Fairview Recreation Center
Snow Disposal
Design Study Report (DSR)

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Executive Summary

The purpose of this report is to outline the design process for a winter stormwater infiltration system (WSIS) located at the Fairview Community Recreation Center (FCRC). The following alternatives were analyzed in the Type Study Report (TSR):

- Location
- Structural Layout
- Material
- Heating

Refer to the TSR in Appendix A-1 for the Site Description and Alternative Analysis.

Analysis concluded that a WSIS for the disposal of parking lot snow would be best placed at the northern edge of the northern parking lot just to the east of the bus stop on 9th Avenue. A dual structure that uses a natural gas heat source and recirculation of melt water was chosen for design. This report will include updated design considerations, geotechnical analysis, and a technical outline of the preferred design alternative. For information regarding the inception of the project see the Dr. Alex Hills Civic Engagement Award Proposal and the included Letters of Recommendation in Appendix A-2.

Design Considerations

The following section will outline design considerations specific to the project’s site, geotechnical, utilities, and operations.

Site

All design alternatives need to account for the access and traffic demands of the FCRC northern parking lot. The northern parking lot is the primary parking facility for the FCRC and the location of the Mobile Pantry two Saturdays per month. The preferred design alternative will ensure parking lot access can be maintained throughout construction. Additionally, since the FCRC is a designated emergency shelter, care shall be taken to ensure any utility shutdowns are well-coordinated and meet applicable municipal standards.

Geotechnical

The soils that surround the WSIS will impact its construction and operation. The soils must support the weight of the structure and provide adequate infiltration of the melted snow. Due to limited funding and lack of geotechnical data, a proposal was written for the Dr. Alex Hills Civic Engagement Award.

The proposal was accepted. With the awarded funds, DOWL HKM was
employed to drill two boreholes at the proposed location (shown in Figures 1 and 2). The resulting soil analysis report is attached in Appendix B-1. The boreholes were drilled to a depth of 15 feet. No water table was encountered. The samples collected from the boreholes classified the soils as poorly graded sand with silt and gravel to a depth of 7’, followed by poorly graded sand with gravel to a depth of 15’. Testing indicated an infiltration rate of 54 in/hr. Frost depth at the time of testing was found to be 5’-6”.

The data obtained verified that the existing soil’s hydraulic conductivity is adequate to support an infiltration gallery necessary to percolate snowmelt water.

Utilities
Connection points must be able to reach the structure with minimal trenching and relocation to limit cost. The area directly surrounding the structure shall have enough space to accommodate the required above and below grade components. The existing on-site and adjacent utilities are summarized in the attached TSR and associated maps delineating these locations are provided in Appendix C.

Operations
The preferred alternative will take into consideration current Municipal Operations onsite. This includes maintenance operations, and traffic flow. Current snow removal and storage operations will be considered throughout design to ensure the preferred alternative will not impede existing procedures.
**Operation Cost**
The preferred alternative is the alternative that is cheaper to operate than current snow removal and disposal procedures. Current annual snow removal costs are assumed to be approximately $16,000.

**Preferred Structural Alternative**

Based on the preferred dual structure, the initial structure has been enlarged to allow for adequate storage, snow-melting capacity, required infiltration rates and feasible operation and maintenance costs. A second vault, from here forth identified as the Machinery vault is to be implemented to provide suitable space for required mechanical units and placed directly adjacent to the Melting vault. All structures as described in the following section shall be installed following excavation and placement of engineer approved and specified leveling course. The geometries, sizes, materials and details of the three unit structures are defined in the following sub-sections.

**Melting Vault**
The preferred Melting vault shall be constructed from stacked precast reinforced concrete units of the following dimensions:

- Four (4) - 16’ x 8’ x 3’ rectangular vaults, 8” walls
- One (1) - 17’-4” x 9’-4” rectangular lid, 8” thick
- One (1) - 17’-4” x 9’-4” rectangular base with 1:12 slope, 8” thick

Use of the above dimensioned components allows adequate internal storage as deemed by the design considerations.

To allow for proper operations and maintenance, the following covers and hatches shall be installed:

- One (1) - 10’ x 4’ rectangular HS-20 rated frame and hatch
- Two (2) – standard stormwater manhole frames and covers

Use of a 10’ x 4’ rectangular HS-20 hatch shall allow use of a front-end loader or traditional plow vehicle with standard 9’ wide plow to deposit snow from the adjacent parking lot directly into the Melting vault without use of additional equipment or procedures. The cast-in-place manhole frames and lids shall allow for regular maintenance of the unit processes installed in the melting structure.

On both sides, beginning at the northeastern and southeastern bottom corners and spanning along the top north and south corners of the Melting vault, the following water-recycle sprayer manifold shall be installed (see Figures 3 and 4):

- One (1) – 12” perforated corrugated metal pipe (CMP), 8’-6” long
- One (1) – 2” pumps
- One (1) – 2” High Density Polyethylene (HDPE) pipe, 25’ long
- Four (4) – ¼” sprayer nozzles

12” perforated CMP shall be installed vertically in the northeastern and southeastern corners of the Melting vault, flush against the eastern base and filled with 3’ of ¾” drain rock. 2” pumps shall be placed in CMP on drain rock and HDPE pipe attached to pumps HDPE piping shall be fitted to bend long the wall and lid of Melting vault. The sprayer manifold shall maintain a 2% grade along the lid of Melting vault to allow for sprayer manifold to drain. ¼” nozzles shall be installed into HDPE piping, spaced 4’ O.C. The northern sprayer manifold nozzles shall be staggered from the southern by 2’. Use of the perforated CMP allows for adequate flow of recycled snow-melt to allow sprayer manifold to operate continuously, while reducing the amount of debris from entering the sprayer manifold.

Figure 4
The following heated glycol loop system shall be installed spanning across the 12” perforated CMP’s. Vertical placement of the glycol loop shall be 4’ measured from the top of the loop to the inside base of the Melting vault:

- One (1) – ¾” glycol loop, 232’ long
- One (1) – ½” 8’ x 2’-6” expanded steel plate

The glycol loop shall be fitted and installed in 8’ rows with 180-degree bends. Each row shall be placed 5/8” O.C. The expanded steel plate shall be placed flush over the front and top of the glycol loop to protect the system from floating ice and debris while serving to disperse heat across the Melting vault.

To allow for adequate snow-melt drainage, an outflow system of the following components shall be installed in the Melting vault:

- One (1) – 12” perforated CMP, 9’-10” long
- One (1) – 8” Ductile Iron (DI) elbow

The 8” DI elbow shall be fitted and installed in the center western wall of the Melting vault, 4’ above the eastern interior base with intake facing down. Fitted and installed around the 8” DI elbow, the 12” perforated CMP shall be vertically placed flush against the western wall and attached to the western base. The 8” DI elbow shall be implemented...
as an outflow pipe, leading to the infiltration gallery. Use of the 12” perforated CMP shall reduce debris to the outflow.

**Machinery Vault**
A second vault structure shall be constructed adjacent to the Melting vault to house the required natural gas boiler unit and glycol head tank (See Section XX). The Machinery vault shall be constructed of precast reinforced concrete to the following internal dimensions:

- One (1) - 8’ x 8’ x 8’ square vault with 8” walls, base and reducing slab

The following lid shall be cast into the Machinery vault reducing slab to allow for regular maintenance of the unit processes:

- One (1) – standard stormwater manhole frame and lid

**Infiltration Gallery**
Proper drainage from the Melting vault shall be maintained by the installation of an infiltration gallery consisting of the following components:

- Two (2) – 24” perforated Corrugated Polyethylene Pipe (CPEP), 20’ long
- Three (3) – 8” Poly Vinyl Chlorinate (PVC) 90 degree bends
- 8” PVC pipe – total of 27’

An 8” PVC 90-degree bend shall be attached to the 8” DI elbow drainage outlet on the exterior of the eastern wall of the Melting vault. From this 90-degree bend, PVC piping shall be placed as specified in the planset and connected to the specified 24” perforated CPEP’s. Perforated CPEP shall be surrounded by ¾” engineer approved drain rock to allow for adequate storage during the infiltration of snow-melt into native soils. The drainage area shall be covered in geotextile fabric on all sides to prevent the introduction of native fines into the infiltration gallery, creating a reduction of infiltration rates.

**Preferred Electrical/Mechanical Alternative**
The preferred melting system shall have two settings: maintain, and melting.

**Maintain Setting**
During snowfall seasons, the WSIS will be running continuously on a maintain setting. The purpose of this setting is to keep the snowmelt pool from changing phase from liquid to solid. At this setting the boiler should run as efficiently as possible in order to maintain phase. A centrifugal pump shall circulate glycol through a heat exchanger. Due to the Melting Vault being well insulated (2 layers of R13), energy losses shall be minimal. Temperature will be regulated via RTD with thermocouple.

**Melting Setting**
During snowfall events, the WSIS will be switched to a melting setting, via pressing a manual switch. The purpose of this setting is to melt snow that has been plowed into the Melting Vault. At this setting the boiler shall run at a significantly higher capacity. The sump pumps shall engage, drawing water up into the sprayer manifolds, and out of the sprayer nozzles onto the snow. This will decrease snow melt time. As snow melts, the water level is maintained via drain valve. A time delay switch and float level switch shall work as secondary preventive measures keeping the WSIS from overflowing or running longer than necessary.

The melting system shall contain the following components:

- Two (2) – 2” 150 GPM sump pumps
- One (1) – 10 HP centrifugal pump driven by an electric motor
- One (1) – electrically ignited natural gas fired boiler
- Two (2) – layers of R13 surrounding exterior of Melting Vault
- One (1) – Glycol loop
- Two (2) – Sprayer manifolds
- Four (4) – Spray nozzles along each manifold

The instrumentation system shall contain the following components:

- One (1) – RTD with thermocouple
- One (1) – Float level switch
- One (1) – Time delay switch
- One (1) – Temperature activated switch
- Two (2) – Manual operation switches
- Two (2) – Automatic toggle switches

**Heating Economics**

From the heating alternative analysis in the TSR, located in Appendix A-1, it was deemed that use of a natural gas boiler shall be the method of heating for the melting pool in the WSIS. Electric power shall be implemented to run pumps, instrumentation, and ignite the boiler. Power shall be implemented using Electric Alternative 1 from the attached TSR. The following section explains:

- Assumptions made for the analysis
- Maintaining a “maintain” setting, providing minimal energy to prevent water in the melting pool from freezing
- Switching to a “melting” setting, increasing the temperature of water in the melting pool and pumping heated water on top of the snow to be melted
- Instrumentation controlling when the system will change from “melting” to “maintain”
- Cost comparisons between the proposed structure and operations versus current operations
Assumptions
Assumptions differing from those presented in the attached TSR include:
  o Melting occurs due to heat from the proposed heating element, saturation in melting pool, and the recirculation of water applied to snow
  o The estimated area of the parking lot: 43,000 sq. ft.
  o Time to melt all snow in the system: 3.56 hrs.
  o Number of loads to clear parking lot: 4.67 loads
  o Time to melt all snow in parking lot: 16.61 hrs.

Maintain Setting
While operating in the “maintain” setting, the WSIS shall implement minimal power from the gas boiler to prevent freezing of the melting pool. During this operation, the centrifugal pump shall run continuously allowing the heat exchanger to properly operate, increasing power requirements.
The monthly cost of running the WSIS on “maintain” setting is shown in Figure 6.
  o Estimated annual cost at maintain setting: $5557.53

Melting Setting
When snow is pushed into the WSIS, the system shall be turned to the “melting” setting by a manual switch. During this operation, the boiler shall increase power output and the pumps shall recirculate snowmelt through the sprayer manifold. In addition, the centrifugal pump shall continuously operate. The monthly cost of running the WSIS on the “melting” setting can also be seen in Figure 6.
  o Estimated annual cost of melting setting: $1301.49

Figure 6
**Estimated Cost of Preferred Alternative**

The estimated construction cost of the WSIS is approximately $161,000 as shown in Table 1. This cost is outlined in Appendix D and was calculated using input from local contractors. However, the construction cost does not include the engineering fees necessary to complete the design of the system. A professional registered structural engineer shall be required to sign all drawings. Additional cost may be incurred due to required permitting of the structure.

An amortization of the construction and annual operation costs was conducted for the 30-year design life of the structure and shown in Figure 6. A comparative analysis was conducted between the $16,000 current annual operation cost of snow removal at FCRC. The WSIS construction and annual operation costs reach a break-even point with current annual operations cost at 15 years into the design life of the system. This indicates that the WSIS would be profitable over snow hauling for every year after the midpoint of the design life.

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**Table 1**

$160,900

**Figure 7**
References


Websoil survey directory.
Fairview Recreation Center
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Executive Summary

The purpose of this report is to identify existing site conditions and conduct a preliminary alternative analysis for a winter stormwater infiltration system (WSIS) located at the Fairview Community Recreation Center. The following alternatives are discussed in this report:

- Location
- Structural Layout
- Material
- Heating

Analysis concluded that a WSIS for the disposal of parking lot snow would be best placed at the northern edge of the northern parking lot just to the east of the bus stop on 9th Avenue. A dual structure that uses a natural gas heat source will be further considered.

Site Description

The project site is the Fairview Community Recreation Center (FCRC). The proposed WSIS would be used for snow disposal of accumulated snow in the FCRC northern parking lot. The characteristics of the site and its surrounding community are described below.

Social and Economic

Fairview is small densely populated lower-middle class neighborhood in downtown Anchorage, Alaska. The average population density of Fairview is 5,127 people per square mile, which far exceeds the 174 people per square mile average for Anchorage (City-Data.com, 2011). The average annual household income in Fairview is roughly $51,500 (Anchorage city-wide average household income, $71,000).

The FCRC is centrally located in Fairview and is used as a fully functional gymnasium, youth center, childcare facility, arts and cultural center, banquet hall, computer lab, meeting location, and emergency shelter. FCRC is also a Food Bank of Alaska Mobile Pantry location on the second and third Saturday of every month. The FCRC regularly hosts sporting events and tournaments that generate significant public involvement. The Fairview Community Council meets at the FCRC on the second Thursday of every month.

Other public facilities and community assets located in Fairview include but are not limited to the following:

- 11 places of worship
- Fairview Elementary School
- Denali Elementary School
- Anchorage Neighborhood Health Clinic
- Anchorage Senior Center
- Anchorage City Jail
- Brother Francis Shelter
Geotechnical
The soils that surround the WSIS will impact its construction and operation. The soils must support the weight of the structure and provide adequate infiltration of the melted snow. The design team has applied for, and received the Dr. Alex Hills Civic Engagement Award. With the funds, DOWL HKM will be employed to drill two boreholes at the proposed location (shown in Figure 1). This will be completed on Wednesday, April 9. With this data the WSIS can be properly designed; however, until it is provided existing data will be used in order to complete the preliminary design of the WSIS. The existing data was taken from several boreholes drilled in the area. This data is summarized below and provided in its entirety in Appendix B.

- **Soil Type:** Well graded gravel at all depths.
- **Water Table:** At a depth of approximately 20 feet in southern lot. No data available for northern lot.
- **Saturated Hydraulic Conductivity (k_{sat}):** 14 in/hr
- **Available Water Capacity:** 0.05-0.10 in/in
- **Moist Bulk Density:** 87.4 – 112.4 lb/ft³

On-site and Adjacent Utilities
The location chosen for the WSIS must consider utility access and conflicts. The existing on-site and adjacent utilities are summarized below and associated maps delineating these locations are provided in Appendix C.

- **Electrical utilities**
  - Utility pole on the northeast corner carrying 120/240-volt electricity
  - Transformer on the northeast corner of the eastern building carrying three-phase 120/208-volt electricity.

- **Communication utilities**
  - Share the utility pole on the northeast corner
  - Present no apparent utility conflicts with location alternatives

- **Natural gas utilities**
  - Service line piping running west to east through the center of the northern parking lot

- **Storm sewer**
  - Main running east to west in 9th Avenue.
  - Catch basin on the southeast corner of the 9th Avenue and Karluk intersection

- **Sanitary sewer**
  - 8-inch cast iron pipe runs east to west in the eastbound lane of 9th Avenue
  - 8-inch cast iron pipe runs east to west through the center of the northern parking lot
  - There are no documented sanitary sewer structures located on site
**Design Considerations**

The following section will outline design considerations specific to the project’s site, soil, utilities, and operations.

**Site**
All design alternatives need to account for the access and traffic demands of the FCRC northern parking lot. The northern parking lot is the primary parking facility for the FCRC and the location of the Mobile Pantry two Saturdays per month. Design will consider alternatives that ensure parking lot access can be maintained throughout construction. Additionally, since the FCRC is a designated emergency shelter, care shall be taken to ensure any utility shutdowns are well-coordinated and meet applicable municipal standards.

**Soil**
Until DOWL HKM is able to perform the tests needed to properly design the WSIS, existing geotechnical data near the proposed area will be used. Existing geotechnical data was acquired through municipal databases. The nearest borehole to the project location is located in 9th Avenue between the FCRC and Alaska Housing. This borehole was driven only 9 feet below the existing ground surface and groundwater was not encountered. Other boreholes from the surrounding area encountered groundwater approximately 20 feet below the existing ground surface. Based on the surrounding boreholes it will be assumed that groundwater will not be encountered at a depth of 15 feet below the existing ground surface.

**Utilities**
Connection points must be able to reach the structure with minimal trenching and relocation to limit cost. The area directly surrounding the structure shall have enough space to accommodate the required above grade components.

**Operations**
The goal is to find a location that will not impede current operations. This includes maintenance operations, and traffic flow. Current snow removal and storage operations will be considered throughout design to ensure the selected alternative will not impede existing procedures.

**Location Alternative Analysis**
The location of the WSIS will be considered herein. Three location alternatives were considered. Refer to Figure 1 for an aerial view of these location alternatives.

**Location 1**
The WSIS will be located in the northeast corner of the FCRC north parking lot shown as “Location 1” in Figure 1. If located here, the WSIS will conflict with the current parking lot snow maintenance operations that utilize this area for snow storage. Therefore, current maintenance practices will need to be changed to accommodate a WSIS in this location. **No further consideration will be given to this location due to conflicts with current snow storage operations.**

**Location 2**
The WSIS will be located on the west side of the FCRC parking lot shown as “Location 2” in Figure 1. Field observations on January 24, 2014 revealed that the FCRC parking lot is graded from a higher elevation on the east side to a lower elevation on the west side. A structure located on the west side of the northern parking lot may be susceptible to inflow from stormwater runoff. **No further consideration will be given to this location due to its potential to collect unintended stormwater run-off.**

**Location 3**
The WSIS will be located in the center of the north-side of the FCRC parking lot, shown as “Location 3” in Figure 1. This location is between two current snow storage locations at the northeast and northwest corners of the FCRC parking lot, therefore not anticipated to impede current maintenance operations. This location’s elevation is higher than its surroundings, therefore it is not expected that stormwater drainage will enter the WSIS. **This location will be further considered as the proposed design location**

![Figure 8. Alternative WSIS Locations (Photo taken from Web Soil Survey on-line)](image-url)
Structural Alternative Analysis

Below are the structure alternatives for the WSIS.

Single Structure Alternative
A single structure WSIS provides combined storage, melting and drainage in a common structure. This structure will be constructed in compact subgrade at the preferred location and will allow snowmelt infiltration into the surrounding soil. This structure type includes a primary structure diameter of four to six feet and may be various sizes in height depending on the structure type.

![Single Structure Conceptual Diagram](image)

Figure 9. Single Structure Conceptual Diagram

Advantages of a single structure system include:
- **Decreased Excavation**: Only one structure will be used, decreasing the amount of soil that will need to be excavated before construction and backfilled after construction. Reducing excavation reduces construction related costs.

Disadvantages of a single structure system include:
- **Increased Proximity of Components**: With the single structure alternative, all heating components, grit separating components and other required components will need to be placed in the same structure, potentially increasing operation and maintenance costs.
- **Less Infiltration of Snowmelt through Compact Soils**: Due to all of the location alternatives being located in the parking lot, the subgrade soils must be
suitably compacted for vehicular loading. This could result in a reduced rate of infiltration.

Due to increased proximity of components and potential increase in maintenance issues, the single structure alternative will not be further considered.

**Dual Structure Alternative**

A dual structure WSIS will include one melting unit and one drainage unit, connected by rigid piping. The melting unit will be constructed in compact subgrade at the preferred location, while the drainage unit will be constructed in less compact soils, adjacent to the melting unit, and will allow snowmelt infiltration into the subgrade water table.

![Dual Structure Conceptual Diagram](image)

**Figure 10. Dual Structure Conceptual Diagram**

Advantages of a dual structure system include:

- **Increased Infiltration:** By using a secondary structure only for drainage, the drainage structure can be placed in less compact soils allowing for greater infiltration with reduced risk of drainage issues.

- **Decreased Cost of Rehabilitation:** Use of a two part structure will decrease costs of rehabilitation, if required. By placing the drainage structure out of the parking...
area, excavation necessary for rehabilitation of the drainage structure will be cheaper and replacement of excavated pavement will not be needed.

- **Decreased Proximity of Components**: A two part structure may allow for components to be placed further apart, decreasing the difficulty involved in maintenance.

Disadvantages of a dual structure system include:

- **Increased Excavation**: A larger excavation area will be required to place the additional subgrade structures and piping. This will increase construction costs.
- **Increased Material**: Additional materials will be required for both a second structure and any piping to connect the two structures.
- **Increased Construction Labor**: Construction labor costs will increase due to the placement of an additional structure and any piping and fittings required to connect the two structures.

*The dual structure alternative will be further considered.*

### Material Alternative Analysis

The material alternatives for the proposed structure are considered below. The potential use of each alternative is discussed along with the advantages and disadvantages involved.

**Precast Reinforced Concrete Structure**

Precast Reinforced Concrete (PRC) includes precast steel reinforced concrete manhole rings, or vaults which will be moved into the site location after excavation. The excavated area around the structure will then be backfilled and compacted to specification.

Advantages of PRC include:

- **Resistance to Weathering**: The proposed structure will be introduced to water and other corrosive chemicals by snowmelt and soil contact. Use of concrete will minimize weathering and increase longevity of the structure.
- **Increased Load Resistance**: In comparison to other considered materials, reinforced concrete will have the greatest resistance to vertical and lateral loading.
- **Pre-analyzed Capacities**: When used in standard geometry and size, PRC structures have pre-analyzed strength capacities, decreasing required structural design time for the proposed structure.

The disadvantages include:

- **Increased Cost of Materials**: Reinforced concrete is the one of the most expensive material in comparison to other alternatives. Use of this material will increase the cost of the proposed structure.
- **Predetermined Geometry and Sizes**: Due to PRC’s common use for a variety of subgrade structures, geometries and sizes are generally limited to a fixed list
catalogue. Custom geometries and sizes are possible, however prices are much higher and the structure will likely need to be analyzed for load capacity.

- **Increased Cost of Construction**: In comparison to other considered materials, PRC will have the second highest cost of labor. Individual PRC rings will need to be hoisted by a backhoe and placed into assembly one at a time.

**PRC will be further considered as a material alternative for structure design.**

**Cast-in-place Structure**

CRC includes a steel reinforced concrete structure cast in the preferred location after excavation. The excavated area around the structure will then be backfilled and compacted to the specification after the required concrete cure time.

The advantages of CRC include:

- **Resistance to Weathering**: Similar to PRC, the use of concrete in CRC will minimize weathering and increase longevity of the structure.
- **Increased Load Resistance**: In comparison to other considered materials, reinforced concrete will have the greatest resistance to vertical and lateral loading.
- **Customizable Geometry and Sizes**: Unlike PRC, CRC is shaped in-situ allowing nearly any geometry and size. This is advantageous for the proposed structure as internal components and regular maintenance may require a non-standard geometry.

The disadvantages of CRC include:

- **Increased Cost of Materials**: As with PRC, CRC uses reinforced concrete. Use of this material will increase the cost of the proposed structure.
- **Increased Labor for Installation**: Labor will be required to set forms, place reinforcement and pour concrete for the proposed structure. Additionally, the rental and operation of a concrete truck will be required. Due to this disadvantage, CRC would be the most expensive material alternative.
- **Increased Construction Time**: A CRC structure will need to be cured until the required strength is met. Use of the structure or the area in near proximity will not be possible until the curing time is over and the excavated area around the structure is backfilled and compacted.
- **Increased Analysis for Strength and Code Requirements**: A greater amount of time will be required to ensure the proposed structure is designed to meet both the required strength for loads and code requirements such as for the Municipality of Anchorage.
- **Increased Time for Specifications and Drawings**: Custom drawings and specifications will be required as CRC is cast in-situ and made in custom shapes and geometries.

*Due to the numerous disadvantages listed above, CRC will not be further considered as a material alternative for structural design.*
Corrugated Metal Pipe Structure
Corrugated Metal Pipe (CMP) will include a vertical or horizontal steel or aluminum pipe structure that will be placed in the preferred location and depth after excavation. The excavated area around the structure will then be backfilled and compacted to the specification.

The advantages of CMP include:
- **Resistance to Weathering**: The proposed structure will be introduced to water and other corrosive chemicals by snowmelt and soil contact. Use of an epoxy coated CMP will minimize weathering and increase longevity of the structure.
- **Manufactured with Perforations**: Use of CMP as a drainage structure will be more cost effective than either reinforced concrete alternative, as CMP can be purchased with perforated holes to allow for increased infiltration of snowmelt in the drainage structure.
- **Decreased Construction Costs**: Due to the decreased weight of CMP, when compared to either reinforced concrete alternative and minimal assembly required for the proposed structure, CMP requires low construction costs.
- **Decreased Cost of Materials**: CMP is a commonly used material for culvert and other drainage design, causing CMP geometries and sizes to be standard and structures to be less expensive.

The disadvantages of CMP include:
- **Increased Analysis for Strength and Code Requirements**: CMP is generally not used alone when vertical loads are present and the CMP structure is oriented in a vertical position. Use of CMP in a vertical structure will require analysis to show it will have adequate load capacity and ensure that Municipal and other codes are met.
- **Custom Footing Design**: A custom footing will likely need to be designed to use CMP vertically in the proposed location. As mentioned above, CMP is generally not used alone in a vertical structure and will likely require more analysis than a PRC structure.
- **Cold Weather Effects**: Use of metal pipe could increase the frost depth in the preferred locations surrounding subgrade. Increase of the frost depth could cause freezing issues involved with melting and infiltration.

*CMP will be further considered as a material alternative.*

Corrugated Polyethylene Pipe Structure
Corrugated Polyethylene Pipe Structure (CPEP) will include a vertical or horizontal polyethylene pipe structure which will be placed in the preferred location and depth after excavation. The excavated area around the structure will then be backfilled and compacted to the specification.

The advantages of CPEP include:
o **Resistance to Weathering**: Use of polyethylene for an underground structure will inhibit corrosion from water and other corrosive chemicals, increasing the structures longevity.

o **Manufactured with Perforations**: Similar to CMP, CPEP can be purchased with perforated holes to allow for increased infiltration of snowmelt in the drainage structure.

o **Decreased Construction Costs**: Similar to CMP, CPEP is lighter than either reinforced concrete alternative and will require less assembly for use as a structural material.

o **Decreased Cost of Materials**: CPEP is a commonly used material for drainage and will be considerably cheaper than CRC. Additionally, use of CPEP as a drainage structure would be more cost effective than PRC.

The disadvantages of CPEP include:

- **Susceptible to Damage in Melting Structure**: Polyethylene will lose strength capacity when exposed to above-average heat. Due to the heating required in the melting structure, CPEP will only considered for use in a drainage structure and will not be considered for a single structure design.

*Due to the issues involved with using CPEP in conjunction with a heating element, CPEP will be further considered as a material alternative for a dual structure, drainage structure design.*

### Heating Alternative Analysis

The following section will provide the evaluation of the heat sources for the melt structure. Natural gas and electric heat alternatives are evaluated below. The following assumptions were made with regards to power requirements and pertain to both heating alternatives:

- Melting in the following analysis is ideal without parasitic losses
- Melting is due to direct contact with heat element
  - Indirect melting due to other forms of heat transfer (such as water) will be evaluated in later design stages
- The snow being removed has a density 40% that of water (very dense)
- The snow is being melted continuously, with seamless refilling of the WSIS
- The rough estimate of the area of the parking lot is 40,000 sq ft

**Natural Gas**

This analysis will focus on the cost of melting snow with natural gas. Construction cost will be further evaluated in later stages of the design process; however, higher construction costs are assumed to be associated with a natural gas heated system due to the following:

- Connection fee for utility
- Purchase of boiler and equipment
The following assumptions were made for the melting analysis of the natural gas heating alternative:
- A 260,000 BTU (76.2 kWh) boiler will heat water that will heat the heat element
- Snow melting facility holds 126 cubic feet

The analysis resulted in the following calculations:
- Time to melt 40,000 sq ft parking lot: 73.58 hours
- Annual cost of operation: $6,883.69
- Annual demand: 909.39 MMBTU (266.52 MWh)

Even though the construction cost could be high the lower operating cost could make the natural gas alternative a more viable alternative. Therefore, a natural gas alternative will be further considered.

**Electrical**

Using electric power to heat the snow would be fairly easy to install. One of the alternatives considered didn’t even require trenching. However, the cost of operating an electric system would be considerably higher. There are three alternatives to using electrical power for the snow melting facility. They include:
- **Alternative 1**: Pulling power from utility pole in northeast corner of parking lot
  - 120/240 V, 1ϕ, secondary
  - No trenching required
- **Alternative 2**: Pulling power from a transformer located at the northeast corner of the FCRC building
  - 120/208 V, 3ϕ
  - Trenching and possible repaving required
- **Alternative 3**: Pulling power from the building
  - 120/208 V, 3ϕ
  - Trenching and repaving required
  - Not recommended

Alternative 3 is not recommended because it is essentially the same as Alternative 2 with regard to power availability and operation cost. The annual operation cost of Alternative 3 is only $78.72 (cost of operating a separate meter) less than Alternative 2, which is much less than the extra repaving required for Alternative 3.

The time it takes to melt snow from a 40,000 sq ft area, annual demand, and the annual cost of operation are calculated under the following assumptions:
- A 21.6 kWh (73,702 BTU) max operating load allowed
  - Current limit of 90 amps
- There are no losses in the system
- Snow melting facility holds 126 cubic feet

The following results are from the calculations:
- Time to melt 40,000 sq ft parking lot: 273.17 hours
Annual cost of operation: $40,862.15
Annual demand: 283.23 MWh (966.41 MMBTU)

Municipal Light and Power (AML&P) has a tariff that they will pay for the installation of the service connection up to the 5 year projection of rates paid. This tariff can cover the cost of installing a riser necessary for alternative 1. Other costs in construction for electric power include:
- Purchase of meter and equipment
- Trenching and/or repaving

Making a service connection at any location alternative will cause no presently visible utility conflicts. If any conflicts arise, they will be easily resolved by trenching around the existing utility.

Decreased construction cost, component cost, and sizing along with varied installation applications are advantages for the electrical alternative. Therefore even with the relatively large operating cost, the electrical alternative will be further considered.

**Recommended Alternatives**

It will be beneficial to keep options open to maximize the $50,000 construction budget. Based on the above analysis, the following are the selected alternatives to be further considered during subsequent design phases:

- Location Alternative 3
  - Dual Structure
    - Melting Structure
      - Precast Reinforced Concrete
        - Natural Gas Powered
        - Electrical Powered
    - Drainage Structure
      - Precast Reinforced Concrete
      - CMP
      - CPEP
Appendix A-2 Dr. Alex Hills Civic Engagement Award Proposal
Dr. Alex Hills Engineering and Civic Engagement Award

Cover Sheet for Application

Submission Procedure: Please fill out the following cover sheet complete with faculty signature. Attach your proposal (no longer than 6 pages) describing your project and letters of support from your community partner and your faculty mentor. Please return electronically to the Center for Community Engagement & Learning (CCEL) at engage@uaa.alaska.edu.

Project Title: Fairview Snow Disposal
Student Name: Richard Bailey
Address: 2901 Capstan Drive
Student ID Number: 30542736
Phone Number(s): 907-317-3941
Email: rcbailey2@alaska.edu
Major: Civil Engineering
Number of Credits enrolled (currently): 6
Student’s Signature: 
Sponsoring Faculty Member: Dr. Aaron Dotson
Department/College: Civil Engineering
Name of Community Partner: Harry Need
I certify that I have reviewed this student’s proposal, that this student is capable of performing the work described and that I will mentor this student throughout the project.
Faculty Name: Dr. Aaron Dotson
Signature: 
Date: 1/30/14

Cover sheet & proposal deadline: Friday, January 31, 2014

Submit via email to engage@uaa.alaska.edu
Center for Community Engagement & Learning • 786-4062 • LIB 211G
Application & information are available on the CCEL website at www.uaa.alaska.edu/engage
Dr. Alex Hills Engineering and Civic Engagement Award

Cover Sheet for Application

Submission Procedure: Please fill out the following cover sheet complete with faculty signature. Attach your proposal (no longer than 6 pages) describing your project and letters of support from your community partner and your faculty mentor. Please return electronically to the Center for Community Engagement & Learning (CCEL) at engage@uaa.alaska.edu.

Project Title: Fairview Snow Disposal

Nathaniel Cox

Address: 4159 Checkmate Drive

Student ID Number: 30990121

Phone Number(s): (907) 223-1109

Email: nicox@alaska.edu

Major: Civil Engineering Number of Credits enrolled (currently): 9

Student’s Signature: ____________________________

Sponsoring Faculty Member: Dr. Aaron Dotson

Department/College: College of Engineering

Name of Community Partner: Harry Need

I certify that I have reviewed this student’s proposal, that this student is capable of performing the work described and that I will mentor this student throughout the project.

Faculty Name: Dr. Aaron Dotson

Signature: ____________________________ Date: 1/30/14

Cover sheet & proposal deadline: Friday, January 31, 2014

Submit via email to engage@uaa.alaska.edu
Center for Community Engagement & Learning • 786-4062 • LIB 211G
Application & information are available on the CCEL website at www.uaa.alaska.edu/engage
Dr. Alex Hills Engineering and Civic Engagement Award

Cover Sheet for Application

Submission Procedure: Please fill out the following cover sheet complete with faculty signature. Attach your proposal (no longer than 6 pages) describing your project and letters of support from your community partner and your faculty mentor. Please return electronically to the Center for Community Engagement & Learning (CCEL) at engage@uua.alaska.edu. Deadline: Friday, January 31, 2014.

Project Title: Fairview Snow Disposal
Student Name: Marissa Stewart
Address: 1031 N Elsinore Ave #3
Student ID Number: 30797284
Phone Number(s): (907) 841-2502
Email: mgstewart@alaska.edu
Major: Civil Engineering
Number of Credits enrolled (currently): 12

Student’s Signature: Marissa Stewart

Sponsoring Faculty Member: Dr. Aaron Dotson
Department/College: Engineering
Name of Community Partner: Harry Need

I certify that I have reviewed this student’s proposal, that this student is capable of performing the work described and that I will mentor this student throughout the project.

Faculty Name: Aaron Dotson
Signature: [Signature]
Date: 1/30/14

Cover sheet & proposal deadline: Friday, January 31, 2014

Submit via email to engage@uua.alaska.edu
Center for Community Engagement & Learning • 786-4062 • LIB 211G
Application & information are available on the CCEL website at www.uua.alaska.edu/engage
Dr. Alex Hills Engineering and Civic Engagement Award

Cover Sheet for Application

Submission Procedure: Please fill out the following cover sheet complete with faculty signature. Attach your proposal (no longer than 6 pages) describing your project and letters of support from your community partner and your faculty mentor. Please return electronically to the Center for Community Engagement & Learning (CCEL) at engage@uaa.alaska.edu.

Project Title: Fairview Snow Disposal

Student Name: Jacob Plancich

Address: 310 Pcarl Dr. Anchorage AK, 90518

Student ID Number: 31053914

Phone Number(s): 907-748-1155

Email: japlancich@alaska.edu

Major: Electrical Engineering Number of Credits enrolled (currently): 12

Student’s Signature: [Signature]

Sponsoring Faculty Member: Aaron Dotson

Department/College: Engineering

Name of Community Partner: Harry Need

I certify that I have reviewed this student’s proposal, that this student is capable of performing the work described and that I will mentor this student throughout the project.

Faculty Name: Aaron Dotson

Signature: [Signature] Date: 1/30/14

Cover sheet & proposal deadline: Friday, January 31, 2014

Submit via email to engage@uua.alaska.edu
Center for Community Engagement & Learning • 786-4062 • LIB 211G
Application & information are available on the CCEL website at www.uaa.alaska.edu/engage
January 30, 2014

To Reviewers of the Alex Hills Civil Engagement Award:

We strongly endorse Richard Bailey, Nathaniel Cox, Jake Plancich, and Marissa Stewart for the 2013 Dr. Alex Hills Engineering and Civil Engagement Award. These students will be designing under our mentorship and the outside technical advise of Mr. Brandon Marcott of Triad Engineering in collaboration with the Fairview Community Council a snow cistern to be installed by the Municipality of Anchorage at the Fairview Recreation Center. This project will demonstrate a technology new to Anchorage with the hope that it could improve snow management in dense communities of high pedestrian traffic. It’s exciting to see the next generation of engineers put their creative skill and ingenuity to use to help Alaska’s communities.

Sincerely,

Aaron Dotson
Assistant Professor
Civil Engineering Department

Scott Hamel
Assistant Professor
Civil Engineering Department
Fairview Community Council  
c/o Harry Need, Board Member  
1315 E 11th Ave  
Anchorage, AK 99501-4801

Judith Owens Manley, Ph.D.  
Director, Center for Community Engagement & Learning  
University of Alaska Anchorage, Library 211F  
3211 Providence Dr  
Anchorage, AK 99508-4614

January 30, 2014

Dear Dr. Owens-Manley,

On behalf of the Fairview Community Council and with the support and approval for our Council President, we respectfully submit this letter in support of an application for the Dr. Alex Hill Engineering & Civic Engagement Award for the Fairview Sidewalk Snow Disposal Project.

We regularly observe the dangerous pedestrian and vehicular interactions created from inadequate snow storage in Anchorage. In the Fairview community, the sidewalks are designated as the snow storage location by the municipality. Pedestrians skirt the edges of winter roadways constricted with snow berms. On-street parking further constricts the residential streets. Meanwhile, we have the lowest rate of vehicle ownership in the municipality. And wintery school days we routinely witness Fairview Elementary School students competing with morning traffic in dark streets that are reduced by snow storage to one-lane.

In order to pilot a possible solution, in 2012, the Fairview Community Council worked with Sen. Ellis and Rep. Gara to obtain $50,000 from the State Legislature for the construction of a Snow Cistern. This would be a pilot project to test a design that could be scaled for private and public uses in our winter city. Unfortunately, the funding is designated for construction only and not design. While the municipality awaits design funding, the snow storage problems persist.

The UAA Design of Civil Engineering Systems Class graciously agreed to make this design project part of their class work. On the Fairview Snow Disposal Project team, we’ve been fortunate to have Rich Bailey, Nat Cox, Marissa Stewart and Jake Plancich commit their considerable skills and abilities to our project. When we asked them why they
chose to work on this particular engineering and design problem, the students told us that they sought a meaningful experience and they wanted to apply their skills to improve our community.

The goal of the project is to deliver a buildable set of plans to the Muni for construction of a pilot snow cistern. Design is the critical step in moving the project from concept to the construction. However, the students and their faculty advisors agree that the design will require additional funding for typical geotechnical and/or geomatic data collection.

The Dr. Alex Hills Engineering & Civic Engagement Award will allow the team to purchase a construction survey. This survey will ensure the accuracy of the design and result in a more efficient construction evolution. We are very impressed with and grateful for the students’ drive to deliver a thorough shovel-ready design. For our neighborhood, for our larger community and for the students’ learning experience; we respectfully request that the Center for Community Engagement and Learning approve Rich Bailey, Nat Cox, Marissa Stewart and Jake Plancich’s request for additional funding.

Should any additional information be useful, please do not hesitate to contact us. Thank you for your consideration.

Sincerely,

Allen Kemplen, Fairview Community Council Executive Board Member

Harry Need, Fairview Community Council Executive Member

C.c. Senator Ellis, Representative Gara, Assemblyman Flynn, Fairview Community Council President S J. Klein

End. TPS Report 58207v1 (2012)
Anchorage - Fairview Sidewalk Snow Disposal Pilot Project

State Funding Requested: $50,000
House District: Anchorage Areawide (16-32)

One-Time Need

Brief Project Description:
This project will install a below grade snow melt cistern accessible a sidewalk level hatch adjacent to the Fairview Recreation Center. A heating element within will allow sidewalk snow to be plowed into the cistern for melting.

Funding Plan:

<table>
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<tr>
<td>Funding Already Secured</td>
<td>($0)</td>
</tr>
<tr>
<td>FY2013 State Funding Request</td>
<td>($50,000)</td>
</tr>
<tr>
<td>Project Deficit</td>
<td>$0</td>
</tr>
</tbody>
</table>

Detailed Project Description and Justification:
This project will install a below grade snow melt cistern accessible a sidewalk level hatch adjacent to the Fairview Recreation Center. A heating element within will allow sidewalk snow to be plowed into the cistern for melting. Similar systems are used in other sub-Arctic environments. This cistern will serve as a test to determine the viability of the cistern melting method of snow disposal in Anchorage.

Project Timeline:
Design expenditures are anticipated in 2013 and 2014. Installation is expected in 2014.

Entity Responsible for the Ongoing Operation and Maintenance of this Project:

Municipality of Anchorage

Grant Recipient Contact Information:

Name: Gary Jones
Title: Capital Program Coordinator
Address: PO Box 196650
         Anchorage, Alaska 99519
Phone Number: (907)/343-8446
Email: jonesgb@mun.org

Has this project been through a public review process at the local level and is it a community priority? □ Yes □ No

For use by Co-chair Staff Only:
$50,000 Approved

3:16 PM 5/2/2012

Page 1

Contact Name: Amory Leake
Contact Number: 465.3704
Fairview Community Snow Disposal

PROJECT
Proposal

Prepared by

Richard Bailey
Nathaniel Cox
Marissa Stewart
Jake Plancich
Project Purpose
The Fairview Community in Anchorage, Alaska lacks adequate snow storage. Snow plowed from the road is distributed to the sidewalks and pedestrian traffic is forced to share the narrowed roadways. Fairview Residents have a lower than average percentage of vehicle ownership, which increases the foot traffic throughout the community. This creates dynamic and dangerous interactions between pedestrian and vehicular traffic. The Municipality of Anchorage has acquired funds to build a pilot snow-melting structure to alleviate snow-storage based congestion. The Fairview Community Recreation Center is the anticipated location for the pilot project. The design for the project will come from UAA's Engineering Department via the course Design of Engineering Systems (CE A438).

Student Learning Goals/Background
The team of students selected for this project includes three civil engineering students (Richard Bailey, Nathaniel Cox, and Marissa Stewart) and one electrical engineering student (Jake Plancich). All team members are expecting to graduate upon completion of the current semester. Involvement in this project will provide the team with an opportunity to apply the fundamental engineering concepts learned in the classroom, while developing their abilities to work and communicate as a team. Furthermore, the young engineers will be presented with an opportunity to interact in a professional environment with local community leaders. This experience could prove invaluable to their development on the way to becoming well-rounded professional engineers. This project allows the students to work on a design project that has a tangible outcome. They will be afforded real-life, practical experience and the opportunity to develop their professional skills on a multidisciplinary project that is representative of common engineering workplace.

Improvement of Community Well-Being and Anticipated Outcomes
Aside from the educational benefits of the project, the design team will be given an opportunity to provide a much-needed service to the benefit of a local community. The satisfaction of performing such a civic duty could promote further forays into pro bono work for members of the design team. The immediate benefit of the proposed project will be to help alleviate the problem of lack of snow-storage at the Fairview Community Recreation Center. It is advantageous to have a snow disposal structure on-site as opposed to trucking the snow to off-site locations. In addition to this, the student team will research the implications of providing scalable below-grade snow-melting structures for residential use along driveways and sidewalks in winter cities. This project could directly result in the following communal improvements:

- Reduction in the space required for snow storage in the Fairview Community Recreation Center Parking Lot
- Development of a new technology for snow storage that could result in more efficient land use and change operational costs
- If proven successful, scalable reproductions of the pilot could be used to mitigate the snow storage issues that constrict winter streets and eliminate sidewalks in areas of high population density
Project Methodology and Rationale
The project will be to determine the engineering feasibility, societal impact, and construction and operational economics of a snow-melting structure. The student team will also explore the technical challenges and economic implications of scaling it to different sizes.

The student team will prepare a Design Study Report (DSR) and a 65% design with preliminary specifications for the snow-melting structure. This work includes but is not limited to the following:

Task 1: Design Study Report
The DSR will include:

- Executive Summary
- Description of Proposed Alternatives
- Alternative Analysis
  - Construction Cost
  - Comparison Chart (Pros/Cons)
- Recommended Alternative
- Figures and Drawings
  - Plan view drawings or maps showing the locations of the chosen alternative and any expected excavation locations

The DSR will require a site visit and review of the existing plans, geotechnical data, technical memoranda, record drawings, groundwater analysis, and utility conflicts. The DSR will be considered a design level of 10%.

Task 2: Design
The student team will prepare a 65% design and preliminary specifications of the selected alternative. It is assumed that the design will include the following drawings:

- Cover Sheet
- Abbreviations and Key Map Sheet
- Notes Sheet
- Overall Site Plan
- Plan and Profile Drawings
- Electrical Schematic and Associated Details
- Work Zone Limits, Easements, and Access
- Detail Drawings

The 65% design includes an itemized engineer’s estimate for the construction cost of the selected alternative.
**Task 3: Scalability Analysis**
The student team will conduct a post design analysis of the scalability of the design alternative. Analysis will include:

- Feasibility Analysis
- Scaled Cost Analysis
- Operational Cost Estimate

**Project Budget and Timeline**
The Fairview Community Counsel has allocated $50,000 from the Anchorage Municipality in order to construct a snow-melting structure. These funds will not be used for the design of the structure, but instead to construct it. In order for the student team to accurately design the structure, the following items will be necessary:

- Land survey of the Fairview Recreation Community Center parking lot
- Various permits for the construction of the structure

The project will need to be completed in the spring semester of 2014; therefore, it will be convenient for the student team to receive the award by February 20\(^{th}\) and no later than March 1\(^{st}\). If this is not possible, the team will be unable to put this award to use for the Fairview Community. In the case that the award recipient has not been decided upon within this time, it would be in the best interest to bestow the Dr. Alex Hills Award to another student candidate.

The estimated 65% design completion date is April 14\(^{th}\), 2014. An overview of the design schedule is shown in Figure 1. Tentative deliverable deadlines are as follows:

- DSR (10% design) – February 14\(^{th}\)
- 35% Design – March 17\(^{th}\)
- 65% Design – April 14\(^{th}\)

![Figure 11](image-url)
Appendix B-1 Dowl HKM Geotechnical Report
MEMORANDUM

To: Mr. Richard Bailey, University of Alaska Anchorage

From: Keri A. Nutter, CPG

Date: April 14, 2014

Project No.: 1131.61689.01

Subject: Fairview Recreation Center Snow Melt System Data Summary Report

On April 7, 2014, we submitted a scope of work to perform one test boring and infiltration testing, with associated laboratory testing in support of the Fairview Recreation Center Snow Melt System Study. The scope was approved and the fieldwork was completed on April 9, 2014.

Two test borings were drilled in the vicinity of the proposed snow melt system near the northern entrance of the Fairview Recreation Center at 1121 East 10th Avenue in Anchorage, Alaska. The approximate locations of the test borings are shown on Figure 1, attached to this memorandum. Test Boring 1 was advanced to a depth of 15 feet and sampled at the surface, 2.5 feet and at 2.5 foot intervals thereafter using split-spoon sampling equipment. A 3/4-inch slotted PVC piezometer was installed for groundwater measurements. The results of the drilling are presented on the graphic test boring log as Figure 2. The test boring was logged by Oscar Lage, a geotechnical engineering technician with our firm. The drilling was performed by Discovery Drilling, Inc.

Test Boring 2 was advanced to a depth of 10 feet approximately 5 feet west of Test Boring 1. A solid 3-inch casing was installed to the bottom of the boring and infiltration testing was completed by your team in general accordance with the MOA drainage design guidelines. The results are shown in Table 1, Infiltration Rates.

Laboratory Testing consisting of two particle-size distribution tests was performed on samples obtained from the depth of infiltration; the results are presented graphically and attached to this memo.

The test borings encountered a 1.5 inch layer of asphalt followed by fill consisting of Poorly Graded Sand with Silt and Gravel. The fill was frozen to 5.5 feet and extended to 7 feet below grade. The native soils following the fill consist of Poorly Graded Sand with Gravel, with less than 5% fines. The infiltration rates reported from the test performed are consistent with this type of soil.
Table 1: Infiltration Rates

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<th>Time (min)</th>
<th>Elapsed Time (min)</th>
<th>Water Level (in)</th>
<th>Change in Water Level (in)</th>
<th>Infiltration Rate (in/min)</th>
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<td></td>
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</table>
1.5" Asphalt Pavement

FILL, POORLY GRADED SAND WITH SILT AND GRAVEL, brown, about 40% gravel, 10% silt, gravel subrounded to 2", medium sand, damp, dense, FROZEN, to 5.5'

FROZEN, to 5.5'

POORLY GRADED SAND WITH GRAVEL, brown, about 10-35% gravel, 0-5% silt, gravel subrounded to 1.5", medium sand, damp, dense

Infiltration Test Performed at 10'

TEST BORING COMPLETED ON 4-9-14
NO GROUNDWATER ENCOUNTERED WHILE DRILLING
PVC STANDPIPE INSTALLED TO 16.5'
3" SOLID CASING INSTALLED TO 10'
NO MEASURABLE GROUNDWATER ON 4-13-14

KEY
= Mechanical Analysis
TD = Total Depth
= Grab Sample
= SPT Sample
= Shelby Tube - pushed
= Direct Push Sample
= 2.5" I.D. Spoon Sample
340# weight, 30" fall

LOGGED BY: Oscar Lage
DRILLING CO.: Discovery Drilling
EQUIPMENT: CME-75 Truck
OPERATOR: Matt Noye
METHOD: 8 in. OD hollow-stem auger

CLIENT: University of Alaska Anchorage
PROJECT: Fairview Rec Center Snow Melt
TEST BORING COMPLETED: 4-9-14
W.O. 1131.61689.01

LOG OF TEST BORING 1
FIGURE 2
**Client:** UAA  
**Project:** Fairview Rec Center  
**Work Order:** D61689

**Location:** Test Boring 1  
Sample 5  
Depth 10'-11.5'

### Particle Size Distribution

- ASTM D422

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Total Weight of Sample 1263.7g

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</table>

Total Weight of Fine Fraction 417.3g

**Engineering Classification:** Poorly Graded Sand, SP  
**Frost Classification:** Not Measured
Location: Test Boring 1
Sample 6
Depth 12'-13.5'

Engineering Classification: Poorly Graded Sand with Gravel, SP
Frost Classification: Not Measured

Particle Size Distribution

<table>
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<tr>
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<td>½&quot;</td>
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Total Weight of Sample 1801.4g
Total Weight of Fine Fraction 330.5g
Appendix B-2 – Additional Borehole Data
Borehole Data for 8th and Karluk St.
BORING NO. 1

WO. NO. A19249
LOGGED BY T. C. Barber

F-4, BROWN SANDY SILT AND GRASS
NFS, BROWN SANDY GRAVEL (FILL), DAMP, DENSE,
FILL DEPTH INDEFINITE

0.5'

NFS, BROWN GRAVELLY SAND WITH COAL, DAMP, DENSE

7.5'

NFS, BROWN GRAVELLY SAND WITH TRACE COAL, DAMP

14.0'

GROUND WATER LEVEL WHILE DRILLING
NFS, SANDY GRAVEL, DENSE

26.0'

BOTTOM OF TEST HOLE = 31.5'. COMPLETED 5/6/80.

31.5'

KEY
PP= UNCONFIRMED COMPRESSION STRENGTH (PENETROMETER) (TSF)
TV= SHEAR STRENGTH (TORVANE) (TSF)
MA= MECHANICAL ANALYSIS
LL= LIQUID LIMIT
PL= PLASTIC LIMIT

- GRAB SAMPLE
- SPT SAMPLE
- 25" D. SPOON SAMPLE, 340# WEIGHT, FALL 30'
- SHELBY TUBE - PUSHED

LOG OF BORING

FIGURE 3

44
BORING NO. 2

ELEVATION DEPTH

ASPHALT
NFS, BROWN SANDY GRAVEL (FILL) 2' 2.0'
NFS, BROWN SANDY GRAVEL, DENSE

NFS, BROWN FINE TO MEDIUM SAND WITH GRAVELLY LAYERS, DAMP, DENSE 9.0'

NFS, BROWN SANDY GRAVEL WITH TRACE COAL, WET TO SATURATED, DENSE 14.0'

GROUND WATER LEVEL WHILE DRILLING

BOTTOM OF TEST HOLE = 25.0'. COMPLETED 5/6/80.

KEY
PP = UNCONFINED COMPRESSION STRENGTH (PENETROMETER) (TSF)
TV = SHEAR STRENGTH (TORVANE) (TSF)
MA = MECHANICAL ANALYSIS
LL = LIQUID LIMIT
PL = PLASTIC LIMIT
☐ = GRAB SAMPLE
☐ = SPT SAMPLE
☐ = 25" ID SPOON SAMPLE
☐ = 340# WEIGHT, FALL 30'
☐ = SHELBY TUBE - PUSHED

LOG OF BORING
LOG OF BORING

KEY
PP = UNCONFINED COMPRESSIVE STRENGTH (PENETROMETER) (TSF)
TV = SHEAR STRENGTH (TORWANE) (TSF)
MA = MECHANICAL ANALYSIS
LL = LIQUID LIMIT
PL = PLASTIC LIMIT
□ = GRAB SAMPLE
□ = SPT SAMPLE
■ 25" G SPOON SAMPLE, 340# WEIGHT, PULL 30'
□ = SHELBY TUBE - PUSHED

BORING NO. 3
LOGGED BY T. RAIBOR

ELEVATION: DEPTH

0' - 1.0' F-4, BROWN SANDY SILT
1.0' - 4.0' NFS, BROWN SANDY GRAVEL
4.0' - CROSS-BEDDED SANDS AND GRAVELS
10.0' - NFS, BROWN GRAVELY SAND, DAMP, DENSE
14.0' - NFS, BROWN SANDY GRAVEL, DAMP, DENSE

GROUND WATER LEVEL WHILE DRILLING

BOTTOM OF TEST HOLE = 30.0'. COMPLETED 5/5/80. 30.0'
Boring No. 4

F-4, BROWN FINE SANDY SILT WITH TRACE GRAVEL, (FILL) 4.0'

NFS, BROWN VERY SANDY GRAVEL, DAMP, DENSE, GRADING TO GRAVELLY SAND (SW) 9.5'

NFS, BROWN-GRAY GRAVELLY SAND, DAMP, DENSE 11.5'

NFS, SANDY GRAVEL WITH TRACE COAL, DENSE

GROUND WATER LEVEL WHILE DRILLING

NFS, BROWN-GRAY SANDY GRAVEL, SATURATED, DENSE 31.0'

Bottom of test hole = 31.0'. Completed 5/5/80.
BORING NO. 7

ELEVATION:     DEPTH

P-4, BROWN SANDY SILT
NFS/F-1, BROWN SANDY GRAVEL WITH TRACE SILT, POSSIBLE FILL
NFS, BROWN SANDY GRAVEL WITH LAYER OF FINE TO MEDIUM SAND

BOTTOM OF TEST HOLE = 10.8'. COMPLETED 5/6/80. 10.8'

LOG OF BORING
BORING NO. 8

LOG OF BORING

ELEVATION

DEPTH

R-4, BROWN SANDY SILT
NFS/F-1, BROWN SLIGHTLY SILTY SANDY GRAVEL, FILL
NFS, BROWN SANDY GRAVEL, DAMP, DENSE

BOTTOM OF TEST HOLE = 11.5'. COMPLETED 5/6/80.

KEY
PP = UNCONFINED COMPRESSIVE STRENGTH (PENETROMETER) (TSF)
TV = SHEAR STRENGTH (TORVANE) (TSF)
MA = MECHANICAL ANALYSIS
LL = LIQUID LIMIT
PL = PLASTIC LIMIT
☐ = GRAB SAMPLE
☑ = SPT SAMPLE
■ = 2.5" ID SPOON SAMPLE
□ = WEIGHT, FALL 30'
□ = SHELBY TUBE - PUSHED
BORING NO. 9

F-4, BROWN SANDY SILT
NFS, BROWN SANDY GRAVEL

Coal at 7', fill to 7'

Bottom of test hole = 7.5'. Completed 5/6/80.

LOG OF BORING

FIGURE 11
BORING NO. IO

MOISTURE CONTENT (%)  DRY DENSITY  

ELEVATION  DEPTH

F-4, BROWN FINE SANDY SILT, FILL

0

5

10

NFS, BROWN SANDY GRAVEL, DAMP, DENSE

4.0'

15

DEPTH (FEET)

83

BOTTOM OF TEST HOLE = 11.5'. COMPLETED 5/5/80.

LOG OF BORING

KEY

PP = UNCONFINED COMPRESSIVE STRENGTH (PENETROMETER) (TSF)
TV = SHEAR STRENGTH (TORVANE) (TSF)
MA = MECHANICAL ANALYSIS
LL = LIQUID LIMIT
PL = PLASTIC LIMIT
☐ = GRAB SAMPLE
☐ = SPT SAMPLE
☐ = 2.5" UD SPOON SAMPLE
☐ = 340# WEIGHT, FALL 30'
☐ = SHELBY TUBE - PUSHED

FIGURE 12
BORING NO. 11

ELEVATION

DEPTH

P-4, BROWN SANDY SILT AND ORGANICS

0.5'

NFS/P-1, BROWN SANDY GRAVEL WITH WOOD AND TRACE SILT, FILL

NFS, BROWN SANDY GRAVEL, DAMP, DENSE, POSSIBLE FILL

6.5'

NFS, BROWN SAND, DENSE

11.0'

BOTTOM OF TEST HOLE = 11.5'. COMPLETED 5/6/90.

11.5'

KEY

PP = UNCONFINED COMpressive STRENGTh (PEnETROMETER) (TSF)
TV = SHEAR STRENGTh (TOrVANE) (TSF)
MA = MECHANICAL ANALYSIS
LL = LIQUID LIMIT
PL = PLASTIC LIMIT
☐ = GRAB SAMPLE
☐ = SPT SAMPLE
☐ = 25° ID SPOON SAMPLE, 340° WEIGHT, FALL 30°
☐ = SHELBY TUBE - PUSHED

LOG OF BORING

FIGURE 13
BORING NO. 12

ELEVATION:

F-1, BROWN SILTY SANDY GRAVEL WITH ORGANICS, FILL

NFS, BROWN SANDY GRAVEL, DAMP, DENSE, SUB- ROUNDED AND ROUNDED PARTICLES

DEPTH

BOTTOM OF TEST HOLE = 6.5'. COMPLETED 5/7/80.

6.5'

LOG OF BORING

FIGURE 14

KEY
PP = UNCONFINED COMPRESSIVE STRENGTH (PENETROMETER) (TSF)
TV = SHEAR STRENGTH (TORWANE) (TSF)
MA = MECHANICAL ANALYSIS
LL = LIQUID LIMIT
PL = PLASTIC LIMIT
☐ - GRAB SAMPLE
☐ - SPT SAMPLE
■ 25" ID. SPOON SAMPLE.
340# WEIGHT, FALL 30'
☐ SHELBY TUBE - PUSHED
BORING NO. 13

ELEVATION=  DEPTH

0.5'

NFS, BROWN SANDY GRAVEL, DAMP, DENSE, SUBROUNDED AND ROUNDED PARTICLES

4.5'

NFS, BROWN GRAVELLY SAND, DAMP, DENSE

BOTTOM OF TEST HOLE = 6.5'. COMPLETED 5/7/80.  6.5'

LOG OF BORING

KEY

PP = UNCONFINED COMPRESSIVE STRENGTH (PENETROMETER) (TSF)
TV = SHEAR STRENGTH (TORVANE) (TSF)
MA = MECHANICAL ANALYSIS
LL = LIQUID LIMIT
PL = PLASTIC LIMIT
☐ - GRAB SAMPLE
☐ - SPT SAMPLE
■ 2.5" ID, SPOON SAMPLE.
340# WEIGHT, FALL 30'
☐ SHELBY TUBE - PUSHED

FIGURE 15
BORING NO. 14

ELEVATION:

DEPTH

F-1/F-4, BROWN SANDY SILT AND GRAVEL MIXED

1.0'

NFS, BROWN SANDY GRAVEL, DAMP

3.0'

NFS, BROWN SANDY GRAVEL (POSSIBLE FILL)

10.0'

NFS, BROWN-GRAY GRAVELLY SAND, VERY DENSE, DAMP

7.0'

BOTTOM OF TEST HOLE = 11.5'. COMPLETED 5/6/80. 11.5'

LOG OF BORING

FIGURE 16
BORING NO. 15

ELEVATION:

DEPTH

1.0'
F-4, BROWN SANDY SILT

5.5'
NFS, BROWN SANDY GRAVEL, DAMP, DENSE

9.0'
NFS, BROWN SAND, DENSE

BOTTOM OF TEST HOLE = 11.5'. COMPLETED 5/6/80.

LOG OF BORING

FIGURE 17
BORING NO. 16

ELEVATION: DEPTH

- F-4, BROWN SANDY SILT, DAMP
- F-2, BROWN SILTY GRAVELLY SAND 2.0'
- BROWN GRAVELLY SAND 3.5'

BOTTOM OF TEST HOLE = 6.5'. COMPLETED 5/7/80. 6.5'

KEY
- PP = UNCONFINED COMpressive STRENGTH (PENetrometer) (TSF)
- Tc = SHEAR STRENGTH (TORvane) (TSF)
- Ma = MECHANICAL ANALYSIS
- LL = LIQUID LIMIT
- PL = PLASTIC LIMIT
- # - GRAB SAMPLE
- - SPT SAMPLE
- # 2.5" ID, SPOON SAMPLE, 340+ WEIGHT, FALL 30'
- ----- SHELBY TUBE - PUSHED

LOG OF BORING

FIGURE 18
Borehole Data for 9th and Karluk St.
BORING NO. 1

WQ. NO. A19248
LOGGED BY T. Barber

MALAC BORING REPORT

MOISTURE CONTENT (%)  DRY DENSITY (G/FT³)

OTHER TESTS
[BLG/PIT]

ELEVATION

DEPTH

CONCRETE

NFS, BROWN SANDY GRAVEL WITH TRACE SILT, DAMP

0.5'

FILL TO APPROXIMATELY 9'

NFS, BROWN GRAVELLY SAND, DAMP, DENSE, INTER-BEDDED WITH BROWN SANDY GRAVEL

10.0'

WATER LEVEL WHILE DRILLING

BROWN GRAVELLY SAND, SATURATED, DENSE

23.0'

BOTTOM OF BORING = 26.5'. COMPLETED 5/2/80.

26.5'

KEY

PP = UNCONFINED COMPRESSIVE STRENGTH (PENETROMETER) (TSF)
TV = SHEAR STRENGTH (TORVANE) (TSF)
MA = MECHANICAL ANALYSIS
LL = LIQUID LIMIT
PL = PLASTIC LIMIT
□ - GRAB SAMPLE
■ - SPT SAMPLE
■ - 2½" ID SPOON SAMPLE
540+ WEIGHT, FALL 30'
■ - SHELBY TUBE - PUSHED

LOG OF BORING

FIGURE 3
BORING NO. 2

ELEVATION: DEPTH

NFS, BROWN SANDY GRAVEL, DAMP, FILL, BOTTOM OF FILL INDEFINITE

--- 4.5'

NFS, BROWN SANDY GRAVEL, DAMP, DENSE

--- 14.5'

NFS, BROWN-GRAY GRAVELLY SAND/SANDY GRAVEL WITH COAL, DAMP, DENSE

--- 18.0'

NFS, GRAY SANDY GRAVEL WITH TRACE COAL, DENSE

--- 23.0'

\( V \) WATER LEVEL WHILE DRILLING

NFS, BROWN-GRAY GRAVELLY SAND, DENSE

--- 26.5'

BOTTOM OF BORING = 26.5', COMPLETED 5/2/80.

LOG OF BORING

FIGURE 4
BORING NO. 3

LOGGED BY C. BARBER

F-4, BROWN SANDY SILT AND ORGANICS, SOFT, ML
NFS, BROWN GRAVELY SAND WITH TRACE SILT
NFS, BROWN SANDY GRAVEL, CLEAN, DRY
NFS, GRAY SAND, MEDIUM DENSE, WET

WATER LEVEL WHILE DRILLING
BOTTOM OF BORING = 26.5'. COMPLETED 5/2/80.

KEY
PP = UNCONFINED COMPRESSIVE STRENGTH (PENETROMETER) (TSF)
TV = SHEAR STRENGTH (TORVANE) (TSF)
MA = MECHANICAL ANALYSIS
LL = LIQUID LIMIT
PL = PLASTIC LIMIT
□ = GRAB SAMPLE
■ = SPT SAMPLE
[2.5" C.D. SPOON SAMPLE]
[300# WEIGHT, FALL 30']
S = SHELBY TUBE - PUSHED

LOG OF BORING

FIGURE 5
BORING NO. 4

ELEVATION = DEPTH

F-4, BROWN SANDY SILT AND ORGANICS

NFS, BROWN-GRAY SANDY GRAVEL, DAMP, DENSE

1.5'

NFS/F-4, BROWN GRAVELLY SAND, DAMP, 3" LENSES
OF SILTY FINE SAND AT 11' TO 11'3", DENSE,
SM WITH 5M LENSES

- 10.5'

NFS, BROWN SANDY GRAVEL, DENSE

- 15.0'

LAYER OF MEDIUM SAND AND TRACK COAL, DAMP, SP

- 20.5'

NFS, BROWN SANDY GRAVEL, DENSE

- 21.0'

WATER LEVEL WHILE DRILLING

NFS, BROWN GRAVELLY SAND, SATURATED, DENSE

- 25.0'

BOTTOM OF BORING = 30.0'. COMPLETED 5/2/80.

- 30.0'

KEY
PP = UNCONFINED COMRESSIVE STRENGTH (PENETROMETER) (TSK)
TV = SHEAR STRENGTH (TORVANE) (TSF)
MA = MECHANICAL ANALYSIS
LL = LIQUID LIMIT
PL = PLASTIC LIMIT
☐ = GRAB SAMPLE
■ = SPT SAMPLE
■ = 2.5" ID SPOON SAMPLE,
340° WEIGHT, FALL 30°
■ = SHELBY TUBE - PUSHED

LOG OF BORING

FIGURE 6
BORING NO. 5

ELEVATION:

DEPTH

P-4, BROWN SANDY SILT WITH ORGANICS

NFS, BROWN-GRAY SANDY GRAVEL, DAMP, DENSE

1.5'

NFS, BROWN FINE TO MEDIUM SAND, WET, SP

15.5'

NFS, BROWN-GRAY SANDY GRAVEL, DAMP, DENSE, WET AT 20'

16.0'

WATER LEVEL WHILE DRILLING

NFS, GRAY SAND, DENSE

23.5'

BOTTOM OF BORING = 26.0'. COMPLETED 5/2/80.

KEY

PF = UNCONFINED COMPRESSIVE STRENGTH (PENETROMETER) (TSF)
TV = SHEAR STRENGTH (TORME) (TSF)
MA = MECHANICAL ANALYSIS
LL = LIQUID LIMIT
PL = PLASTIC LIMIT
□ = GRAB SAMPLE
■ = SPT SAMPLE
■ 25" I.D. SPOON SAMPLE
340# WEIGHT, FALL 30'
□ = SHELBY TUBE - PUSHED

LOG OF BORING

FIGURE 7
BORING NO. 6

ELEVATION:

DEPTH

F-1, BROWN SILTY SANDY GRAVEL, FILL, WITH RANDOM CONCRETE PIECES

3.5'

CONCRETE

4.0'

NFS, BROWN SANDY GRAVEL

5.0'

BOTTOM OF BORING = 5.0'. COMPLETED 5/5/80.

LOG OF BORING

FIGURE 8

KEY

PP = UNCONFINED COMPRESSIVE STRENGTH (PENETROMETER) (TSF)
TV = SHEAR STRENGTH (TORVANE) (TSF)
MA = MECHANICAL ANALYSIS
LL = LIQUID LIMIT
PL = PLASTIC LIMIT
☐ = GRAB SAMPLE
☐ = SPT SAMPLE
☐ = 25° ID SPOON SAMPLE
☐ = 340# WEIGHT, FALL 30'
☐ = SHELBY TUBE - PUSHED
### BORING NO. 7

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<td>NF5, Brown Sandy Gravel</td>
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<tr>
<td>5.0</td>
<td>Bottom of Boring = 5.0', Compl. 5/5/86.</td>
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**KEY**
- PP = Unconfined Compressive Strength (Penetrometer) (TSF)
- TV = Shear Strength (Torvane) (TSF)
- MA = Mechanical Analysis
- LL = Liquid Limit
- PL = Plastic Limit
- ☐ = Grab Sample
- ☑ = SPT Sample
- ■ = 2.5" ID Spoon Sample
- ▭ = Weight, Fall 30'
- ◊ = Shelby Tube - Pushed

**LOG OF BORING**

Figure 9
# Boring No. 8

**Elevation:**

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<tr>
<td>3.0'</td>
<td>NFS, Brown Sandy Gravel, Dam</td>
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<tr>
<td>5.0'</td>
<td>NFS, Brown Gravelly Sand</td>
</tr>
</tbody>
</table>

**Bottom of Boring = 5.0' Completed 5/5/80.**

---

**Key**

- PP = Unconfined Compressive Strength (Penetrometer) (TSF)
- TV = Shear Strength (Torvane) (TSF)
- MA = Mechanical Analysis
- LL = Liquid Limit
- PL = Plastic Limit
- □ = Grab Sample
- ▲ = SPT Sample
- ■ = 25" ID, Spoon Sample, 340# Weight, Fall 30°
- □□ = Shelby Tube - Pushed

---

**Log of Boring**

**Figure 10**
BORING NO. 9

ELEVATION:

DEPTH

F-4, BROWN GRAVELLY SANDY SILT

BROWN SANDY GRAVEL

BOTTOM OF BORING = 5.0'. COMPLETED 5/5/80.

LOG OF BORING

KEY

PP = UNCONFINED COMPRESSIVE STRENGTH (PENETROMETER) (TSF)
TV = SHEAR STRENGTH (TORVANE) (TSF)
MA = MECHANICAL ANALYSIS
LL = LIQUID LIMIT
PL = PLASTIC LIMIT
□ = GRAB SAMPLE
■ = SPT SAMPLE
■ = 2.5" ID SPOON SAMPLE
□ = 3400# WEIGHT, FALL 30'
□ = SHELBY TUBE - PUSHED

WO. NO. A19248
LOGGED BY T. Barber
BORING NO. 10

LOGGED BY T. Barber

ELEVATION:

DEPTH

1.5'

F-4, BROWN SANDY SILT

NFS/F-1, BROWN SANDY GRAVEL WITH ORGANICS, LOOSE, FILL TO 9.5'

9.5'

NFS, BROWN GRAVELLY SAND

BOTTOM OF BORING = 11.5'. COMPLETED 5/5/80.
BORING NO. II

ELEVATION: 0

DEPTH

F-4, BROWN SANDY SILT

2.0'

NFS, BROWN GRAVELLY SAND, DENSE

10.0'

NFS, GRAY SANDY GRAVEL, DAMP, DENSE

11.0'

BOTTOM OF BORING = 11.0', COMPLETED 5/5/80.

KEY

PP = UNCONFINED COMpressive STRENGTH (PENETROMETER) (TSF)

TV = SHeAR STRENGTH (TORVANE) (TSF)

MA = MECHANICAL ANALYSIS

LL = LIQUID LIMIT

PL = PLASTIC LIMIT

☐ = GRAB SAMPLE

☐ = SPT SAMPLE

☒ = 25" I.D. SPOON SAMPLE, 340 lb. WEIGHT, FALL 30'

☐ = SHELBY TUBE - PUSHED

LOG OF BORING  

FIGURE 13
BORING NO. 12

ELEVATION

DEPTH

2.0'

NPS, BROWN SANDY GRAVEL, DAMP, DENSE

BOTTOM OF BORING = 11.5'. COMPLETED 5/5/80.  11.5'

LOG OF BORING

KEY

PP = UNCONFINED COMpressive STRENGTH (Penetrometer) (TSF)
TV = Shear STRENGTH (Torsion) (TSF)
MA = MECHANICAL ANALYSIS
LL = LIQUID LIMIT
PL = PLASTIC LIMIT
□ - GRAB SAMPLE
□ - SPT SAMPLE
□ - 2.5" D. SPOON SAMPLE, 340# WEIGHT, FALL 30'
□ - SHELBY TUBE - PUSHED

FIGURE 14
BORING NO. 13

MOISTURE
CONTENT(%)

DEPTH
(FEET)

DENS.
ITY
(POC)

OTHER
TESTS

ELEVATION:

DEPTH

BROWN SANDY GRAVEL WITH WOOD, DEBRIS, TRASH, LOOSE, (FILL)

FILL

5.5'

NFS. BROWN GRAVELLY SAND

9.5'

NFS. BROWN-GRAY SANDY GRAVEL, DENSE

11.5'

BOTTOM OF BORING = 11.5'. COMPLETED 5/6/89.

KEY

PP= UNCONFINED COMPRESSION STRENGTH (PENETROMETER) (TSF)
TV= SHEAR STRENGTH (TORVANE) (TSF)
MA= MECHANICAL ANALYSIS
LL= LIQUID LIMIT
PL= PLASTIC LIMIT

☐ = GRAB SAMPLE
☐ = SPT SAMPLE
☐ = 2.5" ID SPOON SAMPLE, 340# WEIGHT, FALL 30°
☐ = SHELBY TUBE - PUSHED

LOG OF BORING
Borehole Data for 9th and Karluk St.
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<thead>
<tr>
<th>Depth (feet)</th>
<th>M.I.T. Classification</th>
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<tbody>
<tr>
<td>0</td>
<td>C.W.</td>
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<td>2</td>
<td>SANDY</td>
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<td>4</td>
<td>GRAVEL</td>
</tr>
<tr>
<td>6</td>
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</table>

Hole Depth: 60'

\( w = \) water content
\( D_{20} = 20\% \) Diameter
\( c = \) unit cohesion
\( \phi = \) angle of friction
\( e = \) void ratio
LOCATION 3 1/2 AVE. BETWEEN KARLUK & LATOUCHE
LOT - BANK & SUICIDE, EAST ADDITION

SOILS LOG

HOLE NO. 2
DATE 10-17-80

COMMENTS VISUAL ONLY

DEPT. 21'
WATER TABLE

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<th>UNIFIED CLASS</th>
<th>FROST GROUP</th>
<th>DESCRIPTION</th>
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</tr>
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<td></td>
<td></td>
<td>WELL GRADED GRAVEL - BILL DEPTHS</td>
</tr>
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</tr>
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<tr>
<td>9</td>
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<td></td>
<td>10&quot; S.C. SEW PIPE &amp; B.O.H.</td>
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LOCATION SKETCH:

LEGEND

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>V</td>
<td>WATER TABLE</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>MATERIAL</th>
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</thead>
<tbody>
<tr>
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<td>3-1</td>
<td>3-1</td>
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</table>

ALL FROST CLASSIFICATION BASED ON THE 0.25 mm = 50% OF THE 0.500 UNLESS OTHERWISE NOTED 1/10/80

ADD ON 4/3/88

76
<table>
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<th>LOCATION SKETCH:</th>
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</table>

<table>
<thead>
<tr>
<th>DEPTH</th>
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<th>FROST GROUP</th>
<th>DESCRIPTION</th>
</tr>
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<tbody>
<tr>
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<td>deco - convoluted sand</td>
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<tr>
<td>10</td>
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<td>10'-1' sand layer</td>
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</table>

**LEGEND**

- TEST HOLE
- WATER TABLE
- FROZEN MATERIAL

All frost classification based on the 02/27/59 = 50% of the +1000 unless otherwise noted.

GRID NO. 1757
### SOILS LOG

**LOCATION**

**COMMENTS**

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<tr>
<td>3</td>
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<td></td>
</tr>
<tr>
<td>7</td>
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<td></td>
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**LOCATION SKETCH**

**LEGEND**

- **SYMBOL**
  - • TEST HOLE
  - ▼ WATER TABLE
  - 1 FROZEN MATERIAL

All frost classification based on the 0.02m = 50% of the -200 unless otherwise noted.

**GRID NO:** 1536
### Tables — Saturated Hydraulic Conductivity (Ks) — Summary By Map Unit

<table>
<thead>
<tr>
<th>Map unit symbol</th>
<th>Map unit name</th>
<th>Rating (micrometers per second)</th>
<th>Acres in AOI</th>
<th>Percent of AOI</th>
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</thead>
<tbody>
<tr>
<td>406</td>
<td>Cryorthents and Urban land, 0 to 5 percent slopes</td>
<td>7.7600</td>
<td>3.0</td>
<td>100.0%</td>
</tr>
<tr>
<td><strong>Totals for Area of Interest</strong></td>
<td></td>
<td><strong>3.0</strong></td>
<td><strong>100.0%</strong></td>
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</tbody>
</table>

### Description — Saturated Hydraulic Conductivity (Ks)

Saturated hydraulic conductivity (Ks) refers to the ease with which pores in a saturated soil transmit water. The estimates are expressed in terms of micrometers per second. They are based on soil characteristics observed in the field, particularly structure, porosity, and texture. Saturated hydraulic conductivity is considered in the design of soil drainage systems and septic tank absorption fields.

For each soil layer, this attribute is actually recorded as three separate values in the database. A low value and a high value indicate the range of this attribute for the soil component. A "representative" value indicates the expected value of this attribute for the component. For this soil property, only the representative value is used.

The numeric Ks values have been grouped according to standard Ks class limits.

### Rating Options — Saturated Hydraulic Conductivity (Ks)

- **Units of Measure:** micrometers per second
- **Aggregation Method:** Dominant Component
- **Component Percent Cutoff:** None Specified
- **Tie-break Rule:** Fastest
- **Interpret Nulls as Zero:** No
- **Layer Options (Horizon Aggregation Method):** Depth Range (Weighted Average)
  - **Top Depth:** 0
  - **Bottom Depth:** 144
  - **Units of Measure:** Inches

---

### Report — Physical Soil Properties

<table>
<thead>
<tr>
<th>Anchorage Area, Alaska</th>
</tr>
</thead>
<tbody>
<tr>
<td>Map symbol and soil name</td>
</tr>
<tr>
<td>------------------------</td>
</tr>
<tr>
<td>406—Cryorthents and Urban land, 0 to 5 percent slopes</td>
</tr>
<tr>
<td>Cryorthents, skeletal</td>
</tr>
<tr>
<td>Urban land</td>
</tr>
</tbody>
</table>
Appendix C – Utility Grid Maps
C.1. Anchorage Municipal Light and Power
C.2. ENSTAR Natural Gas Company
C.3. GCI
C.5. Alaska Waste Water Utility - Water Distribution System
C.6. Municipality of Anchorage – Stormwater Map
Appendix D - Calculations
Calculation of Annual Average Cost to Haul Snow

\[ A := 43000 \text{ ft}^2 \quad \text{Area of parking lot} \quad S := 75 \text{ in} \quad \text{Ave annual snow fall} \]

\[ V := A \cdot S = \left(9.954 \cdot 10^3 \right) \text{yd}^3 \quad \text{Uncompacted snow volume} \]

\[ Du := 7\% \quad \text{uncompacted snow density} \]

\[ Dc := 40\% \quad \text{compacted snow density} \]

\[ Dr := \frac{Du}{Dc} = 0.175 \quad \text{Density ratio} \]

\[ V_c := V \cdot Dr = \left(1.742 \cdot 10^3 \right) \text{yd}^3 \quad \text{Compacted annual snow volume} \]

\[ T_v := 10 \text{ yd}^3 \quad \text{Volume of Typical end dump} \]

\[ T_t := \frac{90}{\text{hr}} \quad \$ \text{cost per hour for truck or loader} \]

\[ Tr := \frac{2}{\text{hr}} \quad \text{Trips per truck per hour to dump} \]

\[ L := \frac{V_c}{T_v} = 174 \quad \text{truck loads of snow} \]

\[ L_y := \frac{L}{3 \cdot Tr} \cdot T_t = 2.613 \cdot 10^3 \quad \$ \text{to operate loader annually (Assumes 3 trucks for loading)} \]

\[ Td := \frac{T_t}{Tr} = 45 \quad \$ \text{cost per truck trip to dump} \]

\[ Df := 32 \quad \$ \text{dump fee per truck load} \]

\[ TL := Df + Td = 77 \quad \$ \text{Cost per truck load to dump} \]

\[ T_t := TL \cdot \frac{V_c}{T_v} = 13413 \quad \$ \text{Cost to haul snow per year not including loader time} \]

\[ T_t + L_y = 16025 \quad \$ \text{Total Cost Annually to Haul the average year snow fall from Fariview Community Recreation Center} \]
<table>
<thead>
<tr>
<th>Activity</th>
<th>ID</th>
<th>Cost</th>
<th>P&amp;O</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Demo</td>
<td>1</td>
<td>$2,469.69</td>
<td>$370.45</td>
<td>$2,840.14</td>
</tr>
<tr>
<td>Excavation for Vaults</td>
<td>2</td>
<td>$5,450.96</td>
<td>$817.64</td>
<td>$6,268.61</td>
</tr>
<tr>
<td>Install Vaults</td>
<td>3</td>
<td>$56,264.02</td>
<td>$8,439.60</td>
<td>$64,703.63</td>
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<tr>
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<td>$4,879.65</td>
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<tr>
<td>Install Gas line</td>
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<td>$3,889.75</td>
<td>$583.46</td>
<td>$4,473.21</td>
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<tr>
<td>Backfill Gas Line</td>
<td>6</td>
<td>$4,162.58</td>
<td>$624.39</td>
<td>$4,786.97</td>
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<tr>
<td>Pave AC</td>
<td>7</td>
<td>$5,200.00</td>
<td>$780.00</td>
<td>$5,980.00</td>
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<tr>
<td>Electrical and heating</td>
<td>8</td>
<td>$38,538.47</td>
<td>$5,780.77</td>
<td>$44,319.24</td>
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<tr>
<td>15% Contingency</td>
<td>9</td>
<td>$21,000.00</td>
<td>-</td>
<td>$21,000.00</td>
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<td><strong>TOTAL</strong></td>
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<td><strong>$77,116.66</strong></td>
<td><strong>$11,567.50</strong></td>
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<table>
<thead>
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### Standard Rates

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<th>Rate</th>
<th>wages</th>
<th>WC</th>
<th>total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operator</td>
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<td>$7.30</td>
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<td>$121.74</td>
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<tr>
<td>Laborer</td>
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<td>$64.74</td>
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### OT Rates

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<tbody>
<tr>
<td>Operator</td>
<td></td>
<td>$87.18</td>
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<tr>
<td>Grade Checker</td>
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<td>$80.50</td>
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<td>-</td>
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<tr>
<td>Operator</td>
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<td>$87.18</td>
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<td>-</td>
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</tr>
<tr>
<td>Laborer</td>
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<td>$72.07</td>
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Total Labor $409.27

### Materials

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<td>Asphalt Sub</td>
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<td>AC disposal</td>
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<td>Sub trucking</td>
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* Calculated 417 LF of cutting double the qty for construction joint
* One dump load of AC at Hiland Dump plug price $80
* 2 hours of subcontractor trucking cost @ $125

### Equipment Used

<table>
<thead>
<tr>
<th>Equipment Type</th>
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<tr>
<td>CAT 308 rubber Mini Ex</td>
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<tr>
<td>CAT 583 Roller</td>
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<tr>
<td>CAT 950 Loader</td>
<td></td>
<td>$69.24</td>
<td>0</td>
</tr>
<tr>
<td>CAT 5258 B Skid Steer</td>
<td></td>
<td>$25.85</td>
<td>0</td>
</tr>
<tr>
<td>Pickup Truck</td>
<td></td>
<td>$14.51</td>
<td>0</td>
</tr>
<tr>
<td>Turtle Plate Compactor</td>
<td></td>
<td>$18.25</td>
<td>0</td>
</tr>
<tr>
<td>CASE 210 Excavator</td>
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<tr>
<td>Kenworth With Cozad Lowboy</td>
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subtotal $2,469.69

Markup 15% $370.45

Total $2,840.14
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<th>Rate</th>
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<td>-</td>
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<tr>
<td>Laborer</td>
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<td>Operator</td>
<td>8</td>
<td>$64.74</td>
<td>-</td>
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<table>
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<th>Description</th>
<th>QTY</th>
<th>Unit</th>
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<tr>
<td>Excavation</td>
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</tr>
<tr>
<td>Waste from Ex</td>
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### OT RATES

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<th>Rate</th>
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<th>WC</th>
<th>total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operator</td>
<td>$87.18</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
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<tr>
<td>Operator</td>
<td>$87.18</td>
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</table>

**Total Labor** $1,637.08

### Materials

<table>
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<tr>
<td>Trucking</td>
<td>$1,500.00</td>
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### Equipment

<table>
<thead>
<tr>
<th>Equipment Type</th>
<th>Hours Used</th>
<th>Rate</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAT 308 rubber Mini Ex</td>
<td>8</td>
<td>$31.21</td>
<td>0</td>
</tr>
<tr>
<td>CAT 583 Roller</td>
<td>-</td>
<td>$44.64</td>
<td>0</td>
</tr>
<tr>
<td>Kenworth Tractor w/ Side Dump</td>
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<td>$77.58</td>
<td>0</td>
</tr>
<tr>
<td>CAT 950 Loader</td>
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<td>$69.24</td>
<td>554</td>
</tr>
<tr>
<td>CAT 5258 B Skid Steer</td>
<td>-</td>
<td>$25.85</td>
<td>0</td>
</tr>
<tr>
<td>Pickup Truck</td>
<td>-</td>
<td>$14.51</td>
<td>0</td>
</tr>
<tr>
<td>Turtle Plate Compactor</td>
<td>-</td>
<td>$18.25</td>
<td>0</td>
</tr>
<tr>
<td>Rental 450 hitachi</td>
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<td>$100.00</td>
<td>800</td>
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<tr>
<td>Kenworth With Cozad Lowboy</td>
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</table>

**Subtotal** $5,450.96

**Markup** 15% $817.64

**Total** $6,268.61
## Work Force

<table>
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<tr>
<th>Work Force</th>
<th>Hours</th>
<th>Rate</th>
<th>Total</th>
</tr>
</thead>
<tbody>
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<tr>
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### Grade Checker

<table>
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### Laborer

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### Foreman

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### Materials

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<td>$200.00</td>
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<td>trucking 1</td>
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<td>trucking 2</td>
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<tr>
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<td>Pipe 8&quot; PVC</td>
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<td>Pipe 12&quot; CPFP</td>
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<td>CAT 950 Loader</td>
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<td>CAT 525B B Skid Steer</td>
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<td>Turtle Plate Compactor</td>
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### Total

$64,703.63
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### Laborer

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### Materials

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<tr>
<th>Description</th>
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<tbody>
<tr>
<td>AS&amp;G bedding</td>
<td>$ 324.00</td>
<td>plug price of $18 c CY at AS&amp;G</td>
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<tr>
<td>Drain rock</td>
<td>$ 200.00</td>
<td>plug price of $5 a CY at AS&amp;G</td>
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<tr>
<td>24&quot; CPEP perf</td>
<td>$ 1,120.00</td>
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<tr>
<td>8&quot; PVC</td>
<td>$ 420.00</td>
<td>* Quote from HD Supply $10.5 LF</td>
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<td>12&quot; CPEP</td>
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<td>* Quote from HD Supply $7.5 LF</td>
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<td>8&quot; Gland Pack-non-restrained</td>
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<td>Rate</td>
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<table>
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<th>WC</th>
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| Description    |       |       |       |      | 49 CY |
| Description    |       |       |       |      | 30 CY |

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<table>
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<th>Hours Used</th>
<th>Rate</th>
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<tbody>
<tr>
<td>CAT 308 rubber Mini Ex</td>
<td>$31.21</td>
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<tr>
<td>CAT 583 Roller</td>
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<td>Kenworth Tractor w/ Side Dump</td>
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<td>CAT 950 Loader</td>
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<tr>
<td>Pickup Truck</td>
<td>$14.51</td>
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<td>Turtle Plate Compactor</td>
<td>$18.25</td>
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<td>CASE 210 Excavator</td>
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Total $5,611.60
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### OT Rates

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<tr>
<td>CAT 308 rubber Mini Ex</td>
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<td>Turtle Plate Compactor</td>
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Subtotal $3,889.75

Markup 15% $583.46

Total $4,473.21
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### OT Rates

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<tr>
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**Total Labor** $2,542.54

### Materials

<table>
<thead>
<tr>
<th>Description</th>
<th>Net Cost</th>
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### Equipment Type

<table>
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<th>Rate</th>
<th>Total</th>
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<td>CAT 308 rubber Mini Ex</td>
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<td>$31.21</td>
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<td>CAT 583 Roller</td>
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<td>Kenworth Tractor w/ Side Dump</td>
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<tr>
<td>CAT 950 Loader</td>
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<td>CAT 5258 B Skid Steer</td>
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<td>Pickup Truck</td>
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<td>Turtle Plate Compactor</td>
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<td>CASE 210 Excavator</td>
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<td>$108.41</td>
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<tr>
<td>Kenworth With Cozad Lowboy</td>
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**subtotal** $4,162.58

**Markup** 15% $624.39

**Total** $4,786.97
Estimated melt time of system on site visit was 8 hrs.

Using the equation:

\[ M = C(0.09 + (0.029 + 0.007P)(Ta - Tf)) \]

Where:

\[ M = \text{melt} \left( \frac{\text{inches}}{\text{day}} \right) \]
\[ P = \text{rainfall} \left( \frac{\text{inches}}{\text{day}} \right) \]
\[ C = \text{coefficient to account for variables} \]

Plugging the numbers from the site visit into this equation and solving for \( C \) gives us:

\[ C = \frac{720}{0.09 + (0.029 + 0.007)(18455040)(28)} = 0.00019905 \]

Using our numbers in the same equation we get:

\[ M = 0.00019905(0.09 + (0.029 + 0.007(41472000))(28)) = 1617.98 \frac{\text{in}}{\text{day}} \]

Converting units into hrs/load:

3.56 hrs per WSIS load and 16.61 hrs for the entire parking lot

### Solid Calculations

<table>
<thead>
<tr>
<th>Volume Req'd (cy)</th>
<th>Annual Sediment**</th>
<th>SG's Assumed:</th>
<th>Additional Assumed:</th>
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<tr>
<td></td>
<td></td>
<td>Fresh: 0.2</td>
<td>Lot Area (ft²): 45000</td>
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<tr>
<td></td>
<td></td>
<td>Dense: 0.4</td>
<td>Annual Snow Depth (in.): 75</td>
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<tr>
<td><strong>Actual Size</strong></td>
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<td>Width (ft)</td>
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</tr>
<tr>
<td>Height (ft)</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Length (ft)</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Volume (cy)</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

- **Average Flow Rate:** kg/m³
- **Sand Density:** kg/m³
- **Water Density:** kg/m³

### Lateral Loads

**Conserv.:**
- $y = 156, 125$ pcf
- $\Phi = 30, 40°$
- $K_a = 0.50, 0.357212$
- $H = 14$ ft

**Vehicle:**
- $2P = 32000$ lbf
- **Assuming:** Single Wheel Point

**Lateral Loading:**
- $\sigma_s(z)/z = 78$ pcf
- $\sigma_s(z)*z^2 = 3819.719$ lbf

**Vertical Loading:**
- $\sigma_v = 9.33333333$ ft
- $\Delta \sigma_s * z^2 = 7639.4$ lbf

### Lateral Loading**

<table>
<thead>
<tr>
<th>$z$</th>
<th>$\sigma_v$ (ksf)</th>
<th>$P_{nf}$</th>
<th>$P_{nf} / L$</th>
<th>$P_{nf} = 122.304$ Kip</th>
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<tr>
<td>0.5</td>
<td>0.039</td>
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**Footnotes**
- *See Melting Structure CAD*
- **Based on Street Values**
## Snow Loads

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<td><strong>L</strong> ft</td>
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<td>16</td>
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<tr>
<td><strong>W</strong> ft</td>
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<td>8</td>
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<tr>
<td><strong>Area</strong> ft^2</td>
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<td>128</td>
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<tr>
<td><strong>Snow</strong> psf</td>
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<tr>
<td><strong>Radius</strong> ft</td>
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<tr>
<td><strong>Area Circl.</strong> ft^2</td>
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<td><strong>Height</strong> ft</td>
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<tr>
<td><strong>V_{cone}</strong> cf</td>
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<td><strong>For Cone</strong></td>
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<td>99.84</td>
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<tr>
<td><strong>Load Total</strong> kip</td>
<td>12.8</td>
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*From AASHTO LRFD Bridge Design Specifications - 3.11.6.2*  
**http://www.stanford.edu/~tyshu/Documents/Some%20Useful%20Numbers.pdf*

## Vehicle Lateral Loads

<table>
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<tr>
<th><strong>P</strong> (ft)</th>
<th><strong>v</strong> (mi/h)</th>
<th><strong>A</strong> (in²)</th>
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<td>32</td>
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<td>0.35</td>
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<td>200</td>
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Depth (ft) versus Lateral Vehicle Loads Envelope  
(ksf)

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<th><strong>z (ft)</strong></th>
<th><strong>Depth (ft)</strong></th>
<th><strong>Load Total (kip)</strong></th>
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<td>0.2</td>
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<td>0.6</td>
<td>4.75</td>
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<td>0.8</td>
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1.25 - 1.50 ft pile  
For Cone

### Load Total 6.4 kip

- **Snow 50 psf**  
- **Radius 6.38 ft**  
- **Area Circl. 128 ft^2**  
- **Load Total 6.4 kip**  
- **Density 24.96 pcf**  
- **V_{cone} 512 cf**  
- **Uniform 99.84 psf**  
- **Load Total 12.8 kip**
# Internal Fluid Calculations

<table>
<thead>
<tr>
<th>Melting Structure</th>
<th>Density (snow/water)</th>
<th>Unit Weight Water</th>
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<td></td>
<td>0.4</td>
</tr>
<tr>
<td>Width</td>
<td></td>
<td>62.4 pcf</td>
</tr>
<tr>
<td>Height</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| V<sub>snow</sub>   | 1536 ft<sup>3</sup>  |
| V<sub>water</sub>  | 614.4 ft<sup>3</sup> |
| Weight<sub>water</sub> | 38.34 kip            |