BUILDINGWORK
architecture design preservation

PCLS Lakewood Interim Library

SITE BID SET – ADDENDUM NUMBER 3

ISSUED: August 21, 2023

This Addendum supersedes and supplements all portions of the Site Bid Set dated August 4, 2023, with which it concerns. The Addendum becomes part of the Contract Documents upon issuance. Receipt of the addendum must be acknowledged on bid for bid to be considered valid.

This Addendum includes the following Sections and Attachments:

Section 1: Bid Document Clarifications, Revisions, and Additions
Section 2: Bidder Questions
Attachments: Geotechnical Report, Redlined C103, Revised Specification Sections 015700, 329113

SECTION 1: Bid Document Clarifications, Revisions, and Additions

Revision: City of Lakewood is requiring full replacement of existing asphalt sidewalk on Gravelly Lake Road with Concrete per WSDOT standards. Existing concrete curb and street trees to remain. Construction to be per WSDOT standards. See redlines on Sheet C103 for extent of scope.

Addition: City of Lakewood is requiring the selected contractor to create and submit an SWPPP prior to start of construction. See revised specification section 015700 for requirements.

SECTION 2: Bidder Questions

Question: Plan Sheet C101, Note 10 mentions construction surveying, but the specifications are silent on survey/construction staking outside of quantity verification for unit price work (not applicable.) Please advise if construction staking is owner-provided or if we need to include construction staking costs in our bid.

> **Answer:** Construction staking should be included in contractor costs. Owner will not provide construction staking.

Question: Plan Sheet C101, Note 13 mentions the possibility of needing an NPDES permit and to contact Ecology for information. The specifications are silent on any contractor obligation related to an NPDES permit, and on a project with this short of a timeline and quick anticipated start, we'd expect that the NPDES has been obtained and no contractor obligation outside of any reporting requirement. Please clarify if this permit will be contractor's responsibility.

Answer: The contractor is required to provide and maintain a Stormwater Pollution Prevention Plan (SWPPP) but no additional permitting with the Department of Ecology will be required.

Question: No geotechnical report was included in the bid documents. If one exists, we request it be published to BXWA.

Answer: Geotechnical Report is attached as part of this addendum.

Question: Project Specifications do not include Div 31 (earthwork) or Div 33 (Utilities), but see that Div 32 (Exterior Improvements) is covered by WSDOT standards. Are we to assume Div's 31 and 32 also following WSDOT standards?

Answer: Yes; WSDOT standard specifications for road, bridge, and municipal construction apply to all work not otherwise specifically described in the project manual specifications.

Question: The plans do not include a detail for the 8x6 water connection. Do we have the option to choose a cut-in tee or a hot-tap?

Answer: Connection to be a live tap per City of Lakewood standards

Question: Section 32 9113 Soil Preparation, section 3.3(C) mentions planting area subgrades to be established 15 inches below finish grade. This would leave room for 12 inches of amended topsoil and 3 inches of bark mulch. On plan sheet L102, detail 4 – Soil Amendment shows planting areas to receive 8 inches of amended topsoil and 3 inches of bark mulch. Please clarify.

Answer: Preparation per drawing notes is required. Specification section has been revised to match and is attached.

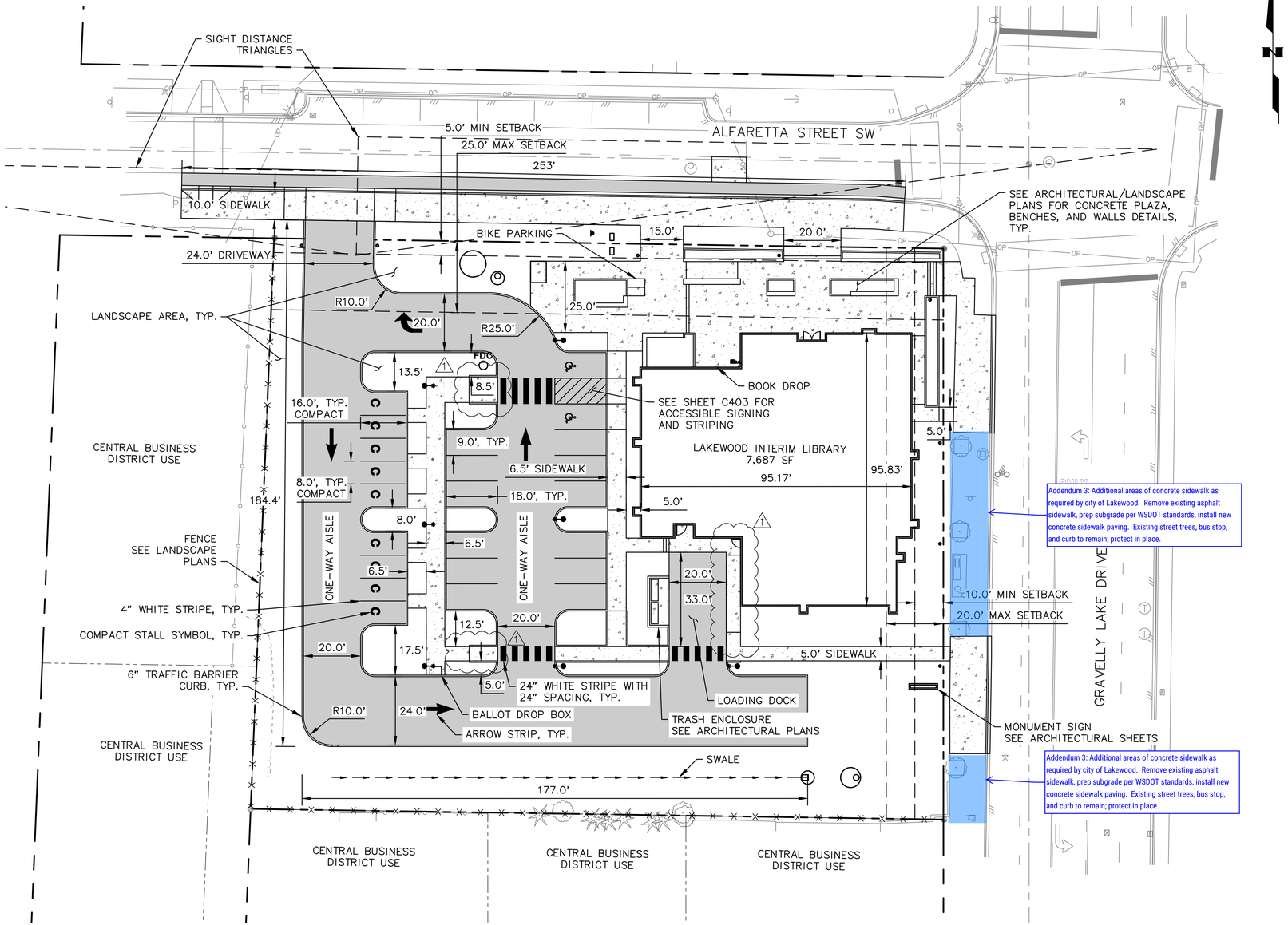
END OF ADDENDUM NUMBER 3

ROADWAY STANDARD NOTES:

1. ALL WORK IN CITY RIGHT-OF-WAY REQUIRES A RIGHT-OF-WAY PERMIT FROM THE CITY OF LAKEWOOD. PRIOR TO ANY WORK COMMENCING, THE GENERAL CONTRACTOR SHALL ARRANGE FOR A PRECONSTRUCTION MEETING TO BE ATTENDED BY ALL MAJOR CONTRACTORS, REPRESENTATIVES OF INVOLVED UTILITIES, AND THE CITY OF LAKEWOOD. CONTACT THE CITY OF LAKEWOOD PUBLIC WORKS ENGINEERING DEPARTMENT TO SCHEDULE THE MEETING. THE CONTRACTOR IS RESPONSIBLE TO HAVE THEIR SET OF PLANS AT THE MEETING.
2. FOR WORK IN CITY RIGHT-OF-WAY, INSPECTIONS ARE REQUIRED AT THE FOLLOWING CONSTRUCTION STAGES:
   - 2.1. INSPECTION NO. 1: CLEARING AND GRUBBING, EMBANKMENT AND EXCAVATION, UNDERGROUND DRAINAGE, WHEN TRENCHING AND PLACEMENT OF PIPE ARE COMPLETE BUT PRIOR TO COVER OR TEMPORARY WATER DETENTION/RETENTION AND SILTATION CONTROL.
   - 2.2. INSPECTION NO. 2: GENERAL ROADWAY, WHEN THE DRAINAGE SYSTEM, UNDERGROUND UTILITIES, AND GRADING TO SUITABLE SUBGRADE ARE COMPLETE, INCLUDING GRAVEL BALLAST IF REQUIRED.
   - 2.3. INSPECTION NO. 3: GENERAL ROADWAY, WHEN THE CRUSHED GRAVEL SURFACING HAS BEEN PLACED.
   - 2.4. INSPECTION NO. 4: GENERAL ROADWAY, WHILE THE PAVING IS IN PROGRESS.
   - 2.5. INSPECTION NO. 5: OVERALL ROADWAY, AFTER PAVING, CLEANING OF DRAINAGE SYSTEM AND ALL NECESSARY CLEANUP, STRIPING, BUTTONING, MONUMENTS, AND ALL DELINEATION WORK.
3. MONUMENTS SHALL BE INSTALLED AT ALL STREET INTERSECTIONS, AT ANGLE POINTS, AND POINTS OF CURVATURE IN EACH STREET. ALL BOUNDARY MONUMENTS.
4. SIGNAGE AND TRAFFIC CONTROL DEVICES ARE SAFETY ITEMS AND SHALL BE INSTALLED PRIOR TO ISSUANCE OF ANY CERTIFICATE OF OCCUPANCY. ALL SIGNAGE SHALL BE IN ACCORDANCE WITH THE MUTCD.
5. SIDEWALKS, DRIVEWAYS, AND OTHER IMPROVEMENTS IDENTIFIED IN THE PRELIMINARY PLAT APPROVAL SHALL BE INSTALLED PRIOR TO FINAL PLAT APPROVAL UNLESS A FINANCIAL GUARANTEE HAS BEEN GRANTED FOR THE INSTALLATION OF SAID IMPROVEMENTS.
6. PRIOR TO ANY SIGN OR STRIPING INSTALLATION OR REMOVAL, THE CONTRACTOR SHALL CONTACT THE CITY TO ARRANGE FOR AN ON-SITE MEETING TO DISCUSS PLACEMENT AND UNIFORMITY.
7. NEW OR REVISED STOP SIGNS, YIELD SIGNS, AND TRAFFIC SIGNALS SHALL BE ADVANCE-WARNED USING THE PROCEDURE OUTLINED IN THE MUTCD. ADVANCE WARNING SIGNS AND FLAGS SHALL BE MAINTAINED BY INSTALLER FOR 30 DAYS AND THEN REMOVED.

SITE PLAN NOTES:

1. ALL RADII IS 5' FROM THE FACE OF CURB UNLESS OTHERWISE NOTED.



1

SITE PLAN

SCALE: GRAPHIC

20' 0 20' 40'

BUILDINGWORK
architecture
design
preservation
159 western avenue west, suite 486
seattle, washington 98119
office 206 775-8668
www.buildingwork.design

PROJECT
LAKEWOOD INTERIM LIBRARY

LOCATION
10202 Gravelly Lake Dr SW
Lakewood WA 98499

PREPARED FOR
PIERCE COUNTY LIBRARY SYSTEM

REVISION	DATE	NAME
1	8/11/23	ADDENDUM 1
Redline	8/21/23	Addendum 3

PROFESSIONAL STAMP

ALMA ABAZA
STATE OF WASHINGTON
20106175
REGISTERED PROFESSIONAL ENGINEER
8/4/2023

CRW ENGINEERING GROUP INC.
14900 INTERURBAN AVE S. SUITE 271
SEATTLE, WASHINGTON 98168
PHONE: (206) 674-4640

SITE PLAN

8/4/2023

SITE BID SET

C103

SECTION 015700 - TEMPORARY CONTROLS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
1. Provide and maintain controls using methods, equipment, and temporary construction.
2. Protect against unfavorable controls over environmental and other factory and site conditions and related areas under your management. Remove physical evidence of temporary control facilities at completion of Work.
3. Protect adjacent buildings and sitework outside of project area.
4. Coordinate with project phasing.
5. Protect existing utilities to remain both on-site and off-site.
6. Include control provisions for:
   a. Dust
   b. Water
   c. Debris: Disposal management requirements are specified in Section 017419.
   d. Pollution
   e. Erosion and sediment
   f. Protection of work
   g. Noise
   h. Fumes (i.e., paints and coatings, exhausts)
   i. Others, as required
7. Ensure compliance with regulations governing the site and vicinity. Designate one person - the Construction Superintendent, or other to enforce provisions preventing:
   a. Air, water, and soil pollution.
   b. Waste generation.
   c. Other irritating, harmful effects.

B. Related Sections:

1. Section 011100 - Summary of Work: Work sequence, Contractor's use of premises
2. Section 015100 - Temporary Utilities and Facilities
3. Section 015719 - Environmental Controls
4. Section 017129 - Cutting and Patching
5. Section 017419 - Construction Waste and Disposal Management
6. Section 017423 - Final Cleaning

1.02 QUALITY ASSURANCE

A. Requirements of Regulatory Agencies: See Section 014100 for referenced Codes, ordinances and the like.
1. Where applicable, conform to requirements of state and local air pollution control agency, and other authorities' rules and regulations.
2. Comply with applicable authorities' requirements including those of local utility companies.

1.03 DUST CONTROL

A. Provide positive methods and apply dust control materials to minimize raising dust from construction operations. Prevent air-borne dust from dispersing into adjacent facilities and the atmosphere.

B. Block out and/or cover HVAC ducts, enclosures, voids and the like during construction to ensure no dust or fume accumulation.

1.04 WATER CONTROL

A. Provide methods to control rain water during site erection/installation of prefabricated building until downspouts are permanently connected to stormwater systems. Prevent damage to prefabricated building and adjoining properties.

B. Control site installation activities to direct surface drainage away from construction areas, and to direct drainage to proper runoff. Maintain excavations free of water.

C. Provide, operate, and maintain hydraulic equipment of adequate capacity to control water.

D. Dispose of drainage water in a manner to prevent flooding, and other damage to any portion of the building, site or adjoining properties.

1.05 POLLUTION CONTROL

A. In accordance with Section 015719, and following:
   1. Provide methods, means, and facilities required to prevent contamination of soil, water, or atmosphere. Allow no discharge of noxious substances or fumes from construction operations.
   2. Provide equipment and personnel; perform emergency measures required to contain spillages. Remove contaminated soils and liquids.
      a. Excavate and dispose of earth contaminated by contractor operations off-site in compliance with laws and regulations.
      b. Replace with suitable compacted fill and topsoil. Provide Owner with receipt of soil acceptability prior to installation.
   3. Take special measures to prevent harmful substances from entering public waters.
      a. Prevent disposal of wastes, effluents, chemicals, or other such substances in or adjacent to bodies of water, or in sanitary or storm sewers.
   4. Provide systems for control of atmospheric pollutants in accordance with federal, state, and local published rules and regulations.
      a. Prevent toxic concentrations of chemicals.
      b. Prevent harmful dispersal of pollutants into the atmosphere or building HVAC system in the adjacent surrounding buildings.

1.06 EROSION AND SEDIMENT CONTROL

A. Provide temporary protection of erodible soils during site erection/installation of prefabricated building until downspouts are permanently connected to stormwater systems and installation crews have demobilized from site. Employ methods as may be necessary to effectively prevent erosion and control sedimentation.

B. Mechanically retard and control runoff rate. This includes construction of diversion ditches, benches, and berms to retard and divert runoff to protected drainage courses.

C. Temporary erosion and siltation control work shall conform to the local and state requirements except costs for the work shall be considered incidental to and included in the contract.

D. Periodically inspect earthwork to detect any evidence of the start of erosion, apply corrective measures as required to control erosion.

1.07 STORMWATER POLLUTION PREVENTION PLAN

A. Contractor is required to create and execute a stormwater pollution prevention plan (SWPPP) that meets the requirements set forth by the City of Lakewood. This plan must be submitted to the AHJ by the contractor prior to the start of work. The City will not issue the final permit until this plan is received.

B. The SWPP must comply with all elements described in the civil contract documents and include the following:
   a. Temporary Erosion and Sedimentation Control (TESC) Inspection log which will be completed by the CESCL and kept on site for review by the City Inpsecor or DOE representative.
   b. A narrative explaining the planned actions for controlling erosion and sedimentation to protect and improve local environmental features
   c. List the ten elements of an effective TESC
   d. A map of the site showing location of each control measure installed. This will be updated as required.
   e. A list of the BMPs you are likely to install.

1.08 PROTECTION OF WORK DURING SITE ERECTION/INSTALLATION/COMPLETION

A. Provide temporary protection measures for roof seams and other openings in walls or roof during transportation to site, during erection/installation of prefabricated components on site and for all other activities associated with project.

B. Provide temporary protection for installed products during final completion on site. Control traffic in immediate area to minimize damage.
   1. Prohibit traffic or storage upon waterproofed or roofed surfaces.

1.09 REMOVAL

A. Remove temporary materials, equipment, services, and construction when Architect authorizes.
   1. Clean and repair damage caused by installations and use of temporary facilities. Remove temporary control installations. Restore existing facilities used during construction to specified, or to original, condition.

PART 2 - PRODUCTS

Not Used.

PART 3 - EXECUTION

Not Used.

END OF SECTION 015700

1 - GENERAL

1.1 SUMMARY

A. Furnish labor, material and equipment required for weed removal, placement and amendment of soil for areas to be planted, and the establishment of finish grades as shown on the Drawings and as specified herein.

B. Coordinate work with installation of other site work including earthwork, irrigation, seeding, and planting.

C. Related sections include the following:

1. Division 01 Section “Temporary Tree and Plant Protection,” for protecting trees remaining on-site that are affected by site operations.
2. Division 31 Section “Earth Moving” for preparation of subgrades prior to placement of topsoil and planting soils specified in this section.
3. Division 32 Section “Plants” for planting placement of amended topsoil backfill.

1.2 DEFINITIONS

A. Finish Grade: Elevation of finished surface of amended topsoil soil.

B. Manufactured Topsoil: Soil produced off-site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce topsoil or planting soil

C. Amended Topsoil: Native or imported topsoil or surface soil modified with soil amendments and fertilizers.

D. Noxious Weed or Noxious Weed Seed: Any weed listed in the current edition of the King County Noxious Weed list as a class A, B, or C noxious weed, whether or not control is required

E. Subgrade: Surface or elevation of subsoil remaining after completing excavation, or top surface of a fill or backfill, before placing planting soil.

F. Topsoil: See Part 2 – Products.

G. Soil Ripping: Loosening the soil by dragging a ripping shank or chisel thru the soil to the depths and spacing specified, and further defined in this specification.

H. Soil Tilling: Loosening the surface of the soil to the depths specified with a rotary tine tilling machine, roto tiller, (or spade tiller), and further defined in this specification.

1.3 SUBMITTALS

A. Product Data: For the following:

1. Fertilizers, including application rates.
2. Soil Amendments.
3. Herbicides.

B. Samples for Verification: For the following:

1. 1/2 cubic foot compost.
2. 1/2 cubic foot of each imported topsoil. Furnish one sample from each site from which soil is to be furnished.
3. Retain soil and compost submittals on site in sealed, accessible container for comparison to delivered soils.

C. Product Certificates: For each type of manufactured product, signed by product manufacturer, and complying with the following:

1. Manufacturer's certified analysis for standard products.
2. Analysis of other materials by a recognized laboratory made according to methods established by the Association of Official Analytical Chemists, where applicable.

D. Qualification Data: For testing agencies.

E. Material Test Reports: Date of testing on all reports shall be a maximum of 90 days prior to the date of submittal for review.

1. Soil Fertility and Agricultural Suitability Analyses and Recommendations Reports for the following:

a. Existing on-site topsoil: From three typical locations as selected by Owner's Representative, minimum 30 days prior to beginning soil preparation work.
b. Imported topsoil: Minimum 30 days prior to beginning soil preparation work.
c. Amended topsoil: Provide soil analyses and results for soil samples taken from 3 typical locations as selected by Owner's Representative, minimum 7 days after soil preparation work has been completed and prior to installing plants.

2. Compost Analysis: Provide analysis for one representative sample of compost minimum 30 days prior to compost being delivered to Project Site.
3. Compost Maturity: Provide results of Compost Maturity Test when submitting Compost Analysis Report and sample.
4. Soil Compaction Test: Provide results of soil compaction tests minimum of 7 days prior to planting and seeding.

F. Delivery Slips: Provide delivery slips for each load of delivered material as proof of shipment of specified materials.

G. Soil Placement Map: Contractor shall provide a plan showing placed location of each load of delivered soil, referenced to delivery slips.

1.4 QUALITY ASSURANCE

A. Soil Fertility and Agricultural Suitability-Testing Laboratory Qualifications: An independent laboratory, recognized by the State Department of Agriculture, with the experience and capability to conduct the testing indicated and that specializes in types of tests to be performed.

1. Acceptable Soil Testing Laboratories are:

a. Western Laboratories, Inc, (800) 658-3858.

B. Soil Analyses: Furnish soil analyses by a qualified soil-testing laboratory stating:

1. Soil Composition: USDA particle size analysis indicating percentages of sand, silt and clay, and percent organic matter.
2. Macro and micro nutrient fertility tests as determined by pH, salinity, nitrate nitrogen, ammonium nitrogen, phosphate phosphorous potassium, calcium, magnesium, soluble copper, zinc, manganese, iron, saturation extract boron and sodium analyses.
3. Sodium Absorption Ratio (SAR).
4. A Cover Letter shall be provided summarizing existing soil conditions and the Laboratory's recommendations.
5. Recommendations by the soil testing lab for fertilizer and soil amendments in pounds per 1,000 square foot or tons per acre, as necessary to correct soil deficiencies.
6. Noxious Weed Germination Test: a minimum of one 36 inch square by 3 inch deep soil sample for each topsoil source considered for use on the project. Place soil in tray with adequate drainage layer beneath, keep soil moist (not saturated) for 7 days in a temperature controlled greenhouse environment, provide photos and written report summarizing germination results.

C. Compost Testing Laboratory Qualifications: An independent laboratory, with the experience and capability to conduct the testing indicated following U.S. Composting Council Seal of Testing Assurance (STA) procedures, or equivalent.

D. Compost Analysis: Provide documentation from supplier that compost has reached a monitored temperature of 140 degrees Fahrenheit for at least one week. Engage an independent soil testing laboratory to test representative sample(s) of compost and furnish compost analysis report for the following parameters:

1. Percent organic matter, percent moisture, percent inerts (foreign matter), pH, soluble salts, and particle size.
2. Nutrient content, including: Nitrogen (N), Phosphorus (P), Potassium (K), Calcium (Ca), and Magnesium (Mg) and Sulfur (S).

3. Trace Metals, including: Arsenic (As), Cadmium (Cd), Chromium (Cr), Copper (Cu), Lead (Pb), Mercury (Hg), Nickel (Ni), and Zinc (Zn).
4. Maturity Indicator. Provide bio-assay results. Provide Carbon-Nitrogen ratio.
5. Stability Indicator: Provide respiration test results.

E. Request inspection and allow observation by Owner's Representative of prepared soils before planting.

F. Soil Compaction Testing: Furnish soil compaction standard tests per ASTM 698. Request inspection and allow observation by Owner's Representative of prepared soils before planting.

1.5 DELIVERY, STORAGE AND HANDLING

A. Deliver packaged materials in manufacturer's unopened containers fully identified by name, brand, type, weight and analysis.

B. Store and handle packaged materials to prevent damage and intrusion of foreign matter.

C. Store stockpiled topsoil in area designated by Owner's Representative. Provide erosion control measures for stockpiled topsoil on site to prevent contamination of the soil. Refer to Division 31 Section "Earth Moving" for control of dust and erosion.

1.6 SOIL AMENDMENT BID QUANTITIES

A. Bid quantities and types of soil amendments shall be based upon those listed in this Section. Types of amendments required and quantities shall be adjusted as necessary based upon actual results of soil fertility and agricultural suitability analyses and recommendations for on-site topsoils.

B. Amount per 6-inch lift of topsoil over 1000 square-feet of landscape area:

1. 25 lbs. Gypsum (Calcium sulfate)
2. 35 lbs. Calcium carbonate limestone 'Calpril'
3. 35 lbs. Dolomite limestone 'Dolpril'
4. 8 lbs. Treble superphosphate (0-45-0)
5. 3 lbs. Ammonium nitrate
6. 4 ozs. Zinc sulfate
7. 8 ozs. Manganese sulfate
8. 1 oz. Laundry Borax
9. 6 cu-yds Compost

1.7 SITE CONDITIONS

A. Topsoil placement and soil preparation shall not take place during periods where saturated soil or surface water is present in work areas.

B. Work shall not take place when temperature is less than 32 degrees Fahrenheit, or when frozen soil exists on site.

1.8 COORDINATION

A. Coordinate soil preparation with Division 31 Section “Earth Moving” such that topsoil, soil amendments and fertilizers are incorporated into ground fill areas in specified lifts and to specified depths below finish grade for planting and lawn areas. Topsoils shall be amended per recommendations of the Soils Testing Laboratory.

B. Coordinate soil preparation with timing and procedures for installation of related site work including irrigation, seeding, and planting.

PART 2 - PRODUCTS

2.1 TOPSOIL

A. Topsoil Definition: ASTM D 5268; natural or cultivated surface-soil layer containing organic matter and sand, silt, and clay particles, conforming to USDA classification for Loam or Sandy Loam; friable, pervious, and black or a darker shade of brown, gray, or red than underlying subsoil; reasonably free of subsoil, clay lumps, gravel, and other objects more than 1 inches in any dimension; and free of weeds, roots, and other deleterious materials, with the following physical properties:

1. Organic Matter: 6 percent minimum to 10 percent maximum.
2. Sodium Adsorption Ratio (SAR): less than 6.0.
3. Saturation Extract concentration for Boron: less than 1.0
4. pH range of from 6.5 to 7.5 (Saturation Extract Conductivity: less than 4.0 dS/m @ 25 degrees Celsius as determined in a saturation extract.
5. Non-soil components: less than 1 percent by volume.
6. Heavy metal concentrations: below the USDA per year load limit.
7. Minimal weed seed.

    a. If regenerative noxious weeds are present in the soil, all resultant growth including roots shall be removed throughout one-year period after acceptance of work at no additional cost to Owner.

B. Topsoil Source: Reuse surface soil stockpiled on-site. Verify suitability of stockpiled surface soil to produce topsoil. Clean surface soil of roots, plants, sod, stones, clay lumps, and other extraneous materials harmful to plant growth. Ensure no contamination of the soils occurs during earthwork and grading, and that the soil remains friable and free of debris.

1. Import Topsoil: Supplement on-site topsoil with imported or manufactured topsoil from off-site sources when quantities are insufficient. Import topsoil is subject to approval and shall conform to USDA soil texture class “Loam” certification by Soil Testing Analysis, no more than 12 months prior to delivery to the site. Obtain

topsoil displaced from naturally well-drained construction or mining sites where topsoil occurs at least 4 inches deep; do not obtain from agricultural land, bogs or marshes.

a. Provide one of the following as Import Topsoil:
   1) Cedar Grove, 3-Way Topsoil, (877) 764-5748
   2) Pacific Topsoils, Inc., 3-Way Topsoil, (425) 337-2700

2.2 INORGANIC SOIL AMENDMENTS

A. Dolomitic Lime: Natural, agricultural limestone (calcium and magnesium carbonate) containing a minimum of 20 percent calcium and 11 percent magnesium and as follows:

1. Screen Analysis: 100 percent passing through No.30 sieve; 70 percent passing through No. 100 sieve; and minimum 30 percent passing through No.325 sieve.
2. Provide lime in form of granulated, prilled, dolomitic limestone, 'DoloPril' by Pacific Calcium, Inc., (877) 571-3555, or equal.

B. Calcitic Lime: Natural, agricultural limestone (calcium carbonate) containing a minimum of 36 percent calcium and as follows:

1. Screen Analysis: minimum of 100 percent passing through No. 10 sieve and a minimum of 80 percent passing through No. 100 sieve.
2. Provide lime in form of granulated, prilled, limestone, 'CalPril' by Pacific Calcium, Inc., (877) 571-3555, or equal.

C. Sulfur: Granular, biodegradable, containing a minimum of 90 percent sulfur, with a minimum of 99 percent passing through No. 6 sieve and a maximum of 10 percent passing through No. 40 sieve.

D. Iron Sulfate: Granulated ferrous sulfate containing a minimum of 20 percent iron and 10 percent sulfur.

E. Aluminum Sulfate: Commercial grade, unadulterated.

F. Gypsum: Agricultural gypsum; minimum 90 percent calcium sulfate, finely ground with 90 percent passing through No. 50 sieve.

G. Sand: Clean washed river sand, free of calcium, chlorides and other deleterious substances.

2.3 ORGANIC SOIL AMENDMENTS

A. Compost: Well-decomposed, commercially manufactured, stable, and weed-free organic matter, no food waste shall be a part of the compost. pH range of 5.5 to 7.5; 100 percent passing through 1/2-inch sieve; soluble salt content of 2.5 to 7.5 decisiemens/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and shall conform as follows:

1. Tested, at minimum, every six months for noxious weeds.

2. Organic matter source (feedstock): Agricultural, food, or industrial residuals; biosolids; yard trimmings; or source-separated or compostable mixed solid waste.
3. Organic Matter Content: 50 to 70 percent of dry weight as determined by ash method.
4. Moisture Content: 40 to 55 percent by weight
5. Free of refuse (less than 1 percent by dry weight), plastics, contaminants or any material toxic to plant growth.
6. Processed to meet U.S. Composting Council's Seal of Testing Assurance (STA) Program, or equivalent.
7. Carbon to Nitrogen Ratio: 30 to 1 or lower.
8. Composted for a minimum of 120 days and reach a monitored temperature of 140 degrees Fahrenheit for at least one week.
9. Available Products and Suppliers:

    a. Cedar Grove Composting., Compost , phone (877) 764-5748.
    b. Pacific Topsoils, Inc., Compost, phone (425) 337-2700
    c. Or approved equal.

2.4 FERTILIZER

A. Fertilizer composition and rate to be determined based upon soil analysis. For bidding purposes, assume: 10 Nitrogen (N), 10 Phosphorus (P), 10 Potassium (K), 5 Sulfur (S) applied at a rate of 10 pounds per 1000 square feet in all planting beds and seeded areas.

B. Bonemeal: Commercial, raw or steamed, finely ground; a minimum of 4 percent nitrogen and [10] [20 percent phosphoric acid.

C. Superphosphate: Commercial, phosphate mixture, soluble; a minimum of 20 percent available phosphoric acid.

D. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent of urea formaldehyde, phosphorous, and potassium in the following composition:

1. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing agency.

E. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium derived from natural organic and inorganic sources in the following composition:

1. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing agency.

2.5 MISCELLANEOUS PRODUCTS

A. Post-Emergent Herbicide: Select one of the following: “Glyphogan Plus” by Mana, “Envoy Plus” by Valent, “Crossbow” by Dow AgroSciences, “Landmaster BW” by Agri Star or approved equal.

B. Pre-Emergent Herbicide: “Ronstar-G” by Bayer, “Dimension EC,” by Dow AgroSciences or equal. Products containing either pendimethalin or DCPA are prohibited.

C. Contact Herbicide for controlling nutsedges: “SedgeHammer” by Gowan.

PART 3 - EXECUTION

3.1 EXAMINATION OF SITE CONDITIONS

A. Examine for site conditions that will adversely affect execution, permanence, quality of work, and survival of plant material and grasses.

B. Identify areas to receive planting and lawn on site.

C. Verify that subgrades and slopes of lawn and planting areas are acceptable to Owner’s Representative prior to commencing work of this Section.

D. Should the Contractor find any discrepancies between the Drawings and the physical conditions, inform the Owner’s Representative immediately for clarification.

E. Begin Work required under this Section only after conditions are satisfactory.

3.2 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities, and existing lawns and exterior plants from damage caused by soil preparation operations.

B. Prepare soils at a time when moisture conditions will permit proper cultivation.

C. Remove stones over 1-inch diameter, sticks, roots, mortar, concrete, rubbish, debris, and all materials harmful to plant life, and legally dispose of them off Owner’s property.

D. Remove or spray as required to eradicate noxious weed growth and roots.

1. Achieve complete removal or kill of all weeds within all areas receiving new plantings and lawn areas.
2. In planting beds, kill achieved by working soil is permissible for annual non-noxious broad-leaf type weeds.
3. Apply post-emergent herbicide over all areas of weed or grass growth within landscaped area to eradicate weed growth and roots. Apply in two applications at manufacturer’s maximum recommended rate, as follows:

    a. First application: Apply 7 days prior to performing soil preparation.

b. Second application (to kill new vegetation): Apply after soil preparation has been completed and minimum of 48 hours prior to planting.
c. Observe manufacturer's recommended period prior to working in treated areas.

4. Apply contact herbicide directly onto foliage of nutsedges. In areas of established lawn grasses infested with nutsedge, apply herbicide by wicking. Do not spray.

E. Locate and securely mark or flag irrigation sprinkler heads, area drains, catch basins, clean outs, manholes, valve boxes, and other site improvements not extending above finish grade.

F. Provide erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, in accordance with Division 31

3.3 SOIL PREPARATION FOR PLANTING AREAS

A. This article pertains to planting areas as shown on the Drawings where mass plantings of trees, shrubs and ground cover plants are scheduled.

B. Excavate 24 inch deep by 12 inch wide pits for percolation testing where planting areas occur in soils compacted due to construction traffic, materials staging, stockpiles exceeding 72 inch height and areas of soil surcharging. Prepare a minimum of ten (10) test pits in locations selected by the Owner's Representative representing the full range of planting areas on site.
1. Fill holes to the top with water and let stand for 1 hour minimum.
2. Refill hole to top with water and measure total depth.
3. Allow hole to drain for 2 to 3 hours and measure total depth of water.
4. If soil drains at a rate of less than 2 inches per hour prepare subgrades in accordance with procedures for poor draining soils.

C. Planting area subgrade preparation:
1. Prepare subgrades as per detail 4 on sheet L102 in the bid drawing set.
2. In areas of poor draining soils prepare subgrades by excavating and removing soil, rock and other construction material to 24 inches minimum below finish grade. Cross-rip subgrades to depth of 6 inches prior to placing topsoil. Retest percolation and modify subgrade until 2 inches per hour percolation is obtained. Adjust quantity and depth of placed topsoil as necessary to achieve finished grade as shown on plans.
3. See Division 31 Section "Earth Moving" for excavation and preparation of subgrades.

D. Planting beds and seeded areas: Place 8 inches of topsoil, compost, soil amendments, and fertilizers as recommended in Agricultural Soil Suitability Report per 1,000 square feet and rototill thoroughly to a depth of 4 inches. Compost shall constitute 5% of the amended soil. Place remainder of topsoil, compost, soil amendments, and/or fertilizers as recommended in Agricultural Soil Suitability Report per 1,000 square feet and rototill thoroughly to a depth of 8 inches, allowing for compaction, natural settlement, and depth of specified mulch.

E. Concrete Planters: Place 8 inches of topsoil, compost, soil amendments, and fertilizers as recommended in Agricultural Soil Suitability Report per 1,000 square feet and rototill thoroughly to a depth of 4 inches. Compost shall constitute 5% of the amended soil. Place the remainder 4 inches of topsoil, compost, soil amendments, and fertilizers as

recommended in Agricultural Soil Suitability Report per 1,000 square feet and rototill thoroughly to a depth of 4 inches, allowing for compaction, natural settlement, and depth of specified mulch.

1. It is the Contractor's option to set up a facility on-site for the preparation and amendment of topsoils, instead of preparing and amending the topsoils in place as indicated in the paragraph above.
2. Set up facility in location as directed by Owner's Representative.

F. Water lightly and allow planting mix to settle. Add additional material at mixture indicated in paragraph above to bring soil level to grades shown on the Drawings with allowance at pavement edges for mulch placement. Provide compaction to 80 percent maximum relative density or as indicated in Division 31 Section "Earth Moving."

G. Meet lines, grades and elevations shown, after light rolling and natural settlement. Fine grade shrub and ground cover areas to smooth even surface with loose, uniformly fine texture. Rake and drag shrub and ground cover areas to remove ridges and fill depressions to obtain firmness and finish grades preparatory to receiving planting.

H. Remove stones over 1/2-inch in any dimension and sticks, roots, rubbish and other extraneous matter.

3.4 SOIL PREPARATION FOR PLANTING PITS OF TREES

A. This article pertains to tree planting when occurring on an individual basis.

1. Backfill Mix: Prepare backfill mix and place in planting pits as specified in Division 32 Section "Plants."
2. Grade smooth to elevations shown.

3.5 SOIL PREPARATION UNDER EXISTING TREES

A. Remove vegetation not indicated to remain beneath canopy of existing trees. Take care not to disturb roots of existing trees.

B. Lightly rake areas and add amended topsoil to meet proposed grades.

3.6 FINE GRADING

A. Finish grade after full settlement including mulch, shall be 1 inch below tops of curbs, walks, or existing grades in shrub areas and 3/4 inch lower in lawn areas.

B. Slope all areas to prevent puddling and drain surface water toward catch basins, drains, curbs, or off-site as shown on Drawings.

C. Soil in all areas shall be thoroughly settled, with a smooth surface free of humps and hollows, and shall be firm enough to resist undesirable impressions when stepped upon.

D. Use levels, screens, drags, or any other equipment necessary to establish and verify grades and surfaces.

E. Finish grade lawn, grass and planting areas to smooth, even surface with loose, uniformly fine texture.

F. Notify Owner’s Representative 36 hours in advance to review fine grading of lawn, grass and planting areas. Finish grades shall be prepared to the satisfaction of the Owner's Representative prior to planting.

G. See Division 32 Section “Plants,” for mulch placement.

3.7 CLEAN-UP

A. Clean up excess materials and debris from project site upon completion of work or sooner if directed by the Owner's Representative.

B. Leave in neat and tidy condition daily.

3.8 DISPOSAL

A. Disposal: Remove surplus soil and waste material, including excess subsoil, unsuitable soil, trash, and debris, and legally dispose of them off Owner’s property.

END OF SECTION

FINAL Geotechnical Report

Lakewood Interim Library

Lakewood, Washington

April 2023

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Final Geotechnical Report
Lakewood Interim Library
Lakewood, Washington

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April 2023
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Figure

Figure 1 – Site Overview and Borehole Locations

Appendices

Appendix A – Borehole Logs
Appendix B – Laboratory Results

1. Introduction and Project Description

CRW Engineering Group, Inc. (CRW) is pleased to present this geotechnical data and design recommendations report to support the development of a new interim library located at 10202 Gravelly Lake Drive SW in Lakewood, Washington. The project includes a modular library building, a new parking lot, sidewalks, light poles, water and sewer service utilities, and landscaping. A geotechnical investigation was conducted by CRW for BuildingWork.

The scope of work included:

- Reviewing historical soil investigations within and near the project area;
- Performing a geotechnical investigation which included soil borings placed based on expected development of the site;
- Installing a piezometer for groundwater level monitoring;
- Overseeing laboratory testing of recovered soil samples including moisture content and gradation;
- Analyzing field observations and testing results; and,
- Preparing the geotechnical report to provide recommendations.

2. Site Conditions

The project is located at 10202 Gravelly Lake Drive SW in Lakewood, Washington, on the corner lot west of Gravelly Lake Drive SW and south of Alfaretta Street SW (Figure 1). The site is flat and is currently undeveloped, maintained as a mowed field with small ornamental trees at the northern edge of the lot. Concrete sidewalks border the site on the north and east boundaries. A vacant lot of similar size borders the site to the west, and a small commercial building with paved parking lots borders the site to the south. The property and the adjacent lot to the west are surrounded by a temporary chain-link fence approximately 6 feet tall. The fence separating the two lots has fallen to the ground.

Environmental reports indicate that this site was developed as a service station in the 1920s and used for this purpose until the early 2000s. All above-grade infrastructure formerly on this site has been removed and buried fuel storage tanks and piping were documented as having been removed in April 1992. Remediation of the site was achieved through removal of contaminated soil. After remediation, the site was backfilled with clean fill reported to be pea gravel and native soil. The site was restored to a level grade (Pacific Environmental, 1992).

2.1 Geology

The surficial geology in the Lakewood area was determined from the Geologic Map of the City of Tacoma, as published by M. Smith (1977) in addition to more recent digital versions of Washington geological maps available on the Washington State Department of Natural Resources website. Soils in the Lakewood area are described as part of the Vashon Drift, Pleistocene-age glacially-derived mineral soils. Sub-groups of the Vashon Drift include outwash and till deposits. Loosely-compacted recessional outwash deposits of sand and gravel are generally found above dense till deposits. Till deposits are described as a dense, poorly-sorted, and non-stratified mixture of gray to blue clay, silt, sand, gravel, and cobbles with occasional large boulders. Clasts are subangular to rounded.

Original site fill beneath formerly asphalt-paved surfaces was described as “damp clayey gravel,” while native soil described as sandy gravel and cobbles was observed to a depth of 16 feet below ground surface (BGS) (Pacific Environmental, 1992). A later investigation noted predominantly dense silty sand or silty gravel with 5 to 20 percent cobbles by volume and up to 20 percent fines to a depth of 31 feet BGS. Clean sand and poorly-graded gravel were also noted in some holes (Delta Environmental, 2001).

2.2 Historical Soils Investigations

Historical geotechnical data was not provided to CRW. Environmental investigations included boring logs describing soil conditions on some parts of the site, but with limited geotechnical information.

2.3 Contaminated Sites

The State of Washington Department of Ecology (DOE) Toxics Cleanup database was reviewed for information about the contaminated site identified at the project site. This site is listed with a status of “Cleanup Complete - No Further Action.” Cleanup Site ID (CSID) is 7082.

3. Field Investigation

A geotechnical investigation was performed on 12 and 13 January 2023 to assess existing soil conditions. The investigation drilled and sampled four boreholes (BH-01 through BH-04) located in areas indicated as being proposed parking lot or building locations, see Figure 1.

3.1 Subsurface Drilling

Holt Services, Inc. of Edgewood, Washington provided drilling services, using a truck mounted Mobile Drill B-60 rig equipped with a nominal 8-inch outer diameter (O.D.) hollow-stem auger to advance the boring. Utilities were located prior to drilling by submitting a locate request to 811.

A CRW engineer supervised the field investigation, managed field operations, and logged the recovered soil samples. Borings were advanced to various depths from 16.5 to 30.92 feet BGS (depth of the last split-spoon advanced beyond the auger). Borehole logs are presented in Appendix A.

3.2 Sample Collection

Soil samples were obtained by advancing a standard split-spoon sampler into the soil beyond the bottom of the auger. Driven samples were collected using a 2-inch O.D. split-spoon sampler via the Standard Penetration Test (SPT). The sampler was advanced 18 inches, counted in 6-inch intervals, using a 140-pound auto-hammer. The number of blows required to drive the sampler each 6-inch interval is reported on the borehole logs. The blow counts shown on the borehole logs are field values that have not been corrected for overburden, sampler size, hammer energy, rod length, or other factors.

Split-spoon samples were collected at approximately 2.5-foot to 5-foot intervals depending on observed lithology. Recovered samples were visually classified in the field before being individually sealed in double plastic bags and transported to Alaska Testlab (ATL) in Anchorage, Alaska for additional testing. Field visual classifications were verified with laboratory testing on selected samples. Soil characteristics, such as classification, consistency, moisture, and color were noted for each sample recovered. Classification was performed following the Unified Soils Classification System (USCS) according to ASTM D2487/D2488.

3.3 Borehole Completion and Monitoring Well Installation

One borehole (BH-01) was completed as a monitoring well for groundwater level monitoring. The unique well ID for this monitoring well is BPW 491. A schedule 40 2-inch nominal diameter polyvinyl chloride (PVC) pipe with threaded connections was installed over the length of the boring, with machine-slotted 0.020-inch screen from 15.5 to 30.5 feet BGS. The annular space was filled with graded 2x12 silica sand from 13 to 30.5 feet BGS. Above 13 feet BGS, hydrated bentonite chips were used to seal the annular space to a depth of 2 feet BGS. The well casing was fitted with a locking plug and finished with a steel flushmount monument installed level with the surrounding ground surface and set in concrete to a depth of 2 feet BGS. A well construction diagram will be prepared by Holt Services and submitted to the WA DOE as required.

Boreholes not completed as monitoring wells were backfilled with soil cuttings.

3.4 Groundwater Monitoring

Groundwater levels were noted during and immediately after drilling. Additional groundwater level measurements were collected after completion of drilling as summarized later in this report.

3.5 PID Field Screening

No field screening was performed. No visual or olfactory evidence of contamination was observed during the investigation.

4. Laboratory Testing and Results

Soil laboratory tests to evaluate index properties of representative samples were performed by the Alaska Testlab (ATL) in their Anchorage, Alaska facility. The laboratory testing program consisted of soil index tests to determine the water content, grain-size distribution, and limited mechanical analysis (LMA). LMA consists of washing a sample over the Number 200 mesh sieve. The coarse fraction of the remaining soil is then dried and sieved through the Number 4 sieve to determine the sand and gravel content. The LMA is a means to determine the percentage of coarse and fine soil in a sample without having to perform full gradations. The laboratory tests were performed in accordance with the test methods of ASTM International or ATL's in-house procedure as listed in Table 4-1.

Table 4-1. Laboratory Analyses and Methods

Analysis	Method	Number of Samples
Water Content	ASTM D2216	31
Grain-size Distribution	ASTM D6913 ASTM D422	4
Limited Mechanical Analysis	ASTM D1140 In-house procedure	11

Results of the laboratory testing are presented in Appendix B.

5. Investigation Findings

5.1 Soil Lithology

Soil in the upper five feet BGS were observed to be poorly or well-graded gravel with sand, except BH-01 where laboratory analysis indicated that the fines content was five percent. In BH-01, most of the lithology to 20 feet BGS is imported fill, based on what is known about the history and past use of the site, with native soils present beyond this depth. In BH-02, the upper five feet BGS is likely imported fill with native soils at depth. In BH-03 and BH-04, drilling action indicated that native soils may start at two to three feet BGS.

Native soils are poorly to well graded gravels and sands with variable fines content containing cobbles up to eight inches in diameter. In a few locations, silty sand or silty gravel were observed.

Fines content in native soils generally ranges from three to ten percent in gravelly and cobbly soils, while in siltier intervals it was measured up to 26 percent. Particle shape was generally subrounded to rounded, with some angular sand and subangular gravel.

5.2 Contaminated Soils

No evidence of petroleum-contaminated soils was observed during this investigation. No odor or sheen was observed. No field screening was performed.

5.3 Groundwater Conditions

Groundwater was observed at approximately 20 feet BGS in BH-01 and BH-02. BH-03 and BH-04 were not advanced past 16.5 feet BGS, and no groundwater was observed in these boreholes. Groundwater level readings were collected in BH-01 on 12 and 13 January 2023. Groundwater levels observed during and after drilling are presented on the borehole logs and in Table 5-1 below.

Table 5-1. Groundwater Levels

Borehole Designation	Depth to Water (feet BGS)			Piezometer	
	At Time of Drilling	Immediately After Drilling	23 Hours After Drilling	Screened Interval (feet BGS)	PVC Total Depth (feet BGS)
BH-01	20	19.7	18.8	15.5 – 30.5	30.5
BH-02	20	-	-	-	-
BH-03	Not Observed	-	-	-	-
BH-04	Not Observed	-	-	-	-

5.4 Seismic Considerations

The project site lies in a region of moderate to high seismicity and may be subjected to relatively large earthquakes and strong ground motion.

Design parameters were determined from the American Society of Civil Engineers' (ASCE) online hazards tool (https://asce7hazardtool.online/) and the United States Geological Survey (USGS) online Unified Hazard Tool (https://earthquake.usgs.gov/hazards/interactive/). Table 5-2 provides general seismic design parameters for the 2,475-year return period consistent with Section 1613 of the International Building Code (International Code Council, 2021) with any applicable State of Washington and City of Lakewood amendments and Chapter 11 of ASCE 7-16 (2016) assuming risk category II. Based on our borings, experience, and judgment, we estimate the site to be designated as Site Class D though due to

the requirements of ASCE 7 (discussed below), only the peak ground acceleration (PGA) is adjusted for site class. Other spectral acceleration values are for bedrock ground motions.

Table 5-2. Seismic Design Parameters

Description	Values
Moment Magnitude, M_w (Mean/Largest Mode)	7.4/7.1
PGA_M (adjusted for site class)	PGA_M =0.55g
MCE_R ground motion (period = 0.2s) – Bedrock motion	S_S = 1.35g
MCE_R ground motion (period = 1.0s) – Bedrock motion	S_1 = 0.471g

We note that, unless the exceptions apply, ASCE 7-16 requires either a site response analysis (SRA) or ground motion hazard analysis (GMHA) be performed to obtain the site's full design response spectrum. SRA or GMHA are beyond the scope of this geotechnical report. We recommend the structural engineer review the exceptions in ASCE 7-16 to evaluate whether the full design response spectrum is required. CRW's geotechnical engineers will aid with further efforts as the design progresses.

6. Geotechnical Engineering Recommendations

Based on our findings and results of our laboratory testing, we have developed the following recommendations based on our understanding of the project.

6.1 Frost Depth

Seasonal frost was not observed at the time of drilling. We understand the IBC with City of Lakewood local amendments specifies a design frost depth of 12 inches.

6.2 Stability Evaluation

6.2.1 Slope Instability

The site is relatively flat, therefore, by inspection, global instability is deemed of no concern.

6.2.2 Loss of Bearing Capacity

Assuming the foundations do not bear on deleterious material, an inspection of blow counts and soil type suggest that the risk of loss of bearing capacity during a seismic event is moderate. Due to the presence of unsaturated liquefiable soils (see below), we recommend a reduced seismic bearing capacity as discussed later in this report.

6.2.3 Liquefaction and Lateral Spreading

Liquefaction is the result of the buildup of excess pore water pressure, beyond hydrostatic, generated in an undrained soil loading condition induced by seismic shaking. In this condition, partial or complete loss of inter-particle friction within the soil mass occurs, resulting in dramatic decrease of the soil's shear strength (Kramer, 1996; Idriss and Boulanger, 2008).

We screened the site for potential liquefaction based on grain size distribution, depth of water, and blow counts. We noted the site was predominantly gravel which resists liquefaction and makes typical liquefaction assessments difficult. Based on inspection of the blow counts, we consider liquefaction potential across most of the site to be low to negligible.

In BH-01, we noted low blow counts in unsaturated gravels from approximately 5 to 20 feet BGS, likely due to poor compaction of the fill. While not saturated, conditions could lead to post-earthquake settlements even in unsaturated sands and gravels, therefore we performed a preliminary liquefaction analysis for dry sands following Pradel (1998). We note that Pradel's work is for sands whereas this site is predominantly gravel therefore we believe our results are conservative though we do not know by how much. The results of our preliminary analysis determined total post-earthquake settlements on the order of 1.2 inches in BH-01. Settlements from the other boreholes are expected to be near zero based on the blow counts. The exact extent of the poorly compacted existing fill is unknown. We estimate, based on historical imagery and where the extent of the previous excavation occurred, the differential settlement to be on the order of 1.2 inches over 18 feet.

Liquefaction-induced lateral deformations are termed lateral spreading. Lateral spreading was evaluated considering the method outlined by Youd et al. (2002). The procedure considers the earthquake magnitude, distance to the seismic source, thickness of the liquefiable layer, fines content, average particle size, and slope of the terrain. The average lateral spreading is estimated to be less than 0.5 inches of movement.

6.3 Shallow Foundations

6.3.1 Bearing Capacity, Settlement, and Lateral Loading

The existing conditions are conductive to shallow foundations in the form of spread or continuous footings. We presume for this report conventional footing depth will be utilized assuming the differential settlement due to seismic-induced post-liquefaction settlements can be accommodated by the structure. If the differential settlement cannot be accommodated by the structure, we recommend relocating the building, overexcavating and replacing poorly compacted existing fill around BH-01 (discussed later), or performing ground improvement (discussed later). In addition, we are aware that sometimes frost protected shallow foundations (FPSF) are considered. Recommendations for FPSF can be provided on request.

The design of shallow foundations must consider the bearing capacity of the underlying soil in addition to the potential for settlement, effects of seasonal frost, susceptibility to erosion/expansion, and loss of bearing due to seismic events. In general, designed foundations should be consistent with current standard of practice and appropriate building code(s). Table 6-1 summarizes recommended bearing capacity and settlement values for shallow foundations. We recommend shallow foundations bear directly on the native granular material, provided that the underlying soils are consistent with conditions observed in the attached borehole logs.

Table 6-1. Shallow Foundation Bearing Values

Description	Value
Allowable bearing pressure (psf)[1]	Static conditions – 3,000 Seismic conditions – 1,500
Minimum/Maximum width (feet)	2/8
Minimum exterior footing embedment below finished grade (feet) –warm footing	2.5
Minimum interior footing embedment below finished grade for warm foundations (inches)	12
Approximate total settlement (inches)[3]	1.0
Estimated differential settlement (inches)[3]	0.5

1. Includes a factor of safety 2.5
2. pcf – pounds per cubic foot, psi/in – pounds per square inch per inch, psf – pounds per square foot
3. Excludes post-liquefaction settlement

These recommendations apply to footings prepared in accordance with our recommendations, isolated from adjacent footings, not eccentrically loaded, and not on a slope. If the footings are not prepared in accordance with our recommendations or other conditions prevail, the bearing capacity values will require reduction.

6.3.2 Uplift

Uplift loads may occur in some foundation elements due to overturning moments resulting from wind and seismic forces. Uplift loads may be resisted by the weight of the footing and soil within the limits of a truncated pyramid above the top of the footing. The shape of the truncated pyramid will vary with material type and density. For the expected fill, the pyramid should be defined by a 16-degree angle α, as shown in Exhibit 6-1, measured from a vertical line extending upward and away from the top edge of the footing.

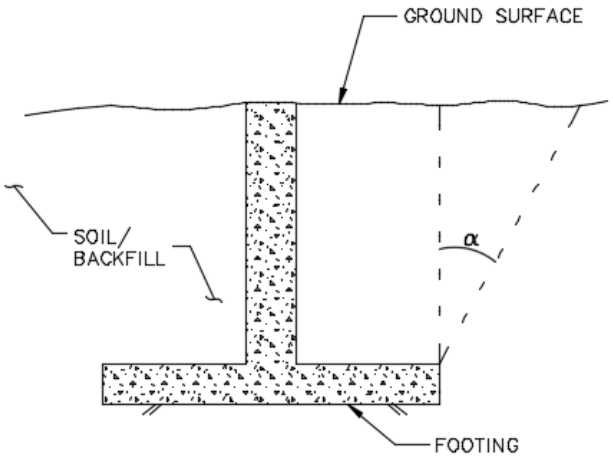

Exhibit 6-1 – Uplift Resistance

6.3.3 Slab Foundation

Slabs-on-grade may be used outside of mat foundations (if constructed). Conventional slabs may be supported on-grade, provided the subgrade soils are prepared as recommended in Section 7.3. We recommend that the slab be founded on either undisturbed native soils or on engineered fill placed over the undisturbed native soils. For any slab foundations, we recommend the use of a subgrade reaction modulus for design. The modulus of subgrade reaction is not an intrinsic property of the soil, but depends on the dimension and the stiffness of the slab. Assuming our recommendations are followed, a coefficient of subgrade reaction, K1, for a 1-foot diameter plate of 250 pounds per cubic inch (pci) can be used for design. This value can be adjusted for use as the subgrade reaction for the mat foundation per the designer's procedure.

We recommend the mat foundation be designed to tolerate a 1-foot cantilever and 2-foot internal span.

We recommend that the slab-on-grade floors be underlain by a 6-inch-thick capillary break consisting of material meeting the requirements of Mineral Aggregate Type 22 (¾-inch crushed gravel), City of Seattle Standard Specifications for Road, Bridge, and Municipal Construction (2020 Edition) 9-03.16, or approved equal.

Provided that loose soil is removed and the subgrade is prepared as recommended, we estimate that slabs-on-grade will not settle appreciably. If loose soils are not completely removed and replaced with properly compacted fill, the potential settlement may be mitigated using bi-axial geogrid beneath the building foundation. The use of geogrid will not completely eliminate the potential for movement but will minimize differential settlement. We recommend the geogrid to be installed around BH-01 to the limits of the historic excavation in that location. CRW's geotechnical will work closely with the civil and structural engineer to provide input for the limits of the geogrid. We anticipate the geogrid to be installed in the northeastern portion of the building footprint, based on the current layout, and extending no more than 8 feet beyond the outer edge of the building foundation where required.

The geogrid should be consistent with Table 3 of Section 9-33.2(1) of the Washington State Department of Transportation (WSDOT) Standard Specifications for Road, Bridge, and Municipal Construction M 41-10, 2023 Edition with similar mechanical properties to Mirafi BXG11. We recommend a minimum of two layers of geogrid with the bottom layer installed between existing subgrade and classified fill and the second layer a minimum of 1 foot above the bottom layer. The geogrid should be installed per the manufacturer's recommended procedures and practices.

An underslab drainage system to remove water from below slabs-on-grade is not considered necessary for this site.

6.4 Pavement Sections

We understand that paved parking lots handling light traffic (predominantly passenger cars and pickups) are to be constructed. The following pavement recommendations were developed based on the Federal Highway Administration's NHI-05-037, Geotechnical Aspects of Pavements (2006), the American Association of State Highway and Transportation Officials (AASHTO) Guide for Design of Pavement Structures (1993), and the City of Lakewood Engineering Standards Manual (2021). We recommend pavement structural sections presented in Tables 6-2 and 6-3 for the parking lot and sidewalk. Material specifications can be found in Section 9-03 of the WSDOT Standard Specifications (2023). Construction recommendations for fill and compaction are provided in Section 7.7 in this report.

Table 6-2. Flexible Asphalt Pavement Section (Parking Lot)

Thickness (inches)	Layer	Type/Material	Compaction (percent)
2/3*	Top/Wearing Course	Asphalt Concrete	-
2	Crushed Surfacing Base Course	Mineral Aggregate per WSDOT M 41-10 9-03.9(3)	95
18/17*	Gravel Base	Mineral Aggregate per WSDOT M 41-10 9-03.10	95

* For areas of the parking lot anticipated to be traversed during the delivery and placement of prefabricated building modules, use 3 inches of asphalt concrete and reduce the gravel base thickness by 1 inch to maintain the same total section thickness.

Table 6-3. Flexible Asphalt Pavement Section (Southern Edge of Alfaretta Street SW, Collector Arterial)

Thickness (inches)	Layer	Type/Material	Compaction (percent)
4	Top/Wearing Course	Asphalt Concrete	-
4	Crushed Surfacing Base Course	Mineral Aggregate per WSDOT M 41-10 9-03.9(3)	95
14	Gravel Base	Mineral Aggregate per WSDOT M 41-10 9-03.10	95

Table 6-4. Rigid Pavement Section (Sidewalk)

Thickness (inches)	Layer	Type/Material	Compaction (percent)
4	Top/Wearing Course	Portland Concrete	-
2	Crushed Surfacing Base Course	Mineral Aggregate per WSDOT M 41-10 9-03.9(3)	95
14	Gravel Base	Mineral Aggregate per WSDOT M 41-10 9-03.10	95

Any existing rigid or flexible pavements that are cut for the installation of utilities must be reconstructed according to the requirements in the City of Lakewood Engineering Standards Manual (2021). Subgrade soils that are disturbed, pumped, or rutted by construction activity should be removed prior to placement

of any classified fill. Equipment should not track over or result in pumping the bottom of the excavation prior to fill placement.

6.5 Utilities

No utilities are currently connected on this site. Stub-outs may exist, but the location of these is not known.

Utilities should be installed per the local utility agencies' standards and the City of Lakewood Engineering Standards Manual (2021) considering frost depth and other constraints. Inspection of utility line subgrade should follow the requirements and standards of the City of Lakewood and the local utility owner.

All utilities should be bedded and compacted per the requirements of the pipe manufacture or local utility entity. Backfill should consist of native material or classified over the bedding, as appropriate to match soils outside the utility trench. The appropriate pavement section should be incorporated into the utility trench design depending on trench location at the site. The satisfactory performance of piped utilities is highly dependent upon the quality of soil below, along the sides, and over the pipe.

6.6 Slopes

Based on our understanding of the project scope, slopes are not anticipated for the project. Recommendations can be provided during design should they be required.

6.7 Retaining Walls and Lateral Earth Pressures

We understand retaining walls are not anticipated for this project; however, we recognize many times the site development changes such that they become necessary. We have provided the following general recommendations which can be refined if retaining walls are ultimately incorporated into the site design.

Retaining walls, including those used for basements or crawl spaces, must be designed to resist lateral earth pressures plus lateral pressure due to surcharge loads applied at the ground surface behind the wall. The magnitude of the earth pressure varies depending on permissible wall movement, type of backfill used, compaction, and drainage.

We recommend a minimum of 5 feet clean, free-draining, and properly-compacted (per our recommendations) coarse-grained soil for backfill meeting the requirements stated in WSDOT M 41-10 Section 9-03.17 Foundation Material Class A, with drainage provisions to prevent the buildup of hydrostatic pressure on the wall. All retaining wall recommendations in this report assume no hydrostatic pressures exist. Alternate recommendations can be provided, should differing materials or drainage exist. Additional lateral loads due to surface loads are not included in the equivalent fluid densities below.

The active earth pressure condition for static loading should be designed to resist the lateral earth pressure exerted by a fluid (i.e. equivalent fluid pressure) with a density of 35 pcf if the retaining wall is allowed to deflect or rotate a minimum of 0.001 times the wall height.

The at-rest pressure condition will occur if the wall is restrained at the top and cannot move sufficiently to permit the active earth pressure condition to exist. Under this condition, retaining walls should be designed to resist the lateral earth pressure exerted by a fluid with a density of 55 pcf.

The passive earth pressure condition for static loading should be designed for 250 psf/foot (pcf) if the retaining wall footing is allowed to deflect or rotate a minimum of 0.01 times the wall height. This equivalent fluid pressure includes a factor of safety of 2.0. A friction coefficient of 0.40 is recommended to be used for resistance of footings to lateral sliding. The passive pressure is permissible for use in footing design.

For seismic lateral earth pressures, we recommend a fluid density of 30 pcf be added to the active earth pressure condition. If restrained, we recommend a fluid density of 30 pcf be added to the at-rest earth pressure condition. The seismic lateral earth pressures can be treated as a triangular distribution with the application of the resultant thrust occurring at 0.4 times the wall height.

We recommend any foundation stem walls be backfilled on both sides simultaneously to prevent differential lateral loading of the foundation wall.

We note equivalent fluid pressures are not applicable to sloped backfills, surcharges, hydrostatic pressures, or braced/tie-back retaining walls. CRW can provide alternate recommendations should any of these conditions or kinds of retaining structures be present or required.

7. Construction Recommendations

7.1 Site Preparation

Existing concrete, grass, trees, and landscaping should be cleared as required to construct the proposed building and pavements. All earthwork should be performed in accordance with project specifications and with local, state, and federal laws and regulations. The City of Lakewood Engineering Standards Manual (2021) has specific requirements for soil stabilization that vary depending on the time of year. Refer to this document for guidance when planning earthwork activities.

7.2 Mitigation of Subgrade Settlement

In the vicinity of BH-01, the poorly compacted existing fill is in a loose condition based on the blow counts. If the differential settlement cannot be accommodated, one option is to overexcavate and replace the material. The existing fill contained pea gravel which is not suitable for direct re-compaction without mechanically mixing or stabilizing it. We recommend the depth of overexcavation be at least 20 feet, based on BH-01, and be thoroughly inspected to remove the poorly compacted existing fill. Native soils are medium dense to dense sand and gravel and do not require excavation and replacement. Excavated existing fill should be replaced with classified fill and compacted as discussed later in this report.

If complete overexcavation is not possible, ground improvement techniques such as vibrocompaction, stone columns, or ram aggregate piers are possible options for providing a stable subgrade to support structures. A detailed discussion of each of these options is not provided here but can be provided on request. Other options like deep dynamic compaction (DDC), grouting, or jetting are considered impractical or uneconomical for this site and therefore are not considered reasonable options.

7.3 Excavations and Subgrade Preparation

All excavations for utilities should follow proper local, state, and federal requirements including those in 29 Code of Federal Regulations (CFR) Part 1926 Occupational Safety and Health Standards Subpart P – Excavations (Occupational Safety and Health Administration [OSHA], 2020). The contractor is responsible for trench stability, worker safety, and regulation compliance as their representatives will be present on a day to day basis and can adjust efforts to obtain the needed stability.

We recommend the area surrounding any excavation be prepared to direct surface water away from the excavation and to minimize surface water or runoff from entering the excavation. This may take the form of sandbags or silt fences. Excavation and backfilling operations should be closely coordinated so that seepage and surface runoff is not allowed to collect and stand in open trenches for long periods.

Excavations above the water table may stand relatively steeply initially but fail suddenly without warning. As the in situ soils dry, they will tend to ravel and slough to their natural angle of repose, which we estimate to be about 1.7H:1V (horizontal to vertical). If surface water is allowed to enter the trench, in situ soils may soften, squeeze, slump over time or due to disturbance, to slopes of 2.5 to 3H:1V or flatter.

We recommend that the excavations be performed with equipment that minimizes disturbance of the subgrade soils. We also recommend that the exposed subgrade be evaluated by a qualified geotechnical engineer or trained inspector to identify unsuitable soils. If unsuitable soils, such as soft silts, debris-laden materials, or organics are encountered, they shall be over-excavated and replaced with engineered fill. Proof-rolling with heavy, rubber-tired construction equipment should be used for this purpose during dry weather and if access for this equipment is practical. Probing should be used to evaluate the subgrade during periods of wet weather or if access is not feasible for construction equipment. The exposed soil should be firm and unyielding, and without significant groundwater. Any soils that are disturbed, pumped, or rutted by construction activity shall be re-compacted or removed prior to placement of any classified

fill. After completion of excavation activities, excavations should be cleared of debris and any structural material used for access.

7.4 Dewatering

Groundwater conditions will vary with environmental and seasonal conditions, such as the frequency and magnitude of rainfall patterns, as well as man-made influences, such as road grades, curbs, and storm sewers. We recommend the contractor evaluate groundwater levels at the time of the construction to determine groundwater impact on the construction procedures, if necessary.

In boreholes where groundwater was encountered, it was observed below approximately 19 feet BGS in both fill and naturally-deposited soils. We do not anticipate dewatering being required during any excavations planned for construction. Surface runoff or seepage after a heavy precipitation event may cause water to pond in open excavations. Sumps and pumps are considered adequate to remove water that enters the excavation, if required.

7.5 Site Grading and Drainage

Site grading, including grade of parking areas, should be established to provide drainage of surface water and roof drainage away from proposed buildings. Grading should be designed to prevent ponding of surface water except where retention ponds or similar devices are intended. If a storm drain system is installed, site drainage should be directed toward storm drain inlets.

Based on the observed groundwater levels onsite during and after drilling and also on soil types recovered in samples, it seems probable that permeability on the site is sufficiently high to readily allow infiltration of surface water and rapid dissipation of disturbances in groundwater. Typical permeability values for the lithologies encountered (Lindeburg, 2019) and estimates using Hazen's formula with native soil properties observed on this site indicate that permeability may range from 1.4 to 270 feet per day (0.7 to 135 inches per hour). Section 7.1 of the City of Lakewood Engineering Standards Manual (2021) recommends a maximum assumed infiltration rate of 60 inches per hour for gravel and coarse sand. This assumed value may be used for site developments of less than an acre in area. A percolation test should be performed in the area to be used for infiltration to determine actual infiltration rates.

7.6 Reuse of Material

The existing gravel may potentially be reused though only meets the criteria for WSDOT Select Borrow (9-03.14(2)) in its current condition based on field observations and laboratory analysis. The presence of cobbles within five feet of ground surface is strongly indicated by drilling action in BH-03 and BH-04. The grain size distributions are within the specifications for maximum fines content for WSDOT Foundation Material Class A (9-03.17), and may meet those criteria with screening, the addition of aggregate between 3/8 and 1.5 inches in diameter, and mixing.

Any excavated on-site soils should be protected from additional moisture inputs through the use of plastic tarps or other means. Cobbles were noted in existing structural fill while drilling, though none were observed to be greater than 6 inches in size. If cobbles exceeding 6 inches in any one direction are encountered during placement of reused material, they should be removed.

When reusing material, consideration should be given to the ability to excavate, sort, and store reusable materials. This effort may be less efficient and cost more than complete removal and replacement with imported materials.

7.7 Fill and Compaction

All earthworks should be performed in accordance with the project specifications and with local, state, and federal laws and regulations.

7.7.1 Classified Fill and Compaction General Requirements

All classified fill material should be thawed, free from lumps, organics, debris, and other deleterious material and should be durable and sound. A vibratory steel drum roller should be used to compact classified fill. However, lightweight or hand-operated compactors should be used near existing structures, utilities, or new foundations to avoid damage to this infrastructure.

No hauling or grading equipment should be used in lieu of appropriate compaction equipment. Any loosening of classified fill material by hauling or other equipment should be repaired and re-compacted. The number of passes required to meet the compaction requirement will depend on the size of compaction equipment used. Each layer should be compacted as recommended in the report and field verification of compaction requirements is recommended.

Subgrade soils should be protected from freezing during construction. No frozen soil should be used as fill, nor should any fill be placed over frozen soil. Any frozen soil should be removed and replaced with appropriate classified fill prior to construction.

7.7.2 Classified Fill and Compaction

Classified fill should be placed in loose lifts not exceeding 12 inches in thickness with lift thickness adjusted based on the contractor's equipment to achieve the required compaction. Each lift of classified fill should be compacted to a minimum of 95 percent of its Modified Proctor Maximum Density, determined per ASTM D1557, unless specified elsewhere in this report.

8. Limitations and Closure

The information submitted in this report is based on our interpretation of data from a field geotechnical exploration performed for this project. The conclusions contained in this report are based on site conditions as they were observed on the drilling dates indicated. It is presumed that the exploratory borings are representative of the subsurface conditions throughout the site. Effort was made to obtain information representative of existing conditions at the site. If, however, subsurface conditions are found to differ, we should be notified immediately to review these recommendations in light of additional information.

If there is substantial lapse of time between the submittal of this report and the start of work at the site, or if conditions have changed due to natural causes or construction operations at or adjacent to the site, we recommend that this report be reviewed to determine the applicability of the conclusions considering the changed conditions and time lapse. Unanticipated soil conditions are commonly encountered and cannot fully be determined by collecting discrete samples or advancing borings. The client and contractor should be aware of this risk and account for contingency accordingly.

Samples will be retained by CRW for six months following the date on which the final report is issued. Other arrangements may be made at the client's request.

This report was prepared by CRW for use on this project only, and may not be used in any manner that would constitute a detriment to CRW. CRW is not responsible for conclusions, opinions, or recommendations made by others based on data presented in this report.

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Figure

Included in this section:
1) Site Overview and Borehole Locations

Appendix A

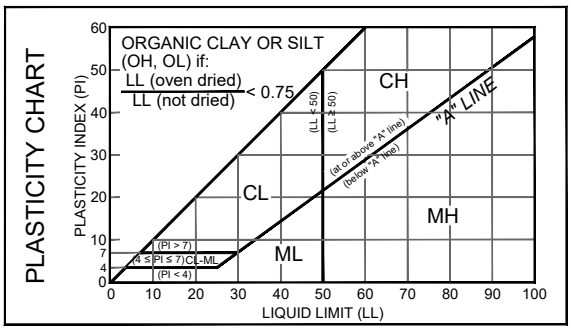
Borehole Logs

Included in this section:

1) Borehole Log Legend
2) Borehole Logs (BH-01 through BH-04)

UNIFIED SOIL CLASSIFICATION (ASTM D 2487)

GROUP SYMBOL	SOIL GROUP NAMES & LEGEND	
BLDR	COBBLES AND BOULDERS	
GW	WELL-GRADED GRAVEL	if soil contains ≥ 15% sand, add "with sand"
GP	POORLY GRADED GRAVEL	
GM	SILTY GRAVEL	
GC	CLAYEY GRAVEL	
SW	WELL-GRADED SAND	if soil contains ≥ 15% gravel, add "with gravel"
SP	POORLY GRADED SAND	
SM	SILTY SAND	
SC	CLAYEY SAND	
CL	LEAN CLAY	if soil contains coarse-grained soil from 15% to 29%, add "with sand" or "with gravel" for whichever type is prominent, or for ≥ 30%, add "sandy" or "gravelly"
ML	SILT	
OL	ORGANIC CLAY OR SILT	
GW	FAT CLAY	
MH	ELASTIC SILT	
OH	ORGANIC CLAY OR SILT	
PT	PEAT	



Gravels or sands with 5% to 12 % fines require dual symbols (GW-GM, GW-GC, GP-GM, GP-GC, SW-SM, SW-SC, SP-SM, SP-SC) and add "with clay or "with silt" to group name. If fines classify as CL-ML for GM or SM, use dual symbol GC-GM or SC-SM.

Optional Abbreviations: Lower case "s" after USCS group symbol denotes either "sandy or "with sand" and "g" denotes either "gravelly" or "with gravel."

COMPONENT DEFINITIONS BY GRADATION

COMPONENT	SIZE RANGE
BOULDERS	ABOVE 12 IN.
COBBLES	3 IN. TO 12 IN.
GRAVEL	3 IN. TO NO. 4 (4.76 mm)
COARSE GRAVEL	3 IN. TO 3/4 IN.
FINE GRAVEL	3/4 IN. TO NO. 4 (4.76 mm)
SAND	NO. 4 (4.76 mm) TO NO. 200 (0.074 mm)
COARSE SAND	NO. 4 (4.76 mm) TO NO. 10 (2.0 mm)
MEDIUM SAND	NO 10 (2.0 mm) TO NO. 40 (0.42 mm)
FINE SAND	NO. 40 (0.42 mm) TO NO. 200 (0.074 mm)
SILT AND CLAY	SMALLER THAN NO. 200 (0.074 mm)
SILT	0.074 mm TO 0.005 mm
CLAY	LESS THAN 0.005 mm

DESCRIPTIVE TERMINOLOGY FOR PERCENTAGES (ASTM D 2488)

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

RELATIVE DENSITY / CONSISTENCY ESTIMATE USING STANDARD PENETRATION TEST (SPT) VALUES (FROM TERZAGHI & PECK 1996)

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

(a) Soils consisting of gravel, sand and silt, either separately or in combination possessing no characteristics of plasticity, and exhibiting drained behavior.
(b) Soils possessing the characteristics of plasticity, and exhibiting undrained behavior.
(c) Refer to ASTM D 1586-99 for a definition of N.
(d) Undrained shear strength, s_u = 1/2 unconfined compression strength, U_c. Note that Torvane measures s_u and Pocket Penetrometer measures U_c.

SAMPLER ABBREVIATIONS

SS	SPT Sampler (2 in. OD, 140 lb hammer)	C	Core (Rock)
SSO	Oversize Spit Spoon (2.5 in. OD, 140 lb typ.)	TW	Thin Wall (Shelby Tube)
HD	Heavy Duty Split Spoon (3 in. OD, 300/340 lb typ.)	MS	Modified Shelby
BD	Bulk Drive (4 in. OD, 300/340 lb hammer typ.)	GP	Geoprobe
CA	Continuous Core (Soil in Hollow-Stem Auger)	AR	Air Rotary Cuttings
G	Grab Sample from surface / testpit	AG	Auger Cuttings

CRITERIA FOR DESCRIBING MOISTURE CONDITION (ASTM D 2488)

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

LABORATORY TEST ABBREVIATIONS

AL	Atterberg Limit	PI	Plastic Index	TS	Thaw Consolidation
Consol	Consolidation	PID	Photoionization Detector	TV	Torvane
LMA	Limited Mechanical Analysis	Proc	Proctor	TXCD	Consolidated Drained Triaxial
MA	Sieve and Hydrometer Analysis	PP	Pocket Penetrometer	TXCU	Consolidated Undrained Triaxial
MC	Moisture Content	P200	Percent Fines (Silt & Clay)	TXUU	Unconsolidated Undrained Triaxial
NP	Non-plastic	SA	Sieve Analysis	VS	Vane Shear
OLI	Organic Loss	SpG	Specific Gravity	Ω	Soil Resistivity

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LEGEND: SOIL CLASSIFICATION AND ABBREVIATIONS

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FROZEN SOIL CLASSIFICATION (ASTM D 4083)

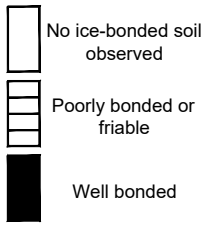
1. DESCRIBE SOIL INDEPENDENT OF FROZEN STATE	CLASSIFY SOIL BY THE UNIFIED SOIL CLASSIFICATION SYSTEM				
	MAJOR GROUP		SUBGROUP		
	DESCRIPTION	DESIGNATION	DESCRIPTION		DESIGNATION
2. MODIFY SOIL DESCRIPTION BY DESCRIPTION OF FROZEN SOIL	Segregated ice not visible by eye	N	Poorly bonded of friable		N_f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

FROST DESIGN SOIL CLASSIFICATION[1]

FROST GROUP[2]	GENERAL SOIL TYPE	% FINER THAN 0.02 mm BY WEIGHT	TYPICAL USCS SOIL CLASS
NFS[3]	(a) Gravels Crushed stone Crushed rock	0 - 1.5	GW, GP
	(b) Sands	0 - 3	SW, SP
PFS[4] [MOA NFS] [FAA NFS]	(a) Gravels Crushed stone Crushed rock	1.5 - 3	GW, GP
[MOA F-2] [FAA FG-2]	(b) Sands	3 - 10	SW, SP
S1 [MOA F-1] [FAA FG-1]	Gravelly soils	3 - 6	GW, GP, GW-GM, GP-GM, GW-GC, GP-GC
S1 [MOA F-2] [FAA FG-2]	Sandy soils	3 - 6	SW, SP, SW-SM, SP-SM, SW-SC, SP-SC
F1[5] [MOA F-1] [FAA FG-1]	Gravelly soils	6 - 10	GM, GC, GM-GC, GW-GM, GP-GM, GW-GC, GP-GC
F2[5] [MOA F-2] [FAA FG-2]	(a) Gravelly soils	10 - 20	GW, GP, GW-GM, GP-GM, GW-GC, GP-GC
	(b) Sands	6 - 15	SM, SW-SM, SP-SM, SC, SW-SC, SP-SC, SM-SC
F3[5] [MOA F-3] [FAA FG-3]	(a) Gravelly soils	Over 20	GM, GC, GM-GC
	(b) Sands, except very fine silty sands	Over 15	SM, SC, SM-SC
	(c) Clays, PI>12	--	CL, CH
F4[5] [MOA F-4] [FAA FG-4]	(a) Silts	--	ML, MH, ML-CL
	(b) Very fine silty sands	Over 15	SM, SC, SM-SC
	(c) Clays, PI≤12	--	CL, ML-CL
	(d) Varved clays or other fine-grained banded sediments	--	CL or CH layered with ML, MH, ML-CL, SM, SC, or SM-SC

(1) From the U.S. Army Corps of Engineers (USACE), EM 1110-3-138, "Pavement Criteria for Seasonal Frost Conditions", April 1984
(2) USACE frost groups directly correspond to frost groups in Municipality of Anchorage (MOA) Design Criteria Manual (DCM). Federal Aviation Administration (FAA) frost groups come from Table 2-2 in Section 2.5.4 of Advisory Circular (AC) 150/5320-6G, Airport Pavement Design and Evaluation (June, 2021).
(3) Non-frost susceptible
(4) Possibly frost susceptible, requires lab test for void ratio to determine frost design classification.
(5) Consistent with MOA Definition.

ICE BONDING SYMBOLS



DEFINITIONS

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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LEGEND: FROZEN SOIL CLASSIFICATION

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BOREHOLE BH-01

CLIENT BuildingWork
PROJECT NAME Lakewood Interim Library
PROJECT NUMBER 52501.00
PROJECT LOCATION Lakewood, Washington
DATE STARTED 01/12/23 **COMPLETED** 01/12/23
GROUND ELEVATION
DRILLING CONTRACTOR Holt Services, Inc.
GROUND WATER LEVELS:
DRILLING METHOD Hollow-Stem Auger
AT TIME OF DRILLING 20.00 ft
LOGGED BY AFS **CHECKED BY** SMH
AT END OF DRILLING 19.70 ft
NOTES
AFTER DRILLING 18.80 ft

DEPTH (ft)	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	FIELD BLOW COUNTS (N VALUE)	POCKET PEN. (psf)	ICE BOND	PID	OTHER TESTS	▲ FIELD N VALUE ▲ 10 20 30 40 / PL MC LL 10 20 30 40
0	GP-GM		POORLY GRADED GRAVEL WITH SILT AND SAND, (GP-GM) 63% gravel, 32% sand, 5% fines Gray, moist, no odor. Angular sand, fine to coarse. Subangular to angular gravel up to 2", some elongate. Likely fill.	SS S1	33	4-8-13 (21)				LMA	
5	GP-GM		POORLY GRADED GRAVEL WITH SILT AND SAND, (GP-GM) 67% gravel, 28% sand, 5% fines Gray, moist, no odor. Rounded gravel up to 0.5", subangular to rounded gravel up to 1.5" appears to have a different provenance. Likely different types of fill.	SS S2	67	2-6-7 (13)				SA	
	GP		POORLY GRADED GRAVEL WITH SAND, (GP) 78% gravel, 20% sand, 2% fines Gray, moist to wet, no odor. Fine to coarse sand. Subangular to rounded gravel up to 1.5". Likely fill.	SS S3	44	3-4-3 (7)				LMA	
			72% gravel, 26% sand, 2% fines	SS S4	33	3-5-6 (11)				LMA	
10			81% gravel, 17% sand, 2% fines	SS S5	33	4-2-2 (4)				SA	
15			Gravel up to 0.5". Likely fill, cuttings from 2.5 to 20 feet BGS and sample at this depth appear to be predominantly pea gravel.	SS S6	22	5-3-4 (7)					
20											

(Continued Next Page)

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BOREHOLE BH-01

CLIENT BuildingWork **PROJECT NAME** Lakewood Interim Library

PROJECT NUMBER 52501.00 **PROJECT LOCATION** Lakewood, Washington

DEPTH (ft)	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	FIELD BLOW COUNTS (N VALUE)	POCKET PEN. (psf)	ICE BOND	PID	OTHER TESTS	▲ FIELD N VALUE ▲ 10 20 30 40 / PL MC LL 10 20 30 40
20			POORLY GRADED GRAVEL WITH SAND, (GP) 81% gravel, 18% sand, 1% fines Brown, wet, no odor. Fine to coarse sand. Subangular to rounded gravel up to 1.5", likely larger in situ. Rounded gravel up to 3" observed in cuttings.	SS S7	50	5-14-21 (35)					
25	GP		81% gravel, 18% sand, 1% fines	SS S8	50	6-10-19 (29)				LMA	
30	SM		SILTY SAND WITH GRAVEL, (SM) 33% gravel, 41% sand, 26% fines Gray, moist to wet, no odor. Fine to coarse sand. Subrounded to rounded gravel up to 1". Likely larger gravel or cobbles based on drilling action and blow count. Fine-grained portion of the sample was soft, but overall mechanical behavior of this interval is likely controlled by the coarse granular component.	SS S9	25	25-55/2"				LMA	>>▲

Bottom of borehole at 30.7 feet.

Notes:
Completed as piezometer to 30.5 feet BGS. 2" PVC with bottom 15 feet hand slotted. Steel flushmount, unique well ID BPW-491-MW1.

CRW Engineering Group, Inc.
3940 Arctic Blvd Ste. 300
Anchorage, Alaska 99503
Telephone: 907-562-3252
Fax: 907-561-2273

BOREHOLE BH-02

CLIENT BuildingWork
PROJECT NAME Lakewood Interim Library
PROJECT NUMBER 52501.00
PROJECT LOCATION Lakewood, Washington
DATE STARTED 01/12/23 **COMPLETED** 01/12/23
GROUND ELEVATION
DRILLING CONTRACTOR Holt Services, Inc.
GROUND WATER LEVELS:
DRILLING METHOD Hollow-Stem Auger
AT TIME OF DRILLING 20.00 ft
LOGGED BY AFS **CHECKED BY** SMH
AT END OF DRILLING
NOTES
AFTER DRILLING

DEPTH (ft)	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	FIELD BLOW COUNTS (N VALUE)	POCKET PEN. (psf)	ICE BOND	PID	OTHER TESTS	▲ FIELD N VALUE ▲ 10 20 30 40 / PL MC LL 10 20 30 40
0	GW		WELL GRADED GRAVEL WITH SAND, (GW) 50% gravel, 45% sand, 5% fines Gray-brown to brown, moist, no odor. Fine to coarse sand. Subangular to rounded gravel up to 1.5". Visual classification in field.	SS S1	50	8-17-24 (41)					○ ▲
				SS S2	39	5-22-25 (47)					○ ▲
5	GW-GM		WELL GRADED GRAVEL WITH SILT AND SAND, (GW-GM) 58% gravel, 37% sand, 5% fines Brown, moist to wet, no odor. Fine to coarse sand. Subangular to rounded gravel up to 1.5", likely larger in situ. Rounded cobbles up to 8" observed in cuttings.	SS S3	50	6-18-19 (37)				SA	○ ▲
				SS S4	28	7-15-13 (28)					○ ▲
10				SS S5	50	10-11-14 (25)					○ ▲
15				SS S6	56	18-23-30 (53)					○ >>▲
20			▽								

(Continued Next Page)

CRW Engineering Group, Inc.
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Telephone: 907-562-3252
Fax: 907-561-2273

BOREHOLE BH-02

CLIENT BuildingWork **PROJECT NAME** Lakewood Interim Library

PROJECT NUMBER 52501.00 **PROJECT LOCATION** Lakewood, Washington

DEPTH (ft)	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	FIELD BLOW COUNTS (N VALUE)	POCKET PEN. (psf)	ICE BOND	PID	OTHER TESTS	▲ FIELD N VALUE ▲ 10 20 30 40 / PL MC LL 10 20 30 40
20	SP		POORLY GRADED SAND WITH GRAVEL, (SP) 48% gravel, 50% sand, 2% fines Brown, wet, no odor. Fine to coarse sand. Subangular to rounded gravel up to 1".	SS S7	39	14-11-11 (22)				LMA	
25	GP-GM		POORLY GRADED GRAVEL WITH SILT AND SAND, (GP-GM) 65% gravel, 20% sand, 15% fines Brown, wet, no odor. Rounded gravel up to 1".	SS S8A	78	15-29-39 (68)					>>
	GM		SILTY GRAVEL WITH SAND, (GM) 44% gravel, 35% sand, 21% fines Brown, moist, no odor. Rounded gravel up to 1".	SS S8B						LMA	
30	SP-SM		POORLY GRADED SAND WITH SILT AND GRAVEL, (SP-SM) 40% gravel, 50% sand, 10% fines Brown to gray, moist, no odor. Fine to coarse sand. Subrounded gravel up to 1".	SS S9	100	22-55/5"					>>

Bottom of borehole at 30.9 feet.

Notes:
Backfilled with cuttings.

CRW Engineering Group, Inc.
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Fax: 907-561-2273

BOREHOLE BH-03

CLIENT BuildingWork
PROJECT NAME Lakewood Interim Library
PROJECT NUMBER 52501.00
PROJECT LOCATION Lakewood, Washington
DATE STARTED 01/12/23 **COMPLETED** 01/12/23
GROUND ELEVATION
DRILLING CONTRACTOR Holt Services, Inc.
GROUND WATER LEVELS:
DRILLING METHOD Hollow-Stem Auger
AT TIME OF DRILLING No water observed.
LOGGED BY AFS **CHECKED BY** SMH
AT END OF DRILLING
NOTES
AFTER DRILLING

DEPTH (ft)	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	FIELD BLOW COUNTS (N VALUE)	POCKET PEN. (psf)	ICE BOND	PID	OTHER TESTS	▲ FIELD N VALUE ▲ 10 20 30 40 / PL MC LL 10 20 30 40
0	GP		POORLY GRADED GRAVEL WITH SAND, (GP) 60% gravel, 35% sand, 5% fines Brown to dark brown, moist, no odor. Fine to coarse sand. Rounded gravel up to 1.5", likely larger in situ. Visual classification in field. Rig repositioned slightly after auger deviated from vertical while penetrating a resistant layer at 2 ft BGS.	SS S1	33	6-7-9 (16)					
				SS S2	22	6-8-17 (25)					
5	SP		POORLY GRADED SAND WITH GRAVEL, (SP) 40% gravel, 56% sand, 4% fines Brown, moist, no odor. Fine to coarse sand. Subangular to rounded gravel up to 1.25", likely larger gravel and cobbles in situ based on drilling action. Auger grinding 4 to 7.5 ft BGS.	SS S3	50	10-17-25 (42)				LMA	
	GP		POORLY GRADED GRAVEL WITH SAND, (GP) 76% gravel, 21% sand, 3% fines Brown, moist, no odor. Fine to coarse sand. Subangular to rounded gravel up to 2", likely larger gravel and cobbles in situ based on drilling action.	SS S4	33	5-12-35 (47)					
10			Auger grinding 9 to 10 ft BGS.	SS S5	50	12-32-17 (49)				LMA	
15				SS S6	44	30-21-30 (51)					>>

Bottom of borehole at 16.5 feet.

Notes:
Backfilled with cuttings.

CRW Engineering Group, Inc.
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Anchorage, Alaska 99503
Telephone: 907-562-3252
Fax: 907-561-2273

BOREHOLE BH-04

CLIENT BuildingWork
PROJECT NAME Lakewood Interim Library
PROJECT NUMBER 52501.00
PROJECT LOCATION Lakewood, Washington
DATE STARTED 01/13/23 **COMPLETED** 01/13/23
GROUND ELEVATION
DRILLING CONTRACTOR Holt Services, Inc.
GROUND WATER LEVELS:
DRILLING METHOD Hollow-Stem Auger
AT TIME OF DRILLING No water observed.
LOGGED BY AFS **CHECKED BY** SMH
AT END OF DRILLING
NOTES
AFTER DRILLING

DEPTH (ft)	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	FIELD BLOW COUNTS (N VALUE)	POCKET PEN. (psf)	ICE BOND	PID	OTHER TESTS	▲ FIELD N VALUE ▲ 10 20 30 40 / PL MC LL 10 20 30 40
0			WELL GRADED GRAVEL WITH SAND, (GW) 63% gravel, 33% sand, 4% fines Dark brown, moist, no odor. Medium to coarse sand. Subrounded to rounded gravel up to 1.5", likely larger in situ. Cobbles up to 5" observed in cuttings. Rig repositioned slightly after auger deviated from vertical while penetrating a resistant layer at 3 ft BGS.	SS S1	39	7-8-7 (15)				SA	
			67% gravel, 30% sand, 3% fines	SS S2	33	4-4-5 (9)				LMA	
5	GW			SS S3	17	5-3-3 (6)					
				SS S4	60	55/5"					>>
10			POORLY GRADED GRAVEL WITH SILT AND SAND, (GP-GM) 53% gravel, 42% sand, 5% fines Brown, moist, no odor. Fine to coarse sand. Angular to rounded gravel up to 2", likely larger gravel and cobbles in situ based on drilling action. Auger grinding throughout this interval.	SS S5	28	20-19-19 (38)				LMA	
	GP-GM										
15				SS S6	28	4-8-19 (27)					

Bottom of borehole at 16.5 feet.

Notes:
Backfilled with cuttings.

Appendix B

Laboratory Results

CRW ENGINEERING GROUP

Alaska Testlab - Anchorage
4040 B Street, Suite 102
Anchorage, AK 99503
Phone: 907-205-1987
Fax: 907-782-4409
info@alaskatestlab.com

Material Test Report

Report No: ASM:23-0105
Issue No: 1

Client: CRW Engineering Group, Inc
3940 Arctic Blvd., Ste. 300
Anchorage, AK, 99503

Project Code: 230782

CC: CRW Inc
Maria Kampsen

Project: Lakewood

Anchorage, AK, 99503
52501.00

Reviewed By: Maria E Kampsen
Title: Senior Engineer
Date: 1/25/2023

Sample Details

Sample ID	23-0105-S01	23-0105-S02	23-0105-S03
Client Sample ID	BH-01 Sa1	BH-01 Sa2	BH-01 Sa3
Date Sampled			

Other Test Results

Description	Method	Results			Limits
Water Content (%)	ASTM D2216	5	4	3	
Date Tested		1/18/2023	1/18/2023	1/18/2023	
Tested By		Tammy Lozano	Tammy Lozano	Tammy Lozano	
Group Code	ASTM D2487	GP-GM	GP-GM	GP	
Group Name		Poorly graded gravel with silt and sand	Poorly graded gravel with silt and sand	Poorly graded gravel with sand	
Atterberg Limits Estimated		Yes	Yes	Yes	
Gravel (%)		63		78	
Sand (%)		32		20	
Fines (%)		5		2	
Tested By	ASTM D2487	Karen Jackson		Karen Jackson	
Method	ASTM D6913		A		
Preparation Method			Oven Dry		
Composite Sieving?			Yes		
Separating Sieve(s)			No. 4		
Cu	ASTM D2487		13.51		
Cc			3.37		

Comments

Soil Classification of Fines (-#200) in LMAs Assumed Unless Verified by Additional Testing

Alaska Testlab - Anchorage
4040 B Street, Suite 102
Anchorage, AK 99503
Phone: 907-205-1987
Fax: 907-782-4409
info@alaskatestlab.com

Material Test Report

Report No: ASM:23-0105
Issue No: 1

Client: CRW Engineering Group, Inc
3940 Arctic Blvd., Ste. 300
Anchorage, AK, 99503

Project Code: 230782

CC: CRW Inc
Maria Kampsen

Project: Lakewood

Anchorage, AK, 99503
52501.00

Reviewed By: Maria E Kampsen
Title: Senior Engineer
Date: 1/25/2023

Sample Details

Sample ID	23-0105-S04	23-0105-S05	23-0105-S06
Client Sample ID	BH-01 Sa4	BH-01 Sa5	BH-01 Sa6
Date Sampled			

Other Test Results

Description	Method	Results			Limits
Water Content (%)	ASTM D2216	4	4	4	
Date Tested		1/18/2023	1/18/2023	1/18/2023	
Tested By		Tammy Lozano	Tammy Lozano	Tammy Lozano	
Group Code	ASTM D2487	GP	GP		
Group Name		Poorly graded gravel with sand	Poorly graded gravel with sand		
Atterberg Limits Estimated		Yes	Yes		
Gravel (%)		72			
Sand (%)		26			
Fines (%)		2			
Tested By	ASTM D2487	Karen Jackson			
Method	ASTM D6913		A		
Preparation Method			Oven Dry		
Composite Sieving?			Yes		
Separating Sieve(s)			No. 4		
Cu	ASTM D2487		3.04		
Cc			1.56		

Comments

Soil Classification of Fines (-#200) in LMAs Assumed Unless Verified by Additional Testing

Alaska Testlab - Anchorage
4040 B Street, Suite 102
Anchorage, AK 99503
Phone: 907-205-1987
Fax: 907-782-4409
info@alaskatestlab.com

Material Test Report

Report No: ASM:23-0105
Issue No: 1

Client: CRW Engineering Group, Inc
3940 Arctic Blvd., Ste. 300
Anchorage, AK, 99503

Project Code: 230782

CC: CRW Inc
Maria Kampsen

Project: Lakewood

Anchorage, AK, 99503
52501.00

Reviewed By: Maria E Kampsen
Title: Senior Engineer
Date: 1/25/2023

Sample Details

Sample ID	23-0105-S07	23-0105-S08	23-0105-S09
Client Sample ID	BH-01 Sa7	BH-01 Sa8	BH-01 Sa9
Date Sampled			

Other Test Results

Description	Method	Results			Limits
Water Content (%)	ASTM D2216	12	18	10	
Date Tested		1/18/2023	1/18/2023	1/18/2023	
Tested By		Tammy Lozano	Tammy Lozano	Tammy Lozano	
Group Code	ASTM D2487		GP	SM	
Group Name			Poorly graded gravel with sand	Silty sand with gravel	
Atterberg Limits Estimated			Yes		
Liquid Limit				0	
Plasticity Index				0	
Gravel (%)			81	33	
Sand (%)			18	41	
Fines (%)			1	26	
Tested By	ASTM D2487		Karen Jackson	Karen Jackson	

Comments

Soil Classification of Fines (-#200) in LMAs Assumed Unless Verified by Additional Testing

Alaska Testlab - Anchorage
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Material Test Report

Report No: MAT:23-0105-S02
Issue No: 1

Client: CRW Engineering Group, Inc
3940 Arctic Blvd., Ste. 300
Anchorage, AK, 99503

Project Code: 230782

CC: CRW Inc
Maria Kampsen

Project: Lakewood

Anchorage, AK, 99503
52501.00

Reviewed By: Maria E Kampsen
Title: Senior Engineer
Date: 1/25/2023

Sample Details

Sample ID 23-0105-S02
Client Sample ID BH-01 Sa2

Other Test Results

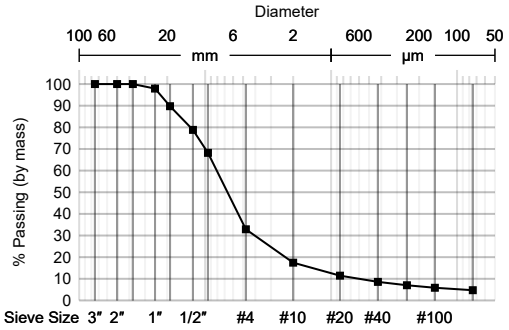
Description	Method	Result	Limits
Water Content (%)	ASTM D2216	4	
Date Tested		1/18/2023	
Tested By		Tammy Lozano	
Group Code	ASTM D2487	GP-GM	
Group Name		Poorly graded gravel with silt and sand	
Atterberg Limits Estimated		Yes	
Method	ASTM D6913	A	
Preparation Method		Oven Dry	
Composite Sieving?		Yes	
Separating Sieve(s)		No. 4	
Cu	ASTM D2487	13.51	
Cc		3.37	
Date Tested		1/20/2023	

Particle Size Distribution

Method: ASTM D6913
Drying By: Oven
Date Tested: 1/20/2023
Tested By: Karen Jackson

Sieve Size	% Passing	Limits
3in	100	
2in	100	
1½in	100	
1in	98	
¾in	90	
½in	79	
3/8in	68	
No.4	32.9	
No.10	17	
No.20	11	
No.40	9	
No.60	7	
No.100	6	
No.200	5	

Chart



Comments

Soil Classification of Fines (-#200) in Sieve Analyses Assumed Unless Verified by Additional Testing
No Plasticity Index Test Performed

Alaska Testlab - Anchorage
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Anchorage, AK 99503
Phone: 907-205-1987
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info@alaskatestlab.com

Material Test Report

Report No: MAT:23-0105-S05
Issue No: 1

Client: CRW Engineering Group, Inc
3940 Arctic Blvd., Ste. 300
Anchorage, AK, 99503

Project Code: 230782

CC: CRW Inc
Maria Kampsen

Project: Lakewood

Anchorage, AK, 99503
52501.00

Reviewed By: Maria E Kampsen
Title: Senior Engineer
Date: 1/25/2023

Sample Details

Sample ID 23-0105-S05
Client Sample ID BH-01 Sa5

Other Test Results

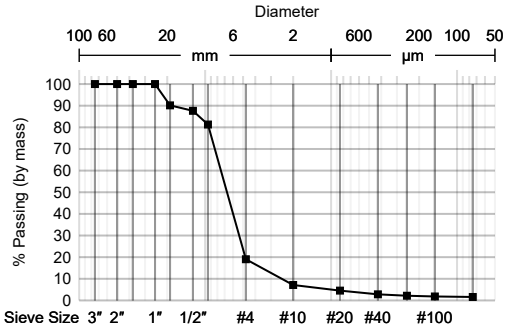
Description	Method	Result	Limits
Water Content (%)	ASTM D2216	4	
Date Tested		1/18/2023	
Tested By		Tammy Lozano	
Group Code	ASTM D2487	GP	
Group Name		Poorly graded gravel with sand	
Atterberg Limits Estimated		Yes	
Method	ASTM D6913	A	
Preparation Method		Oven Dry	
Composite Sieving?		Yes	
Separating Sieve(s)		No. 4	
Cu	ASTM D2487	3.04	
Cc		1.56	
Date Tested		1/20/2023	

Particle Size Distribution

Method: ASTM D6913
Drying By: Oven
Date Tested: 1/20/2023
Tested By: Karen Jackson

Sieve Size	% Passing	Limits
3in	100	
2in	100	
1½in	100	
1in	100	
¾in	90	
½in	88	
3/8in	81	
No.4	19.0	
No.10	7	
No.20	5	
No.40	3	
No.60	2	
No.100	2	
No.200	2	

Chart



Comments

Soil Classification of Fines (-#200) in Sieve Analyses Assumed Unless Verified by Additional Testing
No Plasticity Index Test Performed

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Material Test Report

Report No: ASM:23-0106
Issue No: 1

Client: CRW Engineering Group, Inc
3940 Arctic Blvd., Ste. 300
Anchorage, AK, 99503

Project Code: 230782

CC: CRW Inc
Maria Kampsen

Project: Lakewood

Anchorage, AK, 99503
52501.00

Reviewed By: Maria E Kampsen
Title: Senior Engineer
Date: 1/25/2023

Sample Details

Sample ID	23-0106-S01	23-0106-S02	23-0106-S03	23-0106-S04
Client Sample ID	BH-02 Sa1	BH-02 Sa2	BH-02 Sa3	BH-02 Sa4
Date Sampled				

Other Test Results

Description	Method	Results				Limits
Water Content (%)	ASTM D2216	6	6	6	6	
Date Tested		1/18/2023	1/18/2023	1/18/2023	1/18/2023	
Tested By		Tammy Lozano	Tammy Lozano	Tammy Lozano	Tammy Lozano	
Group Code	ASTM D2487			GW-GM		
Group Name				Well-graded gravel with silt and sand		
Atterberg Limits Estimated				Yes		
Method	ASTM D6913			A		
Preparation Method				Oven Dry		
Composite Sieving?				Yes		
Separating Sieve(s)				No. 4		
Cu	ASTM D2487			33.58		
Cc				1.26		

Comments

Soil Classification of Fines (-#200) in LMAs Assumed Unless Verified by Additional Testing

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Material Test Report

Report No: ASM:23-0106
Issue No: 1

Client: CRW Engineering Group, Inc
3940 Arctic Blvd., Ste. 300
Anchorage, AK, 99503

Project Code: 230782

CC: CRW Inc
Maria Kampsen

Project: Lakewood

Anchorage, AK, 99503
52501.00

Reviewed By: Maria E Kampsen
Title: Senior Engineer
Date: 1/25/2023

Sample Details

Sample ID	23-0106-S05	23-0106-S06	23-0106-S07	23-0106-S08
Client Sample ID	BH-02 Sa5	BH-02 Sa6	BH-02 Sa7	BH-02 Sa8A
Date Sampled				

Other Test Results

Description	Method	Results				Limits
Water Content (%)	ASTM D2216	6	8	11	15	
Date Tested		1/18/2023	1/18/2023	1/18/2023	1/18/2023	
Tested By		Tammy Lozano	Tammy Lozano	Tammy Lozano	Tammy Lozano	
Group Code	ASTM D2487			SP		
Group Name				Poorly graded sand with gravel		
Atterberg Limits Estimated				Yes		
Gravel (%)				48		
Sand (%)				50		
Fines (%)				2		
Tested By	ASTM D2487			Karen Jackson		

Comments

Soil Classification of Fines (-#200) in LMAs Assumed Unless Verified by Additional Testing

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info@alaskatestlab.com

Material Test Report

Report No: ASM:23-0106
Issue No: 1

Client: CRW Engineering Group, Inc
3940 Arctic Blvd., Ste. 300
Anchorage, AK, 99503

Project Code: 230782

CC: CRW Inc
Maria Kampsen

Project: Lakewood

Anchorage, AK, 99503
52501.00

Reviewed By: Maria E Kampsen
Title: Senior Engineer
Date: 1/25/2023

Sample Details

Sample ID	23-0106-S09	23-0106-S10
Client Sample ID	BH-02 Sa8B	BH-02 Sa9
Date Sampled		

Other Test Results

Description	Method	Results		Limits
Water Content (%)	ASTM D2216	8	7	
Date Tested		1/18/2023	1/18/2023	
Tested By		Tammy Lozano	Tammy Lozano	
Group Code	ASTM D2487	GM		
Group Name		Silty gravel with sand		
Liquid Limit		0		
Plasticity Index		0		
Gravel (%)		44		
Sand (%)		35		
Fines (%)		21		
Tested By	ASTM D2487	Karen Jackson		

Comments

Soil Classification of Fines (-#200) in LMAs Assumed Unless Verified by Additional Testing

Alaska Testlab - Anchorage
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Anchorage, AK 99503
Phone: 907-205-1987
Fax: 907-782-4409
info@alaskatestlab.com

Material Test Report

Report No: MAT:23-0106-S03
Issue No: 1

Client: CRW Engineering Group, Inc
3940 Arctic Blvd., Ste. 300
Anchorage, AK, 99503

Project Code: 230782

CC: CRW Inc
Maria Kampsen

Project: Lakewood

Anchorage, AK, 99503
52501.00

Reviewed By: Maria E Kampsen
Title: Senior Engineer
Date: 1/25/2023

Sample Details

Sample ID 23-0106-S03
Client Sample ID BH-02 Sa3

Other Test Results

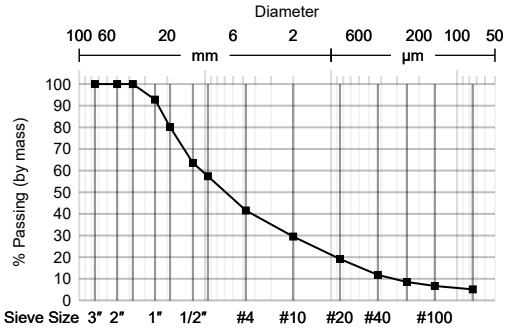
Description	Method	Result	Limits
Water Content (%)	ASTM D2216	6	
Date Tested		1/18/2023	
Tested By		Tammy Lozano	
Group Code	ASTM D2487	GW-GM	
Group Name		Well-graded gravel with silt and sand	
Atterberg Limits Estimated		Yes	
Method	ASTM D6913	A	
Preparation Method		Oven Dry	
Composite Sieving?		Yes	
Separating Sieve(s)		No. 4	
Cu	ASTM D2487	33.58	
Cc		1.26	
Date Tested		1/20/2023	

Particle Size Distribution

Method: ASTM D6913
Drying By: Oven
Date Tested: 1/20/2023
Tested By: Karen Jackson

Sieve Size	% Passing	Limits
3in	100	
2in	100	
1½in	100	
1in	93	
¾in	80	
½in	64	
3/8in	57	
No.4	41.6	
No.10	30	
No.20	19	
No.40	12	
No.60	9	
No.100	7	
No.200	5	

Chart



Comments

Soil Classification of Fines (-#200) in Sieve Analyses Assumed Unless Verified by Additional Testing
No Plasticity Index Test Performed

Alaska Testlab - Anchorage
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info@alaskatestlab.com

Material Test Report

Report No: ASM:23-0107
Issue No: 1

Client: CRW Engineering Group, Inc
3940 Arctic Blvd., Ste. 300
Anchorage, AK, 99503

Project Code: 230782

CC: CRW Inc
Maria Kampsen

Project: Lakewood

Anchorage, AK, 99503
52501.00

Reviewed By: Maria E Kampsen
Title: Senior Engineer
Date: 1/25/2023

Sample Details

Sample ID	23-0107-S01	23-0107-S02	23-0107-S03
Client Sample ID	BH-03 Sa1	BH-03 Sa2	BH-03 Sa3
Date Sampled			

Other Test Results

Description	Method	Results			Limits
Water Content (%)	ASTM D2216	7	8	6	
Date Tested		1/18/2023	1/18/2023	1/18/2023	
Tested By		Tammy Lozano	Tammy Lozano	Tammy Lozano	
Group Code	ASTM D2487			SP	
Group Name				Poorly graded sand with gravel	
Atterberg Limits Estimated				Yes	
Gravel (%)				40	
Sand (%)				56	
Fines (%)				4	
Tested By	ASTM D2487			Karen Jackson	

Comments

Soil Classification of Fines (-#200) in LMAs Assumed Unless Verified by Additional Testing

Alaska Testlab - Anchorage
4040 B Street, Suite 102
Anchorage, AK 99503
Phone: 907-205-1987
Fax: 907-782-4409
info@alaskatestlab.com

Material Test Report

Report No: ASM:23-0107
Issue No: 1

Client: CRW Engineering Group, Inc
3940 Arctic Blvd., Ste. 300
Anchorage, AK, 99503

Project Code: 230782

CC: CRW Inc
Maria Kampsen

Project: Lakewood

Anchorage, AK, 99503
52501.00

Reviewed By: Maria E Kampsen
Title: Senior Engineer
Date: 1/25/2023

Sample Details

Sample ID	23-0107-S04	23-0107-S05	23-0107-S06
Client Sample ID	BH-03 Sa4	BH-03 Sa5	BH-03 Sa6
Date Sampled			

Other Test Results

Description	Method	Results			Limits
Water Content (%)	ASTM D2216	7	6	8	
Date Tested		1/18/2023	1/18/2023	1/18/2023	
Tested By		Tammy Lozano	Tammy Lozano	Tammy Lozano	
Group Code	ASTM D2487		GP		
Group Name			Poorly graded gravel with sand		
Atterberg Limits Estimated			Yes		
Gravel (%)			76		
Sand (%)			21		
Fines (%)			3		
Tested By	ASTM D2487		Karen Jackson		

Comments

Soil Classification of Fines (-#200) in LMAs Assumed Unless Verified by Additional Testing

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Material Test Report

Report No: ASM:23-0108
Issue No: 1

Client: CRW Engineering Group, Inc
3940 Arctic Blvd., Ste. 300
Anchorage, AK, 99503

Project Code: 230782

CC: CRW Inc
Maria Kampsen

Project: Lakewood

Anchorage, AK, 99503
52501.00

Reviewed By: Maria E Kampsen
Title: Senior Engineer
Date: 1/25/2023

Sample Details

Sample ID	23-0108-S01	23-0108-S02	23-0108-S03
Client Sample ID	BH-04 Sa1	BH-04 Sa2	BH-04 Sa3
Date Sampled			

Other Test Results

Description	Method	Results			Limits
Water Content (%)	ASTM D2216	10	10	7	
Date Tested		1/18/2023	1/18/2023	1/18/2023	
Tested By		Tammy Lozano	Tammy Lozano	Tammy Lozano	
Group Code	ASTM D2487	GW	GP		
Group Name		Well-graded gravel with sand	Poorly graded gravel with sand		
Atterberg Limits Estimated		Yes	Yes		
Gravel (%)			67		
Sand (%)			30		
Fines (%)			3		
Tested By	ASTM D2487		Karen Jackson		
Method	ASTM D6913	A			
Preparation Method		Oven Dry			
Composite Sieving?		Yes			
Separating Sieve(s)		No. 4			
Cu	ASTM D2487	31.16			
Cc		1.07			

Comments

Soil Classification of Fines (-#200) in LMAs Assumed Unless Verified by Additional Testing

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Anchorage, AK 99503
Phone: 907-205-1987
Fax: 907-782-4409
info@alaskatestlab.com

Material Test Report

Report No: ASM:23-0108
Issue No: 1

Client: CRW Engineering Group, Inc
3940 Arctic Blvd., Ste. 300
Anchorage, AK, 99503

Project Code: 230782

CC: CRW Inc
Maria Kampsen

Project: Lakewood

Anchorage, AK, 99503
52501.00

Reviewed By: Maria E Kampsen
Title: Senior Engineer
Date: 1/25/2023

Sample Details

Sample ID	23-0108-S04	23-0108-S05	23-0108-S06
Client Sample ID	BH-04 Sa4	BH-04 Sa5	BH-04 Sa6
Date Sampled			

Other Test Results

Description	Method	Results			Limits
Water Content (%)	ASTM D2216	8	6	7	
Date Tested		1/18/2023	1/18/2023	1/18/2023	
Tested By		Tammy Lozano	Tammy Lozano	Tammy Lozano	
Group Code	ASTM D2487		GP-GM		
Group Name			Poorly graded gravel with silt and sand		
Atterberg Limits Estimated			Yes		
Gravel (%)			53		
Sand (%)			42		
Fines (%)			5		
Tested By	ASTM D2487		Karen Jackson		

Comments

Soil Classification of Fines (-#200) in LMAs Assumed Unless Verified by Additional Testing

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Anchorage, AK 99503
Phone: 907-205-1987
Fax: 907-782-4409
info@alaskatestlab.com

Material Test Report

Report No: MAT:23-0108-S01
Issue No: 1

Client: CRW Engineering Group, Inc
3940 Arctic Blvd., Ste. 300
Anchorage, AK, 99503

Project Code: 230782

CC: CRW Inc
Maria Kampsen

Project: Lakewood

Anchorage, AK, 99503
52501.00

Reviewed By: Maria E Kampsen
Title: Senior Engineer
Date: 1/25/2023

Sample Details

Sample ID 23-0108-S01
Client Sample ID BH-04 Sa1

Other Test Results

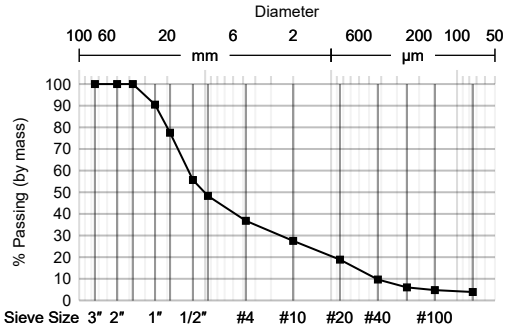
Description	Method	Result	Limits
Water Content (%)	ASTM D2216	10	
Date Tested		1/18/2023	
Tested By		Tammy Lozano	
Group Code	ASTM D2487	GW	
Group Name		Well-graded gravel with sand	
Atterberg Limits Estimated		Yes	
Method	ASTM D6913	A	
Preparation Method		Oven Dry	
Composite Sieving?		Yes	
Separating Sieve(s)		No. 4	
Cu	ASTM D2487	31.16	
Cc		1.07	
Date Tested		1/20/2023	

Particle Size Distribution

Method: ASTM D6913
Drying By: Oven
Date Tested: 1/20/2023
Tested By: Karen Jackson

Sieve Size	% Passing	Limits
3in	100	
2in	100	
1½in	100	
1in	90	
¾in	78	
½in	56	
3/8in	48	
No.4	36.8	
No.10	28	
No.20	19	
No.40	10	
No.60	6	
No.100	5	
No.200	4	

Chart



Comments

Soil Classification of Fines (-#200) in Sieve Analyses Assumed Unless Verified by Additional Testing
No Plasticity Index Test Performed