101	Gravel = 0%, Sand = 5%, Fines = 95.1%
							3	DP			40/30	70	
10		10.0 - 17.5 Frozen, light gray, SILT; well bonded with no excess ice (ML, Nbn)		ML		10.0	4	DP			47/30		
							5	DP			34/30		
15							6	DP			50/30		
		17.5 - 22.5 Frozen, light gray, SILTY SAND; fine-grained sand, little to some silt, well bonded with no excess ice (SM, Nbn)		SM		17.5	7	DP			47/30		
20							8	DP			56/30		Gravel = 0%, Sand = 74%, Fines = 26.0%
		22.5 - 25.0 Frozen, gray, SILT with sand; little fine-grained sand, well bonded with no excess ice (ML, Nbn)		ML		22.5	9	DP			30/30		
25		Borehole completed at 25.0 ft.											
		Notes: 1) No groundwater observed while drilling (WD). 2) Sealed 1-inch Schedule 40 PVC installed to 25 feet below ground surface. 3) Annulus between borehole and PVC backfilled with cuttings.											
30													
35													

GOLDER

DEPTH SCALE: 1 inch to 4.4 feet
DRILLING CONTRACTOR: GeoTek Alaska Inc.
DRILLER: J. Rodgers

LOGGED: C. Valentine
CHECKED: T. Voeller
CHECK DATE: 3/16/2018

Figure A-11

1782343 HOOPER BAY .GPJ LIBRARY-ANC(3-16-18) - NEW LOGO.GLB [ANC BOREHOLE] cvalentine 4/25/18

RECORD OF BOREHOLE TH(2B)-07

SHEET 1 of 1

PROJECT: Hooper Bay Wastewater Lagoon
PROJECT NUMBER: 1782343
LOCATION: Hooper Bay, Alaska

CLIENT: CE2 Engineers, Inc.
DRILLING DATE: 1/21/2018 11:15:32 AM
EQUIPMENT: Geoprobe 6620DT

DATUM: WGS 84
APPROX. ELEVATION: n/a
APPROX. COORDS: 61.54302° N 166.10717° W

DEPTH (ft)	BORING METHOD	SOIL PROFILE DESCRIPTION	ICE BOND	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	SAMPLES NUMBER	TYPE	BLOWS per 6 in (140 lb Hammer (Automatic) 30 in. Drop)	BLOWS PER FT	REC / ATT (inch)	UNCORRECTED BLOWS / FT ■ 10 20 30 40; SALINITY (ppt) △; WATER CONTENT (PERCENT) W_P W W_L 10 20 30 40	NOTES TESTS WATER LEVELS
0	2.5-in. OD Geoprobe	0.0 - 3.0 Frozen, brown, PEAT; organic material, well bonded with approximately 10-50% visible ice by volume as uniformly distributed and irregularly oriented formations (PT, Vu-Vr)		PT			1A & 1B	DP			60/60	246	
		3.0 - 5.0 Frozen, gray, SILT; well bonded with approximately 10-20% visible ice by volume as irregularly oriented formations up to 0.5 inch thick (ML, Vr)		ML		3.0						195	
5		5.0 - 10.0 Frozen, brown, SILT; little orange-colored staining, becoming Nbn at 7.5 feet, well bonded with no excess ice to approximately 5-10% visible ice by volume as inclusions (ML, Vx-Nbn)		ML		5.0	2	DP			55/30		
							3	DP			23/30		
10		10.0 - 17.5 Frozen, olive gray, sandy SILT; some fine-grained sand, trace to little orange-colored staining, well bonded with no excess ice to approximately 0-5% visible ice by volume as inclusions (ML, Vx-Nbn)		ML		10.0	4	DP			52/30		Gravel = 0%, Sand = 46%, Fines = 54.3%
							5	DP			29/30		
15							6	DP			53/30		
		17.5 - 29.0 Frozen, gray, SILT with sand; little fine-grained sand, well bonded with no excess ice (ML, Nbn)		ML		17.5	7	DP			38/30		
20							8	DP			58/48		
25							9	DP			60/60		
		Borehole completed at 29.0 ft.											
30		Notes: 1) No groundwater observed while drilling (WD). 2) Sealed 1-inch Schedule 40 PVC installed to 28.5 feet below ground surface. 3) Annulus between borehole and PVC backfilled with cuttings.											
35													

GOLDER

DEPTH SCALE: 1 inch to 4.4 feet
DRILLING CONTRACTOR: GeoTek Alaska Inc.
DRILLER: J. Rodgers

LOGGED: C. Valentine
CHECKED: T. Voeller
CHECK DATE: 3/16/2018

Figure A-12

1782343 HOOPER BAY .GPJ LIBRARY-ANC(3-16-18) - NEW LOGO.GLB [ANC BOREHOLE] cvalentine 4/25/18

RECORD OF BOREHOLE TH(2B)-08

SHEET 1 of 1

PROJECT: Hooper Bay Wastewater Lagoon
PROJECT NUMBER: 1782343
LOCATION: Hooper Bay, Alaska

CLIENT: CE2 Engineers, Inc.
DRILLING DATE: 1/21/2018 3:48:37 PM
EQUIPMENT: Geoprobe 6620DT

DATUM: WGS 84
APPROX. ELEVATION: n/a
APPROX. COORDS: 61.54445° N 166.10670° W

DEPTH (ft)	BORING METHOD	SOIL PROFILE: DESCRIPTION	ICE BOND	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	SAMPLES: NUMBER	TYPE	BLOWS per 6 in (140 lb Hammer (Automatic) 30 in. Drop)	BLOWS PER FT	REC / ATT (inch)	UNCORRECTED BLOWS / FT ■ 10 20 30 40; SALINITY (ppt) △; WATER CONTENT (PERCENT) W_P W W_L 10 20 30 40	NOTES TESTS WATER LEVELS
0	2.5-in. OD Geoprobe	0.0 - 1.5 Frozen, brown, PEAT; organic material, poorly bonded with no excess ice and friable ice (PT, Nbn-Nf)		PT								244	
		1.5 - 14.0 Moist to wet, gray, SILT; few fine-grained sand, unfrozen, mottled with orange-colored staining (ML)				1.5	1A & 1B	DP			56/60		
5				ML			2	DP			60/60		Gravel = 0%, Sand = 6%, Fines = 94.2%
10							3	DP			54/60		
		14.0 - 25.0 Frozen, light gray to gray, sandy SILT; some fine-grained sand, well bonded with no excess ice and excess ice (ML, Nbn-Nbe)				14.0							
15							4	DP			60/30		Gravel = 0%, Sand = 47%, Fines = 53.3%, SA
				ML			5	DP			40/30		
20							6	DP			52/30		
							7	DP			35/30		
25		Borehole completed at 25.0 ft.											
		Notes: 1) No groundwater observed while drilling (WD). 2) Borehole backfilled with cuttings.											
30													
35													

GOLDER

DEPTH SCALE: 1 inch to 4.4 feet
DRILLING CONTRACTOR: GeoTek Alaska Inc.
DRILLER: J. Rodgers

LOGGED: C. Valentine
CHECKED: T. Voeller
CHECK DATE: 3/16/2018

Figure A-13

1782343 HOOPER BAY .GPJ LIBRARY-ANC(3-16-18) - NEW LOGO.GLB [ANC BOREHOLE] cvalentine 4/25/18

RECORD OF BOREHOLE TH(2B)-09

SHEET 1 of 1

PROJECT: Hooper Bay Wastewater Lagoon
PROJECT NUMBER: 1782343
LOCATION: Hooper Bay, Alaska

CLIENT: CE2 Engineers, Inc.
DRILLING DATE: 1/21/2018 2:22:02 PM
EQUIPMENT: Geoprobe 6620DT

DATUM: WGS 84
APPROX. ELEVATION: n/a
APPROX. COORDS: 61.54615° N 166.11175° W

DEPTH (ft)	BORING METHOD	SOIL PROFILE DESCRIPTION	ICE BOND	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	SAMPLES NUMBER	TYPE	BLOWS per 6 in (140 lb Hammer (Automatic) 30 in. Drop)	BLOWS PER FT	REC / ATT (inch)	UNCORRECTED BLOWS / FT ■ 10 20 30 40; SALINITY (ppt) △; WATER CONTENT (PERCENT) W_P W W_L 10 20 30 40	NOTES TESTS WATER LEVELS
0	2.5-in. OD Geoprobe	0.0 - 3.0 Frozen, brown, PEAT; poorly bonded with friable ice to approximately 50% visible ice by volume as inclusions (PT, Vx-Nf)		PT			1A & 1B	DP			50/48	161	
		3.0 - 6.5 Frozen, gray, SILT; trace orange-colored staining, well bonded with approximately 25-50% visible ice by volume as irregularly oriented formations up to 0.5 inch thick (ML, Vr)		ML		3.0	2	DP			52/30	180 212	
5		6.5 - 9.0 Frozen, gray, SILT with sand; little sand, well bonded with approximately 10% visible ice by volume as inclusions up to 0.1 inch thick (ML, Vx)		ML		6.5	3	DP			36/30	75	Gravel = 0%, Sand = 15%, Fines = 85.5%, SA
		9.0 - 11.5 Frozen, gray, SILT; well bonded with no excess ice (ML, Nbn)		ML		9.0	4	DP			49/30		
10		11.5 - 25.0 Frozen, gray, SILTY SAND; fine-grained sand, little silt, observed slightly less sand and more silt from 14 to 17 feet, possible increased sand content below 17 feet, well bonded with excess ice and no excess ice (SM, Nbe-Nbn)		SM		11.5	5	DP			30/30		
							6	DP			47/30		
15							7	DP			50/30		
							8	DP			43/30		Gravel = 0%, Sand = 84%, Fines = 15.8%, SA
20							9	DP			44/42		
25		Borehole completed at 25.0 ft.											
30		Notes: 1) No groundwater observed while drilling (WD). 2) Sealed 1-inch Schedule 40 PVC installed to 23 feet below ground surface. 3) Annulus between borehole and PVC backfilled with cuttings.											
35													

1782343 HOOPER BAY .GPJ LIBRARY-ANC(3-16-18) - NEW LOGO.GLB [ANC BOREHOLE] cvalentine 4/25/18

GOLDER

DEPTH SCALE: 1 inch to 4.4 feet
DRILLING CONTRACTOR: GeoTek Alaska Inc.
DRILLER: J. Rodgers

LOGGED: C. Valentine
CHECKED: T. Voeller
CHECK DATE: 3/16/2018

Figure A-14

RECORD OF BOREHOLE TH(2B)-10

SHEET 1 of 1

PROJECT: Hooper Bay Wastewater Lagoon
PROJECT NUMBER: 1782343
LOCATION: Hooper Bay, Alaska

CLIENT: CE2 Engineers, Inc.
DRILLING DATE: 1/22/2018 9:31:36 AM
EQUIPMENT: Geoprobe 6620DT

DATUM: WGS 84
APPROX. ELEVATION: n/a
APPROX. COORDS: 61.54518° N 166.10893° W

DEPTH (ft)	BORING METHOD	SOIL PROFILE DESCRIPTION	ICE BOND	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	SAMPLES NUMBER	TYPE	BLOWS per 6 in (140 lb Hammer (Automatic) 30 in. Drop)	BLOWS PER FT	REC / ATT (inch)	UNCORRECTED BLOWS / FT ■ / SALINITY (ppt) △ / WATER CONTENT (PERCENT) W_P W W_L	NOTES TESTS WATER LEVELS
0	2.5-in. OD Geoprobe	0.0 - 2.2 Frozen, red brown, PEAT; Bottom 6 inches Nbe, organic material, well bonded with excess ice to approximately 50% visible ice by volume as inclusions (PT, Vx-Nbe)		PT			1A, 1B, & 1C	DP			60/60	714	
		2.2 - 3.0 Frozen, brown, ORGANIC SILT; well bonded with excess ice (OL, Nbe)		OL		2.2 3.0						202 236	
5		3.0 - 17.5 Frozen, light gray, SILT; few fine-grained sand, Nbe or Nbn from 6 to 11 feet and from 15 to 17.5 feet, well bonded with approximately 15% visible ice by volume as irregularly oriented formations and inclusions up to 0.05 inch thick (ML, Vr-Vx)					2	DP			40/30	△	Gravel = 0%, Sand = 7%, Fines = 92.7%
							3	DP			23/30		
10				ML			4	DP			48/30		
							5	DP			30/30		
15							6	DP			44/30		
		17.5 - 25.0 Frozen, gray, SILTY SAND; fine-grained sand, little silt, fine sand increases with depth, well bonded with excess ice and no excess ice (SM, Nbe-Nbn)				17.5	7	DP			30/30		
20				SM			8	DP			50/30		Gravel = 0%, Sand = 81%, Fines = 18.6%
							9	DP			38/30		
25		Borehole completed at 25.0 ft.											
30		Notes: 1) No groundwater observed while drilling (WD). 2) Sealed 1-inch Schedule 40 PVC installed to 25 feet below ground surface. 3) Annulus between borehole and PVC backfilled with cuttings.											
35													

1782343 HOOPER BAY .GPJ LIBRARY-ANC(3-16-18) - NEW LOGO.GLB [ANC BOREHOLE] cvalentine 4/25/18

GOLDER

DEPTH SCALE: 1 inch to 4.4 feet
DRILLING CONTRACTOR: GeoTek Alaska Inc.
DRILLER: J. Rodgers

LOGGED: C. Valentine
CHECKED: T. Voeller
CHECK DATE: 3/16/2018

Figure A-15

RECORD OF BOREHOLE TH(2B)-11

SHEET 1 of 1

PROJECT: Hooper Bay Wastewater Lagoon
PROJECT NUMBER: 1782343
LOCATION: Hooper Bay, Alaska

CLIENT: CE2 Engineers, Inc.
DRILLING DATE: 1/22/2018 11:13:42 AM
EQUIPMENT: Geoprobe 6620DT

DATUM: WGS 84
APPROX. ELEVATION: n/a
APPROX. COORDS: 61.54585° N 166.10865° W

DEPTH (ft)	BORING METHOD	SOIL PROFILE DESCRIPTION	ICE BOND	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	SAMPLES NUMBER	TYPE	BLOWS per 6 in (140 lb Hammer (Automatic) 30 in. Drop)	BLOWS PER FT	REC / ATT (inch)	UNCORRECTED BLOWS / FT ■ 10 20 30 40; SALINITY (ppt) △; WATER CONTENT (PERCENT) W_P W W_L 10 20 30 40	NOTES TESTS WATER LEVELS
0	2.5-in. OD Geoprobe	0.0 - 4.8 Frozen to 0.5 feet, moist, brown red, PEAT; organic material, well bonded (PT)	■	PT			1	DP			30/46	○	OLI = 8%
5		4.8 - 8.8 Moist, gray, SILTY SAND; little to some silt (SM)		SM		4.8	2	DP			54/60	○ △	Gravel = 0%, Sand = 73%, Fines = 27.0%, SA
10		8.8 - 23.8 Wet, gray, poorly graded SAND with silt; fine-grained (SP-SM)		SP-SM		8.8	3	DP			32/30	○	8.8 ft ▽ 1/22/2018 11:46:37 AM; WD
							4	DP			26/30	○	
15							5	DP			30/30	○	Gravel = 0%, Sand = 93%, Fines = 6.5%, SA
							6	DP			30/30	○	
20							7	DP			60/60	○ △	
25		Borehole completed at 23.8 ft. Notes: 1) Conditions at time of drilling: -Surface ice 1.2 feet thick 2) Groundwater observed at 8.8 feet while drilling (WD). 3) Borehole backfilled with cuttings.											
30													
35													

GOLDER

DEPTH SCALE: 1 inch to 4.4 feet
DRILLING CONTRACTOR: GeoTek Alaska Inc.
DRILLER: J. Rodgers

LOGGED: C. Valentine
CHECKED: T. Voeller
CHECK DATE: 3/16/2018

Figure A-16

1782343 HOOPER BAY .GPJ LIBRARY-ANC(3-16-18) - NEW LOGO.GLB [ANC BOREHOLE] cvalentine 4/25/18

RECORD OF BOREHOLE TH(2B)-12

SHEET 1 of 1

PROJECT: Hooper Bay Wastewater Lagoon
PROJECT NUMBER: 1782343
LOCATION: Hooper Bay, Alaska

CLIENT: CE2 Engineers, Inc.
DRILLING DATE: 1/22/2018 2:47:29 PM
EQUIPMENT: Geoprobe 6620DT

DATUM: WGS 84
APPROX. ELEVATION: n/a
APPROX. COORDS: 61.54420° N 166.10998° W

DEPTH (ft)	BORING METHOD	SOIL PROFILE DESCRIPTION	ICE BOND	USCS	GRAPHIC LOG	ELEV. DEPTH (ft)	SAMPLES NUMBER	TYPE	BLOWS per 6 in (140 lb Hammer (Automatic) 30 in. Drop)	BLOWS PER FT	REC ATT (inch)	UNCORRECTED BLOWS / FT ■ 10 20 30 40; SALINITY (ppt) △; WATER CONTENT (PERCENT) W_P W W_L 10 20 30 40	NOTES TESTS WATER LEVELS
0	6.25-in. OD Geoprobe	0.0 - 0.5 Frozen, red brown, PEAT; tundra organic cover grading into organic silt, well bonded with approximately 5-20% visible ice by volume as inclusions (PT, Vx)	■	PT		0.5	1	SS	2-2-2	4	8/18	■ ○	
		0.5 - 5.0 Frozen, red brown, ORGANIC SILT; poorly bonded with no excess ice and friable ice (OL, Nbn-Nf)		OL			2	SS	2-1-2	3	11/18	■ ○	OLI = 3%
5		5.0 - 12.0 Moist, brown mottled orange, SILTY SAND; fine-grained sand, some silt (SM)		SM		5.0	3	SS	1-3-3	6	14/18	■ ○	Gravel = 0%, Sand = 61%, Fines = 39.3%
							4	SS	3-4-6	10	12/18	■ ○ △	
10													11 ft ▽ 1/22/2018 3:37:45 PM; WD
		12.0 - 24.0 Wet, brown gray, SILTY SAND; fine-grained sand, little silt (SM)				12.0	5	SS	5-9-10	19	12/18	■ ○	
15													
				SM			6	SS	7-11-12	23	18/18	■ ○	Gravel = 0%, Sand = 88%, Fines = 12.1%, SA
20							7	SS	11-19-59	78	18/18	○	>> ■
		Borehole completed at 24.0 ft.											
25		Notes: 1) Groundwater observed at 11 feet while drilling (WD). 2) Borehole backfilled with cuttings.											
30													
35													

1782343 HOOPER BAY .GPJ LIBRARY-ANC(3-16-18) - NEW LOGO.GLB [ANC BOREHOLE] cvalentine 4/25/18

GOLDER

DEPTH SCALE: 1 inch to 4.4 feet
DRILLING CONTRACTOR: GeoTek Alaska Inc.
DRILLER: J. Rodgers

LOGGED: C. Valentine
CHECKED: T. Voeller
CHECK DATE: 3/16/2018

Figure A-17

APPENDIX B

Summary Geotechnical Laboratory Results

GOLDER

TABLE B-1: SAMPLE SUMMARY

Client:	CE2 Engineers, Inc.	**Project No.:**	1782343
Project:	Hooper Bay Wastewater Lagoon		
Location:	Hooper Bay, Alaska	**Reviewed By:**	T. Voeller **Date:** 3/1/2018

SAMPLING DATA							CLASSIFICATION AND INDEX TEST RESULTS										
SAMPLE LOCATION	SAMPLE NUMBER	DEPTH (ft) TOP	DEPTH (ft) BOTTOM	RECOVERY (%)	SAMPLE TYPE	BLOWS PER FOOT	NATURAL MOISTURE CONTENT (%)	LIQUID LIMIT (LL) (%)	PLASTIC LIMIT (PL) (%)	PLASTICITY INDEX (PI) (%)	GRADATION (%) GRAVEL	GRADATION (%) SAND	GRADATION (%) FINES (SILT & CLAY)	ORGANIC CONTENT (%)	SALINITY (ppt) [(d) is directly meas.]	DESCRIPTION (USCS)	TESTS / OTHER TESTS
TH(2A)-01	2	3.0	4.5	100	SS	8	36										
TH(2A)-01	3	8.0	9.5	100	SS	10	40								13		
TH(2A)-01	4	13.0	14.5	100	SS	10	45				0	15	85.1			ML	
TH(2A)-01	5	18.0	19.5	87	SS	16	36								5		
TH(2A)-01	6	23.0	24.5	100	SS	8	34										
TH(2A)-03	1	0.5	1.5	150	SS	19	176										
TH(2A)-03	2	2.0	3.5	7	SS	2	221							15			
TH(2A)-03	3	4.5	6.0	7	SS	1	168										
TH(2A)-03	4	7.0	8.5	87	SS	2	45										
TH(2A)-03	5	9.5	11.0	85	TW		42	58	37	21					5	MH	PI
TH(2A)-03	6	12.5	14.0	100	SS	6	43								5		
TH(2A)-03	7	17.5	19.0	100	SS	4	43	57	33	24						MH	PI
TH(2A)-03	8	22.5	24.0	100	SS	3	39										
TH(2A)-05	1	1.5	3.0	3	SS	0	330										
TH(2A)-05	2	7.0	8.5	87	SS	7	41				0	2	97.9		34	ML	MA
TH(2A)-05	3	12.0	13.5	100	SS	7	42										
TH(2A)-05	4	17.0	19.0	100	TW		46	54	32	22					13	MH	PI
TH(2A)-05	5	22.0	23.5	0	SS	0	48										
TH(2A)-07	1	0.0	1.5	100	SS	25	267										
TH(2A)-07	2	2.5	4.0	100	SS	1	94							17			
TH(2A)-07	3	5.0	6.5	13	SS	1	106										
TH(2A)-07	4	8.0	9.5	100	SS	1	31										
TH(2A)-07	5	13.0	14.5	100	SS	11	33										
TH(2A)-07	6	18.0	19.5	100	SS	32	23				0	78	22.0			SM	
TH(2A)-07	7	23.0	24.5	100	SS	19	22								5		
TH(2A)-08	1	0.0	1.5	100	SS	14	112										
TH(2A)-08	2	2.5	4.0	7	SS	2	171										
TH(2A)-08	3	5.0	6.5	100	SS	4	40								15		
TH(2A)-08	4	7.5	9.0	93	SS	3	41										
TH(2A)-08	5	13.0	14.5	87	SS	2	45										
TH(2A)-08	6	18.0	19.5	67	SS	2	43	49	39	10						ML	PI
TH(2A)-08	7	23.0	25.0	50	TW												

Golder Associates Inc.
2121 Abbott Road, Suite 100, Anchorage, AK
Tel: (907) 344-6001 Fax: (907) 344-6011 www.golder.com

GOLDER

TABLE B-1: SAMPLE SUMMARY

Client:	CE2 Engineers, Inc.	**Project No.:**	1782343
Project:	Hooper Bay Wastewater Lagoon		
Location:	Hooper Bay, Alaska	**Reviewed By:**	T. Voeller **Date:** 3/1/2018

SAMPLING DATA							CLASSIFICATION AND INDEX TEST RESULTS										
SAMPLE LOCATION	SAMPLE NUMBER	DEPTH (ft) TOP	DEPTH (ft) BOTTOM	RECOVERY (%)	SAMPLE TYPE	BLOWS PER FOOT	NATURAL MOISTURE CONTENT (%)	LIQUID LIMIT (LL) (%)	PLASTIC LIMIT (PL) (%)	PLASTICITY INDEX (PI) (%)	GRADATION (%) GRAVEL	GRADATION (%) SAND	GRADATION (%) FINES (SILT & CLAY)	ORGANIC CONTENT (%)	SALINITY (ppt) [(d) is directly meas.]	DESCRIPTION (USCS)	TESTS / OTHER TESTS
TH(2B)-01	1	0.0	1.5	133	SS	35	151										
TH(2B)-01	2	2.5	4.0	7	SS	1	209										
TH(2B)-01	3	5.0	6.5	0	SS	0											
TH(2B)-01	4	10.0	11.5	87	SS	8	37										
TH(2B)-01	5	15.0	16.5	100	SS	9	38										
TH(2B)-01	6	20.0	21.5	100	SS	4	42								10		
TH(2B)-01	7	23.5	25.0	100	SS	6	44	50	33	17						ML	PI
TH(2B)-03	1	0.0	1.5	73	SS	4	213										
TH(2B)-03	2	2.5	4.0	0	SS	1											
TH(2B)-03	3	5.0	6.5	73	SS	2	51										
TH(2B)-03	4	7.5	9.0	80	SS	1	55	65	39	26						MH	PI
TH(2B)-03	5	13.0	14.5	93	SS	12	25				0	91	9.3			SP-SM	
TH(2B)-03	6	18.0	19.5	73	SS	32	23				0	91	9.2		13	SP-SM	SA
TH(2B)-03	7	23.0	24.5	100	SS	108	23										
TH(2B)-04	1	0.0	1.5	100	SS	2	140										
TH(2B)-04	2	2.5	4.0	100	SS	22	182										
TH(2B)-04	3	5.0	6.5	100	SS	25	50										
TH(2B)-04	4A	7.0	8.5	100	DP		37										
TH(2B)-04	4B	8.5	10.0				27										
TH(2B)-04	5	10.0	12.5	100	DP		25				0	81	19.3			SM	
TH(2B)-04	6	12.5	15.0	172	DP		23								0		
TH(2B)-04	7	15.0	17.5	148	DP		28										
TH(2B)-05	1	0.0	5.0	100	DP		81										
TH(2B)-05	2	5.0	7.5	160	DP		101				0	5	95.1			ML	
TH(2B)-05	3	7.5	10.0	132	DP		70										
TH(2B)-05	4	10.0	12.5	156	DP		36										
TH(2B)-05	5	12.5	15.0	112	DP		37										
TH(2B)-05	6	15.0	17.5	168	DP		30										
TH(2B)-05	7	17.5	20.0	156	DP		23										
TH(2B)-05	8	20.0	22.5	188	DP		22				0	74	26.0			SM	
TH(2B)-05	9	22.5	25.0	100	DP		26										
TH(2B)-07	1A	0.0	3.0	100	DP		246										

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TABLE B-1: SAMPLE SUMMARY

Client:	CE2 Engineers, Inc.	**Project No.:**	1782343
Project:	Hooper Bay Wastewater Lagoon		
Location:	Hooper Bay, Alaska	**Reviewed By:**	T. Voeller **Date:** 3/1/2018

SAMPLING DATA							CLASSIFICATION AND INDEX TEST RESULTS										
SAMPLE LOCATION	SAMPLE NUMBER	DEPTH (ft) TOP	DEPTH (ft) BOTTOM	RECOVERY (%)	SAMPLE TYPE	BLOWS PER FOOT	NATURAL MOISTURE CONTENT (%)	LIQUID LIMIT (LL) (%)	PLASTIC LIMIT (PL) (%)	PLASTICITY INDEX (PI) (%)	GRADATION (%) GRAVEL	GRADATION (%) SAND	GRADATION (%) FINES (SILT & CLAY)	ORGANIC CONTENT (%)	SALINITY (ppt) [(d) is directly meas.]	DESCRIPTION (USCS)	TESTS / OTHER TESTS
TH(2B)-07	1B	3.0	5.0				195										
TH(2B)-07	2	5.0	7.5	184	DP		40										
TH(2B)-07	3	7.5	10.0	76	DP		35										
TH(2B)-07	4	10.0	12.5	172	DP		26										
TH(2B)-07	5	12.5	15.0	96	DP		27				0	46	54.3			ML	
TH(2B)-07	6	15.0	17.5	176	DP		25										
TH(2B)-07	7	17.5	20.0	128	DP		22										
TH(2B)-07	8	20.0	24.0	120	DP		22										
TH(2B)-07	9	24.0	29.0	100	DP		22										
TH(2B)-08	1A	0.0	1.5	94	DP		244										
TH(2B)-08	1B	1.5	5.0				41										
TH(2B)-08	2	5.0	10.0	100	DP		32				0	6	94.2			ML	
TH(2B)-08	3	10.0	15.0	90	DP		25										
TH(2B)-08	4	15.0	17.5	200	DP		25				0	47	53.3			ML	SA
TH(2B)-08	5	17.5	20.0	132	DP		22										
TH(2B)-08	6	20.0	22.5	172	DP		21										
TH(2B)-08	7	22.5	25.0	116	DP		25										
TH(2B)-09	1A	0.0	3.0	105	DP		161										
TH(2B)-09	1B	3.0	4.0				180										
TH(2B)-09	2	4.0	6.5	172	DP		212										
TH(2B)-09	3	6.5	9.0	120	DP		75				0	15	85.5			ML	SA
TH(2B)-09	4	9.0	11.5	164	DP		31										
TH(2B)-09	5	11.5	14.0	100	DP		23										
TH(2B)-09	6	14.0	16.5	156	DP		29										
TH(2B)-09	7	16.5	19.0	168	DP		22										
TH(2B)-09	8	19.0	21.5	144	DP		21				0	84	15.8			SM	SA
TH(2B)-09	9	21.5	25.0	106	DP		21										
TH(2B)-10	1A	0.0	2.2	100	DP		714										
TH(2B)-10	1B	2.2	3.0				202										
TH(2B)-10	1C	3.0	5.0				236										
TH(2B)-10	2	5.0	7.5	132	DP		43				0	7	92.7		0	ML	
TH(2B)-10	3	7.5	10.0	76	DP		30										

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TABLE B-1: SAMPLE SUMMARY

Client:	CE2 Engineers, Inc.	**Project No.:**	1782343
Project:	Hooper Bay Wastewater Lagoon		
Location:	Hooper Bay, Alaska	**Reviewed By:**	T. Voeller **Date:** 3/1/2018

SAMPLING DATA							CLASSIFICATION AND INDEX TEST RESULTS										
SAMPLE LOCATION	SAMPLE NUMBER	DEPTH (ft) TOP	DEPTH (ft) BOTTOM	RECOVERY (%)	SAMPLE TYPE	BLOWS PER FOOT	NATURAL MOISTURE CONTENT (%)	LIQUID LIMIT (LL) (%)	PLASTIC LIMIT (PL) (%)	PLASTICITY INDEX (PI) (%)	GRADATION (%) GRAVEL	GRADATION (%) SAND	GRADATION (%) FINES (SILT & CLAY)	ORGANIC CONTENT (%)	SALINITY (ppt) [(d) is directly meas.]	DESCRIPTION (USCS)	TESTS / OTHER TESTS
TH(2B)-10	4	10.0	12.5	160	DP		33										
TH(2B)-10	5	12.5	15.0	100	DP		34										
TH(2B)-10	6	15.0	17.5	148	DP		27										
TH(2B)-10	7	17.5	20.0	100	DP		26										
TH(2B)-10	8	20.0	22.5	168	DP		22				0	81	18.6			SM	
TH(2B)-10	9	22.5	25.0	128	DP		22										
TH(2B)-11	1	0.0	3.8	66	DP		50							8			
TH(2B)-11	2	3.8	8.8	90	DP		20				0	73	27.0		0	SM	SA
TH(2B)-11	3	8.8	11.3	108	DP		22										
TH(2B)-11	4	11.3	13.8	88	DP		23										
TH(2B)-11	5	13.8	16.3	100	DP		22				0	93	6.5			SP-SM	SA
TH(2B)-11	6	16.3	18.8	100	DP		24										
TH(2B)-11	7	18.8	23.8	100	DP		25								0		
TH(2B)-12	1	0.0	1.5	47	SS	4	40										
TH(2B)-12	2	2.5	4.0	60	SS	3	21							3			
TH(2B)-12	3	5.0	6.5	80	SS	6	25				0	61	39.3			SM	
TH(2B)-12	4	7.5	9.0	67	SS	10	27								0		
TH(2B)-12	5	12.5	14.0	67	SS	19	23										
TH(2B)-12	6	17.5	19.0	100	SS	23	23				0	88	12.1			SM	SA
TH(2B)-12	7	22.5	24.0	100	SS	78	22										

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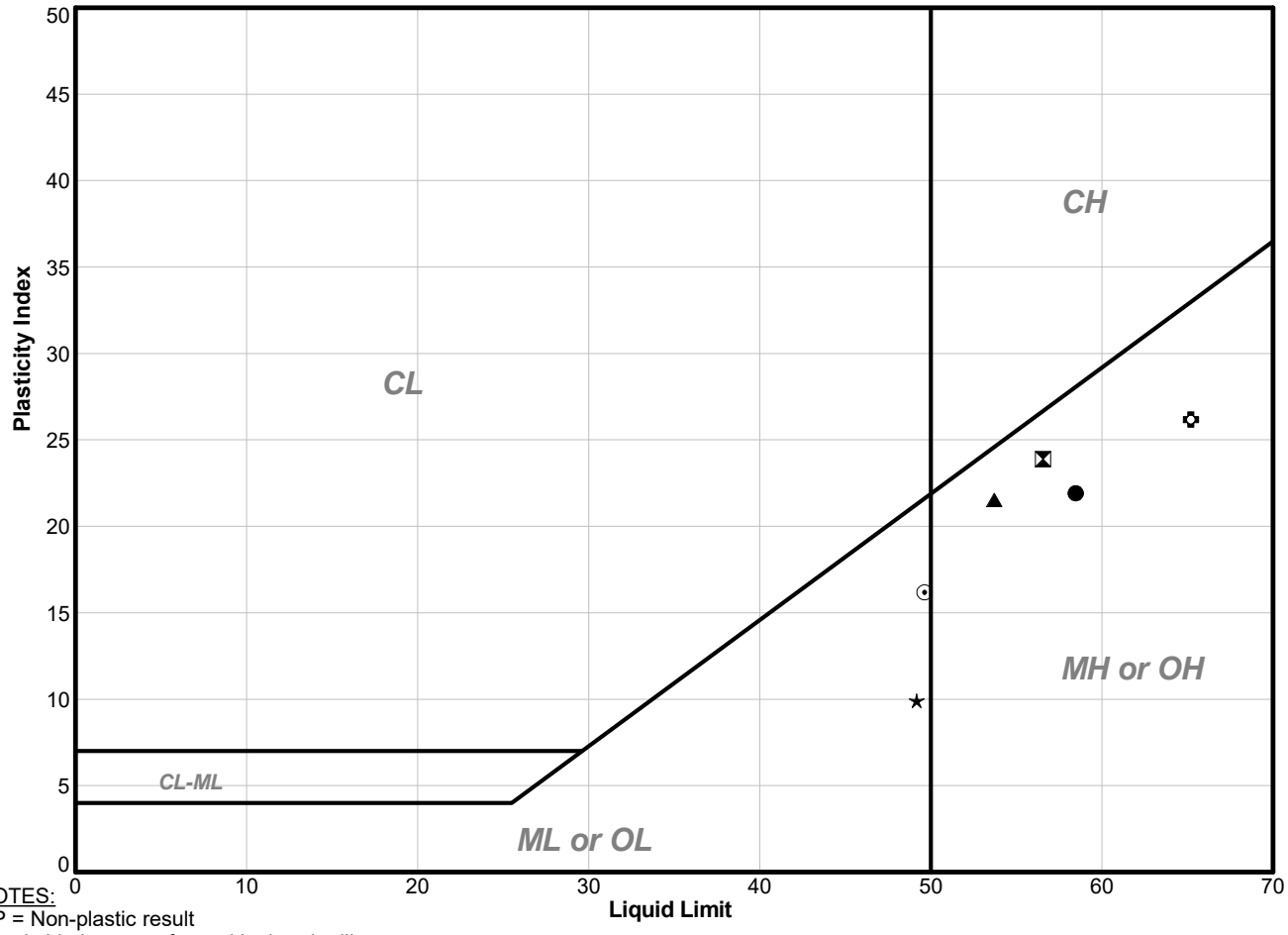
FIGURE B-1: LIQUID LIMIT, PLASTIC LIMIT AND PLASTICITY INDEX

Reference(s)
ASTM D4318

Client:	CE2 Engineers, Inc.	**Project No.:**	1782343	
Project:	Hooper Bay Wastewater Lagoon	**QA/QC By:**	J. Randazzo	**Date:** 3/1/2018
Location:	Hooper Bay, Alaska	**Reviewed By:**	T. Voeller	**Date:** 3/1/2018

PLASTICITY CHART



NOTES:
NP = Non-plastic result
Plastic Limit test performed by hand rolling
Liquid Limit test performed using mechanical device

	Sample Location	Sample Number	Depth (ft)	Bottom (ft)	Passing #40 Sieve (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index	USCS	Natural Moisture Content (%)
●	TH(2A)-03	5	9.5	11.0		58	37	21	MH	42
⊠	TH(2A)-03	7	17.5	19.0		57	33	24	MH	43
▲	TH(2A)-05	4	17.0	19.0		54	32	22	MH	46
★	TH(2A)-08	6	18.0	19.5		49	39	10	ML	43
⊙	TH(2B)-01	7	23.5	25.0		50	33	17	ML	44
✿	TH(2B)-03	4	7.5	9.0		65	39	26	MH	55

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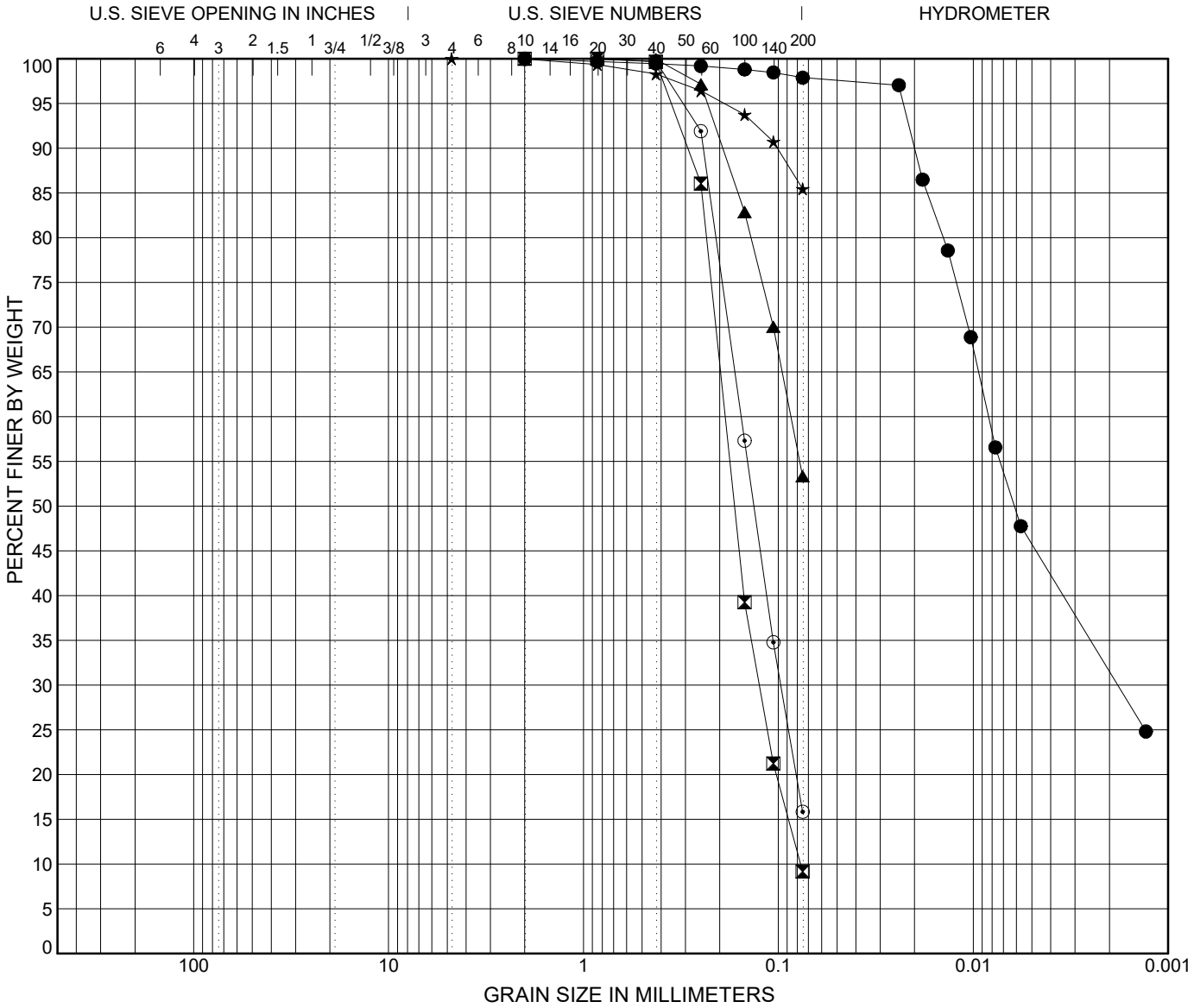
FIGURE B-2: SUMMARY OF PARTICLE SIZE DISTRIBUTION RESULTS

Reference(s)
ASTM D422
ASTM D6913

Client:	CE2 Engineers, Inc.	**Project No.:**	1782343	
Project:	Hooper Bay Wastewater Lagoon	**QA/QC By:**	J. Randazzo	**Date:** 3/1/2018
Location:	Hooper Bay, Alaska	**Reviewed By:**	T. Voeller	**Date:** 3/1/2018



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Sample Location	Sample Number	Depth (ft)	USCS Classification	Cc	Cu	% Gravel	% Sand	% Fines	% < 0.02 mm
●	TH(2A)-05	2	7.0	silt (ML)	-	-	0	2	97.9	90.0
⊠	TH(2B)-03	6	18.0	poorly graded sand with silt (SP-SM)	1.1	2.4	0	91	9.2	
▲	TH(2B)-08	4	15.0	sandy silt (ML)	-	-	0	47	53.3	
★	TH(2B)-09	3	6.5	silt (ML)	-	-	0	15	85.5	
⊙	TH(2B)-09	8	19.0	silty sand (SM)	-	-	0	84	15.8	

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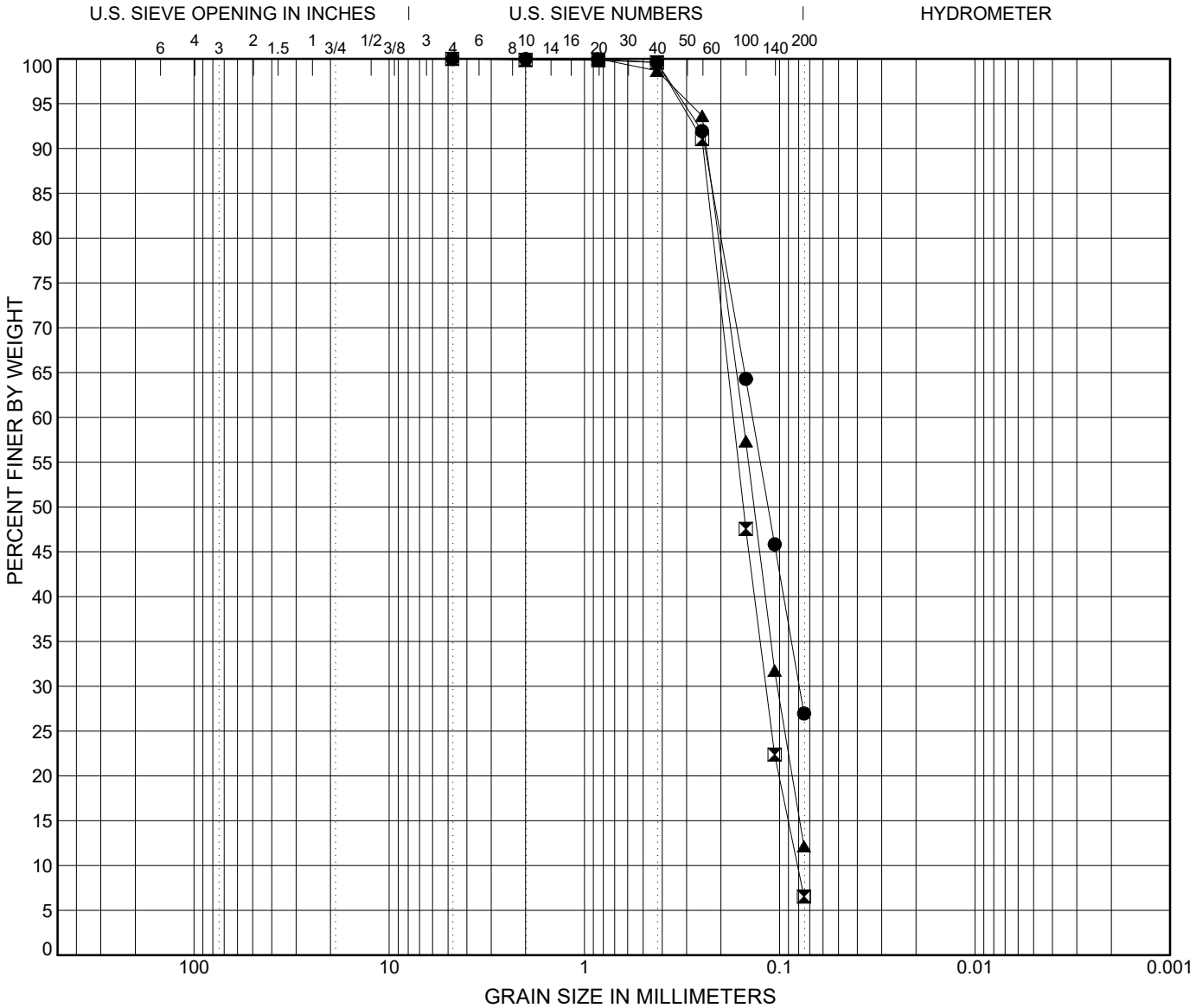
FIGURE B-3: SUMMARY OF PARTICLE SIZE DISTRIBUTION RESULTS

Reference(s)
ASTM D422
ASTM D6913

Client:	CE2 Engineers, Inc.	**Project No.:**	1782343	
Project:	Hooper Bay Wastewater Lagoon	**QA/QC By:**	J. Randazzo	**Date:** 3/1/2018
Location:	Hooper Bay, Alaska	**Reviewed By:**	T. Voeller	**Date:** 3/1/2018



	Sample Location	Sample Number	Depth (ft)	USCS Classification	Cc	Cu	% Gravel	% Sand	% Fines	% < 0.02 mm
●	TH(2B)-11	2	3.8	silty sand (SM)	-	-	0	73	27.0	
⊠	TH(2B)-11	5	13.8	poorly graded sand with silt (SP-SM)	1.0	2.1	0	93	6.5	
▲	TH(2B)-12	6	17.5	silty sand (SM)	0.9	2.1	0	88	12.1	

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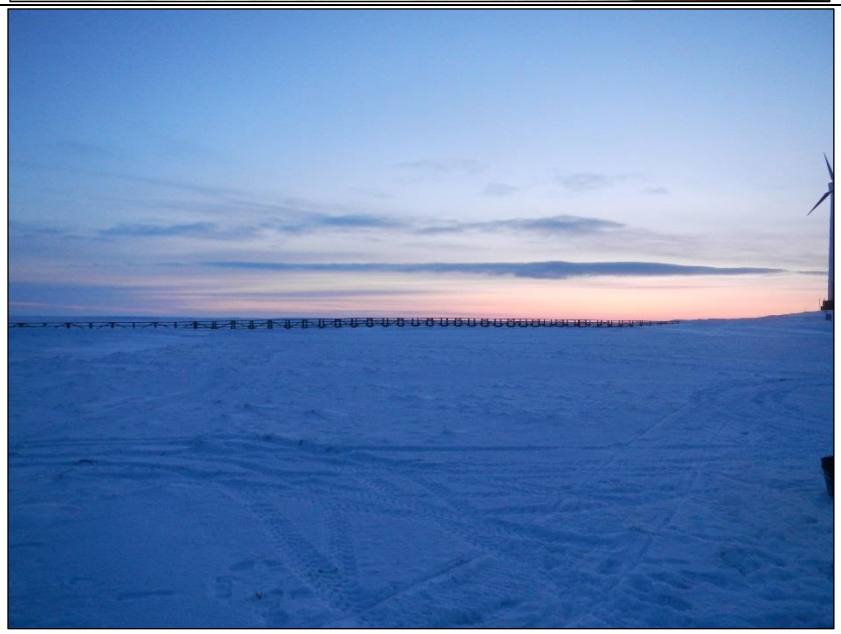
APPENDIX C

Representative Site Photographs

Appendix C: Hooper Bay Wastewater Lagoon Site Photographs	
PHOTO 1 Typical set up over borehole while drilling. Photograph taken at Borehole TH(2B)-1 location.	
PHOTO 2 Example of unfrozen silty soil encountered at Site 2A, sample number 6 at a depth of 13 feet in Borehole TH(2A)-3.	

Appendix C: Hooper Bay Wastewater Lagoon Site Photographs	
PHOTO 3 Soil cuttings from unfrozen silty clay observed at proposed Site 2A, Borehole TH(2A)-3.	
PHOTO 4 Photo looking east from Site 2A toward bridge that runs roughly north-south across slough, photo taken at Borehole TH(2B)-1 location.	

Appendix C: Hooper Bay Wastewater Lagoon Site Photographs	
PHOTO 5 View south at Borehole TH(2B)-3 location (near water crossing).	
PHOTO 6 View of northwest end Option 2B site, looking west, near end of oxbow lake at Borehole TH(2B)-12 location.